DL350
ScopeCorder
USER'S MANUAL

Features Guide

YOKOGAWA
Yokogawa Test & Measurement Corporation

IM DL350-01EN
6th Edition

Thank you for purchasing the DL350 ScopeCorder.
This manual contains useful information about the features of the DL350. To ensure correct use, please read this manual thoroughly before operation.
After reading this manual, keep it in a safe place.

List of Manuals

The following manuals, including this one, are provided as manuals for the DL350. Please read all manuals.

Manuals Included with the Product

Manual Title	Manual No.	Description
DL350 ScopeCorder Getting Started Guide	IM DL350-03EN	This guide explains the handling precautions, common operations, troubleshooting measures, and specifications of this instrument.
DL350 ScopeCorder Request to Download Manuals	IM DL350-73Z2	Describes the manuals provided on the website.
Precautions Concerning the Modules	IM 701250-04E	The manual explains the precautions concerning the modules. This manual is included if you ordered modules.
Battery Pack Handling Precautions	IM 739883-01EN	This manual is included in models with the /EB option (battery pack + battery pack cover). It explains the handling precautions of the battery pack.
DL350 ScopeCorder	IM DL350-92Z1	Document for China.
739883 Battery Pack	IM 739883-92Z1	Document for China. This manual is included in models with the /EB option (battery pack + battery pack cover).
720923 Battery Pack Cover	IM 720923-92Z1	Document for China. This manual is included in models with the /EB option (battery pack + battery pack cover).
Safety Instruction Manual	IM 00C01C01-01Z1	Safety manual (European languages)

Manuals Provided on the Website

Download the following manuals from the YOKOGAWA website.

Manual Title	Manual No.	Description
DL350 ScopeCorder Features Guide	IM DL350-01EN	This manual. This manual explains all the instrument's features other than the communication interface features.
DL350 ScopeCorder User's Manual	IM DL350-02EN	The manual explains how to operate this instrument.
DL350 ScopeCorder Communication Interface User's Manual	IM DL350-17EN	The manual explains the functions of this instrument's communication interface, how to configure it, and the commands used to control this instrument from a PC through the interface.

For details on downloading manuals, see Request to Download Manuals (IM DL350-73Z2). To view the PDF data, you need Adobe Acrobat Reader or a software application that can open PDF data.

The "EN", "E", "Z1", and "Z2" in the manual numbers are the language codes.

Contact information of Yokogawa offices worldwide is provided on the following sheet.

Document No.	Description
PIM 113-01Z2	List of worldwide contacts

6th Edition: April 2024 (YMI)

Notes

- The contents of this manual are subject to change without prior notice as a result of improvements to the product's performance and functionality. Refer to our website to view our latest manuals.
- The figures given in this manual may differ from those that actually appear on your screen.
- Every effort has been made in the preparation of this manual to ensure the accuracy of its contents. However, should you have any questions or find any errors, please contact your nearest YOKOGAWA dealer.
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1 Main Features

Scope Mode and Recorder Mode

This instrument can be used in the following two system modes.

Scope Mode

Scope mode is used to set the time axis using Time/Div and record length. This is the typical time scale setting method for oscilloscopes.

Recorder Mode

Recorder mode is use to set the time axis using the measurement time and sampling interval. This is the typical time scale setting method for recorders.

Vertical Axis

This section explains how to configure the signal input settings and the amplitude-direction display settings. The items that can be set vary depending on the installed modules. A menu for the channel that you select (CH1 to CH6) appears. You can set the various vertical control settings for each channel. Select All CH Setup to display a screen in which you can configure the settings of all channels while viewing the settings in a list.

Measurement Items

When you install the following modules into this instrument, it can measure voltage, temperature, strain, acceleration, frequency, logic, CAN bus signals, CAN FD bus signals, LIN bus signals, SENT signals, and so on.

Voltage

720211 (HS100M12), 720250 (HS10M12), 720254 (4CH 1M16), 720268 (HV (with AAF, RMS)), 701261 (UNIVERSAL), 701262 (UNIVERSAL (AAF)), 701265 (TEMP/HPV), 720266 (TEMP/HPV), 701275 (ACCL/VOLT)

Voltage (For the 16-CH Voltage Input Module)

720220 (16CH VOLT)

Temperature

701261 (UNIVERSAL), 701262 (UNIVERSAL (AAF)), 701265 (TEMP/HPV), 720266 (TEMP/HPV),

Temperature Measurement (For the 16-CH Temperature/Voltage Input Module)

720221 (16CH TEMP/VOLT)

Strain

701270 (STRAIN_NDIS), 701271 (STRAIN_DSUB)

Acceleration

701275 (ACCL/VOLT)

Frequency

720281 (FREQ)

Logic

720230 (LOGIC)

CAN Bus Signal Monitoring

720240 (CAN MONITOR), 720242(CAN/CAN FD), 720245(CAN FD/LIN), 720241 (CAN & LIN)
These modules can be used only with models with the /VE option.

CAN FD Bus Signal Monitoring

720242(CAN/CAN FD), 720245(CAN FD/LIN)
These modules can be used only with models with the /VE option.

LIN Bus Signal Monitoring

720245(CAN FD/LIN), 720241 (CAN & LIN)
These modules can be used only with models with the /VE option.

SENT signal monitoring

720243 (SENT)
These modules can be used only with models with the /VE option.

Vertical Scale

The vertical scale is used to adjust the displayed waveform amplitude so that you can easily view signals. Set the vertical scale for each channel.

- In scope mode, set the time per grid division (1 div) displayed on the screen.
- In recorder mode, the measurement range spans from the negative side to the positive side with 0 at the center. Set the value on the positive side of this range.

Input Coupling

You can change the input coupling setting to match the signal that you are measuring. By changing the setting, you can choose how the vertical (voltage) control circuit is coupled to the input signal. The following types of input coupling are available: DC, AC, GND, TC, DC-RMS, AC-RMS, ACCEL, and OFF.* Set the appropriate input coupling for each input module.

* If you do not want to measure the selected sub channels on a 16-CH voltage input module or a 16-CH temperature/voltage input module, set them to OFF.

Vertical Zoom

You can zoom the waveform vertically. You can zoom the waveform by setting the vertical magnification or by setting upper and lower display limits.

Vertical Position

Because the instrument can display many waveforms, the waveforms may overlap and be difficult to view. If this happens, you can adjust the vertical display position to make waveforms easier to view (vertical position).
Set the vertical position for each channel.

Linear Scaling

Linear scaling is a function that converts measured values into physical values and reads them directly. There two types of linear scaling:

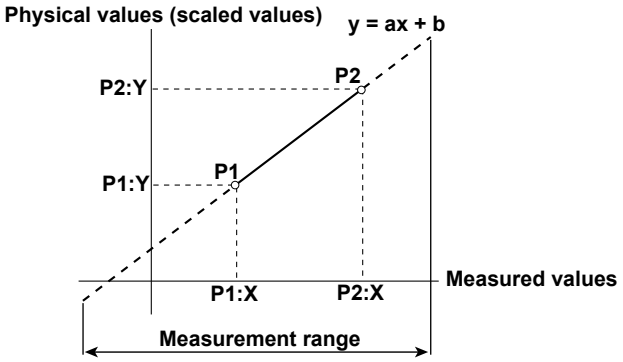
AX+B

Using scaling coefficient A and offset B, the instrument scales values according to the equation below.

Y = AX + B (where X is the measured value and Y is the physical value)

P1-P2

The instrument determines the scale conversion equation (y = ax + b) using four values that you specify: two measured values (P1:X, P2:X) and the value that each one should be converted to (P1:Y, P2:Y).



Waveform Acquisition

Based on the data that has been stored in the acquisition memory, the instrument performs various operations, such as displaying waveforms on the screen, computing, measuring cursors, and automatically measuring waveform parameters.
You can set the number of data points to store in the acquisition memory (the record length), enable or disable the sample data averaging feature, and so on.

Horizontal Axis (Time Axis)

Scope Mode

Set the time axis using Time/Div and record length.

- **Time Scale (Time/Div)**
  Normally, under the initial settings, the time scale is set as a length of time per grid division (1 div). Because the horizontal display range is 10 div, the amount of time on the waveform that is displayed is equal to the time scale × 10.

- **Record Length**
  Record length refers to the number of data points that are stored to the acquisition memory for each channel. *Display record* length refers to the data points from the data stored in the acquisition memory that are displayed on the screen. Normally, the acquisition-memory record length and display record length are the same, but the time scale may cause them to differ. When you change the time scale, the sample rate and record length also change.

- **Relationship between the Time Scale, Record Length, and Sample Rate**
  When you change the time scale, the sample rate and record length also change. For details, see appendix 1 in the *Getting Started Guide*, IM DL350-03EN.

Recorder Mode

Set the time axis using the measurement time and sampling interval.

- **Record Time (Record Time)**
  Record time is the length of time data is recorded. The time range for displaying data is set separately from the record time using display range (Time Range).

- **Sample Interval**
  Sample interval is the time interval that data is acquired into the acquisition memory. The sample interval setting range varies depending on the record time.

Trigger Mode

This is a setting in scope mode.
The trigger mode determines the conditions for updating the displayed waveforms. There are four trigger modes: auto, normal, single, and on-start. The trigger mode setting applies to all trigger types.

Acquisition Mode

Specify how the instrument processes the sampled data, stores it in the acquisition memory, and uses it to display waveforms. There are three acquisition modes: normal, envelope, and averaging.

SD Recording

Data can be recorded into an SD memory card connected to the instrument simultaneously with the start of measurement. The recorded data is saved to files automatically.

Triggers

Triggers are events used to display waveforms. A trigger occurs when the specified trigger condition is met, and a waveform is displayed on the screen.

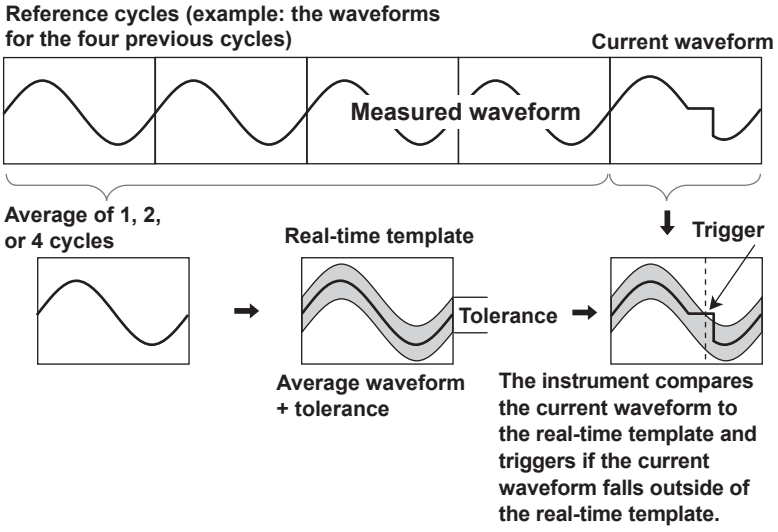
Trigger Types

Scope Mode

There are two trigger types: simple and enhanced.

- **Simple Triggers**
  - The instrument triggers when the input signal (CH1 to CH7, External) set as the trigger source passes through the specified trigger level in the specified way (rising edge, falling edge, or rising or falling edge).
  - The instrument triggers at specified time intervals starting from the specified date and time.

- **Enhanced Triggers**
  - **Edge On A Trigger**
    While state condition A is met, the instrument triggers on the OR of multiple trigger source edges.
  - **OR Trigger**
    The instrument triggers on the OR of multiple trigger source edges.
  - **AND Trigger**
    The instrument triggers on the AND of multiple trigger source conditions. The instrument triggers when all the specified conditions are met at a single point.
  - **Period Trigger**
    The instrument triggers on a specified period of occurrence of state condition B. The instrument triggers when state condition B occurs again.
  - **Pulse Width Trigger**
    The instrument triggers according to the relationship between the state condition B achievement time and the specified reference times (Time or T1 and T2).
  - **Wave Window Trigger**
    The instrument creates real-time templates (Wave Window) using a number of cycles directly preceding the current waveforms. The instrument compares the current waveforms to the real-time templates and triggers if one of the current waveforms falls outside of its real-time template.



Recorder Mode

- **Edge Trigger**
  The instrument triggers when the trigger source input signal passes through the specified trigger level in the specified way (rising edge, falling edge, or rising or falling edge).
- **Time Trigger**
  The instrument triggers at the specified date and time.
- **OR Trigger**
  The instrument triggers on the OR of multiple trigger source edges.
- **AND Trigger**
  The instrument triggers on the AND of multiple trigger source conditions. The instrument triggers when all the specified conditions are met at a single point.

Trigger Source

Trigger source refers to the signal used to determine whether the specified trigger conditions are met. You can set the trigger source to an analog signal, logic signal, external signal, or time. Select the appropriate trigger source for the trigger type.

Trigger Level

Trigger level refers to the signal level used as a reference for detecting a signal's rising and falling edges or high and low states. With simple triggers such as the edge trigger, the instrument triggers when the trigger source level passes through the specified trigger level. The range and resolutions that you can use to set the trigger level vary depending on the type of signal being measured.

Waveform Display

The instrument displays measured time-domain waveforms. You can switch the waveform display using display groups. You can also divide the screen.

Snapshot

You can continue displaying a waveform on the screen as a snapshot waveform after the screen has been updated and the waveform has been cleared in update mode or after the waveform has left the screen in roll mode. Snapshot waveforms appear in white. You can compare them with new waveforms. You can also save and print snapshot waveforms as screen captures.

Cursor Measurement

There are cursors for T-Y (time-axis), X-Y, and FFT waveforms. You can position a cursor over a waveform to view the various measured values at the intersection of the cursor and the waveform.

Automated Measurement of Waveform Parameters

You can use this feature to automatically measure waveform levels, maximum values, frequencies, and other values. You can measure waveform parameters that relate to the voltage axis, time axis, and waveform area. Further, you can display the following statistics for the specified waveform parameter.

The maximum value (Maximum), minimum value (Minimum), average value (Average), standard deviation (SDev), and number of measured values used to calculate statistics (Count)

There are three statistical processing methods:

- **Continuous statistical processing**
  While acquiring waveforms, the instrument measures the measurement items and calculates the statistics of the waveforms that it has acquired so far.
- **Cyclic statistical processing (measurement and statistical processing are performed for each period)**
  The instrument divides the waveform into periods starting at the left side of the screen (the oldest waveform) and moving to the right side of the screen, measures the selected measurement items within each period, and performs statistical processing on the measurement items.
- **Statistical processing of history waveforms**
  The instrument measures the measurement items and calculates the statistics of history waveforms. Measurement and statistical processing begin with the oldest waveform.

Waveform Analysis

Waveform Computation

Arithmetic, binarization, phase shifting (display the waveform with its phase shifted), frequency, period, moving average (2, 4, 8, or 10 points), and RMS can be computed.

FFT

The power spectrum of the input waveform can be displayed in the FFT window. Up to two FFT waveforms can be displayed.

X-Y Waveform

You can observe the correlation between two waveform signal levels by displaying one signal level on the X-axis (horizontal axis) and a second signal level on the Y-axis (vertical axis). Because multiple X-Y waveforms can be displayed, it is easy to compare the relationships between phases. You can use this feature to evaluate DC motors using Lissajous waveforms.

Harmonic Analysis

You can analyze the 1st to the 40th harmonics of rms values (voltage, current) and active power.

GO/NO-GO Determination (Scope mode only)

This feature is useful for signal testing on production lines and for tracking down abnormal phenomena. The instrument determines whether the waveform enters the specified range. When the instrument returns a GO (or NO-GO) result, specified actions are performed.
The instrument returns GO/NO-GO results based on whether waveforms leave or enter the zone that you create using a base waveform.

Waveform Zoom (Scope mode only)

You can magnify displayed waveforms along the time axis. In scope mode, the zoomed waveforms of two locations can be displayed simultaneously (the dual zoom feature). This feature is useful when you set a long acquisition time and want to observe a portion of the waveform closely.

Waveform Display Position and Zoom (Recorder mode only)

You can magnify displayed waveforms along the time axis. In recorder mode, the zoomed waveform of one locations can be displayed.

Searching Waveforms

You can search the displayed waveforms for locations that match the specified conditions. You can zoom-in on the detected locations.

History Waveform Display (Scope mode only)

Acquisition memory stores waveforms that are displayed on the screen and waveform data that have been acquired in the past. The history feature allows you to any single waveform or display all waveforms (and highlight only the specified waveform).
You can also list the timestamps (the times at the time references) of all history waveforms.

Position Information (GPS)

If you connect a GPS unit, an accessory sold separately, position information based on GPS (Global Positioning System) can be obtained.

Notes about Using the 16-CH Voltage Input Module (720220), Notes about Using the 16-CH Temperature/Voltage Input Module (720221)

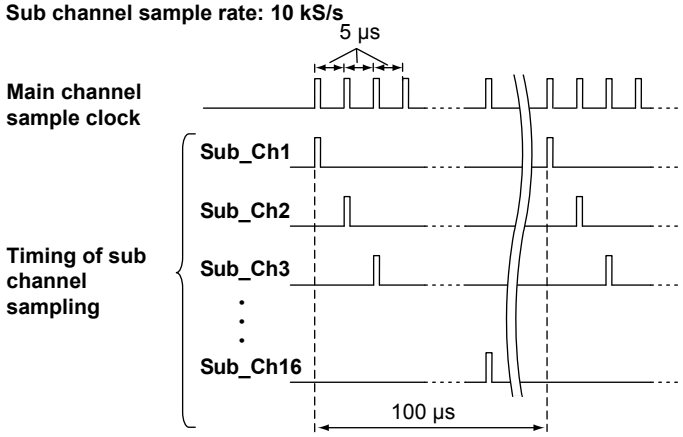
Notes about Using the 16-CH Voltage Input Module (720220)

While normal voltage input modules have two main channels for analog signal input, the 16-CH voltage input module has 16 sub channels for analog input. The 16-CH voltage input module samples the measured sub channels in order.

Main channel sample rate: 200 kS/s

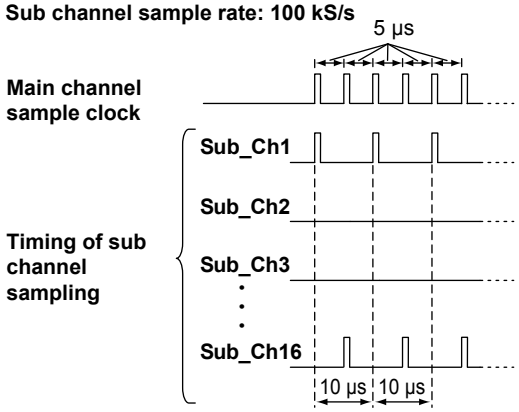
When the number of measured sub channels is 16 (all the sub channels are measured)

Sub channel sample rate: 10 kS/s



When the number of measured sub channels is 2 (sub channels 1 and 16 are measured)

Sub channel sample rate: 100 kS/s



- The 16-CH voltage input module uses only the odd main channels of the slot that it is inserted into. It cannot use the slot's even main channels.
- If you do not want to measure an individual sub channel, turn its input coupling off. Sub channels whose input coupling has been turned off are not scanned.
- The maximum sample rate of the 16-CH voltage input module is 200 kS/s (when only one sub channel is measured). The rate at which data is written to the sub channel acquisition memory varies depending on the main channel sample rate and the number of measuring sub channels. For details on the rate at which data is written to the sub channel acquisition memory, see appendix 2 in the *Getting Started Guide*, IM DL350-03EN.
- The sample rate that is displayed on the screen is the sample rate of the main channel.
- The record length of each sub channel varies depending on the set record length and the number of measured sub channels.

  Record length of each sub channel ≤ set record length/number of measured sub channels
- The timing of waveform acquisition is different for each sub channel, but all the sub channels are stored in the acquisition memory as if they had been sampled at the same timing. This means that the sampling times of the acquired waveform data are different from the sampling times of the actual applied waveforms.

- Because the waveform data stored in the acquisition memory is used to display waveforms on the screen, the data of all sub channels is displayed as if though it were sampled at the same timing.
- The following operations are performed on the waveform data stored in the acquisition memory: waveform zooming, cursor measurement, the automated measurement of waveform parameters, computation, FFT, waveform searches, and the loading and saving of waveform data.
- GO/NO-GO determination and the display and searching of history waveforms are not performed on sub channels.
- When you execute auto setup on the 16-CH voltage input module, sub channel on/off settings and settings that relate to the horizontal axis (Time/Div, Record Time) are not changed.
- Wire all the L input terminals for all the sub channels on the same module to the same potential. The L input terminals of all sub channels are common. Because the L input terminals are electrically connected inside the instrument, connecting different potentials to them could result in short circuiting and damage to the 16-CH voltage input module.
  For information about the terminal arrangement, see section 2.18 in the *Getting Started Guide*, IM DL350-03EN.
- For information about attaching and removing the terminal block and connecting and removing wires from the terminal block, see section 2.18 in the *Getting Started Guide*, IM DL350-03EN.

Notes about Using the 16-CH Temperature/Voltage Input Module (720221)

In comparison with normal temperature modules, which can receive input from two thermocouples, the 16-CH Temperature/Voltage Input Module has sub channels that enable it to receive input from 16 thermocouples through a scanner box. You can also measure the voltage of 16 channels. The 16-CH Temperature/Voltage Input Module samples the measured sub channels in order.

- The 16-CH temperature/voltage input module uses only the odd main channels of the slot that it is inserted into. It cannot use the slot's even main channels.
- If you do not want to measure an individual sub channel, turn its input coupling off. Sampled data is not acquired for channels whose input coupling is turned off.
- Regardless of the number of measured sub channels, the actual maximum sample rate is 100 kS/s. The rate at which data is written to the acquisition memory varies depending on the main channel sample rate. For details on the rate at which data is written to the acquisition memory, see appendix 2 in the *Getting Started Guide*, IM DL350-03EN.
- The sample rate that is displayed on the screen is the sample rate of the main channel.
- Record length of each sub channel ≤ set record length/16
- The timing of waveform acquisition is different for each sub channel, but all the sub channels are stored in the acquisition memory as if they had been sampled at the same timing. This means that the sampling times of the acquired waveform data are different from the sampling times of the actual applied waveforms.
- Because the waveform data stored in the acquisition memory is used to display waveforms on the screen, the data of all sub channels is displayed as if though it were sampled at the same timing.
- The waveforms displayed on the screen are updated at the set data update period regardless of the number of measured sub channels. The previous value is stored repeatedly in acquisition memory until the value changes. Saved waveform data is treated in the same manner.
- The following operations are performed on the waveform data stored in the acquisition memory: waveform zooming, cursor measurement, the automated measurement of waveform parameters, computation, FFT, waveform searches, and the loading and saving of waveform data.
- GO/NO-GO determination and the display and searching of history waveforms are not performed on sub channels.
- When you execute auto setup on the 16-CH voltage input module, sub channel on/off settings and settings that relate to the horizontal axis (Time/Div, Record Time) are not changed.
- Connect the 16-CH temperature/voltage input module to the scanner box with a cable and then connect a thermocouple to the scanner box to perform temperature measurements. For information about how to connect thermocouples to the scanner box's terminal block, see section 2.19 in the Getting Started Guide, IM DL350-03EN.

2 Navigation

Select the following operation according to how the instrument is to be used.

- Scope mode (Scope Mode)
- Recorder Mode (Recorder Mode)
- Load setup file (Load file)
- Easy setup (Easy Setup)

Scope Mode (Scope Mode)

Scope mode is used to set the time axis using Time/Div and record length. This is the typical time scale setting method for oscilloscopes.

Recorder Mode (Recorder Mode)

Recorder mode is use to set the time axis using the measurement time and sampling interval. This is the typical time scale setting method for recorders.

Load Setup File (Load file)

Measurement conditions and other settings can be saved to an SD memory card or USB storage. The saved setup file can be loaded later to configure the instrument before starting measurements. This is useful when you want to set the measurement conditions at the office and then load them at the remote measurement site to make measurements.

Easy Setup (Easy Setup)

The settings in recorder mode are configured in a wizard format.

- Step 1: Channel selection. Turn on and off the recording channels.
- Step 2: Record time.
- Step 3: Sampling interval.
- All channel settings: Set the measurement range and the like of each channel.

When the configuration is complete, the instrument runs in recorder mode.

From the next, I don't display this menu at the time of start.

- Selected: Navigation is not displayed the next time the instrument is started.
- Not selected: Navigation is displayed the next time the instrument is started.

Start

Click this to start the instrument according to the operation selected on the screen.

Notes about Using the 16-CH Voltage Input Module (720220)

Notes about Using the 16-CH Temperature/Voltage Input Module (720221)

▶ See here.

3 Preparation

Initialization of Settings (Initialize)

You can reset the instrument settings to their factory default values. This feature is useful when you want to cancel all the settings that you have entered or when you want to redo measurement from scratch.

Only initialize the instrument if you are sure that it is okay for all of the settings to be returned to their default values. You cannot undo an initialization. We recommend that you save the setup parameters before you initialize the instrument.

Items That Cannot Be Reset

The following settings cannot be reset.

Date and time, communication, language (Japanese or English), network, file path, and other environment settings

Auto Setup (Auto Setup)

The auto setup feature automatically sets the vertical axis (V/div, V range), horizontal axis (time/div, record time), trigger level, and other settings to values that are most suitable for the input signals. This feature is useful when you are not sure what type of signal will be applied to the instrument. The auto setup feature will not work properly on some input signals. There are some modules with which the auto setup feature cannot be used.

Execute auto setup only after you have confirmed that it is okay to execute it. You cannot undo an auto setup.

Center Position after the Execution of Auto Setup

The center position after you execute auto setup will be 0 V.

Applicable Modules

720211 (HS100M12), 720250 (HS10M12), 720254 (4CH 1M16), 720268 (HV (with AAF, RMS)), 701261 (UNIVERSAL), 701262 (UNIVERSAL (AAF)), 701275 (ACCL/VOLT), 720220 (16CH VOLT)*

* When you execute auto setup on the 720220, sub channel on/off settings and settings that relate to the horizontal axis (time/div, record time) are not changed.

Source Channels

Auto setup is performed on all channels except the logic channels.

Waveforms Displayed before the Execution of Auto Setup

Waveforms that were displayed before you execute auto setup will be cleared.

Signals That Auto Setup Can Be Applied To

You can use auto setup for the following types of input signals.

- When a 720211 module is installed: Simple, repeating signals with frequencies between 50 Hz and 10 MHz
  When a 720211 module is not installed: Simple, repeating signals with frequencies between 50 Hz and 1 MHz
- Signals whose maximum absolute input voltage is 20 mV at 1:1 probe attenuation to the maximum range × 10

- The auto setup feature may not work properly for signals that include a DC component or high-frequency components.
- In recorder mode, horizontal axis settings are not changed.

Calibration (Calibration)

Executing Calibration (Execute)

Calibrates the following items. Execute calibration when you want to make accurate measurements.

- Vertical-axis ground level
  Calibration is performed automatically when the power switch is turned on.

Notes about Calibration

- Allow the instrument to warm up for at least 30 minutes before you execute calibration. If you execute calibration immediately after power-on, the calibrated values may drift due to temperature changes or other environmental changes.
- Execute calibration in a stable temperature environment ranging from 5 to 40°C (23 ± 5°C recommended).
- Do not apply signals when calibrating. Calibration may not be executed properly when input signals are being applied to the instrument.

Auto Calibration (Auto CAL)

Auto calibration is executed when you start signal acquisition if any of the time periods listed below has elapsed since the power was turned on.

- Approx. 3 minutes
- Approx. 10 minutes
- Approx. 30 minutes and every 30 minutes thereafter

4 Vertical Axis

This section explains how to configure the signal input settings and the amplitude-direction display settings. The items that can be set vary depending on the installed modules.

Input Settings

All Channel Settings (All CH Setup)

You can configure the settings of all channels while viewing the settings in a list. You can also copy the various vertical axis settings of one channel to another channel. There are some items that cannot be configured from the All CH Setup menu.

▶ See here.

CH1 to CH6, GPS (CH7)

A menu for the selected channel appears. You can set the various vertical control settings for each channel.
CH5 and CH6 are logic measurement channels.
GPS is position information (GPS). It is sometimes displayed as CH7.

Measurement Items

When you install the following modules into this instrument, it can measure voltage, temperature, strain, acceleration, frequency, logic, CAN bus signals, CAN FD bus signals, LIN bus signals, SENT signals, and so on.

- **Voltage measurement**
  720211 (HS100M12), 720250 (HS10M12), 720254 (4CH 1M16), 720268 (HV (with AAF, RMS)), 701261 (UNIVERSAL), 701262 (UNIVERSAL (AAF)), 701265 (TEMP/HPV), 720266 (TEMP/HPV), 701275 (ACCL/VOLT)
- **Voltage measurement (for the 16-CH Voltage Input Module)**
  720220 (16CH VOLT)
- **Temperature Measurement**
  701261 (UNIVERSAL), 701262 (UNIVERSAL (AAF)), 701265 (TEMP/HPV), 720266 (TEMP/HPV)
- **Temperature Measurement (For the 16-CH Temperature/Voltage Input Module)**
  720221 (16CH TEMP/VOLT)
- **Strain measurement**
  701270 (STRAIN_NDIS), 701271 (STRAIN_DSUB)
- **Acceleration measurement**
  701275 (ACCL/VOLT)
- **Frequency measurement**
  720281 (FREQ)
- **Logic measurement**
  720230 (LOGIC)
- **CAN Bus signal monitoring**
  720240 (CAN MONITOR), 720242(CAN/CAN FD), 720245(CAN FD/LIN), 720241 (CAN & LIN)
  These modules can be used only with models with the /VE option.
- **CAN FD Bus Signal Monitoring**
  720242(CAN/CAN FD), 720245(CAN FD/LIN)
  These modules can be used only with models with the /VE option.
- **LIN Bus signal monitoring**
  720245(CAN FD/LIN), 720241 (CAN & LIN)
  These modules can be used only with models with the /VE option.
- **SENT signal monitoring**
  720243 (SENT)
  These modules can be used only with models with the /VE option.

Installing a GPS unit (720940/B8093YA, an accessory sold separately) in this instrument enables position information to be measured.

- **Position information (GPS)**

You can use auto setup to automatically configure the appropriate settings (such as vertical axis, horizontal axis, and trigger settings) for the input signal. This feature is useful when you are not sure what type of signal will be applied to the instrument. The auto setup feature will not work properly on some input signals. Also, there are some modules with which the auto setup feature cannot be used.
▶ See here.

All Channel Settings (All CH Setup)

Input Settings (Setup)

You can configure the settings of all channels while viewing the settings in a list. You can also copy the various vertical axis settings of one channel to another channel. There are some items that cannot be configured from the All CH Setup screen. The settings for each measurement item are as follows:

- **Voltage measurement**
  Waveform display (Disp), label (Label), coupling (Coupling), vertical scale (V/div), bandwidth limit (Band Width), zoom method (DIV/SPAN), position (Position), magnification for zooming (V Zoom), display range limits for zooming (Upper/Lower), probe attenuation and current-to-voltage conversion ratio (Probe)
- **Voltage measurement(For the 16-CH Voltage Input Module)**
  Waveform display (Disp), label (Label), coupling (Coupling), vertical scale (V/div), bandwidth limit (Band Width), zoom method (DIV/SPAN), position (Position), magnification for zooming (V Zoom), display range limits for zooming (Upper/Lower)
- **Temperature measurement**
  Waveform display (Disp), label (Label), coupling (Coupling), thermocouple type (Type), bandwidth limit (Band Width), display range settings (Upper/Lower), reference junction compensation (RJC), burnout (Burn Out)
- **Temperature Measurement (For the 16-CH Temperature/Voltage Input Module)**
  Waveform display (Disp), label (Label), coupling (Coupling), thermocouple type (Type), bandwidth limit (Band Width), burnout (Burn Out), display range settings (Upper/Lower), reference junction compensation (RJC), vertical scale (V/div), zoom method (DIV/SPAN), position (Position), magnification for zooming (V Zoom), display range limits for zooming (Upper/Lower)
- **Strain measurement**
  Waveform display (Disp), label (Label), range unit (Range Unit), measurement range (Range), bandwidth limit (Band Width), display range settings (Upper/ Lower), gauge factor (Gauge Factor), bridge voltage (Excitation)
- **Acceleration measurement**
  Waveform display (Disp), label (Label), coupling (Coupling), gain (Gain), bandwidth limit (Band Width), zoom method (DIV/SPAN), position (Position), magnification for zooming (V Zoom), display range limits for zooming (Upper/Lower), sensitivity (Sensitivity)
- **Frequency measurement**
  Waveform display (Disp), label (Label), measured item (Function), vertical scale (V/div), zoom method (DIV/SPAN), position (Position), magnification for zooming (V Zoom), display range limits for zooming (Upper/Lower), center frequency (CenterFreq), input settings (Input)
- **Logic measurement**
  Waveform display (Disp), label (Label), bit display (Bit Display), chattering elimination (Chatter Elim.), position (Position), magnification for zooming (V Zoom), bit mapping (Mapping)

In the setup menu for configuring all channels, for channels that correspond to CAN bus monitor modules, CAN/CAN FD monitor modules, CAN & LIN bus monitor modules, or SENT monitor modules, or for GPS (CH7), you can only turn on and off (Disp) the waveform display.

Linear Scaling (Linear Scale)

You can configure the linear scaling settings of all channels while viewing the settings in a list. This function is the same as the linear scaling function for voltage measurement.

Linear scaling (Linear Scale); A and B for AX+B or P1:X, P1:Y, P2:X, and P2:Y for P1-P2; unit (Unit); display mode (Disp Type); number of decimal places (Decim Num); unit prefix (Sub Unit)

▶ See here.

The 701271 (STRAIN_DSUB) strain module supports shunt calibration.

Operation (Operation)

Copy (Channel Copy)

You can copy the various vertical axis and linear scaling settings from one channel to other channels whose modules are of the same type as the source channel.

- **Source Channel (Source Channel)**

  Set the source channel to a channel from CH1 to CH6 or to 16chVOLT or 16chTEMP/VOLT.*

  * When a 16-CH voltage input module or 16-CH temperature/voltage input module is installed. After you select 16chVOLT or 16chTEMP/VOLT, select a sub channel.

- **Destination Channel**

  Set the destination channel to a channel from CH1 to CH6.

- **Execute (Execute)**

  Select Execute to copy the settings.

- When a 16-CH Voltage Input Module or 16-CH Temperature/Voltage Input Module is installed, you can also copy the settings of the sub channels. You can specify only channels as copy destinations.
- The waveform display color and label settings are not copied.

Strain Balance and DC Offset Cancellation(Balance & DC Offset Cancel)

Cancel the DC offset on multiple installed strain modules.
If a strain module is installed, stain balancing is executed on the strain module.

- **CH1 to CH4**

  Select the modules that you want to perform strain balancing and DC offset cancellation on.

- **Execute (Execute)**

  Execute strain balancing and DC offset cancellation.
  For information about strain balancing, see the section on strain measurement.

  ▶ See here.

  For information about DC offset cancellation, see the section on DC offset cancellation.

  ▶ See here.

You cannot select channels in which strain modules are not installed.

Voltage Measurement

For voltage measurement, the items that have to be set for each input signal (CH1 to CH4) include vertical scales, vertical positions, input coupling, probe attenuation, bandwidth limit, zoom method, offset, waveform inversion, trace, and linear scaling.

You can measure voltage by connecting probes, measurement leads, etc. to one of the following voltage measurement modules: 720211 (HS100M12), 720250 (HS10M12), 720254 (4CH 1M16), 720268 (HV (with AAF, RMS)), 701261 (UNIVERSAL), 701262 (UNIVERSAL (AAF)), 701265 (TEMP/HPV), 720266 (TEMP/HPV), 701275 (ACCL/VOLT).

For the probe connection method, see section 2.10 in the *Getting Started Guide*, IM DL350-03EN. For the measurement lead connection method, see section 2.12.

Waveform Display On and Off

Select whether to show or hide input signals for each channel. On the 720254 4-CH module, set each sub channel.

* 4-CH modules have sub channels 1 and 2. Sub channel 1 is displayed as “Channel number_1,” and sub channel 2 as “Channel number_2.” For example, sub channels are displayed as CH3_1 and CH3_2.

- ON: Shows the waveform
- OFF: Hides the waveform

Source Trace Selection

Select the source you want to configure from CH1 to CH6.

Vertical Scale (V/Div, V Range)

Voltage Scale Setting

The vertical scale is used to adjust the displayed waveform amplitude so that you can easily view signals. Set the vertical scale for each main channel and each sub channel. On a 720254 4-CH module, select the sub channel.
To change the vertical scale of a sub channel on the 720220 or 720221 16-CH module, select CH1 or CH3, select the sub channel, and then set the vertical scale.
The vertical scale changes when you switch to an input attenuator with a different attenuation.

Scope Mode (V/Div)

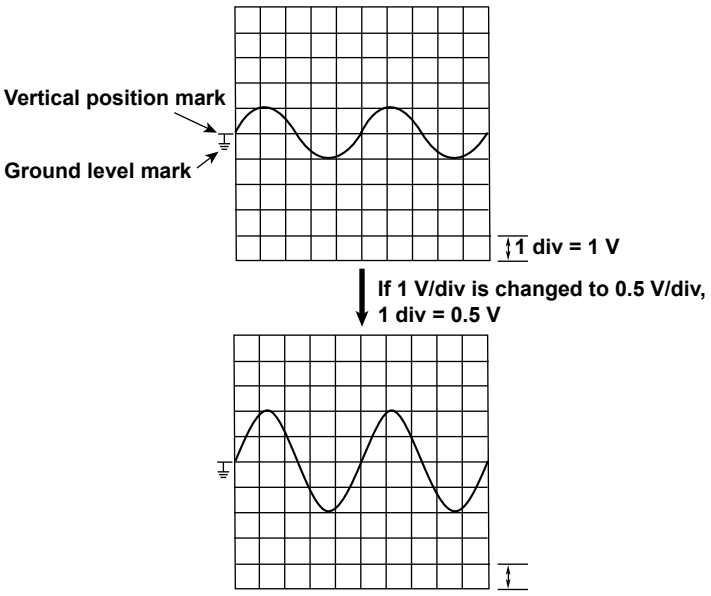
Set the vertical scale by voltage per grid square (V/div) or current per grid square (A/div) on the screen. You can change the scale in steps like this: 1 V/div -> 2 V/div -> 5 V/div.

Recorder Mode (V Range)

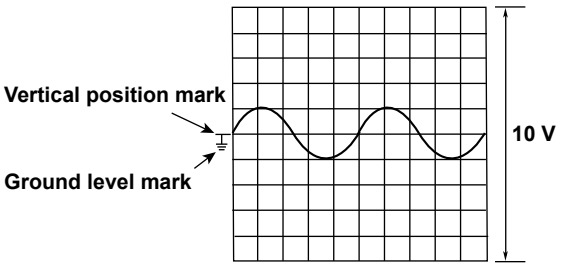
Set the vertical scale by specifying the voltage (V) or current (A) from the top edge to the bottom edge of the waveform screen. You can change the scale in steps like this: 10 V -> 20 V -> 50 V.

Example

Scope Mode



Recorder Mode



- While waveform acquisition is stopped, changing the vertical scale (V/Div, V Range) will not change the displayed waveform. The changed V/div value will be applied the next time that waveform acquisition is started.
- While waveform acquisition is stopped, changing the vertical scale (V/Div, V Range) will not change the cursor-measurement values or the automated measurement values of waveform parameters, they will continue to be based on the V/div value at the time of measurement.

Selectable Range of V/div and V Range

The selectable range varies as shown below depending on the input module. The values in the following table are for when the probe attenuation is 1:1. Multiply the values by 10 when the attenuation is 10:1, by 100 when the attenuation is 100:1, and by 1000 when the attenuation is 1000:1.

Scope Mode

Input Module	Selectable Range
720211 (HS100M12)	10 mV/div to 20 V/div
720250 (HS10M12)	5 mV/div to 20 V/div
720254 (4CH 1M16)	10 mV/div to 50 V/div
720268 (HV (with AAF, RMS))	20 mV/div to 200 V/div
701261 (UNIVERSAL)	5 mV/div to 20 V/div
701262 (UNIVERSAL (AAF))	5 mV/div to 20 V/div
701265 (TEMP/HPV)	0.1 mV/div to 10 V/div
720266 (TEMP/HPV)	0.1 mV/div to 20 V/div
701275 (ACCL/VOLT)	5 mV/div to 10 V/div
720220 (16CH VOLT)	0.2 V/div to 2 V/div
720221 (16CH TEMP/VOLT)	1 mV/div to 2 V/div

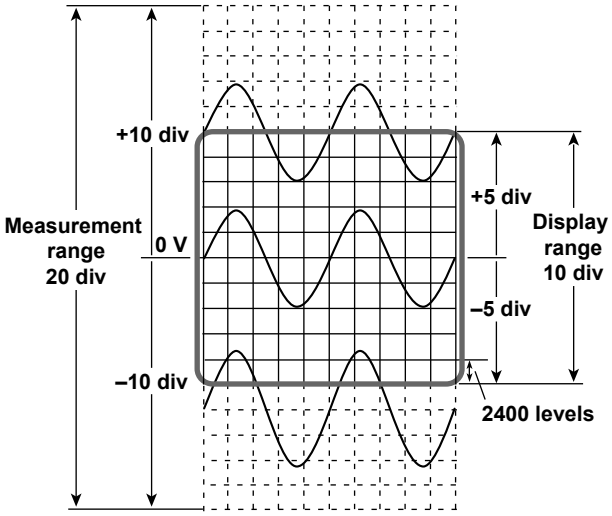
Recorder Mode

Input Module	Selectable Range
720211 (HS100M12)	100 mV to 200 V
720250 (HS10M12)	50 mV to 200 V
720254 (4CH 1M16)	100 mV to 500 V
720268 (HV (with AAF, RMS))	200 mV to 2000 V
701261 (UNIVERSAL)	50 mV to 200 V
701262 (UNIVERSAL (AAF))	50 mV to 200 V
701265 (TEMP/HPV)	1 mV to 100 V
720266 (TEMP/HPV)	1 mV to 200 V
701275 (ACCL/VOLT)	50 mV to 100 V
720220 (16CH VOLT)	2 V to 20 V
720221 (16CH TEMP/VOLT)	10 mV to 20 V

Measurement and Display Ranges

The measurement range of this instrument is 0 V ±10 div (the absolute width, or span, is 20 div). The default display-range setting is ±5 div (the span is 10 div). Using the features listed below, you can move and scale the displayed waveform so that parts of it that were outside of the display range are displayed.

- Vertical position adjustment
- Vertical zoom



- **How to Measure the Voltage with High Accuracy**
  To measure the voltage with high accuracy, increase the vertical scale so that the input signal is measured with the largest possible amplitude. To display multiple waveforms so that they do not overlap without dividing the screen, you have to set the vertical scale to a low value. This prevents you from taking advantage of the A/D converter's resolution. However, if you divide the screen ▶ See here. and arrange the waveforms ▶ See here. in the divided screens, they will not overlap, and you can raise their vertical scales.
- **Measurement Resolution**
  The measurement resolution varies depending on the module. For example, the 720250(HS10M12) and 720211(HS100M12) use 12-bit A/D converters and sample the input signal at a resolution of 150 levels per div. The 720254 (4CH 1M16), 720268 (HV (with AAF, RMS)), 701261 (UNIVERSAL), 701262 (UNIVERSAL (AAF)), 701265 (TEMP/HPV), 720266 (TEMP/HPV), 701275 (ACCL/VOLT), 720220 (16CH VOLT), and 720221 (16CH TEMP/VOLT) use 16-bit A/D converters and sample the input signal at a resolution of 2400 levels per div.

Input Coupling (Coupling)

It is easier to measure the amplitude of an AC signal if you remove its DC component. On the other hand, there are times when you want to measure the ground level or observe the entire signal, including both the DC and AC components. In these kinds of situations, you can change the input coupling setting. By changing the setting, you can choose how the vertical (voltage) control circuit is coupled to the input signal. You can set the input coupling to one of the options listed below.

DC

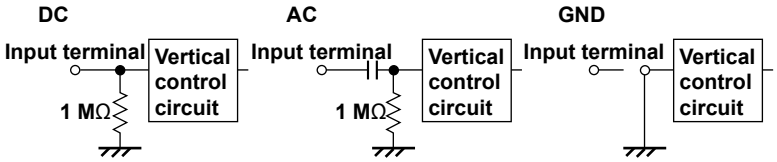
The input signal is coupled directly to the attenuator of the vertical control circuit. Set the input coupling to DC when you want to measure the entire signal, including both the DC and AC components.

AC (Only when measuring AC voltage)

The input signal is coupled to the attenuator of the vertical control circuit through a capacitor. Set the input coupling to AC when you want to measure only the amplitude of the AC signal without the DC component.

GND

The input signal is coupled to the ground rather than to the attenuator of the vertical control circuit. Set the input coupling to GND to check the ground level on the screen.



TC (Only when measuring temperature)

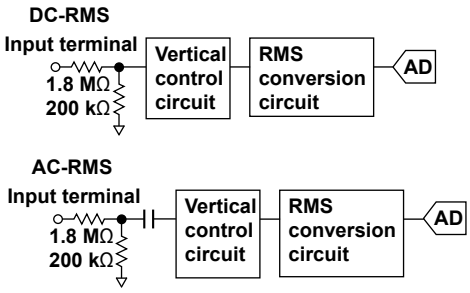
Set the coupling to TC when you are measuring temperature using the 701261 (UNIVERSAL), 701262 (UNIVERSAL (AAF)), 701265 (TEMP/HPV), 720266 (TEMP/HPV), or 720221 (16CH TEMP/VOLT).

DC-RMS

With the 720268 (HV (with AAF, RMS)), the DC and AC components of the input signal are converted to RMS values and displayed. An RMS conversion circuit is connected to the same vertical-control-circuit coupling arrangement that is used when the input coupling is set to DC.

AC-RMS

With the 720268 (HV (with AAF, RMS)), the AC components of the input signal are converted to RMS values and displayed without the DC component. An RMS conversion circuit is connected to the same vertical-control-circuit coupling arrangement that is used when the input coupling is set to AC.



ACCEL (Only when measuring acceleration)

To measure acceleration with the 701275 (ACCL/VOLT), set the input coupling to ACCEL.

OFF (For the 16-CH Voltage Input Module and 16-CH Temperature/Voltage Input Module)

Set the coupling to OFF to not include in the measurement the sub channels selected on the 720220 (16CH VOLT) or 720221 (16CH TEMP/VOLT).

Bandwidth Limit (Bandwidth)

You can specify a bandwidth limit for each module. You can use bandwidth limits to observe input signal waveforms with their noise components removed.

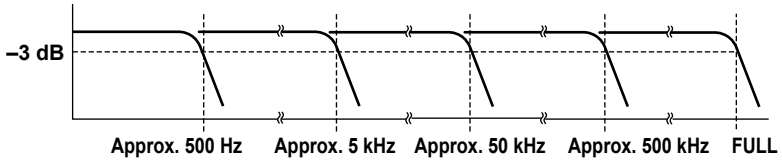
Normal Bandwidth Limits

High frequency components can be eliminated from the input signal. The bandwidth limits vary as shown below depending on the input module.

Input Module	Bandwidth Limit
720211 (HS100M12)	10 kHz, 20 kHz, 40 kHz, 80 kHz, 160 kHz, 320 kHz, 640 kHz, 1.28 MHz, 2 MHz, Full
720250 (HS10M12)	500 Hz, 5 kHz, 50 kHz, 500 kHz, Full
720254 (4CH 1M16)	6.25 Hz, 12 H.5 Hz, 25 Hz, 50 Hz, 100 Hz, 200 Hz, 400 Hz, 800 Hz, 1.6 kHz, 3.2 kHz, 6.4 kHz, 12.8 kHz, 40 kHz, Full
720268 (HV (with AAF, RMS))	400 Hz, 4 kHz, 40 kHz, Auto, Full
701261 (UNIVERSAL),[1] 701262 (UNIVERSAL (AAF)),[1] 701265 (TEMP/HPV)	2 Hz, 8 Hz, 30 Hz, Full
720266 (TEMP/HPV)	0.1 Hz, 1 Hz, 8 Hz, Full
701270 (STRAIN_NDIS), 701271 (STRAIN_DSUB)	10 Hz, 100 Hz, 1 kHz, Full
701261 (UNIVERSAL),[2] 701262 (UNIVERSAL (AAF)), 701275 (ACCL/VOLT)	40 Hz, 400 Hz, 4 kHz, Auto, Full
720281 (FREQ)[3]	100 Hz, 1 kHz, 10 kHz, 100 kHz, Full
720220 (16CH VOLT)	500 Hz, Full

1 When measuring temperature.
2 When measuring voltage. Auto cannot be selected on the 701261.
3 Full cannot be selected when Preset is set to AC100V or AC200V.

For example, on the 701250 (HS1M12), you can set the frequency bandwidth limit to 500 Hz, 5 kHz, 50 kHz, or 500 kHz. The frequency characteristics for the different bandwidth limits are shown below. If you select Full, the module's maximum bandwidth is used.



Bandwidth Limitation on the 720268 (HV (with AAF, RMS))

When you are using the 720268 (HV (with AAF, RMS)) and the bandwidth limit is set to Auto, the anti-aliasing and low-pass filter settings vary as shown below depending on the sample rate.

Sample Rate	Anti-Aliasing Filter	Low-Pass Filter
1 MS/s	40 kHz	40 kHz
500 kS/s	40 kHz	40 kHz
200 kS/s	40 kHz	40 kHz
100 kS/s	40 kHz	40 kHz
50 kS/s	20 kHz	40 kHz
20 kS/s	8 kHz	40 kHz
10 kS/s	4 kHz	4 kHz
5 kS/s	2 kHz	4 kHz
2 kS/s	800 Hz	4 kHz
1 kS/s	400 Hz	400 Hz
500 S/s	200 Hz	400 Hz
200 S/s	80 Hz	400 Hz
100 S/s	40 Hz	400 Hz
50 S/s or less	40 Hz	400 Hz
Ext sample	OFF	OFF

For example, when the sample rate is between 100 kS/s and 50 kS/s, the cutoff frequency of the anti-aliasing filter is 40% of the sample rate.

Bandwidth Limit on the 701262 (UNIVERSAL (AAF)) and 701275 (ACCL/VOLT)

When you are measuring voltage using the 701262 (UNIVERSAL (AAF)) or when you are using the 701275 (ACCL/VOLT) and the bandwidth is set to Auto, the anti-aliasing and low-pass filter settings vary as shown below depending on the sample rate.

Sample Rate	Anti-Aliasing Filter	Low-Pass Filter
200 kS/s or higher	40 kHz	OFF
100 kS/s	40 kHz	OFF
50 kS/s	20 kHz	OFF
20 kS/s	8 kHz	OFF
10 kS/s	4 kHz	4 kHz
5 kS/s	2 kHz	4 kHz
2 kS/s	800 Hz	4 kHz
1 kS/s	400 Hz	400 Hz
500 S/s	200 Hz	400 Hz
200 S/s	80 Hz	400 Hz
100 S/s	40 Hz	40 Hz
50 S/s	20 Hz	40 Hz
5 S/s to 20 S/s	20 Hz	40 Hz
Ext sample	40 kHz	OFF

For example, when the sample rate is between 100 kS/s and 50 kS/s, the cutoff frequency of the anti-aliasing filter is 40% of the sample rate.

Bandwidth Limit on the 720221 (16CH TEMP/VOLT)

The bandwidth limits vary depending on the set data update period.

Data Update Period	Bandwidth Limit	Data Update Period	Bandwidth Limit
100 ms	600 Hz	1 s	50 Hz
300 ms	200 Hz	3 s	10 Hz

Probe Attenuation and Current-to-Voltage Conversion Ratio (Probe)

In voltage (current) measurement, a probe is used to connect the circuit under measurement to a signal input terminal. Using a probe has the following advantages.

- Prevents the disturbance of the voltage and current of the circuit being measured.
- Allows signals to be applied with no distortion.
- Expands the voltage (current) range that the instrument can measure.

When you use a probe, to read the measurement voltage (current) correctly, you must set the attenuation on the instrument to match the probe attenuation or current-to-voltage conversion ratio.

Set the attenuation ratio as indicated below for each probe. (The probes are optional accessories that are sold separately.)

Probe Type	Attenuation
Isolated probe (700929)	10: 1
Isolated probe (701947)	100:1
Current probe (701917/701918)	1 A: 1 V
Current probe (701932/7019333)	10 A: 1 V
Current probe (701930/701931)	100 A: 1 V
Clamp-on probe (720930)	100 A: 1 V
Clamp-on probe (720931)	400 A: 1 V

If you use a probe other than one of the separately sold optional accessories provided by Yokogawa, set the attenuation ratio or current-to-voltage conversion ratio in accordance with that probe. This instrument has the following settings.

Current Probe's Current-to-Voltage Conversion Ratio (Current)

- 0.1 A: 1 V (10 V/A) to 50 kA: 1 V (0.02 mV/A) (1-2-5 steps)
- 250 A: 1 V(0.004 V/A)
- 400 A: 1 V(2.5 mV/A)

The values in parentheses indicate output voltage rates.
For example, if the current-to-voltage conversion ratio is 5 A: 1 V, (0.2 V/A) is indicated.

Voltage Probe's Attenuation Ratio (Voltage)

1: 1 to 50 k: 1 (1-2-5 steps)

Use a probe that is appropriate for the input capacitance of the module that you are using it with. The capacitance cannot be adjusted for an inappropriate probe.

Labels (Label)

You can specify a name of up to sixteen characters in length for each channel.
You can set whether to display labels using the Display menu.

▶ See here.

- The waveform display on/off setting changes to the waveform acquisition on/off setting in cases such as during SD recording and when an increase in the record length places a limitation on the number of channels that can be used.
- The specified display label is used in labels, scale values, the numeric display, and cursor-measurement values.
- Depending on the display and zoom formats, label names may not appear when the waveform display is narrow.

Zoom Method (V Scale)

This is a setting in scope mode. You can choose the method for zooming the waveform vertically.

- DIV: The waveform is zoomed by a set magnification. Set the following items.
  - Waveform Vertical Position (Position)
  - Zooming by Setting a Magnification (V Zoom)
- SPAN: The waveform is zoomed to fit within specified upper and lower display limits.

In recorder mode, V Scale is set with SPAN.

Waveform Vertical Position (Position)

This is a setting in scope mode.

If V Scale is set to DIV, set the waveform vertical position. The instrument can display the waveforms of the main analog-input channels, the waveforms of the sub analog-input channels, and computed waveforms. Because the instrument can display so many waveforms, the waveforms may overlap and be difficult to view. If this happens, you can adjust the vertical display position to make waveforms easier to view (vertical position).

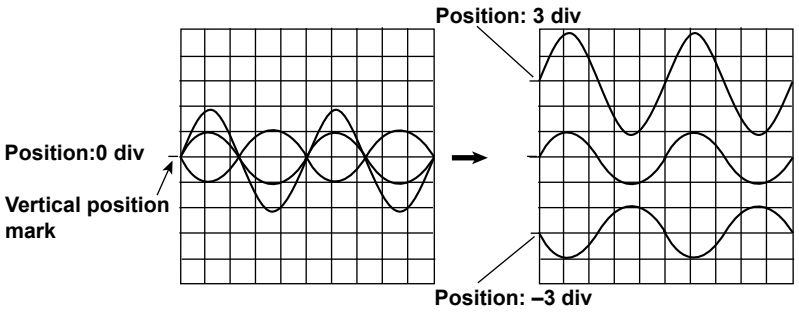
The vertical position can be moved within the range of ±5 div.

When you change the vertical scale (V/div), the location of the vertical position mark does not change.

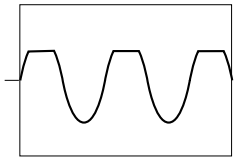
Set the vertical position for each channel and sub channel.

On a 720254 4-CH module, select the sub channel.

To change the position of a sub channel on a 720220 or 720221 16-CH module, select CH1 or CH3, select the sub channel, and set the vertical position.



- You cannot use the vertical position setting to move the vertical position of a temperature, strain, or computed waveform.
- When you change the vertical position (when V Scale is set to DIV) or the upper or lower limit ((when V Scale is set to SPAN)), data that is outside of the measurement range is handled as overflow data. Overflow data will appear as a clipped waveform as shown below.



Zooming by Setting a Magnification (V Zoom)

This is a setting in scope mode.

When V Scale is set to DIV, you can set the vertical magnification and enlarge or reduce the waveform along the vertical axis. This method is useful when you want to change the vertical scale of the waveform after it has been displayed.

Zoom Factor (V Zoom)

The magnifications that you can choose from are listed below.

x0.1, x0.111, x0.125, x0.143, x0.167, x0.2, x0.25, x0.33, x0.4, x0.5, x0.556, x0.625, x0.667, x0.714, x0.8, x0.833, x1, x1.11, x1.25, x1.33, x1.43, x1.67, x2, x2.22, x2.5, x3.33, x4, x5, x6.67, x8, x10, x12.5, x16.7, x20, x25, x40, x50, x100

The range of zoom magnifications that you can choose varies under special circumstances as described below.

When measuring acceleration using the 701275 (ACCL/VOLT)

x0.5 to x50

When using the 720281 (FREQ)

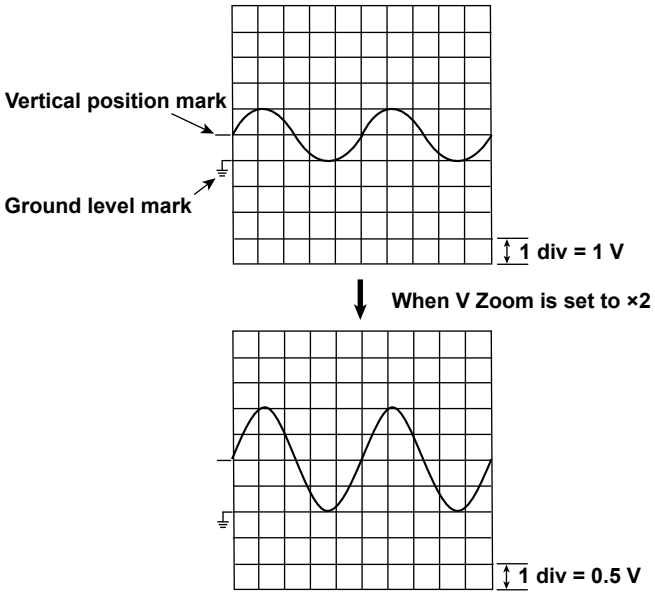
x0.33 to x100

When using the 720230 (LOGIC)

x0.1 to x3.33

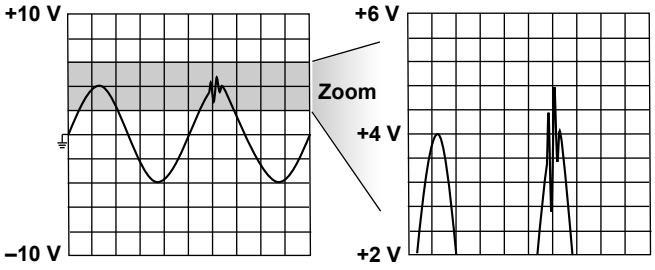
Zoom Position

Zooming is centered on the vertical position.



Zooming by Setting Upper and Lower Display Limits (Upper/Lower)

When V Scale is set to SPAN, you can set the upper and lower vertical limits and enlarge or reduce the waveform along the vertical axis. By setting the appropriate upper and lower limits for the displayed waveform, you can zoom in vertically on the area of the waveform that you want to observe. You can also increase the display range to view parts of the waveform that were outside the range. Zooming the waveform does not change its A/D conversion resolution or accuracy.



Selectable Range of the Upper and Lower Limits

The upper and lower limits can be set within ±(100 × the specified V/div value) or ±2000 V, whichever is lower. Set the limits so that the upper limit is greater than the lower limit.

- The range of the upper and lower limits for the 701270 (STRAIN_NDIS) and 701271 (STRAIN_DSUB) varies as indicated below depending on the range unit.
  When the range unit is μSTR: ±30000 μSTR
  When the range unit is mV/V: ±15 mV/V
- For the 701275 (ACCL/VOLT), the range of the upper and lower limits is ±2000000 units.
- For the 720281 (FREQ), the range of the upper and lower limits is (offset) ± (Value/div × 30). However, depending on the type of signal being measured, the maximum range is as follows:
  When measuring frequencies: –1500 kHz to 1500 kHz
  When measuring revolutions in rpm: –300 krpm to 300 krpm
  When measuring revolutions in rps: –6000 rps to 6000 rps
  When measuring periods: –150 s to 150 s
  When measuring duty ratios: –600% to 600%
  When measuring pulse widths: –150 s to 150 s
  When measuring pulse integration: –1.5E+21 to 1.5E+21
  When measuring velocity: –1.5E+21 to 1.5E+21

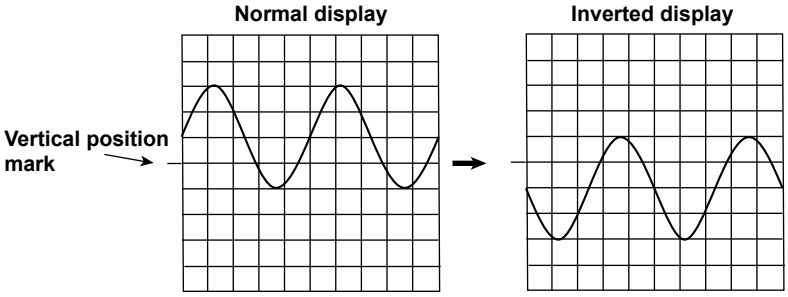
Upper and Lower Limit Linking

You can change the upper and lower limits while keeping the interval between them constant.

If you change V/Div after setting the upper and lower limits, the V/Div on the display will not change, but the measurable range will change. If you change the measurable range so that it is narrower than the range of the set upper and lower limits, when you start waveform acquisition, the parts of the waveform that do not fit within the measurable range may not appear. The measurable range is approximately ±10 div (with 0 in the center) when V Scale is set to DIV.

Inverted Waveform Display (Invert)

When measuring voltage and strain, you can invert the waveform display around the vertical position.



- Cursor measurements, automated measurements of waveform parameters, and computations are performed on the inverted waveforms.
- Even when inverted waveforms are displayed, triggering is based on the uninverted waveforms.
- When you are measuring strain, you cannot invert waveforms whose measurement has finished. The inversion setting will be applied when the next measurement starts.

Display Group (Display Group)

Set whether to assign the channel being configured to display groups 1 to 4 or M (DMM).
This is synchronized to groups 1 to 4 and DMM of the Display (Display) menu.

▶ See here.

Linear Scaling (Linear Scale)

Linear scaling is a function that converts measured values into physical values and reads them directly.
When you measure voltage (current), strain, or frequency (revolutions, periods, duty ratios, power supply frequencies, pulse widths, pulse integration, velocities), you can choose from one of two linear scaling methods: AX + B or P1-P2.

Linear Scaling Modes (Scaling Mode)

- **OFF**
  Linear scaling is not performed.
- **AX+B**
  Using specified scaling coefficient A and offset B, the instrument performs the following computation to scale cursor-measurement values and automated measurement values of waveform parameters. You can specify the unit of the linearly scaled results.
  Y=AX+B
  X: Value before scaling
  Y: Value after scaling

  Selectable range for A and B: −9.9999E+30 to +9.9999E+30
  However, coefficient A cannot be set to zero.

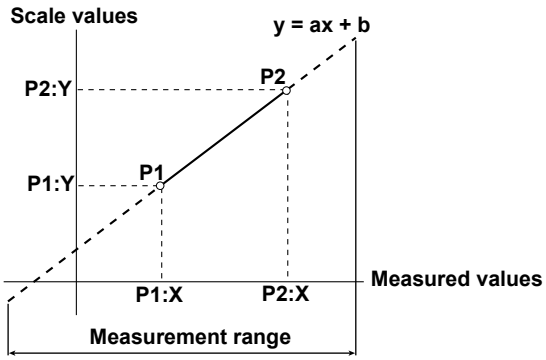
- **P1-P2**

  You can specify two measured values (P1:X, P2:X) and specify a scale value (P1:Y, P2:Y) for each. The scale-conversion equation (y = ax + b) is determined by these four values.
  - Measured value (P1:X, P2:X) range: Same as the measurement range
  - Scale value (P1:Y, P2:Y) range: −9.9999E+30 to +9.9999E+30

    However, you cannot set measured or scaled values P1 and P2 that would make value a in the scaling equation zero or an incalculable value.

  Get Value (Get Value)

  Sets P1:X and P2:X to the current values (the values displayed by the level indicator), regardless of whether waveform acquisition is in progress or stopped.



Unit (Unit)

You can set the unit using up to four alphanumeric characters.

Display Type (Display Type)

When you measure voltage using a voltage module or measure strain using a strain module, you can display the linearly scaled results using one of the following two methods.
Exponent: Values are displayed in exponential notation.
Floating: Values are displayed as decimal numbers.

For Decimal Number, set the number of digits after the decimal point to Auto or a number from 0 to 3. For SubUnit, set the unit prefix to Auto, p, n, μ, m, None, k, M, G, or T.

- If you set Decimal Number to a number from 0 to 3, the specified number of digits after the decimal point are displayed. If you select Auto, all numbers will be displayed using five digits (for example: 1.0000, 250.00).
- If you set SubUnit to a setting other than Auto, numbers will be displayed with the specified unit prefix. If you select Auto, the instrument will automatically select appropriate unit prefixes. The instrument displays values in exponential notation if it is unable to display them as decimal numbers.

Scale Value Display

You can display the linearly scaled values of the upper and lower vertical limits of each channel.
You can turn the scale value display on and off in the Display menu.

▶ See here.

- Linear scaling cannot be performed for measurements of temperature or acceleration.
- The following waveforms cannot be linearly scaled.
  Accumulated waveforms (except for the most recent)
- You can configure linear scaling for each channel.
- The specified scaling coefficient A and offset B are retained even after linear scaling is set to OFF.
- Computations are performed on the linearly scaled values.

Copy (Copy to)

You can copy the various vertical axis and linear scaling settings from a channel to other channels whose modules are of the same type as the source channel.

Source Channel (Source)

Set the source channel to a channel from CH1 to CH6.

Destination Channel

Set the destination channel to a channel from CH1 to CH6.

Execute (Copy Execute)

Select Execute to copy the settings.

Gain Adjustment (Gain Adjustment)

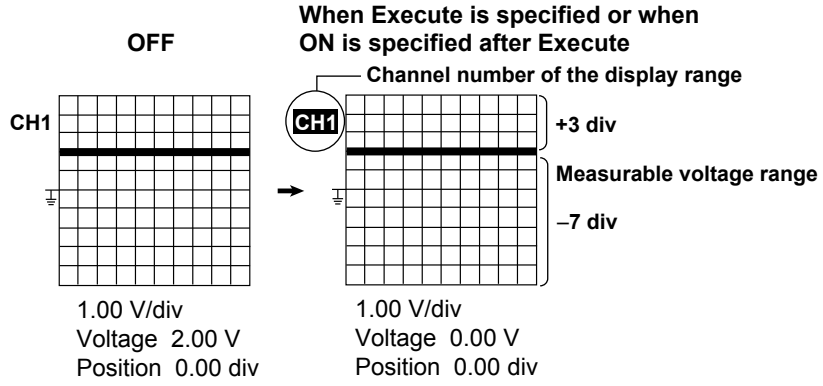
Gain adjustment is used to adjust measured voltages. The adjustment range is ±5%. The setting resolution is down to the fourth decimal place on all modules that can use this function.

- The setting is retained even when the instrument is turned off.
- This function can be used on voltage measurement modules 720211 (HS100M12), 720250 (HS10M12), and 720254 (4CH 1M16).
- The gain adjustment is reset to 1.0000 when Execute or ON is specified for DC offset adjustment.
- Gain adjustment is not possible when DC offset is set to ON.

DC Offset Cancellation (DC Offset Cancel)

This function can be used to determine cursor measurement values, automatically measured values of waveform parameters, and computed values by assuming the DC signal voltage measured during offset adjustment to be 0 V. The adjustment range is ±30% of the measurement range. For example, if the vertical scale is set to 1 V/div, up to 3 V can be assumed to be 0 V. Note that when the offset is adjusted, the measurable range changes.
In addition, if you change the measurement range during offset adjustment, the offset is measured when the range is changed, and this new offset is used to determine the values. However, if you change the vertical scale and the measured value falls outside ±30% of the measurement range, correct measurement will no longer be possible. For example, if you are measuring a 5 V DC signal with the vertical scale set to 2 V/div, adjustment is possible because the signal corresponds to 25% the measurement range. But, if you change the vertical scale to 1 V/div, the signal corresponds to 50% the measurement range, and therefore adjustment is not possible. When DC offset adjustment is enabled, the display range channel number appears highlighted.

- **ON**
  DC offset canceling is enabled.
- **OFF**
  DC offset canceling is disabled.
- **Execute**
  Executes offset adjustment.



- The settings (ON state and the value adjusted with Execute) are not retained when the instrument is turned off. If necessary, save the waveform data and setup data.
- This function can be used on voltage measurement modules 720211 (HS100M12), 720250 (HS10M12), and 720254 (4CH 1M16).

RMS Measurement

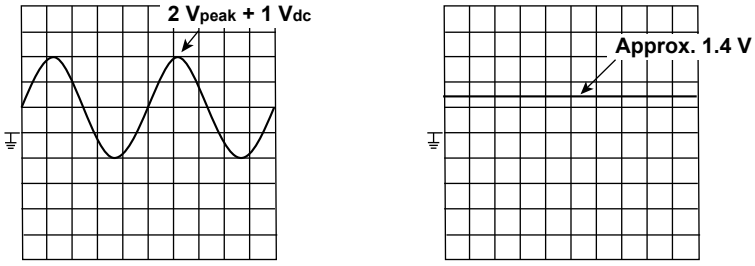
If the module at the selected channel is 720268 (HV (with AAF, RMS)), you can observe the RMS value of the input signal.

AC-RMS

Use this setting when you only want to observe the RMS values of the input signal without the DC component.

Example

When you measure the RMS values of a 2 Vpeak sine wave, an approximately 1.4 VDC signal appears, as shown in the figure on the right.



RMS values are calculated using the following equation.

$$\sqrt{\frac{1}{T}\int_0^T u(t)^2\,dt}$$ **u(t): Input signal, T: One cycle of the input signal**

Given u(t) = Vmsinωt (where Vm is the peak value and ω is the angular velocity of 2πf, with f being the frequency of the sine wave signal), the RMS value Vrms is:

$$V_{rms} = \sqrt{\text{Average of } u(t)^2 \text{ over one cycle}} = \sqrt{\frac{1}{2\pi}\int_0^{2\pi} (V_m \sin \omega t)^2\,dwt} = \frac{V_m}{\sqrt{2}}$$

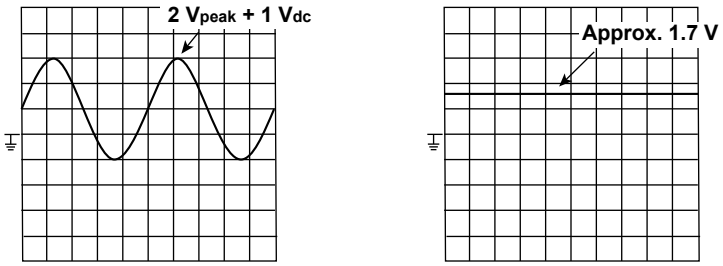
As shown in the example above, if Vm is 2 V, the RMS value Vrms is approximately 1.4 V.

DC-RMS

Use this setting when you want to observe the RMS values of the entire signal, including both the DC and AC components.

Example

When you measure the RMS values of a 2 Vpeak sine wave with a 1 VDC component superimposed on it, an approximately 1.7 VDC signal appears, as shown in the figure on the right.



Given DC component Vdc and AC component u(t) = Vmsinωt, the RMS value Vrms (+ DC) of a sine wave signal with a DC component superimposed on it is:

$$V_{rms\,(+DC)} = \sqrt{\frac{1}{2\pi}\int_0^{2\pi} (V_m \sin \omega t + V_{dc})^2\,dwt} = \sqrt{\left(\frac{V_m}{\sqrt{2}}\right)^2 + (V_{dc})^2}$$

As shown in the example above, if Vdc is 1 V and Vm is 2 V, the RMS value Vrms (+DC) is approximately 1.7 V.

In RMS measurement mode, when a signal with an AC component below 40 Hz is acquired, because of the characteristics of the RMS circuit, a ripple component is displayed, and the RMS values are not displayed properly. DC signals are measured properly.

Voltage Measurement (For the 16-CH Voltage Input Module)

When you measure voltages using the 720220 16-CH voltage input module, the items that you have to set for each input signal (sub channel 1 to sub channel 16) include vertical scales, vertical positions, input coupling, bandwidth limit, zoom method, offset, waveform inversion, trace settings, and linear scaling.
You can connect wiring to the input terminals of the 16-CH voltage input module to measure voltages on 16 channels.
For information about how to connect the wiring, see section 2.18 in the Getting Started Guide, IM DL350- 03EN.

Waveform Display On and Off

You can select whether to display each module's input signal waveforms. You can turn the display of each main channel (CH1 an CH3) on and off.

- ON: Shows the waveform
- OFF: Hides the waveform

- The 16-CH voltage input module uses only the odd main channels of the slot that it is inserted into. It cannot use the slot's even main channels.
- On the 16-CH voltage input module, turning the display of a waveform on or off turns the displays of all of the module's sub channels on or off. To turn off the display of individual sub channels, turn off their input coupling.

Setting All Sub Channels (All SubCH Setup)

You can configure the settings of all sub channels while viewing the settings in a list. You can also copy the various vertical axis settings of one sub channel to another sub channel.
There are some items that cannot be configured from the All SubCH Setup list.

▶ See here.

Sub Channels 1 to 16 (Sub Channel 1 to 16)

The sub channel menu that corresponds to the key you pressed appears. You can set the various vertical axis settings for each sub channel.

Vertical Scale (V/Div, V Range)

▶ See here.

Input Coupling (Coupling)

You can set the input coupling to DC, GND, or OFF. Sub channels whose coupling is set to OFF are not measured or displayed.

▶ See here.

Bandwidth Limit (Bandwidth)

You can set the bandwidth limit to 500 Hz, or Full.

▶ See here.

Labels (Label)

▶ See here.

Zoom Method (V Scale)

▶ See here.

Waveform Vertical Position (Position)

▶ See here.

Zooming by Setting a Magnification (V Zoom)

▶ See here.

Zooming by Setting Upper and Lower Display Limits (Upper/Lower)

▶ See here.

Inverted Waveform Display (Invert)

▶ See here.

Display Group (Display Group)

▶ See here.

Linear Scaling (Linear Scale)

▶ See here.

Copy (Copy to)

You can copy the various vertical axis and linear scaling settings from a sub channel to other sub channels of the same channel.

Source Sub Channel (Source Sub Channel)

Set the source sub channel to a sub channel from 1 to 16.

Destination Sub Channel (Destination Sub Channel)

Set the destination sub channel to a sub channel from 1 to 16.

ALL ON (ALL ON)

Sets all sub channel copy to ON.

ALL OFF (ALL OFF)

Sets all sub channel copy to OFF.

Execute (Copy Execute)

Select Execute to copy the settings.

Notes about Using the 16-CH Voltage Input Module (720220)
Notes about Using the 16-CH Temperature/Voltage Input Module (720221)

▶ See here.

Setting All Sub Channels (All SubChannels Setup)

Input Settings (Setup)

You can configure the settings of all sub channels while viewing the settings in a list. The settings that you can view and configure are listed below. The settings vary depending on the input module.

- **When the Input Coupling Is Set to DC, GND, or OFF**

  Label (Label), coupling (Coupling), vertical scale (V Scale), bandwidth limit (Band Width), zoom method (DIV/SPAN), offset (Offset), position (Position), magnification for zooming (V Zoom), display range limits for zooming (Upper/Lower)

Linear Scaling (Linear Scale)

You can configure the linear scaling settings of all sub channels while viewing the settings in a list. You cannot configure these settings when the input coupling is set to TC.

Linear scaling (Linear Scale); A and B for AX+B or P1:X, P1:Y, P2:X, and P2:Y for P1-P2; unit (Unit); display mode (Disp Type); number of decimal places (Decim Num); unit prefix (Sub Unit)

Channel Copy (Channel Copy)

▶ See here.

Temperature Measurement

For temperature measurement, the items that have to be set for each input signal (CH1 to CH4) include input coupling, thermocouple type, bandwidth limit, trace settings, temperature settings, and temperature unit.
You can connect a thermocouple to one of the temperature modules, 701261 (UNIVERSAL), 701262 (UNIVERSAL (AAF)), 701265 (TEMP/HPV), or 720266 (TEMP/HPV), and measure temperatures.
For information about how to connect thermocouples, see section 2.13 in the *Getting Started Guide*, IM DL350-03EN.

Waveform Display On and Off

Select whether to show or hide input signals for each channel.

- ON: Shows the waveform
- OFF: Hides the waveform

Vertical Scale (V/Div, V Range)

If you set the input coupling to AC, DC, or GND, set the vertical scale (V/Div, V Range).

▶ See here.

Thermocouple Type (Type)

To use a thermocouple, set the input coupling to TC, and select the type of thermocouple.
If the input terminal is open, the displayed value is set to a value less than or equal to the lower limit of the measurement range.

Type	Measurement Range
K	–200 to 1300°C
E	–200 to 800°C
J	–200 to 1100°C
T	–200 to 400°C
L	–200 to 900°C
U	–200 to 400°C
R	0 to 1700°C
S	0 to 1700°C
B	400 to 1800°C
N	0 to 1300°C
W	0 to 2300°C
Au7Fe (AuFe-chromel)	0 to 300K

Input Coupling (Coupling)

Set the coupling to TC when you are measuring temperature using the 701261 (UNIVERSAL), 701262 (UNIVERSAL (AAF)), 701265 (TEMP/HPV), or 720266 (TEMP/HPV).
To measure voltage, set the input coupling to an appropriate voltage measurement setting.

▶ See here.

Bandwidth Limit (Bandwidth)

- 701261 (UNIVERSAL), 701262 (UNIVERSAL (AAF)), 701265 (TEMP/HPV)
  Select 2 Hz, 8 Hz, 30 Hz, Full.
- 720266 (TEMP/HPV)
  Select 0.1 Hz, 1 Hz, 8 Hz, Full.

▶ See here.

Reference Junction Compensation (RJC)

The voltage produced by thermocouple is based on the temperature of the point that you are measuring and the temperature of the reference junction. Reference junction compensation (RJC) refers to the act of correcting for the temperature of the measuring instrument and using it as a cold junction.
On the instrument, you can turn the internal RJC circuit on and off.

- ON: Select ON to use the RJC circuit to perform reference junction compensation.
  There is an RJC circuit inside the 701261, 701262, 701265, and 720266 temperature modules and also inside the 701953 scanner box that is connected to a 720221 16-CH temperature/voltage input module.
- OFF: Select OFF to check measured temperature values or use an external reference junction (0°C).

Normally, you should perform measurements with RJC set to ON.

When you set RJC to OFF and apply a voltage that corresponds to a temperature t to an input terminal, if the measured temperature does not match temperature t, the instrument or the module may be damaged. Contact your nearest YOKOGAWA dealer.

Burnout (Burn Out)

Specify the behavior when the thermocouple input detects a burnout.

- ON: When a burnout is detected, the measured value is fixed at the upper limit (Upper) of the measurement range of thermocouple.
- OFF: Burnouts are not detected.

Labels (Label)

▶ See here.

Temperature Unit (Unit)

Set the temperature unit to °C or K. On models with a language suffix code other than -HJ (Japanese), you can also select Fahrenheit (°F) for the unit.

Display Range (Upper/Lower)

To display the measured waveform on the screen, you need to set upper and lower display range limits that are appropriate for the input.
Selectable range:

- –5432 to 5432°C (when the resolution is 0.1°C)
- –5432 to 5432K (when the resolution is 0.1K)

The minimum span is 2°C (or 2 K).

Upper and Lower Limit Linking

You can change the upper and lower limits while keeping the interval between them constant.

Display Group (Display Group)

▶ See here.

Linear Scaling (Linear Scale)

▶ See here.

Copy (Copy to)

▶ See here.

Temperature Measurement (For the 16-CH Temperature/Voltage Input Module)

The 720221 16-CH temperature/voltage input module can perform temperature or voltage measurements on 16 channels. When the input coupling is set to TC, temperature measurements are performed on 16 channels. When the input coupling is set to DC, voltage measurements are performed on 16 channels.

When the input coupling is set to TC, configure settings such as the thermocouple type, display range, temperature unit, trace, reference junction compensation, and burnout.

For details on the settings when input coupling is set to DC, see "Voltage Measurement (For the 16-CH Voltage Input Module)." ▶ See here.
For the 720221 16-CH Temperature/Voltage Input Module, the bandwidth limit is set depending on the data update period, so no bandwidth limit setting is displayed.

Scanner Box (built-in reference junction)

Connect the 720221 16-CH temperature/voltage input module to a scanner box with a cable to measure temperature or voltage. You can connect up to 16 thermocouples or wires to a 701953 scanner box. For information about how to make the connections, see section 2.19 in the *Getting Started Guide*, IM DL350-03EN.

Waveform Display On and Off

You can select whether to display each module's input signal waveforms. You can turn the display of each main channel (CH1 an CH3) on and off.

- ON: Shows the waveform
- OFF: Hides the waveform

- The 16-CH temperature/voltage input module uses only the odd main channels of the slot that it is inserted into. It cannot use the slot's even main channels.
- On the 16-CH temperature/voltage input module, turning the display of a waveform on or off turns the displays of all of the module's sub channels on or off. To turn off the display of individual sub channels, turn off their input coupling.

Data Update Period (Data update period)

The displayed or saved waveform data is updated at the specified period. The bandwidth limit ▶ See here. varies depending on the data update period.

Data Update Period	Bandwidth Limit
100 ms	600 Hz
300 ms	200 Hz
1 s	50 Hz
3 s	10 Hz

Setting All Sub Channels (All SubChannels Setup)

You can configure the settings of all sub channels while viewing the settings in a list. You can also copy the various vertical axis settings of one sub channel to another sub channel. There are some items that cannot be configured from the All Sub Channels Setup list.

▶ See here.

Vertical Scale (V/Div, V Range)

If you set the input coupling to AC, DC, or GND, set the vertical scale (V/Div, V Range).

▶ See here.

Thermocouple Type (Type)

To use a thermocouple, set the input coupling to TC, and select the type of thermocouple.

▶ See here.

Input Coupling (Coupling)

You can set the input coupling to DC, TC, GND, or OFF. Channels whose coupling is set to OFF are not measured or displayed. Nor is it displayed.

▶ See here.

The setup menu varies depending on the input coupling that you select.

When the Input Coupling Is Set to DC, GND, or OFF

Labels (Label)

▶ See here.

Zoom Method (V Scale)

▶ See here.

Position (Position)

▶ See here.

Zooming by Setting a Magnification (V Zoom)

▶ See here.

Zooming by Setting Upper and Lower Display Limits (Upper/Lower)

▶ See here.

Inverted Waveform Display (Invert)

▶ See here.

Display Group (Display Group)

▶ See here.

Linear Scaling (Linear Scale)

▶ See here.

Copy (Copy to)

▶ See here.

When the Input Coupling Is Set to TC

Labels (Label)

▶ See here.

Reference Junction Compensation (RJC)

▶ See here.

Built-in reference junction in scanner box.

Burnout (Burn Out)

▶ See here.

Temperature Unit (Unit)

▶ See here.

Display Range (Upper/Lower)

▶ See here.

Inverted Waveform Display (Invert)

▶ See here.

Display Group (Display Group)

▶ See here.

Linear Scaling (Linear Scale)

▶ See here.

Copy (Copy to)

▶ See here.

Notes about Using the 16-CH Voltage Input Module (720220)
Notes about Using the 16-CH Temperature/Voltage Input Module (720221)

▶ See here.

Strain Measurement

For strain measurement, the items that have to be set for each input signal (CH1 to CH4) include vertical scales, sensor settings, the bandwidth limit, the display range, the range unit, trace settings, waveform inversion, and linear scaling.

To measure strain, connect a strain measurement bridge (bridgehead) or a strain gauge transducer to the 701270 (STRAIN_NDIS) or 701271 (STRAIN_DSUB) strain module.

For information about how to connect a bridgehead, see section 2.14 in the Getting Started Guide, IM DL350-03EN.

Waveform Display On and Off

Select whether to show or hide input signals for each channel.

- ON: Shows the waveform
- OFF: Hides the waveform

Vertical Scale (V Range)

You can select one of the following measurement ranges.

When µSTR Is Selected

500 µSTR, 1000 µSTR, 2000 µSTR, 5000 µSTR, 10000 µSTR, 20000 µSTR

For information about the measurement ranges, see section 6.13 in the *Getting Started Guide*, IM DL350- 03EN.

When mV/V Is Selected

0.25 mV/V, 0.5 mV/V, 1 mV/V, 2.5 mV/V, 5 mV/V, 10 mV/V

For information about the measurement ranges, see section 6.13 in the *Getting Started Guide*, IM DL350- 03EN.

The number that appears to the right of the range display is the maximum input at the current bridge voltage converted into a voltage value. It is the maximum input voltage for the selected range.

Bandwidth Limit (Bandwidth)

You can set the bandwidth limit to 10 Hz, 100 Hz, 1 kHz, or Full.

▶ See here.

Labels (Label)

▶ See here.

Configuring the Sensor (Sensor Setup)

Bridge Voltage (Excitation)

You can select the voltage to be applied to the bridge head.

- 2V: When the bridgehead resistance (bridge resistance) is 120 Ω to 1000 Ω
- 5V:* When the bridge resistance is 350 Ω to 1000 Ω
- 10V:* When the bridge resistance is 350 Ω to 1000 Ω

You cannot change the bridge voltage during waveform acquisition.

* The bridge voltage can be set to 5 V or 10 V only when:

- The bridge resistance is 350 Ω or more
- The strain gauge transducer supports a bridge voltage of 5 V or 10 V

Gauge Factor (Gauge Factor)

You can set the gauge factor of the strain gauge.

Selectable range: 1.90 to 2.20 (in steps of 0.01)

The gauge factor is a constant that is unique to the gauge. It should be listed in the manual or other documentation for your gauge. You cannot change the gauge factor during waveform acquisition.

Gauge Factor When mV/V Is Selected (Gauge Factor: K)

On the instrument, you can specify the gauge factor. If there is no recommended gauge factor for the strain gauge transducer, set the gauge factor to 2.00. For factors other than 2.00, e is computed with in the instrument using the following equation.

$e = (4/K) \times (V/E)$

e: The measured value of the strain gauge transducer (mV/V).

V: The measured bridge voltage (mV)

E: The applied bridge voltage (V)

K: The gauge factor

When you change the unit of a channel, the units for all the items related to the channel change.

- Upper and lower limits (Upper/Lower)
- Trigger level (Level)
- Automated measurement values of waveform parameters, cursor-measurement values, etc.

Performing Strain Balancing (Balance Execute)

Balancing automatically compensates the unbalanced portion of the bridge resistance. Balancing takes a few seconds.

Range within which balancing is performed:

- ±10000 μSTR (when μSTR is selected)
- ± 5 mV/V (when mV/V is selected)

Range Unit (Range Unit)

Set the range unit.

- µSTR: Units of strain ($\times 10^{-6}$ strain)
- mV/V: Units of strain-gauge-transducer output*

The relationship between µSTR and mV/V is shown in the equation below.

(mV/V) = 0.5 × (µSTR)/1000

Example

500 (µSTR) -> 0.5 × 500 (µSTR)/1000 = 0.25 (mV/V)

* A unit that corresponds to the strain gauge transducer's output. It indicates the amount of transducer output in mV that corresponds to 1 V of applied bridge voltage. On the instrument, the bridge voltage (excitation: applied bridge voltage) can be set to 2 V, 5 V, or 10 V, but the mV/V values are converted and displayed, so the measured values normally remain constant.

Display Range (Upper/Lower)

To display the measured waveform on the screen clearly, you can set upper and lower display range limits that are appropriate for the input.

Selectable range:

- −3.0000E+04 to +3.0000E+04 (when µSTR is selected)
- −1.5000E+01 to +1.5000E+01 (when mV/V is selected)

Set the limits so that the upper limit (Upper) is greater than the lower limit (Lower).

Linking the Upper and Lower Limits of the Display Range

You can change the upper and lower limits while keeping the interval between them constant.

Inverted Waveform Display (Invert)

▶ See here.

Display Group (Display Group)

▶ See here.

Linear Scaling (Linear Scale)

▶ See here.

The 701271 (STRAIN_DSUB) strain module supports shunt calibration.

Copy (Copy to)

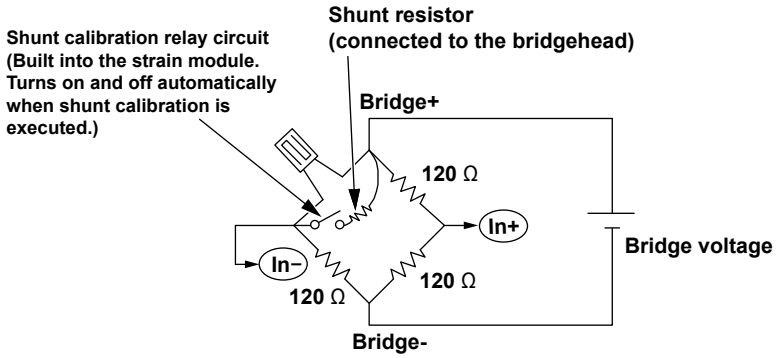
▶ See here.

- When you measure strain, be sure to perform balancing.
- Set the bridge voltage to 5 V or 10 V only when the bridge resistance is 350 Ω or greater. The strain will not be measured properly if you apply a bridge voltage of 5 V or 10 V when the bridge resistance is 350 Ω or less.
- When you use a strain gauge transducer, be sure to use it at a bridge voltage that is within the transducer's recommended voltage range.
- Balancing cannot be performed if there is no strain measurement bridge (bridgehead) or strain gauge transducer connected to the channel that you are trying to perform balancing on.
- When you perform balancing on all channels, if balancing fails on even one of the channels, an error message will appear along with information about the channels for which balancing failed.
- After you turn on the power, connect a new strain gauge, or change the measurement range, bridge voltage, or gauge factor, you need to perform balancing again before you perform measurement.
  The scale value is displayed as "imbalance" immediately after you turn on the power or when you change the range. In this kind of situation, perform balancing.
- When you change the unit of a channel, the units for all the items related to the channel change. This includes the upper and lower limits (Upper/Lower), trigger level (Level), automated measurement values of waveform parameters, and cursor-measurement values.

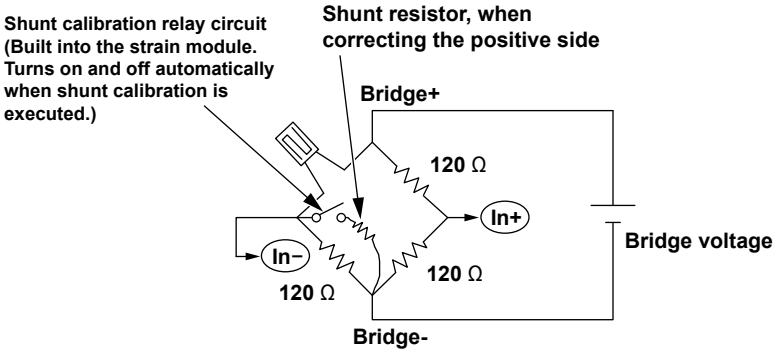
About Shunt Calibration (Only on the 701271(STRAIN_DSUB))

The 701271 (STRAIN_DSUB) strain module supports shunt calibration.
Shunt calibration is a type of scaling in which the strain measurement gain is adjusted through the connection in parallel of a known resistance (the resistance for shunt calibration, hereinafter referred to as the shunt resistance) to the strain gauge. The strain module (701271 (STRAIN_DSUB)) supports shunt calibration with a built-in shunt-calibration relay circuit.
To perform shunt calibration, you need a bridgehead that supports shunt calibration (the 701957 or 701958).

When correcting the gain on the negative side (normal)



When correcting the gain on the positive side



On the instrument, in addition to performing normal shunt calibration (when the shunt-calibration relay circuit is on), you can also set the zero-point value when the relay circuit is off. The zero-point value is valid when the strain value after balancing is performed is not 0.

Linear Scaling Modes (Scaling Mode)

Shunt

Select this mode to perform shunt calibration.

The other linear scaling modes are the same as those listed for voltage measurement.

▶ See here.

P1:X

When (Shunt Cal) Exec is performed, the input value when the relay circuit is off is applied.

P1:Y

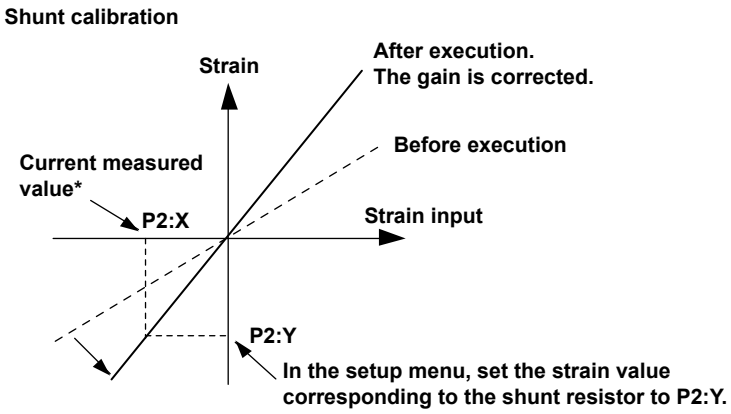
Set the value for when the relay circuit is off (normally 0).

P2:X

When the relay circuit is on and (Shunt Cal) Exec is performed, the input value when the relay circuit is on is applied.

P2:Y

Set the strain value that corresponds to the shunt resistance when the relay circuit is on.



*** Obtained automatically when shunt calibration is performed**

Unit (Unit)

You can set the unit using up to four alphanumeric characters.

Executing Shunt Calibration (Shunt Cal Exec)

Executes shunt calibration.

Display Type (Display Type)

The same as the linear scaling settings for voltage measurement.

▶ See here.

For details about shunt calibration, see appendix 4.

- When you execute shunt calibration, select an appropriate range so that the measured values will stay within the range when the shunt-calibration relay circuit is on. The instrument attempts to perform shunt calibration within the current range.
- An error message will appear if shunt calibration fails (because of out-of-range values or some other reason). When this happens, change the range, and perform shunt calibration again.

Acceleration Measurement

For acceleration measurement, the items that have to be set for each input signal (CH1 to CH4) include vertical scales, the vertical positions, input coupling, the bias, the bandwidth limit, the zoom method, the gain, trace settings, sensitivity, and the unit.
The 701275 (ACCL/VOLT) acceleration module (with AAF) can measure acceleration by using the signal from an acceleration sensor. You can connect it directly to an acceleration sensor with a built-in amp.
Load-output-type acceleration sensors without amp circuits cannot be connected directly to the 701275 (ACCL/VOLT). For information about how to connect acceleration sensors, see section 2.16 in the *Getting Started Guide*, IM DL350-03EN.

Waveform Display On and Off

Select whether to show or hide input signals for each channel.

- ON: Shows the waveform
- OFF: Hides the waveform

Vertical Scale (V/Div, V Range)

If you set the input coupling to anything other than ACCEL, set the vertical scale.

▶ See here.

Gain (Gain)

If you set the input coupling to ACCEL, set the gain.
You can set the ratio of the output signal to the input signal to a value from 0.1 to 100.

Input Coupling (Coupling)

To measure acceleration with the 701275 (ACCL/VOLT), set the input coupling to ACCEL.
To measure voltage, set the input coupling to an appropriate voltage measurement setting.

▶ See here.

Bandwidth Limit (Bandwidth)

You can set the bandwidth limit to 40 Hz, 400 Hz, 4 kHz, Auto, or Full.
When you set the bandwidth limit to Auto, an anti-aliasing filter (AAF) and low-pass filter are set in accordance with the sample rate, and high-frequency noise is removed from the input signal. By using an anti-aliasing filter when you measure voltages, you can remove the aliasing in the FFT.

▶ See here.

The filters can be used not just in acceleration measurements, but also in voltage measurements.

Bias (Bias)

Select whether to supply bias current to the acceleration sensor.

- ON: Bias current is supplied to the acceleration sensor.
- OFF: Bias current is not supplied to the acceleration sensor.

- Do not connect an acceleration sensor when Bias is set to ON. Doing so may damage the instrument.
- The bias current is 4 mA.

Labels (Label)
▶ See here.

Zoom Method (V Scale)
▶ See here.

Waveform Vertical Position (Position)
▶ See here.

Zooming by Setting a Magnification (V Zoom)
▶ See here.

Zooming by Setting Upper and Lower Display Limits (Upper/Lower)
▶ See here.

Unit (Unit)
Set the unit of acceleration to be displayed using up to four characters. The default setting is m/s^2. Change the unit as necessary.

Display Group (Display Group)
▶ See here.

Linear Scaling (Linear Scale)
▶ See here.

Copy (Copy to)
▶ See here.

Sensitivity (Sensitivity)
You can set the sensitivity of the acceleration sensor that you are using to a value between 0.10 mV/Unit and 2000.00 mV/Unit.

Frequency Measurement

For frequency measurement, the items that have to be set for each input signal (CH1 to CH4) include vertical scales, the vertical positions, FV settings, the input settings, the zoom method, the offset, trace settings, and linear scaling.

You can connect a sensor or probe to the 720281 (FREQ) frequency module and measure frequencies, revolutions, periods, duty ratios, power supply frequencies, pulse widths, pulse integration, and velocities. For the sensor connection method, see section 2.17 in the *Getting Started Guide*, IM DL350-03EN. For the probe connection method, see section 2.10.

- Waveform Display On and Off
- Vertical Scale (V/Div, V Range)
- FV Settings (F/V Setup)
- Settings for Each Item
- Labels (Label)
- Input Setup (Input Setup)
- Zoom Method (V Scale)
- Waveform Vertical Position (Position)
- Zooming by Setting a Magnification (V Zoom)
- Zooming by Setting Upper and Lower Display Limits (Upper/Lower)
- Display Group (Display Group)
- Linear Scaling (Linear Scale)
- Copy (Copy to)

Waveform Display On and Off

Select whether to show or hide input signals for each channel.

- ON: Shows the waveform
- OFF: Hides the waveform

Vertical Scale (V/Div, V Range)

▶ See here.

FV Setting (F/V Setup) - frequency measurement

- Measured Item (Function) - frequency measurement
- Settings for Each Item - frequency measurement
- Filter (Filter) - frequency measurement
- Deceleration and Stop Prediction - frequency measurement

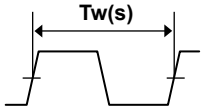
Measured Item (Function) - frequency measurement

You can choose one of the following items to measure.

- **Frequency (Frequency)**

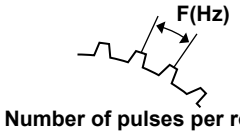
  Frequency (Hz) = 1 ÷ Tw (s)

  Measurable range: 0.01 Hz to 500 kHz



- **Revolutions (rpm)/Revolutions (rps) (Revolution(rpm)/Revolution(rps))**

  Revolutions (rpm) = Frequency (Hz) ÷ pulses per revolution (Nr) × 60
  Measurable range: 0.01 rpm to 100000 rpm
  Revolutions (rps) = Frequency (Hz) ÷ pulses per revolution (Nr)
  Measurable range: 0.001 rps to 2000 rps



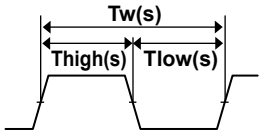
Number of pulses per rotation: Nr

- **Periods (Period)**

  Period (s) = Tw (s)
  Measurable range: 2 µs to 50 s

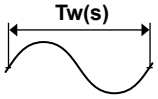
- **Duty Ratios (Duty)**

  Duty (%) = Thigh (s) ÷ Tw (s)
  Or, Duty (%) = Tlow (s) ÷ Tw (s)
  Measurable range: 0% to 100%



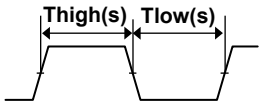
- **Power Supply Frequencies (Power Freq)**

  Power supply frequency (Hz) = 1 ÷ Tw (s)
  Resolution: 0.01 Hz
  Measurable range: (50 Hz, 60 Hz, or 400 Hz) ± 20 Hz



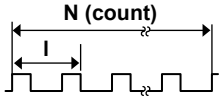
- **Pulse Widths (Pulse Width)**

  Pulse width (s) = Thigh (s)
  Or, pulse width (s) = Tlow (s)
  Measurable range: 1 µs to 50 s



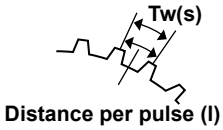
- **Pulse Integration (Pulse Integ)**

  Pulse integration = N (count) × physical amount per pulse (I)
  Set the physical amount per pulse (I) to the distance or flow rate.
  A suitable user-defined unit can be assigned to the specified physical amount.
  Measurable range: Up to 2×10^9 counts



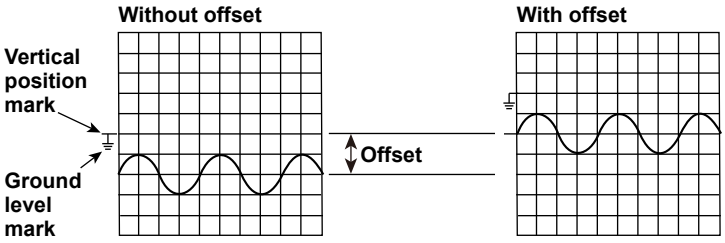
- **Velocity (Velocity)**

  Velocity (km/h) = distance per pulse l (km) ÷ Tw (s) × 3600
  Velocity (m/s) = distance per pulse l (m) ÷ Tw (s)
  You can define unique distances and units (angular velocity and other units).
  Measurable range: F (= 1/Tw) = 0.01 Hz to 500 kHz



Offset (Offset)

By setting an offset, you can move the waveform to a vertical position that is easier to see. You can set the offset for each channel.



Selectable Range of the Offset

The range varies depending on what is being measured.

- When measuring frequency: ±(Value/div) × 1000 or 500 kHz
- When measuring revolutions in rpm: ±(Value/div) × 1000 or 50 krpm
- When measuring revolutions in rps: ±(Value/div) × 1000 or 1000 rps
- When measuring periods: ±(Value/div) × 1000 or 50 s
- When measuring duty ratios: ±(Value/div) × 1000 or 100%
- When measuring power frequency: You cannot set an offset.
- When measuring pulse widths: ±(Value/div) × 1000 or 50 s
- When measuring pulse integration: ±(Value/div) × 1000 or 1.0000E+22
- When measuring velocity: ±(Value/div) × 1000 or 1.0000E+22

Notes about Setting the Offset

Changes to the offset are not applied when acquisition is stopped. The changed offset will be applied to the next measurement.

- The offset does not affect cursor-measurement values, automated measurement values of waveform parameters, or computed values.
- You can change the position of the waveform relative to the vertical position (change the focus of the vertical zoom) by changing the offset.

Settings for Each Item - frequency measurement

When Measuring Revolutions

Pulse/Rotation Setting (Pulse/Rotate)

Set the number of pulses per revolution to a value from 1 to 99999.

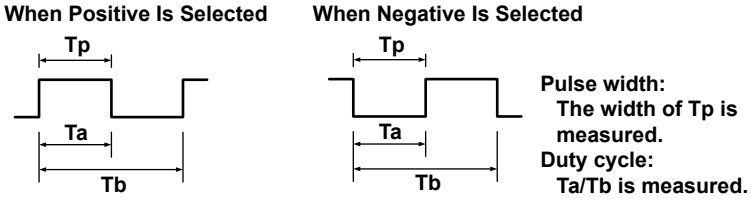
When Measuring Duty Ratios or Pulse Widths

- **Measured Pulse Setting (Measure Pulse)**

  Set the type of pulse to measure to Positive or Negative.

  When Measuring Duty Ratios
  - Positive: The rising-pulse percentage is measured.
  - Negative: The falling-pulse percentage is measured.

  When Measuring Pulse Widths
  - Positive: The rising-pulse width is measured.
  - Negative: The falling-pulse width is measured.



- **Timeout Period (Time out)**

  Set the timeout period for duty ratio measurement. If the pulse polarity does not change for longer than the specified time, the duty ratio is not measured.

  Selectable range: 0.00001 s (10 µs) to 80 s. The default setting is 10.00100 s.

  Resolution: 0.00001 s (10 µs)

  The duty ratio when a timeout occurs is 0% or 100%.
  - Duty ratio (%) when the type of pulse to measure is positive

    0%: When a timeout occurs with the input signal at low level

    100%: When a timeout occurs with the input signal at high level
  - Duty ratio (%) when the type of pulse to measure is negative

    0%: When a timeout occurs with the input signal at high level

    100%: When a timeout occurs with the input signal at low level

When Measuring Power Supply Frequency

Center Frequency Setting (Center Frequency)

Set the center frequency to 50 Hz, 60 Hz, or 400 Hz.

When Measuring Pulse Integration

- **Unit/Pulse Setting (Unit/Pulse)**

  You can set the physical amount per pulse to a value from −9.9999E+30 to 9.9999E+30.

- **Unit Setting (Unit)**

  You can set the displayed pulse-integration unit as necessary using up to four characters.

- **Over Limit Reset Setting (Over Limit Reset)**

  Select ON to reset the pulse count automatically when the range is exceeded. If you do not want to reset the pulse count, select OFF.

- **Manual Reset (Reset)**

  To manually reset the pulse count, select Exec.

When Measuring Velocity

- **Distance/Pulse Setting (Distance/Pulse)**

  You can set the distance per pulse to a value from −9.9999E+30 to 9.9999E+30.

- **Time Unit Setting (Time Unit)**

  You can set the unit of time to hour, min, or sec.
  The output is automatically converted to velocity based on the specified time unit.

- **Unit Setting (Unit)**

  Set the unit of velocity to be displayed using up to four characters. The default setting is m/s.

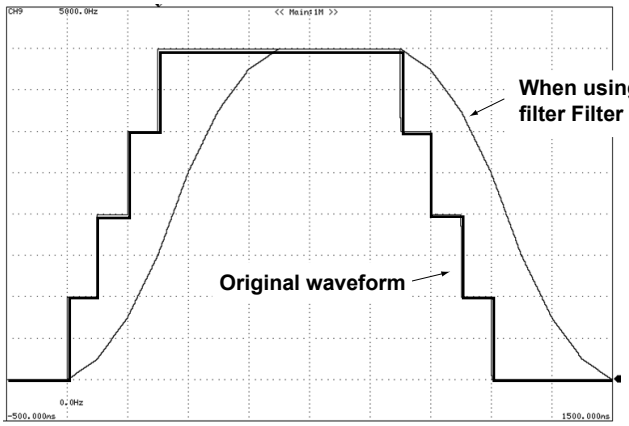
Filter (Filter) - frequency measurement

- **Smoothing (Smoothing)**

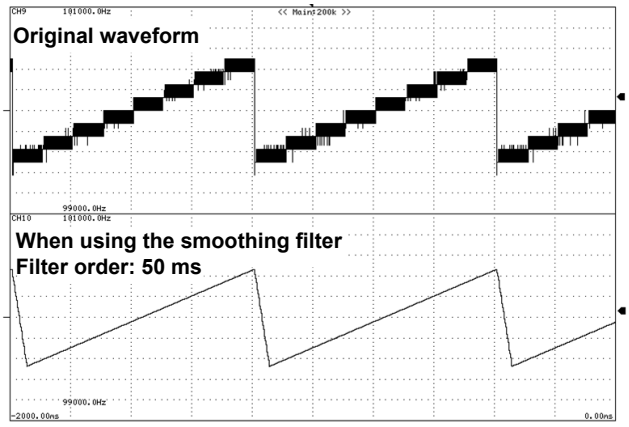
  The frequency module can display waveforms using real-time moving averages of the data. The moving average order can be set through the specification of a time value from 0.1 ms to 1 s (the maximum number of averages is 25000). The number of averages performed (moving average order) = the specified time ÷ 40 μs.

  The smoothing filter has the following characteristics.

  - Smoothes out staircase patterns.
  - Enables you to reduce measurement jitter and increase the resolution. Because of the increased resolution, you can perform high-precision measurements, especially when you measure high frequencies or use the offset feature and enlarge the waveform.
  - Can be used with all frequency-module measurement items.



When using the offset function and making measurements by expanding near 100 kHz

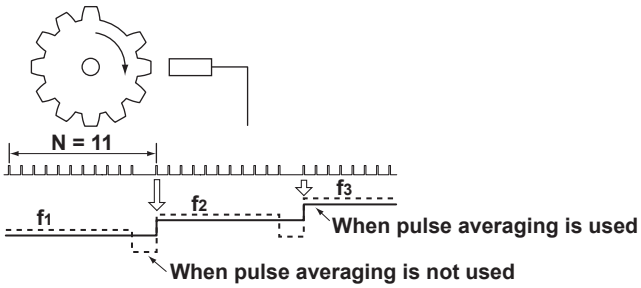


Value/div: 200 Hz/div
Upper display limit: 101 kHz
Lower display limit: 99 kHz

The accuracy improves when the smoothing filter is used.

- **Pulse Averaging (PulseAverage)**

  The input pulses are divided into groups of a specified number (1 to 4096 pulses) and measured. Pulse averaging has the following characteristics.
  - Enables you to eliminate the effects of missing pulses and inconsistent pulse intervals (inconsistencies in the frequency or period waveform) on measurement.
  - Even if you use pulse averaging, the measured results are displayed as per-pulse values, so there is no need to reperform scaling.
  - Pulse averaging can be used in measurements of frequencies, revolutions, periods, power supply frequencies, pulse integration, and velocities.



Deceleration and Stop Prediction - frequency measurement

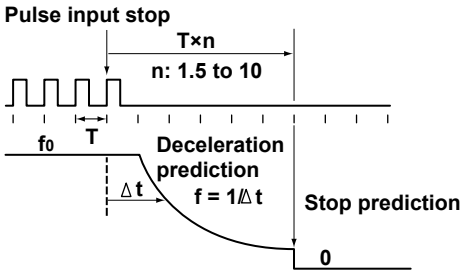
The 720281 (FREQ) automatically performs internal computation and displays waveforms by predicting the deceleration curve and stop point even when the input pulse is suddenly cut off. This function enables the measurement of waveforms of deceleration behavior that are close to the actual physical phenomenon in applications in which the deceleration behavior of an object that has inertia is measured, such as in automobile brake tests.

- **Deceleration Prediction (Deceleration Prediction)**

  The deceleration curve is computed according to the following equation using the elapsed time after the pulse input stops (Δt).
  Frequency (f) = 1/elapsed time (Δt)
  The deceleration prediction starts after the pulse input stops and a pulse period (T) of the pulse one period before the pulse input stopped elapses.

- **Stop Prediction (Stop Prediction)**

  The point at a specified time after the pulse input stops is considered a stop point, and the frequency is set to 0. The time from the point when the pulse input stops to the point when the instrument determines that the object has stopped can be set to 1.5, 2, 3, ..., 9, or 10 times (10 options) the pulse period (T) of the pulse one period before the pulse input stopped.



Labels (Label)

▶ See here.

Input Setup (Input Setup) - frequency measurement

Presets (Preset)

When you select a preset, the instrument automatically configures appropriate settings for all the signals (for some preset options, there are some settings that you will need to configure). You can select User to set all the settings to user-defined values. There are 10 types of presets. For details about the settings of each preset, see appendix 6.

- **Logic 5V, Logic 3V, Logic 12V, Logic 24V**

  Use this preset when the output from the sensor or other equivalent item changes in the range of 0 V to 5 V (or 3 V, 12 V, or 24 V: supply voltage applied to the sensor). The voltage range is automatically set to the optimum voltage range, and the threshold level is automatically set to one-half the voltage.

- **Pull-up 5V**

  Use this preset when the sensor output is open collector or contact output. The pull-up function is enabled only when this preset is selected. The pull-up voltage is approximately 5 V, and the pull-up resistor is 10 kΩ. If you enable the pull-up function, set the input voltage to a value from 0 V to 5 V. If the input voltage exceeds this range, the protection circuit is tripped, and the pull-up resistor is automatically cut off.

- **Zero Cross (ZeroCross)**

  Use this preset when the input voltage changes around 0 V. The input coupling is automatically set to AC, and the threshold level is automatically set to 0 V. When you set the voltage range, make sure that the maximum amplitude does not exceed the voltage range.

- **100 VAC, 200 VAC**

  Use this preset when measuring the supply voltage of 100 V or 200 V power supply systems. The probe type is automatically set to 10:1, the voltage range is automatically set to a value suitable for the input voltage and probe factor, and the coupling is automatically set to AC. Be sure to use the isolated probe (700929) when measuring the power supply voltage.

- **Electromagnetic Pickup(EM Pickup)**

  Use this preset when connecting an electromagnetic pickup directly. The voltage range is automatically set to ±1 V, and the threshold level is automatically set to 0 V.

- **User-Defined (User)**

  Use this preset to configure user-defined input conditions. The pull-up function cannot be enabled.

- When measuring high voltages exceeding 42 V (AC+DCpeak) on the 720281 (FREQ), be sure to use the isolated probe (700929).
- Use EM Pickup only when connecting an electromagnetic pickup.
- When the EM Pickup preset is selected, the LEDs of the frequency module do not illuminate in red, even when the range is exceeded.
- The instrument does not support electromagnetic pickups that need to have power supplied to them or pickups that require terminators at the output. Handle these types of electromagnetic pickups using sensors.
- Keep the output of the electromagnetic pickup within 42 V_{P-P}. The minimum sensitivity is 0.2 V_{P-P}. If the output is less than the minimum sensitivity, the measured values may be unstable.
- When you use the pull-up function, do not let the voltage go outside the range of 0 to 5 V. If the voltage goes outside of this range, the protection circuit will be tripped, and the pull-up circuit will be cut off.

The following 9 setup items are available.

Voltage Range (V Range)

You can set the input voltage range (±FS) to one of the options below.

- When the probe attenuation (Probe) is set to 1:1
  ±1 V, ±2 V, ±5 V, ±10 V, ±20 V, ±50 V (±FS)
- When the probe attenuation (Probe) is set to 10:1
  ±10 V, ±20 V, ±50 V, ±100 V, ±200 V, ±500 V (±FS)

Input Coupling (Coupling)

You can set the input coupling to DC or AC.

▶ See here.

Probe Type (Probe)

You can set the probe type to 1:1 or 1:10.

▶ See here.

Bandwidth Limit (Bandwidth)

You can set the bandwidth limit to 100 Hz, 1 kHz, 10 kHz, 100 kHz, or Full. You cannot select Full when Preset is set to AC100V or AC200V.

▶ See here.

Threshold Level (Threshold)

You can set the level within the FS of the input voltage range. The resolution is the value that corresponds to 1% of the FS.

Hysteresis (Hysteresis)

You can set the hysteresis to ±1%, ±2.5%, or ±5% of the FS of the input voltage range.

Slope (Slope)

Select ⨍ (rising) or ⨍ (falling).

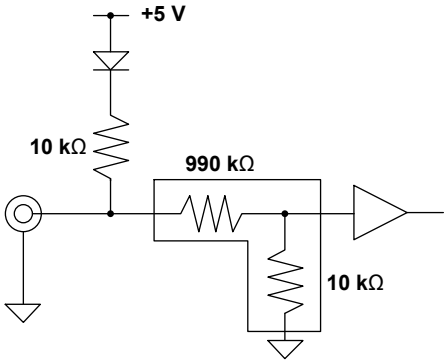
Chattering Elimination (Chatter Elimination)

Eliminates the chattering that occurs in cases such as when the contact input is turned on or off. The changes in the signal over the specified time can be discarded. You can set the interval to a value from 0 to 1000 ms (in 1 ms steps). When 0 ms is selected, chattering elimination is turned off.
Chattering elimination works on both rising and falling edges.

Pull Up (Pull Up)

You can choose whether to enable the pull-up function only when Preset is set to Pull-up 5V. You cannot configure the pull-up setting when another preset is selected.
If you enable the pull-up function, set the input voltage to a value from 0 V to 5 V. If you apply a voltage that is outside of this range, the internal protection circuit will cut off the pull-up circuit.

Internal Equivalent Circuit for When the Pull-up Function Is Enabled



Zoom Method (V Scale)

▶ See here.

Waveform Vertical Position (Position)

▶ See here.

Zooming by Setting a Magnification (V Zoom)

▶ See here.

Zooming by Setting Upper and Lower Display Limits (Upper/Lower)

▶ See here.

Display Group (Display Group)

▶ See here.

Linear Scaling (Linear Scale)

▶ See here.

Copy (Copy to)

▶ See here.

Logic Measurement

For logic measurement, the items that have to be set for each input signal (CH1 to CH6) include vertical positions, the logic bit settings, the logic bit mapping, the zoom method, and trace settings.
You can measure logic signals by connecting a logic probe to the 720230 (LOGIC) logic module or the logic input terminal of the instrument.
For information about how to connect logic probes, see section 2.15 in the Getting Started Guide, IM DL350-03EN.

Waveform Display On and Off

Select whether to show or hide input signals for each channel.

- ON: Shows the waveform
- OFF: Hides the waveform

Labels (Label)

▶ See here.

Bit Settings (Logic Bit Setup)

Bit Display On/Off (Display)

Select whether to show or hide the waveform of each bit.
Bit1 to Bit8, All Bits On, All Bits Off

Bit Name (Bit Name)

You can assign labels to bits using up to sixteen characters.

Depending on the display and zoom formats, label names may not appear when the waveform display is narrow.

Chattering Elimination (Chatter Elimination)

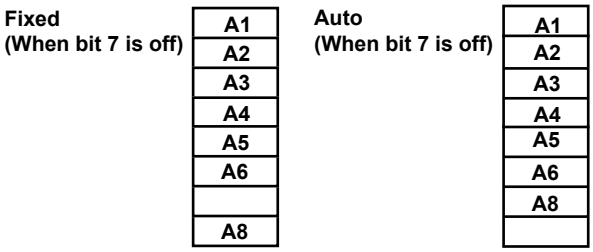
For each bit, you can set whether to eliminate chattering. When eliminating chattering, set the elimination time.
OFF, 5 msec, 10 msec, 20 msec, 50 msec, 100 msec

Zooming by Setting a Magnification (V Zoom)

▶ See here.

Bit Mapping (Bit Mapping)

- Fixed: Spaces are allocated for bits that are turned off.
- Auto: Spaces are not allocated for bits that are turned off. Only the bits that are turned on are displayed. The bits are displayed in order from the top.



Display Group (Display Group)

▶ See here.

Note about Logic Measurement

In the logic settings in the preferences, you can set the display format (Bit or Hex), the cursor order, and the bit order.

▶ See here.

CAN and CAN FD Bus Signal Monitoring (Applies to models with the /VE option)

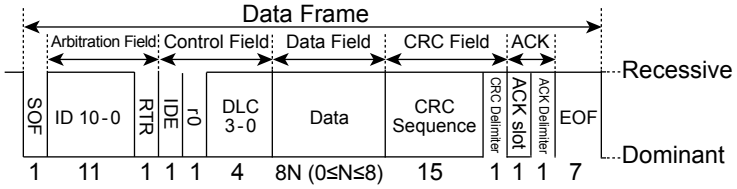
This feature is available only on models with the /VE option.

- You can monitor CAN bus signals using the 720240 CAN bus monitor module or the 720241 CAN & LIN bus monitor module.
- You can monitor CAN/CAN FD bus signals using the 720242 CAN/CAN FD monitor module or the 720245 CAN FD/LIN monitor module.

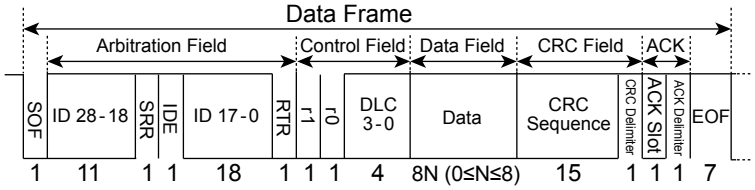
CAN Frame Formats

Data Frames

- **Standard format**

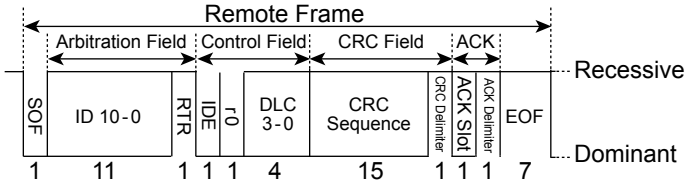


- **Extended format**

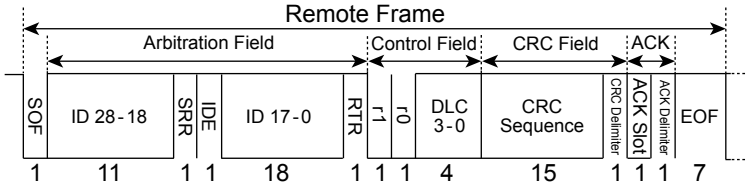


Remote Frames

- **Standard format**



- **Extended format**



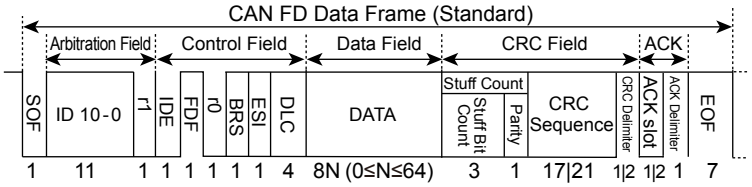
Motorola's Forward format setting is not supported.

CAN FD Frame Formats

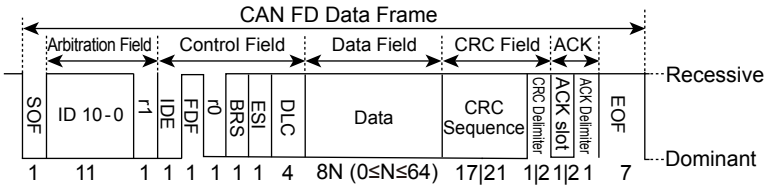
Data Frames

- **Standard format**

CAN FD (ISO 11898-1: 2015)

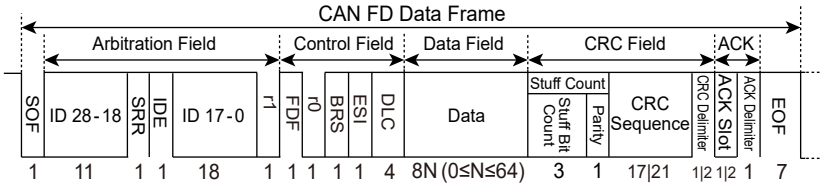


CAN FD (non-ISO)

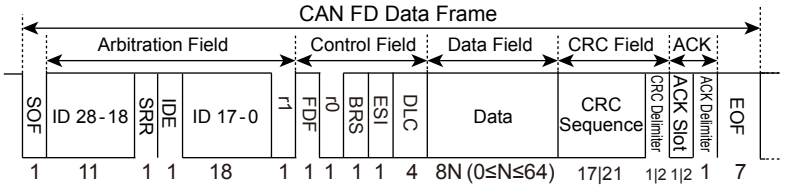


- **Extended format**

CAN FD (ISO 11898-1: 2015)



CAN FD (non-ISO)



The module can be connected as a node to an ISO-11898 CAN bus. The instrument uses the module to read the data frames transferred on the CAN bus and then extracts the specified portion of the data field (CAN data), converts it to time series data, and displays its waveform. The waveforms of up to 60 sub channels can be displayed. You can specify (define) the CAN data using Vector Informatik CANdb database files. Both the standard and extended formats are supported.
In addition, you can output single data frames or remote frames to a CAN bus at a specific time (one-shot output).

For CAN/CAN FD signal monitoring, the items that have to be set include port settings, data extraction conditions, the sub channel display range, the unit of measurement, trace settings, and scaling.

The instrument requires the following processing times to read data frames transferred on the CAN bus. New data frames that the instrument receives during these processing times may be discarded.

- 720240 or 720241

Number of Channels Used per Port	One Port in Operation	Two Ports in Operation
1	40 µs	80 µs
8	60 µs	120 µs
16	80 µs	160 µs
32	120 µs	240 µs
60	200 µs	400 µs

- 720242
  The processing time is 40 µs, regardless of the number of channels or the number of ports.
- 720245
  The processing time is 20 µs, regardless of the number of channels or the number of ports.

Waveform Display On and Off

You can select whether to display each port's input signal waveforms. Each port corresponds to CH1 to CH4.

- ON: Shows the waveform
- OFF: Hides the waveform

CAN/LIN Switching (CAN/LIN)

This setting is available when 720245 (CAN FD/LIN) is installed in the slot.

- CAN: CAN/CAN FD bus signals are monitored.
- LIN: LIN bus signals are monitored.

- Reading Data Frames (CAN Port Config.)
- Sub Channel Display Settings (Display) - CAN
- One Shot Output Settings (One shot out Setup)

Reading Data Frames (CAN Port Config.*)

- Port and All Sub Channel Settings (Port & All SubChannel Setup)
- Loading a CAN Data Definition File (Symbol File Load)
- Configuring the Scales of All Sub Channels (All SubChannel Auto Scale/Default Scale) - CAN

* In the 720245 (CAN FD/LIN) channel settings, the menu name becomes Port Config.

Port and All Sub Channel Settings (Port & All SubChannel Setup)

Port Settings (Port Setup)

- **Bit Rate (Bit Rate)**

  Select the CAN bus signal transmission speed.
  10k, 20k, 33.3k, 50k, 62.5k, 66.7k, 83.3k, 100k, 125k, 200k, 250k, 400k, 500k, 800k, 1Mbps

- **Sample Point (Sample Point)**

  Select the sample point for each bit.
  720240 (CAN MONITOR), 720241 (CAN & LIN): 71%, 78%, 85%
  720242 (CAN/CAN FD), 720245(CAN FD/LIN): 65% to 90%

- **Resynchronization Jump Width (Sync Jump Width)**

  This setting is available when 720240 (CAN MONITOR) or 720241 (CAN & LIN) is installed in the slot.
  Set the correction value used to synchronize the bit timing between sending and receiving nodes.
  1 to 4 in units of Tq (Time Quantum)

- **Number of Samples (Bit Sample Num)**

  This setting is available when 720240 (CAN MONITOR) or 720241 (CAN & LIN) is installed in the slot.
  You can set the number of samples at each bit's sample point.
  1: The sample point data is sampled once. We recommend that you use this setting for high-speed buses.
  3: The sample point data is sampled three times. We recommend that you use this setting for slow and medium speed buses.

- **J1939**

  This setting is available when 720245 (CAN FD/LIN) is installed in the slot.
  Select whether to handle (ON) or not handle (OFF) J1939.
  When ON is selected, IDs supported by J1939 can be used as the ID (Hex) for All SubChannel Setup, expanding the Byte Count and Start Bit setting ranges. Message Format is fixed to XTD and Byte Order to Little.

- **CAN FD**

  CAN FD Standard (FD Standard)

  This setting is available when 720242 (CAN/CAN FD) or 720245 (CAN FD/LIN) is installed in the slot.
  Select the compliant standard for the CAN FD bus signal to be applied.
  ISO: ISO 11898-1: 2015
  non-ISO: Standard before 2015

  Data Bit Rate (Data Bit Rate)

  This setting is available when 720242 (CAN/CAN FD) or 720245 (CAN FD/LIN) is installed in the slot.
  Select the CAN FD bus signal's data phase data transfer rate from one of the settings below.
  10k, 20k, 33.3k, 50k, 62.5k, 66.7k, 83.3k, 100k, 125k, 200k, 250k, 400k, 500k, 800k, 1M, 2M, 3M, 4M, 5Mbps

  Data Sample Point (Data Sample Point)

  This setting is available when 720242 (CAN/CAN FD) or 720245 (CAN FD/LIN) is installed in the slot.
  Select the sample point of the CAN FD bus signal's data phase bits.
  65% to 90%

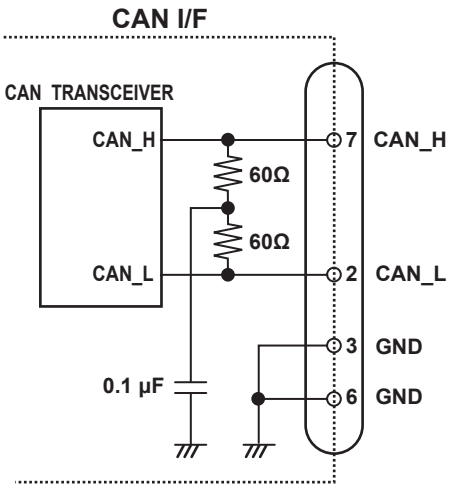
- **Listen Only (Listen Only)**

  ON: The ACK bit is not transmitted.
  OFF: The ACK bit is transmitted.

  One-shot output is not possible when Listen Only is set to ON.

- **Terminator (Terminator)**

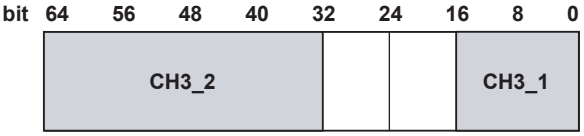
  ON: The 120 Ω terminator between CAN_H and CAN_L on the CAN bus line is turned on.
  OFF: The terminator between CAN_H and CAN_L on the CAN bus line is turned off.



CAN Data Extraction Conditions (All SubChannel Setup)

Set the extraction conditions for the CAN data that is in the data field. You can configure the settings for each sub channel. There are up to 60 sub channels for each port.

When the data field contains two units of data



- Start Bit = 0, Bit Count = 16bit → 2-byte integer (CH3_1)
- Start Bit = 32, Bit Count = 32bit → 4-byte real (CH3_2)

- **Input (Input)**

  ON: The data is monitored.
  OFF: The data is not monitored or displayed.

- **Labels (Label)**

  ▶ See here.

- **Message Format (Msg Fmt)**

  Select the message format of the collected data frames.
  STD: Standard format
  XTD: Extended format

- **ID (Hex)**

  Set the message ID of the collected data frames.

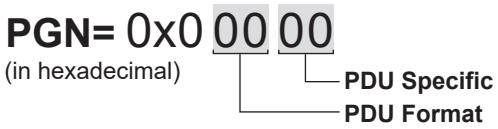
  - When a 720240 (CAN MONITOR), 720242 (CAN/CAN FD), or 720241 (CAN & LIN) is installed in the slot
    Standard format (11 bits): 0x000 to 0x7ff
    Extended format (29 bits): 0x00000000 to 0x1fffffff
  - When a 720245 (CAN FD/LIN) is installed in the slot
    - When J1939 is OFF
      Standard format (11 bits): 0x000 to 0x7ff
      Extended format (29 bits): 0x00000000 to 0x1fffffff
    - When J1939 is ON
      Set the following items.
      Format (Format): Select the notation used to set the following items: hexadecimal (Hex) or decimal (Dec).
      PGN: 0x00000 to 0x3ffff
      Source[1]: 0x00 to 0xff
      Priority[1]: 0x0 to 0x7
      Destination[1]: 0x00 to 0xff
      ID[2]: 0x00000000 to 0x1fffffff

  1 Source and Destination become Don't Care if they are set to 0xfe (NULL address). Priority is always Don't Care.

  2 ID is linked to PGN, Source, Priority, and Destination settings.

PGN value

The underlined sections of the PGN value in the following figure are called PDU Format and PDU Specific.



If the PDU Format is less than f0 (240 in decimal notation), PDU Specific is specifying the Destination value.
If the PDU Format is greater than or equal to f0, PDU Specific is part of the PGN value.
For example, if you set PGN to 0x0ee99, PGN is 0x0ee00 and Destination is 0x99. If you set PGN to 0x0f099, PGN is 0x0f099, and Destination is fixed to 0xff.

- **Byte Count**

  Set the method for extracting the data area of the collected data frames.
  The data extraction range is set to the specified number of bytes from the beginning of the data. This is valid when big endian byte order is in use. If you specify 0, Auto is selected, and all data will be extracted. Normally use Auto. When little endian byte order is in use, the instrument always runs with Byte Count in the Auto setting.

  - 720240 or 720241
    Auto, 1 to 8
  - 720242, 720245(J1939 is OFF)
    Auto, 1 to 64
  - 720245 (J1939 is ON)
    Auto, 1 to 1785

- **Start Bit**

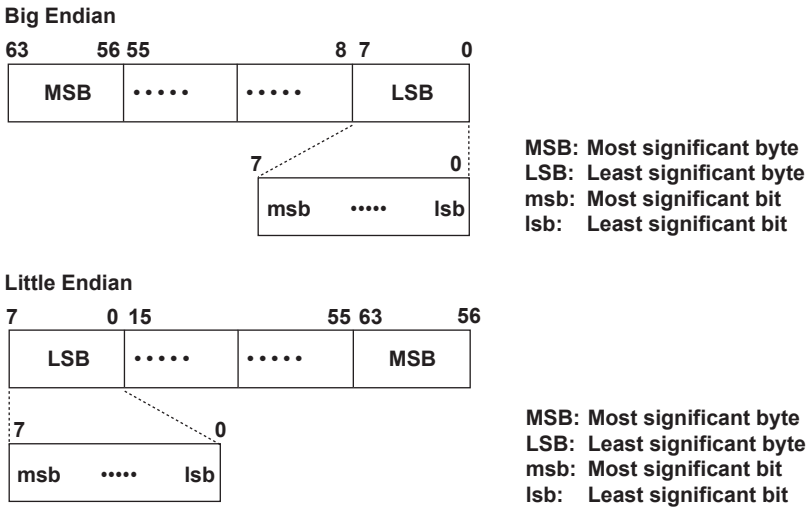
  Specify the bit number of the data extraction starting point.
  - 720240 or 720241
    0 to 63
  - 720242, 720245(J1939 is OFF)
    0 to 511
  - 720245 (J1939 is ON)
    0 to 14279

- **Bit Count (Bit Cnt)**

  Set the number of data bits to extract. The range that you can specify varies depending on the data type.
  Unsigned, Signed: 2 to 32
  Float: The bit length that can be set is only 32.
  Logic: 1 to 8

- **Byte Order**

  Select the method (endian) to use to store the data in the acquisition memory.



