MR8847A

HIOKI

MR8847-51
MR8847-52
MR8847-53

Instruction Manual

MEMORY HiCORDER



Video
Scan this code to watch the instructional video(s).
Carrier charges may apply.

The latest edition of the instruction manual

Read carefully before use.
Keep for future reference.

Part Names and Functions ▶ p.18
Preparing for Measurement ▶ p.27
Maintenance and Service ▶ p.433
Error Messages ▶ p.439

EN

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Introduction

Thank you for purchasing the Hioki MR8847A Memory HiCorder (MR8847-51, MR8847-52, MR8847-53). To obtain maximum performance from the instrument, please read this manual first, and keep it handy for future reference.

Product registration
Register your product in order to receive important product information.

The optional clamps (p. Appx.15) collectively mean "clamp sensors."

The following instruction manuals are available for this instrument. Refer to the relevant manual as usage.

Type	Contents	Printed	CD-stored
Measurement Guide	**Read this booklet first.** Contains basic operating procedures for those who use this instrument for the first time.	✓	–
Instruction Manual (This document)	Contains details and specifications regarding the functions and operations of this instrument.	✓	–
Communication Command Instruction Manual	Contains a list of the communication commands and their explanations to control the instrument with a computer.	–	✓
U8793, MR8790, MR8791 Instruction Manual	Contains specifications and explanations of functions/operations of Models U8793 Arbitrary Waveform Generator Unit, MR8790 Waveform Generator Unit, MR8791 Pulse Generator Unit, and SF8000 Waveform Maker.	–	✓

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Verifying Package Contents

When you receive your instrument, inspect it carefully to ensure that no damage occurred during shipping. In particular, check the accessories, panel switches, and connectors. If damage is evident, or if it fails to operate according to the specifications, contact your authorized Hioki distributor or reseller.
Store the packaging in which the instrument was delivered, as you will need it when transporting the instrument.

Instrument and accessories

Confirm that you received the following items: (One each)

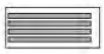


☐ MR8847A Memory HiCorder
(MR8847-51, MR8847-52, MR8847-53)

Accessories



☐ Measurement Guide
☐ Instruction Manual (this document)



☐ Input cable label



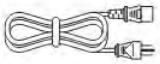
☐ Model 9231 Recording Paper



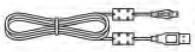
☐ Ferrite clamp-on choke[*1]
(for LAN/USB cable)



☐ Application disc[*2] (CD) (p. 360)
- Model SF8000 Waveform Maker
- Wave Viewer (WV)
- Communication Command Instruction Manual
- U8793, MR8790, MR8791 Instruction Manual



☐ Power cord



☐ USB cable



☐ Paper Roll Axle ×2

☐ Other options as specified in your order "Appx. 3.1 Options" (p. Appx.15)

*1: When one or more pieces of Model 8967 Temp Unit are installed in the instrument, two ferrite clamp-on chokes (small) are supplied per module.
*2: The latest version can be downloaded from our website.

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Safety Information

This instrument and modules are designed to conform to IEC 61010 Safety Standards, and has been thoroughly tested for safety prior to shipment. However, using the instrument in a way not described in this manual may negate the provided safety features.
Before using the instrument, be certain to carefully read the following safety notes:

⚠DANGER

Mishandling during use could result in injury or death, as well as damage to the instrument. Be certain that you understand the instructions and precautions in the manual before use.

⚠WARNING

With regard to the electricity supply, there are risks of electric shock, heat generation, fire, and arc discharge due to short circuits. Individuals using an electrical measuring instrument for the first time should be supervised by a technician who has experience in electrical measurement.

Protective Gear

⚠WARNING

This instrument measures live lines. To prevent electric shock, use appropriate protective insulation and adhere to applicable laws and regulations.

Notation

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

⚠DANGER	Indicates an imminently hazardous situation that will result in death or serious injury to the operator.
⚠WARNING	Indicates a potentially hazardous situation that may result in death or serious injury to the operator.
⚠CAUTION	Indicates a potentially hazardous situation that may result in minor or moderate injury to the operator or damage to the instrument or malfunction.
IMPORTANT	Indicates information related to the operation of the instrument or maintenance tasks with which the operators must be fully familiar.
	Indicates a high voltage hazard. If a particular safety check is not performed or the instrument is mishandled, this may give rise to a hazardous situation; the operator may receive an electric shock, may get burnt or may even be fatally injured.
	Indicates prohibited actions.
	Indicates the action which must be performed.
*	Additional information is presented below.

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Symbols Affixed to the Instrument

	Indicates cautions and hazards. When the symbol is printed on the instrument, refer to the corresponding topic in the Instruction Manual.
	Indicates the ON side of the power switch.
	Indicates the OFF side of the power switch.
	Indicates a fuse.
	Indicates a grounding terminal.
	Indicates DC (Direct Current).
	Indicates AC (Alternating Current).
	Indicates a burn hazard if touched directly.

Standards Symbols

	Indicates the Waste Electrical and Electronic Equipment Directive (WEEE Directive) in EU member states.
	Indicates that the product conforms to regulations set out by the EU Directive.

Other Symbols

This manual uses the following symbols to indicate specific information for operating the instrument.

(p.)	Indicates the location of reference information.
CURSOR (Bold-faced)	Names of settings, buttons, and other screen elements are written in bold blue text.
	Unless otherwise specified, "Windows" represents Windows 7, Windows 8, or Windows 10.
[ ]	Menus, commands, dialogs, buttons in a dialog, and other names on the screen and keys are indicated in brackets.
MEM	Indicates that the memory function supports the function.
REC	Indicates that the recorder function supports the function.
X-Y	Indicates that the X-Y recorder function supports the function.
FFT	Indicates that the FFT recorder function supports the function.
	Click: Press and quickly release the left button of the mouse. Right-click: Press and quickly release the right button of the mouse. Double-click: Quickly click the left button of the mouse twice.

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Accuracy

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

f.s. (maximum display value or scale length)	The maximum displayable value or scale length. For this instrument, the maximum displayable value equals the numerical number of a presently set range (unit: V/div) multiplied by the number of divisions (20) on the vertical axis. Example: When the range is set to 1 V/div, f.s. = 20 V
rdg. (reading or displayed value)	The value currently being measured and indicated on the measuring instrument.
Setting	Indicates the value set as the output voltage, current, or other quantity.

Measurement Categories

To ensure safe operation of measuring instruments, IEC 61010 establishes safety standards for various electrical environments, categorized as CAT II to CAT IV, and called measurement categories.

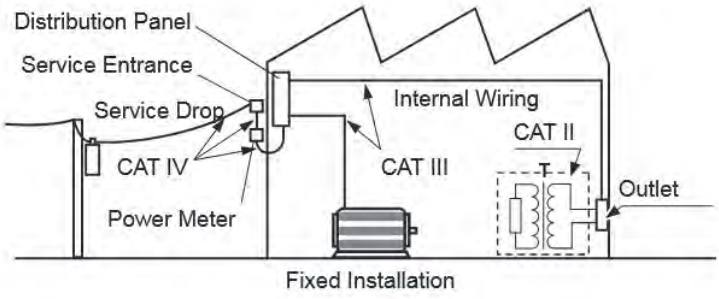
⚠DANGER

- **Using a measuring instrument in an environment designated with a higher-numbered category than that for which the instrument is rated could result in a severe accident, and must be carefully avoided.**
- **Never use a measuring instrument that lacks category labeling in a CAT II to CAT IV measurement environment. Doing so could result in a serious accident.**

CAT II: When directly measuring the electrical outlet receptacles of the primary electrical circuits in equipment connected to an AC electrical outlet with a power cord (portable tools, household appliances, etc.)

CAT III: When measuring the primary electrical circuits of heavy equipment (fixed installations) connected directly to the distribution panel, and feeders from the distribution panel to outlets

CAT IV: When measuring the circuit from the service drop to the service entrance, and to the power meter and primary overcurrent protection device (distribution panel)



The applicable measurement category is determined based on the module being used.
Refer to “18.6 Specifications of Modules” (p. 395).

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Operation Precautions

Before Use

Follow these precautions to ensure safe operation and to obtain the full benefits of the various functions.

⚠DANGER

If the connection cables or the instrument are damaged, there is a risk of an electric shock. Perform the following inspection before using the instrument:

- **Before using the instrument, check that the coatings of the connection cables are neither ripped nor torn and that no metal parts are exposed. Using the instrument under such conditions could result in an electric shock. Replace the connection cables with those specified by our company.**
- **Verify that it operates normally to ensure that no damage occurred during storage or shipping. If you find any damage, contact your authorized Hioki distributor or reseller.**

Installing the instrument and modules

⚠WARNING

Installing the instrument and modules in inappropriate locations may cause a malfunction of the instrument or may give rise to an accident. Avoid the following locations:

- **Exposed to direct sunlight or high temperatures**
- **Exposed to corrosive or combustible gases**
- **Exposed to a strong electromagnetic field or electrostatic charge**
- **Near induction heating systems (such as high-frequency induction heating systems and IH cooking equipment)**
- **Susceptible to vibration**
- **Exposed to water, oil, chemicals, or solvents**
- **Exposed to high humidity or condensation**
- **Exposed to high quantities of dust particles**

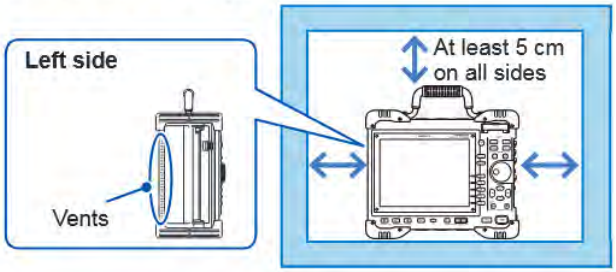
⚠CAUTION

Do not place the instrument on an unstable table or an inclined place. Dropping or knocking down the instrument can cause injury or damage to the instrument.

Installing the instrument

To prevent overheating, be sure to leave the specified clearances around the instrument.

- The instrument should be operated only with the bottom or rear side downwards.
- Vents must not be obstructed.
- Do not install the instrument at an angle.



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Handling the Instrument and Modules

⚠DANGER

- Do not use the modules or the cables with circuits that exceed those ratings or specifications.
  Doing so may damage the instrument or cause it to become hot, resulting in bodily injury.
  Even including any devices, such as an attenuator, in the input terminal will never increase the maximum rated voltage to earth. Take care of the connection not to allow any input voltage to exceed the maximum rated voltage to earth.
- To avoid an electric shock, do not remove the instrument's cover and the modules' cases.
  The internal components of the instrument carry high voltages and may become very hot during operation.

- It is recommended to measure the secondary side of a distribution panel with the U8974 High Voltage Unit. Do not connect the connection cords on the primary side of the distribution panel because an unrestricted current flow can damage the connection cords and facilities if a short-circuit occurs.

⚠WARNING

- Each channel of Model U8979 Charge Unit has the BNC terminal and miniature connector terminal with the common ground. Do not connect cords with each of the terminals simultaneously to avoid a short-circuit.

- To avoid an electric shock, before removing or replacing an input module, confirm that the instrument is turned off and that the connection cords are disconnected.
- To avoid the danger of an electric shock, never operate the instrument with an input module removed. To use the instrument with a module removed, install a blank panel over the opening of the removed module.
- To prevent the instrument damage or an electric shock, use only the screws that are originally installed for securing the module in place.
  If you have lost any screws or find that any screws are damaged, please contact your Hioki distributor for a replacement.
- Setting the measurement mode to [PreAmp] allows Model U8979 Charge Unit to constantly provide power (3.0 mA, 22 V) to sensors. Set any measurement mode other than [PreAmp] or tum off the instrument before connecting a sensor or probe with a BNC terminal to avoid an electric shock or damage to the measurement target.

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⚠CAUTION

- To avoid damaging modules, do not touch the connectors, installed in the instrument, to which the modules are connected.

- Model U8979 Charge Unit has miniature connectors with the maximum input charge of ±500 pC (for six higher-sensitivity range) or ±50,000 pC (for six lower-sensitivity range). Inputting a charge that exceeds these value causes damage to the instrument.
- Use an acceleration sensor with a built-in pre-amplifier that conforms to the specification of Model U8979 (3.0 mA, 22 V). Using a inapplicable sensor may cause damaging itself.
- To avoid damage to the instrument, protect it from physical shock when transporting and handling it. Be especially careful to avoid physical shock due to dropping it.
- The mounting screws must be firmly tightened or the module may not perform to specifications, or may even fail.

- Before carrying the instrument, disconnect all cables and remove the CF card, USB flash drive, and the recording paper.
- Displayed waveforms can frequently fluctuate due to induction potential even when no voltage is applied. This, however, is not a malfunction.
- This instrument may cause interference if used in residential areas. Such use must be avoided unless the user takes special measures to reduce electromagnetic emissions to prevent interference to the reception of radio and television broadcasts.

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Handling the printer and the recording paper

⚠WARNING

The print head and surrounding metal parts can become hot. Be careful to avoid touching these parts.

⚠CAUTION

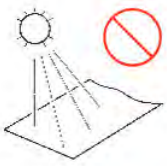
Be careful not to cut yourself with the paper cutter.

- Please use only the specified recording paper. Using non-specified paper may not only result in faulty printing, but printing may become impossible.
- If the recording paper is skewed on the roller, paper jams may result.
- Always use the paper cutter to cut the printed paper. Excessive paper dust can accumulate on the roller if the paper is cut with the print head, which may result in paper jams or white streaks in the printing.

Storing data recordings

The recording paper is thermally sensitive. Observe the following precautions to avoid paper discoloration and fading.

- To avoid paper discoloration, do not expose it to direct sunlight. Store the paper at no more than 40°C and 90% RH.
- Store the paper away from dew and damp places.
- Make photocopies of recording printouts that are to be handled or stored for legal purposes.
- If the thermal paper is exposed to an organic solvent such as alcohol or ketone, it may no longer develop properly, and recorded data may fade. Keep the printer papers away from flexible PVC films and pressure sensitive tapes including scotch tapes because they contain organic solvents.
- Also, the thermal recording paper is ruined by contact with wet diazo copy paper.



Avoid exposure to direct sunlight.



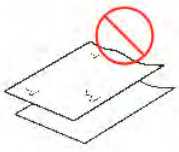
Avoid exposure to volatile organic solvents like alcohol, ethers, and ketones.



Do not store the paper at more than 40°C (104°F) and 90% RH.



Avoid contact with flexible PVC films or adhesive tapes such as scotch tapes.



Avoid stacking with wet Diazo copy paper.

Storing recording paper

- Store thermal paper where its temperature will not exceed 40°C.
- The paper will deteriorate if exposed to light for a long time; thus, do not remove the wrapping paper from the roll until it is ready to be used.

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Handling storage devices

⚠CAUTION

- Do not remove the storage device while it is being accessed by the instrument (while the **SAVE** key is lit in blue). Data saved on the device could be lost.
- Do not turn off the instrument while it is accessing the storage device (while the **SAVE** key is lit up in blue). Data saved on the device could be lost.
- Do not carry the instrument with a USB flash drive left connected. Damage could result.
- Exercise care when using such products because static electricity could damage the storage device or cause a malfunction of the instrument.
- Do not subject the SSD to extreme shock or vibration. Shock can cause it to be damaged.

IMPORTANT

- No compensation is available for loss of data stored on the built-in drive (SSD) or a removable storage device, regardless of the content or cause of damage or loss. Be sure to back up any important data saved on the built-in drive (SSD) or the removable storage device.
- Use only CF cards (no adapter is required to insert a CF card into the instrument.) or USB flash drive sold by Hioki.
- Compatibility and performance are not guaranteed for PC cards or USB flash drive made by other manufacturers. You may be unable to read from or save data to such cards.
  ■Hioki optional CF cards (with an adapter accompanying) and USB flash drive
  Model 9728 PC Card 512M, Model 9729 PC Card 1G, Model 9830 PC Card 2G
  Model Z4006 USB Drive
- With some external storage device, the instrument may not start up if it is turned on while the external storage device is inserted. In such a case, turn on the instrument first, and then insert the external media. Prior testing is recommended.
- The instrument does not support particular kind of USB flash drives, such as those that require fingerprint authentication or a password.
- When saving or loading data, insert the storage device before selecting data to be saved. When the storage device is not inserted, no devices are not displayed in the file list.
- All storage devices (built-in drive **[SSD]**, USB flash drive, and CF card) have a limited service life. After extensive use for a long period, saving and loading data may be disabled. In that case, replace the device with a new one.
- The built-in drive (SSD) is a consumable part. When the saved data reaches the capacity (about 60 TB), no further data can be recorded. In such a case, the SSD should be replaced with a new one.
- When the instrument is left powered off for a one year or more, the data saved on the built-in drive (SSD) may be lost. Be sure to back up the data if the instrument is left powered off for a long time.
- Devices the automatic data saving supports are the built-in drive (SSD), a USB flash drive, and a CF card.

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Before connecting cables

⚠DANGER



When measuring power line voltage

- **Connect the connecting cables to only the secondary side of a breaker. Even if a short-circuit occurs on the secondary side of the breaker, the breaker will interrupt a short-circuit current. Do not connect them to the primary side of the breaker because an unrestricted current flow could damage the instrument and facilities if a short circuit occurs.**
- **To prevent an electrical shock and a bodily injury, do not touch any input terminals on the VT (PT), CT or the instrument when they are in operation.**
- **Do not leave the measurement cables connected to the instrument in an environment where voltage surges exceeding the maximum input voltage may occur. Subjecting the instrument to such a voltage may result in damage to the instrument or a serious accident.**



- **Do not short-circuit two wires to be measured by bringing the connection cables into contact with them. Arcs or such grave accidents are likely to occur.**
- **To avoid a short-circuit or an electric shock, do not touch the metal parts of the connecting cable clips.**
- **To avoid electrical shock, be careful to avoid shorting live lines with the connection cable chips.**

⚠WARNING



To avoid an electric shock and a short-circuit accident, use only the specified test leads to connect the instrument input terminals to the circuit to be tested.

- **To avoid an electric shock, do not exceed the lower of the ratings shown on the instrument and connection cords.**



To prevent an electric shock, confirm that the white or red portion (insulation layer) inside the cable is not exposed. If a color inside the cable is exposed, do not use the cable.

⚠CAUTION



- The cable is hardened in the freezing temperatures. Do not bend or pull it to avoid tearing its shield or cutting cable.
- Connecting cables to the BNC jacks on modules
- Do not use any cable terminated with a metal BNC connector. If you connect a metal BNC cable to an insulated BNC connector, the insulated BNC connector and the instrument may be damaged.



To prevent cable damage, do not step on cables or pinch them between other objects. Do not bend or pull on cables at their base.

IMPORTANT

- Use only the specified connection cables. Use of any cable not specified by our company does not allow safe measurements due to poor connection or other reasons.
- For detailed precautions and instructions regarding connections, refer to the instruction manuals for your modules, connection cables, etc.

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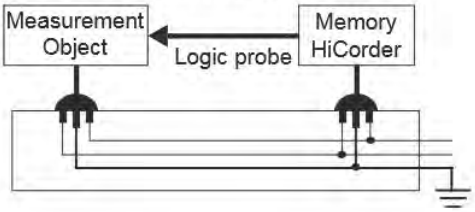
Before connecting a logic probe to the measurement object

⚠DANGER

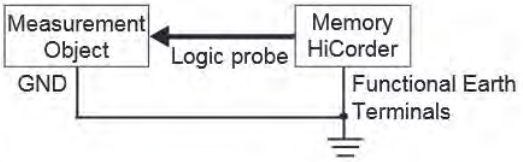
To avoid an electric shock, a short-circuit, and damage to the instrument, observe the following precautions:

- **The ground pin in the logic connector (plug) of Model 9320-01 Logic Probe and Model 9327 Logic Probe are not isolated from the instrument's ground (common ground).**
  Supply power to the instrument with the provided power cord and measurement objects from a single mains circuit.
  Connecting the instrument and a measurement object to different mains circuits from one another or using a non-grounding power cord may cause damage to the measurement object or the instrument because of current flowing through the logic probes resulting from the potential difference between the grounds of the different wiring systems.
  To avoid that, we recommend the following connection procedure:

Connect the provided power cord to the instrument and supply power from the same outlet as the measurement object.



Connect the measurement object's ground to the GND terminal (functional earth terminal) of the instrument.
(Always supply power from the single mains circuit.)
Refer to "2.5.2 Connecting an Earthing Wire to the GND Terminal (Functional Earth Terminal)" (p. 52).



Before turning on the instrument

⚠WARNING

- **To avoid electrical accidents and to maintain the safety specifications of this instrument, connect the power cord provided only to an outlet.**
- **Before turning the instrument on, make sure the supply voltage matches that indicated on its power connector. Connection to an improper supply voltage may damage the instrument and present an electrical hazard.**

⚠CAUTION

Avoid using an uninterruptible power supply (UPS), DC/AC inverter with rectangular-wave or pseudo-sine-wave output to power the instrument. Doing so may damage the instrument.

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Before connecting the instrument to an external device

⚠DANGER

To avoid electrical hazards and damage to the instrument, do not apply voltage exceeding the rated maximum to the external control terminals.

	I/O terminals	Maximum input voltage
Instrument	START/EXT.IN1	−0.5 V to 7 V DC
	STOP/EXT.IN2	−0.5 V to 7 V DC
	PRINT/EXT.IN3	−0.5 V to 7 V DC
	GO/EXT.OUT1	50 V DC, 50 mA DC, 200 mW
	NG/EXT.OUT2	50 V DC, 50 mA DC, 200 mW
	EXT.SMPL	−0.5 V to 7 V DC
	TRIG OUT	50 V DC, 50 mA DC, 200 mW
	EXT.TRIG	−0.5 V to 7 V DC
U8793 Arbitrary Waveform Generator Unit	IN	−0.5 V to 7 V DC
	OUT	30 V DC, 50 mA DC

⚠WARNING

To avoid an electric shock or damage to the equipment, always observe the following precautions when connecting the cables to external control terminals.

- **Always turn off the instrument and any devices to be connected before making connections.**
- **Be careful to avoid exceeding the ratings of the external control terminals and the external connectors.**
- **The external control terminals use the same GND as the instrument. Ensure that devices and systems to be connected to the external control terminals are isolated from one another as required.**

⚠CAUTION

To avoid equipment failure, do not disconnect the USB cable while communications are in progress.

- Use a common ground for both the instrument and the connection equipment. Using different ground circuits will result in a potential difference between the instrument's ground and the connected equipment's ground. If the cable is connected while such a potential difference exists, it may result in equipment malfunction or failure.
- Before connecting or disconnecting any cable, always turn off the instrument and the device to be connected. Failure to do so may result in equipment malfunction or damage.
- After connecting the communications cable, tighten the screws on the connector securely. Failure to secure the connector could result in equipment malfunction or damage.

Disc precautions

- Exercise care to keep the recorded side of discs free of dirt and scratches. When writing text on a disc's label, use a pen or marker with a soft tip.
- Keep discs inside a protective case and do not expose to direct sunlight, high temperatures, or high humidity.

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- Hioki is not liable for any issues your computer system experiences in the course of using this disc.

When the instrument is not used for a long period

- To avoid straining some parts of the printer, and to prevent dirt adhering to the print head, close the printer cover.
- Perform test prints (printer check) three or four times before using the printer that has been in storage and has left unused for a long period.

Precautions during shipment

Store the packaging in which the instrument was delivered, as you will need it when transporting the instrument.

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1 Overview

1.1 Product Overview

This instrument enables you to measure and analyze various waveforms with simple methods.
You can use this instrument mainly for facility diagnosis, preventive maintenance, and troubleshooting.



Sturdy body with easy-to-grasp handle installed

You can install this portable instrument anywhere.

Logic modules can measure signals input on 64 channels

You can take multiple measurements simultaneously.

Easy loading of recording paper High-speed printing

You can load the recording paper through one-touch operation.

High-speed sampling at 20 MS/s

You can conduct reliable response evaluation.

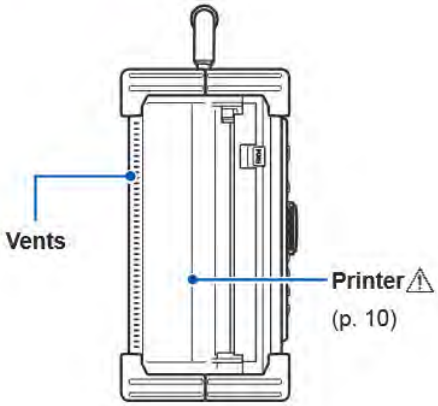
Arbitrary Waveform Generator Unit can output waveforms simulating measured signals

You can have the instrument output realistically simulated waveforms.

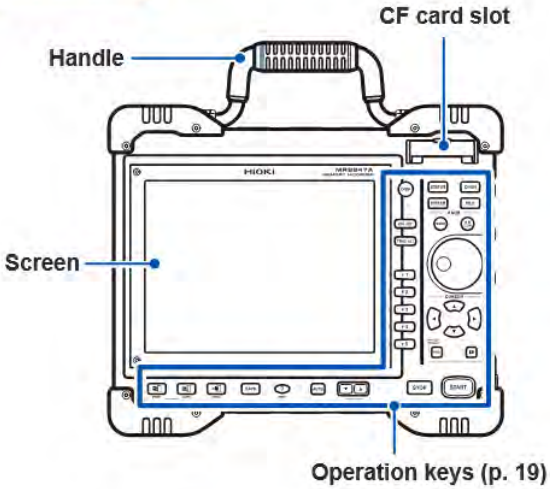
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1.2 Part Names and Functions

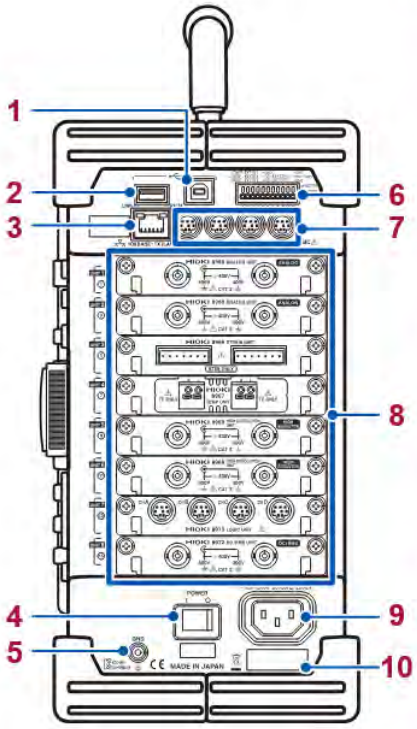
Left side



Front side



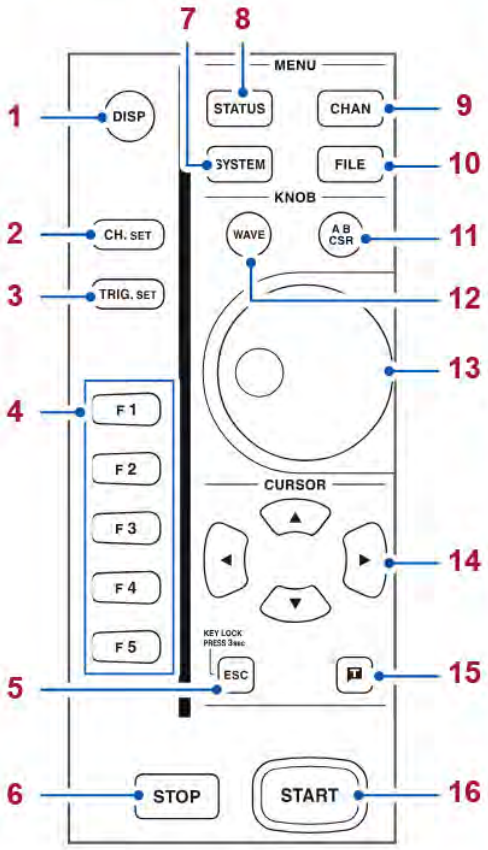
Right side



1	**USB connector (Type B)** Connect the USB cable to operate the instrument with a computer. (p. 361)	6	**External control terminals** Input an external sampling signal. (p. 369) Connect signal cables to operate the instrument externally.
2	**USB connector (Type A)** Connect a USB flash drive or a mouse. (p. 48)	7	**Standard LOGIC terminals⚠** Connect optional Hioki logic probes. (p. 30)
3	**100BASE-TX connector** Connect a LAN cable. (p. 341)	8	**Various modules⚠** **(p. 28), (p. 30)** For details, refer to “8.10 Setting Details of Modules” (p. 184) or “18.6 Specifications of Modules” (p. 395).
4	**Power switch (p. 53)** Flip the switch to turn on and off the instrument. | : Power-on ○ : Power-off	9	**Power inlet⚠** Connect the provided power cord. (p. 52)
5	**GND terminal (Functional earth terminal)** Connect a grounded conductor. (p. 52)	10	**Serial number** The serial number consists of 9 digits. The first two (from the left) indicate the year of manufacture, and the next two indicate the month of manufacture. Required for production control. Do not peel off the label.

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Operation keys



1 DISP key
Displays the waveform screen.

2 CH.SET key
Displays the channel settings window on the waveform screen (p. 70).

3 TRIG.SET key
Displays the trigger settings window on the waveform screen (p. 211).

4 F key
Selects setting items.

5 ESC key
Cancels the last action. Closes the displayed dialog and window.
KEY LOCK:
Press and hold the **ESC** key for 3 seconds to engage the key lock function, which prevents accidental operation. Press and hold this key for 3 seconds to disengage the key lock function.

6 STOP key
Stops the measurement in progress.
Press the key once: Stops the measurement in progress after the instrument records the specified recording length of waveforms.
Press the key twice: Immediately stops the measurement in progress. (p. 338)

7 SYSTEM key
Displays the system screen. (p. 335)

8 STATUS key
Displays the status screen.

9 CHAN key
Displays the channel screen.

10 FILE key
Displays the File screen. (p. 114)

11 AB CSR key
(Lights up in red when selected.)
Sets Cursors A and B. (p. 140)

12 WAVE key
(Lights up in red when selected.)
Assigns waveform scrolling to the jog dial and shuttle ring. (p. 146)

13 Inner: Jog dial
Outer: Shuttle ring
Scrolls waveforms display. (p. 146)
Increases and decreases a setting value. (p. 23)

14 CURSOR key
Moves the cursor up, down, left, and right on the screen.

15 Manual trigger key
Manually trigger the instrument. (p. 226)

16 START key
Starts measurement. (Lights up in green during measurement.) (p. 338)

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17 **PRINT key**
Prints waveforms and lists. (p. 125)

18 **COPY key**
Prints a screenshot. (p. 136)

19 **FEED key**
Feeds paper.

20 **SAVE key (Lights up in blue while the instrument is accessing a storage device.)**
Saves data to a storage device. (p. 91)
The dialog box can be switched between visible and invisible during auto-saving.

21 **HELP key**
Displays help information. (p. 24)

22 **AUTO key**
Starts measurement in the auto-range setting. (p. 82)

23 **TIME/DIV key**
Sets the timebase.

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1.3 Screens Configuration

The screens are configured as listed below. Pressing each of the keys listed below displays a corresponding screen or window.
The waveform screen can display the trigger settings window, and the channel settings window.

Waveform screen

DISP — The display used to observe waveforms.
Configure measurement conditions using the settings window on the right.

Trigger settings window, channel settings window

TRIG. SET — The display used to configure the trigger settings

CH. SET — The display used to configure the settings of analog channels and logic channels

Status screen

STATUS — The window used to configure the measurement methods and numerical calculation settings.
Pressing the **STATUS** key switches the sheets to be displayed in the following order: **[Status]** sheet, **[Num Calc]** sheet, **[Memory Div]** sheet, and **[Wave Calc]** sheet.

Channel screen

CHAN — The screen used to configure the channel, the scaling, and the comment settings
Pressing the **CHAN** key switches the sheets to be displayed in the following order: **[Unit List]** sheet, **[Each Ch]** sheet, **[Scaling]** sheet, and **[Comment]** sheet.

System screen

SYSTEM — The screen used to configure the environment, the file saving, the file printing, and the interface settings, and to initialize data.
Pressing the **SYSTEM** key switches sheets to be displayed in the following order: **[Environment]** sheet, **[File Save]** sheet, **[Printer]** sheet, **[Interface]** sheet, and **[Init]** sheet.

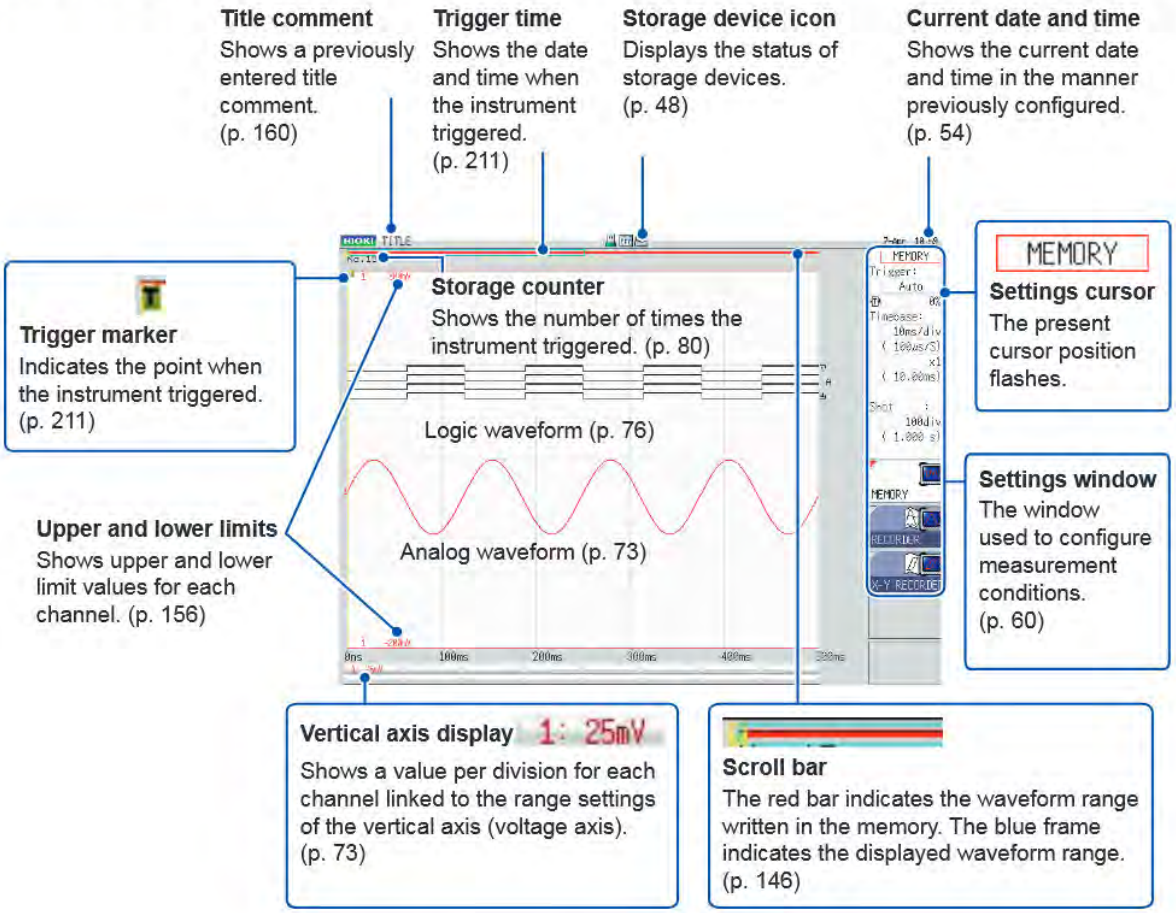
File screen

FILE — The screen used to view saved data files in storage devices (a CompactFlash card, the built-in drive, a USB flash drive, the internal memory).

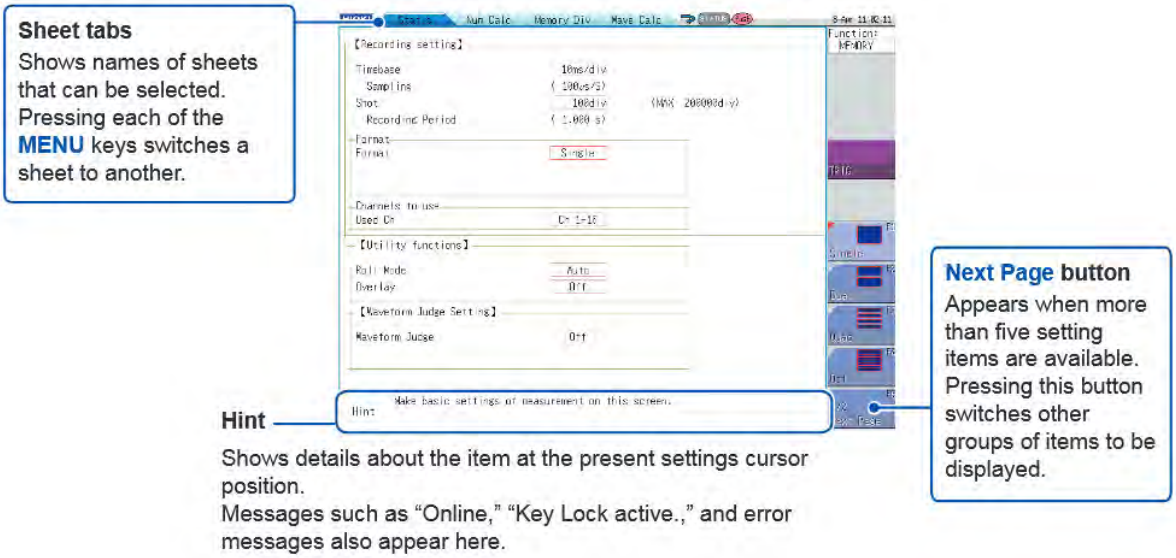
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Explanation of screen contents

Waveform screen



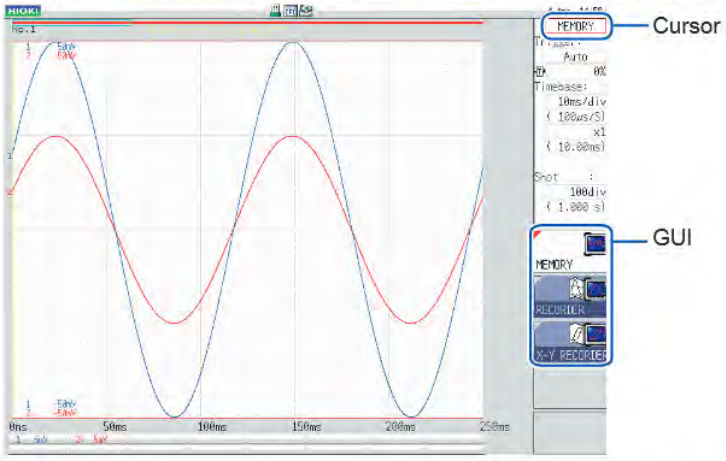
Items common to the Status, Channel, System, and File screens



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1.4 Basic Key Operation

1 **Press the CURSOR key and move the cursor to an item to be changed.**



2 **Check the illustrations on the GUI and press the function key (F key) to change the settings.**
The function assigned to the F key varies depending on the setting items.

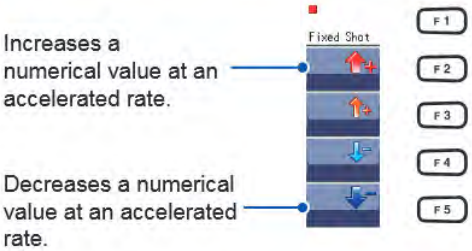
To select an item to be set



Press the F key to change settings.

When there are more than six setting items, press the **F5 [Next Page]** key to switch to the next page.

To increase and decrease a setting value



Press the F key to change the setting value. (Turning the jog dial or shuttle ring enables you to change values.)

3 **For some settings, press the CH.SET key to select [Exec], and press the TRIG.SET key to select [Cancel].**

To enter characters and numbers

See “8.1.3 Entering Alphanumeric Characters” (p. 163).

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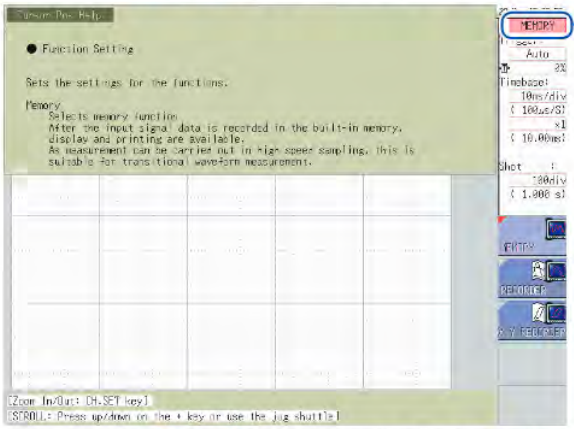
1.4.1 Using the HELP Key

Pressing the **HELP** key displays a simple explanation of the item at the cursor position. You can also search the help messages for the information for which you are looking.

Cursor position help

1 **Move the cursor to the item for which you want to display a help message.**

2 **Press the HELP key. The [Cursor Pos Help] sheet that contains the help message of the cursor position appears.**
Pressing the **CURSOR** up and down keys or turning the **Jog** dial scrolls the information.



- Pressing the **CH.SET** key switches the display mode of the **[Cursor Pos Help]** sheet between the following modes: The full-screen display, the upper-half display, and the lower-half display. The figure above illustrates the upper-half display mode.
- Pressing the HELP key closes the **[Cursor Pos Help]** sheet.

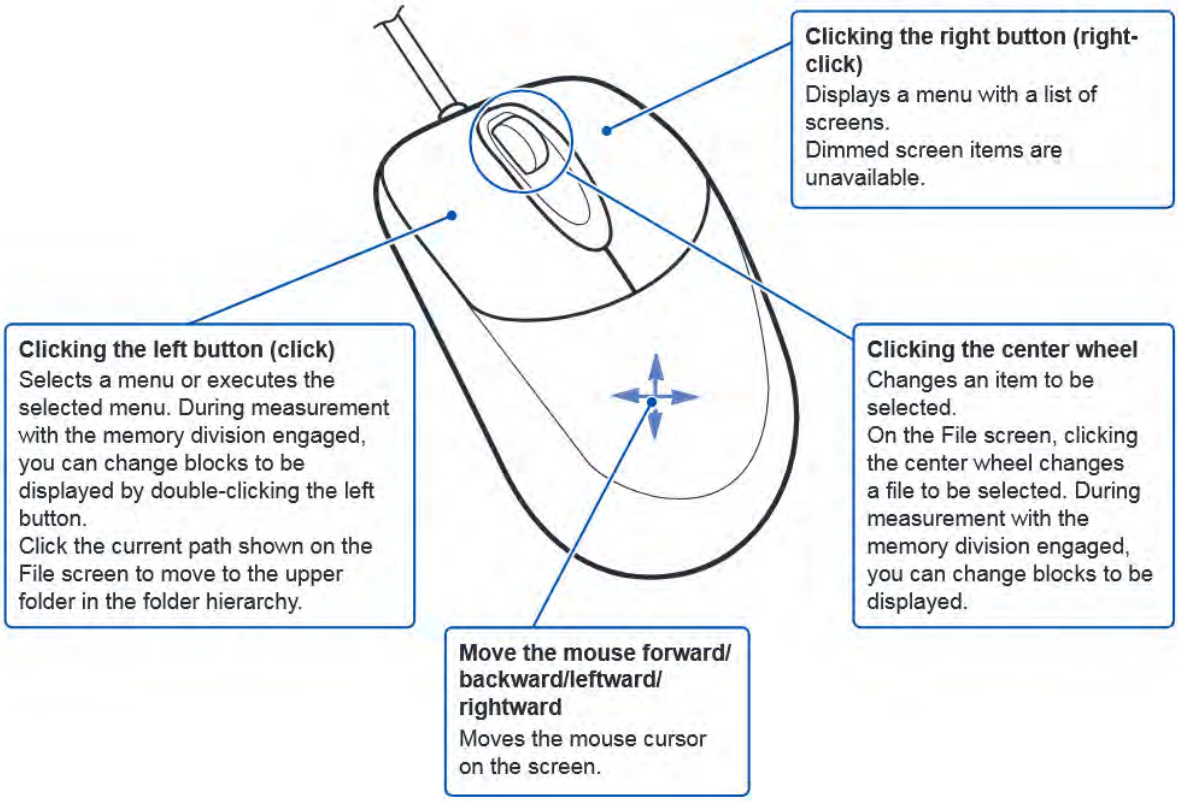
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1.4.2 Using Mouse to Enable Key Operation

Using a commercially available USB mouse enables you to operate the instrument in the manner similar to that with the keys on the instrument.

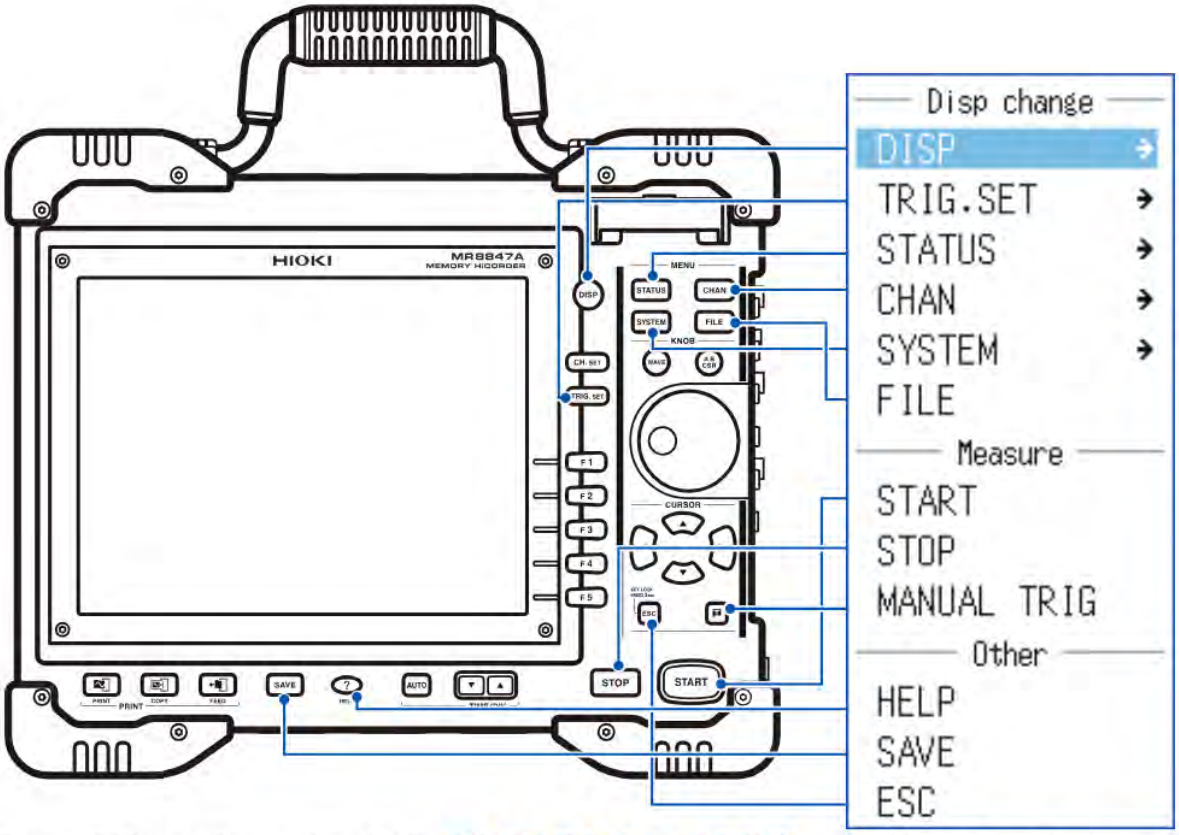
- The instrument may not support some types of mouses.
- Do not connect any type of device other than a mouse or a USB flash drive to the USB connector of the instrument.
- Operating the instrument with a mouse may cause temporary operating delay or abnormal screen display.
- While operating the instrument with a mouse, do not change the interface on the system screen to anything other than "LAN." Operating the instrument with a mouse is disabled while USB communications are in progress.
- External noise may cause the instrument to malfunction while it is operated with a mouse. Keep the mouse and mouse cable as far away as possible from sources of noise.

The figure below illustrates the basic operation of the instrument with a mouse.



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The operation keys of the instrument and the shortcut menu relate to each other as follows.



To operate the functions assigned to the **CH.SET**, **WAVE**, and **AB CSR** keys and to configure those settings, click the icons displayed while a mouse is connected to the instrument.

Icon	Operation key
CH SET	**CH.SET** key
WAVE	**WAVE** key
AB CSR	**WAVE** key

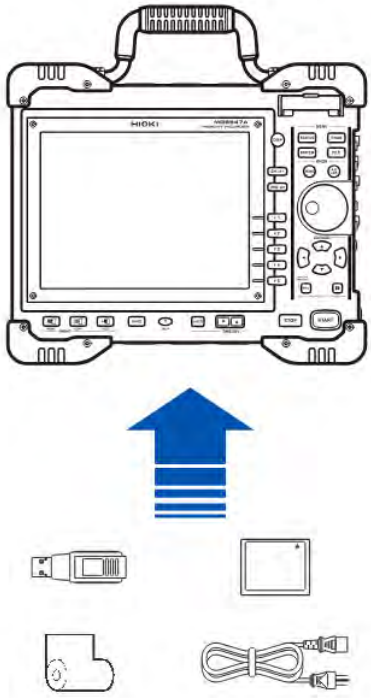
Useful functionality
Dragging the right button of the mouse (hold down the button, moving the mouse rightward, leftward, or forward, and then release the button) performs the same function as when pressing the following keys:
Rightward: START
Leftward: STOP
Upward: ESC

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2 Preparing for Measurement

Procedure

1. **Install the instrument.** (p. 7)
2. **Install or remove modules.** (p. 28)
   (When adding or replacing modules)
3. **Connect logic probes to the LOGIC terminals.** (p. 43)
   (When measuring logic signals)
4. **Connect connection cables to the modules.** (p. 30)
   (When measuring analog signals)
   Probes and cables differ depending on the type of measurement to be performed.
5. **Insert a storage device (CF card, USB flash drive).** (p. 48)
6. **Load a roll of recording paper.** (p. 50)
7. **Connect the power cord.** (p. 52)
8. **Connect an earthing wire to the GND terminal (functional earth terminal).** (p. 52)
   (When performing measurement in noisy environments)
9. **Turn on the instrument.** (p. 53)
10. **Set the clock** (p. 54)
11. **Perform zero-adjustment** (p. 55)
    Perform calibration (p. 56)
    (For the instrument with Model MR8990 installed)



After preparation terminates, start measurement. (p. 57)

To operate the instrument with a computer

Refer to "16 Connecting the Instrument to a Computer" (p. 341).

To control the instrument externally

Refer to "17 Controlling the Instrument Externally" (p. 369).

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2.1 Installing and Removing Modules

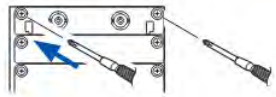
Read “Handling the Instrument and Modules” (p. 8) carefully.

Modules ordered with the instrument has already been installed in the instrument. Follow the procedures below to add, replace, or remove modules from the instrument.

- Up to three logic units can be installed. The instrument ignores the fourth logic module and later modules that are installed in the instrument.
- For information on the analog channel resolution when logic channels are used, refer to “8.10 Setting Details of Modules” (p. 184).