- **Value Type**

  Select the type of CAN data to extract.
  Unsigned: Unsigned integer
  Signed: Signed integer
  Float: Real number
  Logic: Boolean

You can monitor up to 60 sub channels with a single port.
If the input is turned on for all the sub channels and the bit length of each sub channel is 16 bits or less, you can monitor all 60 sub channels.
However, the amount of memory is limited, so each time that the length of a sub channel is set longer than 16 bits, the instrument turns the input of sub channels off (sets them so that they cannot be monitored) in decreasing order starting with sub channel number 60 until the memory usage is within the memory limitations.

All Sub channels Factor/Offset(All SubChannel Factor/Offset)

Configure these settings when the data type is set to Unsigned, Signed or Float. The Factor and Offset values that you set here are used to convert the extracted data to physical values.
Factor: Scaling coefficient (value per bit)
Offset: Offset value
Selectable range: −10.000E+30 to +10.000E+30

Unit

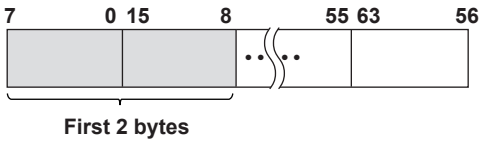
Using up to 16 characters, enter the unit to display for the waveform.

Multiplex Setup (Multiplex Setup)

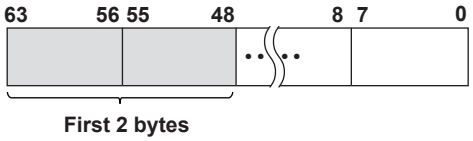
This setting is available when 720245 (CAN FD/LIN) is installed in the slot.
Only the data specified by the Multiplex setting is extracted from the CAN data multiplexed according to Multiplexor and Multiplex Value and acquired in the sub channel. For details, see “Example of Multiplexed CAN Data.”

- **Multiplexor**
  Designates another sub channel of the same channel as the sub channel that you are currently setting as Multiplexor. Select “–” when you are not specifying Multiplexor.
  - Multiplexor Conditions
    Only the sub channels that meet the following setup conditions can be designated as Multiplexor.
    - The message ID and message format settings match those of the sub channel that you are currently setting.
    - The extraction range does not overlap the extraction range of the sub channel that you are currently setting.
    - The extraction range is in the first 2 bytes of the data frame.

Little Endian



Big Endian (e.g., when Byte Count is 8)



  - Multiplexor Setup
    - When there are sub channels that can be designated as Multiplexor
      The menu options show only the sub channels that can be designated as Multiplexor.
    - When there are no sub channels that can be designated as Multiplexor
      A screen appears that helps you with the setup. You can change the sub channel settings or designate a channel as Multiplexor while viewing the reason for not being able to designate a sub channel as Multiplexor.

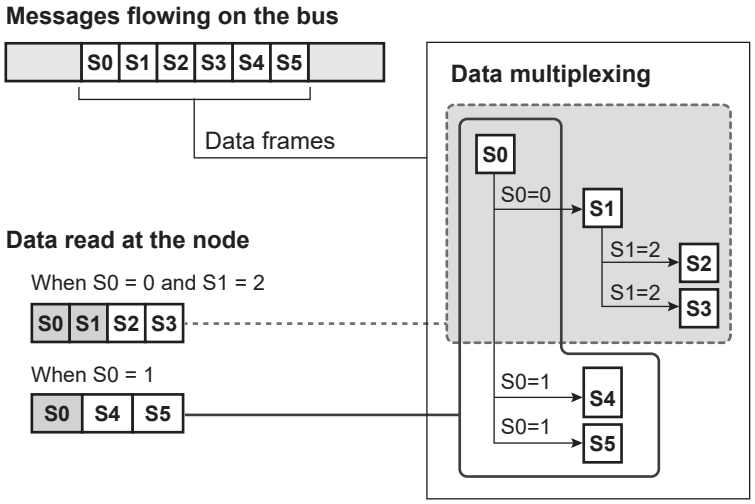
- When a sub channel designated as Multiplexor (CH3_1 for example) no longer meets the Multiplexor conditions or if you designate a sub channel that does not meet the conditions on the screen that helps you with the setup, “ⓘCH3_1” will be displayed, and the setup will be invalid.
- If a sub channel designated as Multiplexor by another sub channel can further designate another sub channel as Multiplexor. However, even between sub channels indirectly related by Multiplexor, as in this case, the above Multiplexor conditions must be met. Also, two sub channels cannot be designated as Multiplexor to each other (including sub channels indirectly related by Multiplexor). For example, if you designate CH3_1 as Multiplexor from CH3_2, you cannot designate CH3_2 as Multiplexor from CH3_1.

- **Multiplex Value**
  Assign a specific value to Multiplexor. If Multiplexor is not designated, this is fixed to 0.
  Selectable range: 0 to the maximum value that can be counted by the Bit Count value (bit length) of the sub channel designated as Multiplexor*

* For example, if Bit Count is 8 bits, the maximum is 0x00FF.

Example of Multiplexed CAN Data

Multiplexed CAN data frames consist of Multiplexor data and data that reference the Multiplexor. Whether the data that reference the Multiplexor is read by a node on the CAN bus is determined by the Multiplexor value (Multiplex Value) that is referenced.
In the following example, S0 is the Multiplexor referenced by S1, S4, and S5, and S1 is the Multiplexor referenced by S2 and S3. The S0 and S1 values (Multiplex Value) determine the combination of data that the node reads.



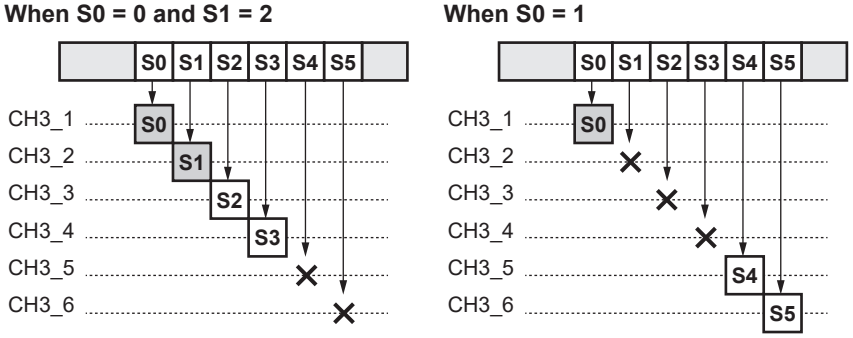
The case where the multiplex value of the multiplexor (e.g., S0) is 0 is indicated as “S0 = 0.”

Example of Multiplex Settings

Taking the above message as an example, the settings for acquiring data from multiplexed CAN data into the instrument are shown below. Only the data of sub channels whose specified Multiplexor and Multiplex Value match those of the CAN data flowing on the bus is acquired.

Sub Channel	Extracted Data	Multiplexor	Multiplex Value	Data Acquisition Conditions*
CH3_1	S0	-	-	Always acquired
CH3_2	S1	CH3_1	0	When S0 = 0
CH3_3	S2	CH3_2	2	When S0 = 0 and S1 = 2
CH3_4	S3	CH3_2	2	When S0 = 0 and S1 = 2
CH3_5	S4	CH3_1	1	When S0 = 1
CH3_6	S5	CH3_1	1	When S0 = 1

* The case where the multiplex value of the multiplexor (e.g., S0) is 0 is indicated as “S0 = 0.”



Loading a CAN/CAN FD Data Definition File (Symbol File Load)

You can configure the CAN/CAN FD data extraction conditions by loading a CAN/CAN FD data definition file (an SBL file).* Data that has been edited using Symbol Editor is assigned to the instrument's sub channels 1 to 60 according to the order in the definition list (you can change the order in the Symbol Editor's definition list).*

* An SBL file (.SBL extension) is a CANdb file (.dbc extension) that has been converted and edited into a physical value/symbol definition file using YOKOGAWA's free Symbol Editor software. You can obtain Symbol Editor from the YOKOGAWA website (https://tmi.yokogawa.com/library/).
CANdb files (.dbc) are signal definition database files created using the CANdb or CANdb++ software produced by Vector Informatik.

Configuring the Scales of All Sub Channels (All SubChannel Auto Scale/Default Scale) - CAN

Configure the scales of all sub channels.
Auto Scale: The upper and lower display range limits are set automatically.
Default Scale: To the greatest extent possible within the settable range, the maximum and minimum values are used to set the display range setting (which is explained below) of the specified sub channel.

Sub Channel Display Settings (Display) - CAN

Configure the display label, zoom magnification, scaling method, and display range settings of the specified sub channel.

Waveform Vertical Position (Position)

Configure this setting when Value Type is set to Logic.

▶ See here.

Zooming by Setting a Magnification (V Zoom)

Configure this setting when Value Type is set to Logic.
Selectable range: x0.1 to x3.33

▶ See here.

Display Range (Upper/Lower)

Configure this setting when Value Type is not set to Logic.
Set the upper and lower limits of the waveform display range.
Selectable range: −30.000E+30 to +30.000E+30

Auto Scale (Auto Scale)

Configure this setting when Value Type is not set to Logic.
The upper and lower display range limits are set automatically.

Default Scale (Default Scale)

Configure this setting when Value Type is not set to Logic.
To the greatest extent possible within the settable range, the maximum and minimum values are used to set the display range setting (explained earlier) of the specified sub channel.

Display Group (Display Group)

▶ See here.

One Shot Output Settings (One Shot Out Setup)

A single specified data frame or remote frame is output at the specified time.

Message Type

This setting is available when 720242 (CAN/CAN FD) or 720245 (CAN FD/LIN) is installed in the slot.
Select the message type.
CAN, CAN FD

Message Format

Select the message format.
STD: Standard format
XTD: Extended format

ID (Hex)

Set the message ID of the output data frame.
Standard format (11 bits): 0x000 to 0x7ff
Extended format (29 bits): 0x00000000 to 0x1fffffff

Frame

Select the frame type.
Remote: Remote frame
Data: Data frame

DLC

Configure this setting when the frame type (Frame) is set to Data.
Set the byte size of the data area of the data frame.
Selectable range: 0 to 15

Setup

Set the above items and Data (Hex).

- **Data (Hex)**
  Configure this setting when the frame type (Frame) is set to Data.
  In hexadecimal notation, specify the data frame value to output.

One Shot Out

Output the data.

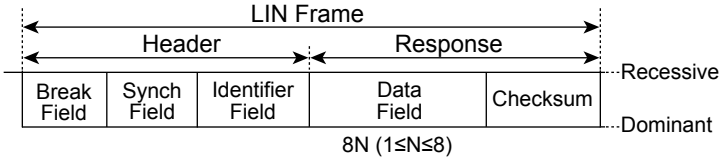
You cannot output the data when in the Port Setup menu, Listen Only is set to ON.

LIN Bus Signal Monitoring (Applies to models with the /VE option)

You can monitor LIN bus signals using the 720245 CAN FD/LIN monitor module or the 720241 CAN & LIN bus monitor module. This feature is available only on models with the /VE option.
For details on the CAN bus signal monitoring feature, see “CAN and CAN FD Bus Signal Monitoring (Applies to models with the /VE option).”

▶ See here.

LIN Frame Format



This section explains the LIN bus signal monitoring feature.
The instrument uses the module to read the ISO-9141 signal, that is transferred on the LIN bus and then extracts the specified portion of the LIN frame (LIN data), converts it to time series data, and displays its waveform. The waveforms of up to 60 sub channels can be displayed. You can also use the LIN descriptor files (LDF) that are described in the LIN configuration language specification to specify (define) LIN data.

For LIN bus signal monitoring using a CAN & LIN Bus Monitor Module, the items that have to be set include port settings, frame settings, data extraction conditions, sub channel display range, unit of measurement, trace settings, and scaling.

The instrument requires the following processing times to read data frames transferred on the LIN bus. New frames that the instrument receives during these processing times may be discarded.

- 720245
  The processing time is 20 µs, regardless of the number of channels or the number of ports.
- 720241

Number of Channels Used per Port	Only LIN Port in Operation	CAN Port in Operation at the Same Time
1	40 µs	80 µs
8	60 µs	120 µs
16	80 µs	160 µs
32	120 µs	240 µs
60	200 µs	400 µs

Waveform Display On and Off

You can select whether to display each port’s input signal waveforms. Each port corresponds to CH1 to CH4.

- ON: Shows the waveform
- OFF: Hides the waveform

CAN/LIN Switching (CAN/LIN)

▶ See here.

- Reading Data Frames (LIN Port Config.)
- Sub Channel Display Settings (Display) - LIN

Reading Data Frames (LIN Port Config.*)

- Frame and All Sub Channel Settings (Frame & All SubChannel Setup)
- Loading a LIN Data Definition File (Symbol File Load)
- Configuring the Scales of All Sub Channels (All SubChannel Auto Scale/Default Scale)

* In the 720245 (CAN FD/LIN) channel settings, the menu name becomes Port Config.

Frame and All Sub Channel Settings (Frame & All SubChannel Setup)

Frame Settings (Frame Setup)

Set the data length and checksum method for LIN frames. You can configure these settings for each ID.

- **Bit Rate (Bit Rate)**

  Select the LIN bus signal transmission speed.
  2400, 9600, 19200bps

- **Data Length**

  Set the data length of the data field.
  1 to 8

- **Checksum**

  Select the checksum method.
  Classic, Enhanced

LIN Data Extraction Conditions (All Sub Channel Setup)

Set the extraction conditions for the LIN data that is in the data field. You can configure the settings for each sub channel.
There are up to 60 sub channels for each port.

When the data field contains two units of data

- Start Bit = 0, Bit Count = 16bit → 2 bytes (CH2_1)
- Start Bit = 32, Bit Count = 32bit → 4 bytes (CH2_2)

- **Input (Input)**

  ON: The data is monitored.
  OFF: The data is not monitored or displayed.

- **Labels (Label)**

  ▶ See here.

- **ID (Hex)**

  Set the ID (6 bits) of the LIN frame to acquire.
  0x00 to 0x3f

- **Start Bit**

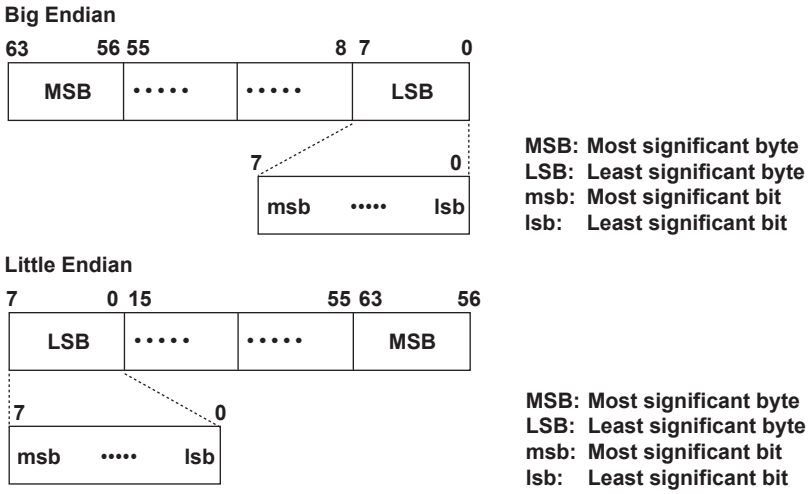
  Specify the bit number of the data extraction starting point.
  0 to 63

- **Bit Cnt**

  Set the number of data bits to extract. The range that you can specify varies depending on the data type.
  Unsigned, Signed: 2 to 32
  Logic: 1 to 8

- **Byte Order**

  Select the method (endian) to use to store the data in the acquisition memory.



- **Value Type**

  Select the type of data to extract.
  Unsigned: Unsigned integer
  Signed: Signed integer
  Logic: Boolean

You can monitor up to 60 sub channels with a single port.
If the input is turned on for all the sub channels and the bit length of each sub channel is 16 bits or less, you can monitor all 60 sub channels.
However, the amount of memory is limited, so each time that the length of a sub channel is set longer than 16 bits, the instrument turns the input of sub channels off (sets them so that they cannot be monitored) in decreasing order starting with sub channel number 60 until the memory usage is within the memory limitations.

All Sub channels Factor/Offset(All SubChannel Factor/Offset)

Configure these settings when the data type is set to Unsigned or Signed. The Factor and Offset values that you set here are used to convert the extracted data to physical values.
Factor: Scaling coefficient (value per bit)
Offset: Offset value
Selectable range: –10.000E+30 to +10.000E+30

Unit

Using up to 16 characters, enter the unit to display for the waveform.

Loading a LIN Data Definition File (Symbol File Load)

You can configure the LIN data extraction conditions by loading a LIN data definition file (an SBL file).*
Data that has been edited using Symbol Editor is assigned to the instrument's sub channels 1 to 60 according to the order in the definition list (you can change the order in the Symbol Editor's definition list).*

* An SBL file (.SBL extension) is an LDF file that has been converted and edited into a physical value/symbol definition file using YOKOGAWA's free Symbol Editor software. You can obtain Symbol Editor from the YOKOGAWA website (https://tmi.yokogawa.com/library/).
A LDF file is a definitions file that has been written according to the LIN configuration language specification.

Configuring the Scales of All Sub Channels (All SubChannel Auto Scale/Default Scale) - LIN

Configure the scales of all sub channels.

All SubChannel Auto: The upper and lower display range limits are set automatically.

All SubChannel Default: To the greatest extent possible within the settable range, the maximum and minimum values are used to set the upper and lower limits of all sub channels.

Sub Channel Display Settings (Display) - LIN

Configure the display label, zoom magnification, scaling method, and display range settings of the specified sub channel.

Waveform Vertical Position (Position)

Configure this setting when Value Type is set to Logic.

▶ See here.

Zooming by Setting a Magnification (V Zoom)

Configure this setting when Value Type is set to Logic.

Selectable range: x0.1 to x3.33

▶ See here.

Display Range (Upper/Lower)

Configure this setting when Value Type is not set to Logic.

Set the upper and lower limits of the waveform display range.

Selectable range: −30.000E+30 to +30.000E+30

Auto Scale (Auto Scale)

The upper and lower display range limits are set automatically.

Default Scale (Default Scale)

To the greatest extent possible within the settable range, the maximum and minimum values are used to set the display range setting (explained earlier) of the specified sub channel.

Display Group (Display Group)

▶ See here.

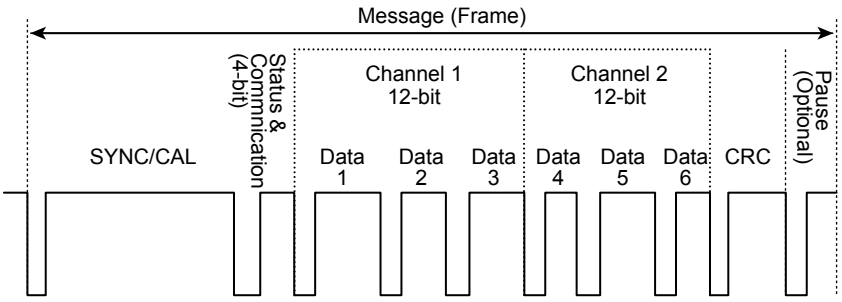
SENT Signal Monitoring (Applies to models with the /VE option)

You can monitor SENT signals using the 720243 SENT monitor module. This feature is available only on models with the /VE option.

SENT Message Format

Fast CH

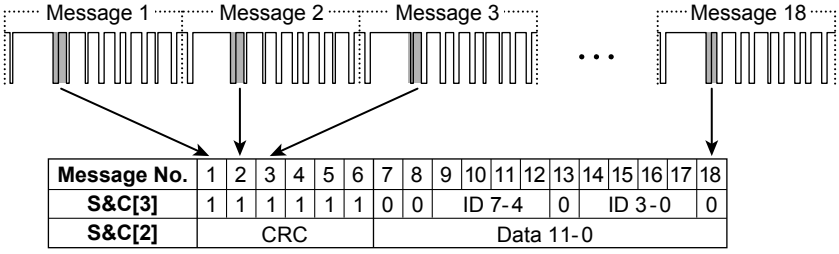
- Up to 6 nibbles (24 bits) of data can be sent.
- The size of the value is expressed with the pulse width. 0: 12 ticks to 15: 27 ticks



Example of 12-bit data x 2

Slow CH

- Composed of bits 2 and 3 of the S&C (Status & Communication) nibble of multiple Fast CH data.
- Sends data that changes slowly and error information.
- Three types of formats (data size 8-bit, 12-bit, 16-bit) are available.



Message No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
S&C[3]	1	1	1	1	1	1	0	0	ID 7-4				0	ID 3-0				0
S&C[2]	CRC						Data 11-0											

Example of Enhanced (ID 8bit + Data 12bit)

This module reads SENT signals based on SAE J2716, extracts the specified portion of the SENT message, converts it to time series data, and displays its waveform. This module has two ports. For each port, the waveforms of up to 11 sub channels can be displayed.

For SENT signal monitoring using a SENT monitor module, the items that have to be set include format, error channel, probe, data extraction conditions, sub channel display range, unit of measurement, trace settings, and scaling.

- Waveform Display On and Off
- Reading SENT Messages (SENT Port Config. - Port Setup)
  Frame settings (SENT Format), Error channel settings (Error Channel Setup), Input settings (Input Setup)
- SENT Data Extraction Conditions
  Common settings, data type FastCH extraction conditions, data type SlowCH extraction conditions
- SENT Data Conversion Conditions
- SENT Data Display Settings (Display)
  Trace settings (Trace Setup), display group (Select Display Gr.), sub channel 1: FastCH to 11: Error Count display settings

Waveform Display On and Off

You can select whether to display each port's input signal waveforms. Each port corresponds to CH1 to CH4.

- ON: Shows the waveform
- OFF: Hides the waveform

Reading SENT Messages (Port Setup)

Setting the Format (SENT Format)

Set the message format for SENT signals.

Clock Tick (Clock Tick)

Set the reference clock period of SENT signals. The time between consecutive falling edges of the signal is counted using this period. The clock tolerance is fixed at ±20.0%.
Selectable range: 1.00 µs to 100.00 µs
Resolution: 0.01 µs

Data Nibble Number (Data Nibble Number)

Set the number of data nibbles of Fast CH messages.
Selectable range: 1 to 8

Pause Pulse (Pause Pulse)

Select whether to include pause pulses in Fast CH messages.
ON: Pause pulses are included.
OFF: Pause pulses are not included.

CRC Type (CRC Type)

Select the CRC type.
Legacy: CRC is added using the type recommended in version FEB2008 and older.
Recommended: CRC is added using the type recommended in version JAN2010.

Slow CH Type (SlowCH Type)

Select the Slow CH message format.
Short (ID 4bit + Data 8bit): 4 bit message ID and 8 bit data field
Enhanced (ID 8bit + Data 12bit): 8 bit message ID and 12 bit data field
Enhanced (ID 4bit + Data 16bit): 4 bit message ID4 and 16 bit data field

High Speed 12bit (High Speed 12bit)

Select whether to handle (ON) or not handle (OFF) High Speed 12bit.
When set to ON, data nibble number is fixed to 4.

Fast Channel Multiplexing (Fast Channel Multiplexing)

Select whether to handle (ON) or not handle (OFF) fast channel multiplexing.
ON: You can specify FC and set the data type of sub channels 5 to 9 to Fast CH.
OFF: The FC setup menu does not appear. The data type of sub channels 5 to 9 is fixed to Slow CH.

Fast channel multiplexing can be handled when the 720243 (SENT) module version is 0x07 or later.

Setting Error Channels (Error Channel Setup)

For each of the following error types, set whether to detect them as errors, whether to display triggers, and whether to count them as errors.

Error Type	Error Detection (Detect)	Trigger Display (Error Trigger)	Error Count (Error Count)
Fast Channel CRC	Always ON	ON/OFF	ON/OFF
Slow Channel CRC	Always ON	ON/OFF	ON/OFF
Nibble Value	Always ON	ON/OFF	ON/OFF
Successive Calibration Pulses (Option2)	ON/OFF	ON/OFF	ON/OFF
Pulse Number	Always ON	ON/OFF	ON/OFF

ON: enable, OFF: disable

Error Detection (Detect)

- **Fast Channel CRC**

  An error is detected when the CRC Nibble value of the Fast CH message is different from the value calculated using the specified CRC type (explained earlier). If an error is detected, the data in the Fast CH message is not used to update the Fast CH data. Nor is the Slow CH data that includes a Fast CH message updated.

- **Slow Channel CRC**

  An error is detected when the CRC value of the Slow CH data obtained from the Fast CH message S&C Nibble value is not correct. If an error is detected, the Slow CH data is not updated.

- **Nibble Value**

  An error is detected when the nibble length of S&C, data, or CRC is outside the 12 to 27 tick range after a SYNC/CAL pulse of the Fast CH message is detected. If an error is detected, the data in the Fast CH message is not used to update the Fast CH data. Nor is the Slow CH data that includes a Fast CH message updated.

- **Successive Calibration Pulses (Option2)***

  An error is detected, when as a result of comparing the SYNC/CAL pulse of the current Fast CH message to the last preceding valid SYNC/CAL pulse, their difference is 1/64 tick or greater. If an error is detected, the data in the Fast CH message is not used to update the Fast CH data.
  However, if three consecutive errors are detected, the third SYNC/CAL pulse is considered as valid, and the third Fast CH message data is used to update the Fast CH data.

  * The instrument uses the “Option 2” detection method as defined in SAE J2716.

- **Pulse Number**

  An error is detected when the number of SYNC/CAL pulses of the current Fast CH message and the number of the next SYNC/CAL pulses are different from the specified value (the number of data nibbles explained earlier, Pause Pulse ON/OFF). If no other errors are detected, the data in the Fast CH message is used to update the Fast CH data. The Slow CH data that includes a Fast CH message is also updated.

If a SYNC/CAL pulse is not detected within the timeout period explained later, all Fast CH and Slow CH data are set to zero. This is not detected as an error.

Trigger Display (Error Trigger)
If an error is detected, the pulse waveform is displayed for two sampling periods of the SENT module.

Error Count (Error Count)

An error is counted when any of the error types is detected. This shows the total number of errors.
Maximum count: 65535

Error Count Reset (Error Count Reset on Start)

Set whether to reset the error count to zero when waveform acquisition is started with the START/STOP key on the front panel.
ON: The count is reset.
OFF: The count is not reset.

Manual Error Count Reset (Error Count Reset)

You can manually reset the error count to zero.

Input Settings (Input Setup)

Set the probe attenuation and the timeout value for SENT signal input. The threshold level is fixed.

Probe Attenuation (Probe)

Select the attenuation of the probes connected to SENT ports.
1:1, 10:1

Threshold Level (Threshold H, Threshold L)

The threshold level for determining whether the SENT signal is high or low level is fixed.
Threshold H: 3.5 V
Threshold L: 1.5 V

* The SENT module voltage range is fixed at ±20 V.

Timeout Value (Time Out)

Set the timeout value for SYNC/CAL pulse detection.
If a SYNC/CAL pulse is not detected within the specified time, all Fast CH and Slow CH data are set to zero.
Selectable range: 0.1 ms to 2000.0 ms
Resolution: 0.1 ms

SENT Data Extraction Conditions (All Sub Channel Setup)

Set the extraction conditions for each data type.

SENT Data Acquisition Destination

SENT data is extracted and acquired in each sub channel. The types of data acquired in sub channels are as follows. When Fast Channel Multiplexing is set to ON, you can select Fast CH for sub channels 5 to 9.

- **Fast Channel Multiplexing Is Set to OFF**

Sub Channel	Data Type
1:FastCH	FastCH
2:FastCH	FastCH
3:FastCH	FastCH
4:S&C	S&C (Status & Communication)
5:SlowCH	SlowCH
6:SlowCH	SlowCH
7:SlowCH	SlowCH
8:SlowCH	SlowCH
9:SlowCH	SlowCH
10:Error Trigger	Error Trigger
11:Error Count	Error Count

- **Fast Channel Multiplexing Is Set to ON**

Sub Channel	Data Type
1:FastCH	FastCH
2:FastCH	FastCH
3:FastCH	FastCH
4:S&C	S&C (Status & Communication)
5:SlowCH	SlowCH or FastCH
6:SlowCH	SlowCH or FastCH
7:SlowCH	SlowCH or FastCH
8:SlowCH	SlowCH or FastCH
9:SlowCH	SlowCH or FastCH
10:Error Trigger	Error Trigger
11:Error Count	Error Count

Common Settings

Input (Input)

Set the input for data type Fast CH, S&C (Status & Communication), SlowCH, Error Trigger, and Error Count.
ON: The data is monitored.
OFF: The data is not monitored or displayed.

Labels (Label)

You can set the label for data type Fast CH, S&C (Status & Communication), SlowCH, Error Trigger, and Error Count. You can also set the label for bits 0 to 3 of S&C.

▶ See here.

Data Type FastCH Extraction Conditions

FC

Data from messages with the specified FC (frame control) is acquired in the acquisition memory. When fast channel multiplexing is set to ON, you can specify FC.
Selectable range: 0x00 to 0x0F
The default setting is 0x00.

Endian

Select the method (endian) to use to store the data in the acquisition memory.
Big: Big endian
Little: Little endian

Start Bit

Set the data extraction start position in terms of the bit position (bit number) from the beginning of the data nibble. Set it in terms of the number of data nibbles N of Fast CH messages, explained earlier.
Selectable range: 0 to (4× N)−1
To set the start bit to the most significant bit of each data nibble, specify 4×(n1) where n is the data nibble number.

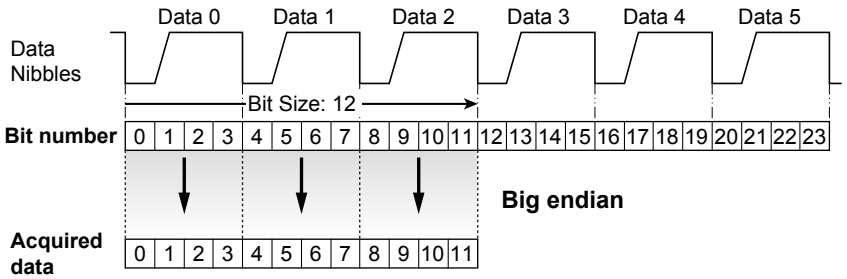
Bit Size

Set the number of data bits to extract. Data is extracted from the start bit towards the back of the data. Set it in terms of the number of data nibbles N of Fast CH messages, explained earlier.
Selectable range: 1 to {(4× N)−(Start Bit value)}, except FastCH3 is up to 16

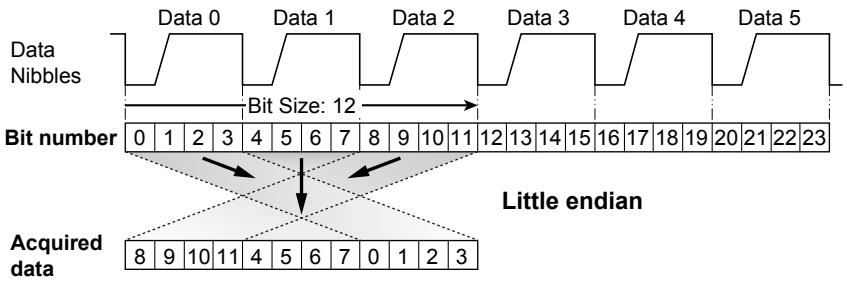
If the number of bits of 1:FastCH is set to 17 or higher, the memory area of 2:FastCH will be used. Therefore, to set the number of bits of 1:FastCH to 17 or higher, set the 2:FastCH input to OFF. To set 2:FastCH input to ON, set the number of bits of 1:FastCH to 16 or less.

Data Type FastCH Extraction Example

If Endian: Big, Start Bit: 0, Bit Size: 12



If Endian: Little, Start Bit: 0, Bit Size: 12



Value Type

Select the type of data to extract.
Unsigned: Unsigned integer
Signed: Signed integer

Data Type SlowCH Extraction Conditions

ID

This is indicated in the Endian column.
Data whose message ID matches the specified ID is acquired in acquisition memory. Configure the settings according to the Slow CH message format explained earlier.

Slow CH Message Format	Selectable Range
Short (ID 4 bit + Data 8 bit)	0x00 to 0x0F
Enhanced (ID 8 bit + Data 12 bit)	0x00 to 0xFF
Enhanced (ID 4 bit + Data 16 bit)	0x00 to 0x0F

Start Bit

Set the least significant bit position for starting extraction as a position (bit number) from the least significant bit of the data field. Configure the settings according to the Slow CH message format explained earlier.

Slow CH Message Format	Selectable Range
Short (ID 4 bit + Data 8 bit)	0 to 7
Enhanced (ID 8 bit + Data 12 bit)	0 to 11
Enhanced (ID 4 bit + Data 16 bit)	0 to 15

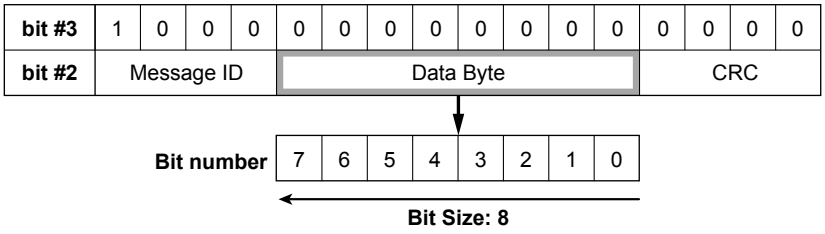
Bit Size

Set the number of data bits to extract. Data is extracted from the start bit towards the front of the data. Configure the settings according to the Slow CH message format explained earlier.

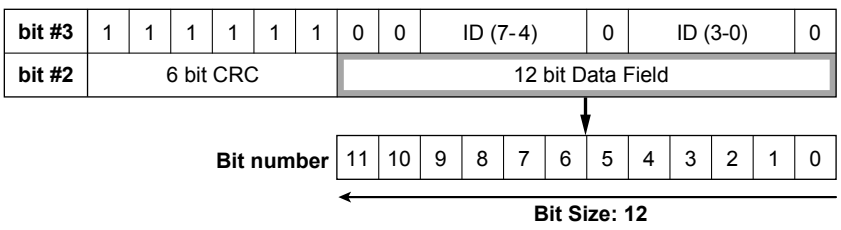
Slow CH Message Format	Selectable Range
Short (ID 4 bit + Data 8 bit)	1 to {8−(Start Bit value)}
Enhanced (ID 8 bit + Data 12 bit)	1 to {12−(Start Bit value)}
Enhanced (ID 4 bit + Data 16 bit)	1 to {16−(Start Bit value)}

Data Type SlowCH Extraction Example

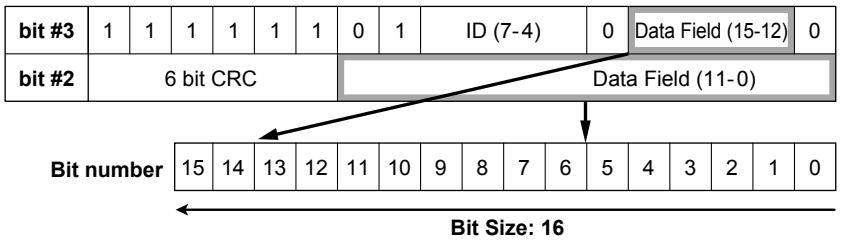
If Slow CH message format: Short (ID 4bit + Data 8bit), Start Bit: 0, Bit Size: 8



If Slow CH message format: Enhanced (ID 8bit + Data 12bit), Start Bit: 0, Bit Size: 12



If Slow CH message format: Enhanced (ID 4bit + Data 12bit), Start Bit: 0, Bit Size: 16



Value Type

Select the type of data to extract.
Unsigned: Unsigned integer
Signed: Signed integer

SENT Data Conversion Conditions

Set the conversion conditions for data type Fast CH and SlowCH.

Factor/Offset

The Factor and Offset values that you set here are used to convert the extracted data to physical values.
Factor: Scaling coefficient (value per bit)
Offset: Offset value
Selectable range: –10.000E+30 to +10.000E+30

Unit

Using up to 16 characters, enter the unit to display for the waveform.

Error Count Reset (Error Count Reset)

You can reset the error count to zero.

SENT Data Display Settings (Display)

Configure the display label, zoom magnification, scaling method, and display range settings of the specified sub channel.
For the association of each sub channel and the data type, see “SENT Data Acquisition Destination.”

Zooming by Setting a Magnification (V Zoom)

Configure this setting when the data type is set to S&C (Status & Communication) and Error Trigger.
Selectable range: x0.1 to x3.33

▶ See here.

Display Range (Upper/Lower)

Set the upper and lower limits of the waveform display range. Configure this setting when the data type is set to Fast CH, SlowCH, or Error Count.
Selectable range: −30.000E+30 to +30.000E+30

Auto Scale (Auto Scale)

Configure this setting when the data type is set to Fast CH, SlowCH, or Error Count.
The upper and lower display range limits are set automatically.

Default Scale (Default Scale)

Configure this setting when the data type is set to Fast CH, SlowCH, or Error Count.
To the greatest extent possible within the settable range, the maximum and minimum values are used to set the display range setting (explained earlier) of the specified sub channel.

Display Group (Display Group)

▶ See here.

Position Information (GPS)

For position information, set whether to turn the display on or off, the items to be set, measurement range, label, display range, display group, and the like.

Installing a GPS unit (720940/B8093YA, an accessory sold separately) enables the following items to be measured.

- Latitude (Latitude) [°]
- Longitude (Longitude) [°]
- Altitude (Altitude) [m]
- Velocity (Velocity) [km/h]
- Direction (Direction) [°] with North assumed to be 0°
- Status (Status)
  - Bit1: 3D FIX. Set to 1 when 3D position is determined.
  - Bit2: PPS (Pulse Per Second). Set to 1 when time pulses synchronized to the GPS time are obtained.

Display ON/OFF (GPS)

Set whether to show or hide position information.

- ON: Position information is shown.
- OFF: Position information is hidden.

To acquire position information, you need to set GPS Data to ON.

All Items Setup (All Items Setup)

On a single screen, you can set the measurement range, label, display range, position, magnification, and the like for each position information entry

Items to Be Set (Item)

Select the items to be set for each position information entry, such as the display on/off state, measurement range, label, and display range.

- Latitude: Latitude [°]
- Longitude: Longitude [°]
- Altitude: Altitude [m]
- Velocity: Velocity [km/h]
- Direction: Direction [°] with North assumed to be 0°
- Status: 3D FIX, PPS status

Display ON/OFF State of Each Position Information Entry

Set whether to show or hide each position information entry.

- ON: Position information is shown. If the waveform display (described earlier) is also set to ON, the position information that is set to ON here will be displayed on the screen.
- OFF: Position information is hidden.

Measurement Range (Range)

Set the measurement range for the altitude (Altitude) and velocity (Velocity).

- Altitude (Altitude)
  3276.7m: The measurement range is set to −3276.7 to 3276.7 m. The measurement resolution is set to 0.1 m.
  32767m: The measurement range is set to –32767 to 32767 m. The measurement resolution is set to 1 m.
- Velocity (Velocity)
  655.35km/h: The measurement range is set to 0 to 655.35 km. The measurement resolution is set to 0.01 km/h.
  6553.5km/h: The measurement range is set to 0 to 6553.5 km. The measurement resolution is set to 0.1 km/h.

Labels (Label)

▶ See here.

Bit 1, Bit 2 (Bit1, Bit2)

Set the display label for the 3D FIX and PPS statuses (Status).

▶ See here.

Display Range (Upper/Lower)

To display position information on the screen, set the upper and lower limits of the display range according to the position information variation range.

Selectable range:

- Latitude: −90.000000 to 90.000000°. Positive is north latitude; negative is south latitude.
- Longitude: −180.000000 to 180.000000°. Positive is east longitude; negative is west longitude.
- Altitude
  When the measurement range (Range) is 3276.7 m: −3276.8 to 3276.7 m
  When the measurement range (Range) is 32767 m: -32768 to 32767 m
- Velocity
  When the measurement range (Range) is 655.35 km/h: 0.00 to 655.35 km/h
  When the measurement range (Range) is 6553.5 km/h: 0.0 to 6553.5 km/h
- Direction: 0.00 to 360.00°. 0° is north; 90° is east; 180° is south; 270° is west.

Position (Position)

Configure this setting when Item is set to Status.

▶ See here.

Zooming by Setting a Magnification (V Zoom)

Configure this setting when Item is set to Status.

▶ See here.

Display Group (Display Group)

▶ See here.

5 Waveform Acquisition

Based on the data that has been stored in the acquisition memory, the instrument performs various operations, such as displaying waveforms on the screen, computing, measuring cursors, and automatically measuring waveform parameters.
This chapter explains how to set the number of data points to store in the acquisition memory (the record length), how to enable or disable the sample data averaging feature, and so on.

Settings

The settings vary depending on the system mode as follows:

Settings in Scope Mode

- Time Scale (Time/Div)
- Record Length (Record Length)
- Trigger Mode (Trigger Mode)
- Acquisition Settings (Acquisition Setup)
- Trigger (Trigger)
- Time Base (Time Base)
- Trigger Position (Position)
- Trigger Delay (Trigger Delay)
- Action/SD Recording (Action/SD Recording)
- Waveform Acquisition (START/STOP)

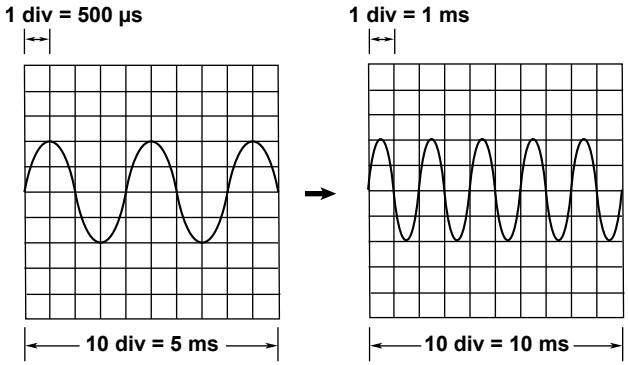
Settings in Recorder Mode

- Acquisition Time, Record Time, Acquisition Length, Record Length (Acquisition Time, Record Time, Acquisition Length, Record Length)
- Sampling Interval (Sampling Interval)
- Numeric Record Interval (Numeric Interval)
- Acquisition Conditions (Acquisition Condition)
- Acquisition Method (Acquisition Method)
- Trigger (Trigger)
- Acquisition Mode (Acquisition Mode)
- Time Base (Time Base)
- Waveform Acquisition (START/STOP)

Time Scale (Time/Div)

This is a setting in scope mode.

When the internal clock is being used, the time scale is set as a length of time per grid division (1 div). The selectable ranges are 1 µs/div* to 30 s/div, 1 min/div to 30 min/div, 1 hour/div to 12 hour/div, 1 day/div to 5 day/div. The transition from seconds to minutes to hours to days occurs automatically. Because the horizontal display range is 10 div, the amount of time on the waveform that is displayed is equal to the time scale × 10.



Internal and External Clocks (Time base selection)

Under the initial settings, the instrument samples the waveform data using the clock signal produced by its internal time-base circuit (internal clock).

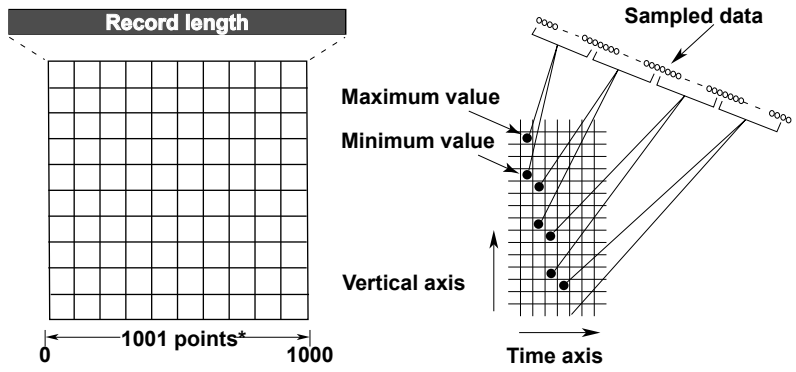
You can also use an external clock signal to control sampling. Apply the external clock signal to the external clock input terminal on the left panel of the instrument. This external clock input is useful for synchronizing to the clock signal of the waveform that is being measured.

When you control sampling using an external clock, you cannot change the time scale. To change the time-axis display range, change the record length or zoom in on the time axis.

▶ See here.

How the Time Axis Relates to the Display of the Waveform

There are 10 div along the time axis, and 1001 points (logical number of points, not the dots on the screen) are used to draw the waveforms. As such, if the display record length is greater than or equal to 2 kpoint, as shown in the figure on the right, the instrument draws the waveform by determining the maximum and minimum values at each fixed interval (P-P compression) and aligning them vertically at the same time position (total number of points: 2002).



*** 1001 is the logical number of points. On the screen, the data is compressed to 800 or 500 dots (1000 dots in the full-screen waveform display).**

<P-P compression display>

Zooming Horizontally and Drawing Waveforms

The instrument can expand (zoom) the waveform horizontally. When the zoom factor of the waveform is increased, the number of displayed points decreases. The instrument displays the waveform using P-P compressed until the number of displayed points falls to 2002, but it cannot display the waveform using continuous lines when the number of displayed points falls below 1001. When this happens, the instrument interpolates the display data so that the number of displayed points is 1001.

Dot Display

Under the initial settings, display interpolation is performed automatically, but you can also disable display interpolation (set it to OFF) and display the waveform using dots. When interpolation is disabled, up to 2001 points or 100001 points (2 kpoint or 100 kpoint, whichever is selected) of all the acquired data are displayed without P-P compression. For example, if the number of displayed points is set to 100 kpoint and the display record length is 10 kpoint (the number of acquired data points is 10001 points), the instrument draws all the points of the waveform by aligning 10 points vertically at the same time axis position. If the number of acquired data points exceeds 2001 or 100001, to display the waveform, the instrument reduces the amount of data to 2001 or 100001 points (2 kpoint or 100 kpoint, whichever is selected) by removing the data between displayed points.

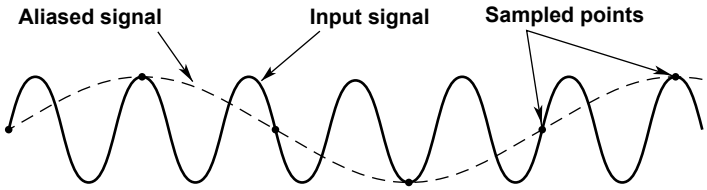
Relationship between the Time Scale, Record Length, and Sample Rate

When you change the time scale, the sample rate and record length also change. For details, see appendix 1, “Relationship between the Time Scale, Record Length, and Sample Rate” in the *Getting Started Guide*, IM DL350-03EN.

Sample Rate

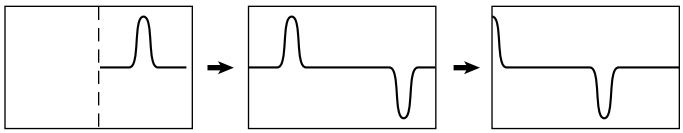
If you change the time scale, the sample rate also changes. The sample rate is the number of samples-per-second (S/s).

* If the sample rate is comparatively low with respect to the input signal frequency, the harmonics contained in the signal are lost. When this happens, some of the harmonics will be misread as low-frequency waves due to the effects described by the Nyquist sampling theorem. This phenomenon is called aliasing. You can avoid aliasing by acquiring waveforms with the acquisition mode set to Envelope.



Time Scale and Roll Mode Display

When the trigger mode is Auto, Single, or On Start and the time scale is 100 ms/div or longer, instead of updating waveforms through triggering (update mode), the instrument displays the waveforms in roll mode. In roll mode, waveforms scroll from right to left as new data is captured and the oldest values are deleted from the screen.



This allows waveforms to be observed in the same way as on a pen recorder. Roll mode is useful for observing signals with long repeating periods and signals that change slowly. It is also effective when you want to detect occasional glitches (pulse signals in the waveform).

You can use auto setup to automatically configure the appropriate settings (such as vertical axis, horizontal axis, and trigger settings) for the input signal. This feature is useful when you are not sure what type of signal will be applied to the instrument. The auto setup feature will not work properly on some input signals. Also, there are some modules with which the auto setup feature cannot be used.

▶ See here.

Acquisition Time, Record Time, Acquisition Length, Record Length (Acquisition Time, Record Time, Acquisition Length, Record Length)

These are settings in recorder mode.

- When the time base is Internal
  Data is acquired for the specified time.
  - When the acquisition method is Memory, Memory + Save on Stop, or Memory + SD Numeric Recording
    The acquisition time (Acquisition Time) is displayed.
    Selectable range: 10s to 20day
  - When the acquisition method is SD Recording
    The record time (Record Time) is displayed.
    Selectable range: 10s to 50day

- When the time base is External
  - When the acquisition method is Memory, Memory + Save on Stop, or Memory + SD Numeric Recording
    The acquisition length (Acquisition Length) is displayed. This is a function similar to the record length (Record Length).
    ▶ See here.
  - When the acquisition method is SD Recording
    The record length (Record Length) is displayed.
    ▶ See here.

Record Length (Record Length)

Record length refers to the number of data points that are stored to the acquisition memory for each channel. *Display record* length refers to the data points from the data stored in the acquisition memory that are displayed on the screen. Normally, the acquisition-memory record length and display record length are the same, but the time scale may cause them to differ. When you change the time scale, the sample rate and record length also change.

In scope mode, on the standard model of the instrument, you can set the record length between 10 kpoint and 100 Mpoint. If you use SD recording, you can set the length to up to 20 Gpoint. For details about the record lengths that can be set, see appendix 3 in the *Getting Started Guide*, IM DL350-03EN.

Use a long time scale when you want to observe a phenomenon over a long period of time. When you want to observe a phenomenon at a high time resolution, set a long record length, and raise the sample rate. When the record length is long, computation and measurement processing take longer than when the record length is short.

The lengths of time for which you can record data to the acquisition memory when the record length is 100 Mpoint are listed below.

Sample Rate	In Seconds	In Minutes	In Hours	In Days
100 MS/s	1			
10 MS/s	10			
1 MS/s	100			
100 kS/s	600	10		
10 kS/s	6000	100	1 hour 40 min	
1 kS/s	72000	12000	20	
500 S/s	180000	3000	50	2 days 2 hours

The following limitations on waveform acquisition conditions and the number of waveforms that can be stored in the acquisition memory (the number of history waveforms) apply depending on the set record length.

▶ See here.

Notes about Setting the Record Length

- Increasing the record length automatically limits the number of channels that can be used. When some channels are unavailable, the number of channels that can be used appears in the record length setup menu.
- When the acquisition mode is set to Average, the maximum record length is 5 Mpoint.
- The maximum record length when SD recording is in use is 20 Gpoint (one channel).
- In the following situations, the record length cannot be set above 10 Mpoint.
  - When the trigger mode is auto or normal
  - When roll mode display is not in use
- On the instrument, record lengths are expressed in units of points. There are some products, such as the DL750, for which record lengths are expressed in units of words.

Sampling Interval (Sampling Interval)

This is a setting in recorder mode. For details on the sampling interval, see appendix 5 in the Getting Started Guide, IM DL350-03EN.

Numeric Record Interval (Numeric Interval)

This is a setting in recorder mode when the acquisition method is Memory + SD Numeric Recording.
Set the interval for recording numeric values in ASCII format to the SD card. Acquisition to the acquisition memory is performed at the sample interval.
You can select one of the numeric recording intervals listed below.
1sec, 2sec, 5sec, 10sec, 15sec, 20sec, 30sec, 1min, 2min, 5min, 10min, 15min, 20min, 30min, 60min

Acquisition Conditions (Acquisition Condition)

This is a setting in recorder mode.
Set the acquisition start and end conditions. There are four acquisition conditions.

Acquisition Time (Acquisition Time)

When you press the START/STOP button, data acquisition starts. When the specified acquisition time elapses, acquisition automatically stops.

Continuous Acquisition (Continuous)

When you press the START/STOP button, data acquisition starts. Acquisition continues even when the specified acquisition time elapses. When you stop recording by pressing the START/STOP button, the past data from when the acquisition ended to the specified record time is saved.

Start on Trigger (Start on Trigger)

When you press the START/STOP button, the instrument enters the trigger-wait state. When a trigger occurs, acquisition starts. When the specified acquisition time elapses, acquisition automatically stops.

Stop on Trigger (Stop on Trigger)

When you press the START/STOP button, data acquisition starts. Acquisition continues even when the specified acquisition time elapses. When a trigger occurs, the instrument stops acquisition and saves from when the trigger occurred up to the specified acquisition time.

Acquisition Method (Acquisition Method)

This is a setting in recorder mode.
Set the acquisition method. There are four acquisition methods.

Memory (Memory)

Data is saved to the acquisition memory.

Memory + Save on Stop(Memory + Save on Stop)

Data is saved to the acquisition memory. The following actions can be executed at the end of measurement.

- Save waveform data (Save Waveform)
- Save a screen capture (Save Image)
- Send email (Mail)
- Beep (Beep)
- Save harmonic analysis results (Harmonic)
- Save FFT computation results (FFT)

Set the data save destination, mail address, and the like with the following menu commands.

- Save setup (Save Setup)
  Save waveform data (Save Waveform)
  Save screen capture (Save Image)
- Mail setup (Mail Setup)

Memory + SD Numeric Recording (Memory + SD Numeric Recording)

Data is saved to the acquisition memory. Numeric data continues to be recorded to the SD card when a measurement is in progress.

- Numeric Record Interval (Numeric Interval)
- Time Information (Time Info.)
- Decimal Point (Decimal Point)
- Auto Naming (Auto Naming), File Name (File Name), Comment (Comment)
  ▶ See here.

SD Recording (SD Recording)

SD recording is executed.
▶ See here.

Trigger mode (Trigger Mode)

This is a setting in scope mode.

The trigger mode determines the conditions for updating the displayed waveforms. There are four trigger modes.

Auto Mode (Auto)

If the trigger conditions are met before an approximately 50 ms timeout, the instrument updates the displayed waveforms on each trigger occurrence. If not, the instrument automatically updates the displayed waveforms. If simple trigger is in use and the trigger source is set to Time, the instrument operates in Normal mode even when Auto mode is specified.

If the time axis is set to a value that would cause the display to switch to roll mode, roll mode display will be enabled.

Normal Mode (Normal)

The instrument updates the waveform display only when the trigger conditions are met. If no triggers occur, the display is not updated. If you want to view waveforms that the instrument cannot trigger on, or if you want to check the ground level, use Auto mode.

Single Mode (Single)

When the trigger conditions are met, the instrument updates the displayed waveform once and stops waveform acquisition.

If the time axis is set to a value that would cause the display to switch to roll mode, roll mode display will be enabled. When the instrument triggers, it begins recording data. When data has been acquired up to the amount specified by the set record length, the waveform display stops.

Instant Start Mode (On Start)

Regardless of the trigger settings, when you press the START key, the instrument updates the displayed waveforms once and stops signal acquisition.

If the time axis is set to a value that would cause the display to switch to roll mode, roll mode display will be enabled. When data has been acquired up to the amount specified by the set record length, the waveform display stops.

- The trigger mode setting applies to all trigger types.
- When waveforms are being acquired, the trigger condition appears in the center of the bottom of the screen.

Acquisition Settings (Acquisition Setup)

There are acquisition settings.

- Acquisition Mode (Acquisition Mode)
- Acquisition Count (Acquisition Count)

Acquisition Mode (Acquisition Mode)

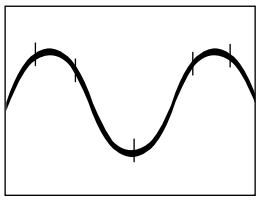
Select from the following.

Normal Mode (Normal)

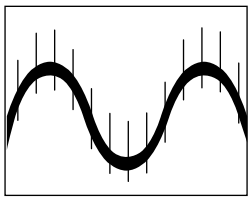
Displays waveforms without processing the sampled data.

Envelope Mode (Envelope)

The instrument determines the maximum and minimum values among the data sampled at the maximum sample rate for each module at a time interval that is twice the sampling period (the inverse of the sample rate) of Normal mode, saves the values as pairs in the acquisition memory, and uses the saved value pairs to display the waveforms. This mode is effective when you want to avoid aliasing, because the sample rate is essentially kept high regardless of the time scale. It is also effective when you want to detect glitches (narrow pulse signals) or when you want to display the envelope of a modulated signal.



Normal mode



Envelope mode

Averaging Mode (Average)

The instrument acquires waveforms multiple times, averages the same time points relative to the trigger point, saves them in the acquisition memory, and uses them to display averaged waveforms. Averaging mode is useful when you want to remove random noise from waveforms.

The averaging method varies depending on the acquisition count.

When Acquisition Count Is Set to Infinity

Exponential average

$$An = \frac{1}{N}\{(N-1)An-1 + Xn\}$$

An: nthth averaged value
Xn: nthth measured value
N : Attenuation constant (2 to 256 in 2n^{n} steps)

When Acquisition Count Is Set to a Value between 2 and 65536 (in 2n^{n} steps)

Linear average

$$AN = \frac{\sum_{n=1}^{N} Xn}{N}$$

Xn: nthth measured value
N : Average count = acquisition count

- When waveforms are acquired in averaging mode, they are saved to the acquisition memory as a single record. This means that the history feature cannot be used.
- You cannot select averaging mode when:
  - The display is in roll mode.
  - The trigger mode is Single or On Start.
  - SD recording is being executed.
- Waveforms of logic, CAN bus monitor, LIN bus monitor, or SENT monitor modules cannot be averaged.

Acquisition Count (Acquisition Count)

This is a setting in scope mode.

The ranges within which you can set the waveform acquisition count are indicated below. If you select Infinite, the instrument continues waveform acquisition until you stop it using the START/STOP key. Changes to the number of acquisitions are not applied during waveform acquisition. They are applied after acquisition stops.

- When the acquisition mode is set to Normal or Envelope
  1 to 65536 (in steps of 1) or Infinite
- When the acquisition mode is set to Average
  2 to 65536 (in 2^n steps) or Infinite

- The number of waveforms that have been stored to the acquisition memory appears in the lower left of the screen.
- If the trigger mode is set to Single or On Start, you can set the acquisition count only when the action mode is on. ▶ See here.
- When the destination that data is saved to when an action is performed is set to OFF ▶ See here., the maximum value that the acquisition count can be set to is 1000.

Trigger (Trigger)

▶ See here.

Time Base (Time Base)

Under the initial settings, the instrument samples the measured signals using the clock signal produced by its internal time-base circuit (internal clock). You can also use an external clock signal to control sampling. One data sample is stored to the acquisition memory at every pulse in the external clock signal. The external clock input is useful when you want to monitor the waveform using a clock signal that is in sync with the signal being measured.

Apply the external clock signal to the external-clock input terminal (CLKI) on the left panel. For the specifications of the external-clock input terminal, see the *Getting Started Guide*, IM DL350-03EN.

Internal	The internal clock signal is used as the time base (time scale settings Time/Div and Record Time are valid).
External	An external clock signal is used as the time base (time scale settings Time/Div and Record Time are invalid).

Pulses per Rotation (Pulse/Rotate)

When the time base is an external clock, you can specify how many pulses of the external clock signal (how many sampled data acquisitions) correspond to one mechanical rotation (or period). For example, if you set Pulse/Rotate to 100 pulses, when the record length is 10 kpoint, 100 rotations worth of sampled data will be acquired. When Pulse/Rotate is set to 1 pulse, each point of sampled data corresponds to a single rotation. The Pulse/Rotate setting only affects the horizontal-cursor measurement values and how the time axis is displayed on the screen. For example, if you set Pulse/Rotate to 100 pulses, when the record length is 10 kpoint, 1 div will correspond to 10 rotations. With these settings, if you move the cursor by 1 div, the measured horizontal value will increase or decrease by 10.

Selectable range for pulses: 1 to 24000

Notes about Sampling Using an External Clock Signal

- Roll mode display is not available in scope mode.
- There is no function for dividing the frequency of the clock signal.
- The time axis cannot be changed. To change the time-axis display range, change the record length, or zoom in on the time axis.
- The measured time values in cursor measurements and automated measurements of waveform parameters indicate the number of clock signal pulses. For these measurements, units are not displayed.
- The trigger settings listed below are invalid.
  Trigger delay, period trigger, pulse width trigger

Maximum Sample Rates for Each Module

If you set the sample rate of the instrument to a rate that is higher than a module's maximum sample rate, because the data is updated at the module's maximum sample rate, all the data within the module's data update interval will be the same. The maximum sample rates for each module are listed below.

Module		Maximum Sample Rate	
		Internal Clock	External Clock
720211		100 MHz	1 MHz
720250		10 MHz	1 MHz
720254/720268/720281		1 MHz	1 MHz
720220		200 kHz	200 kHz
701261/701262	(when measuring voltage)	100 kHz	100 kHz
	(when measuring temperature)	500 Hz	500 Hz
701265		500 Hz	500 Hz
720266		125 Hz	125 Hz
720221		10 Hz	10 Hz
701270/701271/701275		100 kHz	100 kHz
720230		10 MHz	1 MHz
720240/720242/720245/720241/720243		100 kHz	100 kHz

Notes about Using the 16-CH Voltage Input Module (720220)

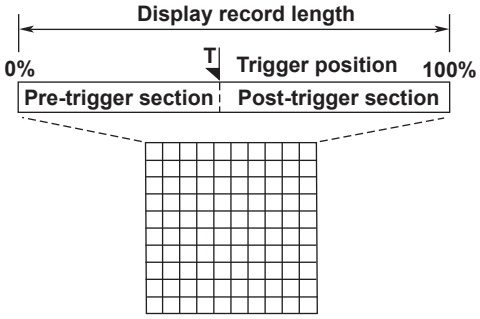
Notes about Using the 16-CH Temperature/Voltage Input Module (720221)

▶ See here.

Trigger Position (Position)

This is a setting in scope mode.

When you move the trigger position, the ratio of the displayed data before the trigger point (the pre-trigger section) to the data after the trigger point (the post-trigger point) changes. When the trigger delay is 0 s, the trigger point and trigger positions coincide.



Selectable range: 0.0 to 100% of the display record length

Resolution: 0.1%

- When waveform acquisition is stopped, if you change the trigger position, the setting is not applied until you start waveform acquisition and update the waveforms.
- If you change the time scale (Time/Div or Record Time), the location of the trigger position does not change.

Time Reference Point

In addition to the trigger position, a time reference point is indicated. The times that appear in the lower left and right of the screen are the times from this time reference point. The cursor time-measurement values are also based on this reference point.

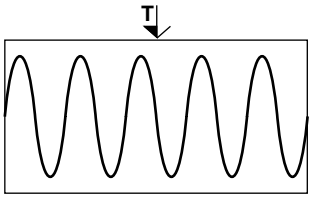
When waveform acquisition is stopped the displayed location of the time reference point varies as indicated below.

- **In Update Mode**

  When the displayed waveform is updated by the trigger, the time reference point is displayed as indicated below. The time reference point and the trigger point are the same.

  - Under Normal Waveform Update Conditions When All Pre-Trigger and Post-Trigger Data Has Been Acquired

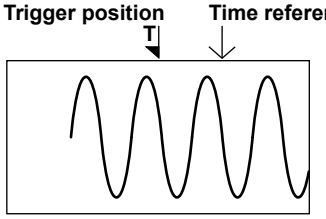
    The trigger position and the time reference point are displayed at the same position.

  - When Waveform Acquisition Is Stopped before All Pre-Trigger and Post-Trigger Data Has Been Acquired

    The trigger position and the time reference point are displayed separately.

    Trigger position **Time reference point**

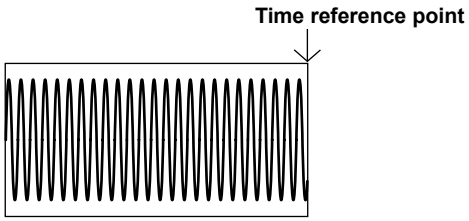
    

- **In Roll Mode**

  In roll mode, in which waveforms scroll from right to left, the time reference point is displayed as indicated below.

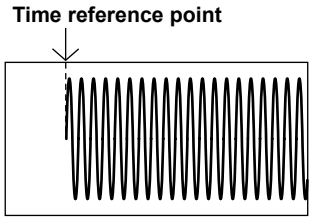
  - When the Trigger Mode Is Auto Mode

    The point in time when waveform acquisition was stopped is the time reference point (right side of the screen).

  - When the Trigger Mode Is Instant Start Mode (On Start)

    The point in time when waveform acquisition was started is the time reference point.

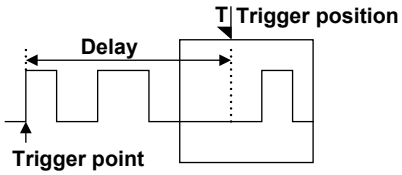
Trigger Delay (Trigger Delay)

This is a setting in scope mode.

The instrument normally displays waveforms before and after the trigger point. You can set a trigger delay to display waveforms that the instrument has acquired a specified amount of time after the trigger occurrence.

Selectable range: 0.00 µs to 10000000.00 µs (10 s)

Resolution: 0.01 µs



- If you change the time scale (Time/Div or Record Time) so that the unit becomes larger, because of display-digit limitations, the delay time that you set when the unit was small will not appear in the setup menu, but it is retained.
- You cannot specify a trigger delay when an external clock is being used as the time base.

Action/SD Recording (Action/SD Recording)

This is a setting in scope mode.

- OFF: Action/SD recording is not executed.
- Action (Action): Action is executed.
- SD Recording (SD Recording): SD recording is executed.

Action (Action)

If Mode is set to ON, the specified action (operation) is performed in the following situations.

- When the instrument triggers, and the corresponding waveform acquisition stops
- When the action condition of GO/NO-GO determination is met
- When waveform acquisition stops

Action mode

For the following actions, select whether to execute them (ON) or not (OFF).

- Save waveform data (Save Waveform)
- Save a screen capture (Save Image)
- Send email (Mail)
- Beep (Beep): Generate a beep sound
- Save harmonic analysis results (Harmonic): Saves harmonic analysis results to a file in CSV format

- When data is saved, the settings for saving harmonic analysis results on the Save/Load menu are applied (except the save destination).
- The save destination is same as that specified for waveform data in action settings. See "Notes about the "Save Data" and "Save Image" Actions."

- Save FFT computation results (FFT): Saves FFT computation results to a file in CSV format

- When data is saved, the settings for saving FFT computation results on the Save/Load menu are applied (except the save destination).
- The save destination is same as that specified for waveform data in action settings. See "Notes about the "Save Data" and "Save Image" Actions."

Action Settings (Action Setup)

Save Waveform Data (Save Waveform)

The instrument saves the waveform data to the specified destination (SD card, USB storage device, or network drive).

- **Data Format**

  This setting is the same as the data-format setting for saving waveform data.

  ▶ See here.

- **File Path (File Path)**

Specify where to save the file.

▶ See here.

- **Auto Naming (Auto Naming), File Name (File Name)**

  These settings are the same as the auto-naming and file-name settings for saving waveform data.

  ▶ See here.

Changing the auto-naming, file-name, and data-format settings for saving waveform data will change the corresponding settings under Waveform Save in the Save/Load menu.

Save a Screen Capture (Save Image)

The instrument saves the screen capture data to the specified destination (SD card, USB storage device, or network drive).

- **File Path (File Path), Auto Naming (Auto Naming), File Name (File Name)**
  ▶ See here.

Changing the auto-naming and file-name settings for saving image data will change the corresponding settings under Image Save in the Save/Load menu.

Send Email (Mail)

The instrument sends an email to the specified address.

- **Email Send Count (Mail Count)**
  This is a setting in scope mode.
  Set the number of email transmissions.
  - Infinite: Email continues to be transmitted until you stop the action.
  - 1 to 1000: Email transmission stops when the number of sent emails reaches the specified count.

In recorder mode, the number of email transmissions is 1. As such, the above settings are not displayed.

- **Mail Setup (Mail Setup)**
  Set the mail address and the like. This is the same as Network > Mail in the Utility menu.
  ▶ See here.

Notes about Action

- You cannot change settings while the action feature is active.
- The actions may be slow if there is network access while the following operations are being performed.
  Printing and saving of screen capture data and saving of waveform data
- When SD recording is enabled, the action feature cannot be used.

Notes about the “Save Data” and “Save Image” Actions

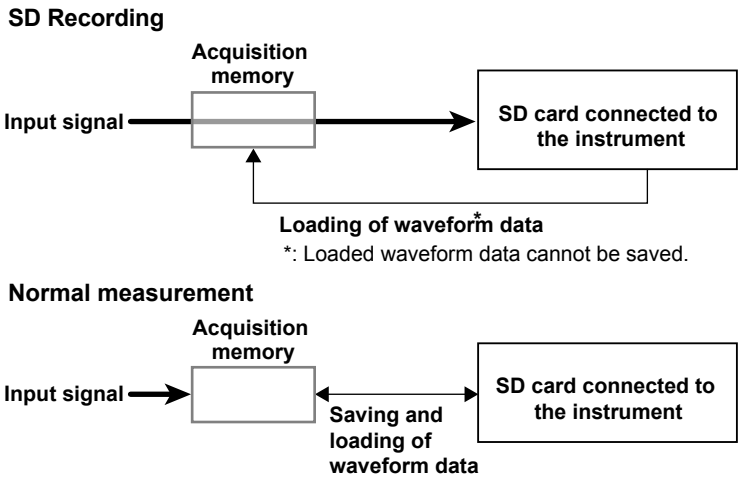
- Do not set the storage medium’s root folder as the save destination. A file whose name is longer than eight characters will be counted as two files. If such files exist, the number of files that can be stored will decrease.
- The maximum number of files that can be created in a single folder is 1000. Make sure that there are no files in the destination folder before you start the action feature.
- If you select save waveform data (Save Waveform) and save a screen capture (Save Image) at the same time, specify separate folders to save to.
- If you set Auto Naming to Numbering, as the number of saved files increases, the amount of time required to save a file will also increase.
- Save Destination Folder during Action Execution
  In the specified drive, a folder is automatically created with the date (year, month, and day) as its name, and data is saved to that folder using file names specified by the auto naming feature. If the number of files in the save destination folder exceeds 1000, a new folder is automatically created with the date and an incremented sequence number (000 to 999) as its name, and the data continues to be saved in the new folder.
  You can configure the instrument so that data is saved to the specified folder, not to the folder that is automatically created with the date. ▶ See here.

SD Recording (SD Recording)

When measurement starts, you can record data to an SD memory card inserted into the SD memory card slot of this instrument. The recorded data is saved to files automatically. You can load the data that has been saved.

- The instrument stops acquiring waveforms after it has acquired the amount of data that corresponds to the set record length. The maximum record length is 50 days.
- When you enable the SD recording feature, the trigger mode is automatically set to On Start.
- SD recording is possible for the numbers of channels, sample rates, set record lengths, and time axis settings listed below.

Number of Channels	Maximum Sample Rate	Set Record Length	Time Scale
1	1 MS/s	1 Mpoint or more	1 s/div or more (the roll mode display area)
2	500 kS/s		
5	200 kS/s		
10	100 kS/s		



You can assign a file name and save it to the SD memory card.
In SD recording, a folder for the current date is created on the specified drive, and the recorded-data files are saved to that folder.

Auto Naming (Auto Naming), File Name (File Name)

These settings are the same as the auto-naming and file-name settings for saving waveform data.
▶ See here.

File Division ON/OFF (File Divide)

You can specify the number of files that the recorded data is divided into. You can use this feature to avoid creating large files that take time to process.

Number of File Divisions (Number)

You can select the number of file divisions. The actual number of files that will actually be saved is a number close to the specified number.

- SD recording cannot be performed when the record length is less than 1 Mpoint.
- SD recording cannot be performed when the action mode is on.
- When you enable the SD recording feature, the trigger mode is automatically set to On Start.
- During SD recording, only starting and stopping of SD recording, the zoom display settings, and the protect feature are valid.
- The upper limit of the time axis zoom factor during SD recording is the maximum zoom factor that can be displayed during SD recording.
- During SD recording, you cannot display history waveforms, loaded waveforms, or computed waveforms.
- You can perform the following operations on data that has been recorded to an SD card. You cannot use the history feature.
  Cursor measurement, automated measurement of waveform parameters (up to 100 Mpoint), waveform zooming, computation and printing
- During SD recording, the instrument may respond more slowly to operations.
- The maximum number of files that can be saved to a single folder is 1000.
- Do not store more than 513 files in the root directory of the SD card. Doing so will slow the file access operations to all files. In addition, we cannot guarantee the operation of SD recording feature when the instrument is in this state.
- Do not connect USB storage media to the instrument during SD recording or when you will start SD recording.
- Data recorded on the SD card can be loaded into this instrument and resaved in binary (.WDF), ASCII (.CSV), or MATLAB (.MAT) format. The size of the file that can be resaved is up to 2 GB. Date resaved in binary format (.WDF) cannot be loaded into this instrument.
- If files are created and deleted repeatedly from the SD card, file access will slow down. Further, errors may occur in SD recording. If errors occur, format the SD card, or replace with a new one.

Waveform Acquisition (START/STOP)

When you start waveform acquisition, the instrument stores waveform data to the acquisition memory and updates the displayed waveforms each time it triggers. The acquisition memory is divided into many areas based on the set record length, and the maximum number of acquirable waveforms are stored in the memory. You can recall past waveforms that are stored in the memory by using the history feature when waveform acquisition is stopped.

Instrument Operation When the Acquisition Mode Is Set to Averaging

- Averaging stops when you stop acquisition.
- If you start acquisition again, averaging starts from the beginning.

START/STOP Key Operations during Accumulation

- Accumulation stops when you stop waveform acquisition.
- When you start acquisition again, the displayed waveforms up to that point are cleared, and accumulation restarts from the beginning.

The START/STOP Key Is Disabled:

- When the instrument is in remote mode.
- When the instrument is being set up automatically or when it is accessing a storage medium.

- If you change the waveform acquisition conditions and start waveform acquisition, the past data stored in the acquisition memory is cleared.
- You can use the snapshot feature to retain the displayed waveform on the screen. This feature allows you to update the display without having to stop waveform acquisition.
- Regardless of the trigger settings, you can make the instrument trigger by pressing the TRIGGER key.

6 Trigger

Triggers are events used to display waveforms. A trigger occurs when the specified trigger condition is met, and a waveform is displayed on the screen.
In scope mode, set the trigger type in Trigger Settings (Setting).
In recorder mode, set the trigger type in Trigger (Trigger).

Trigger Settings (Setting)

This is a setting in scope mode.
The following trigger types are available.

Simple (Simple)

- Simple trigger: Simply triggers on a trigger source edge.
  In addition to using the signals (analog signals and logic signals) applied to the modules installed in the slots as trigger sources, you can also use the time or an external signal (the signal applied to the TRGI terminal).

Enhanced (Enhanced)

- Edge On A trigger: While state condition A is met, the instrument triggers on the OR of multiple trigger source edges.
- OR trigger: The instrument triggers on the OR of multiple trigger source edges.
- AND trigger: The instrument triggers on the AND of multiple trigger source conditions.
- Period trigger: The instrument triggers on a specified period of occurrence of state condition B.
- Pulse Width trigger: The instrument triggers after state condition B has been met for a specified duration (width).
- Wave Window trigger: The instrument creates real-time templates (Wave Window) using a number of cycles directly preceding the current waveforms. The instrument compares the current waveforms to the real-time templates and triggers if one of the current waveforms falls outside of its real-time template.

* A state condition is a condition that is met when the levels of specified trigger sources are High or Low relative to a specified trigger level. If you set a signal to X (Don't Care), the state of the specified signal is not used to determine whether the state condition is met.

Manual Trigger (Manual Trigger)

Regardless of the trigger settings, you can make the instrument trigger by pressing the TRIGGER key on the front panel.

Trigger (Trigger)

This is a setting in recorder mode.
The following trigger types are available.

- Edge trigger: Simply triggers on a trigger source edge.
- Time trigger: Triggers at the specified time.
- OR trigger: The instrument triggers on the OR of multiple trigger source edges.
- AND trigger: The instrument triggers on the AND of multiple trigger source conditions.

Manual Trigger (Manual Trigger)

Regardless of the trigger settings, you can make the instrument trigger by pressing the TRIGGER key on the front panel.

Signal Type and Trigger Type Combinations

The signal type (analog or logic) determines what trigger types you can use.

About the Wave Window trigger ▶ See here.

Scope Mode

	CH1 to CH6, GPS		
	Analog Signal (including sub channels)	Logic Signal Bit 1 to Bit 8	Mixed
Simple	Yes	Yes	–
Edge On A	Yes	Yes	Yes
OR	Yes	Yes	Yes
AND	Yes	Yes	Yes
Period	Yes	Yes	Yes
Pulse Width	Yes	Yes	Yes

Recorder Mode

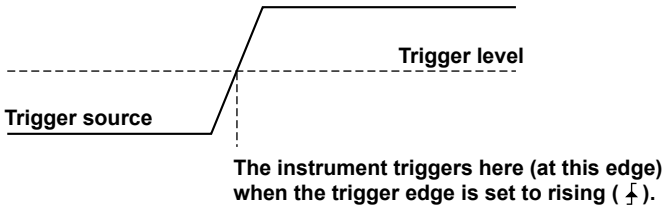
	CH1 to CH6, GPS		
	Analog Signal (including sub channels)	Logic Signal Bit 1 to Bit 8	Mixed
Edge	Yes	Yes	–
OR	Yes	Yes	Yes
AND	Yes	Yes	Yes

Basic Trigger Settings

- Trigger source: The trigger source signal.
- Trigger slope: Specifies which edge, rising or falling, the instrument will trigger on.
- Trigger level: The trigger determination level.
- Trigger hysteresis: The trigger level margin (the instrument does not trigger on changes in the signal level within this margin).
- Trigger position: The position where the trigger point will be displayed (applies to all trigger types).
- Trigger delay: The delay from the trigger point (applies to all trigger types).

Simple (Simple)

- The instrument triggers on trigger source edges (rising or falling edges). *Edge* refers to a point where the trigger source (CH1 to CH6, External) passes through the trigger level.
- The instrument triggers at the specified date and time.



Trigger Source (Source)

Trigger source refers to the signal used to determine whether the specified trigger conditions are met. Select from the following.

Analog Signal (CH1 to CH4), GPS

Select a channel from CH1 to CH4 to use the analog signal being applied to the corresponding terminal as the trigger source.

CH1 to CH4,[1] 16chVOLT,[2] 16chTEMP/VOLT,[2] CAN,[3] LIN,[3] SENT[3], GPS[4]

1 You can select the channel of an installed module. On a 4-CH module, select sub channel 1 or 2.
2 When a 16-CH voltage input module or 16-CH temperature/voltage input module is installed. After you select 16chVOLT or 16chTEMP/VOLT, select a sub channel.
3 On a model with the /VE option when a CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus, or SENT monitor module is installed. After you select CAN, LIN, or SENT, select a sub channel. However, you cannot select a sub channel whose Input setting is set to OFF. ▶ See here.
4 When GPS is enabled. Select GPS and then a sub channel.

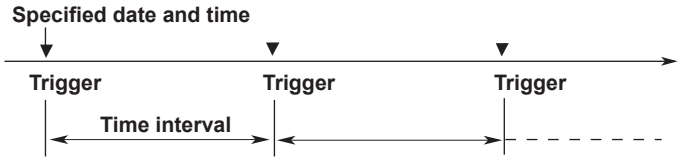
Logic Signal (Bit 1 to Bit 8)

Select a bit from 1 to 8 to use the logic signal being applied to the port of a logic input module or the logic input terminal of the instrument as the trigger source. Bits 1 to 8 appear as options below the channel (CH1 to CH6) that corresponds to the logic input module or the logic input terminal of the instrument.

Time (Time)

Select Time to use the date and time as the trigger source. The trigger occurs at the specified date and time and at specified intervals afterwards.

- Specify the year, month, day, hour, minute, and second.
- You can select one of the time intervals listed below.
  10 sec, 15 sec, 20 sec, 30 sec, 40 sec, 50 sec, 1 min, 2 min, 3 min, 4 min, 5 min, 6 min, 7 min, 8 min, 9 min, 10 min, 15 min, 20 min, 25 min, 30 min, 40 min, 45 min, 50 min, 1 hour, 2 hour, 3 hour, 4 hour, 5 hour, 6 hour, 7 hour, 8 hour, 9 hour, 10 hour, 11 hour, 12 hour, 18 hour, 24 hour



- Depending on the specified time interval, a trigger may occur while the waveform is being acquired or in the pre-trigger section (the section before the trigger that is acquired for observation). When this happens, the trigger is ignored.
- If the specified date and time fall within the pre-trigger section, a trigger occurs at the end of the pre-trigger section.
- If the specified date and time are in the past, triggers occur at the points in the present defined by the function (specified date and time) + (time interval × integer N).
- If you set the number of acquisitions, the specified number of waveforms are acquired. When the specified number of acquisitions is infinite, waveform acquisition continues until you press START/STOP.

External Signal (External)

Select External to use the signal that is received through the left-panel TRGI input terminal as the trigger source.

Trigger Slope (Slope)

Slope refers to the movement of the signal from a low level to a high level (rising edge) or from a high level to a low level (falling edge). When a slope is used as one of the trigger conditions, it is called a *trigger slope*.
The following trigger slope settings are available for triggering the instrument.

⎍	The instrument triggers when the trigger source changes from a level below the trigger level to a level above the trigger level (rising).
⎎	The instrument triggers when the trigger source changes from a level above the trigger level to a level below the trigger level (falling).
⎍⎎	The instrument triggers on both rising and falling edges.

* ⎍⎎ can be selected only when a simple trigger is used with an analog trigger source.

Trigger Level (Level)

Trigger level refers to the signal level used as a reference for detecting a signal's rising and falling edges or high and low states. With simple triggers such as the edge trigger, the instrument triggers when the trigger source level passes through the specified trigger level.
The range and resolutions that you can use to set the trigger level vary depending on the type of signal being measured.

When Measuring Voltage

Selectable range: ±10 div (two times the display range)
Resolution: 0.01 div. (Example: when the probe attenuation is 1:1 and the voltage scale is 2 mV/div, the resolution is 0.02 mV.)

When Measuring Temperature

Selectable range: The range of thermocouple being used. Resolution: 0.1°C or 0.1 K

When Measuring Strain

Selectable range: Selectable range: The range of the strain module being used. Resolution: 1 μSTR or 0.0005 mV/V

When Measuring Acceleration

Selectable range: ±10.00 div. Resolution: 0.01 unit

When Measuring Frequency (Revolutions, periods, duty ratios, power supply frequencies, pulse widths, pulse integration, velocities)

See section 6.13 in the *Getting Started Guide*, IM DL350-03EN.

When Monitoring CAN Bus, LIN Bus or SENT Signals

When the Data Type (Value Type) is Unsigned or Signed

Selectable range: The settable value is determined from the bit length (Bit Count) of the relevant sub channel.
Resolution: Scaling factor (Factor)

When the Data Type (Value Type) is Float

Selectable range: (The span between the upper (Upper) and lower (Lower) limits of the display range) × 2
Resolution: (Span × 2)/48000

When Acquiring Position Information (GPS)

Selectable range:

- Latitude: −90.000000 to 90.000000°. Positive is north latitude; negative is south latitude.
- Longitude: −180.000000 to 180.000000°. Positive is east longitude; negative is west longitude.
- Altitude
  When the measurement range (Range) is 3276.7 m: −3276.8 to 3276.7 m
  When the measurement range (Range) is 32767 m: -32768 to 32767 m
- Velocity
  When the measurement range (Range) is 655.35 km/h: 0.00 to 655.35 km/h
  When the measurement range (Range) is 6553.5 km/h: 0.0 to 6553.5 km/h
- Direction: 0.00 to 360.00°. 0° is north; 90° is east; 180° is south; 270° is west.

Trigger Hysteresis (Hysteresis)

Trigger hysteresis establishes a trigger level margin (hysteresis) so that the instrument does not trigger if the signal level change is within the margin.

For each type of measured signal, you can set the hysteresis around the trigger level to one of the options listed below. You cannot set hysteresis when the trigger source is set to Time, External, Line, or a logic signal.

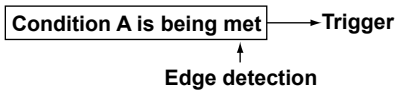
			
Voltage	Approx. ±0.1 div	Approx. ±0.5 div	Approx. ±1 div
Temperature	Approx. ±0.5°C (K)	Approx. ±1°C (K)	Approx. ±2°C (K)
Strain	Approx. ±2.5% of the range	Approx. ±12.5% of the range	Approx. ±25% of the range
Acceleration	Approx. ±0.1 div of the range	Approx. ±0.5 div of the range	Approx. ±1 div of the range
Frequency, CAN, LIN, SENT, GPS	Approx. ±0.01 div of the range	Approx. ±0.5 div of the range	Approx. ±1 div of the range

* The above values are approximate values. They are not strictly warranted.

Edge On A Trigger (Enhanced)

This is available only in scope mode.

While state condition A is met, the instrument triggers on the OR of multiple trigger source edges.



Trigger Source

You can use CH1 to CH6 and Bit 1 to Bit 8 as the trigger sources. Bit 1 to Bit 8 appear as options when

- When a logic input module is installed in a slot.
- When the logic input terminal (CH5 or CH6) of this instrument is in use.

▶ See here.

State Condition (A State)

To set state condition A, select the states of the trigger sources in relation to the trigger level.

Example

	State Condition A
CH1	H
CH2	L
CH3	X
CH4	L
CH5-	
Bit 1	X
Bit 2	L
……	…
Bit 8	X
CH6-	
Bit 1	H
……	…
Bit 8	L

H: The signal level must be high.
L: The signal level must be low.
X: The signal is not used as a condition.

Edge Detection Condition (Edge)

Set the condition for detecting the trigger source edge.

⤴	An edge is detected when the trigger source changes from a level below the trigger level to a level above the trigger level (rising).
⤵	An edge is detected when the trigger source changes from a level above the trigger level to a level below the trigger level (falling).
–	The signal is not used as a trigger condition.

Trigger Level (Level) and Trigger Hysteresis (Hys)

Set these items for each trigger source.

These items are the same as the trigger level and hysteresis of the simple trigger.

State Condition Achievement Condition (Condition)

Select whether the result of comparing the trigger source states to their specified conditions must be true or false for the state condition to be considered met.

True	The result must be true.
False	The result must be false.

Trigger Position (Position), Trigger Delay (Delay)

- Trigger position ▶ See here.
- Trigger delay ▶ See here.

OR Trigger (Enhanced)

The instrument triggers on the OR of multiple trigger source edges.

Trigger Source

You can use CH1 to CH6, Ext (external signal applied to the TRGI terminal), and Bit 1 to Bit 8 as the trigger sources. Bit 1 to Bit 8 appear as options when

- When a logic input module is installed in a slot.
- When the logic input terminal (CH5 or CH6) of this instrument is in use.

▶ See here.

Edge Detection Condition (Edge)

Set the conditions for detecting each trigger source edge.

⤴	An edge is detected when the trigger source changes from a level below the trigger level to a level above the trigger level (rising).
⤵	An edge is detected when the trigger source changes from a level above the trigger level to a level below the trigger level (falling).
IN	An edge is detected when the trigger source enters the specified level range.
OUT	An edge is detected when the trigger source leaves the specified level range.
–	The signal is not used as a trigger condition.

* IN and OUT are selectable only when the trigger source is an analog signal (CH1 to CH4).

Trigger Level (Level)

Set these items for each trigger source.

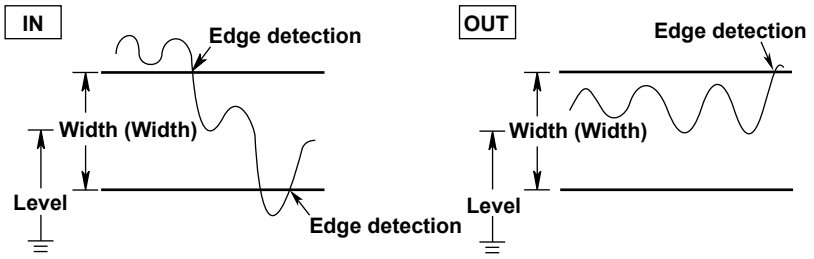
When the Edge Detection Condition Is ⤴ or ⤵

Set the level used to detect the trigger source's rising or falling edge.

▶ See here.

When the Edge Detection Condition Is IN or OUT

An edge is detected when the trigger source enters (IN) or leaves (OUT) the specified level range. You can specify the level range settings for each analog signal trigger source.



Setting	Selectable Range	Resolution
Level (center value) Width (Width)	Same as the trigger level	

Trigger Level Width (Width)

Set the trigger level width when the edge detection condition is IN or OUT.

Trigger Hysteresis (Hys)

Set these items for each trigger source.

This item is the same as the hysteresis of the simple trigger.

Trigger Position (Position), Trigger Delay (Delay)

- Trigger position ▶ See here.
- Trigger delay ▶ See here.

AND Trigger (Enhanced)

The instrument triggers on the AND of multiple trigger source conditions. The instrument triggers when all the specified conditions are met at a single point.

Trigger Source

You can use CH1 to CH6 and Bit 1 to Bit 8 as the trigger sources. Bit 1 to Bit 8 appear as options when

- When a logic input module is installed in a slot.
- When the logic input terminal (CH5 or CH6) of this instrument is in use.

▶ See here.

Achievement Condition (Condition)

Set the achievement condition for each trigger source.

H	The signal level must be high.
L	The signal level must be low.
IN	The signal must be within the specified level range.
OUT	The signal must be outside of the specified level range.
–	The signal is not used as a trigger condition.

* IN and OUT are selectable only when the trigger source is an analog signal (CH1 to CH4).

Trigger Level (Level)

Set these items for each trigger source.

When the Achievement Condition Is H or L

Set the level for determining whether the trigger sources are high or low.

▶ See here.

When the Achievement Condition Is IN or OUT

An edge is detected when the trigger source enters (IN) or leaves (OUT) the specified level range. You can specify the level range settings for each analog signal trigger source.

▶ See here.

Trigger Level Width (Width)

Set the trigger level width when the edge detection condition is IN or OUT.

Trigger Hysteresis (Hys)

Set these items for each trigger source.
This item is the same as the hysteresis of the simple trigger.

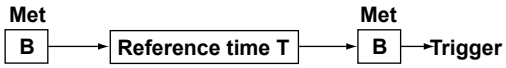
Trigger Position (Position), Trigger Delay (Delay)

- Trigger position ▶ See here.
- Trigger delay ▶ See here.

Period Trigger (Enhanced)

This is available only in scope mode.

The instrument triggers on a specified period of occurrence of state condition B. The instrument triggers when state condition B occurs again.



Trigger Source

You can use CH1 to CH6 and Bit 1 to Bit 8 as the trigger sources. Bit 1 to Bit 8 appear as options when

- When a logic input module is installed in a slot.
- When the logic input terminal (CH5 or CH6) of this instrument is in use.

▶ See here.

State Condition (B State)

To set state condition B, select the states of the trigger sources in relation to the trigger level.

Example

	State Condition A
CH1	H
CH2	L
CH3	X
CH4	L
CH5-	
Bit 1	X
Bit 2	L
.....	...
Bit 8	X
CH6-	
Bit 1	H
.....	...
Bit 8	L

H: The signal level must be high.
L: The signal level must be low.
X: The signal is not used as a condition.

Trigger Level (Level) and Trigger Hysteresis (Hys)

Set these items for each trigger source.

These items are the same as the trigger level and hysteresis of the simple trigger.

Determination Mode

Set what kind of relationship must be established between period T and the specified reference times (Time or T1 and T2) for the instrument to trigger.

T < Time	Period T must be shorter than the reference time (Time).
T > Time	Period T must be longer than the reference time (Time).
T1 < T < T2	Period T must longer than reference time T1 and shorter than reference time T2.
T < T1, T2 < T	Period T must be shorter than reference time T1 or longer than reference time T2.

Reference Times (Time, T1, T2)

You can set the reference times (Time, T1, and T2) within the following ranges.

Setting	Selectable Range	Resolution
Time	0.02 µs to 10000000.00 µs (10 s)	0.01 µs
T1	0.02 µs to 9999999.99 µs	
T2	0.03 µs to 10000000.00 µs (10 s)	

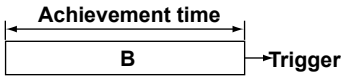
Trigger Position (Position), Trigger Delay (Delay)

- Trigger position ▶ See here.
- Trigger delay ▶ See here.

Pulse Width Trigger (Enhanced)

This is available only in scope mode.

The instrument triggers according to a specified duration (achievement time) for which state condition B has been met. The timing of the triggering varies depending on the determination mode.



Trigger Source

You can use CH1 to CH6 and Bit 1 to Bit 8 as the trigger sources. Bit 1 to Bit 8 appear as options when

- When a logic input module is installed in a slot.
- When the logic input terminal (CH5 or CH6) of this instrument is in use.

▶ See here.

State Condition (B State)

To set state condition B, select the states of the trigger sources in relation to the trigger level.

Example

	State Condition A
CH1	H
CH2	L
CH3	X
CH4	L
CH5-	
Bit 1	X
Bit 2	L
……	…
Bit 8	X
CH6-	
Bit 1	H
……	…
Bit 8	L

H: The signal level must be high.
L: The signal level must be low.
X: The signal is not used as a condition.

Trigger Level (Level) and Trigger Hysteresis (Hys)

Set these items for each trigger source.

These items are the same as the trigger level and hysteresis of the simple trigger.

Determination Mode (Mode)

Set what kind of relationship must be established between the state condition B achievement time and the specified reference times (Time or T1 and T2) for the instrument to trigger.

B < Time	The instrument triggers when the achievement time is shorter than the reference time (Time), and the state condition changes to not met.
B > Time	The instrument triggers when the achievement time is longer than the reference time (Time), and the state condition changes to not met.
B TimeOut	The instrument triggers when the achievement time is longer than the reference time (Time).
B Between	The instrument triggers when the achievement time is longer than reference time T1 and shorter than reference time T2, and the state condition changes to not met.

Reference Times (Time, T1, T2)

You can set the reference times (Time, T1, and T2) within the following ranges.

Setting	Selectable Range	Resolution
Time	0.02 µs to 10000000.00 µs (10 s)	0.01 µs
T1	0.01 µs to 9999999.99 µs	
T2	0.02 µs to 10000000.00 µs (10 s)	

Triggering may not function properly when the interval between achievement times is less than 0.01 µs or when the duration of the achievement time is less than 0.01 µs (Typical).

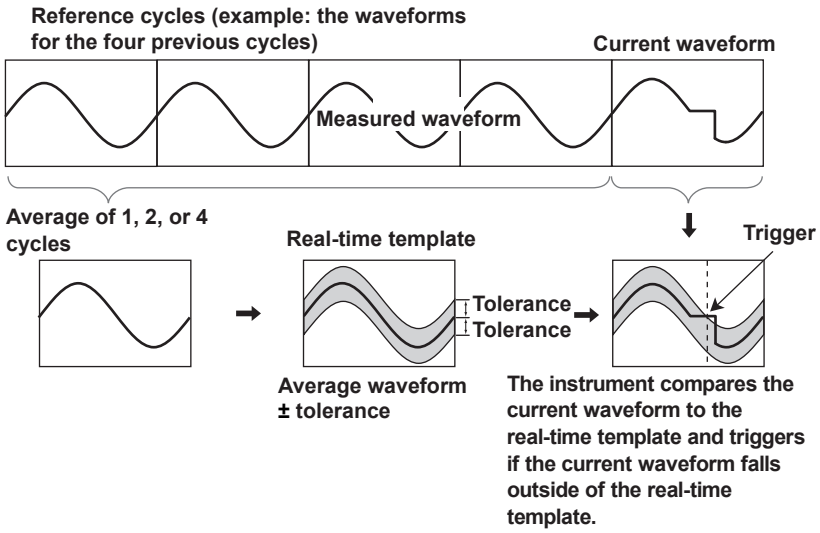
Trigger Position (Position), Trigger Delay (Delay)

- Trigger position ▶ See here.
- Trigger delay ▶ See here.

Wave Window Trigger (Enhanced)

This is available only in scope mode.

The instrument creates real-time templates (Wave Window) using a number of cycles directly preceding the current waveforms. The instrument compares the current waveforms to the real-time templates and triggers if one of the current waveforms falls outside of its real-time template.



Trigger Source

You can select the trigger sources from CH1 to CH6. The modules that you can use as sources for the Wave Window trigger are listed below. You cannot use other modules or temperature-measurement channels as sources.

720211 (HS100M12)	720250 (HS10M12)
Sub channel 1 of 720254 (4CH 1M16)	720268 (HV (with AAF, RMS))
701261 (UNIVERSAL) (only voltage measurement)	701262 (UNIVERSAL (AAF)) (only voltage measurement)
701270 (STRAIN_NDIS)	701271 (STRAIN_DSUB)
701275 (ACCL/VOLT)	

Template Channels (Condition)

Select which trigger sources to use to make real-time templates. The instrument triggers if the condition of even one of the channels is met.

- ON: Use
- OFF: Don't use

Tolerance Width (Width)

To create a real-time template for a channel, set the distance from the averaged waveform (of 1, 2, or 4 cycles before the current waveform) that will be tolerated. The range within which you can set the distance varies depending on the type of signal being measured.

Signal Type	Selectable Range*
Voltage	0.01 × the voltage scale to 10 × the voltage scale
Strain	1 µSTR to (measurement range) × 2 or 0.0005 mV/V to (measurement range) × 2
Acceleration	0.01 Unit to (Unit/div) × 10

For example, when Width is set to 2 V, the tolerance width is ±2 V around the averaged waveform.

* The resolution of each signal type is the same as the trigger level resolution. ▶ See here.

Cycle Frequency (Cycle Frequency)

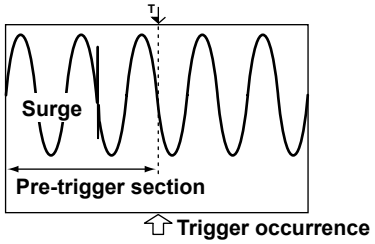
Set the trigger source frequency. If the actually frequency is within ±10% of the specified value, it is automatically tracked.
Selectable range: 40 to 1000 Hz.
Resolution: 1 Hz

Reference Cycles (Reference Cycle)

Select how many waveforms before the current waveform are used to create the real-time templates. When the sample rate is 500 kS/s and the number of channels used to make real-time templates is 9 or more, you can set only the number of cycles to 2. Even if you select 4 cycles, only two are used.

1	The previous waveform is used.
2	Two previous waveforms are used.
4	Four previous waveforms are used.

If a surge or other abnormal waveform occurs in the reference cycle, the abnormal waveform will be included in the averaged waveform, so the instrument will trigger on the next normal waveform. This may make it appear is if the trigger has been delayed by a few cycles.



When you use the wave window trigger, we recommend that you set a pre-trigger length that is longer than the reference cycle so that you can observe waveform abnormalities that occur in the reference cycle.

Sync Channel (Sync. Ch)

Select the channel used to detect the points at which waveform comparison for the wave window trigger starts and stops. Select the synchronization channel by selecting Auto or a channel from CH1 to CH4 that has a module that the wave window trigger can be used with.

Auto

Of the modules that the wave window trigger can be used with, the module with the smallest number is automatically selected.
Level for detecting the start and end points: The center of the amplitude of the sync-channel signal measured for 0.5 seconds after the start of waveform acquisition.
Detection hysteresis: Same as the simple trigger hysteresis ▶ See here.

CH1 to CH4

Select a channel whose module can be used with the wave window trigger. If triggering does not function properly when you select Auto, you can specify an appropriate channel.
For the selected channel, you need to set the level for detecting the start and end points and set the detection hysteresis.

Level for Detecting the Start and End Points (Level) and Detection Hysteresis (Hysteresis)

If you set the sync channel to a channel from CH1 to CH4, you need to set the level for detecting the start and end points and set the detection hysteresis. These items are the same as the trigger level and hysteresis of the simple trigger.

Trigger Position (Position), Trigger Delay (Delay)

- Trigger position ▶ See here.
- Trigger delay ▶ See here.

Operating Conditions of the Wave Window Trigger

You can use the wave window trigger with the following waveforms and settings. You cannot use the wave window trigger when the record length is 25 kpoint or less and the time axis setting is shorter than 10 ms/div.

Waveforms	AC waveforms and triangular waveforms between 40 kHz and 1 kHz. (The trigger cannot be used with rectangular waveforms, such as inverter waveforms, or waveforms with fast rising edges.)
Sample rate	10 kS/s to 500 kS/s
Acquisition mode	Normal
Trigger mode	Normal, Single, Single(N) When the trigger mode is Auto or Auto Level, it is difficult for the wave window trigger to occur.

Edge Trigger (Edge)

The instrument triggers when the trigger source input signal passes through the specified trigger level in the specified way.

Trigger Source (Source)

This item is the same as the trigger source of the simple trigger.
You cannot select time trigger (Time).

Trigger Slope (Slope), Trigger Level (Level) and Trigger Hysteresis (Hys)

These items are the same as the trigger slope, trigger level and hysteresis of the simple trigger.

Time Trigger (Time)

This is available only in recorder mode.
Date and time are used to trigger the instrument.

Date and Time Setting (Date/Time Setup)

The instrument triggers at the specified date and time.
Specify the year, month, day, hour, minute, and second.

7 Display

Window Types (Display)

This instrument has the following types of windows.

T-Y (Time axis) Waveform Display Window

- Main window
  Displays normal waveforms, which are not magnified
- Zoom window (Zoom1 and Zoom2)
  Displays zoomed waveforms according to the settings specified using the Zoom menu
  Zoom2 window can only be displayed in scope mode. (It cannot be displayed in recorder mode.)

X-Y Window (Window 1, Window 2)

Displays X-Y waveforms according to the settings specified using the X-Y menu

FFT Window (FFT1 window, FFT2 window)

Displays FFT waveforms according to the settings specified using the FFT menu

Extra Window

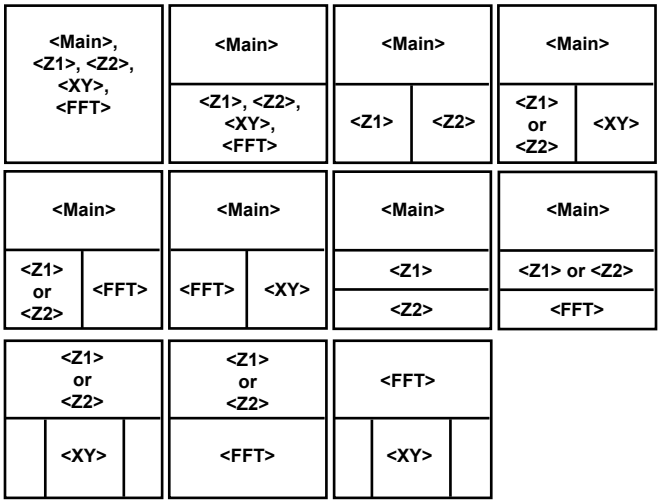
This window displays cursor-measurement values, automated measurement values of waveform parameters, and so on. It can be used when values overlap with waveforms and are difficult to see.

Switching the Channel Information Area Display

You can switch between the full-screen waveform display, the channel information display, and the waveform numeric-monitor display.

Display Pattern Examples

The main display patterns are shown in the figure below.



- Zoom1 and Zoom2 are abbreviated to Z1 and Z2.
  Z2 window can only be displayed in scope mode. (It cannot be displayed in recorder mode.)
- You can create patterns in which the main window is not displayed.

Under the following conditions, a total of 64 waveforms can be displayed on the main, Zoom1, and Zoom2 windows.

Trigger mode: Auto

Time/div: 100 ms/div or 200 ms/div

Display Group (Select Group)

Only the waveforms of the selected group are displayed on the screen.
All the channels (CH, Math, and sub channels) are automatically assigned to Gr.1 to 4, DMM. You can change these assignments.

Display Format (Format)

You can evenly divide the T-Y waveform display window so that you can easily view input waveforms and computed waveforms. You can set the number of divisions to one of the values listed below.
Group 1 (Group 1),* 1, 2, 3, 4, 5, 6, 8, 12, 16

* Group 1 is an option that appears when display groups 2 to 4 are selected. Select Group 1 to set the display groups 2 to 4 to the same format as group 1.

The number of displayed points in each division varies depending on the number of divisions. Even if the number of displayed points changes, the vertical resolution does not change. The number of displayed points when only the Main window is displayed is as follows:

Divisions	Displayed Points	Divisions	Displayed Points	Divisions	Displayed Points
1	473 points	4	117 points	8	59 points
2	237 points	5	93 points	12	39 points
3	158 points	6	77 points	16	29 points

Waveform Arrangement, Color, and Grouping (Trace Setup)

You can set the following items for the input channels (CH1 to CH4) of the modules installed in the slots, the instrument's logic input channels (CH5, CH6), and the computation channels (Math1, Math2).

Clear (Clear)

Clears all the items of waveforms assigned to Gr.1 to 4, DMM for each group.

Auto Grouping (Auto Grouping)

Of the available channels (CH, Math, and sub channels), waveforms with the display turned on are automatically assigned to Gr.1 to 4, DMM.

Mapping Mode (Mapping Mode)

Set how to map channels to the divided screens on the mapping list.

- **Auto**
  Waveforms with the display set to ON are mapped from the top in ascending order by number.
  * For sub channels, even if the waveform display (Display) is set to ON, if the input coupling (Coupling) or input (Input) is set to OFF, the sub channels will be deleted from the mapping list when auto grouping (Auto Grouping) is selected.
- **User**
  The waveforms are arranged according to the user-specified map (Map).

Input Channel (CH)

Select the input or computation channel to be placed in the mapping list.

Display Color (Color)

You can set the display color of each of the waveforms to one of 16 colors.
You can assign all waveforms regardless of whether their displays are turned on.

- This can be set for each sub channel for the 16-CH voltage input, 16-CH temperature/voltage input, CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus monitor, SENT monitor, and 4-CH modules.
- Because logic input modules and logic input terminals (CH5 and CH6) of this instrument are not displayed as individual bits but are instead displayed as single channels, they can have only one color assigned to it.

Map (Map)

When the mapping mode is set to User, you can set how to map each waveform to the divided screens. You can assign all waveforms regardless of whether their displays are turned on.

- This can be set for each sub channel for the 16-CH voltage input, 16-CH temperature/voltage input, CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus monitor, SENT monitor, and 4-CH modules.
- Because logic input modules and logic input terminals (CH5 and CH6) of this instrument are not displayed as individual bits but are instead displayed as single channels, they can be assigned only to one zone.

Group 1 to 4, DMM (Gr.1 to 4, DMM)

Specify the channels (CH, Math, and sub channels) that are assigned to each group. You can also automatically reassign just the waveforms of the channels (CH, Math, and sub channels) whose displays are turned on to Gr.1 to 4, DMM.

- You can assign the same channel to multiple groups.
- You cannot assign the following channels to separate groups.
  - The bits of a single logic input module
  - The bits of the logic input terminals (CH5 and CH6) of this instrument
- You cannot assign Math channels to DMM.

Environment Settings (Preference)

Interpolation Method (Dot Connect)

In interpolation zones in the T-Y waveform display,* Xviewer can display waveforms by interpolating between sampled data points.

* Interpolation zone refers to the condition in which a given number of data points are not contained in the 10 div along the time axis. The number of data points that define the interpolation zone varies depending on the display record length and zoom factor.

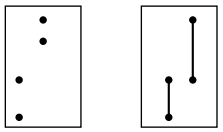
You can set the interpolation method to one of the options below.

- **OFF**
  Displays the data using dots without interpolation.
- **Sine Interpolation (Sine)**
  Interpolates a sine curve between two points using the (sinx)/x function. This method is suitable for the observation of sine waves.
- **Linear Interpolation (Line)**
  Linear interpolation is performed between two points.
- **Pulse Interpolation (Pulse)**
  Interpolates between two points in a staircase pattern.

Outside of the Interpolation Zone

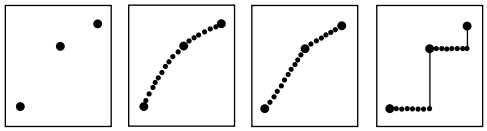
- **When Interpolation Method Is OFF**
  If the interpolation method is set OFF in the T-Y waveform display or when the X-Y waveform display is shown, the instrument displays the acquired data without P-P compression by removing the data between fixed intervals. When the record length exceeds 2 kpoint, the instrument removes data until there are only 2 kpoint and displays two points on each vertical line. When the record length is less than 2 kpoint, all the points are displayed.

- **When Interpolation Method Is Sine, Line, or Pulse**
  The dots are connected vertically.
  If the number of data points is 2002 or greater, the instrument determines the P-P compression values (the maximum and minimum sampled-data values in a given interval), and displays vertical lines (rasters) connecting each pair of maximum and minimum P-P compression values.



OFF **Sine/Line/Pulse**

In the Interpolation Zone



OFF **Sine** **Line** **Pulse**

The interpolation method is set to Pulse when:

- The input signal is a logic signal.
- The acquisition mode is Envelope.

Accumulation (Accumulate)

Ordinarily, momentary waveform anomalies are difficult to recognize because the displayed waveform is updated whenever the trigger is activated. In waveform accumulation, older waveforms remain while new waveforms continue to appear.

- ON: Waveforms are accumulated.
- OFF: Waveforms are not accumulated.

Clearing Accumulated Waveforms

You can clear accumulated waveforms by selecting Clear Trace.

- Automated measurement of waveform parameters and GO/NO-GO determination are performed on the most recent waveform.
- If you press START/STOP to stop waveform acquisition, accumulation stops. When you restart waveform acquisition, accumulation resumes from the condition that it was in when it was stopped.
- When Accumulate is set to ON, you cannot change the settings of the history feature.
- When Accumulate is set to ON, even if you change the display format, the waveforms that are currently on the screen are not cleared. To clear waveforms, press CLEAR TRACE.
- You cannot set accumulate to ON in the roll mode display.
- When you set accumulate to OFF, the accumulated waveforms are cleared. To redisplay the waveforms, use the history feature, and select the record number of the waveforms that you want to display. You can select only waveforms that have record numbers. You cannot display earlier waveforms.
- If the instrument does not trigger when the trigger mode is set to Normal, the waveform intensity is retained until the next time the instrument triggers.

Manual Event (Manual Event)

Indicates the positions of manually input events. You can input manual events and display positions when:

- SD recording is being executed.
- In recorder mode.

You can input manual events by applying a low edge to the external start/stop input (EVNT) terminal. You can enter up to 100 events. For the specifications of the EVNT terminal, see section 4.5 in the *Getting Started Guide*, IM DL350-03EN.

Scale Value (Scale Value)

Items Whose Scale Values Are Displayed (Display Item)

You can display the upper and lower limits (scale values) of each waveform's vertical or horizontal axes.

- OFF: Hides the scale values
- ALL: The vertical axis (V Scale) and horizontal axis (Time Scale) are displayed.
- Time Scale: Only the horizontal axis (Time Scale) is displayed.

Horizontal Axis Display Mode (Time Scale Mode)

Set the type of time to display on the horizontal scale.

- Auto: If the horizontal scale (Time/Div) during measurement is greater than 6 min/div, absolute time is used. Otherwise, relative time is used.
- Relative: Relative time from the start of measurement
- Absolute: Absolute time of measurement (not selectable when the measurement time is 1 second or less)

Trace Label Display (Trace Label)

You can display waveform labels next to the displayed waveforms. If the waveform display is narrow because of the display format settings, labels may not be displayed.

- ON: Hides labels
- OFF: Shows labels

Level Indicator (Level Indicator)

A level indicator that shows the levels of the waveforms whose displays are turned on appears on the right side of the waveform display area. It shows the current levels of the sampled data.

Grid (Graticule)

You can set the window grid to one of the following options.

-  : Displays the grid using broken lines
-  : Displays the grid using crosshairs
-  : Displays a frame

Extra Window (Extra Window)

When waveforms and measured values overlap and are difficult to see, you can use the extra window to display them separately. The extra window appears below the T-Y waveform display window. The following values appear in the extra window.

- Cursor-measurement values
- Automated measurement values of waveform parameters
- The digital values of each channel (only during roll mode display)

Height of the Extra Window

Set the height of the extra window.

OFF: The extra window is not displayed.

1 to 8: The extra window is set to the selected height.

Auto: The extra window appears automatically when you perform cursor measurements and automated measurements of waveform parameters.

- The number of displayed points on the T-Y waveform display window varies depending on the height of the extra window. Even if the number of displayed points changes, the vertical resolution does not change.
- When the extra window is displayed, depending on the Zoom Format, the scale values may overlap and be difficult to read.

Display Ratio of the Main Window (Main Ratio)

When a zoom waveform, FFT, or X-Y waveform is displayed, set the size of the main window in relation to the overall waveform display area.

- 50%: The main window appears in the upper half of the screen.
- 20%: The main window appears in the upper 20% screen.
- 0%: The main window is not displayed.

Window Layout (Window Layout)

Set the window layout when two windows consisting of any of the following windows are displayed: zoom window, FFT window, X-Y window, or harmonic window.

- Side: Horizontal
- Vertical: Vertical (valid only when Main Ratio is set to 0 % when an X-Y window is displayed)

Intensity (Intensity)

You can set the intensities of the grid (Grid), cursor (Cursor), and marker (Marker) to values within the range of 1 to 8.

Snapshot (SnapShot)

This is available only in scope mode. Retains the currently displayed waveforms on the screen. This feature allows you to update the display without having to stop waveform acquisition. It is a useful feature when you want to compare waveforms.

Snapshot waveforms are displayed in white.

You cannot perform the following operations on snapshot waveforms.

Cursor measurement, automated measurement of waveform parameters, zoom, or computation

You can save and load snapshot waveforms.

Clear Trace (Clear Trace)

Clears all the waveforms that are displayed on the screen.

If you change the display format or perform other similar operations, the instrument redisplays the channel waveforms, computed waveforms, and loaded waveforms that were displayed before you executed the clear trace operation.

Snapshot and clear trace features are disabled:

- When the instrument is in remote mode.
- When the instrument is printing, when it is executing auto setup, or when it is accessing a storage medium.
- When go/no-go determination is in progress, when action is in progress, or when searching is in progress.

Horizontal Scale (Horizontal)

This is a setting in recorder mode.

Display Time (Display Time)

Set the waveform display time by specifying the time from the left edge to the right edge of the waveform screen. The time scale of the waveform screen changes automatically according to the specified display time.

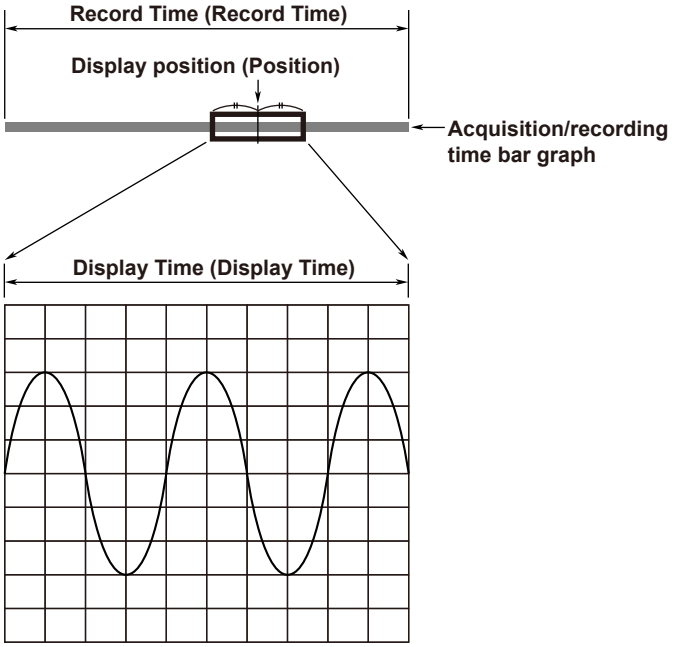
Selectable range

From the acquisition time setting until the number of data points in the waveform window becomes 10 points/div

Display Position (Position)

Set which point (ddhhmmss) between the left edge and the right edge of record time will be displayed at the center of the waveform.

The display time is the box enclosed by a solid line on the record time bar graph. The center position of the display time is expanded to display the waveform.



Auto Scrolling (Auto Scroll)

This is a setting in recorder mode.

You can scroll the display time automatically in the specified direction. You can view the waveform and stop scrolling at the appropriate position.

⏮	Displays the left edge of the recording time bar graph
⏭	Displays the right edge of the recording time bar graph
■	Stops scrolling
◀	Starts scrolling to the left
▶	Starts scrolling to the right

Speed (Speed)

You can select the auto scrolling speed in the range of 1 to 10.

- –: Decreases the speed
- +: Increases the speed

Switching the Channel Information Area Display

When channel information is displayed, clicking ﹀ clears the channel information and shows the full-screen waveform display. Clicking ﹀ shows the information of channels whose display is set to ON.

Numeric Monitor

Displays the level indicator values of each channel in the numeric monitor. The numeric monitor update interval is approximately 0.5 seconds.

8 Saving and Loading Data

You can save the following types of data.

- Waveform data
- Setup data
- Screen capture data
- Snapshot waveform data
- Automated measurement data
- FFT computation results
- Harmonic analysis results

You can load the following types of data into the instrument.

- Waveform data
- Setup data
- Snapshot waveform data
- Symbol definition files

You can also rename and copy files and set or clear protection on files.

Storage Media You Can Save and Load From

The instrument can access the following five types of storage media for saving and loading data.

SD Memory Card (SD-Card)

The SD memory card inserted into the SD memory card slot of the instrument.

The SD memory card insertion status is displayed in the upper left of the screen.

- : SD card installed
- : SD card not installed

USB Storage Medium (USB-0/USB-1)

A USB storage device that is connected to the instrument's USB port. USB2.0 mass storage devices compatible with USB Mass Storage Class Ver. 1.1 can be connected to the instrument.

Network Drive (Network)

A storage device on the network. You can use a network storage device by connecting the instrument to an Ethernet network.

Notes about Using USB Storage

- Connect USB storages device directly, not through a USB hub.
- Only connect a compatible USB keyboard, mouse, or storage device to the USB port for peripherals.
- Do not connect and disconnect multiple USB devices repetitively. Provide a 10-second interval between removal and connection.
- Do not connect or remove USB cables from the time when the instrument is turned on until key operation becomes available (approximately 20 to 30 seconds).
- You can use USB storage media that are compatible with USB Mass Storage Class Ver. 1.1.
- The instrument can handle up to four storage media. If the connected medium is partitioned, the instrument treats each partition as a separate storage medium. As such, the instrument can handle up to four partitions.
- Do not connect USB storage media to the instrument during SD recording or when you will start SD recording.

Saving Waveform Data (Waveform Save)

You can save the waveform data that the instrument has measured to a file in binary, ASCII, or MATLAB format.

- Setting the File Name (FileName Setup)
- Waveform Data Save Conditions (Waveform Save Setup)
- Detail Setup(Detail)

Setting the File Name (FileName Setup)

File Path (Path)

Displays the specified storage medium for saving data.

Save Destination (File List)

Specify the data save destination.

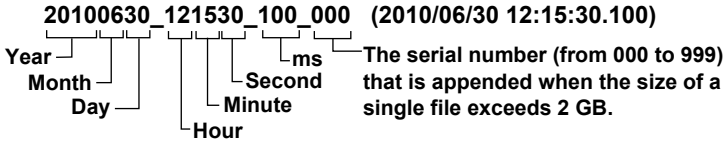
Auto Naming (Auto Naming)

File names can be automatically assigned.

- OFF
  The auto naming feature is disabled. The name that you specify using the File Name setting is used. If there is a file with the same name in the save destination folder, you cannot save the data.
- Numbering (Numbering)
  The instrument automatically adds a four-digit number from 0000 to 9999 after the common name specified using the File Name setting (up to 32 characters) and saves files.
- Date (Date)
  The file name is the date and time (down to ms) when the file is saved. The file name specified using the File Name setting is not used.

- Whether Auto Naming is set to Numbering, Date, or OFF, when the size of a single file exceeds 2 GB, an underscore and a three-digit serial number (000 to 999) are appended to the file names.

File Name Example for When Auto Naming Is Set to Date



- The underscore and three-digit serial number are not appended to the file name when the file size is 2 GB or less. However, when a file is saved through the SD recording feature, an underscore and the three-digit serial number 000 are appended to the file name even if the file size does not exceed 2 GB.
- Save Destination Folder during SD Recording and Action Execution
  In the specified drive, a folder is automatically created with the date (year, month, and day) as its name, and data is saved to that folder using file names specified by the auto naming feature. If the number of files in the save destination folder exceeds 1000, a new folder is automatically created with the date and an incremented sequence number (000 to 999) as its name, and the data continues to be saved in the new folder.
  You can configure the instrument so that data is saved to the specified folder when an action is executed, not to the folder that is automatically created with the date. ▶ See here.

File Name (File Name)

You can set the common file name that is used when the auto naming feature is turned off or when the auto naming feature is set to Numbering. The maximum number of characters that you can use for file names and folder names is 32 characters. The following restrictions apply.

- The following types of characters can be used: 0 to 9, A to Z, a to z, _, −, =, (,), {, }, [,], #, $, %, &, ~, !, `,and @. @ cannot be entered consecutively.
- The following exact strings cannot be used due to MS-DOS limitations:
  AUX, CON, PRN, NUL, CLOCK, LPT1, LPT2, LPT3, LPT4, LPT5, LPT6, LPT7, LPT8, LPT9, COM1, COM2, COM3, COM4, COM5, COM6, COM7, COM8, COM9
- Keep the full path name (absolute path from the root folder) within 255 characters. If this is exceeded, an error will occur when you perform file operations (save, copy, rename, create folder, etc.). When an operation is being performed on a folder, the full path is up to the name of the folder. When an operation is being performed on a file, the full path is up to the name of the file.

The following additional restrictions apply when you use the file name auto naming feature.

- If you set auto naming to Numbering, the file name will be the common name that you specify as the file name with a four-character sequence number.
- If you set auto naming to Date (date and time), the characters that you entered for the file name will not be used. File names will only consist of the date information.

Comment (Comment)

You can add a comment that consists of up to 120 characters when you save a file. You do not have to enter a comment. All characters, including spaces, can be used in comments.

Waveform Data Save Conditions (Waveform Save Setup)

Data Format (Format)

Set the data type to binary, ASCII, or MATLAB.

- **Binary (Binary)**
  - The sampled data stored to the acquisition memory is saved to a file in binary format. The extension is .WDF. A thumbnail file is also saved at the same time. The thumbnail file can be viewed in the File Property screen.
  - You can load the saved binary format data into the instrument, display the waveform of the data, and view the values that it contains. Accumulate is always set to OFF for loaded data.
  - The instrument numbers of the DL350 and following modules are saved as file properties.
    720211, 720250, 720254, 720268, 720266, 720281, 720221, 720241
    The instrument numbers of other modules are not saved.

- **ASCII (ASCII)**
  - The sampled data stored in the acquisition memory is converted using the specified range and saved to a file in ASCII format. The extension is .CSV. You can use the file to analyze waveforms on your PC.
  - You cannot load this type of data into the instrument.
  - If the main channel sample rate and the rate at which data is written to the sub channel acquisition memory are different, “NAN” may be present in the start section of the sub channel data. The minimum number of NAN points is zero. The maximum is according to the following equation.

$$\frac{\text{Main Channel Sample Rate}}{\text{Rate at which data is written to the sub channel acquisition memory}}$$

- **MATLAB**
  - The sampled data stored in the acquisition memory is saved to a file in MATLAB format. You can select whether to include text format information (ON) or not (OFF).
    The extension is .MAT. You can use the file to analyze waveforms on your PC.
  - You cannot load this type of data into the instrument.

Data size

The data sizes indicated below are for when the record length is 100 kpoint and you save the measured data from CH1 to CH4 with all computed waveforms turned off and one history waveform.

Data Type	Extension	Size (In bytes)
Binary	.WDF	Approx. 800 k ((100 kpoint) × 4 channels × 2) + internal setup data (200 k to 1 M depending on the installation state)
ASCII	.CSV	4 to 5Mpoint
MATLAB	.MAT	Approx. 1.6 M: (100 kpoint) × 4 × 4, 1 byte per bit for logic signals

Saving History Waveforms (History)

Select from the following.

- One waveform (1 Record): Only the waveform with the record number specified in the history menu is saved.
- All waveforms (All Record): All history waveforms between the start and end numbers specified in the History menu are saved.

* If the data type is set to MATLAB, the number of history waveforms that can be saved is fixed to one (1 Record), and options are not displayed.

Average waveforms of history waveforms cannot be saved. Save the necessary range of history waveforms using All Record, load the saved history waveforms, and then set the display mode of the history function to Average Record to display the average waveform.

Saving All Displayed Waveforms (Save Trace All)

Saves all the displayed waveforms.

Waveforms to Save (Waveform Save Trace)

- You can select CH1 to CH6[1], 16chVOLT[2], 16chTEMP/VOLT[2], CAN[3], LIN[3], SENT[3], Math. The selected waveforms that are displayed are saved.
  1 You can select the channel of an installed module.
  2 When a 16-CH voltage input module or 16-CH temperature/voltage input module is installed. You cannot select sub channels.
  3 On a model with the /VE option when a CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus, or SENT monitor module is installed. You cannot select sub channels.
- The vertical-axis, horizontal-axis, and trigger settings are also saved along with the waveforms.

Save Range (Range)

You can select the waveform save range (area) from one of the choices below.

- Scope mode
  - Main (Main): Saves the data displayed in the main window
  - Zoom1, Zoom2 (Zoom1, Zoom2): Saves the range of data displayed in the zoom window
  - Cursor range (Cursor Range): Saves the data in the area between the cursors
- Recorder mode
  - All (All): Saves all the data during the acquisition time
  - Display area (Display Area): Saves the data in the area shown in the waveform display window
  - Zoom (Zoom): Saves the range of data displayed in the zoom window
  - Cursor range (Cursor): Saves the data in the area between the cursors

Cursors (Cursor1, Cursor2)

When the save range is set to Cursor, set the save range with Cursor 1 and Cursor 2.
You can set in the range of –5 to +5 div from the center of the waveform display window.

- Scope mode: Set the positions in divisions.
- Recorder mode: Set the positions in terms of the time (ddhhmmss) corresponding to divisions.

The start and end points are similar to the settable range of the cursor display position in cursor measurement.
For details, see “Selectable Range of Cursor Positions.”

▶ See here.

Detail Setup(Detail)

Decimal Point (Decimal Point)

When you save data in ASCII format, you can choose how to separate the data.

- Point (Point): The decimal point is a period, and the separator is a comma.
- Comma (Comma): The decimal point is a comma, and the separator is a period.

Data Removal Interval (Interval)

When you save data in ASCII format, you can thin out the data before you convert it to ASCII format. Set the data removal interval.
OFF (no data is removed), 5 points (Per 5), 10 points (Per 10), 20 points (Per 20), 50 points (Per 50), 100 points (Per 100), 200 points (Per 200), 500 points (Per 500), 1000 points (Per 1000), 2000 points (Per 2000), 5000 points (Per 5000)
For example, if you select Per 5, the data will be removed as indicated below.
First data point, +5, +10, +15...

Time Information (Time Info.)

When you save data in ASCII format, you can choose whether to save time information.

- ON: Time information is saved.
- OFF: Time information is not saved.

Saving Sub Channel Data (Sub Channel)

When you save data in ASCII format, you can choose how to interpolate the sub channel data of 16-CH voltage input modules, 16-CH temperature/voltage input modules, .CAN bus monitor modules, CAN/CAN FD monitor modules, CAN & LIN bus monitor modules, and SENT monitor modules.

- Supplement (Supplement): Blank spaces are filled with repetitions of the same data so that the sub channels have the same amount of data as an ordinary channel.
- Space (Space): Spaces are left where there is no data.

MATLAB Save Settings (MATLAB Save Setup)

You can select whether to include text format information (ON) or not (OFF).

Notes about Using the 16-CH Voltage Input Module (720220)

Notes about Using the 16-CH Temperature/Voltage Input Module (720221)

▶ See here.

- If you change the extension of the saved data file, by using a PC or some other device, the instrument will no longer be able to load it.
- Up to 1000 files and folders can be displayed in the file list. If there are more than a total of 1000 files and folders in a given folder, the file list for that folder will display only 1000 files and folders. There is no way to set which files and folders are displayed.

Data Format for Saving Multiple Records

The instrument saves data that contains multiple records, such as history waveforms, in the following data format.

ASCII format: CR+LF is inserted between records.

<Header>
CH1 data 1-1, CH2 data 1-1, ..., [CR+LF]
CH1 data 1-2, CH2 data 1-2, ..., [CR+LF]
⋮
CH1 data 1-m, CH2 data 1-m, ..., [CR+LF]
[CR+LF]
CH1 data 2-1, CH2 data 2-1, ..., [CR+LF]
CH1 data 2-2, CH2 data 2-2, ..., [CR+LF]
⋮
CH1 data 2-n, CH2 data 2-n, ..., [CR+LF]
[CR+LF]
⋮

One history record

Saving Setup Data (Setup Save)

You can save the instrument setup information to the specified storage medium. The extension is .SET.

Setting the File Name (FileName Setup)

▶ See here.

Saving Other Types of Data (Others Save)

Save Type (Save Type)

You can save the following types of data.

- Measure: You can save the results of the automated measurement of waveform parameters to a file in CSV format.
- Snap: You can save the waveform data captured in a snapshot. The extension is .SNP.
- Image: You can save the displayed screen image to a file in PNG, BMP, or JPEG.
- FFT: You can save FFT computation results to a file in CSV format.
- Harmonic: You can save harmonic analysis results to a file in CSV format.

Automated Measurement Values of Waveform Parameters (Measure)

Save the results of automatic waveform parameter measurement to a file in CSV format. The extension is .CSV. CSV files are text files that contain data separated by commas. They are used to convert data between spreadsheet and database applications.

The maximum number of previous values that you can save is equal to 100000 ÷ number of items that are turned on.

Data size in bytes = Number of measured items × 15 × number of history waveforms

Setting the File Name (FileName Setup)

▶ See here.

Unit (Unit)

You can select whether to save the units of measure along with the measured results.

- ON: Units are saved.
- OFF: Units are not saved.

Time Information (Time Info.)

▶ See here.

Snapshot (Snap)

You can save the waveform data captured in a snapshot. The extension is .SNP.

Setting the File Name (FileName Setup)

▶ See here.

Screen Capture (Image)

You can save the displayed screen image to a file in PNG, BMP, or JPEG.

Save Conditions (Image Save Setup)

- **File Path (Path), Save Destination (File List), Auto Naming (Auto Naming), File Name (File Name), Comment (Comment)**

▶ See here.

- **Data Format (Format)**

  You can select the format to save to from the options listed below.
  - PNG: The extension is .PNG. The file size is approximately 50 KB for black and white mode and approximately 100 KB for color mode.
  - The extension is .BMP. The file size is approximately 70 KB for black and white mode and approximately 1 MB for color mode.
  - The extension is .JPG. The file size is approximately 250 KB for color mode.

  The file sizes listed here are for reference. Actual file sizes will vary depending on the image that is saved.

- **Color (Color)**

  You can select the color format to save to from the options below.
  - OFF: Saves data in black and white.
  - Color (Color): Saves data using 65536 colors.
  - Color (reverse) (Color (Reverse)): Saves data using 65536 colors. The screen background will be white. This option appears when the color theme is set to black (Black).
  - Gray (Gray): Saves data using 16 grayscale levels.

- **Background Transparent or Opaque (Background)**

  For PNG format, you can save the waveform display area with a transparent background. This feature is convenient when you want to compare waveforms by overlaying screen captures on the PC.
  - Normal (Normal): Saves data without changing the background (not made transparent).
  - Transparent (Transparent): Saves data by making the background transparent.

FFT Computation Results (FFT)

You can save the FFT computation results that were specified using FFT1 or FFT2 to a file in CSV format. The extension is .CSV.

Setting the File Name (FileName Setup)

▶ See here.

Frequency Information (Frequency Info.)

You can select whether to save frequency information along with computed results.
- ON: Frequency information is saved.
- OFF: Frequency information is not saved.

Decimal Point (Decimal Point)

▶ See here.

Harmonic Analysis Results (Harmonics)

You can save harmonic analysis results to a file in CSV format.

Setting the File Name (FileName Setup)

▶ See here.

Unit (Unit)

You can select whether to save the units of measure along with the measured results.
- ON: Units are saved.
- OFF: Units are not saved.

Saving (Execute Save)

Saves the data to the specified save destination with the specified file name.

SAVE Key Setup (Save Key Setup)

Set the operation to perform when the SAVE key is pressed.

Save waveform data (Save Waveform)

▶ See here.

Screen Capture Saving (Save Image)

▶ See here.

Printing on a USB Printer (USB)

Printing is possible on a printer connected through USB. The screen displayed on the instrument is printed exactly as it appears.

Connection Procedure

Connect a printer to the standard type A USB port on the left side panel of this instrument.
Connect the USB printer directly, not through a hub. You can connect or remove the USB cable regardless of whether the instrument is on or off (hot-plugging is supported). If you connect a USB printer when the instrument is on, the instrument will detect the printer and enable it for use.

- Do not connect multiple printers to the USB ports.
- While the printer is printing, do not turn off the printer or remove the USB cable.
- Do not connect or remove USB cables from the time when the instrument is turned on until key operation becomes available (approximately 20 to 30 seconds).

Printer Type (Format)

The following USB Printer Class Ver.1.0 printers can be used.

- HP Inkjet: HP inkjet printers, single function models
- Brother: Brother PocketJet or RJ-4030 printer

- Do not connect an incompatible USB printer.
- For USB printers that have been tested for compatibility, contact your nearest YOKOGAWA dealer.

Print Setup (Print Setup)

Color (Color)

When the printer type is HP Inkjet, select the color mode from the following options.

- ON: Printing is performed using the same colors as the screen (however with no background and grid printed in black).
- OFF: Printing is performed in black and white.

Mode (Mode)

When the printer type is Brother, select the print mode from the following options.

- Hard Copy (Hard Copy): The waveforms displayed on the screen are printed as they appear on the screen.
- Long Print (Long Print): The specified print time range of the waveforms displayed on the screen are printed with the time axis expanded. The vertical size is adjusted automatically so that they fit in the short side (210 mm) of A4 paper. Brother RJ-4030 does not support Long Print.

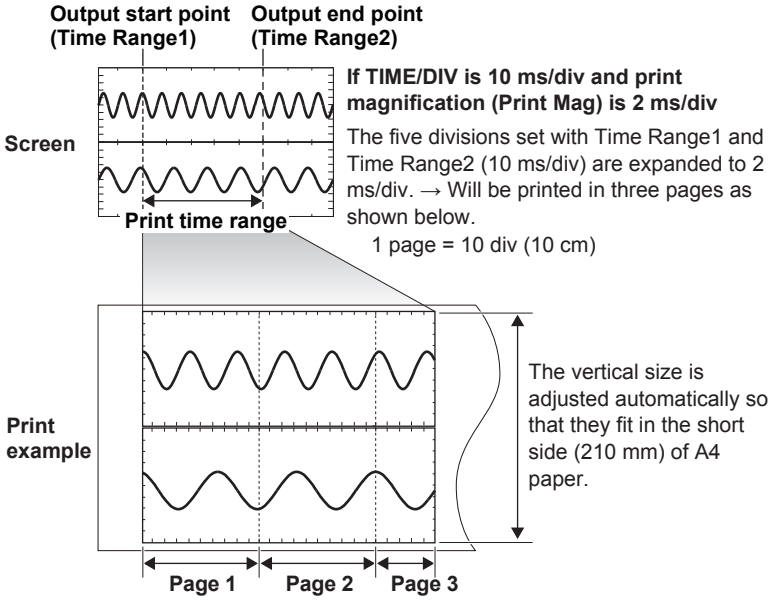
Comment (Comment)

If the mode is long print, you can specify a comment using up to 26 characters. The comment appears at the bottom of the screen. The comment is used when saving files.

Print Time Range of Long Print (Time Range1/Time Range2)

If the mode is set to Long Print, set the print time range to print. Move and set the cursors for the output start point (Time Range1) and output end point (Time Range2).

Selectable range: ±5 div of the time axis



Print Magnification (Print Mag) of Long Print

If the mode is set to Long Print, set the print time magnification.

The method to set the magnification varies depending on whether the waveforms to be printed are sampled using the internal clock or sampled using an external clock.

- **For waveforms sampled with the internal clock**

  Set using the time per division (T/div). If it is set to the same value as the sampling T/div, 10 divisions of waveforms are printed on a page (= 10 cm).

  The selectable range varies depending on the T/div value and record length (in 1-2-5 steps).

- **For waveforms sampled with an external clock**

  Set using the magnification. If the magnification is set to 1, 10 divisions of waveforms are printed on a page (= 10 cm).

  Selectable range: Varies depending on the record length.

The maximum number of pages that can be printed at once is 25. If the maximum number of print pages is exceeded, an error message will appear when printing is executed.

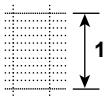
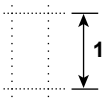
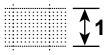
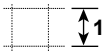
Width of the Vertical Scale (Graticule Type)

Select DIV or 10mm.

- DIV: Grid that divides the print zone into 10 sections
- 10mm: Grid of a millimeter graph paper type

Printed scale

The format of the printed scale varies depending on the selected scale width and the grid type selected on the Display menu as shown below.

Scale Width (Graticule Type)	Grid (Graticule)		
			
DIV		No scale	
10 mm		No scale	

Display Information (Display Information)

Select whether to print the following display information.

- **Time (Time)**

  The recording start time and recording end time from the time reference mark are printed at the bottom of the print area.

- **Gauge (Gauge)**

  A gauge, arrow indicating the ground position, and trace number are printed to the left of the print area.

- **Header (Header)**

  The time of the waveform time reference, time reference mark, and T/div are printed in the top section of the print area. For details on the time of the waveform time reference, see section 1.3 in the Getting Started Guide, IM DL350-03EN.

- **Annotation (Annotation)**

  Trace information or messages assigned to each channel are printed at the bottom of the waveform print area.

Annotation Type (Annotation Type)

If you select the annotation print check box, select the annotation type from the following options.

- Trace information (Trace Info): V/div, filter, module settings, and the like are printed.
- Message (Message): Character strings assigned to each channel are printed.

Annotation Message (Annotation Message)

If you set the annotation type to message, set the following items.

- Trace (Trace): Select the target waveform to assign the annotation message.
- Message (Message): Set the message for the waveform selected with Trace (Trace) using up to 50 characters.

Notes on printing with a USB printer

- The comment may not be printed properly on some printers. Use a USB printer that has been tested for compatibility.
- The instrument may not be able to detect out-of-paper or other errors on the USB printer.

Notes on Long Print

- Long Print is not possible while waveform acquisition is in progress.
- The items that can be printed using Long Print are T-Y waveform data stored in the acquisition memory, math waveforms, and SD recording waveforms.
- If history waveforms are displayed, only the waveform selected with Select Record is applicable for Long Print.
- Snapshots and accumulated waveforms cannot be printed using Long Print.
- If the number of print pages exceeds 25, Long Print is not possible.

Loading Waveform Data (Waveform Load)

You can load waveform data that are saved.
Waveform data in binary format (files with .WDF extensions) can be loaded.
You can load a specified waveform data file with the setup data. All the data in the file is loaded. Waveforms of computed data appear when computation is turned on. Because setup data is also loaded, the instrument settings change when you load waveform data. If you start waveform acquisition by pressing the START/STOP key, the loaded data is cleared.

If the module configuration when the waveform data is saved and that when the data is loaded are different, you cannot load the waveform data.

Loading Setup Data (Setup Load)

The setup data of the specified file is loaded. The extension is .SET.
* The following settings will not be changed.
  Date and time, time synchronization feature, storage media format, USB keyboard language, USB communication feature, menu background color, key lock, network

If the module configuration when the setup data is saved and that when the data is loaded are different, only the setup data of modules that match is loaded. When loading is complete, a message indicating the channel numbers that were not loaded is displayed.

Loading Other Types of Data (Others Load)

This is selectable only in scope mode.
The snapshot waveforms of the specified file or the contents of a symbol definition file are loaded.

Snapshot Waveforms (Snap)

The extension is .SNP. The snapshot waveforms that you load are displayed in white on the screen.

Symbol Definition Files (Symbol)

The extension is .SBL. These are CAN data or LIN data definition files.
This is displayed when a CAN bus monitor, CAN/CAN FD monitor, or CAN & LIN bus monitor module is installed.

Loading Symbols (Symbol Load)

This is available in recorder mode when a CAN bus monitor, CAN/CAN FD monitor, or CAN & LIN bus monitor module is installed.
The specified symbol definition file is loaded.
The extension is .SBL. This is a CAN data or LIN data definition file.

Loading (Execute Load)

Loads the data of the specified file.

File Operation

You can perform file operations such as creating folders on the storage medium, deleting and copying files, and changing file names.

Changing the Storage Medium

You can select the storage medium that you want to access. The instrument displays various storage media as follows:

- SD-1: The SD memory card inserted into the SD memory card slot of the instrument
- USB-0: The USB storage device that is connected to a instrument's USB port (type A) for connecting peripheral devices (the first connected device)
- USB-1: The USB storage device that is connected to a instrument's USB port (type A) for connecting peripheral devices (the second connected device).
- Network: A storage device on the network

Sorting the List (Sort To)

You can sort the file list by file name, data size, date, etc.

Display Format

Select whether to display a list of files or to display thumbnails.

Selecting the Type of Files to List (*.* (or *.extension)))

You can limit the type of files that appear in the list by selecting an extension. There are options that display files with several different extensions.

File Property (File Property)

You can view information about the selected file, such as its name (File Name), file size (File Size), the date and time when it was saved (Date/Time), its attributes (Attribute), and the GPS position information at trigger points. For binary waveform data (the extension is .WDF), you can view the instrument numbers of the DL350 and the following modules as file properties.

7201281, 720221, 720241

You cannot view the instrument numbers of other modules.

Making Folders (Make Dir)

You can make folders.

You can use the same characters in folder names that you can in file names.

▶ See here.

File Utility (Utility)

Deleting Files and Folders (Delete)

You can delete the selected files and folders.

Renaming Files and Folders (Rename)

You can rename a selected file or folder.

Copying and Moving Files (Copy and Move)

You can copy or move the selected files and folders to other storage media or folders. You can copy or move multiple files at the same time.

Selecting Files (Select All, Deselect All)

Selects or deselects all the files in the list.

You can abort (Abort) the file copy and delete operations, except for the file that is being processed at the time.

9 Cursor Measurement

You can move cursors on the waveforms displayed on the screen to view the measured values at the points where the cursors intersect the waveforms. You can select whether to measure the P-P compressed data values on the screen or the data values that have been acquired in the acquisition memory.

▶ See here.

This section explains cursor measurements of T-Y waveforms.

- Cursor measurements of waveforms in the X-Y window

  ▶ See here.
- Cursor measurements of waveforms in the FFT window

  ▶ See here.

Turning Cursor Measurement On and Off

- ON: Cursor measurement is performed.
- OFF: Cursor measurement is not performed.

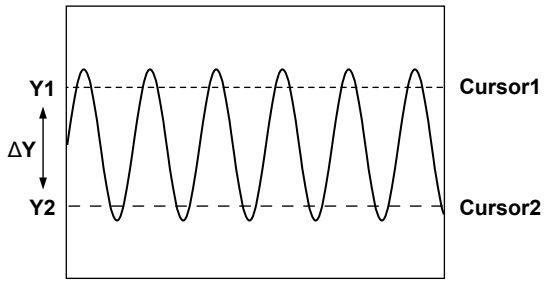
Cursor Type (Type)

The following types of T-Y waveform cursors are available.

- Horizontal cursors (Horizontal): Two horizontal cursors are used to measure vertical values.
- Vertical cursors (Vertical): Two vertical cursors are used to measure time values.
- Marker cursors (Marker): Four marker cursors that move on the waveform are used to measure waveform values.
- Angle cursors (Degree): Two angle cursors are used to measure angles.
- Horizontal and vertical cursors (H & V): Two horizontal cursors and two vertical cursors are used to measure vertical and time values.

Horizontal Cursors (Horizontal) - T-Y waveforms

Two dashed lines (horizontal cursors) appear on the horizontal axis. You can measure the vertical value at the position of each horizontal cursor and measure the level difference between the horizontal cursors.



Measurement Source Waveform (Trace)

Set the measurement source waveform to one of the waveforms below.

CH1 to CH4[1], 16chVOLT[2], 16chTEMP/VOLT[2], CAN[3], LIN[3], SENT[3], Math1 to Math2

1 You can select the channel of an installed module. On a 4-CH module, select sub channel 1 or 2. You cannot select the input channel of a logic module.
2 When a 16-CH voltage input module or 16-CH temperature/voltage input module is installed. After you select 16chVOLT or 16chTEMP/VOLT, select a sub channel.
3 On a model with the /VE option when a CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus, or SENT monitor module is installed. After you select CAN, LIN, or SENT, select a sub channel.
   - You cannot select a sub channel if the input of the data extraction conditions (All SubChannel Setup) is set off.
   - This cannot be selected on a CAN bus monitor or, CAN/CAN FD monitor, CAN & LIN bus monitor module if the data type (Value Type) is set to Logic. On a SENT monitor module, S&C and Error Trigger sub channels cannot be selected.

Moving the Cursors (Cursor1/Cursor2)

Use Cursor1 and Cursor2 to move the cursors.

You can set in the range of –5 to +5 div from the center of the waveform display window. The step resolution is 0.01 div.

Linking Cursors

You can move the cursors without changing the interval between Cursor1 and Cursor2.

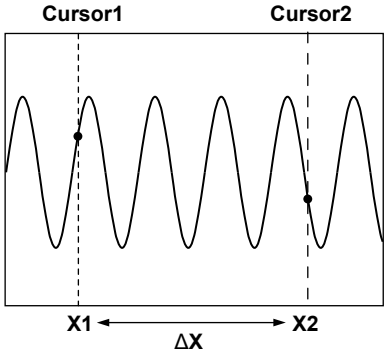
Measurement Items (Item Setup)

You can measure the following vertical values at the cursor positions.

Y1	Vertical value at Cursor1
Y2	Vertical value at Cursor2
ΔY	Difference between the vertical values of Cursor1 and Cursor2

Vertical Cursors (Vertical) - T-Y waveforms

Two straight dashed lines appear on the vertical axis (these are the vertical cursors). You can measure the time between the trigger position and each cursor, the time difference between the two cursors, and the reciprocal of the time difference between the two cursors. You can also measure the vertical signal value at each cursor position and the level difference between the two cursors.



Measurement Source Waveform (Trace)

Set the measurement source waveform to one of the waveforms below.
ALL, CH1 to CH6[1], 16chVOLT[2], 16chTEMP/VOLT[2], CAN[3], LIN[3], SENT[3], Math1 to Math2

1 You can select the channel of an installed module. On a 4-CH module, select sub channel 1 or 2.
2 When a 16-CH voltage input module or 16-CH temperature/voltage input module is installed. After you select 16chVOLT or 16chTEMP/VOLT, select a sub channel.
3 On a model with the /VE option when a CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus, or SENT monitor module is installed. After you select CAN, LIN, or SENT, select a sub channel.
You cannot select a sub channel if the input of the data extraction conditions (All SubChannel Setup) is set off.

Moving the Cursors (Cursor1/Cursor2)

Use Cursor1 and Cursor2 to move the cursors.
You can set in the range of –5 to +5 div from the center of the waveform display window. The setting resolution varies depending on the display resolution.

- Scope mode: Set the positions in divisions.
- Recorder mode: Set the positions in terms of the time (ddhhmmss) corresponding to divisions.

The start and end points are similar to the settable range of the cursor display position in cursor measurement. For details, see “Selectable Range of Cursor Positions.”

▶ See here.

Linking Cursors

You can move the cursors without changing the interval between Cursor1 and Cursor2.

Measurement Items (Item Setup)

You can measure the following horizontal values at the cursor positions.

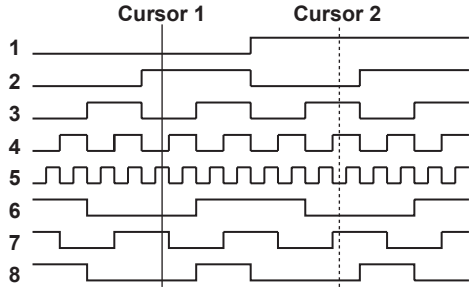
X1	Time value at Cursor1
X2	Time value at Cursor2
ΔX	Difference between the time values of Cursor1 and Cursor2
1/ΔX	Reciprocal of the difference between the time values of Cursor1 and Cursor2
Y1	Vertical value at the intersection of Cursor1 and the waveform[1]
Y2	Vertical value at the intersection of Cursor2 and the waveform[2]
ΔY	Vertical value at the intersection of Cursor1/Cursor2 and the waveform[2]

1 When Trace is set to ALL, the values for the channels of all installed modules, the sub channels, and the Math channel are measured.
2 This option does not appear when Trace is set to ALL.

Example of Logic Signal Measurement

When you measure logic waveforms using vertical cursors, the measured values of Y1 and Y2 are determined in the manner shown below.

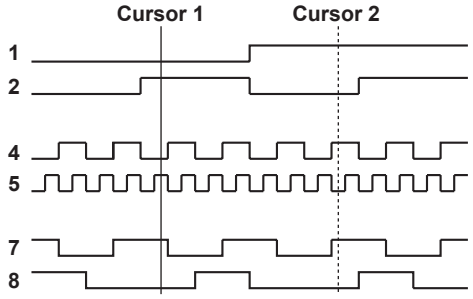
When No Bits Are Turned Off



• When the cursor order is 1->8
Bit Y1: 01001010
Y2: 10110010
Hex Y1: 4A
Y2: B2

• When the cursor order is 8->1
Bit Y1: 01010010
Y2: 01001101
Hex Y1: 52
Y2: 4D

When Some Bits Are Turned Off



• When the cursor order is 1->8
Bit Y1: 01-01-10
Y2: 10-10-10
Hex Y1: 16
Y2: 2A

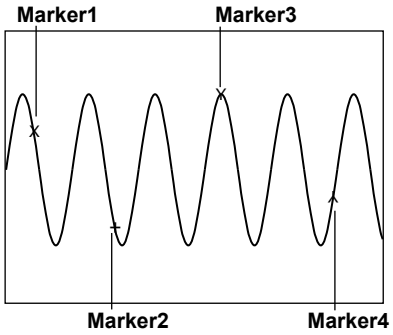
• When the cursor order is 8->1
Bit Y1: 01-10-10
Y2: 01-01-01
Hex Y1: 1A
Y2: 15

You can set the display format (Bit or Hex), the cursor order (Cursor Order), and the bit order (Bit Order) using Preference > Logic in the Utility menu.

▶ See here.

Marker Cursors (Marker) - T-Y waveforms

Four markers are displayed on the selected waveform. You can measure the level at each marker, the amount of time from the trigger position to each marker, and the level and time differences between markers.



Marker Settings (Marker Setup)

Measurement Source Waveform (Trace)

Set the measurement source waveform to one of the waveforms below.

- OFF: Not use
- CH1 to CH4[1], 16chVOLT[2], 16chTEMP/VOLT[2], CAN[3], LIN[3], SENT[3], Math1 to Math2
  1 You can select the channel of an installed module. On a 4-CH module, select sub channel 1 or 2. You cannot select the input channel of a logic module.
  2 When a 16-CH voltage input module or 16-CH temperature/voltage input module is installed. After you select 16chVOLT or 16chTEMP/VOLT, select a sub channel.
  3 On a model with the /VE option when a CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus, or SENT monitor module is installed. After you select CAN, LIN, or SENT, select a sub channel.
    - You cannot select a sub channel if the input of the data extraction conditions (All SubChannel Setup) is set off.
    - This cannot be selected on a CAN bus monitor or, CAN/CAN FD monitor, CAN & LIN bus monitor module if the data type (Value Type) is set to Logic. On a SENT monitor module, S&C and Error Trigger sub channels cannot be selected.

Marker Shape (Marker Form)

Set the shape of the displayed marker to one of the options below.

- Mark: A dot
- Line: A crosshair

Measurement Items (Display Item)

Marker cursors move on the waveform data. You can measure the following values at the markers.

X1	Time value at Marker1
X2	Time value at Marker2
X3	Time value at Marker3
X4	Time value at Marker4
Δ(X2-X1)	Difference between the time values of Marker1 and Marker2
Δ(X3-X1)	Difference between the time values of Marker1 and Marker3
Δ(X4-X1)	Difference between the time values of Marker1 and Marker4
Δ(X3-X2)	Difference between the time values of Marker2 and Marker3
Δ(X4-X2)	Difference between the time values of Marker2 and Marker4
Δ(X4-X3)	Difference between the time values of Marker3 and Marker4
Y1	Vertical value at Marker1
Y2	Vertical value at Marker2
Y3	Vertical value at Marker3
Y4	Vertical value at Marker4
Δ(Y2-Y1)	Difference between the vertical values of Marker1 and Marker2
Δ(Y3-Y1)	Difference between the vertical values of Marker1 and Marker3
Δ(Y4-Y1)	Difference between the vertical values of Marker1 and Marker4
Δ(Y3-Y2)	Difference between the vertical values of Marker2 and Marker3
Δ(Y4-Y2)	Difference between the vertical values of Marker2 and Marker4
Δ(Y4-Y3)	Difference between the vertical values of Marker3 and Marker4

Movement Target Marker (Target Marker)

Select the marker you want to move. You can select the measurement source waveform (Trace) of the marker displayed here.

Position (Position)

Set the position of the selected marker.

You can set in the range of –5 to +5 div from the center of the waveform display window. The setting resolution varies depending on the display resolution.

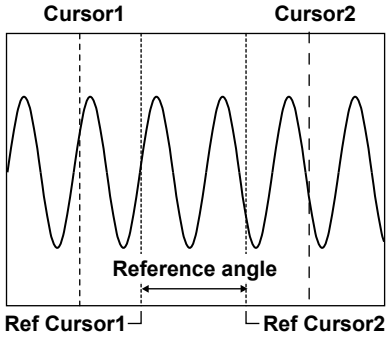
- Scope mode: Set the positions in divisions.
- Recorder mode: Set the positions in terms of the time (ddhhmmss) corresponding to divisions.

The start and end points are similar to the settable range of the cursor display position in cursor measurement. For details, see “Selectable Range of Cursor Positions.”

▶ See here.

Angle Cursors (Degree) - T-Y waveforms

You can measure time values and convert them to angles. On the time axis, set the zero point (Ref Cursor1 position), which will be the measurement reference, the end point (Ref Cursor2 position), and the reference angle that you want to assign to the difference between Ref Cursor1 and Ref Cursor2. Based on this reference angle, you can measure the angle between two angle cursors (Cursor1 and Cursor2).



Degree Setting (Degree Setup)

Measurement Source Waveform (Trace)

Set the measurement source waveform to one of the waveforms below.
ALL, CH1 to CH6[1], 16chVOLT[2], 16chTEMP/VOLT[2], CAN[3], LIN[3], SENT[3], Math1 to Math2

1 You can select the channel of an installed module. On a 4-CH module, select sub channel 1 or 2.
2 When a 16-CH voltage input module or 16-CH temperature/voltage input module is installed. After you select 16chVOLT or 16chTEMP/VOLT, select a sub channel.
3 On a model with the /VE option when a CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus, or SENT monitor module is installed. After you select CAN, LIN, or SENT, select a sub channel.
You cannot select a sub channel if the input of the data extraction conditions (All SubChannel Setup) is set off.

Reference Angle (Ref Value)

Set the reference angle you want to assign to the range defined by Ref Cursor1 and Ref Cursor2.
Selectable range: 1 to 720

Measurement Items (Display Item)

The instrument measures the angle cursor (Cursor1 and Cursor2) positions as angles.

X1	Angle of Cursor1 from Ref Cursor1
X2	Angle of Cursor2 from Ref Cursor1
ΔX	Angle difference between Cursor1 and Cursor2
Y1	Vertical value at the intersection of Cursor1 and the waveform[1]
Y2	Vertical value at the intersection of Cursor2 and the waveform[2]
ΔY	Vertical value at the intersection of Cursor1/Cursor2 and the waveform[2]

1 When Trace is set to ALL, the values for the channels of all installed modules, the sub channels, and the Math channel are measured.
2 This option does not appear when Trace is set to ALL.

Movement Target (Target)

Select the cursor you want to move from the following:

- Cursor: Angle cursor
- Reference: Reference cursor

Moving the Cursors (Cursor)

You can move the cursors. You can set in the range of –5 to +5 div from the center of the waveform display window. The setting resolution varies depending on the display resolution.

- Scope mode: Set the positions in divisions.
- Recorder mode: Set the positions in terms of the time (ddhhmmss) corresponding to divisions.

The start and end points are similar to the settable range of the cursor display position in cursor measurement. For details, see “Selectable Range of Cursor Positions.”

▶ See here.

Linking Cursors

You can move the cursors without changing the interval between Cursor1 and Cursor2.

Horizontal and Vertical Cursors (H & V) - T-Y waveforms

Displays the horizontal and vertical cursors simultaneously.

Horizontal and Vertical Cursor Settings (H&V Setup)

Measurement Source Waveform (Trace)

Set the measurement source waveform to one of the waveforms below.

ALL, CH1 to CH6[1], 16chVOLT[2], 16chTEMP/VOLT[2], CAN[3], LIN[3], SENT[3], Math1 to Math2

1 You can select the channel of an installed module. On a 4-CH module, select sub channel 1 or 2. You cannot select the input channel of a logic module.
2 When a 16-CH voltage input module or 16-CH temperature/voltage input module is installed. After you select 16chVOLT or 16chTEMP/VOLT, select a sub channel.
3 On a model with the /VE option when a CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus, or SENT monitor module is installed. After you select CAN, LIN, or SENT, select a sub channel.
   - You cannot select a sub channel if the input of the data extraction conditions (All SubChannel Setup) is set off.
   - This cannot be selected on a CAN bus monitor or, CAN/CAN FD monitor, CAN & LIN bus monitor module if the data type (Value Type) is set to Logic. On a SENT monitor module, S&C and Error Trigger sub channels cannot be selected.

Measurement Items (Display Item)

You can measure the following horizontal and vertical values at the cursor positions.

Horizontal Axis	
X1	Time value at V-Cursor1
X2	Time value at V-Cursor2
ΔX	Difference between the time values of V-Cursor1 and V-Cursor2
1/ΔX	Reciprocal of the difference between the time values of V-Cursor1 and V-Cursor2
Vertical Axis	
Y1	Vertical value of H-Cursor1
Y2	Vertical value of H-Cursor2
ΔY	Difference between the vertical values of H-Cursor1 and H-Cursor2
ΔY/ΔX	The amount of change in the vertical value per unit time in the cursor range

Movement Target (Target)

Select the cursor you want to move from the following:

- H-Cursor: Horizontal cursor
- V-Cursor: Vertical cursor

Moving the Cursors (V-Cursor, H Cursor1/H-Cursor)

Use the vertical cursor (V-Cursor) and horizontal cursor (H-Cursor) to move the cursors.

You can set in the range of –5 to +5 div from the center of the waveform display window. The step resolution of the vertical cursor is 0.005 div. The setting resolution varies depending on the display resolution.

- Scope mode: Set the positions in divisions.
- Recorder mode: Set the positions in terms of the time (ddhhmmss) corresponding to divisions.

The start and end points are similar to the settable range of the cursor display position in cursor measurement. For details, see “Selectable Range of Cursor Positions.”

▶ See here.

Notes about Cursor Measurement

Cursor Measurement

- You cannot perform cursor measurement on snapshot waveforms or accumulated waveforms that have been acquired in the past. You can perform cursor measurement on the most recent accumulated waveform.
- For history waveforms, cursor measurement is performed on the waveform whose record number is selected.
- The measured time values are based on the trigger position.
- The measured value for data that cannot be measured appears as "***."
- The pulse/rotate setting affects only the X-axis (horizontal) cursor measurement values.

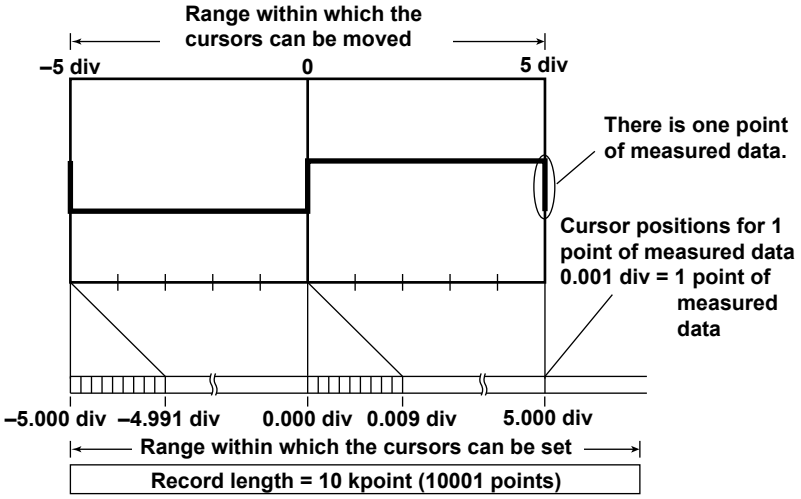
Selectable Range of Cursor Positions

When Cursor Read Mode is set to ACQ, in cursor measurements, measurement is performed on the data stored in the acquisition memory, not on the displayed data. Because 1001 points are displayed along the time axis, the number of acquired data points is equal to the set record length × 1. For example, if the record length is set to 10 kpoint, the number of acquired data points is 10001. This means that there will be 10 points of measured data at the same display point on the screen.

If there is a single point of measured data at each display point, all measured data can be measured by moving the cursor at 0.01 div steps.

On the main window, if there are several points of measured data at each display point, the cursor movement step is set to 0.005 div, and the maximum and minimum values of the measured data points at the display point can be measured. In this case, the cursor's selectable range on the positive side is 5.000 div, making it possible to measure the maximum and minimum values of the several points of measured data at the right-most display point.

Further, if you use the zoom feature to expand the waveform so that the number of displayed points of measured data is 1 kpoint or less, cursor measurement will be possible on all measured data. In this case, the several points of measured data at the +5 div position will also be displayed, and the cursor's selectable range on the positive side will be expanded. The selectable range varies depending on the record length. For example, if the above set record length is 10 kpoint, there are 10 points of measured data at the +5 div position. Therefore, the cursor's selectable range on the positive side is +5.000 div.



Notes about Using the 16-CH Voltage Input Module (720220)

Notes about Using the 16-CH Temperature/Voltage Input Module (720221)

▶ See here.

10 Automated Measurement of Waveform Parameters

For waveforms that are displayed on the screen, various measurement items (waveform parameters), such as maximum and minimum values, can be measured automatically and their statistics can be calculated.
The following types of statistical processing are available for the automatically measured values of waveform parameters.

- Automated measurement of waveform parameters: Automated measurement is performed.
- Continuous statistical processing (Continuous Statistics): Continuous statistical processing is performed.
- Cyclic statistical processing (Cycle Statistics): Statistical processing is performed for each period (cyclic statistical processing).
- Statistical processing of history waveforms (History Statistics): Statistical processing is performed on history waveforms.

Automated Measurement of Waveform Parameters

The instrument automatically measures the specified measurement items on the source waveform.

Turning Automated Measurement of Waveform Parameters On and Off

- ON: Waveform parameters are automatically measured.
- OFF: Waveform parameters are not automatically measured.

Setting Automated Measurement of Waveform Parameters (Measure Setup)

Measurement Items (Item)

Measurement Source Waveform (Trace)

Set the measurement source waveform to one of the waveforms below.
CH1 to CH6[1], 16chVOLT[2], 16chTEMP/VOLT[2], CAN[3], LIN[3], SENT[3], Math1 to Math2, XY1 to XY2

1 You can select the channel of an installed module. On a 4-CH module, select sub channel 1 or 2. Logic module channels are valid only for Frequency, Pulse, AvgFreq, Period, and Duty parameter measurements.
2 When a 16-CH voltage input module or 16-CH temperature/voltage input module is installed. After you select 16chVOLT or 16chTEMP/VOLT, select a sub channel.
3 On a model with the /VE option when a CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus, or SENT monitor module is installed. After you select CAN, LIN, or SENT, select a sub channel. This cannot be selected on a CAN bus monitor, CAN/CAN FD monitor, or CAN & LIN bus monitor module if the data type (Value Type) is set to Logic. On a SENT monitor module, S&C and Error Trigger sub channels cannot be selected.

Measurement Item

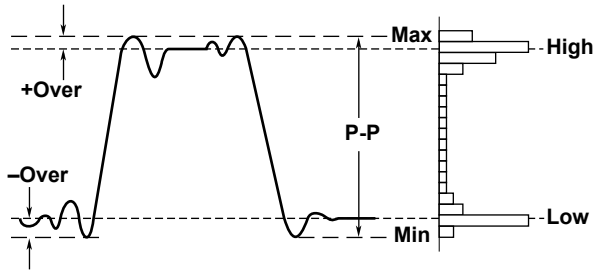
You can choose from the 28 measurement items and delay measurement items listed below. The instrument can store a total of up to 64000 data values for all waveforms (CH1 through CH6, 16chVOLT, 16chTEMP/VOLT, CAN, LIN, SENT, and Math1 to Math8). A total of up to 32 measurement items can be displayed on the screen.

- **Voltage Measurement Items**

Peak to Peak (P-P)	P-P value (Max − Min) [V]
Amplitude (Amp)	Amplitude (High − Low) [V]
Maximum (Max)	Maximum voltage [V]
Minimum (Min)	Minimum voltage [V]
High	High voltage [V]
Low	Low voltage [V]
Average (Avg)	Average voltage ((1/n)Σxi) [V]
Middle(Mid)	(Max+Min)/2 [V]
RMS[1]	Rms voltage $((1/(\sqrt{n}))(\Sigma(xN^2))^{1/2})$ [V]
Std.Deviation (SDev)	Standard deviation $(1/n(\Sigma xi^2-(\Sigma xi)^2/n)^{1/2})$ [V]
+Overshoot (+Over)	Overshoot ((Max−High)/(High−Low) × 100) [%]
−Overshoot (−Over)	Undershoot ((Low−Min)/(High−Low) × 100) [%]

1 On a channel that has been set to power spectrum computation (PS or PSD), if RMS is set to ON, “Rms = overall value” appears on the screen.
For details about power spectrum computation or overall value, see appendix 2.

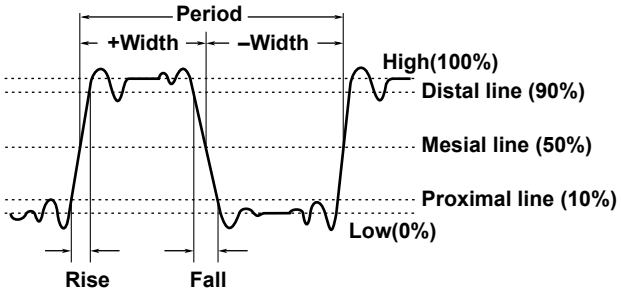
* The names in parentheses are the measurement item names that appear when the measured values are displayed.



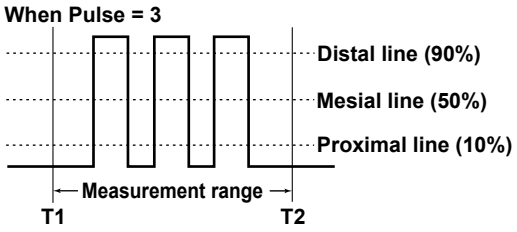
- **Time Measurement Items**

Rise	Rise time [s]
Fall	Fall time [s]
Frequency (Freq)	Frequency [Hz]
Period	Period [s]
+Width	Time width of the portion that is greater than the mesial value [s]
−Width	Time width of the portion that is less than the mesial value [s]
Duty	Duty cycle (+Width/Period × 100) [%]
Avg.Frequency (Avg.F)	Average frequency in the measurement time period [Hz]
Avg.Period (Avg.P)	Average period in the measurement time period [s]

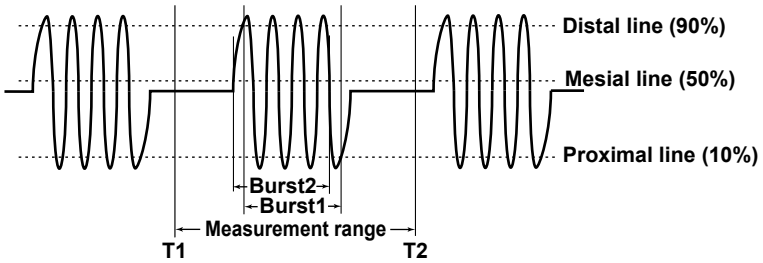
* The names in parentheses are the measurement item names that appear when the measured values are displayed.



Pulse	Pulse count Set the measurement time period (Time Range) to a value appropriate for the pulse that you want to measure.



Burst1, Burst2	Burst period [s] Set the measurement time period (Time Range) to a value appropriate for the burst period that you want to measure.



- **Other Measurement Items**

When Trace Is Set to CH, Sub Channel, or Math	
Integ1TY (Integ1)	Area under the positive parts
Integ2TY (Integ2)	Area of the positive amplitude − area of the negative amplitude
When Trace Is Set to XY	
Integ1XY (Integ1)	Total triangular area of the X-Y waveform
Integ2XY (Integ2)	Total trapezoidal area of the X-Y waveform

* The names in parentheses are the measurement item names that appear when the measured values are displayed.

For detailed information about how the area is computed, see Appendix 1, “How to Calculate the Area of a Waveform.”

All Clear (All Clear)

You can turn off all the items for the waveform selected for Trace at once.

Copy (Copy to)

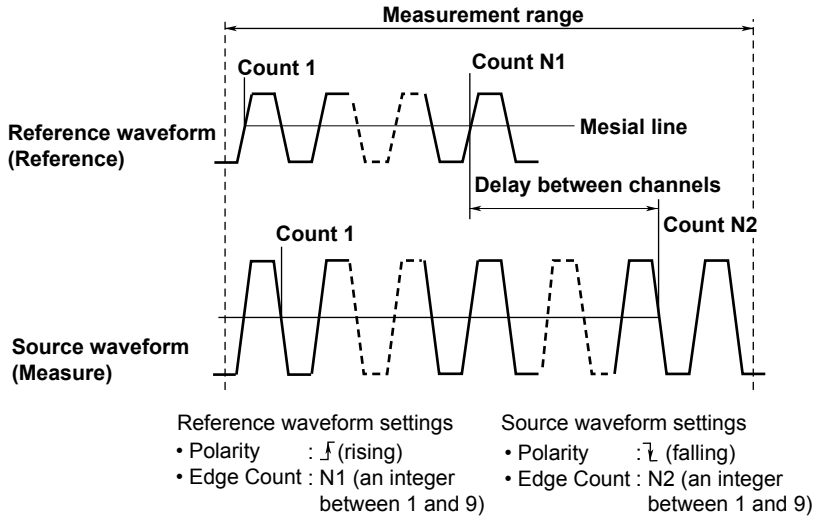
You can copy the settings of the waveform selected for Trace to other traces.

- You can turn the following channels on and off separately: CH1 to CH6[1], 16chVOLT[2], 16chTEMP/VOLT[2], CAN[3], LIN[3], SENT[3], Math1 to Math2.
  1. You can select the channel of an installed module. On a 4-CH module, select sub channel 1 or 2. For logic modules, settings are copied between logic modules.
  2. When a 16-CH voltage input module or 16-CH temperature/voltage input module is installed. After you select 16chVOLT or 16chTEMP/VOLT, select a sub channel.
  3. On a model with the /VE option when a CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus, or SENT monitor module is installed. After you select CAN, LIN, or SENT, select a sub channel. This cannot be selected on a CAN bus monitor, CAN/CAN FD monitor, or CAN & LIN bus monitor module if the data type (Value Type) is set to Logic. On a SENT monitor module, S&C and Error Trigger sub channels cannot be selected.
- All ON: All traces are turned on.
- All OFF: All traces are turned off.
- Execute: Select Execute to copy the settings.

When Trace is set to XY, All Clear and Copy to are not available.

Setting the Delay (Delay Setup)

The time difference between traces or the time difference from the trigger point to a rising or falling edge is called the delay between channels.



Reference waveform settings
• Polarity : ⎍ (rising)
• Edge Count : N1 (an integer between 1 and 9)

Source waveform settings
• Polarity : ⎎ (falling)
• Edge Count : N2 (an integer between 1 and 9)

- **Mode**

  Select a delay measurement mode.
  - OFF: Delay measurement is not performed.
  - Time: The delay between channels is displayed as a time.
  - Degree: The delay between channels is displayed as an angle.

- **Polarity**

  Select the slope of the edge you want to detect.
  - ⎍ : Rising
  - ⎎ : Falling

- **Edge Count**

  Sets which edge counted from the start point (T Range1) of the measurement time period to use as a detected point (measured point).
  Selectable range: 1 to 9

- **Reference**

  Select whether to use a trace or trigger as the reference for the reference waveform.
  - Trace: A trace is used.
  - Trigger: A trigger is used.

- **Reference Waveform (Reference Trace)**

  When Reference is set to Trace, set the reference waveform.
  - Trace: Select a reference waveform. CH1 to CH6[1], 16chVOLT[2], 16chTEMP/VOLT[2], CAN[3], LIN[3], SENT[3], Math1 to Math2
    1 You can select the channel of an installed module. On a 4-CH module, select sub channel 1 or 2.
    2 When a 16-CH Voltage Input Module or 16-CH Temperature/Voltage Input Module is installed. After you select 16chVOLT or 16chTEMP/VOLT, select a sub channel.
    3 On a model with the /VE option when a CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus, or SENT monitor module is installed. After you select CAN, LIN, or SENT, select a sub channel. This cannot be selected on a CAN bus monitor, CAN/CAN FD monitor, or CAN & LIN bus monitor module if the data type (Value Type) is set to Logic. On a SENT monitor module, S&C and Error Trigger sub channels cannot be selected.
  - Polarity: Select the slope of the edge you want to detect (⎍: rising, ⎎: falling).
  - Edge Count: Sets which edge counted from the start point (T Range1) of the measurement time period to use as a detected point (reference point). Selectable range: 1 to 9

- The voltage level of the detected point is the mesial line.
- The measurement item name that appears when the measured values are displayed is (Delay).
- If Mode is set to Degree and Reference is set to Trigger, the measured value is displayed as '*****'.
- If you set the delay measurement's Reference to Trace, measurements will not be performed when the sample rates of the base waveform and the measurement source waveform are different. The measured value is displayed as '*****'.

Measurement Time Period (Time Range1/Time Range2)

Set the measurement time period using two vertical cursors. The position of the thin dashed line (Time Range1) is the measurement start point. The position of the thick dashed line (Time Range2) is the measurement end point. However, for SD recording, the maximum number of data points that are measured is 100 Mpoint from Time Range 1.

Selectable range: –5 div to +5 div

- Scope mode: Set the positions in divisions.
- Recorder mode: Set the positions in terms of the time (ddhhmmss) corresponding to divisions.

The start and end points are similar to the settable range of the cursor display position in cursor measurement. For details, see "Selectable Range of Cursor Positions."

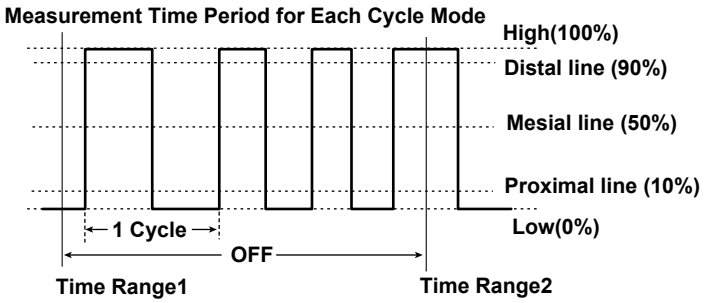
▶ See here.

1-Cycle Mode (1-Cycle Mode)

Instead of automatically measuring the measurement time period specified by Time Range1 and Time Range2, you can automatically measure the first period after Time Range1.
The method of determining the period is the same as the method for determining the Period measurement item.

In this mode, after the period is determined, the values of the measurement items related to voltage and area are computed. This mode is effective for measurement items, such as Rms or Avg, that may result in errors depending on the measurement time period setting.
The measurements of time axis items and X-Y areas are not affected.

- OFF: 1-cycle mode is disabled.
- ON: 1-cycle mode is enabled.



If the space between Time Range1 and Time Range2 is less than one period, "*****" is displayed for the measured value.

Notes about Automated Measurement of Waveform Parameters

- Measurements cannot be made on a snapshot waveform or an accumulated waveform that is not the most recent waveform.
- When an item is impossible to measure its measured value is displayed as '*****'.
  - When the measurement time period exceeds 100 Mpoint on a SD recording waveform
  - When the delay measurement mode is Degree and the trigger source is set to the reference of the reference waveform
- The instrument may not measure correctly if the waveform amplitude is small.
- If there are two or more waveform periods within the measurement time period, the time-axis parameters are measured on the first period.
- When automated measurement is performed on an SD recorded waveform, extra time will be required for processing.
- Automated measurement may require additional time depending on settings such as the memory length, the number of measurement items, and the input waveform. During automated measurement, appears in the center of the screen.
- To cancel automated measurement, set Mode to OFF. Measurement stops immediately.
- For FFT waveforms, only the Max and Min items can be measured. For a power spectrum, only the overall value can be measured.

Statistical Processing (Statistics)

Turning Statistical Processing On and Off

- ON: Statistical processing is enabled.
- OFF: Statistical processing is disabled.

Statistical Processing Type (Type)

The following types of statistical processing are available.

- Continuous statistical processing (Continuous Statistics): Continuous statistical processing is performed.
- Cyclic statistical processing (Cycle Statistics): Statistical processing is performed for each period (cyclic statistical processing).
- Statistical processing of history waveforms (History Statistics): Statistical processing is performed on history waveforms.

Continuous Statistical Processing (Continuous Statistics)

While acquiring waveforms, the instrument calculates the statistics of the waveforms that it has acquired so far. If you stop waveform acquisition and then restart it, the instrument will continue statistical processing and include the data from before waveform acquisition was stopped. The instrument also performs statistical processing for selected automatically measured items that are not displayed. The number of measured values used to calculate statistics (Count) is equal to the number of waveforms that have been acquired up to that point.
If you add an additional automatically measured item to apply statistical processing to, the number of measured values used to calculate the statistics (Cnt) is reset to 1 regardless of whether the instrument is acquiring waveforms.

Measurement Item

Statistical processing is performed on the same measurement items that the automated measurement of waveform parameters is performed on. The following five statistics are computed for the measurement items whose measurement has been turned on. The maximum number of measurement items that can be displayed on the screen is 3.

- Maximum: Maximum value
- Minimum: Minimum value
- Average: Average value
- SDev: Standard deviation
- Count: Number of measured values used to calculate statistics

The measurement items are the same as those for the automated measurement of waveform parameters.

▶ See here.

If you select CH1 P-P as the automatically measured item, the number of measured values used to calculate the maximum, minimum, mean, and standard deviation values for CH1 P-P appear at the bottom of the screen.
The instrument can display the statistical results of four automatically measured items. If five or more automatically measured items are selected, the instrument displays the first three items ordered by ascending channel number and the order that the items appear in the Item Setup automated-measurement-item selection menu (P-P, Amp, Max, Min, ..., Init1XY, and Init2XY).
Example 1:
When CH1: P-P, Amp; CH2: Min; CH3: Max, Min are selected, the following items are displayed: CH1: P-P; CH2: Min; CH3:Max.
Example 2:
When CH1: Max, Min; CH2: P-P, Amp are selected, the following items are displayed: CH1: Max, Min; CH2: P-P.

You can view the statistics of other items in the following way.

- Load the items into a PC using the communication feature.
- Save the statistical items as automated measurement values of waveform parameters, and load the data into a PC.
- Scroll through the list of calculated statistics using the arrow keys.

Measurement Time Period

This setting is the same as the measurement time period setting for the automated measurement of waveform parameters.

▶ See here.

1-Cycle Mode (1-Cycle Mode)

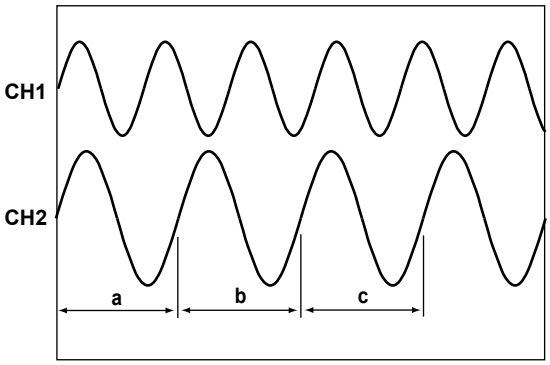
This setting is the same as the 1-cycle mode setting for the automated measurement of waveform parameters.

▶ See here.

Cyclic Statistical Processing (Cycle Statistics)

The instrument determines periods in order from the oldest data of the displayed waveform, measures the selected automatically measured items within each period, and performs statistical processing on the results of automated measurement. The method used to determine the period in cyclic statistical processing is the same as the method used to determine the Period waveform parameter. You can choose whether to determine the period for the selected waveform and use it on all source waveforms or to determine individual periods for each waveform.

Example in Which Cycle Trace Is Set to CH2



Measures the items in ranges a, b, and c, and calculates statistics on the items in the order a, b, and c.
The items of other channels are also measured in ranges a, b, and c.
If you select Own, the items are measured automatically over each waveform's period.

Measurement Items

These items are the same as those for the continuous statistical processing of automated measurement parameters.

▶ See here.

The following items are not measured:

- For waveforms that are used in period determination
  Avg.Frequency, Avg.Period, Pulse (pulse count), Integ1XY (area), Integ2XY (area), Delay
- For other waveforms
  Integ1XY (area), Integ2XY (area), Delay

Measurement Time Period

This setting is the same as the measurement time period setting for the automated measurement of waveform parameters.

▶ See here.

Cycle Trace (Cycle Trace)

Selects the source waveform used to determine the period.

- **CH1 to CH6[1], 16chVOLT[2], 16chTEMP/VOLT[2], CAN[3], LIN[3], SENT[3], Math1 to Math2**

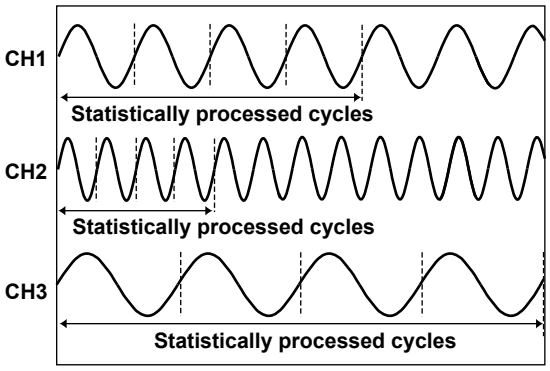
  The period of the specified waveform is applied to all waveforms.

  1 You can select the channel of an installed module. On a 4-CH module, select sub channel 1 or 2.
  2 When a 16-CH voltage input module or 16-CH temperature/voltage input module is installed. After you select 16chVOLT or 16chTEMP/VOLT, select a sub channel.
  3 On a model with the /VE option when a CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus, or SENT monitor module is installed. After you select CAN, LIN, or SENT, select a sub channel. This cannot be selected on a CAN bus monitor, CAN/CAN FD monitor, or CAN & LIN bus monitor module if the data type (Value Type) is set to Logic. On a SENT monitor module, S&C and Error Trigger sub channels cannot be selected.

- **Own**

  A period is determined for each source waveform. However, if signals that have different periods are applied to multiple channels, the number of iterations of automated measurement and statistical processing for each signal is equal to the number of periods in the slowest signal.

When Cycle Trace Is Set to Own



The number of cycles in the channel with the slowest cycle (CH3) is four, so statistical processing is performed on the four oldest cycles of the data for CH1 and CH2. The remaining data is not used for statistical processing.

Statistical processing is performed in periods that are determined in order from the oldest data of the displayed waveform. It cannot be used at the same time as 1-cycle mode.

Execution of Measurement (Execute Measure)

Executes statistical processing. You can select Execute Measure when Mode is set to Cycle Statistics or History Statistics.

Press Abort to stop statistical processing.

- The number of cycles being used for the cyclic statistical processing is displayed in the statistical display's Count column.
- The number of cycles that can be used in cyclic statistical processing varies depending on the number of measured items that the instrument is calculating the statistics of.
  64000/(the number of measured items that the instrument is calculating the statistics of)
- If the sample rates of the cycle trace and the displayed waveform are different, the displayed waveform will not be measured. The measured value and statistical processing value are both displayed as "*****."

Result Display (Result Window)

Displays a list of calculated statistics. You can display the list of statistics when Mode is set to Cycle Statistics or History Statistics.

Numbers are assigned to the data in order from the oldest cycle data or history data, and the automated measurement results for each number are displayed.

The maximum and minimum values for each parameter are indicated on the list by ↑ (maximum value) and ↓ (minimum value). If the same value appears in multiple locations, the oldest occurrence of the value is marked as the maximum or minimum value.

The number of data points that can be listed is 64000. If the number of data points exceeds 64000, the most recent data points in the history waveform or automatically measured item data are displayed. If the number of data points exceeds 64000, the maximum and minimum values may be outside of range of the displayed list. When this happens, ↑ (maximum value) and ↓ (minimum value) will not appear.

In cyclic statistical processing, you can select a waveform by tapping a waveform on the result display list to display one period of the waveform with the selected number on the zoom display.

Statistical Processing of History Waveforms (History Statistics)

This is selectable only in scope mode.

In the statistical processing of history waveforms, the instrument measures automatically measured items on the acquired waveform using the history feature and performs statistical processing on them. Statistical processing is performed on older waveform data first. The waveforms that statistical processing is performed on are those waveforms shown in the List that can be accessed from the History menu. Statistical processing of history waveforms can be used with 1-cycle mode and the delay feature.

Measurement Items

These items are the same as those for the continuous statistical processing of automated measurement parameters.

▶ See here.

Measurement Time Period

This setting is the same as the measurement time period setting for the automated measurement of waveform parameters.

▶ See here.

Execution of Measurement (Execute Measure)

This item is the same as the Execute Measure item for cyclic statistical processing.

▶ See here.

- In the statistical processing of history waveforms, the number of history waveforms that processing is performed on is indicated in the Count column of the statistical value display.
- The number of history waveforms that can be used in the statistical processing of history waveforms varies depending on the number of measured items that the instrument is calculating the statistics of.
  64000/(the number of measured items that the instrument is calculating the statistics of)

Result Display (Display Result)

This item is the same as the Display Result item for cyclic statistical processing.

▶ See here.

In the statistical processing of history waveforms, you can select a waveform by tapping a waveform on the result display list to display its history waveform.

Notes about Statistical Processing

- During statistical processing,  appears in the center of the screen. Only Abort is valid.
- Statistical processing cannot be performed:
  - On SD recorded waveforms.
  - On FFT waveforms.
- The starting and stopping of statistical processing may require additional time depending on settings such as the record length, the number of statistical processing items, and the input waveform.

Detail Settings (Detail Setup)

Set the reference level that is used to measure various parameter values, such as the rise and fall times, for each measurement source waveform.

Source Waveform (Trace)

Select the trace for setting the details.

CH1 to CH6[1], 16chVOLT[2], 16chTEMP/VOLT[2], CAN[3], LIN[3], SENT[3], Math1 to Math2

*1 You can select the channel of an installed module. On a 4-CH module, select sub channel 1 or 2. You cannot select the channel of a logic module.

*2 When a 16-CH voltage input module or 16-CH temperature/voltage input module is installed. After you select 16chVOLT or 16chTEMP/VOLT, select a sub channel.

*3 On a model with the /VE option when a CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus, or SENT monitor module is installed.. After you select CAN, LIN, or SENT, select a sub channel. This cannot be selected on a CAN bus monitor, CAN/CAN FD monitor, or CAN & LIN bus monitor module if the data type (Value Type) is set to Logic. On a SENT monitor module, S&C and Error Trigger sub channels cannot be selected.

- **Distal, Mesial, and Proximal Settings (Mode)**
  Set the method for setting the three levels that are used as references in the measurement of various parameter values, such as the rise and fall times.
  - %
    You can set the distal, mesial, and proximal values as percentages of the specified trace. The high value of the specified trace is equal to 100.0%, and the low value is equal to 0.0%.
  - Unit
    You can set the distal, mesial, and proximal values of the specified trace by specifying physical values, such as voltages or temperatures.

- **Selecting What You Will Set (Target): Distal, Mesial, or Proximal**
  Select which level you will set: Distal, Mesial, or Proximal.

- **Distal, Mesial, and Proximal Settings (Distal, Mesial, Proximal)**
  You can set the distal, mesial, and proximal values.
  Selectable range: 0.0 to 100.0% (in 0.1% steps) or voltage or temperature values that correspond to ±10 div (the steps that you can set voltage and temperature values in vary depending on the module. See Range of V/div).

- **High/Low Specification Method (High/Low)**
  The high and low levels are the 100% and 0% levels used to measure various parameter values, such as the rise and fall times. You can choose one of the following methods for setting the high and low levels.
  - Auto
    The instrument sets the high value to the high amplitude level and the low value to the low amplitude level based on the voltage level frequency of the waveform in the measurement time period while taking into account the effects of ringing, spikes, etc. This method is suitable for measuring square waves and pulse waves.
  - Max-Min
    The instrument sets the high and low values to the maximum and minimum values in the measurement time period. This method is suitable for measuring sinusoidal and saw waves. It is not suitable for waveforms that have ringing and spikes.

Saving Automated Measurement Values of Waveform Parameters (Save)

▶ See here.

Notes about Using the 16-CH Voltage Input Module (720220)

Notes about Using the 16-CH Temperature/Voltage Input Module (720221)

▶ See here.

11 Waveform Analysis

Analysis feature

The analysis feature varies depending on the system mode as follows.

- Analysis features in scope mode
- Analysis features in recorder mode

Analysis Features in Scope Mode

- Computation (Math)
- FFT (FFT)
- X-Y waveforms (X-Y)
- Harmonic analysis (Harmonics)
- GO/NO-GO determination (GO/NO-GO)
- Waveform zoom (Zoom)
- Searching Waveforms (Search)
- History waveform display (History)
- Position Information (GPS)

Analysis Features in Recorder Mode

- Computation (Math)
- FFT (FFT)
- X-Y waveforms (X-Y)
- Harmonic analysis (Harmonics)
- Waveform display position and zoom (Zoom)
- Searching Waveforms (Search)
- Position Information (GPS)

12 Computation

You can perform various computations on up to 1 Mpoint of data. (When more than 1 Mpoint of waveform data is displayed, computation is performed on the first 1 Mpoint of data from the computation start point.)
The results of computation are displayed in Math1 and Math2. Waveforms stored through SD recording cannot be computed.

Turning Computation On and Off (Mode)

Select whether to use computation.

- ON: Computation is used.
- OFF: Computation is not used.

Computation Waveform Selection (Select Math Trace)

Select a computed waveform to use to display the computation results.
Math1 and Math2

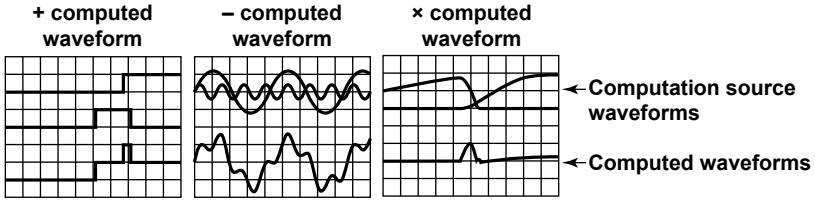
Operators and Functions (Operation)

Select an operator or function (operation definition) from the options below.

- OFF: Computation is not used.
- S1+S2: Adds the waveforms assigned to Source1 and Source2
- S1–S2: Subtracts the waveform assigned to Source2 from the waveform assigned to Source1
- S1*S2: Multiplies the waveforms assigned to Source1 and Source2
- S1/S2: Divides the waveform assigned to Source1 by the waveform assigned to Source2
- A(S1)+B(S2)+C: Performs addition with coefficients on the waveforms assigned to Source1 and Source2
- A(S1)–B(S2)+C: Performs subtraction with coefficients on the waveforms assigned to Source1 and Source2
- A(S1)*B(S2)+C: Performs multiplication with coefficients on the waveforms assigned to Source1 and Source2
- A(S1)/B(S2)+C: Performs division with coefficients on the waveforms assigned to Source1 and Source2
- Bin(S1): Converts the waveform assigned to Source to binary
- Shift(S1): Shows the waveform assigned to Source with its phase shifted
- FREQ(S1): Calculates the frequency of the waveform that has been assigned to Source
- Period(S1): Calculates the period of the waveform that has been assigned to Source
- MEAN(S1): Calculates the moving average of the waveform that has been assigned to Source
- RMS(S1): Calculates the RMS value of the waveform that has been assigned to Source

Basic Arithmetic (S1+S2, S1–S2, S1*S2, and S1/S2)

Performs addition, subtraction, multiplication, or division on the two waveforms assigned to Source1 and Source2.



Math Source Waveforms (Source1 and Source2)

CH1 to CH4[1], 16chVOLT[2], 16chTEMP/VOLT[2], CAN[3], LIN[3], SENT[3], Math1[4]

1 You can select the channel of an installed module. On a 4-CH module, select sub channel 1 or 2. You cannot select the channel of a logic module.
2 When a 16-CH voltage input module or 16-CH temperature/voltage input module is installed. After you select 16chVOLT or 16chTEMP/VOLT, select a sub channel.
3 On a model with the /VE option when a CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus, or SENT monitor module is installed. After you select CAN, LIN, or SENT, select a sub channel. This cannot be selected on a CAN bus monitor, CAN/CAN FD monitor, or CAN & LIN bus monitor module if the data type (Value Type) is set to Logic. On a SENT monitor module, S&C and Error Trigger sub channels cannot be selected.
4 You can use the Math1 waveform as a math source waveform of Math2. You cannot use another computation waveform as the math source waveform for Math1.

When computation is performed on a linearly scaled channel, the scaled values are used.

Basic Arithmetic with Coefficients (A(S1)+B(S2)+C, A(S1)–B(S2)+C, A(S1)*B(S2)+C, and A(S1)/B(S2)+C)

Performs addition, subtraction, multiplication, or division with coefficients on the two waveforms assigned to Source1 and Source2.

Math Source Waveforms (Source1 and Source2)

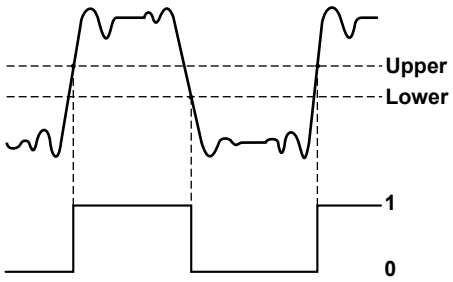
The options are the same as were described for basic arithmetic.

Coefficients (A, B, and C)

Set the scaling coefficients (A and B) and the offset (C).
Selectable range: –9.9999E+30 to +9.9999E+30

Binary Conversion (Bin (S1))

Using the specified threshold levels, you can convert the waveform assigned to Source to a digital waveform.



Math Source Waveforms (Source)

This setting is the same as that for basic arithmetic.

▶ See here.

Upper and Lower Thresholds (Upper/Lower)

Set the upper and lower threshold values. All values above the upper threshold on the math source waveform are converted to ones, and all values below the threshold are converted to zeros.

Phase Shift (Shift (S1))

You can shift the phase of the waveform assigned to Source, display the resulting waveform, and use the phase-shifted data in computations.

Math Source Waveforms (Source)

This setting is the same as that for basic arithmetic.

▶ See here.

Shift (Shift)

You can shift waveforms within the following ranges.

- **When the Internal Clock Is Being Used as the Time Base**
  Selectable range: The time values between −(record length/2) points to (record length/2 points)
  Step: 1 ÷ sample rate
  The sample rate varies depending on the record length, Time/Div, and record time settings. For details, see appendix 1, “Relationship between the Time Scale, Record Length, and Sample Rate” in the *Getting Started Guide*, IM DL350-03EN.

- **When an External Clock is Being Used as the Time Base**
  Selectable range: −(record length/2) points to (record length/2 points)
  Step: 1

Frequency (FREQ(S1))

Calculates the frequency of the waveform that has been assigned to Source.

Math Source Waveforms (Source)

The options are the same as were described for basic arithmetic. However, you can select an input channel of a logic module (select the channel, and then select the bit). You cannot select the input channel of a frequency module.

▶ See here.

Upper and Lower Limits (Upper/Lower)

Set the upper and lower threshold values.
The upper and lower limits are the same as those of binary conversion.

Period (Period)

Calculates the period of the waveform that has been assigned to Source.

Math Source Waveforms (Source)

The options are the same as were described for basic arithmetic. However, you can select an input channel of a logic module (select the channel, and then select the bit). You cannot select the input channel of a frequency module.

▶ See here.

Upper and Lower Thresholds (Upper/Lower)

Set the upper and lower threshold values.
The upper and lower limits are the same as those of binary conversion.

Moving Average (MEAN)

Calculates the moving average according to the specified average count of the sampling data of the waveform that has been assigned to Source.
From the start of sampling to the specified average count, average is taken up to the most recent point.

Math Source Waveforms (Source)

The options are the same as were described for basic arithmetic. However, you cannot select input channels of frequency modules.

▶ See here.

Average Count (Count)

Set the average count to 2, 4, 8, or 10.

RMS Value (RMS)

Calculates the RMS value of the waveform that has been assigned to Source.

$$\sqrt{\frac{1}{N}\sum_{n=1}^{N} s(n)^2}$$

s: Sampling data
N: Number of samples

Math Source Waveforms (Source)

The options are the same as were described for basic arithmetic. However, you cannot select input channels of frequency modules.

▶ See here.

Upper and Lower Limits (Upper/Lower)

Set the upper and lower signal limits for separating calculation periods.
The upper and lower limits are the same as those of binary conversion.

Unit (Unit)

You can assign a unit of up to four characters in length to the math results. The specified unit is reflected in the scale values.

Label (Label)

You can create a label of up to eight characters in length. The labels that you create are displayed on the screen.

Vertical Scale (Vert Scale)

Set the method used to set the vertical display range of computed waveforms to one of the following options.

- Auto: The upper and lower limits are set automatically.
- Manual: The upper and lower limits must be set manually.

Upper and Lower Limits (Upper/Lower)

Set the upper and lower limits when Scaling Mode is set to Manual.
The selectable range is −9.9999E+30 to 9.9999E+30.

Display ON/OFF (Display)

This is synchronized to the on/off state of computation.

Start Point and End Point (Start Point/End Point)

Set the computation start and end point.
Selectable range: –5 div to +5 div

- Scope mode: Set the positions in divisions.
- Recorder mode: Set the positions in terms of the time (ddhhmmss) corresponding to divisions.

The maximum range from the computation start point to the computation end point varies as indicated below depending on the number of computations.

- One computation: Up to 2 Mpoint
- Two computations: Up to 1 Mpoint

The start and end points are similar to the settable range of the cursor display position in cursor measurement. For details, see “Selectable Range of Cursor Positions.”

▶ See here.

An icon () appears in the center of the top of the screen when computations are being executed.

Averaging Settings (Average Setup)

This is a setting in scope mode.
You can average and compute the peak values of computed data.

Averaging Modes (Average Mode)

The following types of averaging are available.

- OFF: Averaging is not performed.
- Linear averaging (Linear): Values are averaged linearly.
- Exponential averaging (Exp): Values are averaged exponentially.
- Cycle averaging (Cycle): Values are averaged across cycles.
- Peak computation (Peak): Peak values are computed.

Linear Averaging (Linear)

The number of values specified by the average count are added and divided by the average count, and the resulting values are used to display the waveform. For the equation, see the equation for linear averaging in Averaging Mode.

- **Average Domain (Average Domain)**
  Select what to average.
  - Time: A time-domain waveform is averaged.
  - Freq: A frequency-domain waveform is averaged.
- **Average Count (Average Count)**
  Set the average count.
  Selectable range: 2 to 128 in 2^n steps

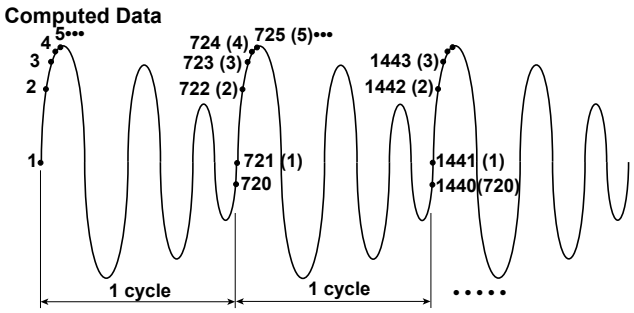
Exponential Averaging (Exp)

Using the specified attenuation constant, the instrument attenuates the influence of previous computed data to produce averaged values, and uses the results to display the waveform. For the equation, see the equation for exponential averaging in Averaging Mode.

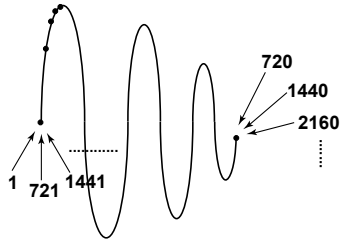
- **Average Domain (Average Domain)**
  Select what to average.
  - Time: A time-domain waveform is averaged.
  - Freq: A frequency-domain waveform is averaged.
- **Average Count (Average Count)**
  Set the average count.
  Selectable range: 2 to 128 in 2^n steps

Cycle Averaging (Cycle)

The data from the computation start point to the computation end point is divided into the number of data points (Cycle Count) that is specified as being a single cycle, and equivalent points in each divided cycle are averaged with each other. The resulting values are used to display the waveform.
The figure below shows the results of cycle averaging when Cycle Count is set to 720.



Cycle Averaging Results
Equivalent points in each divided cycle are linearly averaged, and the resulting values are used to display the waveform.



- **Cycle Count (Cycle Count)**

  Set the number of data points in one cycle.
  Selectable range: 10 to 1800

All the data between the computation start and end points can be computed. If the data cannot be divided evenly by the specified cycle count, the remaining data is ignored.

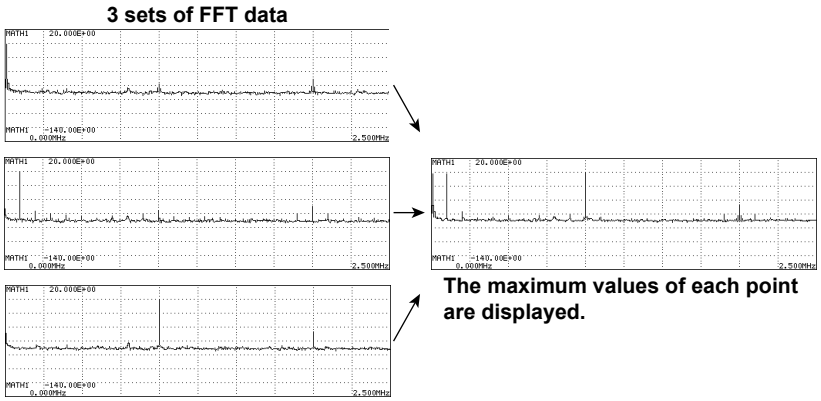
- Cycle averaging cannot be performed on an FFT waveform.

- **Cycle Averaging Example**

  When the record length is 10 kpoint, the cycle count is 720, the computation start point is −5.000 div, and the computation end point is +5.000 div
  10 k/720 = 13.88...: 13 cycles are used for the computation.
  13 × 720 = 9360: The data from the computation start point (point 1) to point 9360 is included in the cycle average computation.

Peak Computation (Peak)

The maximum value at each point of the computed data is determined, and the resulting values are used to display the waveform. For each computation, the new computed value is compared with the past value, and the larger value is kept.



- The instrument normally performs scaling by using the computed data at the beginning (auto scaling). For coherence functions and in other cases where the amplitude of the averaged waveform changes significantly, use manual scaling.
- When you execute averaging, after measurement is stopped, computation cannot be restarted. However, computation can be restarted if the number of data points for cycle averaging is changed.
- If you measure an averaged waveform with auto scaling enabled, you cannot change the scaling by switching to manual scaling after measurement has stopped. Changes to the scaling settings are applied to the next measurement.
- Averaging cannot be performed on pulse width computation.
- If you change the computation conditions during averaging, the computed data up to that point is deleted, and averaging starts over.

Notes about Computation

Waveforms stored through SD recording cannot be computed.

Notes about Using the 16-CH Voltage Input Module (720220)
Notes about Using the 16-CH Temperature/Voltage Input Module (720221)

▶ See here.

13 FFT

The power spectrum of the input waveform can be displayed in the FFT window. Up to two FFT waveforms can be displayed. Power spectrum, linear spectrum, and power spectrum density can be computed. FFT computation cannot be performed on waveforms stored through SD recording.

FFT Waveform Selection

Set the FFT trace to FFT1 or FFT2.

Turning the FFT On and Off

Set whether to perform FFT computation. If you set this to ON, the FFT window appears.

- ON: FFT computation is performed.
- OFF: FFT computation is not performed.

FFT Settings (FFT Setup)

Spectrum Type (Type/Sub Type)

Set the spectrum type.

Type	Sub Type	Description
LS	REAL	Real part of the linear spectrum of the specified waveform
LS	IMAG	Imaginary part of the linear spectrum of the specified waveform
LS	MAG	Amplitude of the linear spectrum of the specified waveform
LS	LOGMAG	Logarithmic amplitude of the linear spectrum of the specified waveform
LS	PHASE	Phase of the linear spectrum of the specified waveform
RS	MAG	Magnitude of the specified waveform's RMS spectrum
RS	LOGMAG	Logarithmic magnitude of the specified waveform's RMS spectrum
PS	MAG	Amplitude of the power spectrum of the specified waveform
PS	LOGMAG	Logarithmic amplitude of the power spectrum of the specified waveform
PSD	MAG	Amplitude of the power spectrum density of the specified waveform
PSD	LOGMAG	Logarithmic amplitude of the power spectrum density of the specified waveform

FFT Computation Source Waveforms (Source)

Select the FFT computation source waveforms from the options below.

CH1 to CH4[1], 16chVOLT[2], 16chTEMP/VOLT[2], CAN[3], LIN[3], SENT[3], Math1 to Math2

1 You can select the channel of an installed module. On a 4-CH module, select sub channel 1 or 2. You cannot select the channel of a logic module.

2 When a 16-CH voltage input module or 16-CH temperature/voltage input module is installed. After you select 16chVOLT or 16chTEMP/VOLT, select a sub channel.

3 On a model with the /VE option when a CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus, or SENT monitor module is installed. After you select CAN, LIN, or SENT, select a sub channel. This cannot be selected on a CAN bus monitor, CAN/CAN FD monitor, or CAN & LIN bus monitor module if the data type (Value Type) is set to Logic. On a SENT monitor module, S&C and Error Trigger sub channels cannot be selected.

When computation is performed on a linearly scaled channel, the scaled values are used.

Unit (Unit)

▶ See here.

Vertical Scale (Vert. Scale)

You can select the method for setting the vertical scale from the following options.

- Auto: The center and scale of the vertical axis are set automatically.
- Manual: The center and scale of the vertical axis must be set manually.

Center/Scale (Center/Sens.)

When Vert. Scale Mode is set to Manual, set the center and scale of the vertical axis.

Horizontal Zoom (Horiz. Scale)

Select one of the following horizontal display ranges.

- Auto: The horizontal center point and span are set automatically (the entire range is displayed).
- Left/Right: You must set the left and right ends of the display range manually.
- Center/Span: You must set the horizontal center point and span manually. You can select this only when the horizontal scale is set to Hz.

Horizontal Range (Left/Right, Center/Span)

Horizontal Range (Left/Right)

When the horizontal zoom is set to Left/Right, set the left and right ends of the horizontal display range.
Selectable range: 0.00 kHz to the maximum frequency

Horizontal Range (Center/Span)

When the horizontal zoom is set to Center/Span, set the center point and span of the horizontal display range.
Selectable range of the center: 0.00 kHz to the maximum frequency
Selectable range of the span: the frequency resolution x10 to the maximum frequency

Horizontal Scale (Axis)

Select one of the following horizontal scale types.

- Hz: A normal (linear) scale is used.
- Log Hz: A logarithmic scale is used.

Start Point (Start Point)

Set the computation start point.
Selectable range: –5 div to +5 div

- Scope mode: Set the positions in divisions.
- Recorder mode: Set the positions in terms of the time (ddhhmmss) corresponding to divisions.

The start and end points are similar to the settable range of the cursor display position in cursor measurement. For details, see “Selectable Range of Cursor Positions.”

▶ See here.

Detail Settings (Detail Setup)

Number of FFT Points (Points)

You can set the number of points from the start of computation on the T-Y waveform to one of the options below.
1k, 2k, 5k, 10k, 20k, 50k, 100k

Window Function (Window)

You can select the window function from the following options.

Rect (Rectangular window)

The rectangular window is suited to transient signals, such as impulse waves, which attenuate completely within the time window.

Hanning (Hanning window)

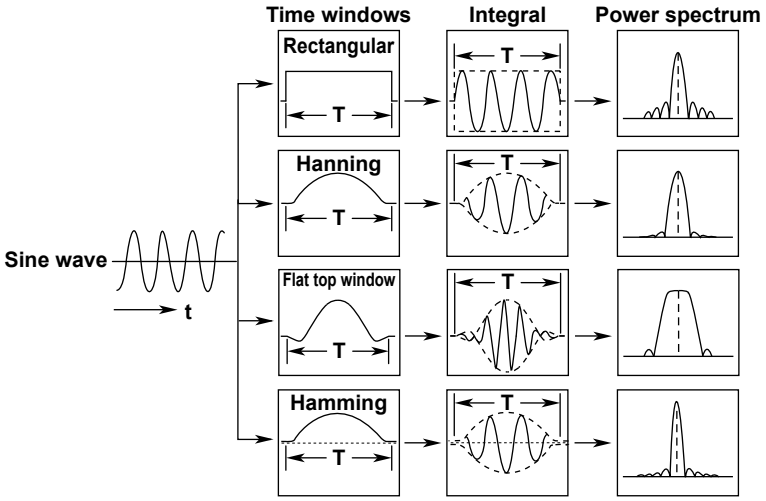
The Hanning window encourages continuity of the signal by gradually attenuating the parts of the signal located near the ends of the time window down to the 0 level. Hence, it is suited to continuous signals. The Hanning window has a higher frequency resolution than the flattop window.

FlatTop (Flattop window)

The Hanning window encourages continuity of the signal by gradually attenuating the parts of the signal located near the ends of the time window down to the 0 level. Hence, it is suited to continuous signals. The flattop window has a higher spectral level accuracy than the flattop window.

Hamming (Hamming window)

In the Hanning window, the values at the ends become 0 and the signal components there do not affect the spectrum. The Hamming window is a corrected Hanning window. Its characteristics are similar to those of the Hanning window, but the frequency resolution of its main beam is greater than that of the Hanning window. The Hamming window is suited for dividing close signals.



Rectangular : $W(t) = u(t) - u(t - T)$ u(t): **Step function**

Hanning : $W(t) = 0.5 - 0.5\cos(2\pi\frac{t}{T})$

Flat top : $W(t) = \{0.54 - 0.46\cos(2\pi\frac{t}{T})\}\frac{\sin\{2\pi(1 - 2t/T)\}}{2\pi(1 - 2t/T)}$

Hamming : $W(t) = 0.54 - 0.46\cos(2\pi\frac{t}{T})$

Averaging Modes (Average Mode)

You can average and compute the peak values of computed data.
The following types of averaging are available.

- OFF: Averaging is not performed.
- Linear averaging (Linear): Values are averaged linearly.
- Exponential averaging (Exp): Values are averaged exponentially.
- Peak computation (Peak): Peak values are computed.

Linear Averaging (Linear)

The number of values specified by the average count are added and divided by the average count, and the resulting values are used to display the waveform. For the equation, see the equation for linear averaging in Averaging Mode.

- **Average Domain (Average Domain)**
  Select what to average.
  - Time: A time-domain waveform is averaged.
  - Freq: A frequency-domain waveform is averaged.

- **Linear Count (Linear Count)**
  Set the average count.
  Selectable range: 2 to 128 in 2^n steps

Exponential Averaging (Exp)

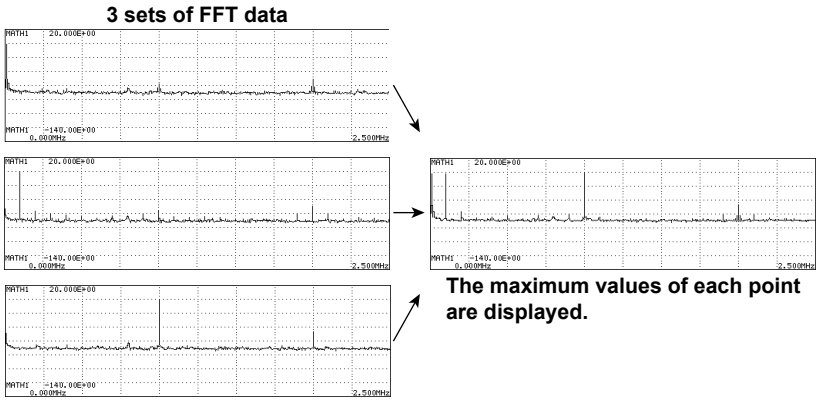
Using the specified attenuation constant, the instrument attenuates the influence of previous computed data to produce averaged values, and uses the results to display the waveform. For the equation, see the equation for exponential averaging in Averaging Mode.

- **Average Domain (Average Domain)**
  ▶ See here.

- **Attenuation Constant (Average Weight)**
  Set the attenuation constant.
  Selectable range: 2 to 256 in 2^n steps

Peak Computation (Peak)

The maximum value at each point of the computed data is determined, and the resulting values are used to display the waveform. For each computation, the new computed value is compared with the past value, and the larger value is kept.



- The instrument normally performs scaling by using the computed data at the beginning (auto scaling). When the amplitude of the averaged waveform changes significantly, use manual scaling.
- When you execute averaging, after measurement is stopped, computation cannot be restarted.
- If you measure an averaged waveform with auto scaling enabled, you cannot change the scaling by switching to manual scaling after measurement has stopped. Changes to the scaling settings are applied to the next measurement.
- If you change the computation conditions during averaging, the computed data up to that point is deleted, and averaging starts over.

Cursor Measurement on FFT Waveforms

Turning Cursor Measurement On and Off

- ON: Cursor measurement is performed.
- OFF: Cursor measurement is not performed.

Cursor Type (Type)

The following types of FFT waveform cursors are available.

- Marker cursors (Marker): You can use four marker cursors to measure frequencies, levels, and the distances between markers.
- Peak cursor (Peak): The FFT waveform's maximum peak is detected, and its frequency and level are measured.
- Peak list (Peak List): Up to 10 peaks that meet the threshold and excursion conditions are detected, and their frequencies and levels are measured. The detected peaks can be displayed in a list.

Marker Cursors (Marker)

You can measure the frequency and level at each marker and the frequency and level differences between markers. You can select a measurement source waveform for each cursor.

Marker Settings (Marker Setup)

- **Measurement Source Waveform (Trace)**

  Set the measurement source waveform for each marker to one of the waveforms below.
  - OFF: Disables measurement.
  - FFT1: The waveform in the FFT1 window is measured.
  - FFT2: The waveform in the FFT2 window is measured.

- **Marker Shape (Marker Form)**

  Set the shape of the displayed marker to one of the options below.
  - Mark: A dot
  - Line: A crosshair

Display Item (Display Item)

Marker cursors move on the waveform data. You can measure the following values at the markers.

X1	Frequency at Marker1
X2	Frequency at Marker2
X3	Frequency at Marker3
X4	Frequency at Marker4
Δ(X2-X1)	Frequency difference between Marker1 and Marker2
Δ(X3-X1)	Frequency difference between Marker1 and Marker3
Δ(X4-X1)	Frequency difference between Marker1 and Marker4
Δ(X3-X2)	Frequency difference between Marker2 and Marker3
Δ(X4-X2)	Frequency difference between Marker2 and Marker4
Δ(X4-X3)	Frequency difference between Marker3 and Marker4
Y1	Level at Marker1
Y2	Level at Marker2
Y3	Level at Marker3
Y4	Level at Marker4
Δ(Y2-Y1)	Level difference between Marker1 and Marker2
Δ(Y3-Y1)	Level difference between Marker1 and Marker3
Δ(Y4-Y1)	Level difference between Marker1 and Marker4
Δ(Y3-Y2)	Level difference between Marker2 and Marker3
Δ(Y4-Y2)	Level difference between Marker2 and Marker4
Δ(Y4-Y3)	Level difference between Marker3 and Marker4

Movement Target Marker (Marker No.)

Select the marker you want to set the position of.

Position (Position)

Set the position of the selected marker.
You can move the markers within the range of −5 to 5 div of the frequency axis in 0.01 div steps.

Peak Cursors (Peak)

In the frequency range defined by FFT1 Range1 and Range2 and the frequency range defined by FFT2 Range1 and Range 2, the instrument detects the maximum peaks (Peak1 and Peak2) and measures their frequencies and levels. You can set the two frequency ranges in the range of −5 to 5 div.

Peak Settings (Peak Setup)

The following values at the peaks are measured.

F1	Frequency at Peak1
F2	Frequency at Peak2
Y1	Level at Peak1
Y2	Level at Peak2

Range Source Waveform (Range)

Set the peak measurement source waveform to one of the waveforms below.

- FFT1: The waveform in the FFT1 window is measured.
- FFT2: The waveform in the FFT2 window is measured.

Upper and Lower Limits of the Range (Range 1/Range 2)

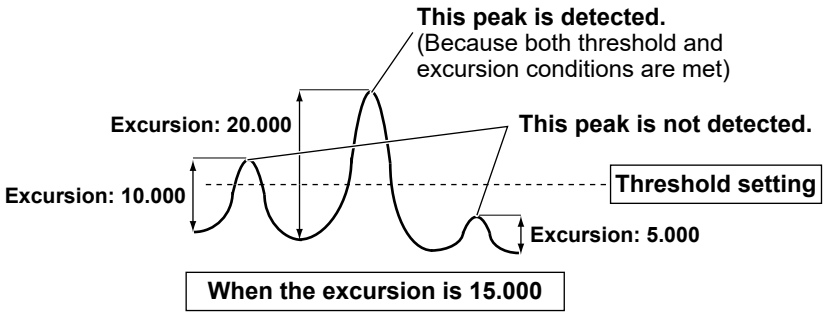
Set the range for detecting peaks on the frequency axis in the range of –5 to +5 div.
These are linked to the peak list detection range.

Peak List (Peak List)

Detects up to 10 peaks in the measurement source FFT waveforms in descending order by level and measures their frequencies and levels. The detected peaks can be displayed in a list for each measurement source waveform.

Peak Settings (Peak Setup)

Detects peaks that meet both the threshold and excursion conditions in the specified detection range.



- **Measurement Source Waveform (Trace)**
  Select the measurement source waveforms from FFT1 or FFT2.
- **Threshold (Threshold)**
  Set the threshold value for detecting peaks. Peaks whose level is greater than the specified value are detected.
  Selectable range: –9.9999E+30 to +9.9999E+30, in 1E–30 steps
- **Excursion (Excursion)**
  Set the excursion (difference between maximum and minimum levels) for detecting peaks. Peaks with excursions greater than the specified value are detected.
  Selectable range: 0 to +9.9999E+30, in 1E–30 steps
- **Upper and Lower Limits of the Range (Range 1/Range 2)**
  Set the range for detecting peaks on the frequency axis in the range of −5 to +5 div.
  These are linked to the peak cursor detection range.

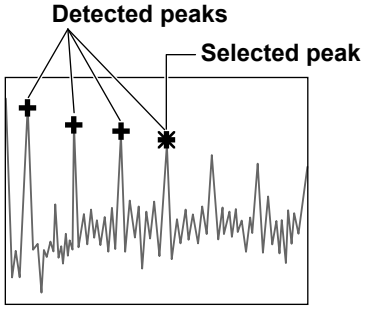
List View (List)

Lists detected peaks (up to 10) in ascending order by frequency. The selection button to the left of the number of the selected peak becomes ◉ (blue).

- 1 to 10: A number specified with List No.
- Frequency (Frequency): Displays the peak frequency
- Peak: Displays the peak level ↑ appears to the right of the value of the peak with the highest level.

Peak Selection (List No.)

Select the peak by specifying the number of a detected peak (1 up to 10 in ascending order by frequency). The frequency and level of the selected peak are displayed on the screen. On the waveform, crosshairs are displayed at the peak positions, and ✱ is displayed at the selected peak.



Notes about Cursor Measurement

▶ See here.

FFT Waveform Saving (Save)

▶ See here.

Notes about FFT Computation

Notes about Displaying Power Spectrums

- You cannot display a power spectrum if the display record length is less than the number of computed data points (Point).
- The following settings are shared for all computation channel: FFT Points, Window, and Start Point.

Notes on Computation

- Computation is normally performed on the sampled data in the acquisition memory. For waveforms that are acquired in Envelope mode, computation is performed on the maximum and minimum values at each acquisition interval.
- When you enter the FFT menu and set FFT 1 and FFT 2 to ON, Math1 and Math2 cannot be used.
- An icon () appears in the center of the top of the screen when FFT computation is being executed.
- FFT computation cannot be performed on waveforms stored through SD recording.

Notes about Using the 16-CH Voltage Input Module (720220)

Notes about Using the 16-CH Temperature/Voltage Input Module (720221)

▶ See here.

14 X-Y Waveforms

You can view the correlation between two waveform levels by assigning the level of one waveform to the X-axis (horizontal axis) and the level of the other waveform to the Y-axis (vertical axis). Two pairs of X-Y waveforms can be displayed in the X-Y window.
You can perform cursor measurements on the displayed X-Y waveforms. You can also observe T-Y (time axis) waveforms and X-Y waveforms simultaneously.

Turning the X-Y Window Display On and Off (Display)

You can select whether to display each X-Y window.

- ON: The X-Y window is displayed.
- OFF: The X-Y window is not displayed.

Two Pairs of X-Y Waveforms (X-Y Trace Setup)

Two pairs of X-Y waveforms, XY1 and XY2, can be displayed in the window. You can configure the following settings for each X-Y waveform.

Display on/off (Display)

You can select whether to display each X-Y waveform in the X-Y window.

- ON: X-Y waveform is displayed.
- OFF: X-Y waveform is not displayed.

X Trace and Y Trace (X Trace and Y Trace)

For XY1 and XY2, you can select which waveforms to assign to the X and Y axes from the following options.
CH1 to CH4[1], 16chVOLT[2], 16chTEMP/VOLT[2], CAN[3], LIN[3], SENT[3], Math1 to Math2

1 You can select the channel of an installed module. On a 4-CH module, select sub channel 1 or 2. You cannot select the input channel of a logic module.
2 When a 16-CH voltage input module or 16-CH temperature/voltage input module is installed. After you select 16chVOLT or 16chTEMP/VOLT, select a sub channel.
3 On a model with the /VE option when a CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus, or SENT monitor module is installed. After you select CAN, LIN, or SENT, select a sub channel. This cannot be selected on a CAN bus monitor, CAN/CAN FD monitor, or CAN & LIN bus monitor module if the data type (Value Type) is set to Logic. On a SENT monitor module, S&C and Error Trigger sub channels cannot be selected.

- An X-Y waveform cannot be displayed if the waveforms assigned to its X and Y axes have different sample rates.
- An X-Y waveform cannot be displayed if it is a combination of a sub channel on the 16-CH voltage input module and a normal channel. You can display an X-Y waveform of two sub channels that have the same sample rate. The same limitation applied to 16-CH temperature/voltage input, CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus monitor, and SENT monitor modules.
- An X-Y waveform can be displayed if it is a combination of a sub channel on the 16-CH voltage input module and a sub channel on a CAN bus monitor module and if the two sub channels have the same sample rate. This is also true for the combination of a 16-CH temperature/voltage input module and a CAN/CAN FD monitor, CAN & LIN bus monitor, or SENT monitor module.
- X-Y waveforms can be created from normal T-Y waveforms. They cannot be created from zoomed waveforms.
- Logic waveforms and event waveforms cannot be used to make X-Y waveforms.
- You cannot create an X-Y waveform using one trace whose horizontal-axis unit is time and another trace whose horizontal-axis unit is frequency.

Start Point and End Point (Start Point/End Point)

You can set the start and end points of the X-Y waveforms on the T-Y waveforms.
Selectable range: ±5 div from the center of the T-Y waveform window

- Scope mode: Set the positions in divisions.
- Recorder mode: Set the positions in terms of the time (ddhhmmss) corresponding to divisions.

The start and end points are similar to the settable range of the cursor display position in cursor measurement. For details, see “Selectable Range of Cursor Positions.”

▶ See here.

Linking Start and End Points

You can adjust the start and end points without changing the interval between them.

Interpolation Method (Dot Connect)

In interpolation zones in the X-Y waveform display,* Xviewer can display waveforms by interpolating between sampled data points.

* Interpolation zone refers to the condition in which a given number of data points are not contained in the X-Y waveform display. The number of data points that define the interpolation zone varies depending on the display record length.

You can set the interpolation method to one of the options below.

- **OFF**
  Displays the data using dots without interpolation.
- **Linear Interpolation (Line)**
  Linear interpolation is performed between two points.

Diagram Explaining the Interpolation Method

▶ See here.

Setting the Number of Data Points to Use for Waveform Display (Decimation)

In the X-Y waveform display, the instrument displays the acquired data by removing the data between fixed intervals. You can set the number of points to use to display waveforms to one of the options listed below.

- **When 2k Is Selected**
  When the record length exceeds 2 kpoint, the instrument removes data until there are only 2 kpoint and displays two points on each vertical line. When the record length is less than 2 kpoint, all the points are displayed.
- **When 100k Is Selected**
  When the record length exceeds 100 kpoint, the instrument removes data until there are only 100 kpoint and displays 100 points on each vertical line. When the record length is less than 100 kpoint, all the points are displayed.

During hard disk recording and roll mode display, if there are more than 100 points of data per div, the maximum and minimum values for specified intervals of data are displayed through linear interpolation.

Display Ratio of the Main Window (Main Ratio)

▶ See here.

Window Layout (Window Layout)

Set the window layout when a combination of two windows—an X-Y window and another window (zoom window, FFT window, or harmonic window)—is displayed.

- Side: Horizontal
- Vertical: Vertical (valid only when Main Ratio is set to 0 % when an X-Y window is displayed)

Pen Marker (Pen Marker)

You can display a pen marker on an X-Y waveform whose display is turned on. It shows the current sampled point of the waveform.

Clearing Waveforms at Acquisition Start (Trace clear on Start)

Choose whether to clear the current X-Y waveforms when waveform acquisition is started through the pressing of the START/STOP key.

- ON: X-Y waveforms are cleared.
- OFF: X-Y waveforms are not cleared.

- To zoom in or out on an X-Y waveform, change the upper and lower limits (Upper and Lower) of the channel that you want to zoom, or change the vertical zoom (V Zoom).
- On voltage input modules, to change the displayed position of an X-Y waveform, change the positions of the channels that it is based on.

Cursor Measurement on X-Y Waveforms

Cursor Type (Type)

The following types of X-Y waveform cursors are available.

- OFF: Cursor measurement is not performed.
- Horizontal cursors (Horizontal): Two horizontal cursors are used to measure vertical (Y-axis) values.
- Vertical cursors (Vertical): Two vertical cursors are used to measure horizontal (X-axis) values.
- Marker cursors (Marker): Four marker cursors that move on the waveform are used to measure waveform values.
- Horizontal and vertical cursors (H & V): Two horizontal cursors and two vertical cursors are used to measure vertical (Y-axis) and horizontal (X-axis) values.

Horizontal Cursors (Horizontal)

Two dashed lines (horizontal cursors) appear on the horizontal axis. You can measure the vertical (Y axis) value at the position of each horizontal cursor and measure the level difference between the horizontal cursors.

Measurement Source Waveform (Trace)

Set the measurement source waveform to one of the waveforms below.
XY1, XY2

Moving the Cursors (Cursor1/Cursor2)

Use Cursor1 and Cursor2 to move the cursors.
You can set in the range of –5 to +5 div from the center of the waveform display window. The step resolution is 0.01 div.

Linking Cursors

You can move the cursors without changing the interval between Cursor1 and Cursor2.

Measurement Items (Item Setup)

You can measure the following vertical (Y axis) values at the cursor positions.

Y1	Vertical (Y axis) value at Cursor1
Y2	Vertical (Y axis) value at Cursor2
ΔY	Difference between the vertical (Y axis) values of Cursor1 and Cursor2

Vertical Cursors (Vertical)

Two dashed lines (vertical cursors) appear on the vertical axis. You can measure the horizontal (X axis) value at the position of each vertical cursor and measure the level difference between the vertical cursors.

Measurement Source Waveform (Trace)

Set the measurement source waveform to one of the waveforms below.
XY1, XY2

Moving the Cursors (Cursor1/Cursor2)

Use Cursor1 and Cursor2 to move the cursors.
You can set in the range of –5 to +5 div from the center of the waveform display window. The step resolution is 0.01 div.

Linking Cursors

You can move the cursors without changing the interval between Cursor1 and Cursor2.

Measurement Items (Item Setup)

You can measure the following horizontal (X axis) values at the cursor positions.

X1	Horizontal (X axis) value at Cursor1
X2	Horizontal (X axis) value at Cursor2
ΔX	Difference between the horizontal (X axis) values of Cursor1 and Cursor2

Marker Cursors (Marker)

Four markers are displayed on the selected waveform. You can measure the level at each marker, the amount of time from the trigger position to each marker, and the level and time differences between markers.

Marker Settings (Marker Setup)

Measurement Source Waveform (Trace)

Set the measurement source waveform to one of the waveforms below.
OFF, XY1, XY2

Marker Shape (Marker Form)

Set the shape of the displayed marker to one of the options below.

- Mark: A dot
- Line: A crosshair

Measurement Items (Item Setup)

Marker cursors move on the waveform data. You can measure the following values at the markers.

X1	Horizontal (X axis) value at Marker1
X2	Horizontal (X axis) value at Marker2
X3	Horizontal (X axis) value at Marker3
X4	Horizontal (X axis) value at Marker4
Y1	Vertical (Y axis) value at Marker1
Y2	Vertical (Y axis) value at Marker2
Y3	Vertical (Y axis) value at Marker3
Y4	Vertical (Y axis) value at Marker4
T1	Time from the trigger position at Marker1
T2	Time from the trigger position at Marker2
T3	Time from the trigger position at Marker3
T4	Time from the trigger position at Marker4
Δ(T2-T1)	Time difference between Marker1 and Marker2
Δ(T3-T1)	Time difference between Marker1 and Marker3
Δ(T4-T1)	Time difference between Marker1 and Marker4

Movement Target Marker (Marker)

Select the marker you want to move.

Position (Position)

Set the position of the selected marker.
You can set in the range of –5 to +5 div from the center of the waveform display window. The step resolution is 0.005 div.

Horizontal and Vertical Cursors (H & V)

You can display the horizontal and vertical cursors simultaneously and measure vertical (Y axis) and horizontal (X axis) values.

Measurement Source Waveform (Trace)

Set the measurement source waveform to one of the waveforms below.
XY1, XY2

Measurement Items (Item Setup)

You can measure the following horizontal (X axis) and vertical (Y axis) values at the cursor positions.

Horizontal Axis (X axis)	
X1	Horizontal (X axis) value at V-Cursor1
X2	Horizontal (X axis) value at V-Cursor2
ΔX	Difference between the horizontal (X axis) values of V-Cursor1 and V-Cursor2
ΔX/ΔY	Amount of change on the horizontal axis corresponding to the amount of change on the vertical axis
Vertical Axis (Y axis)	
Y1	Vertical (Y axis) value at H-Cursor1
Y2	Vertical (Y axis) value at H-Cursor2
ΔY	Difference between the vertical (Y axis) values of H-Cursor1 and H-Cursor2
ΔY/ΔX	Amount of change on the vertical axis corresponding to the amount of change on the horizontal axis

Movement Target Marker (Target)

Select the marker you want to move.

Moving the Cursors (V Cursor1/V Cursor2, H Cursor1/H Cursor2)

Use the vertical cursors (V-Cursor1, V-Cursor2) and horizontal cursors (H-Cursor1, H-Cursor2) to move the cursors.
You can set in the range of –5 to +5 div from the center of the waveform display window. The step resolution is 0.01 div.

Linking Cursors

You can move the two vertical cursors (V-Cursor1, V-Cursor2) and two horizontal cursors (H-Cursor1, H-Cursor2) without changing the interval between them.

15 Harmonic Analysis

Harmonic Analysis (Harmonics)

Harmonics refer to sine waves whose frequency is an integer multiple (2 and higher) of the fundamental wave except for the fundamental wave itself.
When the fundamental is mixed with harmonics, waveform distortion results.
The instrument analyzes the harmonics of rms values (voltage and current) and active power.
Harmonic analysis can be performed from the 1st order to the 40th harmonic for rms values and active powers.

Modules on Which Harmonic Analysis Can Be Performed

Harmonic analysis can be performed only when one of the following modules is installed.
720211 (HS100M12), 720250 (HS10M12), 720254 (4CH 1M16), 720268 (HV (with AAF, RMS)), 701261 (UNIVERSAL), 701262 (UNIVERSAL (AAF)), 701265 (TEMP/HPV), 720266 (TEMP/HPV), 701275 (ACCL/VOLT)

Measurement Functions

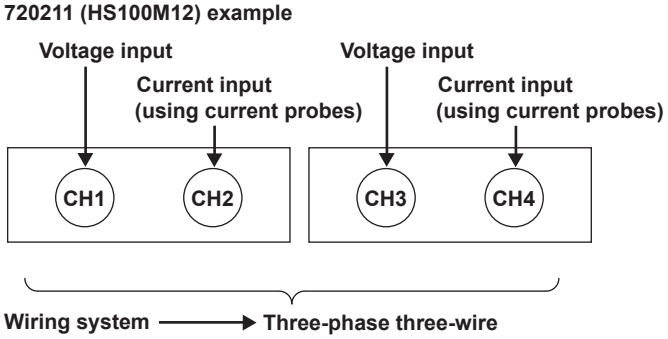
The various physical quantities such as rms voltage, average current, power, and phase difference that the instrument measures and displays are called measurement functions. Each physical quantity is displayed with a corresponding symbol.

Measurement Function Types

The following measurement functions are available.

- **Rms Value Measurement Functions**
  RMS (rms values of the 1st to the 40th harmonic), HDF (percentage contents of the 1st to the 40th harmonic), PHI (phases of the 1st to the 40th harmonic), FREQ (fundamental frequency), RMS (total rms value), THDIEC (distortion factor: IEC), THDCSA (distortion factor: CSA)
- **Active Power Measurement Functions**
  P (active powers of the 1st to the 40th harmonic), HDF (active power percentage contents of the 1st to the 40th harmonic), PHI (power phases of the 1st to the 40th harmonic), FREQ (fundamental frequency), U (total rms voltage), I(total rms current), P (total active power), Q (total reactive power), S (total apparent power), Lambda (power factor)

Voltage and Current Input Channels and Wiring Systems



Fundamental Frequency (Frequency)

Set the fundamental frequency.

50 Hz, 60 Hz, Auto

Start Point (Start Point)

Set the start point of harmonic analysis.

Selectable range: –5 div to +5 div

- Scope mode: Set the positions in divisions.
- Recorder mode: Set the positions in terms of the time (ddhhmmss) corresponding to divisions.

The start and end points are similar to the settable range of the cursor display position in cursor measurement. For details, see “Selectable Range of Cursor Positions.”

▶ See here.

Harmonic Analysis on Voltage and Current (Line RMS Setup)

Performs harmonic analysis on voltage and current.

Analysis Mode (Mode)

- ON: Harmonic analysis is performed on voltage and current.
- OFF: Harmonic analysis is not performed on voltage and current.

Math Source Waveforms (Source)

The modules described in “Modules on Which Harmonic Analysis Can Be Performed” under “Harmonic Analysis (Harmonic)” are applicable.

Hysteresis (Hysteresis)

See Trigger Hysteresis.

Harmonic Analysis on Active Power (Power Setup)

Performs harmonic analysis on active power.

Analysis Mode (Mode)

- ON: Harmonic analysis is performed on active power.
- OFF: Harmonic analysis is not performed on active power.

Wiring System (Wiring)

The following three wiring systems are available on the instrument.

1P2W: 1P2W

1P3W: Single-phase three-wire

3P3W: Three-phase three-wire

To apply voltage, use a passive probe.

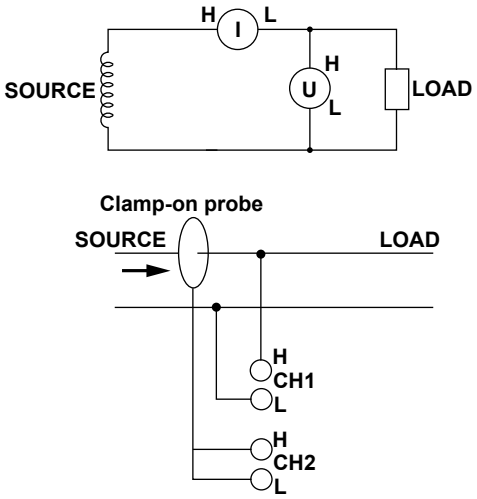
For details on how to select the appropriate passive probes and how to connect them (high and low), see section 2.10 in the Getting Started Guide, IM DL350-03EN.

To apply current, use a current probe.

For details on how to select the appropriate current probes and how to connect them (current direction), see section 2.10 in the Getting Started Guide, IM DL350-03EN, and the user’s manual that came with the current probe.

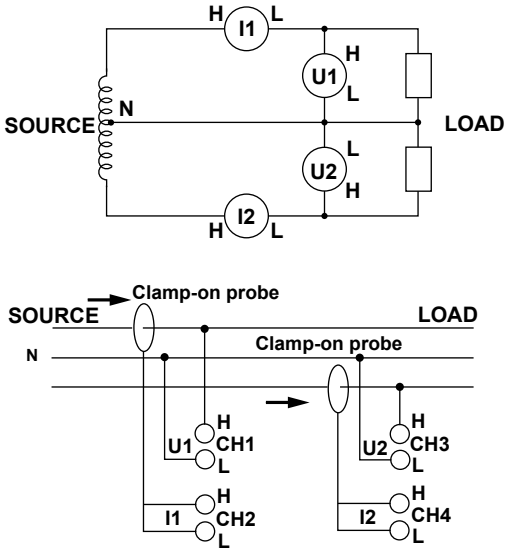
- **Single-Phase Two-wire (1P2W)**

  Two channels that receive one pair of voltage and current signals can be wired.



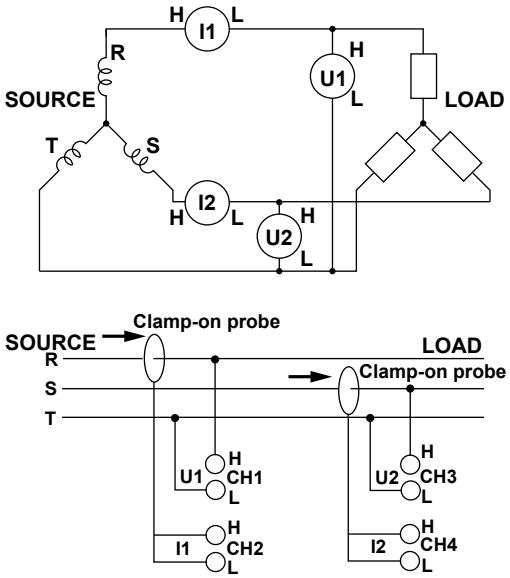
- **Single-Phase Three-Wire (1P3W)**

  Four channels that receive two pairs of voltage and current signals can be wired.



- **Three-Phase Three-Wire (3P3W)**

  Four channels that receive two pairs of voltage and current signals can be wired.



Math Source Waveforms (U1, I1, U2, I2)

The modules described in “Modules on Which Harmonic Analysis Can Be Performed” under “Harmonic Analysis (Harmonic)” are applicable.

Frequency Source (Frequency Source)

The same channel as the math source waveform. Select U1, I1, U2, or I2.

Hysteresis (Hysteresis)

See Trigger Hysteresis.

Display (Display)

Display Mode (Mode)

Select from the following.

- OFF: Bar graph and numeric list are not displayed.
- Bar: A bar graph is displayed for the calculated harmonic value of each harmonic up to the 40th harmonic.
- List: A numerical list is displayed for the calculated harmonic value of each harmonic up to the 40th harmonic.

Display Items (Item)

The following parameters can be displayed.

RMS (rms value), Power (active power)

Display Settings (Display Setup)

Displayed Order (Disp Order)

Select the harmonic orders to display from the following.

- All: The data of all harmonic orders is displayed.
- Even: The data of even harmonic orders is displayed.
- Odd: The data of odd harmonic orders is displayed.

Phase Scaling (Phase Scaling)

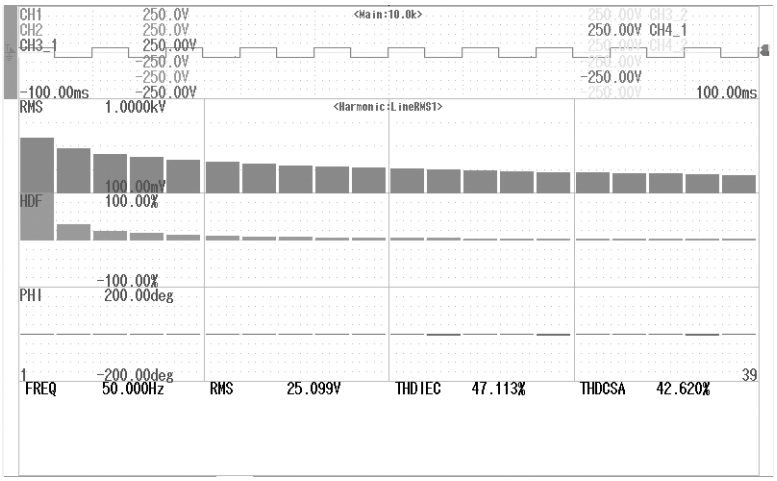
Select how to display phase differences.

- Degree: Degrees
- Radian: Radian

Vertical Scale (V Scale)

Set the vertical scale to Linear or Log (logarithmic).
This setting applies to the scales for RMS (rms value) and P (active power).

Graph display example



1st harmonic ⟶ **Up to the 40th harmonic**

Save Settings (Save)

Unit (Unit)

- ON: A unit is included.
- OFF: A unit is not included.

Save Conditions (Save Setup)

- **File Path (Path), Save Destination (File List), Auto Naming (Auto Naming), File Name (File Name), Comment (Comment)**

▶ See here.

Saving (Save)

Saves the harmonic analysis data to the specified save destination with the specified file name.

16 GO/NO-GO Determination (Scope mode only)

The instrument determines whether the acquired waveform meets the reference condition (GO result) or not (NO-GO result). When the instrument produces a GO or NO-GO result, it executes the specified actions.

Turning GO/NO-GO Determination On and Off

Select whether to use GO/NO-GO determination.

- OFF: GO/NO-GO determination is disabled.
- ON: GO/NO-GO determination is enabled.

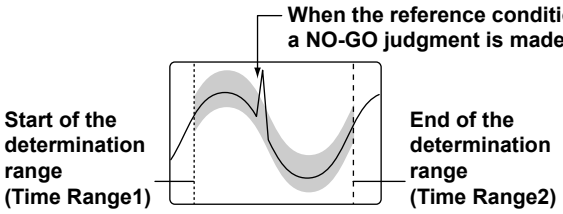
Type (Type)

Sets or queries the reference condition of GO/NO-GO determination.

- OFF: GO/NO-GO determination is disabled.
- Waveform zone (Wave Zone): GO/NO-GO determination is performed in the waveform zone set on the screen.
- Waveform parameter (Parameter): GO/NO-GO determination is performed using the settings of the specified waveform parameters.

Waveform Zone (Wave Zone)

The instrument returns GO/NO-GO results based on whether waveforms leave or enter the zone that you create using a base waveform.



Determination Period (Time Range1 and Time Range2)

You can set the determination period by setting Time Range1 and Time Range2.

Selectable range: –5 div to +5 div

The start and end points are similar to the settable range of the cursor display position in cursor measurement. For details, see “Selectable Range of Cursor Positions.”

▶ See here.

Linking Determination Periods

You can set the determination period without changing the interval between time range 1 (Time Range 1) and time range 2 (Time Range 2).

Judgment Conditions (Judgement Setup)

For each of 8 judgment conditions, you can set the source waveform, zone number, and judgment criterion. You can also set the judgment logic, action condition, sequence, and acquisition count and enable or disable synchronization with a remote signal.

Pattern Setup (Pattern Setup)

Determination Logic (Logic)

You can select the determination logic from the following options.

- AND: The actions are performed when all the conditions from 1 to 8 are met.
- OR: The actions are performed when a condition from 1 to 8 is met.

Judgment Criterion (Mode)

Select the judgment criterion from the following options.

- X: The condition is not used for GO/NO-GO determination.
- IN: The instrument returns a GO result when the source waveform is within the GO/NO-GO determination zone. If even part of the source waveform is outside of the determination zone, the instrument returns a NO-GO result.
- OUT: The instrument returns a GO result when the entire source waveform is outside the GO/NOGO determination zone. If even part of the source waveform is inside the determination zone, the instrument returns a NO-GO result.

Source Waveform (Trace)

Set the waveform to use for GO/NO-GO determination to one of the waveforms below.
CH1 to CH4,* Math1, or Math2

* You can select the channel of an installed module. On a 4-CH module, select sub channel 1 or 2. However, you cannot select the channel of a logic module, 16-CH voltage input, 16-CH temperature/voltage input, CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus monitor, or SENT monitor module.

Zone Number (Zone No.)

Select the number of the waveform zone you want to use for GO/NO-GO determination from the range indicated below.
Zone 1 to Zone 6 (Zone1 to Zone6)

Sequence (Sequence)

Action Condition (ActCondition)

Set the action condition to one of the settings below.

- Always (Always): The actions are always performed. The actions will be executed each time that the instrument triggers.
- At failure (Fail): The actions are executed when the specified GO conditions are not met.
- At success (Success): The actions are executed when the specified GO conditions are met.

Sequence (Sequence)

Select the sequence for executing actions.

- Single (Single): Execution stops after the actions are performed once.
- Continue (Continue): Actions are executed repeatedly. However, the actions stop repeating after the number of specified waveform acquisitions (the Acquisition Count setting). If Acquisition Count is set to Infinite, the actions continue until waveform acquisition is stopped by the pressing of the START/STOP key.

Acquisition Count (Acquisition Count)

Set the number of waveform acquisitions.

- Infinite: Waveform acquisition continues until it is stopped by the pressing of the START/STOP key.
- 1 to 65536: The instrument stops waveform acquisition after it acquires the specified number of waveforms.

External Start (Remote)

You can perform GO/NO-GO determination and output the results in sync with an external signal applied to the GO/NO-GO I/O terminal of the instrument.

- OFF: GO/NO-GO determination is not performed through the use of an external signal.
- ON: GO/NO-GO determination is performed through the use of an external signal.

Action (Action)

▶ See here.

Editing a Waveform Zone (Edit Zone)

Number of the Waveform Zone to Edit

Select the number of the waveform zone you want to edit from the range indicated below. If a zone has already been created for that number, the zone will be displayed. If no zone has been created for a number, select a base waveform from the base waveform editing menu (New), and then edit the zone.

Zone 1 to Zone 6 (Zone1 to Zone6)

Editing the Source Waveform Zone (Zone Edit)

Editing a Base Waveform (New)

When you create a new waveform zone, you need to select the waveform that you will base it on (the base waveform). Select a waveform whose display is on.

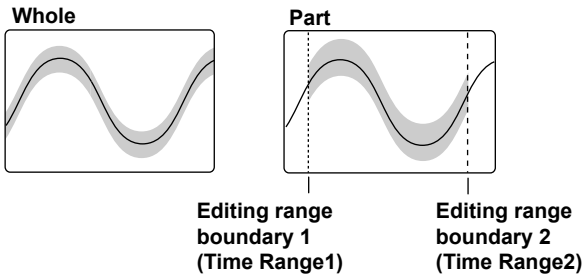
CH1 to CH4[1], Math1 to Math2

1 You can select the channel of an installed module. On a 4-CH module, select sub channel 1 or 2. However, you cannot select the channel of a logic module, 16-CH voltage input, 16-CH temperature/voltage input, CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus monitor, or SENT monitor module.

Specifying the Editing Range

Select the part of the base waveform that you want to edit.

- Whole (Whole): The whole waveform is within the editing range.
- Part (Part): A portion of the waveform is within the editing range.



Zone Settings

When Edit is set to Whole, you can set the upper, lower, left, and right boundaries of the waveform zone. When Edit is set to Part, you can set the upper and lower boundaries of the zone.

- Upper and Lower Limits (Upper/Lower)
  Selectable range: ±10 div vertically from the base waveform
  When Edit is set to Part, you can set the upper and lower boundaries of the area between Time Range1 and Time Range2.
- Left and right sides (Left and Right): These settings can be configured only when Edit is set to Whole.
  Selectable range: ±5 div from the center of the screen
- Time range 1 and time range 2 (Time Range1 and Time Range2): These settings can be configured only when Edit is set to Part.
  Selectable range: ±5 div on the time axis

Save Destination (Store as)

You can select one of the following save destinations for the waveform zone.

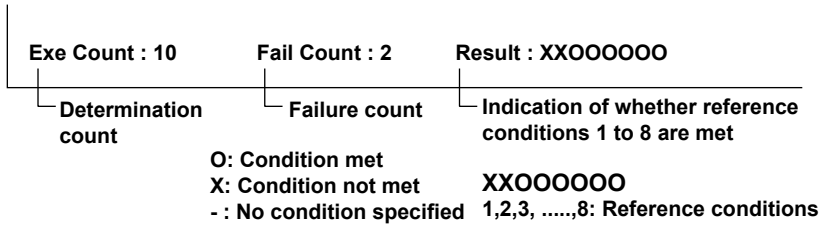
- Zone 1 to zone 6 (Zone1 to Zone6): The save destination is changed to the selected zone number.
- Cancel (Cancel): The save destination is not changed.

Saving a Waveform Zone (Execute Store)

Save the waveform zone.

GO/NO-GO Determination Results

The results of GO/NO-GO determination (and the numbers of determinations and failures) appear at the bottom of the screen.



In this example, reference conditions 1 and 2 are not met while the conditions defined by base waveforms 3 to 8 are met.

Waveform Parameter (Parameter)

Upper and lower limits for automated measurement of waveform parameters are set, and GO/NO-GO determination is performed on whether the parameters are within or outside the range.

Determination Period (Time Range1 and Time Range2)

▶ See here.

Linking Determination Periods

▶ See here.

Judgment Conditions (Judgement Setup)

For each of 8 judgment conditions, you can set the source waveform, waveform parameter, upper and lower limits of the waveform parameter, and judgment criterion. You can also set the judgment logic, action condition, sequence, and acquisition count and enable or disable synchronization with a remote signal.

Pattern Setup (Pattern Setup)

Determination Logic (Logic)

▶ See here.

Judgment Criterion (Mode)

Select the judgment criterion from the following options.

- X: The condition is not used for GO/NO-GO determination.
- IN: The instrument returns a GO result when the value is within the specified upper and lower limits. Otherwise, the instrument returns NO-GO.
- OUT: The instrument returns a GO result when the value is outside the specified upper and lower limits. Otherwise, the instrument returns NO-GO.

Source Waveform (Trace)

▶ See here.

Item (Item)

You can use all automatically measured waveform parameters as judgment conditions. You can perform GO/NO-GO determination on up to 8 parameters at the same time.

▶ See here.

Setting the Upper and Lower Limits of the Parameters (Upper/Lower)

Selectable range: –9.9999E+30 to 9.9999E+30

Sequence (Sequence)

Action Condition (ActCondition), Sequence (Sequence), Acquisition Count (Acquisition Count), External Start (Ext Start)

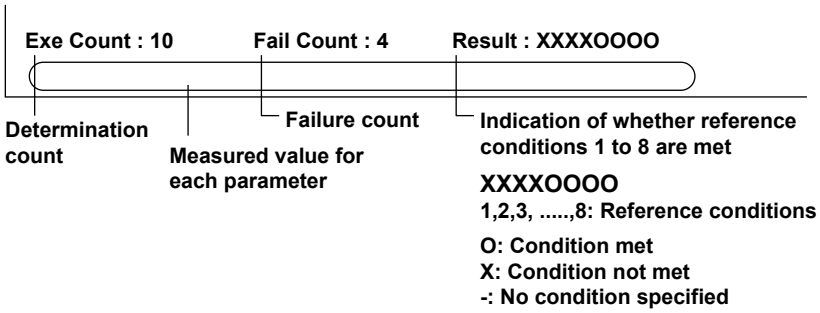
▶ See here.

Action (Action)

▶ See here.

GO/NO-GO Determination Results

The results of GO/NO-GO determination (and the numbers of determinations and failures) appear at the bottom of the screen.



In this example, reference conditions 1 and 4 are not met while the conditions defined by reference conditions 5 to 8 are met.

Notes about GO/NO-GO Determination

- During determination, all keys other than START/STOP are invalid.
- When performing GO/NO-GO determination with waveform zones you cannot start measurement if the number of data points (record length) to be acquired of the waveform is less than 2000.
- The determination interval is synchronized to the trigger. However, while actions are being performed after determination, the instrument will not trigger.
- While you are accessing the instrument through the Web server, if one of the following operations is performed, actions cannot be executed until you finish accessing the instrument.

  Printing and saving of screen capture data and saving of waveform data

Notes about the “Save Data” and “Save Image” Actions

▶ See here.

Notes about Using the 16-CH Voltage Input Module (720220)

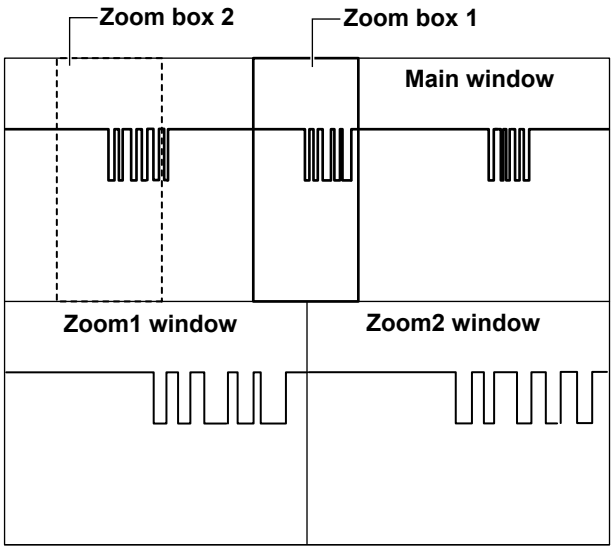
Notes about Using the 16-CH Temperature/Voltage Input Module (720221)

▶ See here.

17 Waveform Zoom (Scope mode only)

You can magnify displayed waveforms along the time axis. The zoomed waveforms of two locations can be displayed simultaneously (the dual zoom feature). You can also specify which channel you want to zoom in on. You cannot zoom if the number of displayed points on the screen is less than or equal to 100.

Example of the Dual Zoom Display



If the Zoom1 or Zoom2 waveform window and the main waveform window (Main) are displayed at the same time, a zoom box appears in the Main window so that you can check the zoom position.

Vertical Zoom

You can magnify displayed waveforms along the vertical axis by using the Channel menu.

▶ See here.

Turning the Zoom Window Display (Display) On and Off

You can set whether to display each of the zoom windows, Zoom1 and Zoom2. When a zoom window is displayed, a zoom box appears in the main window. It indicates what part of Main window is being zoomed in on.

- ON: The zoom window is displayed.
- OFF: The zoom window is not displayed.

T/div of the Zoom Window (T/Div)

Set the zoom factor in T/Div. You can set separate horizontal zoom factors for Zoom1 and Zoom2. The zoom-window time scale changes automatically based on the specified zoom factor.

Selectable Range

Two times the time scale (Time/Div) of the main window to the point where the number of data points in the zoom window reaches 10 points per div.

- When an external clock signal is being used as the time base, you can select one of the following magnifications. You can select any magnification up to the point where the number of data points in the zoom window reaches 10 points per div.
  Up to 1000000 in 1-2.5-5 steps (×2, ×2.5, ×5, ×10, ×25, ×50, ×100, ×250, ×500, ×1000, ×2500, and so on)
- The upper limit of the zoom factor during SD recording is the maximum zoom factor that can be displayed during SD recording.

Position (Zoom Position)

You can set the center position of the zoom box in the range of –5 to +5 div from the center of the waveform display window. On the main window, the box enclosed by a solid line is for Zoom1 and that enclosed by a broken line is for Zoom2. Waveforms are magnified around the centers of the zoom boxes.

Zoom Link

You can move the zoom positions while retaining the positional relationship between the two zoom boxes. Likewise, you can also adjust the zoom factors while retaining the relationship between the two zoom factors.

Display Format (Format)

Select how to display the zoom windows from one of the options listed below. If you select a number, the zoom windows are divided evenly, and waveforms are displayed within the divisions.

- Main: Same as the display format of the main window of each display group.
- 1, 2, 3, 4, 5, 6, 8, 12, 16: The window is broken up into the specified number of divisions.

Zoom Source Window (Zoom2 Source)

Select the waveforms that you want to enlarge in the Zoom2 window.

- Main (Main): Main window waveforms
- Zoom1: Zoom1 window waveforms

Display Ratio of the Main Window (Main Ratio)

Set the percentage of the entire waveform display area that the main screen will occupy.

- 50%: The main window appears in the upper half of the screen.
- 20%: The main window appears in the upper 20% screen.
- 0%: The main window is not displayed.

Window Layout (Window Layout)

Set the window layout when two zoom windows are displayed or when a combination of two windows—an zoom window and another window (FFT window, X-Y window, or harmonic window)—are displayed.

- Side: Horizontal
- Vertical: Vertical (valid only when Main Ratio is set to 0 % when an X-Y window is displayed)

Waveforms That Are Zoomed (Allocation)

The waveforms of the channels whose check boxes are selected in the allocation window and whose displays are turned on are displayed.

Waveforms to Be Auto Scrolled (Target)

Select which waveform, Zoom1 or Zoom2, to move the zoom position of.

Auto Scrolling (Auto Scroll)

This feature automatically moves the zoom position in the specified direction. You can view the zoom waveform and stop scrolling at the appropriate position.

	Zooms in on the left edge of the Main window
	Zooms in on the right edge of the Main window
	Stops scrolling
	Starts scrolling to the left
	Starts scrolling to the right

Speed (Speed)

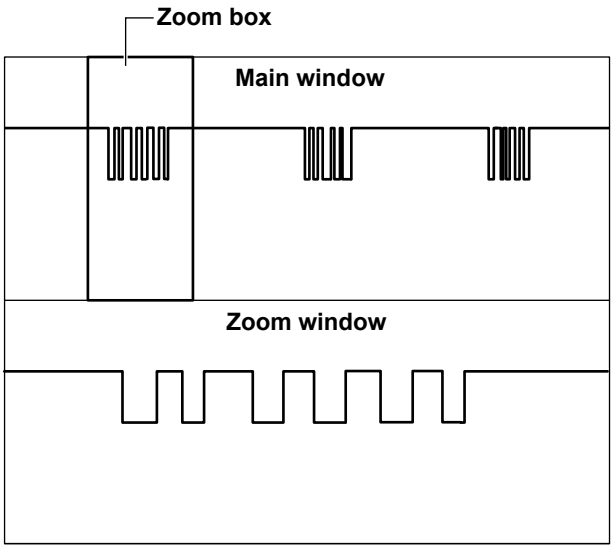
You can select the auto scrolling speed in the range of 1 to 10.

- –: Decreases the speed
- +: Increases the speed

18 Waveform Display Position and Zoom (Recorder mode only)

You can magnify displayed waveforms along the time axis. The zoomed waveform of one locations can be displayed. You can also specify which channel you want to zoom in on. You cannot zoom if the number of displayed points on the screen is less than or equal to 100.

Example of the Zoom Display



Vertical Zoom

You can magnify displayed waveforms along the vertical axis by using the Channel menu.

▶ See here.

Turning the Zoom Window Display (Display) On and Off

Set whether to display the zoom window. When a zoom window is displayed, a zoom box appears in the main window. It indicates what part of Main window is being zoomed in on.

- ON: The zoom window is displayed.
- OFF: The zoom window is not displayed.

Time Range of the Zoom Window

Set the zoom factor in time range. The zoom-window time scale changes automatically based on the specified zoom factor.

Selectable Range

Two times the time scale (record time) of the main window to the point where the number of data points in the zoom window reaches 10 points per div.

- When an external clock signal is being used as the time base, you can select one of the following magnifications. You can select any magnification up to the point where the number of data points in the zoom window reaches 10 points per div.
  Up to 1000000 in 1-2.5-5 steps (×2, ×2.5, ×5, ×10, ×25, ×50, ×100, ×250, ×500, ×1000, ×2500, and so on)
- The upper limit of the zoom factor during SD recording is the maximum zoom factor that can be displayed during SD recording.

Position (Zoom Position)

You can set the center position of the zoom box in terms of the time (ddhhmmss) corresponding to –5 to +5 div from the center of the waveform display window.

On the main window, the box enclosed by a solid line is the zoom box. Waveforms are magnified around the centers of the zoom boxes.

Display Format (Format)

Select how to display the zoom windows from one of the options listed below. If you select a number, the zoom windows are divided evenly, and waveforms are displayed within the divisions.

- Main: Same as the display format of the main window of each display group.
- 1, 2, 3, 4, 5, 6, 8, 12, 16: The window is broken up into the specified number of divisions.

Display Ratio of the Main Window (Main Ratio)

Set the percentage of the entire waveform display area that the main screen will occupy.

- 50%: The main window appears in the upper half of the screen.
- 20%: The main window appears in the upper 20% screen.
- 0%: The main window is not displayed.

Window Layout (Window Layout)

Set the window layout when a combination of two windows—a zoom window and another window (FFT window, X-Y window, or harmonic window)—is displayed.

- Side: Horizontal
- Vertical: Vertical (valid only when Main Ratio is set to 0 % when an X-Y window is displayed)

Waveforms That Are Zoomed (Allocation)

The waveforms of the channels whose check boxes are selected in the allocation window and whose displays are turned on are displayed.

Auto Scrolling (Auto Scroll)

This feature automatically moves the zoom position in the specified direction. You can view the zoom waveform and stop scrolling at the appropriate position.

⏮	Zooms in on the left edge of the Main window
⏭	Zooms in on the right edge of the Main window
■	Stops scrolling
◀	Starts scrolling to the left
▶	Starts scrolling to the right

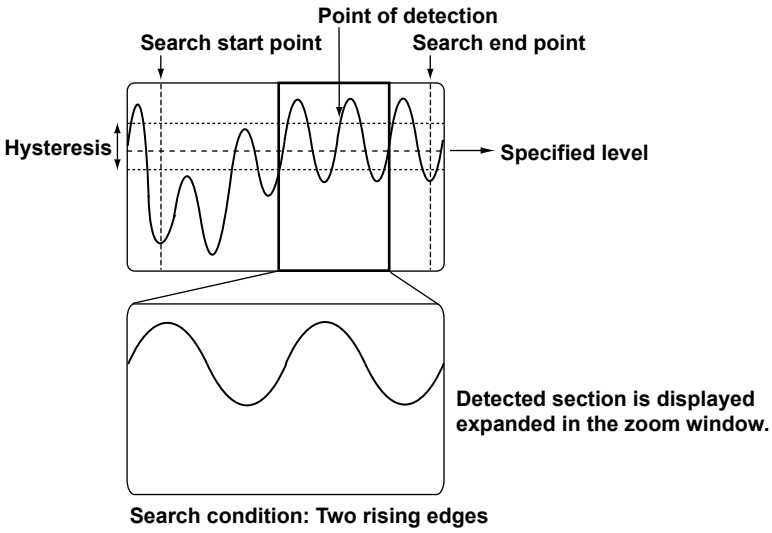
Speed (Speed)

You can select the auto scrolling speed in the range of 1 to 10.

- –: Decreases the speed
- +: Increases the speed

19 Searching Waveforms

You can search the displayed waveforms for locations that match the specified conditions. You can zoom-in on the detected locations. You can search the waveforms within the specified search range over up to 10 Gpoint.



- In scope mode, the Zoom1 window is displayed automatically when you open the Search menu.
- In recorder mode, the Zoom1 window is not displayed automatically when you open the Search menu.

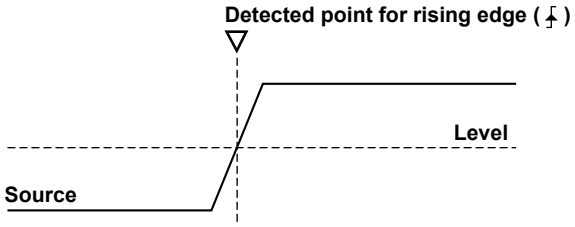
Search Type (Type)

Set the search type to one of the options below.

- Edge: The instrument searches for edges.
- Event: The instrument searches for an event.
- Logic Pattern: The instrument searches for logic patterns. This setting is valid only for logic signals. This setting is only valid for logic signals.
- Time: The instrument searches for a time.

Edge Search (Edge)

Search for positions where the rising or falling slope of the specified waveform passes through the specified level.



Search Conditions (Setup)

Set the search conditions, such as the waveforms to search, judgment level, polarity, hysteresis, count, and bit settings.*

* Only on the channel of a logic module

Source Waveform (Trace)

Select the waveforms to search from the options listed below.

CH1 to CH6[1], 16chVOLT[2], 16chTEMP/VOLT[2], CAN[3], LIN[3], SENT[3]

1 You can select the channel of an installed module. On a 4-CH module, select sub channel 1 or 2.
2 When a 16-CH voltage input module or 16-CH temperature/voltage input module is installed. After you select 16chVOLT or 16chTEMP/VOLT, select a sub channel.
3 On a model with the /VE option when a CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus, or SENT monitor module is installed. After you select CAN, LIN, or SENT, select a sub channel.

Judgment Level (Level)

Set the level used to detect the rising or falling edges of the waveforms. You can set the level to a value within the 10 div of the screen. The resolution at which you can set the level varies depending on the module.

Polarity (Polarity)

Select which type of edge to detect from the options listed below.

- : Rising
- : Falling
- : Rising or falling

Hysteresis (Hysteresis)

You can set a range (hysteresis) within which level changes are not treated as edges. You can set the hysteresis to one of the settings below. The hysteresis widths vary depending on the input module.

- : Low hysteresis
- : Medium hysteresis
- : High hysteresis

Bit Settings (Bit Setting)

For each bit from Bit1 to Bit8, you can select which type of edge to detect from the options listed below. This setting is available only for the channels of logic modules. The instrument searches based on the OR of each bit.

- : Rising
- : Falling
- : Rising or falling
- −: The signal is not used as a trigger condition.

Count (Count)

Set the number of times the specified edge (, , or) must repeat. You can select a number from 1 to 1000000.

The detected point is the point at which the search conditions are met the specified number of times. For example, if the count is set to 5, when five points that meet the search conditions are found, the fifth point becomes the detected point.

Search Range (Start/End Point)

Set the search start and end points (Start Point and End Point).

Selectable range: –5 div to +5 div

- Scope mode: Set the positions in divisions.
- Recorder mode: Set the positions in terms of the time (ddhhmmss) corresponding to divisions.

The start and end points are similar to the settable range of the cursor display position in cursor measurement. For details, see “Selectable Range of Cursor Positions.”

▶ See here.

Pattern Number (Pattern No.)

Specify the number of the detected point (location where the search conditions are met) to display in the zoom window. The maximum detected point number is 1000. If the search does not yield any results, “No Match” appears.

Executing a Search (Execute)

The instrument searches for positions where the specified search conditions are met from the left edge of the search range. Up to 1000 points can be detected. When the point is found, the instrument finishes searching and displays the detected point as follows.