Installing a module

Right side

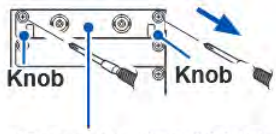


Required items: Phillips-head screwdriver (No. 2)

1. **Turn off the instrument.**
2. **Orient the module and insert it all the way into the instrument.**
   Make certain that the module is installed in such a way that the characters printed on the module’s panel are right side up about those printed on the instrument.
3. **Tighten the two module mounting screws with a Phillips screwdriver.**

Removing a module

Right side



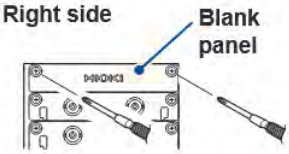
(Example: Model 8966)

Required items: Phillips-head screwdriver (No. 2)

1. **Turn off the instrument.**
2. **Remove all connection cables and thermocouples connected to the module.**
3. **Remove the power cord.**
4. **Loosen the two module mounting screws with a Phillips screwdriver.**
5. **Pull the knobs and pull out the module.**

When not installing another module after removal

Right side



1. **Place a blank panel.**
2. **Tighten two screws with a Phillips screwdriver.**

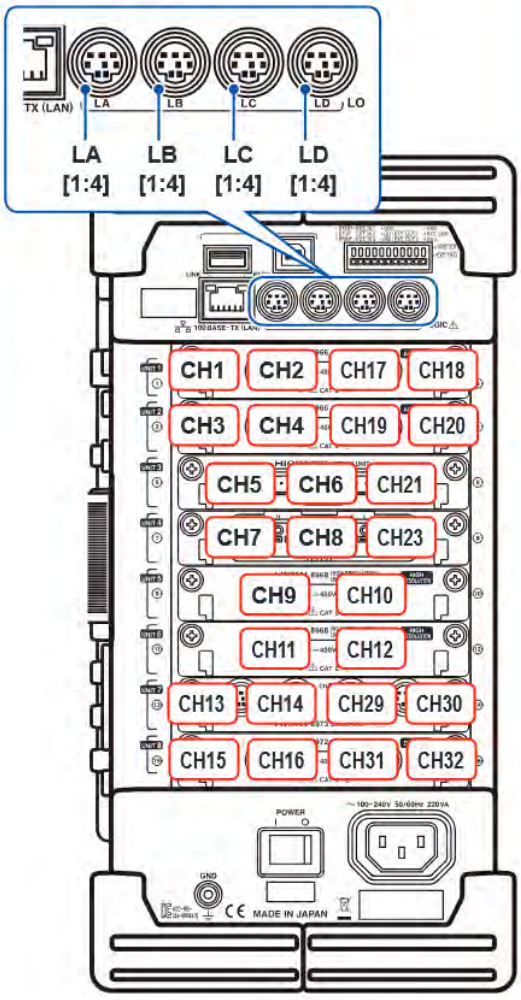
If measurement is performed with the instrument without a blank panel installed, the instrument may fail to meet specifications because of temperature instability within modules.

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Channel configuration

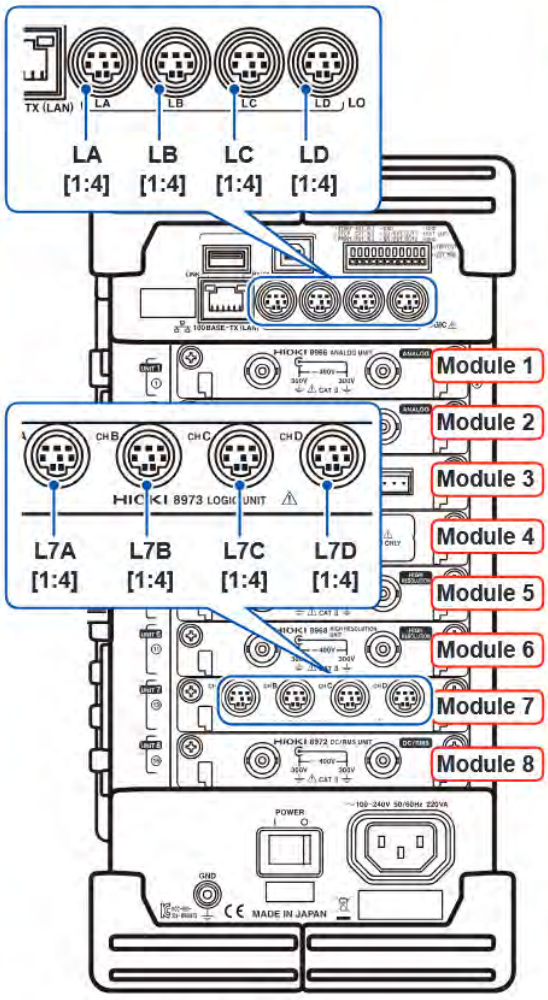
Modules are numbered beginning at the top, and channels are numbered beginning at the left of the module installed at the top.
You can find out information about the modules installed in the instrument in the System Information (p. 446).

When the instrument logic channels only are used



Example channel numbers
- Units 1, 2: 4ch unit
- Units 3, 4: 3ch unit
- Units 5, 6: 2ch unit
- Units 7, 8: 4 ch unit

When the instrument logic channels are used in combination with logic modules



Example channel numbers
If a Logic Unit has been installed as unit 7

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2.2 Attaching Connection Cables

Read “Before connecting cables” (p. 12) carefully.
For detailed precautions and instructions regarding connections, refer to the instruction manuals for your modules, connection cables, etc.

Measuring voltage

Applicable modules
- Model 8966 Analog Unit
- Model U8975 4CH Analog Unit
- Model U8978 4CH Analog Unit
- Model 8968 High Resolution Unit
- Model 8972 DC/RMS Unit
- Model U8979 Charge Unit

Connect connection cables to the BNC female connectors on modules.

The following connection cables can be connected to the modules:

- Model L9197 Connection Cord
  (Maximum input voltage: 600 V)
  Large alligator clip type



- Model L9198 Connection Cord
  (Maximum input voltage: 300 V)
  Small alligator clip type

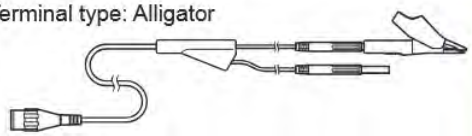


- Model L9217 Connection Cord
  (Maximum input voltage: 300 V)
  For measuring output signal from a BNC connector



- Model L9790 Connection Cord
  (Maximum input voltage: 600 V)
  Terminal type: Alligator, contact, grabber

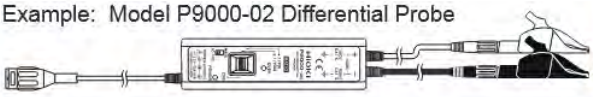
Example: Terminal type: Alligator



- Model 9166 Connection Cord
  (Maximum input voltage: 30 V AC, 60 V DC)
  Electrical clips

When a voltage to be measured exceeds a maximum input rating of a module being used
- Model 9322 Differential Probe*1
- Model 9665 10:1 Probe
- Model 9666 100:1 Probe
- Model P9000-01/-02 Differential Probe*2

Example: Model P9000-02 Differential Probe

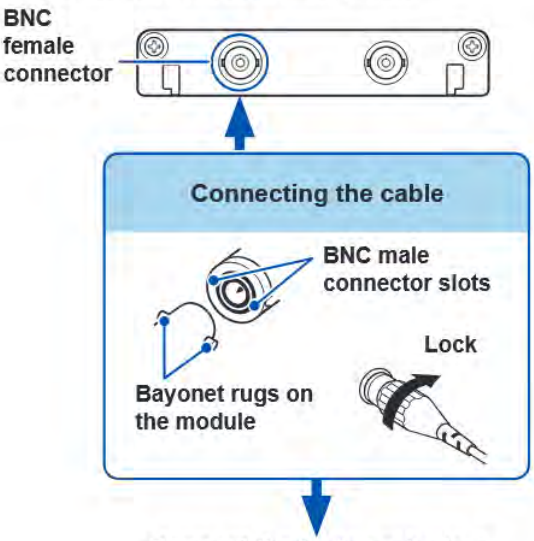


*1 An optional power cord or AC adapter is required.
*2 An optional AC adapter or a commercially available USB cable is required.

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Connecting cables to the BNC female terminals on modules

Example: Model 8966 Analog Unit



Required item: Connection cables

1. **Connect the BNC male connector of the cable to a BNC female connector on the module.**
2. **Align the slots in the BNC male connector with the bayonet lugs on the BNC female connector on the module, then attach the male connector while turning it clockwise until it locks.**
3. **Connect the cable clips to a measurement object.**

To disconnect the connection cable from the BNC female connector

Turn the BNC male connector counterclockwise, then pull it out.

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Measuring Frequency, Number of Rotations, and Count

Refer to (p. 31) for details about connecting a cable to the BNC female terminal.

Applicable Module
• Model 8970 Freq Unit

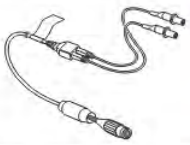
Connect cables to BNC female connectors on modules.

The following connection cables can be connected to the modules:

• Model L9197 Connection Cord
(Maximum input voltage: 600 V)
Large alligator clip type



• Model L9198 Connection Cable
(Maximum input voltage: 300 V)
Small alligator clip type

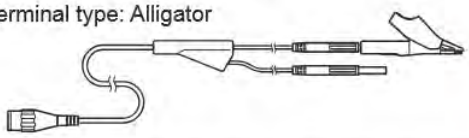


• Model L9217 Connection Cord
(Maximum input voltage: 300 V)
For measuring output signal
from a BNC connector



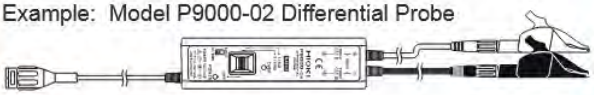
• Model L9790 Connection Cable
(Maximum input voltage: 600 V)
Terminal type: Alligator, contact, grabber

Example: Terminal type: Alligator



When a voltage to be measured exceeds a maximum input rating of a module being used
• Model 9322 Differential Probe*1
• Model P9000-01/-02 Differential Probe*2

Example: Model P9000-02 Differential Probe



*1 An optional power cord or AC adapter is required.
*2 An optional AC adapter or a commercially available USB cable is required.

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Measuring temperature

Applicable Module
• Model 8967 Temp Unit

Connect a thermocouple to the terminal block on the module.

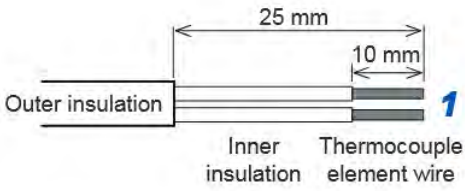
The following thermocouple can be connected to the module.

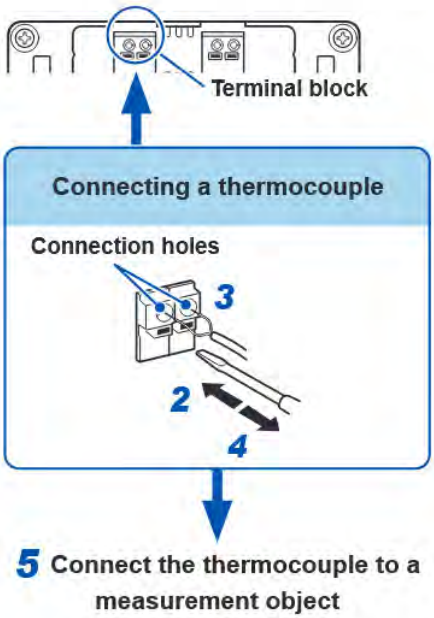
Thermocouple (Compatible wire: from 0.4 mm to 1.2 mm in diameter)

Connect thermocouple to terminal block



Connecting thermocouples to the terminal blocks





Required items:
Thermocouple, flat-blade screwdriver (2.6-mm blade)

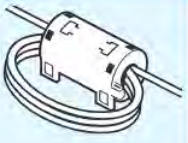
Recommended wire:
Compatible wire: Thermocouple element wires from 0.4 mm to 1.2 mm in diameter
Strip length: 10 mm

1. **Strip the insulation of the thermocouple wires as shown on the left.**
   Strip length: approx. 10 mm
2. **Depress the button on the terminal block on the module with the flat-blade screwdriver.**
3. **Insert each thermocouple wire into the appropriate terminal hole while depressing the button.**
   Confirm proper polarity.
4. **Release the button.**
   The thermocouple is connected.
5. **Connect to the measurement object.**

To remove the thermocouple

Pull the thermocouple wire while depressing the button.

- If noise influences surrounding equipment, turn the thermocouple around the accessory ferrite clamp-on choke several times (as seen in the right diagram).
- When connecting the thermocouple that is more than 3 meters long, the measurement may be affected by EMC environments including external noise.



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Measuring vibration or displacement with a strain gauge transducer

Applicable Module
- Model U8969 Strain Unit
- Model 8969 Strain Unit

The following device can be connected to the module.

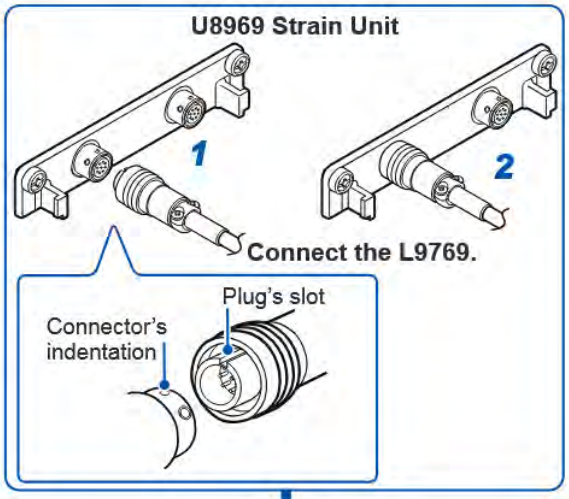
- Strain gauge transducer (Not available from Hioki)

Connect L9769 or 9769 Conversion Cable to the strain gauge transducer.

Connect a strain gauge transducer to a connector on Model U8969 Strain Unit via Model L9769 Conversion Cable; Model 8969 Strain Unit via Model 9769 Conversion Cable.

Connecting the strain gauge transducer to a module's connector

Example: Connecting the strain gauge transducer to Model U8969 Strain Unit via Model L9769 Conversion Cable



3 **Connect Model L9769 to the strain gauge transducer.**

4 **Connect the strain gauge transducer to a measurement object.**

Required items:
Model L9769 Conversion Cable, strain gauge transducer

1. **Insert Model L9769 into a connector of Model U8969 with the slot of the plug aligned with the outward indentation of the connector.**
2. **Insert the plug into the connector until they are locked together.**
3. **Connect Model L9769 to the strain gauge transducer.**
4. **Connect the strain gauge transducer to a measurement object.**

How to disconnect Model L9769

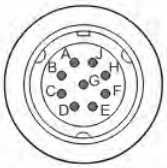
Pull the sleeve of the plug gently, releasing the plug, and disconnect the cable.

The instrument describes Model U8969 as "8969."

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Connector pin-out

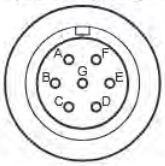
Model U8969 Strain Unit



The metal shell is connected to the GND of the instrument.

Pin mark	Description
A	BRIDGE+
B	INPUT−
C	BRIDGE−
D	INPUT+
E	FLOATING COMMON
F	SENSE+
G	SENSE−
H, J	N.C.

Model L9769 Conversion Cable
(Strain gauge transducer end)



Applied voltage:
bridge voltage of 2 V

The metal shell is connected to the GND of the instrument.

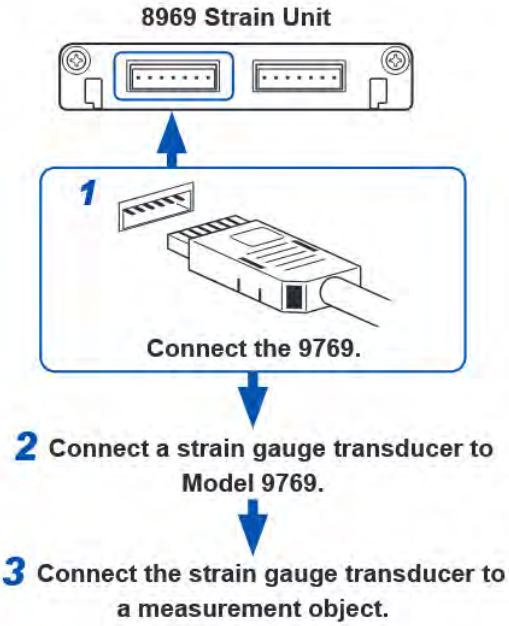
Pin mark	Description
A	BRIDGE+, SENSE+
B	INPUT−
C	BRIDGE−, SENSE−
D	INPUT+
E	FLOATING COMMON
F, G	N.C.

Connection of Model L9769

- Pin F of the module end is connected with Pin A of the strain gauge transducer end.
- Pin G of the module end is connected with Pin C of the strain gauge transducer end.

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Example: Connecting the strain gauge transducer to Model 8969 Strain Unit via Model 9769 Conversion Cable



Required items:
Model 9769 Conversion Cable, strain gauge transducer

1 Connect Model 9769 to a connector on the module.

Insert the connector of Model 9769 with the orange part facing upward.

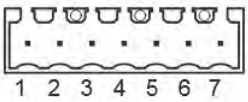
2 Connect the Model 9769 to the strain gauge transducer.

3 Connect the strain gauge transducer to a measurement object.

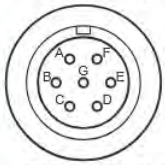
Connector pin-out

Model 8969 Strain Unit

(Pin 1 is on the left when the module's top side is on the up)



Model 9769 Conversion Cable
(Strain gauge transducer end)



Applied voltage: bridge voltage of 2V

The metal shell is connected to the GND of Model 8969.

Pin No.	Description
1	BRIDGE+
2	SENSE+
3	INPUT+
4	INPUT−
5	BRIDGE−
6	SENSE−
7	FLOATING COMMON

Pin mark	Description
A	BRIDGE+
B	INPUT−
C	BRIDGE−
D	INPUT+
E	FLOATING COMMON
F, G	N.C.

IMPORTANT

- Preforming measurement with a strain gauge requires a bridge box. Use a strain gauge and bridge box both of which are commercially available.
- The bridge box may be susceptible to the effect of noise. For more information about how to ground the bridge box, refer to its instruction manual or contact the manufacturer of the bridge box.

IMPORTANT

Do not excessively bend the cable and the base between cable and connector, pull on them, nor twist them. Doing so may cause the conversion cable to break.

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Measuring current

Current sensors that can be connected to current modules

The following current sensors can be connected to Model U8977 3CH Current Unit and Model 8971 Current Unit. Use of conversion cables may be required depending on sensors and modules.

✓: Directly connectible

Model number	Model name	Maximum input current / Frequency	Conversion cable for U8977	Conversion cable for 8971	Connector*1
9709	AC/DC Current Sensor	500 A DC to 100 kHz	CT9900	9318	Plastic
9709-05			✓	CT9901 + 9318	Metal
9272-05	Clamp on Sensor	20 A/200 A 1 Hz to 100 kHz	✓	CT9901 + 9318	Metal
9272-10			CT9900	9318	Plastic
CT6830	AC/DC Current Probe	2 A DC to 100 kHz	✓	Not connectible	Metal
CT6831		20 A DC to 100 kHz			
CT6841	AC/DC Current Probe	20 A DC to 1 MHz	CT9900	9318	Plastic
CT6841-05 CT6841A			✓	CT9901 + 9318	Metal
CT6843	AC/DC Current Probe	200 A DC to 500 kHz	CT9900	9318	Plastic
CT6843-05 CT6843A			✓	CT9901 + 9318	Metal
CT6844	AC/DC Current Probe	500 A DC to 200 kHz	CT9900	9318	Plastic
CT6844-05 CT6844A			✓	CT9901 + 9318	Metal
CT6845	AC/DC Current Probe	500 A DC to 100 kHz	CT9900	9318	Plastic
CT6845-05 CT6845A			✓	CT9901 + 9318	Metal
CT6846	AC/DC Current Probe	1000 A DC to 20 kHz	CT9900	9318	Plastic
CT6846-05 CT6846A			✓	CT9901 + 9318	Metal
CT6862	AC/DC Current Sensor	50 A DC to 1 MHz	CT9900	9318	Plastic
CT6862-05			✓	CT9901 + 9318	Metal
CT6863	AC/DC Current Sensor	200 A DC to 500 kHz	CT9900	9318	Plastic
CT6863-05			✓	CT9901 + 9318	Metal
CT6865	AC/DC Current Sensor	1000 A DC to 20 kHz	CT9900	9318	Plastic
CT6865-05			✓	CT9901 + 9318	Metal
CT6875 CT6875A CT6875A-1	AC/DC Current Sensor	500 A DC to 2 MHz	✓	CT9901 + 9318	Metal
CT6876 CT6876A CT6876A-1	AC/DC Current Sensor	1000 A DC to 1.5 MHz	✓	CT9901 + 9318	Metal

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Model number	Model name	Maximum input current / Frequency	Conversion cable for U8977	Conversion cable for 8971	Connector*1
CT6877 CT6877A CT6877A-1	AC/DC Current Sensor	2000 A DC to 1 MHz	✓	Not connectible	Metal
CT6872 CT6872-01	AC/DC Current Sensor	50 A DC to 10 MHz	✓	CT9901 + 9318	Metal
CT6873 CT6873-01	AC/DC Current Sensor	200 A DC to 10 MHz	✓	CT9901 + 9318	Metal
CT6904A	AC/DC Current Sensor	500 A DC to 4 MHz	✓	CT9901 + 9318	Metal
CT6904A-1	AC/DC Current Sensor	500 A DC to 2 MHz	✓	CT9901 + 9318	Metal
CT6904A-2	AC/DC Current Sensor	800 A DC to 4 MHz	✓	CT9901 + 9318	Metal
CT6904A-3	AC/DC Current Sensor	800 A DC to 2 MHz	✓	CT9901 + 9318	Metal

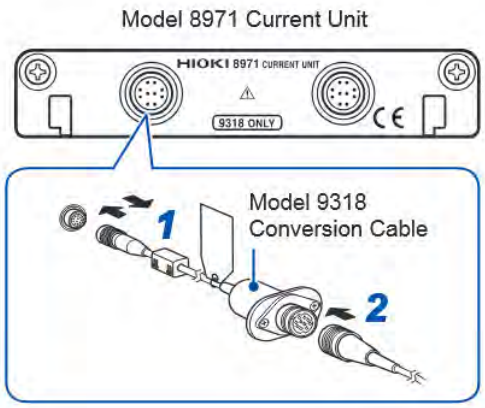
*1: Metal connector (ME15W), plastic connector (PL23)

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Connecting current sensors to Model 8971 Current Unit

Current sensors with a black resin connector (PL23), whose model numbers do not end in -05, can be connected to Model 8971 using the optional Model 9318 Conversion Cable*.

***: Model 9318 Conversion Cable is an accessory of Model 8971 Current Unit.**



1. **Aligning the guides of the conversion cable with those of the sensor connector on the module, and straightly insert the plug until it locks.**
2. **Align the guides of the current sensor to be used with those of the conversion cable connector, and straightly insert the plug until it locks.**
   The instrument automatically recognizes the model of the current sensor.
3. **Clamp the current sensor around a line of a measurement target.**

How to disconnect the current sensor

1. **Hold and pull the plastic collar of the conversion cable, which releases the lock, and the remove the connector.**
2. **Hold and pull the plastic collar of the current sensor, which releases the lock, and the remove the connector.**

When measuring current with Model 9018-50 Clamp On Probe

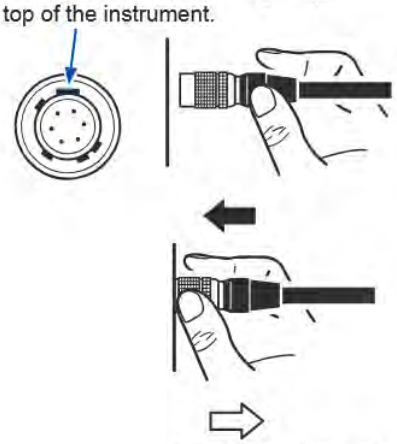
Using Model 9018-50 enables voltage measurement modules such as Model 8966 Analog Unit to measure current.
For more information about how to configure the instrument for use in this type of application, refer to “8.5.1 Example of Scaling Settings” (p. 174).

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Connecting current sensors to Model U8977 3CH Current Unit

Current sensors with metal connectors (ME15W), indicated by a model number ending in -05, can be connected directly.

Orient so that the wide ridge is positioned at the top of the instrument.



Grip the metal part of the connector.

1 **Align the connector guides.**

2 **Push the connector straight in until it locks.**

Grip the connector by the non-metal part and push it in.

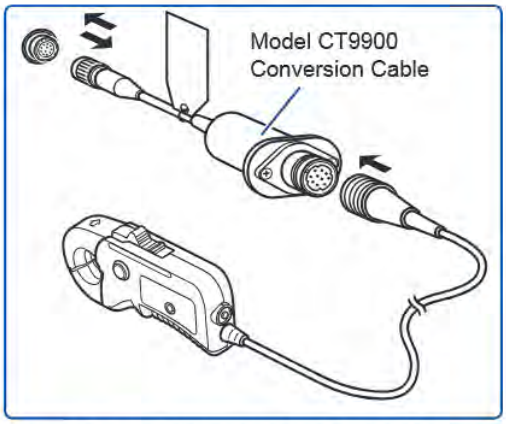
The instrument will detect the current sensor type automatically.

Disconnecting current sensors

1 **Grip the connector's metal part and slide it towards you to disengage the lock.**

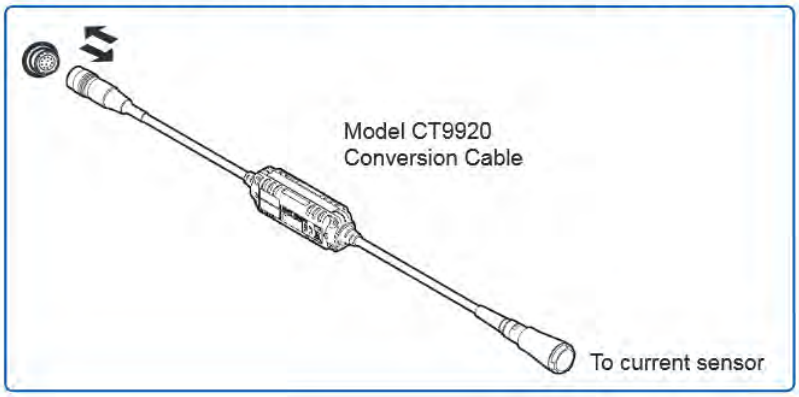
2 **Pull the connector towards you.**

Current sensors with a black resin connector (PL23), whose model numbers do not end in -05, can be connected to Model U8977 3CH Current Sensor using the optional Model CT9900 Conversion Cable.



If the CT6846 or CT6865 (1000 A rating) is connected using Model CT9900 Conversion Cable, it will be recognized as a 500 A AC/DC sensor. Set the CT ratio to 2.00.

Current sensors in the CT7000 series can be connected to Model U8977 3CH Current Unit using the optional Model CT9920 Conversion Cable. When using the CT9920, sensors will not be recognized automatically. Select the supported mode on the settings screen.
Supported models: CT7631, CT7636, CT7642, CT7731, CT7736, CT7742, CT7044, CT7045, CT7046



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Measuring acceleration

Familiarize yourself with "Operation Precautions" (p. 7) before connecting a current sensor.

Applicable Module
• Model U8979 Charge Unit

The following device can be connected to the module.
• Acceleration sensor (Not available from Hioki)

Connect a acceleration sensor to Model U8979 Charge Unit.

Acceleration sensor connectable with Model U8979

⚠CAUTION

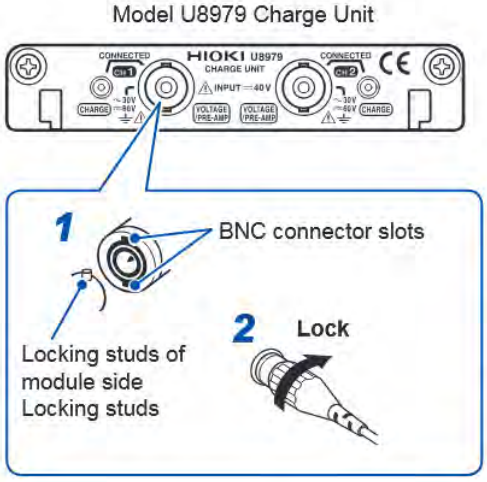
Use an acceleration sensor with a built-in pre-amplifier that conforms to the specification of Model U8979 Charge Unit. Using an inapplicable sensor may cause damaging itself.

Acceleration sensor type	Terminal the sensor is connected to	Note
With a built-in pre-amplifier	BNC connector	Drive power: 3.0 mA, 22 V
Charge output	Miniature connector (#10-32)	–

Connecting an acceleration sensor with a built-in pre-amplifier

Connecting a BNC-output acceleration sensor with a built-in pre-amplifier

Model U8979 Charge Unit



1. **Align the slots in the BNC connector of an acceleration sensor with the locking studs of a BNC connector on the module, and insert the connector.**
2. **Turn the BNC connector of the acceleration sensor clockwise until it locks.**
3. **Attach the acceleration sensor with the built-in pre-amplifier to a measurement target.**

How to remove the acceleration sensor

Turn the BNC connector of the acceleration sensor counter-clockwise to release the lock and remove the connector.

Connecting an acceleration sensor other than a sensor with a built-in pre-amplifier

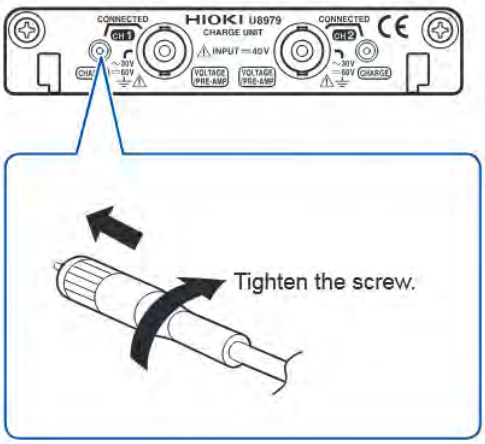
Convert the output connector into the BNC connector using a commercially available conversion connector or conversion cable to connect the sensor.

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Connecting a charge-output acceleration sensor

Connecting a charge-output acceleration sensor equipped with the miniature connector (#10-32)

Model U8979 Charge Unit



1 **Align the screw of the miniature connector, and turn the connector clockwise to tighten it.**

2 **Attach the charge-output acceleration sensor to a measurement target.**

How to disconnect the current sensor

Turn the miniature connector counterclockwise, and then pull out the connector.

Connecting a charge-output acceleration sensor equipped with a connector other than a miniature connector (#10-32)

Convert the output connector into the miniature connector (#10-32) using a commercially available conversion connector or conversion cable to connect the sensor.

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Measuring logic signals

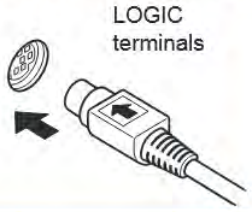
Read “Before connecting a logic probe to the measurement object” (p. 13) carefully.
For more information about logic probe specifications, refer to the instruction manual of your logic probe.

Applicable Module
• Model 8973 Logic Unit

The logic channels LA through LD are installed in the instrument.

The following logic probes can be connected to the module.

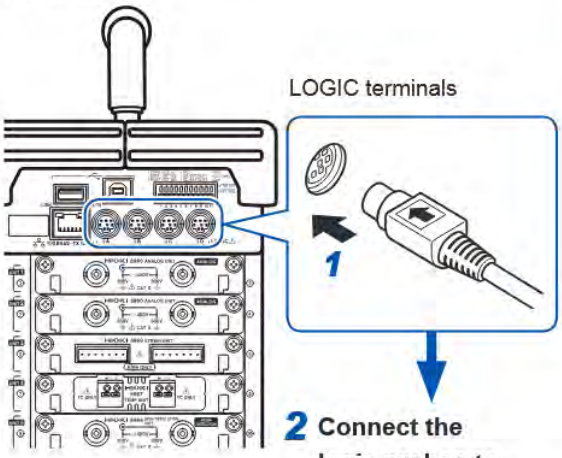
• Model 9320-01 Logic Probe
• Model MR9321-01 Logic Probe
• Model 9327 Logic Probe



Connecting logic probes to the logic terminals

Example: Connecting Model 9327 Logic Probe

Right side



Required items:
Model 9327 Logic Probe

1. **Aligning the plug slots of the logic probe with a logic terminal, insert the logic probe plug.**
2. **Connect the logic probe to a measurement object.**

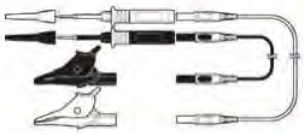
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Measuring voltage with a high degree of accuracy (digital voltmeter)

Applicable Module
- Model MR8990 Digital Voltmeter Unit

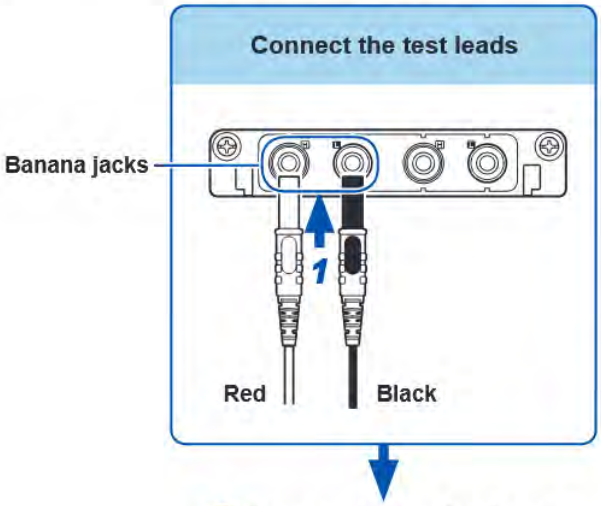
The following lead can be connected to the module.

- Model L2200 Test Lead (Maximum input voltage: 1000 V)



Connect the test lead to the banana jacks on the module.

Connecting test leads to the banana jacks



Required items: Test leads mentioned above

1 Connect the test leads to the banana jacks on the module.

Connect the black lead to the L jack; and the red lead to the H jack. Make sure the test lead plugs are fully inserted in the jacks.

2 Connect the test lead to a measurement object.

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Measuring high voltage

Applicable Module
- Model U8974 High Voltage Unit

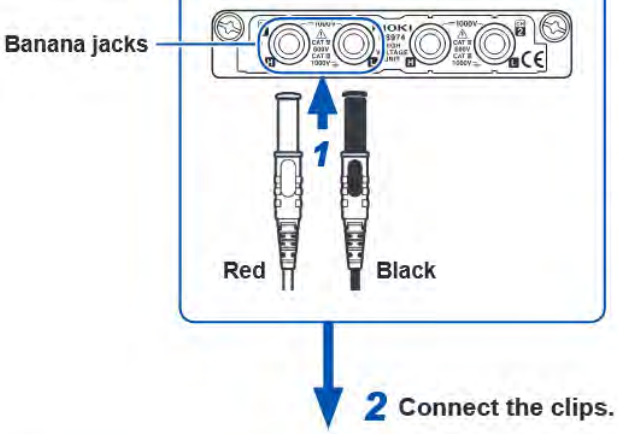
The following cables can be connected to the module.
- Model L4940 Connection Cable Set
  (Maximum input voltage: 1000 V)



Connect the connection cable to the banana jacks on the module.

Connecting connection cables to the banana jacks

Connect the connection cable



Required items:
Model L4940 Connection Cable Set

1 **Connect the plugs of the connection cable to banana jacks on the module.**
Connect each of the plugs to the banana jack in the same color.

2 **Insert accessory clips into another side of the cable.**

3 **Connect the cable clips to a measurement object.**

Accessory clips	
 Model L4934	Model L4934 Small Alligator Clip Set * Model L4932 is required when using Model L4934.
	Model L4935 Alligator Clip Set
	Model L9243 Grabber Clip
	Model L4936 Bus Bar Clip Set
	Model L4937 Magnetic Adapter Set
	Model L4932 Test Pin Set

3 **Connect the clips to a measurement object.**

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Outputting waveforms

Applicable Modules
- Model U8793 Arbitrary Waveform Generator Unit
- Model MR8790 Waveform Generator Unit

Connect the connection cable to the output terminal of a module.

The following cables can be connected to the module.

- Model L9795-01 Connection Cable (Electrical clips)

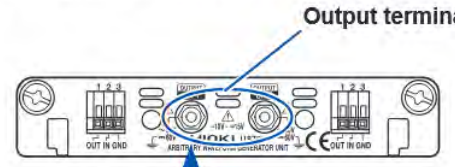


- Model L9795-02 Connection Cable (BNC output)

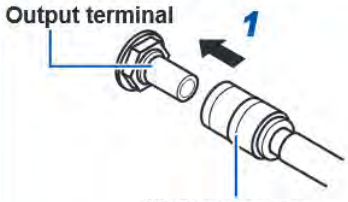


Connecting a connection cable to the output terminals

Example: Model U8793



Connect the connection cable



2 **Connect the connection cable to an object to which the instrument applies the waveform.**

Required item: Connection cable mentioned above

1 **Insert the SMB connector of connection cable in the output terminal of the module until it clicks.**

2 **Connect the cable clips to an object to which the instrument applies the waveform.**

To disconnect output connectors

Firmly pinch the head of the SMB connector (other than the cable), and pull it out.

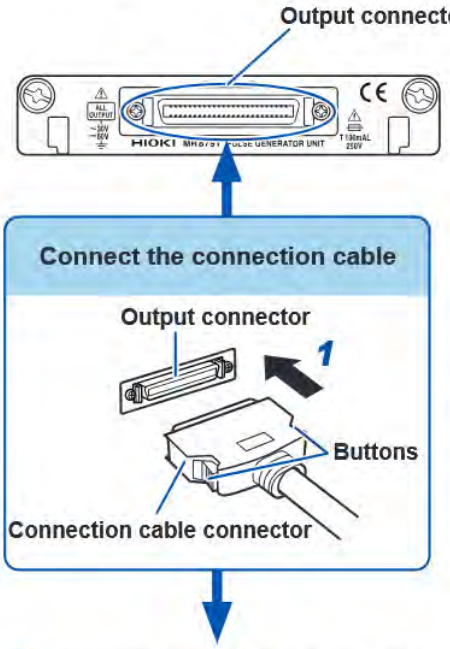
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Outputting a pulse waveform

Applicable Module
- Model MR8791 Pulse Generator Unit

Required items: Commercially available cable
(Half-pitch 50 pins)

Connecting a connection cable to the output connector



Required items: Commercially available cable

1 **Connect the connection cable to the output connector of the module.**

2 **Connect the connection cable to the object to which the instrument applies the waveform.**

To disconnect the connection cable from output connectors

Pull the connector while depressing the buttons of the connection cable.

Output connector

10250-52A2PL: Sumitomo 3M products (SCSI-2 connector), (Centronics half-pitch 50 pins socket-contact)
Refer to “Specifications of output connector” (p. 424).

- The metal shell of the connector 10250-52A2PL has the same potential as the ground of the instrument (frame ground).
- Use a lock-type connector for connecting a wire harness and the connector.

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2.3 Preparing Storage Devices

Read “Handling storage devices” (p. 11) carefully.

2.3.1 Available Storage Devices (Inserting a CF Card and a USB Flash Drive)

Icons indicating storage devices



USB flash drive | CF card | Built-in drive

The icons indicating the status of storage devices always appear at the top of the screen.



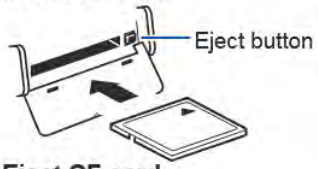
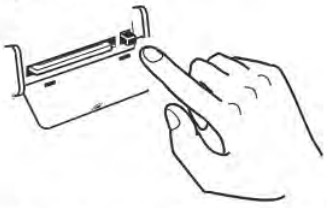
: Storage devices are inserted.



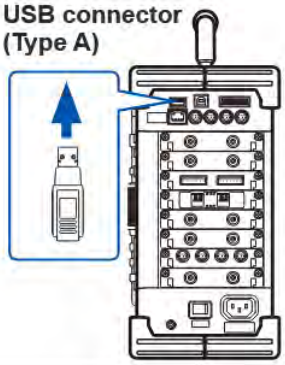
: Storage devices are inserted and selected as the save destination.
(Shown in red)



: Storage devices are not inserted; however, selected as the save destination.
(Shown in black)

Storage device	How to insert devices, notes
CF card 	**Insert a CF card** Fully insert a CF card with the top facing upward and the mark (▲) pointing toward the slot. When the eject button sticks out, depress the button, and then insert the CF card completely. Inserting the CF card while the eject button is sticking out may cause damage to the instrument. If the CF card cannot be inserted completely, do not insert it forcedly. Depress the eject button to make it stick out, and then insert the CF card again. **To remove the CF card** Depress the eject button. After the button is extended, depress it again to eject the CF card. **Front side** CF card slot  **Insert CF card**  **Eject CF card** 
Built-in drive 	Model U8331 SSD Unit (storage capacity: 128 GB* 1 GB = 1,000,000,000 bytes) * After formatting the drive, its capacity is decreased to less than 128 GB, which is an actually available capacity. The optional Model U8331 SSD Unit (factory option) is required. Hioki formatted the hard disk during the production process.

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Storage device	How to insert devices, notes
Memory (INT) 	• The memory installed in the instrument is available. Only settings files can be written in the memory. • Automatic writing of data is not possible.
USB flash drive 	• Do not connect any devices other than USB flash drives. • The instrument does not support all commercially available USB flash drives. • To use a USB flash drive, you have to configure the setting on the instrument. See the procedure described on the following page. **Inserting a USB flash drive** Orient the USB flash drive and insert it all the way into the connector. **Removing the USB flash drive** Make sure that the instrument is not accessing the USB flash drive (for saving or loading data, etc.), and then remove the USB flash drive. (No operation is required on the instrument.) **Right side** **USB connector (Type A)** 

Depending on the intended use of the USB flash drive, connector types and settings on the instrument differ.

USB usage	Connector	Instrument settings		Reference information
		Interface	USB setting	
Using a USB flash drive	Type A	LAN	USB Stick	See the following procedure.
Retrieving files saved on a CF card or the built-in drive with a computer (via a USB cable)	Type B	LAN	Mass storage HDD, Mass storage CF	"16.4" (p. 359)
Operating the instrument from a computer (via a USB cable)	Type B	USB	Interface	"16.6.1" (p. 361)

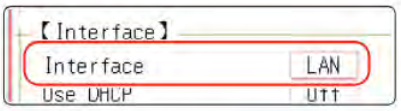
Even when the SSD is installed as a built-in drive, it is recognized as an HDD.

Procedure

To display the screen

Press the **SYSTEM** key several times to display the **[Interface]** sheet on the system screen.

1 **Move the cursor to the [Interface] box, and then select [LAN].**



2 **Move the cursor to the [USB Set] box, and then select [USB Stick].**



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2.3.2 Formatting Storage Devices

The instrument can format CF cards, USB flash drives, the built-in drive, and the internal memory. Once they are formatted, the "HIOKI8847" folder is created.

> Note that formatting a storage device deletes all the information on the storage device, and the deleted information is unrecoverable.

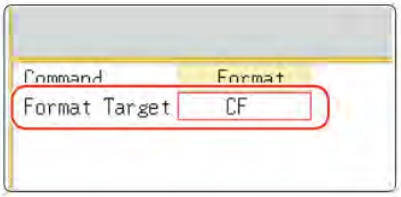
Procedure

To display the screen
Press the **FILE** key to display the file screen.

1 **Insert a storage device.**

2 **Select [Next Page].**
Select **[Format]**.

The cursor is placed on the **[Format Target]** box.



3 **Select a storage device to be formatted, and then select [Exec].**
The specified storage device is formatted.

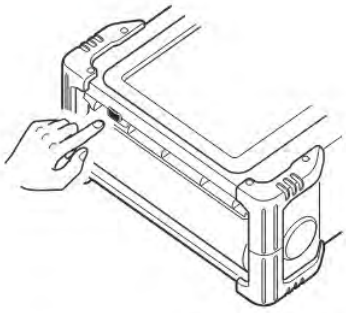
A confirmation window is displayed.
Select **[Yes]** to proceed the formatting action.
Select **[No]** to cancel the formatting action.

2.4 Loading Recording Paper

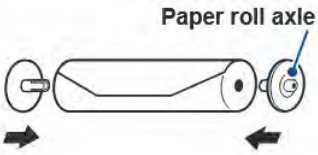
Read "Handling the printer and the recording paper" (p. 10) carefully.

Procedure

Required items: Model MR9231 Recording Paper, Paper roll axles (accessory)

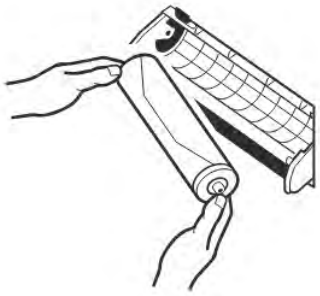


1 **Press the button to open the printer cover.**



2 **Insert the paper roll axles into the core of Model 9321 Recording Paper.**

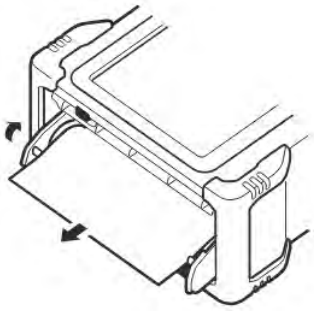
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3 **Put the paper into the holder.**

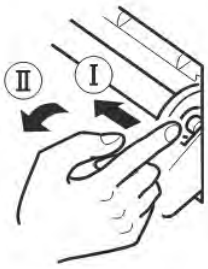
Insert first the left side of the paper into the holder, and then, until the holder clicks, put the paper into the holder while pressing the paper leftward.

> Face the print side of the paper upward. If the paper is put in the holder without the paper roll axle installed, the printer cover cannot be open, resulting in damage to the printer.



4 **Pull out the edge of the paper toward yourself, and close the printer cover while applying the face of the paper to the cover's side surface.**

> The surface of the paper may become sticky due to the residue left behind by the adhesive tape, with the result that the printing on that area becomes unprintable. Unroll approximately the first 200 mm of paper before inserting it into the printer.



How to withdraw the recording paper

As shown in the left figure, withdraw the paper while pressing the paper roll axle leftward.

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2.5 Supplying Power

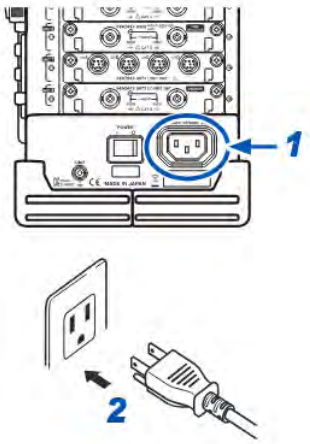
Read “Before turning on the instrument” (p. 13) carefully.

2.5.1 Connecting the Power Cord

Procedure

1. **Connect the power cord to the power inlet on the instrument.**
2. **Plug the power cord into the mains outlet.**

Right side

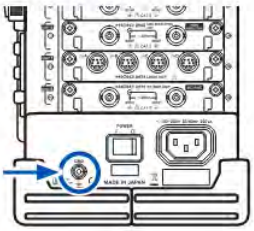


2.5.2 Connecting an Earthing Wire to the GND Terminal (Functional Earth Terminal)

When performing measurement in a noisy environment, you can improve the noise immunity by connecting an earthing wire to the GND terminal (functional earth terminal).

When using a potential transformer (PT) for AC power line measurement or others, connect an earthing wire to the GND terminal of the PT.

Right side

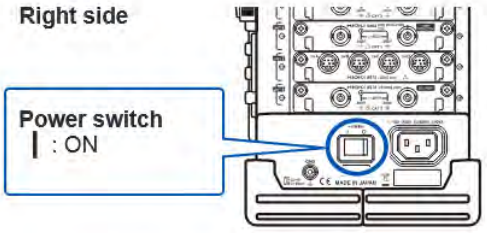


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2.5.3 Turning On and Off the Instrument

Turning on the Instrument

Right side



Set the power switch in the on position (|).

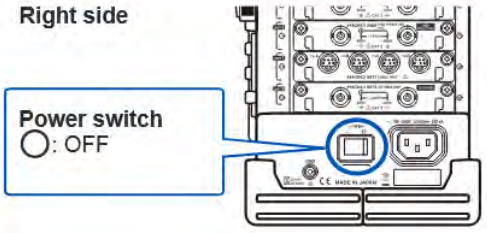
The splash screen is displayed first, and then the waveform screen is displayed.

Before starting measurement
To perform precise measurement, warm up the instrument about 30 minutes after turning on the instrument to stabilize the internal temperature of the modules. After warm-up, perform zero adjustment before performing measurement.

Turning off the instrument

Before turning off the instrument
When the instrument is turned off, data recorded in the internal memory is deleted. When you do not want to lose recorded data, save it first to a CF card or an external storage device.
Refer to "5 Saving/Loading Data and Managing Files" (p. 91).

Right side



Set the power switch in the off position (◯).

The instrument is turned off.
After the instrument is turned on again, the display is displayed with the same settings as when the instrument was turned off last time.
When the auto-setup function is enabled, settings are read and configured automatically. (p. 113)

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2.6 Setting the Clock

Set date and time for the built-in clock as follows.
The clock has an automatic calendar with leap year correction and 24-hour format.
The functions listed below make use of the clock. Ensure that the clock is set correctly before using these functions.

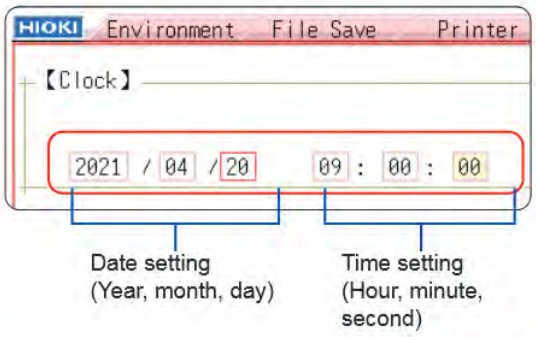
- Performing measurement with timer-based trigger enabled
- Printing data including times of trigger events
- Saving measured data

Procedure

To display the screen
Press the **SYSTEM** key several times to display the **[Init]** sheet on the system screen.

1 **Move the cursor to the [Clock] box.**

2 **Select the digits to change and set the numeric values.**



3 **While the cursor is placed on one of the [Clock] settings, select [Apply].**

The date and time settings are accepted.
The date and time are displayed at the top right of the screen.



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2.7 Adjusting the Zero Position (zero-adjustment)

This operation compensates potential deflection of modules and sets the reference potential of the instrument to 0 V.
The compensation operation is performed for all channels and ranges.

Before performing zero-adjustment

- Warm up the instrument for about 30 minutes after the power-on to stabilize the internal temperature of the modules, and then perform zero-adjustment.
- Note that zero-adjustment cannot be performed during measurement.
- Key operation is not accepted during zero-adjustment.
- The time required for zero-adjustment varies depending on types and the number of modules installed in the instrument. (The operation may take several seconds.)

Procedure

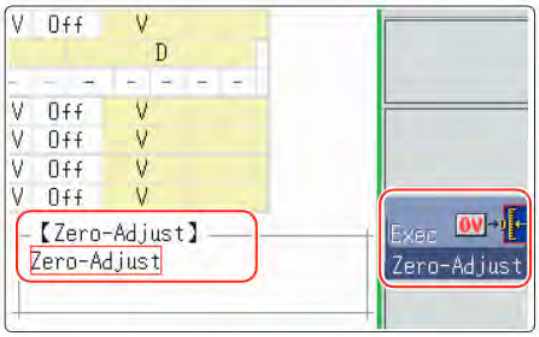
To display the screen

Press the **CHAN** key several times to display the **[Unit List]** sheet on the channel screen.

1 **Move the cursor to the [Zero-Adjust] box.**

2 **Select [Exec Zero-Adjust].**

The zero-adjustment is executed.



Zero-adjustment has no effect on the 8969 and U8969 Strain Unit.
(Adjust the zero position using the auto-balance. (p. 188))

Perform zero-adjustment in the following cases.

- When a module has been replaced
- When the instrument has been cycled.
- When settings has been initialized (system reset)
- When measurement mode has been switched between DC and RMS on Model 8971 Current Unit, 8972 DC/RMS Unit, or U8974 High Voltage Unit
- When measurement mode has been switched on Model U8979 Charge Unit
- When the ambient temperature has changed significantly
  The zero-position drift* may occur.

* Drift:
This means a spurious output caused by a shift in an operating point of an operational amplifier. Drift can occur due to changes in temperature and due to component aging over a period of use.

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2.8 Performing Calibration (When Model MR8990 is Installed)

This operation calibrates the scale of MR8990 Digital Voltmeter Unit.
The compensation operation is performed for all channels and ranges.

Before performing calibration

- Warm up the instrument for about 30 minutes after the power-on to stabilize the internal temperature of the modules, and then perform zero-adjustment.
- Note that calibration cannot be performed during measurement. However, when the calibration setting is set to on, calibration is performed at the start of measurement.
- Key operation is not accepted during calibration.
- The time required for calibration varies depending on types and number of modules installed in the instrument. (The operation may take several seconds.)

Procedure

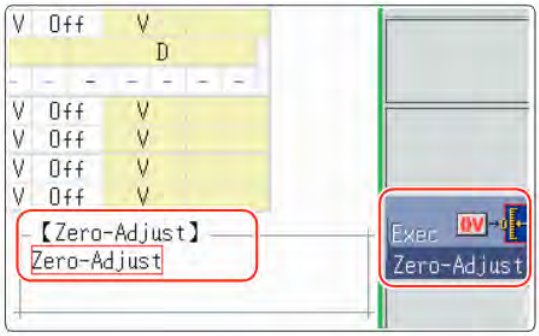
To display the screen

Press the **CHAN** key several times to display the **[Unit List]** sheet on the channel screen.