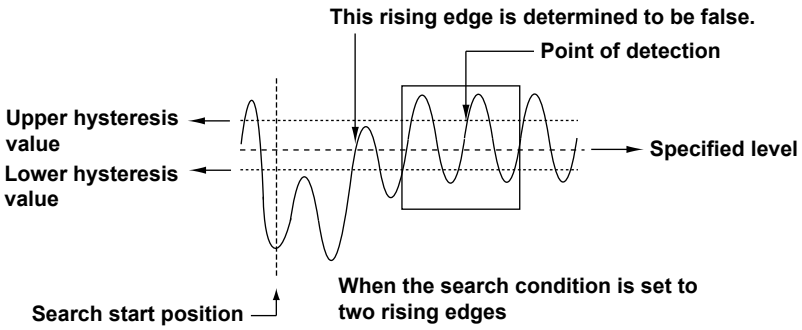
- Recorder mode
  When zoom display is turned on, the detected point is displayed at the center.
- Scope mode
  The detected point is displayed expanded in the Zoom1 window.

If you execute searching again in this condition, the instrument uses the detected point as the starting point and searches to the right.

If you execute searching numerous times and several detected points are found, you can specify a pattern number to display the corresponding detected point at the center.

Edge Search Determination

If the peak is below the upper limit of the hysteresis immediately after a rising edge or above the lower limit of the hysteresis immediately after a falling edge, the instrument will not count the edge.



Event Search (Event)

You can search for an event number that was assigned during measurement.

Event Number (Select Number)

Select the event number that you want to search for.
When searching manual events, the selectable range is 1 to 100 (maximum number of input events).

* When the trigger mode is auto, event search is performed only on the event numbers remaining on the display screen.

Executing a Search (Execute)

The instrument displays the waveforms of the area around the selected event number expanded in the zoom window.

▶ See here.

Logic Pattern Search (Logic Pattern)

The instrument searches for the specified logic pattern. This setting is valid only for the logic input terminals (CH5 and CH6) of this instrument and logic modules.

Search Conditions (Setup)

Set the following search conditions: the waveforms to search, bit settings, and count.

Source Waveform (Trace)

Select the waveforms to search from the options listed below.
CH1 to CH6*

* You can select only the following channels.

- Channels of logic modules
- Sub channels of CAN bus monitor, CAN/CAN FD monitor, or CAN & LIN bus monitor modules whose data types are set to Logic.
- S&C and Error trigger sub channels of SENT monitor modules

Bit Settings (Bit Setting)

To set the logic signal pattern that you want to detect, set the signal states for Bit1 to Bit8. The instrument searches based on the AND of each bit.

- H: High level
- L: Low level
- X: The state of the bit is not used as a condition.

Count (Count)

Set the number of times the specified pattern must repeat. You can select a number from 1 to 1000000.

Search Range (Start Point/End Point), Search Number, Executing a Search (Execute)

▶ See here.

Time Search (Time)

Search for a specific year, month, day, and time.

Search Conditions (Setup)

Time (Absolute Time)

Specify the time that you want to search for.
Set the year (Year), month (Month), day (Day), hour (Hour), minute (Minute), second (Second), and microsecond (µSecond).

Executing a Search (Execute)

The instrument displays the waveform expanded in the zoom window at the specified time.

▶ See here.

Notes about Searching Waveforms

- You cannot search during data acquisition.
- The search results are invalid after you:
  - Start data acquisition.
  - Change the settings.
- If you invert or change the offset voltage of a waveform that has been selected as a waveform to search, the search is performed on the new waveform.

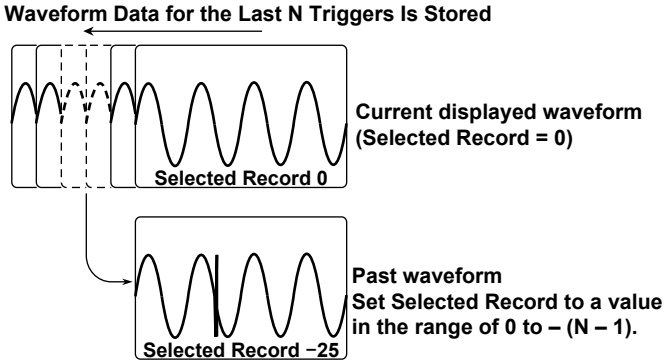
Notes about Using the 16-CH Voltage Input Module (720220)

Notes about Using the 16-CH Temperature/Voltage Input Module (720221)

▶ See here.

20 History Waveform Display (Scope mode only)

Acquisition memory stores waveforms that are displayed on the screen and waveform data that have been acquired in the past. The history feature allows you to any single waveform or display all waveforms (and highlight only the specified waveform). You can also list the timestamps (the times at the time references) of all history waveforms.



Calculation, Cursor Measurement, Automated Measurement, Statistical Processing, and FFT

You can perform calculations, cursor measurement, automated measurement of waveform parameters, or FFT computation on the history waveform that you specified with Selected Record. You can also calculate statistics of automatically measured values on all history waveforms.

Displaying and Analyzing XY Waveforms

You can display XY waveforms and perform analysis on the history waveform you specified with Selected Record. If the display mode is set to All, XY waveforms of all history waveforms are displayed.

Display Mode (Display Mode)

Selects how history waveforms are displayed.

- One waveform (1 Record): Only the waveform that corresponds to the selected record number is displayed.
- All waveforms (All Record): All history waveforms from the specified start (Start Record) to stop (End Record) number are overlaid. All waveforms other than the highlighted one are displayed in an intermediate color.
- Averaged waveform (Average Record): Linear averaging is performed on all history waveforms from the specified start (Start Record) to stop (End Record) number, and the results are displayed as a single waveform.

An averaged waveform cannot be displayed for the following history waveforms.
Waveforms with record lengths of 250 kpoint or greater

Highlighting (Selected Record)

The latest history waveform is assigned the record number zero, and older waveforms are assigned numbers in descending order (−1, −2, −3, and so on).
The waveform and timestamp that correspond to the record number you specify here are highlighted.
Selectable range: 0 to −(the number of waveform acquisitions − 1)

Maximum Number of Waveform Acquisitions

(Maximum number of history waveforms that can be stored in the acquisition memory)

The number of history waveforms that can be stored varies depending on the selected record length as follows:

Record Length	Number of Waveforms	
	With 4-CH Module	Without 4-CH Module
10 kpoint	1000	1000
25 kpoint	528	1000
50 kpoint	263	528
100 kpoint	105	263
250 kpoint	52	105
500 kpoint	24	52
1 Mpoint	9	24
2.5 Mpoint	4	9
5 Mpoint	1	4
10 Mpoint	1	1
25 Mpoint	1	1
50 Mpoint	1	1
100 Mpoint	−	1

− This record length cannot be set.

Display Range (Start and End Record)

Using record numbers, set the range of history waveforms to display when the display mode is set to All or Average.

Selectable range: 0 to −(the number of waveform acquisitions − 1)

List of History Waveforms (List)

The history waveform record numbers and the timestamps when the waveforms were acquired are listed.

Clear History (Clear History)

Clears all history waveforms.

You cannot use clear history in the following situations.

- When the instrument is in remote mode.
- When the instrument is printing, when it is executing auto setup, or when it is accessing a storage medium.
- When go/no-go determination is in progress, when action is in progress, or when searching is in progress.

Notes on Using the History Feature

- You can start waveform acquisition when the History menu is displayed. However, you cannot change the history feature settings while waveform acquisition is in progress.
- When the acquisition mode is set to Average, you cannot use the history feature.
- You cannot use the history feature when SD recording is being executed.
- If you stop waveform acquisition, even if one complete screen's worth of waveform data has not been acquired, the waveform at which the trigger occurred is displayed as a single history waveform.
- If you stop waveform acquisition and then start it again without changing the waveform acquisition conditions, the waveform data continues to be stored in the acquisition memory.
- If you change the waveform acquisition conditions and start waveform acquisition, the past data stored in the acquisition memory is cleared.
- An averaged waveform cannot be displayed for the following waveforms.
  Waveforms with record lengths of 250 kpoint or greater
- The settings are restricted so that the following relationship is retained: Last record (End Record) ≤ Selected Record ≤ first record (Start Record).
- When you load waveform data from the specified storage medium, history waveforms up to that point are cleared. The loaded waveform data is placed in record number zero. If you load a file containing multiple history waveforms, the latest waveform is placed in zero, and earlier waveforms are placed in order to record numbers 1, 2, and so on.
- Computation and automated measurement of waveform parameters are performed on the waveform of the record number specified by Selected Record. You can analyze old data as long as you do not overwrite the acquisition memory contents by restarting waveform acquisition. If Display Mode is set to Average Record, analysis is performed on the averaged waveform.
- The times that are listed are the times at the time references. When the waveform display is in update mode, the time references are the trigger times. Furthermore, these times vary as indicated below depending on the trigger mode.

Trigger Mode	Condition	Time Displayed in the List
Auto/Auto Level	Roll mode	Stop time
Single	Roll mode, no trigger	Stop time
On Start	–	Start time

- When all the waveforms are displayed, if a large number of records are selected, it may take time for them to be displayed completely. When the display is not complete,  appears in the center of the screen. If you want to stop the operation, set Display Mode to 1 Record.
- History waveforms are cleared when you turn the power off.

21 Position Information (GPS)

If you connect a GPS unit, an accessory sold separately, position information based on GPS (Global Positioning System) can be obtained.

Turning GPS Data On and Off

Set whether to obtain a position information from GPS.

- ON: Position information is obtained.
- OFF: Position information is not obtained.

When set to ON, the following position information is obtained in place of the logic input of CH6.

- Latitude (GPS): Latitude [°]. Positive is north latitude; negative is south latitude.
- Longitude (GPS): Longitude [°]. Positive is east longitude; negative is west longitude.
- Altitude (GPS): Altitude [m]
- Velocity (GPS): Velocity [km/h]
- Direction (GPS): Direct [°]. 0° is north; 90° is east; 180° is south; 270° is west.
- Status (GPS):
  - Bit1: 3D FIX. Set to 1 when 3D position is determined.
  - Bit2: PPS. Set to 1 when time pulses synchronized to the GPS time are obtained.

Time Synchronization Feature (Time Sync)

▶ See here.

Time Difference (Time Difference)

▶ See here.

22 Ethernet Communication (Network)

You can configure TCP/IP parameters and use the optional Ethernet interface to perform the following tasks.

TCP/IP

TCP/IP settings for connecting to an Ethernet network.
Set the IP address, subnet mask, and default gateway.

▶ See here.

Web Server (Web Server)

You can connect the instrument as a Web server to a network.
You can connect to the instrument from a PC on the same network and monitor the instrument display from the PC.

▶ See here.

Mail (Mail)

The action can be set to mail transmission.

▶ See here.

Network Drive (Net Drive)

You can save waveform data and setup data to a network drive.

▶ See here.

SNTP

The instrument clock can be set using SNTP. The instrument can be configured to automatically adjust its clock when it is turned on.

▶ See here.

VXI11 (VXI11)

Set the timeout.

▶ See here.

To connect a PC to the instrument, use a hub or router, and connect to a network. Do not connect a PC directly to the instrument.

TCP/IP (TCP/IP)

Configure the settings that the instrument needs to connect to a network.

DHCP

DHCP is a protocol that temporarily allocates settings that a PC needs to connect to the Internet.
To connect to a network that has a DHCP server, turn the DHCP setting on. When DHCP is turned on, the IP address can be automatically obtained when the instrument is connected to a network. (You do not have to set it manually.)
When DHCP is turned off, you must set the appropriate IP address, subnet mask, and default gateway for the network.

DNS

DNS is a system used to associate Internet host names and domain names with IP addresses. Given AAA.BBBBB.com, AAA is the host name and BBBBB.com is the domain name. You can use host names and domain names to access the network instead of using IP addresses, which are just numbers. The instrument allows you to specify the host by name, instead of by IP address. Set the domain name and the DNS server address (0.0.0.0 by default). For details, consult your network administrator.

DNS Servers (DNS Server1/DNS Server2)

You can specify up to two DNS server addresses: primary and secondary. If querying fails with the primary DNS server, the secondary DNS server is automatically used to find the mapping of the host name and domain name to the IP address.

Domain Suffixes (Domain Suffix1/Domain Suffix2)

The domain suffix is a piece of information that is automatically added when a query is made to a DNS server using only a portion of the domain name. For example, if BBBBB.co.jp is registered as a domain suffix and a query is made using “AAA,” the name “AAA.BBBBB.co.jp” is searched.
You can specify up to two domain suffixes: Domain Suffix1 and Domain Suffix 2.
You can use up to 127 characters. The characters that you can use are 0 to 9, A−Z, a−z, and dashes.

TCP/IP settings are applied when you select Bind in the dialog box or when you turn on the instrument the next time.

Web Server (Web Server)

You can connect the instrument as a Web server to a network.
Set the user name and password that will be used by devices on the network to access the instrument. Also, set the access timeout value.

User Name (User Name)

Set the user name that will be used to access the instrument from a PC. The characters that you can use are all the ASCII characters on the keyboard. If you set the user name to “anonymous,” you can connect to the instrument without entering a password.
The instrument supports the MD5 algorithm (RSA Data Security, Inc. MD5 Message DigestAlgorithm).

Password (Password)

Set the password that will be used to access the instrument from a PC. The characters that you can use are all the ASCII characters on the keyboard.

To apply the settings that you specified, press Entry.

Web Server Overview

When the instrument is connected to the network as an Web server, the following features become available.

Web Server Feature

You can display and control the instrument’s screen and operation panel from a browser on your PC via Ethernet.

Controlling from a PC

- Overview: An overview of the instrument, such as the model name and serial number, is displayed on a browser on your PC.
- Remote: The instrument’s screen and operation panel are displayed on a browser on your PC. The instrument’s screen displayed on the PC can be saved to a file.
  You can set the screen update interval to OFF, 200 ms, 500 ms, 1 s, 3 s, or 5 s. However, updating may be delayed from the specified update interval depending on the communication status and the load status of the instrument.
- Remote control: You can control the screen and panel in the remote display state.
  Some of the instrument’s operations are not supported. Nor can you turn on or off the instrument.
- File downloading: You can download files stored in a USB device or SD memory card (2.5 MB or less) connected to this instrument to a PC.

Mail (Mail)

You can send trigger times and other information in emails to a specific email address as an action in the action feature.

Mail Server (Mail Server)

Specify the IP address of the mail server on the network that the instrument will use. In a network with a DNS server, you can specify the host name and domain name instead of the IP address.

Mail Address (Mail Address)

You can specify multiple email recipient addresses. Separate each address with a comma.

Comment (Comment)

If necessary, you can enter a comment in the first line of emails.

Attaching Image Files (Attached Image File)

You can attach a capture of the screen that is displayed at the time the email is sent.

File format: The format that you set in the Save/Load menu for saving screen captures.
File name: DL_image[time].extension
(Example: DL Image1006171158.extension is a screen capture taken at 11:58 on June 17, 2010.)
Resolution: SVGA (800 × 600 dots)
Approximate File Size
Normal screen: Approx. 30 KB
Maximum: Approx. 1.0 MB (when the screen contains many colors)

Timeout (TimeOut (sec))

If the instrument cannot send an email for the amount of time specified here, it disconnects from the mail server.

Sending a Test Mail (Send Test Mail)

You can send a test mail to check whether emails can be sent properly.

Network Drive (Net Drive)

You can save waveform data and setup data to a network drive.

FTP Server (FTP Server)

Specify the IP address of the FTP server on the network that you want to save waveform or setup data to. In a network with a DNS server, you can specify the host name and domain name instead of the IP address.

Login Name (Login Name)

Specify the login name. The characters that you can use are all the ASCII characters on the keyboard.

Password (Password)

Specify the password that corresponds to the login name. The characters that you can use are all the ASCII characters on the keyboard.

Passive Mode (Passive)

Turn passive FTP on or off.
In passive mode, the FTP client sets the port number for data transfer. Enable passive mode when you have set an external FTP server as a network drive or when you are accessing an FTP server through a firewall.

Timeout (TimeOut (sec))

If the instrument cannot transfer files for a certain amount of time, it disconnects from the FTP server.

Connecting to the Network Drive(Connect/Disconnect)

When you press the Connect button, the instrument connects to the specified network drive, and the drive appears in the file list (File List). When you press the disconnect button, the network drive is disconnected and removed from the file list (File List).

If the network drive or fixed IP address is not set correctly, you may not be able to operate the instrument for the specified timeout period.

SNTP (SNTP)

The instrument clock can be set using Simple Network Time Protocol (SNTP). The instrument can be configured to automatically adjust its clock when it is turned on.

SNTP Server (SNTP Server)

Specify the IP address of the SNTP server that the instrument will use. In a network with a DNS server, you can specify the host name and domain name instead of the IP address.

Timeout (TimeOut (sec))

If the instrument cannot connect to the SNTP server for a certain amount of time, it aborts the operation.

Automatic Adjustment (Adjust at Power On)

You can configure the instrument so that its clock is automatically synchronized to the SNTP server clock when the instrument is turned on when it is connected to the network.

Executing Time Adjustment (Adjust)

The instrument clock is synchronized to the SNTP server clock.

- If the time difference from GMT (Greenwich Mean Time) is set in the date/time setting, the instrument will make appropriate adjustments to the time information received from the SNTP server.
  ▶ See here.
- If you do not want the instrument to synchronize with an SNTP server, do not set the SNTP server IP address.

VXI11 (VXI11)

Timeout (TimeOut)

If the instrument is not accessed for a certain amount of time, it will disconnect from the network. The timeout value can be set to Infinite or in the range of 1 to 3600 s.

23 Other Features

- System Configuration (System)
- Network (Network)
- Environment Settings (Preference)
- File Operation (File)
- Self-test (SelfTest)
- Overview (Overview)

System Configuration (System Configuration)

The following settings can be configured.

- Date and time on the instrument
- LCD settings
- Settings for DC power operation
- Settings for battery operation
- Language
- USB settings

Date and Time Setting (Date/Time)

The instrument date and time.

Turning the Display On and Off (Display)

Set whether to display the date and time on the instrument screen.

Display Format (Format)

- 2017/06/30 (year/numeric month/day)
- 30/06/2017 (day/numeric month/year)
- 30-JUN-17 (day-English abbreviation of the month-last two digits of the year)
- 30 JUN 2017 (day month (English abbreviation) year)

Date and Time Setting (Date/Time)

Sets the date and time.

Time Synchronization Feature (Time Synchro)

This is a feature to synchronize the instrument with the (Global Positioning System) GPS on the basis of a GPS signal received by the GPS unit. This feature has two conditions: Unlock and Lock.
When a GPS signal is properly received, the instrument enters into the Lock condition and acquires time information.

Turning the Time Synchronization Feature On and Off (GPS Time Synchro)

You can select whether to use a GPS signal for time synchronization.

Setting the Time Difference from GPS or SNTP (GPS/SNTP Time Diff)

Set the time difference between the region where you are using the instrument and the GPS or SNTP.

Selectable range: Set the time difference in the range of −12 hours 00 minutes to 14 hours 00 minutes.

For example, Japan standard time is ahead of the time obtained from the GPS by 9 hours. In this case, set Time Hour to 9 and Minute to 00.

Checking the Standard Time

Using one of the methods below, check the standard time of the region where you are using this instrument.

- Check the Date, Time, Language, and Regional Options on your PC.
- Check the website at the following URL: http://www.worldtimeserver.com/

- This instrument does not support Daylight Saving Time. To set the Daylight Savings Time, reset the time difference from Greenwich Mean Time.
- Date and time settings are backed up using an internal lithium battery. They are retained even if the power is turned off.
- This instrument has leap-year information.

Setting the LCD (LCD Setup)

Turning Off the LCD (LCD Turn OFF)

You can turn off the LCD. When the LCD is off, you can turn it back on by pressing a key.

Settings for DC Power Operation (DC Power)

- **Automatically Turning Off the LCD (Auto OFF)**

  Enable or disable the auto off feature, which automatically turns off the LCD when the panel keys are not used for a given time period. The LCD turns back on when you press a key.

- **Auto Off Time (Auto OFF Time)**

  Set the time for automatically turning off the power.

- **Adjusting the Brightness (Brightness)**

  You can adjust the brightness in the range of 1 (darkest) to 10 (brightest). You can prolong the LCD service life by decreasing the LCD brightness or by turning off the LCD when you do not need to view it.

Settings for Battery Operation (Battery)

- **Automatically Turning Off the LCD (Auto OFF), Auto Off Time (Auto OFF Time), Brightness Adjustment (Brightness)**

  These settings are the same as those for DC operation.

Others (Others)

Language (Language)

Sets the language that is used in the setup menu and messages.

USB Communication (USB Function)

You can specify the communication features that are used when you connect the instrument to a PC through USB.

- **TMC**

  You can use USB TMC (Test and Measurement Class) to control the instrument from a PC. To connect the instrument to a PC through the USB port, carry out the following procedure.

  Install YOKOGAWA USB TMC driver on your PC.

  (Do not use USB TMC drivers (or software) supplied by other companies.)

- **Storage**

  You can access the instrument from a PC and read data from the SD card inserted in the instrument.

  - There is no need to install the USB TMC driver into your PC.
  - When USB Function is set to Storage, only the SD card inserted in the instrument can be used as a storage device. You cannot access the storage media connected to the USB ports of the instrument.
  - When you access the SD card of the instrument from a PC, only perform read operations. Otherwise, the instrument may be damaged.
  - When USB Function is set to Storage and files are being accessed, do not remove the USB cable or turn off the instrument. Doing so may damage the instrument.

For information about how to obtain the YOKOGAWA USB TMC driver (YKMUSB), contact your nearest YOKOGAWA dealer. You can also access the YOKOGAWA USB driver download website and download the driver (https://tmi.yokogawa.com/library/).

USB Keyboard Language (USB Keyboard)

Sets the USB keyboard language to English or Japanese. The USB keyboard can be used to enter file names, comments, etc.

USB Keyboard Input (USB Key Input)

When using a Japanese USB keyboard, set the input type to Roman (Roman) or Kana (kana).

SD Card Format (SD Card Format)

You can format SD memory cards.

When you format an SD memory card, all the data saved in the card will be erased.

Additional Option License (Option Installation)

On the instrument's with firmware version 1.10 and later, you can add the following options after purchasing the instrument. Install the options after you have purchased the license keys for them.

Options That Can Be Added

/VE	Vehicle edition

The SUFFIX (suffix code) inscribed in the name plate on the instrument case indicates the installed options at the time of factory shipment. After you add options through additional option licenses, check the options on the instrument overview screen.

Network (Network)

▶ See here.

Environment Settings (Preference)

Logic Settings (Logic)

Logic Channel Display Format (Numerical Format)

Choose whether to display the logic waveform values in the numeric monitor as binary (Bit) or hexadecimal (Hex) values.

Bit Order (Bit Order)

- **Cursor Read Order (Cursor)**

  Choose the order that you want to read the bit data from logic input signals in.
  - 1->8: Bit 1 to bit 8
  - 8->1: Bit 8 to bit 1

- **Bit Data Display Order (Waveform)**

  Choose the order that you want to display the bit data from logic input signals in.
  - 1->8: Bit 1 to bit 8
  - 8->1: Bit 8 to bit 1

Terminal Setup (Terminal)

Enabling or Disabling the Remote High Edge (STOP) Signal (Remote Stop)

Select whether to enable (ON) the high edge (STOP) in the external start/stop remote signal or disable (OFF).

Trigger Output Signal (Trigger Out)

Select the type of signal to transmit from the trigger output terminal from the following options.

- Normal (Normal)
  A falling signal is transmitted when a trigger occurs.
- Pulse (Pulse)
  A pulse signal is transmitted when a trigger occurs. You can set the pulse width.
- Sample Pulse (Sample Pulse)
  A pulse signal is transmitted at regular intervals when waveform acquisition is started. You can set the pulse rate.
- Start/Stop (Start/Stop)
  A high level signal is transmitted during waveform acquisition, and a low level signal is transmitted otherwise.

Pulse Width (Pulse Width)

When you set the trigger output signal type to Pulse, you can set the pulse width to 1 ms, 50 ms, 100 ms, or 500 ms.

Pulse Rate (Pulse Rate)

If you set the type of trigger output signal to sample pulse, set the pulse rate in the range of 5 Hz to 200 kHz (in 1-2-5 steps).

Key and Touch Settings (Key/Touch)

START/STOP Key Response Time (START/STOP Response Time)

You can set the response time of the START/STOP key to instant (Quick) or 1 s or more (> 1sec).

Key and Touch Lock (Key/Touch Protect)

You can lock the control keys and touch panel to prevent unintentional changes to the current state of the instrument.

- Protect Target (Protect Target)
  Select whether to lock the keys and touch panel or only the touch panel.
- Turning Password Release On and Off (Password Release)
  Select whether to require a password to unlock keys.
- Password (Password)
  Specify the password using up to eight alphanumeric characters.
- Applying Key and Touch Lock (Protect)
  Applies key and touch lock.

Menu Settings (Menu)

Color Theme (Color Theme)

Set the color theme to black (Black) or white (White).

Channel Information (Channel Information)

Select the information to display in the channel information area at the bottom of the screen.

- Setting: Vertical scale, input coupling, probe attenuation, and bandwidth limit are displayed.
- Value: Measured data is displayed.

Custom Menu (Custom Menu)

Select the menu to assign to the user menu in the lower right of the screen.

Scope Mode	Recorder Mode	Menu
Yes	Yes	Not Assign: No menu
Yes	Yes	Acquire: Waveform acquisition
Yes	Yes	Display: Display
Yes	Yes	Save: Data saving
Yes	Yes	Load: Data loading
Yes	Yes	Cursor: Cursor measurement
Yes	Yes	Measure: Automated measurement of waveform parameters
Yes	Yes	Math: Computation
Yes	Yes	FFT: FFT
Yes	Yes	X-Y: X-Y waveform
Yes	Yes	Harmonic: Harmonic analysis
Yes	Yes	Search: Waveform search
Yes	—	History: History waveform display
—	Yes	Easy Setup: Easy Setup
Yes	Yes	Initialize: Initialization
Yes	Yes	AutoSetup: Auto setup
Yes	Yes	Calibration: Calibration
Yes	—	Snap Shot: Snapshot
Yes	Yes	Clear Trace: Clear trace
Yes	Yes	Event: Event
Yes	Yes	Key and Touch Lock: Key/Touch Protect
Yes	Yes	START/STOP: Waveform acquisition start and stop
Yes	Yes	Manual Trigger: Manual trigger execution
Yes	Yes	Save Execute: Save and print

Yes: Selectable

—: Not selectable

Others (Others)

Cursor Read Mode (Cursor Read Mode)

You can select whether to perform cursor measurements on P-P compressed display data or the data that has been acquired in the acquisition memory.

- Display Data (Display)
  Cursor measurements are performed on the display data.
- Acquisition (ACQ)
  Cursor measurements are performed on sampled data in acquisition memory.

▶ See here.

Setting the Destination That Data Is Saved to upon Action Execution (Action Folder Mode)

You can select the destination that data is saved to when actions are executed.

- ON: Data is saved to the folder that is automatically created with the date.
  If the number of files in the save destination folder exceeds 1000, a new folder is automatically created with the date and an incremented sequence number (000 to 999) as its name, and the data continues to be saved in the new folder.
- OFF: Data is saved in the folder that you have specified.
  - The maximum number of files that can be saved to a single folder is 1000. Make sure that there are no files in the destination folder before you execute an action.

  ▶ See here.
  - If the measurement count (Acquisition Count) is set to a number greater than 1000, the measurement cannot be started.

  ▶ See here.

Backup at Power-Off (Backup Save Mode)

- ON: When an SD card is inserted, waveform data in memory is saved to the SD card when the power is turned off.
- OFF: Waveform data in memory is not saved to the SD card when the power is turned off.

Beep on Error (Beep on Error)

- ON: A beep is generated when an error occurs.
- OFF: A beep is not generated even when an error occurs.

File Operation (File)

▶ See here.

Self-test (Selftest)

You can check whether the memory, keys, and the like are operating properly.

Test Type (Type)

You can perform the following tests.

Keyboard (Key Board)

The panel key test checks the front panel keys. If the name of the key that you press is highlighted, the key is operating properly.

Memory (Memory Only)

Tests whether the internal memory is operating properly. If they are operating properly, “Pass” appears. If an error occurs, “Error” appears.

SD Memory Card (SD-Card)

Tests whether the SD memory card is operating properly. If an error occurs, “Error” appears.

Version Update (Version Up)

This is not a self-test. If you execute this item, the firmware of installed modules that can be updated will be updated. You cannot undo this operation. This is a maintenance feature. Use it only when you receive instruction to do so from YOKOGAWA.

Touch Panel (TouchPanel)

Calibrates the touch panel.
For details, see section 5.4 in the Getting Started Guide (IM DL350-03EN).

Execution (Test Exec)

Executes the selected item.

If an Error Occurs during a Self-Test

If an error occurs even after you carry out the following procedure, contact your nearest YOKOGAWA dealer.

- Execute the self-test again several times.
- Confirm whether or not the media being tested is properly inserted.

Overview (Overview)

You can display the following information about the instrument. The instrument numbers of the DL350 and the following modules are also displayed.

720211, 720221, 720241, 720242, 720245, 720243, 720254, 720250, 720266, 720268, 720281

The instrument numbers of other modules are not displayed.

- Model
- Serial No: Instrument number
- Slot: Models and Instrument numbers of the inserted modules
- Options
- Default Language
- Firm Version
- FPGA1/2 Version

- 701261, 701262, 701265, 720221, 720240, 720241, and 720266 have a CPU and firmware in the module. For slots that have these modules installed in them, the version number of the firmware installed on the module is also displayed.

  For the 701261, 701262, 701265, 720266

  Example: 701265 A.AA

  A.AA is the version of the firmware installed on the module.

  For the 720221, 720240, and 720241

  Example: 720221 B.BB/C.CC

  B.BB is the version of the firmware installed on the module. C.CC is the version of the firmware on the instrument that can be installed on the 720221. If the two above versions are the same, only one version number will be displayed.
- For the 720281, 720242, 720245, and 720243, the module version is displayed.

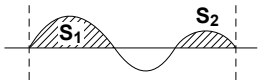
  Example: 720281 0xAA

Appendix

Appendix 1 How to Calculate the Area of a Waveform

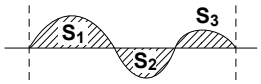
Integ1TY

Sum of only the positive curve areas : $S_1 + S_2$



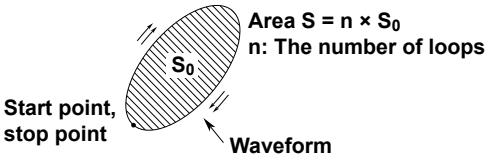
Integ2TY

Sum of the positive and negative curve areas: $S_1 + S_3 – S_2$

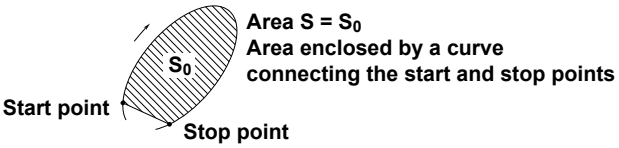


Integ1XY

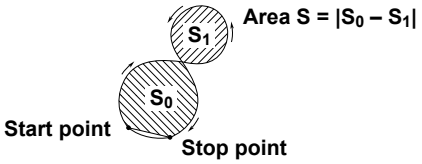
(1) Multiple Loops



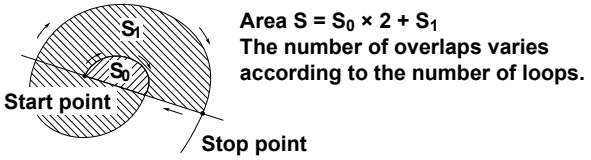
(2) Non-Closed Curve



(3) Loop Tracing a Figure-Eight

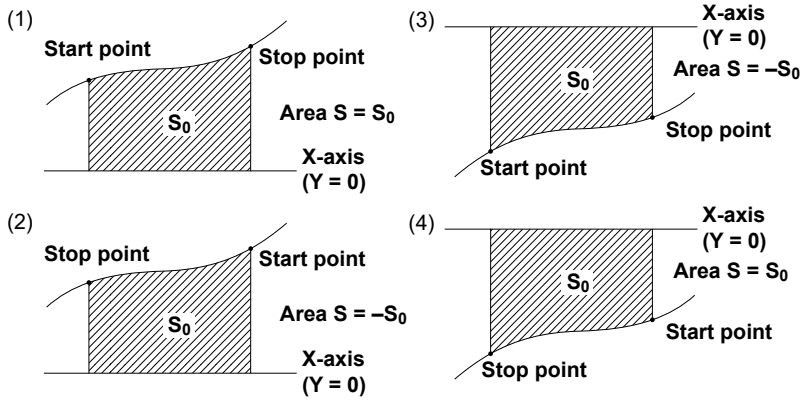


(4) Loop Tracing a Spiral

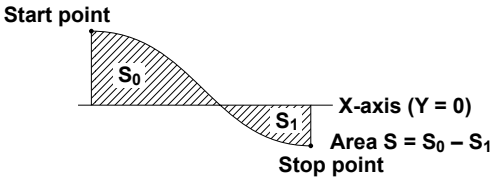


Integ2XY

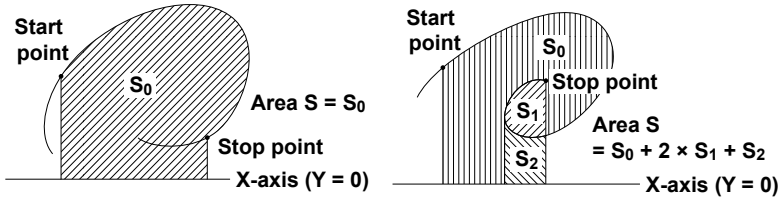
(1) When Each Y Data Point Corresponds to a Single X Data Point



(2) When the Waveform Extends into the Negative Side



(3) When Multiple Y Data Corresponds to One Point of X Data



Appendix 2 About the FFT Function

FFT Function

Each frequency component G of a linear spectrum is represented by G=R + jI, where R is the real part and I is the imaginary part.

Linear Spectrum

The linear spectrum can be directly determined with the FFT. Through this spectrum, the magnitude and phase of each frequency component included in the measured waveform can be found. The power spectrum and the like can also be determined from one or two linear spectra.
Because the FFT is a complex function, the linear spectrum produces the real part and imaginary part of the frequency components. The magnitude and phase of the linear spectrum can also be determined from this result.
This instrument can determine the following spectra.

Item	Expression	Computation
Real part	LS-REAL	R
Imaginary part	LS-IMAG	I
Bandwidth	LS-MAG	$\sqrt{(R^2 + I^2)}$
Log magnitude	LS-LOGMAG	$20 \times \log \sqrt{(R^2 + I^2)}$
Phase	LS-PHASE	$\tan^{-1}(I/R)$

Log magnitude reference (0 dB): 1 Vpeak

RMS Spectrum

The RMS spectrum expresses the amplitudes of the linear spectrum with RMS values. It does not contain phase information.
This instrument can determine the following spectra.

Item	Expression	Computation
Bandwidth	RS-MAG	$\sqrt{(R^2 + I^2)/2}$
Log magnitude	RS-LOGMAG	$20 \times \log \sqrt{(R^2 + I^2)/2}$

Log magnitude reference (0 dB): 1 Vrms

Power Spectrum

The power spectrum expresses the power (squared value) of each frequency component included in the measured signal. It is determined by taking the product of the linear spectrum and its complex conjugate. It does not contain phase information.
This instrument can determine the following spectra.

Item	Expression	Computation
Bandwidth	PS-MAG	DC component R^2+I^2
		AC component $(R^2+I^2)/2$
Log magnitude	PS-LOGMAG	DC component $10 \times \log(R^2+I^2)$
		AC component $10 \times \log\{(R^2+I^2)/2\}$

Log magnitude reference (0 dB): 1 $Vrms^2$

Power Spectrum Density

The power spectrum density expresses the power spectrum per unit frequency. It is determined by dividing the power spectrum by the frequency resolution Δf found during the computation of the power spectrum. The computation varies depending on the window function.
Power spectrum density is used to compare power spectra computed at different frequency bands. However, it is not necessary for signals having a line spectrum such as sine waves.
This instrument can determine the following spectra.

Item	Expression	Computation
Bandwidth	PSD-MAG	PS-MAG/(Δf × k)
Log magnitude	PSD-LOGMAG	10 × log PS-MAG/(Δf × k)

Log magnitude reference (0 dB): 1 $Vrms^2$

Overall Value

The overall value is the total RMS value determined from the frequency spectrum included in the signal. The overall value is the square root of the summation of the power spectrums of all frequencies.

$$\text{Overall value} = \sqrt{\frac{2\times PS_0 + \Sigma\, PS_i}{k}} \quad \text{(Vrms)}$$

"Rms = overall value" appears on the screen when automated measurement of waveform parameters is being performed (Measure is set to ON) on the channel that has been selected for power spectrum computation (PS or PSD) and Rms is set to ON.

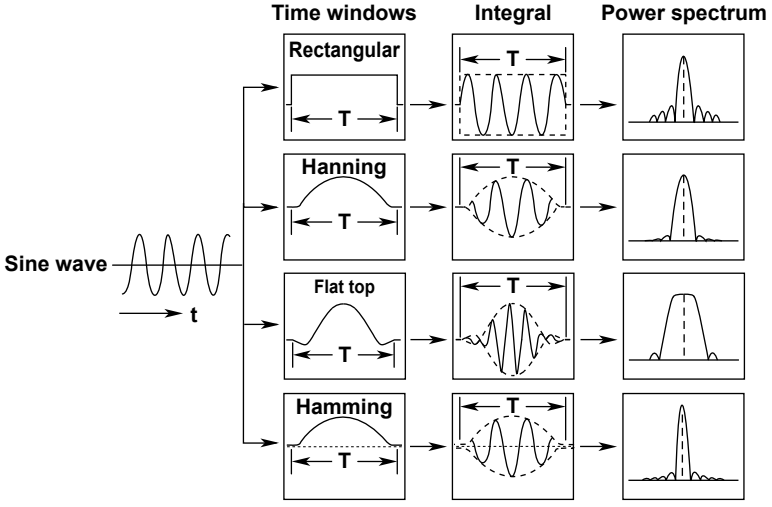
k

k varies as indicated below depending on the selected time window.

Time Window Type	k
Rect (Rectangular window)	1
Hanning (Hanning window)	1.5
FlatTop (Flattop window)	3.19693
Hamming (Hamming window)	1.3628

Time Windows

You can use a rectangular, Hanning, flattop, Hamming, or exponential time window.
The rectangular window is best suited to transient signals, such as impulse waves, which attenuate completely within the time window.
The Hanning, flattop, and Hamming windows allow continuity of the signal by gradually attenuating the parts of the signal located near the ends of the time window down to the 0 level. Hence, they are suited to continuous signals. The Hanning window provides a relatively higher frequency resolution compared to the flattop window. However, the flattop window has a higher level of accuracy. The Hamming window is a corrected Hanning window. The frequency resolution of its main beam is greater than that of the Hanning window. The Hamming window is suited for dividing close signals.
When the waveform being computed is a continuous signal, consider the above characteristics in selecting the proper window to be applied.



Rectangular : $W(t) = u(t) - u(t - T)$ u(t): **Step function**

Hanning : $W(t) = 0.5 - 0.5\cos(2\pi\frac{t}{T})$

Flat top : $W(t) = \{0.54 - 0.46\cos(2\pi\frac{t}{T})\}\frac{\sin\{2\pi(1 - 2t/T)\}}{2\pi(1 - 2t/T)}$

Hamming : $W(t) = 0.54 - 0.46\cos(2\pi\frac{t}{T})$

Notes When Executing the FFT Computation

Computation is normally performed on the sampled data in the acquisition memory. However, for waveforms that have been acquired in envelope mode, computation is performed on the maximum and minimum values per acquisition interval.

Appendix 3 Fundamental Equations for Defining Strain

Definition of Strain

ΔL/L = ε .....(1)

ε: Strain
L: Initial length of the material
ΔL: Amount of change due to external strain

Definition of the Gauge Factor

Gauge factor (K) refers to the ratio between the mechanical strain and the change in the resistance of the strain gauge resistor.

$$\varepsilon = \frac{\Delta L}{L} = \frac{\Delta R/R}{K} \quad \text{.....(2)}$$

$$(\Delta R/R) = K \times \varepsilon \quad \text{.....(3)}$$

R: Gauge resistance
ΔR: Amount of change in resistance when strain is applied

Normally, K = 2.0. However, the value varies depending on the strain gauge material.

General Equation for the Measured Voltage (V) and Strain (ε) of a Wheatstone Bridge (1 Gauge Method)

If we assume V to be the voltage measured on the bridge and E to be the voltage applied to the bridge,
V = (1/4) × E × (ΔR/R) .....(4)

From equation (3),
(ΔR/R) = K × ε

Thus, V = (1/4) × E × K × ε .....(5)

When Determining the Strain (e) from the Measured Voltage (V) (Using a Strain Gauge and the 1 Gauge Method)

If we derive e from equation (5)
ε = (4/K) × (V/E) .....(6)

When Determining the Measured Value of the Strain Gauge Sensor (e) from the Voltage Measured on the Bridge (V) (Strain Gauge Sensor)

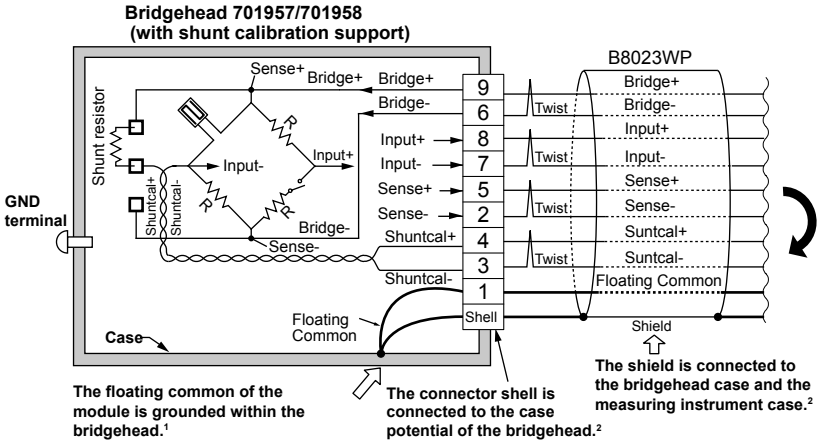
Assuming e to be the measured value (measured value of the strain gauge sensor: mV/V unit) and substituting ε = e in equation (6),
e = (4/K) × (V/E) .....(7)

In the case of a strain gauge sensor, set the gauge factor (K) to 2 on the instrument. If you change the value of K, the values are converted through the use of the above equation.

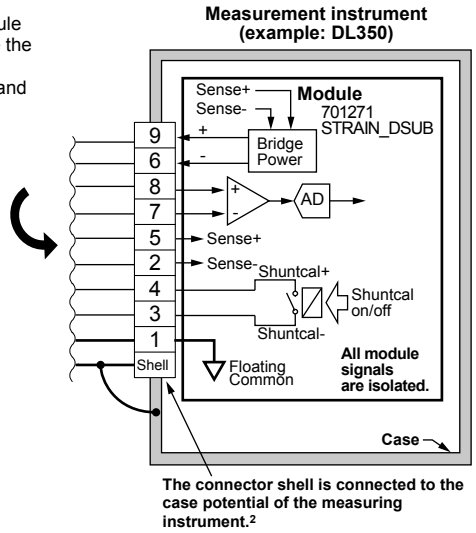
Appendix 4 About Shunt Calibration

Shunt calibration is a type of scaling in which the strain measurement gain is adjusted through the connection in parallel of a known resistance (the resistance for shunt calibration, hereinafter referred to as the shunt resistance) to the strain gauge. The strain module (701271 (STRAIN_DSUB)) supports shunt calibration with a built-in shunt-calibration relay circuit.

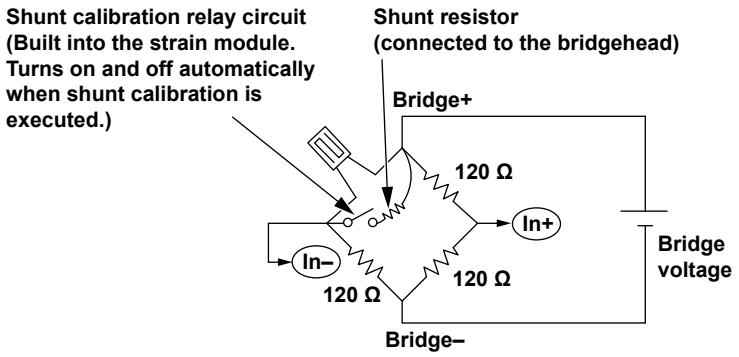
To perform shunt calibration, you need a bridgehead that supports shunt calibration (the 701957 or 701958).



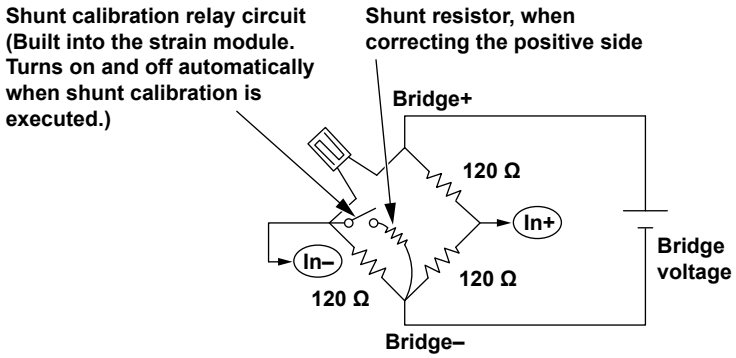
1 The GND (floating common) of the module is connected to the case potential inside the bridge box.
2 The bridgehead case, the cable shield, and the measuring instrument case are connected as measures against noise.



- **When correcting the gain on the negative side (normal)**



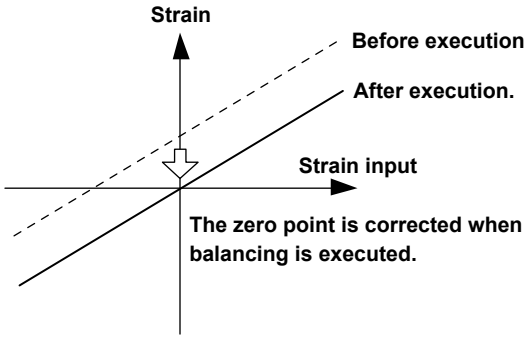
• **When correcting the gain on the positive side**



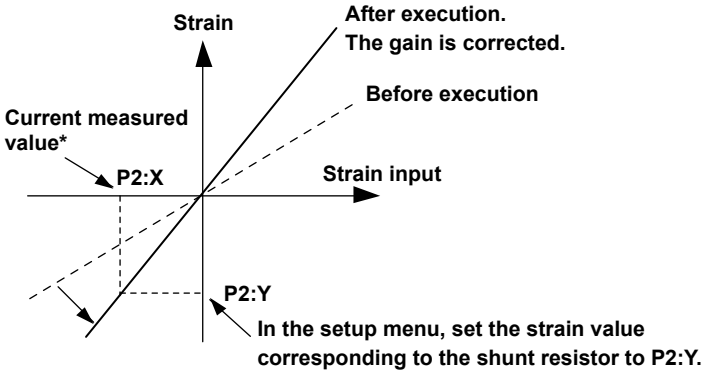
Shunt Calibration Procedure

1. Calculate the strain value (μSTR) that corresponds to the shunt resistor you will use. For the calculation procedure, see “Calculating the Shunt Resistance” in the next section.
2. Execute balancing without applying a load to the strain gauge, and correct the zero point.
3. Execute shunt calibration, and correct the gain.
   To execute shunt calibration, in the CH menu, select Linear Scale, Mode, and then Shunt. Usually, the negative gain is corrected. However, if you are correcting the positive gain, change the position of the shunt resistor as shown in the above figure.

• **Balance**



• **Shunt calibration**



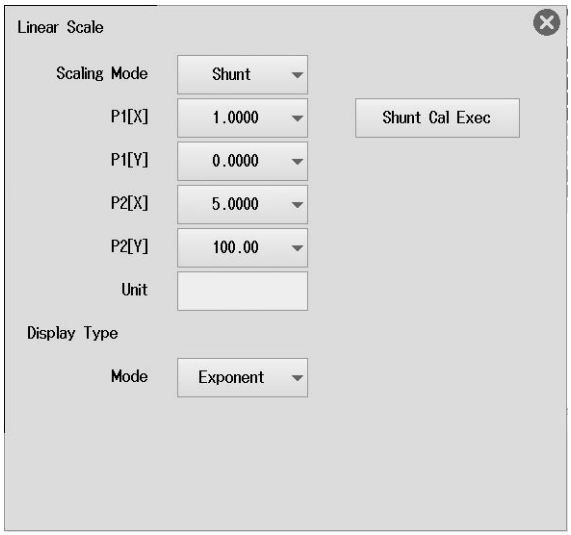
*** Obtained automatically when shunt calibration is performed**

Shunt Calibration Execution Menu

The shunt calibration execution menu appears when from the Channel menu, you select CH1 to 4 > Detail tab > Linear Scale > Scaling Mode > Shunt. In normal shunt calibration, only P2:Y is set. On the instrument, in addition to performing normal shunt calibration (when the shunt-calibration relay circuit is on), you can also set the zero-point value when the relay circuit is off. The zero-point value is valid when the strain value after balancing is performed is not 0.

Items in the Execution Menu

(1) P1[X]: When shunt calibration is executed, the input value when the relay circuit is off is applied.
(2) P1[Y]: Set the value for when the relay circuit is off (normally 0).
(3) P2[X]: When shunt calibration is executed, the input value when the relay circuit is on is applied.
(4) P2[Y]: Set the strain value that corresponds to the shunt resistance when the relay circuit is on.



- When you execute shunt calibration, select an appropriate range so that the measured values will stay within the range when the shunt-calibration relay circuit is on. The instrument attempts to perform shunt calibration within the current range.
- An error message will appear if shunt calibration fails (because of out-of-range values or some other reason). When this happens, change the range, and perform shunt calibration again.
- Do not connect and disconnect multiple USB devices repetitively. Provide a 10-second interval between removal and connection.

Reducing Noise

Because measurements are made at the mV level, the strain gauge is extremely susceptible to noise. If the execution of balancing or shunt calibration fails, it may be due to noise. Please take the following points into consideration.

- Because the strain gauge is attached away from the bridgehead, we recommend that you use twisted wire for extensions.
- Use a bridgehead with high noise resistance. We recommended that you use a YOKOGAWA bridgehead (701957 or 701958); they are highly resistant to noise.

Calculation of the Shunt Resistance

To execute shunt calibration, you need to calculate the shunt resistance (Rs) and the expected strain (ε) in advance. For "P2-Y," use ε as given in the equation below (normally a negative value).
In the general method given for shunt calibration (the easy method), an error of 1 to 2% is introduced as the strain value (ε) increases. Therefore, use the detailed method whenever possible.

Equation for Rs and ε When Shunt Calibration Is Executed

General Equation (Easy method)

$\Delta R/R = K \times \varepsilon$ .....(1): Fundamental strain equation

$\Delta R = R - R//Rs^{*}$ .....(2): Equation for the change in resistance when the shunt resistance is on

* In this manual, the equation for parallel resistances is expressed as follows:

$$R//Rs = \frac{1}{\frac{1}{R} + \frac{1}{Rs}} = \frac{R \times Rs}{R + Rs}$$

If ΔR from (1) and (2) is canceled out,

$$Rs = R \times (1 - K \times \varepsilon)/(K \times \varepsilon)$$

Equation A: General equation for calculating the shunt resistance (includes error)

- ε : **Strain (strain value that you want to be generated when the shunt resistance is turned on)**
- **K: Gauge factor**
- **R: Bridge resistance**
- **ΔR: Resistance change**
- **Rs: Shunt resistance (shunt resistance you want to derive)**

Detailed Equation

$$V_0 = E \times (R_1 \times R_3 - R_2 \times R_4)/\{(R_1 + R_2) \times (R_3 + R_4)\}$$

.....(1) Basic equation for a Wheatstone bridge

When shunt calibration is on,

$$V_0 = E \times (R_1 \times R_3 - R' \times R_4)/\{(R_1 + R') \times (R_3 + R_4)\}$$

.....(2): Equation when shunt calibration is on

$R' = R_2//Rs$ **.....(3): Equation for combined resistance R'**

$R_1 = R_2 = R_3 = R_4 = R$ **....(4): Since R_1 to R_4 are equal, they are represented as R.**

Also, from the basic equation of strain,

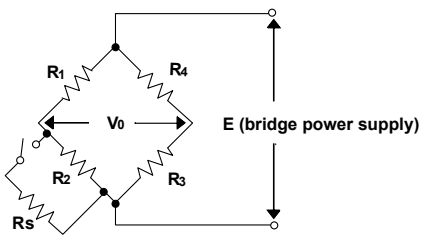
$V_0/E = K \times \varepsilon/4$ **.....(5): Basic equation of strain**

If V_0/E and R_1 to R_4 from (2), (3), (4), and (5) are canceled out,

$$Rs = R \times (1 - K \times \varepsilon/2)/(K \times \varepsilon)$$

Equation B: Detailed equation for calculating the shunt resistance (no error)

- **E: Bridge voltage**
- **V_0: Bridge output voltage**
- **R_1 to R_4: Bridge resistance (where $R_1 = R_2 = R_3 = R_4$)**
- **Rs: Shunt resistance (shunt resistance you want to derive)**
- **R': Combined resistance when the relay is turned on (R' = R//Rs)**



Calculation Example

When Determining the Shunt Resistance (Rs) from the Strain (ε)

Given a gauge factor (K) of 2,

Detailed equation (equation B) $Rs = R \times (1-\varepsilon)/(2 \times \varepsilon)$ .....(6)

General equation (equation A) $Rs = R \times (1-2 \times \varepsilon)/(2 \times \varepsilon)$ .....(7) Degree of error of 1 to 2%

Desired Strain ε (μSTR)	Rs Value (Ω) Derived from the Detailed Equation (6)		Rs Value (Ω) Derived from the General Equation (7)	
	R = 120 Ω	R = 350 Ω	R = 120 Ω	R = 350 Ω
1,000	59,940	174,825	59,880	174,650
2,000	29,940	87,325	29,880	87,150
5,000	11,940	34,825	11,880	34,650
10,000	5,940	17,325	5,880	17,150

When Determining the Strain (ε) from the Shunt Resistance (Rs)

If we derive ε from equations (6) and (7),

Detailed equation (equation B) $\varepsilon = 1/(1+2 \times Rs/R)$ .....(8)

General equation (equation A) $\varepsilon = 1/\{2 \times (1+Rs/R)\}$ .....(9) Degree of error of 1 to 2%

• When the Bridge Resistance R is 120 Ω

RS Value (Ω)	Strain ε (μSTR) Derived from the Detailed Equation (8)	Strain ε (μSTR) Derived from the General Equation (9)
60,000	999	998
30,000	1,996	1,992
12,000	4,975	4,950
6,000	9,901	9,804

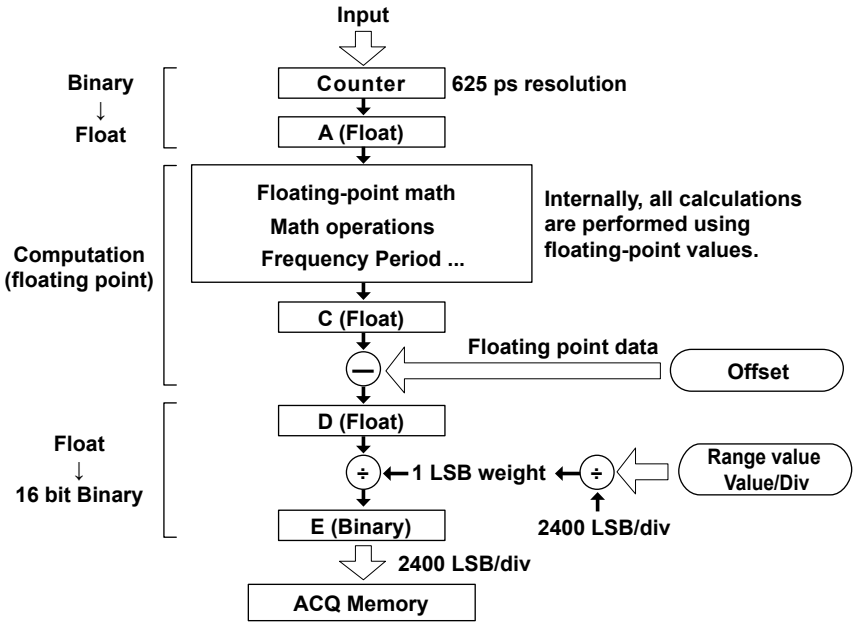
• When the Bridge Resistance R is 350 Ω

RS Value (Ω)	Strain ε (μSTR) Derived from the Detailed Equation (8)	Strain ε (μSTR) Derived from the General Equation (9)
180,000	971	970
90,000	1,941	1,937
36,000	4,838	4,814
18,000	9,629	9,537

Appendix 5 Frequency Module's Math Expression and Smoothing Filter's Filter Response

Computation Format (Resolution) of the Frequency Module

The computation flow on the frequency module is indicated below.



The frequency module measures the period of the input signal at a resolution of 625 ps. Therefore, the minimum resolution is 625 ps.

Computations are performed in floating point format. The data that is output from the frequency module and written to the acquisition memory (ACQ Memory) is 16-bit binary data. The frequency module converts the data using a weight of 1 LSB that is determined by Value/div. The data is normalized to 2400 LSB/div when displayed on the screen.

Input: Conversion from Counter Values to Floating Point Values

The frequency module converts the count value that it obtains at 625 ps resolution to floating point format, and determines period A using the following equation.

Period: A (Float) = (Count value) × 625 ps

Computation

Various computations are performed in floating point format based on the settings.

Example: Frequency: C (float) = 1/A (float)

Calculation of the 1 LSB Weight of the Output

The 1 LSB weight of the output is determined from the range (value/div).

Because 1 div = 2400 LSB,

1 LSB weight of the output = (Value/div)/2400

Computation Output: Conversion from Floating Point Values to 16-bit Binary Values (When the Offset Is 0)

When the offset value is 0, offset calculation is not performed, and C (float) = D (float).

The data is converted into 16-bit binary data and written to the acquisition memory (ACQ Memory).

16-bit binary data: E (binary) = D (float) ÷ (1 LSB weight of the output)

Offset Computation

When the offset value is not 0, the frequency module computes the offset value in floating point format using the following equation and then converts the value to 16-bit binary data.

D (float) = C (float) − offset value (float)

In offset computation, if the computed result C (float) is equal to the offset value, the output is 0. If the computed result C (float) is less than the offset value, E (binary) is negative.

Filter Characteristics (Time Delay) of the Smoothing Filter

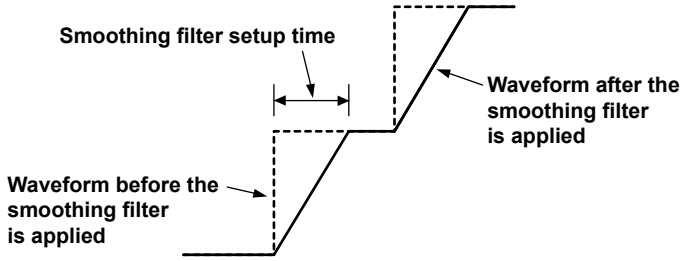
The smoothing filter is a moving average filter in which computation is performed in real time. The smoothing filter takes the simple average of the data whose data update rate is 1 µs (1 MHz) over 40 µs and performs moving average at 40 µs intervals. The computation interval of moving average is constant, independent of the instrument's sample rate. The data computed at 40 µs intervals is linearly interpolated to 1 µs data and transmitted.

The moving average order (the number of averaged points) is specified in terms of time. The maximum value is 25000 points (when the time is set to 1000 ms).

The characteristics of the smoothing filter are as follows:

- The filter is a low-pass filter.
- The pass band is flat.
- The filter has linear phase characteristics. The group delay is constant for a given filter order.
  The group delay can be derived through the following equation.
  Group delay = (the number of moving-averaged points − 1) × 40 µs/2
- The filter has comb-shaped bandwidth characteristics.

The figure below shows the result of applying the smoothing filter to a waveform that changes in steps. The smoothing filter setup time follows the step change.



Appendix 6 List of Preset Settings of the Frequency Module

Logic 5V

Setup Item	Value
V Range	±10 V
Coupling	DC
Probe	Yes[1]
Bandwidth	Yes[2]
Threshold	2.5 V
Hys	Yes[3]
Slope	Yes[4]
Chattering Suppression	Yes[5]
Pull Up	No

Logic 3V

Setup Item	Value
V Range	±5 V (Probe = 1:1) ±10 V (Probe = 10:1)
Coupling	DC
Probe	Yes[1]
Bandwidth	Yes[2]
Threshold	1.5 V
Hys	Yes[3]
Slope	Yes[4]
Chattering Suppression	Yes[5]
Pull Up	No

Logic 12V

Setup Item	Value
V Range	±20 V
Coupling	DC
Probe	Yes[1]
Bandwidth	Yes[2]
Threshold	6 V
Hys	Yes[3]
Slope	Yes[4]
Chattering Suppression	Yes[5]
Pull Up	No

Logic 24V

Setup Item	Value
V Range	±50 V
Coupling	DC
Probe	Yes[1]
Bandwidth	Yes[2]
Threshold	12 V
Hys	Yes[3]
Slope	Yes[4]
Chattering Suppression	Yes[5]
Pull Up	No

Pull-up 5 V

Setup Item	Value
V Range	±10 V
Coupling	DC
Probe	1: 1
Bandwidth	Yes[2]
Threshold	2.5 V
Hys	Yes[3]
Slope	Yes[4]
Chattering Suppression	Yes[5]
Pull Up	Yes[6]

ZeroCross

Setup Item	Value
V Range	Yes[7]
Coupling	AC
Probe	Yes[1]
Bandwidth	Yes[2]
Threshold	0 V
Hys	Yes[3]
Slope	Rising
Chattering Suppression	Yes[5]
Pull Up	No

100 VAC

Setup Item	Value
V Range	±200 V
Coupling	AC
Probe	10:1
Bandwidth	Yes[2] (Full cannot be selected)
Threshold	0 V
Hys	Yes[3]
Slope	Rising
Chattering Suppression	Yes[5]
Pull Up	No

200 VAC

Setup Item	Value
V Range	±500 V
Coupling	AC
Probe	10:1
Bandwidth	Yes[2] (Full cannot be selected)
Threshold	0 V
Hys	Yes[3]
Slope	Rising
Chattering Suppression	Yes[5]
Pull Up	No

EM Pickup

Setup Item	Value
V Range	±1 V
Coupling	DC
Probe	1:1
Bandwidth	Yes[2]
Threshold	0 V
Hys	Yes[3]
Slope	Rising
Chattering Suppression	Yes[5]
Pull Up	No

User

Setup Item	Value
V Range	Yes[7]
Coupling	Yes[8]
Probe	Yes[1]
Bandwidth	Yes[2]
Threshold	Yes[9]
Hys	Yes[3]
Slope	Yes[4]
Chattering Suppression	Yes[5]
Pull Up	No

When you select a preset, the setup items are automatically set to the values in the table. The meaning of Yes and No in the table is as follows:
Yes: The setting can be configured.
No: The setting cannot be configured (it does not appear on the menu).

1 Set the probe type to 1:1 or 10:1.
2 Set the bandwidth limit to 100 Hz, 1 kHz, 10 kHz, 100 kHz, or Full. You cannot select full for AC100V or AC200V.
3 Set the hysteresis to ±1%, ±2.5%, or ±5%.
4 Set the slope to rising or falling.
5 Set the chattering elimination value to a value from 0 ms to 1000 ms.
6 Enable or disable the pull-up. This setting is available only for Pull-up 5V. 7 Voltage ranges:
7 Voltage ranges:
When probe = 1:1, select ±1 V, ±2 V, ±5 V, ±10 V, ±20 V, or ±50 V.
When probe = 10:1, select ±10 V, ±20 V, ±50 V, ±100 V, ±200 V, or ±500 V.
8 Set the coupling to DC or AC.
9 Set the threshold level to a value within the specified voltage range.

Appendix 7 TCP and UDP Port Numbers

The TCP and UDP port numbers that are used on the Ethernet interface of the instrument are listed below.

TCP Port Numbers

Port Number	Description	Used For
20	File Transfer [Default Data]	FTP client,* and a portion of the Web server
21	File Transfer [Control]	FTP client,* and a portion of the Web server
25	Simple Mail Transfer Protocol	SMTP client
80	World Wide Web HTT	Web server and WebDAV server
515	–	LPR client
111 1024 1025 10002 (send)	–	Instrument control through the Ethernet interface

UDP Port Numbers

Port Number	Description	Used For
67	Bootstrap Protocol Server	DHCP client
68	Bootstrap Protocol Client	(listen port)
123	Network Time Protocol	SNTP client

* The port number when FTP passive mode is disabled. When FTP passive mode is enabled, you can set any port number. When FTP passive mode is disabled, connections are established from the server. If you are connecting the instrument from behind a firewall, enable FTP passive mode.

Appendix 8 Firmware Version and New Features

This manual covers DL350 firmware versions 1.35 and later. The following table contains new features that are available for each firmware version. If you are using an older version, you will not be able to use all the features described in this manual. To view the firmware version, press Utility and then the Overview, and check Firm Version on the Overview screen that is displayed.

Version	Suffix Code	New Features
1.10	Standard	A timeout function was added to the duty cycle measurement of the FV setting on the frequency module (720281).
		A fast channel multiplexing function was added to the SENT monitor module (720243).
		A screen for setting all position information entries at once and a setting that is used to turn on or off each position information entry were added.
		The maximum number of characters of the common name when the auto naming function is set to sequence number was changed to 32.
		Brother RJ-4030 was added as a supported printer.
		A function that displays on the zoom display one period of the waveform selected in the result display list of cycle statistics was added.
		A function that displays the history waveform selected in the result display list of history statistics was added.
		Measurement items were added to the XY cursor.
		An additional option license function was added.
1.20	Standard	CAN/CAN FD monitor module (720242) was added.
		A channel copy function was added to All Sub Channel Settings of the 16-CH voltage input module (720220) and 16-CH temperature/ voltage input module (720221).
1.30	Standard	Probe (probe's attenuation ratio and current-to-voltage conversion ratio) settings were added.
		START/STOP, Save Execute, and Manual Trigger were added to MENU (the top menu).
		START/STOP, Save Execute, and Manual Trigger were added to the custom menu.
		The instrument's Web server feature was expanded.
1.35	Standard	Saving harmonic analysis results and FFT computation results added to action modes
		Peak List added to the FFT cursor measurement types
	/VE	CAN FD/LIN Monitor Module (720245)
		High Speed 12 bit SENT signals

Appendix 9 Using Data Files (WDF Files)

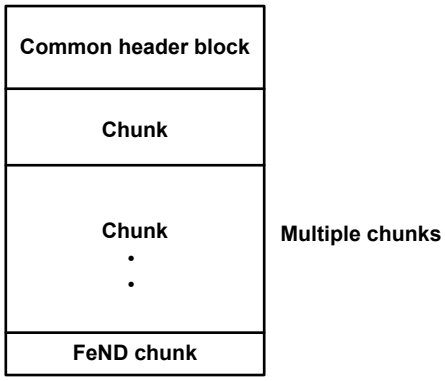
- To use the data in binary data files generated by the instrument on a PC, use the “WDF File Access Library” provided by YOKOGAWA.
- To convert data into YOKOGAWA’s legacy file format (*.WVF + *.HDR), use the “Binary Data File Converter” provided by YOKOGAWA.
- To view the data in WDF files without using the “WDF File Access Library,” refer to the following information.

The information does not apply to files created using SD recording or free-run recording on this instrument. To use the data in these types of files, use the “WDF File Access Library” provided by YOKOGAWA.

Information for Viewing Data in WDF Files

WDF File Structure

A WDF file is made up of a common header block and blocks of data organized by type, which are referred to as *chunks*. Chunks are analogous to boxes that data is placed in. Multiple chunks are strung together to form a single WDF file. A special chunk called “FeND chunk” that contains no data always appears at the end of a file (except for waveform files divided into multiple files).



Common Header Block

The main role of the common header block is to indicate that the file is a WDF waveform file. An identifier is contained in the first four bytes. The next four bytes indicate the size of the common header. The rest of the common header block is undisclosed.

Offset	Type	Identifier	byte	Description
0x0000	CHR	FileID	4	“%WDF”
0x0004	UINT	Length	4	Common header size
0x000C	-	Data	-	Undisclosed

Chunk

Chunks are structured like boxes that hold data. A chunk consists of a unique name (four characters long), data size, data, and end marker.
The data size indicates the size of the stored raw data; it does not include the size of the chunk name, the value field (which indicates the data size) or the end marker. The total chunk size is raw data + 16 bytes. To use the information in a WDF file, there is no need to read the raw data in every chunk; the chunks in the file can be scanned or skipped until the appropriate one is found.

Offset	Type	Identifier	byte	Description
0x0000	CHR	ChunkType	4	Chunk name string
0x0004	UINT64	Length	8	Data size in chunk
0x000C	-	Data	-	Raw data (data size in length)
	UINT	EndMark	4	0xffffffff or the data's CRC32 value

Waveform Analysis Information Chunk

Analysis information are stored in XHDR chunks.
An analysis information chunk starts with a 4-byte "XHDR" identifier and ends with a 4-byte 0xFFFFFFFF end mark. The eight bytes immediately after the "XHDR" identifier contains the data size (in bytes) of the analysis information chunk.
The content of the data is text information (described later), which closely resembles the information in YOKOGAWA's legacy WVF and HDR files.

Offset	Type	Identifier	byte	Description
0x0000	CHR	ChunkType	4	Chunk type "XHDR" or "DHDR"
0x0004	UINT64	Length	8	Data size
0x000C	-	Data	-	Analysis information (text information)
	UINT	EndMark	4	0xffffffff or the data's CRC32 value

Analysis Information Overview

Analysis information data is big endian.

The data in analysis information chunks is text. The line feed code is "0x0A."

Analysis Information Example

The following example shows the waveform file analysis information containing four channels and five history entries.

```
//YOKOGAWA ASCII FILE FORMAT

$PublicInfo
FormatVersion       1.00
Model               DL850
Endian              Big
DataFormat          Trace
GroupNumber         1
TraceTotalNumber    4
DataOffset          103000
$Group1TraceNumber  4
BlockNumber         5
TraceName           CH1                 CH2                 CH3                 CH4
BlockSize           10001               10001               10001               10001
VResolution         4.1666667E-04       2.0833333E-02       2.0833333E-02       2.0833333E-02
VOffset             0.0000000E+00       0.0000000E+00       0.0000000E+00       0.0000000E+00
VDataType           IS2                 IS2                 IS2                 IS2
VUnit               V                   V                   V                   V
VPlusOverData       ?                   ?                   ?                   ?
VMinusOverData      ?                   ?                   ?                   ?
VIllegalData        -32768              -32768              -32768              -32768
VMaxData            32767               32767               32767               32767
VMinData            -32767              -32767              -32767              -32767
HResolution         5.0000000E-05       5.0000000E-05       5.0000000E-05       5.0000000E-05
HOffset             -2.5000000E-01      -2.5000000E-01      -2.5000000E-01      -2.5000000E-01
HUnit               s                   s                   s                   s
Date                2017/03/30          2017/03/30          2017/03/30          2017/03/30
Time                08:50:42.14396930   08:50:42.14396930   08:50:42.14396930   08:50:42.14396930

$PrivateInfo
DisplayPointNo.     0
ModelVersion        0.71
StartOffset1        0     0     0     0
StartOffset2        0     0     0     0
StartOffset3        0     0     0     0
StartOffset4        0     0     0     0
StartOffset5        0     0     0     0
TrigTime1           2017/03/30 08:50:42.14396930
TrigTime2           2017/03/30 08:50:42.74396930
TrigTime3           2017/03/30 08:50:43.34396930
TrigTime4           2017/03/30 08:50:43.94396930
TrigTime5           2017/03/30 08:50:44.54396930
ModuleName          701275 720250
DataEnd
```

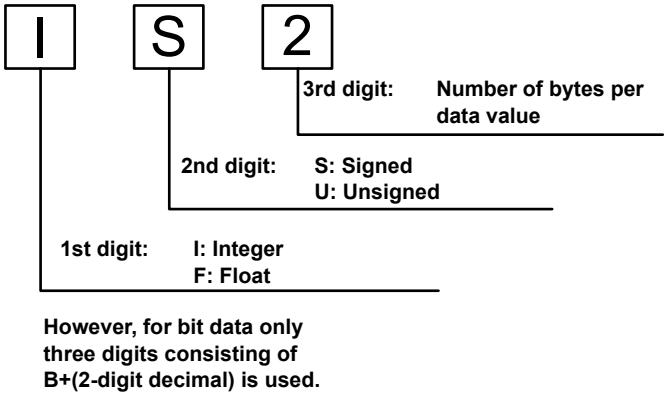
Description of Parameters in Analysis Information

//YOKOGAWA ASCII FILE FORMAT	A line that starts with "//" is a comment line.
$PublicInfo	A label that indicates common information. A label always starts with a dollar ($) mark The character code of the dollar mark is 0x24.
FormatVersion	Version number of this piece of analysis information
Model	Model of the measuring instrument that generated the file
Endian	Big or Little. All files generated by the instrument are big endian.
Trace	Internal structure of the waveform data Trace or Block. All files generated by the instrument are Trace.
GroupNumber	Total number of groups in the analysis information
TraceTotalNumber	Number of traces that this data file contains
DataOffset	How many bytes into the file where binary data begins
$Group	A label indicating the beginning of group information
TraceNumber	Number of traces in the relevant group
BlockNumber	Number of history entries
TraceName	Trace label of each trace
BlockSize	Number of data points in the block corresponding to the trace name
VResolution	Y-axis conversion coefficient of each trace
VOffset	Y-axis conversion offset of each trace The Y-axis value (vertical value) can be determined using the following conversion formula. Y-axis value = VResolution × binary data + VOffset
VDataType	Data type of each trace (details provided separately)
VUnit	Y-axis unit
VPlusOverData, VMinusOverData	(Reserved)
VIllegalData	Indicates illegal data when an illegal calculation is performed (such as dividing by 0) or hidden code for preventing the data from being displayed on the screen
VMaxData, VMinData	Maximum and minimum values that data may take on in this block of each trace
HResolution, HOffset	Coefficient and offset of time-axis conversion of each trace Time-axis value = HResolution × (data number – 1) + HOffset
HUnit	Time-axis unit
Date	Date of the first (oldest) history number
Time	Time of the first (oldest) history number
$PrivateInfo	
DisplayPointNo.	How many points into the waveform data where measurement start point begins
ModelVersion	Firmware version number
StartOffset1	Number of phase difference points per trace (history number at the end)
TrigTime1	Time reference time for each history entry (trigger time) (history number at the end)
ModuleName	Model of the installed module
UpperScale	Upper limit of the display scale of each trace
LowerScale	Lower limit of the display scale of each trace
DataEnd	End of information

Data Type Expression (VDataType)

Type of waveform data stored in a file is indicated by the VDataType field

VDataType is a 3-character text string. The definition of each character is provided below.



The data types are shown below.

Module/Data Type	Bit Count	Value Type	VDataType
2-CH and 4-CH modules, SCAN, temperature SCAN, Math	–		IS2
LOGIC	–		B16
CAN, CAN/CAN FD, CAN/LIN	2 to16	Unsigned	IU2
	2 to16	Signed	IS2
	17 to 32	Unsigned	IU4
	17 to 32	Signed	IS4
	–	Float	IS2
	1 to 8	Logic	B16
SENT	1 to 16	Unsigned	IU2
	1 to 16	Signed	IS2

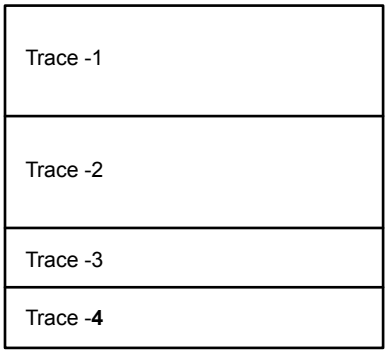
Bit data is stored in 16 bits. The bits are arranged in order from the least significant bit (bit 1 to bit 8), and the highest 8 bits are not used.

Waveform Data

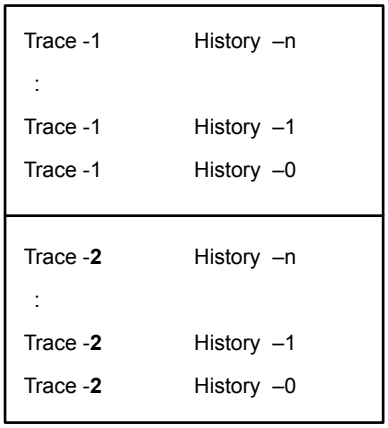
Waveform data begins DataOffset bytes into the file.[1]
Data is arranged in order by trace. The number of data points is indicated by BlockSize of each trace in the waveform analysis information. The data size of each point is indicated by VDataType.
Due to different sampling rates on the measurement module, the number of data points may vary for each trace.

For waveform data saved using the “history all” feature, the data of all history entries is stored for each trace. The history entries are arranged in order from the oldest to the most recent. The number of stored history entries can be verified by BlockNumber in the waveform analysis information.

Data example saved for one history entry



Data example saved using “history all”



1 “DrAW” chunks hold waveform data. A “DrAW” chunk contains “the data size in chunk” followed by the file data size (4 bytes) and file number (4 bytes). DataOffset points to the head of the raw data, which comes after these pieces of data.

StartOffset

Sub channel data may not begin from the first point of the main channel data.
In such a case, it begins after the “start offset” of the main channel data.
Normally, this information does not need to be considered.

Label	Item	Description	Number of Parameters	Notes	Data Example
$PublicInfo		A label indicating the beginning of common information	0		
	Format Version	File format version number	1		1.00
	Model	Measuring instrument model			DL350
	Endian	Waveform data endianness			Big
	Data Format	Waveform data save format (Trace or Block)		Fixed to Trace	Trace
	Group Number	Number of trace groups			2
	TraceTotal Number	Number of traces			8
	Data Offset	Offset in waveform data file			682874
$Group		Label indicating the beginning of a group (a number from 1 to GroupNumber is attached to the end)	0		
	Trace Number	Number of traces in the group	1		4
	Block Number	Number of history entries			5
	Trace Name	Trace name (label)	Trace Number (1 to 4)	Spaces are converted to underscores.	CH1
	BlockSize	Number of data points			10010
	V Resolution	Y-axis conversion coefficient (VResolution × raw data value + VOffset)			8.3333333E-04
	VOffset	Y-axis offset			0.0000000E+00
	VData Type	Binary data type (integer or real number, signed or unsigned, number of bytes per data)			IS2
	VUnit	Y-axis unit			V
	VPlusOver Data	Upper limit of normal data		Fixed to “?” for reserve	?
	VMinus Over Data	Lower limit of normal data		Fixed to “?” for reserve	?
	VIllegal Data	Hidden code value		“?” for modules that do not have a hidden code	-32768
	VMaxData	Maximum data value		Maximum value that the data type can take on	32767
	VMinData	Minimum data value		Minimum value that the data type can take on	-32767
	H Resolution	X-axis conversion coefficient (X-axis value = HResolution × (data number – 1) + HOffset)			1.0000000E-06
	HOffset	X-axis offset			-5.0000000E03
	HUnit	X-axis unit			s
	Date	Time reference date		Only the first history entry when there are multiple entries. 8 decimal places for seconds for Time (nsec)	2013/08/18
	Time	Time reference time			14:23:30. 01234567

Label	Item	Description	Number of Parameters	Notes	Data Example
$PrivateInfo		Label indicating the beginning of model-specific information	0		
	Display Point No.	How many points into the waveform data where measurement start point begins	TraceTotal Number	For WVF compatibility	1
	Model Version	Firmware version number	1		3.01
	Start Offset1	Number of phase difference points per trace (history number at the end)	TraceTotal Number	Output as many times as there are history entries	0 0 13
	Trig Time1	Time reference time for each history entry (trigger time) (history number at the end)	1	Output as many times as there are history entries	2013/08/18 14:23:30. 01234567
	ModuleName	Model of the installed module	2		720250 720254
	UpperScale	Upper limit of the display scale of each trace	TraceTotal Number		2.5000E+02
	LowerScale	Lower limit of the display scale of each trace	TraceTotal Number		-2.5000E+02
	DataEnd	End of information	0		

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Numerics

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DL350
ScopeCorder
USER'S MANUAL

YOKOGAWA
Yokogawa Test & Measurement Corporation

IM DL350-02EN
6th Edition

Thank you for purchasing the DL350 ScopeCorder. This User's Manual explains how to use the DL350. To ensure correct use, please read this manual thoroughly before operation.
After reading this manual, keep it in a safe place.

List of Manuals

The following manuals, including this one, are provided as manuals for the DL350. Please read all manuals.

Manuals Included with the Product

Manual Title	Manual No.	Description
DL350 ScopeCorder Getting Started Guide	IM DL350-03EN	This guide explains the handling precautions, common operations, troubleshooting measures, and specifications of this instrument.
DL350 ScopeCorder Request to Download Manuals	IM DL350-73Z2	Describes the manuals provided on the website.
Precautions Concerning the Modules	IM 701250-04E	The manual explains the precautions concerning the modules. This manual is included if you ordered modules.
Battery Pack Handling Precautions	IM 739883-01EN	This manual is included in models with the /EB option (battery pack + battery pack cover). It explains the handling precautions of the battery pack.
DL350 ScopeCorder	IM DL350-92Z1	Document for China
739883 Battery Pack	IM 739883-92Z1	Document for China This manual is included in models with the /EB option (battery pack + battery pack cover).
720923 Battery Pack Cover	IM 720923-92Z1	Document for China This manual is included in models with the /EB option (battery pack + battery pack cover).
Safety Instruction Manual	IM 00C01C01-01Z1	Safety manual (European languages)

Manuals Provided on the Website

Download the following manuals from the YOKOGAWA website.

Manual Title	Manual No.	Description
DL350 ScopeCorder Features Guide	IM DL350-01EN	This manual explains all the instrument's features other than the communication interface features.
DL350 ScopeCorder User's Manual	IM DL350-02EN	This manual. The manual explains how to operate this instrument.
DL350 ScopeCorder Communication Interface User's Manual	IM DL350-17EN	The manual explains the functions of this instrument's communication interface, how to configure it, and the commands used to control this instrument from a PC through the interface.

For details on downloading manuals, see Request to Download Manuals (IM DL350-73Z2). To view the PDF data, you need Adobe Acrobat Reader or a software application that can open PDF data.

The "EN", "E", "Z1", and "Z2" in the manual numbers are the language codes.

Contact information of Yokogawa offices worldwide is provided on the following sheet.

Document No.	Description
PIM 113-01Z2	List of worldwide contacts

6th Edition: April 2024 (YMI)

Notes

- The contents of this manual are subject to change without prior notice as a result of improvements to the product's performance and functionality. Refer to our website to view our latest manuals.
- The figures given in this manual may differ from those that actually appear on your screen.
- Every effort has been made in the preparation of this manual to ensure the accuracy of its contents. However, should you have any questions or find any errors, please contact your nearest YOKOGAWA dealer.
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- Other company and product names are trademarks or registered trademarks of their respective holders.

Revisions

- 1st Edition: July 2017
- 2nd Edition: December 2017
- 3rd Edition: April 2018
- 4th Edition: February 2022
- 5th Edition: January 2023
- 6th Edition: April 2024

Conventions Used in This Manual

Notes and Cautions

The notes and cautions in this manual are categorized using the following symbols.

Improper handling or use can lead to injury to the user or damage to the instrument. This symbol appears on the instrument to indicate that the user must refer to the user's manual for special instructions. The same symbol appears in the corresponding place in the user's manual to identify those instructions. In the manual, the symbol is used in conjunction with the word "WARNING" or "CAUTION."

WARNING Calls attention to actions or conditions that could cause serious or fatal injury to the user, and precautions that can be taken to prevent such occurrences.

CAUTION Calls attention to actions or conditions that could cause light injury to the user or damage to the instrument or user's data, and precautions that can be taken to prevent such occurrences.

French

AVERTISSEMENT Attire l'attention sur des gestes ou des conditions susceptibles de provoquer des blessures graves (voire mortelles), et sur les précautions de sécurité pouvant prévenir de tels accidents.

ATTENTION Attire l'attention sur des gestes ou des conditions susceptibles de provoquer des blessures légères ou d'endommager l'instrument ou les données de l'utilisateur, et sur les précautions de sécurité susceptibles de prévenir de tels accidents.

Note Calls attention to information that is important for the proper operation of the instrument.

Prefixes k and K

This manual distinguishes prefixes k and K used before units as follows:

k	Denotes 1000. Example: 100 kS/s (sample rate)
K	Denotes 1024. Example: 720 KB (file size)

Operation Screen and Common Operations

Operation Screen and Descriptions

This manual explains procedures using English menu screens. In procedural explanations, applicable menus and items are indicated with bold characters (e.g., **Setup**).
For instructions on how to set the menu language, see section 20.3.

Touch Panel Operations

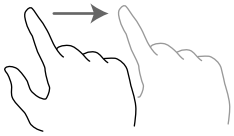
The basic touch panel operations are described below.

Tap

Tap refers to the act of gently hitting the screen with your finger.
Tapping is used on the instrument screen to select areas with a mark, close a setup menu, and so on.

Drag, Swipe, and Slide

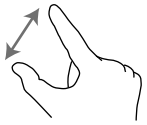
Press your finger against the screen and move your finger across the screen.
Drag refers to the act of selecting and moving items, such as a trigger level icon.
Swipe refers to the act of moving a relatively wide display range, such as scrolling the setting screen.
Slide is also a term sometimes used depending on the movement operation.



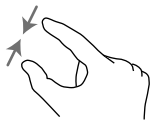
Pinch Out and Pinch In

Pinch out refers to the act of pressing two fingers against the screen and spreading them apart. Pinch in refers to the act of pressing two fingers against the screen and drawing them together.
On a screen displaying waveforms, you can pinch out to zoom in and pinch in to zoom out.

Pinch out



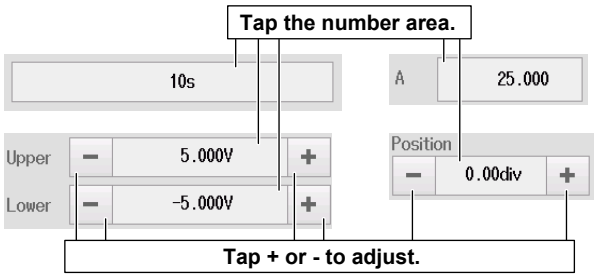
Pinch in



Entering Values

When a control for entering a value is displayed (such as the one shown below), tapping the value area opens an input box (numeric keypad). After entering a value with the numeric keypad, tap **Enter** to confirm the value.

Example of a Control for Entering a Value



- The least significant digit increases or decreases. Carrying over and borrowing occur automatically.
- Holding down + or - changes the value consecutively.

Example of an Input Box (Numeric keypad)

Tap here to set the default value and close the input box (numeric keypad).
(You do not need to tap Enter.)

Tap to enter an exponent.

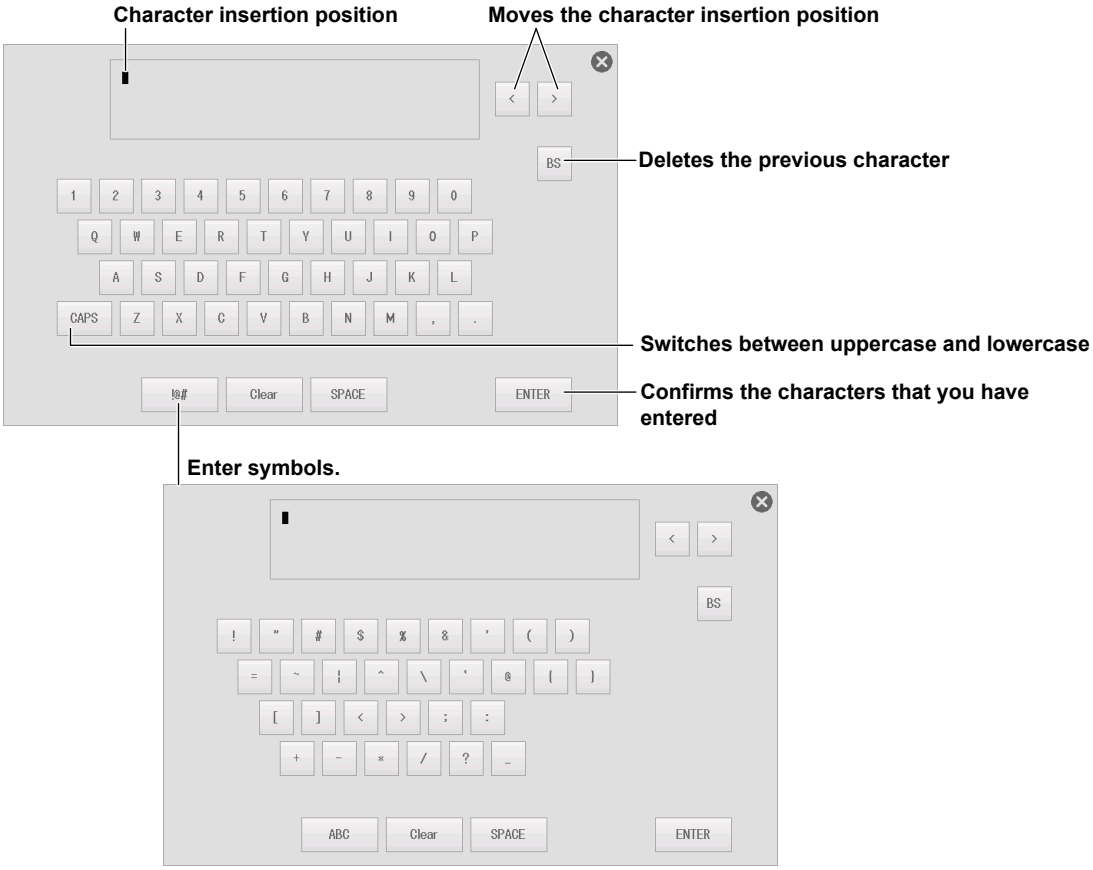
Entering Character Strings

Use the keyboard that appears on the screen to enter character strings such as file names and comments.

The keyboard used in the next example has the message language (see section 20.3) set to English.

How to Operate the Keyboard

1. With the keyboard displayed, tap the character you want to enter.
2. Repeat step 1 to enter all of the characters in the string.
3. Tap **ENTER**. The character string is confirmed, and the keyboard disappears.



Note

- @ cannot be entered consecutively.
- File names are not case-sensitive. Comments are case-sensitive. The following file names cannot be used due to MS-DOS limitations:
  AUX, CON, PRN, NUL, CLOCK, COM1 to COM9, and LPT1 to LPT9

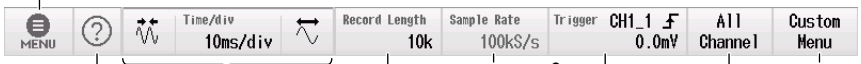
Menu Shown in the Footer Area

A menu is shown in the footer area of the waveform screen. You can set various items by using the menu, list (options), or input box that appears when you tap the menu commands.

For Scope Mode

When the Time Base[1] Is Internal

Top menu
This is the entrance to the setup menu of each function.



Time scale ► section 3.1
(Can be adjusted in steps)

Sample rate[2]

Trigger
► chapter 4

Custom menu
► section 20.5

Help
Displays explanations of functions

Record length
► section 3.1

All channel settings
► section 2.1

When the Time Base[1] Is External

Top menu
This is the entrance to the setup menu of each function.

This operation is not possible.

Displays time base External

Record length
► section 3.1

Trigger
► chapter 4

Custom menu
► section 20.5

Help
Displays explanations of functions

Pulse/rotation
► section 3.1

All channel settings
► section 2.1

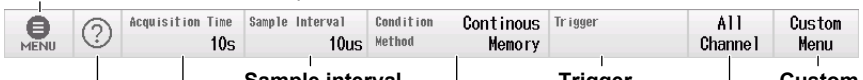
1 For setting the time base in scope mode, see section 3.1.
2 The sample rate varies depending on the time scale and record length settings.

For Recorder Mode

When the Acquisition Method* Is Set to Memory, Memory + Save on Stop, or Memory + SD Numeric Recording

- **When the Time Base* Is Internal**

Top menu
This is the entrance to the setup menu of each function.



Sample interval
► section 3.2

Trigger
► chapter 4

Custom menu
► section 20.5

Acquisition time
► section 3.2

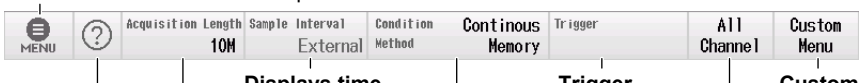
Acquisition condition
Acquisition method
► section 3.2

All channel settings
► section 2.1

Help
Displays explanations of functions

- **When the Time Base* Is External**

Top menu
This is the entrance to the setup menu of each function.



Displays time base External

Trigger
► chapter 4

Custom menu
► section 20.5

Acquisition time
► section 3.2

Acquisition condition
Acquisition method
► section 3.2

All channel settings
► section 2.1

Help
Displays explanations of functions

When the Acquisition Method* Is Set to SD Recording

- **When the Time Base* Is Internal**

Top menu
This is the entrance to the setup menu of each function.

Sample interval
► section 3.2

Trigger
► chapter 4

Custom menu
► section 20.5

Recording time
► section 3.2

Acquisition condition
Acquisition method
► section 3.2

All channel settings
► section 2.1

Help
Displays explanations of functions

- **When the Time Base* Is External**

Top menu
This is the entrance to the setup menu of each function.

Displays time base External

Trigger
► chapter 4

Custom menu
► section 20.5

Record length
► section 3.2

Acquisition condition
Acquisition method
► section 3.2

All channel settings
► section 2.1

Help
Displays explanations of functions

* For setting the acquisition method and time base in recorder mode, see section 3.2.

Contents

1.1 Selecting Scope Mode or Recorder Mode

This section explains how to select scope mode or recorder mode.

- Navigation
- Scope Mode and Recorder Mode

► Features Guide: “Navigation”

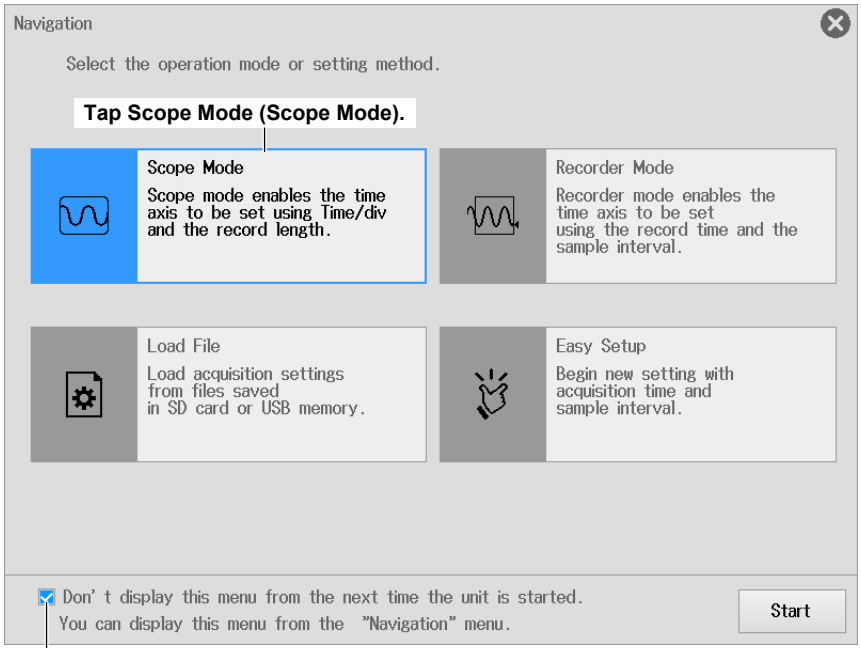
Navigation Screen

When you start the instrument, the navigation screen appears.

Tap the measurement mode and then **Start**. The waveform screen for the selected mode appears.

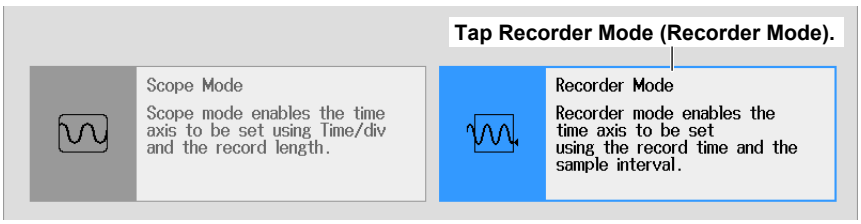
Navigation Screen

To select scope mode



If you select this check box, the waveform screen will appear the next time you start the instrument. Tapping **MENU** > **Navigation** on the waveform screen displays this navigation screen.

To select recorder mode



1.2 Loading Setup Files

This section explains how to use the navigation feature to load a setup file according to your application.

- Navigation
- Setup file
- Executing the load

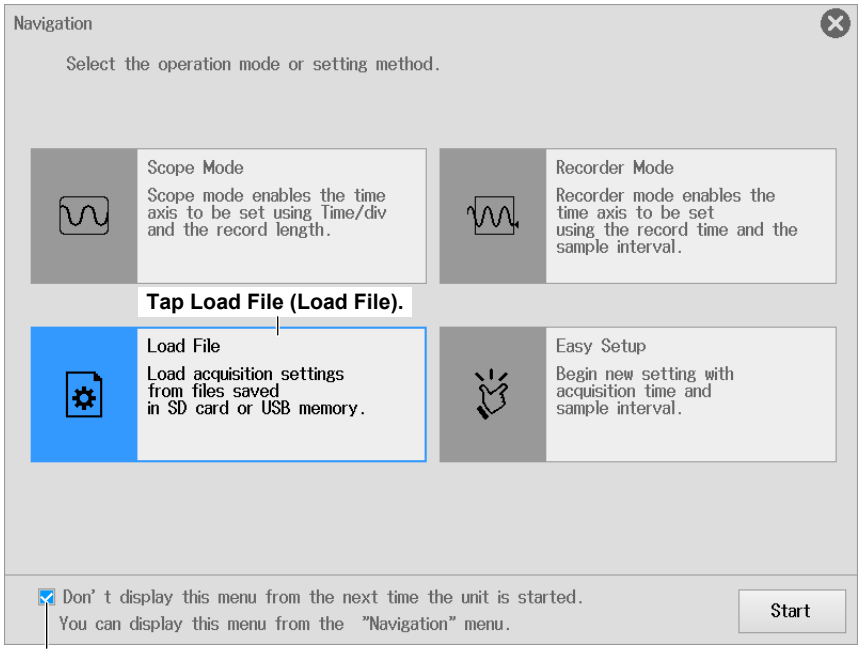
► Features Guide: “Navigation”

Navigation Screen

When you start the instrument, the navigation screen appears.

Tap **Load File** and then **Start**. A file list appears.

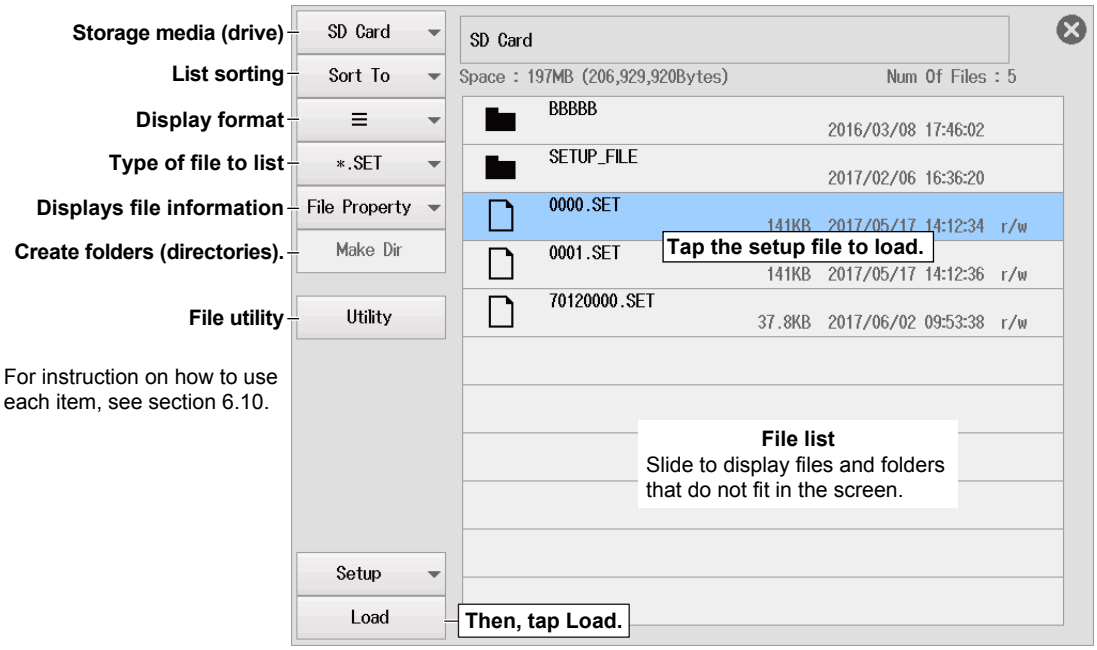
Navigation Screen



If you select this check box, the waveform screen will appear the next time you start the instrument. Tapping **MENU** > **Navigation** on the waveform screen displays this navigation screen.

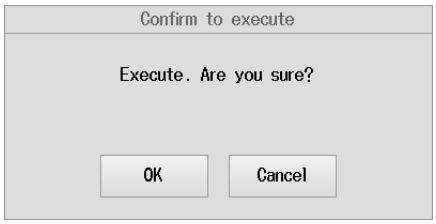
Selecting a Setup File

1. On the file list, tap the setup file you want to load.
2. Tap **Load**. A confirmation message appears.



Executing the Load

3. Tap **OK**. The setup file is loaded.



1.3 Configuring the Recorder Mode Using the Easy Setup

This section explains how to use the wizard of the navigation feature to configure the recorder mode settings.

- Navigation
- Turning recording channels on and off
- Recording time
- Sample interval
- All channels setup menu

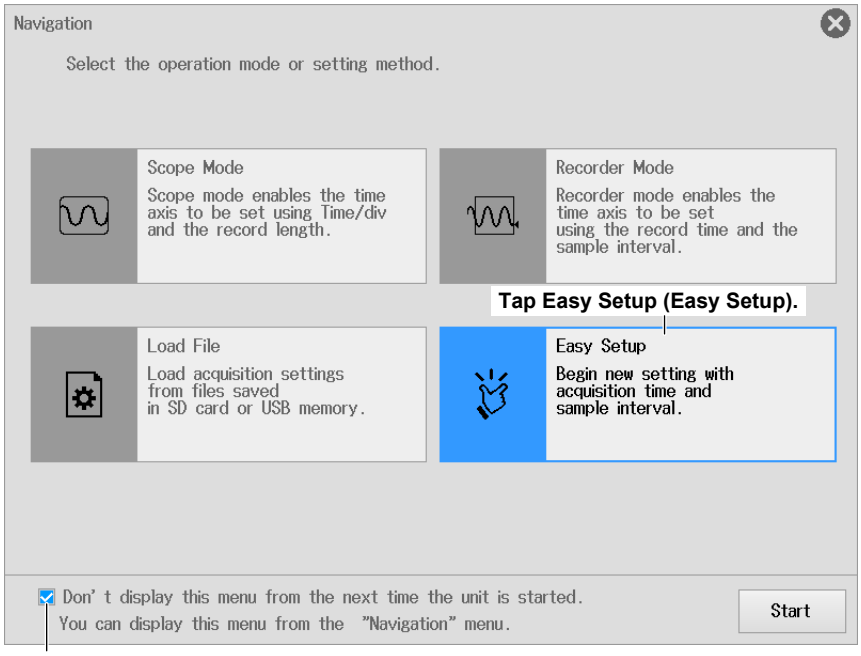
► Features Guide: “Navigation”

Navigation Screen

When you start the instrument, the navigation screen appears.

Tap **Easy Setup** and then **Start**. A Select Channel screen appears.

Navigation Screen

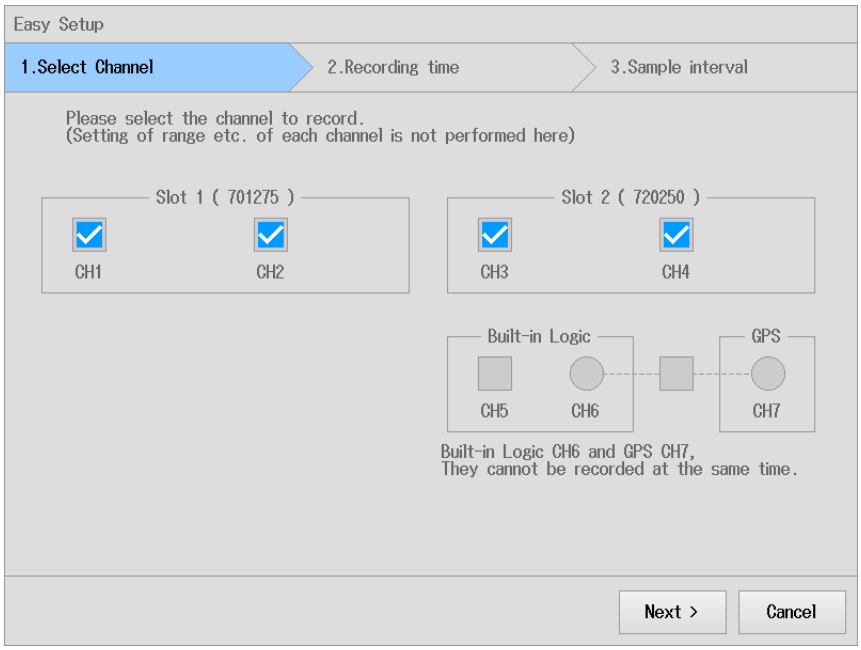


If you select this check box, the waveform screen will appear the next time you start the instrument. Tapping **MENU** > **Navigation** on the waveform screen displays this navigation screen.

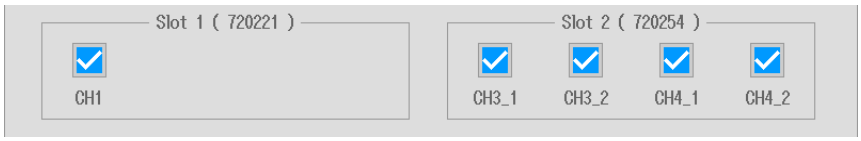
Turning Recording Channels On and Off

1. Tap the check box of each channel.
   - Select the check boxes of the channels you want to record. Clear the check boxes otherwise.
   - For the detail settings of the instrument's internal logic, see section 2.9. For the detail settings of the GPS, see chapter 18.
2. Tap **Next**. A Recording time screen appears.
   Tapping **Cancel** displays the waveform screen.

Channel Selection Screen



16CH module (720220 (16CH VOLT), 720221 (16CH TEMP/VOLT))

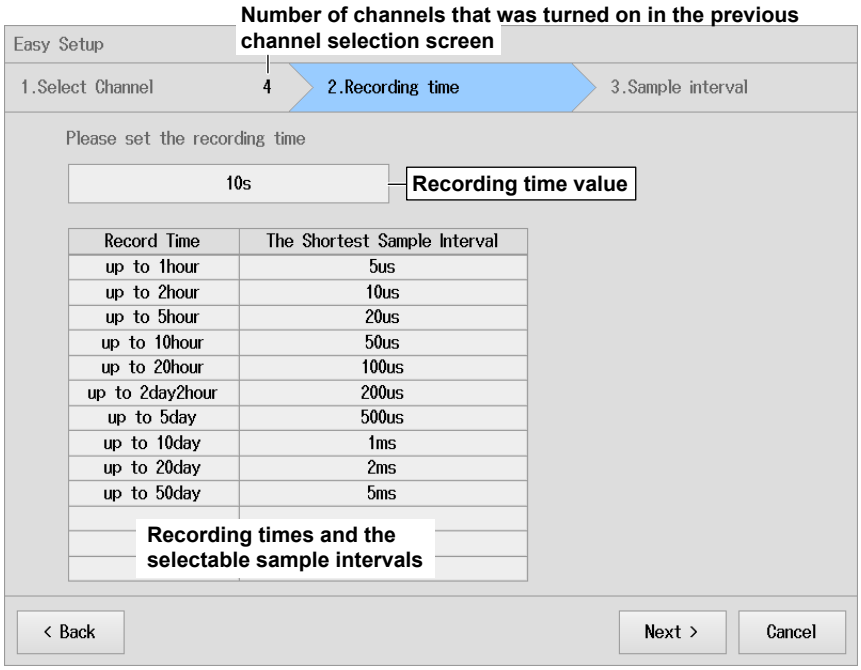


4-CH module (720254 (4CH 1M16))

Setting the Record Time

1. Tap the **record time value**. An input box appears.
2. Use the input box to set the record time.
   - Set in the range of 10 s to 50 days.
     If you enter the value and unit and then tap **Enter**, the input record time is applied.
     If you enter only the value and tap **Enter**, the input value is assumed to be in seconds (s).
     If you do not enter the value or unit and tap **Enter**, the default value is applied.
   - The following combinations of time units can be used. Other combinations are not allowed.
     Minutes and seconds, hours and minutes, days and hours
3. Tap **Next**. A Sample interval screen appears.
   - Tapping **< Back** displays the Select Channel screen.
   - Tapping **Cancel** displays the waveform screen.

Recording Time Screen

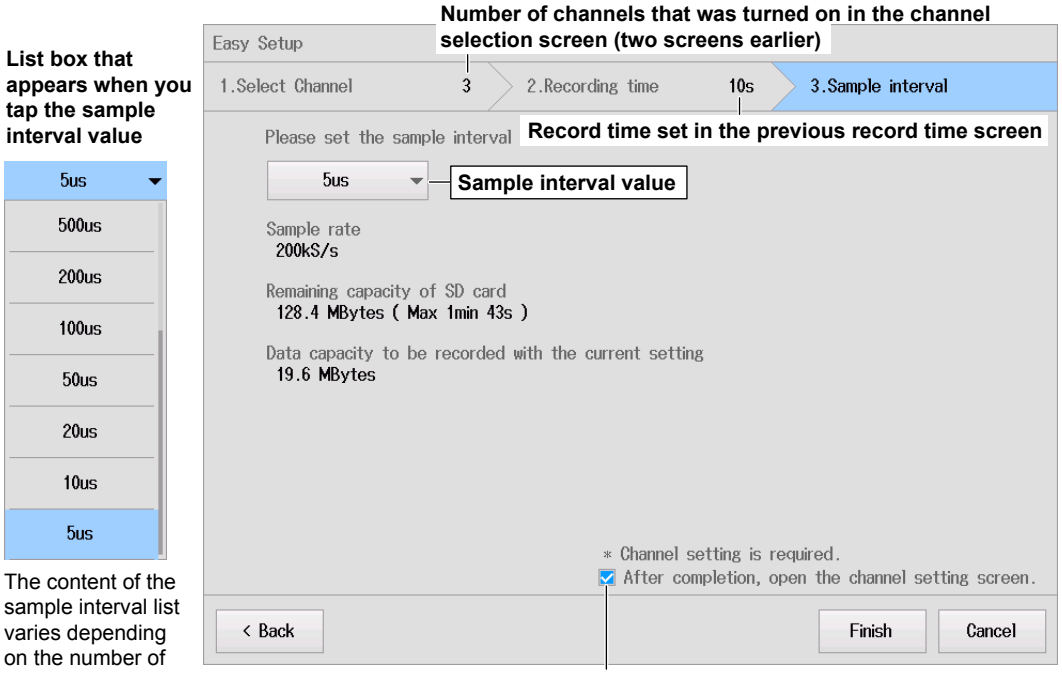


Input Box That Appears When You Tap the Record Time Value

Setting the Sample Interval

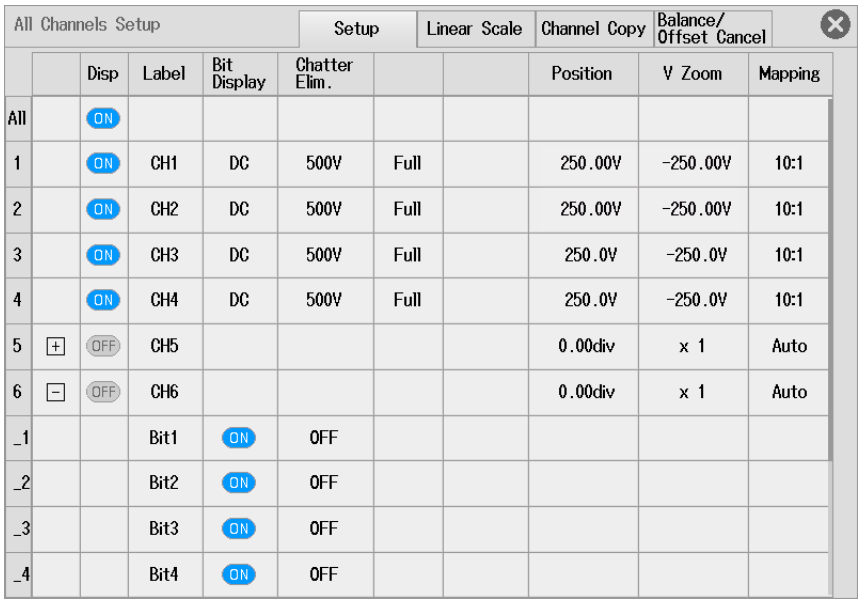
1. Tap the **sample interval value**. On the list of available options, tap the sample interval you want to use.
   - The content of the list varies depending on the number of recording channels and record time.
   - The sample rate and recording data size vary according to the specified sample interval.
2. Tap **Finish**. An All Channel Setup screen appears.
   - Tapping **< Back** displays the Recording time screen.
   - Tapping **Cancel** displays the waveform screen.

Sample Interval Screen



Example of the All Channels Setup Screen

For the setting procedure on the All Channels Setup screen, see section 2.1.



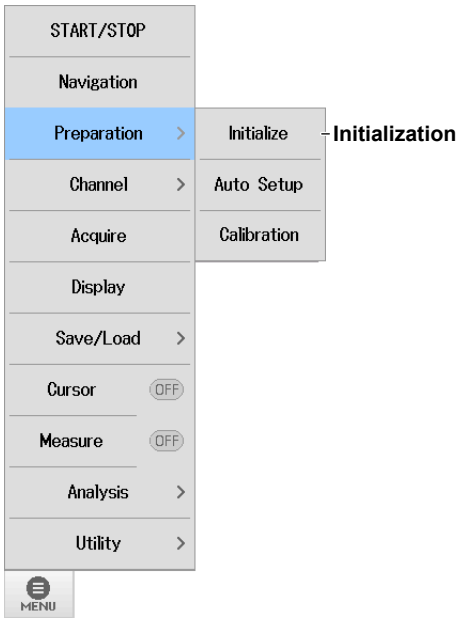
		Disp	Label	Bit Display	Chatter Elim.			Position	V Zoom	Mapping
All		ON								
1		ON	CH1	DC	500V	Full		250.00V	-250.00V	10:1
2		ON	CH2	DC	500V	Full		250.00V	-250.00V	10:1
3		ON	CH3	DC	500V	Full		250.0V	-250.0V	10:1
4		ON	CH4	DC	500V	Full		250.0V	-250.0V	10:1
5	⊞	OFF	CH5					0.00div	x 1	Auto
6	⊟	OFF	CH6					0.00div	x 1	Auto
_1			Bit1	ON	OFF					
_2			Bit2	ON	OFF					
_3			Bit3	ON	OFF					
_4			Bit4	ON	OFF					

1.4 Initializing the Settings

This section explains how to initialize the settings to their factory default values.

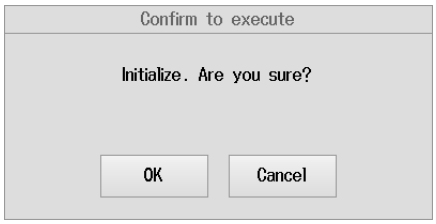
► Features Guide: “Initialization of Settings (Initialize)”

1. On the waveform screen, tap **MENU** > **Preparation**. The following menu appears.
2. Tap **Initialize**. A confirmation message appears.



Executing Initialization

3. Tap **OK**. Initialization is executed.



Settings That Cannot Be Reset to Their Factory Default Values

- Date and time settings
- Communication settings
- Language setting (English or Japanese)
- System mode
- Network settings

1.5 Performing Auto Setup

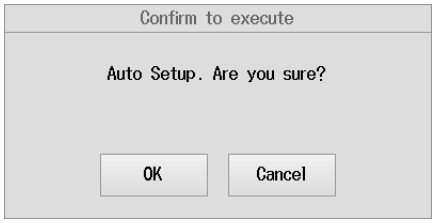
This section explains how to perform auto setup, which automatically sets the instrument's settings to the values that are most suitable for the input signals.

► Features Guide: "Auto Setup (Auto Setup)"

1. On the waveform screen, tap **MENU** > **Preparation**. The following menu appears.
2. Tap **Auto Setup**. A confirmation message appears.

Executing Auto Setup

3. Tap **OK**. Auto setup is executed.

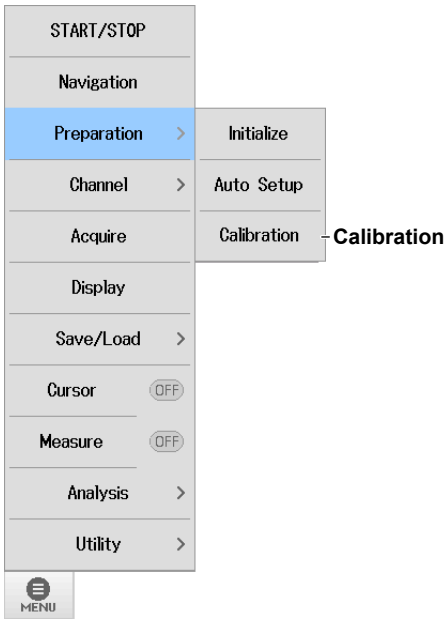


1.6 Calibrating the Instrument

This section explains how to calibrate the instrument. Execute calibration when you want to make accurate measurements.

► Features Guide: “Calibration (Calibration)”

1. On the waveform screen, tap **MENU** > **Preparation**. The following menu appears.
2. Tap **Calibration**. A calibration menu appears.



Calibration

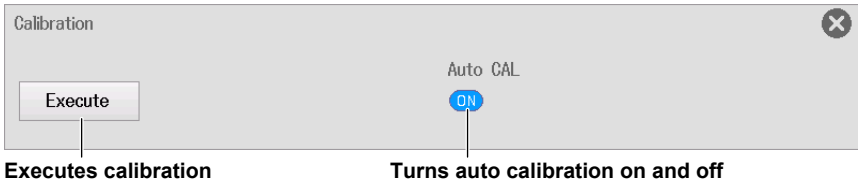
Executing Calibration

Tap **Execute**. Calibration is executed.

Turning Auto Calibration On and Off

Tap **ON** or **OFF** under Auto CAL.

To enable auto calibration, select ON. Otherwise, select OFF.



2.1 Configuring on the All Channels Setup Screen

This section explains the following settings for configuring all channels.

- Input settings
- Linear scaling
- Copying channels
- Balancing and offset canceling
  (Strain balancing (strain module) and DC offset cancellation)

► Features Guide: “All Channel Settings (All CH Setup)”

On the waveform screen, tap **MENU** > **Channel** > **All CH Setup**. An All Channels Setup screen appears.

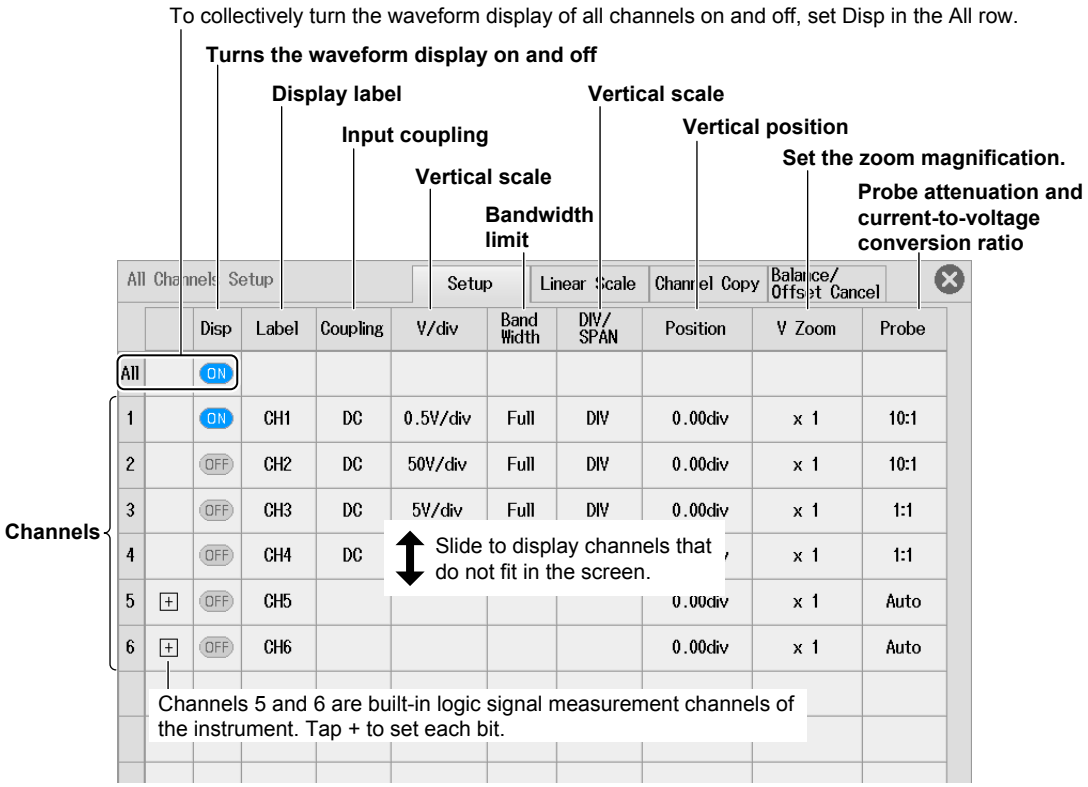
You can also display the All Channels Setup screen by tapping **All Channel** on the bottom menu bar of the waveform screen.

All Channel Setup Screen

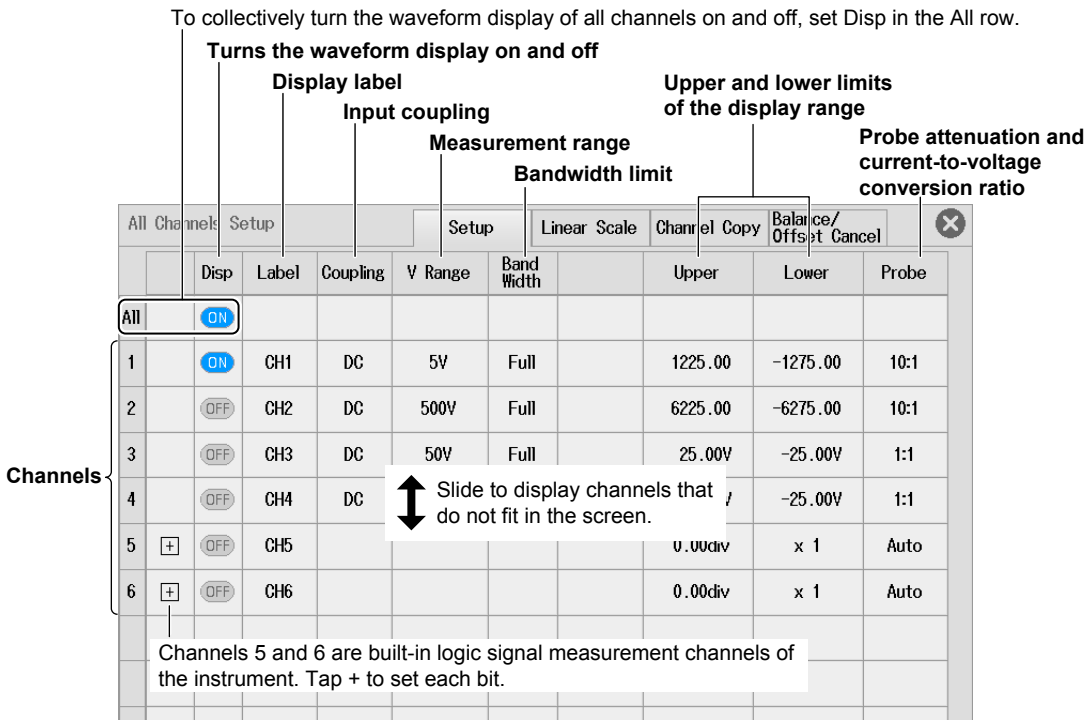
Input Settings (Setup)

1. Tap the **Setup** tab. An input setting screen appears.
   The items on the input setting screen vary depending on the installed modules and measurement items. For details on the settings, see the explanation of each measurement item in section 2.2 and later.
2. Tap the items of each channel. Use the displayed list (options) or input box to set the items.

Example of an Input Setting Screen in Scope Mode

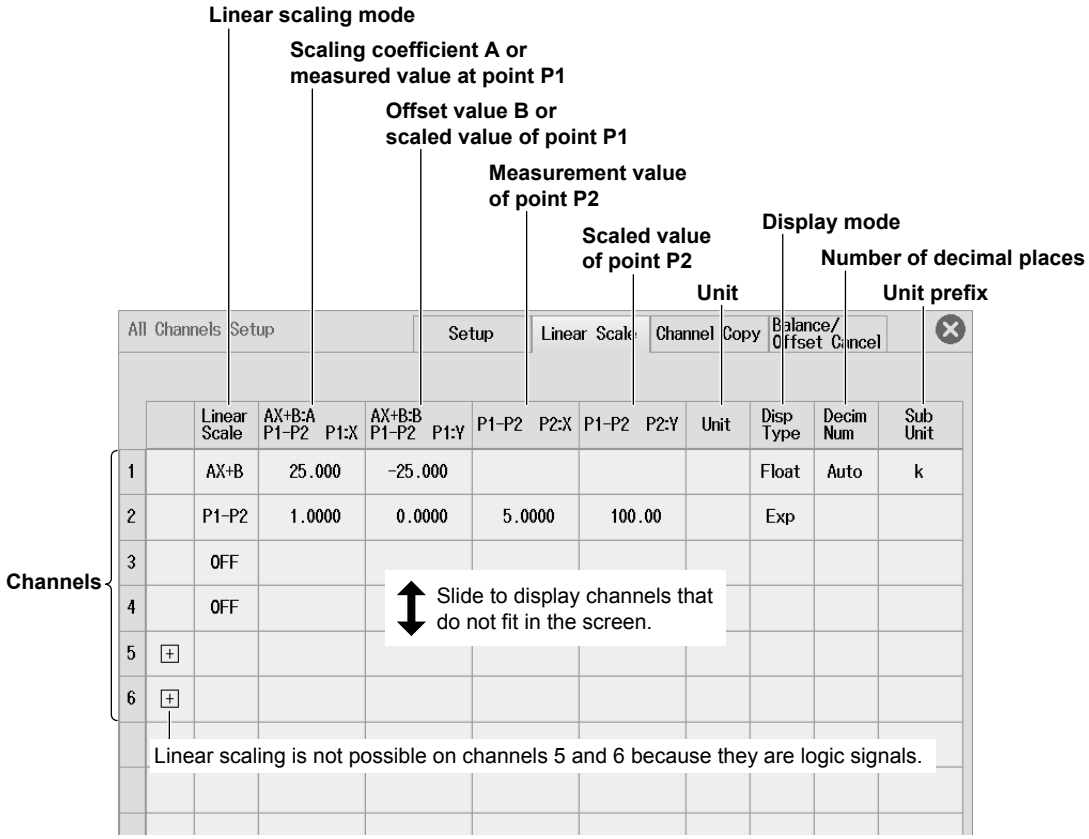


Example of an Input Setting Screen in Recorder Mode



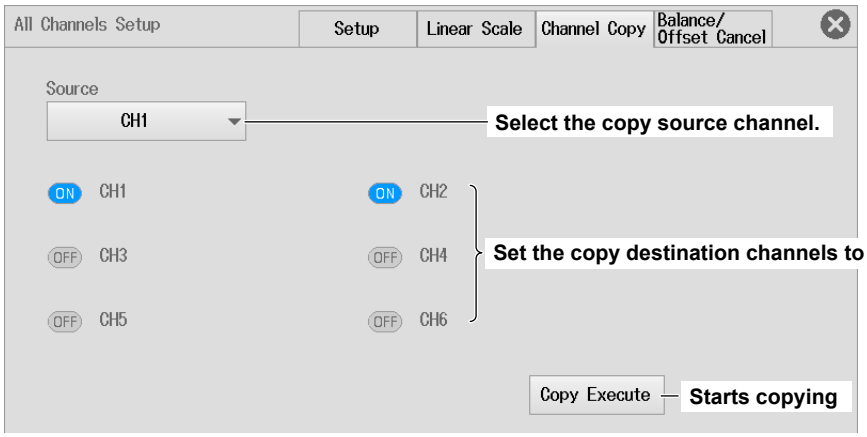
Linear Scaling (Linear Scale)

1. Tap the **Linear Scale** tab. The Linear Scale screen appears.
   For details on the settings, see the explanation of linear scaling in section 2.2.
2. Tap the items of each channel. Use the displayed list (options) or input box to set the items.



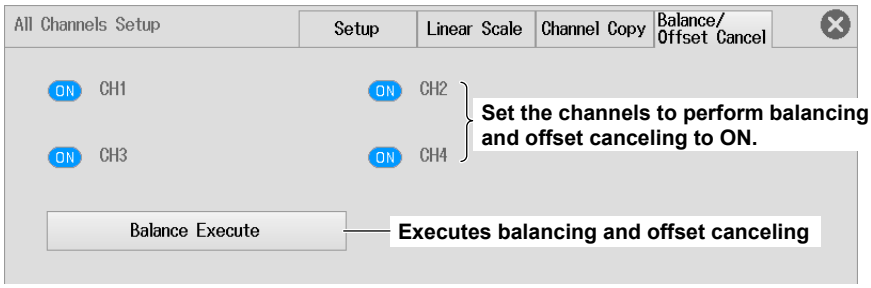
Copying Channels (Channel Copy)

1. Tap the **Channel Copy** tab. The Channel Copy screen appears.
2. Tap each item to set options from the displayed list or execute commands.



Balancing and Offset Canceling (Balance/Offset Cancel)

1. Tap the **Balance/Offset Cancel** tab. The Balance/Offset Cancel screen appears.
   For instructions on how to set balancing and DC offset cancellation, see the explanation of DC offset cancellation in section 2.2 and strain balance in section 2.6.
2. Tap each item to set options and execute commands.



2.2 Configuring Voltage Measurements

This section explains the following settings for the vertical axis of voltage measurements.

For Scope Mode

- Basic settings (waveform display on/off, vertical scale, input coupling, bandwidth limit, probe attenuation, current-to-voltage conversion ratio, display labels)
- Display settings (vertical scale (zoom method), vertical position, vertical zoom (zooming by setting the magnification), zooming by setting the high limit and low limit of the display range, waveform inverted display on/off, display groups)
- Detail settings (linear scaling, channel copying, gain adjustment, DC offset cancellation on/off)

For Recorder Mode

- Basic settings (waveform display on/off, measurement range, input coupling, bandwidth limit, probe attenuation, current-to-voltage conversion ratio, display labels)
- Display settings (high limit and low limit of the display range, waveform inverted display on/off, display groups)
- Detail settings (linear scaling, channel copying, gain adjustment, DC offset cancellation on/off)

► Features Guide: “Voltage Measurement”

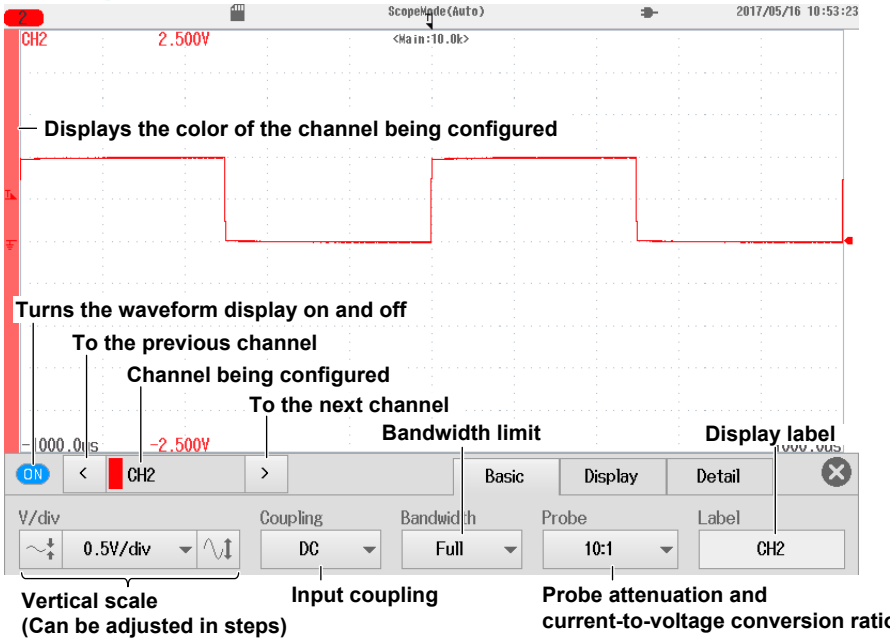
Channel Setting Menu

1. On the waveform screen, tap **MENU** > **Channel** > any channel from **CH1 to CH4**. A channel setting menu appears.
   - You can also tap or double-tap any channel from CH1 to CH4 in the channel information area to display the channel setting menu. (If the channel is selected, tap; otherwise, double-tap.)
   - For a 4-CH module (720254 (4CH 1M16)), select the sub channel (if the display label is set to default, the channel number followed by an underscore and a number as in CH3_1).

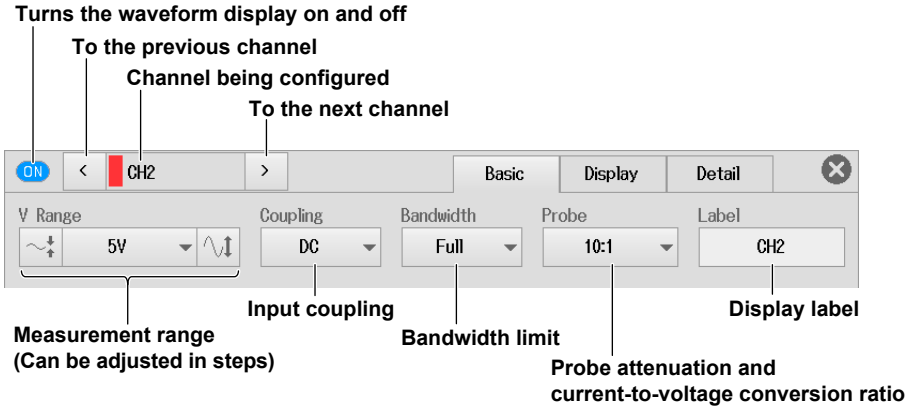
Basic Setup (Basic)

2. Tap the **Basic** tab.
3. Tap each item. Use the displayed list (options) or input box to set the items.

For Scope Mode

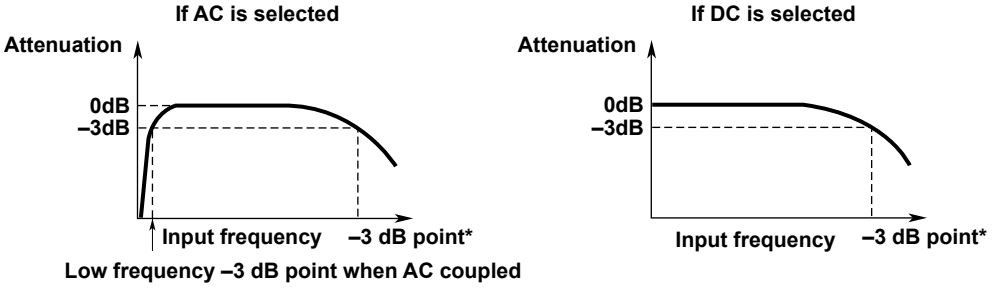


For Recorder Mode



Input Coupling (Coupling)

The following figure shows the frequency characteristics when the input coupling is set to AC or DC. Note that if the input coupling is set to AC, the instrument does not acquire low-frequency signals or signal components as indicated in the figure below.



* This value differs depending on the input module.
For details, section 6.13, “Module Specifications,” in the Getting Started Guide (IM DL350-03EN).

CAUTION

If the input coupling is AC, in accordance with the frequency response, the input signal is attenuated more in lower frequencies. As a result, even when a high voltage signal is actually applied, it may not be measured as a high voltage signal. Furthermore, the over-range indicator may not be displayed on the screen. As necessary, switch the input coupling to DC to check the input signal voltage.
Applying an input signal whose voltage exceeds the maximum input voltage of the input module may damage the input section.

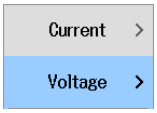
French

ATTENTION

Si le courant du couplage d’entrée est alternatif (CA), conforme à la réponse en fréquence, le signal d’entrée est davantage atténué aux fréquences plus basses. Par conséquent, même si vous appliqué un signal de tension élevée, ce dernier risque de ne pas être mesuré comme tel. De plus, le voyant de dépassement de plage risque de ne pas s’afficher à l’écran. Le cas échéant, basculez le couplage d’entrée sur CC (courant continu) afin de vérifier la tension du signal d’entrée.
Si la tension du signal d’entrée dépasse la tension d’entrée maximale du module d’entrée, la section d’entrée risque d’être endommagée.

Probe Attenuation and Current-to-Voltage Conversion Ratio (Probe)

3. After step 2 on page 2-4, tap Probe. The following setup menu appears.



4. Select **Voltage** or **Current**, and select a value from the displayed menu.

Voltage Probe's Attenuation Ratio

1: 1, 2: 1, 5: 1, 10: 1, 20: 1, 50: 1, 100: 1, 200: 1, 500: 1, 1000: 1, 2000: 1, 5000: 1, 10 k: 1, 20 k: 1, 50 k: 1

Current Probe's Current-to-Voltage Conversion Ratio

0.1A:1V (10V/A), 0.2A:1V (5V/A), 0.5A:1V (2V/A), 1A:1V (1V/A), 2A:1V (0.5V/A), 5A:1V (0.2V/A), 10A:1V (0.1V/A), 20A:1V (0.05V/A), 50A:1V (0.02V/A), 100A:1V (0.01V/A), 200A:1V (0.005V/A), 250A:1V (0.004V/A), 400A:1V (2.5mV/A), 500A:1V (0.002V/A), 1kA:1V (1mV/A), 2kA:1V (0.5mV/A), 5kA:1V (0.2mV/A), 10kA:1V (0.1mV/A), 20kA:1V (0.05mV/A), 50kA:1V (0.02mV/A)

Note

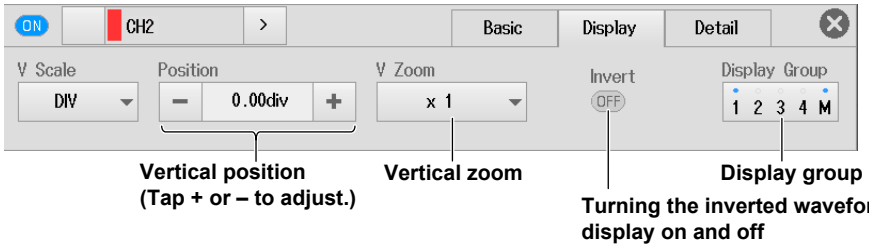
If the probe attenuation or current-to-voltage conversion ratio is not set correctly, the voltage and scale values of the input signals will not be displayed correctly. For example, if you use a 10:1 voltage probe but set the probe type to 1:1, the automatically measured amplitude of the waveform will be 1/10 the real value.

Configuring the Display (Display)

2. Tap the **Display** tab.
3. Tap each item. Use the displayed list (options) or input box to set the items.

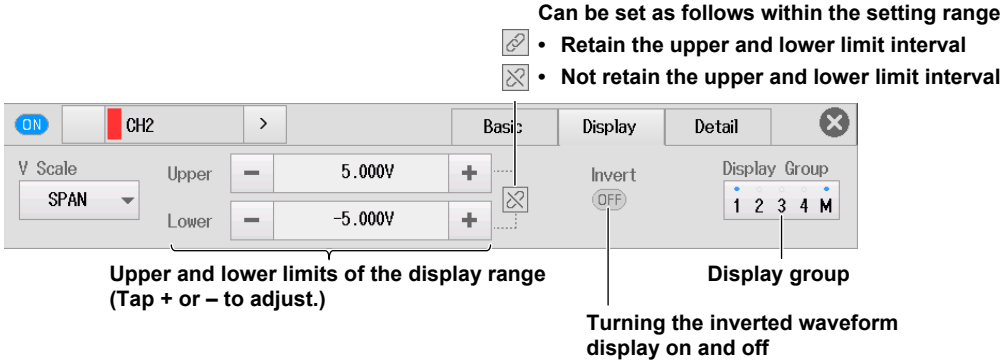
For Scope Mode

When V Scale (vertical scale) Is Set to DIV

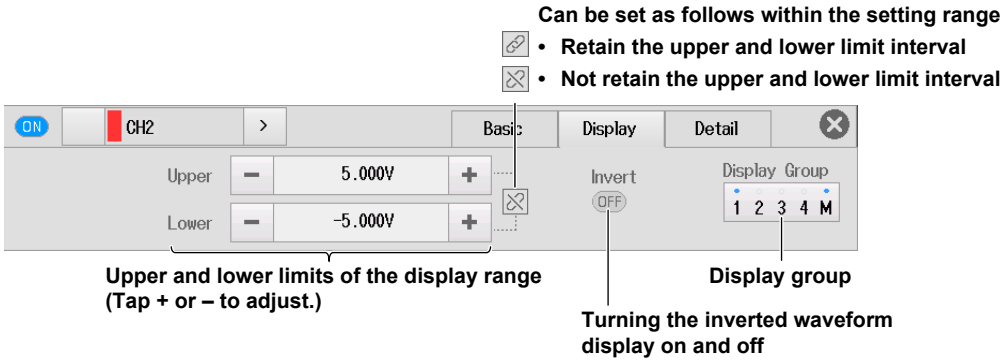


The vertical position can be moved also by tapping the up and down arrows that appear when you slide the waveform screen.
► See “Setting the Waveform Vertical and Horizontal Positions” (explained later).

When V Scale (vertical scale) Is Set to SPAN



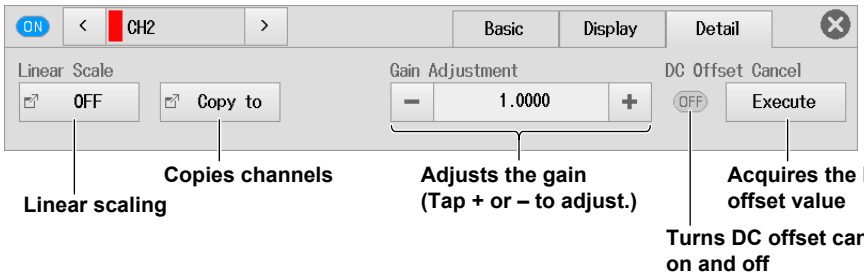
For Recorder Mode



Detail Setting (Detail)

2. Tap the **Detail** tab.
3. Tap each item. Use the displayed list (options) or input box to set the items.

Items Common to Scope Mode and Recorder Mode



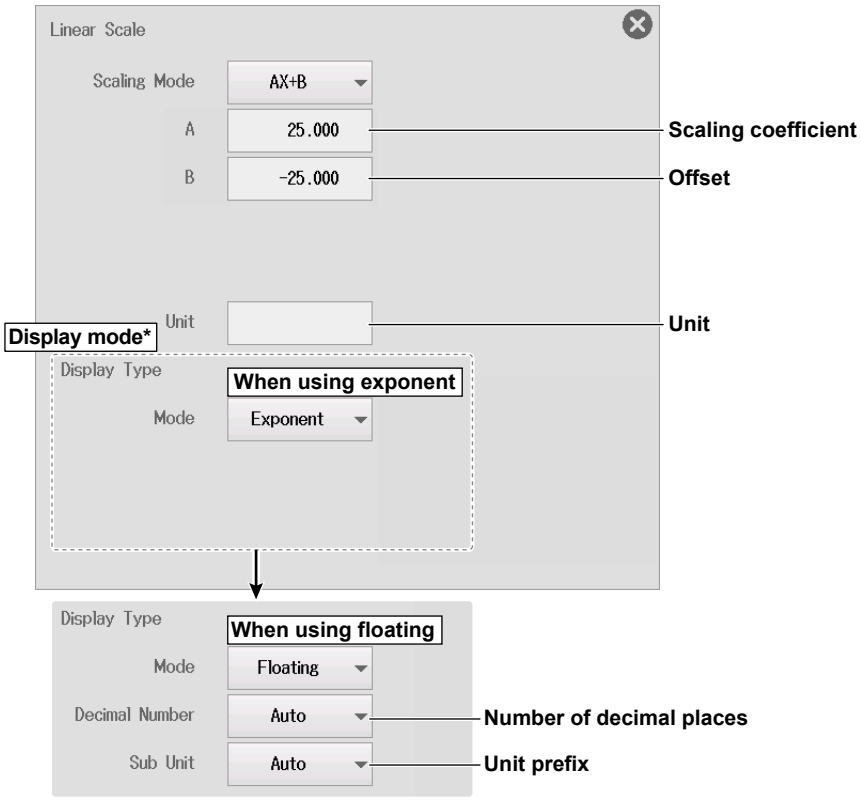
Note

- When DC offset cancellation is set to ON, you cannot adjust the gain.
- The gain adjustment is reset to 1.0000 when you execute DC offset cancellation or set it to on.

Linear Scaling (Linear Scale)

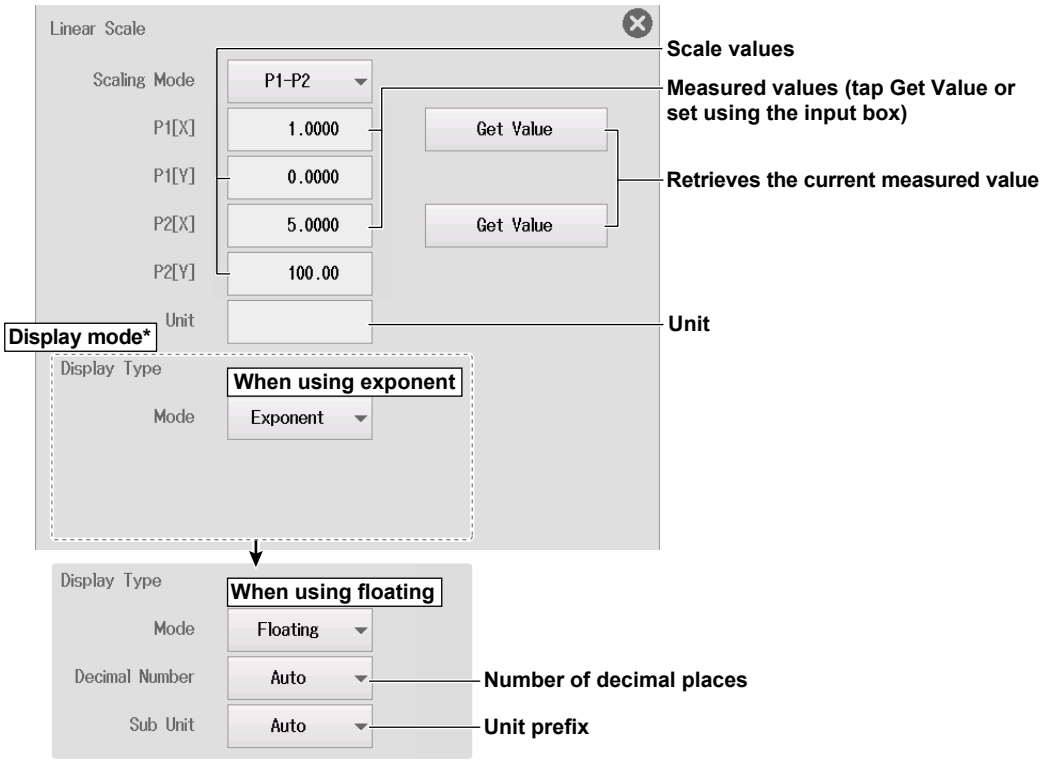
Tap **Linear Scale**. The following screen appears.

- **When the Scaling Mode Is Set to AX+B**



* Set these when measuring voltage with a voltage module or strain with a strain module.

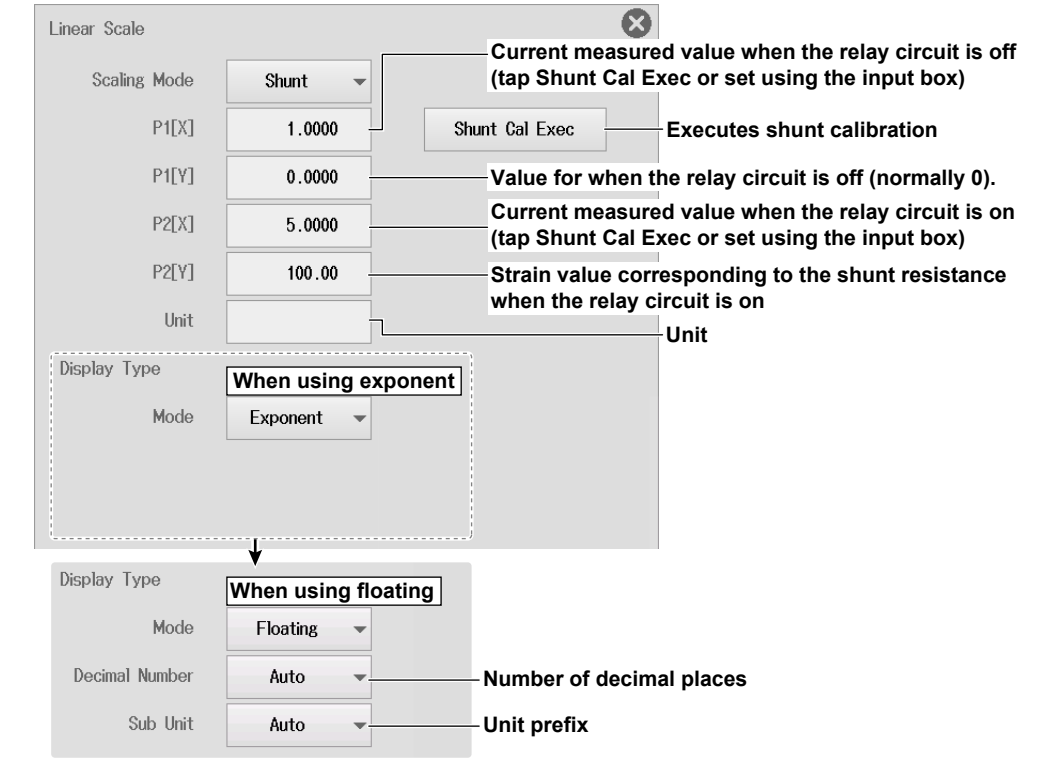
- **When the Scaling Mode Is Set to P1–P2**



* Set these when measuring voltage with a voltage module or strain with a strain module.

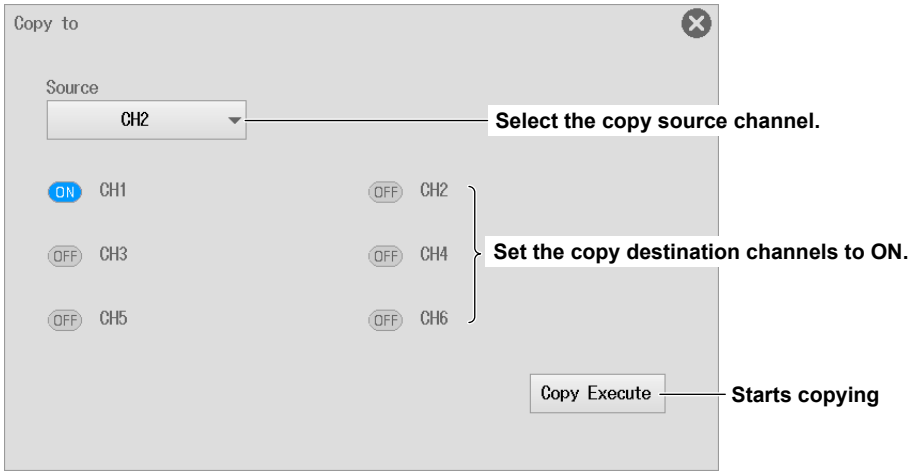
- **When the Scaling Mode Is Set to Shunt**

  Shunt mode is available for the strain module (701271 (STRAIN_DSUB)). This module has a built-in relay circuit for shunt calibration.



Copying Channels (Copy to)

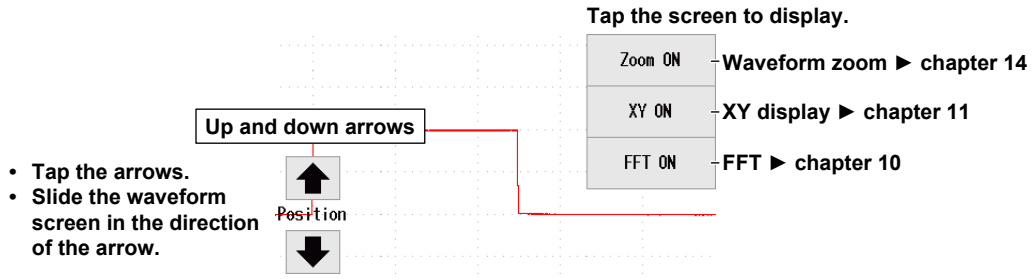
Tap **Copy to**. The following screen appears.



Setting the Waveform Vertical and Horizontal Positions (Sliding the waveform screen)

For Scope Mode

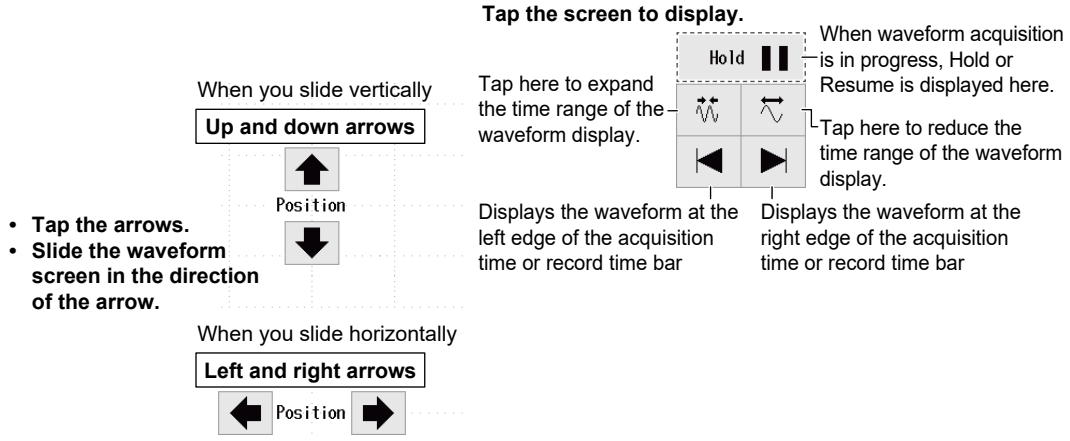
When you slide your finger across the waveform screen, up and down arrows appear. You can move the vertical position by performing the following operation while the arrows are displayed.



On the display setting screen of the channel setting menu described earlier, you can set the vertical position by entering a value.

For Recorder Mode

When you slide your finger across the waveform screen, up, down, left, and right arrows appear. You can move the vertical or horizontal position by performing the following operation while the arrows are displayed.



2.3 Configuring Voltage Measurements (For 16-CH voltage input modules)

This section explains the following settings for the 16-CH voltage input module:

For Scope Mode

- All sub channel settings
- Basic settings (waveform display on/off, vertical scale, input coupling, bandwidth limit, display labels)
- Display settings (vertical scale (zoom method), vertical position, vertical zoom (zooming by setting the magnification), zooming by setting the high limit and low limit of the display range, waveform inverted display on/off, display groups)
- Detail settings (linear scaling, channel copying)

For Recorder Mode

- All sub channel settings
- Basic settings (waveform display on/off, measurement range, input coupling, bandwidth limit, display labels)
- Display settings (high limit and low limit of the display range, waveform inverted display on/off, display groups)
- Detail settings (linear scaling, channel copying)

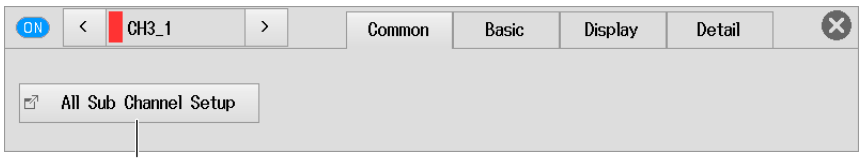
► Features Guide: “Voltage Measurement (For the 16-CH Voltage Input Module)”

Sub Channel Setting Menu

1. On the waveform screen, tap **MENU** > **Channel** > **CH1** or **CH3**. A sub channel setting menu appears.
   You can also tap or double-tap a sub channel (if the display label is set to default, the channel number followed by an underscore and a number as in CH3_1) in the channel information area to display the sub channel setting menu.
   (If the channel is selected, tap; otherwise, double-tap.)

Setting All Sub Channels (All Sub Channel Setup)

2. Tap the **Common** tab.



All sub channel settings

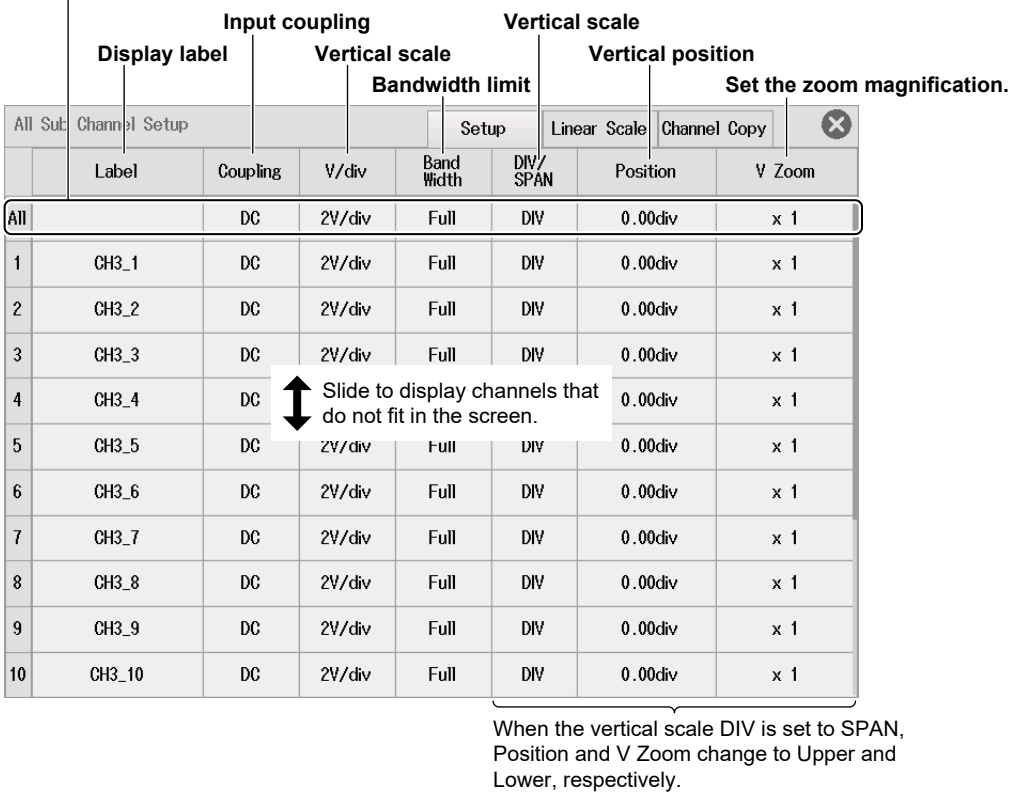
3. Tap **All Sub Channel Setup**. The All Sub Channel Setup screen appears.

Configuring Input Settings (Setup)

4. Tap the **Setup** tab. An input setting screen appears.
5. Tap the items of each sub channel. Use the displayed list (options) or input box to set the items.
   If you do not want to measure sub channels individually, set the input coupling to OFF.

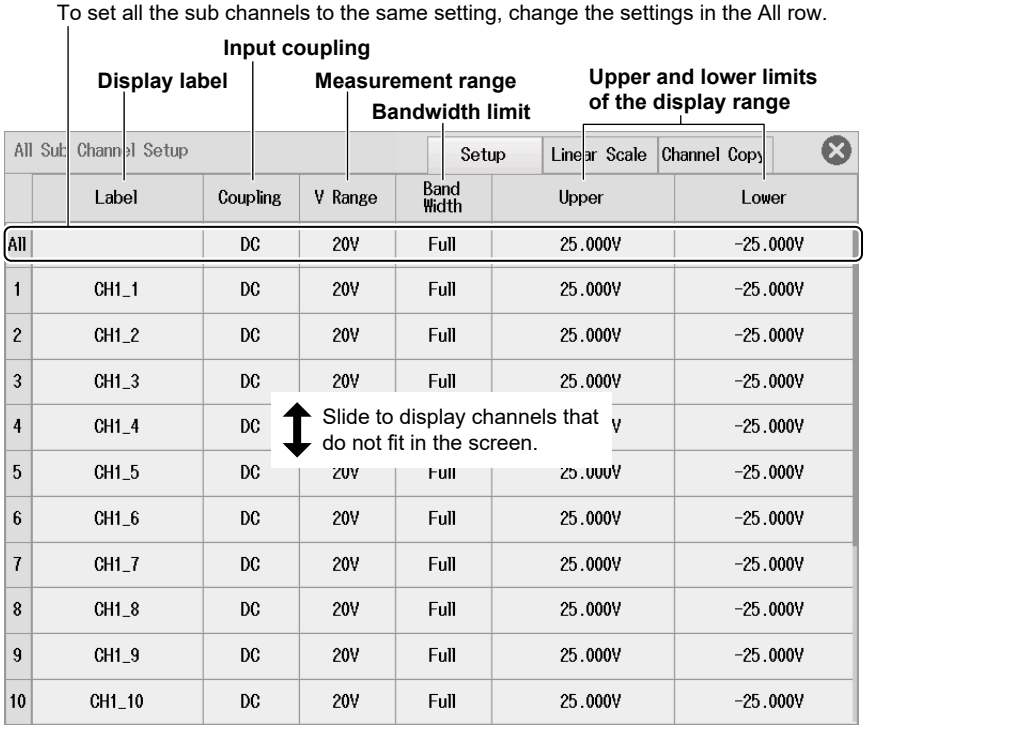
Example of an Input Setting Screen in Scope Mode

To set all the sub channels to the same setting, change the settings in the All row.



Example of an Input Setting Screen in Recorder Mode

To set all the sub channels to the same setting, change the settings in the All row.

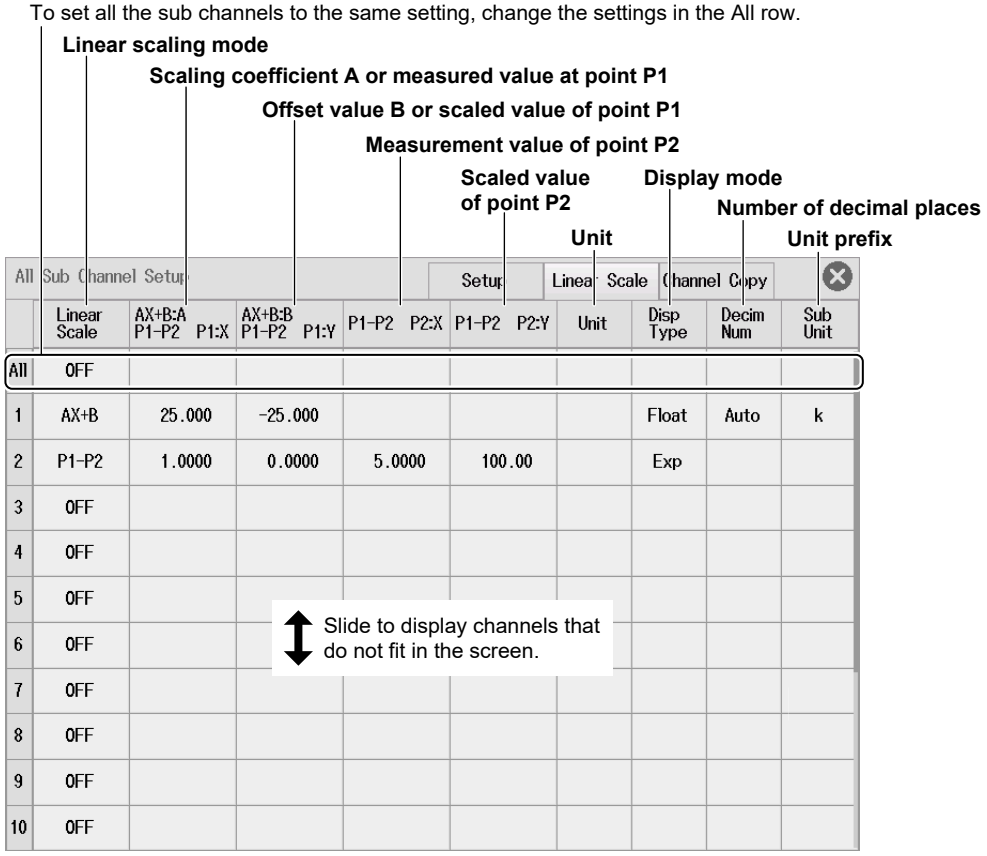


Linear Scaling (Linear Scale)

4. Tap the **Linear Scale** tab. The Linear Scale screen appears.
For details on the settings, see the explanation of linear scaling in section 2.2.

5. Tap the items of each sub channel. Use the displayed list (options) or input box to set the items.

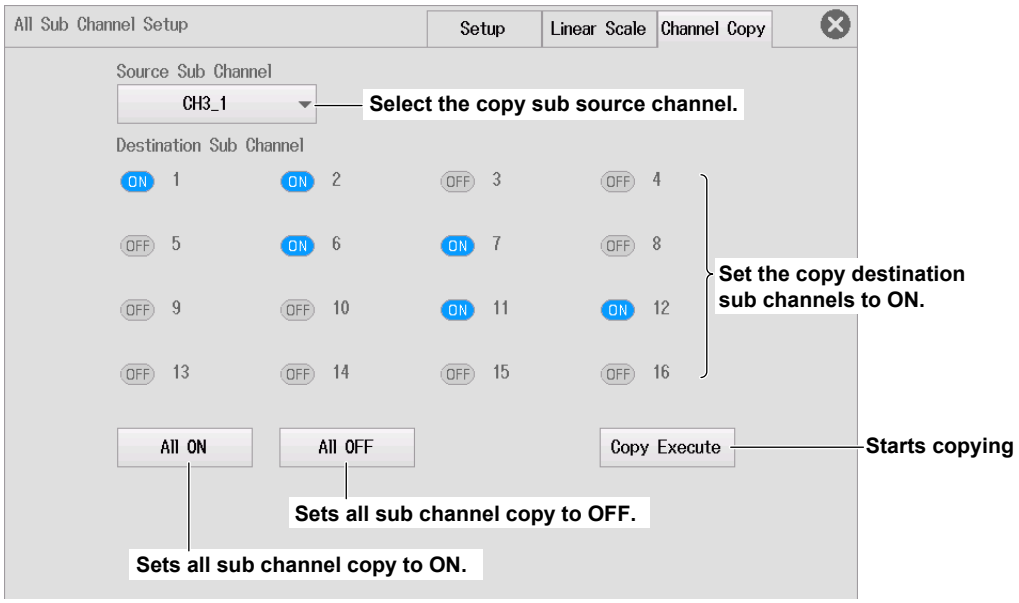
To set all the sub channels to the same setting, change the settings in the All row.



Copying Channels (Channel Copy)

4. Tap the **Channel Copy** tab. The Channel Copy screen appears.

5. Tap each item to set options from the displayed list or execute commands.

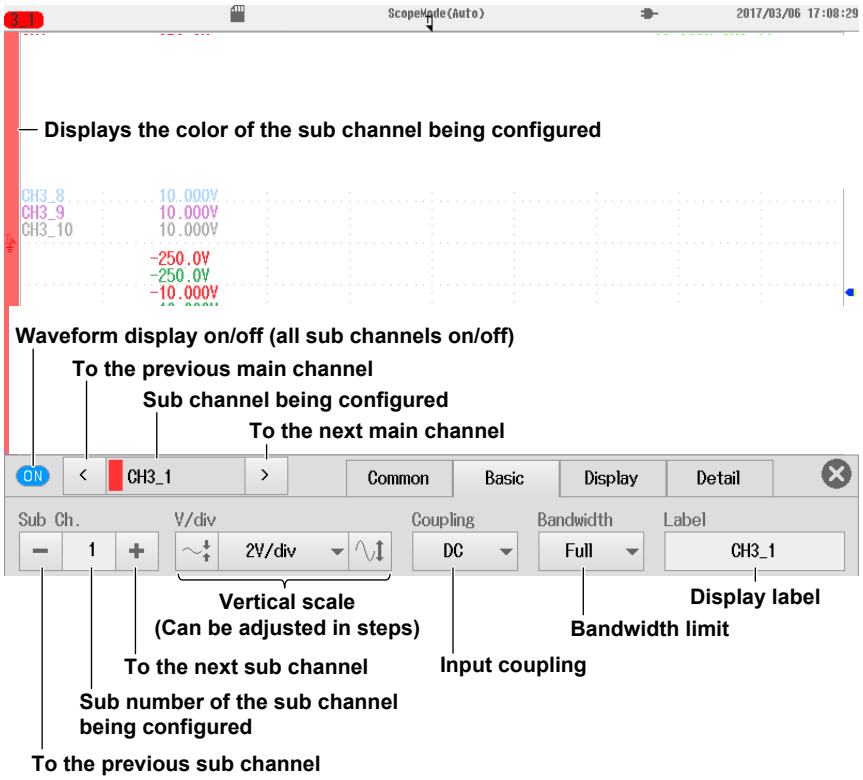


Copying channels can also be set using **Copy to** on the **Detail** tab.

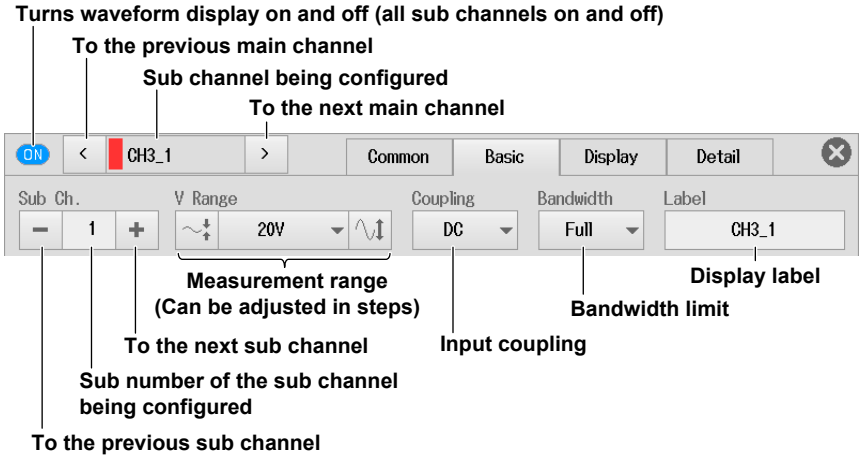
Basic Setup (Basic)

2. Tap the **Basic** tab.
3. Tap each item. Use the displayed list (options) or input box to set the items.

For Scope Mode



For Recorder Mode



Input Coupling (Coupling)

Frequency characteristics when the input coupling is set to AC or DC and notes ► section 2.2

If you do not want to measure sub channels individually, set the input coupling to OFF.

Configuring the Display (Display)

► section 2.2

For the sub channel settings (Sub Ch.), see “Basic Setup (Basic)” on the previous page.

Detail Setting (Detail)

► section 2.2

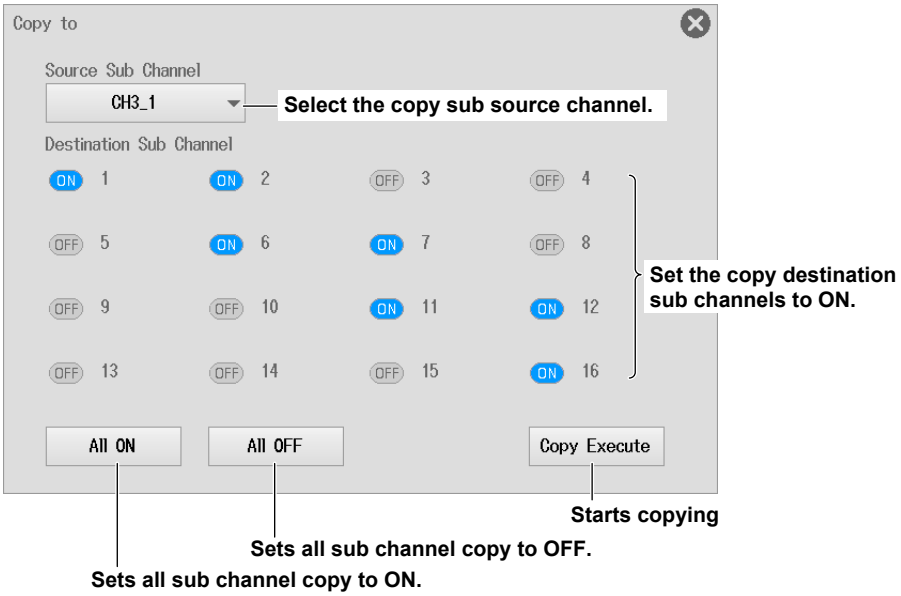
For the sub channel settings (Sub Ch.), see “Basic Setup (Basic)” on the previous page.

Linear Scaling (Linear Scale)

► section 2.2

Copying Channels (Copy to)

Tap **Copy to**. The following screen appears.



Copying channels can also be set using **Channel Copy** tab on the **All Sub Channel Setup** screen.

Setting the Waveform Vertical and Horizontal Positions (Sliding the waveform screen)

► section 2.2

2.4 Configuring Temperature Measurements

This section explains the following settings for temperature measurements:

Items Common to Scope Mode and Recorder Mode

- Basic settings (waveform display on/off, setting input coupling to TC, thermocouple type, bandwidth limit, RJC on/off, burnout on/off, display labels)
- Display settings (temperature unit, high limit and low limit of the display range, display groups)
- Detail settings (copying channels)

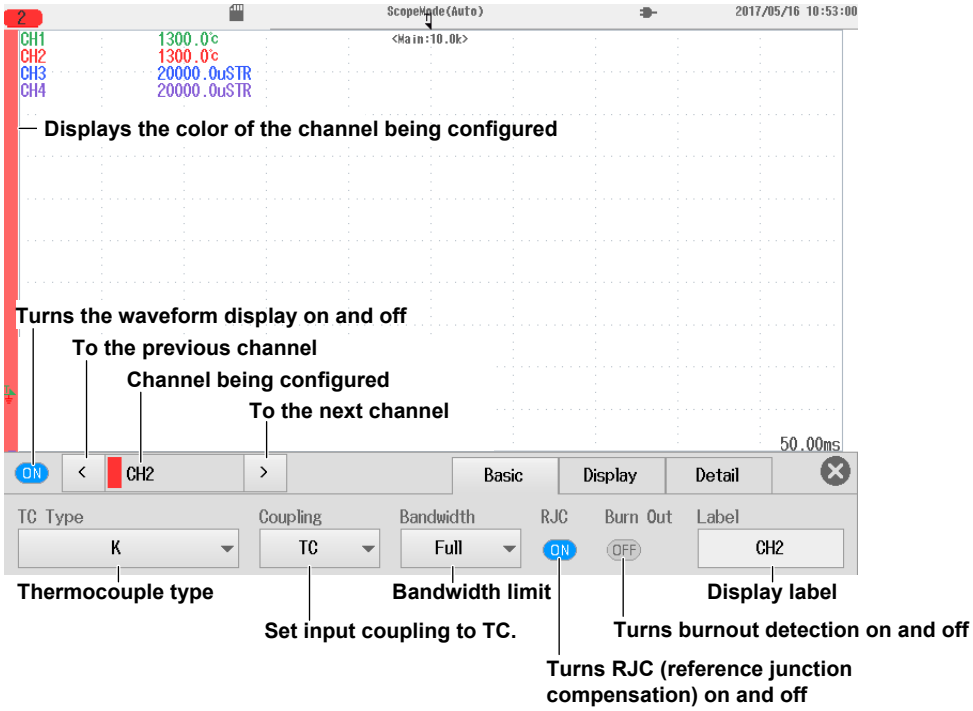
► Features Guide: “Temperature Measurement”

Channel Setting Menu

1. On the waveform screen, tap **MENU** > **Channel** > any channel from **CH1 to CH4**. A channel setting menu appears.
   You can also tap or double-tap any channel from CH1 to CH4 in the channel information area to display the channel setting menu.
   (If the channel is selected, tap; otherwise, double-tap.)

Basic Setup (Basic)

2. Tap the **Basic** tab.
3. Tap each item. Use the displayed list (options) or input box to set the items.



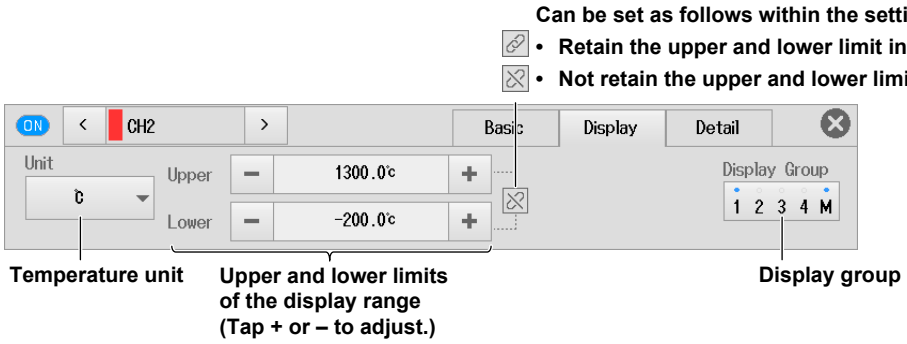
Input Coupling (Coupling)

To measure temperature, set the input coupling to TC.

To measure voltage, set the input coupling to an appropriate voltage measurement setting. ► section 2.2

Configuring the Display (Display)

2. Tap the **Display** tab.
3. Tap each item. Use the displayed list (options) or input box to set the items.



Detail Setting (Detail)

2. Tap the **Detail** tab.

Copying Channels (Copy to)

► section 2.2

Setting the Waveform Vertical and Horizontal Positions (Sliding the waveform screen)

► section 2.2

2.5 Configuring Temperature Measurements (For 16-CH temperature/voltage input modules)

This section explains the following temperature measurement settings for the 16-CH temperature/voltage input module. For voltage measurement settings, see section 2.3.

Items Common to Scope Mode and Recorder Mode

- Data update period
- All sub channel settings
- Basic settings (waveform display on/off, setting input coupling to TC, thermocouple type, display labels, RJC on/off, burnout on/off)
- Display settings (temperature unit, high limit and low limit of the display range, waveform inverted display on/off, display groups)
- Detail settings (channel copying)

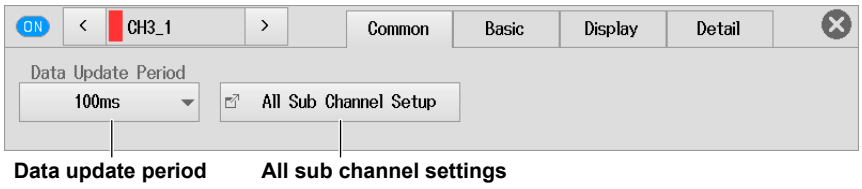
► Features Guide: “Temperature Measurement (For the 16-CH Temperature/Voltage Input Module)”

Sub Channel Setting Menu

1. On the waveform screen, tap **MENU** > **Channel** > **CH1** or **CH3**. A sub channel setting menu appears.
   You can also tap or double-tap a sub channel (if the display label is set to default, the channel number followed by an underscore and a number as in CH3_1) in the channel information area to display the sub channel setting menu.
   (If the channel is selected, tap; otherwise, double-tap.)

Setting the Data Update Period (Data Update Period) and Setting All Sub Channels (All Sub Channel Setup)

2. Tap the **Common** tab.



3. Tap **Data Update Period**. Use the displayed list (options) to set the data update period.
4. Tap **All Sub Channel Setup**. The All Sub Channel Setup screen appears.

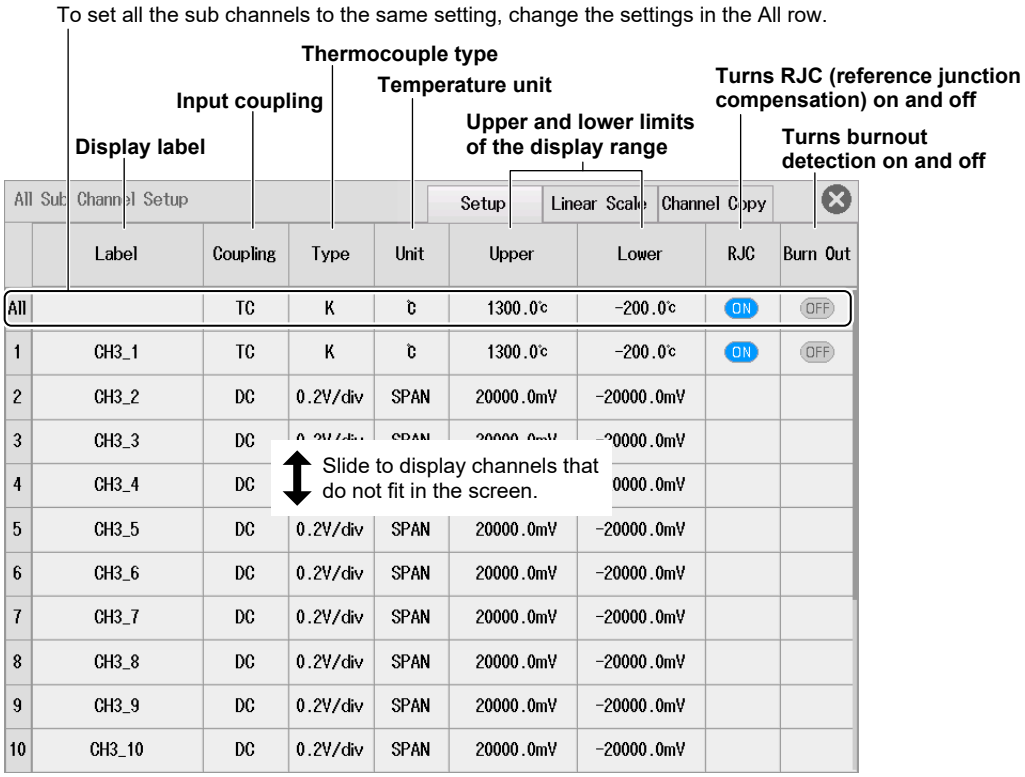
Configuring Input Settings (Setup)

5. Tap the **Setup** tab. An input setting screen appears.

6. Tap the items of each sub channel. Use the displayed list (options) or input box to set the items.

Example of an Input Setting Screen in Scope Mode

- **When the Input Coupling Is Set to TC**



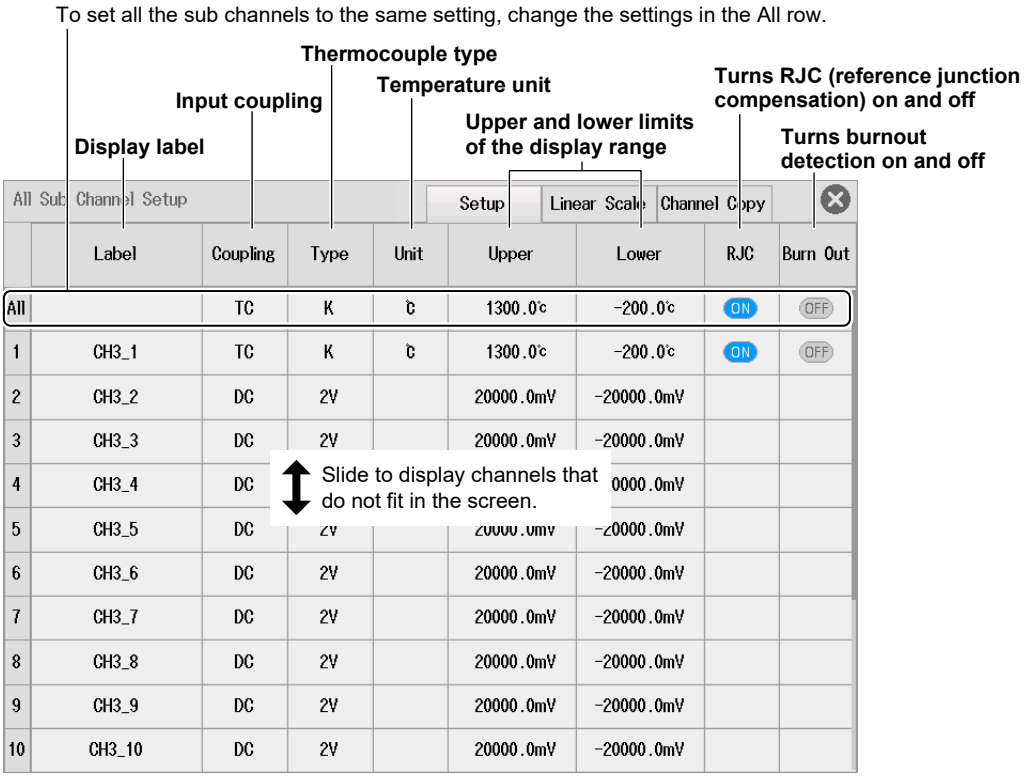
- **When the Input Coupling Is Set to DC, GND, or OFF**

  ► section 2.3

  For the 16-CH temperature/voltage input module, there is no bandwidth limit setting.

Example of an Input Setting Screen in Recorder Mode

- **When the Input Coupling Is Set to TC**



- **When the Input Coupling Is Set to DC, GND, or OFF**

  ► section 2.3

  For the 16-CH temperature/voltage input module, there is no bandwidth limit setting.

Linear Scaling (Linear Scale)

You can set linear scaling on sub channels with the input coupling set to DC, GND, or OFF.

5. Tap the **Linear Scale** tab. The Linear Scale screen appears.

   For details on the settings, see the explanation of linear scaling in section 2.2.

6. Tap the items of each sub channel. Use the displayed list (options) or input box to set the items.

Linear Scaling Screen

► section 2.3

Copying Channels (Channel Copy)

5. Tap the **Channel Copy** tab. The Channel Copy screen appears.
6. Tap each item to set options from the displayed list or execute commands.

Channel Copy Screen

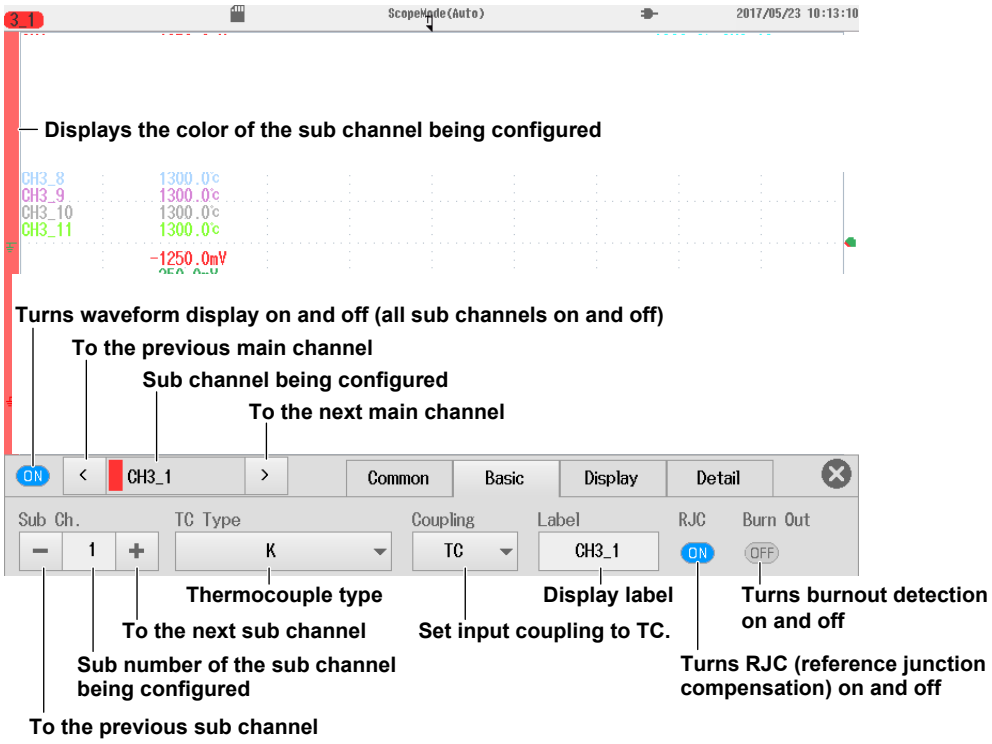
► section 2.3

Copying channels can also be set using **Copy to** on the **Detail** tab.

Basic Setup (Basic)

2. Tap the **Basic** tab.
3. Tap each item. Use the displayed list (options) or input box to set the items.

When the Input Coupling Is Set to TC



When the Input Coupling Is Set to DC, GND, or OFF

► section 2.3

For the 16-CH temperature/voltage input module, there is no bandwidth limit setting.

Configuring the Display (Display)

When the Input Coupling Is Set to TC

► section 2.4

For the sub channel settings (Sub Ch.), see “Basic Setup (Basic)” on the previous page.

When the Input Coupling Is Set to DC, GND, or OFF

► section 2.2

For the sub channel settings (Sub Ch.), see “Basic Setup (Basic)” on the previous page.

Detail Setting (Detail)

► section 2.2

For the 16-CH temperature/voltage input module, there is no gain adjustment or DC offset cancellation setting.

For the sub channel settings, see “Basic Setup (Basic)” on the previous page.

Linear Scaling (Linear Scale)

You can set linear scaling on sub channels with the input coupling set to DC, GND, or OFF.

► section 2.2

Copying Channels (Copy to)

► section 2.3

Copying channels can also be set using **Channel Copy** tab on the **All Sub Channel Setup** screen.

Setting the Waveform Vertical and Horizontal Positions (Sliding the waveform screen)

► section 2.2

2.6 Configuring Strain Measurements

This section explains the following settings for strain measurements:

Items Common to Scope Mode and Recorder Mode

- Basic settings (waveform display on/off, measurement range, bandwidth limit, display labels, sensor settings, strain balancing)
- Display settings (range unit, high limit and low limit of the display range, waveform inverted display on/off, display groups)
- Detail settings (linear scaling, channel copying)

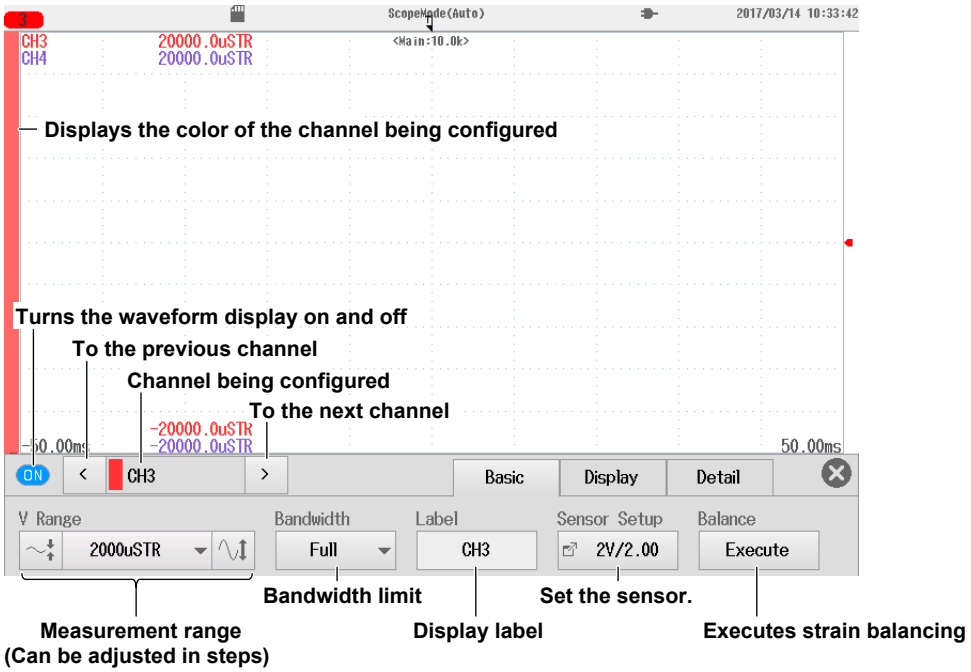
► Features Guide: “Strain Measurement”

Channel Setting Menu

1. On the waveform screen, tap **MENU** > **Channel** > any channel from **CH1 to CH4**. A channel setting menu appears.
   You can also tap or double-tap any channel from CH1 to CH4 in the channel information area to display the channel setting menu.
   (If the channel is selected, tap; otherwise, double-tap.)

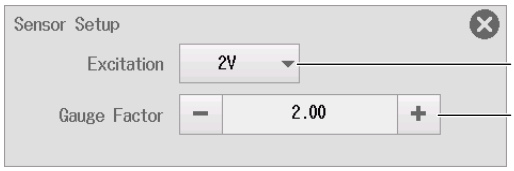
Basic Setup (Basic)

2. Tap the **Basic** tab.
3. Tap each item. Use the displayed list (options) or input box to set the items.



Configuring the Sensor (Sensor Setup)

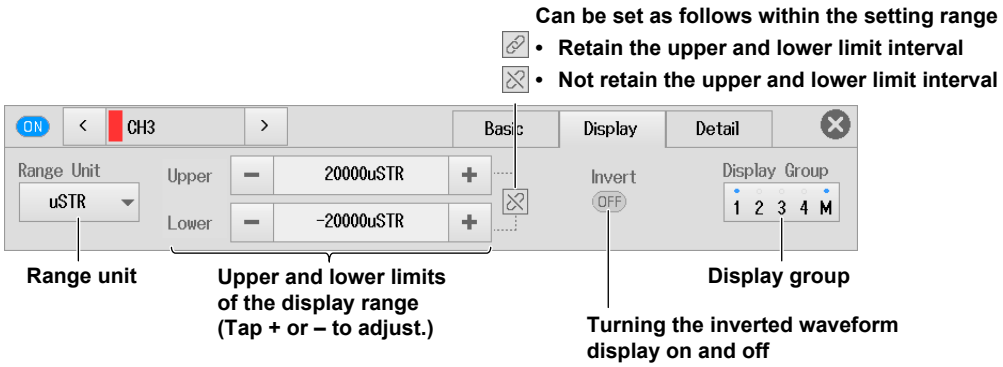
4. Tap **Sensor Setup**. The following screen appears.



Configuring the Display (Display)

2. Tap the **Display** tab.

3. Tap each item. Use the displayed list (options) or input box to set the items.



Range Unit (Range Unit)

- μSTR: Units of strain ($\times 10^{-6}$ strain)
- mV/V: Units of strain-gauge-transducer output
  The mV/V range is calculated from the following equation.
  mV/V = 0.5 × (μSTR/1000)

Detail Setting (Detail)

► section 2.2

For the strain module, there is no gain adjustment or DC offset cancellation setting.

Linear Scaling (Linear Scale)

► section 2.2

Copying Channels (Copy to)

► section 2.2

Setting the Waveform Vertical and Horizontal Positions (Sliding the waveform screen)

► section 2.2

2.7 Configuring Acceleration Measurements

This section explains the following settings for acceleration measurements:

For Scope Mode

- Basic settings (waveform display on/off, gain, setting the input coupling to ACCEL, bandwidth limit, bias current supply to the acceleration sensor on and off, display labels)
- Display settings (vertical scale (zoom method), vertical position, vertical zoom (zooming by setting the magnification), zooming by setting the high limit and low limit of the display range, unit of acceleration, display groups)
- Detail settings (copying channels, acceleration sensor sensitivity)

For Recorder Mode

- Basic settings (waveform display on/off, gain, setting the input coupling to ACCEL, bandwidth limit, bias current supply to the acceleration sensor on and off, display labels)
- Display settings (high limit and low limit of the display range, unit of acceleration, display groups)
- Detail settings (copying channels, acceleration sensor sensitivity)

► Features Guide: “Acceleration Measurement”

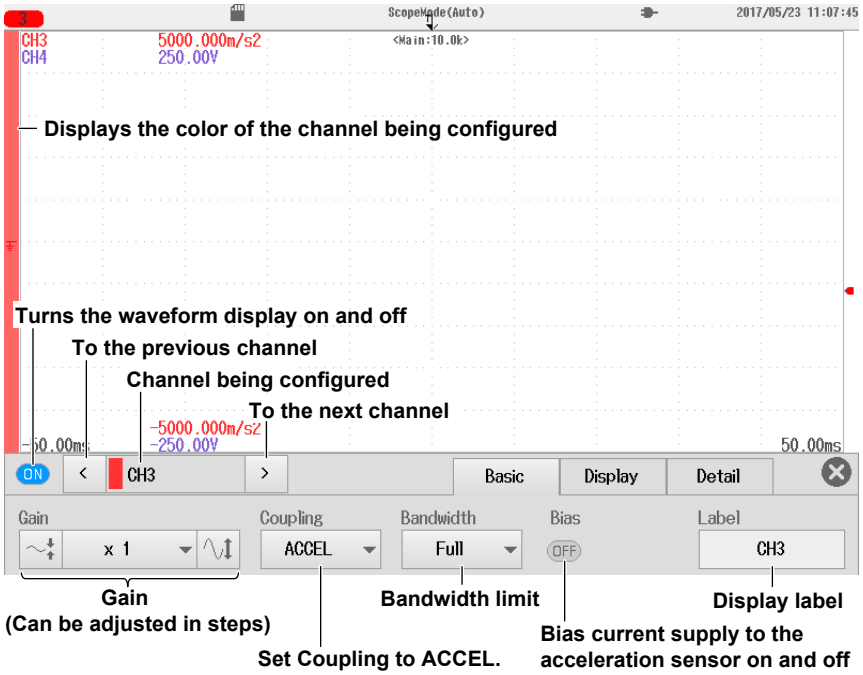
Channel Setting Menu

1. On the waveform screen, tap **MENU** > **Channel** > any channel from **CH1 to CH4**. A channel setting menu appears.
   You can also tap or double-tap any channel from CH1 to CH4 in the channel information area to display the channel setting menu.
   (If the channel is selected, tap; otherwise, double-tap.)

Basic Setup (Basic)

2. Tap the **Basic** tab.
3. Tap each item. Use the displayed list (options) or input box to set the items.

Items Common to Scope Mode and Recorder Mode



Input Coupling (Coupling)

To measure acceleration, set the input coupling to ACCEL.

To measure voltage, set the input coupling to an appropriate voltage measurement setting.

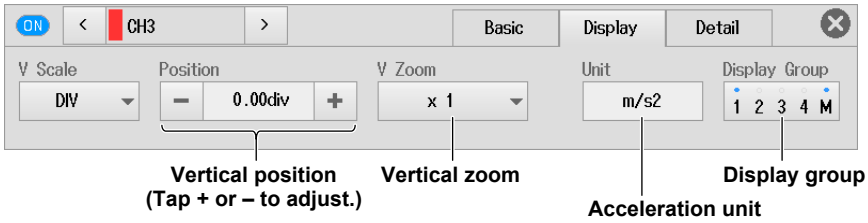
► section 2.2

Configuring the Display (Display)

2. Tap the **Display** tab.
3. Tap each item. Use the displayed list (options) or input box to set the items.

For Scope Mode

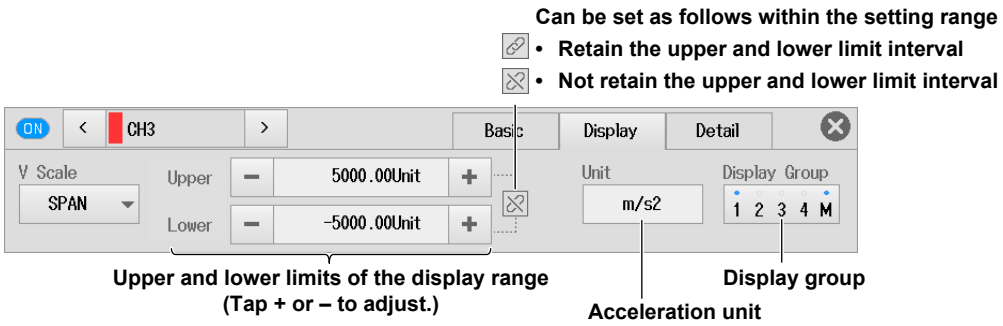
When V Scale (vertical scale) Is Set to DIV



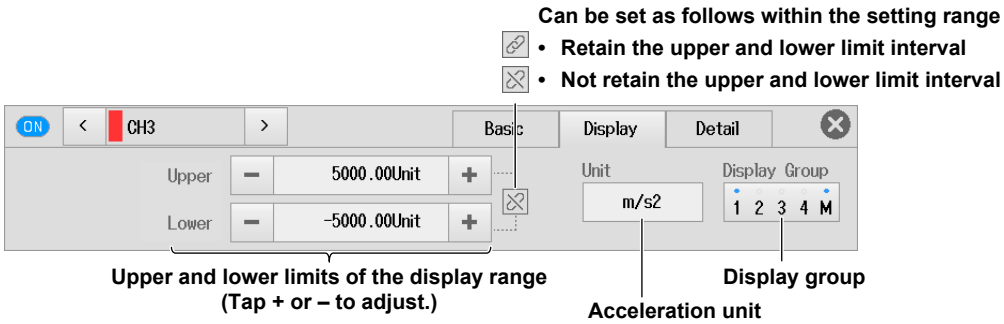
The vertical position can be moved also by tapping the up and down arrows that appear when you slide the waveform screen.

► section 2.2

When V Scale (vertical scale) Is Set to SPAN



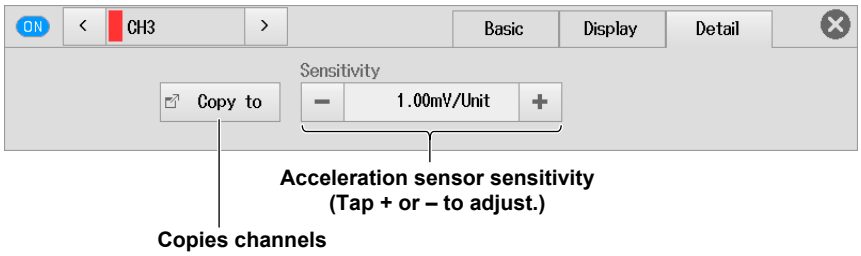
For Recorder Mode



Detail Setting (Detail)

2. Tap the **Detail** tab.
3. Tap each item. Use the displayed list (options) or input box to set the items.

Items Common to Scope Mode and Recorder Mode



Copying Channels (Copy to)

► section 2.2

Setting the Waveform Vertical and Horizontal Positions (Sliding the waveform screen)

► section 2.2

2.8 Configuring Frequency, Revolution, Period, Duty Cycle, Power Supply Frequency, Pulse Width, Pulse Integration, and Velocity Measurements

This section explains the following settings for frequency, revolution, period, duty cycle, power supply frequency, pulse width, pulse integration, and velocity measurements:

For Scope Mode

- Basic settings (waveform display on/off, vertical scale, FV setup (measurement item), display labels, input setup)
- Display settings (vertical scale (zoom method), vertical position, vertical zoom (zooming by setting the magnification), zooming by setting the high limit and low limit of the display range, display groups)
- Detail settings (linear scaling, channel copying)

For Recorder Mode

- Basic settings (waveform display on/off, measurement range, FV setup (measurement item), display labels, input setup)
- Display settings (high limit and low limit of the display range, display groups)
- Detail settings (linear scaling, channel copying)

► Features Guide: “Frequency Measurement”

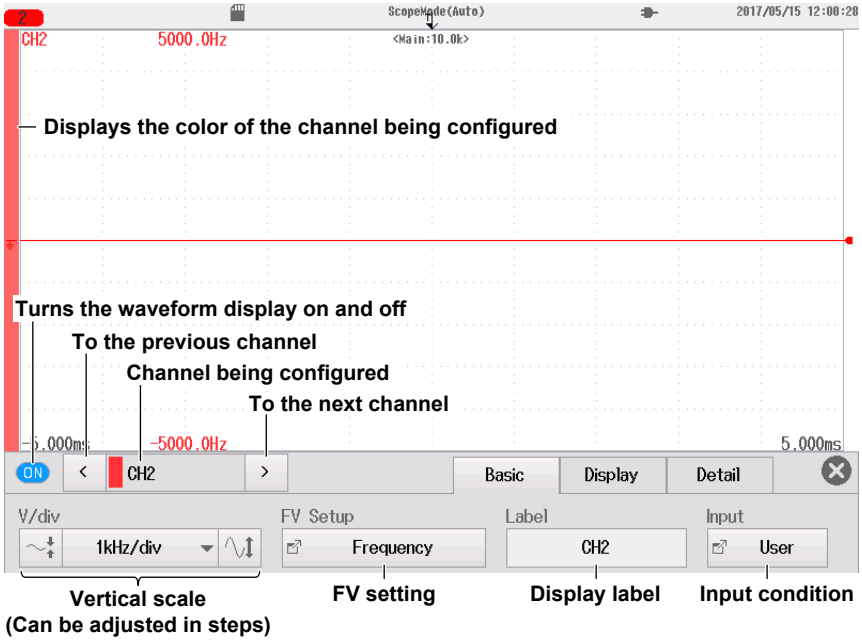
Channel Setting Menu

1. On the waveform screen, tap **MENU** > **Channel** > any channel from **CH1 to CH4**. A channel setting menu appears.
   You can also tap or double-tap any channel from CH1 to CH4 in the channel information area to display the channel setting menu.
   (If the channel is selected, tap; otherwise, double-tap.)

Basic Setup (Basic)

2. Tap the **Basic** tab.
3. Tap each item. Use the displayed list (options) or input box to set the items.

For Scope Mode



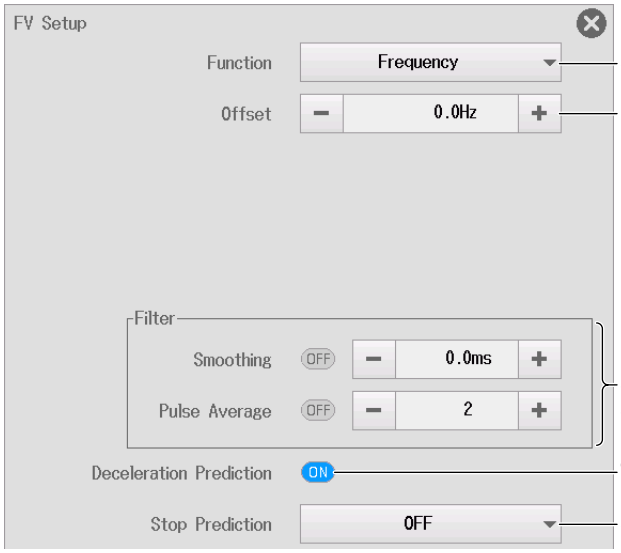
For Recorder Mode

FV Setup (FV Setup)

4. Tap **FV Setup**. The following screen appears.

5. Tap each item. Use the displayed list (options) or input box to set the items.

- **When the measurement item is Frequency**



Set to Frequency.

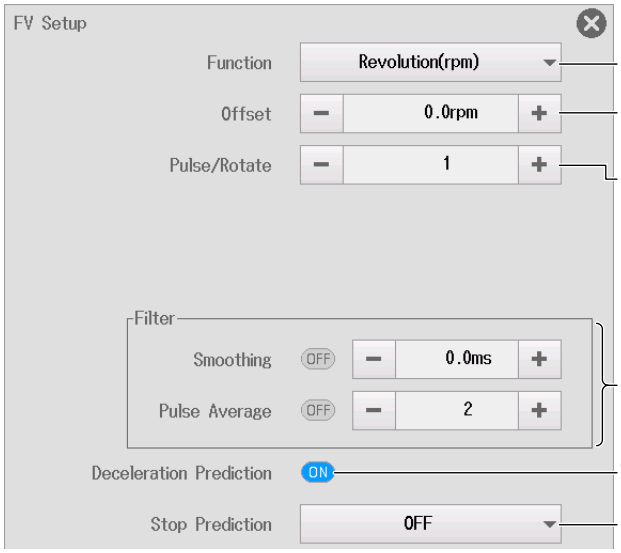
Offset (Tap + or – to adjust.)
(This item is not available in recorder mode.)

Filter (Tap + or – to adjust.)
- **Smoothing**
- **Pulse average**

Turns decelerating prediction on and off

Stop prediction

- **When the measurement item is Revolution (rpm)**



Set to Revolution (rpm).

Offset (Tap + or – to adjust.)
(This item is not available in recorder mode.)

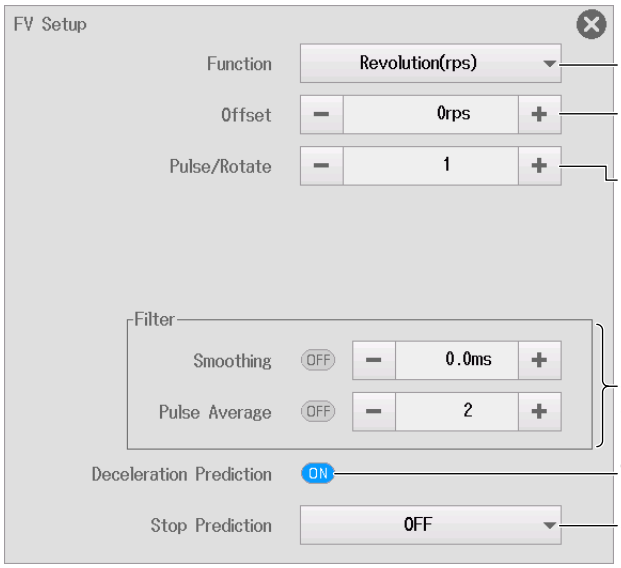
Pulse/rotate (Tap + or – to adjust.)
(Number of pulses per rotation)

Filter (Tap + or – to adjust.)
- **Smoothing**
- **Pulse average**

Turns decelerating prediction on and off

Stop prediction

- **When the measurement item is Revolution (rps)**



Set to Revolution (rps).

Offset (Tap + or – to adjust.)
(This item is not available in recorder mode.)

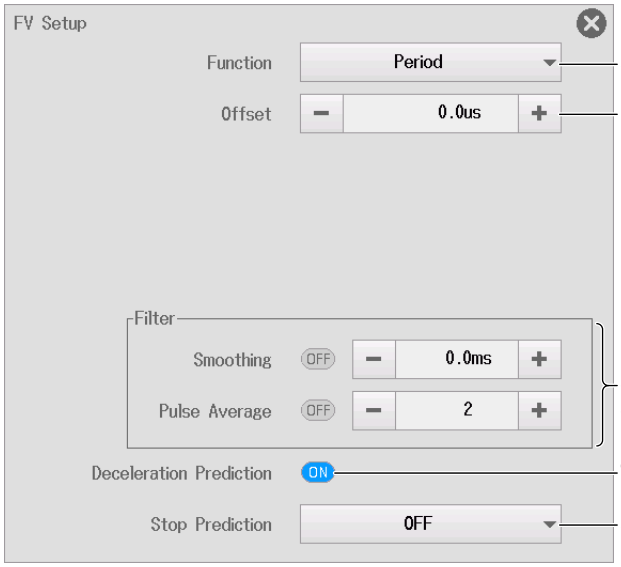
Pulse/rotate (Tap + or – to adjust.)
(Number of pulses per rotation)

Filter (Tap + or – to adjust.)
- **Smoothing**
- **Pulse average**

Turns decelerating prediction on and off

Stop prediction

- **When the measurement item is Period**



Set to Period.

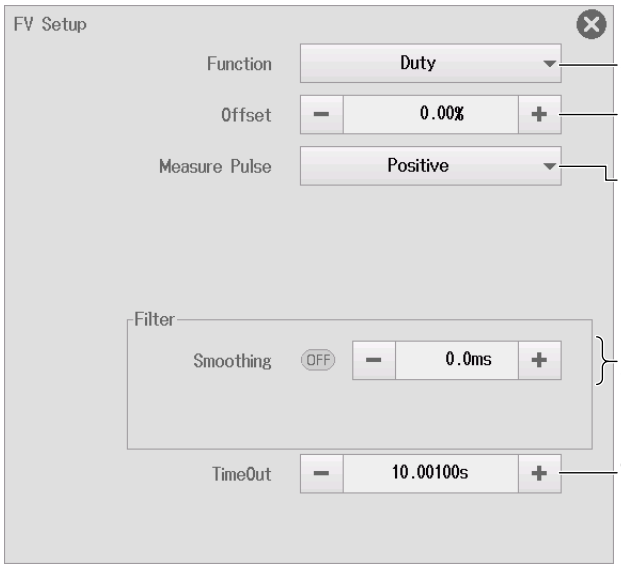
Offset (Tap + or – to adjust.)
(This item is not available in recorder mode.)

Filter (Tap + or – to adjust.)
- **Smoothing**
- **Pulse average**

Turns decelerating prediction on and off

Stop prediction

- **When the measurement item is Duty**



Set to Duty.

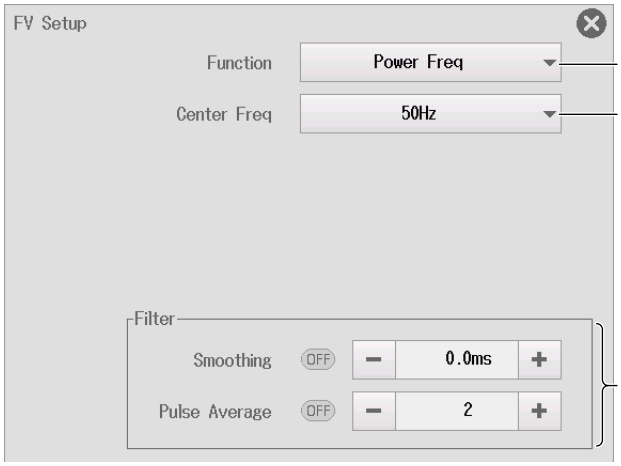
Offset (Tap + or – to adjust.)
(This item is not available in recorder mode.)

Measurement pulse selection

Filter (Tap + or – to adjust.)
- **Smoothing**

Timeout period (Tap + or – to adjust.)

- **When the measurement item is Power Freq**

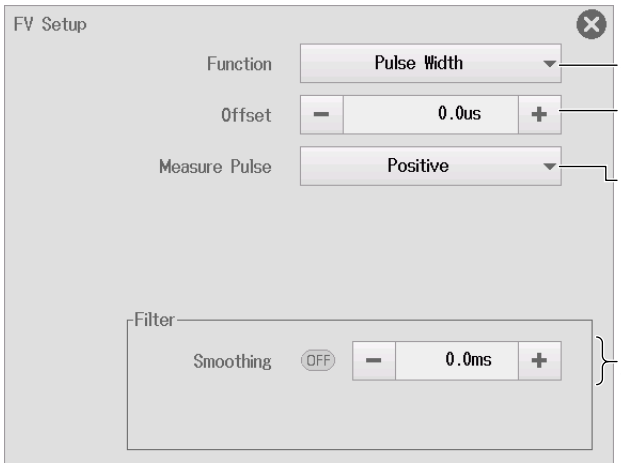


Set Function to Power Freq.

Center frequency

Filter (Tap + or – to adjust.)
- **Smoothing**
- **Pulse average**

- **When the measurement item is Pulse Width**



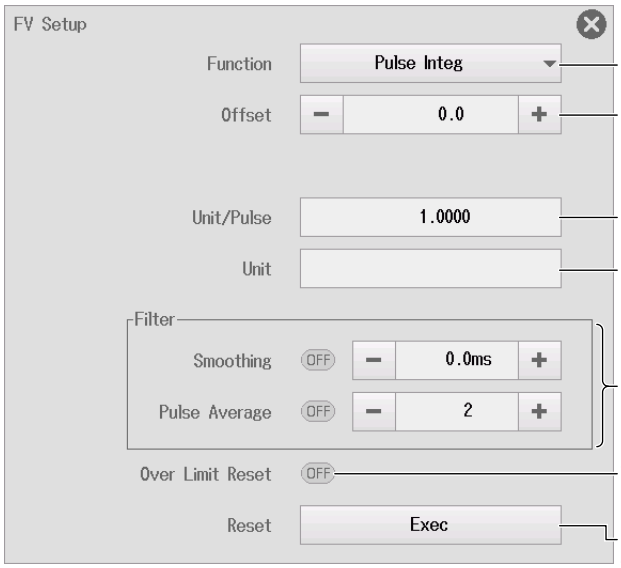
Set to Pulse Width.

Offset (Tap + or – to adjust.)
(This item is not available in recorder mode.)

Measurement pulse selection

Filter (Tap + or – to adjust.)
- **Smoothing**

- **When the measurement item is Pulse Integ**



Set to Pulse Integ.

Offset (Tap + or – to adjust.)
(This item is not available in recorder mode.)

Unit/pulse (Physical amount per pulse)

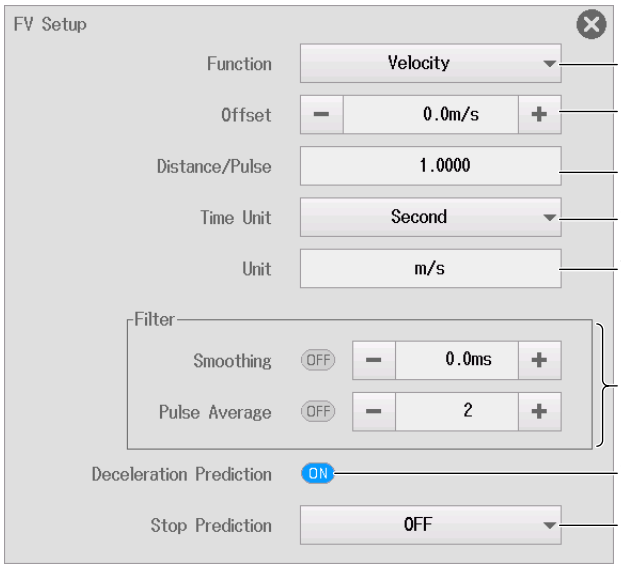
Pulse integration unit

Filter (Tap + or – to adjust.)
- **Smoothing**
- **Pulse average**

Turns auto reset at pulse count overflow on and off

Executes the manual reset of the pulse count

- **When the measurement item is Velocity**



Set to Velocity.

Offset (Tap + or – to adjust.)
(This item is not available in recorder mode.)

Distance/pulse (Distance per pulse)

Time unit

Velocity unit

Filter (Tap + or – to adjust.)
- **Smoothing**
- **Pulse average**

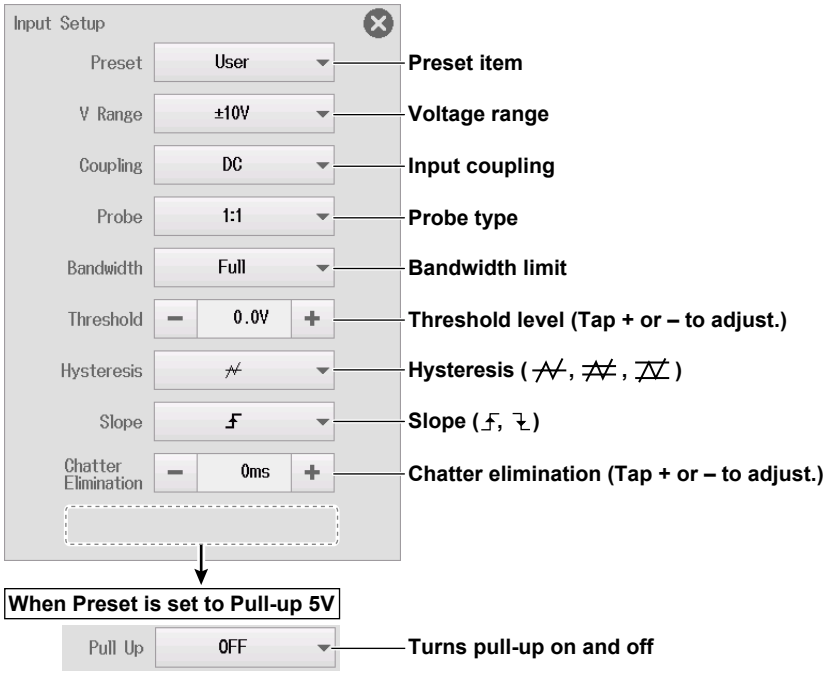
Turns decelerating prediction on and off

Stop prediction

Input Setup (Input Setup)

4. Tap **Input**. The following screen appears.

5. Tap each item. Use the displayed list (options) or input box to set the items.



Setting Preset Items

You can set the preset to one of the following 10 options: Logic 5V, Logic 3V, Logic 12V, Logic 24V, Pull-up 5V, ZeroCross, AC100V, AC200V, EM Pickup, or User (user-defined).
The settable input items differ depending on the preset that you set. You can only turn pull-up on and off when the preset is set to Pull-up 5V.

Configuring the Display (Display)

For Scope Mode

► section 2.2

- There are no inverted waveform display items.
- If the FV setup measurement item is Power Freq, V Scale is fixed to DIV, so no options will appear.
- If the FV setup measurement item is Pulse Integ or Velocity, the setting for retaining the upper and lower limit interval for when V Scale is set to SPAN is not available.

For Recorder Mode

► section 2.2

- There are no inverted waveform display items.
- If the FV setup measurement item is Power Freq, the same vertical position and vertical zoom menu as scope mode is displayed.
- If the FV setup measurement item is Pulse Integ or Velocity, the setting for retaining the upper and lower limit interval is not available.

Detail Settings (Detail)

Items Common to Scope Mode and Recorder Mode

► section 2.2

- There are no gain adjustment and DC offset items.
- The linear scaling setting menu does not have the display mode item.

Setting the Waveform Vertical and Horizontal Positions (Sliding the waveform screen)

► section 2.2

2.9 Configuring Logic Signal Measurements

This section explains the following settings for logic measurements:

Items Common to Scope Mode and Recorder Mode

- Basic settings (waveform display on/off, display labels, bit settings, copying channels)
- Display settings (vertical position, vertical zoom (zooming by setting the magnification), bit mapping, display groups)

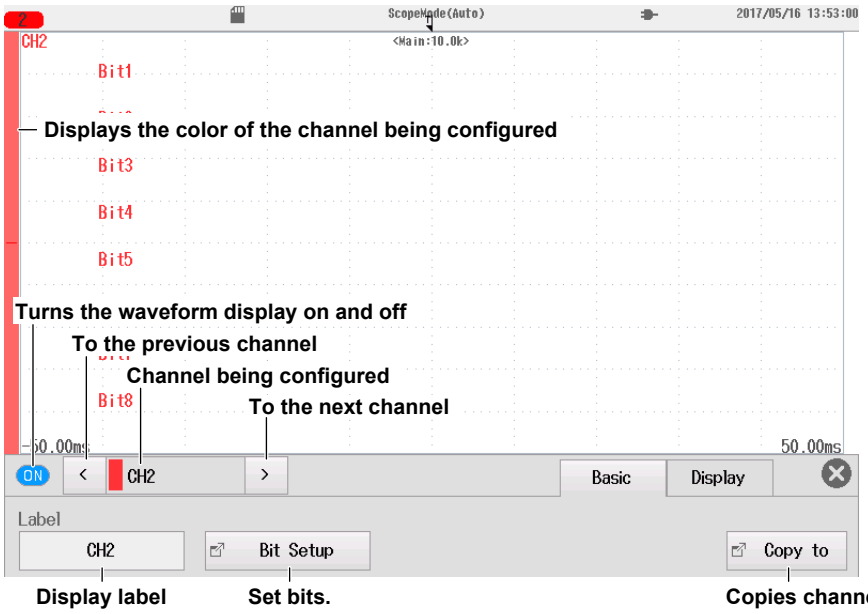
► Features Guide: “Logic Measurement”

Channel Setting Menu

1. On the waveform screen, tap **MENU** > **Channel** > any channel from **CH1 to CH6**. A channel setting menu appears.
   You can also tap or double-tap any channel from CH1 to CH6 in the channel information area to display the channel setting menu.
   (If the channel is selected, tap; otherwise, double-tap.)

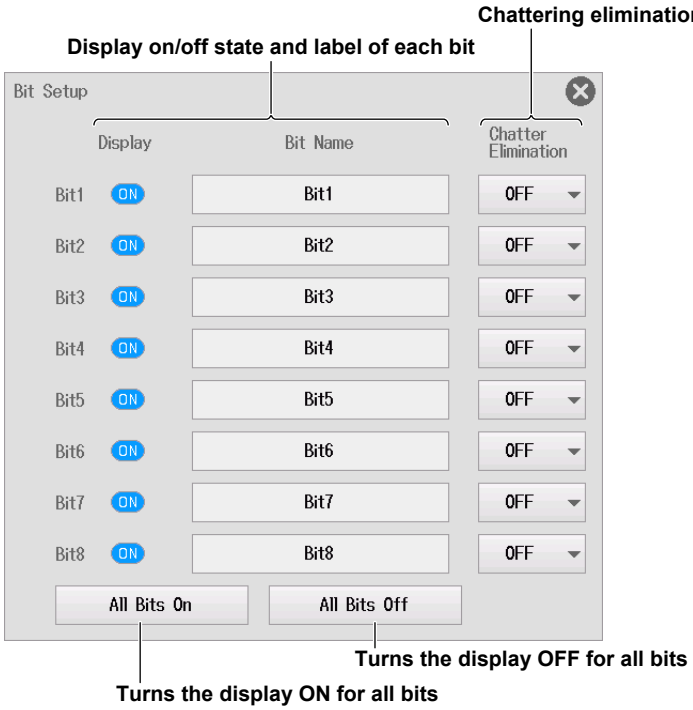
Basic Setup (Basic)

2. Tap the **Basic** tab.
3. Tap each item. Use the displayed list (options) or input box to set the items.



Bit Settings (Bit Setup)

4. Tap **Bit Setup**. The following screen appears.
5. Tap each item. Use the displayed list (options) or input box to set the items.

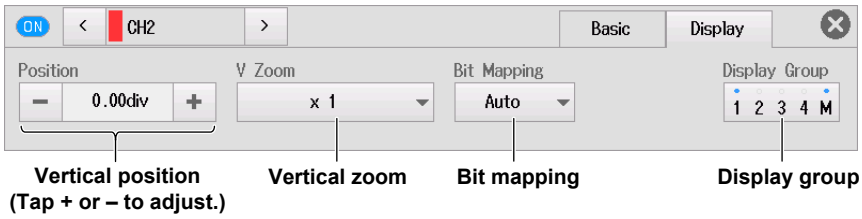


Copying Channels (Copy to)

► section 2.2

Configuring the Display (Display)

2. Tap the **Display** tab.
3. Tap each item. Use the displayed list (options) or input box to set the items.



Setting the Waveform Vertical and Horizontal Positions (Sliding the waveform screen)

► section 2.2

2.10 Configuring the Monitoring of CAN and CAN FD Bus Signals (/VE option)

This section explains the following settings for monitoring CAN and CAN FD bus signals:

Items Common to Scope Mode and Recorder Mode

- CAN port configuration (waveform display on/off, port and all sub channel settings, loading CAN/CAN FD data definition files, scaling all sub channels)
- Display settings (display range of each sub channel, scaling each sub channel, vertical position of each sub channel, vertical zoom of each sub channel (zooming by setting the magnification), display groups)
- One shot output

► Features Guide: “CAN and CAN FD Bus Signal Monitoring”

Channel Setting Menu

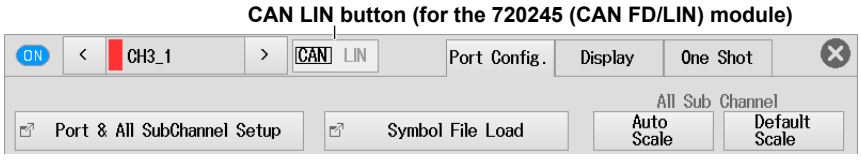
1. On the waveform screen, tap **MENU** > **Channel** > any channel from **CH1 to CH4**. A channel setting menu appears.

   You can also tap or double-tap any channel from CH1 to CH4 in the channel information area to display the channel setting menu.
   (If the channel is selected, tap; otherwise, double-tap.)

Selecting the Bus Signal (for the 720245(CAN FD/LIN) module)

2. Tap the CAN LIN button to set the bus type to CAN.

   If the button is set to CAN LIN , CAN is already selected, so you do not need to carry out this step.

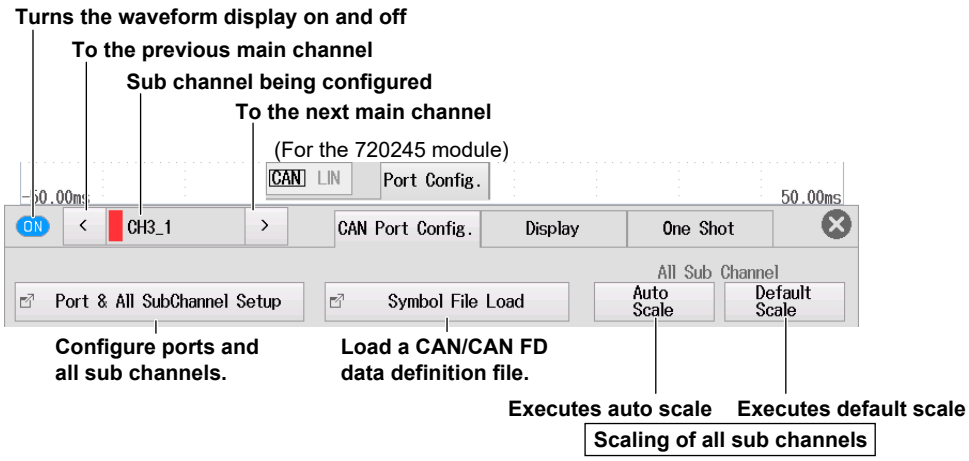


CAN Port Configuration (CAN Port Config or Port Config*)

3. Tap the **CAN Port Config.** tab.

   * For the 720245(CAN FD/LIN) module, tap the Port Config tab.

4. Tap each item to set options and execute commands.



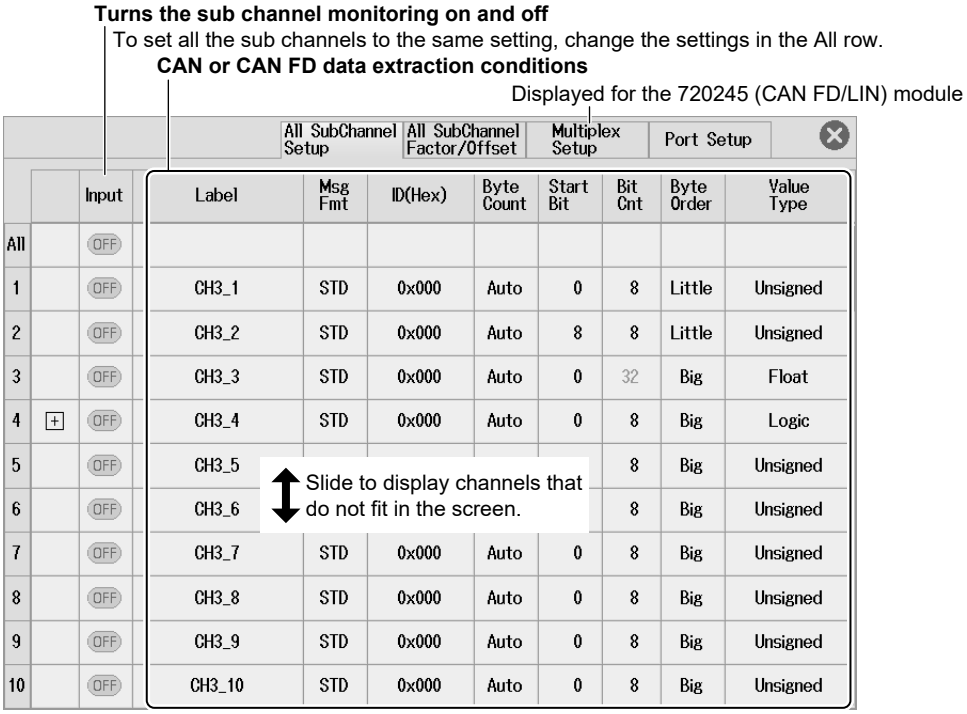
Port and All Sub Channel Settings (Port & All SubChannel Setup)

5. Tap **Port & All SubChannel Setup**. A Port & All SubChannel Setup screen appears.

All Sub Channel Setup (All SubChannel Setup - CAN or CAN FD Data Extraction Conditions)

6. Tap the **All SubChannel Setup** tab. The following screen appears.

7. Tap each item. Use the displayed list (options) or input box to set the items.

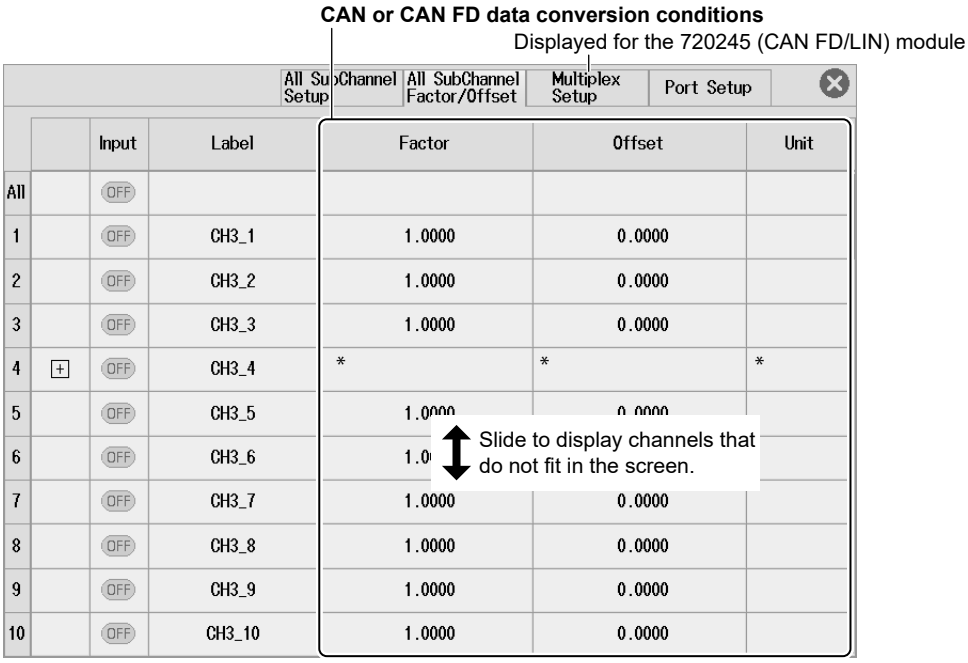


		Input	Label	Msg Fmt	ID(Hex)	Byte Count	Start Bit	Bit Cnt	Byte Order	Value Type
All		OFF								
1		OFF	CH3_1	STD	0x000	Auto	0	8	Little	Unsigned
2		OFF	CH3_2	STD	0x000	Auto	8	8	Little	Unsigned
3		OFF	CH3_3	STD	0x000	Auto	0	32	Big	Float
4	⊞	OFF	CH3_4	STD	0x000	Auto	0	8	Big	Logic
5		OFF	CH3_5					8	Big	Unsigned
6		OFF	CH3_6					8	Big	Unsigned
7		OFF	CH3_7	STD	0x000	Auto	0	8	Big	Unsigned
8		OFF	CH3_8	STD	0x000	Auto	0	8	Big	Unsigned
9		OFF	CH3_9	STD	0x000	Auto	0	8	Big	Unsigned
10		OFF	CH3_10	STD	0x000	Auto	0	8	Big	Unsigned

All Sub Channel Factor/Offset (All SubChannel Factor/Offset - CAN or CAN FD Data Conversion Condition)

6. Tap the **All SubChannel Factor/Offset** tab. The following screen appears.

7. Tap each item. Use the displayed input box to set the items.



		Input	Label	Factor	Offset	Unit
All		OFF				
1		OFF	CH3_1	1.0000	0.0000	
2		OFF	CH3_2	1.0000	0.0000	
3		OFF	CH3_3	1.0000	0.0000	
4	⊞	OFF	CH3_4	*	*	*
5		OFF	CH3_5	1.0000	0.0000	
6		OFF	CH3_6	1.0		
7		OFF	CH3_7	1.0000	0.0000	
8		OFF	CH3_8	1.0000	0.0000	
9		OFF	CH3_9	1.0000	0.0000	
10		OFF	CH3_10	1.0000	0.0000	

* You cannot set Factor, Offset, or Unit when the data type (Value Type) is set to Logic.

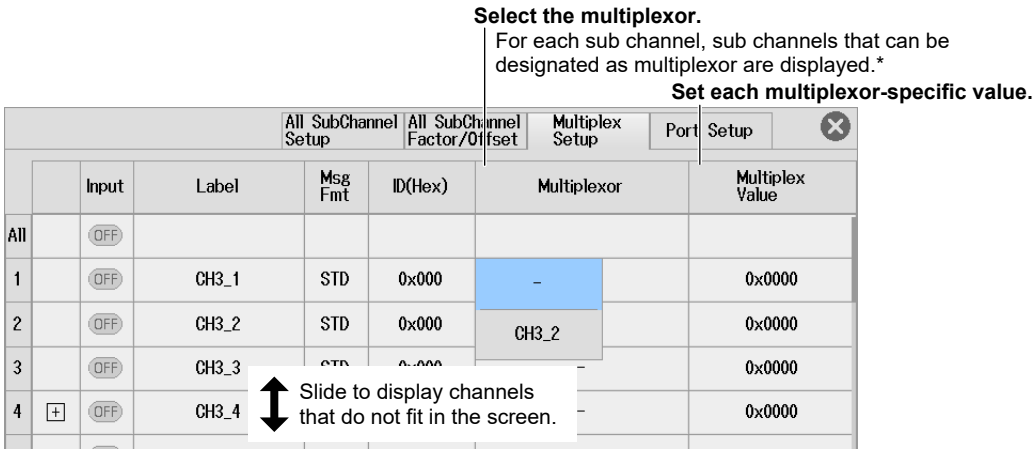
Setting Multiplexing (Multiplex Setup: multiplexed data acquisition setting)

Set this item for the 720245 (CAN FD/LIN) module.

6. Tap the Multiplex Setup tab. The following screen appears.

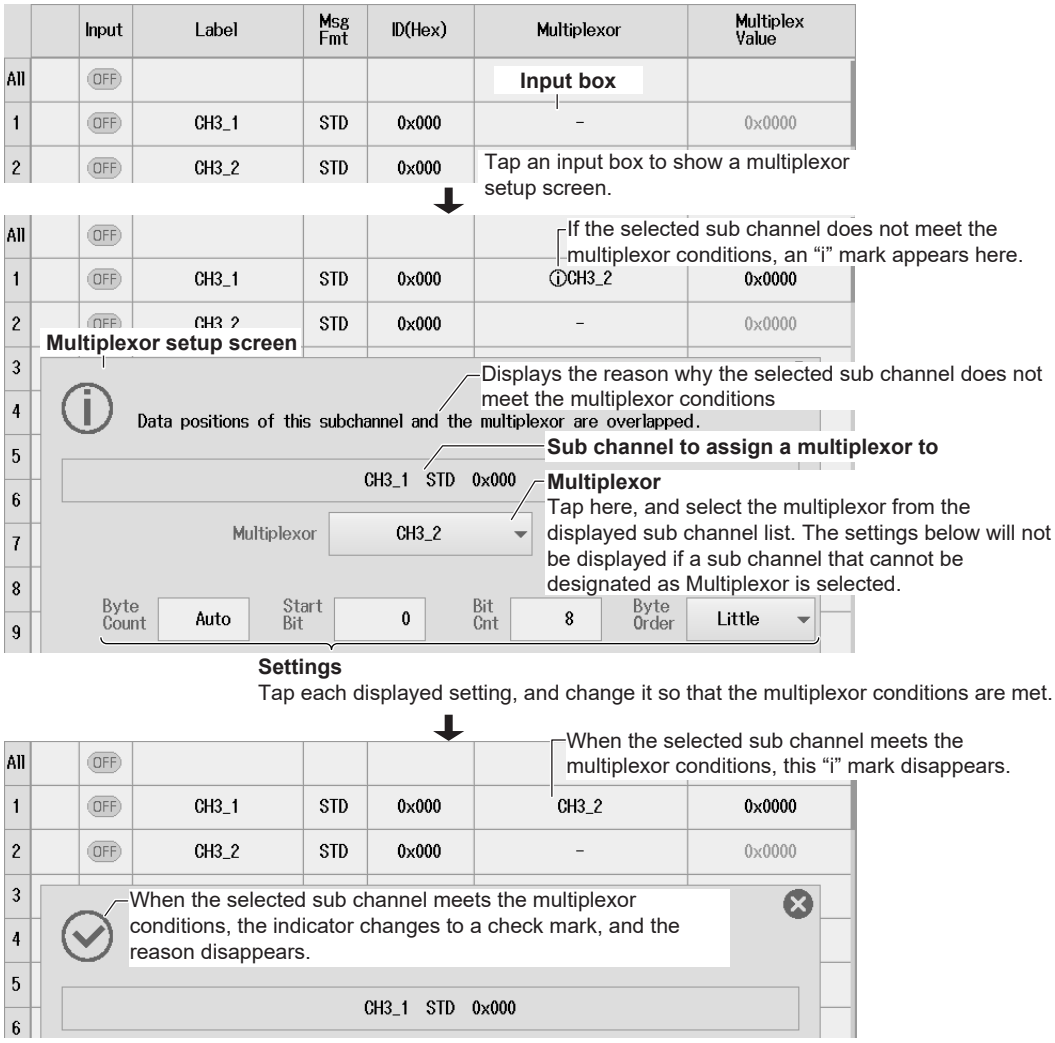
7. Tap each item. Use the displayed input box to set the items.

- **When there are sub channels that can be designated as multiplexor**



* For multiplexor conditions, see “CAN and CAN FD Bus Signal Monitoring” in the Features Guide.

- **When there are no sub channels that can be designated as multiplexor**

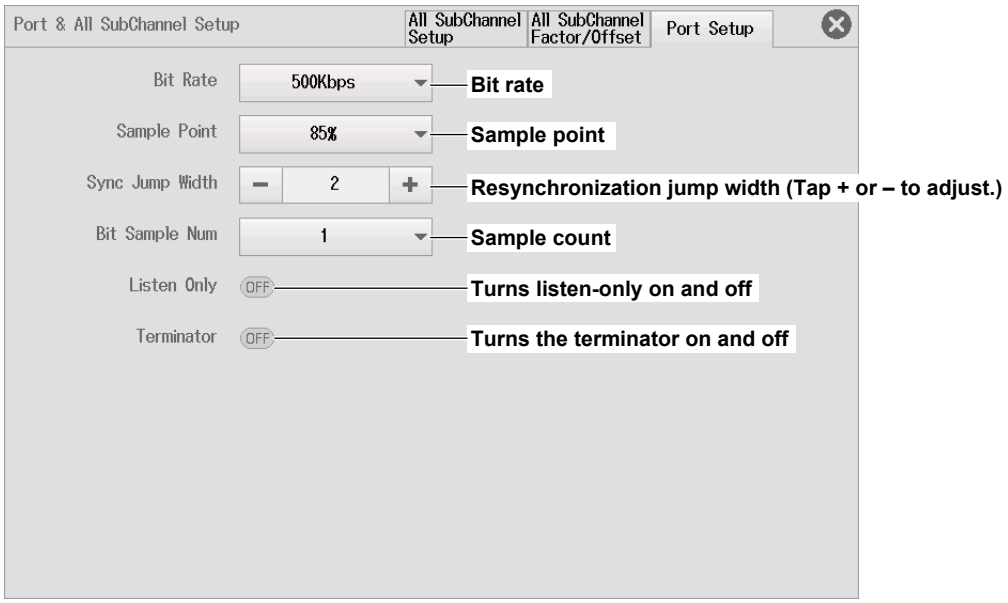


Port Settings (Port Setup)

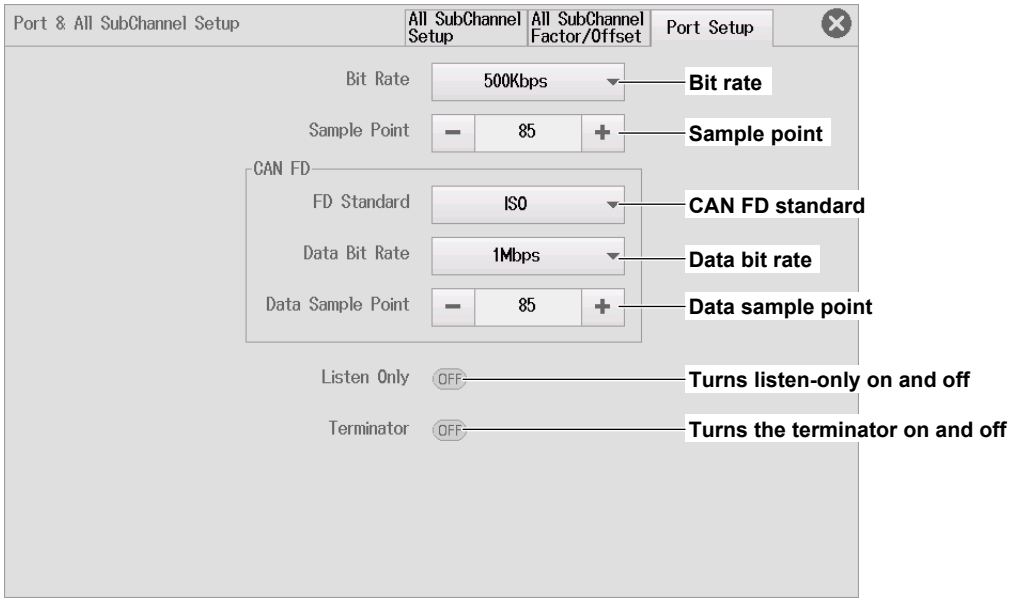
6. Tap the **Port Setup** tab. The following screen appears.

7. Tap each item. Use the displayed list (options) or input box to set the items.

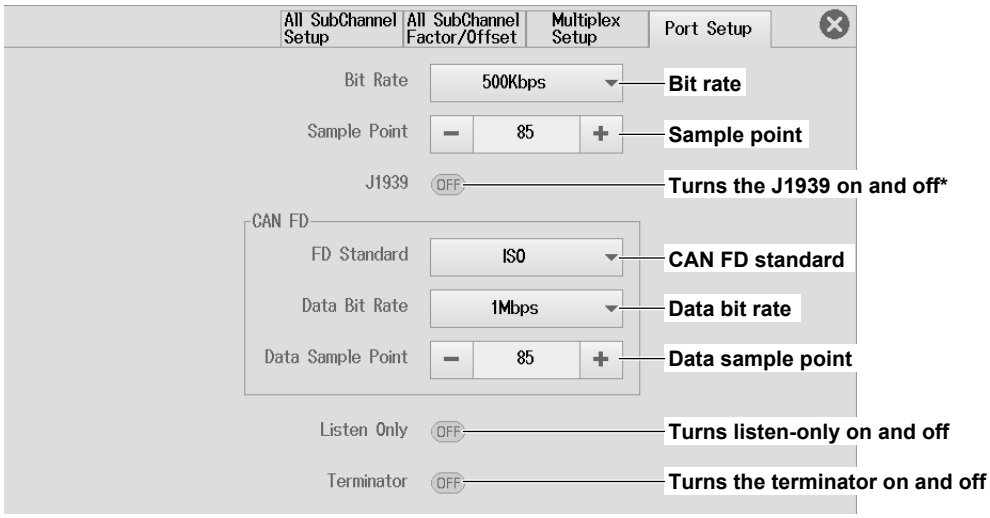
- **CAN Bus Signal Monitoring (for the 720240 (CAN MONITOR), 720241 (CAN & LIN) modules)**



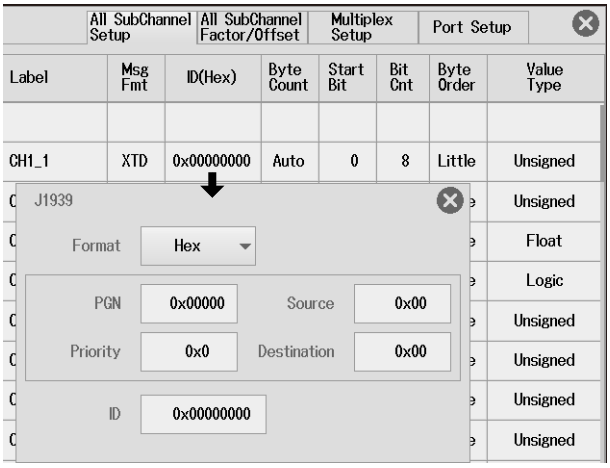
- **CAN and CAN FD Bus Signal Monitoring (for the 720242 (CAN/CAN FD) module)**



- **CAN and CAN FD Bus Signal Monitoring (for the 720245 (CAN FD/LIN) module)**



* When J1939 is ON, IDs supported by J1939 can be used as the ID (Hex) for All SubChannel Setup (All SubChannel Setup), expanding the Start Bit setting range. Msg Fmt is fixed to XTD and Byte Order to Little. For details on the IDs supported by J1939 and the Start Bit setting range, see “CAN and CAN FD Bus Signal Monitoring” in the Features Guide.



Loading a CAN/CAN FD Data Definition File (Symbol File Load)

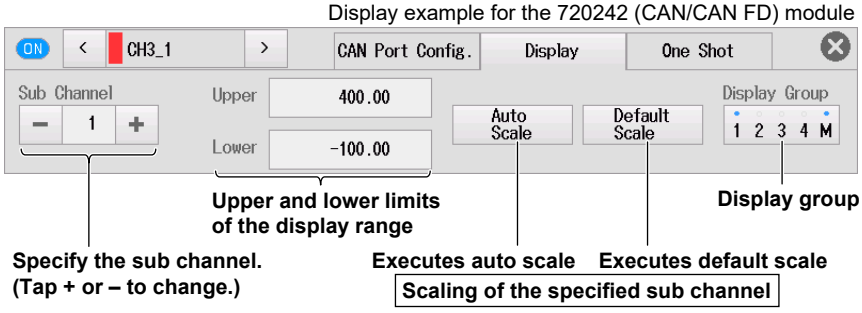
5. Tap **Symbol File Load**. A file list appears.
6. On the file list, tap a symbol file (SBL file).
   For details on file list operations, see section 6.10.
7. Select the load destination channel.
   ► section 6.9
8. Tap **Load**. A confirmation message appears.
9. Tap **OK**. The symbol file is loaded.

Sub Channel Display Settings (Display)

3. Tap the **Display** tab.
4. Tap each item. Use the displayed list (options) or input box to set the items.

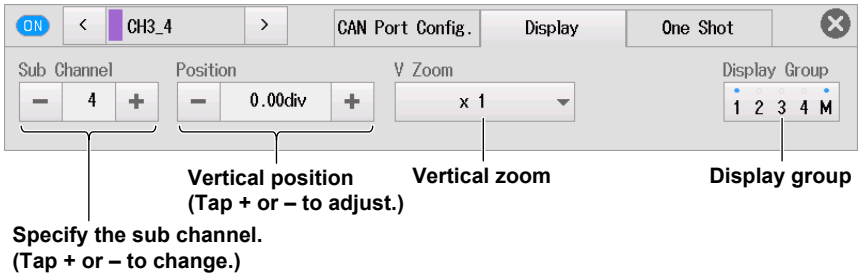
When the Data Type (Value Type) Is Unsigned, Signed, or Float

Display example for the 720242 (CAN/CAN FD) module



When the Data Type (Value Type) is Logic

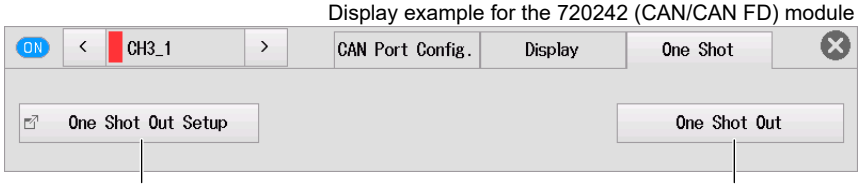
Display example for the 720242 (CAN/CAN FD) module



One Shot Output (One shot)

3. Tap the **One Shot** tab.
4. Tap each item to set options and execute commands.

Display example for the 720242 (CAN/CAN FD) module



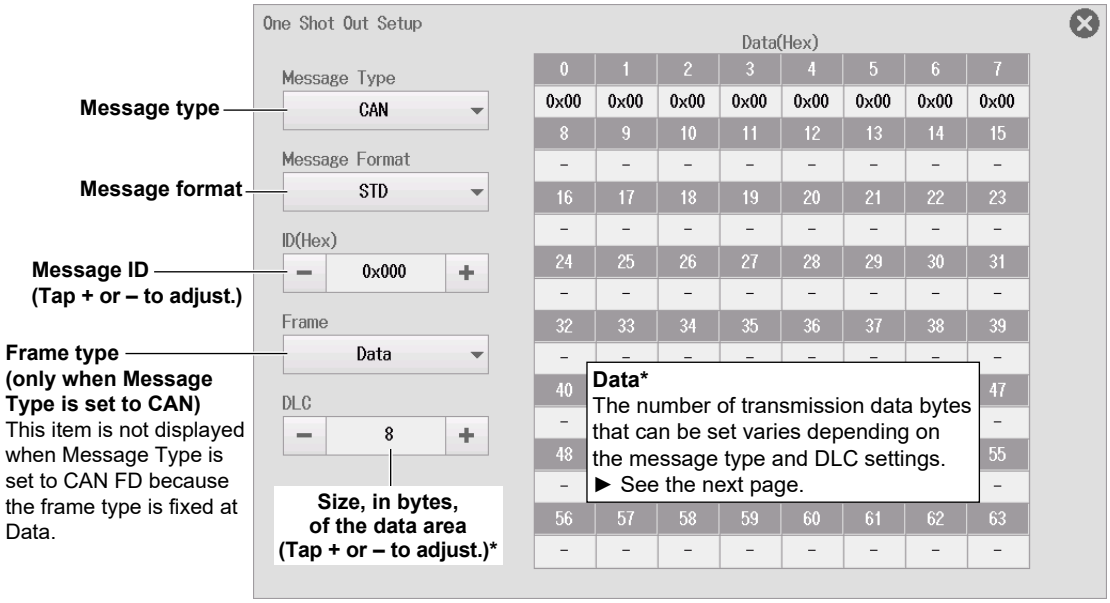
One Shot Output Settings (One Shot Out Setup)

5. Tap **One Shot Out Setup**. A One Shot Out Setup screen appears.

CAN Frame One-Shot Output (for the 720240 (CAN MONITOR), 720241 (CAN & LIN) modules)

* These are the items you set when the frame type is set to data (Data).

CAN or CAN FD Frame One-Shot Output (for the 720242 (CAN/CAN FD), 720245 (CAN FD/LIN) module)



* These are the items you set when the frame type is set to data (Data).

DLC value and the number of transmission data bytes

When DLC = 0 to 8

DLC	Number of Data Bytes	
	CAN	CAN FD
0	0	0
1	1	1
2	2	2
3	3	3
4	4	4
5	5	5
6	6	6
7	7	7
8	8	8

DLC	0	1	2	3	4	5	6	7
0	–	–	–	–	–	–	–	–
1	0x00	–	–	–	–	–	–	–
2	0x00	0x00	–	–	–	–	–	–
3	0x00	0x00	0x00	–	–	–	–	–
4	0x00	0x00	0x00	0x00	–	–	–	–
5	0x00	0x00	0x00	0x00	0x00	–	–	–
6	0x00	0x00	0x00	0x00	0x00	0x00	–	–
7	0x00	0x00	0x00	0x00	0x00	0x00	0x00	–
8	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00

When DLC ≥ 9

- When the message type is CAN

DLC	Number of Data Bytes
9 to 15	8

- When the message type is CAN FD

DLC	Number of Data Bytes
9	12
10	16
11	20
12	24
13	32
14	48
15	64

DLC	0	1	2	3	4	5	6	7
9	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00
	8	9	10	11	12	13	14	15
	0x00	0x00	0x00	0x00	–	–	–	–
	16	17	18	19	20	21	22	23
	–	–	–	–	–	–	–	–
10	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00
	8	9	10	11	12	13	14	15
	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00
	16	17	18	19	20	21	22	23
	–	–	–	–	–	–	–	–
11	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00
	8	9	10	11	12	13	14	15
	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00
	16	17	18	19	20	21	22	23
	0x00	0x00	0x00	0x00	–	–	–	–
12	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00
	8	9	10	11	12	13	14	15
	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00
	16	17	18	19	20	21	22	23
	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00
	24	25	26	27	28	29	30	31
	–	–	–	–	–	–	–	–
	32	33	34	35	36	37	38	39
	–	–	–	–	–	–	–	–
	40	41	42	43	44	45	46	47
	–	–	–	–	–	–	–	–
13	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00
	8	9	10	11	12	13	14	15
	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00
	16	17	18	19	20	21	22	23
	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00
	24	25	26	27	28	29	30	31
	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00
	32	33	34	35	36	37	38	39
	–	–	–	–	–	–	–	–
	40	41	42	43	44	45	46	47
	–	–	–	–	–	–	–	–
14	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00
	8	9	10	11	12	13	14	15
	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00
	16	17	18	19	20	21	22	23
	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00
	24	25	26	27	28	29	30	31
	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00
	32	33	34	35	36	37	38	39
	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00
	40	41	42	43	44	45	46	47
	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00
15	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00
	8	9	10	11	12	13	14	15
	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00
	16	17	18	19	20	21	22	23
	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00
	24	25	26	27	28	29	30	31
	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00
	32	33	34	35	36	37	38	39
	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00
	40	41	42	43	44	45	46	47
	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00
	48	49	50	51	52	53	54	55
	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00
	56	57	58	59	60	61	62	63
	0x00	0x00	0x00	0x00	0x00	0x00	0x00	0x00

2.11 Configuring the Monitoring of LIN Bus Signals (/VE option)

This section explains the following settings for monitoring LIN bus signals:

Items Common to Scope Mode and Recorder Mode

- LIN port configuration (waveform display on/off, frame and all sub channel settings, loading LIN data definition files, scaling all sub channels)
- Display settings (display range of each sub channel, scaling each sub channel, vertical position of each sub channel, vertical zoom of each sub channel (zooming by setting the magnification), display groups)

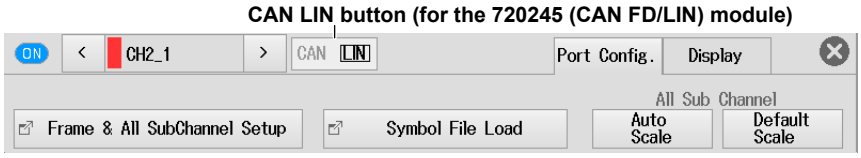
► Features Guide: “LIN Bus Signal Monitoring”

Channel Setting Menu

1. On the waveform screen, tap **MENU** > **Channel** > **CH2** or **CH4**. A channel setting menu appears.
   You can also tap or double-tap CH2 or CH4 in the channel information area to display the channel setting menu.
   (If the channel is selected, tap; otherwise, double-tap.)

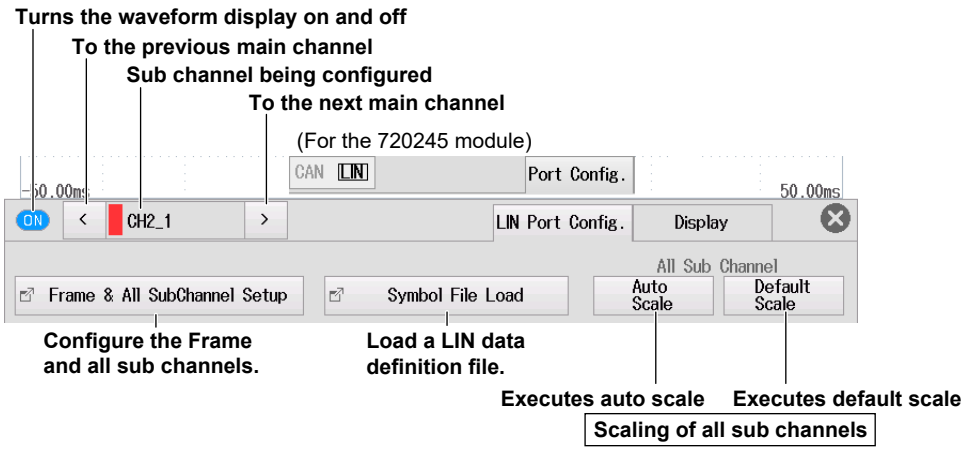
Selecting the Bus Signal (for the 720245(CAN FD/LIN) module)

2. Tap the CAN LIN button to set the bus type to LIN.
   If the button is set to CAN LIN, LIN is already selected, so you do not need to carry out this step.



LIN Port Configuration (LIN Port Config or Port Config*)

3. Tap the **LIN Port Config.** tab.
   * For the 720245(CAN FD/LIN) module, tap the Port Config tab.
4. Tap each item to set options and execute commands.



Frame and All Sub Channel Settings (Frame & All SubChannel Setup)

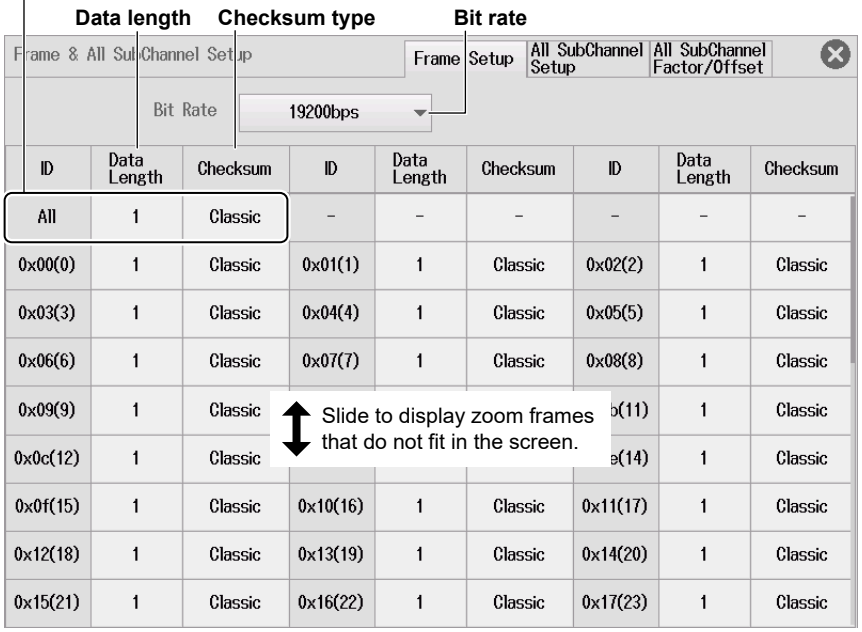
5. Tap **Frame & All SubChannel Setup**. A Frame & All SubChannel Setup screen appears.

Frame Settings (Frame Setup)

6. Tap the **Frame Setup** tab. The following screen appears.

7. Tap each item. Use the displayed list (options) or input box to set the items.

To set frames 0 to 59 to the same setting at once, change the settings in the All row.
You cannot change the settings for frames 60 or above at once.



ID	Data Length	Checksum	ID	Data Length	Checksum	ID	Data Length	Checksum
All	1	Classic	-	-	-	-	-	-
0x00(0)	1	Classic	0x01(1)	1	Classic	0x02(2)	1	Classic
0x03(3)	1	Classic	0x04(4)	1	Classic	0x05(5)	1	Classic
0x06(6)	1	Classic	0x07(7)	1	Classic	0x08(8)	1	Classic
0x09(9)	1	Classic				b(11)	1	Classic
0x0c(12)	1	Classic				e(14)	1	Classic
0x0f(15)	1	Classic	0x10(16)	1	Classic	0x11(17)	1	Classic
0x12(18)	1	Classic	0x13(19)	1	Classic	0x14(20)	1	Classic
0x15(21)	1	Classic	0x16(22)	1	Classic	0x17(23)	1	Classic

Note

All IDs are displayed. Only the settings for the frames that have IDs that data will be read for will be enabled. The settings for frames that have other IDs will be ignored.

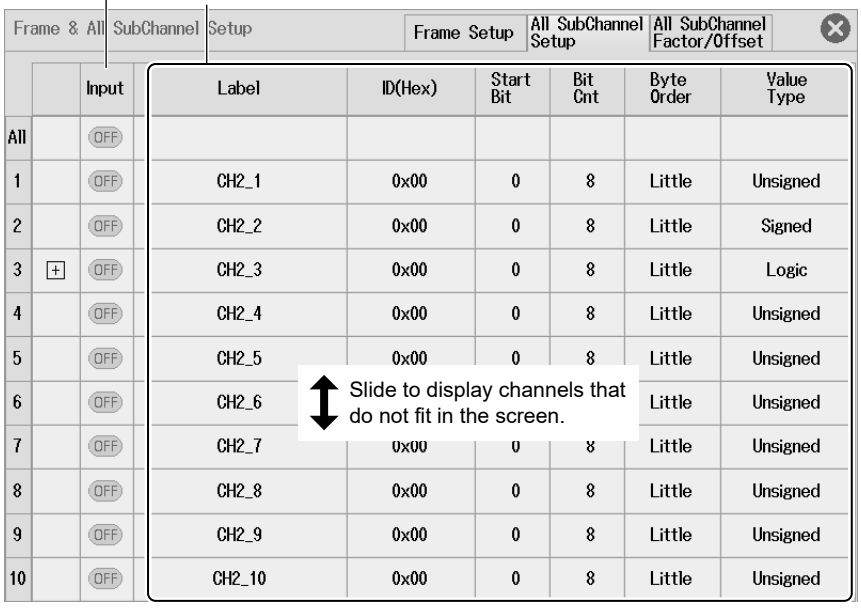
All Sub Channel Setup (All SubChannel Setup - LIN Data Extraction Conditions)

6. Tap the **All SubChannel Setup** tab. The following screen appears.

7. Tap each item. Use the displayed list (options) or input box to set the items.

Turns the sub channel monitoring on and off
To set all the sub channels to the same setting, change the settings in the All row.