1 **Move the cursor to the [Zero-Adjust] box.**

2 **Select [Exec Zero-Adjust].**

Calibration is executed.



In the following cases, calibration should be executed again.

- When a module has been replaced
- When the instrument has been cycled.
- When settings has been initialized (system reset)
- When the ambient temperature has changed significantly

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3 Measurement

3.1 Measurement Procedure

1 Inspecting the instrument before measurement

Refer to “3.2 Inspecting the Instrument Before Measurement” (p. 59).

2 Configuring the basic measurement settings

	Refer to the following pages:
Select a suitable recording method for an object to be measured	“3.3.1 Measurement Functions” (p. 60)
Set the sampling rate	"3.3.2 Time Axis Range and Sampling Rate" (p. 62)
Set the recording length	"3.3.3 Recording Length (Number of Divisions)" (p. 66)
Set the waveform display format and printing format	"3.3.4 Screen Layout" (p. 69)

Advanced settings

Refer to the following pages:
"7.4 Plotting X-Y Composite Curves" (p. 148)
"8.2 Displaying Waveforms During the Writing in the Memory Simultaneously (Roll Mode)" (p. 167)
“8.3 Overlaying New Waveforms With Past Waveforms” (p. 168)
“10 Numerical Calculation Functions” (p. 235)

3 Configuring the input channel settings

	Refer to the following pages:
Configure the analog channel settings	“3.4.2 Configuring Analog Channels Settings” (p. 73)
Configure the logic channel settings	“3.4.3 Configuring Logic Channel Settings” (p. 76)

Advanced settings

Refer to the following pages:
“8.1 Adding Comments” (p. 160)
“8.5 Converting Input Values (Scaling Function)” (p. 171)
“8.6 Setting the Waveform Position (Variable Function)” (p. 178)
“8.1 Adding Comments” (p. 160)
“8.8 Inverting the Waveform (Invert Function)” (p. 182)

4 Configuring the trigger settings

Refer to “9 Setting the Trigger” (p. 211).

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5 Starting measurement

Refer to the following pages:
"3.5 Starting and Stopping Measurement" (p. 79)
"5 Saving/Loading Data and Managing Files" (p. 91)
"6 Printing Data" (p. 125)
"7.1 Reading Measured Values (Using Cursors A and B)" (p. 140)
"7.3.2 Scrolling the Waveforms With the Jog Dial and Shuttle Ring" (p. 146)
"7.5 Magnifying and Demagnifying Waveforms" (p. 150)

6 Completing the measurement

Refer to "3.5 Starting and Stopping Measurement" (p. 79).

To observe the input signal

Pressing the **AUTO** key configures the timebase of the input waveform, vertical axis (voltage axis) range, and zero-adjust settings automatically and then starts measurement.
Refer to "3.6 Measurement With Automatic Range Setting (Auto-Ranging Function)" (p. 82).

To load previously saved settings

Load the settings file using the file screen.
Saving the settings with respect to each measurement object and each application enables you to perform measurement more convenient.
Refer to "5.3 Loading Data" (p. 110).

To automatically load previously saved settings at power-on

Previously saved measurement settings can be automatically loaded from a file when the instrument is turned on. Simply insert a CF card containing an auto-settings file before turning on the instrument.
Refer to "5.4 Automatically Loading Settings (Auto-setup Function)" (p. 113).

Make sure that the "HIOKI8847" folder of the CF card contains the file.

To initialize the instrument (restoring the basic default settings)

From the system screen, select the **[Init]** sheet to reset the instrument to the factory default settings.
After initialized, the instrument is set up to perform simple measurement easily.
If the operation of the instrument seems unusual or overly complex, initialize the instrument.
Refer to "19.2 Resetting the Instrument" (p. 437).

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3.2 Inspecting the Instrument Before Measurement

Before using the instrument for the first time, verify that it operates normally to ensure that no damage occurred during storage or shipping. If you find any damage, contact your authorized Hioki distributor or reseller.

(1) Inspecting products used with the instrument

When using probes and connection cables

Is insulation of a probe or connection cable to be used damaged, or is bare metal exposed?

- Metal exposed → Do not use them if damage is present, as you could receive an electric shock. Request repairs.
- No metal exposed → **Go to Step (2)**

When using clamp sensors

Is a clamp cracked or damaged?

- Yes → Do not use them if damage is present, as you could receive an electric shock. Request repairs.
- No → **Go to Step (2)**

(2) Inspecting the instrument and modules

Is there any visible damage to the instrument or modules?

- Yes → If damage is evident, request repairs.
- No ↓

When turning on the instrument

Does the Hioki logo appear on the screen?

- No → The power cord may be damaged, or the instrument may be damaged. Request repairs.
- Yes ↓

Does the waveform screen appear?

- Nothing appears, or the display is abnormal. → The instrument may be damaged. Request repairs.
- Yes ↓

Inspection terminates.

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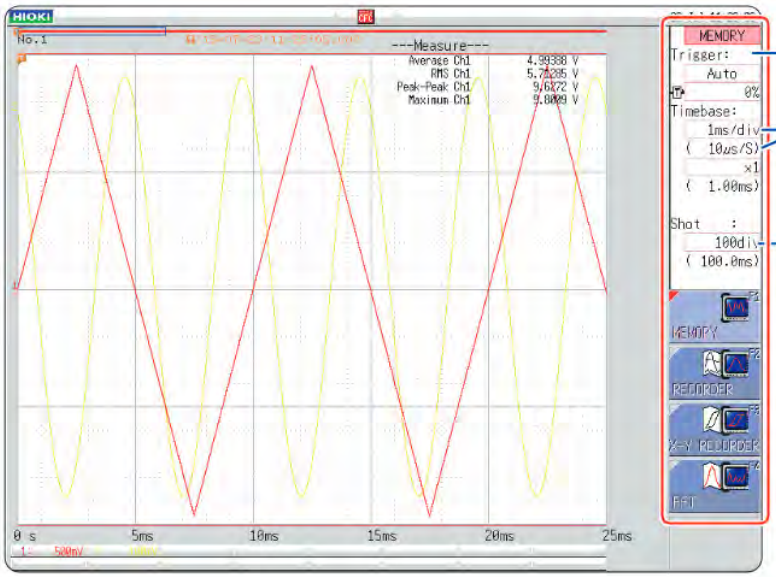
3.3 Setting Measurement Conditions

This section describes how to set measurement conditions.
The settings window displayed on the Waveform display enables you to configure basic settings conveniently while you are observing waveforms. The basic settings can also be configured on the **[Status]** sheet of the status screen

How to open the settings window



Press the **[DISP]** key.



Settings window (p. 60)

Timebase (Sampling rate) (p. 62)

Recording length (Number of divisions) (p. 66)

3.3.1 Measurement Functions

Select a function depending on a type of measurement.

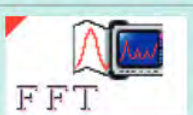
Procedure

To display the screen

Press the **DISP** key to display the waveform screen.

Move the cursor to the function box (the uppermost column of the settings window).

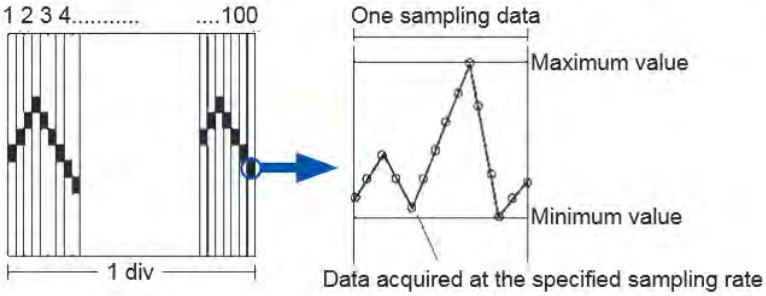
MEMORY (Default setting) / RECORDER / X-Y RECORDER / FFT

	**Used to measure instantaneous waveforms and transient phenomenon.** You can use the trigger and calculation functions.
	**Used to observe and record fluctuations of phenomenon changing slowly** You can print data in real time.
	**Used to observe signals endlessly in X-Y curve format** You can set the X-Y composite curves plotting setting to on/off in the same manner as the pen raising/lowering setting installed in typical X-Y pen recorders. Refer to "4 X-Y Recorder" (p. 85).
	**Used to analyze frequencies** **You can conduct various types of the spectrum and octave analyses.** Refer to "13 FFT Function" (p. 273).

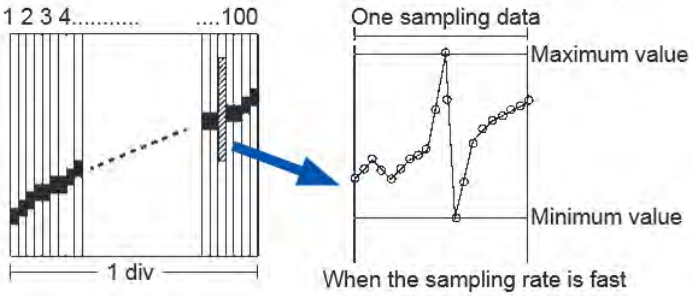
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Values obtained by the recorder function

While the recorder function is being used, the instrument obtains measured values at a previously set sampling rate and lets both the maximum and minimum values be a sampling data value during each of the sampling data periods. Thus, every sampling data value ranges in amplitude.



If the input waveform fluctuates widely due to noise even though usually it fluctuates slightly, the difference between the maximum and minimum values obtained with the instrument at the sampling rate that is relatively faster can be inordinately large.
Set the sampling rate to a slower setting to prevent this phenomenon from being observed.



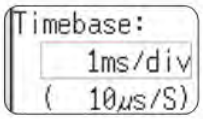
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3.3.2 Timebase and Sampling Rate

MEM REC

The timebase setting defines a time length per division of the horizontal axis (time/div).
The sampling setting defines an interval at which the instrument samples waveforms.

(While the memory function is being used, the sampling rate appears, enclosed in parentheses, under the timebase box. See the right figure. The displayed sampling rate changes along with the timebase)



Procedure

To display the screen
Press the **DISP** key to display the waveform screen.

For the memory function

1 **Move the cursor to the [Timebase] box.**

2 **Set the time per division on the horizontal axis (time axis).**

5 (Default setting), 10, 20, 50, 100, 200, 500 µs/div
1, 2, 5, 10, 20, 50, 100, 200, 500 ms/div
1, 2, 5, 10, 30, 50 s/div, 1 min/div, 100 s/div
2, 5 min/div

To control the sampling rate using an external signal, select **[External]** and input the signal to the external sampling terminal. To set back the setting to the internal sampling, select **[Internal]** and set the time.
When the external sampling is used, the settable number of sampling per division can range from 10 S/div to 1000 S/div.
Refer to "17.2.3 External Sampling (EXT.SMPL)" (p. 375).
If using Model U8975, U8977, or U8978, the 5 µs/div range will not be available (the default setting will be 10 µs/div).

For the recorder function

1 **Move the cursor to the [Timebase] box.**

2 **Set the time per division on the horizontal axis (time axis).**

10 (Default setting), 20, 50, 100, 200, 500 ms/div
1, 2, 5, 10, 30, 50 s/div, 1 min/div, 100 s/div
2, 5, 10, 30 min/div, 1 h/div

3 **Move the cursor to the [Timebase] box.**

4 **Set the sampling rate.**

1 (Default setting), 10, 100 µs
1, 10, 100 ms
(Select a sampling rate from among the options that are 1/100 of the timebase or less)

The selectable range varies depending on the timebase setting.
The higher the sampling rate is, the better you can observe minute changes.

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MEM

How to select the timebase

Refer to the table below to set the timebase.

For example, to measure a waveform with a frequency of 100 kHz, a maximum display frequency of between 200 kHz and 800 kHz should be selected according to the following table. When you want to set the maximum display frequency to 400 kHz, the timebase should be set to 10 µs/div.

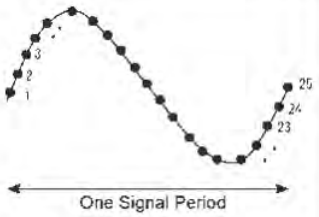
Timebase	Sampling rate	Maximum display frequency
5 µs/div	50 ns (20 MS/s)	800 kHz
10 µs/div	100 ns (10 MS/s)	400 kHz
20 µs/div	200 ns (5 MS/s)	200 kHz
50 µs/div	500 ns (2 MS/s)	80 kHz
100 µs/div	1 µs (1 MS/s)	40 kHz
200 µs/div	2 µs (500 kS/s)	20 kHz
500 µs/div	5 µs (200 kS/s)	8 kHz
1 ms/div	10 µs (100 kS/s)	4 kHz
2 ms/div	20 µs (50 kS/s)	2 kHz
5 ms/div	50 µs (20 kS/s)	800 Hz
10 ms/div	100 µs (10 kS/s)	400 Hz
20 ms/div	200 µs (5 kS/s)	200 Hz
50 ms/div	500 µs (2 kS/s)	80 Hz
100 ms/div	1 ms (1 kS/s)	40 Hz
200 ms/div	2 ms (500 S/s)	20 Hz
500 ms/div	5 ms (200 S/s)	8 Hz
1 s/div	10 ms (100 S/s)	4 Hz
2 s/div	20 ms (50 S/s)	2 Hz
5 s/div	50 ms (20 S/s)	0.8 Hz
10 s/div	100 ms (10 S/s)	0.4 Hz
30 s/div	300 ms (3.33 S/s)	0.13 Hz
50 s/div	500 ms (2 S/s)	0.08 Hz
1 min/div	600 ms (1.67 S/s)	0.04 Hz
100 s/div	1 s (1 S/s)	0.067 Hz
2 min/div	1.2 s (0.83 S/s)	0.033 Hz
5 min/div	3 s (0.33 S/s)	0.013 Hz

The unit "S/s" stands for the number of samplings per second.

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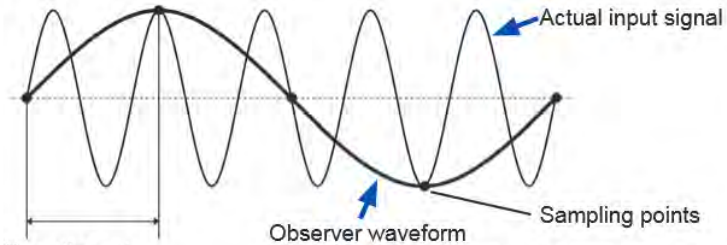
What is the maximum display frequency?

To plot sine waves that allow you to observe those peaks on the LCD, the instrument needs to sample the waveforms at least 25 points per cycle. The maximum display frequency varies depending on the timebase setting.



If instrument plots non-existent waveforms (aliasing)

If a measured signal fluctuates at a higher frequency compared to the specified sampling speed, the instrument can probably plot non-existent waveforms fluctuating at a lower frequency than that of realistic signal when the signal frequency reaches a certain level. This effect is called aliasing.



Aliasing occurs because the sampling rate is slower than the cycle of the input signal.

For the memory function, because the sampling rate can significantly vary according to the timebase setting, select the timebase setting carefully to avoid aliasing from occurring. Since the timebase setting determines the maximum display frequency, perform measurement at as fast timebase setting as possible.

When recording signals repeatedly, the auto-range function (p. 82) is useful.

The sampling rate is automatically set to 1/100 of the selected timebase.

When Model MR8990 Digital Voltmeter Unit is installed, the sampling rate of its channels is automatically set to 1/50 of the selected timebase.

Example: When Model 8966 is installed as Unit 1 (CH1 and CH2) and Model MR8990 as Unit 2 (CH3 and CH4), then the timebase is set to 1 s/div
Sampling rate of Unit 1 (Model 8966): 10 ms
Sampling rate of Unit 2 (Model MR8990): 20 ms

To automatically set the timebase

Pressing the **AUTO** key selects a suitable timebase for an input signal and starts measurement. (This function can be used in the memory function only.)
Refer to “3 Measurement in Automatic Range Setting (Auto-Range Function)” (p. 82).

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REC

- The timebase and sampling rate can be set independently. The sampling rate is selected depending on the timebase setting.
- As mentioned below, when the former timebase settings are selected, the instrument displays waveforms that are demagnified horizontally (in the time axis direction) at the latter scale size.
  20 ms/div, ×1/2; 10 ms/div, ×1/5

To perform measurement minimizing the effect of noise

While measuring a waveform that usually fluctuates only slightly, with a fast sampling rate set, a difference between the maximum and minimum values may become large if the amplitude of the waveform changes sharply. To prevent this effect, select a slower sampling rate or enable the module's low-pass filter (p. 73).

Note common to MEM REC

The data refresh rate is not allowed to exceed the maximum sampling rate of the module.
During the period while data is being not updated, the same data is measured, with the result that stair-like waveforms are plotted.
Even when a single signal is sampled simultaneously by two modules, the data may differ with one another due to differences in the sampling rate, frequency bandwidth, and frequency response.

Data refresh rate for various modules

Module	Max. timebase	Max. sampling rate or data refresh rate	Reference information
Model 8966 Model 8973	5 µs/div	50 ns (20 MS/s)	–
Model 8967	Depends on data refresh setting	Depends on data refresh setting	Refer to "8.10.3" (p. 187).
Model 8968	100 µs/div	1 µs (1 MS/s)	–
Model 8969 Model U8969 Model U8979	500 µs/div	5 µs (200 kS/s)	–
Model 8970	Depends on setting	Depends on setting	Refer to "8.10.5" (p. 189).
Model 8971	100 µs/div	1 µs (1 MS/s)	Refer to "8.10.6" (p. 192).
Model 8972	Depends on response setting	Depends on response setting	Refer to "8.10.7" (p. 192).
Model U8975 Model U8977 Model U8978	20 µs/div	200 ns (5 MS/s)	–
Model MR8990	Depends on NPLC setting	Depends on NPLC setting	–
Model U8974	100 µs/div	Depends on response setting	Refer to "8.10.9" (p. 194).

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3.3.3 Setting the Recording Length (Number of Divisions)

MEM REC

Set the recording length (number of divisions) of each data acquisition.

Procedure

To display the screen

Press the **DISP** key to display the waveform screen.

For the memory function

1 **Move the cursor to the [Shot] box.**

2 **Select the type.**

Fixed Shot	Select the length from among the fixed values.
User Shot	Freely specify a value in one division increments.

3 **Set the recording length.**

(Fixed Shot)

Model MR8847-51 (Memory capacity: 64 MW)
25, 50, 100, 200, 500, 1,000, 2,000, 5,000, 10,000, 20,000 div 50,000 div (in 2/4/8-ch mode) 100,000 div (in 2/4-ch mode) 200,000 div (in 2-ch mode)
Model MR8847-52 (Memory capacity: 256 MW)
25, 50, 100, 200, 500, 1,000, 2,000, 5,000, 10,000, 20,000, 50,000 div 100,000 div (in 2/4/8/16-ch mode) 200,000 div (in 2/4/8-ch mode) 500,000 div (in 2/4-ch mode) 1,000,000 div (in 2-ch mode)
Model MR8847-53 (Memory capacity: 512 MW)
25, 50, 100, 200, 500, 1,000, 2,000, 5,000, 10,000, 20,000, 50,000, 100,000 div 200,000 div (in 2/4/8/16-ch mode) 500,000 div (in 2/4/8-ch mode) 1,000,000 div (in 2/4-ch mode) 2,000,000 div (in 2-ch mode)

(User Shot)

Model MR8847-51	1 div to 20,000 div (in 32-ch mode*) 1 div to 40,000 div (in 16-ch mode) 1 div to 80,000 div (in 8-ch mode) 1 div to 160,000 div (in 4-ch mode) 1 div to 320,000 div (in 2-ch mode)
Model MR8847-52	1 div to 80,000 div (in 32-ch mode*) 1 div to 160,000 div (in 16-ch mode) 1 div to 320,000 div (in 8-ch mode) 1 div to 640,000 div (in 4-ch mode) 1 div to 1,280,000 div (in 2-ch mode)
Model MR8847-53	1 div to 160,000 div (in 32-ch mode*) 1 div to 320,000 div (in 16-ch mode) 1 div to 640,000 div (in 8-ch mode) 1 div to 1,280,000 div (in 4-ch mode) 1 div to 2,560,000 div (in 2-ch mode)

*: If using Model U8975, U8977, or U8978

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For the recorder function

1 **Move the cursor to the [Shot] box.**

2 **Select the type.**

Fixed Shot	Select the length among the prepared values.
User Shot	Freely specify a value in one division increments.

3 **Set the recording length.**

(Fixed Shot)

Cont. ON-OFF	When **[ON]** is selected, the instrument performs measurement while continuously overwriting the data in the memory. You can save and print the data obtained during the period from the measurement was stopped until the recording reached its maximum record length.

Model MR8847-51 (Memory capacity: 64 MW)
25, 50, 100, 200, 500, 1,000, 2,000, 5,000, 10,000 div 20,000 div*
Model MR8847-52 (Memory capacity: 256 MW)
25, 50, 100, 200, 500, 1,000, 2,000, 5,000, 10,000, 20,000 div 50,000 div*
Model MR8847-53 (Memory capacity: 512 MW)
25, 50, 100, 200, 500, 1,000, 2,000, 5,000, 10,000, 20,000, 50,000 div 100,000 div*

*: If not using Model U8975, U8977, or U8978

(User Shot)

Model MR8847-51	1 div to 10,000 div 1 div to 20,000 div*
Model MR8847-52	1 div to 40,000 div 1 div to 80,000 div*
Model MR8847-53	1 div to 80,000 div 1 div to 160,000 div*

*: If not using Model U8975, U8977, or U8978

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MEM

Recording length and the number of samples

Every division of the recording length includes 100 samples. The total number of samples in a specified recording length is: Set recording length (divisions) × 100 samples + 1.
However, when the Model MR8990 Digital Voltmeter Unit is installed, the number of samples is as follows:

- When only Model MR8990 is installed
  Number of samples in a division: 50 samples
  Total number of samples in the recording length:
  Set recording length (divisions) × 50 samples + 1

- When both Model MR8990 and other modules are installed
  Channels for Model MR8990
    Number of samples in a division: 50 samples
    Total number of samples in the recording length:
    Set recording length (divisions) × 50 samples + 1
  Channels for other modules
    Number of samples in a division: 100 samples
    Total number of samples in the recording length:
    Set recording length (divisions) × 100 samples + 2

REC

Each recording length division includes 100 samples, each of which consists of two values: the maximum and minimum values.
Data obtained with Model MR8990 using the recorder function has a resolution of 16 bits.

When recording length is set to [Cont.]

- The instrument saves data that is obtained during the period that lasts until the measurement terminates and has the following maximum recording lengths.
  Model MR8847-51: 20,000 div (If using Model U8975, U8977, or U8978: 10,000 div)
  Model MR8847-52: 80,000 div (If using Model U8975, U8977, or U8978: 40,000 div)
  Model MR8847-53: 160,000 div (If using Model U8975, U8977, or U8978: 80,000 div)
- For the range settings of from 10 ms/div to 200 ms/div, the instrument does not perform the real-time print even when the printer setting (real-time print) is set to on. Perform printing manually after measurement terminates (p. 130)
- When the auto-saving is set to on, the instrument does not save any data during the measurement. When the measurement terminates, the data presently written in the internal memory is saved.

When the recording length is changed during measurement
Measured data already acquired in the memory is discarded, and measurement is started using the newly set recording length.

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3.3.4 Setting Screen Layout

MEM REC X-Y

You can lay out waveform displays of input signals on the waveform screen.
This setting also applies to the printing setting.

Selecting X-Y1 mode or X-Y4 mode plots X-Y composite curves.
(This function can be used in the memory and X-Y recorder functions.)
Refer to "7.4 Plotting X-Y Composite Curves" (p. 148).

Procedure

To display the screen

Press the **STATUS** key several times to display the **[Status]** sheet on the status screen.

For the memory function

Move the cursor to the [Format] box.

Single	Displays and records waveforms in a graph. (Default setting)
Dual	Displays and records waveforms in two graphs.
Quad	Displays and records waveforms in four graphs.
Oct	Displays and records waveforms in eight graphs.
Hex	Displays and records waveforms in 16 graphs.
X-Y Single	Plots and records curves that illustrate correlations between them assigning multiple input signals to the X and Y axes in a graph.
X-Y Quad	Plots and records curves that illustrate correlations between them assigning multiple input signals to the X and Y axes in four graphs.

For the recorder function

Move the cursor to the [Format] box.

Single	Displays and records waveforms in a graph. (Default setting)
Dual	Displays and records waveforms in 2 graphs.
Quad	Displays and records waveforms in 4 graphs.
Oct	Displays and records waveforms in 8 graphs.
Hex	Displays and records waveforms in 16 graphs.

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Analog channel assignment

In Dual, Quad, Oct, and Hex mode, you can freely assign analog channels to the different graphs.

Procedure

To display the screen

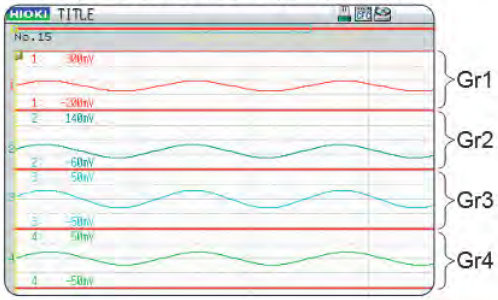
Press the **CHAN** key several times to display the **[Unit List]** sheet on the channel screen.

1 **Move the cursor to the [Graph] box.**

2 **Select the display screen with respect to each channel.**

The graphs are numbered beginning from the top like Gr1, Gr2, Gr3.

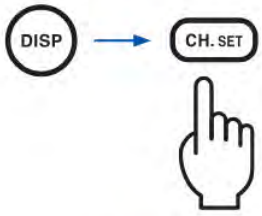
<Example screen after assigning channels>



3.4 Configuring Input Channels Settings

Configuring analog and logic channels settings.

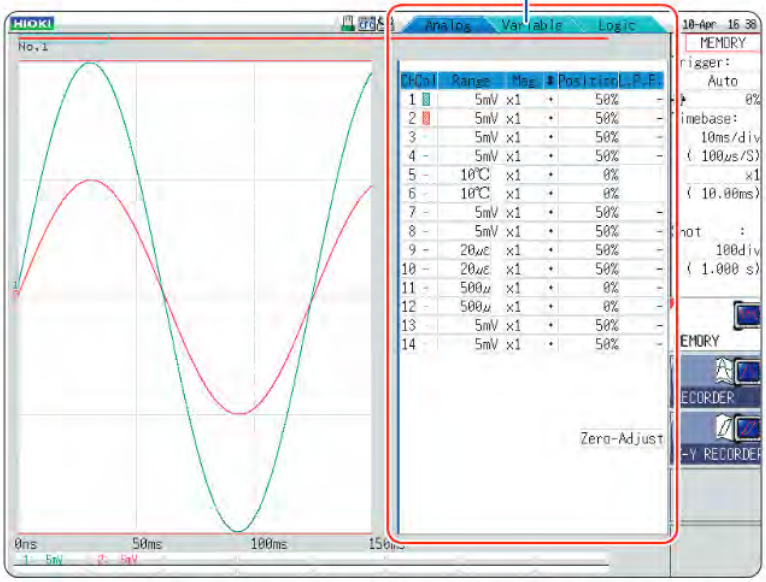
To open the channel settings window



Pressing **CH.SET** key switches the sheets.

[Analog]
↓
[Variable]
↓
[Logic]
↓
[Wave Calc] (when [Wave Calculation] is set to on)
or
[Generator] (when a waveform generator module is installed)
↓
No display

Refer to “Setting the variable function while the waveforms obtained through all of the channels are being displayed” (p. 180).



If the channel setting screen is hard to be observed due to waveforms overlay, reduce the waveform display width to separate the waveform display screen from trigger settings screen.
Refer to "7.7.3 Switching the Waveform Display Width" (p. 156).

To reduce the number of displayed waveforms

Set the waveform display color setting on the Channel setting window to off.
Refer to “1. Waveform display color” (p. 73).

To apply a channel setting to another channel

Refer to “8.9 Copying Settings to Other Channels (Copy Function)” (p. 183).

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3.4.1 Channel Setting Procedure

The procedure below shows how to configure the analog channels (CH1 through CH16) settings.

1 Configuring the settings of input and screen display

Refer to the following pages:

Configuring the input coupling setting	(p. 74)
Selecting an appropriate range for the input signal	(p. 73)
Scaling the input value (As needed)	(p. 171)
Configuring the filter setting (If performed in noisy environment)	(p. 76)
Finely adjust the waveform amplitude (As needed)	(p. 74)
Magnify/demagnify the waveform vertically (in the voltage-axis direction) (As needed)	(p. 74)

2 Configuring the trigger settings (as needed)

Refer to (p. 211).

3 Configuring the settings of waveform display colors and positions

Refer to the following pages:

Setting the waveform display color	(p. 73)
Setting the display position and magnification ratio (As needed)	(p. 178)

4 Configuring the graph display settings

Refer to the following pages:

In Single, Dual, Quad, Oct, and Hex mode	(p. 70)
In X-Y Single and X-Y Quad mode	(p. 149)

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- Setting the input coupling set to GND disables the range settings because the waveforms seem to have no amplitude.
- Filter attenuation may influence correct range settings.
- When choosing trigger settings, set the vertical axis (voltage axis) range first. When you change the range after specifying the trigger, the trigger setting is changed.
- When using the variable function, set the vertical axis (voltage axis) range first. When you change the range setting after applying the variable function, observation of waveforms with sufficient precision may not be possible.
- When using the variable and scaling functions together, enable the scaling function first. When you enable the scaling function after enabling the variable function, an unintended display may be displayed.

This section describes the setting procedure for logic channels (standard logic terminals: LA through LD, expansion logic terminals: L1A through L8D).

1 Configuring the display settings

Configuring the logic recording width settings Refer to (p. 76).

2 Configuring the settings of waveform display colors and positions

Refer to the following pages:

Setting the waveform display positions (p. 76)

Set waveform display colors (p. 77)

- The waveform display positions can be specified in one percent point increments.
- No logic waveforms are displayed in X-Y1 and X-Y4 modes
- Op to three logic modules can be installed. The fourth logic module and later modules installed in the instrument are ignored.

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3.4.2 Configuring Analog Channels Settings

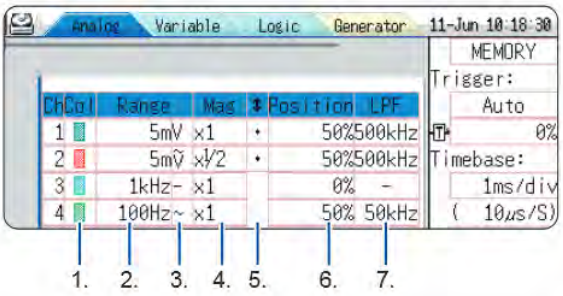
For information about specific settings for each module, refer to “8.10 Setting Details of Modules” (p. 184).

Procedure

To display the screen

Press the **DISP** key to display the waveform screen, and then press the **CH.SET** key to open the channel settings window (**[Analog]** sheet).

1. **Move the cursor to a box for which you want to change the settings.**
2. **Select settings by pressing the F key.**



To apply the channel settings to another channel

Refer to “8.9 Copying Settings to Other Channels (Copy Function)” (p. 183).

1. Waveform display color

Sets the color of the waveform of the selected channel. Each channel can have a different color setting from or the same color setting as other channels.

Off	Displays no waveform. When **[Save Channel]** of the auto-saving setting is set to **[Display Ch]**, the instrument does not save any data of this channel. Refer to “Select the channels to be saved.” (p. 99).
On	Displays the waveform. To select the display color, press **[↑]** and **[↓]** in the **F** keys.
ALL On-Off	You can switch the waveforms display between on and off for entire channels.

2. Vertical axis (voltage axis) range

Sets the vertical axis (voltage axis) range with respect to each channel. You can set the vertical axis range in terms of voltages per division.
When the variable auto-correction is set to **[Off]** and the variable function is set to **[On]**, the size of the waveform displayed on the screen is fixed regardless of the vertical axis (voltage axis) ranges.

Full-scale value (Full-scale value) = [Vertical axis (voltage axis) range] × 20 div
Example: When the vertical axis (voltage axis) range is set at 1 V/div, the full-scale value is calculated as 1 V/div × 20 = 20 V.
The measurable range is ±20 V.

If a waveform amplitude falls outside of the range

Changes the vertical axis (voltage axis) range to a lower sensitivity setting.

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3. Input coupling

You can set the input signal coupling method. Typically, select the DC coupling.

DC (V, –)	Measures the input signals including both DC components and AC components. (Default setting)
AC ($\widetilde{V}$, ~)	Measures the input signal, including AC components only. DC components are rejected.
GND ($\perp$)	Measures the input signals short-circuiting the input signal to the ground (This enables you to check the zero position of the signal).

4. Vertical axis (voltage axis) magnification ratio

You can set the magnification ratio of waveforms in the vertical axis (voltage axis) direction for displaying and printing waveforms respect to each channel. Magnifying waveforms are performed based on the zero position. Magnifying waveforms does not influence the measurement resolution.
Refer to "7.5.3 Magnifying/demagnifying the Waveforms Vertically (in the Voltage Axis Direction)" (p. 153).

To display waveforms magnified in user-defined magnification ratios, enables the variable function.
When signs of displayed waveforms are reversed, you can flip the waveforms vertically.
Refer to "8.6 Setting the Waveform Position (Variable Function)" (p. 178) and "8.8 Inverting the Waveform (Invert Function)" (p. 182).

5. Vernier

You can finely adjust input voltage amplitudes freely on the waveform screen (This fine adjustment changes waveforms shape only seemingly).
Finely adjusting waveform amplitudes enables you to calibrate the instrument for physical values recorded with sensors such as noise, temperature, and acceleration sensors.
Refer to "8.7 Fine-Adjusting Input Values (Vernier Function)" (p. 181).

6. Zero position

You can set the zero-volt level display position. If the zero-volt input level is displaced, perform the zero-adjust.
Refer to "2.7 Adjusting the Zero Position (zero-adjustment)" (p. 55) and "2.8 Performing Calibration (When Model MR8990 is Installed)" (p. 56).

To move the zero positions of entire channels at a time, press **[Preset]**.

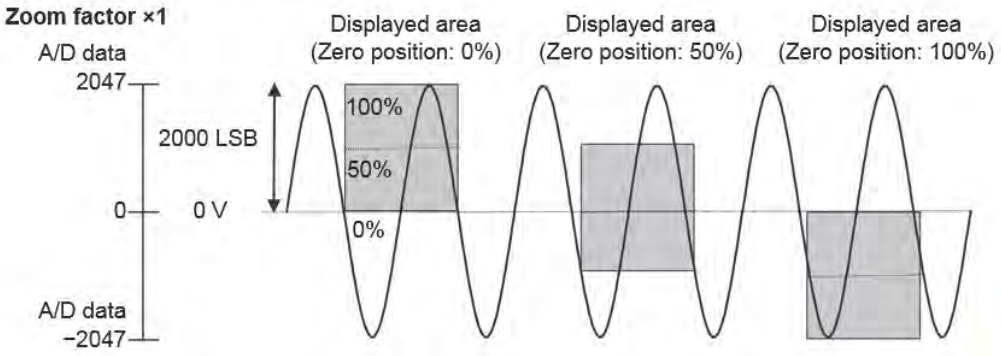
Ascending (3%→96%)	Moves the zero position of CH1 to the 10% level of the vertical axis and those of the following channels, through CH16, to each position that increases in 5 percentage points increments.
Descending (96%→3%)	Moves the zero position of CH1 to the 90% level of the vertical axis and those of the following channels, through CH16, to each position that decreases in 5 percentage points increments.
All Ch 0%	Moves the zero position of entire channels to the 0% level of the vertical axis.
All Ch 50%	Moves the zero position of entire channels to the 50% level of the vertical axis.

If the zero position of the waveform obtained with Model 8969 or U8969 Strain Unit is displaced, perform the auto-balance.
Refer to "8.10.4 Setting Model 8969 and U8969 Strain Unit" (p. 188).

- The zero position setting merely change waveform positions, not applying any offsets to inputs signals.
- The vertical axis (voltage axis) magnification/demagnification of waveforms is performed based on the zero position.
- The zero position adjustment and the vertical axis (voltage axis) magnification/demagnification merely change displayable voltage ranges on the waveform screen. No actual measurement ranges are not changed.

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The zero positions are moved as shown in the illustration below. (Example: Model 8966 Analog Unit)



Resolution of each module in screen display range (LSB)

Module	Magnification ratio									
	×1/10	×1/5	×1/2	×1	×2	×5	×10	×20	×50	×100
Model 8966 (Analog) Model 8971 (Current) Model 8972 (DC/RMS)	20000 (4000)	10000 (4000)	4000	2000	1000	400	200	100	40	20
Model 8967 (Temperature)*	200000	100000	40000	20000	10000	4000	2000	1000	400	200
Model 8968 (High resolution) Model U8974 (High voltage) Model U8975 Model U8978 (4CH analog) Model U8977 (3CH current)	320000 (64000)	160000 (64000)	64000	32000	16000	6400	3200	1600	640	320
Model 8969 Model U8969 (Strain) Model U8979 (Charge)	250000 (64000)	125000 (64000)	50000	25000	12500	5000	2500	1250	500	250
Model 8970 (Power frequency)	20000	10000	4000	2000	1000	400	200	100	40	20
Model 8970 (Count)	400000	200000	80000	40000	20000	8000	4000	2000	800	400
Model 8970 (Excluding power frequency and count)	100000	50000	20000	10000	5000	2000	1000	500	200	100
Model MR8990 (DVM)	10000000 (1200000)	5000000 (1200000)	2000000 (1200000)	1000000	500000	200000	100000	50000	20000	10000

The magnification ratios enclosed in the brackets represent ranges of valid data.
*: For Model 8967 Temp Unit, the valid range varies depending on thermocouples. For information about the minimum resolution, see the specifications of Model 8967 Temp Unit.

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7. Low-pass Filter

You can set the low-pass filter installed in the module. Enabling this function can eliminate unwanted high-frequency components.

Settable filter types varies depending on modules. Select a suitable setting according to an input signal characteristics.

3.4.3 Configuring Logic Channel Settings

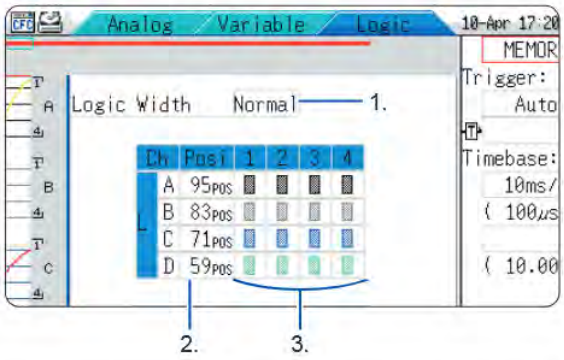
The **[Logic]** sheet appears in Single, Dual, Quad, Oct, and Hex mode.

Procedure

To display the screen

Press the **DISP** key to display the waveform screen, and then press the **CH.SET** key to open the channel settings window (**[Logic]** sheet).

1. **Move the cursor to a box for which you want to change the settings.**
2. **Select settings by pressing the F key.**



To apply the channel settings to another channel

Refer to "8.9 Copying Settings to Other Channels (Copy Function)" (p. 183).

1. Logic width

You can change the display width of the logic waveform.
Making waveforms narrower can enhance the readability of the display containing a large number of waveforms.

Wide	Displays waveforms at expanded width.
Normal	Displays waveform at the normal width.
Narrow	Displays waveform at reduced width. (Default setting)

2. Waveform display position

You can set the logic waveforms positions.
You can freely move the positions of the logic waveforms within the range of the display.

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3. Waveform display color

You can set the waveforms color of the selected channel. You can set the same color as those for other channels.
For logic modules, either each module or each channel can have a different color setting.

OFF	Displays no waveform. When **[Save Channel]** of the auto-saving setting is set to **[Display Ch]**, the instrument does not save any data of this channel. Refer to "Select the channels to be saved." (p. 99).
ON	Displays the waveform. Press the **F** key to set the display colors.
Probe ON-OFF	Switches the waveform display between on and off at a time for those obtained with a single probe.
ALL ON-OFF	Switches the entire logic waveform display between on and off at a time. This setting is selectable when the cursor is placed on any item of the waveform display position box.

Setting the standard logic (LA, LB, LC, and LD) display setting to **[ON]** disables Model 8970 Freq Units installed in Unit 1 and Unit 2 positions. Furthermore, it deteriorates the resolutions of Models 8967 Temp Unit, 8968 High Resolution Unit, 8969 Strain Unit, U8969 Strain Unit, U8974 High Voltage Unit, and U8979 Charge Unit from 16 bits to 12 bits. Installing Models MR 8990 Digital Voltmeter Unit, U8793 Arbitrary Waveform Generator Unit, MR8790 Waveform Generator Unit, or MR8791 Pulse Generator Unit installed in Unit 1 and Unit 2 positions disables the standard logic terminals.

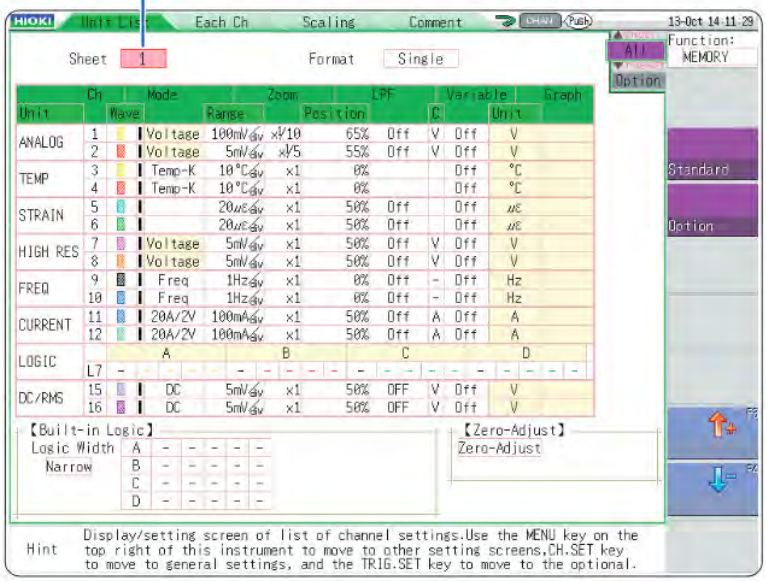
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3.4.4 Display Sheet

MEM REC

The input channel settings can be set with respect to each display sheet. Up to four sheets are available. You can assign waveforms to be displayed to each display sheets and switch a display sheet to another.

Switching sheets (1 through 4)



- You can set the following display-related settings only with respect to each display sheet.
  Analog waveform: Display on/off, waveform color, magnification ratio, zero position, graph, variable (on/off, upper and lower limits)
  Logic waveform: Display on/off, waveform color, display position, logic width
  X-Y waveform: Display on/off, display color, X ch, Y ch, waveform calculation (X ch, Y ch)
  Common setting: Display format

- The measurement-related settings other than above are common to all displayed sheets. When a range is changed, the ranges of entire display sheets are changed.
- Saving settings files operation saves the settings of all displayed sheets.
- Saving waveform files operation saves the waveforms in the setting of the sheet displayed at the time of saving. When you try to load a waveform file, only the sheet displayed at the time of saving can be loaded because other sheets were not saved.

You can configure the waveform calculation settings using the channel setting window.
See "3.4 Configuring Input Channels Settings" (page 70)

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3.5 Starting and Stopping Measurement

Procedure

To display the screen

Press the **DISP** key to display the waveform screen.

To start measurement

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

- When measurement is started, waveform data displayed on the screen is cleared.
- Applying a signal to the external control terminal can start measurement.
  Refer to "17 Controlling the Instrument Externally" (p. 369).

To prevent starting measurement unintentionally

To prevent starting measurement by operation mistakes, you can set the **START** key acceptance condition.
Refer to "Start Action" (p. 338).

To automatically save data during measurement

Refer to "5.2.2 Automatically Saving Waveforms" (p. 96).

To print waveforms

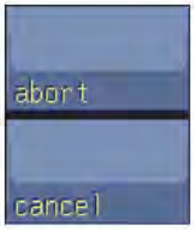
Refer to "6 Printing Data" (p. 125).

To stop the measurement in progress

Press the **STOP** key once to stop the measurement in progress after the specified recording length expires.
Press the **STOP** key once again to stop the measurement in progress immediately.

You can change key acceptance conditions for the **START** and **STOP** keys.
Refer to "15 Setting the System Environment" (p. 335).

Pressing the **STOP** key may display the following GUI on screen.



F1 Stops the measurement in progress immediately.
(the same behavior as that when pressing the **STOP** key twice)

F2 Cancels the stopping action and continue the measurement in progress.

When no keys are operated during this status, the measurement is terminated after the specified recording length expires, and the display returns to the previous screen.

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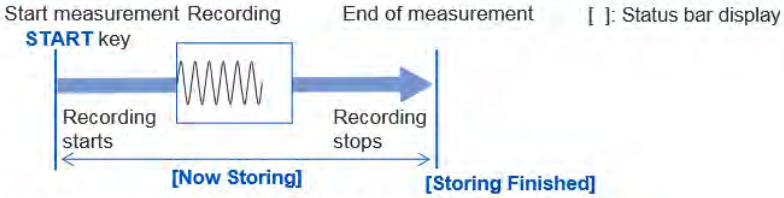
Measurement and internal operations

Two options of the measurement methods available: the normal measurement (starts measuring and recording waveforms at once) and trigger measurement (starts recording waveforms when trigger conditions are satisfied). In this manual, "Start of measurement" indicates the time when you press the **START** key, and "start of acquisition" indicates a start time of waveform acquisition on the waveform screen.

To trigger the instrument once or repeatedly
Select the trigger mode. (p. 213)
To observe data acquired preceding the trigger point
Set a pre-trigger. (p. 227)

Typical measurement

Without trigger setting

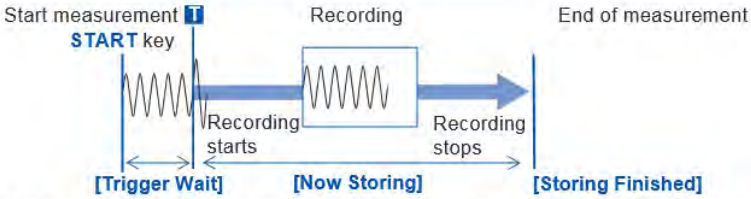


The recording terminates after the recording length expires.

Triggered measurement

Triggering the instrument once

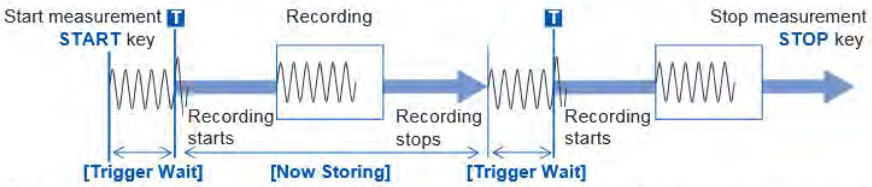
Trigger mode:
[Single]
With the pre-trigger not enabled



A trigger event starts recording, and the recording terminates after the recording length of the data is acquired.

Triggering the instrument repeatedly

Trigger mode:
[Repeat]
With the pre-trigger not enabled

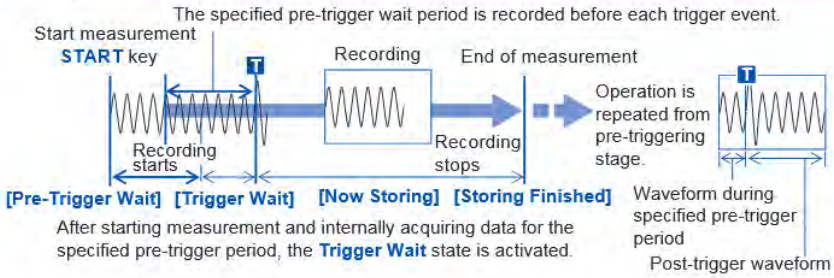


A trigger event starts recording, and the recording terminates after the recording length of the data is acquired, setting the instrument to wait for another trigger.

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Triggering the instrument repeatedly and recording phenomena before each trigger event

Trigger mode:
[Repeat]
With the pre-trigger enabled



The data before a trigger event (for the pre-trigger period) is acquired.

When the trigger mode is set to **[Repeat]** or **[Auto]** (the memory function only), the number of trigger events is displayed at the top of the screen. (storage counter)
Refer to “Explanation of screen contents” (p. 22).

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3.6 Measurement in Automatic Range Setting (Auto-Range Function) MEM

This function is enabled only for measurement with the analog modules with the memory function enabled.

When you press the **AUTO** key after inputting signals to an analog module and select **[Auto Range]**, the horizontal axis range (timebase), vertical axis (voltage axis) range, and zero position are selected automatically, and then measurement is started.
The timebase is set to the lowest numbered channel of the channels with those waveform display setting set to on. In addition, it is set automatically so that waveforms with a length of from one cycle to 2.5 cycles in 25 divisions are recorded.

Setting the auto-range function set to on changes the following items.

Module-related conditions (For all channels)	
Vertical axis (voltage axis) range	Automatically-set value
Zero position	
Vertical axis (voltage axis) magnification ratio	×1
Low-pass filter	Off
Input coupling	DC

Trigger conditions (For a single channel only)	
Trigger mode	Auto
Logical operation between trigger sources	OR
Pre-trigger	20%
Internal trigger	Set to on is only the lowest numbered channel of channels with those waveform display setting. (If the difference between maximum and minimum value is eight divisions or less, the second lowest numbered channel is turned on.)
Trigger type	Level trigger: Slope, Rising Trigger level: Automatically-set value Filter: Off

Condition of [Status] sheet on the status screen	
Timebase	Automatically-set value (time axis magnification ratio: ×1)

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- When measurement is started in the auto-range setting, the trigger output signal is output from the external control terminal block's TRIG OUT terminal. Keep this in mind when performing auto-range measurement while using the trigger output terminal.
- The auto-range function automatically selects settings for an input signal when the function is enabled. After supplying an input signal (waveform), start auto-range measurement.
- If the input signal of the lowest numbered channel with the waveform display setting set to on have extremely low amplitude, the timebase is set according to the input signal of the next lowest numbered channel.
- If the range cannot be set for any channels with waveform display setting set to on, a warning message is displayed, with the result that the measurement in progress is interrupted.
- The auto-range measurement disables the auto-saving and auto-printing functions.
- For a low-frequency signal of less than 10 Hz, the optimal ranges cannot be selected automatically. Set the ranges manually.
- Using the following modules disables the auto-range function:
  Models 8967 Temp Unit, 8969 Strain Unit, U8969 Strain Unit, 8970 Freq Unit, MR8990 Digital Voltmeter Unit

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4 X-Y Recorder

- You can plot X-Y composite curves each of which presents the relationship between an input signal and another in real time.
- Since the instrument writes the data of plotted curves in the memory, it can save the data as files as well as print the curves.
- You can set the waveforms plotting setting to on and off in the same manner as the pen raising and lowering setting installed in typical X-Y pen recorders.
- You can observe up to eight X-Y composite curves simultaneously.
- Since the instrument writes X-Y composite curves in the memory, it can redraw the X-Y composite curves in other display settings after measurement.

Example of X-Y recorder waveform screen (in X-Y4 mode)



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4.1 Measurement procedure

1 Inspecting the instrument before measurement

Refer to "3.2 Inspecting the Instrument Before Measurement" (p. 59).

2 Configuring the basic measurement settings

Refer to the following pages:

Setting the measurement function to the X-Y recorder	"Measurement function" (p. 87)
Setting the sampling rate	"Sampling" (p. 87)
Setting the X-Y composite curve display mode	"Format" (p. 87)
Specify whether to perform X-Y composite curve interpolation	"Dots-Line (interpolation)" (p. 87)
Specify whether to clear previous X-Y composite curve data	"Disp Clear" (p. 87)

3 Configuring the input channel settings

Configuring the analog channel settings

Refer to "3.4.2 Configuring Analog Channels Settings" (p. 73).

Logic channels cannot be used.

Advanced settings

Refer to the following pages:
"8.6 Setting the Waveform Position (Variable Function)" (p. 178)
"8.7 Fine-Adjusting Input Values (Vernier Function)" (p. 181)
"8.1 Adding Comments" (p. 160)
"8.5 Converting Input Values (Scaling Function)" (p. 171)

4 Starting measurement

Refer to the following pages:
"4.3 Starting and Stopping Measurement" (p. 88)
"7.1 Reading Measured Values (Using Cursors A and B)" (p. 140)

The X-Y recorder function does not support the following operations:
- Trigger setting
- Auto-saving
- Auto-printing

5 Completing the measurement

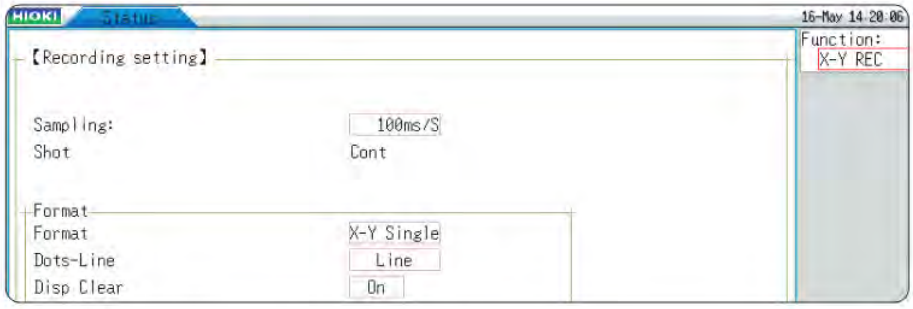
Refer to the following pages:
"4.3 Starting and Stopping Measurement" (p. 88)
"4 Redraw X-Y composite curves" (p. 88)
"5.2.3 Saving Data Selectively (SAVE Key)" (p. 103)
"6.3 Manually Printing Data by Pressing the PRINT Key (Selection Print)" (p. 130)

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4.2 Setting Measurement Conditions

To set the measurement conditions, press the **STATUS** key to display the status screen, and then select the **[Status]** sheet. (The measurement functions and sampling rates can also be set on the waveform screen.)

Setting items



Measurement function Set the measurement function to **[X-Y REC]**.

Sampling Set the sampling rate.

1 ms, 10 ms, 100 ms (Default setting)

The setting **[1 ms]** can be set only when the **[Dots-Line]** is set to **[Dots]**.

Format Select the graph format for the waveform screen display or printout of the input signal. Up to eight phenomena can be observed simultaneously.

X-Y Single	The waveforms of Graphs 1 through 8 are shown and recorded on a single screen. (Default setting)
X-Y Quad	The waveforms of Graphs 1 through 8 are shown and recorded on four screens.

Dots-Line (interpolation) Select whether to display and print the input waveform (sampling data) as dots (sampling points) or perform the linear interpolation. Dot display allows faster sampling.

Dots	Displays and prints sampling data as dots.
Line	Displays and prints linearly interpolated sampling data. (Default setting)

Disp Clear When previously plotted X-Y composite curves remain at the start of measurement, you can choose between leaving them and clearing them. When you choose to leave them, the new waveforms are displayed as an overlay.

Off	Overlays new waveforms with the existing waveforms.
On	Clears the previously plotted waveforms. (Default setting)

Setting measurement conditions terminates.
Next, configure the analog channel settings.
For details, refer to “3.4.2 Configuring Analog Channels Settings” (p.73).

To choose channels used to plot X-Y composite curves

Refer to “7.4 Plotting X-Y Composite Curves” (p.148).

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4.3 Starting and Stopping Measurement

Press the **DISP** key to go to the waveform screen.

1 Start measurement.

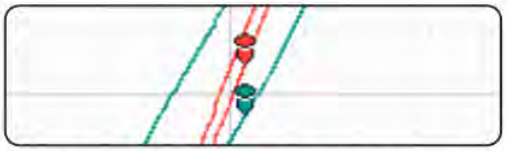
Press the **START** key to start measurement.

2 Setting the X-Y composite curves plotting set to on and off (setting the pen setting to up and down)

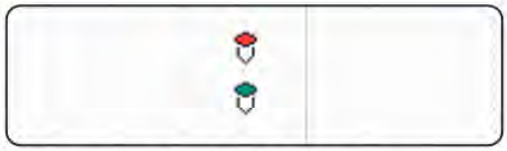
You can choose this setting both before and during measurement. Setting the pen setting to Down enables the X-Y composite curve plotting function. Setting the pen setting to Up disables the X-Y composite curve plotting function. This setting applies to all channels.
Move the cursor to the **[Pen]** box to change the setting.

Up	Disable the X-Y composite curve plotting function.
Down	Enable X-Y composite curves to be plotted.

Pressing the **TRIG.SET** key or the **Manual Trigger** key can switch the **[Pen]** setting between up and down as well.



Setting the pens in the Down position
The pens are shown in colors and curves are plotted.



Setting the pens in the Up position
The pens are shown in white, and no X-Y composite curves are plotted.

3 Stop the measurement in progress

Press the **STOP** key to stop the measurement in progress.

4 Redraw X-Y composite curves

The instrument plots the X-Y composite curves that start from any specified sampling point and consists of 4,000,000 (if using the U8975, U8977, or U8978: 2,000,000) samples of the data recorded before the measurement terminated, playing back the X-Y composite curve plotting in the same manner as video recorders.
This setting applies to all channels. You can specify the playback speed. (You can change it also during playback.) X-Y composite curves are only played back on the screen, not affecting the printout data. To print the same X-Y composite curves as shown on the screen, use the screenshot function (p. 136).

Move the cursor to the **[Player]** box.

Clear	Clears only the displayed X-Y composite curves. (The instrument does not discard the waveform data written in the memory.)
Redraw	Redraws the X-Y composite curves. The X-Y composite curve display conditions can also be changed for plotting the curves again.
First	Moves the pens to the start points of the X-Y composite curves.
Last	Moves the pens to the end points of the X-Y composite curves.
Play/Stop	Starts and stops the X-Y composite curve playback.

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Move the cursor to the **[Speed]** box. In the **[Normal]** setting, plays back the X-Y composite curves at the same speed as at which they recorded.	Very Fast / Fast / Normal (Default setting) / Slow / Very Slow

Inputting signals to the external control terminal can start and stop measurement and switch the **[Pen]** setting between up and down as well. (p. 371)

To redraw the X-Y composite curves in different X-Y composite curve display settings

- Even after the X-Y composite curve display is cleared, the waveform data is still retained in the memory. This makes it possible to redraw the X-Y composite curves in different settings, which include the display format, display color, channels used for plotting the curves, channel magnification ratio, and channel offset, from those previously set. (Select **[Redraw]**) Executing **[Redraw]** update the screen and printout data.
  (Until **[Redraw]** is not executed, the screen and print data are not updated, even if the settings are changed.)
- The X-Y composite curves can also be redrawn by operating the jog dial and shuttle ring.
  Jog dial Plots the X-Y composite curves and plays back the plotting of the curves inversely in one sample increments.
  Shuttle ring Plots the X-Y composite curves and plays back the plotting of the curves inversely at speed proportional to the rotation angle.

- To play back the plotting of the X-Y composite curves inversely, plot curves in the direction of earlier data. Erasing the X-Y composite curves is not possible.
- If the measured data exceeds 4,000,000 (if using the U8975, U8977, or U8978: 2,000,000) samples, it is only possible to redraw up to 4,000,000 (if using the U8975, U8977, or U8978: 2,000,000) samples in the past, counting backward from the point when measurement terminated. The instrument discards waveform data obtained earlier.
- Redrawing the X-Y composite curves with the jog dial and shuttle ring affects the X-Y composite curves displayed on the screen only and does not affect the printout data. To print the same X-Y composite curves as shown on the screen, use the screenshot function (p. 136).

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4.4 Observing X-Y Composite Curves

Up to 4,000,000 samples of waveform data are written in the memory, and you can observe those measured values using Cursors A and B. (p. 140)
The bar at the top of the screen indicates the amount of the occupied memory.

When the number of samples reaches 4 million, the sign **[OVER]** appears next to the screen bar at the top.



s

Saving X-Y composite curves

Pressing the **SAVE** key or executing the saving command using the file screen saves the waveform data written in the memory as a file.
Refer to “5.2.3 Saving Data Selectively (SAVE Key)” (p.103).

The data saved in this way as a file can be loaded into the instrument; however, cannot be loaded into computers.

Printing X-Y composite curves

Pressing the **PRINT** key prints out the X-Y composite curves.
Refer to “6.3 Manually Printing Data by Pressing the PRINT Key (Selection Print)” (p.130).

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5 Saving/Loading Data and Managing Files

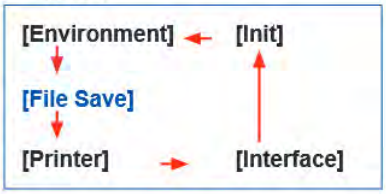
This chapter explains how to save and load data and manage files.

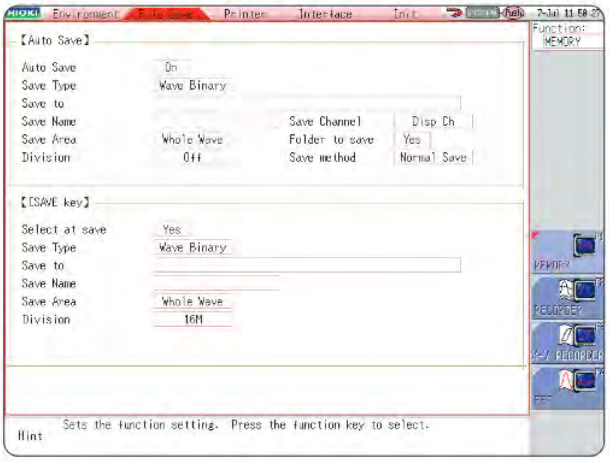
Before saving data, configure the save settings on the **[File Save]** sheet of the system screen.
The **File screen** allows you to load data and manage files.

To display the [File Save] sheet



Pressing the **SYSTEM** key switches the sheets to be displayed in the following order:





Operations available on the [File Save] sheet

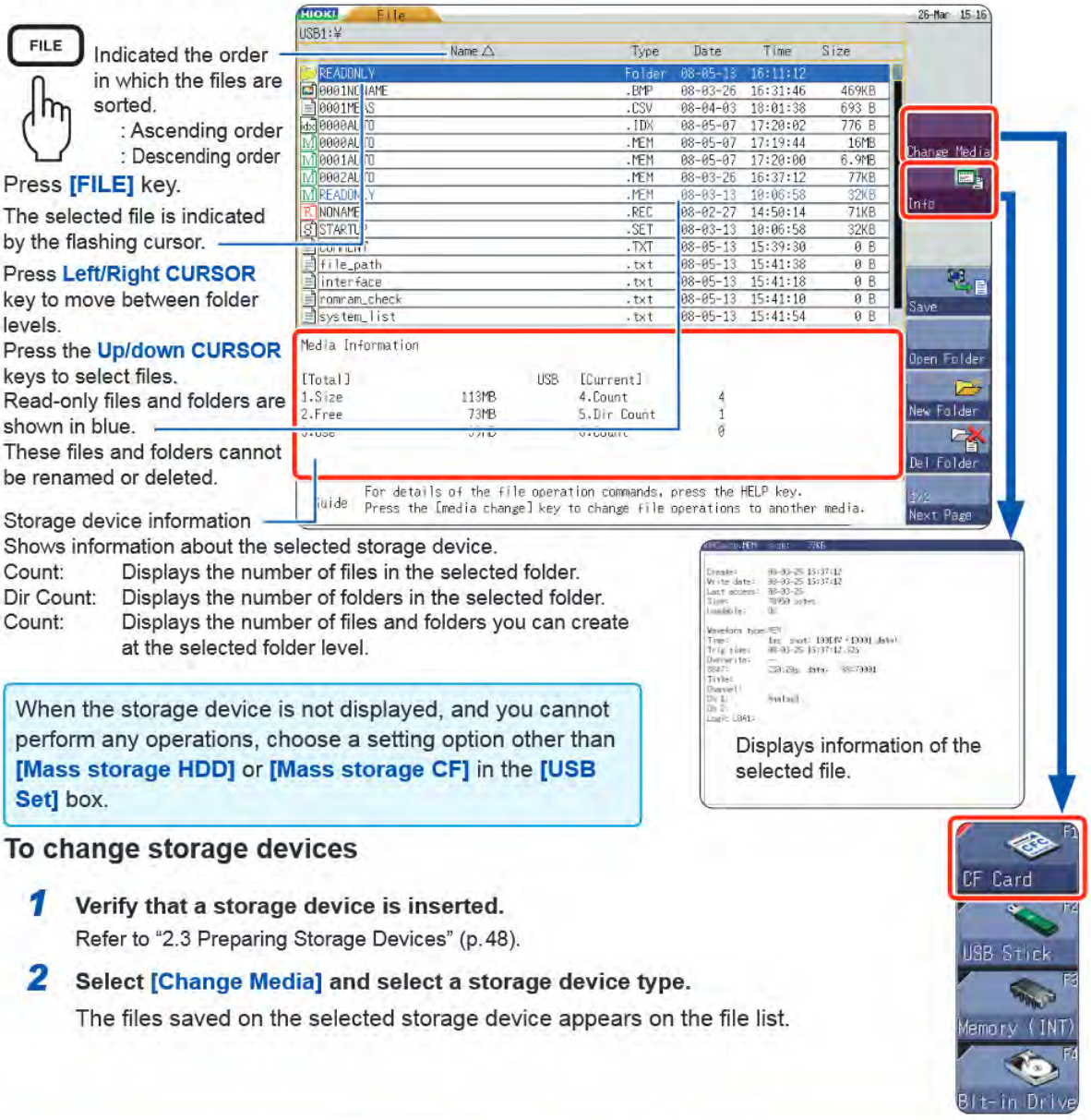
The following settings are available on the **[File Save]** sheet. Refer to (p. 95).

Auto-saving settings
Setting the method of the auto-saving of waveform data.

SAVE key settings
Setting the method of saving the data when pressing the **SAVE** key.

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To display the file screen



When the storage device is not displayed, and you cannot perform any operations, choose a setting option other than **[Mass storage HDD]** or **[Mass storage CF]** in the **[USB Set]** box.

To change storage devices

1 **Verify that a storage device is inserted.**
Refer to "2.3 Preparing Storage Devices" (p.48).

2 **Select [Change Media] and select a storage device type.**
The files saved on the selected storage device appears on the file list.

Operations available from the file screen

Formatting storage devices (p. 50)

Loading data (p. 110)

Saving and loading auto-settings files (p. 113)

Managing files (p. 95)

- Saving data (p. 115)
- Creating a new folder (p. 118)
- Copying a file (p. 122)
- Sorting files (p. 120)
- Deleting a file (p. 119)
- Renaming a file (p. 121)
- Printing a file table (p. 123)

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5.1 Data That Can Be Saved and Loaded

✓: Yes, –: No

File type	File format	Icon	File extension and description		Save		Load	Computer-readable
					Auto.	Manual		
Settings data[*1]	Binary		SET	Settings data (measurement conditions)	–	✓	✓	–
Waveform data[*2] The entire length of the waveforms or the portion of waveforms within the range between Cursors A and B (acquired in the instrument)	Binary		MEM	Memory function waveform data	✓	✓	✓	–[*4]
			REC	Recorder function waveform data	✓	✓	✓	–[*4]
			XYC	X-Y recorder function X-Y curve data	–	✓	✓	–
			FFT	FFT function data	✓	✓	✓	–
	Text		CSV	Text data	✓	✓	–	✓
Waveform management data[*3] (memory division / division save)	(Index file)		IDX	Index data for division save	✓	✓	✓	–
			SEQ	Index data for memory division (automatically created during batch saving)	✓	✓	✓	–
Captured screen images (Display/ Waveform screens)	BMP[*5]		BMP	Image data	–	✓	–	✓
Numerical calculation results	Text		CSV	Text data	✓	✓	–	✓
Comments for printing	Text		TXT	Text data	–	–	✓[*6]	✓
Waveform evaluation settings data	Binary		ARE	Settings data (Measurement conditions + waveform evaluation areas)	–	✓	✓	–
Waveform evaluation area	BMP		BMP	Waveform evaluation area image data	–	✓	✓	✓
Arbitrary waveform data	Binary		WFG	User-defined waveform data (For U8793)	–	✓	✓	–
User-defined waveform data	Text		TFG	User-defined waveform data (For U8793)	–	–	✓	✓
Pulse pattern data	Binary		PLS	Pulse pattern data (For MR8791)	–	✓	✓	–
Generation program data	Program		FGP	Generation program data (For U8793)	–	✓	✓	–

*1: Multiple files can be registered in the instrument and loaded selectively. Automatic loading at power-on is also possible. (p. 113)

*2: To load the data onto the instrument
Save the data in binary format. The waveform data and a part of the measurement settings data are saved.
To load the data onto computers
Save the data in text format. (p. 95)
To save a portion of the waveform
Specify the range to be saved with Cursor A and B. (p. 140), (p. 145)

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*3: To load the data, which is saved with the memory division enabled, of entire blocks at once
Save measured data in the **[All blocks]** setting. A directory including waveform data for each block and index data (SEQ) is automatically created. Load this index data.
To load waveform data that is saved using division save
Load the IDX index data.
*4: Load files with Wave Viewer (Wv).
*5: This is a standard Windows graphics format. Many graphics programs can open files in this format.
*6: You can print out text files created with a computer along with loaded waveforms. Other processing operations are not available.

Files that exceed 2 GB cannot be saved.

Data that cannot be loaded onto the instrument

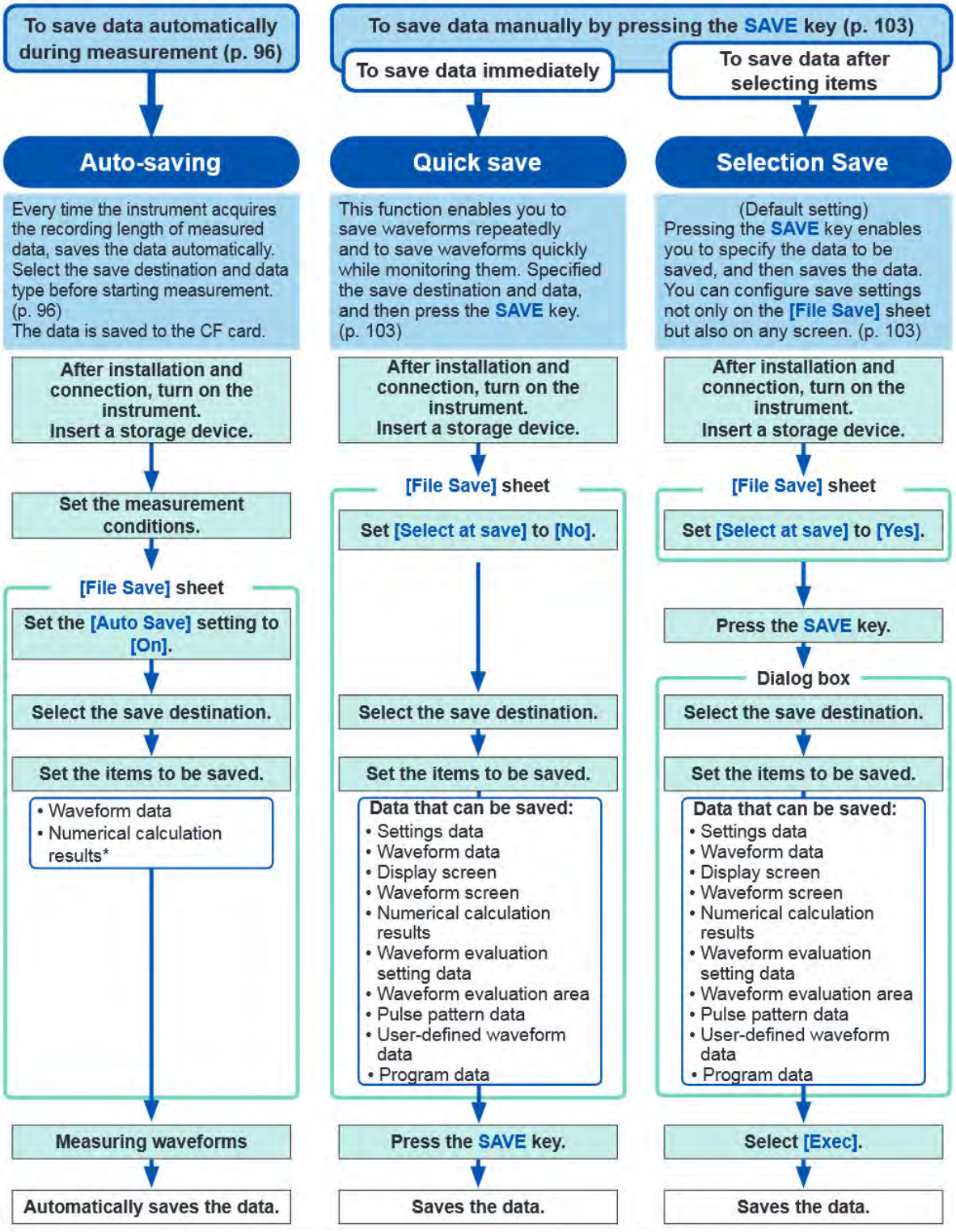
- Data saved by other instruments
- Image files other than waveform evaluation areas ()
- Files displayed with the icon .

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5.2 Saving Data

5.2.1 Save Types and Setting Procedure

There are basically three types of save operations.



Check the following before saving data:
- Have you already inserted and initialized the storage device? (p. 48), (p. 50)
- Is the save destination specified correctly?
- Is [Auto Save] set to [On]? (For auto-saving)

*** To save numerical calculation results automatically**

Refer to "10.4 Saving the Numerical Calculation Results" (p.246).

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5.2.2 Automatically Saving Waveforms

The instrument automatically saves the waveform data as files every time it writes the recording length of the waveform data in the memory. Set the save destination and items to be saved before starting measurement.

Procedure

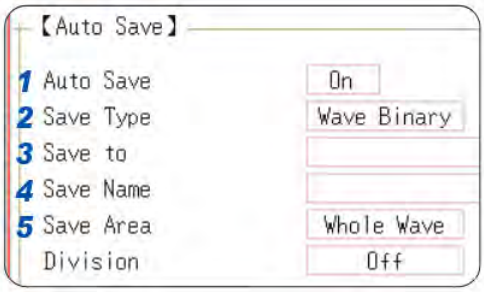
To display the screen

Press the **SYSTEM** key to open the system screen, and then select the **[File Save]** sheet.

1 **Enable auto-saving.**

Move the cursor to the **[Auto Save]** box, and select **[On]**.

Default setting: Off (no automatic saving)



2 **Set the save type.**

Move the cursor to the **[Save Type]** box.

Wave Binary	Saves waveform data in binary format. (Only the data saved in binary format can be loaded onto the instrument.)
Wave Text	Saves waveform data in text format. The instrument decimates the data and saves it as a file. (You can open the files with editors and spreadsheet software installed in computers; however, cannot load onto the instrument.)

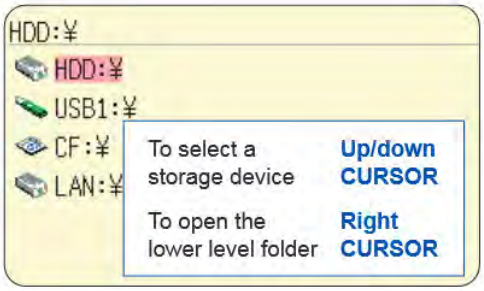
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3 Set the save destination.

Move the cursor to the **[Save To]** box and select **[Edit]**.

The folder dialog box is displayed (at the bottom right).

Move the cursor to a device to be set as the save destination*, and select **[Confirm]** to confirm the selection.



HDD	Automatically saves the waveform data on the built-in drive. (When Model U8331 SSD Unit is installed.)
CF	Automatically saves the waveform data on a CF card.
USB	Automatically saves the waveform data on a USB flash drive.
LAN	Automatically saves the waveform data on a computer connected via LAN. Model 9333 LAN Communicator is required.

When the root directory (the topmost folder on the storage device) is selected, the "HIOKI8847" folder is automatically created. (When the storage device has been formatted with the instrument, the instrument has already created the folder.) Files are saved in this folder.

To create a new folder to be set as the save destination,
select **[New Folder]**. When the save destination is set to **[LAN]**, the **[New Folder]** command is ignored, and a folder named with the current date is created.

*

- **To save the waveform data on a computer connected via LAN**
  The 9333 LAN Communicator must be installed on the computer on which the data is to be saved. For more information about how to operate and configure the Model 9333 LAN Communicator, as well as install it on computers, refer to the instruction manual of Model 9333 LAN Communicator.
- **When the save destination is set to [LAN]**
  The IP addresses of the instrument and the computer connected via LAN must be set. For more information about how to set the IP addresses, refer to (p. 342).

4 Set the file name.

Move the cursor to the **[Save Name]** box and enter a file name.
Refer to "Save operations (When the save destination is set to [LAN])" (p. 102).

When the save destination is set to **[LAN]**, the file is named in the previously-determined format and the name entered in the **[Save Name]** box is ignored.
Refer to "Save operations (When the save destination is set to [LAN])" (p. 102).

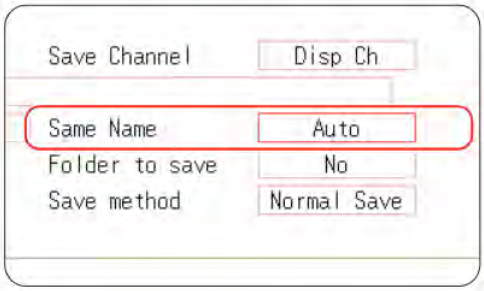
File name
The maximum number of characters for **[Save Name]** is 123. The maximum path length including file name is 255 in characters.

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5 **Specify the action when a file with the same name exists in the target folder.**

Move the cursor to the **[Same Name]** box.

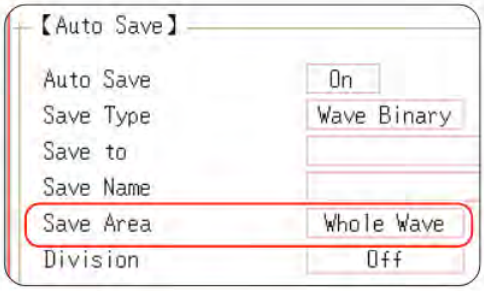
Auto	When no files with the same name exist, the instrument gives the predetermined name to a file and saves it. When another file with the same name exists, the instrument gives the name beginning with a 4-digit number to a file and saves it (default setting). When the name of the existing file begins with a numeral, the instrument gives the name beginning with the sequence number that follows the existing file name's number to a file.
Serial	Unconditionally, the instrument gives the name beginning with a 4-digit number to a file and saves it. When another file with the same name exists, the instrument gives the name beginning with a 4-digit number increasing the number in one increments to a file and saves it.



6 **Set the save area.**

Move the cursor to the **[Save Area]** box.

Whole Wave	Saves the entire data written in the memory. (Default setting)
A-B Wave	Saves the data within the range between Cursors A and B. When only Cursor A is set, the instrument saves entire data within the range after Cursor A point. To set Cursors A and B, refer to (p. 140).

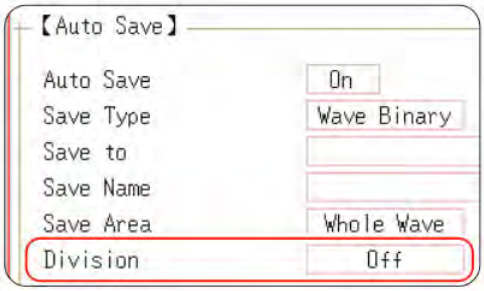


7 **(When [SaveType] is set to [Wave Binary])**

Select whether to divide files.

Move the cursor to the **[Division]** box.

Off	Saves a file without dividing it.
16M, 32M, 64M	Divides a file into sections that have a selected size and saves them.

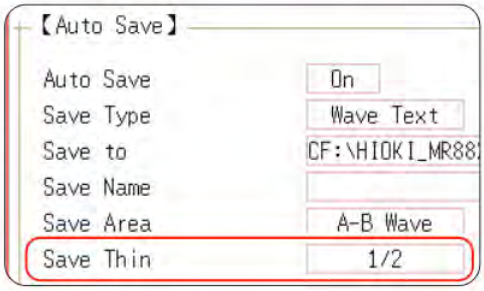


(When [SaveType] is set to [Wave Text])

Set the data decimation factor.

Move the cursor to the **[Save Thin]** box.

OFF	No data is decimated.
1/2 to 1/1000	Sets the decimation factor (ratio of retained samples to whole samples).



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Division save
- You can divide the large size of waveform data and save them as multiple files.
- When saving data with **[Division]** is set to any setting options other than **[Off]**, a folder is automatically created, and then waveform files and an index file (extension: IDX) are created in the folder. Loading the IDX file allows the waveform files to be loaded in a batch.
- Activating the division save disables the delete save. Refer to (p. 100).
- Automatic division save is disabled when using the memory division function.

Refer to "Divided files are loaded in a batch." (p.112) and "12 Memory Division Function" (p.267).

Decimation

A large amount of space is required to save files in text format. Data decimation reduced the file size.

Example: When **[Save Thin]** is set to **[1/2]**

Every other data point is saved. The number of data points is reduced to 1/2 of the original amount.

Save destination

Data can also be automatically saved on a USB flash drive; however, we recommend using Hioki's optional CF card instead for data protection.

8 Select the channels to be saved.

Move the cursor to the **[Save Channel]** box.

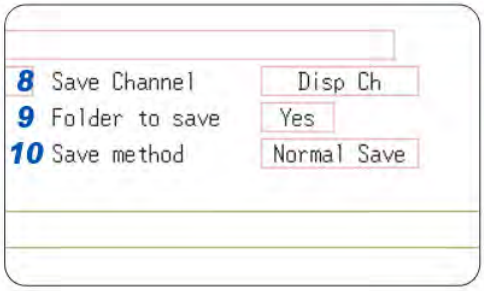
Disp Ch	Saves the data obtained through the channels the waveform displays of which are set to **[On]** on all sheets. (Default setting)
All Ch	Saves the data obtained through all measured channels (When using the memory function, it saves the data obtained through the channels that have been set to **[Used Ch]** on the status settings screen). Saves the data obtained through the channels the waveform displays of which are set to **[Off]**.

9 Select whether to create folders.

Move the cursor to the **[New Folder]** box.

No	Creates no folders at the start of measurement.
Yes	Creates a folder at the start of measurement and saves files in this folder.

When **[Save to]** is set to **[LAN]**, this setting is ignored, and a folder named as of the current date is created.



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10 **Set the save method when the space of the storage device is insufficient.**

Move the cursor to the **[Save method]** box.

Normal Save	Stops the automatic saving when the storage device is full.
Delete Save	Deletes old files and continue the automatic saving when the storage device is full. (Waveform files only.) Waveform files saved after measurement started are deleted in the order in which they were saved (oldest first). No waveform files already saved on the media when measurement started will be deleted.

When the save destination is set to [LAN], the save method is changed to [Normal Save], and this setting is ignored.

11 **Confirm the measurement conditions and start measurement.**

Press the **START** key.

After the instrument writes the data in the memory, the waveforms are saved on the specified storage device.

- **Number of files a folder can retain**
  A folder can retain 5000 of files and folders collectively.
  Refer to "Auto-saving operations (When the save destination is set to a storage device)" (p. 101).
- **[Preparing files] display**
  Sometimes the **[Preparing files]** message is displayed after measurement starts. This indicates that the instrument is checking the state of the destination in which the file will be saved. The more the files exist in the destination folder, the longer it takes to check its state.
  When a printing action is attempted simultaneously with a saving action, the printing action may be performed in priority to the saving action, with the result that the **[Preparing files]** message may be displayed for a long time.

To close the auto-saving dialog box

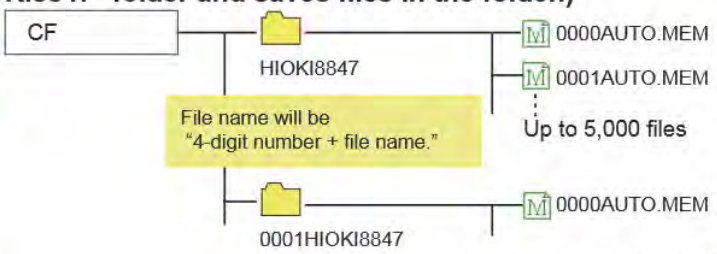
Press the **SAVE** key to toggle dialog box display.

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Auto-saving operations (When the save destination is set to a storage device)

Example 1: Saving files in the topmost directory of the storage device (the instrument creates the HIOKI8847 folder and saves files in the folder.)

Save to	CF:\HIOKI8847
Save method	Normal Save
New Folder	OFF



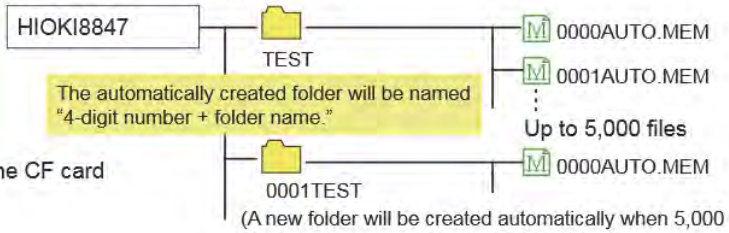
If the storage device is full
Stops the automatic saving.

(When the number of files in the HIOKI8847 folder has reached 5000, a new folder is created automatically)

Example 2: Saving files in a folder on a storage device

Save to	CF:\HIOKI8847\TEST
Save method	Normal Save
New Folder	OFF

(Create a folder named "TEST" on the CF card beforehand.)

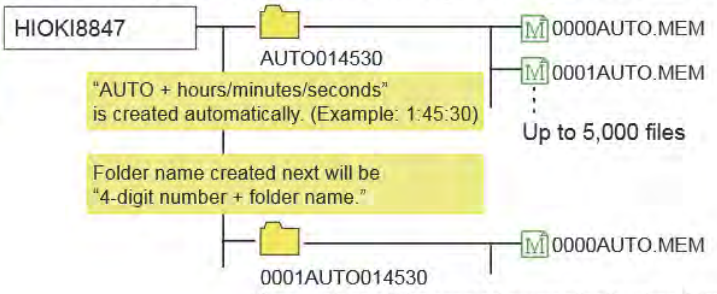


(A new folder will be created automatically when 5,000 files have been saved in the TEST folder.)

If the storage device is full
Stops the automatic saving.

Example 3: Creating a folder on a storage device automatically, saving data in the folder.

Save to	CF:\HIOKI8847
Save method	Normal Save
New Folder	ON

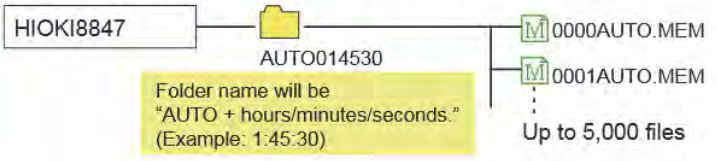


If the storage device is full:
Stops the automatic saving.

(A new folder will be created automatically when 5,000 files have been saved in the AUTO014530 folder.)

Example 4: Saving files automatically using the deleting/saving file function.

Save to	CF:\HIOKI8847 or a specified folder in the HIOKI8847 folder
Save method	Delete Save
New Folder	OFF



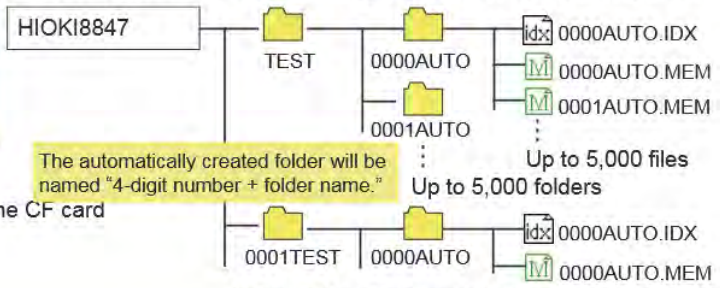
When the number of files in the folder has reached 5000, or when the storage device is full, deletes the files in the AUTO014530 folder (or specified folder) in sequence, starting with the oldest file, and replaces them with new files. Only waveform files are deleted.

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Example 5: Dividing files and saving them to an existing folder on the storage device.

Save to	CF:\HIOKI8847\TEST
Save method	Normal Save
New Folder	OFF

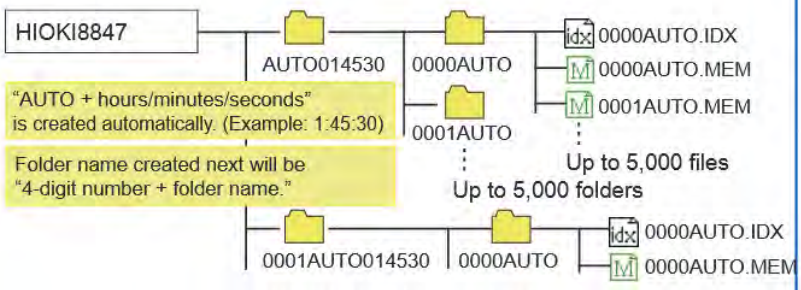
(Create a folder named "TEST" on the CF card beforehand.)



If the storage device is full:
Stops the automatic saving.

Example 6: Dividing files, saving them in an automatically created folder on a storage device

Save to	CF:\HIOKI8847
Save method	Normal Save
New Folder	ON



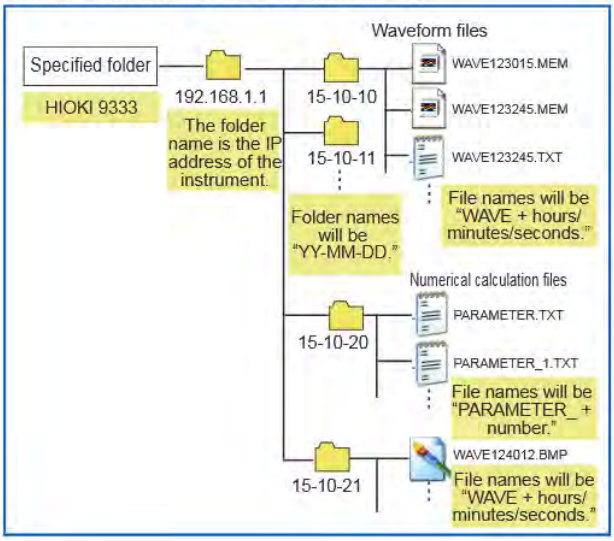
If the storage device is full:
Stops the automatic saving.

Save operations (When the save destination is set to [LAN])

The file is saved according to the method (on the right figure) specified in the **[Save Settings]** dialog box of Model 9333 LAN Communicator.
For more information about how to configure the save settings, refer to the instruction manual of Model 9333 LAN Communicator.



The instrument gives the names in the previously-determined formats to the destination folders and files, and then saves them as follows:



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5.2.3 Saving Data Selectively (SAVE Key)

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

Procedure

To display the screen

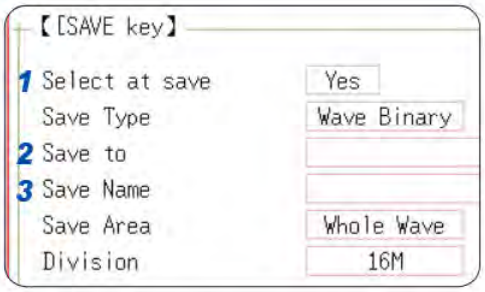
Press the **SYSTEM** key several times to display the **[File Save]** sheet on the system screen.

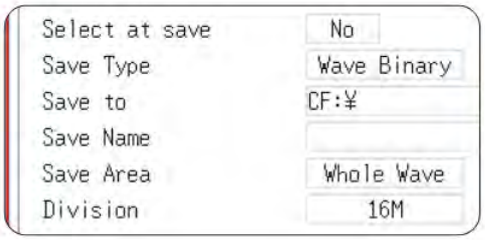
1 Set the save method when the SAVE key is pressed.

Move the cursor to the **[Select at save]** box, and select **[No]**.

Yes	Displays a dialog box when the **SAVE** key is pressed to enable you to select the items to be saved, and then saves a file consisting of the selected items. (Default setting) Refer to "Selection Save" (p.95).
No	Saves a file instantly consisting of the predetermined items when the **SAVE** key is pressed. Refer to "Quick save" (p.95).

Once **[Select at save]** is set to **[Yes]**, the subsequent settings can be set in the dialog box that is displayed by pressing the **SAVE** key at the start of measurement. (See the center figure on the right.)
However, the dialog box cannot be disabled while another dialog box such as the folder dialog box is being displayed.

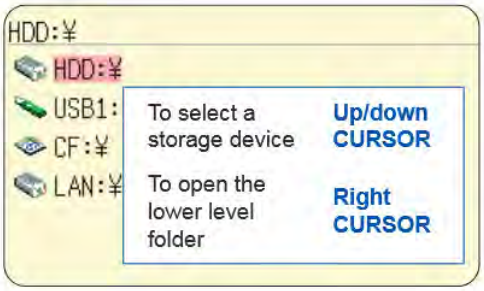




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2 Set the save destination.

Move the cursor to the **[Save to]** box, and select **[Edit]**.



The folder dialog box is displayed (See the bottom figure on the right).

Move the cursor to a storage device used as the save destination, and select **[Confirm]** to confirm the selection.

HDD	Automatically saves a file on the built-in drive. (When Model U8331 SSD Unit is installed)
CF	Automatically saves a file on a CF card.
USB	Automatically saves a file on a USB flash drive.
LAN	Automatically saves a file on the computer connected via LAN. Model 9333 LAN Communicator is required.

When the root directory (topmost folder on the storage media) is selected, the "HIOKI8847" folder is automatically created. (When the storage device has been formatted with the instrument, the instrument has already created the folder.) Files are saved in this folder.

To create a new folder to be set as the save destination, select **[New Folder]**.

When the save destination is set to **[LAN]**, the **[New Folder]** command is ignored, and a folder named with the current date is created.

3 Set the file name.

Move the cursor to the **[Save Name]** box and enter a file name.

Refer to "Save operations (When the save destination is set to [LAN])" (p. 102).

When the save destination is set to **[LAN]**, the file is named in the previously-determined format and the name entered in the **[Save Name]** box is ignored.

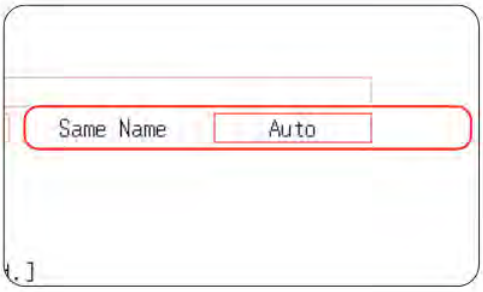
Refer to "Save operations (When the save destination is set to [LAN])" (p. 102).

File name
The maximum number of characters for **[Save Name]** is 123. The maximum path length including file name is 255 in characters.

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4 **Specify the action when a file with the same name exists in the target folder.**

Move the cursor to the **[Same Name]** box.



Auto	When no files with the same name exist, the instrument gives the predetermined name to a file and saves it. When another file with the same name exists, the instrument gives the name beginning with a 4-digit number to a file and saves it (default setting).
Serial	Unconditionally, the instrument gives the name beginning with a 4-digit number to a file and saves it. When another file with the same name exists, the instrument gives the name beginning with a 4-digit number increasing the number in one increments to a file and saves it.

If you specify a filename that begins with a single-byte character, its numerical portion will be incremented by one during subsequent saves. If there are more than 5 digits, numbering will start with “0001.”
If you wish to use a date or other number as the filename, enter a letter or other character before the single-byte numerical portion.

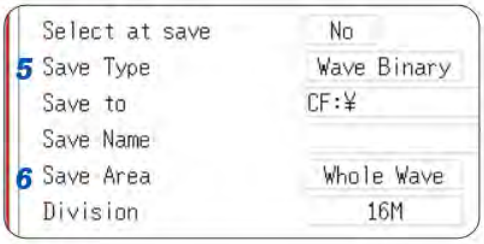
Example: If you specify “A200817” as the filename

- Auto
  A200817
  0001A200817
  0002A200817
  0003A200817
- Serial
  0001A200817
  0002A200817
  0003A200817

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5 **Set the items to be saved.**

Move the cursor to the **[Save Type]** box.



Setting	Saves the settings data.
Wave Binary	Saves waveform data in binary format. Select this option to reload the waveforms with the instrument.
Wave Text	Saves waveform data in text format. Select this option to load the waveform data with a computer. (Memory, recorder, and FFT functions only)
Wave ALLWave Bin	Saves data included in all blocks in binary format. (Only when **[Memory Div.]** is set to **[On]**.)
Wave ALLWave Txt	Saves waveform data in text format. (When **[Memory Div.]** is set to **[On]**)
Display screen	Saves screen display data in BMP format. You can see data saved in BMP format on a computer with graphic viewing software.
Waveform screen	Saves printer output data of waveforms in BMP format. You can see the data saved in BMP format on a computer with graphic viewing software.
Numerical calculation results	Saves numerical calculation results. (Memory function only)
Waveform evaluation settings	Saves settings data and waveform evaluation areas.
Waveform evaluation area	Saves evaluation areas created with the waveform evaluation function in black-and-white BMP format. You can edit saved data with a computer and load back onto the instrument. Edit images using black and white only.
Pulse pattern	Saves pulse patterns registered in the MR8791.
Arbitrary waveform	Saves user-defined waveforms registered in the U8793.
Program	Saves program data registered in the U8793.

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6 (When [Save Type] is set to [Wave Binary] or [Wave Text])

Move the cursor to the **[Save Area]** box.

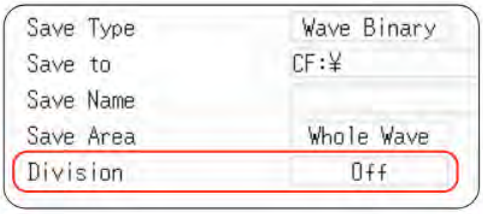
Whole Wave	Saves the entire data written in the memory. (Default setting)
A-B Wave	Saves the data within the range between Cursors A and B. When only Cursor A is set, the instrument saves entire data within the range after Cursor A point. Refer to "7.2 Specifying the Waveform Range (Cursors A and B)" (p. 145).

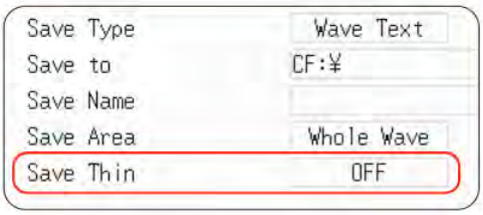
The instrument saves the data obtained through the channels displayed on the screen.

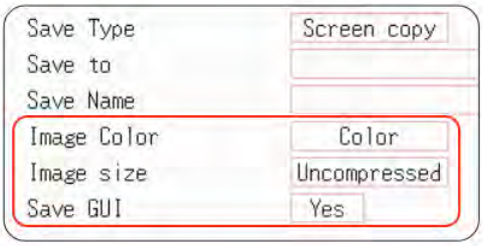
7 Advanced settings

Available settings differ depending on the saving type.

Save types	Settings	Description
Setting	–	–
Wave Binary	**Division**	**(Off, 16 M, 32 M, 64 M)** Select this option to divide a large file into several files and save them. The instrument creates a folder with the specified name, divides a file into several files, and then saves them in the folder.
Wave Text	**Save Thin**	**(OFF, 1/2 to 1/1000)** Select this option to decimate data, and then save it. Sets the decimation factor (ratio of retained sample to the whole sample).
Display screen (Hard copy of the display)	**Image Color**	**(Color, Gray, Mono, Mono [Rev])** Specifies the color of image files to be created.
	Image size	**(Uncompressed, Compressed)** Specifies whether to compress image files.
	Save GUI	**(Yes, No)** Specifies whether to include the GUI in image files.

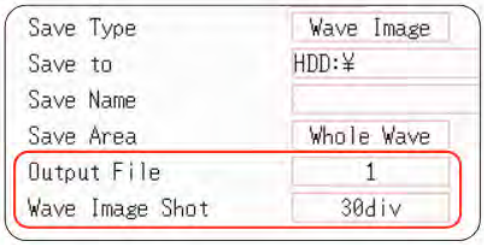


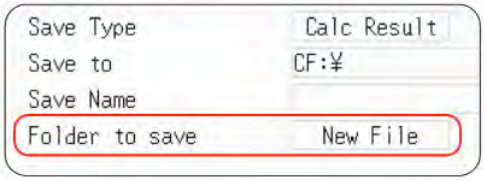




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Save types	Settings	Description
Waveform screen (Print image)	**Output File**	**(All, 1 through 250)** Specifies the number of files to be saved. To specify a print range, open the **[Printer]** sheet using the system screen, and set the print range setting to **[A-B Wave]**. (Memory and recorder functions only)
	Wave Image Shot	**(1 through 60 div)** Specifies the number of samples per file. If the number of measurement samples is lower than the number of divisions entered in the **[Wave Image Shot]** box, the instrument saves the measured data of only the actual number. (Memory and recorder functions only)
Calc Result	**Folder to save**	**(New File, Existing File)** Specifies whether the instrument gives a new name to the file (adds sequential numbers when the file with the same name exists) to a file every time, or appends data to the existing file.





8 **(For memory function) When using the memory division function**

Select the blocks to be saved.
Move the cursor to the **[Save Block]** box.

All Blks	Saves all blocks that include waveforms.
Start-End	Saves all used blocks beginning from the start block.

The data save settings are terminated.
Whenever the **SAVE** key is pressed, the instrument saves data in these settings.

Display image files saved with the **[Image size]** setting set to **[Compressed]** cannot be displayed with some image viewer applications.

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5.2.4 Saving Waveform Outputting Data to a Storage Device

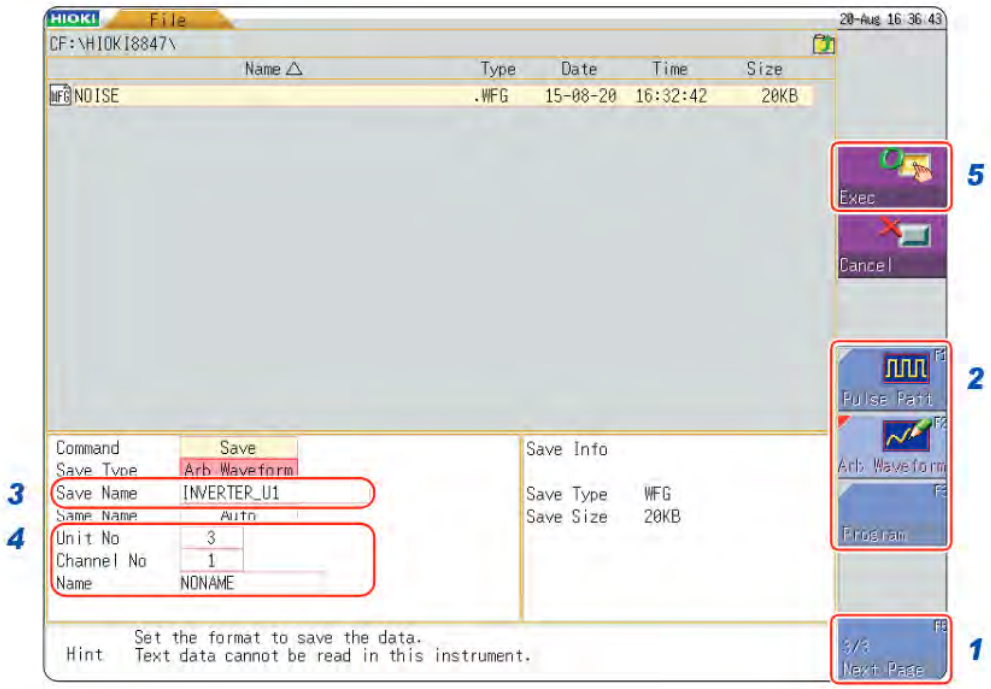
You can save pulse pattern data registered in Model MR8791, arbitrary waveform data registered in Model U8793, or program data in a storage device.

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

Procedure

To display the screen

Press the **FILE** key to display the **[File]** sheet.



1 **Press [Next Page].**

2 **Select [Pulse Patt], [Arb Waveform], or [Program].**

3 **Enter a file name in the [Save Name] box.**

4 **Register the unit number of the MR8971 or the U8793 in the [Unit No] box, the channel number in the [Channel No] box, and the data name in the [Name] box.**

5 **Press [Exec].**

The data registered in the module is saved onto the storage device.

For each of detailed save settings, refer to the instruction manual of Models U8793, MR8790, and MR8791

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5.3 Loading Data

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

Data loading procedure

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

Only settings and measured data saved in binary format can be loaded into the instrument.

Waveform data

- Insert a storage device.
- Select data to be loaded. (Extension: **.MEM**, **.REC**, **.FFT**, **.XYC**, **.IDX**, **.SEQ**)
- Select **[Load]**.
- Select **[Exec]**.
- Load the data.

Settings data

- Insert a storage device.
- Select data to be loaded. (Extension: **.SET**)
- Select **[Load]**.
- Select **[Exec]**.
- Load the data.

Text comment

- On **[Printer]** sheet, set **[Text Comment]** to **[Before Wave]** (or **[After Wave]**).
- Insert a storage device.
- Select data to be loaded. (Extension: **.TXT**)
- Select **[Load]**.
- Select **[Exec]**.
- Load the data.