LIN data extraction conditions

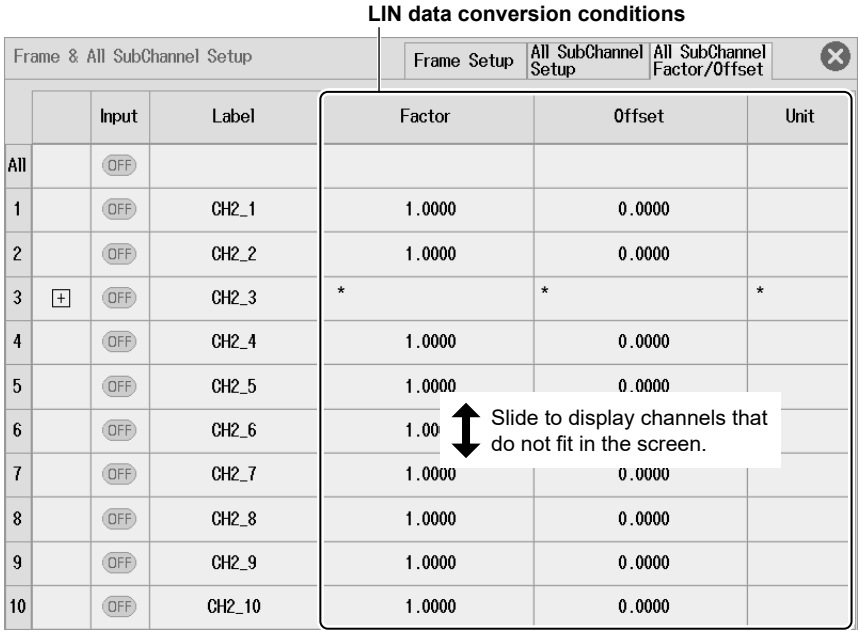


		Input	Label	ID(Hex)	Start Bit	Bit Cnt	Byte Order	Value Type
All		OFF						
1		OFF	CH2_1	0x00	0	8	Little	Unsigned
2		OFF	CH2_2	0x00	0	8	Little	Signed
3	+	OFF	CH2_3	0x00	0	8	Little	Logic
4		OFF	CH2_4	0x00	0	8	Little	Unsigned
5		OFF	CH2_5	0x00	0	8	Little	Unsigned
6		OFF	CH2_6				Little	Unsigned
7		OFF	CH2_7	0x00	0	8	Little	Unsigned
8		OFF	CH2_8	0x00	0	8	Little	Unsigned
9		OFF	CH2_9	0x00	0	8	Little	Unsigned
10		OFF	CH2_10	0x00	0	8	Little	Unsigned

All Sub Channel Factor/Offset (All SubChannel Factor/Offset - LIN Data Conversion Condition)

6. Tap the **All SubChannel Factor/Offset** tab. The following screen appears.

7. Tap each item. Use the displayed input box to set the items.



		Input	Label	Factor	Offset	Unit
All		OFF				
1		OFF	CH2_1	1.0000	0.0000	
2		OFF	CH2_2	1.0000	0.0000	
3	⊞	OFF	CH2_3	*	*	*
4		OFF	CH2_4	1.0000	0.0000	
5		OFF	CH2_5	1.0000	0.0000	
6		OFF	CH2_6	1.00		
7		OFF	CH2_7	1.0000	0.0000	
8		OFF	CH2_8	1.0000	0.0000	
9		OFF	CH2_9	1.0000	0.0000	
10		OFF	CH2_10	1.0000	0.0000	

* You cannot set Factor, Offset, or Unit when the data type (Value Type) is set to Logic.

Loading a LIN Data Definition File (Symbol File Load)

5. Tap **Symbol File Load**. A file list appears.

6. On the file list, tap a symbol file (SBL file).
For details on file list operations, see section 6.10.

7. Select the load destination channel.
► section 6.9

8. Tap **Load**. A confirmation message appears.

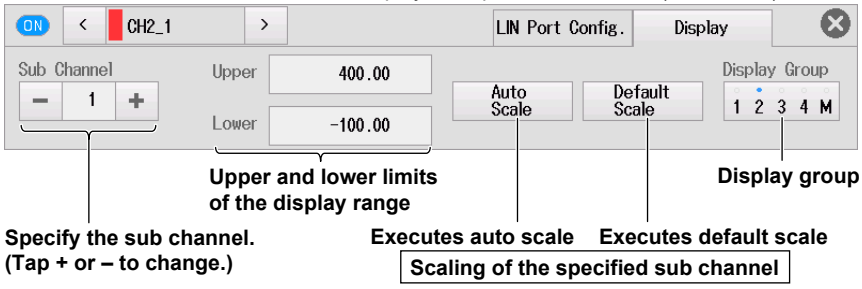
9. Tap **OK**. The symbol file is loaded.

Sub Channel Display Settings (Display)

3. Tap the **Display** tab.
4. Tap each item. Use the displayed list (options) or input box to set the items.

When the Data Type (Value Type) is Unsigned or Signed

Display example for the 720241 (CAN & LIN) module



Upper and lower limits of the display range

Display group

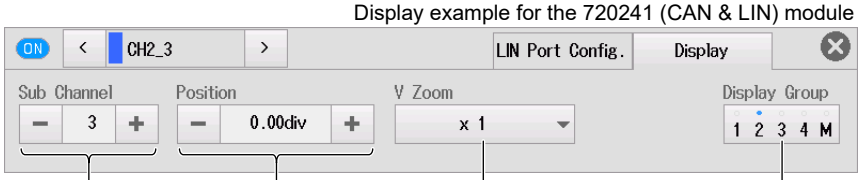
Specify the sub channel. (Tap + or – to change.)

Executes auto scale **Executes default scale**

Scaling of the specified sub channel

When the Data Type (Value Type) is Logic

Display example for the 720241 (CAN & LIN) module



Vertical position (Tap + or – to adjust.)

Vertical zoom

Display group

Specify the sub channel. (Tap + or – to change.)

2.12 Configuring the Monitoring of SENT Signals (/VE option)

This section explains the following settings for monitoring SENT signals:

Items Common to Scope Mode and Recorder Mode

- SENT port configuration (waveform display on/off, SENT format, error channel, input settings, all sub channel settings, error count reset)
- Display settings (display range of each sub channel, scaling each sub channel, vertical position of each sub channel, vertical zoom of each sub channel (zooming by setting the magnification), display groups)

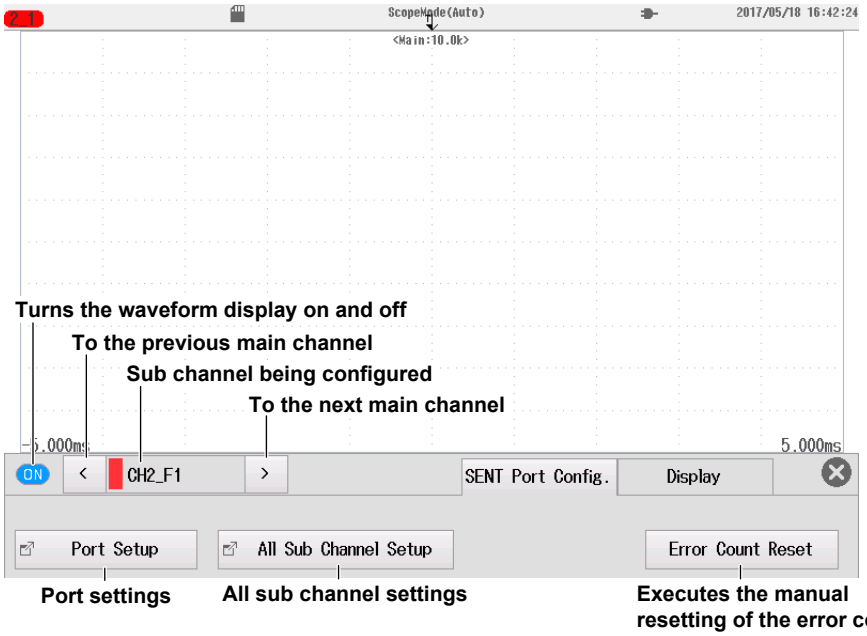
► Features Guide: “SENT Signal Monitoring”

Channel Setting Menu

1. On the waveform screen, tap **MENU** > **Channel** > any channel from **CH1 to CH4**. A channel setting menu appears.
   You can also tap or double-tap any channel from CH1 to CH4 in the channel information area to display the channel setting menu.
   (If the channel is selected, tap; otherwise, double-tap.)

SENT Port Configuration (SENT Port Config)

2. Tap the **SENT Port Config.** tab.
3. Tap each item to set options and execute commands.



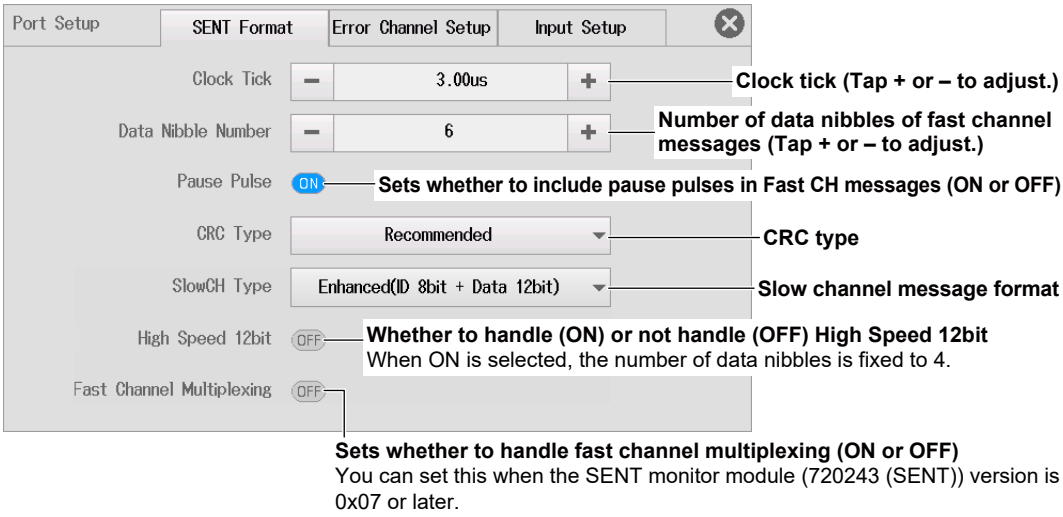
Port Settings (Port Setup)

4. Tap **Port Setup**. A Port Setup screen appears.

SENT Format (SENT Format)

5. Tap the **SENT Format** tab. The following screen appears.

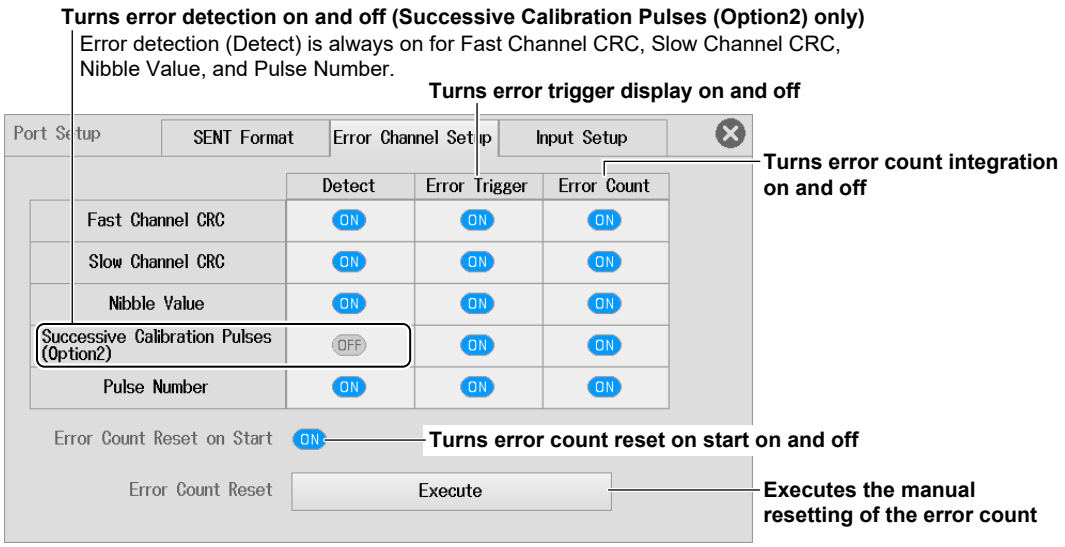
6. Tap each item. Use the displayed list (options) or input box to set the items.



Error Channel Settings (Error Channel Setup)

5. Tap the **Error Channel Setup** tab. The following screen appears.

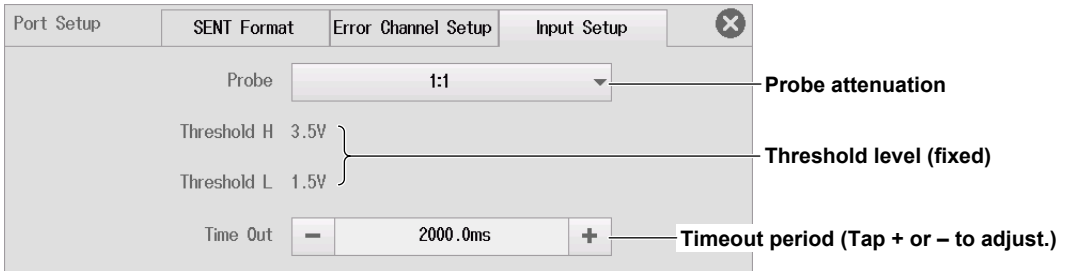
6. Tap each item to set options and execute commands.



Input Settings (Input Setup)

5. Tap the **Input Setup** tab. The following screen appears.

6. Tap each item. Use the displayed list (options) or input box to set the items.



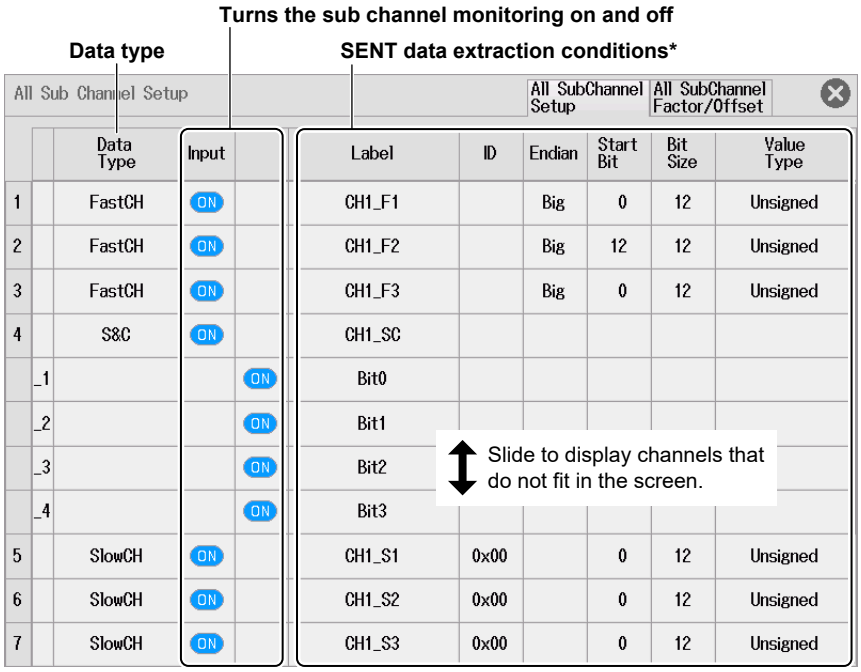
All Sub Channel Setup (All Sub Channel Setup)

4. Tap **All Sub Channel Setup**. An All Sub Channel Setup screen appears.

All Sub Channel Settings (All SubChannels Setup - SENT Data Extraction Conditions)

5. Tap the **All SubChannel Setup** tab. The following screen appears.

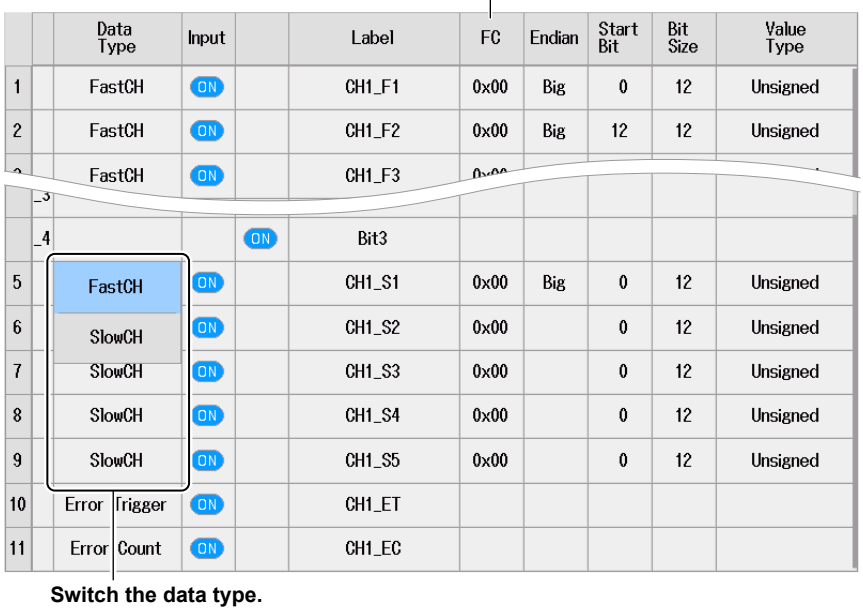
6. Tap each item. Use the displayed list (options) or input box to set the items.



		Data Type	Input		Label	ID	Endian	Start Bit	Bit Size	Value Type
1		FastCH	ON		CH1_F1		Big	0	12	Unsigned
2		FastCH	ON		CH1_F2		Big	12	12	Unsigned
3		FastCH	ON		CH1_F3		Big	0	12	Unsigned
4		S&C	ON		CH1_SC					
	_1			ON	Bit0					
	_2			ON	Bit1					
	_3			ON	Bit2					
	_4			ON	Bit3					
5		SlowCH	ON		CH1_S1	0x00		0	12	Unsigned
6		SlowCH	ON		CH1_S2	0x00		0	12	Unsigned
7		SlowCH	ON		CH1_S3	0x00		0	12	Unsigned

When Fast Channel Multiplexing is set to ON

If you tap a sub channel whose data type (Data Type) is set to FastCH, the ID column changes to an FC column, and you can set FC (Frame Control). If you tap a sub channel whose data type is set to SlowCH, you can set ID.



		Data Type	Input		Label	FC	Endian	Start Bit	Bit Size	Value Type
1		FastCH	ON		CH1_F1	0x00	Big	0	12	Unsigned
2		FastCH	ON		CH1_F2	0x00	Big	12	12	Unsigned
		FastCH	ON		CH1_F3					
	_4			ON	Bit3					
5		FastCH	ON		CH1_S1	0x00	Big	0	12	Unsigned
6		SlowCH	ON		CH1_S2	0x00		0	12	Unsigned
7		SlowCH	ON		CH1_S3	0x00		0	12	Unsigned
8		SlowCH	ON		CH1_S4	0x00		0	12	Unsigned
9		SlowCH	ON		CH1_S5	0x00		0	12	Unsigned
10		Error Trigger	ON		CH1_ET					
11		Error Count	ON		CH1_EC					

Sub Channel and Data Type

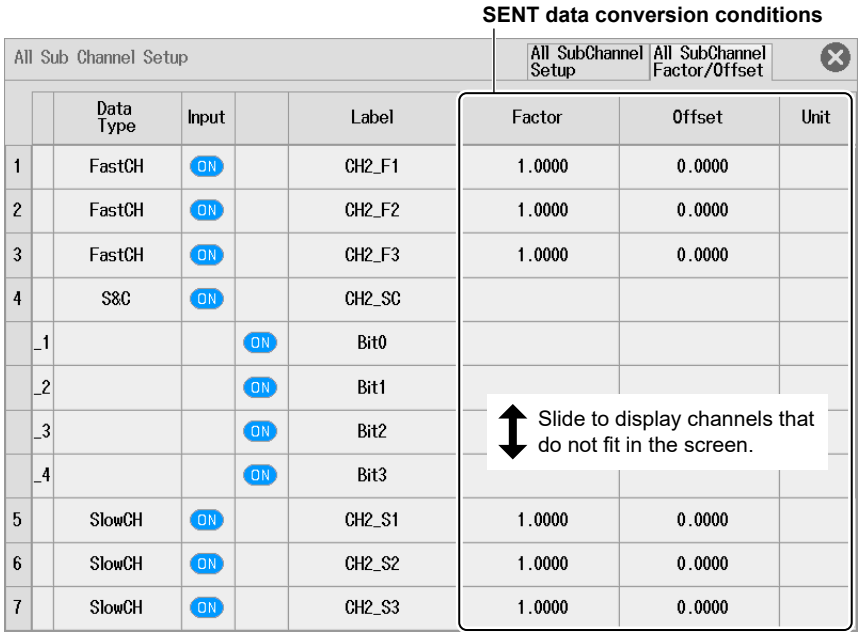
The types of data acquired in sub channels are as follows.

Sub Channel	Data Type	
1	FastCH	
2		
3		
4	S&C (Stauts & Communication)	
5	SlowCH, FastCH*	* You can change this to FastCH only when Fast Channel Multiplexing is set to ON.
6		
7		
8		
9		
10	Error Trigger	
11	Error Count	

All Sub Channel Factor/Offset (All SubChannel Factor/Offset - SENT Data Conversion Condition)

5. Tap the **All SubChannel Factor/Offset** tab. The following screen appears.

6. Tap each item. Use the displayed input box to set the items.

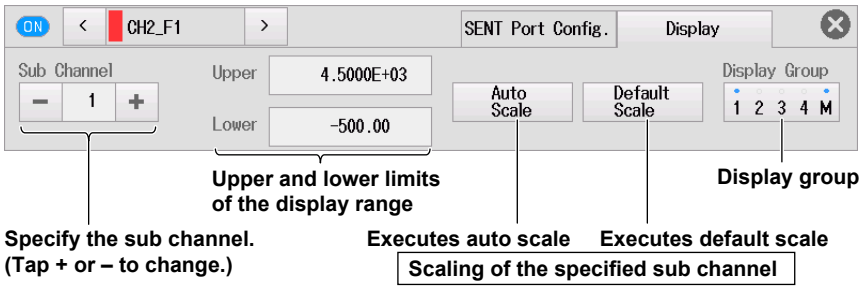


		Data Type	Input		Label	Factor	Offset	Unit
1		FastCH	ON		CH2_F1	1.0000	0.0000	
2		FastCH	ON		CH2_F2	1.0000	0.0000	
3		FastCH	ON		CH2_F3	1.0000	0.0000	
4		S&C	ON		CH2_SC			
	_1			ON	Bit0			
	_2			ON	Bit1			
	_3			ON	Bit2			
	_4			ON	Bit3			
5		SlowCH	ON		CH2_S1	1.0000	0.0000	
6		SlowCH	ON		CH2_S2	1.0000	0.0000	
7		SlowCH	ON		CH2_S3	1.0000	0.0000	

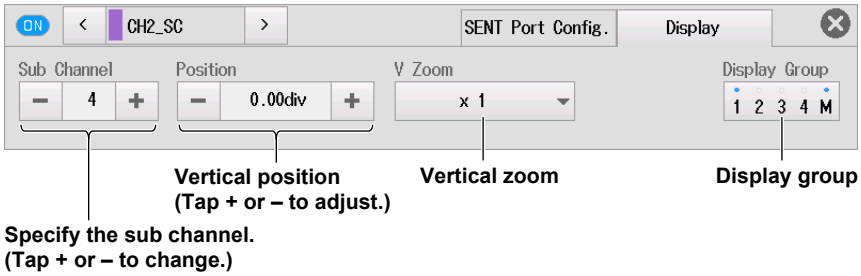
Sub Channel Display Settings (Display)

2. Tap the **Display** tab.
3. Tap each item. Use the displayed list (options) or input box to set the items.

When the Data Type Is Fast CH, SlowCH, or Error Count



When the Data Type Is S&C (Status & Communication) and Error Trigger



2.13 Configuring the GPS Position Information Monitor

This section explains the following settings for monitoring position information with the GPS (Global Positioning System).

To acquire GPS position information, a GPS unit (an accessory sold separately) must be connected to the instrument and the position information acquisition setting must be turned on (see section 18.1).

Items Common to Scope Mode and Recorder Mode

- Common settings (All Items Setup)
- Basic settings (position information, display labels, range, 3D positioning status, GPS time sync status)
- Display settings (position information, display range, vertical position, vertical zoom, display groups)

► Features Guide: “Position Information (GPS)”

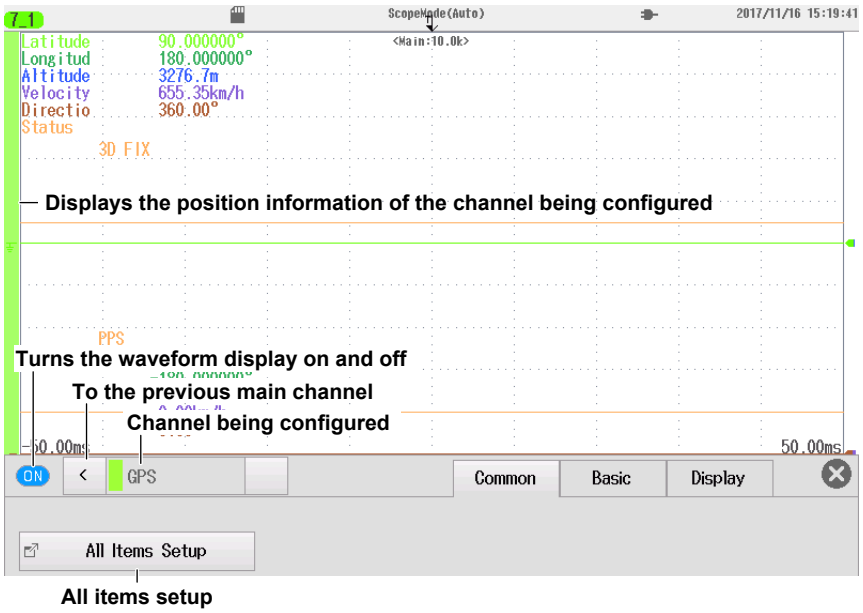
1. Set position information acquisition to ON. For the procedure, see section 18.1.

Channel Setting Menu

2. On the waveform screen, tap **MENU** > **Channel** > **GPS**. A channel setting menu appears.
   You can also tap or double-tap GPS in the channel information area to display the channel setting menu. (If the channel is selected, tap; otherwise, double-tap.)

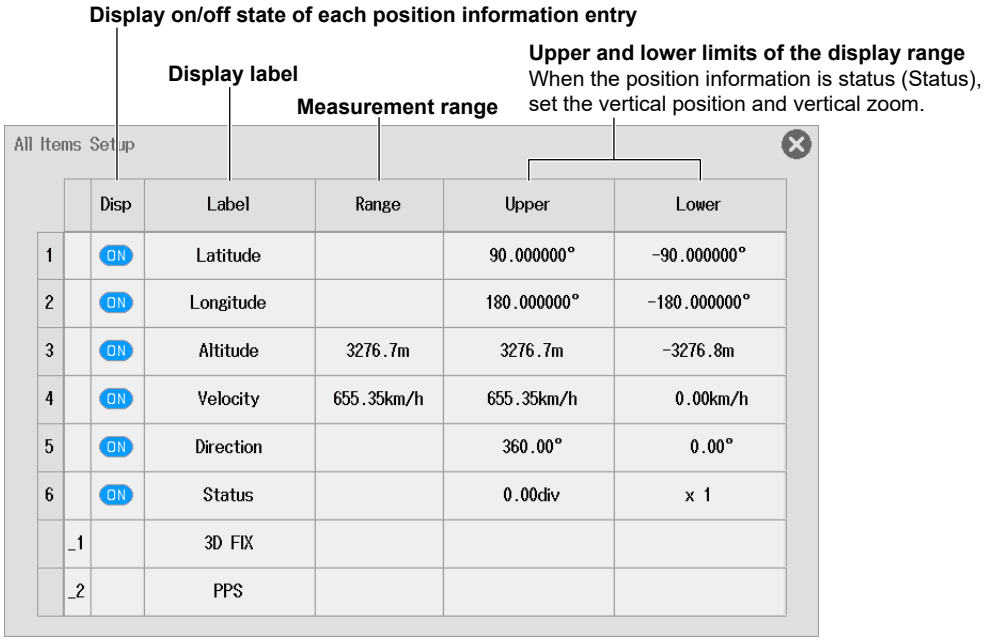
Common Settings (Common)

3. Tap the **Common** tab.
4. Tap each item to set options.



All Items Setup (All Items Setup)

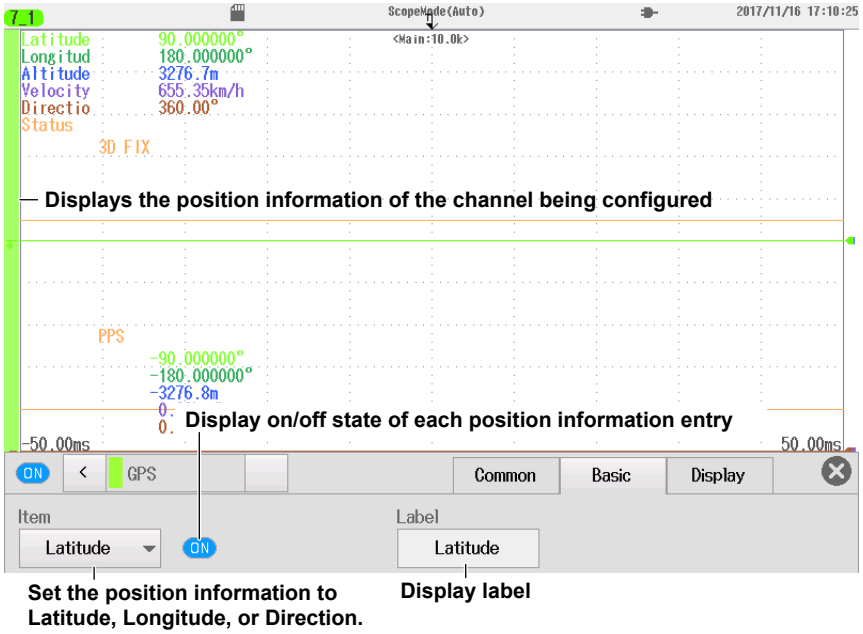
5. Tap the **All Items Setup** tab. The following screen appears.
6. Tap each item. Use the displayed list (options) or input box to set the items.



Basic Setup (Basic)

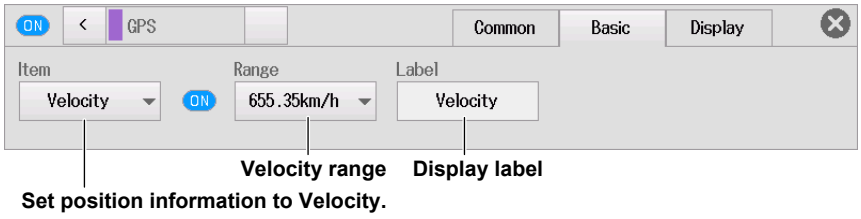
3. Tap the **Basic** tab.
4. Tap **Item**. Use the displayed list (options) to set the position information.
5. Tap each item. Use the displayed list (options) or input box to set the items.

Latitude (Latitude), Longitude (Longitude), Direction (Direction)

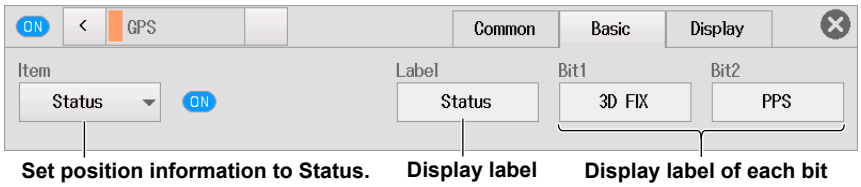


Altitude (Altitude)

Velocity (Velocity)



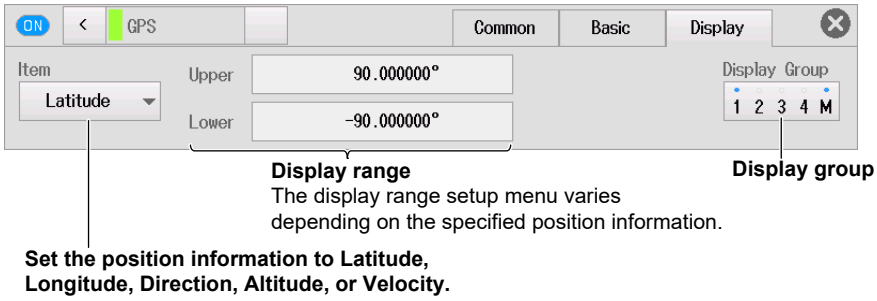
Status (Status)



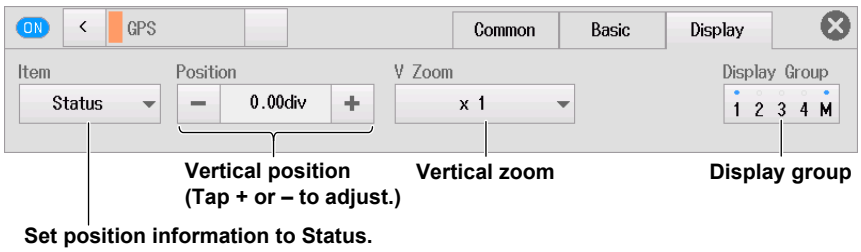
Configuring the Display (Display)

3. Tap the **Display** tab.
4. Tap **Item**. Use the displayed list (options) to set the position information.
5. Tap each item. Use the displayed list (options) or input box to set the items.

Latitude (Latitude), Longitude (Longitude), Direction (Direction), Altitude (Altitude), Velocity (Velocity)



Status (Status)



3.1 Setting Conditions for Waveform Acquisition (Scope mode)

This section explains the following settings for acquiring waveforms.

Applicable to Scope Mode

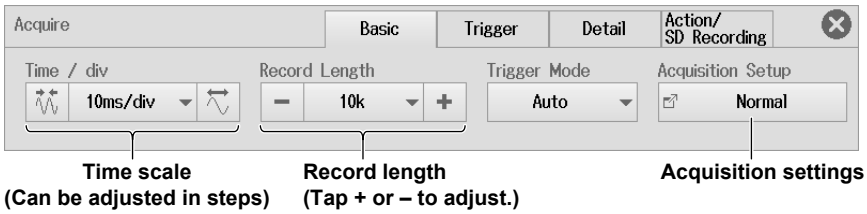
- Basic settings (time scale, record length, acquisition mode, waveform acquisition count)
- Detail settings (time base, trigger position, trigger delay)
- Action/SD recording (action (action mode, action settings), SD recording (auto naming, file name, detail settings)

For recorder mode, see section 3.2.

► Features Guide: “Waveform Acquisition”

Waveform Acquisition Basic Setting Menu

1. On the waveform screen, tap **MENU** > **Acquire**. The Acquire menu appears.
2. Tap the **Basic** tab.
3. Tap each item. Use the displayed list (options) or input box to set the items.



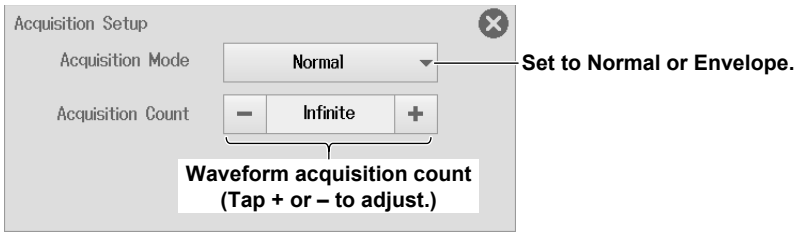
Acquisition Settings (Acquisition Setup)

4. Tap **Acquisition Setup**. Tap **Acquisition Mode**. Use the displayed list (options) to select the acquisition mode.

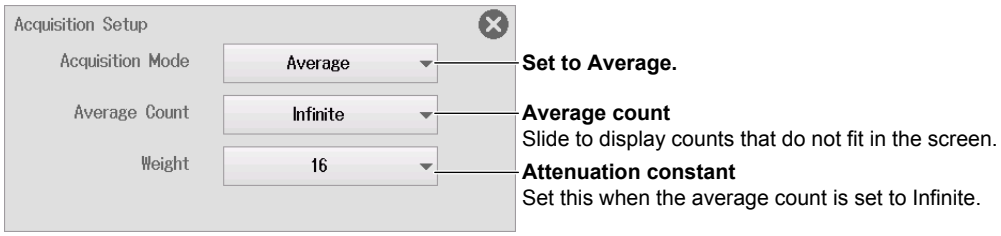
Acquisition Mode

Normal: Displays waveforms without processing the sampled data. Set the waveform acquisition count.
Envelope: Displays waveforms in envelope mode. Set the waveform acquisition count.
Average: Displays averaged waveforms. Set the average count or attenuation constant.

- **Normal Mode (Normal), Envelope Mode (Envelope)**



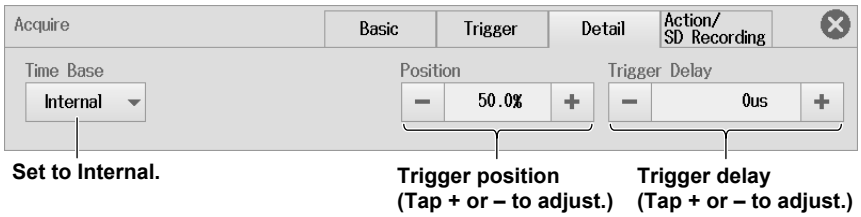
- **Averaging Mode (Average)**



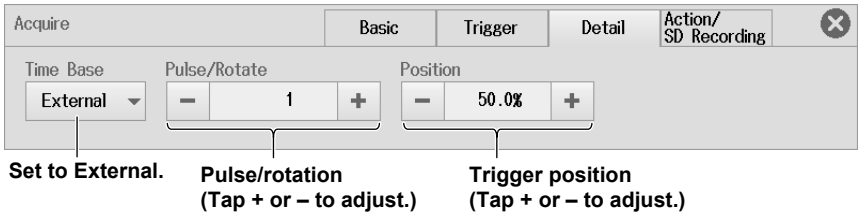
Waveform Acquisition Detail Setting Menu

2. Tap the **Detail** tab.
3. Tap **Time Base**. Use the displayed list (options) to set the time base.
4. Tap each item. Use the displayed input box to set the items.

When the time base is the internal clock signal



When the time base is an external clock signal



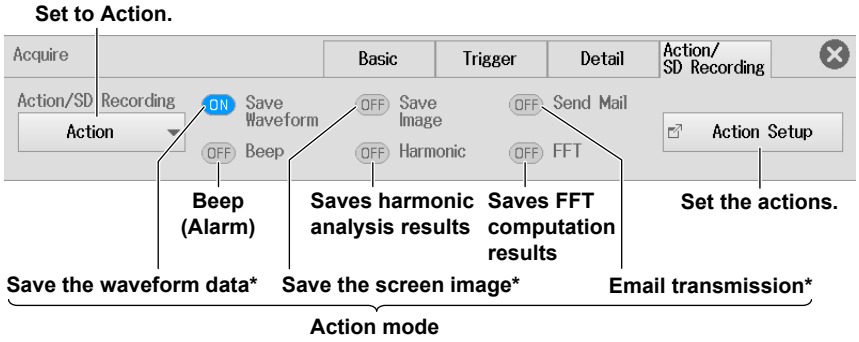
Waveform Acquisition Action/SD Recording

2. Tap the **Action/SD Recording** tab.

Action (Action)

When the acquisition mode is set to Normal (Normal) or Envelope (Envelop), you can set an action.

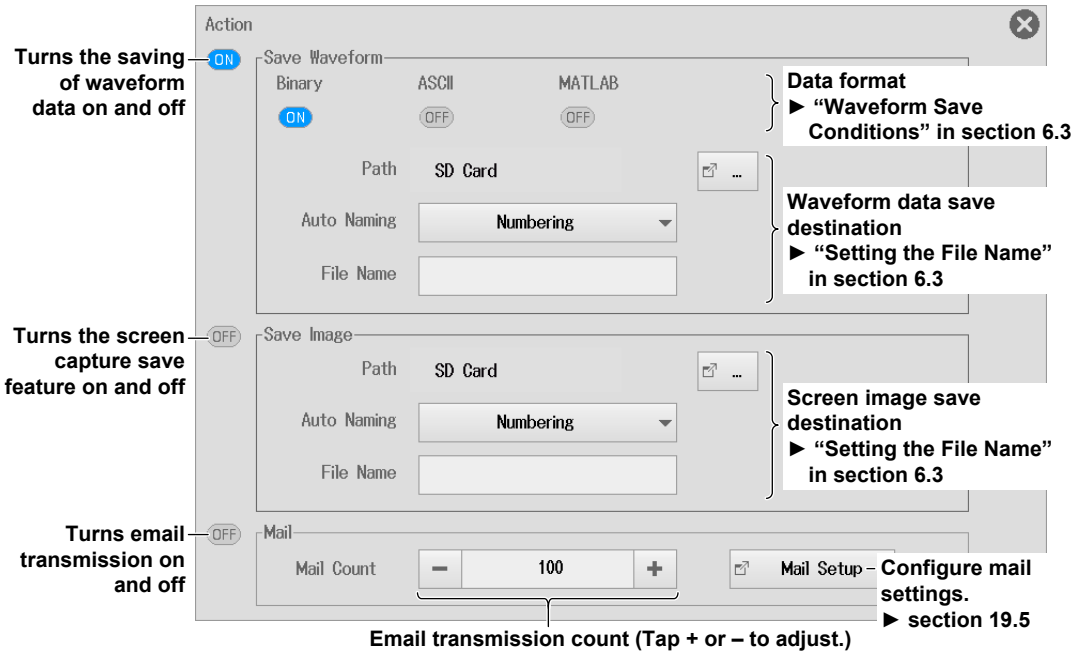
3. Tap **Action/SD Recording**, and select the action (Action).
4. Tap each item. Use the displayed list (options) or input box to set the items.



Set the actions you want to execute to ON.
Items with an asterisk can also be turned on and off on the action setting screen.

Action Settings (Action Setup)

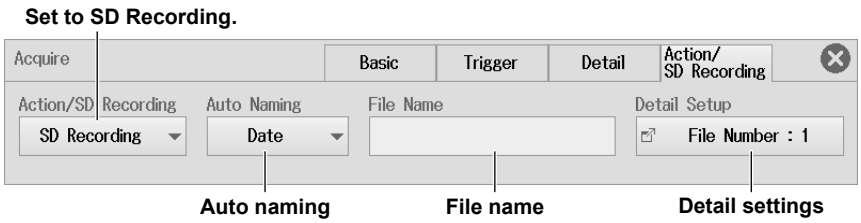
5. Tap **Action Setup**. The following screen appears.



SD Recording (SD Recording)

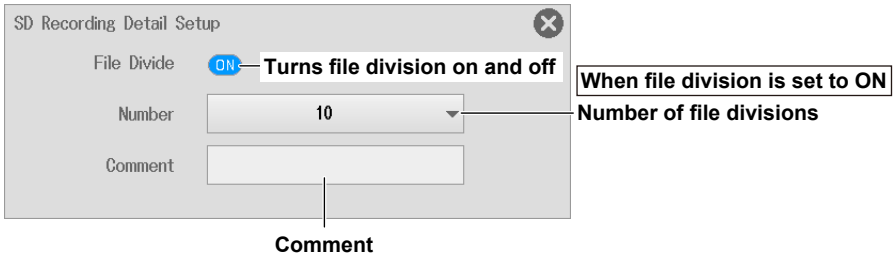
When the acquisition mode is set to Normal (Normal) or Envelope (Envelop), you can set SD recording.

3. Tap **Action/SD Recording**, and select SD Recording (SD Recording).
4. Tap each item. Use the displayed list (options) or input box to set the items.



Detail Settings (Detail Setup)

5. Tap **Detail Setup**. The following screen appears.



3.2 Setting Conditions for Waveform Acquisition (Recorder mode)

This section explains the following settings for acquiring waveforms.

Applicable to Recorder Mode

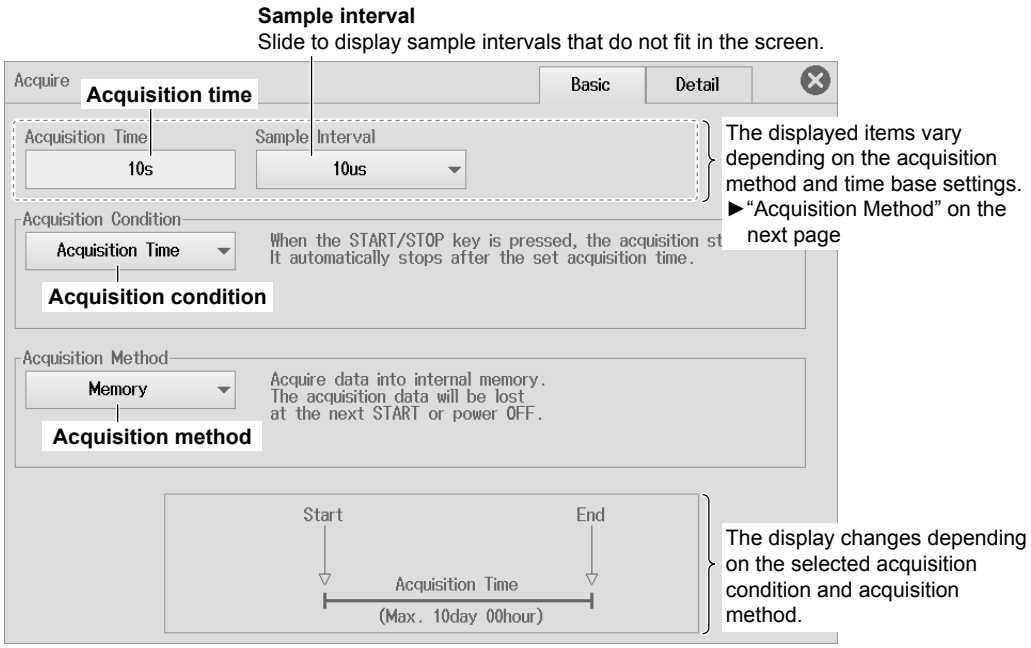
- Basic settings (acquisition time/acquisition length, sample interval, record time/record length, numeric recording interval, acquisition condition, acquisition method)
- Detail settings (acquisition method, acquisition mode, time base)

For scope mode, see section 3.1.

► Features Guide: “Waveform Acquisition”

Waveform Acquisition Basic Setting Screen

1. On the waveform screen, tap **MENU** > **Acquire**. The Acquire screen appears.
2. Tap the **Basic** tab. The basic setting screen appears.
3. Tap each item. Use the displayed list (options) or input box to set the items.



Acquisition Condition (Acquisition Condition)

* When the acquisition method is SD Recording (SD Recording), this item is not available.

4. Tap **Acquisition Condition**. Use the displayed list (options) to set the acquisition condition.

There are four acquisition conditions.

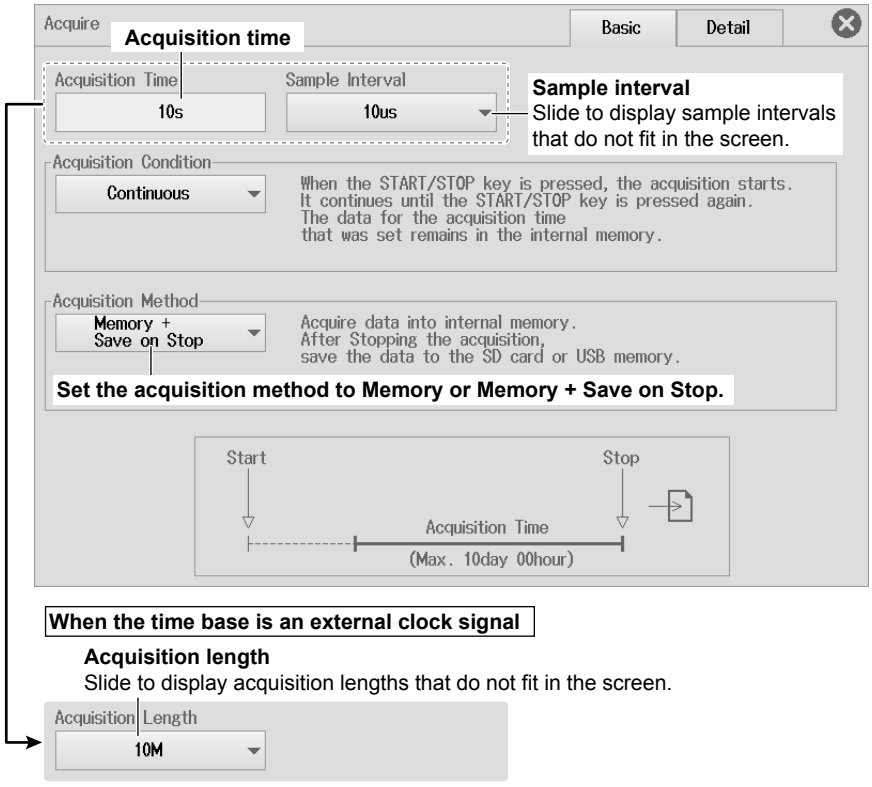
- Acquisition time (Acquisition Time)
- Continuous acquisition (Continuous)
- Start acquisition on trigger (Start On Trigger)
- Stop acquisition on trigger (Stop On Trigger)

Acquisition Method (Acquisition Method)

5. Tap **Acquisition Method**. Use the displayed list (options) to set the acquisition method.

You can also set the acquisition method in the detail settings explained later.

Memory (Memory), Memory + Save on Stop (Memory + Save on Stop)



When the time base is an external clock signal

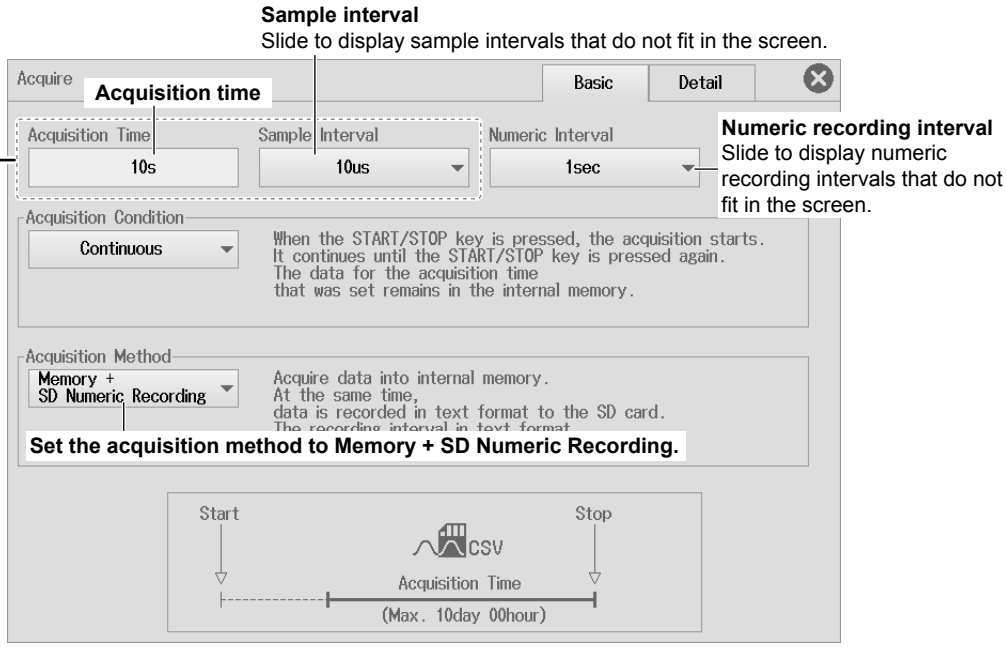
Acquisition length

Slide to display acquisition lengths that do not fit in the screen.

For time base settings, see “Detail” explained later.

Memory + SD Numeric Recording (Memory + SD Numeric Recording)

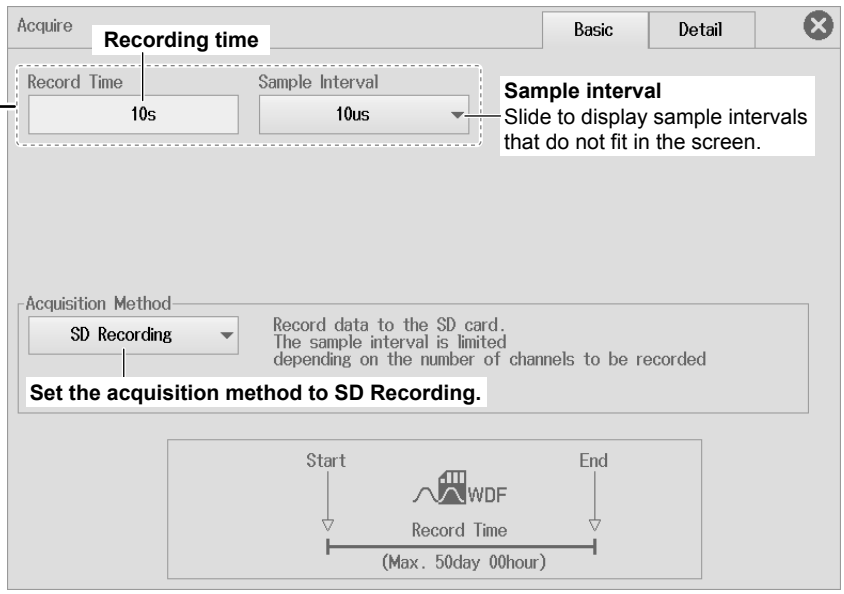
6. Tap **Numeric Interval**. Use the displayed list (options) to set the numeric recording interval.



When the time base is an external clock signal

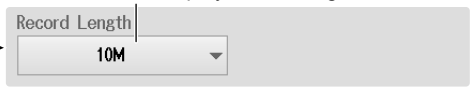
► "Memory (Memory), Memory + Save on Stop (Memory + Save on Stop)" on the previous page.

SD Recording (SD Recording)



When the time base is an external clock signal

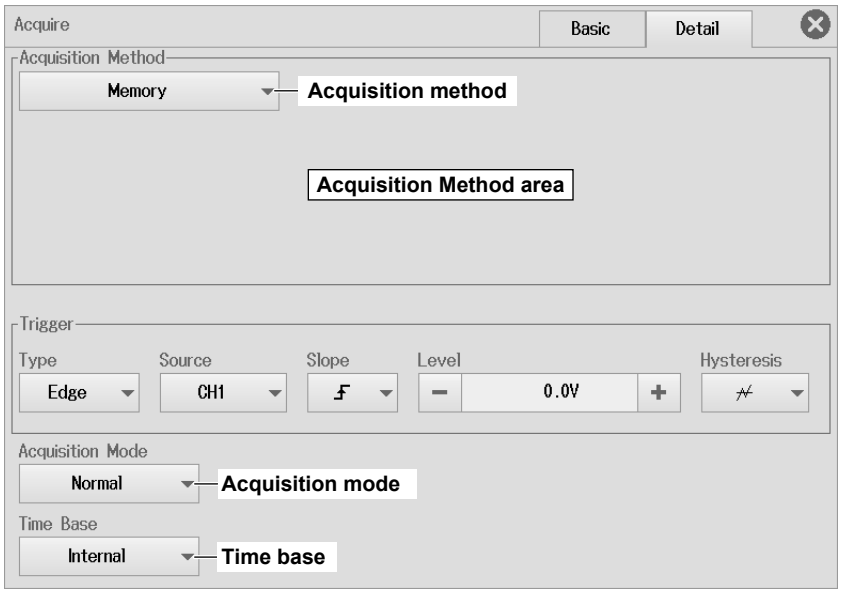
Record length
Slide to display record lengths that do not fit in the screen.



For time base settings, see "Detail" explained later.

Waveform Acquisition Detail Setting Screen

2. Tap the **Detail** tab. The Detail Setup screen appears.
3. Tap each item. Use the displayed list (options) or input box to set the items.



When the time base is an external clock signal

Set to External.

Pulse/rotation (Tap + or – to adjust.)

Acquisition Method (Acquisition Method)

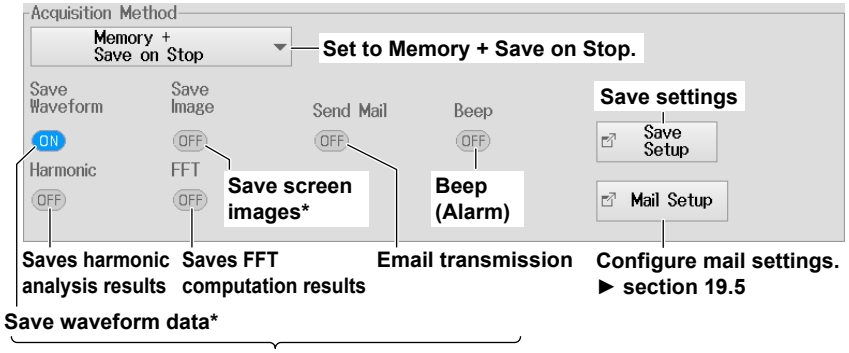
4. Tap **Acquisition Method**. Use the displayed list (options) to set the acquisition method.
   The items shown in the Acquisition Method area vary depending on the specified acquisition method.

Memory (Memory)

► See the above figure.

Memory + Save on Stop (Memory + Save on Stop)

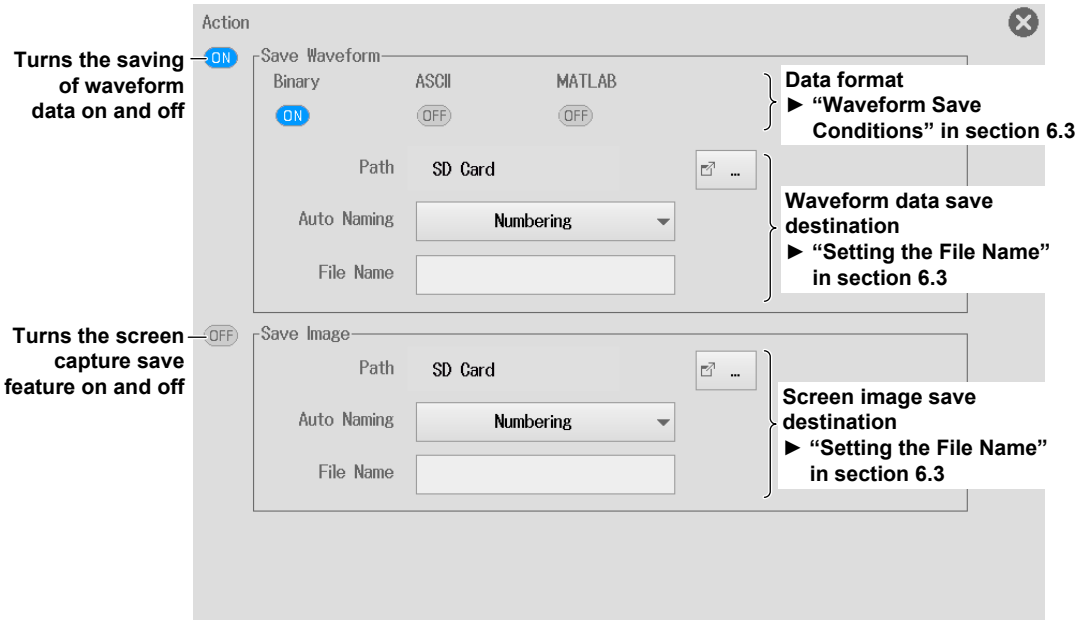
5. Tap each item. Use the displayed list (options) or input box to set the items.



Set the actions you want to execute at the end of measurements to ON.
Items with an asterisk can also be turned on and off on the save setting screen.

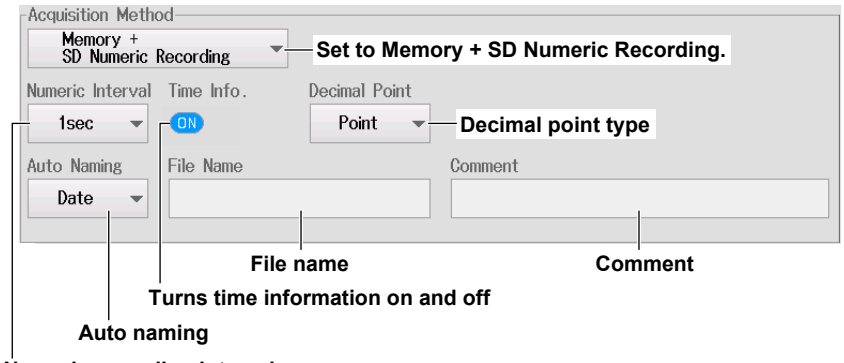
Save Settings (Save Setup)

6. Tap **Save Setup**. The following screen appears.



Memory + SD Numeric Recording (Memory + SD Numeric Recording)

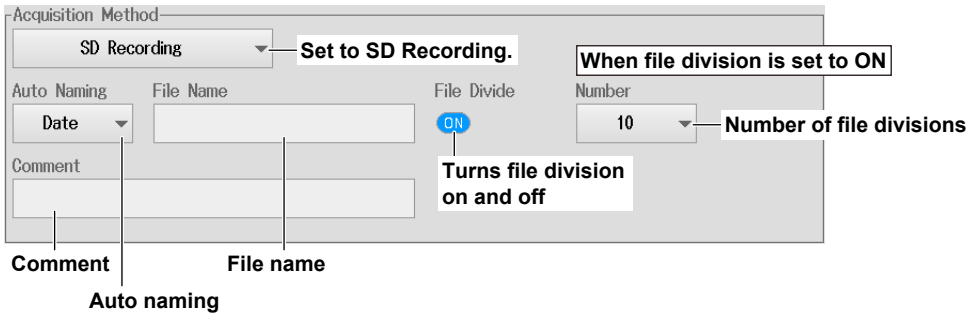
5. Tap each item. Use the displayed list (options) or input box to set the items.



Slide to display numeric recording intervals that do not fit in the screen.

SD Recording (SD Recording)

5. Tap each item. Use the displayed list (options) or input box to set the items.



3.3 Starting and Stopping Waveform Acquisition

This section explains how to start and stop waveform acquisition.

Items Common to Scope Mode and Recorder Mode

START/STOP key

► Features Guide: “Waveform Acquisition (START/STOP)”

Waveform Acquisition (START/STOP)

Press **START/STOP** to start or stop waveform acquisition.
The key is illuminated while the instrument is acquiring waveforms.

Note

You can also tap START/STOP on the waveform screen’s MENU to start and stop waveform acquisition.

4.1 Setting the Trigger Mode

This section explains the following setting for updating the displayed waveform.

Applicable to Scope Mode

Trigger mode

This setting is not available in recorder mode.

► Features Guide: “Trigger mode (Trigger Mode)”

Waveform Acquisition Basic Setting Menu

1. On the waveform screen, tap **MENU** > **Acquire**. The Acquire menu appears.
2. Tap the **Basic** tab.
3. Tap **Trigger Mode**. Use the displayed list (options) to select the trigger mode.

Trigger mode (Trigger Mode)

Auto

If the trigger conditions are met within a 50-ms timeout period, the instrument updates the displayed waveforms on each trigger occurrence. If not, the instrument automatically updates the displayed waveforms. If simple trigger is in use and the trigger source is set to Time, the instrument operates in Normal mode even when Auto mode is specified. If the time axis is set to a value that would cause the display to switch to roll mode, roll mode display will be enabled.

Normal

The instrument updates the waveform display only when the trigger conditions are met. If no triggers occur, the display is not updated. If you want to view waveforms that the instrument cannot trigger on, or if you want to check the ground level, use Auto mode.

Single

When the trigger conditions are met, the instrument updates the displayed waveform once and stops signal acquisition. If the time axis is set to a value that would cause the display to switch to roll mode, roll mode display will be enabled. When the instrument triggers, it begins recording data. When data has been acquired up to the amount specified by the set record length, the waveform display stops.

On Start

Regardless of the trigger settings, when you press the START key, the instrument updates the displayed waveforms once and stops signal acquisition. If the time axis is set to a value that would cause the display to switch to roll mode, roll mode display will be enabled. When data has been acquired up to the amount specified by the set record length, the waveform display stops.

4.2 Setting the Trigger Position and Trigger Delay

This section explains the following setting for updating the displayed waveform.

Applicable to Scope Mode

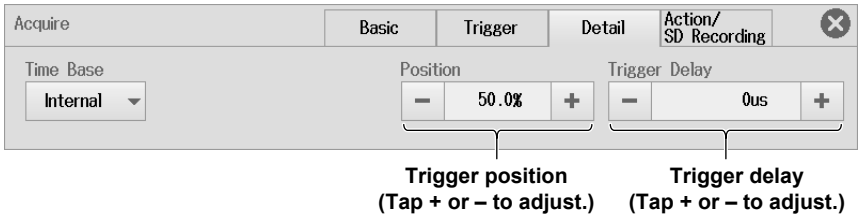
Trigger position and trigger delay

These settings are not available in recorder mode.

► Features Guide: “Trigger Position (Position)”
“Trigger Delay (Trigger Delay)”

Waveform Acquisition Detail Setting Menu

1. On the waveform screen, tap **MENU** > **Acquire**. The Acquire menu appears.
2. Tap the **Detail** tab > **Time Base**, and select Internal.
3. Tap each item. Use the displayed input box to set the items.



4.3 Triggering on an Edge Trigger

This section explains the following settings for triggering on the edges of an analog-signal trigger source:

For Scope Mode

Setting the trigger to Simple, trigger source, trigger slope, trigger level, trigger hysteresis

For Recorder Mode

Setting the trigger type to Edge, trigger source, trigger slope, trigger level, trigger hysteresis

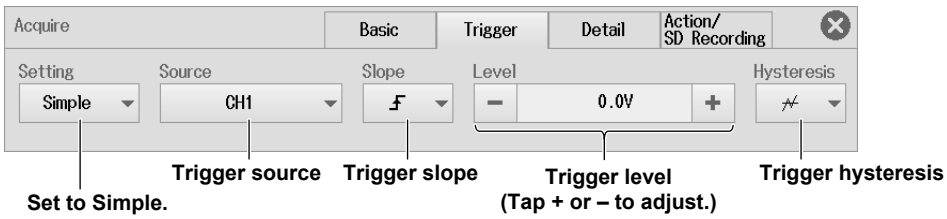
► Features Guide: “Trigger Settings (Setting),” “Trigger (Trigger)”
“Trigger Source (Source),” “Trigger Slope (Slope)”
“Trigger Level (Level),” “Trigger Hysteresis (Hysteresis)”

Waveform Acquisition Trigger Menu

1. On the waveform screen, tap **MENU** > **Acquire**. The Acquire menu appears.

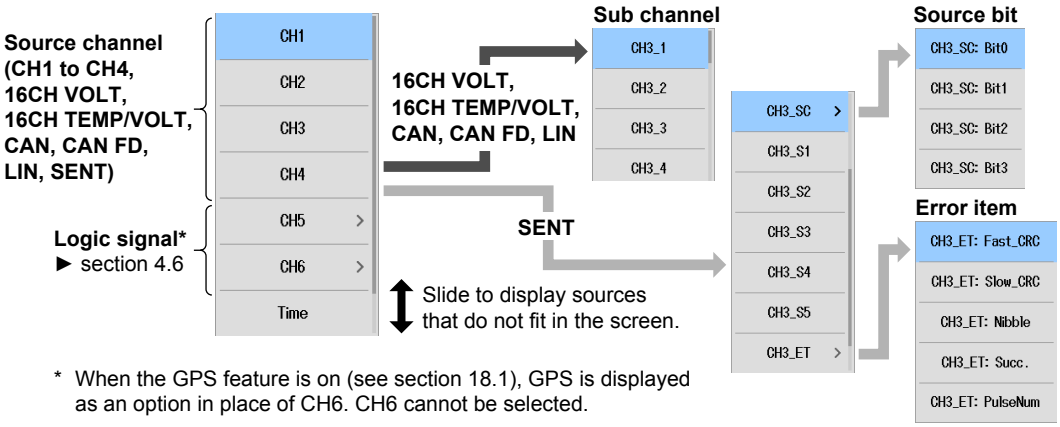
For Scope Mode

2. Tap the **Trigger** tab > **Setting**, and select Simple.
3. Tap each item. Use the displayed list (options) or input box to set the items.



Trigger Source (Source)

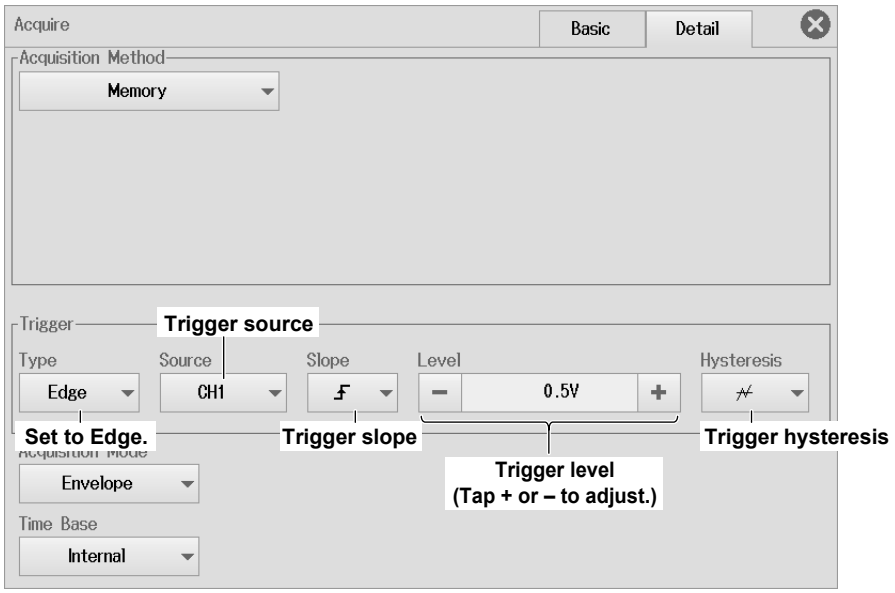
4. Tap **Source**. Select the trigger source from the list (a context-sensitive list that varies depending on the installed module).
   The displayed options vary depending on the installed module, waveform display on/off state, and waveform label settings. For CAN, CAN FD, LIN, and SENT, sub channel whose input (Input) is set to OFF cannot be selected.



* When the GPS feature is on (see section 18.1), GPS is displayed as an option in place of CH6. CH6 cannot be selected.

For Recorder Mode

2. Tap the **Detail** tab > **Type** in the Trigger area, and select Edge.
3. Tap each item in the Trigger area. Use the displayed list (options) or input box to set the items.



Trigger Source (Source)

► See the description on the previous page for scope mode.

4.4 Triggering on a Timer Trigger

This section explains the settings that are used when triggering on a specific date and time.

For Scope Mode

Setting the trigger to Simple, setting the trigger source to Time, date and time, time interval

For Recorder Mode

Setting the trigger type to Time, date and time

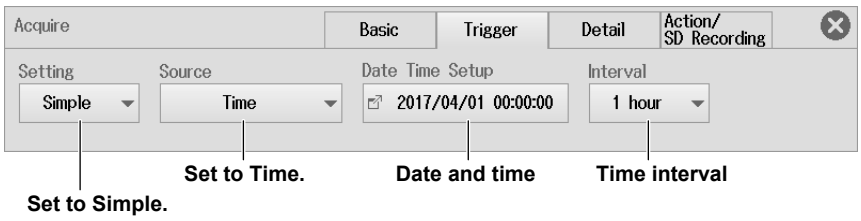
► Features Guide: “Time (Time),” “Trigger Source (Source)”

Waveform Acquisition Trigger Menu

1. On the waveform screen, tap **MENU** > **Acquire**. The Acquire menu appears.

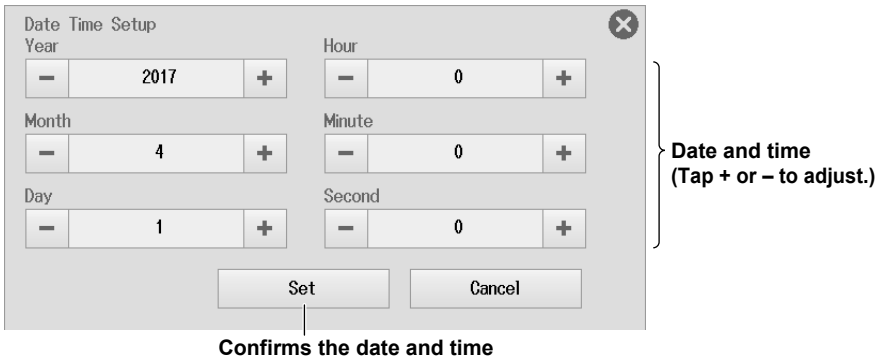
For Scope Mode

2. Tap the **Trigger** tab > **Setting**, and select Simple.
3. Tap **Source**, and select Time.
4. Tap each item. Use the displayed list (options) or input box to set the items.



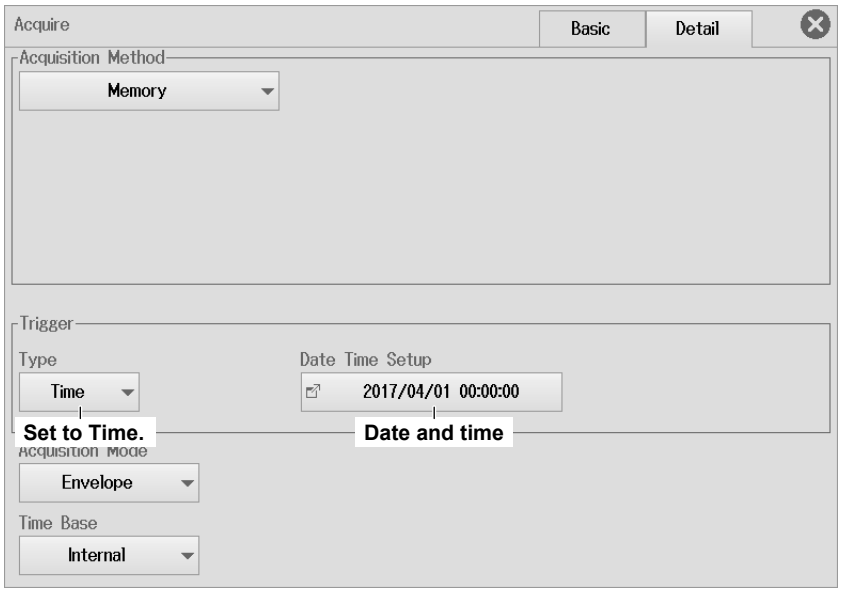
Date and Time (Date/Time Setup)

5. Tap **Date Time Setup**. The following screen appears.
6. Tap each item. Use the displayed list (options) or input box to set the items.



For Recorder Mode

2. Tap the **Detail** tab > **Type** in the Trigger area, and select Time.



Date and Time (Date Time Setup)

► See the description on the previous page for scope mode.

4.5 Triggering on an External Trigger

This section explains the settings that are used when triggering on an external signal.

Applicable to Scope Mode

Setting the trigger to Simple, setting the trigger source to External, trigger slope

For Recorder Mode

Setting the trigger type to Edge, setting the trigger source to External, trigger slope

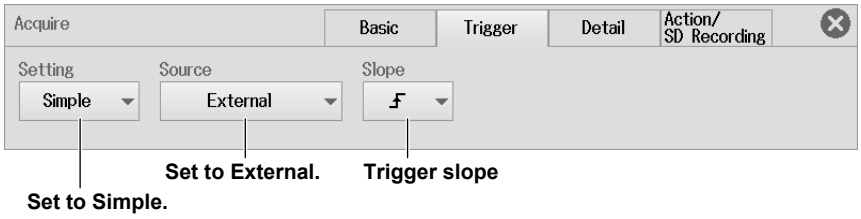
► Features Guide: “External Signal (External),” “Trigger Source (Source)” “Trigger Slope (Slope)”

Waveform Acquisition Trigger Menu

1. On the waveform screen, tap **MENU** > **Acquire**. The Acquire menu appears.

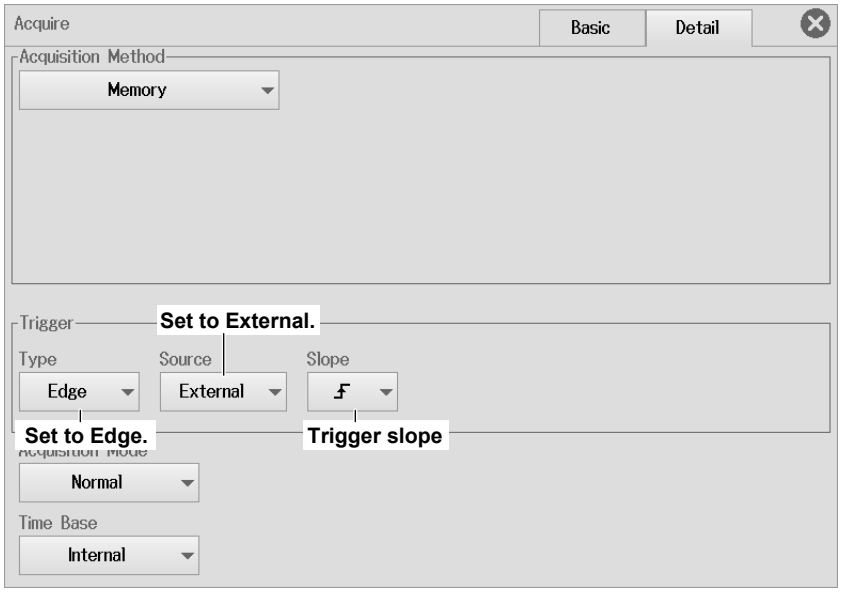
For Scope Mode

2. Tap the **Trigger** tab > **Setting**, and select Simple.
3. Tap **Source**, and select External.
4. Tap **Slope**, and select the trigger slope.



For Recorder Mode

2. Tap the **Detail** tab > **Type** in the Trigger area, and select Edge.
3. Tap **Source**, and select External.
4. Tap **Slope**, and select the trigger slope.



4.6 Triggering on an Edge Trigger of a Logic Signal

This section explains the following settings for triggering on the edges of a logic-signal trigger source:

For Scope Mode

Setting the trigger to Simple, trigger source, source bit, trigger slope

For Recorder Mode

Setting the trigger type to Edge, trigger source, source bit, trigger slope

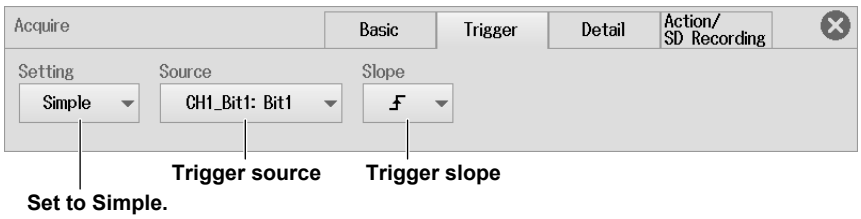
► Features Guide: “Simple (Simple),” “Trigger Source (Source)” “Trigger Slope (Slope)”

Waveform Acquisition Trigger Menu

1. On the waveform screen, tap **MENU** > **Acquire**. The Acquire menu appears.

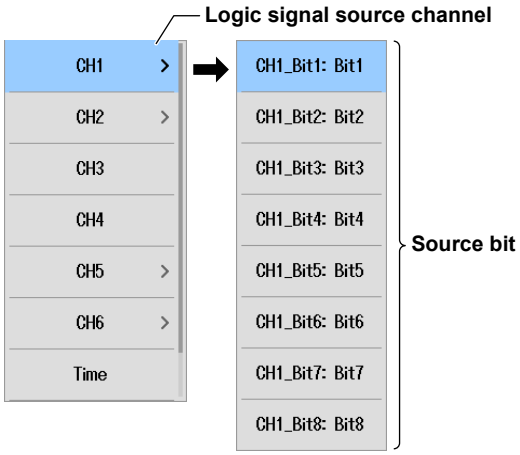
For Scope Mode

2. Tap the **Trigger** tab > **Setting**, and select Simple.
3. Tap **Slope**, and select the trigger slope.



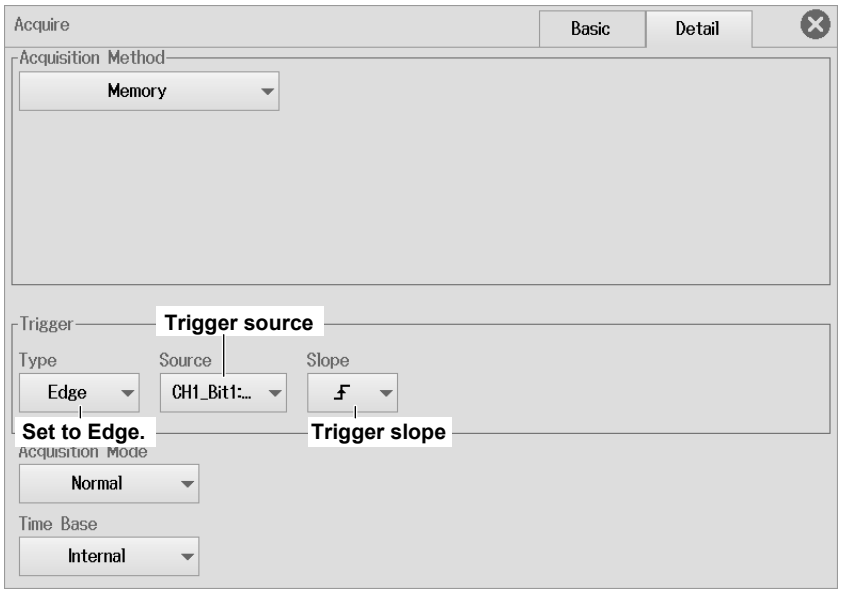
Trigger Source (Source)

4. Tap **Source**, and select a channel of the logic input module or CH5 or CH6. A list of source bits appears.
5. Tap the source bit you want to select.



For Recorder Mode

2. Tap the **Detail** tab > **Type** in the Trigger area, and select Edge.
3. Tap **Slope**, and select the trigger slope.



Trigger Source (Source)

► See the description on the previous page for scope mode.

4.7 Triggering on an Edge On A Trigger

This section explains the following settings for triggering on an Edge On A trigger.

Applicable to Scope Mode

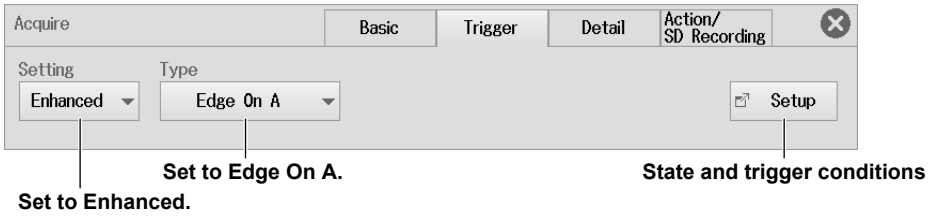
Setting the trigger to Enhanced, setting the trigger type to Edge On A, state condition, edge detection condition, trigger condition, state condition achievement condition

These settings are not available in recorder mode.

► Features Guide: “Edge On A Trigger (Enhanced)”

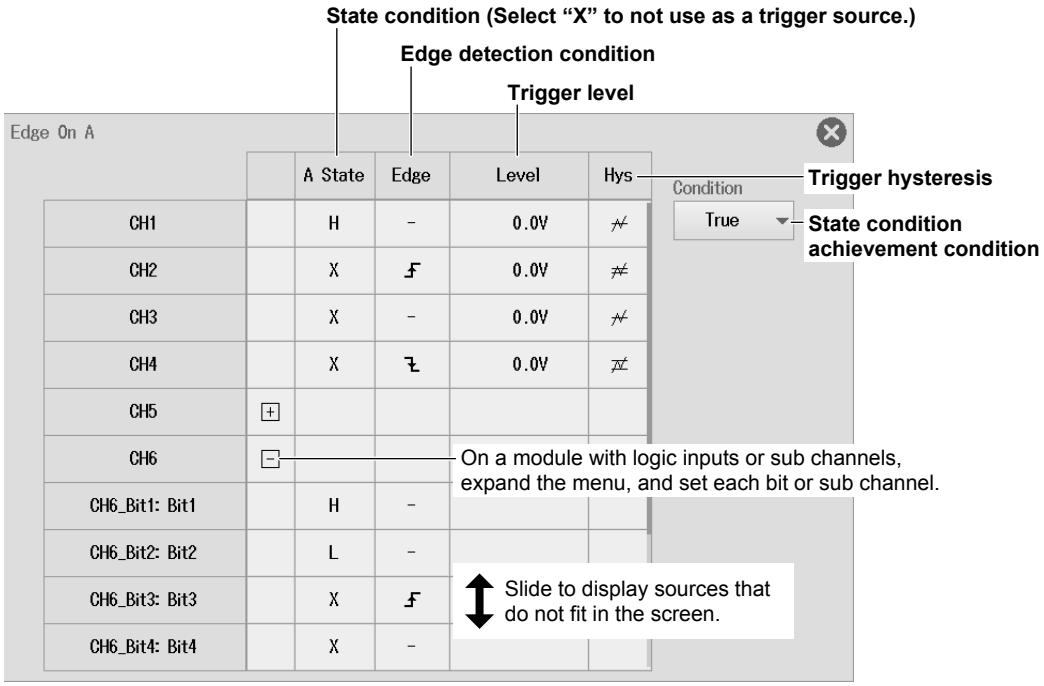
Waveform Acquisition Trigger Menu

1. On the waveform screen, tap **MENU** > **Acquire**. The Acquire menu appears.
2. Tap the **Trigger** tab > **Setting**, and select Enhanced.
3. Tap **Type** and select Edge On A.



State Condition, Trigger Condition (Setup)

4. Tap **Setup**. The following screen appears.
5. Tap each item. Use the displayed list (options) or input box to set the items.



4.8 Triggering on an OR Trigger

This section explains the following settings for triggering on an OR trigger.

For Scope Mode

Setting the trigger to Enhanced, setting the trigger type to OR, edge detection condition, trigger condition

For Recorder Mode

Setting the trigger type to OR, edge detection condition, trigger condition

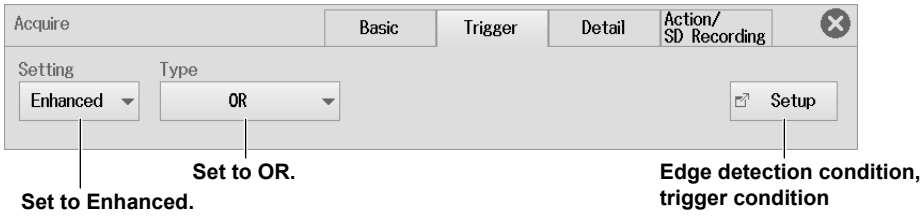
► Features Guide: “OR Trigger (Enhanced)”

Waveform Acquisition Trigger Menu

1. On the waveform screen, tap **MENU** > **Acquire**. The Acquire menu appears.

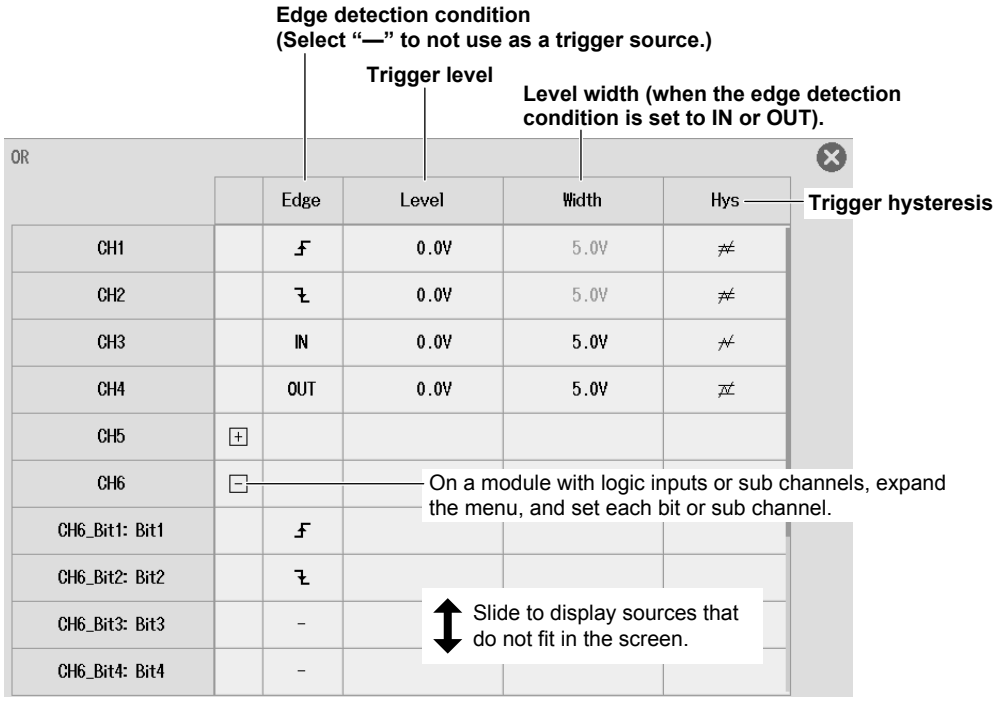
For Scope Mode

2. Tap the **Trigger** tab > **Setting**, and select Enhanced.
3. Tap **Type** and select OR.



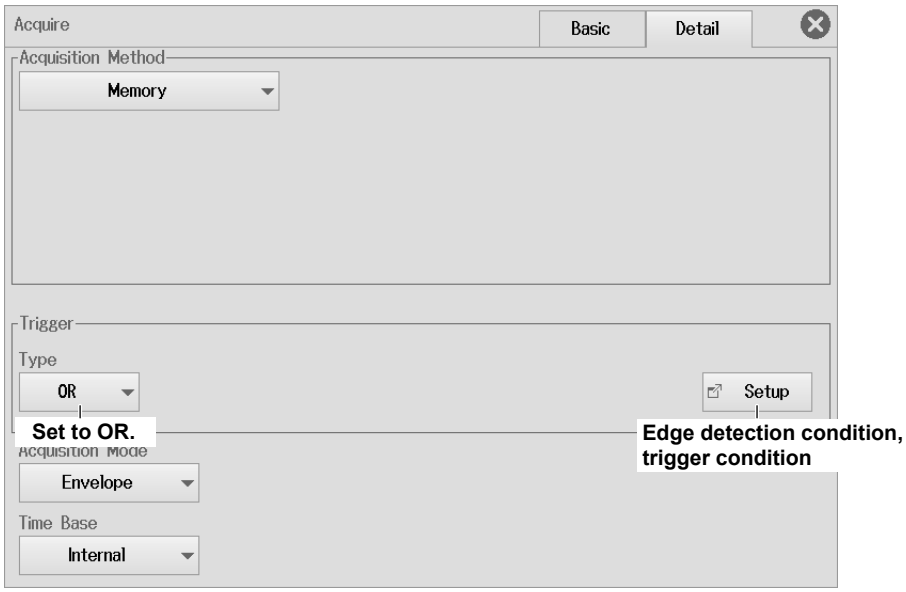
Edge Detection Condition, Trigger Condition (Setup)

4. Tap **Setup**. The following screen appears.
5. Tap each item. Use the displayed list (options) or input box to set the items.



For Recorder Mode

2. Tap the **Detail** tab > **Type** in the Trigger area, and select OR.



Edge Detection Condition, Trigger Condition (Setup)

► See the description on the previous page for scope mode.

4.9 Triggering on an AND Trigger

This section explains the following settings for triggering on an AND trigger.

For Scope Mode

Setting the trigger to Enhanced, setting the trigger type to AND, achievement condition, trigger condition

For Recorder Mode

Setting the trigger to AND, achievement condition, trigger condition

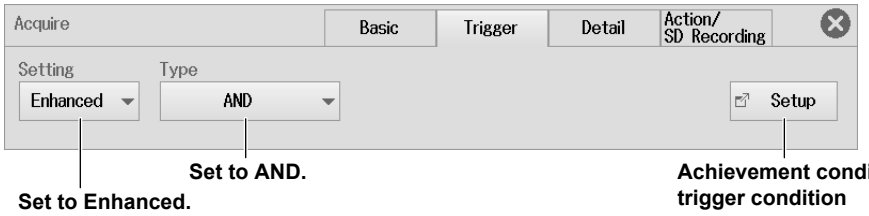
► Features Guide: “AND Trigger (Enhanced)”

Waveform Acquisition Trigger Menu

1. On the waveform screen, tap **MENU** > **Acquire**. The Acquire menu appears.

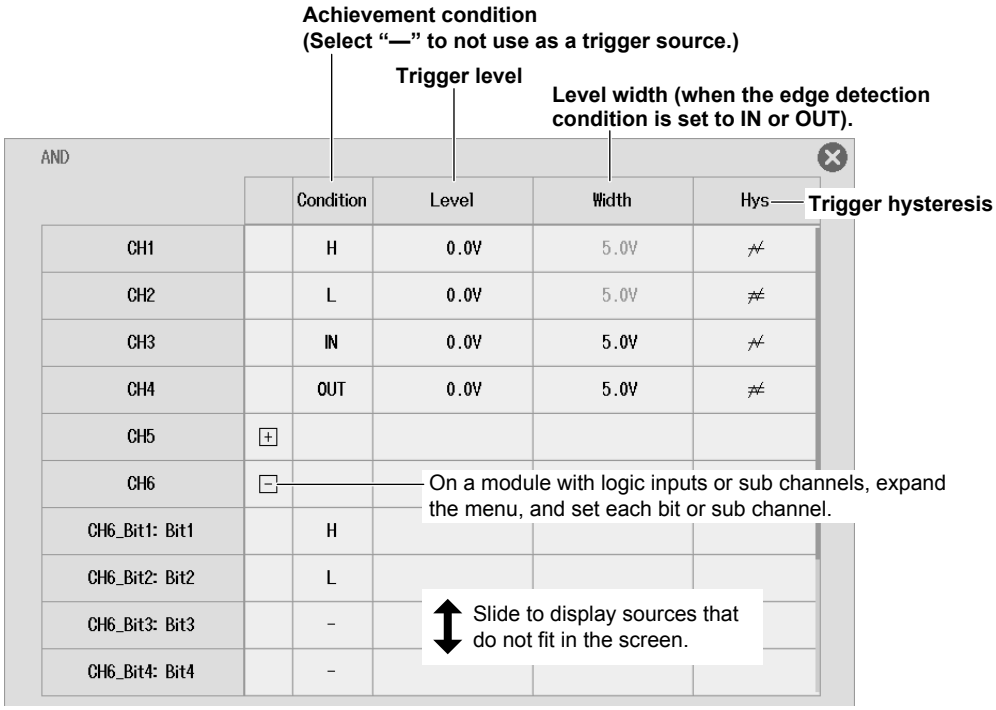
For Scope Mode

2. Tap the **Trigger** tab > **Setting**, and select Enhanced.
3. Tap **Type** and select AND.



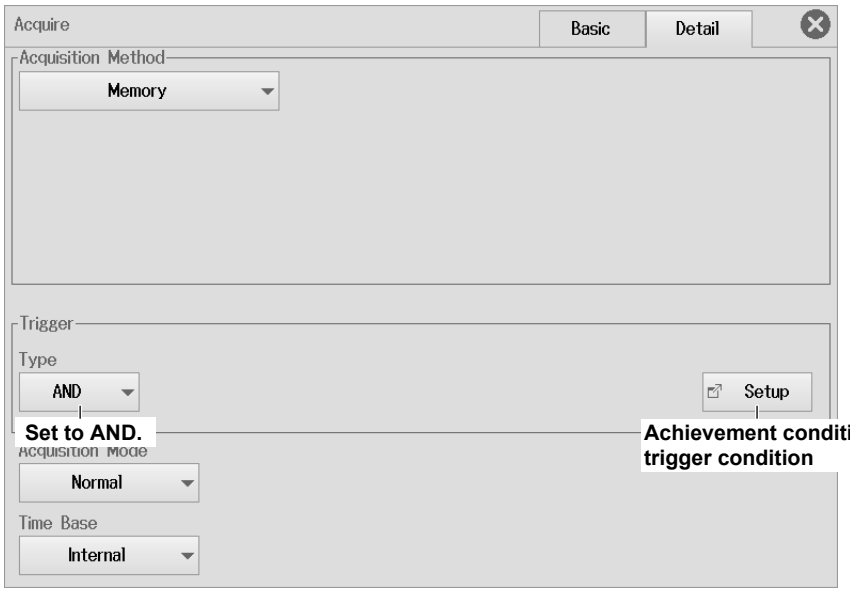
Achievement condition, Trigger Condition (Setup)

4. Tap **Setup**. The following screen appears.
5. Tap each item. Use the displayed list (options) or input box to set the items.



For Recorder Mode

2. Tap the **Detail** tab > **Type** in the Trigger area, and select AND.



Achievement condition, Trigger Condition (Setup)

► See the description on the previous page for scope mode.

4.10 Triggering on a Period Trigger

This section explains the following settings for triggering on a period trigger.

Applicable to Scope Mode

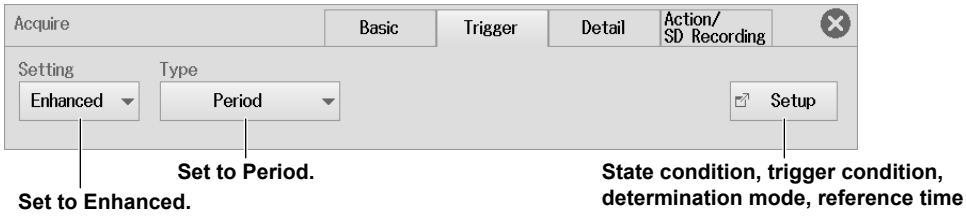
Setting the trigger to Enhanced, setting the trigger type to Period, state condition, trigger condition, determination mode, reference time

These settings are not available in recorder mode.

► Features Guide: “Period Trigger (Enhanced)”

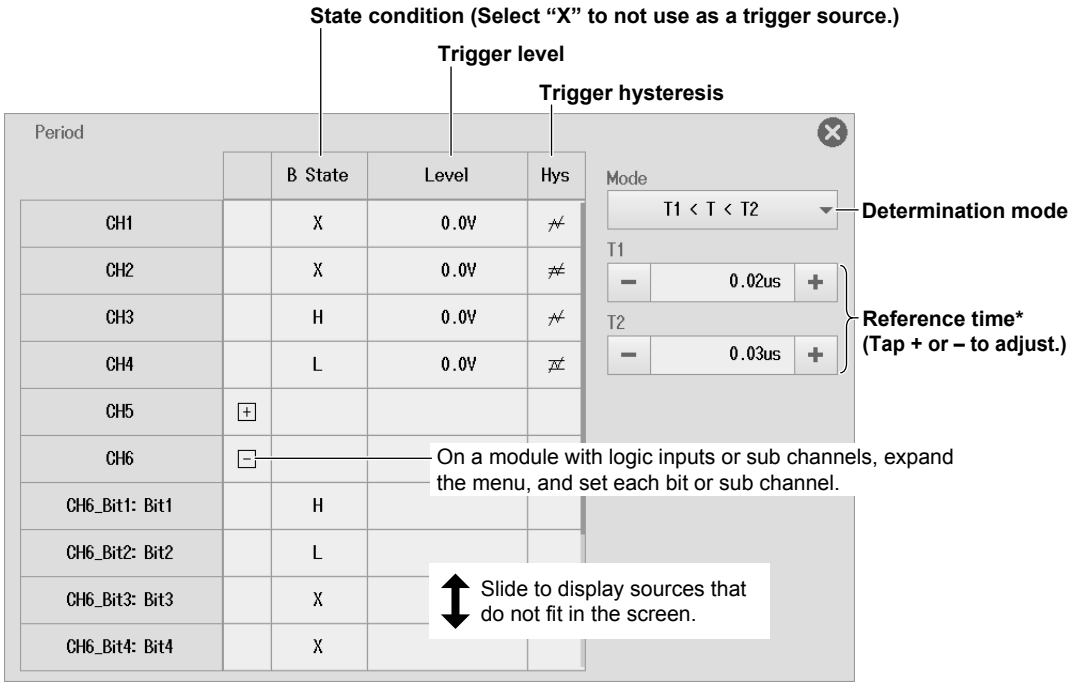
Waveform Acquisition Trigger Menu

1. On the waveform screen, tap **MENU** > **Acquire**. The Acquire menu appears.
2. Tap the **Trigger** tab > **Setting**, and select Enhanced.
3. Tap **Type** and select Period.



State Condition, Trigger Condition, Determination Mode, Reference Time (Setup)

4. Tap **Setup**. The following screen appears.
5. Tap each item. Use the displayed list (options) or input box to set the items.



* Set T1 and T2 when the determination mode is T1 < T < T2 or T <T1, T2 < T.
Set Time when the determination mode is T < Time or T >Time.

Determination Mode (Mode)

Set what kind of relationship must be established between period T and the specified reference times (Time or T1 and T2) for the instrument to trigger.

T < Time	Period T must be shorter than the reference time (Time).
T > Time	Period T must be longer than the reference time (Time).
T1 < T < T2	Period T must be longer than reference time T1 and shorter than reference time T2.
T < T1, T2 <T	Period T must be shorter than reference time T1 or longer than reference time T2.

4.11 Triggering on a Pulse Width Trigger

This section explains the following settings for triggering on a pulse width trigger.

Applicable to Scope Mode

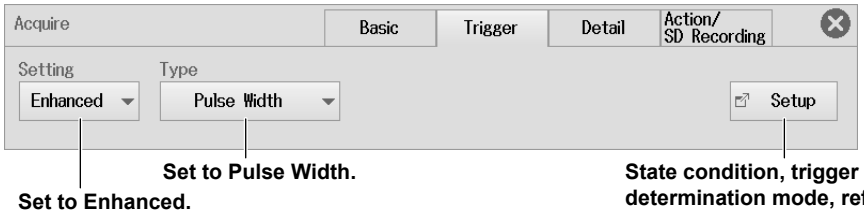
Setting the trigger to Enhanced, setting the trigger type to Pulse Width, state condition, trigger condition, determination mode, reference time

These settings are not available in recorder mode.

► Features Guide: “Pulse Width Trigger (Enhanced)”

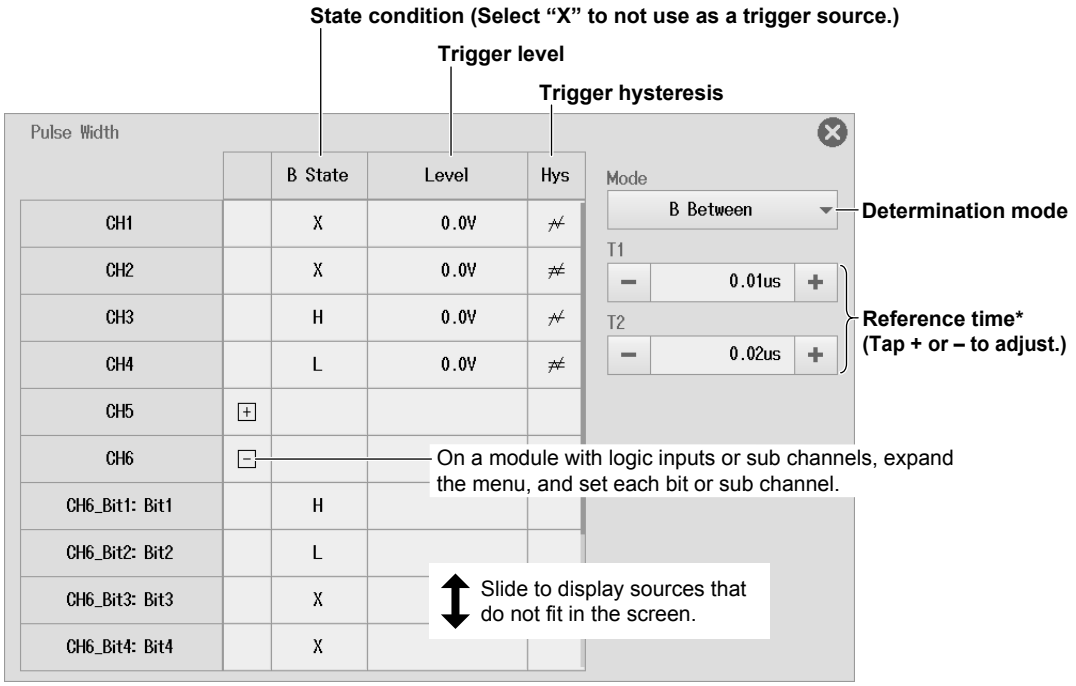
Waveform Acquisition Trigger Menu

1. On the waveform screen, tap **MENU** > **Acquire**. The Acquire menu appears.
2. Tap the **Trigger** tab > **Setting**, and select Enhanced.
3. Tap **Type** and select Pulse Width.



State Condition, Trigger Condition, Determination Mode, Reference Time (Setup)

4. Tap **Setup**. The following screen appears.
5. Tap each item. Use the displayed list (options) or input box to set the items.



* Set T1 and T2 when the determination mode is B Between.
Set Time when the determination mode is B < Time, B >Time, or B TimeOut.

Determination Mode (Mode)

Set what kind of relationship must be established between the state condition B achievement time and the specified reference times (Time or T1 and T2) for the instrument to trigger.

B < Time	The instrument triggers when the achievement time is shorter than the reference time (Time), and the state condition changes from being met to not being met.
B > Time	The instrument triggers when the achievement time is longer than the reference time (Time), and the state condition changes from being met to not being met.
B TimeOut	The instrument triggers when the achievement time is longer than the reference time (Time).
B Between	The instrument triggers when the achievement time is longer than reference time T1 and shorter than reference time T2, and the state condition changes from being met to not being met.

4.12 Triggering on a Wave Window Trigger

This section explains the following settings for triggering on a wave window trigger.

Applicable to Scope Mode

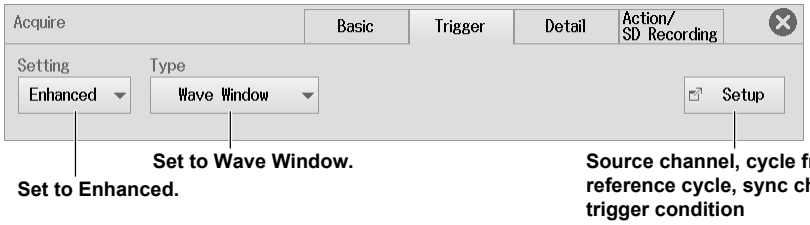
Setting the trigger to Enhanced, setting the trigger type to Wave Window, source channel, tolerance, cycle frequency, reference cycle, sync channel, trigger condition

These settings are not available in recorder mode.

► Features Guide: “Wave Window Trigger (Enhanced)”

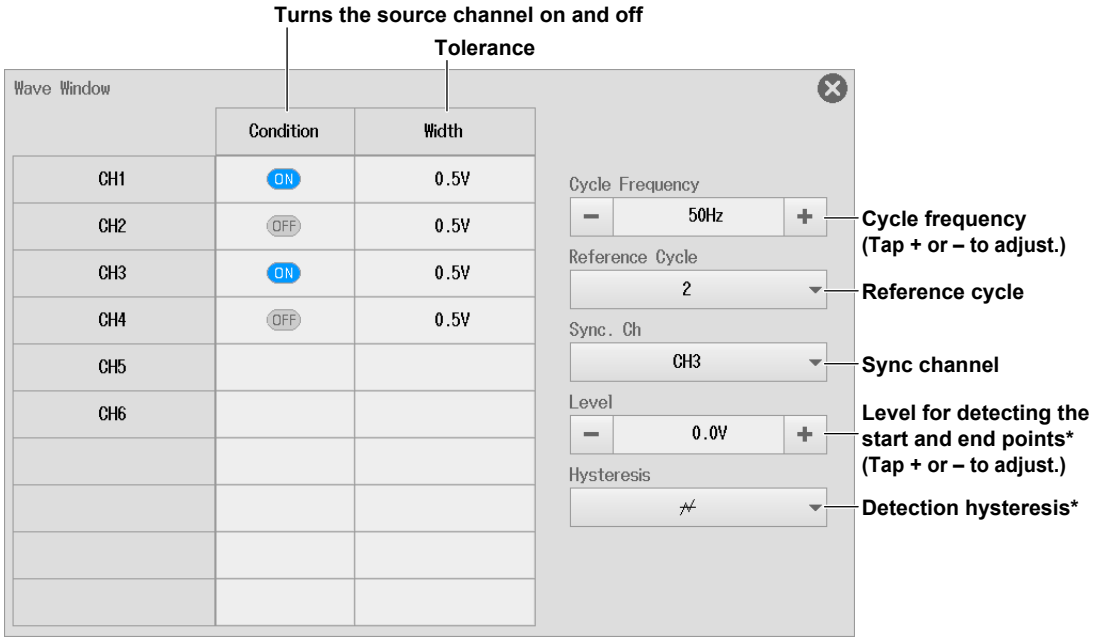
Waveform Acquisition Trigger Menu

1. On the waveform screen, tap **MENU** > **Acquire**. The Acquire menu appears.
2. Tap the **Trigger** tab > **Setting**, and select Enhanced.
3. Tap **Type** and select Wave Window.



Source Channel, Cycle Frequency, Reference Cycle, Sync Channel, Trigger Condition (Setup)

4. Tap **Setup**. The following screen appears.
5. Tap each item. Use the displayed list (options) or input box to set the items.



* Set when the sync channel is CH1 to CH4.

4.13 Triggering the Instrument Manually (Manual Trigger)

This section explains how to trigger the instrument manually.

Items Common to Scope Mode and Recorder Mode

TRIGGER key

► Features Guide: “Trigger Settings (Setting)”
“Trigger (Trigger)”

Press **TRIGGER** (

).

Note

You can also tap Utility on the waveform screen’s MENU and then tap Manual Trigger to execute a manual trigger.

5.1 Setting Display Groups and Display Format

This section explains the following settings for displaying waveforms.

Items Common to Scope Mode and Recorder Mode

Display group, display format (number of divided screens)

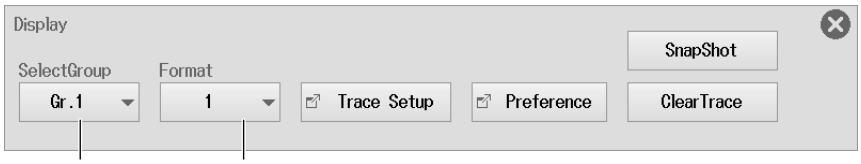
► Features Guide: “Display Group (Select Group)”
“Display Format (Format)”

Display Menu

1. On the waveform screen, tap **MENU** > **Display**. The Display menu appears.

For Scope Mode

2. Tap each item. Use the displayed list (options) to set the items.

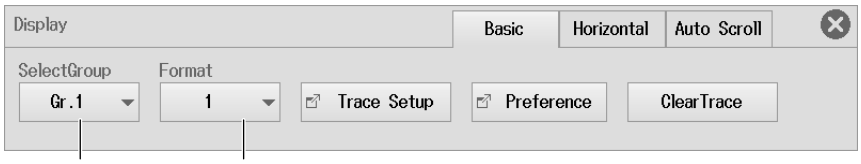


Display group **Display format**

- Display format Group 1 can be selected when the display group is Gr.2 to Gr.4.
- This item is not available when the display group is DMM.

For Recorder Mode

2. Tap the **Basic** tab.
3. Tap each item. Use the displayed list (options) to set the items.



Display group **Display format**

- Display format Group 1 can be selected when the display group is Gr.2 to Gr.4.
- This item is not available when the display group is DMM.

5.2 Setting the Waveform Arrangement, Color, and Grouping

This section explains the following settings for displaying waveforms.

Items Common to Scope Mode and Recorder Mode

Waveform arrangement, color, and grouping

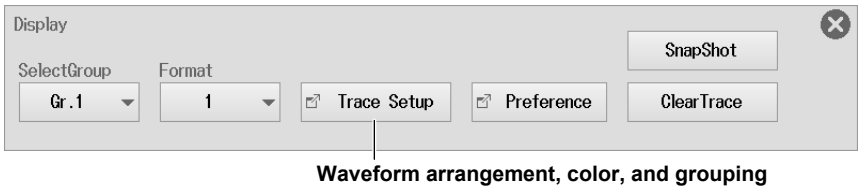
► Features Guide: “Waveform Arrangement, Color, and Grouping (Trace Setup)”

Display Menu

1. On the waveform screen, tap **MENU** > **Display**. The Display menu appears.

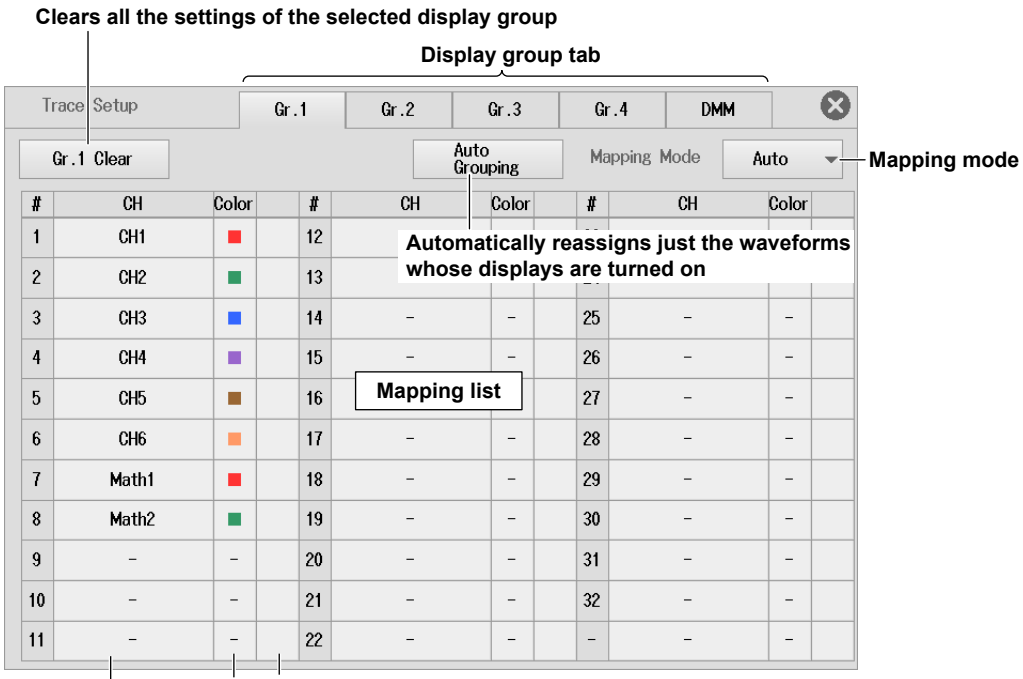
For Scope Mode

2. Tap **Trace Setup**.



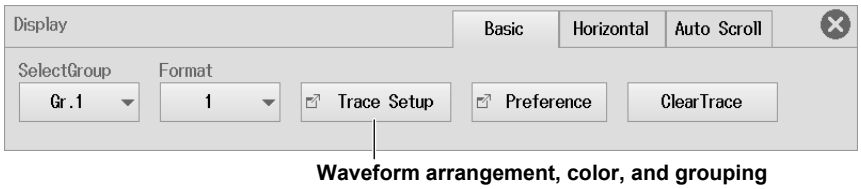
Waveform arrangement, color, and grouping

3. Tap the display group tab you want to group.
4. Tap each item. Use the displayed list (options) or input box to set the items.



For Recorder Mode

2. Tap the **Basic** tab.
3. Tap **Trace Setup**.



Waveform arrangement, color, and grouping

► See the description on the previous page for scope mode.

5.3 Configuring the Display Preferences

This section explains the waveform information and preference settings for displaying waveforms.

Items Common to Scope Mode and Recorder Mode

- Waveform data (interpolation method, decimation, accumulation, manual event)
- Information (scale value, horizontal axis display mode, font size, trace label, level indicator)
- Window (grid, extra window, display ratio of main window, window layout)
- Intensity (grid, cursor, marker)

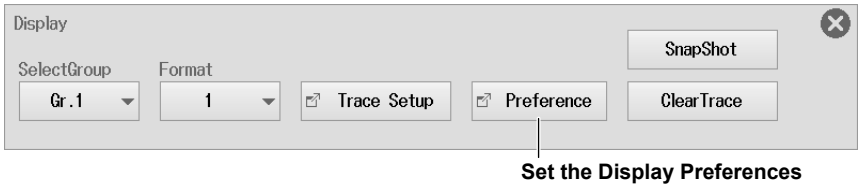
► Features Guide: “Environment Settings (Preference)”

Display Menu

1. On the waveform screen, tap **MENU** > **Display**. The Display menu appears.

For Scope Mode

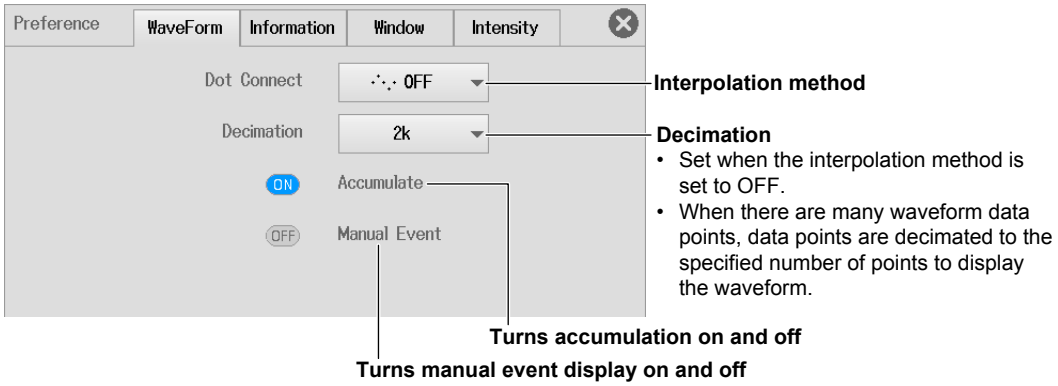
2. Tap **Preference**.



Setting the Display Preferences

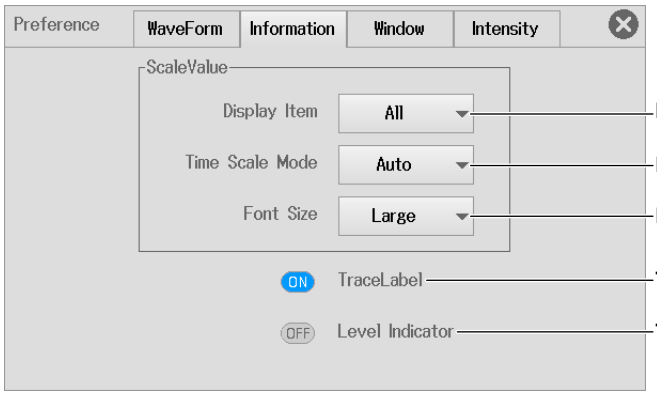
- **Waveform data**

3. Tap the **WaveForm** tab.
4. Tap each item. Use the displayed list (options) or **ON/OFF** to set the items.



- **Information**

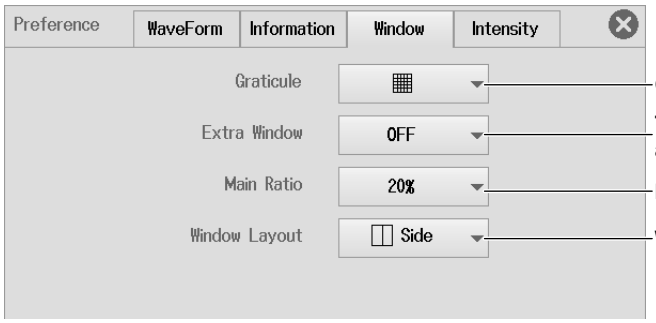
3. Tap the **Information** tab.
4. Tap each item. Use the displayed list (options) or **ON/OFF** to set the items.



Items whose scale values are displayed
Horizontal axis display mode
Font size
Turns trace labels on and off
Turns level indicator display on and off

- **Window**

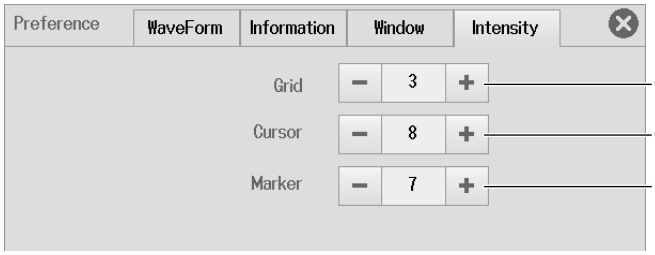
3. Tap the **Window** tab.
4. Tap each item. Use the displayed list (options) to set the items.



Grid
Turns extra window display on and off and sets the height of the extra window
Main window's display ratio
Window layout

- **Intensity**

3. Tap the **Intensity** tab.
4. Tap each item. Use the displayed input box to set the items.



Grid intensity (Tap + or – to adjust.)
Cursor intensity (Tap + or – to adjust.)
Marker intensity (Tap + or – to adjust.)

For Recorder Mode

2. Tap the **Basic** tab.
3. Tap **Preference**.

Configuring the Display Preferences

► See the description on the previous two page for scope mode.

The Accumulate on/off setting is not available in recorder mode.

5.4 Using the Snapshot and Clear Trace Features

This section explains how to take snapshots and clear traces.

For Scope Mode

- Snapshot
- Clear trace

For Recorder Mode

Clear trace
(The snapshot feature is not available in recorder mode.)

► Features Guide: “Snapshot (SnapShot)”
“Clear Trace (Clear Trace)”

Display Menu

1. On the waveform screen, tap **MENU** > **Display**. The Display menu appears.

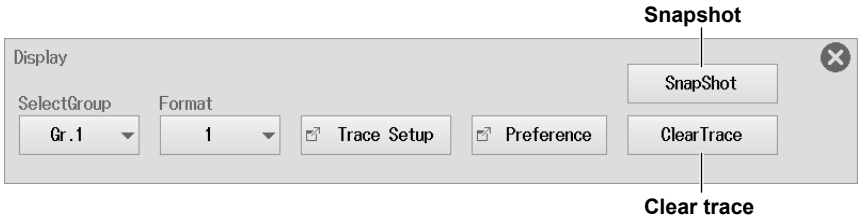
For Scope Mode

Snapshot

2. Tap **SnapShot**.

Clear trace

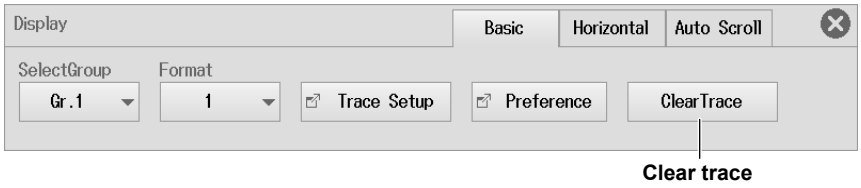
2. Tap **Clear Trace**.



For Recorder Mode

Clear trace

2. Tap the **Basic** tab.
3. Tap **Clear Trace**.



5.5 Setting the Display Time and Display Position

This section explains the following settings for displaying acquired waveforms.

Applicable to Recorder Mode

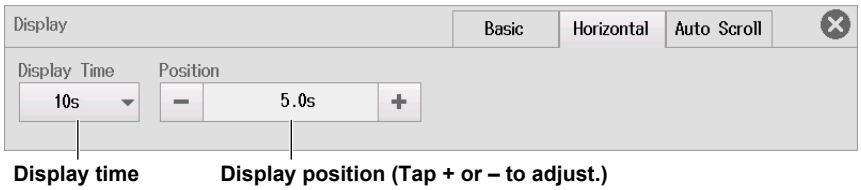
Display time, display position

These settings are not available in scope mode.

► Features Guide: “Horizontal Scale (Horizontal)”

Display Menu

1. On the waveform screen, tap **MENU** > **Display**. The Display menu appears.
2. Tap the **Horizontal** tab.
3. Tap each item. Use the displayed list (options) or input box to set the items.



5.6 Auto Scrolling the Display Range

This section explains the following settings for auto scrolling the display range.

Applicable to Recorder Mode

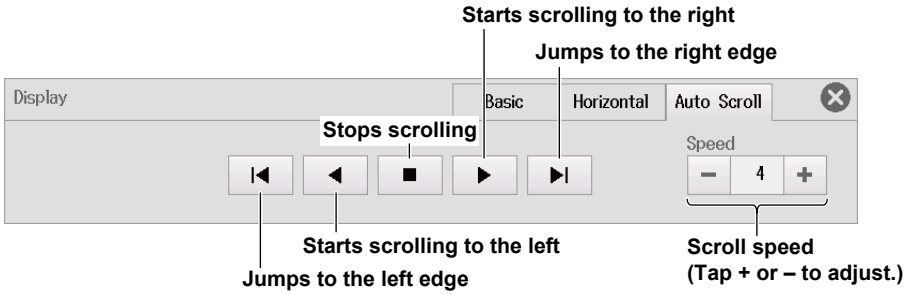
Scroll direction, jumping to the left or right edge, scroll speed

These settings are not available in scope mode.

► Features Guide: “Auto Scrolling (Auto Scroll)”

Display Menu

1. On the waveform screen, tap **MENU** > **Display**. The Display menu appears.
2. Tap the **Auto Scroll** tab.
3. Tap the appropriate buttons. The display range scrolls according to the buttons you tap.
   To change the scroll speed, tap the **Speed** value. Use the displayed input box to set the scroll speed.



6.1 Connecting a Storage Device

This section explains the following settings for connecting to a storage device.

Items Common to Scope Mode and Recorder Mode

SD memory card, USB storage device

SD Memory Card

CAUTION

- Do not insert the SD memory card in the wrong direction. Doing so may damage the SD memory card and the instrument.
- Inserting and removing the SD memory card quickly (within the span of a second) may damage the instrument.
- Removing the SD memory card from the instrument while the card is being accessed may corrupt the data on the SD memory card. Be sure to close the SD memory card drive cover.
- An icon appears at the top center of the screen when the SD memory card is being accessed.

French

ATTENTION

- Ne pas insérer la carte mémoire SD dans le mauvais sens. Cela pourrait endommager la carte mémoire SD ainsi que l'instrument.
- L'insertion et le retrait rapides de la carte mémoire SD (en l'espace d'une seconde) pourrait endommager l'instrument.
- Le retrait de la carte mémoire SD de l'instrument alors qu'une personne est en train d'y accéder pourrait corrompre les données de la carte mémoire SD. Veiller à fermer le clapet du lecteur de la carte mémoire SD
- Une icône apparaît en haut au centre de l'écran lorsqu'une personne est en train d'accéder à la carte mémoire SD.

Compatible SD Memory Cards

You can use memory cards that conform to the SD or SDHC standard with the instrument. For details, contact your nearest YOKOGAWA dealer.

This instrument shows the installation status of an SD memory card at the top of the screen.

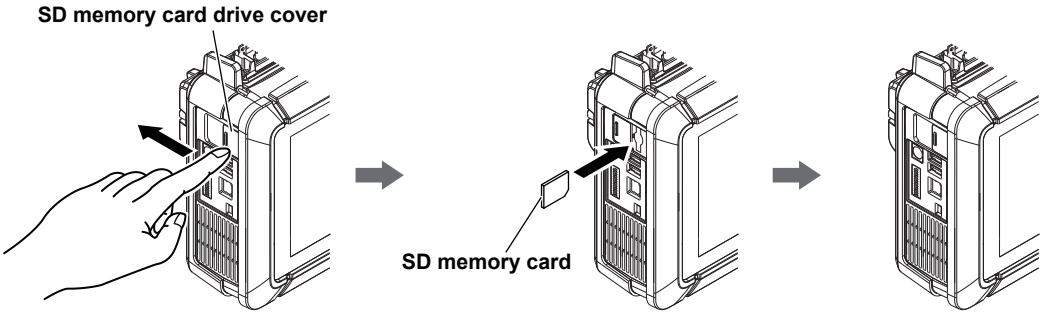
When an SD memory card is installed:
When an SD memory card is not installed:

Note

- When using an SD memory card with a PC, make sure that the PC is compatible with the SD memory card. Also, depending on the type of PC, some of the SD cards listed above may not function properly. Check it in advance.
- We recommend you test the operation of the SD memory card once before saving data to it. Further, when you want to save important data, format the SD memory card first.
- If file operations (save, copy, move, delete, etc.) are performed repeatedly on the SD memory card, file access may slow down. If this occurs, format the SD memory card, or replace with a new one.

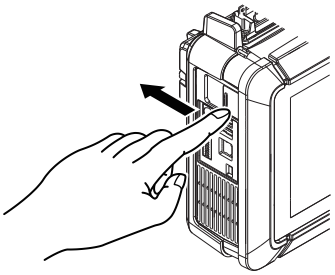
How to Insert an SD Memory Card

1. Slide the SD memory card drive cover. The SD memory card drive is on the left side panel of the instrument.
2. Insert the SD memory card into the slot with the front of the card facing the front panel. If you are using an SD memory card that has a write-protection feature and you want to save data to or format the card, disable the write-protection feature before you insert the SD memory card into the instrument.
3. Slide the SD memory card drive cover. Slide until you hear it click.

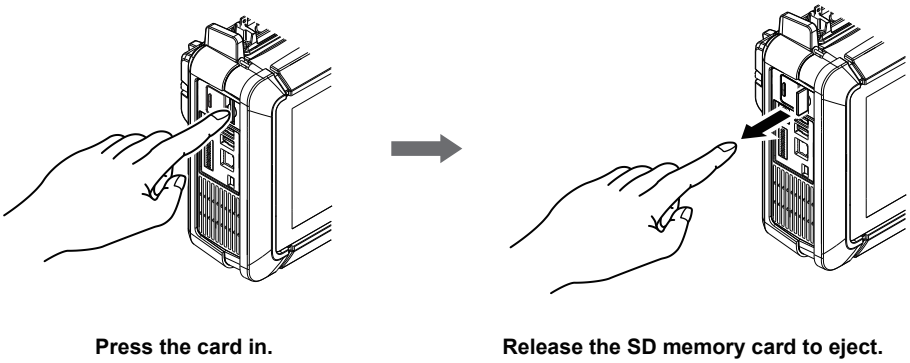


Removing the SD Memory Card

1. Slide the SD memory card drive cover.



2. Push the SD memory card with your finger and release to eject the card. Remove the SD memory card.



General SD Memory Card Handling Precautions

Follow the general handling precautions that are provided with your SD memory card.

USB Storage Device

CAUTION

- Do not remove the USB storage device or turn off the power when the medium is being accessed. If you do so, the data on the USB storage device may be corrupted.
- An icon appears at the top center of the screen when the USB storage device is being accessed.

French

ATTENTION

- Pendant que le dispositif accède au support de stockage USB, ne retirez pas ce dernier et ne mettez pas l'alimentation hors tension. Vous risqueriez d'endommager les données sur le support de stockage USB.
- Une icône au centre de la partie supérieure de l'écran indique que le dispositif est en train d'accéder au support de stockage USB.

Compatible USB Storage Devices

You can use USB storage devices that are compatible with USB Mass Storage Class version 1.1.

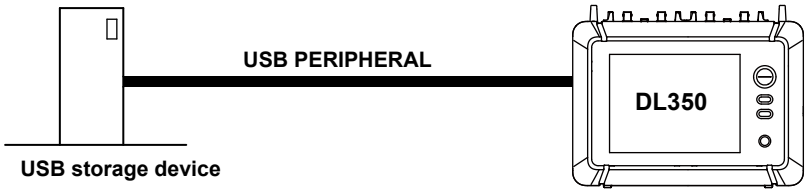
Note

- Only connect a USB keyboard, USB mouse, USB printer, or USB storage device to the USB connector for peripherals.
- The instrument can handle up to four storage devices. If the connected device is partitioned, the instrument treats each partition as a separate storage device.
- Connect USB storages device directly, not through a USB hub.
- Do not connect and disconnect the two USB devices repetitively. Provide at least a 10-second interval between removal and connection.

How to Connect a USB Storage Device

When connecting a USB storage device to the instrument's USB port, connect the USB cable directly as shown in the figure below. You can connect/disconnect a USB cable at any time regardless of whether the instrument is on or off (hot-plugging is supported). Connect the type A connector of the USB cable to the instrument, and connect the type B connector to the USB storage device. If you connect a USB storage device when the power switch is on, the device becomes available for use after the instrument identifies it.

The instrument has two USB ports: USB-0 and USB-1. The port numbers are not fixed. The port at which the first USB storage device is detected becomes USB-0. The second detected USB storage device becomes USB-1.



General USB Storage Device Handling Precautions

Follow the general handling precautions that are provided with your USB storage device.

6.2 Formatting an SD Memory Card

This section explains the following settings for formatting the SD memory card.

Items Common to Scope Mode and Recorder Mode

Formatting an SD memory card

► Features Guide: “System Configuration (System Configuration)”

CAUTION

- When you format an SD memory card, all the data saved in the card will be erased.
- If a formatted SD memory card cannot be detected by the instrument, use the instrument to format it again.

French

ATTENTION

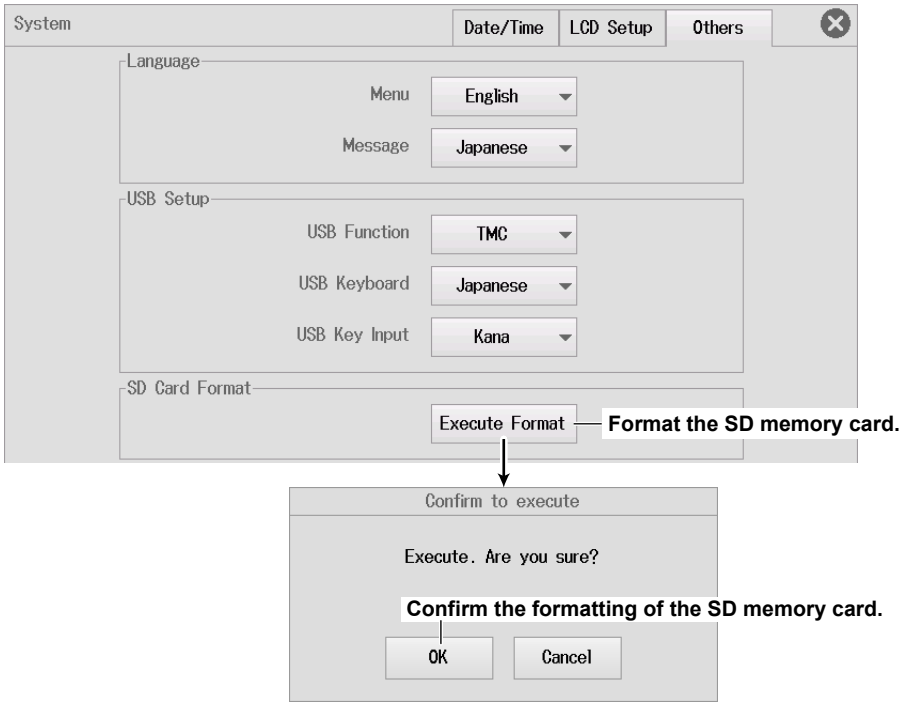
- Lorsque vous formatez un support de la carte mémoire SD, toutes les données qu’il contient sont supprimées.
- Si le l’instrument ne détecte pas un support de la carte mémoire SD formaté, utilisez le l’instrument pour formater de nouveau le support de la carte mémoire SD.