Waveform evaluation area

- Insert a storage device.
- Select data to be loaded. (Extension: **.ARE**, **.BMP**)
- Select **[Load]**.
- Select **[Exec]**.
- Load the data.

Waveform output data

- Insert a storage device.
- Select data to be loaded. (Extension: **.WFG**, **.TFG**, **.PLS**, **.FGP**)
- Select **[Load]**.
- Specified the module and channel of the loading target.
- Select **[Exec]**.
- Load the data.

For the detailed settings for loading (registration) of pulse pattern data, arbitrary waveform data, and program data, refer to “8.11 Registering Waveforms in the U8793 Arbitrary Waveform Generator Unit” (p.206) or the instruction manual of Models U8793, MR8790, and MR8791.

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Procedure

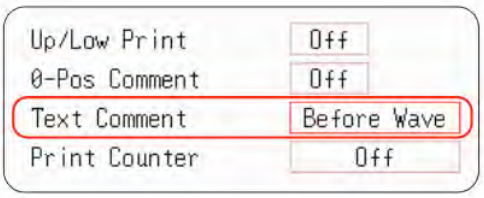
To display the screen

Press the **FILE** key to display the file screen.

1 **To load a text comment**

Press the **SYSTEM** key to display the **[Printer]** sheet on the system screen.

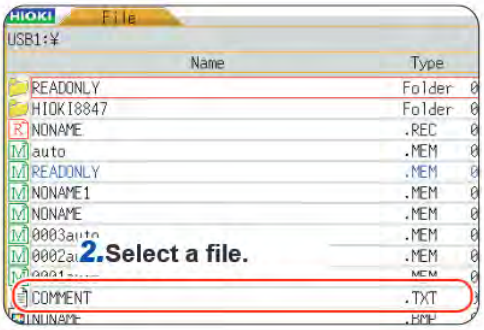
Move the cursor to the **[Text Comment]** box, and select **[Before Wave]** (or **[After Wave]**).



2 **Select a file.**

Use the **CURSOR** keys to select the file to be loaded.
(Identify the file type based on an extension.)

Refer to "(Extension)" in "Data loading procedure" (p.110).



3 **Load the file.**

Select **[Exec]** to load the file.

The name of the loaded file is displayed at the top of the screen.

To cancel the file loading action, select **[Cancel]**.

When loading data from the sources other than the internal memory or built-in drive
Insert the storage media before selecting the media.

Other limitations
- You cannot load any data saved with other instruments.
- Loading waveform data changes the settings of the instrument to the settings when the data was saved. To reset the instrument settings, execute **[Clear Wave Data]** (p. 438) or start measurement.

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To load waveform files in a bundle

Loading the following index files permits waveform files to be loaded in a batch. The following settings create index files along with waveform files.

Extension	Explanation
IDX	Divided files are loaded in a batch. **(To create index files, on the system screen, select the [File Save] sheet, enter the dividing size in the [Division] box, and then save the waveform files. Note: When [Save type] is not set to [Wave Binary], no index files are created.)** Refer to "5.2.2 Automatically Saving Waveforms" (p.96) and "5.2.3 Saving Data Selectively (SAVE Key)" (p.103).
SEQ	(When using the memory division function of the memory function) Waveform files of all blocks are loaded in a batch. **(To create index files, first, on the status screen, select the [Memory Div] sheet, set [Memory Div] to [On]. Next, on the system screen, on the [File Save] sheet, set [Save Type] to [ALL-Wave Bin]. Then, save the waveform files.)** Refer to "12.1 Configuring the Recording Settings" (p.269) and "5.2.3 Saving Data Selectively (SAVE Key)" (p.103).

Loading a waveform evaluation area

The files with the following two extensions can be loaded onto the instrument.

Extension	Explanation
ARE	Files with an ARE extension contain a waveform evaluation area and settings data. (Files that are saved with the [Area settings] setting.)
BMP	Files with a BMP extension contain a waveform evaluation area. (Files saved with the [Area image] setting can be edited on computers and loaded back onto the instrument.)

Loading data for waveform generation (registration)

The files with the following extensions, which are for waveform generation modules, can be loaded onto the instrument.
You can load the data on the signal generator screen of the channel screen (displayed by pressing the CHAN key) or of the file screen (displayed by pressing the FILE key).
For details, see the instruction manual of Models U8793, MR8790, and MR8791.

Extension	Explanation
WFG,TFG	Loading a file with a WFG or TFG extension permits its waveform generation data to be registered in channels of a specified arbitrary waveform generator module. The loaded (registered) waveform data is output from Model U8793 Arbitrary Waveform Generator Unit. Refer to "8.11 Registering Waveforms in the U8793 Arbitrary Waveform Generator Unit" (p.206).
PLS	Loading a file with a PLS extension permits its pulse pattern data to be registered in channels of a specified arbitrary wave generator module. The loaded (registered) pulse pattern waveform is output from Model MR8791 Pulse Generator Unit.
FGP	Loading a file with an FGP extension permits its waveform generation program file to be registered in channels of a specified arbitrary waveform generator module.

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5.4 Automatically Loading Settings (Auto-setup Function)

The saving settings described below permit themselves to be automatically loaded at startup.

The auto-setup function supports the STARTUP file saved on a CF card only.
When the STARTUP file is saved on the built-in drive, USB flash drive, or RAM (internal memory), it is not be referred. Always create the STARTUP file on a CF card.

Procedure

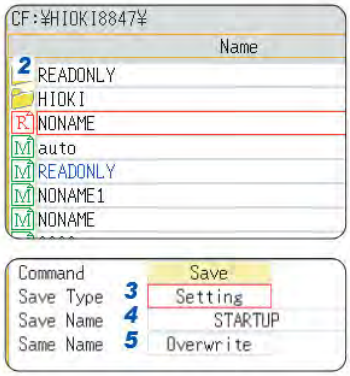
To display the screen

Press the **FILE** key to display the file screen. (p. 92)

1 **Select [Change Media] and specify the CF card.**

2 **When the "HIOKI8847" folder exists in the root directory (topmost folder on the storage device), move the cursor to that folder.**

When the folder does not exist, go to the root directory. (The instrument creates the "HIOKI8847" folder and saves settings in it.)



3 **Select [Save] and set the [Save Type] setting to [Setting].**

4 **Move the cursor to the [Save Name] box and enter "STARTUP."**

Refer to "8.1.3 Entering Alphanumeric Characters" (p. 163).

5 **Move the cursor to the [Same Name] box and select [Overwrite].**

6 **Select [Exec].**

To cancel the automatic file loading action

Select **[Cancel]**.

When the instrument is turned on next, the settings are loaded automatically.

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5.5 Managing Files

Press the **FILE** key to display the file screen. The file screen allows you to manage data saved in storage devices.
Select a file on the file list with the **CURSOR** key.

Before performing an operation, insert a storage device (except for the optional built-in drive). If no storage device is inserted, the **[NO FILE]** message appears on the file list of the file screen.

List of file operations

Operation key	Function indication (GUI)	Description	Reference page
CH.SET	Media Change	Changes storage devices.	(p. 92)
F1	Save	Selects channels, and then saves settings data and waveform data that belong to the selected channels as files.	(p. 115)
	Sort	Sorts the files on the file list in the selected order.	(p. 120)
F2	Open Folder	Opens the selected folder.	(p. 118)
	Load	Loads settings data or waveform data from a file.	(p. 110)
	Copy	Copies a file to a specified folder. When a folder is selected, displays items in the folder.	(p. 122)
F3	New Folder	Creates a new folder.	(p. 118)
	Rename	Renames a file or folder.	(p. 121)
F4	Delete	Deletes a file or folder.	(p. 119)
	Initialization	Formats the selected storage device.	(p. 50)
F5	Next Page	Switches the operations assigned to the F keys (GUI).	

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5.5.1 Saving Data

You can save settings data, waveform data, and waveform generation data in a storage device. The instrument saves data in the folder indicated by the cursor.
You can specify a range using Cursors A and B and save a portion of waveform data.

Procedure

To display the screen

Press the **FILE** key to display the file screen. (p. 92)

1 Select a storage device.

Refer to "To change storage devices" (p. 92).

2 Move the cursor to the target folder.

3 Set the items to be saved.

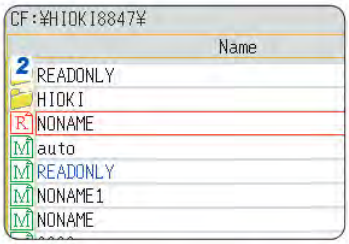
Select **[Save]**, and then move the cursor to the **[Save Type]** box.

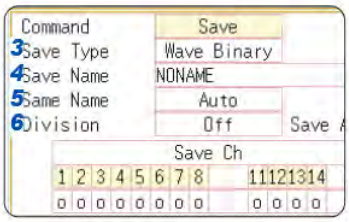
Setting	Settings data
Wave Binary	Waveform data (Binary)
Wave Text	Waveform data (Text) (Memory, recorder, FFT function)
Numerical calculation results	Numerical calculation results (Text)
Waveform evaluation settings	Settings data and evaluation area
Waveform evaluation area	Evaluation area data
Pulse pattern	Pulse pattern data registered in the MR8791*
Arbitrary waveform	User-defined waveform data registered in the U8793*
Program	Program data registered in the U8793*

*Refer to "5.2.4 Saving Waveform Outputting Data to a Storage Device" (p. 109) for more information about how to save data.

4 Enter a file name.

Move the cursor to the **[Save Name]** box.
Enter a file name.
Refer to "8.1.3 Entering Alphanumeric Characters" (p. 163).





- Only the files in text format can be loaded onto computers. Data saved in text format cannot be loaded onto the instrument. To reload the data onto the instrument, save data in binary format.
- When **[Memory (Int)]** is selected as the save destination, only settings data can be saved.
- Waveform evaluation areas can be saved in black-and-white BMP format.
- You can edit the saved data with a computer and load it back onto the instrument.
- Edit images in black-and-white only.

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5 Specify the action when a file with the same name exists in the target folder.

Move the cursor to the **[Same Name]** box.

Auto	When no files with the same name exist, the instrument gives the predetermined name to a file and saves it. When another file with the same name exists, the instrument gives the name beginning with a 4-digit number to a file and saves it (default setting). When the name of the existing file begins with a numeral, the instrument gives the name beginning with the sequence number that follows the existing file name's number to a file.
Serial	Unconditionally, the instrument gives the name beginning with a 4-digit number to a file and saves it. When another file with the same name exists, the instrument gives the name beginning with a 4-digit number increasing the number in one increments to a file and saves it.
Overwrite	The instrument saves the file with the specified name.
Error	When a file with the same name exists, the instrument displays an error message.

6 (When the save type is set to [Wave Binary])

Select whether to divide files.
Move the cursor to the **[Division]** box.

OFF	Saves a file without dividing it.
16M, 32M, 64M	Divides a file into sections with a selected size and saves them.

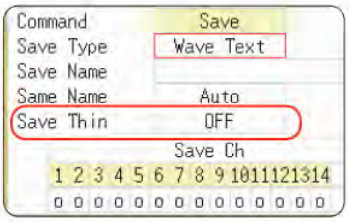
Refer to "Division save" (p. 117).

(When the save type is set to [Text])

Set the data decimation factor.

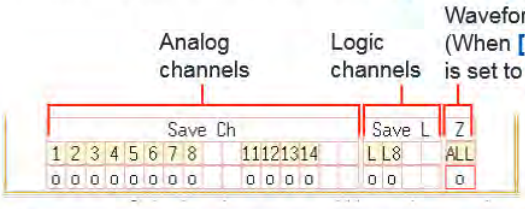
Move the cursor to the **[Save Thin]** box.

OFF	No data is decimated.
1/2 to 1/1000	Sets the decimation factor (ratio of retained sample to the whole sample).



7 Select the channels to be saved.

Move the cursor to an item under **[Save Ch]**.



–	The data obtained through the channel is not saved.
○	The data obtained through the channel is saved.
All Ch	Saves waveforms acquired across all channels (analog, logic, calculated waveforms).
Reset	Returns to previous settings.

When saving settings data, you can create a settings file for the automatic settings loading as follows: (1) specified the folder **[HIOKI8847]** on the CF card as the save destination, and (2) select **[Save Name]**.
Refer to "5.4 Automatically Loading Settings (Auto-setup Function)" (p. 113).

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8 **Execute the save operation.**

Select **[Exec]**.
To cancel the file saving action, select **[Cancel]**.

File name
The maximum number of characters for **[Save Name]** is 123. The maximum path length including file name is 255 in characters.

Division save
- You can divide the large size of waveform data and save them as multiple files if necessary.
- When saving data with **[Division]** is set to any setting option other than **[Off]**, a folder is automatically created, and then waveform files and an index file (extension: IDX) are created in the folder.
- Loading the IDX file allows the waveform files to be loaded in a batch.
  Refer to "To load waveform files in a bundle" (p. 112).
- Each file can be treated as a separate waveform data file.

Other limitations
Data saved in text format cannot be loaded onto the instrument.

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5.5.2 Checking the Contents in a Folder (Opening a Folder)

Opening a folder enables you to observe its contents. (The instrument displays the contents of the folder.)

Procedure

To display the screen

Press the **FILE** key to display the file screen. To change storage devices (p. 92)

1 **Move the cursor to the folder in which you want to see contents.**

2 **Select [Open Folder], or press the Right CURSOR key.**

The list of the folder contents will be displayed.

To move up to a higher-level folder

Press the **Left CURSOR** key.

5.5.3 Creating New Folders

You can create new folders in the presently displayed folder.

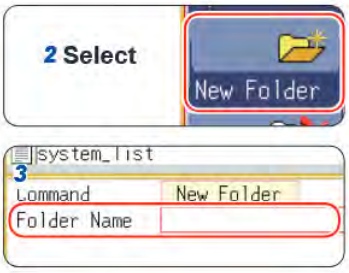
Procedure

To display the screen

Press the **FILE** key to display the file screen. To change storage devices (p. 92)

1 **Have the instrument display a folder in which you want to create a new folder.**

2 **Select [New Folder].**



3 **Enter the folder name in the [Folder Name] box.**

Refer to "8.1 Adding Comments" (p. 160).

4 **Select [Exec].**

The instrument creates the new folder.

To cancel the folder creating action

Select **[Cancel]**.

Folder name

The maximum number of characters for **[Folder Name]** is 127. The maximum path length including file name is 255 in characters.

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5.5.4 Deleting Files and Folders

Follow this procedure to delete files or folders.

Procedure

To display the screen

Press the **FILE** key to display the file screen. To change storage devices (p. 92)

1 **Select the file or folder you want to delete.**

2 **Select [Del Folder].**

[DeleteOne] is displayed in the **[DeleteTarget]** box.

3 **(When multiple files are to be deleted)**

Select [Multi Files].

[DeletePlural] is displayed in the **[DeleteTarget]** box.

Slct/Deslct	Selects the individual file or folder at the cursor. When any file or folder is presently selected, the selection is cleared.
Slct/Deslct All	Selects all files and folders. When any file or folder is presently selected, the selection is cleared.
Rev Slct	Presently selected files and folders are cleared and presently unselected files and folders are selected.

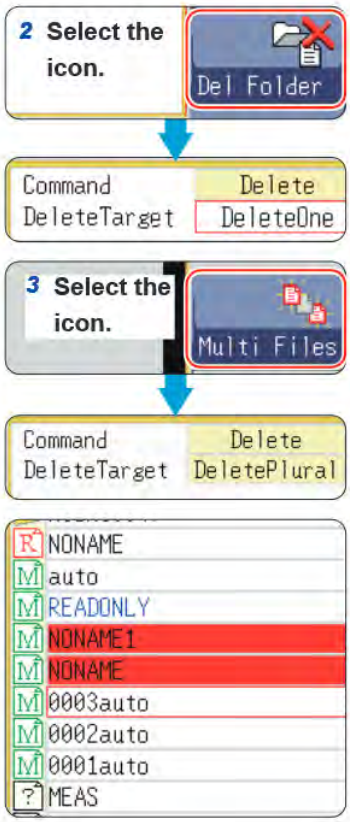
Selected files or folders are shown in red (See the right figure).

4 **Select [Exec]**

The selected files or folders are deleted.

To cancel the deleting action

Select **[Cancel]**.



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5.5.5 Sorting Files

You can sort files in the selected order.

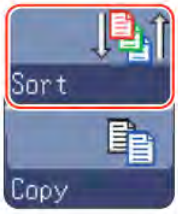
Procedure

To display the screen

Press the **FILE** key to display the file screen. To change storage devices (p. 92)

1 **Select [Sort], and then select a sort criterion in the [Type] box.**

OFF	Does not sort files.
Name	Sorts files in alphabetical order.
Type	Sorts files by type of data (settings, MEM waveforms, etc.)
Date	Sorts files in creation date and time order.
Size	Sorts files in size order.



1 **Select the icon.**



2 **Move the cursor to [Order].**

Ascending order	A to Z, old to new, small to large
Descending order	Sorts files in the reverse order

Folders and files are sorted in the specified order.

3 **Select [OK].**

The sort screen is closed.

An item selected as the sort criterion is displayed in the file list (with : Ascending order mark; : Descending order mark) and its GUI is marked. When the folder contains both files and folders, folders are listed upper than files.

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5.5.6 Renaming Files and Folders

You can rename files and folders.

Procedure

To display the screen

Press the **FILE** key to display the file screen. To change storage devices (p. 92)

1 **Select the file or folder you want to rename.**

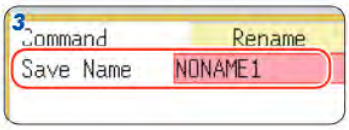
2 **Select [Rename].**



2 **Select the icon.**

3 **Select [Enter Char], and enter a name in the [Save Name] box.**

Refer to "8.1 Adding Comments" (p. 160).



4 **Select [Exec].**

The file or folder is renamed.

To cancel the renaming action

Select **[Cancel]**.

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5.5.7 Copying a File Into a Specified Folder

You can copy files into the specified folders.

Procedure

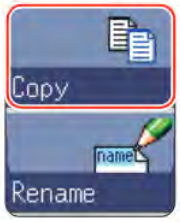
To display the screen

Press the **FILE** key to display the file screen. (p. 92)

1 **Move the cursor to the file you want to copy.**

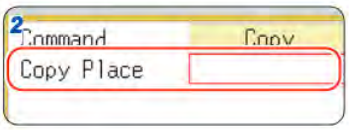
2 **Select [Copy].**

Move the cursor to **[Copy Place]**.



3 **Select [Edit].**

The folder dialog box appears (See the right figure).

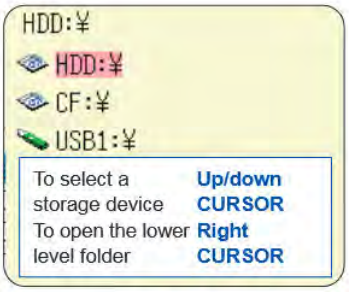


4 **Move the cursor to the target folder and select [Confirm].**

5 **(When copying multiple files)**

Select [Multi Files].

Slct/Deslct	Selects the individual file or folder at the cursor. When any file or folder is presently selected, the selection is cleared.
Slct/Deslct All	Selects all files and folders. When any file or folder is presently selected, the selection is cleared.
Rev Slct	Presently selected files and folders are cleared and presently unselected files and folders are selected.



Selected files or folders are shown in red (See the right figure).



Select [Select End].



6 **Select [Exec].**

The files are copied to the specified destination.

To cancel the file copying action

Select **[Cancel]**.

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5.5.8 Printing the File Table

You can print the file table displayed on the file list of the file screen. The file table containing all displayed items are printed.
Only folder names are printed. Any other information on the contents contained in folders is not printed.

Before printing file tables, make sure the recording paper is loaded correctly.
Refer to "2.4 Loading Recording Paper" (p.50).

Procedure

To display the screen

Press the **FILE** key to display the file screen. To change storage devices (p. 92)

Press the PRINT key.
The file table is printed.

To stop the printing action before it has finished
Press the **STOP** key.

The contents printed on file tables are as follows.

Print Example

No.	File Name	Type	Date	Size	Attribute
1	0001AUTO	MEM	15-10-30 00:00:00	21kB	[ ]
2	0002AUTO	MEM	15-10-30 00:01:00	21kB	[ ]
.					
.					
.					

File attributes are represented by single letters as follows.

R	For loading only
H	Hidden file
S	System file
D	Folder
A	Archive (Backup)

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6 Printing Data

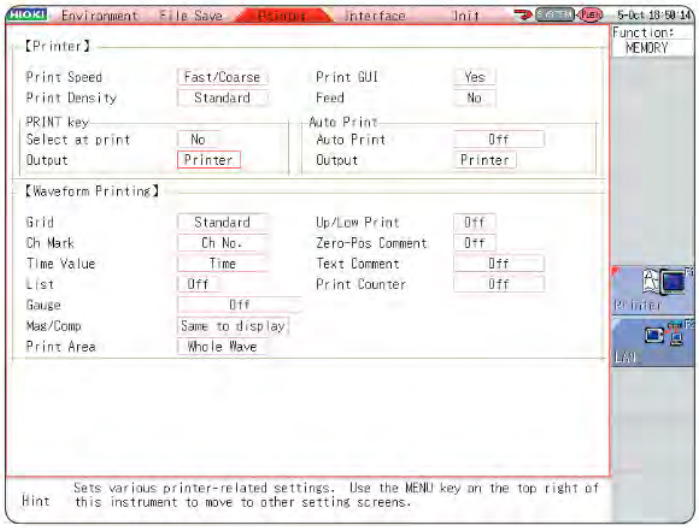
The **[Printer]** sheet enables you to set the print method and detailed printer options.

To display the [Printer] sheet



Pressing the **PRINT** key switches the sheets to be displayed in the following order:





What you can do on the [Printer] sheet

Setting the print methods

Refer to the following pages:

"6.1 Print Type and Procedure" (p. 126)
- Auto-printing (p. 127)
- Manual print (p. 130)

"6.6.1 Printing the Screenshot" (p. 136)
"6.6.2 Printing Reports (A4-Sized Print)" (p. 136)
"6.6.3 Printing a List" (p. 138)
"6.6.4 Printing the Text Coments" (p. 138)

Configuring the printer settings

- Print speed (p. 133)
- Grid type (p. 133)
- Channel marker type (p. 133)
- List (p. 134)
- Gauge (p. 134)
- Printer density (p. 133)
- Horizontal axis (Time axis) Zoom (Mag/Comp) (p. 134)
- Upper/Lower limit print (p. 135)
- Zero-position comment print (p. 135)
- Print counter (p. 135)

On/off setting of printing comment and setting condition

Refer to the following pages:

"8.1.1 Adding, Displaying, and Printing the Title Comment" (p. 160)
"8.1.2 Adding, Displaying, and Printing the Channel Comments" (p. 161)

- As much as possible, avoid printing in hot and humid environments. Otherwise, the printer life may be severely shortened.
- If you continue solid printing (black print), print may be blurred. In such a case, stop the printing and start printing after a while.

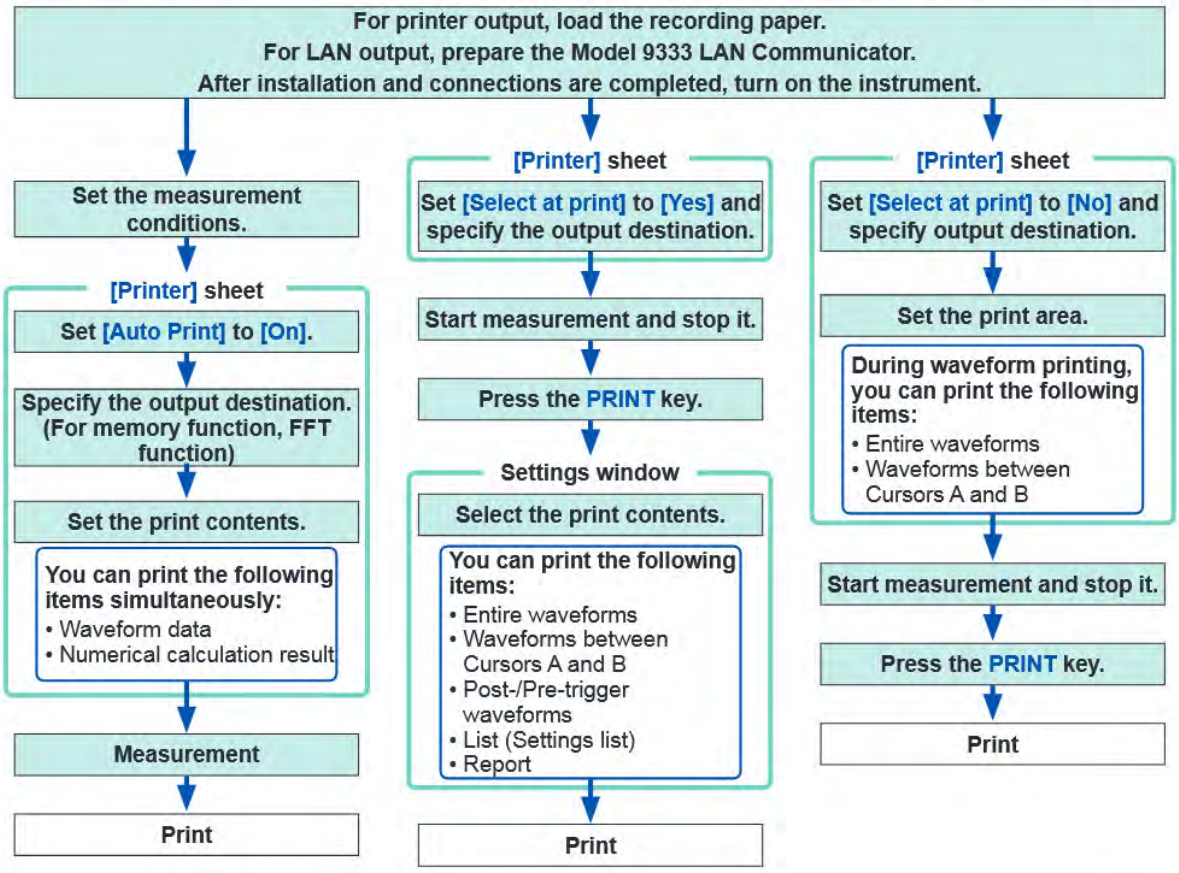
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6.1 Print Type and Procedure

There are three basic types of printing.

Printing data automatically during measurement	Printing data after selecting contents to be printed after measurement.	Printing data by pressing the PRINT key after measurement.
Auto-printing	**Selection Print**	**Quick Print**
When the memory function* is used, the recording length of data is written in the memory, and then printed automatically. When the recorder function is used, printing is carried out in real time along with the recording. When the FFT function is used, data is printed automatically after FFT analysis completes. In any cases, select print items before starting measurement.	(Default setting) Pressing the PRINT key while the file screen is being displayed enables you to select the contents to be printed, and then printing is started. This is useful for printing different items every time. When the file screen is displayed, a file table is printed. When any other screen is displayed, a list is printed.	Print content when the PRINT key is pressed When the waveform screen is displayed: Waveform When the file screen is displayed: File table When any other screen is displayed: List During waveform printing, the range specified in [Print Area] will be printed.

* When using the roll mode function, you can print waveforms simultaneously with displaying them.
(However, when the timebase is set to any settings higher than 500 ms/div, the start of the print is delayed.)



When both the auto-printing and auto-saving are enabled, the auto-saving is executed first.
However, when the roll mode function (default setting: [Auto]) is used with the memory function, the auto-printing is executed first.

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6.2 Setting Auto-printing

MEM REC FFT

This function can be used in the memory, recorder, and FFT functions.
These settings must be set before starting measurement.
When you press the **START** key to start measurement, measured data will be printed automatically. When using the printer output, make sure that the recording paper is loaded correctly. When using the LAN output, make sure that the computer connected via LAN is prepared.

Procedure

To display the screen

Press the **SYSTEM** key and then select the **[Printer]** sheet.

1 Enable auto-printing.

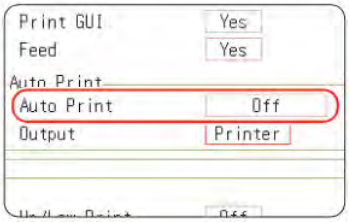
(When using the memory or FFT function)

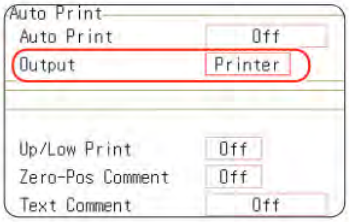
Move the cursor to the **[Auto Print]** box, and select **[On]**.

Default setting: Off (no automatic printing)

(When using the recorder function)

Move the cursor to the **[Realtime Print]** box, and select **[On]**.

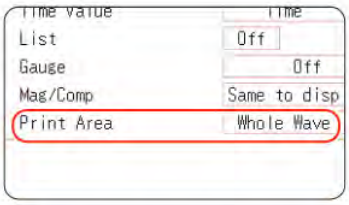




2 (When using the memory or FFT function) Designate the output destination.

Move the cursor to the **[Output]** box.

Printer	The data is automatically printed by the internal printer. (Default setting)
LAN	The data is automatically output to the computer connected via LAN. Model 9333 LAN Communicator is required.



3 (When using the memory function) Specify the print area as required.

Move the cursor to the **[Print Area]** box.

Whole waveforms	Prints the entire waveform data written in the internal memory of the instrument. (Default setting)
A-B waveforms	Prints only the portion specified with Cursors A and B out of the entire waveform data written in the internal memory of the instrument.

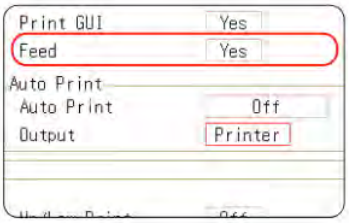
While the recorder function is being used, the entire length of the waveform is printed during measurement regardless of the print area setting.

- **To output waveform data to the computer connected via LAN**
  Model 9333 LAN Communicator is required to be installed on the computer to which the data is to be output. For more information about how to operate and configure it as well as install it on the computer, refer to the instruction manual of Model 9333.
- **When the output destination is set to [LAN]**
  The IP addresses of the instrument and the computer connected via LAN must be set. For more information about how to set the IP addresses, refer to (p. 342).

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4 **Set the print margins between two actions of the automatic print**

Move the cursor to the **[Feed]** box.



Yes	Leaves a margin. (Default setting)
No	Does not leave margins.*

* Leaves a 2-mm-width margin.

The setting in the **[Feed]** box is also applicable for normal printing.

5 **Check the measurement conditions and start measurement.**

(Press the START key.)

When using the memory function

The recording length of data is written into the memory and then printed automatically.

When using the recorder function

The data is written in the memory and printed in real time.

When using the FFT function

Data is analyzed with the FFT method and then printed automatically.

To stop the printing action before it has finished

Press the **STOP** key. Measurement in progress is also stopped.

You can suspend the printing action and resume it by pressing the **F** key during the real-time printing (recorder function).
Move the cursor to the **[Realtime Print]** box and select **[On]** or **[Off]**.
When the suspended printing action is resumed, the data is printed according to the print range setting.

- When both the auto-printing and auto-saving are enabled, the auto-saving is executed first. However, when the roll mode function (default setting: **[Auto]**) is used with the memory function, the auto-printing is executed first.
- When manually printing data after waveform is written in the memory with Cursors A and B setting set to on, the selected range of data is printed.

Timebase (Time/div)	Measurement conditions	Printing action
Up to 200 ms/div	Memory function (roll mode: Off)	The recording length of data is written into the memory and then printed automatically.
	Memory function (roll mode: On) Recorder function (Recording length: Other than **[Cont.]**)	The data is printed with the minimum of delay behind the data recording.
	Recorder function (Recording length: **[Cont.]**)	Printing disabled
More than 500 ms/div	Memory function (roll mode: Off)	The recording length of data is written into the memory and then printed automatically.
	Memory function (roll mode: On) Recorder function	The data is printed simultaneously with the data recording.

When the waveform evaluation is performed, the evaluation area is printed at the same time.
To disable the evaluation area to be printed, set the waveform evaluation to **[Off]**. (p. 326)

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When **[Output]** is set to **[LAN]**, real-time printing is disabled. The instrument with the auto-printing setting prints the data automatically after the recording length of the data is written in the memory regardless of the timebase setting.

Printing numerical calculation results simultaneously

On the status screen, select the **[Num Calc]** sheet, and set **[Print Calc Result]** to **[On]**.

Refer to "10.5 Printing the Numerical Calculation Results" (p. 248).

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6.3 Manually Printing Data by Pressing the PRINT Key (Selection Print)

Pressing the **PRINT** key on the waveform screen enables you to specify the print range and data type, and then start printing of the data.
This action can prevent inadvertent printing due to operator error.

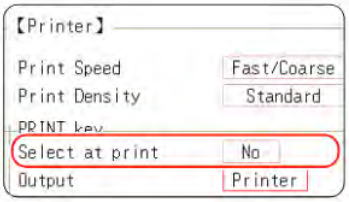
Procedure

To display the screen

Press the **SYSTEM** key and then select the **[Printer]** sheet.

1 Enable the selection at time of printing.

Move the cursor to the **[Select at print]** box, and select **[Yes]**.



2 Specify the output destination.

Move the cursor to the **[Output]** box.

Printer:	The data is automatically printed with the internal printer. (Default setting)
LAN	The data is automatically output to the computer connected via LAN. Model 9333 LAN Communicator is required.

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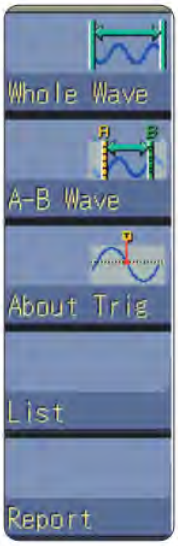
3 Start and then stop measurement.

Press the **START** key to start measurement.
Press the **STOP** key to stop the measurement in progress.

Printing is not possible during measurement. Stop the measurement in progress before start printing.

4 Select print contents and execute printing.

When you press the **PRINT** key, the "Exec Select print" GUI appears on the right side of the screen.



Whole Wave	Prints the entire waveform data written in the internal memory of the instrument. (Default setting)
A-B Wave	Prints only the portion specified with Cursors A and B out of the entire waveform data written in the internal memory of the instrument. (Memory and recorder functions only)
About Trig	Prints each 10 divisions of the waveform data before and after the trigger point. (Memory function only)
List	Prints the main settings.
Report	Prints the report. Refer to "6.6.2 Printing Reports (A4-Sized Print)" (p. 136).

When the selection has been made, the printing is started.

To stop the printing action before it has finished

Press the **STOP** key.

When the waveform evaluation is performed, the evaluation area is printed at the same time. To disable the evaluation area to be printed, set the waveform evaluation to **[Off]**. (p. 326)

- **To output waveform data to the computer connected via LAN**
  Model 9333 LAN Communicator is required to be installed on the computer to which the data is to be output. For more information about how to operate and configure the Model 9333 LAN Communicator, as well as install it on computers, refer to the instruction manual of Model 9333 LAN Communicator.
- **When the output destination is set to [LAN]**
  The IP addresses of the instrument and the computer connected via LAN must be set. For more information about how to set the IP addresses, refer to (p. 342).

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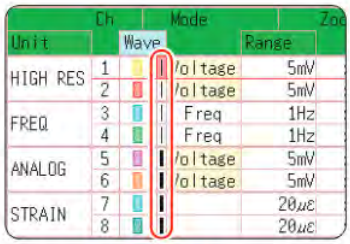
6.4 Setting the Print Density of the Waveform

You can set the printing density of the waveform with respect to each channel.

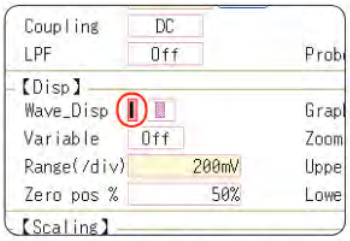
Procedure

To display the screen

Press the **CHAN** key to open the channel screen, and then select the **[Unit List]** sheet or **[Each Ch]** sheet.



[Unit List] sheet



[Each Ch] sheet

Move the cursor to the [Wave] column or the [Wave_ Disp] box.

Light, Midlight, Standard (Default setting), Middark, Dark

When the waveform print density is set to **[Light]**, a temporary drop in power voltage (for example, a momentary power failure) during printing may cause the print to fail.

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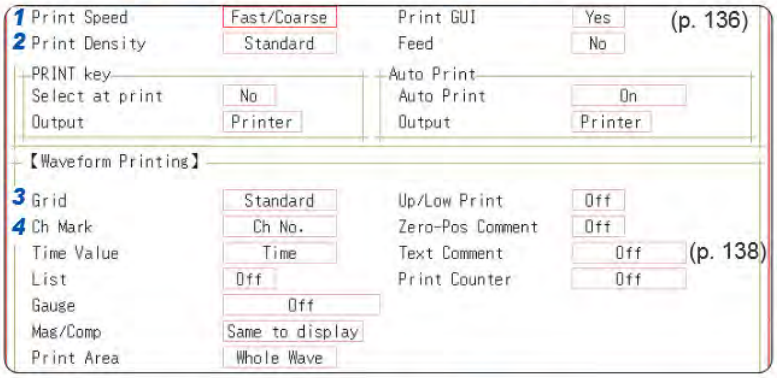
6.5 Configuring the Printer Settings

Configure the printer settings on the **[Printer]** sheet of the system screen.

Printer settings

To display the screen

Press the **SYSTEM** key and then select the **[Printer]** sheet.



1 **Select the print speed (quality).**

Move the cursor to the **[Print Speed]** box.

Fast (coarse, default setting), Normal, Slow (fine)

2 **Select the printer density.**

Move the cursor to the **[Print Density]** box.

Light, Midlight, Standard (Default setting), Middark, Dark

3 **Select the grid type.**

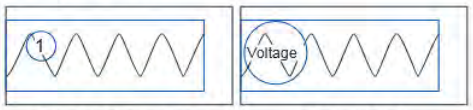
Move the cursor to the **[Grid]** box.

Off, Standard (Default setting), Fine, Std Dark, Fine Dark

4 **Select the channel marker type.**

Move the cursor to the **[Ch Mark]** box.

<Print Example>



Channel number Comment

OFF	Print waveforms without any channel numbers or comments.
Ch No.	Prints waveforms including channel numbers. (Default setting)
Comment	Prints the comments entered in the **[Comment]** sheet on the channel screen, over the waveform. A comment must have been set. Refer to “8.1 Adding Comments” (p. 160).

Grid type

Even when the grids are displayed on the screen, no grids are printed.

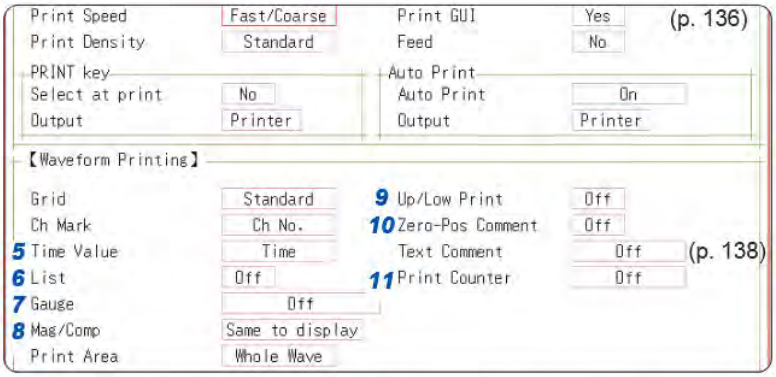
Print speed

When **[USB Set]** is set to **[Mass Storage HDD]** or **[Mass Storage CF]**, the instrument always prints data at a speed of the **[Slow/Fine]** setting.

When the save destination for the auto-saving is set to the USB flash drive, the instrument with the auto-printing setting prints data at a speed of the **[Normal]** setting even when the print speed is set to **[Fast]**.

The **[Fast/Coarse]** setting has the maximum print speed of 50 mm/s; **[Normal]**, 20 mm/s; and **[Slow/Fine]**, 10 mm/s. The speed, however, depends on printing conditions.

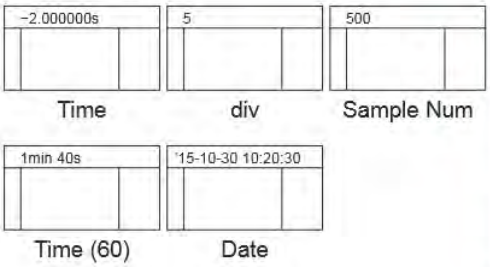
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5 Select the horizontal axis (time axis) display value.

Move the cursor to the **[Time Value]** box.

<Print Example>



Time*	Prints waveforms on the scale markings based on the time from the trigger point (the unit is fixed). (Default setting)
Time (60)*	Prints waveforms on the scale markings based on the time from the trigger point (in sexagesimal [base-60] system).
div	Prints waveforms on the scale markings based on the number of divisions from trigger event.
Date*	Prints waveforms on the scale markings based on the date and time when waveform was written in the memory.
Sample Num	Prints waveforms on the scale markings based on the number of samples from the trigger point.

* Printing for external sampling is done according to the **[Sample Num]** setting.

6 Configure the list setting

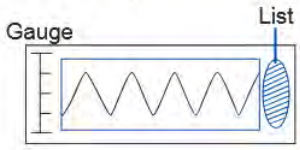
Move the cursor to the **[List]** box.

Off	Prints waveforms without any lists. (Default setting)
On	Prints a list following waveform print.

7 Configure the gauge setting.

Move the cursor to the **[Gauge]** box.

<Print Example>



Off	Print waveforms without any gauges. (Default setting)
Before Wave	Prints the gauge proceeding waveform print.
After Wave	Prints the gauge following waveform print.
Before&Aft Wave	Prints the gauges following and proceeding waveform print.

8 Configure the horizontal axis (time axis) magnification and demagnification setting.

Move the cursor to the **[Mag/Comp]** box.

Horizontal axis (Time axis) zoom
When the time axis zoom setting is used, printing will be executed with this zoom setting, regardless of the zoom setting set on the waveform screen.

× 10 to × 1/200,000 (When using the memory function) × 1 to × 1/50,000 (When using the recorder function)	Prints waveforms in the magnification or demagnification ratio set here.
Same to display	Prints waveform in the magnification or demagnification ratio set for the waveform screen. (Default setting)

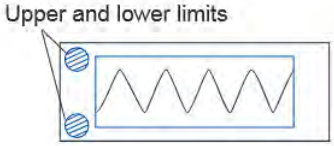
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9 **Set the upper and lower limit value.**

Move the cursor to the **[Up/Low Print]** box.

<Print Example>

Upper and lower limits



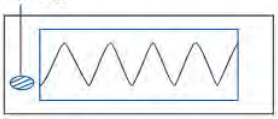
Off	Prints waveforms without upper and lower limits. (Default setting)
On	Prints waveforms with upper and lower limits.

10 **Set the zero-position comment.**

Move the cursor to the **[Zero-Pos Comment]** box.

<Print Example>

Comment



Off	Prints waveforms with channel numbers. (Default setting)
On	Prints waveforms with the comment at the zero position .

- The comment is not printed when the X-Y display or the FFT function is used.
- No zero-position comments are printed at the channels for which no comments have been set.

Refer to "8.1 Adding Comments" (p. 160).

11 **Configure the counter print setting.**

Move the cursor to the **[Print Counter]** box.

Off	Prints waveforms without any counter. (Default setting)
Date	Prints the date of printing and the number of waveforms written in the memory. (Example: 04-8-1-0001)
Counter Name	Prints waveforms with the counter name and the number of waveforms written in the memory. (Example: Device A-0001)

(When [Print Counter] is set to [Date] or [Counter Name])

To assign the first counter number freely, set the counter number.

Move the cursor to the **[Counter Num]** box and set a count.

Refer to "8.1.3 Entering Alphanumeric Characters" (p. 163).

The count is automatically cleared to zero when the instrument is turned on.
The count is increased in one increments every time a waveform is written in the memory.
(Maximum count 9999)

(When [Counter Name] is selected)

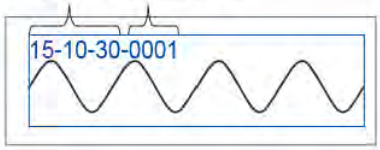
Enter a counter name.

Move the cursor to the **[Counter Name]** box and enter a counter name. (Up to 10 characters)

Refer to "8.1.3 Entering Alphanumeric Characters" (p. 163).

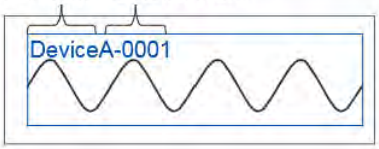
<Example of Date and Counter Num>

Date Counter Num



<Example of Counter name and Counter Num>

Counter Name Counter Num



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6.6 Advanced Print Functions

You can print the screenshot of the screen display, reports, and lists.

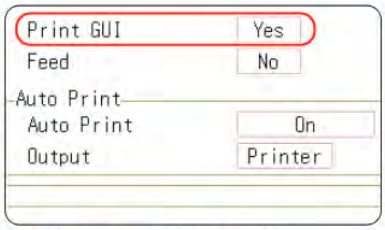
6.6.1 Printing the Screenshot

Press **COPY** key while the screen you want to print is displayed. The screenshot is printed.
The GUI section can be included on the print.

Configuring the GUI print setting

To display the screen

Press the **SYSTEM** key and then select the **[Printer]** sheet.

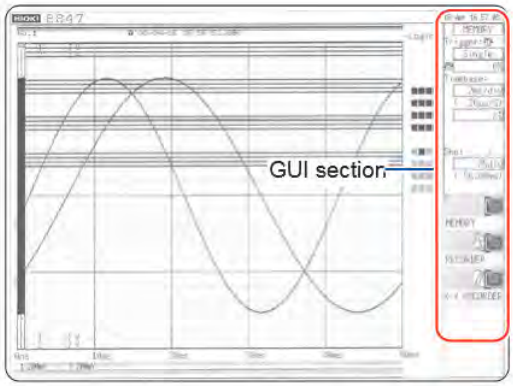


Set [Print GUI] to [Yes].

To stop the printing action before it has finished

Press the **STOP** key.

<Print Example>



6.6.2 Printing Reports (A4-Sized Print)

You can print the screen-displaying range of waveforms, upper and lower limit values, and channel settings in A4 size. When the zoom display is used, two zoom display screens are printed.
Cursors A and B shown on the waveform screen can also be printed.
When the comment type is set to **[Comment]** or **[Set&Com]** on the **[Comment]** sheet of the channel screen, the title comment can also be printed.
Refer to “8.1.1 Adding, Displaying, and Printing the Title Comment” (p. 160).

Procedure

To display the screen

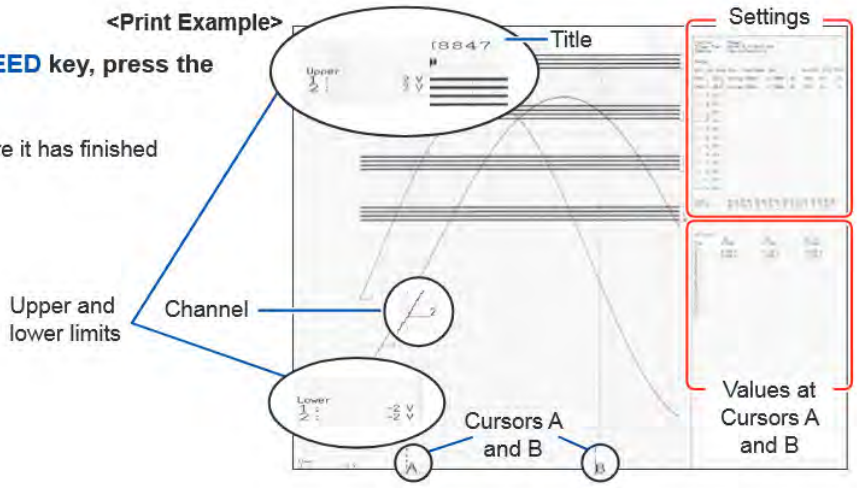
1. Press the **DISP** key to open the screen. The waveform screen is displayed.
2. Press the **DISP** key. The display menu is displayed.
3. Select the **[WAVE WIDTH]** menu.

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While holding down the FEED key, press the COPY key.

To stop the printing action before it has finished
Press the **STOP** key.

<Print Example>



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6.6.3 Printing a List

You can print lists of function status information and channel setting information.
The items included in the printed list are the same as those in the list function setting.
Refer to “Configure the list setting” (p. 134).

Press the **PRINT** key while any screen other than the waveform and file screen is displayed.

To stop the printing action before it has finished
Press the **STOP** key.

> The list to be printed contains the setting conditions for the waveform data written in the memory. The list content does not change even when the settings are changed after the waveform data was written in the memory.

6.6.4 Printing the Text Coments

You can print a text document edited on a computer together with a waveform.

1 **Create a text file using [Notepad] or another suitable application on the computer.**

The maximum size of the text comment that can be imported to the instrument is 104 × 200.
Print width will be adjusted to the widest line.

2 **Press the SYSTEM key and set [Text Comment] on the [Printer] sheet.**

Off	Prints waveforms without any text comment. (Default setting)
Before Wave	Prints a text comment proceeding waveforms.
After Wave	Prints a text comment following waveforms.

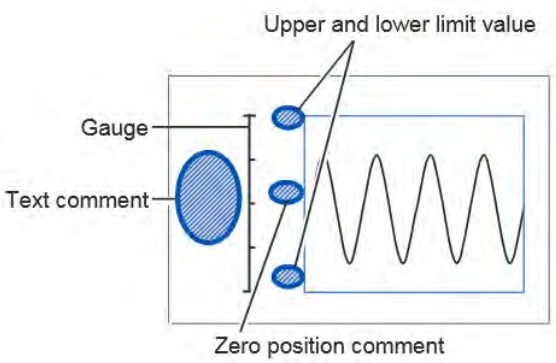
3 **Press the FILE key to display the file screen and import a text file, which is created on the computer, into the instrument.**

Refer to “5.3 Loading Data” (p. 110).

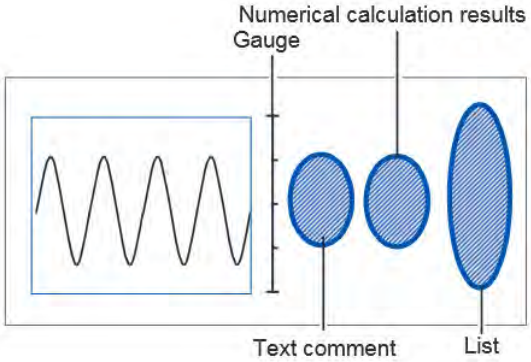
The text file contents are printed along with the waveform.

Print example: Positioning with regard to other print items

<When Before Wave is selected>



<When After Wave is selected>

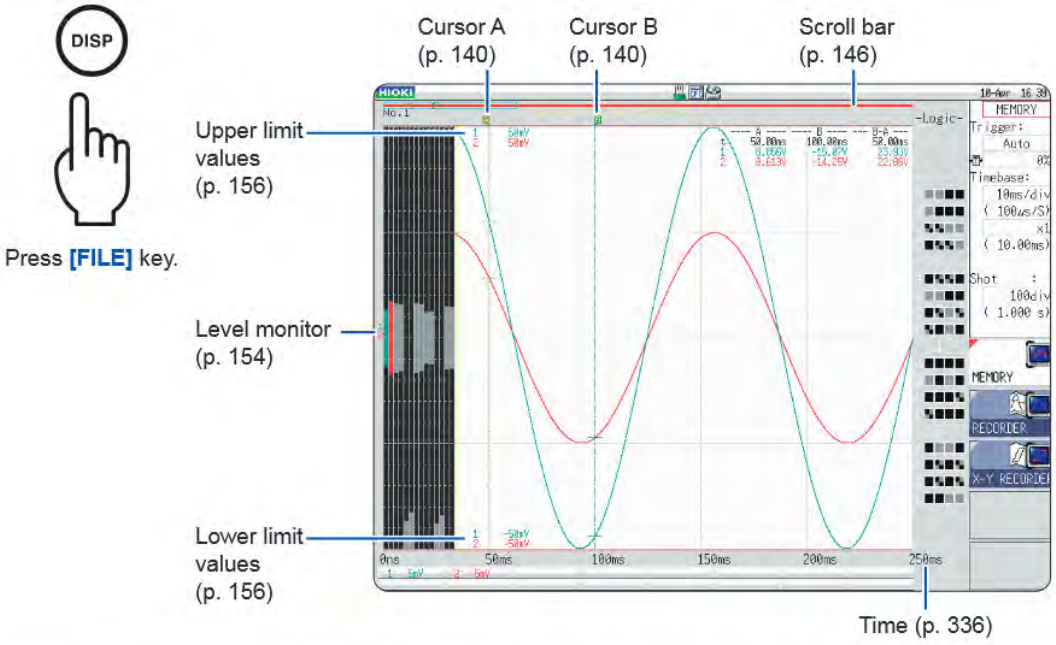


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7 Monitoring and Analyzing Waveforms on the Waveform Screen

Analytical operations such as the display magnification, display demagnification, and search are available on the waveform screen. The measurement conditions or other configuration can also be changed on this screen.