Utility System Menu

1. On the waveform screen, tap **MENU** > **Utility** > **System**. A System screen appears.

Formatting an SD Memory Card (SD Card Format)

2. Tap the **Others** tab.
3. Tap **Execute Format** to execute.



6.3 Saving Waveform Data

This section explains the following settings for saving waveform data):

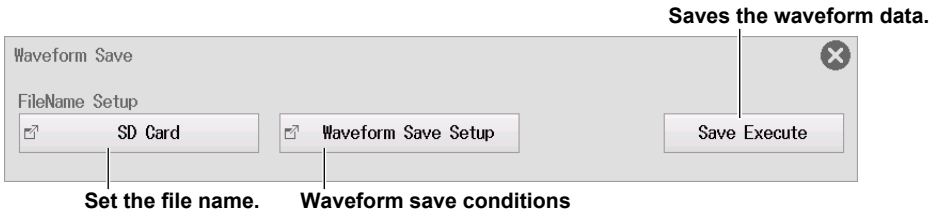
Items Common to Scope Mode and Recorder Mode

Save destination, file name, data format, save range, waveform to save, saving waveform data

► Features Guide: “Saving Waveform Data (Waveform Save)”

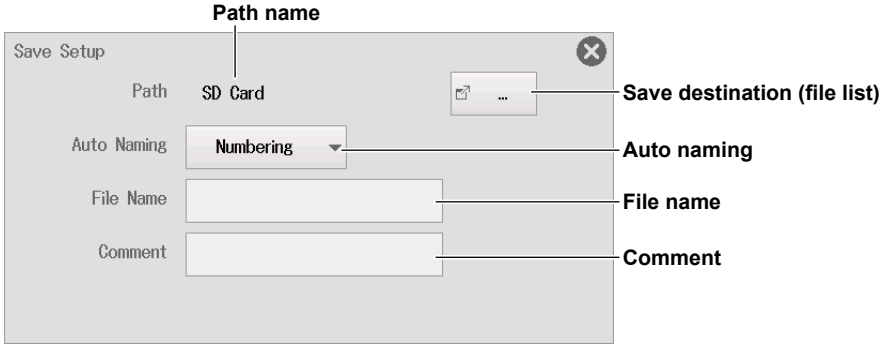
Save/Load Waveform Save Menu

1. On the waveform screen, tap **MENU** > **Save/Load** > **Waveform Save**. A Waveform Save menu appears.
2. Tap each item. Use the displayed input box to set the items.



Setting the File Name (FileName Setup)

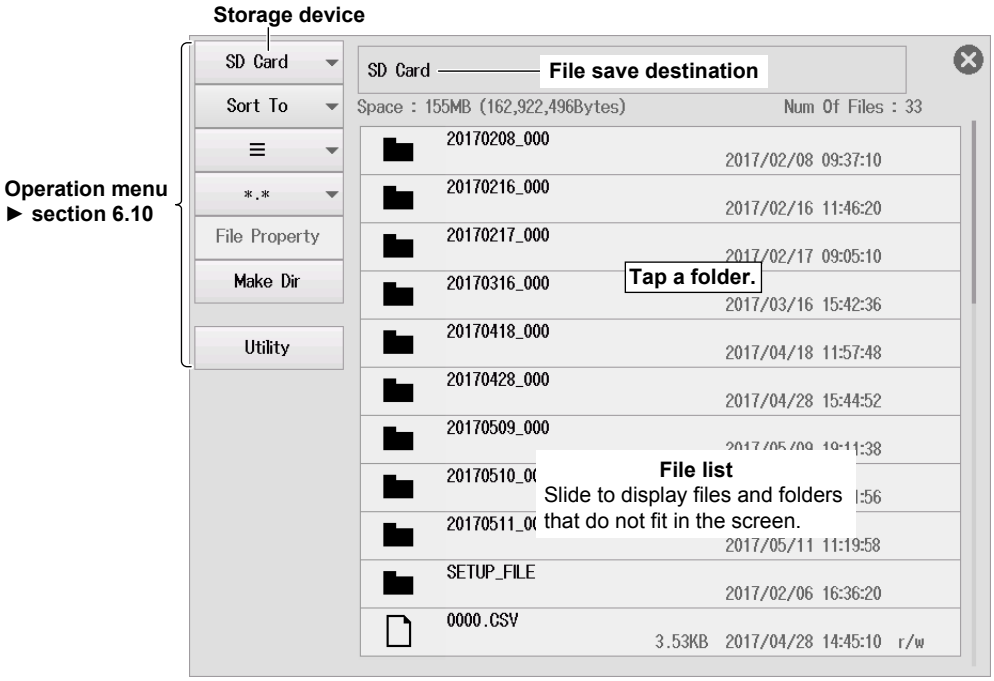
3. Tap **FileName Setup**. A Save Setup menu appears.
   * The set path name appears.
4. Tap each item. Use the displayed list (options) or input box to set the items.



Save Destination (File List)

5. Tap [...]. The following screen appears.

6. Set the waveform data save destination (device/folder).

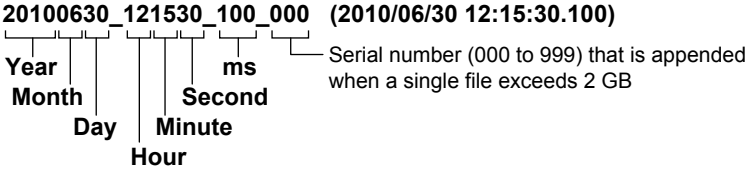


Auto Naming (Auto Naming)

OFF: The auto naming feature is disabled. The name that you specify using the File Name setting is used. If there is a file with the same name in the save destination folder, you cannot save the data.

Numbering: The instrument automatically adds a four-digit number (0000 to 9999) after the common name specified using the File Name setting (up to 32 characters).

Date: The file name is the date and time (down to ms) when the file is saved. The file name specified using the File Name setting is not used.



Regardless of whether the auto naming feature is set to OFF, Numbering, or Date, if the data size of a single file exceeds 2 GB, an underscore and a three-digit sequence number (000 to 999) is appended to the file name. The sequence number is incremented by one each time a file is added. This is appended only if the file exceeds 2 GB.

However, when a file is saved through the SD recording feature, an underscore and the three-digit serial number are appended to the file name even if the file size does not exceed 2 GB.

Comment (Comment)

You can add a comment that consists of up to 120 characters when you save a file. You do not have to enter a comment. All characters, including spaces, can be used in comments.

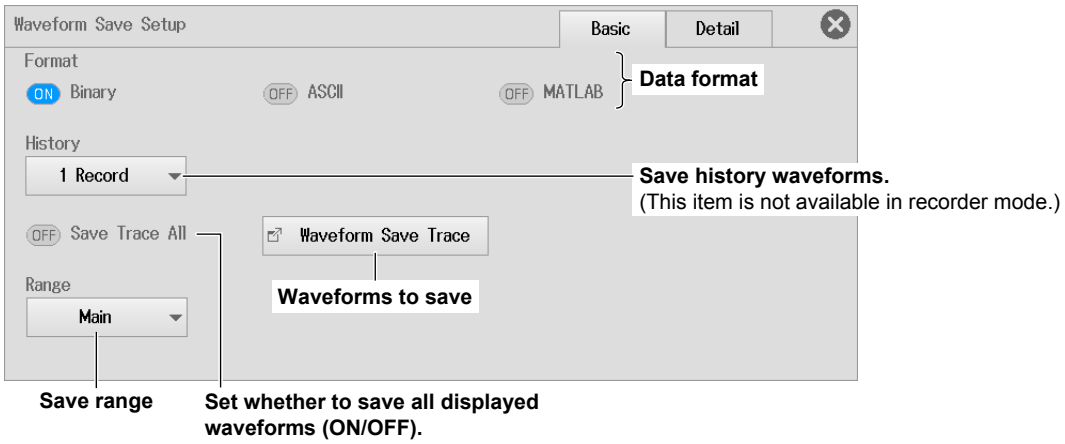
Waveform Save Conditions (Waveform Save Setup)

3. Tap **Waveform Save Setup**. A Waveform Save Setup menu appears.

Basic Setup (Basic)

4. Tap the **Basic** tab. **The following screen appears.**

5. Tap each item. Use the displayed list (options) or input box to set the items.



- **Data Format (Format)**

  You can save the sampling data stored in the acquisition memory in the following data formats.

Data Format	Extension	
Binary	.WDF	Data is saved in binary format. You can load this type of data into the instrument. ► section 6.7
ASCII	.CSV	Data is scaled using the specified range and saved to a file in ASCII format. You cannot load this type of data into the instrument.
MATLAB	.MAT	Data is saved in MATLAB format. You cannot load this type of data into the instrument.

- **Saving History Waveforms (History)**

  Set this item for scope mode.

  1 Record: The one waveform that is selected with Select Record on the History menu will be saved.

  All Record: All waveforms within the range bounded by Start Record and End Record on the History menu will be saved.

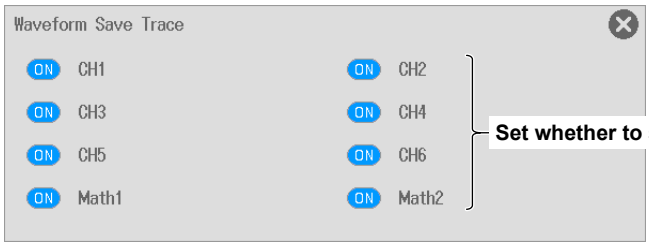
  * If the data type is set to MATLAB, a single waveform (1 record) selected with Select Record from the History menu is saved, regardless of the 1 Record or All Record setting.

Note

Average waveforms of history waveforms cannot be saved. Save the necessary range of history waveforms using All Record, load the saved history waveforms, and then select Average Record from the History menu to display the average waveform.

- **Waveforms to Save (Waveform Save Trace)**

6. Tap **Waveform Save Trace**. The following screen appears.
7. Tap each item to set options.



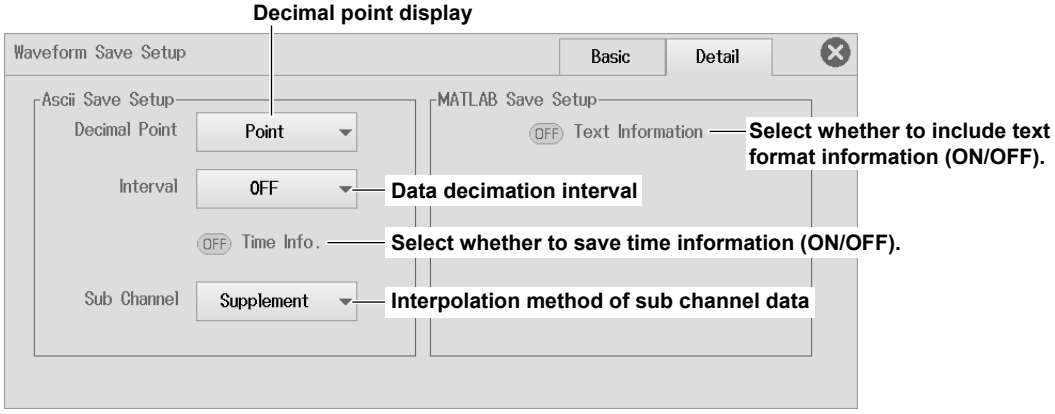
- You can select CH1 to CH6, 16CH VOLT, 16CH TEMP/VOLT, CAN, CAN FD, LIN, SENT, and Math waveforms. The waveforms you select that are displayed are saved.
- In scope mode, if you set History to All Record, Math waveforms will not be saved. If you want to save the Math data, set History to 1 Record.
  If you set History to All Record, all history waveforms within the range bounded by Start Record and End Record on the History menu will be saved. If you want to select which waveform will be saved, do not select All Record.

- **Save Range (Range)**
  You can select the waveform save range (area) from one of the choices below.
  - Scope mode
    Main: The normal waveform range. Waveforms are saved up to the displayed record length (the range that is displayed on the screen).
    Zoom1: The range of zoom waveform Zoom1.
    Zoom2: The range of zoom waveform Zoom2.
    Cursor Range: The range that is bounded by Cursor1 and Cursor2.
  - Recorder mode
    All: The entire range during the acquisition time.
    Display area: The range shown in the waveform display window.
    Zoom: The range shown in the zoom window.
    Cursor: The range specified with cursors.

Detail Settings (Detail)

4. Tap the **Detail** tab. **The following screen appears.**

5. Tap each item. Use the displayed list (options) or input box to set the items.



- **Decimal Point (Decimal Point)**
  When you save data in ASCII format, you can choose how to separate the data.
  Point (Point): The decimal point is a period, and the separator is a comma.
  Comma (Comma): The decimal point is a comma, and the separator is a period.

- **Data Removal Interval (Interval)**
  When you save data in ASCII format, you can thin out the data before you convert it to ASCII format. Set the data removal interval.
  OFF (no data is removed), 5 points (Per 5), 10 points (Per 10), 20 points (Per 20), 50 points (Per 50), 100 points (Per 100), 200 points (Per 200), 500 points (Per 500), 1000 points (Per 1000), 2000 points (Per 2000), 5000 points (Per 5000)
  For example, if you select Per 5, the data will be removed as indicated below.
  First data point, +5, +10, +15...

- **Time Information (Time Info.)**
  When you save data in ASCII format, you can choose whether to save time information (ON/OFF).

- **Interpolation Method of Sub Channel Data (Sub Channel)**
  When you save data in ASCII format, you can choose how to interpolate the sub channel data of 16-CH voltage input, 16-CH temperature/voltage input, CAN bus monitor, CAN/CAN FD monitor, CAN & LIN bus monitor, and SENT monitor modules.
  Supplement (Supplement): Blank spaces are filled with repetitions of the same data so that the sub channels have the same amount of data as an ordinary channel.
  Space (Space): Spaces are left where there is no data.

- **MATLAB Save Settings (MATLAB Save Setup)**
  You can select whether to include text format information (ON) or not (OFF).

6.4 Saving Setup Data

This section explains the following settings for saving setup data. You can save setup data to a file.

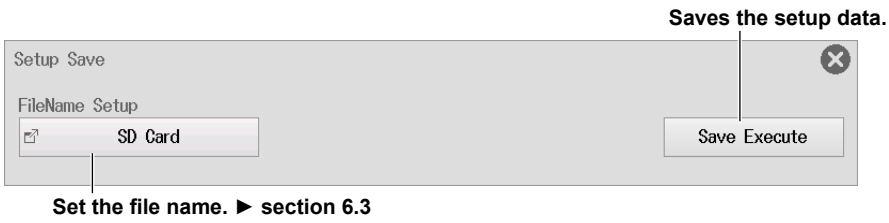
Items Common to Scope Mode and Recorder Mode

Save destination, file name, saving setup data

► Features Guide: “Saving Setup Data (Setup Save)”

Save/Load Setup Save Menu

1. On the waveform screen, tap **MENU** > **Save/Load** > **Setup Save**. A Setup Save menu appears.
2. **Tap each item to set options and execute commands.**



Saving Setup Data (Save Execute)

- Setup parameters are saved to a file. The extension is .SET.
- The date, time, and communication setup parameters are not saved.
- You cannot save setup data during waveform acquisition. Press START/STOP to stop the waveform acquisition.

6.5 Saving Other Types of Data

This section explains the following settings for saving the results of automated measurement of waveform parameters, snapshot waveform data, screen captures, FFT computation results, and harmonic analysis results.

Items Common to Scope Mode and Recorder Mode

Save destination, file name, data to save, data format (screen image), color data (screen image), saving data

► Features Guide: “Saving Other Types of Data (Others Save)”

Save/Load Others Save Menu

1. On the waveform screen, tap **MENU** > **Save/Load** > **Others Save**. An Others Save menu appears.

Save Type (Save Type)

Measure: You can save the results of the automated measurement of waveform parameters to a file in CSV format.

Snap: You can save the waveform data captured in a snapshot. The extension is .SNP.

Image: You can save the displayed screen image to a file in PNG, BMP, or JPEG.

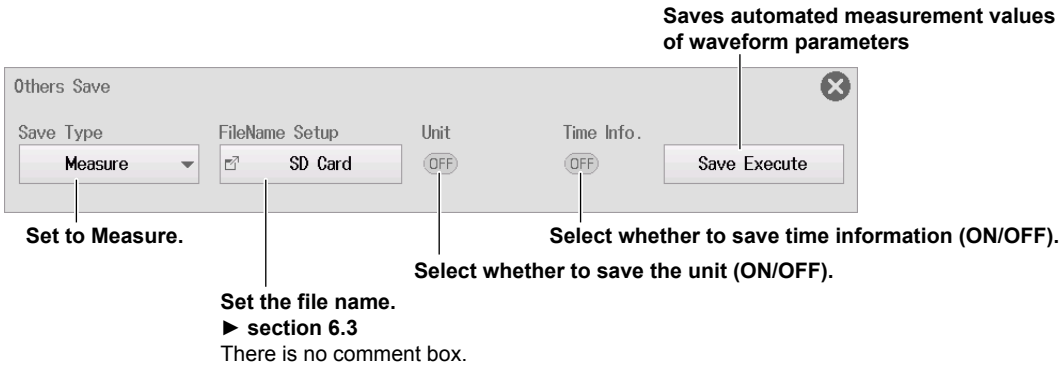
FFT: You can save FFT computation results to a file in CSV format.

Harmonic: You can save harmonic analysis results to a file in CSV format.

Automated Measurement Values of Waveform Parameters (Measure)

2. Select **Measure**.
3. Tap each item to set options and execute commands.

Proceed to step 5 on page 6-14.



Snapshot (Snap)

2. Select **Snap**.
3. Tap each item to set options and execute commands.

Proceed to step 5 on page 6-14.

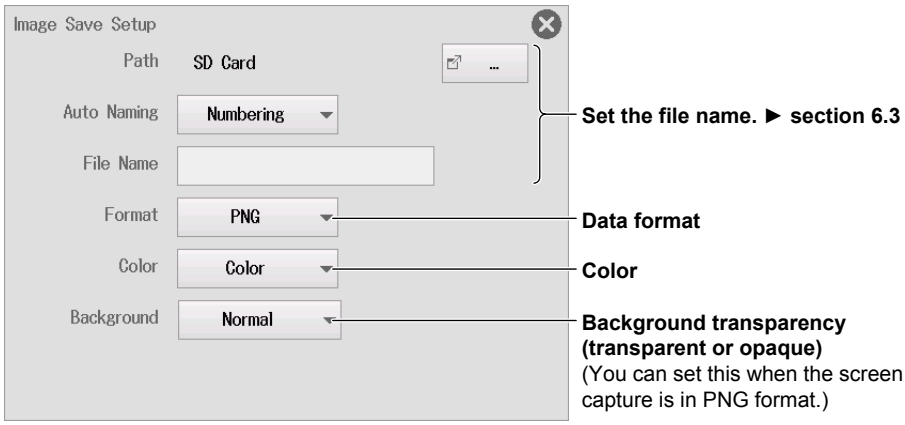
Screen Capture (Image)

2. Select **Image**.
3. Tap each item to set options and execute commands.

Save Conditions (Image Save Setup)

4. Tap **Image Save Setup**. An Image Save Setup screen appears.
   * The specified data format and color format are displayed.

Proceed to step 5 on page 6-14.



- **Data Format (Format)**

  You can save the following types of files to the specified storage device. The table below shows the extensions that are automatically assigned to each format and the approximate sizes of files in each format.

Data Format	Extension	File Size[1]
PNG	*.PNG	Approx. 100 KB (approx. 50 KB)[2]
JPEG	*.JPG	Approx. 250 KB
BMP	*.BMP	Approx. 1 MB (approx. 70 KB)[2]

1 When Color is set to Color, Color (Reverse), or Gray
2 The file sizes in parentheses indicate the file size when Color is set to OFF.

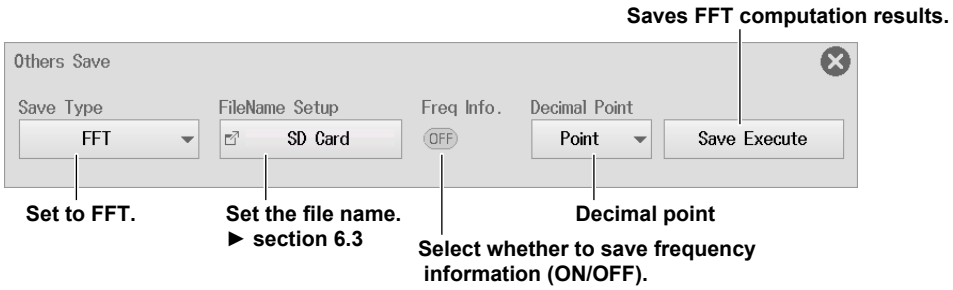
- **Color (Color)**

  OFF: A black-and-white image is produced.
  Color: An image is produced with a 65536-color palette.
  Color (Reverse): An image is produced with a 65536-color palette. The screen background will be white. You can select this when the color theme in environment settings is set to Black (Black).
  Gray: An image is produced with a 16-color grayscale palette.

FFT Computation Results (FFT)

2. Select **FFT**.
3. Tap each item. Use the displayed list (options) or input box to set the items.

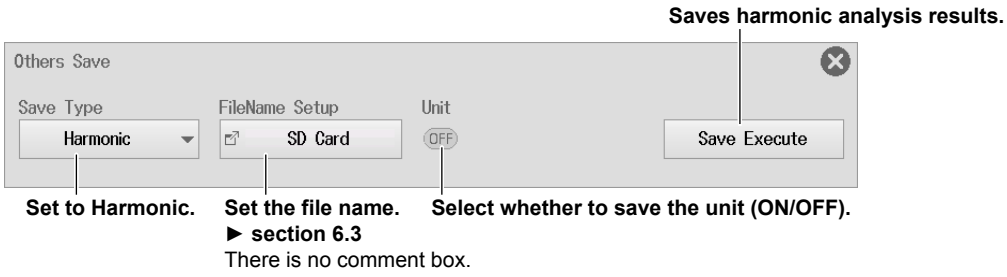
Proceed to step 5.



Harmonic Analysis Results (Harmonics)

2. Select **Harmonic**.
3. Tap each item to set options and execute commands.

Proceed to step 5.



Saving (Execute Save)

5. Tap **Save Execute**. Saves the data to the specified save destination with the specified file name.

6.6 Setting the SAVE Key Function

This section explains the following settings for using the SAVE key to save waveform data and screen images and print then on a USB printer.

Items Common to Scope Mode and Recorder Mode

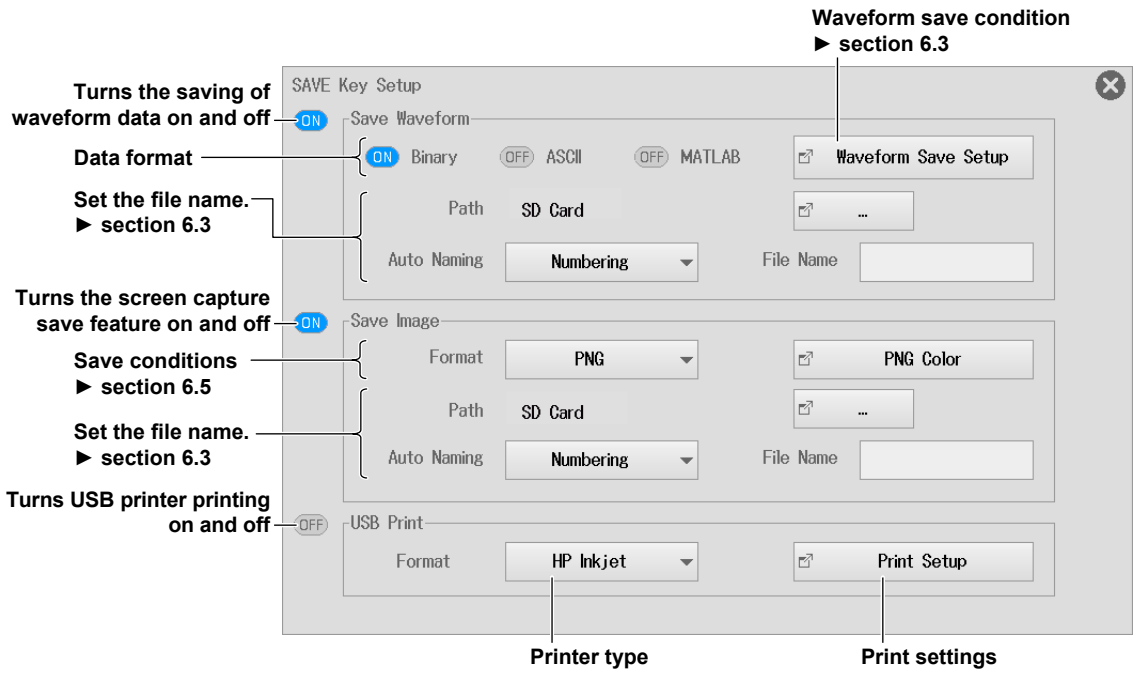
- Saving waveform data (save destination, file name, data format, save range, waveform to save)
- Saving a screen image (save destination, file name, data format (screen image), color data (screen image))
- Printing on a USB printer (output destination, printer type, color, comment, mode, long print (print range (output start point and output end point), print magnification)

► Features Guide: “SAVE Key Setup (Save Key Setup)”

Save/Load Save Key Setup Menu

1. On the waveform screen, tap **MENU** > **Save/Load** > **SAVE Key Setup**. A SAVE Key Setup menu appears.
2. Tap each item. Use the displayed list (options) or input box to set the items.

If USB printer printing is off, proceed to step 5 on page 6-18.



USB Printer Printing (USB Print)

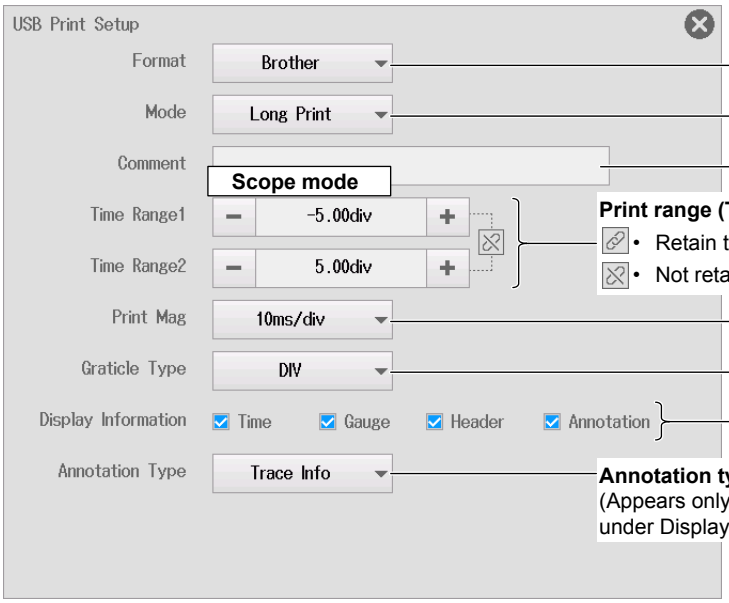
3. Tap **Print Setup**. A USB Print Setup screen appears.
4. Tap each item to set options.

When the Printer Type is HP Inkjet

When the Printer Type is Brother

- **When the mode is Hard Copy (Hard Copy)**

- **When the mode is Long Print (Long Print)**



Set to Brother.

Set to Long Print.

Comment

Print range (Tap + or – to adjust.)

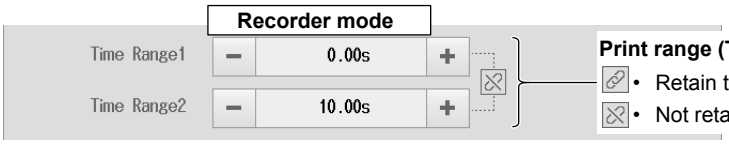
- Retain the upper and lower limit interval
- Not retain the upper and lower limit interval

Print magnification

Set width of the vertical scale.

Display information

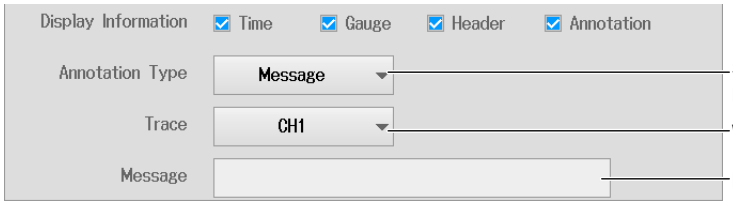
Annotation type
(Appears only when the Annotation check box under Display Information is selected.)



Print range (Tap + or – to adjust.)

- Retain the upper and lower limit interval
- Not retain the upper and lower limit interval

When Annotation Type is set to Message



Set the annotation type to Message.

Waveform to set

Message (up to 50 characters)

Print Magnification (Print Mag)

Set the print time magnification. Multiple pages are printed according to the print time range and print magnification.

Length of a page = 10 div (approx. 10 cm)

Note

The maximum number of pages that can be printed at once is 25. If the maximum number of print pages is exceeded, an error message will appear when printing is executed.

The method to set the magnification varies depending on whether the waveforms to be printed are sampled using the internal clock or sampled using an external clock.

- **For waveforms sampled with the internal clock**
  Set using the time per division (T/div).
  The selectable range varies depending on the T/div value and record length (in 1-2-5 steps).
- **For waveforms sampled with an external clock**
  Set using the magnification.
  Selectable range: Varies depending on the record length.

Saving

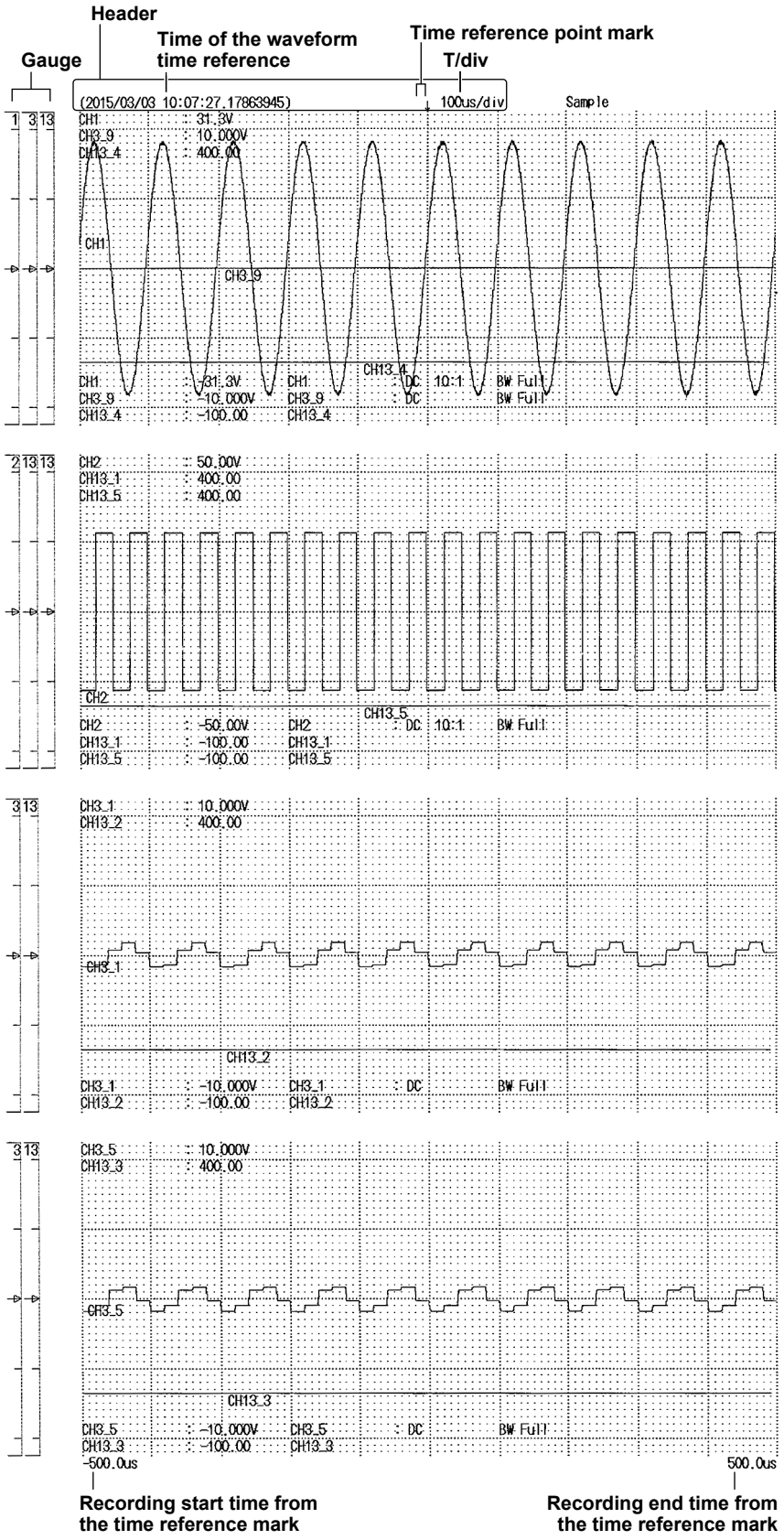
5. Press **SAVE**.

When waveform data saving and screen image saving are on, waveform data and screen image files are saved in the specified folder. When USB printer printing is on, a screen capture is output to the USB printer.

Note

You can also tap Save/Load on the waveform screen's MENU and then tap SAVE Execute to save and print.

Long Print Example



6.7 Loading Waveform Data

This section explains the following settings for loading waveform data):

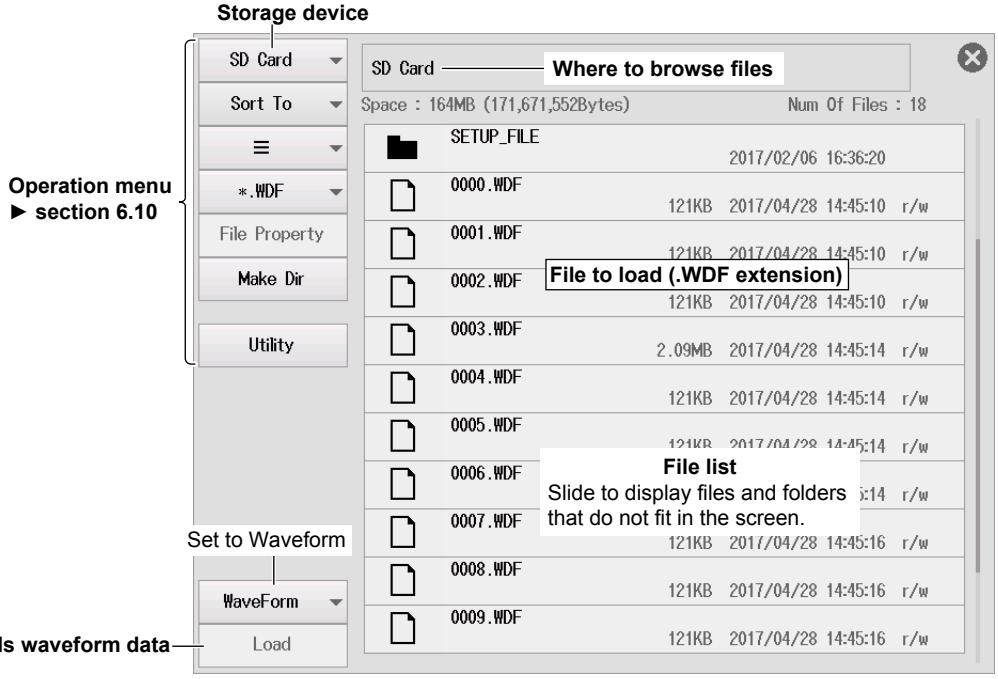
Items Common to Scope Mode and Recorder Mode

Displaying file information, loading to channels

► Features Guide: “Loading Waveform Data (Waveform Load)”

Save/Load Waveform Load Menu

1. On the waveform screen, tap **MENU** > **Save/Load** > **Waveform Load**. The following screen appears.
2. Select the file to load from the file list.
3. Tap **Load**. A confirmation message appears.
4. Tap **OK** or **Cancel**.



Loading Waveform Data (Load)

- The selected waveform data file is loaded together with the setup file. The extension is .WDF. Loaded data is cleared when you start measurement.
- If the module configuration when the waveform data is saved and that when the data is loaded are different, waveform data cannot be loaded.

6.8 Loading Setup Data

This section explains the following settings for loading setup data.

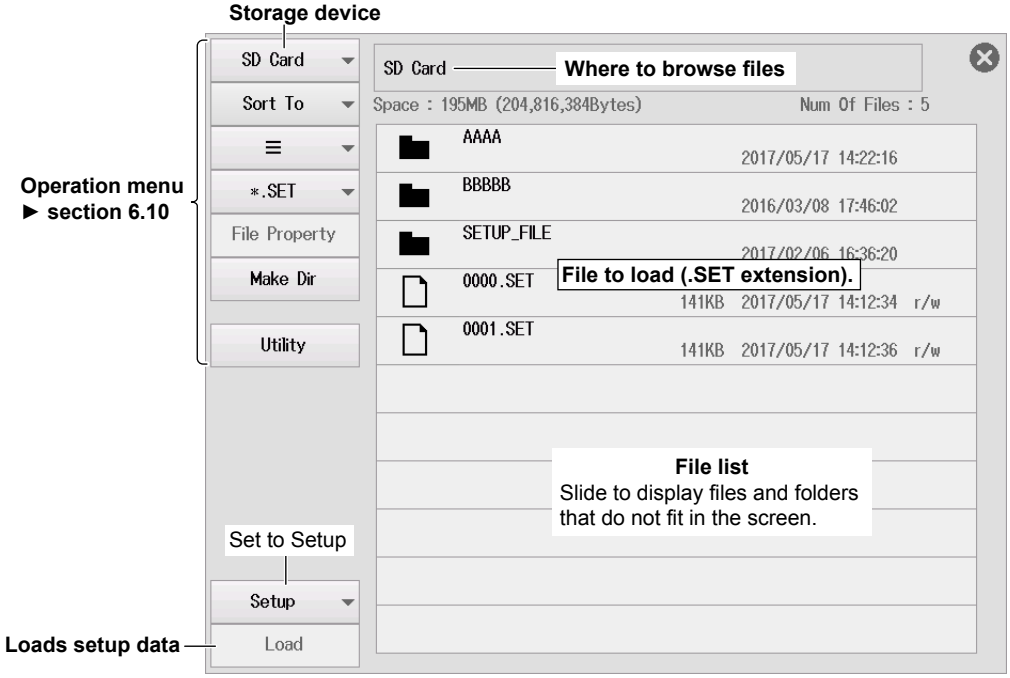
Items Common to Scope Mode and Recorder Mode

Displaying file information, loading setup data

► Features Guide: “Loading Setup Data (Setup Load)”

Save/Load Setup Load Menu

1. On the waveform screen, tap **MENU** > **Save/Load** > **Setup Load**. The following screen appears.
2. Select the file to load from the file list.
3. Tap **Load**. A confirmation message appears.
4. Tap **OK** or **Cancel**.



Loading Setup Data (Load)

- Select the setup data and load it. The extension is .SET.
- If the module configuration when the setup data is saved and that when the data is loaded are different, only the setup data of modules that match is loaded. When loading is complete, a message indicating the channel numbers that were not loaded is displayed.

6.9 Loading Other Types of Data

This section explains the following settings for loading snapshot waveforms or symbol definition files. Symbol definition files are displayed when a CAN bus monitor, CAN/CAN FD monitor, or CAN & LIN bus monitor module is installed.

For Scope Mode

Displaying file information, data type to load (snapshot waveform, symbol definition file), loading data

For Recorder Mode

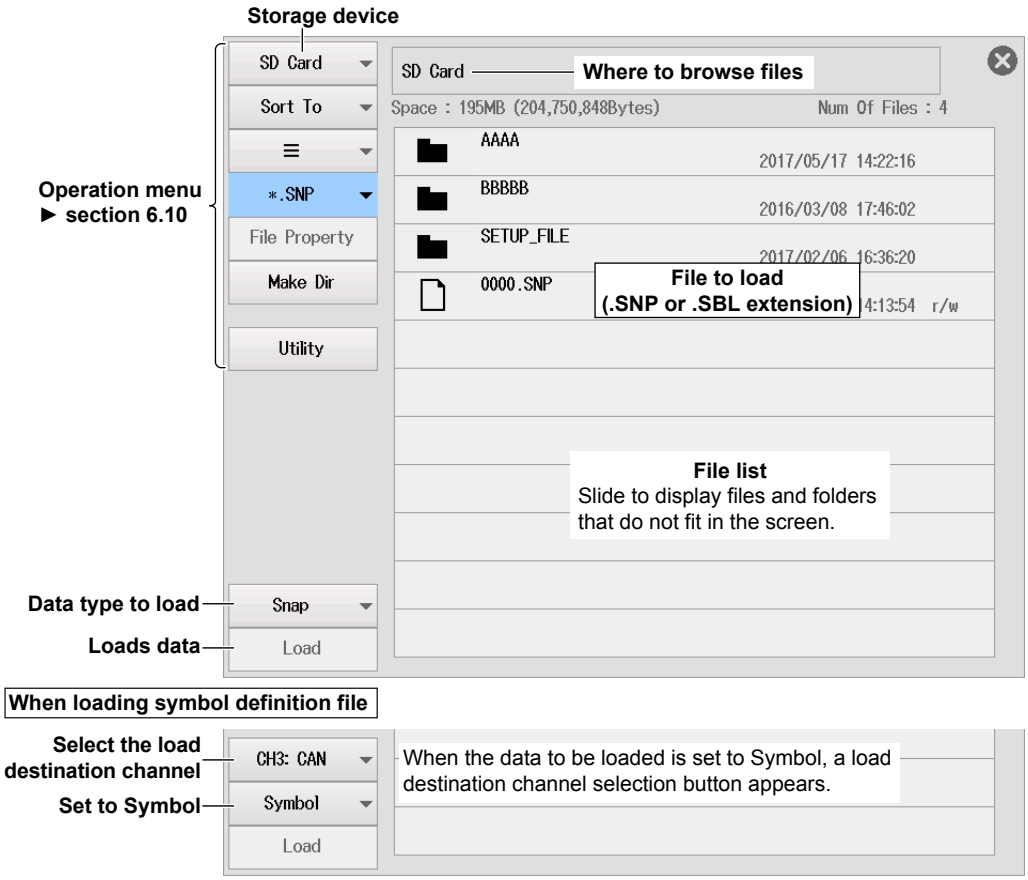
Displaying file information, data type to load (symbol definition file), loading data

► Features Guide: “Loading Other Types of Data (Others Load)”
“Loading a CAN/CAN FD Data Definition File (Symbol File Load)”
“Loading a LIN Data Definition File (Symbol File Load)”

For Scope Mode

Save/Load Others Load Menu

1. On the waveform screen, tap **MENU** > **Save/Load** > **Others Load**.
   The following screen appears.
2. To load a CAN/CAN FD or LIN data definition file (.SBL), tap Snap, and select Symbol.
3. Select the file to load from the file list.
4. Tap **Load**. A confirmation message appears.
5. Tap **OK** or **Cancel**.



Data Type to Load

Snap: A saved snapshot waveform is loaded. The extension is .SNP.

Symbol: A CAN/CAN FD or LIN data definition file is loaded. The extension is .SBL.

Clearing the Waveform

To clear a loaded snapshot waveform, perform clear trace or initialize.

For Recorder Mode

Save/Load Symbol Load Menu

1. On the waveform screen, tap **MENU** > **Save/Load** > **Symbol Load**.
2. Select the file to load from the file list.
   ► See the figure on the previous page.
3. Select the load destination channel.
4. Tap **Load**. A confirmation message appears.
5. Tap **OK** or **Cancel**.

6.10 Performing File Operations

This section explains the following settings for performing various file operations from the file list or the file utility menu.

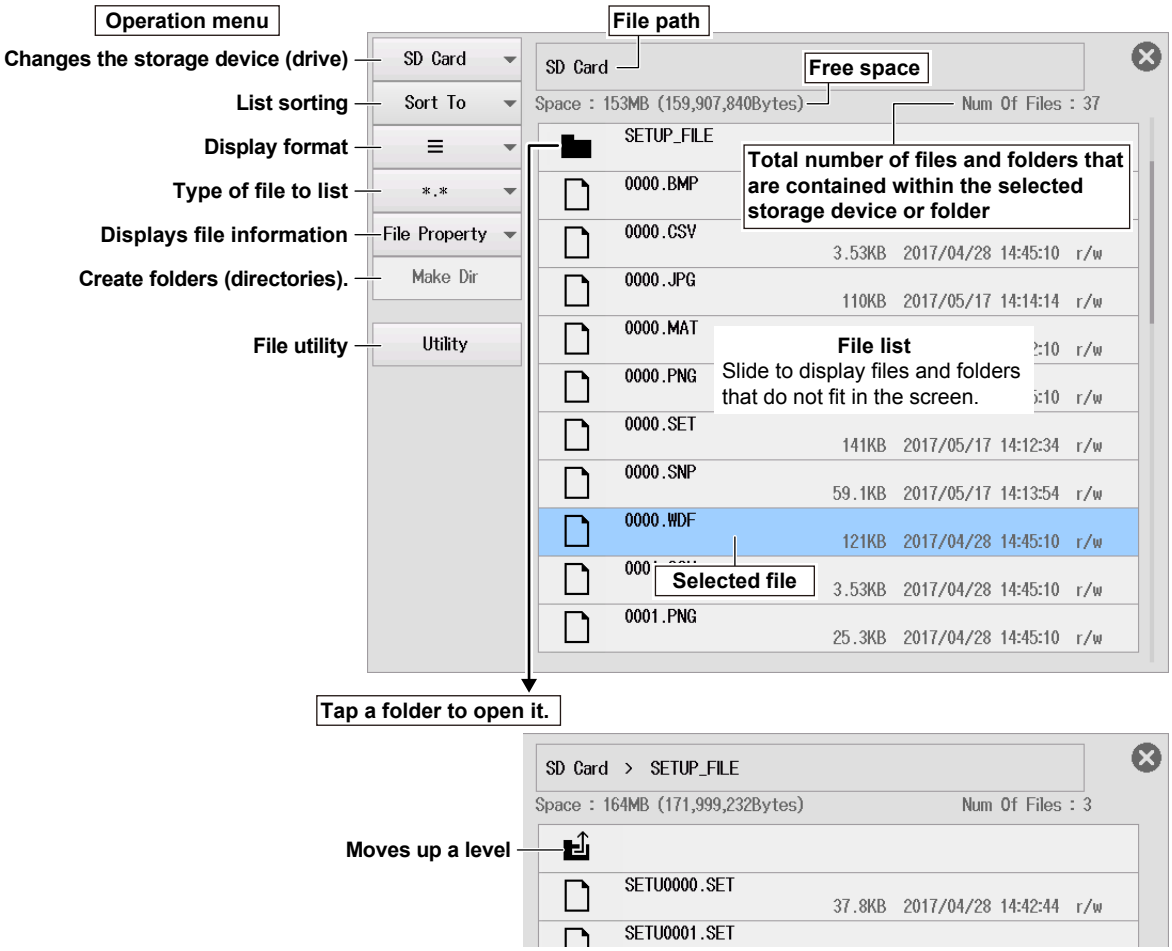
Items Common to Scope Mode and Recorder Mode

Changing the storage device, list sorting, display format, selecting the files to list, displaying file information, creating folders (directories), file utility (deleting files and folders, changing file and folder names, copying files and folders, moving files and folders, selecting and unselecting all)

► Features Guide: “File Operation”

Utility File Menu

1. On the waveform screen, tap **MENU** > **Utility** > **File**. The file operation screen will appear.

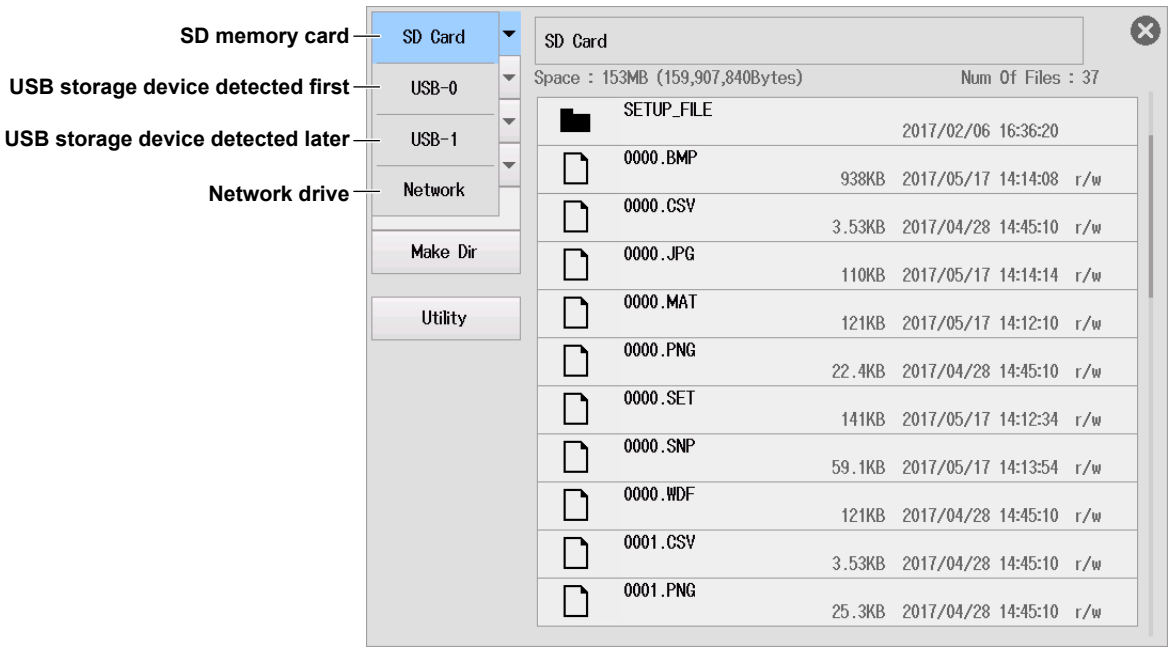


Note

The maximum number of files that can be shown in the file list is about 1000. This number varies depending on the storage device connection status and folder structure. It is possible to save files in a folder that contains more than 1000 files, but they may not appear in the file list. If this happens, delete some files or move them to another folder so that the number of files in the folder is less than about 1000 files.

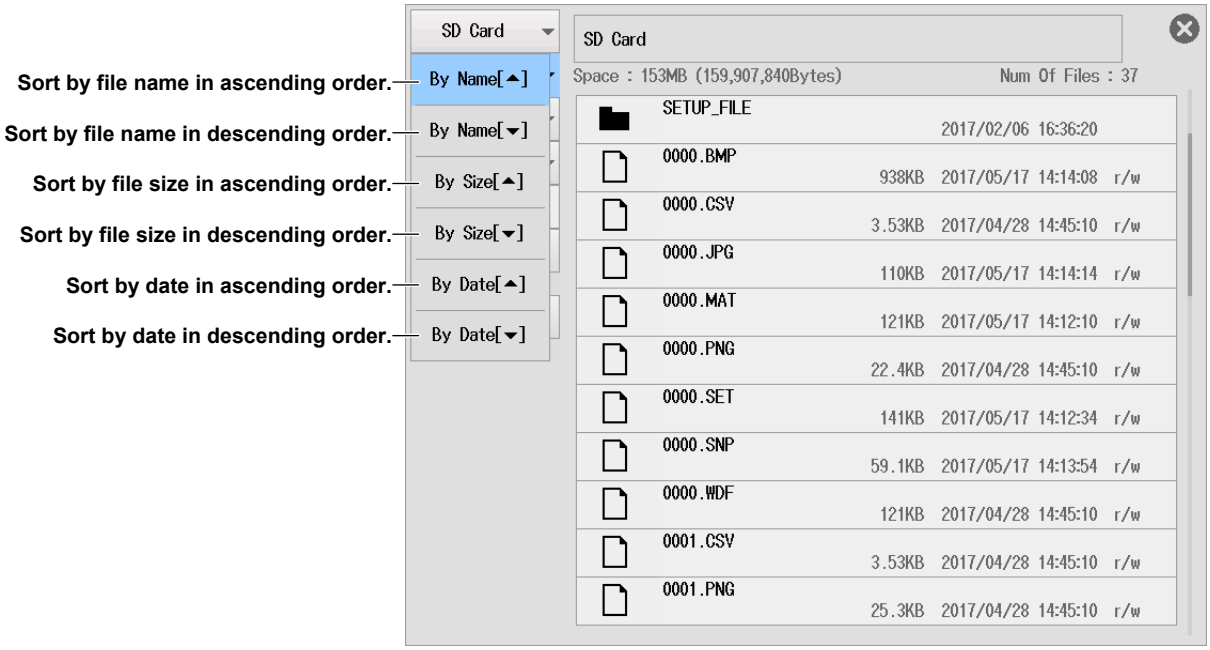
Changing the Storage Device or Drive (Change Drive)

2. Tap a storage device on the menu. Use the displayed list (options) to set the storage device you want to control.



Sorting the List (Sort To)

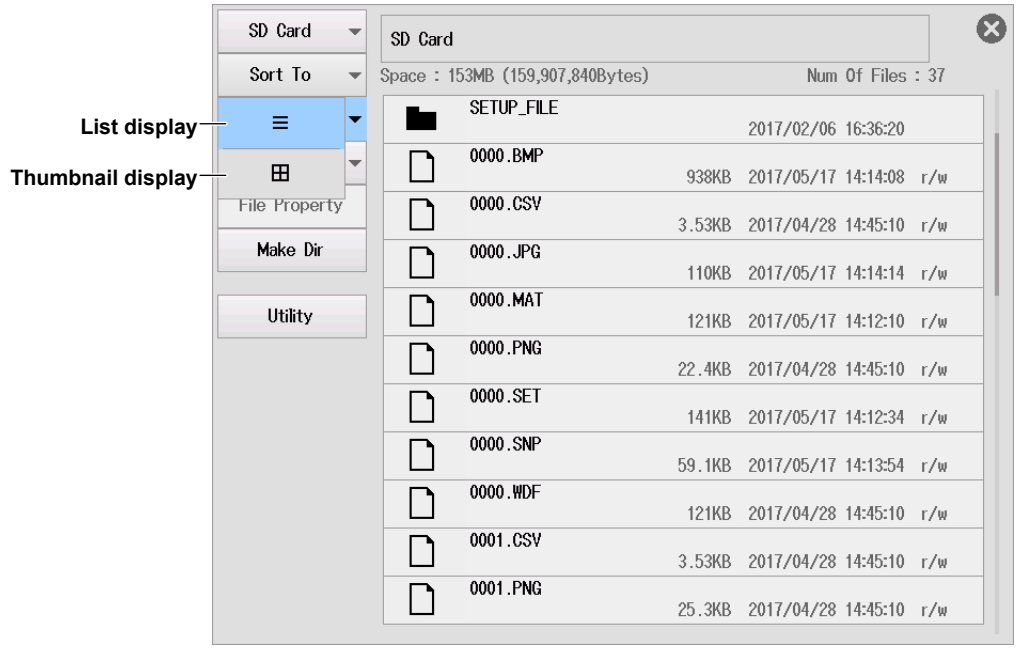
2. On the menu, tap **Sort To**. Use the displayed list (options) to set the display order.



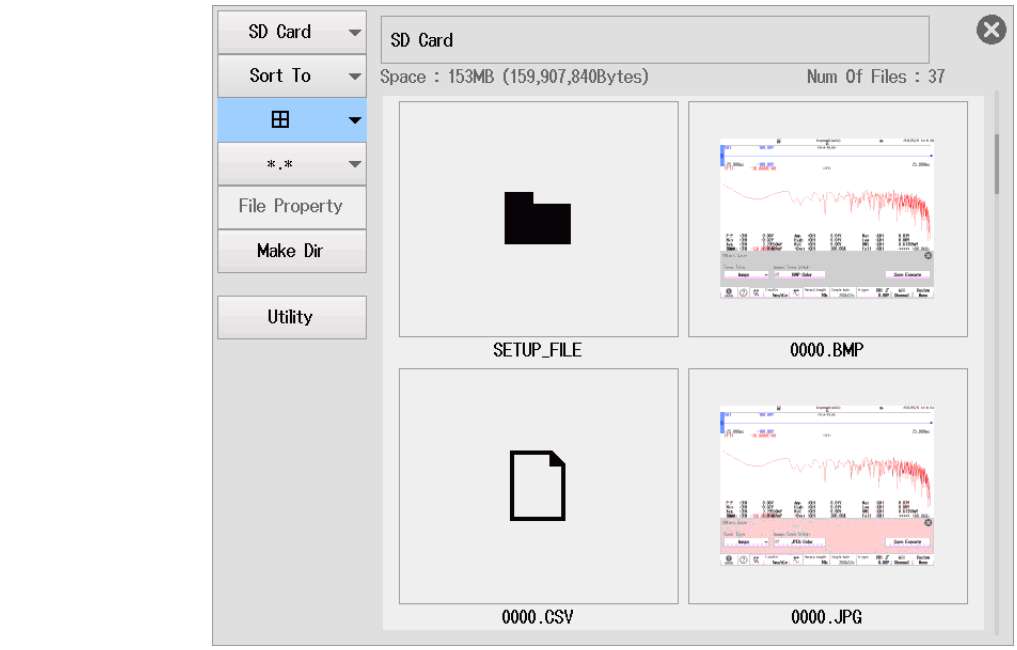
Display Format

2. Tap a display format on the menu. Use the displayed list (options) to set the display format of the file list.

List display (≡)



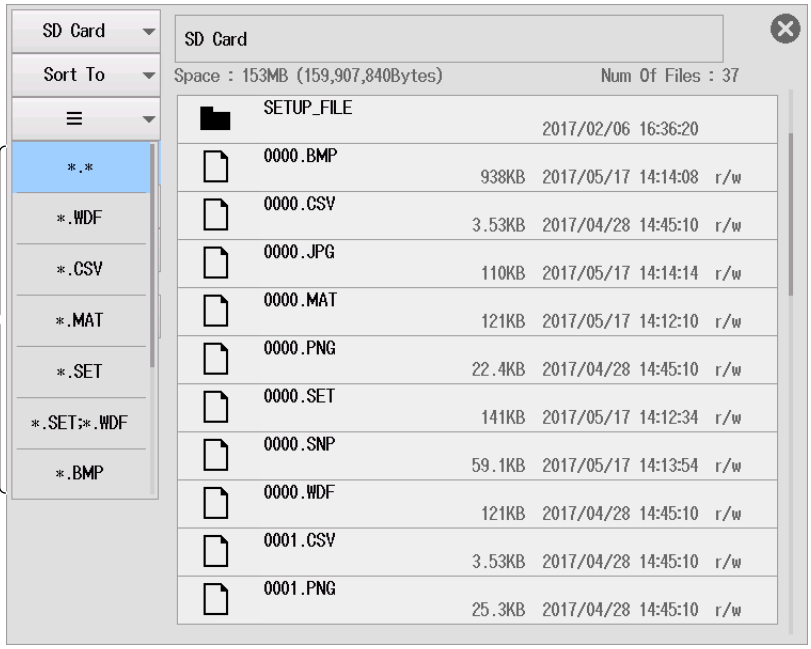
Thumbnail display (⊞)



Selecting the Type of Files to List

2. On the menu, tap ***.*** (or *.extension). Use the displayed list (options) to select the type of files to list by specifying the extension.

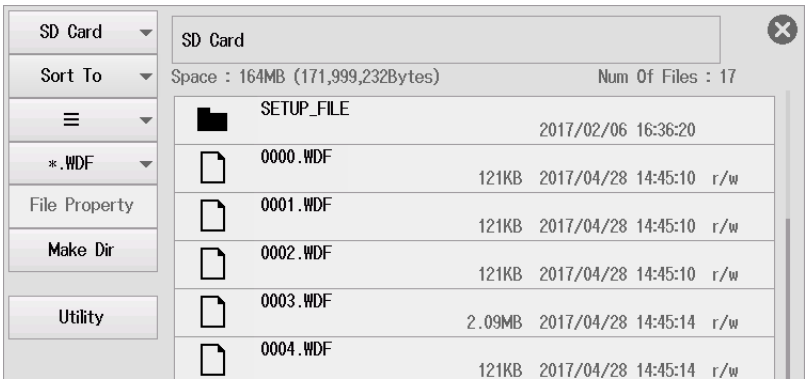
Select the extension of the files to list.
Slide to display extensions that do not fit in the screen.



Extension	File Type
.	All files
*.WDF	Binary waveform files
*.CSV	ASCII waveform files
*.MAT	MATLAB waveform files
*.SET	Setup files
.SET;.WDF	Setup files and binary waveform files
*.BMP	Bitmap image files
*.PNG	PNG image files
*.JPG	JPEG image files
*.SNP	Snapshot waveform files
*.SBL	SBL files (CAN/CAN FD or LIN data definition files)

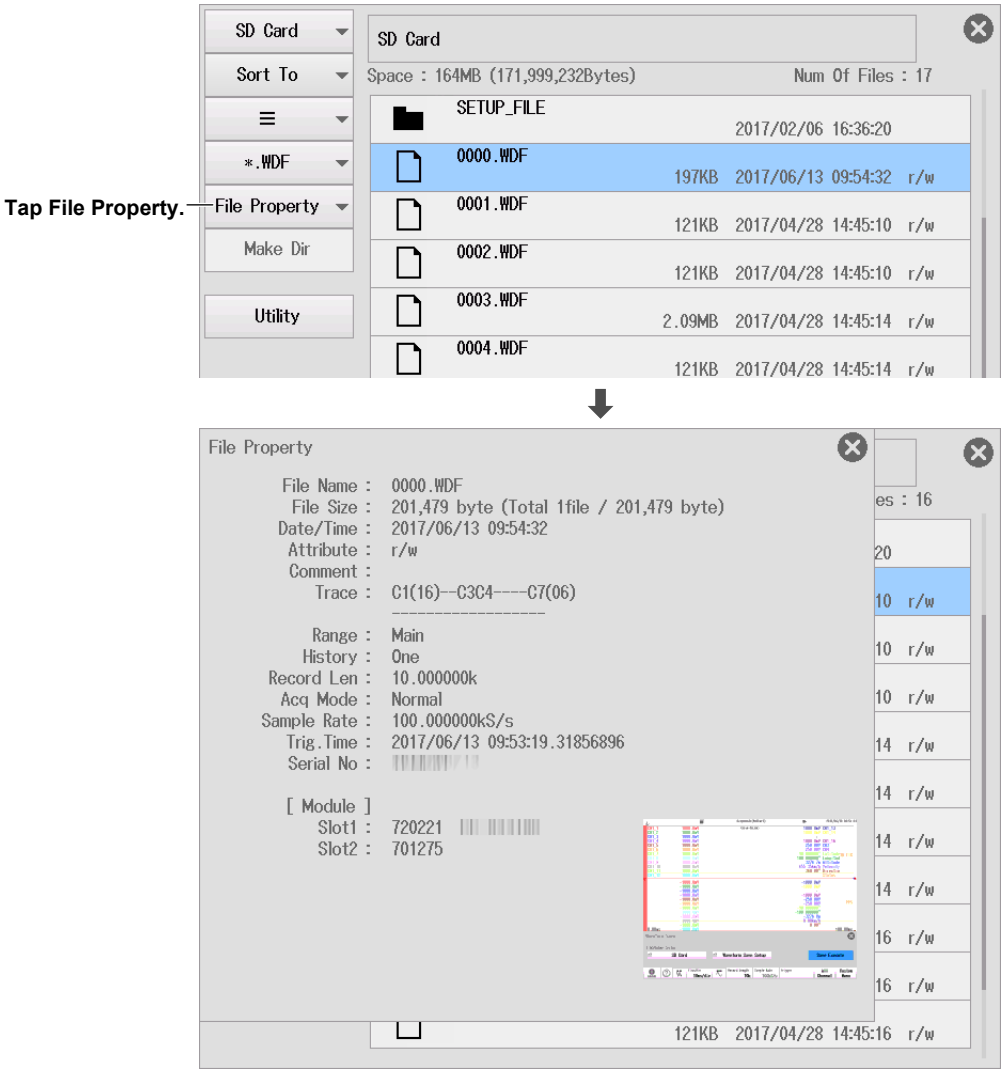
The type of files listed is limited to the selected type.

Example When *.WDF Is Selected



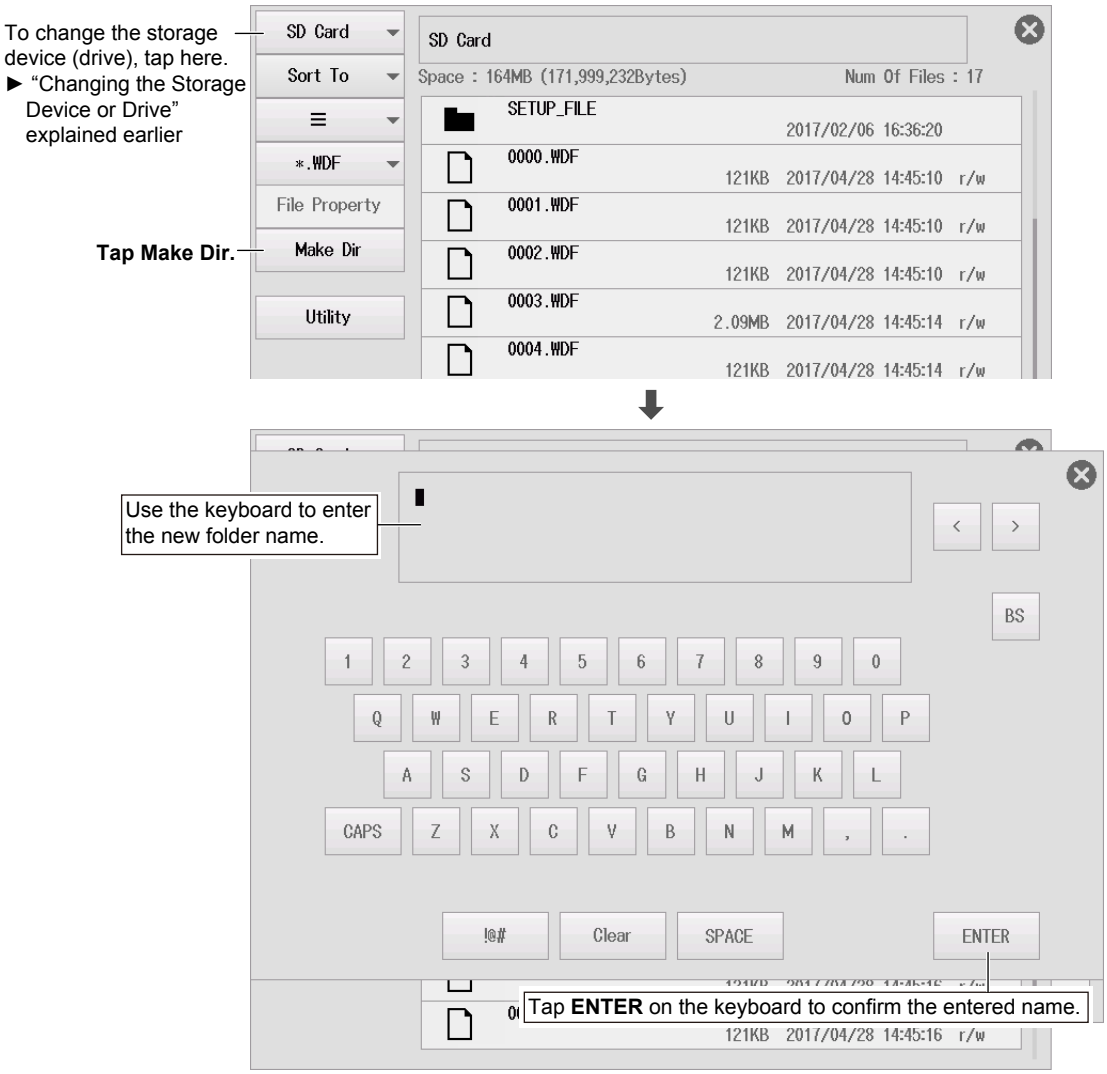
File Properties (File Property)

2. On the file list, tap the file you want to view the information of. **File Property** on the menu is enabled.
3. On the menu, tap **File Property**. Information on the selected file is displayed.



Making Folders (Make Dir)

2. Select the drive or folder in the file list that you want to make the new folder in.
3. On the menu, tap **Make Dir**. The following screen appears.

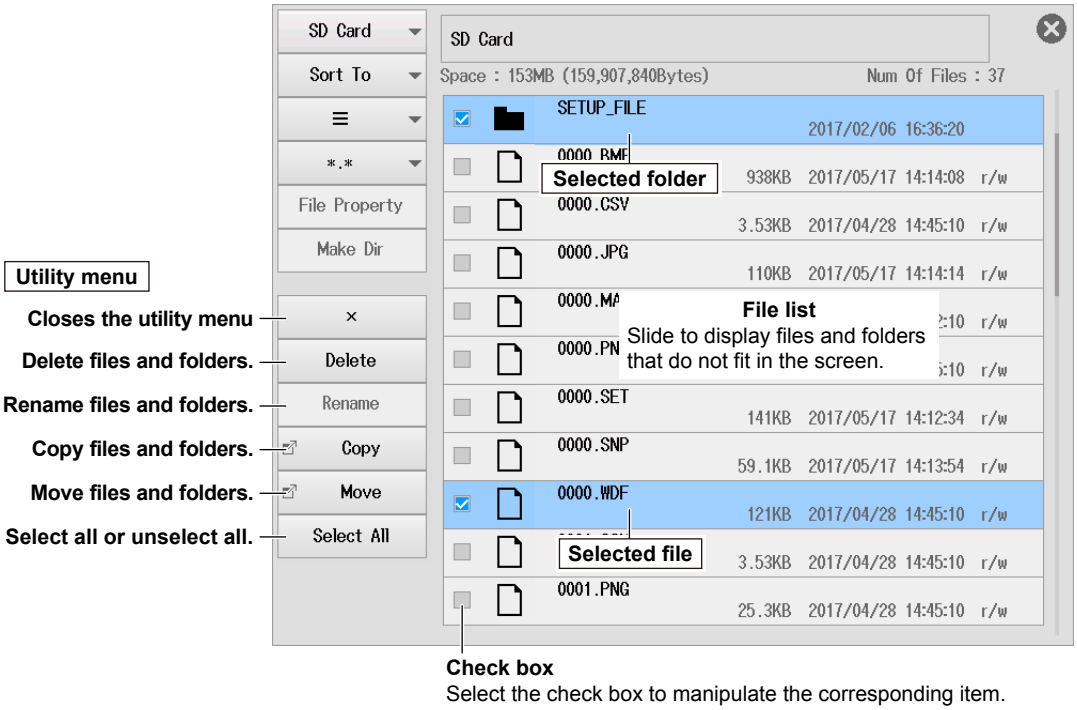


File Utility (Utility)

2. On the menu, tap **Utility**.

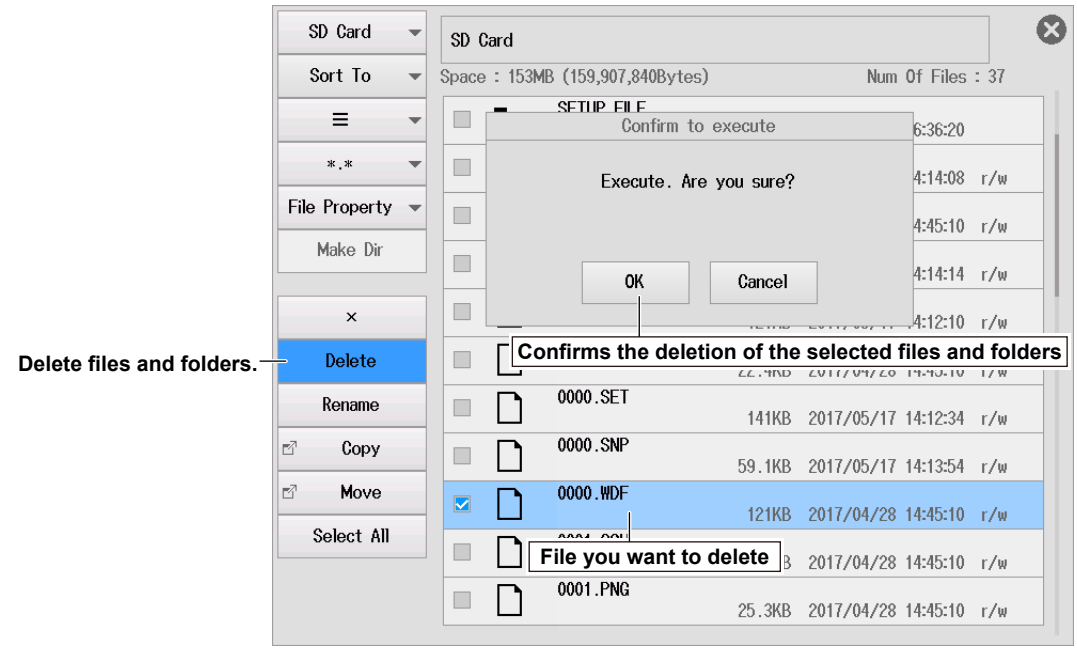
   A utility menu opens. If the file list display format is set to list, check boxes for selecting and unselecting files and folders appear. You can select the files and folders to manipulate by tapping them on the list.

   * To open a folder, close the utility menu, and tap the folder.



Deleting Files and Folders (Delete)

3. Select the file or folder that you want to delete from the file list.
4. On the utility menu, tap **Delete**. A confirmation message appears.



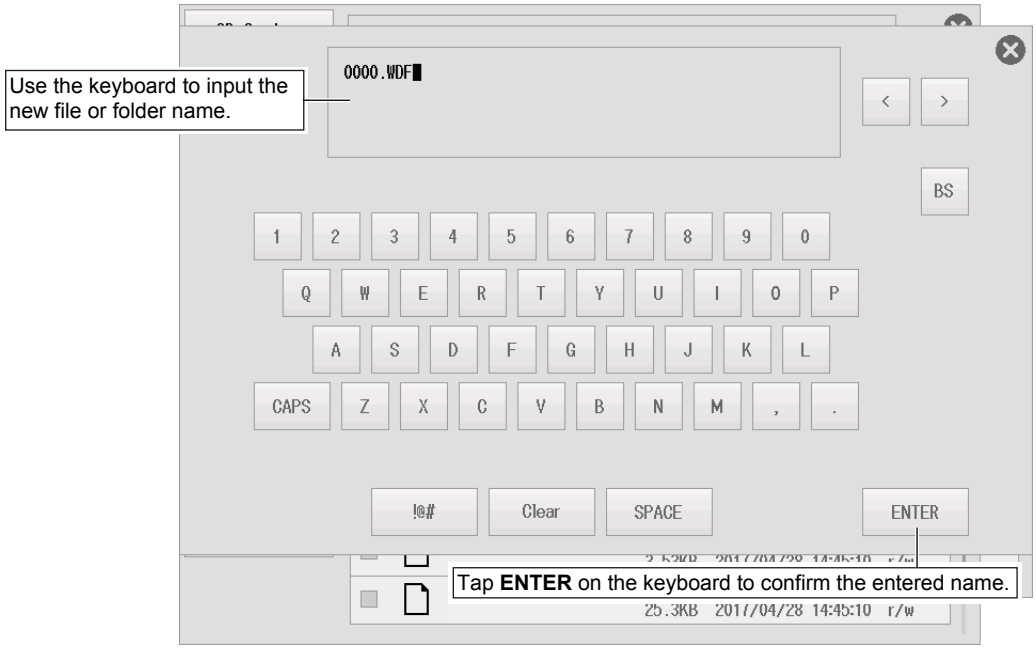
5. Tap **OK**. The progress is shown on the screen.
6. When the process is complete, tap **Close**.

Note

You can abort (Abort) file deleting. However, files that are already being processed are not applicable.

Renaming Files and Folders (Rename)

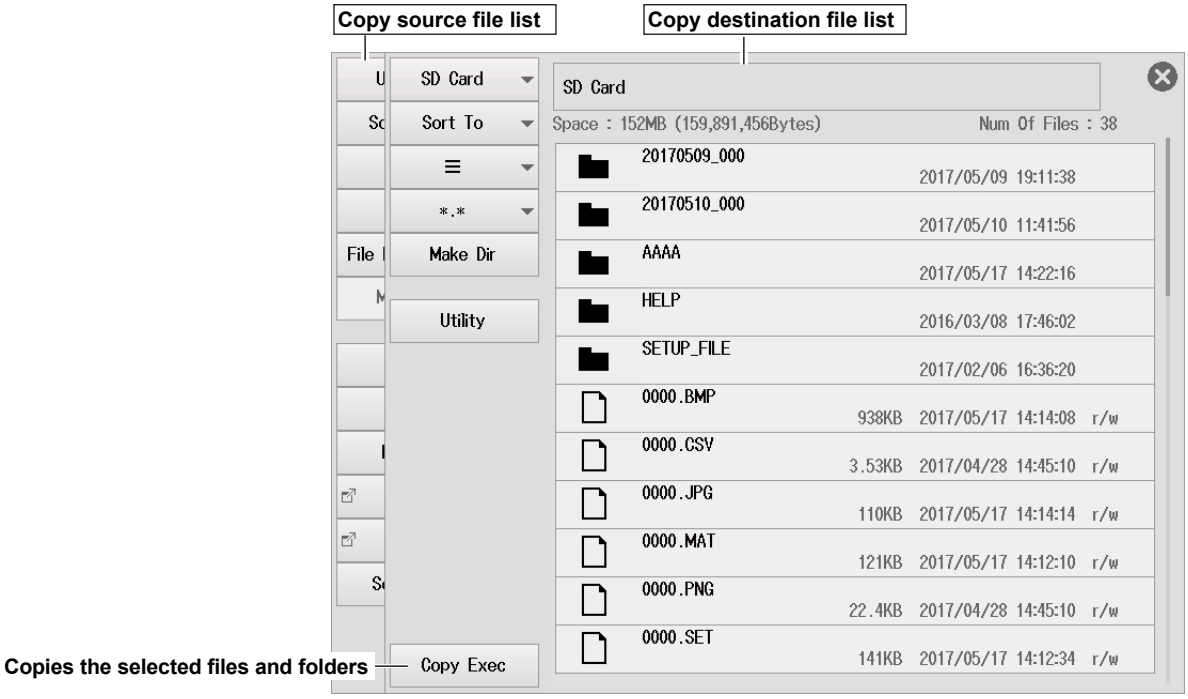
3. Select the file or folder that you want to rename from the file list.
4. On the utility menu, tap **Rename**. The following screen appears.



Copying Files and Folders (Copy)

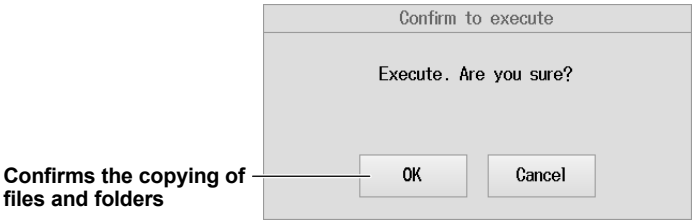
3. Select the file that you want to copy from the file list.

4. On the utility menu, tap **Copy**. The following screen appears.



5. Select the drive or folder on the file list that you are copying to.

6. On the utility menu, tap **Copy Exec**. A confirmation message appears.



7. Tap **OK**. The progress is shown on the screen.

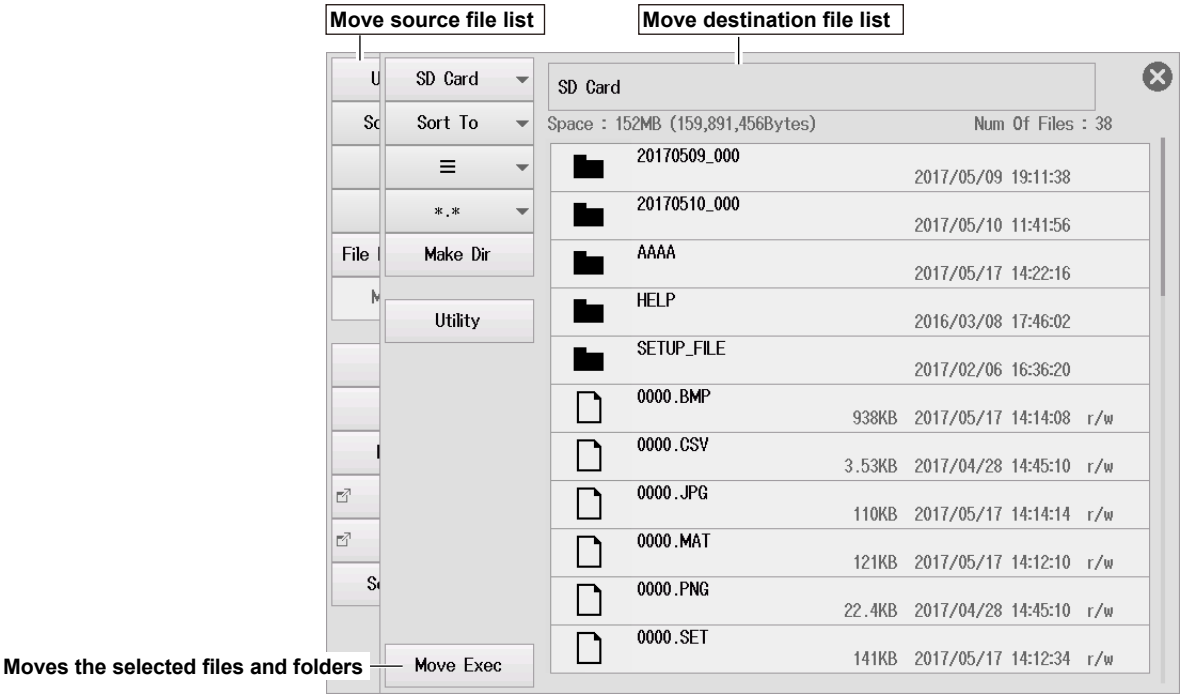
8. When the process is complete, tap **Close**.

Note

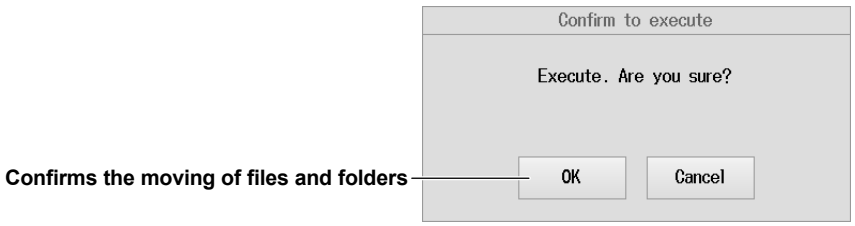
- You can abort (Abort) file copying.
- Changing the storage device, list sorting, display format, selecting the files to list, creating folders (directories), file utility (deleting files and folders, changing file and folder names) can also be performed on the copy destination file list.

Moving Files and Folders (Move)

3. Select the file that you want to move from the file list.
4. On the utility menu, tap **Move**. The following screen appears.



5. Select the drive or folder in the file list that you are moving to.
6. On the utility menu, tap **Move Exec**. A confirmation message appears.



7. Tap **OK**. The progress is shown on the screen.
8. When the process is complete, tap **Close**.

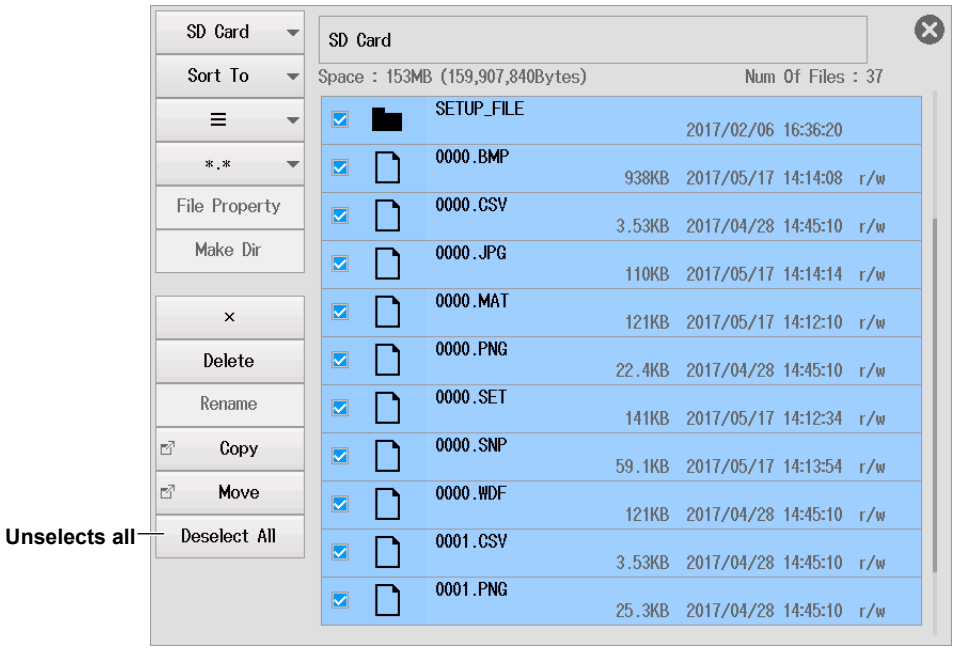
Note

Changing the storage device, list sorting, display format, selecting the files to list, creating folders (directories), file utility (deleting files and folders, changing file and folder names) can also be performed on the move destination file list.

Selecting All, Unselecting All (Select All/Deselect All)

3. On the utility menu, tap **Select All**. All the files and folders in the drive or folder on the file list are selected.

Select All on the utility menu changes to **Deselect All**.



Tapping **Deselect All** unselects all the files and folders.

7.1 Measuring with Horizontal Cursors

This section explains the following settings for measuring T-Y waveforms with horizontal cursors:

Items Common to Scope Mode and Recorder Mode

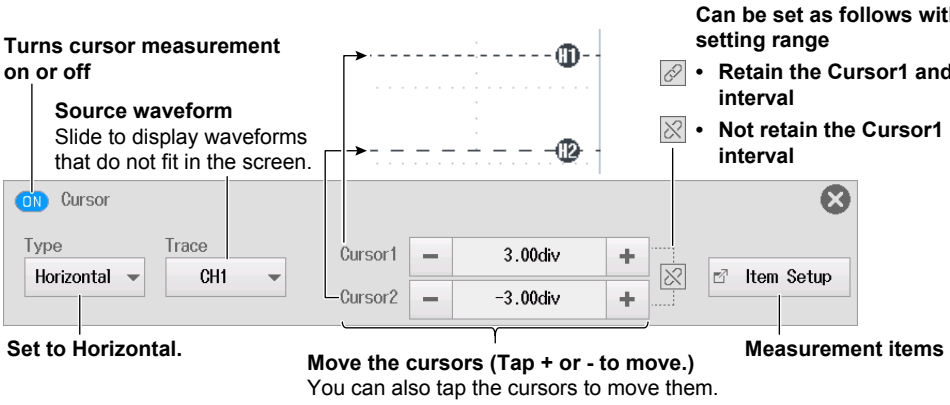
Cursor measurement on/off, setting the cursor type to Horizontal, measurement source waveform, moving cursors, measurement items

For information on setting the cursor measurement items for X-Y waveforms, see chapter 11.

► Features Guide: “Horizontal Cursors (Horizontal) - T-Y waveforms”

Cursor Horizontal Menu

1. On the waveform screen, tap **MENU** > **Cursor**. The Cursor menu appears.
   At this point, cursor measurement is automatically turned on.
2. Tap **Type** and select Horizontal.
3. Tap each item. Use the displayed list (options) or input box to set the items.



Measurement Items (Item Setup)

4. Tap **Item Setup**. The following screen appears.

7.2 Measuring with Vertical Cursors

This section explains the following settings for measuring T-Y waveforms with vertical cursors:

Items Common to Scope Mode and Recorder Mode

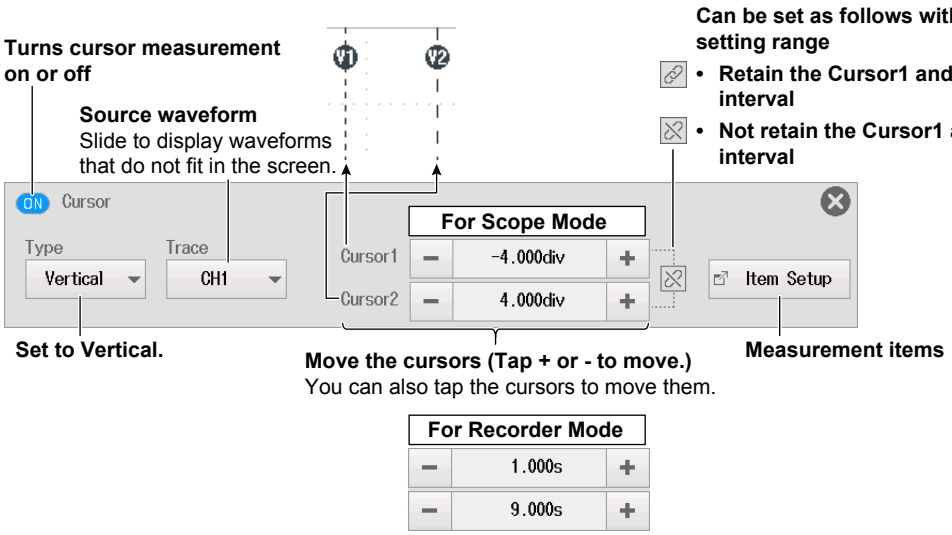
Cursor measurement on/off, setting the cursor type to Vertical, measurement source waveform, moving cursors, measurement items

For information on setting the cursor measurement items for X-Y waveforms, see chapter 11.

► Features Guide: “Vertical Cursors (Vertical) - T-Y waveforms”

Cursor Vertical Menu

1. On the waveform screen, tap **MENU** > **Cursor**. The Cursor menu appears.
   At this point, cursor measurement is automatically turned on.
2. Tap **Type** and select Vertical.
3. Tap each item. Use the displayed list (options) or input box to set the items.



Measurement Items (Item Setup)

4. Tap **Item Setup**. The following screen appears.

7.3 Measuring with Marker Cursors

This section explains the following settings for measuring T-Y waveforms with marker cursors:

Items Common to Scope Mode and Recorder Mode

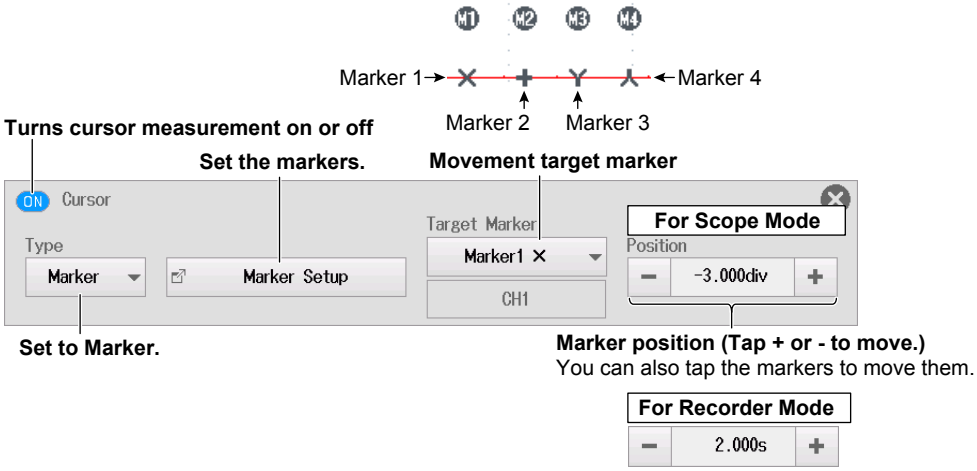
Cursor measurement on/off, setting the cursor type to Marker, marker settings (measurement source waveform, marker form, measurement items), movement target marker, marker position

For information on setting the cursor measurement items for FFT waveforms, see chapter 10.
For information on setting the cursor measurement items for X-Y waveforms, see chapter 11.

► Features Guide: “Marker Cursors (Marker) - T-Y waveforms”

Cursor Marker Menu

1. On the waveform screen, tap **MENU** > **Cursor**. The Cursor menu appears.
   At this point, cursor measurement is automatically turned on.
2. Tap **Type** and select Marker.
3. Tap each item. Use the displayed list (options) or input box to set the items.



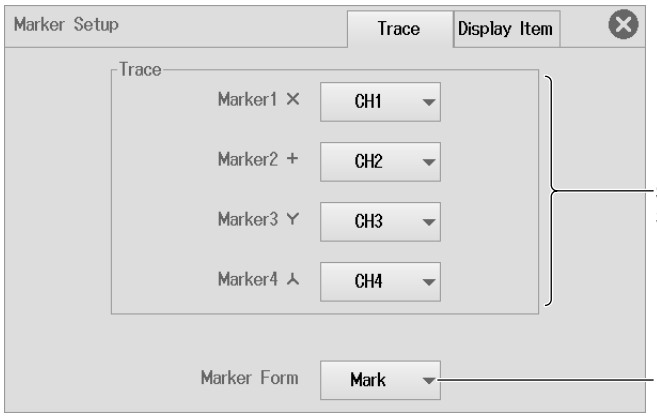
Setting the Marker (Marker Setup)

4. Tap **Marker Setup**.

Measurement Source Waveform and Marker Form (Trace)

5. Tap the **Trace** tab. The following screen appears.

6. Tap each item. Use the displayed list (options) to set the items.



Measurement Items (Display Item)

5. Tap the **Display Item** tab. The following screen appears.

7.4 Measuring with Angle Cursors

This section explains the following settings for measuring T-Y waveforms with angle cursors:

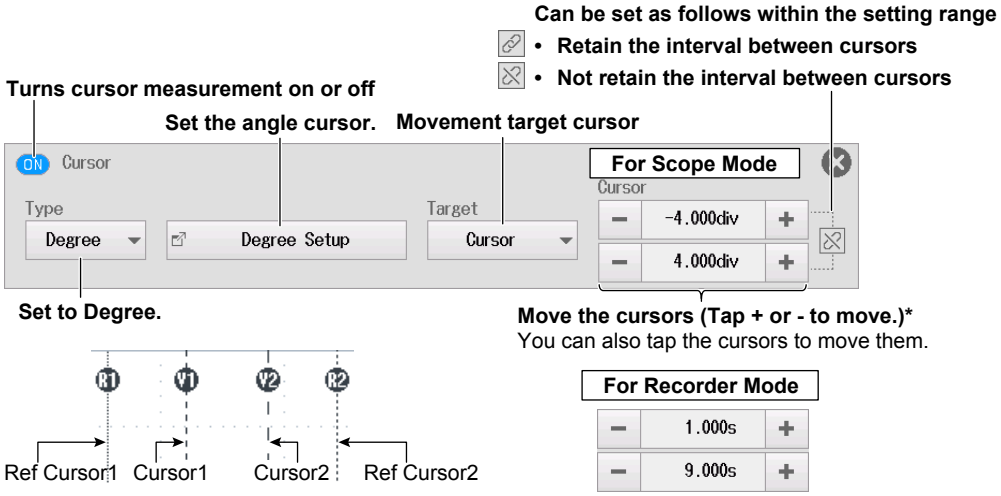
Items Common to Scope Mode and Recorder Mode

Cursor measurement on/off, setting the cursor type to Degree, angle cursor settings (measurement source waveform, reference angle, measurement items), movement target cursor, moving cursors

► Features Guide: “Angle Cursors (Degree) - T-Y waveforms”

Cursor Degree Menu

1. On the waveform screen, tap **MENU** > **Cursor**. The Cursor menu appears.
   At this point, cursor measurement is automatically turned on.
2. Tap **Type** and select Degree.
3. Tap each item. Use the displayed list (options) or input box to set the items.



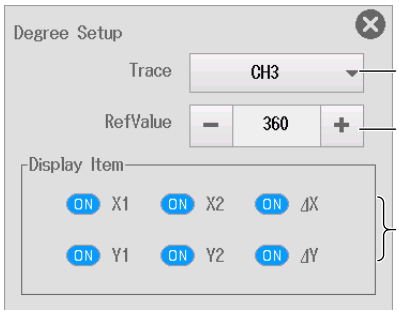
* When the movement target is Reference (reference cursor), move Ref Cursor1 and Ref Cursor2 to set the time width (time length) that corresponds to the reference angle. When the movement target is Cursor (angle cursor), move Cursor1 and Cursor2 to set the time width. The time width is converted into an angle based on the reference angle and becomes the measurement angle.

Movement target cursor	Reference	Cursor
Cursor movement Top row	Moves Ref Cursor1	Moves Cursor1
Cursor movement Bottom row	Moves Ref Cursor2	Moves Cursor2

Setting the Angle Cursor (Degree Setup)

4. Tap **Degree Setup**. The following screen appears.

5. Tap each item. Use the displayed list (options) or input box to set the items.



Source waveform
Slide to display waveforms that do not fit in the screen.

Reference angle (Tap + or – to adjust.)

Set this to ON for items to be measured.

7.5 Measuring with Horizontal and Vertical Cursors

This section explains the following settings for measuring T-Y waveforms with horizontal and vertical cursors:

Items Common to Scope Mode and Recorder Mode

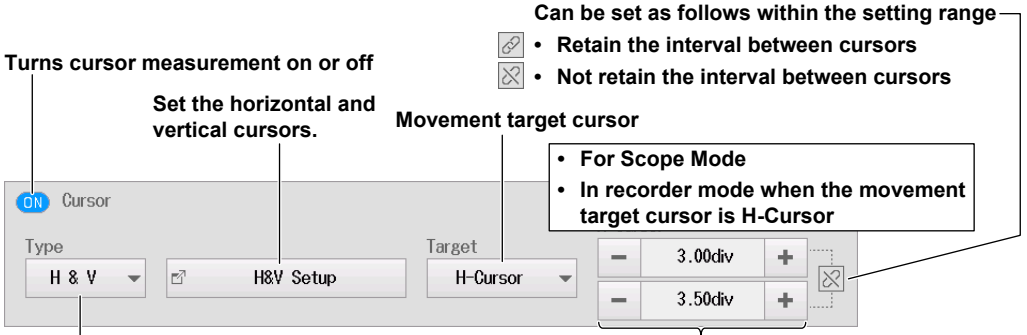
Cursor measurement on/off, setting the cursor type to H&V, horizontal and vertical cursor settings (measurement source waveform, measurement items), movement target cursor, moving cursors

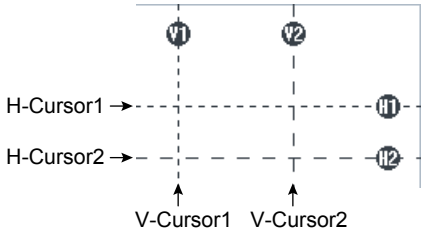
For information on setting the cursor measurement items for X-Y waveforms, see chapter 11.

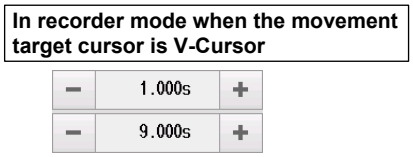
► Features Guide: “Horizontal and Vertical Cursors (H & V) - T-Y waveforms”

Cursor H & V Menu

1. On the waveform screen, tap **MENU** > **Cursor**. The Cursor menu appears.
   At this point, cursor measurement is automatically turned on.
2. Tap **Type** and select H & V.
3. Tap each item. Use the displayed list (options) or input box to set the items.



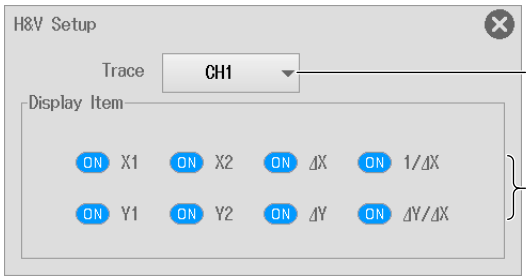




Movement target cursor	H-Cursor	V-Cursor
Cursor movement Top row	Moves H-Cursor1	Moves V-Cursor1
Cursor movement Bottom row	Moves H-Cursor2	Moves V-Cursor2

Setting the Horizontal and Vertical Cursors (H&V Setup)

4. Tap **H&V Setup**. The following screen appears.



Source waveform
Slide to display waveforms that do not fit in the screen.

Set this to ON for items to be measured.

8.1 Automatically Measuring Waveform Parameters

This section explains the following settings for automatically measuring waveform parameters.

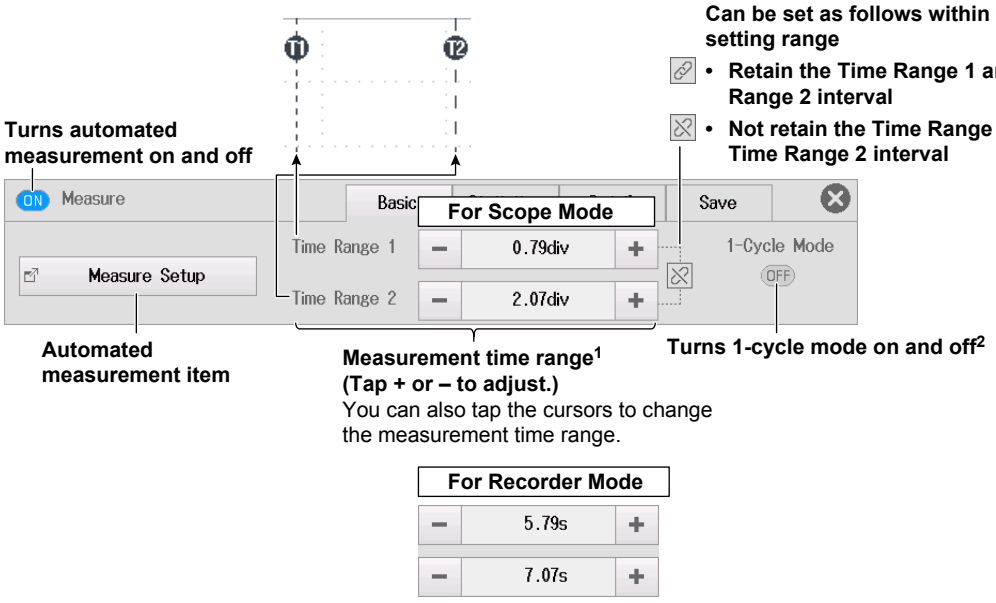
Items Common to Scope Mode and Recorder Mode

Automated measurement on/off, automated measurement parameters (measurement source waveform, measurement item, copying measurement items, delay (delay between channels)), measurement time range, 1-cycle mode on/off, high/low level setting method, time measurement reference level

► Features Guide: “Automated Measurement of Waveform Parameters”

Measure Basic Setting Menu

1. On the waveform screen, tap **MENU** > **Measure**. The Measure menu appears.
   At this point, automated measurement of waveform parameters is automatically turned on.
2. Tap the **Basic** tab.
3. Tap each item. Use the displayed list (options) or input box to set the items.



1 For SD recording waveforms, up to 100 Mpoint from the measurement start point (Time Range1) are measured.

2 If the space between Time Range1 and Time Range2 is less than one period, “*****” is displayed for the measured value.

Automated Measurement Items (Measure Setup)

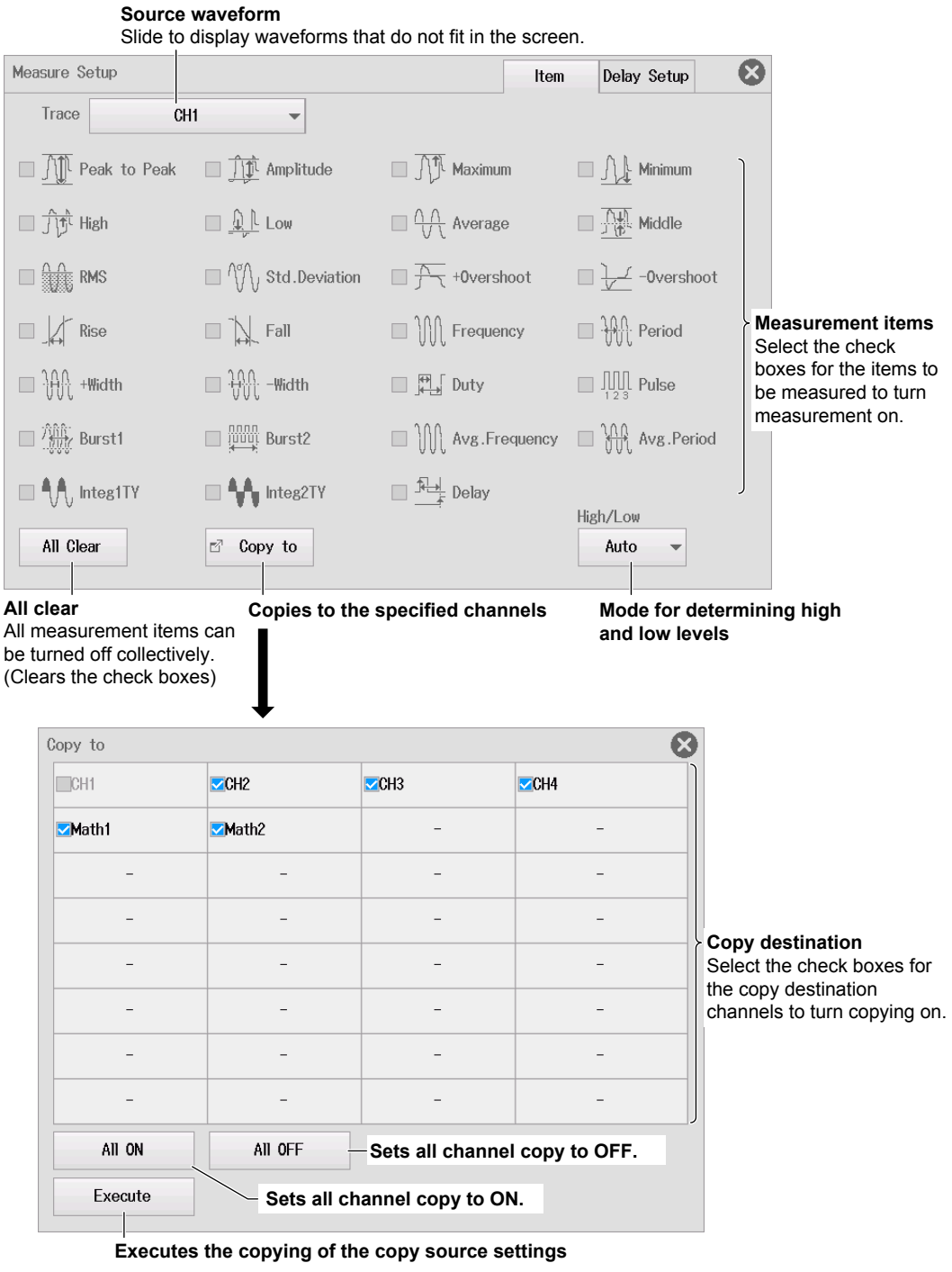
3. Tap **Measure Setup**.

Source Waveform and Measurement Items

4. Tap the **Item** tab. The any of the following screens appears according to the measurement source waveform.

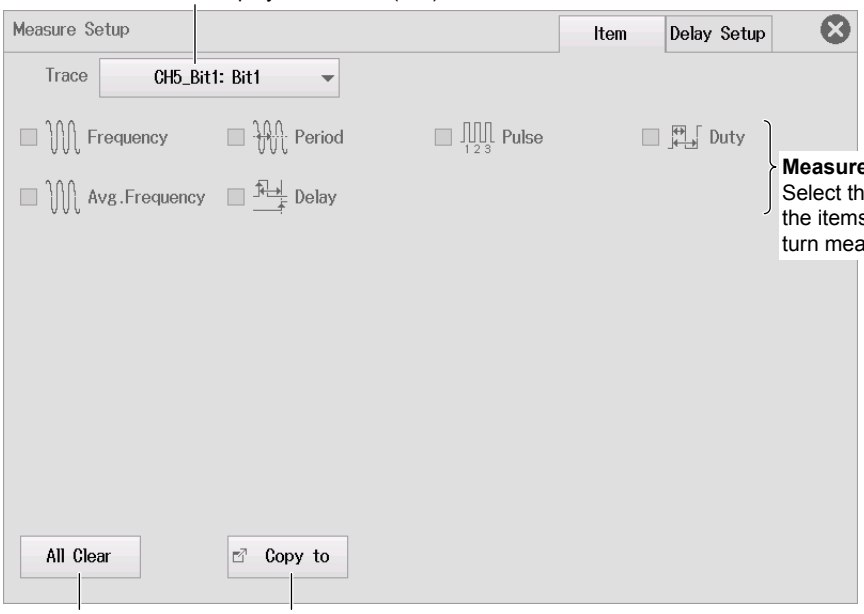
5. Tap each item to set options and execute commands.

- **When the measurement source waveform is CH1 to CH4, 16CH VOLT, 16CH TEMP/VOLT, CAN, CAN FD, LIN, SENT, Math1 to Math2, GPS**



- **When the measurement source waveform is a logic waveform**

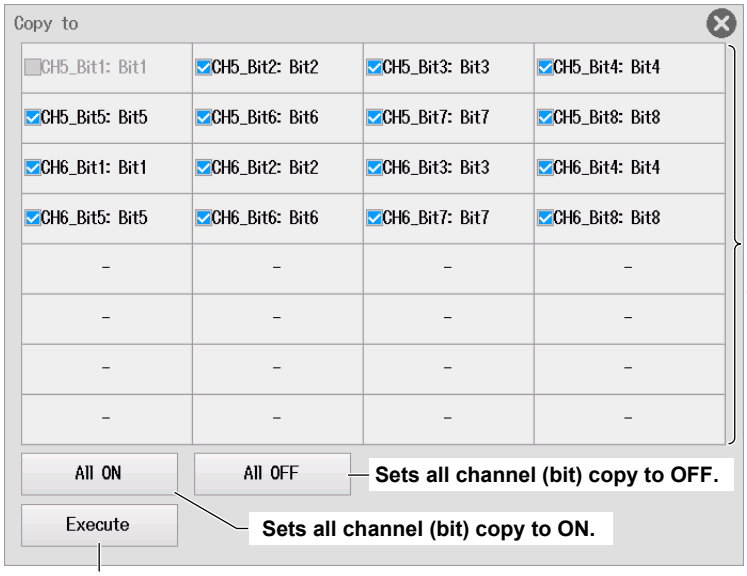
Measurement source waveform (bit)
Slide to display waveforms (bits) that do not fit in the screen.



Measurement items
Select the check boxes for the items to be measured to turn measurement on.

All clear
All measurement items can be turned off collectively. (Clears the check boxes)

Copies to the specified channels bits)



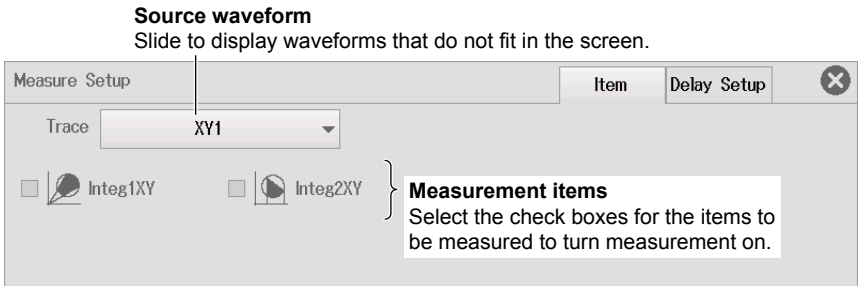
Copy destination
Select the check boxes for the copy destination channels (bits) to turn copying on.

Sets all channel (bit) copy to OFF.

Sets all channel (bit) copy to ON.

Executes the copying of the copy source settings

- **When the measurement source waveform is an X-Y waveform**

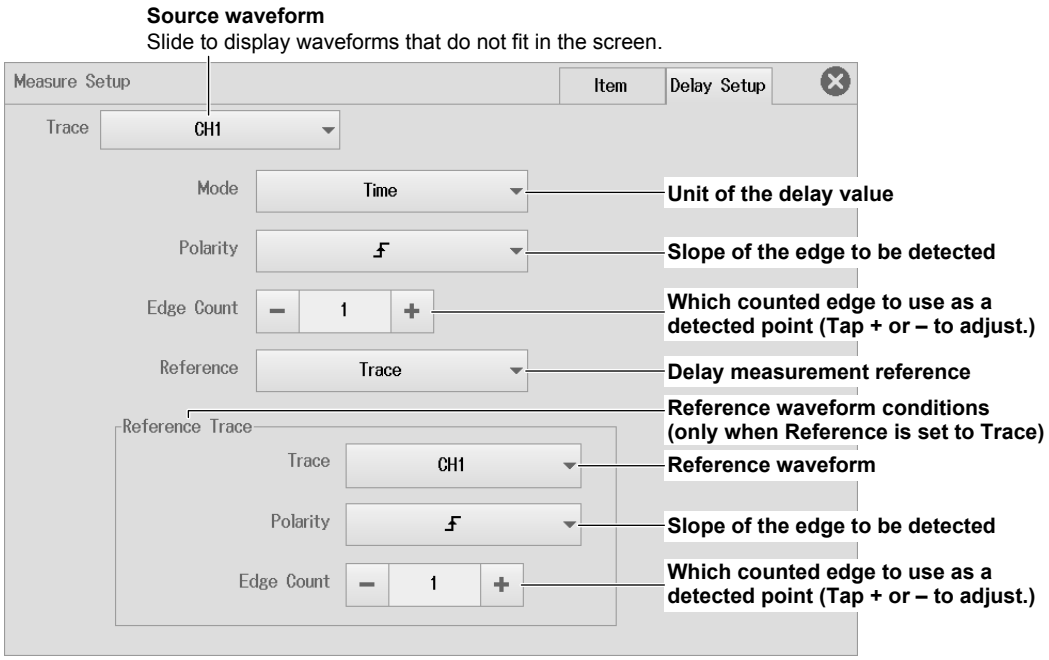


Delay (Delay between Channels)

4. Tap the **Delay Setup** tab. The following screen appears.

You cannot set the delay (delay between channels) when the measurement source waveform is an X-Y waveform.

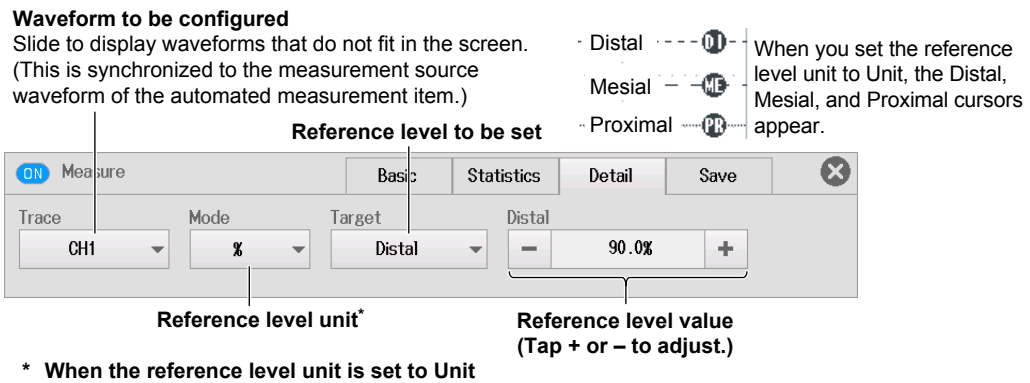
5. Tap each item. Use the displayed list (options) or input box to set the items.



Time Measurement Reference Level (Detail)

2. Tap the **Detail** tab.

3. Tap each item. Use the displayed list (options) or input box to set the items.



*** When the reference level unit is set to Unit**

You can also tap the Distal, Mesial, and Proximal cursors to set the reference levels.

8.2 Performing Continuous Statistical Processing

This section explains the following setting for performing continuous statistical processing on the displayed waveforms:

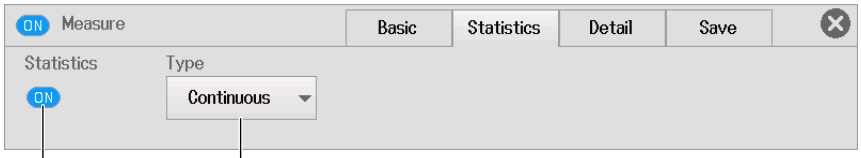
Items Common to Scope Mode and Recorder Mode

Statistical processing on/off, setting the statistical processing type to Continuous

► Features Guide: “Continuous Statistical Processing (Continuous Statistics)”

Measure Statistics Menu

1. On the waveform screen, tap **MENU** > **Measure**. The Measure menu appears.
   At this point, automated measurement of waveform parameters is automatically turned on.
2. Tap the **Statistics** tab.
3. Tap **Type** and select Continuous.



Set to Continuous.

Turns statistical processing on and off

8.3 Performing Cyclic Statistical Processing

This section explains the following settings for performing cycle statistic processing on the displayed waveforms):

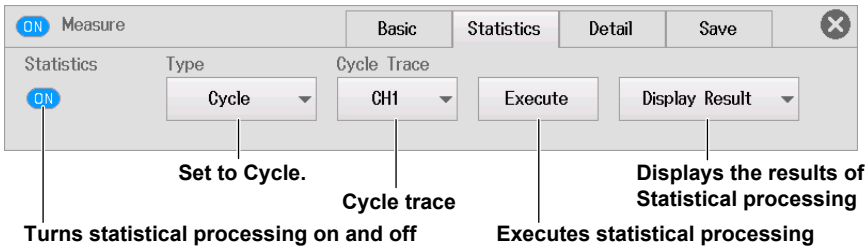
Items Common to Scope Mode and Recorder Mode

Statistical processing on/off, setting the statistical processing type to Cycle, cycle trace (source waveform used to determine the cycle), displaying the results of statistical processing

► Features Guide: “Cyclic Statistical Processing (Cycle Statistics)”

Measure Statistics Menu

1. On the waveform screen, tap **MENU** > **Measure**. The Measure menu appears.
   At this point, automated measurement of waveform parameters is automatically turned on.
2. Tap the **Statistics** tab.
3. Tap **Type** and select Cycle.
4. Tap each item to set options and execute commands.



Cycle Trace (Cycle Trace)

Own

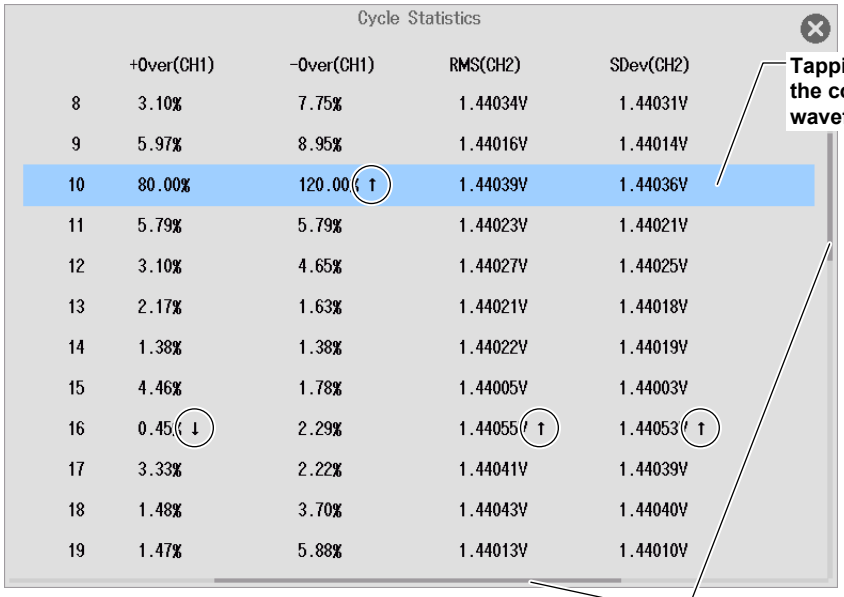
The instrument determines the cycle of each source waveform. It then automatically measures the waveform parameters and performs statistical processing for each cycle. If signals that have different periods are applied to multiple channels, the number of iterations of automated measurement and statistical processing for each signal is equal to the number of periods in the slowest signal.

CH1 to CH6, 16CH VOLT, 16CH TEMP/VOLT, CAN, CAN FD, LIN, SENT, Math1 to Math2, GPS

The instrument automatically measures the waveform parameters of all the source waveforms and performs statistical processing on the measured values for each cycle of the specified channel.

Displaying the Results of Statistical Processing

↑: Displayed next to the maximum value of each measurement item.
↓: Displayed next to the minimum value of each measurement item.



Tapping the list displays the corresponding waveform.

When this scroll bar is displayed, you can scroll the display.

8.4 Performing Statistical Processing on History Waveforms

This section explains the following settings for performing statistical processing on history waveforms.

Applicable to Scope Mode

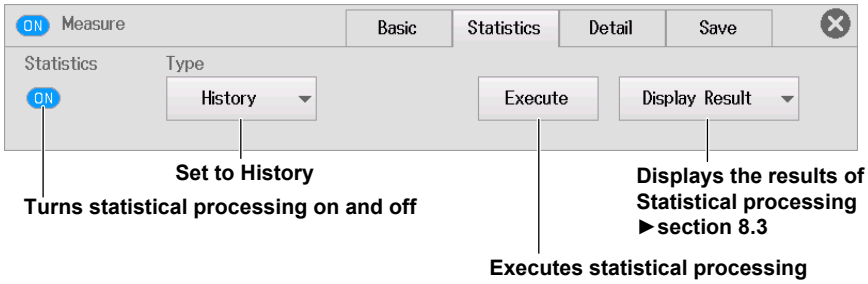
Statistical processing on/off, setting the statistical processing type to History, displaying the results of statistical processing

These settings are not available in recorder mode.

► Features Guide: “Statistical Processing of History Waveforms (History Statistics)”

Measure Statistics Menu

1. On the waveform screen, tap **MENU** > **Measure**. The Measure menu appears.
   At this point, automated measurement of waveform parameters is automatically turned on.
2. Tap the **Statistics** tab.
3. Tap **Type** and select History.
4. Tap each item to set options and execute commands.



8.5 Saving Automated Measurement Values of Waveform Parameters

This section explains the following settings for saving the results of automated measurement of waveform parameters.

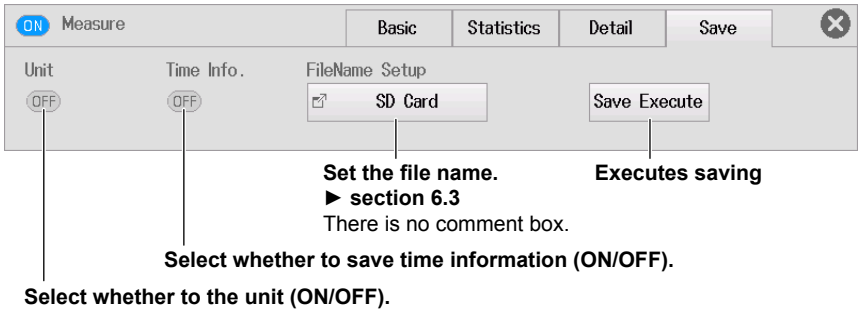
Items Common to Scope Mode and Recorder Mode

Saving the unit (on/off), saving time information (on/off), save destination, file name

► Features Guide: “Saving Other Types of Data (Others Save)”

Measure Save Menu

1. On the waveform screen, tap **MENU** > **Measure**. The Measure menu appears.
   At this point, automated measurement of waveform parameters is automatically turned on.
2. Tap the **Save** tab.
3. Tap each item to set options and execute commands.



9.1 Setting Equations

This section explains the following settings for setting equations.

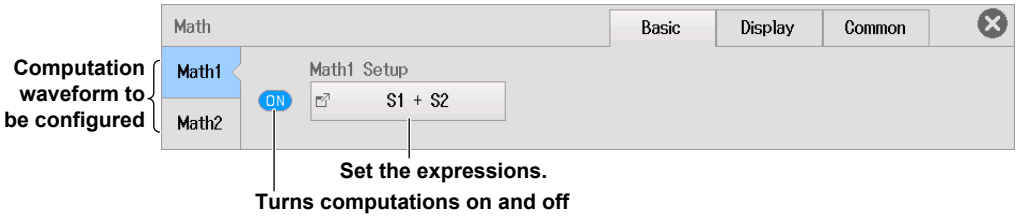
Items Common to Scope Mode and Recorder Mode

Target computation waveform, computation on/off, setting equations (operator, function, computation source waveform, unit, label, settings for specific operators and functions)

► Features Guide: “Computation”

Math Basic Setting Menu

1. On the waveform screen, tap **MENU** > **Analysis** > **Math**. The Math menu appears.
   At this point, the computation of Math1 or Math2 is automatically turned on.
2. Tap the **Basic** tab.
3. Tap **Math1** or **Math2**, and select the target computation waveform.
4. Tap each item to set options.

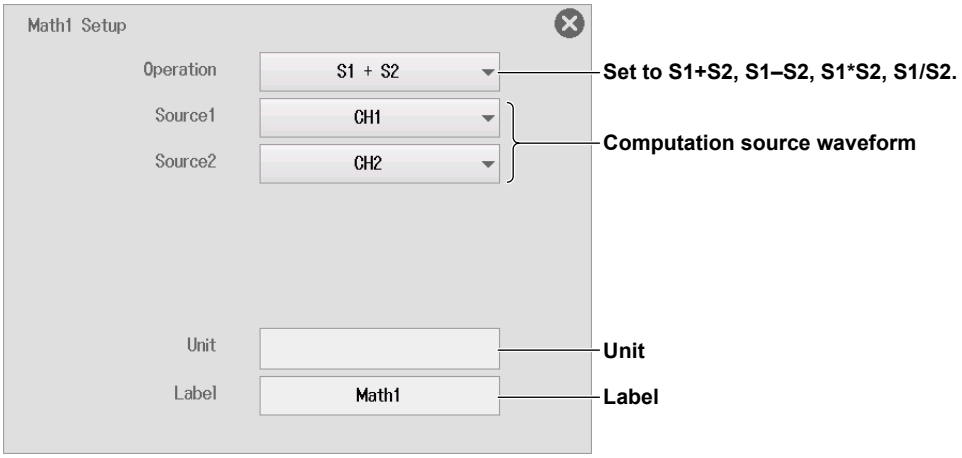


Setting the Equation (Math1 Setup, Math2 Setup)

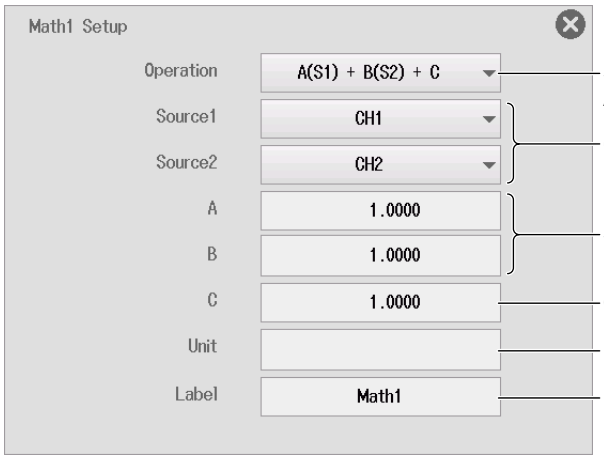
5. Tap **Math1 Setup**. The following screen appears.
   When the computation waveform is Math2, the button name changes to **Math2 Setup**.
6. Tap each item. Use the displayed list (options) or input box to set the items.

This section describes the Math1 Setup screen. Math2 Setup can be set in the same manner.

Addition, Subtraction, Multiplication, and Division



Addition, Subtraction, Multiplication, and Division with Coefficients



Set to A(S1)+B(S2)+C, A(S1)−B(S2)+C, A(S1)*B(S2)+C, or A(S1)/B(S2)+C.

Computation source waveform

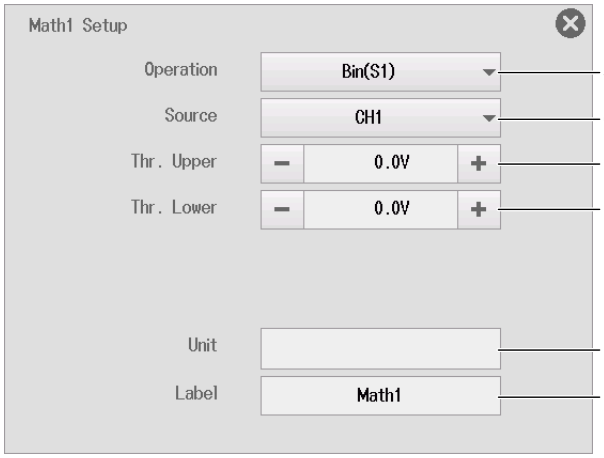
Scaling coefficient

Offset

Unit

Label

Binary Computation



Set to Bin(S1).

Computation source waveform

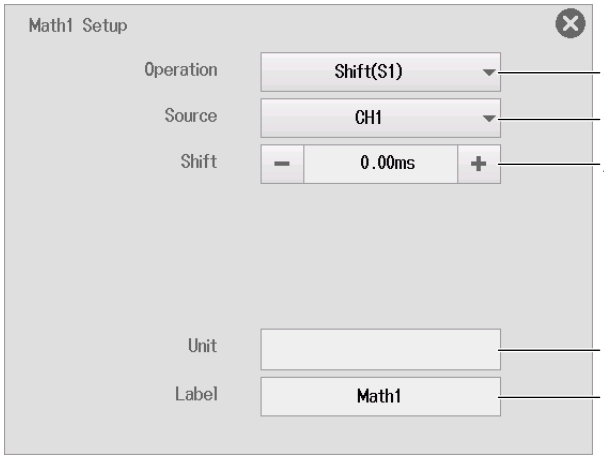
Upper threshold limit (Tap + or – to adjust.)

Lower threshold limit (Tap + or – to adjust.)

Unit

Label

Phase Shift



Set to Shift(S1).

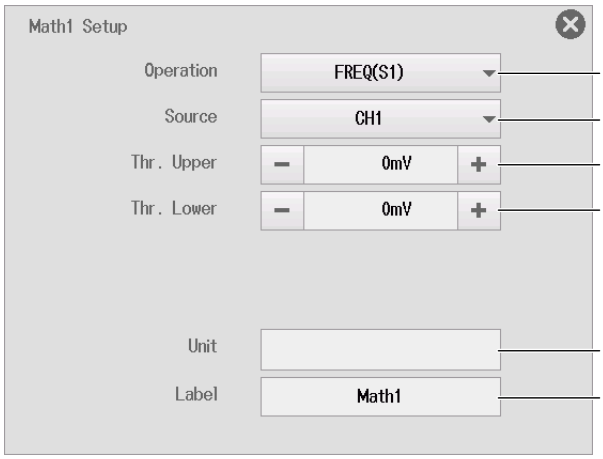
Computation source waveform

Amount of phase shift (Tap + or – to adjust.)

Unit

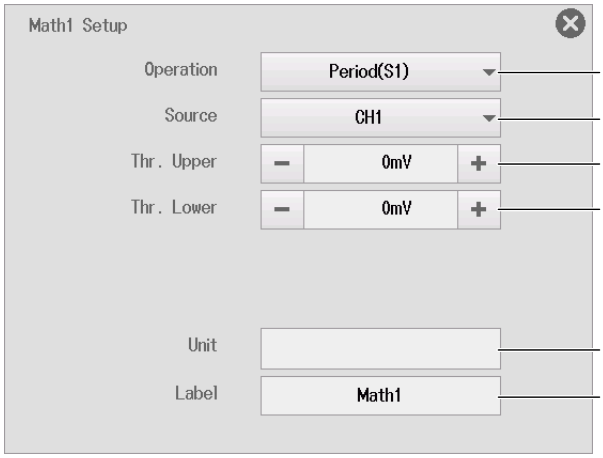
Label

Frequency



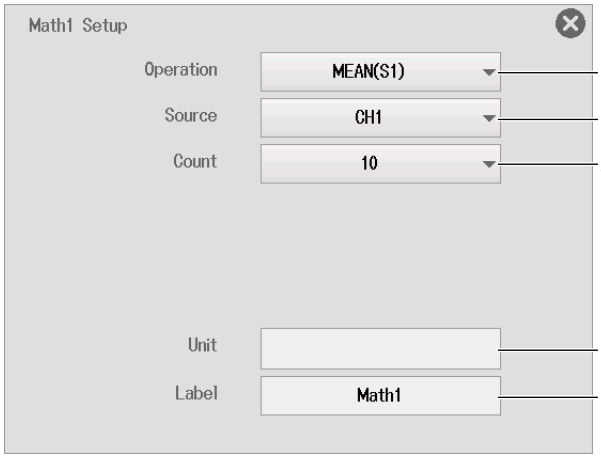
Set to FREQ(S1).
Computation source waveform
Upper threshold limit (Tap + or – to adjust.)
Lower threshold limit (Tap + or – to adjust.)
Unit
Label

Period



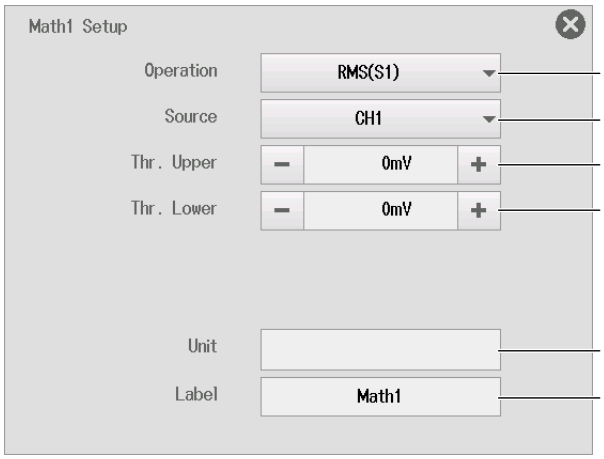
Set to Period(S1).
Computation source waveform
Upper threshold limit (Tap + or – to adjust.)
Lower threshold limit (Tap + or – to adjust.)
Unit
Label

Moving average



Set to MEAN(S1).
Computation source waveform
Average Times
Unit
Label

Rms Value



Set to RMS(S1).

Computation source waveform

Upper threshold limit (Tap + or – to adjust.)

Lower threshold limit (Tap + or – to adjust.)

Unit

Label

9.2 Setting the Display Conditions for Computed Waveforms

This section explains the following settings for displaying computed waveforms.

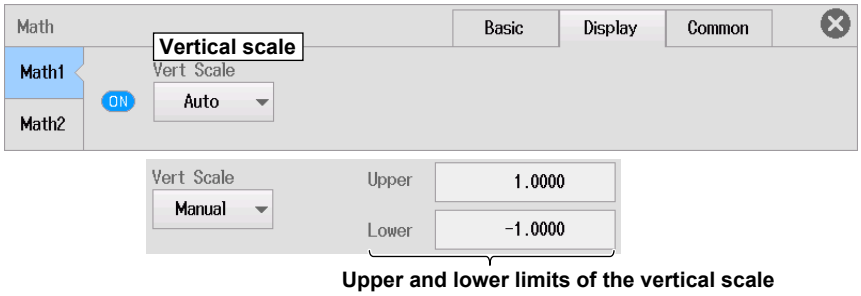
Items Common to Scope Mode and Recorder Mode

Vertical scale

► Features Guide: “Computation”

Math Display Setting Menu

1. On the waveform screen, tap **MENU** > **Analysis** > **Math**. The Math menu appears.
   At this point, the computation of Math1 or Math2 is automatically turned on.
2. Tap the **Display** tab.
3. Tap **Math1** or **Math2**, and select the target computation waveform.
4. Tap **Vert Scale**, and select Auto or Manual.
5. If you select Manual, set the upper and lower limits of the vertical scale.



Upper and lower limits of the vertical scale

9.3 Setting the Computation Range and Averaging

This section explains the following settings for computation range and averaging.

For Scope Mode

Computation start and end points, averaging settings (including peak computation)

For Recorder Mode

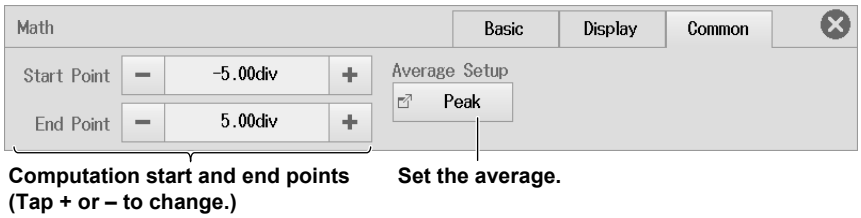
Computation start and end points

► Features Guide: “Computation”

Math Common Setting Menu

1. On the waveform screen, tap **MENU** > **Analysis** > **Math**. The Math menu appears.
   At this point, the computation of Math1 or Math2 is automatically turned on.
2. Tap the **Common** tab.
3. Tap each item. Use the displayed list (options) or input box to set the items.

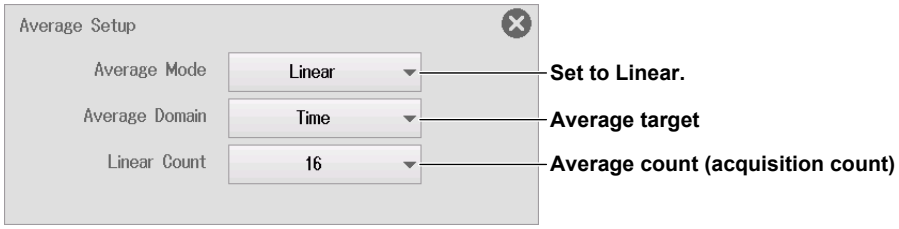
For Scope Mode



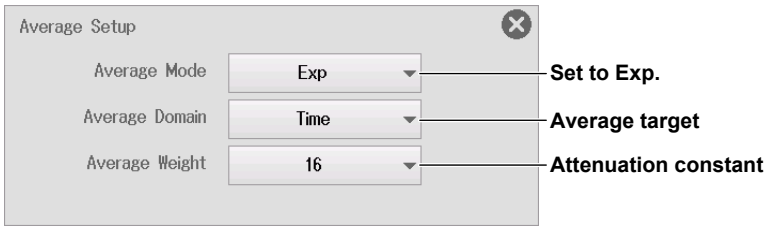
Configuring Averaging (Average Setup)

4. Tap **Average Setup**. The following screen appears.

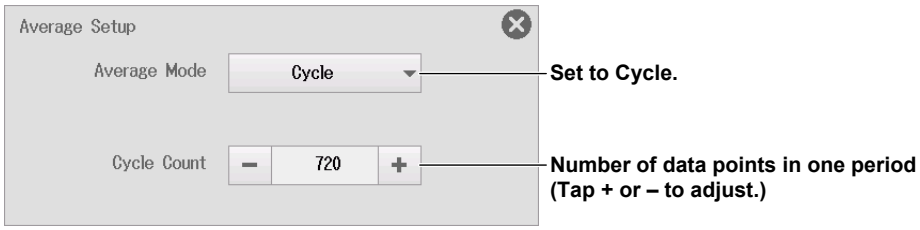
- **Linear average**



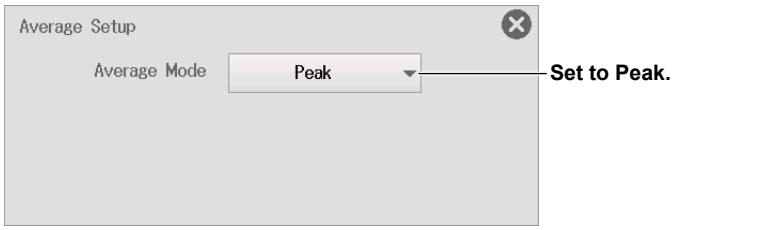
- **Exponential average**



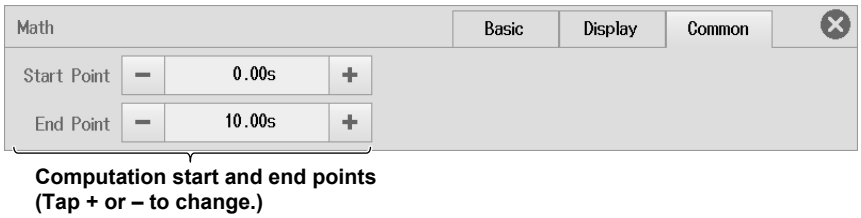
- **Cycle average**



- **Peak computation**



For Recorder Mode



10.1 Setting Conversion Equations

This section explains the following settings for the conversion equation of FFT computation.

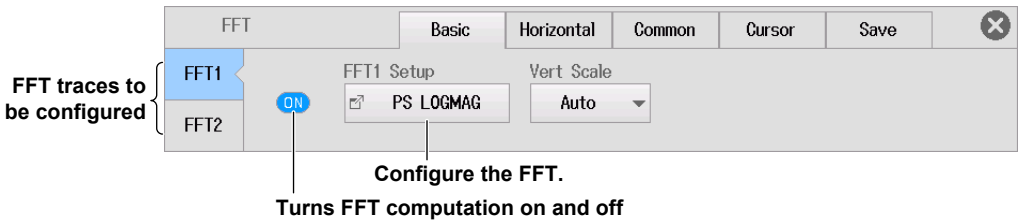
Items Common to Scope Mode and Recorder Mode

Target FFT waveform, FFT computation on/off, FFT settings (spectrum type, computation source waveform, unit)

► Features Guide: “FFT”

FFT Basic Setting Menu

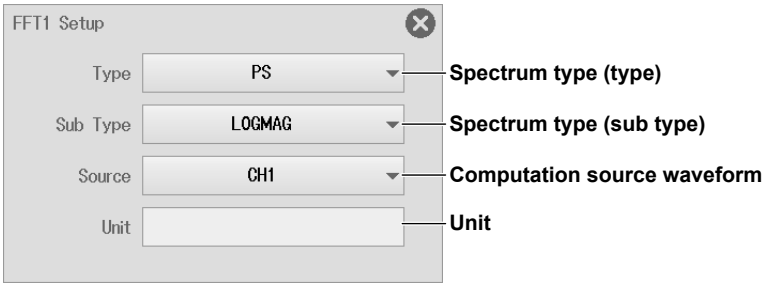
1. On the waveform screen, tap **MENU** > **Analysis** > **FFT**. The FFT menu appears.
   At this point, the FFT computation of FFT1 or FFT2 is automatically turned on.
2. Tap the **Basic** tab.
3. Tap **FFT1** or **FFT2**, and select the target FFT waveform.
4. Tap each item to set options.



Setting the FFT (FFT1 Setup, FFT2 Setup)

5. Tap **FFT1 Setup**. The following screen appears.
   When the computation waveform is FFT2, the button name changes to **FFT2 Setup**.
6. Tap each item. Use the displayed list (options) or input box to set the items.

This section describes the FFT1 Setup screen. FFT2 Setup can be set in the same manner.



10.2 Setting the Vertical Axis of the FFT

This section explains the following settings for the vertical axis of the FFT.

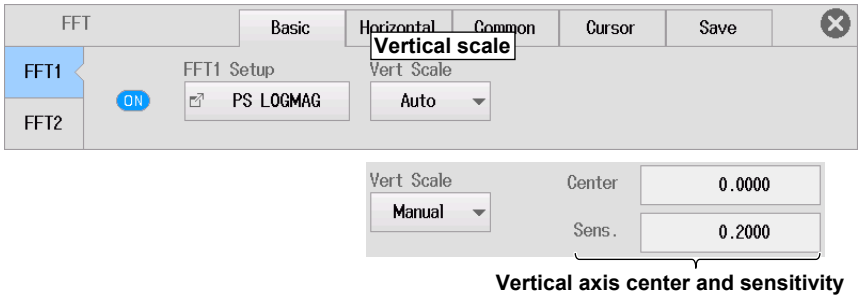
Items Common to Scope Mode and Recorder Mode

Vertical scale

► Features Guide: “FFT”

FFT Basic Setting Menu

1. On the waveform screen, tap **MENU** > **Analysis** > **FFT**. The FFT menu appears.
   At this point, the FFT computation of FFT1 or FFT2 is automatically turned on.
2. Tap the **Basic** tab.
3. Tap **FFT1** or **FFT2**, and select the target FFT waveform.
4. Tap **Vert Scale**, and select Auto or Manual.
5. If you select Manual, set the center point and sensitivity of the vertical axis.



10.3 Setting the Horizontal Axis of the FFT

This section explains the following settings for the horizontal axis of the FFT.

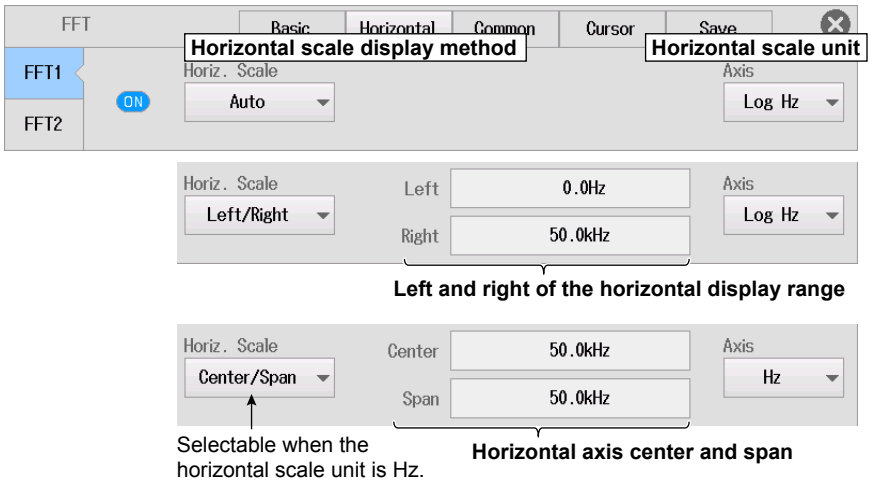
Items Common to Scope Mode and Recorder Mode

Horizontal scale display method, Horizontal scale unit, horizontal range

► Features Guide: “FFT”

FFT Horizontal Menu

1. On the waveform screen, tap **MENU** > **Analysis** > **FFT**. The FFT menu appears.
   At this point, the FFT computation of FFT1 or FFT2 is automatically turned on.
2. Tap the **Horizontal** tab.
3. Tap **FFT1** or **FFT2**, and select the target FFT waveform.
4. Tap each item. Use the displayed list (options) or input box to set the items.



10.4 Setting the Computation Start Point, Number of FFT Points, Window Function, and Averaging

This section explains the following settings for performing FFT computation.

For Scope Mode

Computation start point, detail settings (number of FFT points, window function, averaging settings (including peak computation))

For Recorder Mode

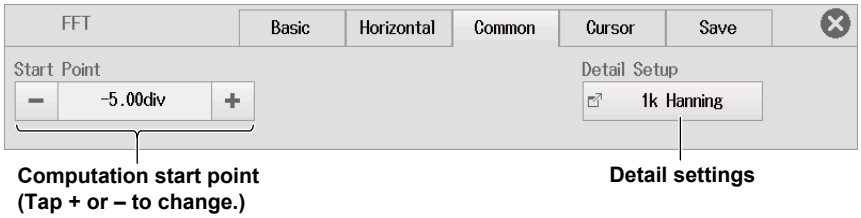
Computation start point, detail settings (number of FFT points, window function)

► Features Guide: “FFT”

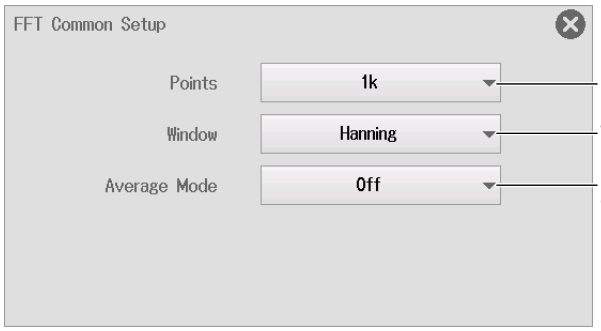
FFT Common Setting Menu

1. On the waveform screen, tap **MENU** > **Analysis** > **FFT**. The FFT menu appears.
   At this point, the FFT computation of FFT1 or FFT2 is automatically turned on.
2. Tap the **Common** tab.
3. Tap each item. Use the displayed list (options) or input box to set the items.

For Scope Mode



Detail Settings (Detail Setup)

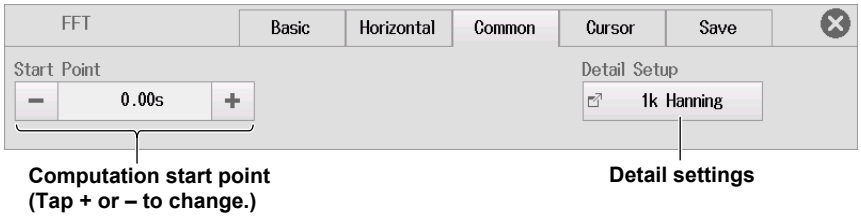


FFT points

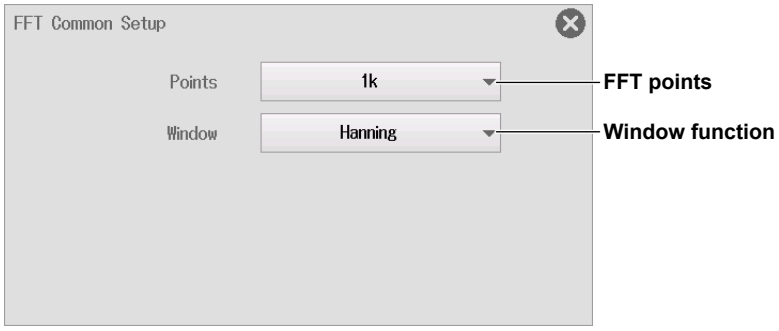
Window function

Set the average.
This is the same as the Math computation average settings Linear, Exp, and Peak.
► section 9.3
(This is synchronized to the Math computation average setting.)

For Recorder Mode



Detail Settings (Detail Setup)



10.5 Measuring FFT Waveforms with Cursors

This section explains the following settings for measuring FFT waveforms with cursors for each cursor type:

Items Common to Scope Mode and Recorder Mode

Cursor measurement on/off, cursor type, measurement source waveform, moving cursors, measurement items, marker settings, marker position, peak detection range

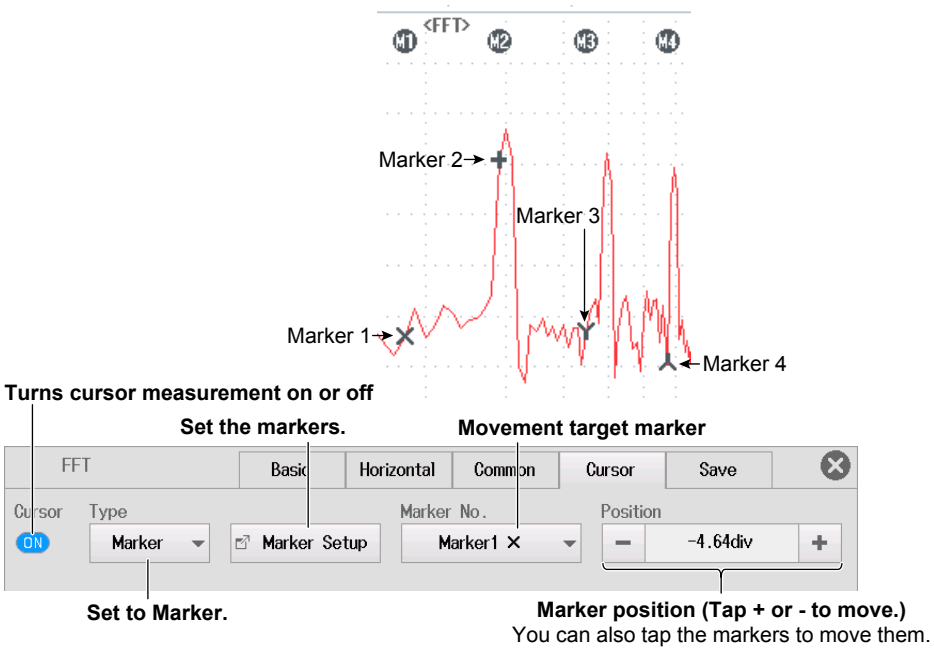
► Features Guide: “Cursor Measurement on FFT Waveforms”

FFT Cursor Menu

1. On the waveform screen, tap **MENU** > **Analysis** > **FFT**. The FFT menu appears.
   At this point, the FFT computation of FFT1 or FFT2 is automatically turned on.
2. Tap the **Cursor** tab.

Measuring FFT Waveforms with Marker Cursors (Marker)

3. Tap **Type** and select Marker.
4. Tap each item. Use the displayed list (options) or input box to set the items.



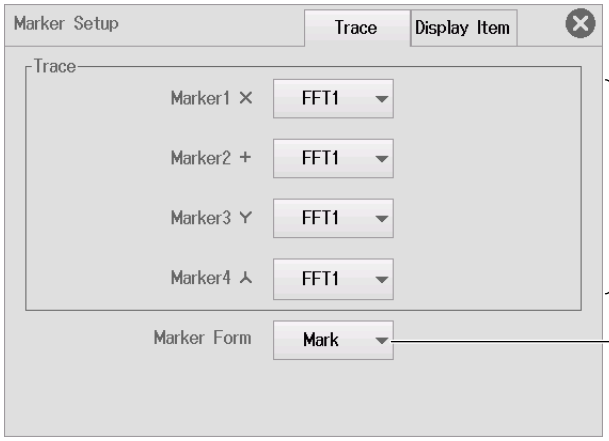
Setting the Marker (Marker Setup)

5. Tap **Marker Setup**.

- **Measurement Source Waveform and Marker Form (Trace)**

6. Tap the **Trace** tab. The following screen appears.

7. Tap each item. Use the displayed list (options) to set the items.

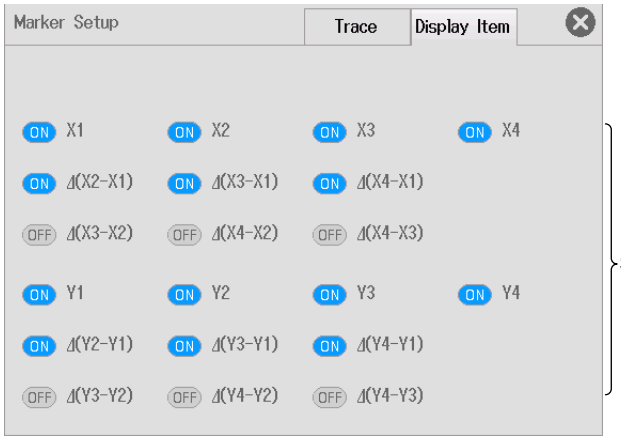


Source waveform
Set these items for each marker.

Marker form

- **Measurement Items (Display Item)**

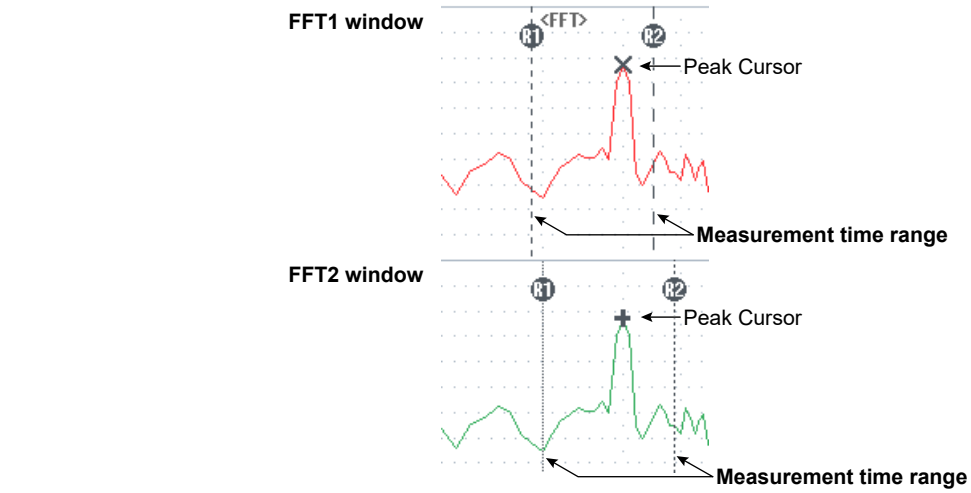
6. Tap the **Display Item** tab. The following screen appears.

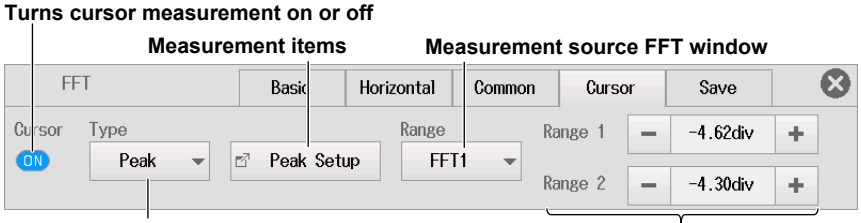


Set this to ON for items to be measured.

Measuring FFT Waveforms with Peak Cursors (Peak)

3. Tap **Type** and select Peak.
4. Tap each item. Use the displayed list (options) or input box to set the items.



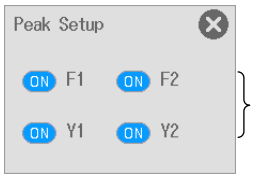


Measurement time range (Tap + or – to change.)

- You can also tap the range cursors (R1, R2) to change the range.
- This is synchronized with the peak list range.

Measurement Items (Peak Setup)

5. Tap **Peak Setup**. The following screen appears.

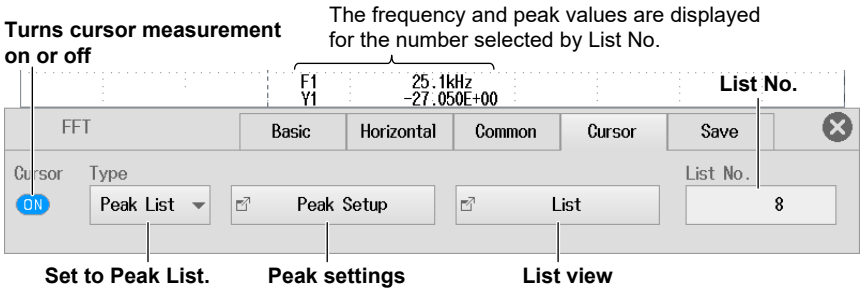


Set this to ON for items to be measured.

Listing FFT Waveform Peaks (Peak List)

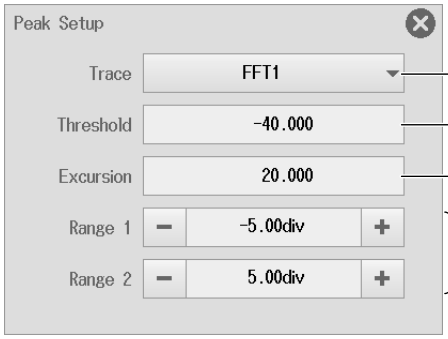
3. Tap Type and select Peak List.

4. Tap each item. Use the displayed list (options) or input box to set the items.



Peak Settings (Peak Setup)

5. Tap Peak Setup. The following screen appears.



Measurement source FFT window

Threshold

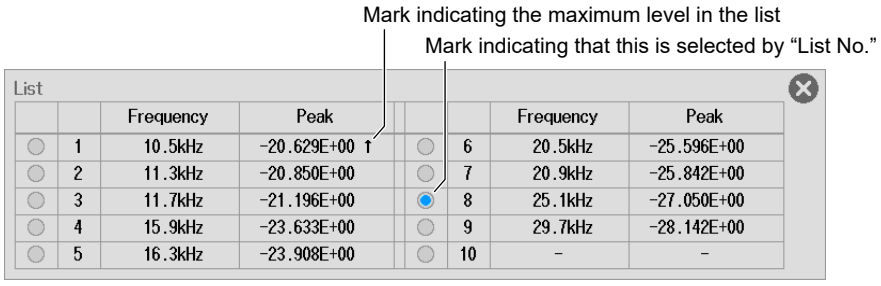
Difference between peak and valley

Measurement time range (Tap + or – to change.)

- You can also tap the range cursors (R1, R2) to change the range.
- This is synchronized with the peak cursor range.

List Display (List)

6. Tap List. A list of peaks appears.



10.6 Saving the Results of FFT Computation

This section explains the following settings for saving the results of FFT computation.

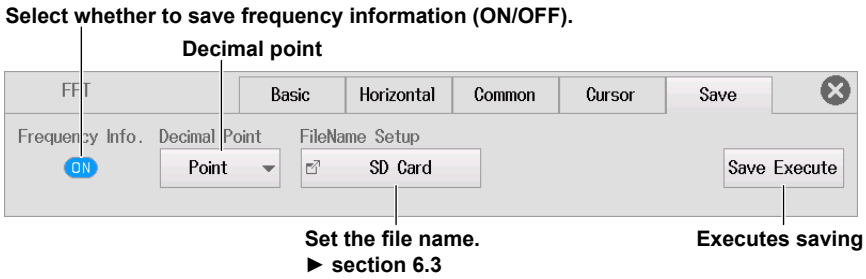
Items Common to Scope Mode and Recorder Mode

Saving frequency information (on/off), decimal point, save destination, file name

► Features Guide: “Saving Other Types of Data (Others Save)”

FFT Save Menu

1. On the waveform screen, tap **MENU** > **Analysis** > **FFT**. The FFT menu appears.
   At this point, the FFT computation of FFT1 or FFT2 is automatically turned on.
2. Tap the **Save** tab.
3. Tap each item to set options and execute commands.



11.1 Setting the X-Y Waveform Trace

This section explains the following settings for displaying X-Y waveforms.

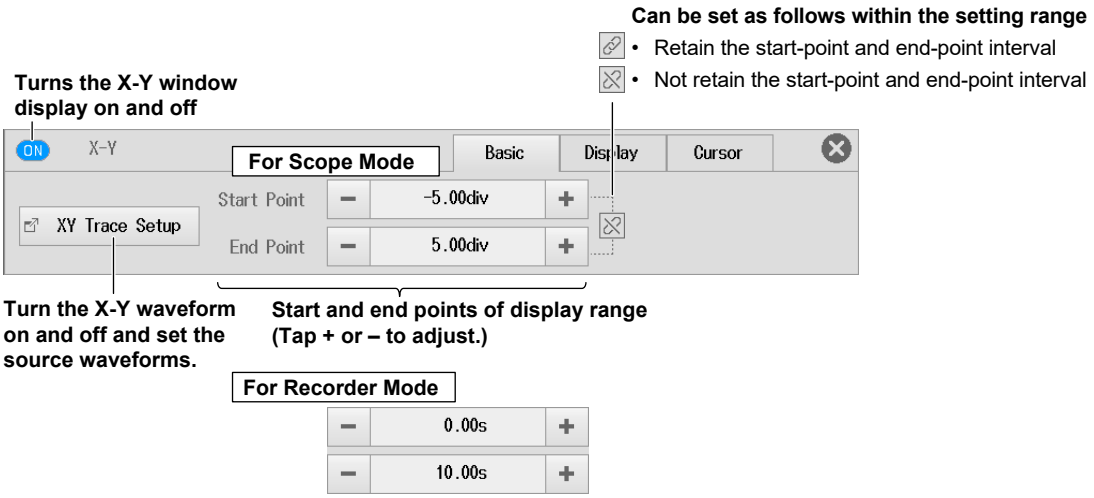
Items Common to Scope Mode and Recorder Mode

X-Y waveform display on/off, source waveform (X-axis, Y-axis), start point and end point of display range

► Features Guide: “X-Y Waveforms”

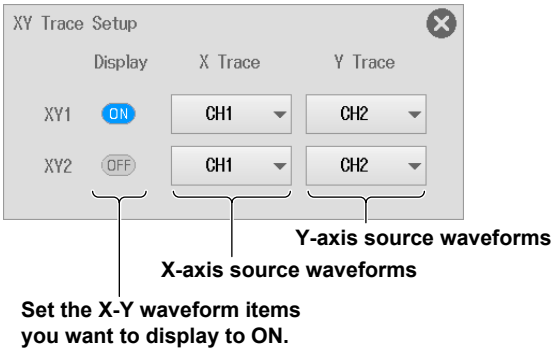
X-Y Basic Setting Menu

1. On the waveform screen, tap **MENU** > **Analysis** > **X-Y**. An X-Y window and X-Y menu appear.
2. Tap the **Basic** tab.
3. Tap each item. Use the displayed list (options) or input box to set the items.



Turning the X-Y Waveform Display On and Off and Setting the Source Waveforms (XY Trace Setup)

4. Tap **XY Trace Setup**. The following screen appears.



11.2 Setting the Display Conditions for X-Y Waveforms

This section explains the following settings for the display conditions of X-Y waveforms.

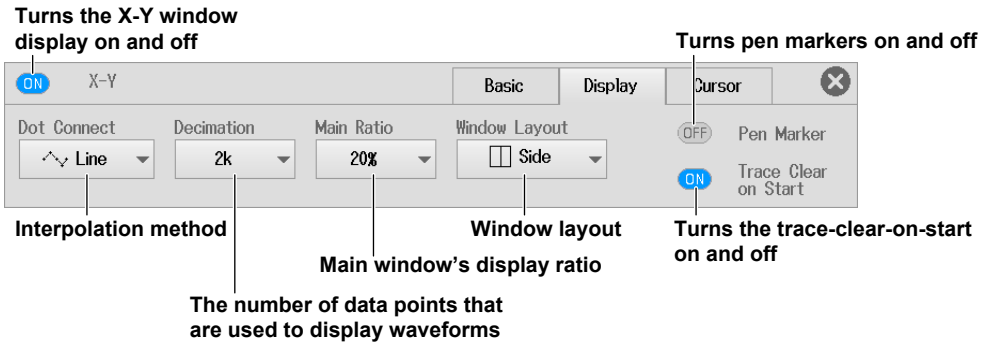
Items Common to Scope Mode and Recorder Mode

Interpolation method, number of points to use to display waveforms, display ratio of main window, window layout, pen marker on/off, clearing waveforms at acquisition start on/off

► Features Guide: “X-Y Waveforms”

X-Y Display Setting Menu

1. On the waveform screen, tap **MENU** > **Analysis** > **X-Y**. An X-Y window and X-Y menu appear.
2. Tap the **Display** tab.
3. Tap each item. Use the displayed list (options) or input box to set the items.



11.3 Measuring X-Y Waveforms with Cursors

This section explains the following settings for measuring X-Y waveforms with cursors for each cursor type:

Items Common to Scope Mode and Recorder Mode

Cursor measurement on/off, cursor type, measurement source waveform, moving cursors, measurement items, marker settings, marker position

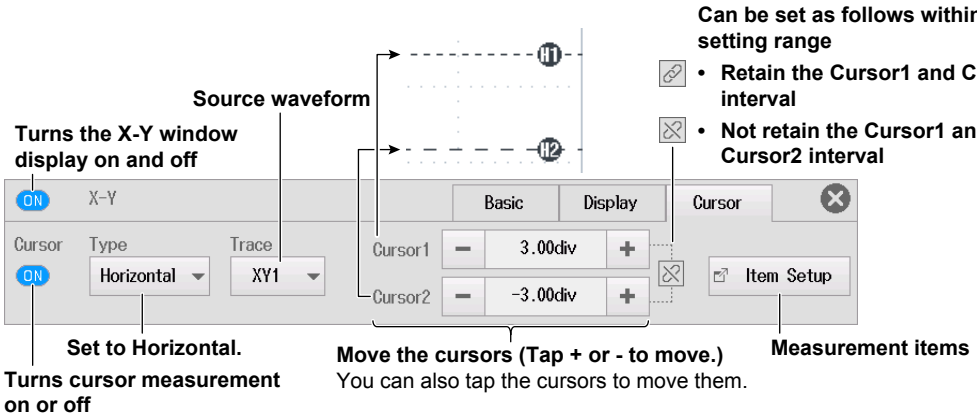
► Features Guide: “Cursor Measurement on X-Y Waveforms”

X-Y Cursor Menu

1. On the waveform screen, tap **MENU** > **Analysis** > **X-Y**. An X-Y window and X-Y menu appear.
2. Tap the **Cursor** tab.

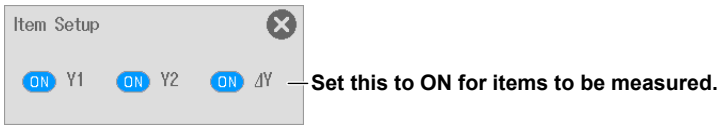
Measuring with X-Y Waveforms with Horizontal Cursors

3. Tap **Type** and select Horizontal.
4. Tap each item. Use the displayed list (options) or input box to set the items.



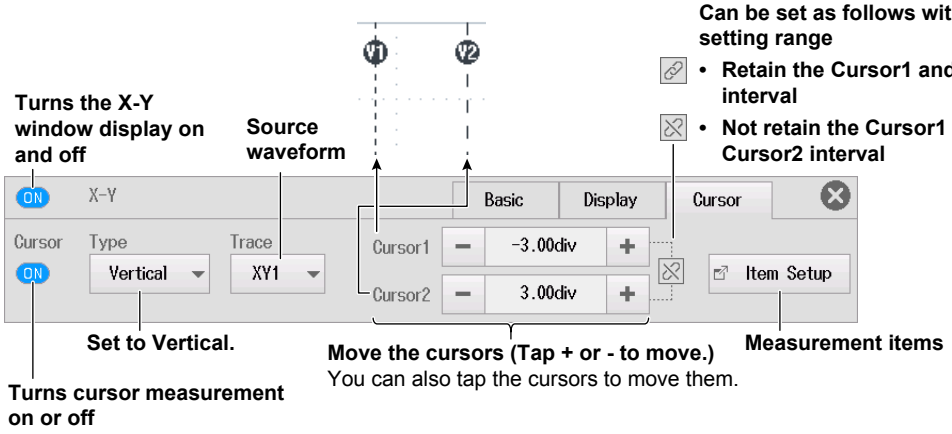
Measurement Items (Item Setup)

5. Tap **Item Setup**. The following screen appears.



Measuring X-Y Waveforms with Vertical Cursors

3. Tap **Type** and select Vertical.
4. Tap each item. Use the displayed list (options) or input box to set the items.

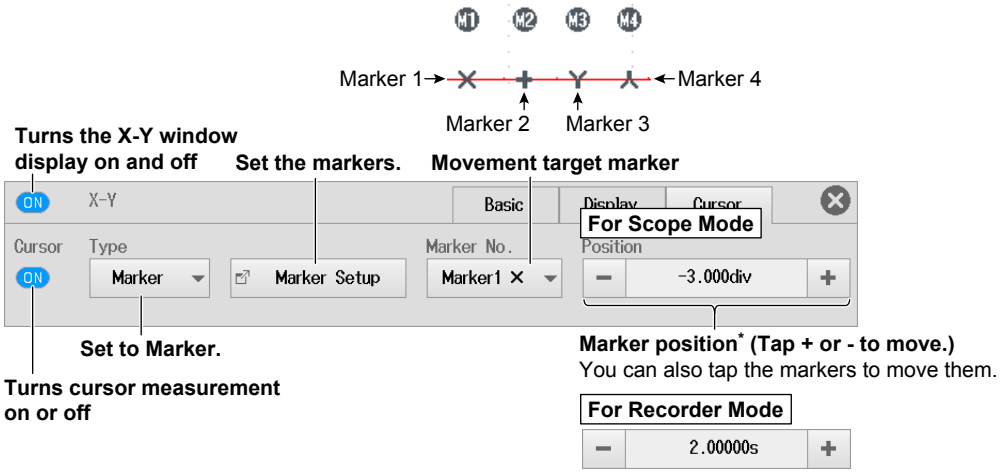


Measurement Items (Item Setup)

5. Tap **Item Setup**. The following screen appears.

Measuring X-Y Waveforms with Marker Cursors (Marker)

3. Tap **Type** and select Marker.
4. Tap each item. Use the displayed list (options) or input box to set the items.



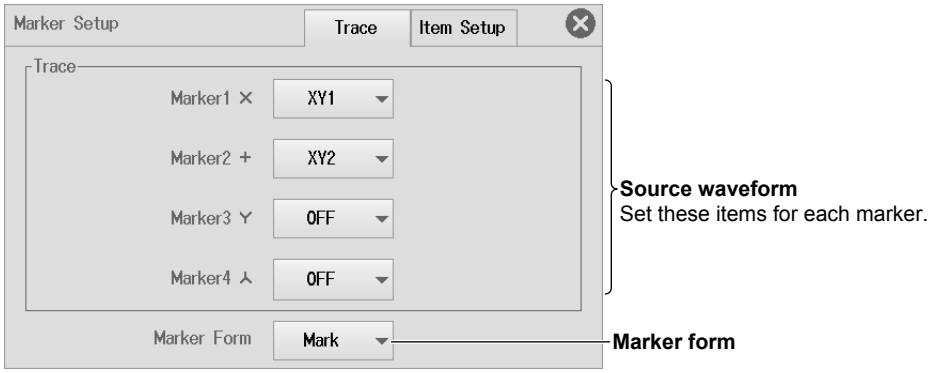
* You can move the marker positions also by moving the X1, X2, X3, and X4 cursors displayed in the T-Y waveform area. X1, X2, X3, and X4 cursors correspond to Marker 1, Marker 2, Marker 3, and Marker 4, respectively.

Setting Markers (Marker Setup)

5. Tap **Marker Setup**.

• Measurement Source Waveform and Marker Form (Trace)

6. Tap the **Trace** tab. The following screen appears.

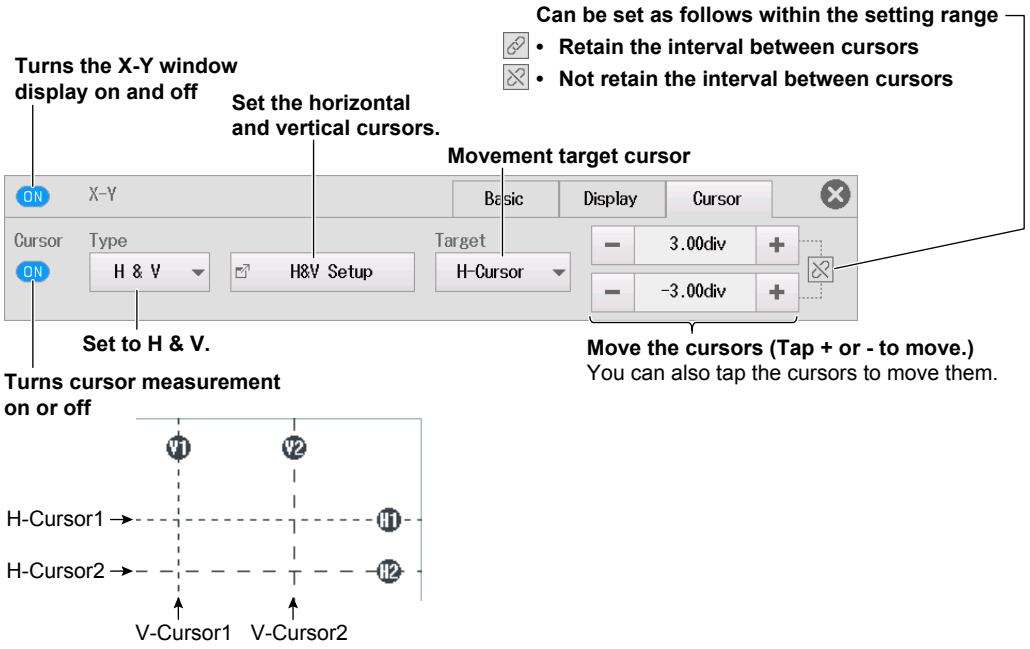


• Measurement Items (Display Item)

7. Tap the **Display Item** tab. The following screen appears.

Measuring X-Y Waveforms with Horizontal and Vertical Cursors (H & V)

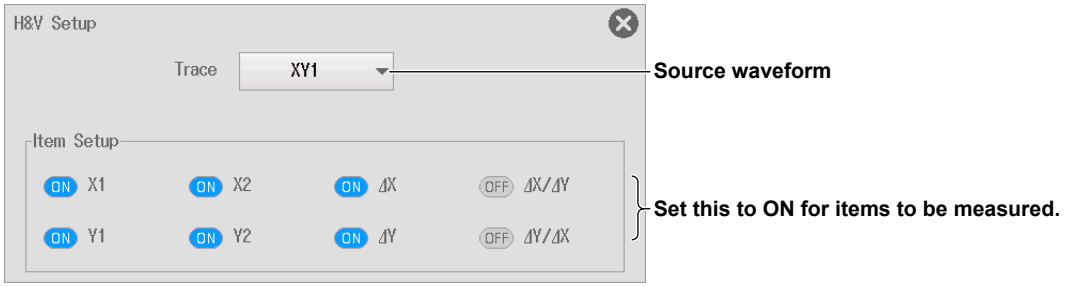
3. Tap **Type** and select H & V.
4. Tap each item. Use the displayed list (options) or input box to set the items.



Movement target cursor	H-Cursor	V-Cursor
Cursor movement Top row	Moves H-Cursor1	Moves V-Cursor1
Cursor movement Bottom row	Moves H-Cursor2	Moves V-Cursor2

Setting Horizontal and Vertical Cursors (H&V Setup)

5. Tap **H&V Setup**. The following screen appears.



12.1 Setting the Harmonic Analysis Conditions

This section explains the following settings for harmonic analysis conditions.

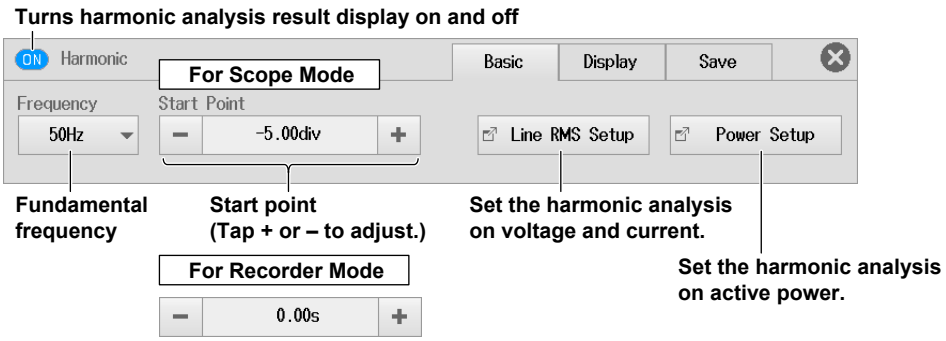
Items Common to Scope Mode and Recorder Mode

Harmonic analysis display on/off, fundamental frequency, start point, harmonic analysis on voltage and current, harmonic analysis on active power

► Features Guide: “Harmonic Analysis”

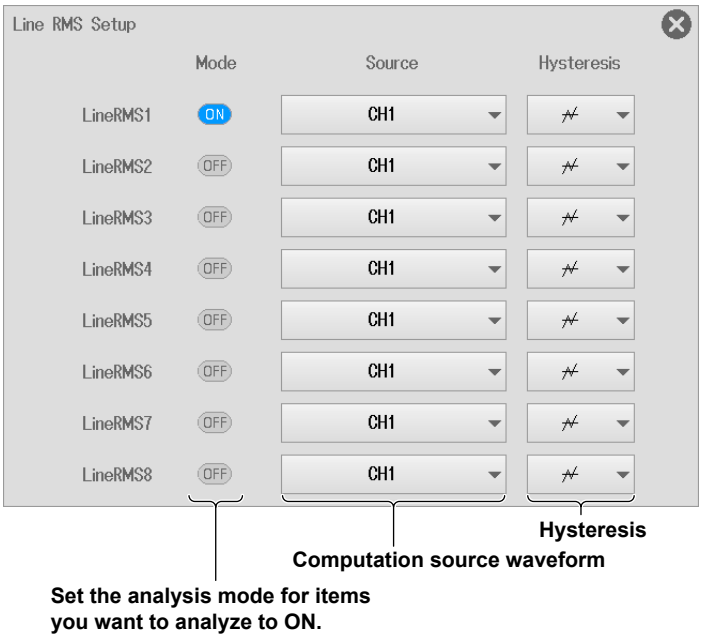
Harmonic Analysis Basic Setting Menu

1. On the waveform screen, tap **MENU** > **Analysis** > **Harmonic**. The Harmonic menu appears.
   At this point, harmonic analysis is automatically turned on.
2. Tap the **Basic** tab.
3. Tap each item. Use the displayed list (options) or input box to set the items.



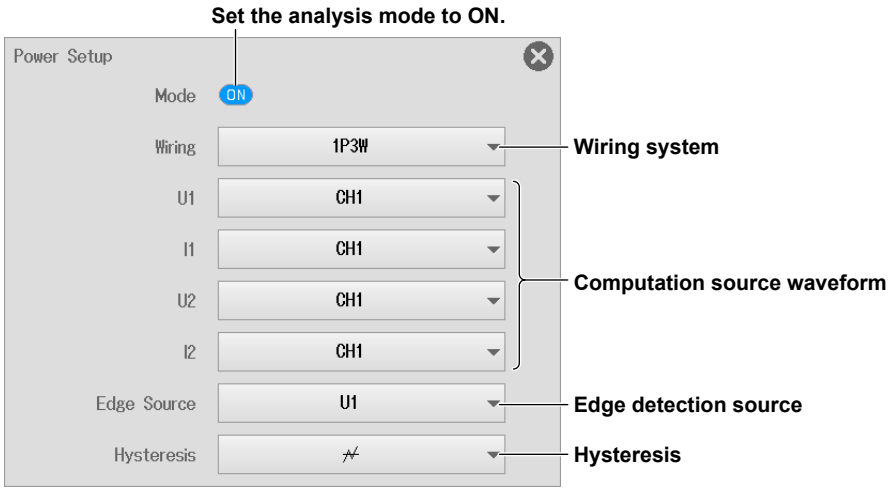
Setting the Harmonic Analysis on Voltage and Current (Line RMS Setup)

4. Tap **Line RMS Setup**. The following screen appears.



Setting the Harmonic Analysis on Active Power (Power Setup)

4. Tap **Power Setup**. The following screen appears.



12.2 Setting the Harmonic Analysis Display Conditions

This section explains the following settings for harmonic analysis display conditions.

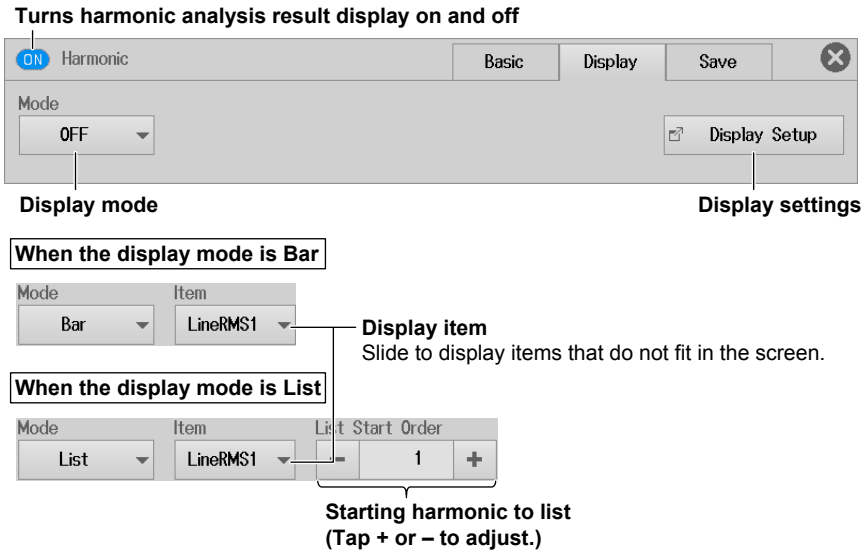
Items Common to Scope Mode and Recorder Mode

Display mode, displayed items, displayed order, phase scale, vertical scale

► Features Guide: “Display (Display)”

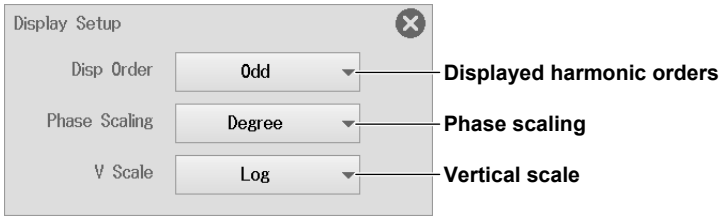
Harmonic Analysis Display Setting Menu

1. On the waveform screen, tap **MENU** > **Analysis** > **Harmonic**. The Harmonic menu appears.
   At this point, harmonic analysis is automatically turned on.
2. Tap the **Display** tab.
3. Tap **Mode** and select the display mode.
4. Tap each item. Use the displayed list (options) or input box to set the items.



Configuring the Display (Display Setup)

5. Tap the **Display Setup** tab. The following screen appears.



12.3 Setting the Harmonic Analysis Save Conditions

This section explains the following settings for harmonic analysis save conditions.

Items Common to Scope Mode and Recorder Mode

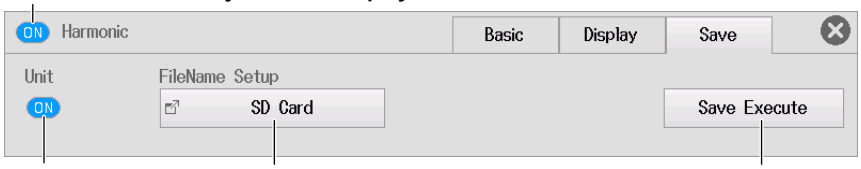
Unit display on/off, setting save conditions, executing the save operation

► Features Guide: “Save Settings (Save)”

Harmonic Analysis Save Setting Menu

1. On the waveform screen, tap **MENU** > **Analysis** > **Harmonic**. The Harmonic menu appears.
   At this point, harmonic analysis is automatically turned on.
2. Tap the **Save** tab.
3. Tap each item to set options and execute commands.

Turns harmonic analysis result display on and off



Select whether to the unit (ON/OFF).

Set the file name.
► section 6.3
There is no comment box.

Start saving

13.1 Performing GO/NO-GO Determination with Waveform Zones

This section explains the following settings for performing GO/NO-GO determination with waveform zones:

Applicable to Scope Mode

- Basic settings (GO/NO-GO determination on/off, setting the determination type to Wave Zone, determination period, linking determination periods, judgment conditions)
- Action (action mode, action settings)
- Editing waveform zones (number of the waveform zone to edit, editing the source waveform zone)

This setting is not available in recorder mode.

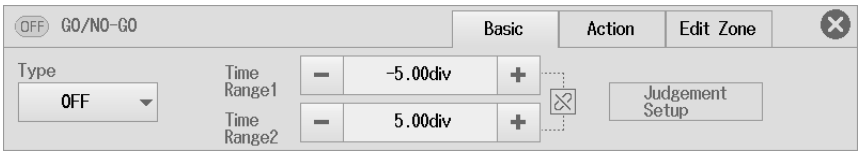
► Features Guide: “GO/NO-GO Determination (Scope mode only)”

GO/NO-GO Menu

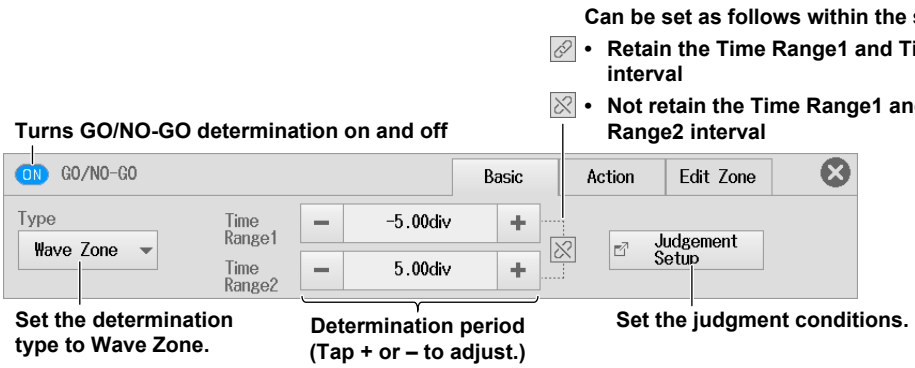
1. On the waveform screen, tap **MENU** > **Analysis** > **GO/NO-GO**. The GO/NO-GO menu appears.

Basic Setup (Basic)

2. Tap the **Basic** tab.



3. Tap **Type** and select Wave Zone. The GO/NO-GO determination on/off display is set to ON, and the **Judgement Setup** button is enabled.
4. Tap each item. Use the displayed list (options) or input box to set the items.

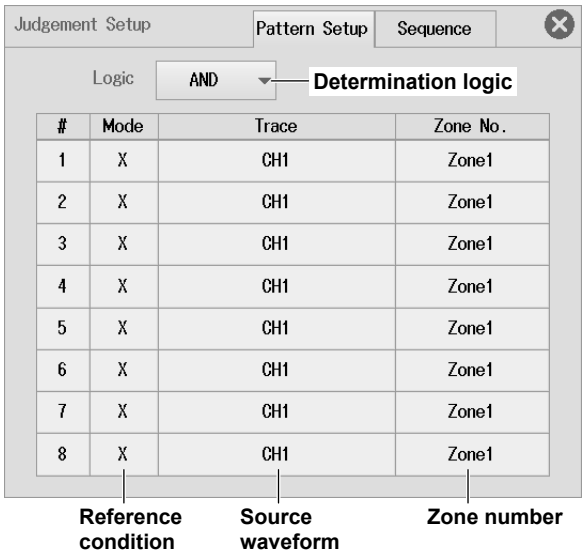


Setting the Judgment Conditions (Judgement Setup)

5. Tap **Judgement Setup**.

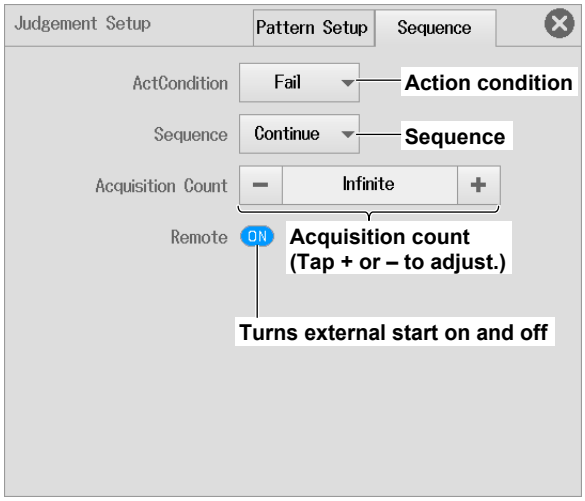
• Setting the Pattern (Pattern Setup)

6. Tap the **Pattern Setup** tab. The following screen appears.



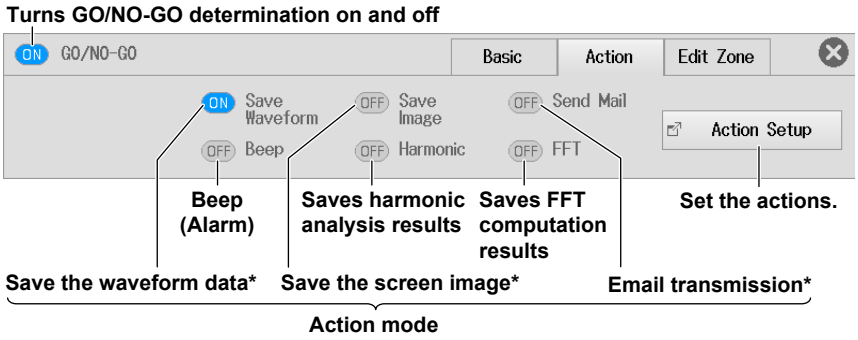
• Sequence (Sequence)

7. Tap the **Sequence** tab. The following screen appears.



Action (Action)

2. Tap the **Action** tab. The following menu appears.
3. Tap each item to set options.



Set the actions you want to execute to ON.
Items with an asterisk can also be turned on and off on the action setting screen.

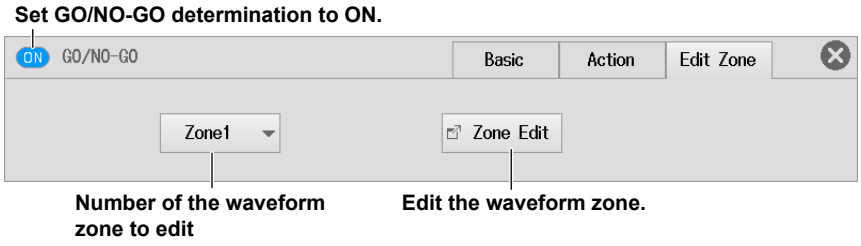
Action Settings (Action Setup)

► section 3.1

Editing a Waveform Zone (Edit Zone)

You can edit waveform zones when the GO/NO-GO determination type is set to Wave Zone.

2. Tap the **Basic** tab > **Type**, and select Wave Zone.
3. Tap the **Edit Zone** tab. The following menu appears.
4. Tap the number of the waveform zone you want to edit, and select the source waveform zone.



Editing the Source Waveform Zone (Zone Edit)

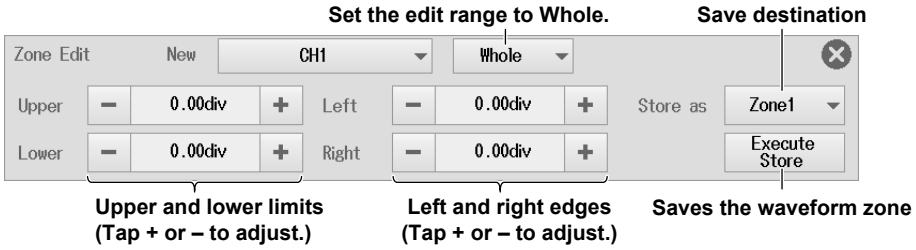
To perform other operations while editing a zone, tap ⊗ to close the zone edit menu. Settings that you are editing will be discarded.

5. Tap **Zone Edit**.
6. When you create a new waveform zone, you need to select the waveform that you will base it on (the base waveform).

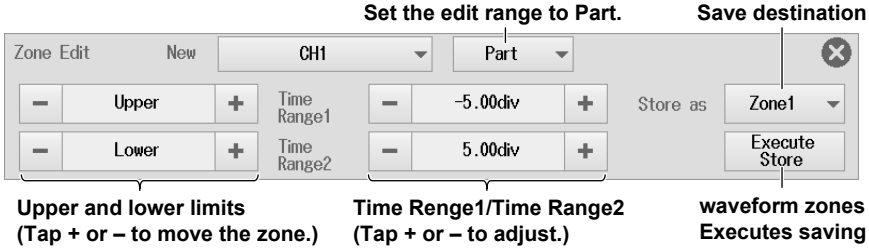
   Select a waveform whose display is on. The waveform zone edit items are displayed.

7. Tap each item. Use the displayed list (options) or input box to set the items.

- **When making the edit range the entire waveform**



- **When making the edit range a section of the waveform**



8. Tap **Execute Store**.

13.2 Performing GO/NO-GO Determination with Waveform Parameters

This section explains the following settings for performing GO/NO-GO determination with waveform parameters.

Applicable to Scope Mode

- Basic settings (GO/NO-GO determination on/off, setting the determination type to Parameter, determination period, linking determination periods, judgment conditions)
- Action (action mode, action settings)

This setting is not available in recorder mode.

► Features Guide: “GO/NO-GO Determination (Scope mode only)”

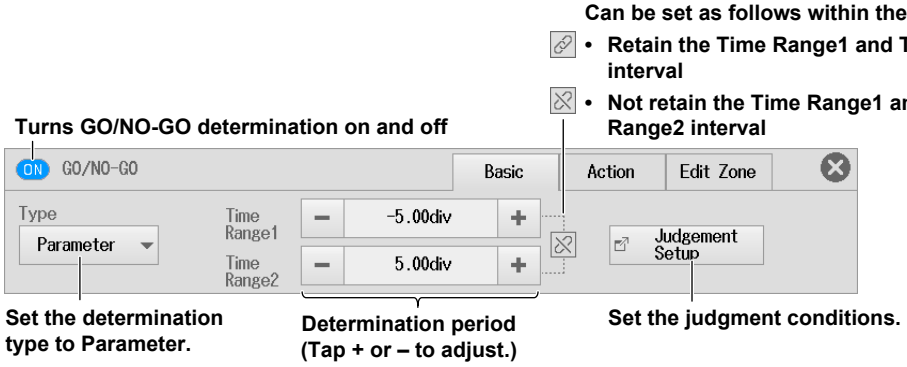
GO/NO-GO Menu

1. On the waveform screen, tap **MENU** > **Analysis** > **GO/NO-GO**. The GO/NO-GO menu appears.

Basic Setup (Basic)

2. Tap the **Basic** tab.

3. Tap **Type** and select Parameter. The GO/NO-GO determination on/off display is set to ON, and the **Judgement Setup** button is enabled.
4. Tap each item. Use the displayed list (options) or input box to set the items.

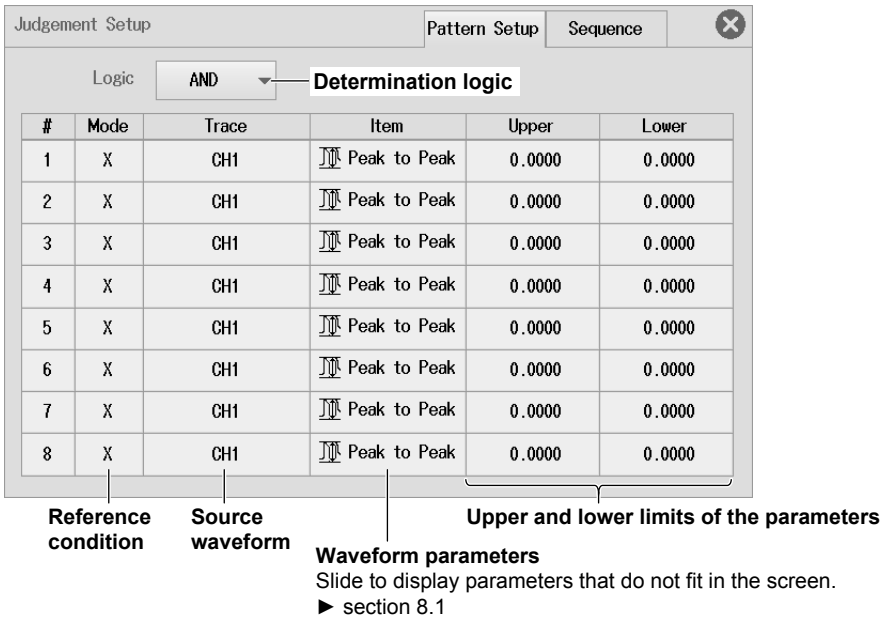


Setting the Judgment Conditions (Judgement Setup)

5. Tap **Judgement Setup**.

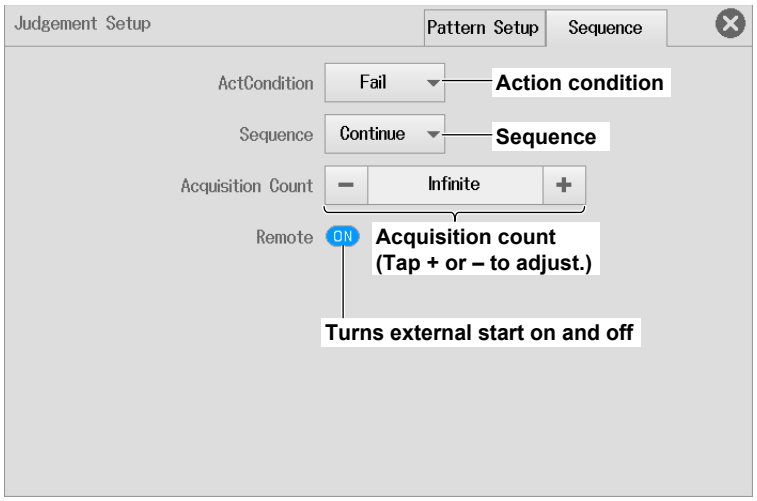
• Setting the Pattern (Pattern Setup)

6. Tap the **Pattern Setup** tab. The following screen appears.



• Sequence (Sequence)

7. Tap the **Sequence** tab. The following screen appears.



Action (Action)

►sections 13.1, 3.1

14.1 Setting the Waveform Zoom Range

This section explains the following settings for zooming the time scale of waveforms.

Applicable to Scope Mode

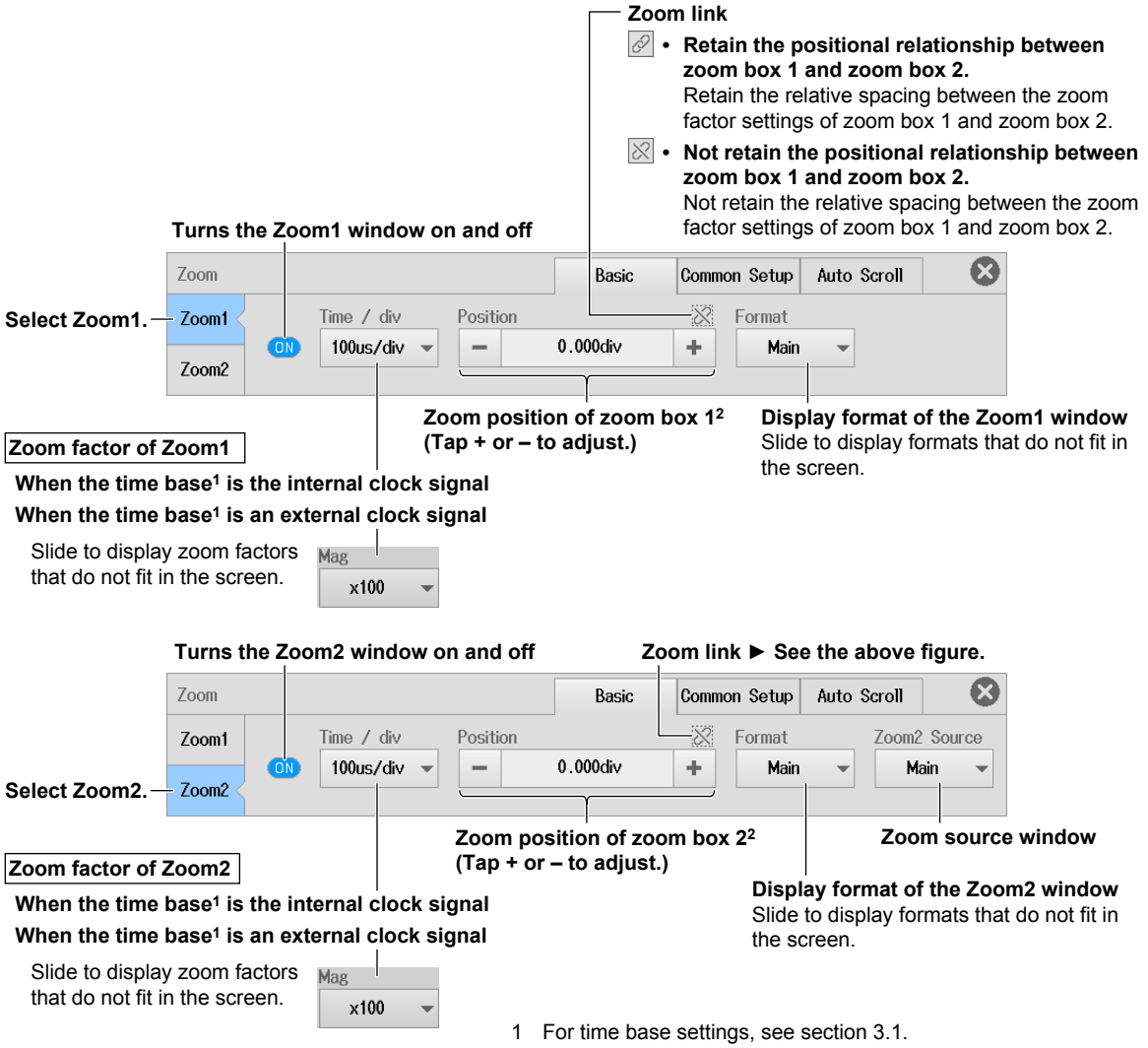
Zoom window display on/off, zoom factor (Time/div or Mag), zoom position, zoom link, display format

For recorder mode, see chapter 15.

► Features Guide: “Waveform Zoom (Scope mode only)”

Zoom Basic Setting Menu

1. On the waveform screen, tap **MENU** > **Analysis** > **Zoom**. The Zoom menu appears.
   At this point, the Zoom1 or Zoom2 window appears automatically.
2. Tap the **Basic** tab.
3. Tap **Zoom1** or **Zoom2**, and select the target zoom window.
4. Tap each item. Use the displayed list (options) or input box to set the items.



1 For time base settings, see section 3.1.
2 For the zoom position, set the center position of the zoom box.

14.2 Setting the Display Conditions for Waveforms

This section explains the following settings for zooming the time scale of waveforms.

Applicable to Scope Mode

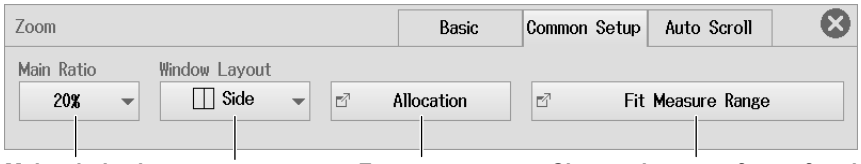
Display ratio of main window, window layout, zoom source waveform, the range for performing automated measurement of waveform parameters

For recorder mode, see chapter 15.

► Features Guide: “Waveform Zoom (Scope mode only)”

Zoom Common Setting Menu

1. On the waveform screen, tap **MENU** > **Analysis** > **Zoom**. The Zoom menu appears.
   At this point, the Zoom1 or Zoom2 window appears automatically.
2. Tap the **Common Setup** tab.
3. Tap each item. Use the displayed list (options) or input box to set the items.



Main window’s display ratio

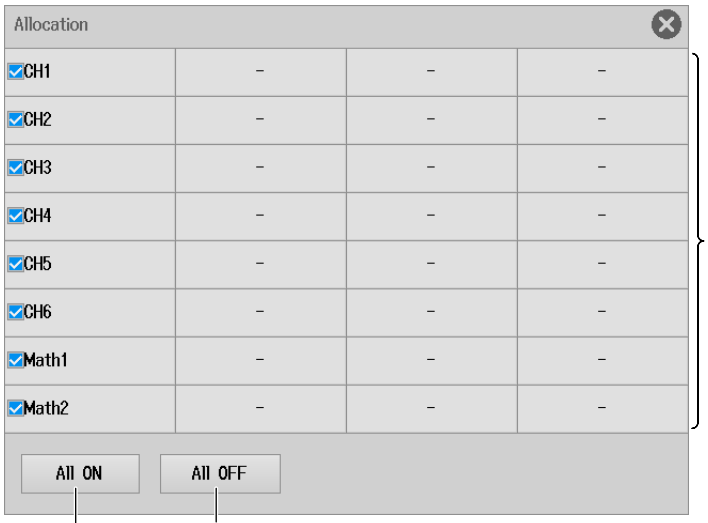
Window layout

Zoom source waveform

Change the range for performing automated measurement of waveform parameters.

Allocating Zoom Source Waveforms (Allocation)

4. Tap **Allocation**. The following screen appears.



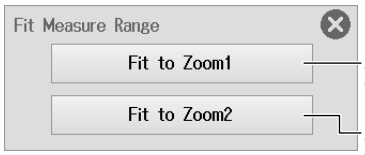
Zoom source waveforms
The waveform channels that can be selected are displayed.
Select the check boxes for the zoom source channels to turn them on.

Set all channels to zoom source OFF.

Set all channels to zoom source ON.

Change the Range for Performing Automated Measurement of Waveform Parameters (Fit Measure Range)

4. Tap **Fit Measure Range**. The following screen appears.



Aligns the range on which automated measurement of waveform parameters is performed to zoom box 1.

Aligns the range on which automated measurement of waveform parameters is performed to zoom box 2.

For details on the range for performing automated measurement of waveform parameters, see section 8.1.

14.3 Auto Scrolling the Zoom Position

This section explains the following settings for auto scrolling the zoom range.

Applicable to Scope Mode

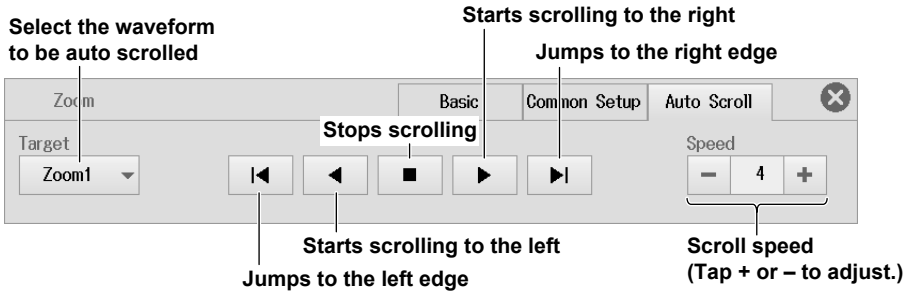
Auto scroll source waveform, scroll direction, jumping to the left or right edge, scroll speed

For recorder mode, see chapter 15.

► Features Guide: “Auto Scrolling (Auto Scroll)”

Zoom Auto Scroll menu

1. On the waveform screen, tap **MENU** > **Analysis** > **Zoom**. The Zoom menu appears.
   At this point, the Zoom1 or Zoom2 window appears automatically.
2. Tap the **Auto Scroll** tab.
3. Tap **Target**, and select Zoom1 or Zoom2.
4. Tap the appropriate buttons. The zoom position scrolls according to the buttons you tap.
   To change the scroll speed, tap the **Speed** value. Use the displayed input box to set the scroll speed.



15.1 Setting the Waveform Display Range and Zoom Range

This section explains the following settings for zooming the time scale of waveforms.

Applicable to Recorder Mode

Zoom window display on/off, zoom factor (Time Range), zoom position, display format

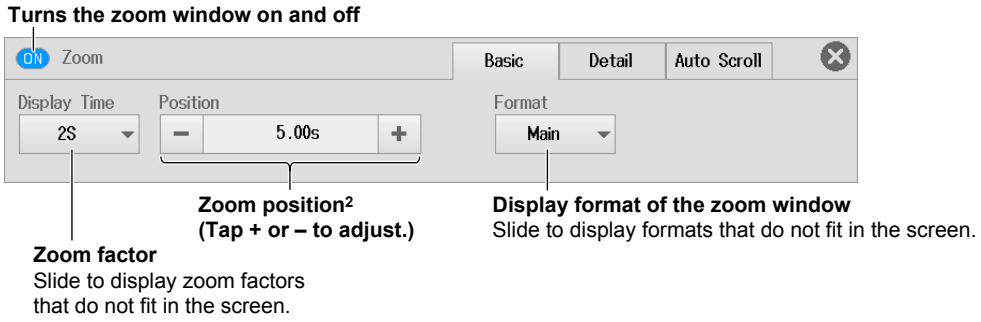
For scope mode, see chapter 14.

► Features Guide: “Waveform Display Position and Zoom (Recorder mode only)”

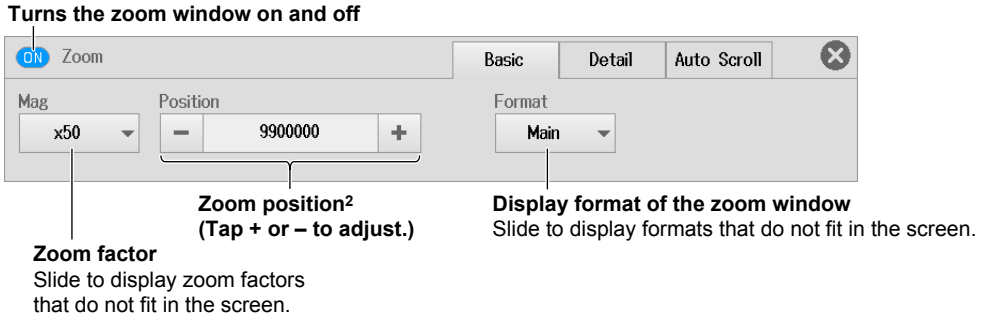
Zoom Basic Setting Menu

1. On the waveform screen, tap **MENU** > **Analysis** > **Zoom**. The Zoom menu appears.
   At this point, a zoom window appears automatically.
2. Tap the **Basic** tab.
3. Tap each item. Use the displayed list (options) or input box to set the items.

- **When the time base[1] is the internal clock signal**



- **When the time base[1] is an external clock signal**



1 For time base settings, see section 3.2.
2 For the zoom position, set the center position of the zoom box.

15.2 Setting the Display Conditions for Waveforms

This section explains the following settings for zooming the time scale of waveforms.

Applicable to Recorder Mode

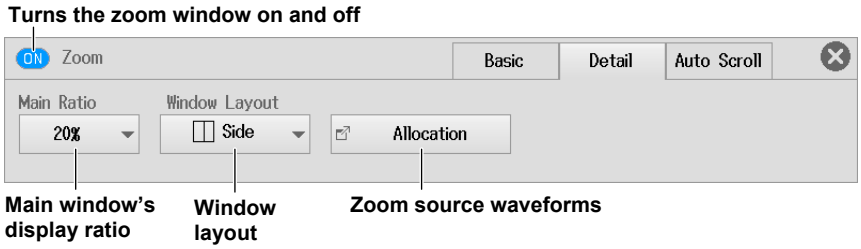
Zoom window display on/off, display ratio of main window, window layout, zoom source waveform, the range for performing automated measurement of waveform parameters

For scope mode, see chapter 14.

► Features Guide: “Waveform Display Position and Zoom (Recorder mode only)”

Zoom Detail Setting Menu

1. On the waveform screen, tap **MENU** > **Analysis** > **Zoom**. The Zoom menu appears.
   At this point, a zoom window appears automatically.
2. Tap the **Detail** tab.
3. Tap each item. Use the displayed list (options) or input box to set the items.



Allocating Zoom Source Waveforms (Allocation)

► section 14.2

15.3 Auto Scrolling the Zoom Position

This section explains the following settings for auto scrolling the zoom range.

Applicable to Recorder Mode

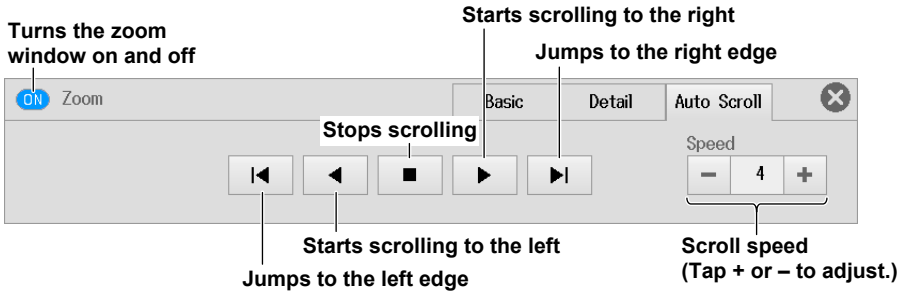
Scroll window display on/off, scroll direction, jumping to the left or right edge, scroll speed

For scope mode, see chapter 14.

► Features Guide: “Auto Scrolling (Auto Scroll)”

Zoom Auto Scroll menu

1. On the waveform screen, tap **MENU** > **Analysis** > **Zoom**. The Zoom menu appears.
   At this point, a zoom window appears automatically.
2. Tap the **Auto Scroll** tab.
3. Tap the appropriate buttons. The zoom position scrolls according to the buttons you tap.
   To change the scroll speed, tap the **Speed** value. Use the displayed input box to set the scroll speed.



16.1 Searching for Edges

This section explains the following settings for searching for edges.

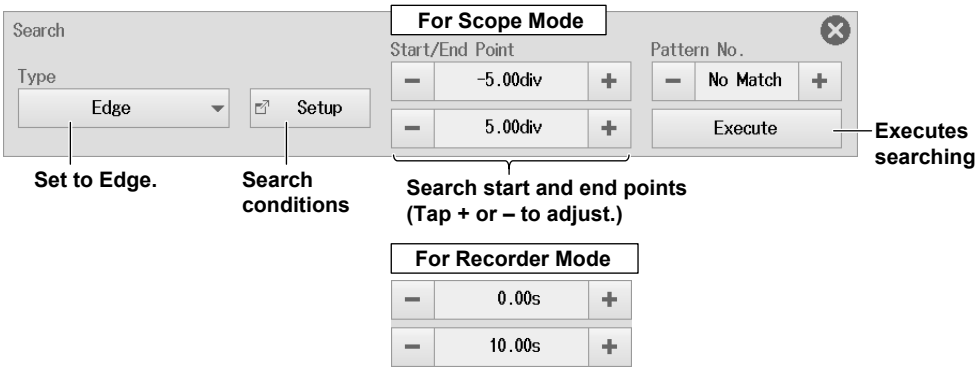
Items Common to Scope Mode and Recorder Mode

Search type, search conditions (source waveform, level for determining the state of the source waveform, edge polarity, hysteresis, and the number of times to detect the conditions), detected point number, search range (search start point and end point), executing the search

► Features Guide: “Edge Search (Edge)”

Search Edge Menu

1. On the waveform screen, tap **MENU** > **Analysis** > **Search**. The Search menu appears.
2. Tap **Type** and select **Edge**.
3. Tap each item. Use the displayed input box to set the items.

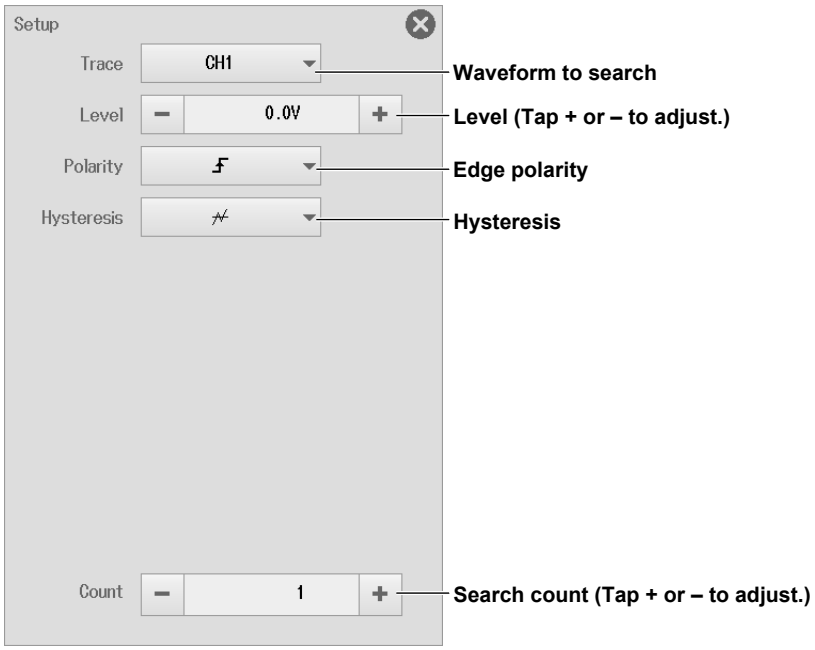


- In scope mode, the Zoom1 window is displayed automatically when you open the Search menu.
- In recorder mode, the Zoom window is not displayed automatically when you open the Search menu. For the zoom window display settings, see section 15.
- In both scope mode and recorder mode, the search target is the main window.

Setting Search Conditions (Setup)

4. Tap **Setup**. A menu appears according to the waveform to be searched you specified.
5. Tap each item. Use the displayed list (options) or input box to set the items.

If the waveform to search is set to CH1 to CH4, 16CH VOLT, 16CH TEMP/VOLT, CAN,[1] CAN FD,[1] LIN,[1] SENT,[1] GPS[2]

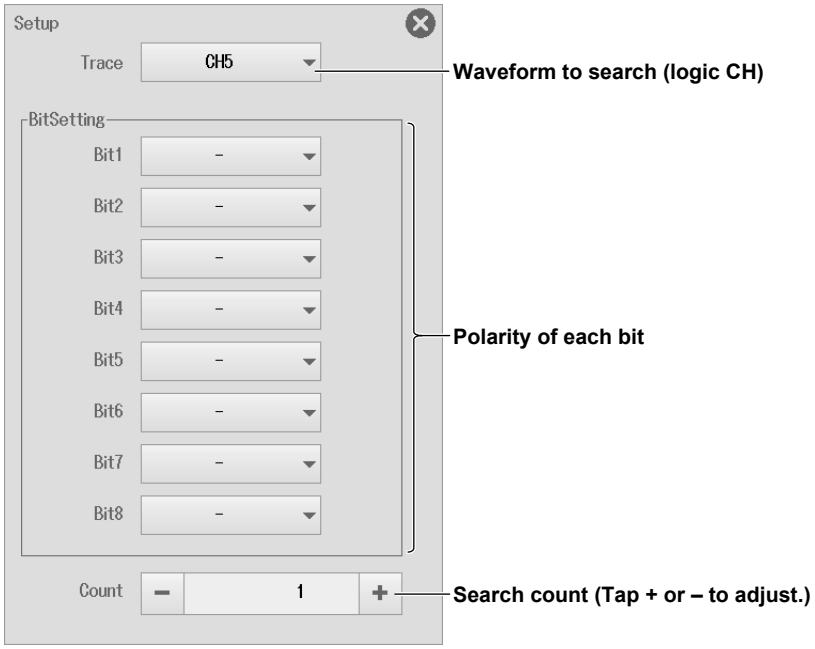


1 Use this menu for waveforms whose sub channel Value Type on the CAN bus monitor, CAN/CAN FD monitor, or CAN & LIN bus monitor is Unsigned, Signed, or Float and waveforms whose sub channel on the SENT monitor is FastCH, SlowCH, or Error Count.

2 Use this menu when the GPS feature is on and the position information is set to Latitude, Longitude, Altitude, Velocity, or Direction.

If the Waveform to Search Is Set to a Logic Channel

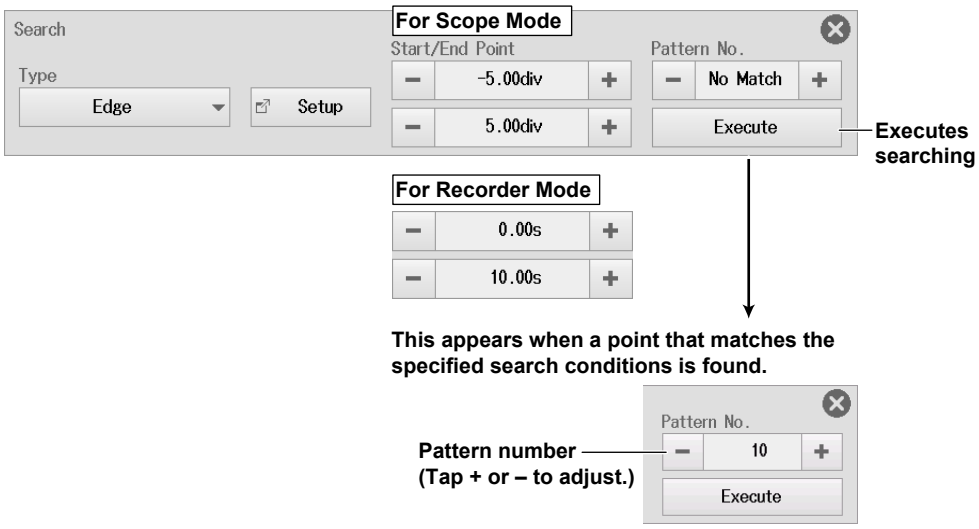
- **For CH5 or CH6**
- **Waveforms of logic input modules**
- **Waveforms whose sub channel Value Type on the CAN bus monitor, CAN/CAN FD monitor, or CAN & LIN bus monitor is Logic**
- **Waveforms whose sub channel on the SENT monitor is S&C or Error Trigger**
- **When the GPS feature is on and the position information is set to Status**



Executing a Search (Execute)

6. Tap **Execute.** The instrument searches for the search conditions. If the instrument finds points that match the search conditions (detected points), it shows numbers (0, 1, 2, etc.) from the left of the waveform display in the order that the points were detected.

7. You can set the pattern number and display the waveform with the detected point in the center of the zoom window.



16.2 Searching for Events

This section explains the following settings for searching for events):

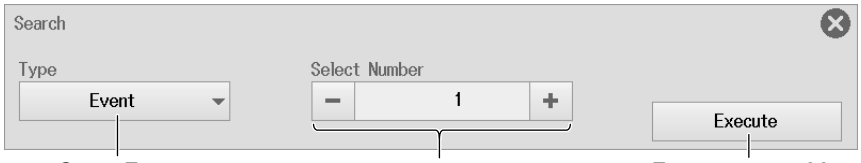
Items Common to Scope Mode and Recorder Mode

Search type, search target (event number)

► Features Guide: “Event Search (Event)”

Search Event Menu

1. On the waveform screen, tap **MENU** > **Analysis** > **Search**. The Search menu appears.
2. Tap **Type** and select **Event**.
3. Tap each item to set options and execute commands.



Set to Event. **Event number (Tap + or – to adjust.)** **Executes searching**

Executing a Search (Execute)

4. **Tap Execute.** The instrument displays the waveform with the selected event number in the center of the zoom window.

16.3 Searching for Logic Patterns

This section explains the following settings for searching for logic patterns):

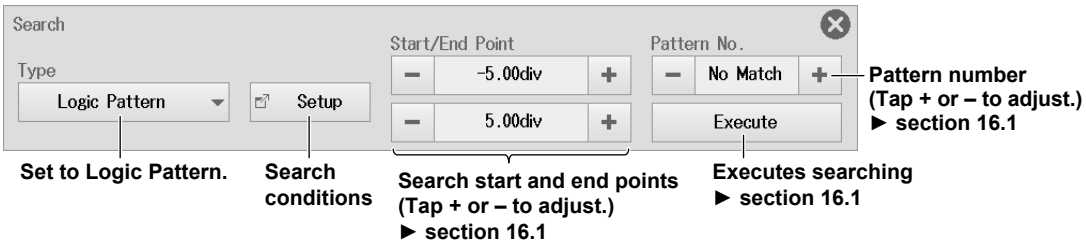
Items Common to Scope Mode and Recorder Mode

Search type, search conditions (source waveform, source bits, and the number of times to detect the conditions)

► Features Guide: “Logic Pattern Search (Logic Pattern)”

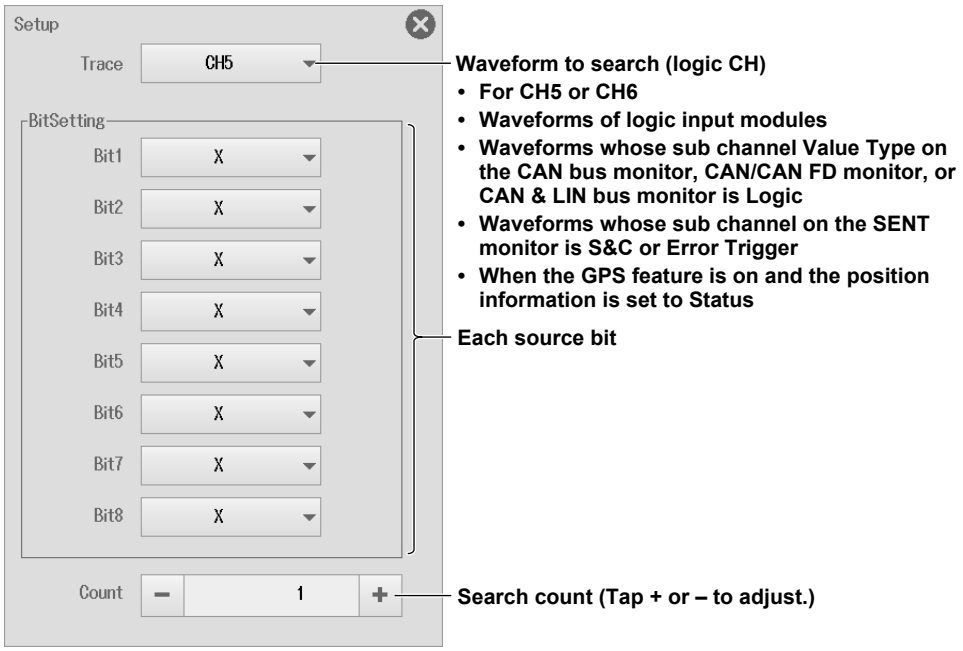
Search Logic Pattern Menu

1. On the waveform screen, tap **MENU** > **Analysis** > **Search**. The Search menu appears.
2. Tap **Type** and select **Logic Pattern**.
3. Tap each item. Use the displayed input box to set the items.



Setting Search Conditions (Setup)

4. Tap **Setup**. The Setup screen appears.
5. Tap each item. Use the displayed list (options) or input box to set the items.



16.4 Searching for a Specific Date and Time

This section explains the following settings for searching for a specific date and time.

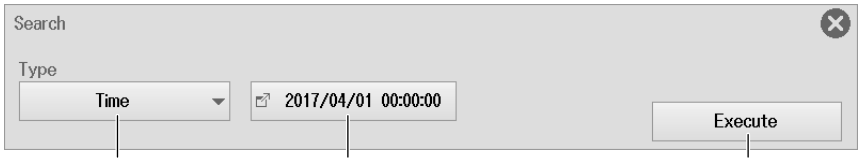
Items Common to Scope Mode and Recorder Mode

Search type, search target (date and time)

► Features Guide: “Time Search (Time)”

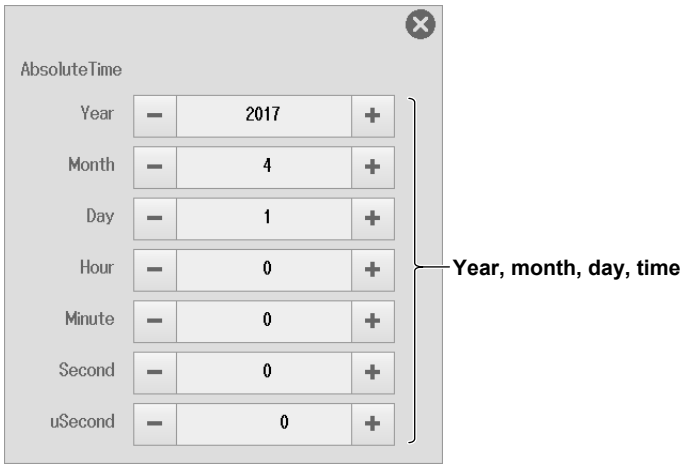
Search Time Menu

1. On the waveform screen, tap **MENU** > **Analysis** > **Search**. The Search menu appears.
2. Tap **Type** and select **Time**.
3. Tap each item to set options and execute commands.



Setting Search Conditions

4. Tap **yyyy/mm/dd hh:mm:ss**.* The Setup screen appears.
   * The set date and time appear.
5. Tap each item. Use the displayed input box to set the items.



Executing a Search (Execute)

6. Tap **Execute.** The waveform is displayed in the zoom window with the specified time at the center.

17.1 Displaying History Waveforms

This section explains the following settings for displaying history waveforms, which are waveforms that were previously saved to acquisition memory.

Applicable to Scope Mode

Display mode, highlight display (selected record number), display range (start and end numbers), displaying a list of timestamps, clearing all history waveforms

These settings are not available in recorder mode.

► Features Guide: “History Waveform Display (Scope mode only)”

History Menu

1. On the waveform screen, tap **MENU** > **Analysis** > **History**. The History menu appears.
2. Tap each item. Use the displayed list (options) or input box to set the items.

* This setting only appears when Display Mode is set to 1 Record or All Record.

Setting the Display Mode (Display Mode)

1 Record: Only the waveform corresponding to the selected record number is displayed.[1]

All Record: All selected waveforms are superimposed on each other.[2] All other waveforms[1] are displayed with an intermediate color.

Average Record: All selected waveforms[2] are linearly averaged and displayed.

1 Specify the highlighted waveform with Selected Record.

2 Specify with Start and End Record.

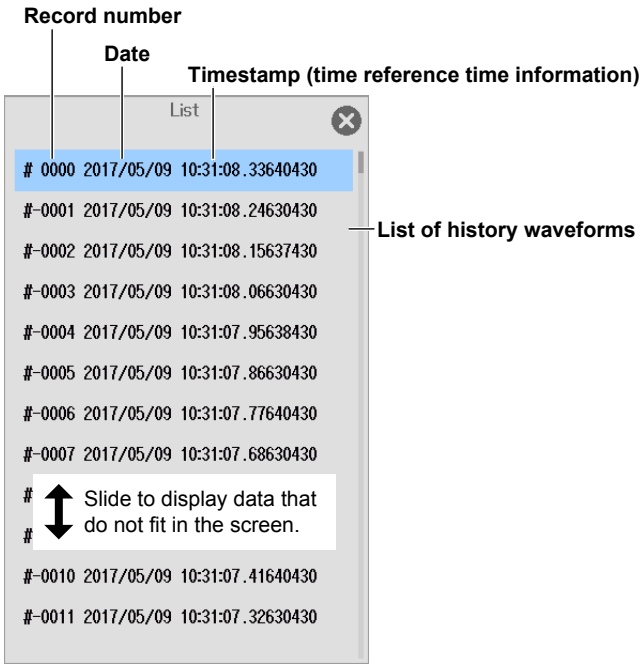
Note

The averaging feature requires a certain amount of acquisition memory. If this is not available, you will not be able to display the Average Record.

List of History Waveforms (List)

3. Tap **List**. The following screen appears.

Tapping the data selected from the list displays the corresponding waveform.



Note

Notes on Using the History Feature

- When the acquisition mode is set to Average, you cannot use the history feature.
- You cannot use the history feature when SD recording is being executed.
- If you stop waveform acquisition, even if one complete screen's worth of waveform data has not been acquired, the waveform at which the trigger occurred is displayed as a single history waveform.
- You can start waveform acquisition when the History menu is displayed. However, you cannot change the history feature settings while waveform acquisition is in progress.
- The settings are restricted so that the following relationship is retained: Last record (End Record) ≤ Selected Record ≤ first record (Start Record).
- When you load waveform data from the specified storage medium, history waveforms up to that point are cleared. The loaded waveform data is placed in record number zero. If you load a file containing multiple history waveforms, the latest waveform is placed in zero, and earlier waveforms are placed in order to record numbers –1, –2, and so on.
- Computation and automated measurement of waveform parameters are performed on the waveform of the record number specified by Selected Record. You can analyze old data as long as you do not overwrite the acquisition memory contents by restarting waveform acquisition. If Display Mode is set to Average Record, analysis is performed on the averaged waveform.
- History waveforms are cleared when you turn the power off.

18.1 Acquiring Position Information

This section explains the following settings for acquiring position information with the GPS (Global Positioning System).

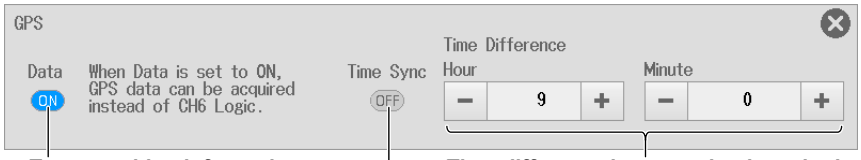
Items Common to Scope Mode and Recorder Mode

Position information acquisition on/off, time synchronization feature on/off, time difference between the time obtained from the GPS and the time of the region that this instrument is used in

► Features Guide: “Position Information (GPS)”

GPS Menu

1. On the waveform screen, tap **MENU** > **Analysis** > **GPS**. The GPS menu appears.
2. Tap each item to set options and execute commands.



Turns position information acquisition on and off

Time difference between the time obtained from the GPS and the time of the region that this instrument is used in (Tap + or – to adjust.)

Turns the time synchronization feature on and off

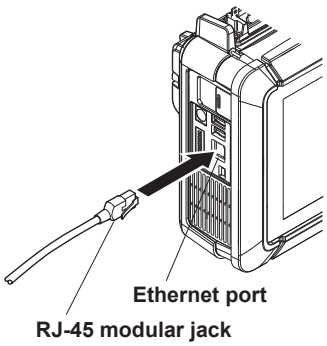
19.1 Connecting the Instrument to a Network

This section explains how to connect the instrument to a network.

Ethernet Interface Specifications

There is an Ethernet port located on the side panel of the instrument.

Item	Specifications
Ports	1
Electrical and mechanical	IEEE802.3 compliant
Transmission system	Ethernet(100BASE-TX/10BASE-T)
Communication protocol	TCP/IP
Supported services	Server: HTTP (Web) and VXI-11 Client: FTP (Net Drive), SMTP (mail), SNTP, DHCP, and DNS
Connector type	RJ-45 modular jack



Items Required to Connect the Instrument to a Network

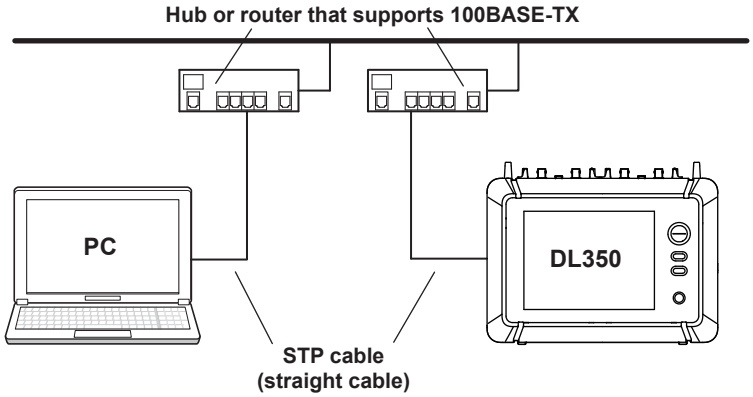
Cable

Use an STP (Shielded Twisted-Pair) cable that is compatible with your network environment (transmission speed).

Connection Method

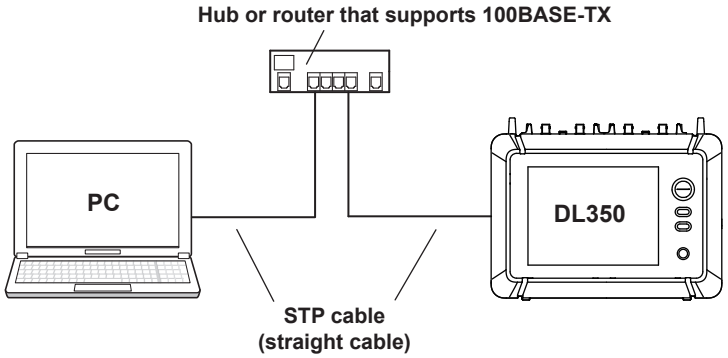
To Connect to a PC over a Network

1. Turn off the instrument.
2. Connect one end of an STP cable to the Ethernet port on the side panel.
3. Connect the other end of the STP cable to a hub or router.
4. Turn on the instrument.



To Connect to a PC through a Hub or Router

1. Turn off the instrument and the PC.
2. Connect one end of an STP cable to the port on the side panel.
3. Connect the other end of the STP cable to a hub or router.
4. Connect the PC to the hub or router in the same way.
5. Turn on the instrument.



Note

- Use a hub or router that conforms to the transfer speed of your network.
- When you connect a PC to the instrument through a hub or router, the PC must be equipped with an auto switching 100BASE-TX/10BASE-T network card.
- Do not connect the instrument to a PC directly. Direct communication without a hub or router is not guaranteed to work.
- If you specify a fixed IP address or network drive, be sure to use the instrument in an environment where it can be accessed. If it cannot be accessed, you may not be able to operate the instrument for the specified timeout period.

19.2 Configuring TCP/IP Settings

This section explains the following TCP/IP settings for connecting to a network.

Items Common to Scope Mode and Recorder Mode

- DHCP (IP address, subnet mask, and default gateway)
- DNS (domain name, DNS server IP address, and domain suffix)

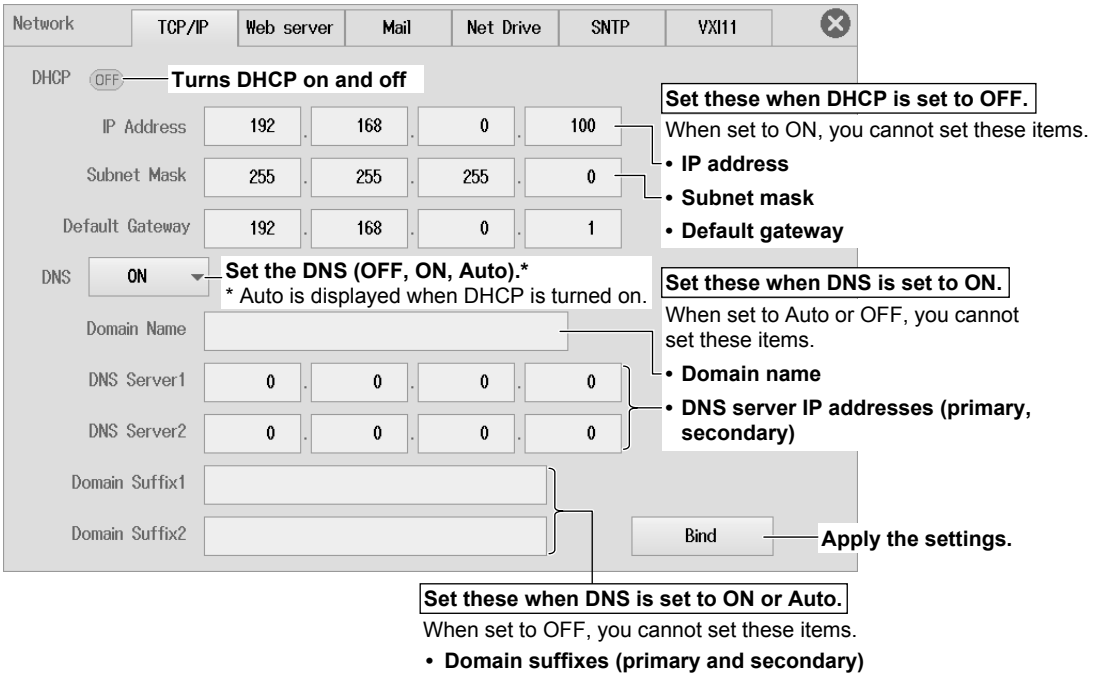
► Features Guide: “TCP/IP (TCP/IP)”

Utility Network Menu

1. On the waveform screen, tap **MENU** > **Utility** > **Network**. A network screen appears.

Configuring TCP/IP Settings (TCP/IP)

2. Tap the **TCP/IP** tab.
3. Tap each item. Use the displayed list (options) or input box to set the items.



DNS Settings (DNS)

OFF: DNS is disabled.

ON: DNS is enabled. Set the domain name, and the DNS server’s primary and secondary IP addresses and domain suffixes.

Auto: DNS is enabled. Set the domain suffix. The domain name and the DNS server IP addresses are set automatically. This option can only be selected when DHCP is on.

19.3 Monitoring the Instrument's Display from a PC (Web Server)

This section explains the following settings for connecting to the instrument from a PC over a network to show the instrument's display on the PC and to start and stop waveform acquisition from the PC:

Items Common to Scope Mode and Recorder Mode

User name, password, timeout period, connecting from a PC

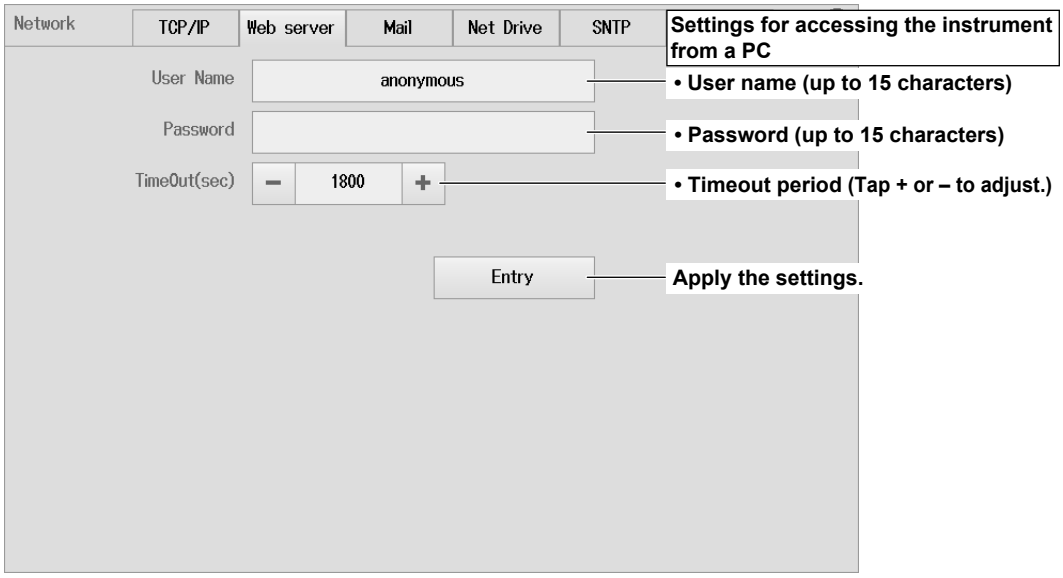
► Features Guide: "Web Server (Web Server)"

Utility Network Menu

1. On the waveform screen, tap **MENU** > **Utility** > **Network**. A network screen appears.

Configuring the Web Server (Web Server)

2. Tap the **Web Server** tab.
3. Tap each item. Use the input box to set the items.



19.4 Connecting to a Network Drive

This section explains the following settings for accessing a network drive through an Ethernet connection to load or save various instrument's data.

Items Common to Scope Mode and Recorder Mode

FTP server (file server), login name, password, FTP passive mode on/off, timeout period, connecting/disconnecting from the network drive

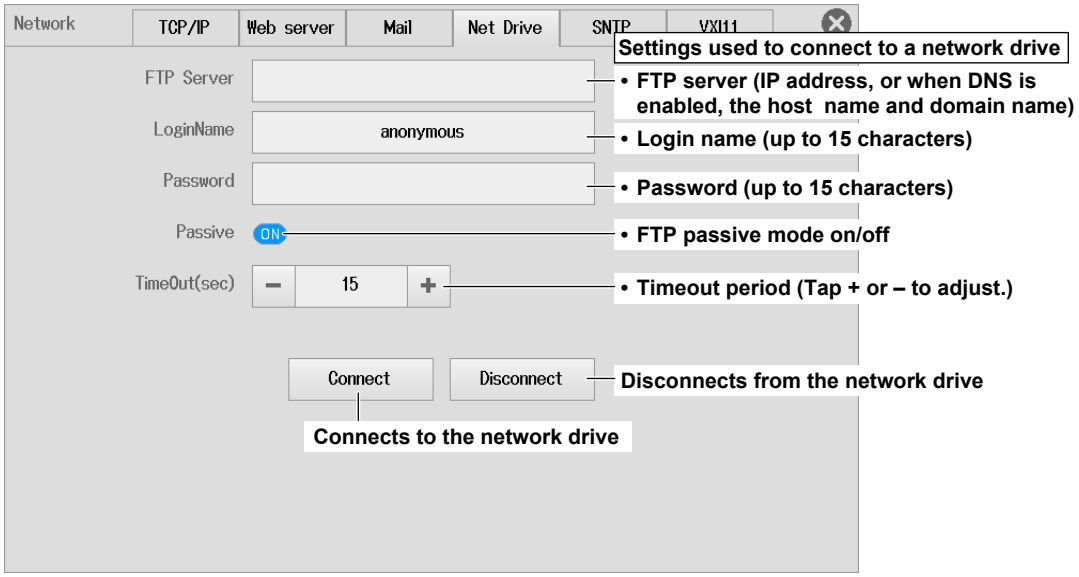
► Features Guide: "Network Drive (Net Drive)"

Utility Network Menu

1. On the waveform screen, tap **MENU** > **Utility** > **Network**. A network screen appears.

Configuring a Network Drive and Connecting to It (Net Drive)

2. Tap the **Net Drive** tab.
3. Tap each item. Use the displayed input box to set the items.



19.5 Configuring Mail Transmission (SMTP client)

This section explains the following settings for transmitting mail to a specified mail address on a network.

Items Common to Scope Mode and Recorder Mode

Mail server, mail transmission destination address, comment, image data attachment, timeout period, mail test transmission

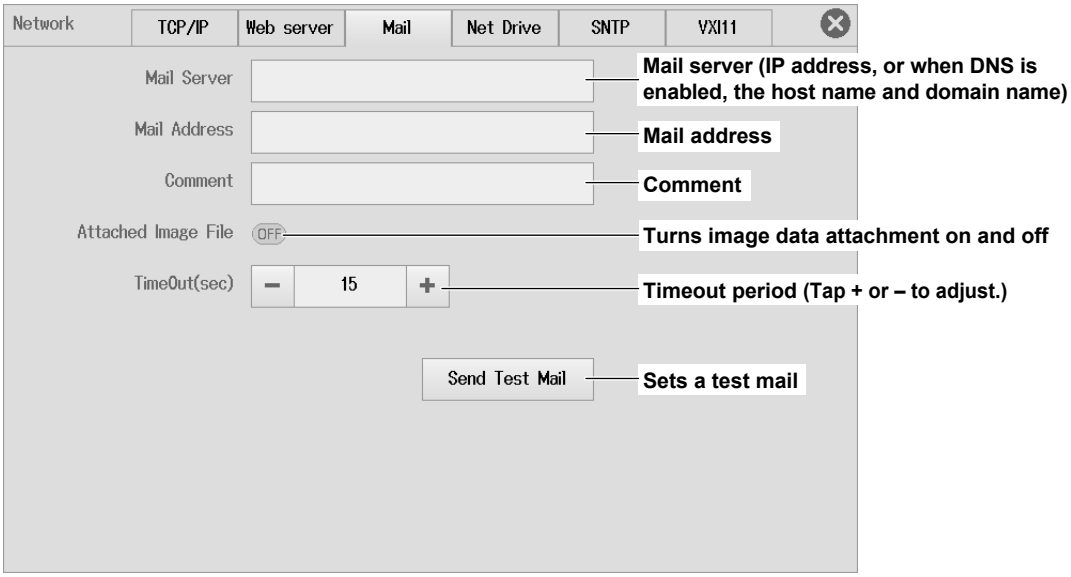
► Features Guide: “Mail (Mail)”

Utility Network Menu

1. On the waveform screen, tap **MENU** > **Utility** > **Network**. A network screen appears.

Configuring Mail (Mail)

2. Tap the **Mail** tab.
3. Tap each item. Use the displayed input box to set the items.



19.6 Using SNTP to Set the Date and Time

This section explains how to use SNTP to set the Instrument's date and time.

Items Common to Scope Mode and Recorder Mode

SNTP server, timeout period, auto adjustment on/off, time adjustment

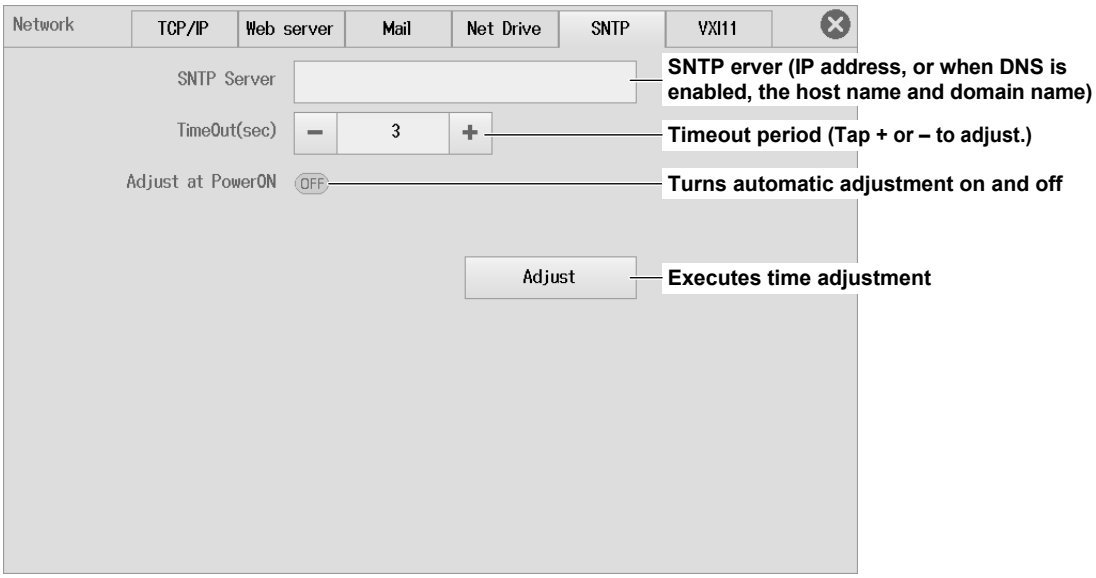
► Features Guide: "SNTP (SNTP)"

Utility Network Menu

1. On the waveform screen, tap **MENU** > **Utility** > **Network**. A network screen appears.

Configuring SNTP Settings (SNTP)

2. Tap the **SNTP** tab.
3. Tap each item. Use the displayed input box to set the items.



19.7 Configuring the VXI-11

This section explains how to set the timeout period for when there is no access to the instrument when the instrument is connected to the network using VXI-11.

Items Common to Scope Mode and Recorder Mode

Timeout period

► Features Guide “VXI11 (VXI11)”

Utility Network Menu

1. On the waveform screen, tap **MENU** > **Utility** > **Network**. A network screen appears.
2. Tap the **VXI11** tab.
3. Tap **Time Out**. Use the displayed input box to set the timeout period.

20.1 Setting the Date and Time

For details on setting the date and time, see the *Getting Started Guide*, IM DL350-03EN.

20.2 Configuring the LCD

This section explains the following settings for adjusting the LCD.

Items Common to Scope Mode and Recorder Mode

LCD off, LCD auto-off on/off, auto-off time, adjusting the brightness

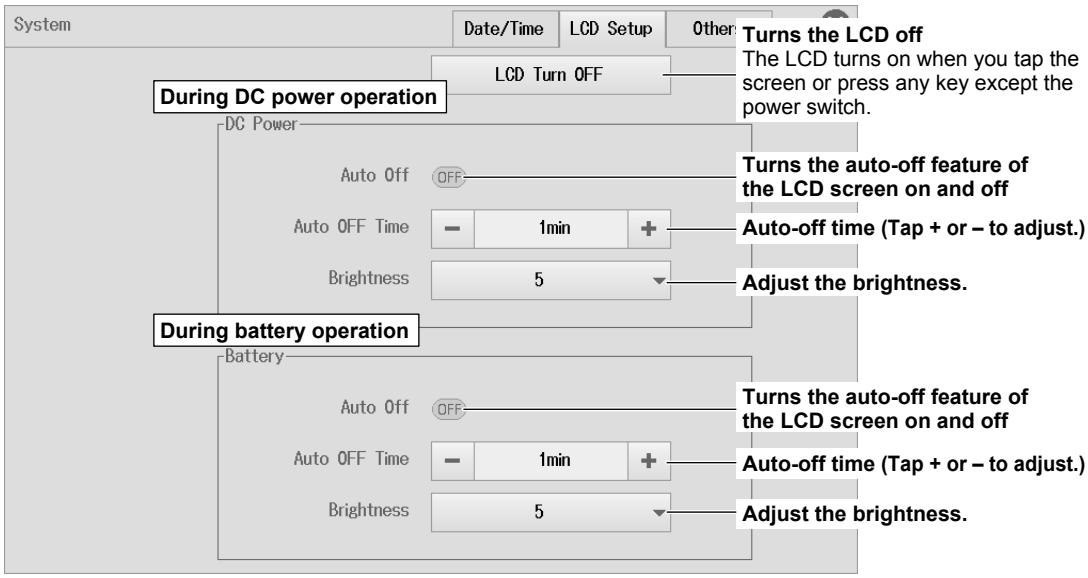
► Features Guide: “System Configuration (System Configuration)”

Utility System Menu

1. On the waveform screen, tap **MENU** > **Utility** > **System**. The System Setup screen appears.

Configuring the LCD (LCD Setup)

2. Tap the **LCD Setup** tab.
3. Tap each item. Use the displayed list (options) or input box to set the items.



20.3 Setting the Message Language, Menu Language, and USB

This section explains the following language and USB communication feature settings.

Items Common to Scope Mode and Recorder Mode

Message language, menu language, USB communication feature, USB keyboard language, USB keyboard input

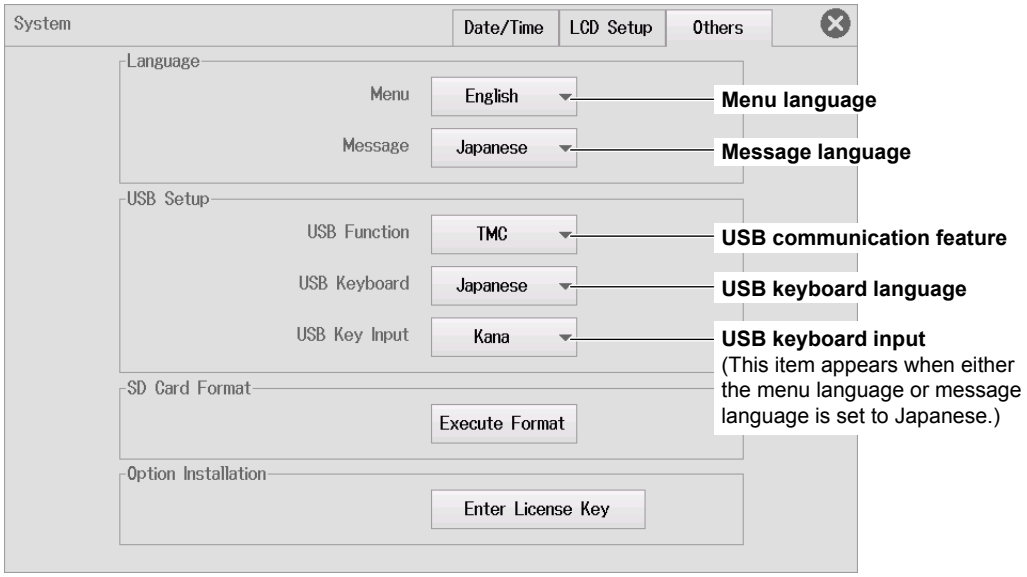
► Features Guide: “System Configuration (System Configuration)”

Utility System Menu

1. On the waveform screen, tap **MENU** > **Utility** > **System**. The System Setup screen appears.

Setting the Language, USB Communication Feature, USB Keyboard (Others)

2. Tap the **Others** tab.
3. Tap each item. Use the displayed list (options) to set the items.



20.4 Adding Options to the DL350

For details on how to add options, see the Getting Started Guide (IM DL350-03EN).

20.5 Setting Preferences

This section explains the following settings.

Items Common to Scope Mode and Recorder Mode

- Logic (logic channel display method, cursor reading order, bit data display order)
- Terminal (enabling or disabling the remote signal high edge (STOP), trigger output signal)
- Key, touch (start/stop key response time, touch lock)
- Menu (color theme, channel information, custom menu)
- Others (cursor read mode, data save destination upon action execution, backup at power-off on/off, beep on error on/off)

► Features Guide: “Environment Settings (Preference)”

Utility Preference Menu (Preference)

1. On the waveform screen, tap **MENU** > **Utility** > **Preference**. The Environmental setting window appears.

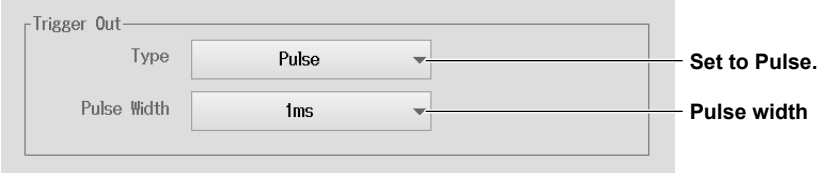
Configuring the Logic Settings (Logic Setup)

2. Tap the **Logic Setup** tab.
3. Tap each item. Use the displayed list (options) to set the items.

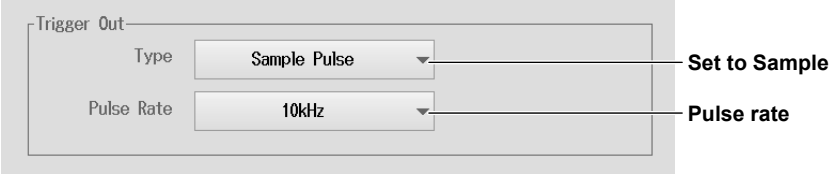
Configuring the External I/O Terminal Settings (Terminal Setup)

2. Tap the **Terminal Setup** tab.
3. Tap each item to set options and execute commands.

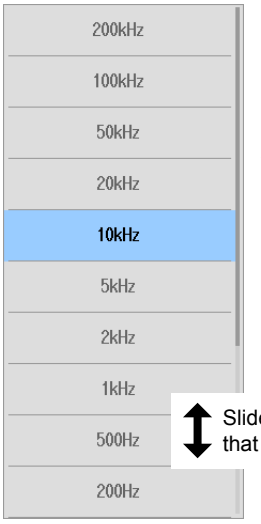
When the Terminal Output Signal Is Set to Pulse



When the Terminal Output Signal Is Set to Sample Pulse



List that appears when you tap Pulse Rate

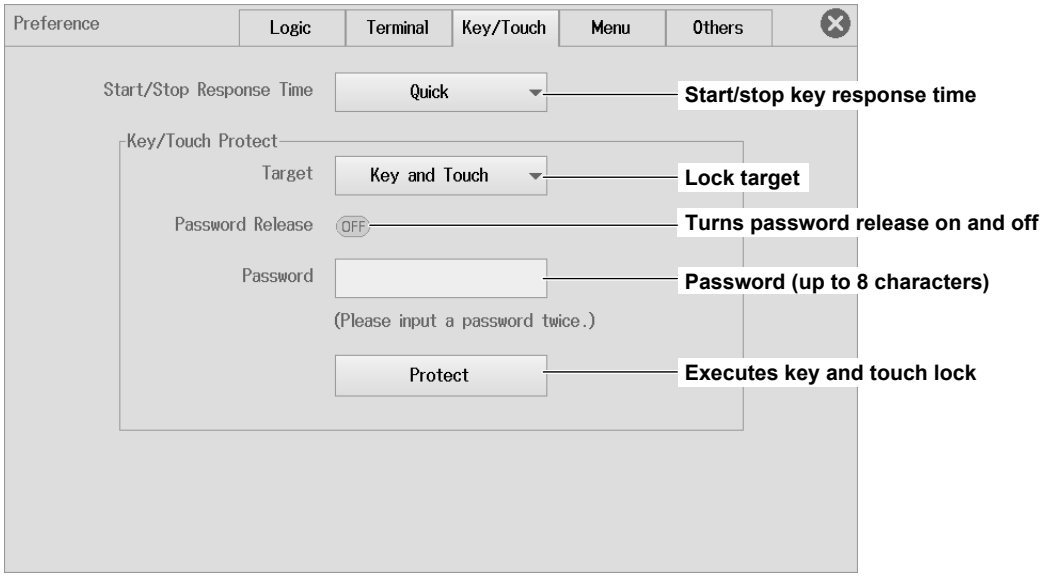


Slide to display pulse rates that do not fit in the screen.

* You cannot specify a frequency that is faster than the instrument's sample rate (main channel sample rate). The pulse rate must be set so that the instrument's sample rate is an integer multiple of the pulse rate. You may not be able to use the pulse rate that you select depending on the combination of the pulse rate and the instrument's sample rate.

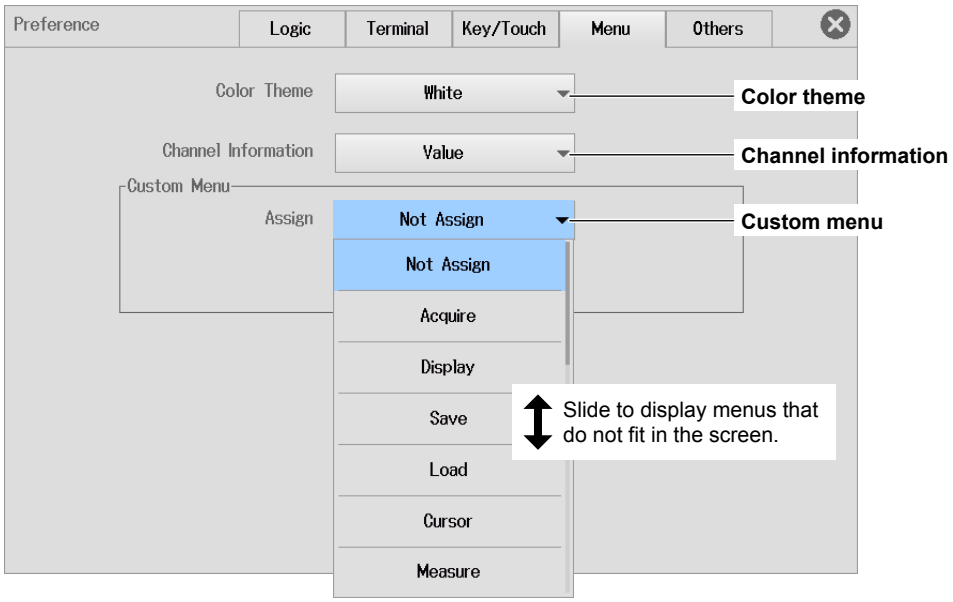
Setting the Start/Stop Key Response Time and Key/Touch Lock (Key/Touch)

2. Tap the **Key/Touch** tab.
3. Tap each item. Use the displayed list (options) or input box to set the items.



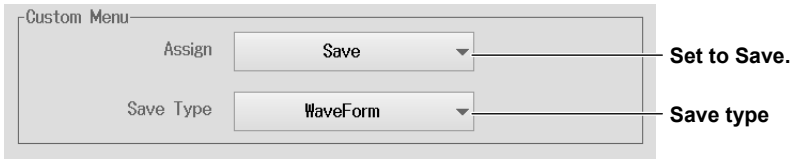
Setting the Color Theme, Channel Information, and Custom Menu

2. Tap the **Menu** tab.
3. Tap each item. Use the displayed list (options) to set the items.

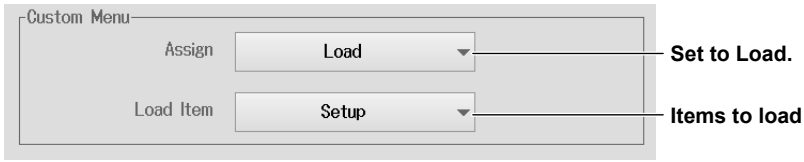


List that appears when you tap Custom Menu
The custom menu list varies depending on the operation mode (scope mode or recorder mode).

When Custom Menu Is Set to Save

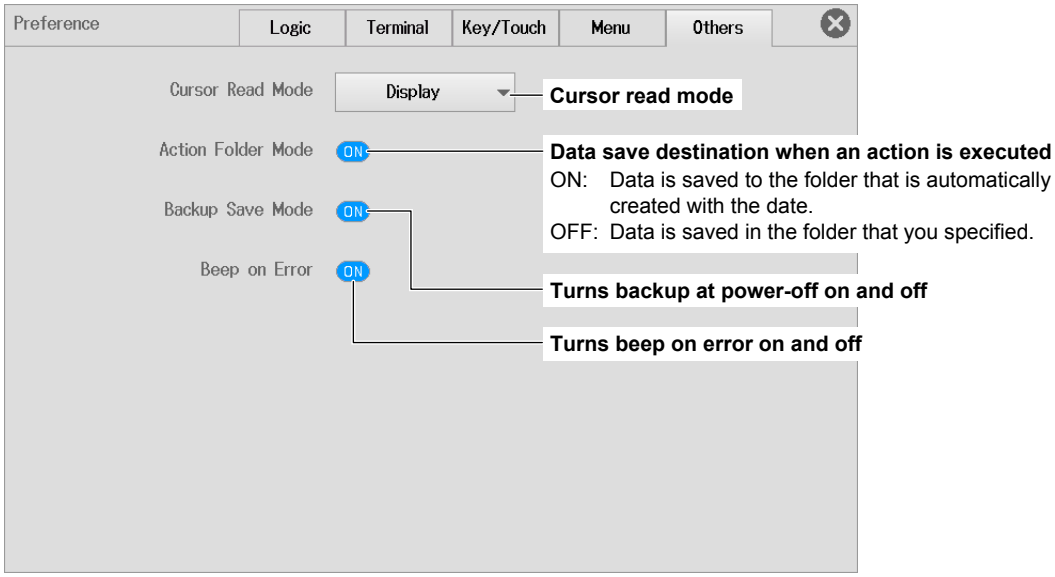


When Custom Menu Is Set to Load



Cursor Read Mode, Data Save Destination Upon Action Execution, Backup at Power-Off , Beep on Error (Others)

2. Tap the **Others** tab.
3. Tap each item to set options.



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