To display the waveform screen



Operations available on the waveform screen

Cursors A and B
- Reading measured values (p. 140)
- Specifying the waveform range (p. 145)

Moving the waveform display position
- Moving the waveforms with the jog dial and shuttle ring (p. 146)
- Move the waveform position (p. 147)

Plotting X-Y composite curves (p. 148)

Magnifying and demagnifying waveforms
- Magnifying and demagnifying waveforms horizontally (in the time axis direction) (p. 150)
- Magnifying a part of waveforms horizontally (in the time axis direction) (zoom function) (p. 151)
- Magnifying and demagnifying waveforms vertically (in the voltage axis direction) (p. 153)

Monitoring input levels (p. 154)

Switching the Waveform Screen (p. 156)
- Displaying the upper and lower limit values
- Displaying comments
- Switching the waveform display width

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7.1 Reading Measured Values (Using Cursors A and B)

- You can read time lag, frequency, and potential difference (and scaling values when the scaling is enabled) as numerical values using Cursors A and B on the waveform screen. The cursors also enable you to specify ranges used for calculating values and the X-Y composite curve printing.
- When X-Y composite curves are displayed, you can read measured values using Cursors A and B. For split-screen display, you can read the potential difference even when each of Cursors A and B are set on different graphs.

Setting Cursors A and B

To display the screen

Press the **DISP** key to display the waveform screen, and then press the **AB CSR** key to display Cursors A and B settings window.

1 **Select the cursor type.**

Move the cursor to the **[AB Cursors]** box.

OFF	Uses no cursors.
Div	Moves the cursors horizontally (in the time axis direction) (for X-Y composite curves, in the X-axis direction)
Range	Moves cursors vertically (in the voltage axis direction) (for X-Y composite curves, in the Y-axis direction)
Trace	Traces waveform data.

2 **Select the cursors to be moved.**

Move the cursor to the **[Kind]** box.

A	Uses only Cursor A.
A-b	Uses Cursors A and B, but moves Cursor A only.
a-B	Uses Cursors A and B, but moves Cursor B only.
A&B	Moves both Cursors A and B together.

3 **Select the channels to be measured with Cursors A and B.**

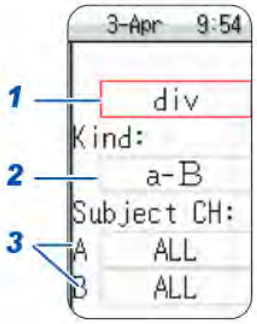
Move the cursor to the **[A]** or **[B]** boxes.

ALL	Shows measured values of all channels. (When cursor type is set to **[Trace]** or **[Range]**.
CH1 to CH16	Shows measured values of the channels selected from CH1 through CH32. (In Single, Dual, Quad, and Oct mode)
Gr1 to Gr8	Chooses the channels to be used for plotting X-Y composite curves from Gr1 through Gr8 . (for X-Y screen)
Analog Ch↔Calc Ch	Switches the cursor target between the analog channel and the waveform calculation data when calculated data exists .

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4 **Move Cursors A and B with the jog dial or shuttle ring.**

(When the **AB CSR** key LED is on, you can move the cursors with the jog dial or the shuttle ring.
Pressing any key other than the **AB CSR** key closes the setup screen.)



If numerical values are hard to read
Press the **DISP** key to display measured values separately from the waveforms.
Refer to "7.7.3 Switching the Waveform Display Width" (p.156).

If Cursors A and B are not displayed on the screen even though engaged
You can check the positions of Cursors A and B on the scroll bar. (p. 146)
Turning the jog dial and shuttle ring allows each of the cursors to be displayed on the screen.
When the cursor type is set to **[div]** or **[Trace]**, you can perform the cursor measurement even if Cursors A and B are not displayed on the screen.

To view the waveforms recorded before or after Cursors A and B that are out of display range
When using Cursors A and B, you can display the waveforms that are presently being out of display range immediately using the jump function.
Refer to "7.3.3 Changing Position (Jump Function)" (p.147).

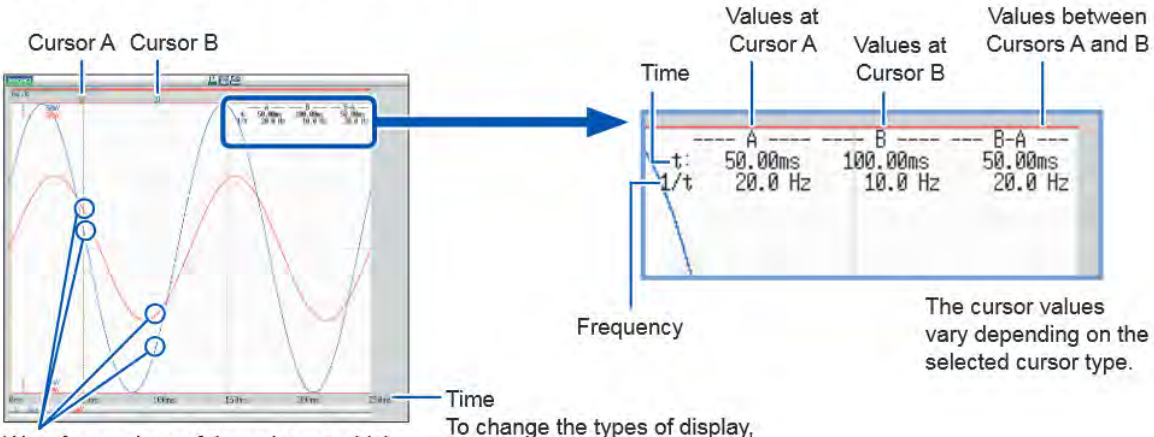
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Reading measured values on the waveform screen (in Single, Dual, Quad, and Oct mode)

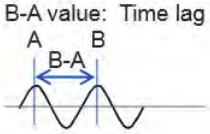
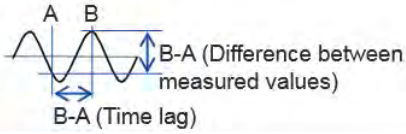
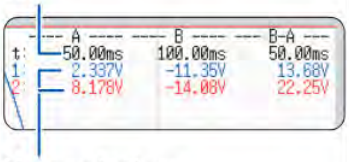
To display the screen

Press the **DISP** key to display the waveform screen.

<Screen display (for time axis cursor)>



<Cursor values>

Cursor type	Cursor value	Cursor value display example (when two cursors are used)
Div (Time and frequency)	**t:** Values at Cursors A and B: Time from the trigger point or the start of recording B-A value: Time lag between Cursors A and B  **1/t:** Frequency the period of which is t	See "Screen display" above.
Range (Measured values)	Each value at Cursor A and B: Measured value of the channel B-A value: Difference between measured values at Cursors A and B 	
Trace (Time and measured values)	Time values Values at Cursors A and B: Time from the trigger point or the start of recording B-A value: Time lag between Cursors A and B Measured values Values at Cursors A and B: (Memory function) measured value (Recorder function) maximum, minimum values B-A value: Difference between measured values at Cursors A and B 	Time  Measured values

When you press the **DISP** key and then change the waveform display width, the waveforms and cursor values are displayed separately.

Refer to "7.7.3 Switching the Waveform Display Width" (p. 156).

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- When using the external sampling, the value t represents the number of samples.
- When the voltage range is changed during measurement using the recorder function or X-Y recorder function, measured values are acquired by tracing the waveforms in the range settings when the measurement was stopped. The data measured with MR8990 Digital Voltmeter Unit is updated every time Cursor A and B moves two points.

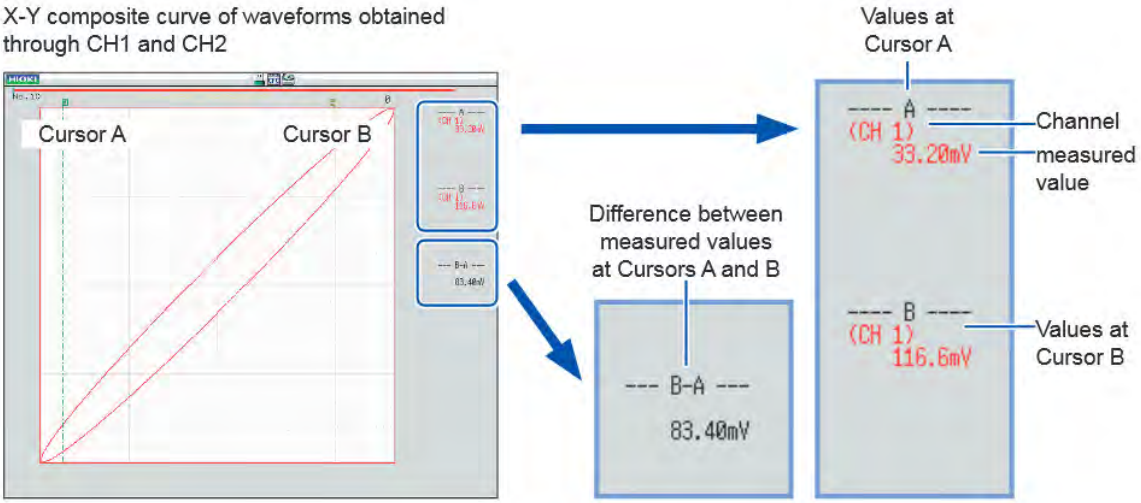
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Reading measured values on the waveform screen (in Single, Dual, Quad, and Oct mode)

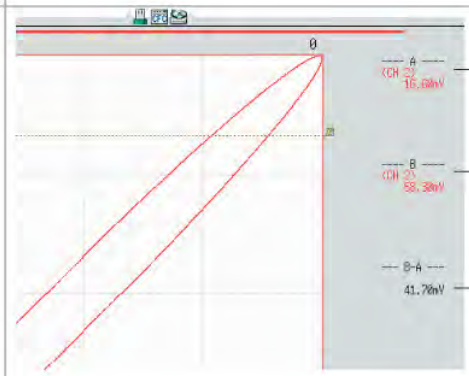
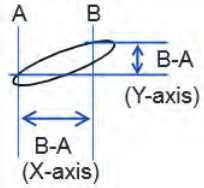
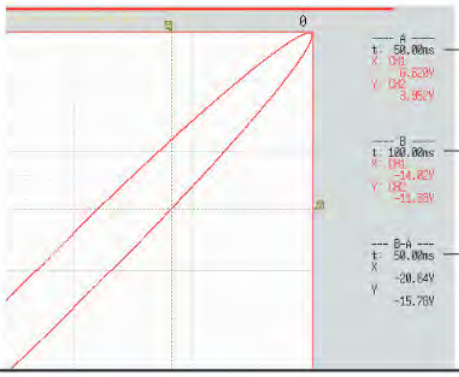
To display the screen

Press the **DISP** key to display the waveform screen.

<Screen display (X-axis cursor)>



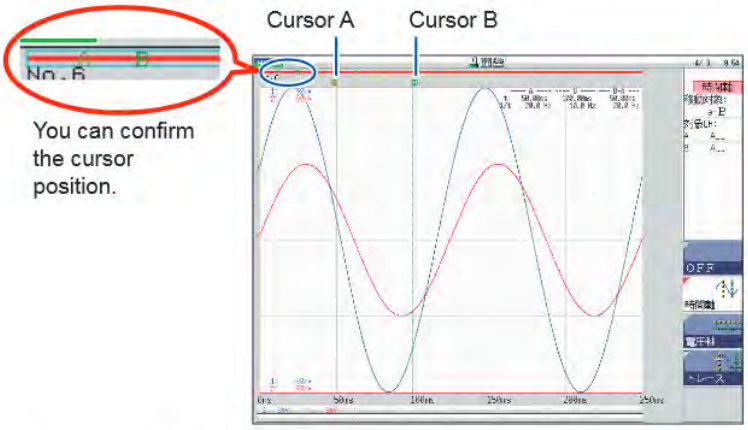
<Cursor values>

Cursor type	Cursor value	Cursor value display example (when two cursors are used)
X-axis (X-axis measured value)		See "Screen display" above.
Y-axis (Y-axis measured value)		**(Channel on Y-axis)**  Measured value at Cursor A Measured value at Cursor B Difference between measured values at Cursors A and B
Trace (Time and X-axis and Y-axis measured values)		**(Channels on X and Y axes)**  Measured value at Cursor A Measured value at Cursor B Time lag and measured value difference between Cursor A and B

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7.2 Specifying the Waveform Range (Cursors A and B)

When the waveforms are displayed on the voltage-time graph, you can specify the range with the time axis cursor or trace cursor.
The specified range is applicable for saving files, printing waveforms, plotting X-Y composite curves, and performing the numerical calculation. The range selection is retained even when the waveform display format is changed.



The rough procedure is as follows.

1 **Set Cursors A and B.**
Refer to "Setting Cursors A and B" (p. 140).

2 **Specify a range.**

- **For saving files**
  Display the system screen, select the **[Save file]** sheet, move the cursor to the **[Save Area]** box, and then select **[A-B Wave]**.
  Refer to "5.2.2 Automatically Saving Waveforms" (p. 96) and "5.2.3 Saving Data Selectively (SAVE Key)" (p. 103).
- **For printing data**
  Display the system screen, select the **[Printer]** sheet, move the cursor to the **[Slct Print Area]** box, and then select **[A-B Wave]**.
  Refer to "6.2 Setting Auto-printing" (p. 127) and "6.3 Manually Printing Data by Pressing the PRINT Key (Selection Print)" (p. 130).
- **For plotting X-Y composite curves**
  Display the status screen, select the **[Status]** sheet, move the cursor to the **[Combo Area]** box, and then select **[A-B Wave]**.
  Refer to "7.4 Plotting X-Y Composite Curves" (p. 148).
- **For performing numerical calculation**
  Displays the status screen, select the **[Num Calc]** sheet, move the cursor to the **[Calc Area]** box, and then select **[A-B Wave]**.
  Refer to "6.2 Setting Auto-printing" (p. 127).

About how to read measured values and cursor types
Refer to "7.1 Reading Measured Values (Using Cursors A and B)" (p. 140).

Available range in which Cursor A and B can be specified
The available range depends on the function.
- Memory function: Measured data recorded during one time of measurement
- Recorder function: The range of the measured data recorded during one time of measurement or the range of measured data the instrument can record internally, calculated from the end of recording
  The maximum measured data the instrument can record internally is as follows:
  MR8847-51: Up to 20,000 div (if using Model U8975, U8977, or U8978: 10,000 div)
  MR8847-52: Up to 80,000 div (if using Model U8975, U8977, or U8978: 40,000 div)
  MR8847-53: Up to 160,000 div (if using Model U8975, U8977, or U8978: 80,000 div)

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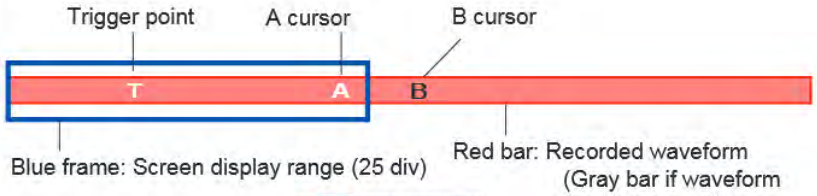
7.3 Moving the Waveform Display Position MEM REC

This function can be used in the memory and recorder functions.

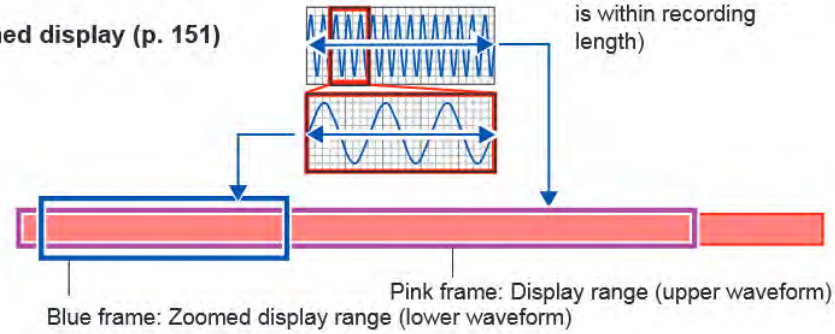
7.3.1 Display Position

The scroll bar provides the relative position and size of the displayed portion of the waveforms within the entire recording length of the waveforms. The trigger time, trigger position, and positions of Cursors A and B (When using voltage axis cursor or trace cursor) are also displayed.

To verify the display range on the scroll bar

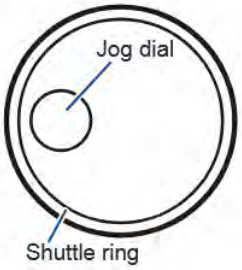


With the zoomed display (p. 151)



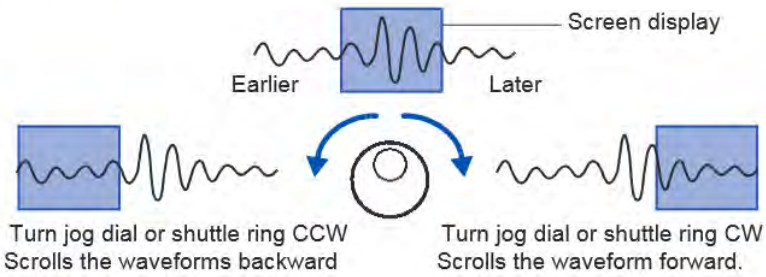
7.3.2 Scrolling the Waveforms With the Jog Dial and Shuttle Ring

Rotating the jog dial and shuttle ring allows you to scroll waveforms that have been measured or those exist.



The scrolling speed varies depending on the rotation angle of the shuttle ring.
Pressing the **WAVE** key assigns the jog dial and shuttle ring to scroll waveforms.
(While the **WAVE** key LED is on, you can scroll the waveforms with the jog dial and shuttle ring.)

Scroll direction



To see previously obtained waveforms in roll mode

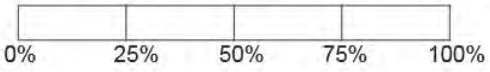
Rotating the jog dial or shuttle ring allows you to observe the previously obtained waveforms during measurement.
To redisplay the waveforms, select **[Scroll]**.

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7.3.3 Changing Position (Jump Function)

You can specify the portion of the waveforms and display them immediately.
You can choose a display location from the following:

- Trigger point
- Positions of Cursor A and B
- Specified location (from 0%, beginning of the waveform, to 100%, end of the waveform)



Procedure

To display the screen

Press the **DISP** key to display the waveform screen, and then press the **WAVE** key to display the wave settings GUI displays.

1 **Specify the position by pressing the F keys ([←], [→]).**

The waveforms included in the yellow frame on the scroll bar are to be displayed.



2 **Select [move].**

The waveform included in the selected display position is displayed on the screen.



New position

To move the display position when waveforms are written in the memory with the [Memory Div: On] setting of the memory function

Press the **F1** key **[Pos↔Block]**. Move the position with no blocks displayed in the upper part of the screen.
When a block is displayed in the upper part of the screen, you can select a block of the waveforms written in the memory and display it. (p. 157)

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7.4 Plotting X-Y Composite Curves

MEM X-Y

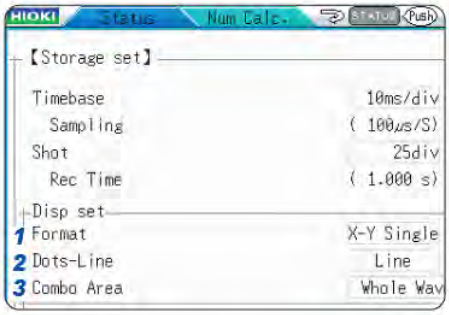
This function can be used in the memory and X-Y recorder functions.

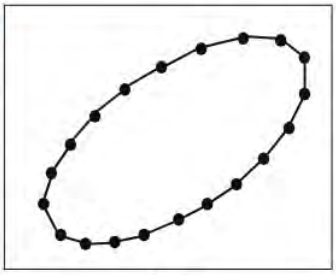
- Using the recorder function causes Model 8990 to acquire data with a resolution of 16 bits.
- To plot X-Y composite curves, display the status screen, follow the procedure below:
  (1) Select the **[Status]** sheet.
  (2) Set **[Format]** to X-Y1 screen or X-Y4 screen. (3) Assign any analog channel to the X-axis and Y-axis.
  Up to eight X-Y composite curves can be plotted.
- The magnification/demagnification ratio in the vertical axis (voltage axis) direction also applies for plotting X-Y composite curves simultaneously.

Procedure

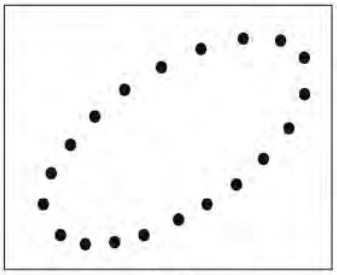
To display the screen

Press the **STATUS** key to display the status screen, and then select the **[Status]** sheet.





Line



Dots

1 **Move the cursor to the [Format] box.**

X-Y Single	Displays and records the waveforms of graphs 1 through 8 in Single mode .
X-Y Quad	Displays and records the waveforms of graphs 1 through 8 in Quad mode.

2 **Move the cursor to the [Dots-Line] box.**

Dots	Displays dots representing only measured data points. The order written in the memory does not appear.
Line	Displays the data as a waveform by drawing lines connecting measured data points in the order written in the memory. (Default setting)

3 **Move the cursor to the [Combo Area] box.**

Refer to "7.2 Specifying the Waveform Range (Cursors A and B)" (p. 145).

Whole Wave	Plots X-Y composite curves using all data.
A-B Wave	Plots X-Y composite curves using only data included in the range specified by Cursors A and B.

To shorten the time taken to display waveforms after measurement

- Set the dot-line interpolation setting to **[Dots]**.
- Specify the plotting range using Cursors A and B. (memory function only)

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Procedure

To display the screen

Press the **DISP** key to display the waveform screen, and then press the **CH.SET** key to display the X-Y settings window.

4 **Set the waveform color used in the graph display.**

Move the cursor to the graph line color map to be set, and choose a color.

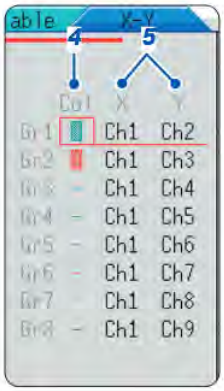
You can also select the same color as other lines.

OFF	Displays no waveform. When **[Save Channel]** of the channel is set to **[Disp Ch]**, the data obtained through the channel is not saved automatically. Refer to "Select the channels to be saved." (p. 99).
ON	Displays the waveform. Select the display color by pressing the **[↑]** and **[↓]** key in the **F** keys.

5 **Select the channels for plotting the X-Y composite curve.**

Move the cursor to the X (time axis) and Y (voltage axis) column, and assign channels.

You can assign the same channel multiple times.



To plot X-Y composite curves using the data included in the range between Cursors A and B

Follow the procedure below.

1. Press the **STATUS** key to display the status screen, and then select the **[Status]** sheet.
2. Set **[Format]** to Single, Dual, Quad, Oct, or Hex.
3. Press the **DISP** key to display to the waveform screen.
4. Specify the range for plotting X-Y composite curves with Cursors A and B. Refer to the following pages: (p. 140), (p. 145).
5. Press the **STATUS** key to display the status screen, and then select the **[Status]** sheet.
6. Set **[Format]** to **[X-Y1 Single]** or **[X-Y Quad]**.

To move the pen displayed on the X-Y composite curves

Pressing the **WAVE** key, which puts the LED on, enables the pens on all the waveforms to be moved with the jog dial and shuttle ring. The time at the pen position is displayed at the top right of the screen.

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7.5 Magnifying and Demagnifying Waveforms

7.5.1 Magnifying and Demagnifying Waveforms Horizontally (in the Time Axis Direction) MEM REC

This function can be used in the memory and recorder functions. (However, with the recorder function, waveform magnification is not available.)
Magnifying waveforms horizontally (in the time axis direction) enables you to observe data in detail. Also, demagnifying waveforms horizontally (in the time axis direction) enables you to observe overall waveform fluctuations easily.
Waveforms displayed on the screen are magnified and demagnified with reference to the left edge of the screen. However, when Cursors A and B are displayed on the screen, waveforms are magnified or demagnified with reference to Cursor A and B. You can change the magnification/demagnification ratio even after measurement.



Procedure

To display the screen

Press the **DISP** key to display the waveform screen.

1 **Move the cursor to the [Time Mag]box.**

2 **Select a magnification ratio.**

Memory function

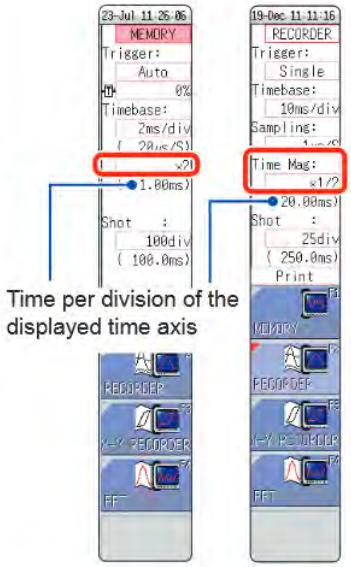
×10, ×5, ×2, ×1, ×1/2, ×1/5, ×1/10, ×1/20, ×1/50, ×1/100, ×1/200, ×1/500, ×1/1000, ×1/2000, ×1/5000, ×1/10000, ×1/20000, ×1/50000, ×1/100000, ×1/200000

Selecting **[Zoom On]** enables a part of the waveforms to be magnified in the time axis direction.
Refer to "7.5.2 Zoom Function (Magnifying a Section of the Horizontal Axis (Time Axis))" (p. 151).

Selecting **[All Wave]** enables the entire recording length of the waveforms to be displayed.

Recorder function

×1, ×1/2, ×1/5, ×1/10, ×1/20, ×1/50, ×1/100, ×1/200, ×1/500, ×1/1000, ×1/2000, ×1/5000, ×1/10000, ×1/20000, ×1/50000



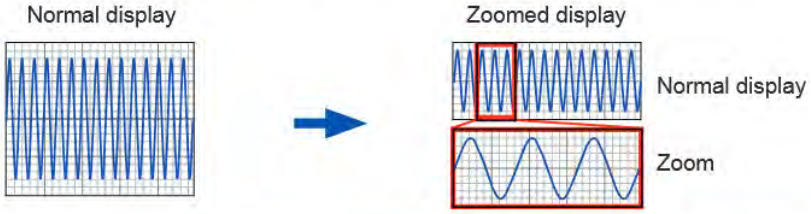
To print the waveforms in a different magnification/demagnification ratio from the ratio used to display the waveforms

Specify the ratio on the **[Printer]** sheet.
Refer to "Configure the horizontal axis (time axis) magnification and demagnification setting." (p. 134).
It may take a long time to display waveforms loaded from the storage device in a high demagnification ratio.

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7.5.2 Zoom Function (Horizontally Magnifying a Part of Waveforms [in the time axis direction]) MEM

This function can be used in the memory function only.
You can display partly magnified (zoomed-in) waveforms together on the horizontally split dual displays with the normal waveforms.
The normal waveforms are displayed on the upper half of the screen, whereas the zoomed-in waveforms are displayed on the lower half.



When the zoom function is used, pressing the **PRINT** key prints the waveforms displayed on the lower half of the screen. (The print format is that for a single screen waveform. If Cursors A and B are used, the selected section is printed.)

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Procedure

To display the screen

Press the **DISP** key to display the waveform screen.

1 **Move the cursor to the [Zoom Mag] box.**

2 **Select [Zoom On].**

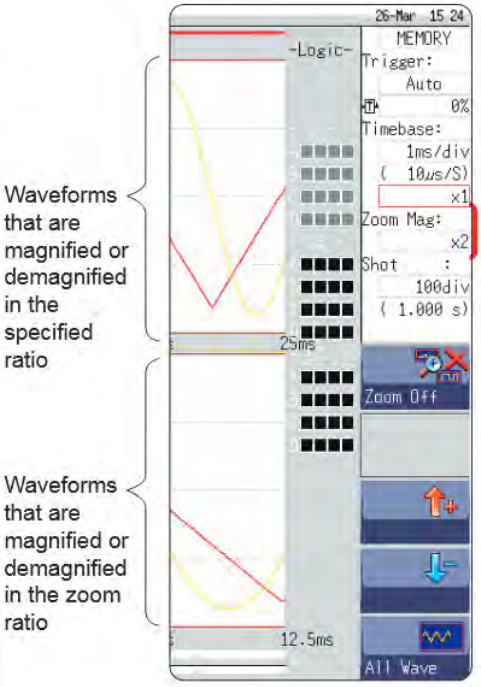
The zoom function is enabled, and the screen is horizontally split into two: the upper and lower screens. (Upper: waveforms magnified in the specified ratio; lower: partly magnified (zoomed) waveforms)



3 **Select the zoom-in ratio.**

Move the cursor to the [Zoom Mag] box, and set the zoom-in ratio.

The zoomed-in waveforms are displayed on the lower screen.
When the **[Zoom Mag]** setting is set to the same or a lower one than the magnification/demagnification ratio, the zoom-in waveforms are displayed automatically in the next higher ratio of the **[Zoom Mag]** setting.



4 **Scroll the zoomed-in waveforms.**

Refer to "7.3.2 Scrolling the Waveforms With the Jog Dial and Shuttle Ring" (p. 146).

To clear the zoom-in display

Move the cursor to the **[Zoom Mag]** box, and select **[Zoom Off]**. (The zoom-in display is cleared with the magnification/demagnification ratio set to the same ratio as the zoom-in ratio.)
Example: When the zoom-in display is cleared with the zoom-in ratio set to × 5, the magnification/demagnification ratio is set to **[×5]**.

To view the entire length of waveforms (Memory function only)

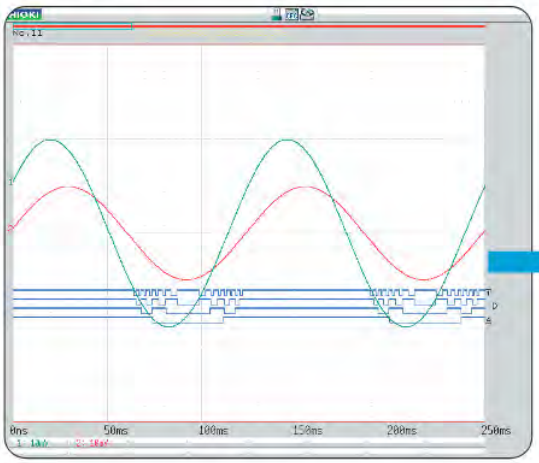
Move the cursor to the magnification/demagnification ratio box in the settings window and select **[All Wave]**. The entire recording length of the waveforms are displayed on the screen.

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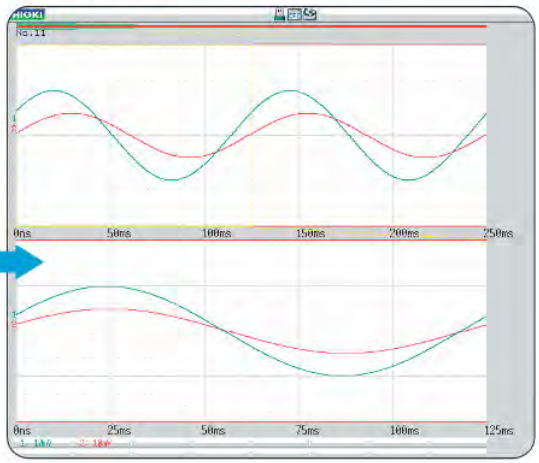
Logic waveform display

When the zoom function is enabled and the logic waveform display position is set to one that is less than the **[50pos]** setting, no logic waveforms are displayed.
Example: With the display position set to **[30pos]**

Normal display



Zoomed display

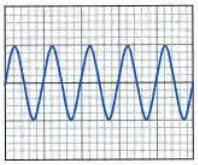


7.5.3 Magnifying/demagnifying the Waveforms Vertically (in the Voltage Axis Direction)

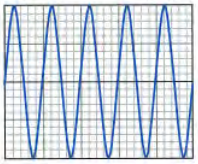
MEM REC

This function can be used in the memory and recorder functions.
You can magnify and demagnify the waveforms vertically (in the voltage axis direction) for the display or printing with respect to each channel.
The waveforms are magnified and demagnified with reference to the zero position.

Normal display



Magnified display (× 2)



Procedure

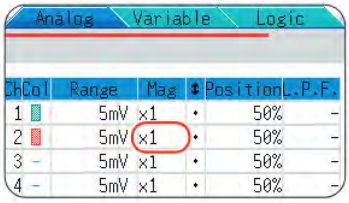
To display the screen

Press the **DISP** key to display the waveform screen, and then press the **CH.SET** key to display the channel settings window (**[Analog]** sheet).

Move the cursor to the [Mag] box of the channel to be adjusted.

×1/10, ×1/5, ×1/2, ×1, ×2, ×5, ×10, ×20, ×50, ×100

Selecting **[Invert]** inverts the sign (positive and negative) of the waveforms.
Refer to “8.8 Inverting the Waveform (Invert Function)” (p. 182).



To display waveforms in a freely selected ratio

Refer to “8.6 Setting the Waveform Position (Variable Function)” (p. 178).

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7.6 Monitoring Input Levels (Level Monitor)

7.6.1 Level Monitor

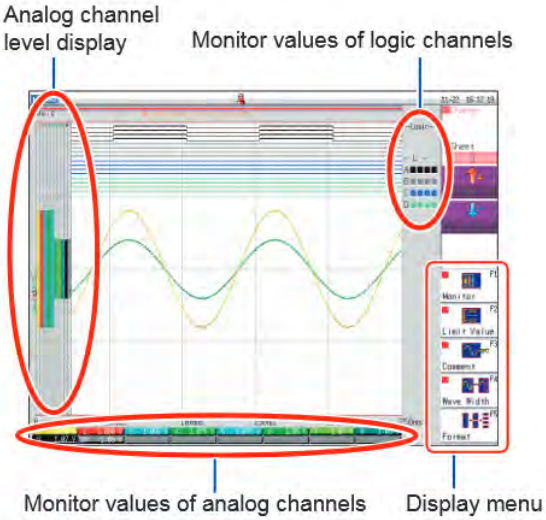
You can monitor all input waveform levels in real time.
You can display analog channels and logic channels at a time.

Procedure

To display the menu

Press the **DISP** key to display the display menu.

Selecting **[Monitor]** allows the analog channel level monitor to be displayed in the left part of the waveform screen and the logic channel level monitor to be displayed on the right side of the waveform screen.



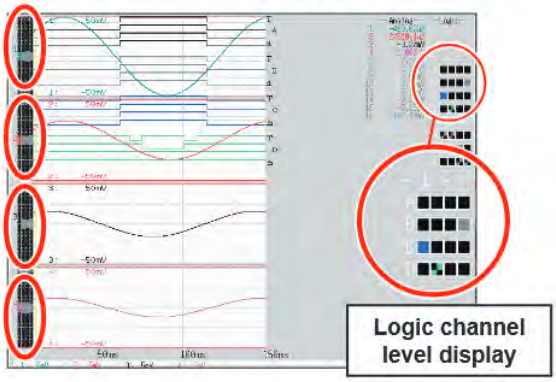
To clear the level monitor

Select **[Monitor]** again.

When waveforms are displayed in Dual, Quad, Oct, or Hex mode (p. 69)
The level monitors are displayed with respect to each graph.

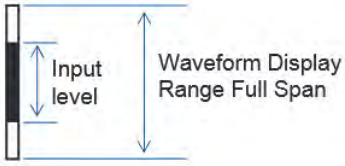
You can combine the upper and lower limits indication with the level monitor.

Refer to "7.7.1 Displaying Upper and Lower Limits on the Waveform Screen" (p.156).



How to read the level monitors

Analog channel level display



Logic channel level display



When the display setting is On, the part indicated in white takes the color specified for the waveform display. When the setting is Off, the part becomes gray. The part indicated in black is the background color.

- No input levels for channels in which no modules are installed are displayed.
- No analog levels of channels that are unavailable due to the **[Use Ch]** settings are displayed. (Example: When **[Use Ch]** is set to **[Ch1-4]**, the levels for CH5 through CH16 are not displayed.

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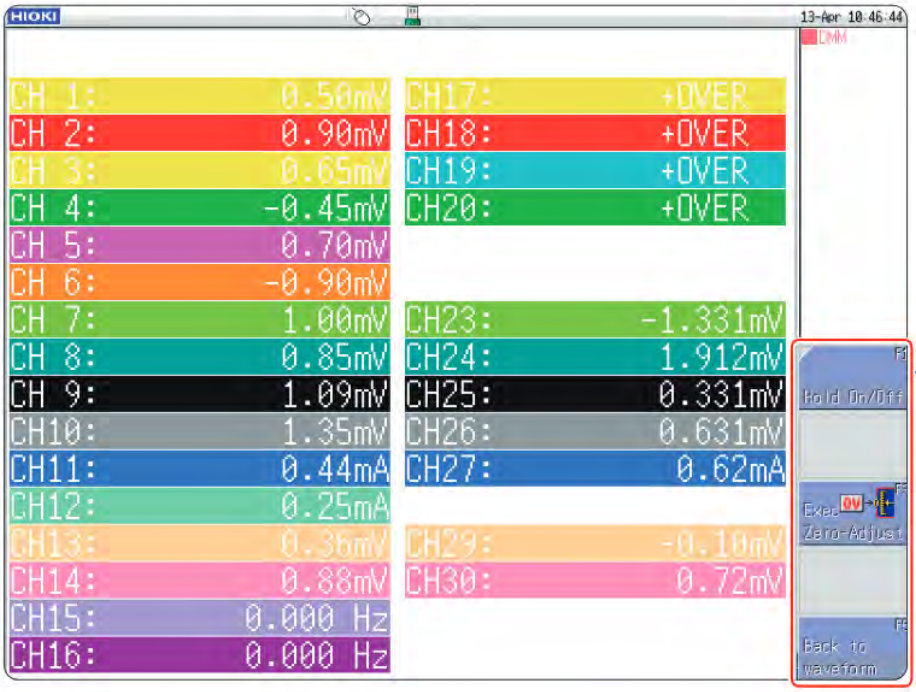
7.6.2 Numerical Value Monitor

You can read input signals as numerical values displayed in the same way as digital multimeters (DMMs).

Procedure

To display the screen

Press the **DISP** key twice.



Display menu

When the mouse is connected, clicking the **[DMM]** icon displayed at the upper right of waveform screen allows numerical value (DMM display) to be displayed.



To return to the waveform screen

Press **[Return to Waveform screen]** displayed at the right side of the display menu screen or the **DISP** key.

To suspend (hold) the display update

Press **[HOLD On/Off]** displayed on the right side of the display menu screen.
The HOLD mark, which indicates that the display update is suspended, is displayed on the screen.

To resume the display update

Press **[HOLD On/Off]** to resume the display update.

To execute the zero-adjust

The zero-adjust (calibration for Model MR8990) can also be executed on the numerical value (DMM) display screen. Press the **[Exec. Zero-Adjust]** displayed at the right side of the display menu screen.

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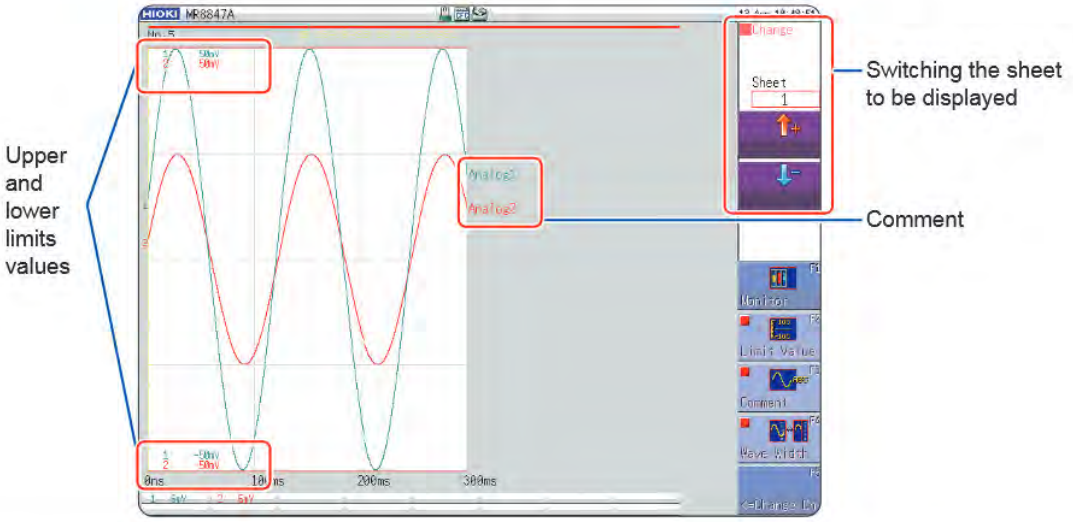
7.7 Switching the Waveform Screen Display (Display Menu)

You can display the additional information such as upper and lower limit values and comments using the display menu. You can also set the waveform display width.
Refer to “7.6.1 Level Monitor” (p.154).

Procedure

To display the menu

Press the **DISP** key to display the waveform screen, and then press the **DISP** key again to display the display menu.



To hide the menu

Select the same menu again.

7.7.1 Displaying Upper and Lower Limits on the Waveform Screen

Select **[Limit Value]** to display the upper and lower limit values on the waveform screen.

7.7.2 Displaying Comments on the Waveform Screen

Select **[Comment]** to display the comment on the waveform screen.

- You have to enter a comment on the **[Comment]** sheet of the channel screen.
  Refer to “8.1 Adding Comments” (p.160).
- Other windows and monitors will appear overlapping the comment. Hide the channel settings window, trigger settings window, level monitor, etc., or set **[Wave Width]** to a narrower setting.

7.7.3 Switching the Waveform Display Width

Selecting **[Wave Width]** allows you to change the display width of the waveform screen.
If waveforms are hard to see because numeric values or settings information are overlaid, this function is useful to display the other information separately from the waveforms.
The function is available for the channel settings window and trigger settings window.

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7.7.4 Switching Channel Information (U8975, U8977, and U8978 only)

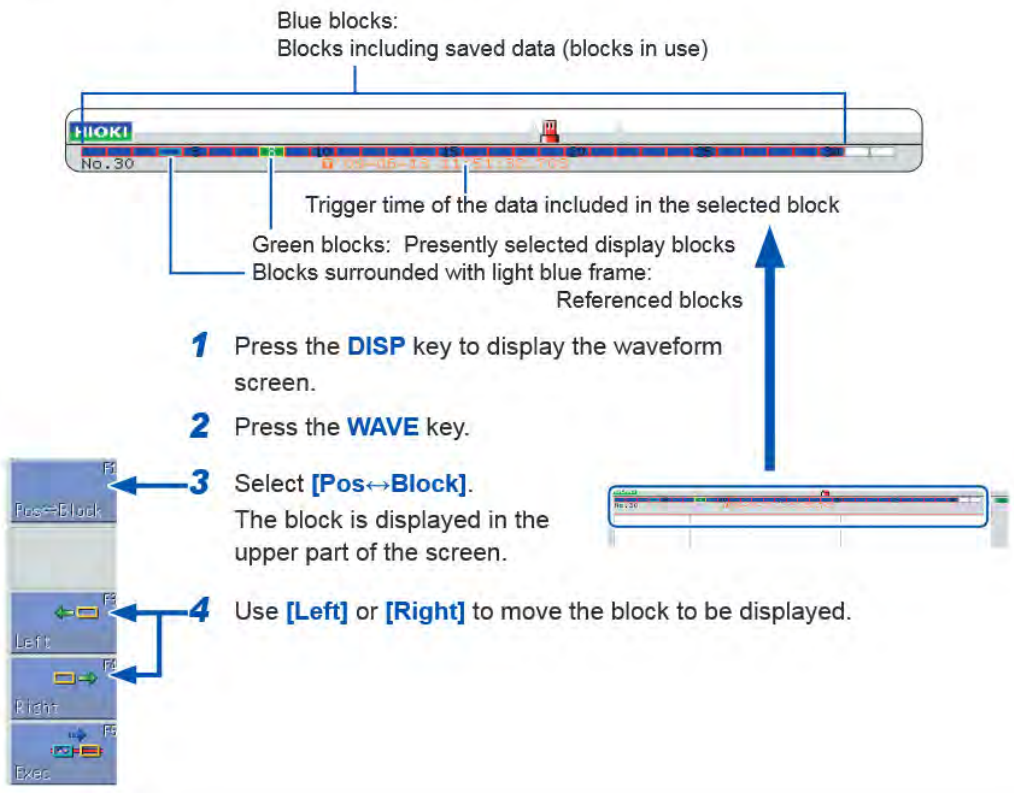
Selecting **[<=Change Ch]** will switch the set range information on the bottom of the screen to CH1 to CH16 or CH17 to CH32.
If the level monitor is on, the monitor values will switch to CH1 to CH16 or CH17 to CH32.

7.7.5 Switching the Sheet to Be Displayed

Select between **[↑]** and **[↓]** to switch the sheet to be displayed.
You can specify the settings with respect to each displayed sheet on the unit list tab of the channel settings window.
Refer to "3.4.4 Display Sheet" (p.78).

7.8 Viewing Waveforms Divided Into Blocks MEM

This function can be used in the memory function only.
You can check usage of blocks when waveforms were recorded by using the memory division.
Furthermore, you can select any block to display waveforms recorded in it.
When the memory division is not used, you can display up to 16 measured waveforms depending on the recording length.
Refer to "7.3 Moving the Waveform Display Position" (p.146).



To display waveforms overlapping those recorded in other blocks (reference blocks)

Display the status screen, select the **[Memory Div]** sheet, set **[Ref Block]** to **[On]**, and select **[All Blks On]**.
Refer to "12.2 Configuring the Display Settings" (p.270).

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8 Advanced Functions

Adding comments (p. 160)

Converting input values (scaling) (p. 171)

Freely setting the waveform display (p. 178)

Fine-adjusting input values (p. 181)

Inverting waveforms (p. 182)

Copying a setting to another channel (p. 183)

Advanced measurement and settings

- Displaying waveforms during the recording (p. 167)
- Overlay waveforms with the waveforms recorded before (p. 168)

Detailed module settings (p. 184)

- Setting the anti-aliasing filter
- Setting thermocouple types
- Setting the reference point compensation
- Setting the wire break detection
- Setting the data update
- Executing the auto-balance
- Setting the voltage dividing ratio of the probe
- Setting the response time
- Setting the measurement mode

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8.1 Adding Comments

8.1.1 Adding, Displaying, and Printing the Title Comment

Entering a title comment enables itself to be displayed at the top of the waveform screen and to be printed on the recording paper. (Available number of characters: up to 40)
Refer to “6.6.2 Printing Reports (A4-Sized Print)” (p. 136).

Procedure

To display the screen

Press the **CHAN** key to display the channel screen, and then select the **[Comment]** sheet.



1 **Set the print content of the title.**

Move the cursor to the **[Title Print]** box.

OFF	Does not print any setting conditions or title comment.
Setting	Prints the setting conditions of the instrument.
Comment	Prints the title.
Set& Comment	Prints both the setting conditions and title.

2 **Enter the title comment.**

Move the cursor to the **[Title Comment]** box.

Enter Char	Enables you to enter the comment. Refer to “Entering texts” (p. 163).
Clear	Clears the entered comment.
Undo	Returns to the state before the most recent change.

To select the comment from the previously registered terms

Pressing the **WAVE** key after activating the text input displays the list of previously registered terms.
It is also possible to select a comment from previously entered titles (history list).
Refer to “Entering texts from the term list or history list” (p. 165).

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8.1.2 Adding, Displaying, and Printing the Channel Comments

Entering comments with respect to each channel enables you to confirm the comments of each channel on the screen. The comments can also be printed on the recording paper. (Available number of characters: up to 40)

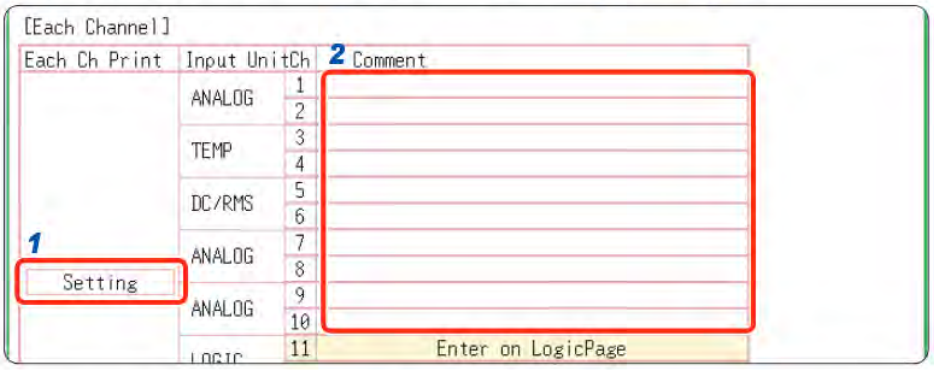
To copy the comment to another channel

You can copy the comment on the **[Comment]** sheet.
Refer to "8.9 Copying Settings to Other Channels (Copy Function)" (p. 183).

Procedure

To display the screen

Press the **CHAN** key to display the channel screen, and then select the **[Comment]** sheet.



1 Select contents to be printed for each analog channel.

Move the cursor to the box in the **[Each Ch Print]** column for each channel.

OFF	Does not print any setting items and channel comments.
Setting	Prints the settings for each channel. (Not displayed on the screen)
Comment	Prints the comments of each channel.
Set& Comment	Prints both the settings and comments of each channel.

2 Enter comments for each analog channel.

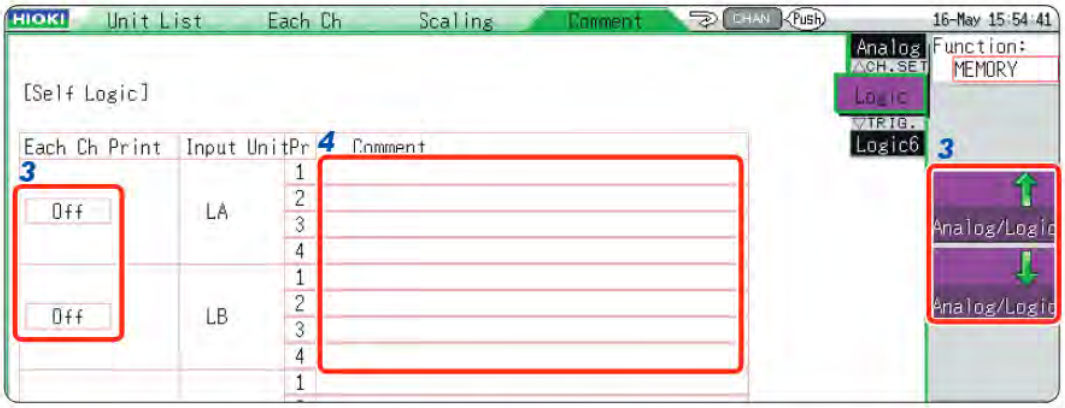
Move the cursor to the **[Comment]** column.

Enter Char	Enables you to enter the comment. Refer to "Entering texts" (p. 163).
Clear	Clears the entered comment.
Undo	Returns to the state before the most recent change.

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To select the comment from the previously registered terms

Pressing the **WAVE** key after activating the text input displays the list of previously registered terms.
It is also possible to select words from the previously entered analog channel comments (history list).
Refer to “Entering texts from the term list or history list” (p. 165).



5 **Select the print content for each logic channel.**

Select **[Analog/Logic]** to display the logic channel page.

Move the cursor to **[Each Ch Print]**.

Off	Does not print any comments.
Comment	Prints comments.

6 **Enter the comment for each logic channel.**

Move the cursor to the **[Comment]** column.

Enter Char	Enables you to enter the comment. Refer to “Entering texts” (p. 163).
Clear	Clears the entered comment.
Undo	Returns to the state before the most recent change.

To select from the previously registered terms

Pressing the **WAVE** key after activating text input displays the list of the previously registered terms.
It is also possible to select words from the previously entered logic channels (History List).
Refer to “Entering texts from the term list or history list” (p. 165).

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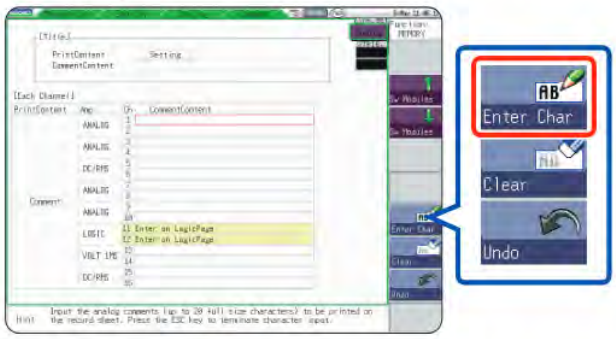
8.1.3 Entering Alphanumeric Characters

Move the cursor to the setting item for which you wish to enter text and choose the content with the **F** key.

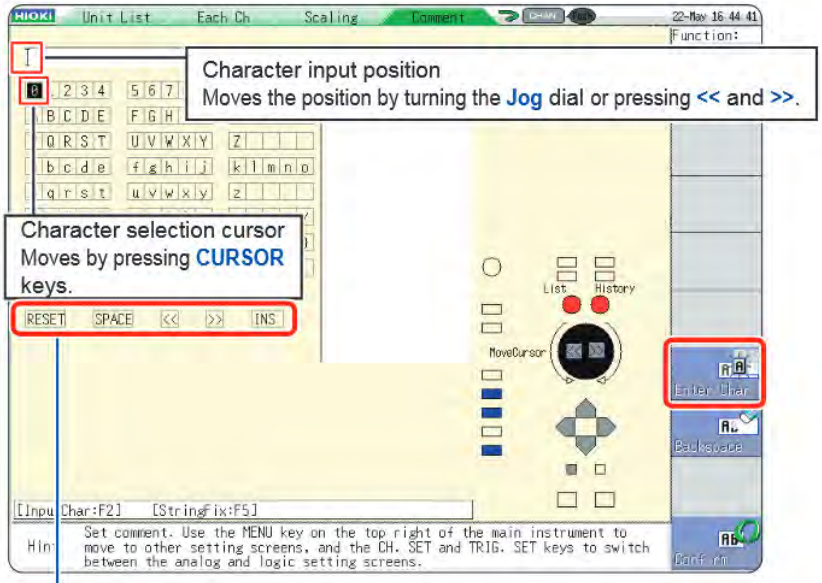
Entering texts

1 **Move the cursor to the comment field and select [Enter Char].**

The virtual keyboard is displayed.



2 **Select characters by pressing CURSOR keys on the virtual keyboard, and select [Enter Char] to enter the comments.**



RESET	Deletes all of the entered characters. (Move the cursor to **RESET**, and press **[Enter Char]**.)
SPACE	Inserts a space. (Move the cursor to **SPACE**, and press **[Enter Char]**.)
OVWR/INS	Switches between overwrite mode (OVWR) and insert mode (INS). (Move the cursor to **[OVWR/INS]**, and press **[Enter Char]** to switch between OVWR and INS.)
<<	Moves the character input position to the left.
>>	Moves the character input position to the right.

Press the **CH.SET** key or **TRIG.SET** key to change the input mode.

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3 **Select [Confirm] to confirm the entry.**

The virtual keyboard is closed.
Press the **ESC** key to suspend the entering.
(Pressing the **ESC** key again closes the virtual keyboard.)

To enter units and symbols
Some characters are saved using alternative characters.
(When saved as numerical calculation results or in text format)
"^{2}" is saved as "^2"; "^{3}," as "^3"; "μ ," as "~u"; "Ω," as "~o"; "ε," as "~e"; "°," as "~c"; and "±," as "~+."
Characters not allowed to be used in file names cannot be entered.

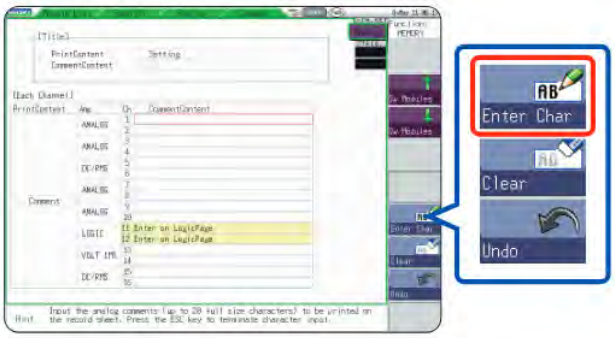
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Entering texts from the term list or history list

While the virtual keyboard is being displayed, pressing the **WAVE** key displays the term list, and pressing the **AB CSR** key displays the history list.
They are available to enter the previously registered terms or the previously entered terms.

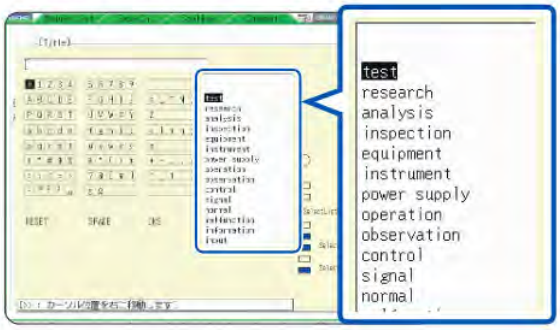
1 **Move the cursor to the comment box and select [Enter Char].**

The virtual keyboard is displayed.



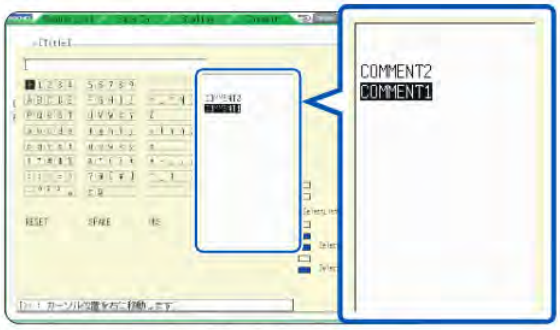
2 **Press the WAVE key to select from the previously registered terms.**

The list of the previously registered terms is displayed.



Press the AB CSR key to select from the previously entered terms.

The history list is displayed.



Press the **ESC** key to suspend the entry from the list.

3 **Press the up and down CURSOR keys or rotate the jog dial to select a term from the list, and select [Enter Char].**

4 **Select [Confirm] to confirm the entry.**

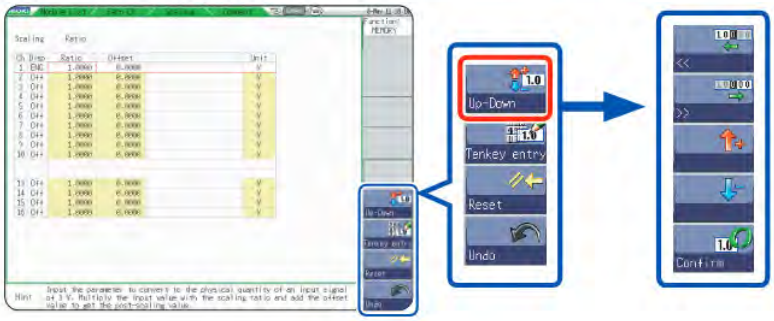
The virtual keyboard is closed.
Select **[Go back]** to undo the changes after you have confirmed the text.

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Entering numerals by increasing and decreasing them

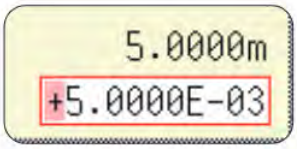
1 **Move the cursor to the numeric input box and select [Up-Down].**

The virtual keyboard for digit input is displayed.



2 **Enter numerals using the virtual keyboard.**

(Press F1 and F2 to move the digit. Press F3 and F4 to increase and decrease the value, respectively.)



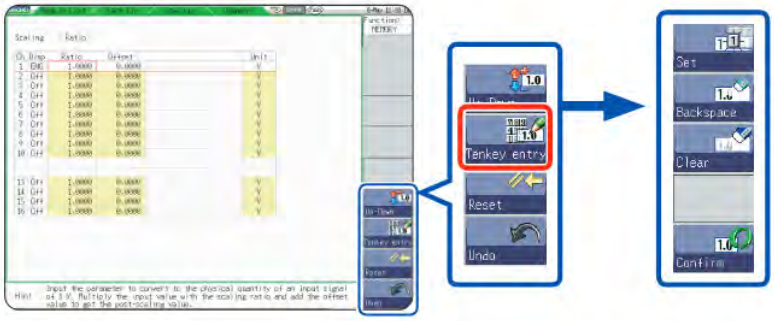
3 **Select [Confirm] to confirm the entry.**

Press the **ESC** key to suspend the entering.

Entering numerals with the numerical keypad

1 **Move the cursor to the numeric input box and select [Tenkey entry].**

The virtual numerical keypad is displayed.



2 **Enter numerals using the virtual numerical keypad.**



ESC: Cancels the input.
BS: Deletes a character.
C: Deletes all characters.
Enter: Confirms the entry

3 **Select [Confirm] to confirm the entry.**

Press the **ESC** key to suspend the entering.

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8.2 Displaying Waveforms During the Writing in the Memory Simultaneously (Roll Mode) MEM

This function can be used in the memory function only.
You can display and print the waveforms at the same time as the data is acquired (with the auto-print set to on). (p. 127)

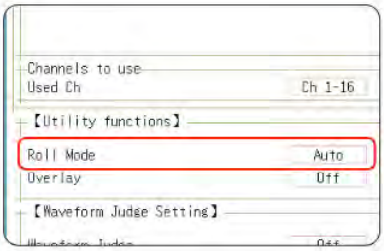
- If the instrument measures signals at low sampling rate using the memory function, it takes a long time to write the entire recording length of data in the memory. Measurement in roll mode is useful in such cases.
- The waveforms scroll automatically.

Procedure

To display the screen

Press the **STATUS** key to display the status screen, and then select the **[Status]** sheet.

Move the cursor to the [Roll Mode] box.



OFF	Writes the data normally in the memory. After writing the specified recording length of data in the memory, displays the waveforms.
On	Displays the waveforms while writing the data in the memory (with the setting of 10 ms or slower). However, when the timebase is set to 5 ms/div or faster, the instrument displays the waveforms after the writing in the memory.
Auto	Displays the waveforms in the specified magnification ratio during the writing in the memory regardless of the timebase setting. (Default setting) However, when the waveforms are displayed using a time axis faster than 100 ms per division, or when the timebase is set to 5 µs/div, the instrument displays the waveforms after the writing in the memory.

When the roll mode function is set to [On]

- **The roll mode function and the overlay function cannot be used simultaneously.**
  When the roll mode function is enabled, the overlay function is automatically set to **[Off]**. Besides when the overlay function is enabled, roll mode is set to **[Auto]**. (p. 168)
- The roll mode, memory division, and waveform calculation functions cannot be used simultaneously.

Roll mode function	Memory division function	Waveform calculation function
On	Off	Off
Off	On	Off
Off	Off	On

Note: When any one of the functions is set to **[On]**, the other functions are automatically set to **[Off]**.

- When the auto-print (p. 127) is enabled, the printing is available while the waveforms are being displayed simultaneously. However, for X-Y composite curves, all data must be written in the memory before the printing.
  In addition, while evaluating data by calculating the numerical values, the instrument automatically prints the waveforms based on the evaluation conditions on completion of the numerical calculation.

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When the roll mode function is set to [Off]

Since the instrument displays the waveforms after storing the entire recording length of the data, it takes a long time after starting measurement until displaying the waveforms with a relatively slower sampling.

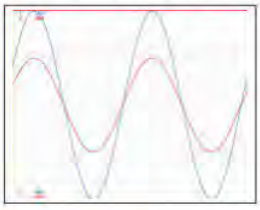
8.3 Overlaying New Waveforms With Past Waveforms

MEM

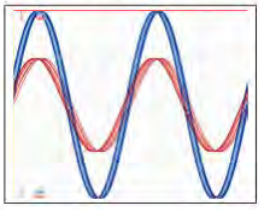
This function can be used in the memory function only.
The instrument overlays the new waveforms with the presently displayed waveforms.

- You can compare the new waveforms with those recorded before. (Available with the trigger mode set to **[Repeat]** or **[Auto]**) (p. 213)
- There are two overlaying methods: the automatic overlaying during measurement and the manual overlaying.

Normal display



Waveforms plotted using the overlay function



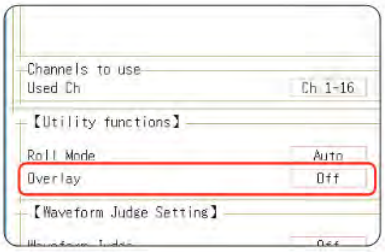
Procedure

To display the screen

Press the **STATUS** key to display the status screen, and then select the **[Status]** sheet.

Move the cursor to the [Overlay] box.

Off	Does not overlay the waveforms. (Default setting)
Auto	Overlays the waveforms newly written in the memory with the presently displayed waveforms every time the new ones are written in the memory. When the trigger mode is set to **[Cont.]** or **[Auto]**, the instrument overlays the new waveforms with the presently displayed waveforms from the start of the measurement to the stop.
Manual	Overlays the new waveforms with the presently displayed waveforms manually. (See the next section for the method of the overlaying.)



This mode cannot be used simultaneously with roll mode. Refer to "When the overlay function is enabled (set to [Auto] or [Manual])" (p. 169).

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Overlaying the waveforms manually (Leaving any waveforms to be displayed on the screen)

To display the screen

Press the **DISP** key to display the waveform screen.

Move the cursor to the [Overlay] box.

Overlay (**F1** key)	Leaves the waveforms written in the memory on the screen. The overlay setting continues to be available until the waveforms are cleared.
Clear (**F5** key)	Clears all the overlaid waveforms that are displayed on the screen. Cleared waveforms cannot be displayed again.



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

- The roll mode function (p. 167) and overlay function (p. 168) cannot be used together. When the roll mode function is enabled, the overlay is automatically set to **[Off]**.
  Besides, when the overlay function is enabled, roll mode is set to **[Auto]**.
- The printing and tracing with Cursors A and B apply only to the last acquired waveforms.
- The following operations are not available on the waveform screen:
  Scrolling waveforms, switching zoom function between on and off, changing horizontal (in the time axis direction) magnification/demagnification ratio, changing the zero position.
- In the following cases, the instrument leaves only the most recent waveform and clears the others.
  - When the **[Format]** setting is changed on the **[Status]** sheet
  - When the **[Combo Area]** setting is changed (with the **[Format]** set to **[X-Y Single]** or **[X-Y Quad]**)
  - When the waveform display settings (display magnification, zero position, variable, display on/off, waveform color) are changed on the **[Unit List]** or **[Each Ch]** sheets

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8.4 Setting Channels to Be Used (Extending the Recording Length)

MEM

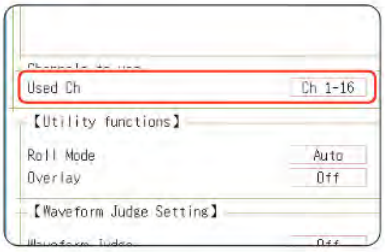
This function can be used in the memory function only.
Select the analog and logic channels to use.
The fewer the number of the channels in use is, the longer the recording length becomes.
Minimizing the number of channels to be used allows the storage memory to be allocated to the channels.

Procedure

To display the screen

Press the **STATUS** key to display the status screen, and then select the **[Status]** sheet.

Move the cursor to the [Used Ch], and select the number of channels to be used.



Ch1-2, Ch1-4, Ch1-8, Ch1-16 (Default setting)

If using If using Model U8975, U8977, or U8978, this setting will not be available (the setting is fixed to Ch1-32).

Data obtained through the standard logic channels LA to LD are written in the memory using 4 bits of the analog channels CH1 to CH4.

Available channels

When the **[Used Ch]** setting is used, the available analog channels, standard logic channels, and the logic channels of Model 8973 Logic Unit are as follows:

Used channel	Analog	Standard logic	8973 Logic Unit *1
Ch1-2	CH1, CH2	LA, LB	L1
Ch1-4	CH1 through CH4	LA through LD	L1, L2
Ch1-8	CH1 through CH8	LA through LD	L1 through L4
Ch1-16	CH1 through CH16	LA through LD	L1 through L8
Ch1-36*2	CH1 through CH32	LA through LD	L1 through L8

*1: Up to three logic modules can be installed in the instrument.
*2: If using Model U8975, U8977, or U8978

Precautions for using Model MR8791 Pulse Generator Unit

- Changing the used channel settings causes the pattern data to be erased.
- If the channels to be used are Ch1-16 or Ch1-32, you can select pattern output.

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8.5 Converting Input Values (Scaling Function)

About the scaling function

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

Gauge scales, scaled values (upper and lower limits of the vertical axis [voltage axis]), and measured values at Cursors A and B are expressed as scaled values in terms of the specified units.
You can set the scaling with respect to each channel.



Scaling setting examples

Refer to "When using a clamp sensor" (p. 174) (Example: Scaling from [V] to [A]) and "When using Model 8969 or U8969 Strain Unit" (p. 175) (Example: Scaling from [με]) to [G]).

Scaling Methods

Two scaling methods are available:

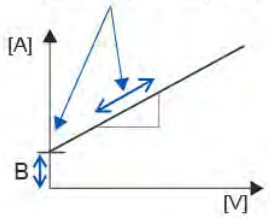
- Conversion ratio method
- Two-point method

Setting the scaling that uses the conversion ratio method

(Example: Scaling from [V] to [A])

Set the physical quantity per volt (conversion ratio: change in terms of engineering units [eu] per change in terms of volts) of the input signal, the offset value, and the measurement unit name. The instrument converts measured values acquired in terms of volts into those in terms of the specified one employing the settings.
Example:
Conversion ratio: Change in terms of amperes per change in terms of volts, Offset value: B
Unit name: Ampere (A)

Converts values using slope (conversion ratio) and offset value



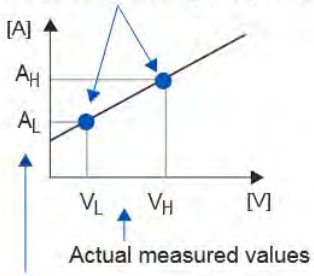
Setting the scaling that uses the two-point method

Set two points of the input signal in terms of volts, those after conversion, the name of the converted measurement unit. The instrument converts measured values acquired in terms of volts into those in terms of the specified one employing the settings.
Example:

Two points of values in terms of volts	Values to be converted in terms of the specified one
V_H: Higher potential point	A_H: Value for higher potential point
V_L: Lower potential point	A_L: Value for lower potential point

Unit name: A

Converts values using conversion ratio and offset value, both of which are calculated using two points.



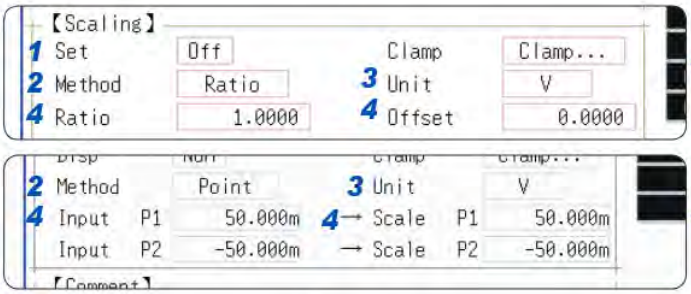
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When the conversion ratio setting is changed, V_L and V_H set as two points used for conversion do not change, whereas the values for A_L and A_H change.

Procedure

To display the screen

Press the **CHAN** key to display the channel screen, and then select the **[Each Ch]** sheet.



Setting method: Display when **[Method]** is set to **[Ratio]**

Setting method: Display when **[Method]** is set to **[Point]**

1 Enable the scaling function.

Move the cursor to the **[Set]** box.

Off	Does not scale any values.
NUM	Displays values in decimal notation adding the metric prefix such as milli (m) and kilo (k).
SCI	Displays values in scientific notation (as a power of 10).

2 Select the scaling method.

Move the cursor to the **[Method]** box.

Ratio	Converts values using the conversion ratio method.
Point	Scales values using the two-point method.

3 Specify the unit of measurement.

Move the cursor to the **[Unit]** box and enter the unit name. (Up to 7 characters)
Refer to "Entering texts" (p. 163).

Input example:
Decimal 1.2345 mV
Exponent
1.2345E−03 V

4 Enter the numerical values for conversion.

For the [Ratio] setting

(Set the conversion ratio and offset.)

Move the cursor to the **[Ratio]** and **[Offset]** boxes in turn.

Enter numerical values in each field.

−9.9999E+9 to 9.9999E+9

Refer to "Entering Alphanumeric Characters" (p. 163).

For the [Point] box

(Enter two input values and those after conversion.)

Move the cursor to the **[Input P1]**, **[Scale P1]**, **[Input P2]**, and **[Scale P2]** boxes in turn.

Enter numerical values in each field.

−9.9999E+9 to 9.9999E+9

Refer to "Entering Alphanumeric Characters" (p. 163).

- When data is saved in text format or as numerical calculation results, some characters and symbols are saved using alternative characters.
- "^{2}" is saved as "^2"; "^{3}," as "^3"; "μ," as "~u"; "Ω," as "~o"; "ε," as "~e"; "°," as "~c"; and "±," as "~+."

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To enter the current input values in the [Input P1] and [Input P2] boxes with no change.

Select **[Monitor Val]**.

To reset the scaling settings

Move the cursor to the **[Set]** box and select **[Reset]**.

To copy the scaling setting to another channel

Display the channel screen, and select the **[Scaling]** sheet.

Refer to "8.9 Copying Settings to Other Channels (Copy Function)" (p. 183).

To use a combination of the scaling and variable functions (p. 178)

The signal output from the sensor is displayed as a vertically maximized waveform. (p. 180)

By factory default, the automatic correction of the variable function (p. 337) has been set to **[On]**.
In this setting, the variable setting changes along with the vertical axis (voltage axis) range and scaling settings.
When you prefer to prioritize the variable function setting, follow either of the following procedures:

- Set the scaling first, and then set the variable function
- Set the variable using values to which the scaling has not been applied, then set the scaling.

Setting the automatic correction of the variable function to **[Off]** disables the interaction between the scaling and variable settings.

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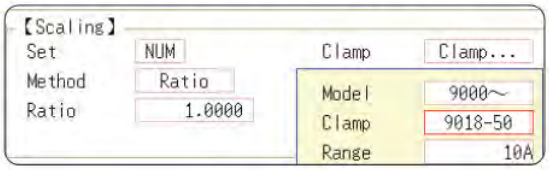
8.5.1 Example of Scaling Settings

When using the clamp sensor

Example 1

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

The 9018-50 Clamp On Probe provides 0.2 V output when measuring a current of 10 A. The scaling should be set to display 0.2 V input as 10 A and 0 V input as 0 A.



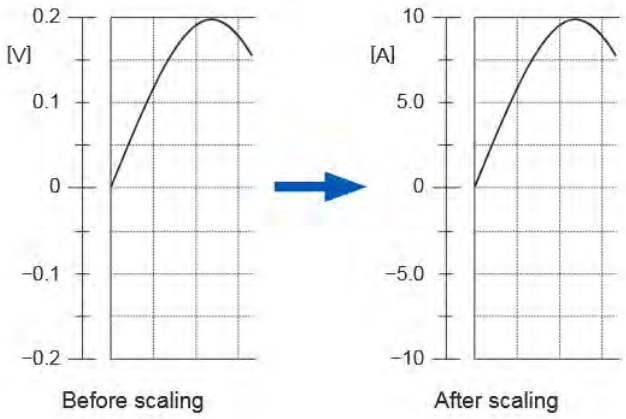
Set	NUM or SCI
Clamp	9018-50
Unit*	Ampere (A)
Method*	Ratio
Ratio*	50.000

*: Set automatically when a clamp sensor is selected.

To select the clamp sensor

1. Move the cursor to the **[Clamp]** box and select **[Select]**.
   The cursor moves to the **[Model]** box.
2. Select **[9000]**.
   The cursor moves to the **[Clamp]** box.
3. Select **[9018-50]** from the clamp list by pressing the **F** keys, and select **[Confirm]**.
   The unit of measurement, scaling method, and conversion ratio will be set automatically.
4. Select the same range as that of the clamp sensor when using the range selection type of clamp sensors. Select **[10A]** here.

Set the vertical axis (voltage axis) range according to the output of Model 9018-50.
For example, to display a voltage of 0.2 V at the full-scale value (maximum displayable value), set the vertical axis (voltage axis) range to 20 mV/div (a division of the vertical axis [voltage axis] corresponds to 20 mV).



Before scaling　　After scaling

Scaling the signals from the sensor enables them to be displayed as current values.
Values at the Cursors A and B and gauges are displayed and printed as current values.
Refer to “Gauge” (p. 134) and “Value at Cursors A and B” (p. 127).

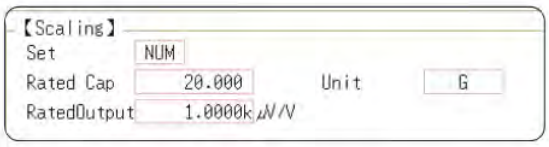
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When using Model 8969 or U8969 Strain Unit

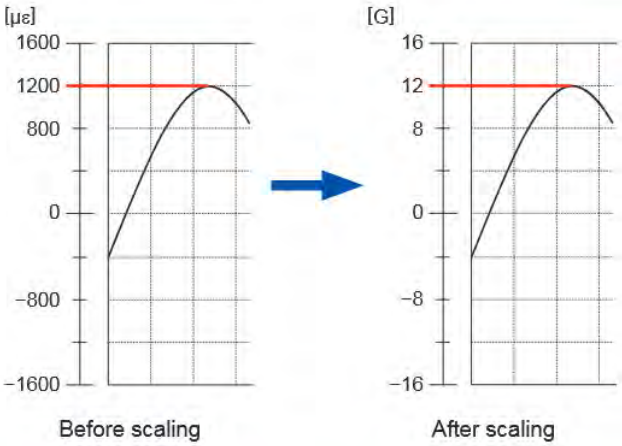
Example 2

To display data measured with the strain gauge transducer with a rated capacity of 20 G and a rated output of 1000 µV/V in terms of gees (G).

For the rated capacity and rated output, consult the inspection record of the strain gauge transducer to be used. Set the rated capacity and rated output so that the following expression holds:



Set	NUM
Unit	G
Rated Cap (Rated capacity)	20.000
Rated Output	1.0000k



Scaling signals from the strain gauge transducer enabled them to be displayed as physical values.
Values at the Cursors A and B and gauges are displayed and printed as physical values.
Refer to Gauge (p. 134) and Values at Cursors A and B (p. 127).

Set the parameters such that the rated capacity divided by two times the rated output is less than or equal to 9.9999×10^9.

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When the strain gauge transducer's inspection record provides the calibration factor

Set **[Method]** on the **[Scaling]** sheet to **[Ratio]**.

Example 3

To display the data measured with the strain gauge transducer with a calibration factor of 0.001442 G / 1 × 10^{-6} strain* in terms of gees (G).

Set the conversion ratio to the value of the calibration factor (0.001442 [G]).
(*10^{-6} strain = με)
Move the cursor to the appropriate channel and set the settings as follows.

Set	NUM
Unit	G
Ratio (Conversion ratio)	0.001442 [G] (Displayed as "1.4420m")

Method Ratio

Ch	Set	Ratio	Offset		Unit
1	Off	1.0000	0.0000		V
2	Off	1.0000	0.0000		V
3	Off	1.0000	0.0000		V
4	Off	1.0000	0.0000		V
5	Off	1.0000	0.0000		℃
6	Off	1.0000	0.0000		℃
7	Off	1.0000	0.0000		V
8	Off	1.0000	0.0000		V
9	NUM	1.4420m	0.0000		G
10	Off	1.0000	0.0000		G
11	Off	1.0000	0.0000		Hz
12	Off	1.0000	0.0000		Hz

F1
Off

Using the strain gauge with a gauge rate of other than 2.0

The Model 8969 or U8969 Strain Unit measures outputs of the gauge supposing that the gauge rate is 2.0.
When using a strain gauge with a gauge rate of other than 2.0, the gauge rate needs to be set as the conversion ratio.
For example, if the gauge rate is 2.1, the conversion ratio is 0.952 (2/2.1).

Gage Rate 2.00

The gauge ratio is fixed.

Example 4

To display data measured with the strain gauge (gauge rate: 2.1), in terms of gees (G).

The scaling using both the gauge rate and the ratio that converts outputs into the physical values are required. In this case, set the conversion ratio to the product of the conversion ratios of the gauge rate and the scaling ratio.

Where the conversion ratio of the gauge rate is 0.952, and the conversion ratio to convert outputs into the physical values is 0.001442 *
Conversion ratio = 0.952 × 0.001442 = 0.0013728

As with Example 3, enter **[0.0013728]** as the conversion ratio.
* To convert values measured with the strain gauge into physical values, calculate using Young's modulus or Poisson's ratio of the measurement object. The conversion method varies depending on the conditions in which the strain gauge is used.

Refer to "Appx. 2.2 Files Size of Setting and Image Files" (p. Appx.5).

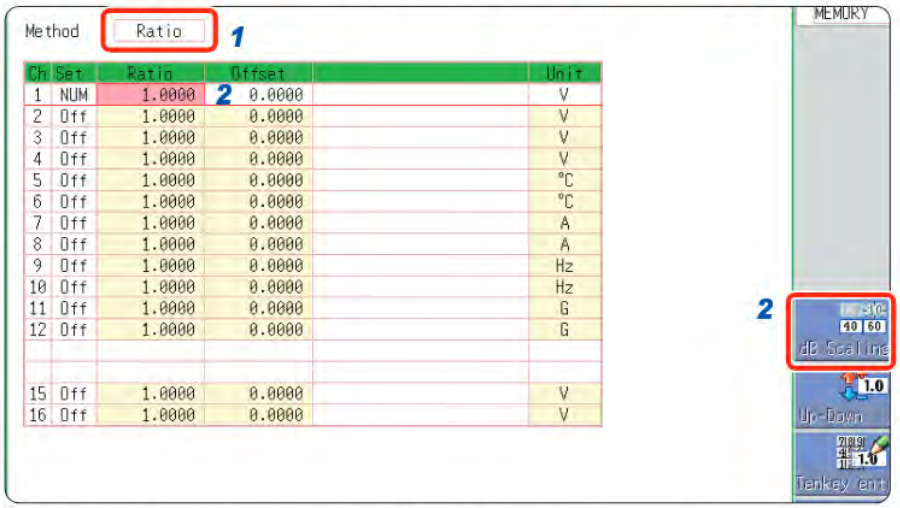
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Using the decibel values

Example 5 To convert 40 dB of input into 60 dB

1 For scaling values, set [Method] to [Ratio].

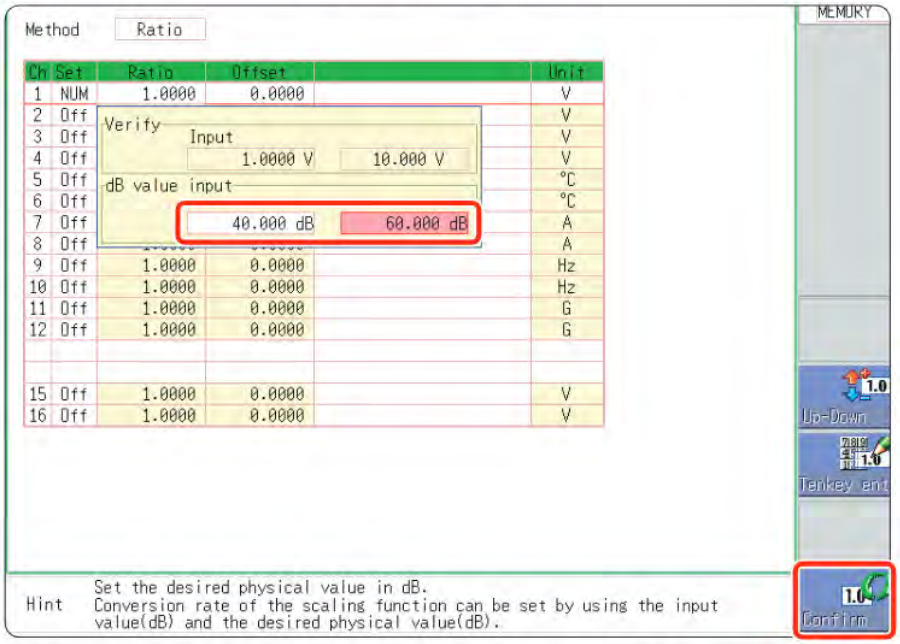
2 Move the cursor to the conversion rate setting. Select [dB Scaling] in the function keys.



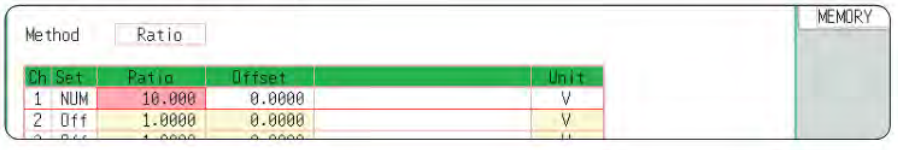
3 Enter 40 dB in the entry field and 60 dB in the physical quantity field.

4 After entering the values, select [Confirm].

Refer to "8.1.3 Entering Alphanumeric Characters" (p. 163).



The conversion rate corresponding to the entered decibel values is entered. (The offset becomes zero.)



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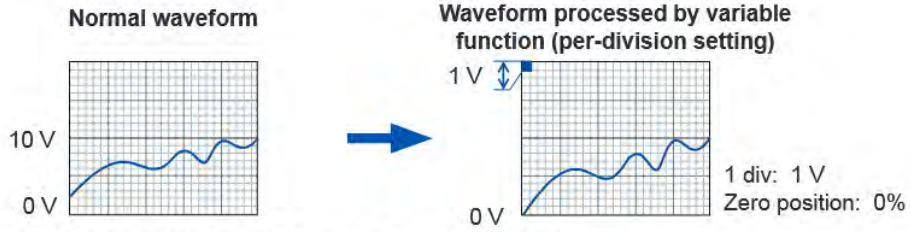
8.6 Setting the Waveform Position (Variable Function)

You can freely set the waveform height and display position along the vertical axis (voltage axis).

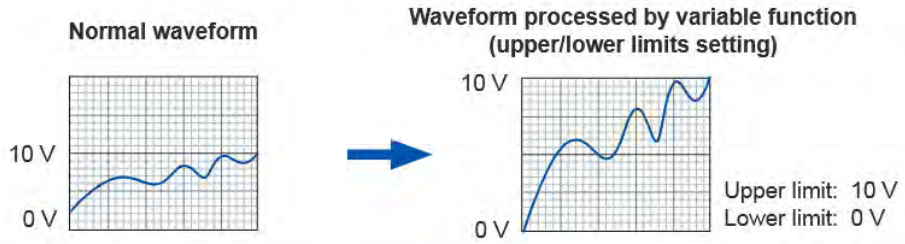
Precautions when using the variable function
- Verify that the proper vertical axis (voltage axis) range is set for the input signal.
- Even when the upper and lower limits of the variable setting are changed, the vertical axis (voltage axis) range does not change.

The following two setting methods are available:

- **Set the displaying range per division (one-division setting)**
  Set the displaying range per the vertical division and the zero position of the waveform on the vertical axis (voltage axis).



- **Set the upper and lower limits (upper-lower setting)**
  Set the upper and lower limits on the vertical axis (voltage axis) to display the vertically maximized waveform.



The two variable methods are available: the **[Each Ch]** sheet accessible from the channel screen allows you to configure settings with respect to each channel (p. 179), and the display range window, which displays the waveforms obtained through all of the channels, allows you to configure a common setting for all channels. (p. 180).

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Setting the variable function with respect to each channel

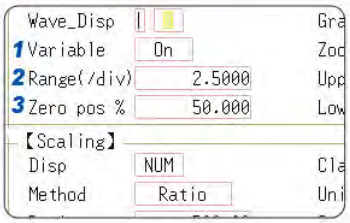
Procedure

To display the screen

Press the **CHAN** key to display the channel screen, and then select the **[Each Ch]** sheet.

1 **Enable the variable function.**

Move the cursor to the **[Variable]** box, and select **[On]**.

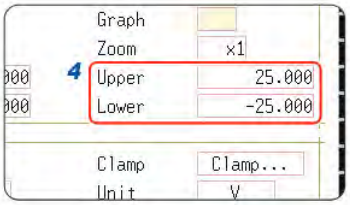


2 **Set the display range per division**

Move the cursor to the **[Range(/div)]** box, and enter a numerical value.
(The unit of measurement varies depending on the measurement mode of the module.)
(When you change the value, the upper and lower limit values for the display also change accordingly.)

3 **Set the waveform displaying position in the vertical axis (vertical axis) direction by entering the zero position.**

Move the cursor to the **[Zero pos %]** box, and enter the numerical value in terms of **[%]**.
(When you change the value, the upper and lower limit values for the display also change accordingly.)



To reset the settings

Select **[Reset]** to reset the values to default.

4 **(When setting the variable by entering upper and lower values)**

Move the cursor to the **[Upper]** and **[Lower]** boxes in turn, and enter the values.
(When you change these values, the display range and zero position values also change accordingly.)

- Setting the variable using upper and lower values allows waveforms to be displayed as a vertically maximized waveform.
- Depending on the scaling setting, the displayed upper and lower values may be less than one. In such cases, set **[Variable]** to **[On]** and then select **[Auto Set]**.
  The upper and lower limit values are set so that the waveforms are displayed in such a way that they are directly readable based on the presently set values.

- For information on the numeric input method, refer to "8.1.3 Entering Alphanumeric Characters" (p. 163).
- The **[Unit List]** sheet accessible from the channel screen also allows you to switch the variable function between on and off with respect to each channel.
- Using a combination of the scaling and variable functions enables a sensor's output to be displayed as a vertically maximized waveform. (p. 180)
- When the scaling is enabled, the scaled values are displayed. When these settings are changed, the numerical values indicating the display range of the level monitor change accordingly.

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Setting the variable function while the waveforms obtained through all of the channels are being displayed

Procedure

To display the screen

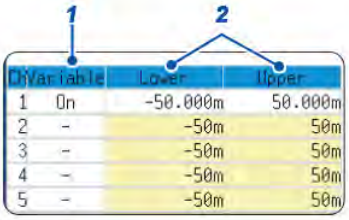
Press the **DISP** key to display the waveform screen, and then press the **CH.SET** key to display the display range window.

1 **Enable the variable function.**

Move the cursor to the **[Variable]** box, and select **[On]**.

2 **Set the upper and lower limits.**

Move the cursor to the **[Upper]** and **[Lower]** boxes in order, and enter numerical values.



When using a combination of the scaling and variable functions

When the auto-correction of the variable function (p. 337) is set to on (Default setting)

The variable function setting changes according to the scaling and vertical axis (voltage axis) range settings. Set the scaling function, and then set the variable function.
If you change the scaling setting after enabling the variable function, the displayed size of waveforms does not change because the variable setting is automatically corrected.

When the auto-correction of the variable function is set to off

Set the scaling function, and then set the variable function.
If you want to set the variable function first, enter the values that are scaled (converted physical values).

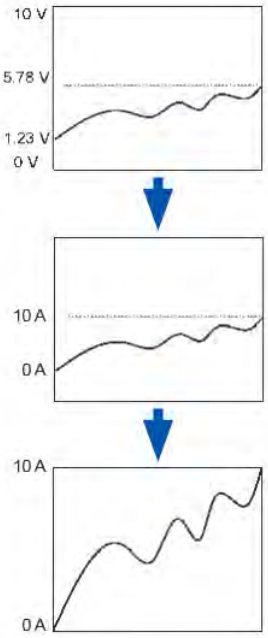
To display the waveform output from the sensor as vertically maximized waveforms

Using the variable function in combination with the scaling function enables the voltage output from the sensor to be converted into the physical units of the measurement object.

Example:
Set the scaling as follows:
Scaling: Decimal or exponent, Two-point setting
Units: A
A sensor output voltage of 1.23 V (Input 1) is converted into a current of 0 A (Physical quantity 1).
A sensor output voltage of 1.23 V (Input 2) is converted into a current of 0 A (Physical quantity 1).

(With the variable function set to off)
The output voltage from the sensor is displayed as the value in terms of volts.
It is displayed with the vertical axis (voltage axis) range setting and the zero position set on the channel settings window (**[Analog]** sheet).

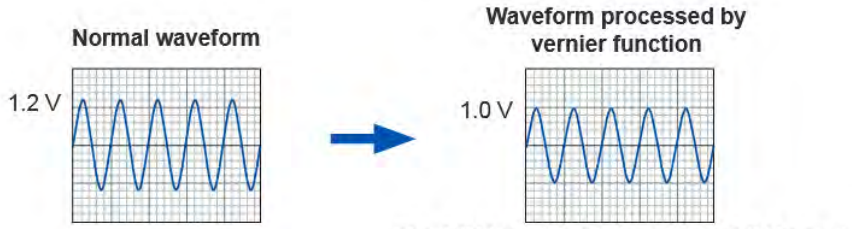
Set the variable function as follows:
Variable: On, Upper/lower limits setting
Lower limit: 0 [A], upper limit: 10 [A]
The output from the sensor is displayed as a vertically maximized waveform.



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8.7 Fine-Adjusting Input Values (Vernier Function)

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



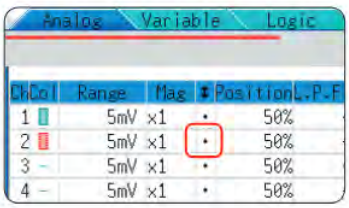
The 1.2 V input is displayed as a 1.0 V signal.

Procedure

To display the screen

Press the **DISP** key to display the waveform screen, and then press the **CH.SET** key to display the analog channel settings window.

1 **Move the cursor to the vernier setting column [↕] of the channel to be adjusted.**



2 **Make the adjustment with the F keys while watching the waveform.**

Vernier↑	Magnifies the waveform.
Vernier↓	Demagnifies the waveform.
Vernier Reset	Returns the waveform to the original position.

- The adjustable range is from 50% to 200% of the original waveform. The magnification and demagnification ratios are not displayed.
- You cannot check if the vernier function has adjusted waveforms by observing printed waveforms or lists.
- The waveform data (printed data, saved data as files) is adjusted by the vernier function.

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8.8 Inverting the Waveform (Invert Function)

This function can be used for analog channels only. You can turn over the waveforms upside down by inverting signs.

Example:
- When a current sensor is clamped around a wire with its current direction mark mistakenly in the direction opposite to the current flow
- When a signal is inputted with spring-pulling force negative and spring-compressing force positive; however, you would like to display the results with spring-pulling force positive and spring-compressing force negative

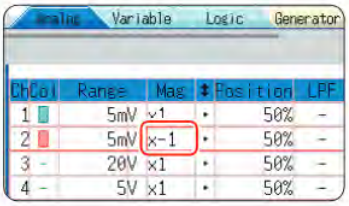
Procedure

To display the screen

Press the **DISP** key to display the waveform screen, and then press the **CH.SET** key to display the analog channel settings window.

1 **Move the cursor to the [Mag] column of the channel to be inverted.**

2 **Select [Invert].**



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

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8.9 Copying Settings to Other Channels (Copy Function)

You can copy a setting to other channels and calculation numbers (when using the FFT function) on the following screens:

- Channel settings window
- Display range window
- Trigger settings window
- Status screen > **[Status]** sheet > "Analysis" list and "Scale" list (When using the FFT function only)
- Status screen > **[Num Calc]** sheet
- Status screen > **[Wave Calc]** sheet
- Channel screen > **[Unit List]** sheet
- Channel screen > **[Scaling]** sheet
- Channel screen > **[Comment]** sheet

The procedure below explains how to copy settings on the channel settings window.

Procedure

To display the screen

Press the **DISP** key to display the waveform screen, and then press the **CH.SET** key to display the channel settings window.

1 **Move the cursor to the channel number (calculation No.) of the copy source.**

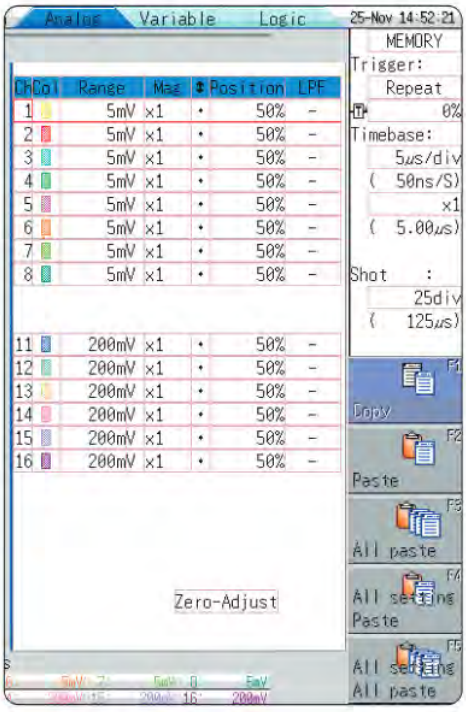
2 **Select [Copy].**

3 **Move the cursor to the channel number (calculation number) to which the settings are pasted.**

4 **Select [Paste].**

To copy the settings to all channels (calculations), move the cursor to a channel number (calculation number) other than the copy source and select **[All Paste]**.

To copy all the settings including the unit list, scaling, and variable, select **[All setting Paste]** or **[All setting All paste]**.



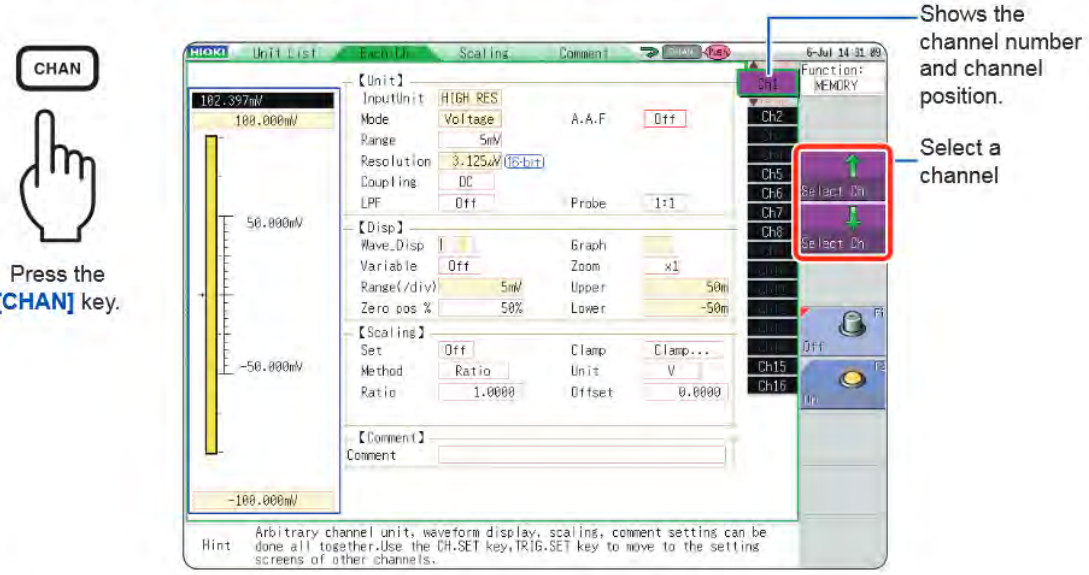
When channel settings are copied to different model modules, settings other than the scaling cannot be copied.

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8.10 Setting Details of Modules

You can configure detailed settings with respect to each module on the **[Each Ch]** sheet of the channel screen.

How to display the [Each Ch] sheet and select channels



Logic channel allocation when using the standard LOGIC terminals

	Module	Memory for each channel (16 bits)			
		4 bits	4 bits	4 bits	4 bits
CH1*	Analog	Analog CH1			LA
CH2*		Analog CH2			LB
CH3*	Logic	L2A	L2B	–	LC
CH4*		L2C	L2D		LD
CH5	Analog	Analog CH5			
CH6		Analog CH6			
CH7	Logic	L4A	L4B	–	
CH8		L4C	L4D		
CH9	Analog	Analog CH9			
CH10		Analog CH10			
CH11	Analog	Analog CH11			
CH12		Analog CH12			
CH13	Analog	Analog CH13			
CH14		Analog CH14			
CH15	Analog	Analog CH15			
CH16		Analog CH16			

* When the logic channels LA through LD are allocated to CH1 through CH4, they provide 12-bit precision.
When Model 8970 Freq Unit is allocated to CH1 through CH4, using the standard logic channels LA through LD prohibits the modules of corresponding channels from being used. When Model MR8990 Digital Voltmeter Unit, U8793 Arbitrary Waveform Generator Unit, MR8790 Waveform Generator Unit, or MR8791 Pulse Generator Unit is allocated to CH1 through CH4, the corresponding standard logic channels described in the above table cannot be used.

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If using Model U8975, U8977, or U897

	Unit	Memory for each channel (16 bits)			
		4 bits	4 bits	4 bits	4 bits
CH1*	4CH analog*1	Analog CH1			LA
CH2*		Analog CH2			LB
CH17		Analog CH17			
CH18		Analog CH18			
CH3*	Logic	L2A	L2B	-	LC
CH4*		L2C	L2D		LD
CH19		-			
CH20		-			
CH5	Analog	Analog CH5			
CH6		Analog CH6			
CH21		-			
CH22		-			
CH7	Logic	L4A	L4B	-	
CH8		L4C	L4D		
CH23		-			
CH24		-			
CH9	Analog	Analog CH9			
CH10		Analog CH10			
CH25		-			
CH26		-			
CH11	3CH analog*2	Analog CH11			
CH12		Analog CH12			
CH27		Analog CH27			
CH28		-			
CH13	4CH analog*1	Analog CH13			
CH14		Analog CH14			
CH29		Analog CH29			
CH30		Analog CH30			
CH15	Analog	Analog CH15			
CH16		Analog CH16			
CH31		-			
CH32		-			

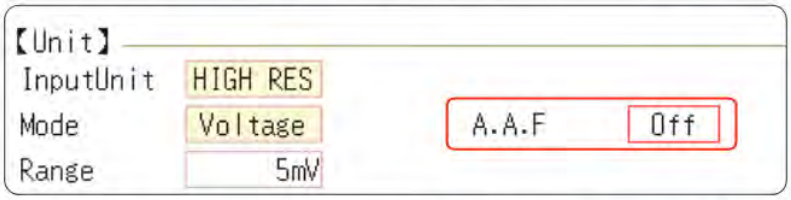
*1: U8975 4CH Analog Unit or U8978 4CH Analog Unit
*2: U8977 3CH Current Unit

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8.10.1 Setting the Anti-aliasing Filter (A.A.F) MEM

The anti-aliasing filter (A.A.F) setting is configurable for Model 8968 High Resolution Unit and Model U8979 Charge Unit only.

Refer to "How to display the [Each Ch] sheet and select channels" (p. 184).



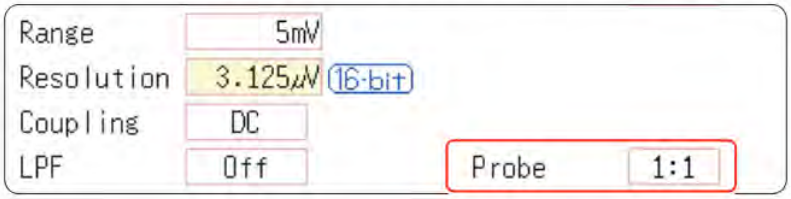
A.A.F

The anti-aliasing filter can prevent aliasing distortion. The cutoff frequency automatically changes according to the timebase or, when the FFT function is used, the frequency range setting.

Off	Disables the anti-aliasing filter. (Default setting)
On	Enables the anti-aliasing filter. (Using the external sampling disables the anti-aliasing filter **[A.A.F]**)

8.10.2 Setting the Probe Voltage Dividing Ratio

Refer to "How to display the [Each Ch] sheet and select channels" (p. 184).



Probe

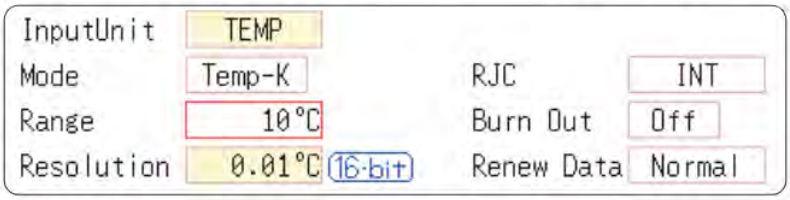
Set this setting when performing measurement with a connection cable or probe.

1:1	Select this option when Model L9197, L9198 or L9217 Connection Cord is connected to the input module. (Default setting)
10:1	Select this option when Model 9665 10:1 Probe is connected to the input module.
100:1	Select this option when Model 9666 100:1 Probe or P9000-01/-02 Differential Probe is connected to the input module.
1000:1	Select this option when Model 9322 Differential Probe or P9000-01/-02 Differential Probe is connected to the input module.

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8.10.3 Setting Model 8967 Temp Unit

Refer to "How to display the [Each Ch] sheet and select channels" (p. 184).



Mode

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

Selection	Measurement input range	Selection	Measurement input range
Temp-K	−200°C to 1350°C	Temp-R	0°C to 1700°C
Temp-J	−200°C to 1100°C	Temp-S	0°C to 1700°C
Temp-E	−200°C to 800°C	Temp-B	400°C to 1800°C
Temp-T	−200°C to 400°C	Temp-W	0°C to 2000°C
Temp-N	−200°C to 1300°C		

RJC (Reference junction compensation)

When connecting a thermocouple directly to the module, select **[INT]**.
The reference junction compensation is performed in the module.
When connecting a thermocouple via a reference junction device (e.g., zero-point bath), select **[EXT]**.

INT	Performs the reference junction compensation inside the module. (Default setting) (Measurement accuracy: The sum of the accuracy of the temperature measurement and that of the reference junction compensation.)
EXT	Does not perform the reference junction compensation inside the module. (Measurement accuracy: The accuracy of the temperature measurement only)

Burn Out

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

Off	Does not check wires for breaks.
On	Checks wires for breaks. The instrument flows approximately 100 nA of minuscule current through the thermocouple to detect breaks. If the thermocouple wires are long or have a relatively high resistance, set **[Burn Out]** to **[Off]** not to cause measurement errors.

Renew Data (Data refresh)

The data refresh rate has three options: Fast, Normal, and Slow.
The default setting is **[Normal]**. This setting eliminates noise, allowing stable measurement.
For quicker response, select **[Fast]**; however, note that this setting makes the measurement more susceptible to noise. For further improved measurement stability, select **[Slow]**.

Fast	Updates data approximately every 1.2 ms.
Normal	Updates data approximately every 100 ms. (Default setting)
Slow	Updates data approximately every 500 ms.

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8.10.4 Setting Model 8969 and U8969 Strain Unit

The Model 8969 or U8969 Strain Unit can perform the auto-balance.
Executing the auto-balance adjusts the reference output level of the transducer to the specified zero position.
This function can be used for Model 8969 or U8969 Strain Unit only.

The instrument describes Model U8969 as "8969."

Before executing the auto-balance

- Turn on the instrument and leave it for 30 minutes to allow the internal temperature of the module to stabilize.
- After connecting a strain gauge transducer to the module and a measuring target, execute the auto-balance without any input including distortion.
- The auto-balance cannot execute during measurement.
- Key operations are not accepted during the auto-balance.

To execute the auto-balance

Refer to "How to display the [Each Ch] sheet and select channels" (p. 184).



Setting Item: [Range]

Auto Bal All Chs	Executes the auto-balance for all of the channels in which Model 8969 or U8969 Strain Unit is installed.
Auto Bal Ch 1	Executes the auto-balance for the presently selected channel.

You can execute the auto-balance also on the **[Analog]** sheet of the channel settings window. (when selecting the range of a channel in which the Strain Unit is installed.)

To display the channel settings window ([Analog] sheet)
Refer to "3.4.2 Configuring Analog Channels Settings" (p. 73).

In the following cases, execute the auto-balance again.
- After changing the vertical axis (strain axis) range
- After replacing the module
- After replacing the strain gauge transducer
- After cycling the instrument
- After performing the system reset
- When the ambient temperature has changed significantly (the zero position may drift)

If the message "Warning: Auto balance failed." appears

The channel for which the auto-balance failed is displayed.
Verify the following, and execute the auto-balance again.
- Is the strain gauge transducer not subject to any load?
  (Make sure that it is not subject to vibration, etc.)
- Is the strain gauge transducer correctly connected to a measuring target?

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8.10.5 Setting Model 8970 Freq Unit

When the standard logic (LA, LB, LC, LD, LE, LF, LG, and LH) is displayed, Model 8970 Freq Unit installed as modules 1, 2, 9, or 10 cannot be used.

Refer to "How to display the [Each Ch] sheet and select channels" (p. 184).

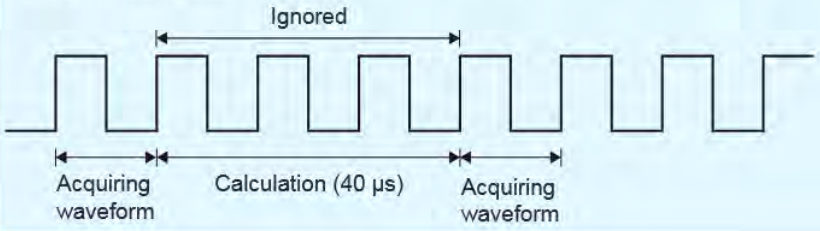
InputUnit	FREQ		VRange	±10V
Mode	Count		Threshold	+2.5V
Range	2k		Timing	Start
Resolution	1.00	16-bit	Count Over	Hold
Coupling	DC		Slope	↑
LPF	Off		Divide	1

Mode

Switches the measurement mode.

Frequency	Measures the frequency of the measurement waveform (hertz, Hz) (Default setting)
RPM	Measures the number of rotations of the measurement target (rotations/minute, r/min)
Power Frequency	Measures the power frequency variation (hertz, Hz)
Count	Accumulates the number of input pulses
Duty	Measures the duty ratio of the measurement waveform (percent, %)
Pulse width	Measures the pulse width (seconds, s)

A Pulse with a frequency of 25 kHz or higher, which rises during the dead time (calculating period), cannot be measured.



VRange (Input voltage)

Set the maximum level of the input signal.

±10 V (Default setting), ±20 V, ±50 V, ±100 V, ±200 V, ±400 V

Select the value by pressing the **F** keys.

Threshold

- Measured values are acquired based on the following: the time interval between the times when the measurement waveform exceeds or falls below the threshold value, and the number of times when the waveform exceeds or falls below the threshold value.
- The upper and lower limits of the threshold value and the fluctuation in the threshold value vary depending on the VRange setting.
- While setting the threshold, the level monitor displays the voltage level.
- Select the value by pressing the **F** keys.

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

Slope

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

↑	Detects the waveform when it exceeds the specified level. (Default setting)
↓	Detects the waveform when it falls below the specified level.

Divide

The instrument determines the frequency every time this number of pulses are counted.

1 (Default setting) to 4096

Select the figure by pressing the **F** keys.

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

Timing

You can use this setting only when setting **[Mode]** to **[Count]**.
You can set when to start accumulating the number of the pulses.

Start	Starts the accumulating when the **START** key is pressed. (Default setting)
Trigger	Starts accumulating the number of the pulses when the instrument triggers.

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

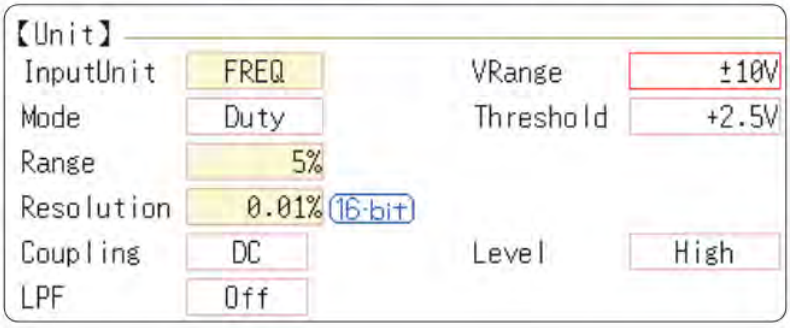
Count Over

You can use this setting only when setting **[Mode]** to **[Count]**.

Hold	Counting the pulses, and stops the counting when the number of pulses reaches the upper limit (65535 for the 2 k range).
Back	Starts counting the pulses, and bring the count back to zero when the number of pulses reaches five times of the range (50000 for the 2 k range).

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Refer to "How to display the [Each Ch] sheet and select channels" (p. 184).



Level

You can use this setting only when setting **[Mode]** to **[Pulse Width]** or **[Duty]**.
For the pulse width measurement and duty ratio measurement, you can select whether to detect the parts that are above the threshold level or those that are below the level.

High	Measures the parts of waveforms that are above the threshold value. (Default setting)
Low	Measures the parts of waveforms that are below the threshold value.

Refer to "How to display the [Each Ch] sheet and select channels" (p. 184).



Smoothing

You can use this setting only when setting **[Mode]** to **[Freq]** or **[RPM]**.

Sets the smoothing.

Off	Records the measured data without the smoothing. (The waveforms are recorded in a staircase pattern.) (Default setting)
On	Interpolates the measured data to smooth the waveforms and outputs the waveforms. (Upper limit: 10 kHz, outputting data with this setting to On lags behind that with this setting set to Off.)

Hold

You can use this setting only when setting **[Mode]** to **[Freq]** or **[RPM]**.

Sets the hold for frequencies and counts.

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

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8.10.6 Setting Model 8971 Current Unit

There's no need to change the mode as it is set when the clamp sensor is automatically detected.

Refer to "How to display the [Each Ch] sheet and select channels" (p. 184).



Mode

20A/2V	Sets this option when Model 9272 (20 A range), 9277, or CT6841 Clamp Sensor is connected. (Default setting)
200A/2V	Sets this option when Model 9272 (200 A range), 9278, CT6843, or CT6863 Clamp Sensor is connected.
50A/2V	Sets this option when Model CT6862 Clamp Sensor is connected.
500A/2V	Sets this option when Model 9279, 9709, CT6844, CT6845, CT6846*, CT6865*, CT6875, or CT6876* Clamp Sensor is connected.

* When Model CT6846, CT6865 or CT6876 is connected to Model 8971 Current Unit through Model 9318 Conversion Cable (Model CT9901 Conversion Cable), the instrument recognizes that as an 500 A AC/DC sensor is connected; set the scaling ratio to 2.00.

Range

DC	Current measurement (Default setting)
RMS	RMS current measurement
High sensitivity	Sets the range to high sensitivity.
Low sensitivity	Sets the range to low sensitivity.

8.10.7 Setting Model 8972 DC/RMS Unit

Refer to "How to display the [Each Ch] sheet and select channels" (p. 184).



Mode

Switches the measurement modes.

DC	Voltage measurement (Default setting)
RMS	RMS measurement

Response

You can set the response time for the RMS measurement to one of the three speeds: Fast, Normal, and Slow.
Usually, set the response time to **[Fast]**; however, setting the response time to **[Normal]** or **[Slow]** can stabilize the measured value when the frequency is relatively low or when the voltage fluctuates severely.

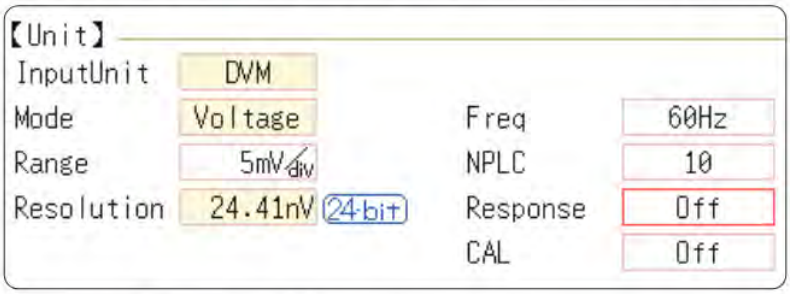
Fast	Sets the response time to approx. 100 ms. (Default setting)
Normal	Sets the response time to approx. 800 ms.
Slow	Sets the response time to approx. 5 ms.

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8.10.8 Setting Model MR8990 Digital Voltmeter Unit

- Installing the Model MR8990 Digital Voltmeter Unit as Unit 1 and Unit 2 disables the standard logic channels.
- The resolution of the data measured by the recorder function is 16 bits.
- If you start a measurement that uses a higher-sensitivity measurement range than 5 V/div with the input terminals opened, the instrument will reach an over-range state.

Refer to "How to display the [Each Ch] sheet and select channels" (p. 184).



Freq

You can switch the power frequency.
Switch between 50 Hz and 60 Hz according to the power frequency in your region.

50Hz	Sets the period to 20 ms (Default setting)
60Hz	Sets the period to 16.67 ms

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

NPLC

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

0.1 to 0.9, 1 (Default setting) to 10, 20, 30, 40, 50, 60, 70, 80, 90, 100

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

Response

Refreshes data at high speed.

Off	Refreshes data at the integration time set for NPLC. (Default setting)
On	Calculates the moving average and refreshes the data at high speed. Refreshes the data at 0.1 PLC when NPLC is set to 9 or less. Refreshes the data at 1 PLC when NPLC is set to 10 or above.

CAL

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

Off	Does not calibrate the instrument or synchronize between the channels. (Default setting)
On	Calibrates the instrument and synchronizes between the channels.
Synchronization	Only synchronizes between the channels.

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- It takes approximately 150 ms to calibrate the MR8990. During this period, no measurement is performed.
- If the channels are synchronized with each other, the signal that interrupts the integration is sent to each module at the start of measurement; thus, the instrument has to wait until the first integration finishes.
  The wait time required for this process is (10 ms + integration time*).
  * The integration time varies depending on the NPLC setting.
  Even when synchronization is not performed, the wait time described above is also required for measurement performed immediately after the settings of the Model MR8990 Digital Voltmeter Unit are changed. However, no wait time is required when the measurement is performed with the same settings.
- When **[CAL]**is set to **[Off]** (Default setting), perform calibration manually.
  Refer to "2.8 Performing Calibration (When Model MR8990 is Installed)" (p. 56).

8.10.9 Setting Model U8974 High Voltage Unit

Refer to "How to display the [Each Ch] sheet and select channels" (p. 184).



Mode Switches the measurement mode.

DC	Voltage measurement (Default setting)
RMS	RMS measurement

Response You can set the response time for the RMS measurement to one of the three speeds: Fast, Normal, and Slow.
Setting the response time to **[Slow]** can stabilize the measured values when the frequency is relatively low or when the voltage fluctuates severely.

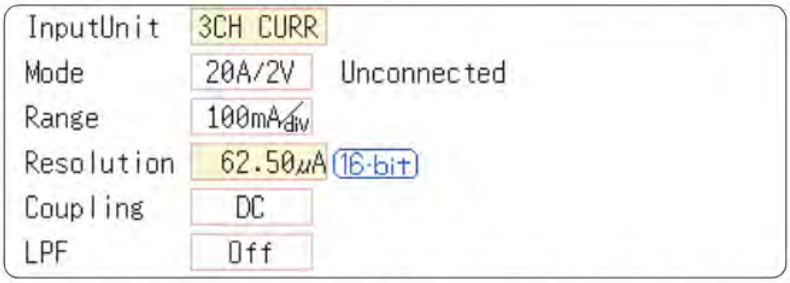
Fast	Sets the response time to 150 ms.
Normal	Sets the response time to 500 ms. (Default setting)
Slow	Sets the response time to 2.5 s.

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8.10.10 Setting Model U8977 3CH Current Unit

Each of Model 9709, Model CT6860 series, and Model CT6840 consists of a current sensor with the sub model-number "-05," which has a metal connector, and that without the sub model-number "-05," which has a black plastic connector.
You can directly connect a current sensor that has the sub model-number "-05," which has a metal connector, with Model U8977 3CH Current Unit. Using Model CT9900 Conversion Cable, you can connect a current sensor without the sub model-number "-05," which has a black plastic connector, to Model U8977 3CH Current Unit.

Refer to "How to display the [Each Ch] sheet and select channels" (p. 184).



Current sensors to be connected determine whether the instrument automatically recognizes mode or whether you have to choose a current sensor setting.

Mode

(When the instrument automatically recognizes the sensors connected) Confirm the output rate displayed in the **[Mode]** area.
Available measurement ranges, which depend on automatically recognized output rates, are as follows:

2A/2V	10 mA, 20 mA, 50 mA, 100 mA, 200 mA, 500 mA (/div)
20A/2V	100 mA, 200 mA, 500 mA, 1 A, 2 A, 5 A (/div)
50A/2V	200 mA, 500 mA, 1 A, 2 A, 5 A, 10 A (/div)
200A/2V	1 A, 2 A, 5 A, 10 A, 20 A, 50 A (/div)
500A/2V*	2 A, 5 A, 10 A, 20 A, 50 A, 100 A (/div)
1000A/2V	5 A, 10 A, 20 A, 50 A, 100 A, 200 A (/div)
2000A/2V	10 A, 20 A, 50 A, 100 A, 200 A, 500 A (/div)
None	When no current sensor is connected.

* When Model CT6846-05 or Model CT6865-05 connects via Model CT9900 Conversion Cable, the instrument recognizes the sensor as a 500 A AC/DC sensor. Set the conversion ratio at 2.00 in the scaling setting.

(When you have to choose a current sensor setting) Tap the [Mode] box, and then choose a connected current sensor.
Available measurement ranges, which depend on chosen current sensors, are as follows:

CT7631/CT7731	10 A (/div)
CT7636/CT7736	10 A, 20 A, 50 A (/div)
CT7642/CT7742	100 A, 200 A (/div)
CT7044/CT7045/CT7046	100 A, 200 A, 500 A (/div)
0.1mV/A	100 A, 200 A, 500 A, 1000 A, 2000 A, 5000 A (/div)
1mV/A	10 A, 20 A, 50 A, 100 A, 200 A, 500 A (/div)
10mV/A	1 A, 2 A, 5 A, 10 A, 20 A, 50 A (/div)
100mV/A	100 mA, 200 mA, 500 mA, 1 A, 2 A, 5 A (/div)
1000mV/A	10 mA, 20 mA, 50 mA, 100 mA, 200 mA, 500 mA (/div)

When a current sensor included in Model CT7000 series connects via Model CT9920 Conversion Cable, set a current sensor model name or its output rate.

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8.10.11 Setting Model U8979 Charge Unit

This setting allows you to choose between voltage measurement and acceleration measurement (charge-output or built-in pre-amplifier) for a channel.
A channel can measure either one of them.
[Voltage] mode and **[PreAmp]** mode use BNC connectors, whereas **[Charge]** mode uses miniature connectors.
Model U8979 can automatically recognize TEDS-compliant* sensors.
*: Transducer electronic data sheet

⚠WARNING

Setting the measurement mode to [PreAmp] allows Model U8979 Charge Unit to constantly provide power (3.0 mA, 22 V) to sensors. Set any measurement mode other than [PreAmp] or tum off the instrument before connecting a sensor or probe with a BNC terminal to avoid an electric shock or damage to the measurement target.

Refer to "How to display the [Each Ch] sheet and select channels" (p. 184).



Mode

Switches the measurement mode.

Mode	Measurement target	Measurement sensitivity
Voltage	Voltage	–
Charge (Default setting)	Charge-output acceleration sensor	0.1 pC/(m/s^2) to 10 pC/(m/s^2)
PreAmp	Acceleration sensor with a built-in preamplifier	0.1 mV/(m/s^2) to 10 mV/(m/s^2)

(When setting mode to **[PreAmp]**)
Move the cursor to the **[Sens.]** box and execute **[TEDS Load]**.
Acquires sensitivity of a connected sensor. However, the instrument can acquire sensitivity of TEDS-compliant acceleration sensors with a built-in pre-amplifier only.
When sensor sensitivity has been acquired, it is automatically set.

A.A.F

The anti-aliasing filter can prevent aliasing distortion that may be produced during FFT calculation. The cutoff frequency automatically changes according to the sampling rates or frequency range (for the FFT function) settings.

OFF	Disables the anti-aliasing filter. (Default setting)
ON	Enables the anti-aliasing filter. (Disabled when the external sampling is used, or the sampling rate is set at 100 kS/s or faster)

Sensitivity

You can enter sensor sensitivity to two decimal places. For a charge-output acceleration sensor or non-TEDS-compliant sensor, enter its sensitivity marked on the sensor, which represents sensitivity per meter per second squared.

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Setting example for sensor sensitivity

Example 1

For a sensor with its sensor sensitivity per meter per second squared marked

Sensor sensitivity	(setting value)
1.08 pC/(m/s^2)	1.08

Example 2

For a sensor with its sensor sensitivity per gee (G) marked.

For a sensor with its sensitivity marked, enter a quotient of the marked sensitivity divided by 9.8 m/s^2.

Sensor sensitivity	(setting value)
For sensor sensitivity of 64 pC/G 64.0 / 9.8 = 6.53061... pC/(m/s^2)	6.531 (to two decimal places)

To convert a unit from meter per second squared into gee (G)

The instrument measure charge quantities per meter per second squared. You can convert such charge quantities into those per gee (G) using the scaling function.
Refer to “8.5 Converting Input Values (Scaling Function)” (p. 171).

Configure the scaling setting as follows;

Example 1

Specifying a conversion ratio

Ratio	0.1020E+00 (= 1/9.8)
Offset	0.0000E+00
Units	G

Example 2

Specifying two points

Input1	9.8000E+00	Scale1	1.0000E+00
Input2	0.0000E+00	Scale2	0.0000E+00
Units	G		

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When using an out-of-setting-range current sensor

You can use an out-of-setting-range current sensor using the scaling function.
Refer to “5.2.2 Automatically Saving Waveforms” (p. 96).

Sensitivity	Multiply the sensor sensitivity of a sensor to be used by a certain value to allow a product to fall within the setting range (0.1 to 10), and enter the product.
Scaling	Configure the scaling setting so that a scaling ratio is the same value as the number you multiplied the sensor sensitivity by.

Example 1

For sensor sensitivity of 23.4 pC/(m/s^2)

Specify 10 pC/(m/s^2), which results from multiplying the sensor sensitivity by 1/2.34, as the sensor sensitivity.
To display measured values after multiplying them by 1/2.34, configure the scaling setting as follows:

To configure the scaling setting using the conversion ratio method

Ratio	0.4274E+00 (= 10/23.4)
Offset	0.0000E+00
Units	m/s^2

To configure the scaling setting using the 2-point method

Input1	2.3400E+00	Scale1	1.0000E+00
Input2	0.0000E+00	Scale2	0.0000E+00
Units	m/s^2		

Example 2

For sensor sensitivity of 0.05 pC/(m/s^2)

Specify 0.1 pC/(m/s^2), which results from multiplying the sensor sensitivity by two, as the sensor sensitivity.
To display measured values after multiplying them by two, configure the scaling setting as follows:

To configure the scaling setting using the conversion ratio method

Ratio	2.0000E+00 (= 0.1/0.05)
Offset	0.0000E+00
Units	m/s^2

To configure the scaling setting using the 2-point method

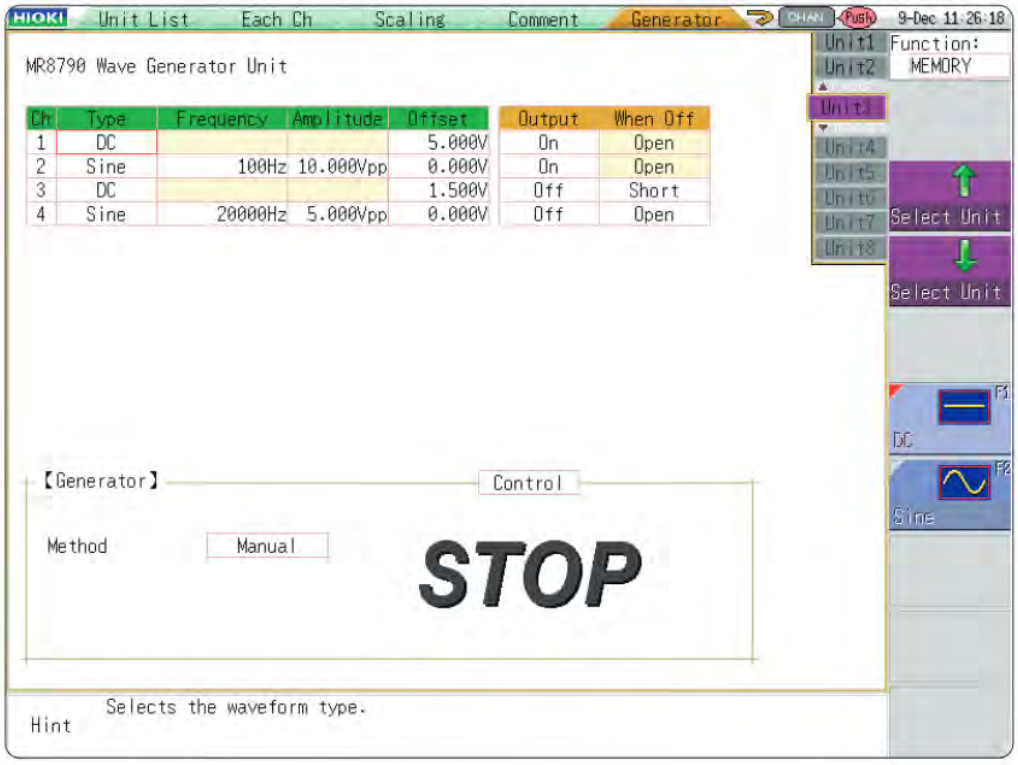
Input1	0.0500E+00	Scale1	1.0000E+00
Input2	0.0000E+00	Scale2	0.0000E+00
Units	m/s^2		

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8.10.12 Setting MR8790 Waveform Generator Unit

The channels with Model MR8790 installed cannot be used for measurement.

Refer to “How to display the [Each Ch] sheet and select channels” (p. 184).



Type Selects the waveform types.

DC	Outputs a DC signal (Default setting)
Sine	Outputs a sine wave

Frequency Sets the frequency of the output signal.

0 Hz to 20000 Hz

Amplitude Sets the amplitude of the output signal.
The output voltage range the accuracy of which is guaranteed is between −10 V and +10 V, which includes the amplitude and the offset. If the sum of the amplitude and the offset is set to the outside of the guaranteed accuracy range, parts of the waveform will be clamped to the upper limit, approximately +14 V and the lower limit, approximately −14 V.

0.000 V p-p to 20.000 V p-p

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Offset

For DC output: Sets a DC voltage.
For sine wave output: Sets an offset voltage.
The output voltage range the accuracy of which is guaranteed is between −10 V and +10 V, which includes the amplitude and the offset. If the sum of the amplitude and the offset is set to the outside of the guaranteed accuracy range, parts of the waveform will be clamped to the upper limit, approximately +14 V and the lower limit, approximately −14 V.

−10 V to +10 V

When Off

Sets the output terminal condition when no signals output.

Open	Separates the output terminals from the internal circuit and opens the terminals.
Short	Separates the output terminals from the internal circuits and short-circuits the terminals.

Output

Switches the waveform output.

On	Outputs the waveform.
Off	Does not output any waveform.

Control

Sets the waveform output.

RUN	Starts outputting waveforms.
PAUSE	Pauses the output of the waveforms. Outputs the voltage that was being outputted when **[PAUSE]** was pressed.
STOP	Stops outputting the waveforms.

Method

Selects the control method for the waveform output.

Manual	Enables the control of waveform output only on the signal generation screen.
Sync.	In addition to the manual control, outputs waveforms synchronizing with the start and end of the measurement. **START** key: Starts the output when the measurement starts. **STOP** key: Stops the output when the measurement stops.
Keys	In addition to the manual control, enables the instrument's keys to be used for the waveform output control. **START** key: Starts the output. **STOP** key: Stops the output. Manual trigger key: Pauses the output.

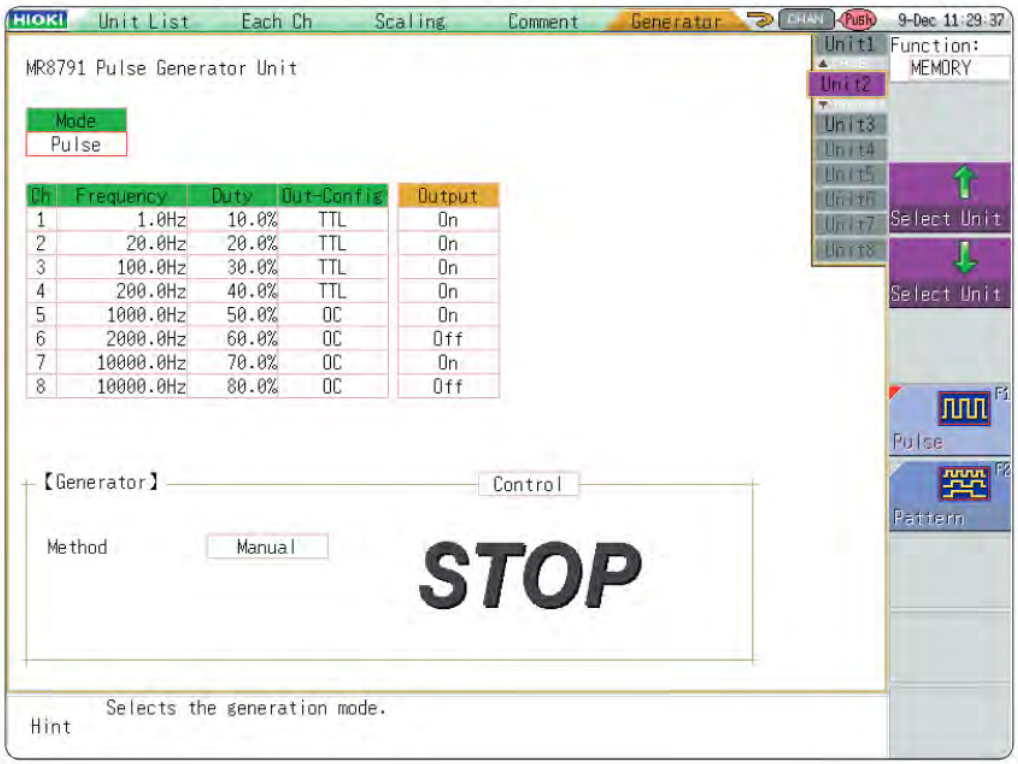
For details, see the instruction manuals of Models U8793, MR8790, and MR8791.

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8.10.13 Setting MR 8971 Pulse Generator Unit

The channels with Model MR8791 installed cannot be used for measurement.

Refer to “How to display the [Each Ch] sheet and select channels” (p. 184).



Mode Select the output types.

Pulse	Outputs a pulse signal (Default settings)
Pattern	Output a pattern signal

Refer to the instruction manual of Models U8793, MR8790, and MR8791 for details of the pattern output setting.

- Setting the channel to be used to Ch1-16 or Ch1-32 allows the pattern output to be selected.
- When the channel to be used is changed, the pattern data is erased.

How to set the channel to be used
Refer to “8.4 Setting Channels to Use (Extending the Recording Length)” (p. 170).

Frequency Sets the frequency of the pulse output.

0 Hz to 20000 Hz

Duty Sets the duty ratio of the pulse signal.

0% to 100%

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Out-Config Sets the output type.

TTL	Sets the output type to TTL
OC	Sets the output type to open collector

Output Switches the signal output.

On	Outputs signals.
Off	Does not output signals.

Control Sets the signal output.

RUN	Starts the output.
PAUSE	Pauses the output. Outputs the voltage that was being outputted when **[PAUSE]** was pressed.
STOP	Stops the output.

Method Selects the control method for the signal output.

Manual	Enables the control of signal output only on the signal generation screen.
Sync.	In addition to the manual control, outputs signals synchronizing with the start and end of the measurement. **START** key: Starts the output when the measurement starts. **STOP** key: Stops the output when the measurement stops.
Keys	In addition to the manual control, enables the instrument's keys to be used for the signal output control. **START** key: Starts the output. **STOP** key: Stops the output. Manual trigger key: Pauses the output.

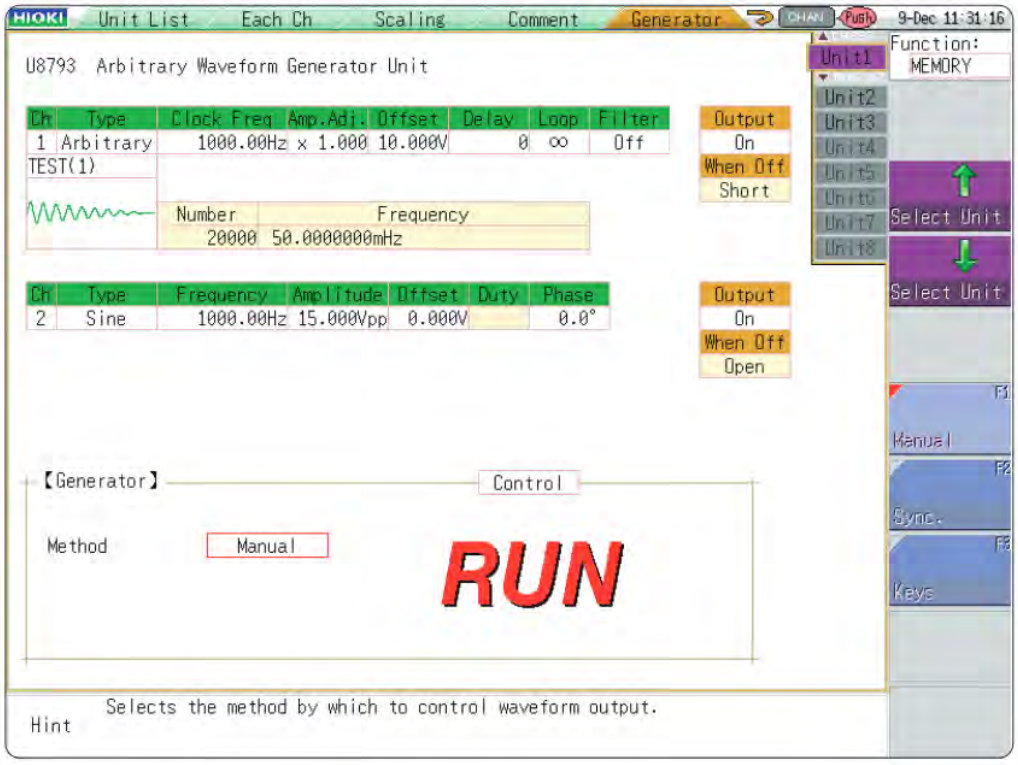
For details, see the instruction manuals of Models U8793, MR8790, and MR8791.

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8.10.14 Setting U8793 Arbitrary Waveform Generator Unit

The channels with Model U8793 installed cannot be used for measurement.

Refer to “How to display the [Each Ch] sheet and select channels” (p. 184).



Type Selects the waveform types.

DC	Outputs a DC signal (Default setting)
Sine	Outputs a sine wave.
Square	Output a rectangular wave.
Pulse	Output a pulse wave.
Triangle	Output a triangular wave.
Ramp-up	Outputs a ramp-up wave.
Ramp-down	Outputs a ramp-down wave.
Arbitrary	Outputs user-defined waveform.
Program	Outputs the waveform set by using a program.

Refer to the instruction manuals of Model U8793, MR8790, and MR8791 for the **[Program]** setting.

Frequency Sets the frequency of an output signal.

0 Hz to 100000 Hz

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Amplitude

Sets the amplitude of an output signal.
The output voltage range the accuracy of which is guaranteed is between −10 V and +10 V, which includes the amplitude and the offset. If the sum of the amplitude and the offset is set to the outside of the guaranteed accuracy range, parts of the waveform will be clamped to the upper limit, approximately +16 V and the lower limit, approximately −11 V.

0.000 V p-p to 20.000 V p-p

Offset

For DC output: Sets a DC voltage.
For sine wave output: Sets an offset voltage.
The output voltage range the accuracy of which is guaranteed is between −10 V and +10 V, which includes the amplitude and the offset. If the sum of the amplitude and the offset is set to the outside of the guaranteed accuracy range, parts of the waveform will be clamped to the upper limit, approximately +16 V and the lower limit, approximately −11 V.

−10 V to +15 V

Phase

Sets the phase.

−360° to 360°

Duty

Sets the duty ratio for the pulse wave output.

0.1% to 99.9%

When Off

Sets the output terminal status when the output is off.

Open	Separates the output terminals from the internal circuit and opens the terminals.
Short	Separates the output terminals from the internal circuits and short-circuits the terminals.

Output

Controls waveform output.

On	Outputs a waveform.
Off	Does not output a waveform.

Control

Sets the signal output.

RUN	Starts the output. (Output indicator: Red)
PAUSE	Pauses the output. Outputs the voltage that was being outputted when **[PAUSE]** was pressed. (Output indicator: Red)
STOP	Stops the output. (Output indicator: Off)

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Method Selects the control method for the signal output.

Manual	Enables the control of signal output only on the signal generation screen.
Sync.	In addition to the manual control, outputs signals synchronizing with the start and end of the measurement. **START** key: Starts the output when the measurement starts. **STOP** key: Stops the output when the measurement stops.
Keys	In addition to the manual control, enables the instrument's keys to be used for the signal output control. **START** key: Starts the output. **STOP** key: Stops the output. Manual trigger key: Pauses the output.

Settings for [Arbitrary]

Data name Registers and deletes data of an output waveform. Up to eight waveforms can be registered.

Filter Filters the output waveform.

Off (Default setting) to 1 MHz

Clock Freq Set the clock frequency of the D/A converter that generates waveforms.
The period and frequency of the output waveform are displayed on the lower level.

Delay Set the delay for the waveform generation. A positive delay value represents that the phase leads.

−250,000 data to 250,000 data (Default settings: 0)

Loop Set the repeat count for generating waveforms.

1 to 50,000, ∞ (Default setting: ∞)

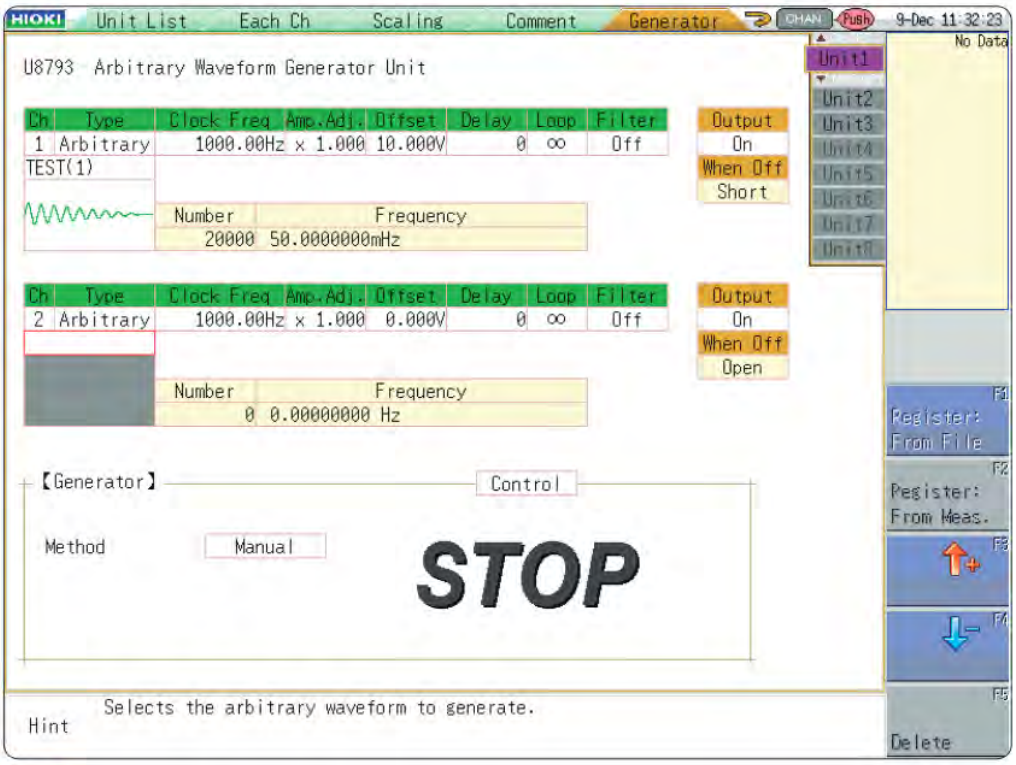
Amp Adj Set the amplitude level for the output waveform.

Offset Set the offset voltage for the output waveform.

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8.11 Registering Waveforms in the U8793 Arbitrary Waveform Generator Unit

You can register waveforms in the Model U8793. You can output the registered waveforms from the Model U8793.



Procedure

To display the screen

Press the **CHAN** key to display the channel screen, and then select the **[Generator]** sheet.

1 Set Type to Arbitrary.

Move the cursor to the **[Type]** box on the settings screen, and select **[Arbitrary]** by pressing the **F** keys.

2 Register the waveform.

Move the cursor to the item listed below **[Arbitrary]** on the settings screen.

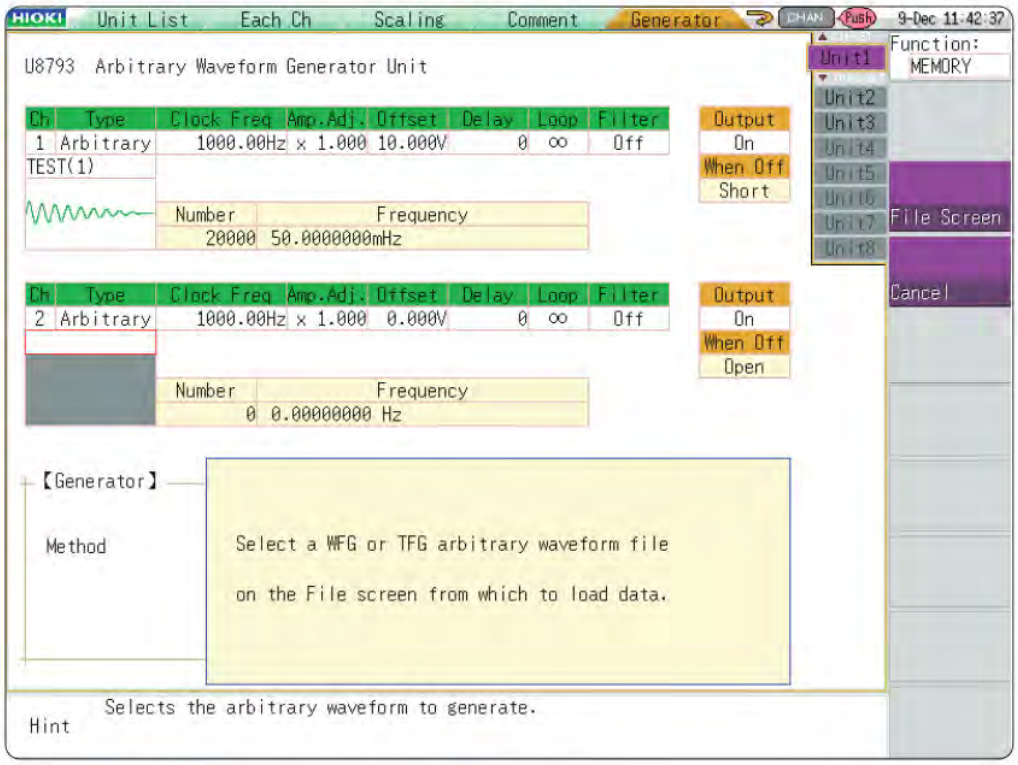
3 Select the waveform data.

Register: From File	Registers the data by loading data saved in a storage device.
Register: From Meas.	Registers the data that has been measured using the memory function. You can also register the data after loading the MEM files from a storage device onto the instrument.
↑ or ↓	Resisters the data by selecting the arbitrary waveform data registered in the U8793. (Used for selecting and deleting output waveforms.)
Delete	Deletes the data written in the U8793 memory. If eight waveforms are already registered, delete any of them and then register the data.

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Registering a waveform by selecting a file

1 **Select [Register..from file] by pressing F keys**



2 **Select [to File scrn] by pressing the CH.SET key.**

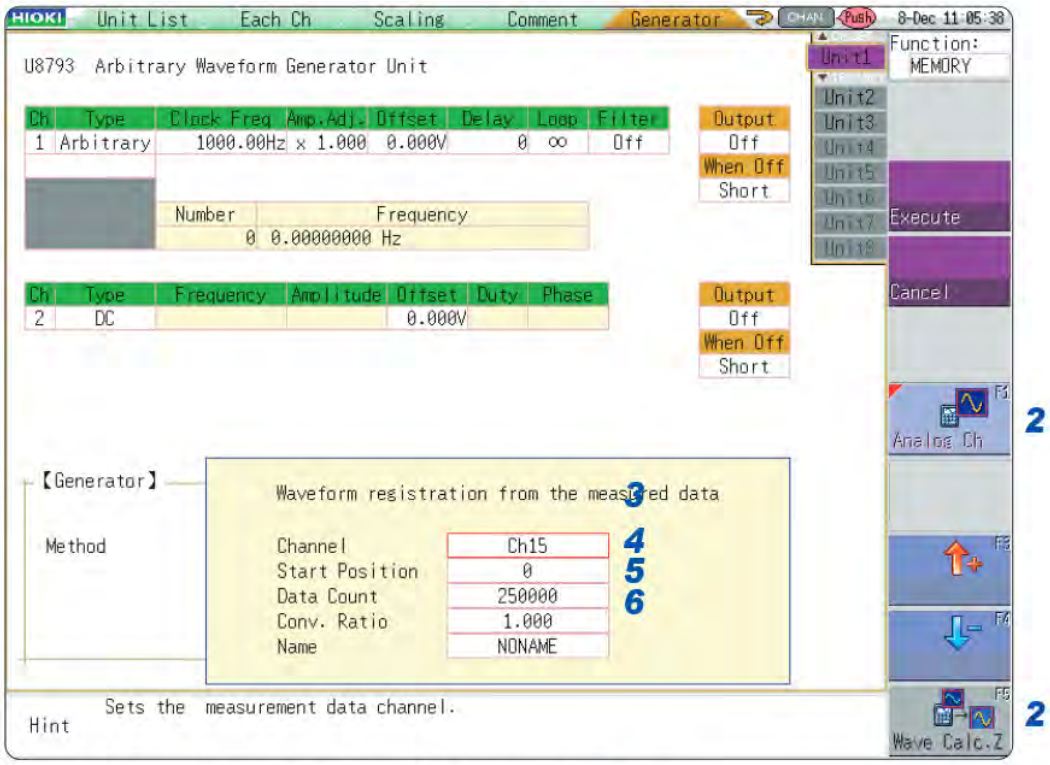
The file screen is displayed.

3 **Select a user-defined waveform file with the WFG or TFG extension on the file screen and then register the file.**

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Registering a waveform from measured data

1 **Select [Register..from measurement data] by pressing F keys**



2 **Select the waveform to be registered by pressing F keys.**

Analog Ch	Registers the waveform measured through an analog channel.
Wave Calc. Z	Registers the waveform obtained from a waveform calculation result.

3 **Select the waveform channels to be registered.**

Analog waveform

Ch1 through Ch16

Waveform calculations

Z1 through Z16

4 **Set the data count to be registered.**

Whole waveform	Registers the whole wave.*
A-B waveforms	Registers the waveform between Cursors A and B.*
Tenkey input	Sets the data starting position and data count freely using the numeric keypad.

* Up to 250,000 data point can be registered.

5 **Set the conversion ratio.**

Amplifies or attenuates voltage values of the measured data and register them.

0.001 times to 100 times

6 **Enter a data name.**

Enter the data name registered as a user-defined waveform data in the memory of the U8793 into the **[Name]** box.
When no data name is entered, the data is registered as **[NONAME]**.

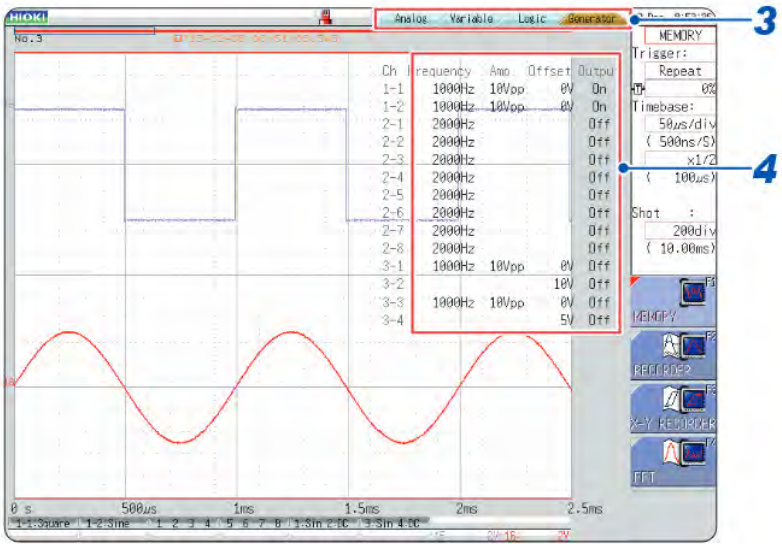
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8.12 Saving Waveforms Registered in Model U8793 onto a Storage Device

You can save the user-defined waveform data registered in Model U8793 onto a storage device.
For saving methods, refer to “5.2.4 Saving Waveform Outputting Data to a Storage Device” (p. 109).

8.13 Setting Output Waveform Parameters on the Waveform Screen

You can configure the output settings of the MR8790, MR8791, and U8793 on the waveform screen.
You can configure and change these settings during measurement or output.



1 **Display the waveform screen (if another screen is displayed, press DISP to display the waveform screen).**

2 **Press CH.SET (to display the tabs).**

3 **Press CH.SET or select the [Generator] tab with the mouse.**

4 **Set the following parameters.**

Frequency	Sets the frequency.
Amp	Sets the amplitude.
Offset	Sets the offset.
Output	Turns on and off the output.

For details, see the instruction manuals of Models U8793, MR8790, and MR8791.

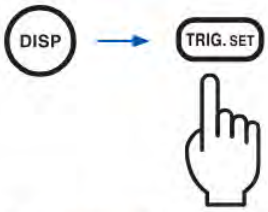
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9 Setting the Trigger

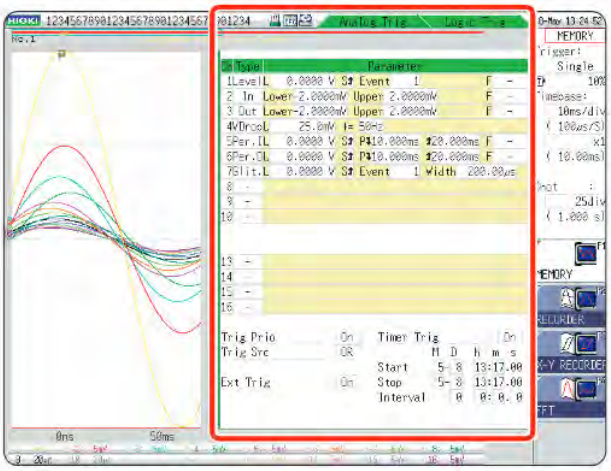
The trigger function allows you to start and stop measurement using signals or conditions. When recording is started or stopped by specific signals, it is called “the instrument triggers.”
You can configure the trigger settings on the trigger settings window of the waveform screen.
The X-Y recorder function does not support the trigger function.

How to open the trigger settings window



The window changes every time the **TRIG.SET** key is pressed.





If the trigger setting screen is difficult to see because it is overlapped with the waveforms, narrow the waveform display width so that the waveform display screen and trigger settings screen are displayed separately from each other.
Refer to “7.7.3 Switching the Waveform Display Width” (p. 156).

Operations available on the trigger settings window

Setting the trigger
- Setting the trigger mode (p. 213)
- Setting the logical trigger connective (AND/OR) among the trigger sources (p. 232)
- Setting the pre-trigger (p. 227)
- Setting the trigger timing (p. 230)

Setting the trigger sources

Setting the analog trigger (p. 214)
- Setting the level trigger
- Setting the window trigger
- Setting the period trigger
- Setting the glitch trigger
- Setting the voltage sag trigger

Setting the timer trigger (p. 222)

Setting the external trigger (p. 226)

Setting the manual trigger (p. 226)

Setting the logic trigger (p. 220)
- Setting the logic trigger condition
- Setting the trigger filter
- Setting the trigger pattern

Setting the trigger output (p. 377)

Searching trigger point (p. 233)

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9.1 Setting Procedure

Setting trigger mode

Set whether the instrument repeatedly waits for a trigger after measurement. (p. 213)

Setting trigger type

Set the trigger source.

- Analog trigger (p. 214)
- Logic trigger (p. 220)
- Timer trigger (p. 222)
- External trigger (p. 226)
- Manual trigger (p. 226)

MEM FFT
Setting pre-trigger.

Set the recording lengths preceding and following trigger points. (p. 227)

REC
Setting trigger timing

Set the start and stop timings for triggered recordings. (p. 230)

Selecting the logical trigger conditions, AND or OR, between channels.

Select the logical trigger conditions, AND and OR, between the analog, logic, external, and timer triggers . (p. 232)

Starting measurement

Press the **START** key to start measurement. (The key lights up in green.)
(Operation may differ depending on the **START** key behavior settings (p. 338).)
When the trigger conditions are met, the instrument starts to acquire data.

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

Available settings for the respective items vary depending on the function.

- The instrument triggers based pm the logical trigger connective (AND/OR) among the trigger sources except for the manual trigger. (p. 232)
- When triggering, the instrument output the TRIG OUT signal from the external control terminals. (p. 377)

If using Model U8975 4CH Analog Unit, Model U8977 3CH Current Unit, U8978 4CH Analog Unit or MR8990 Digital Voltmeter Unit, the trigger point display may shift by 1 sample.

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9.2 Setting the Trigger Mode

Set whether the instrument repeatedly waits for a trigger after measurement.
If all trigger sources are set to Off (i.e., with no trigger setting), measurement starts immediately (freely running).

Procedure

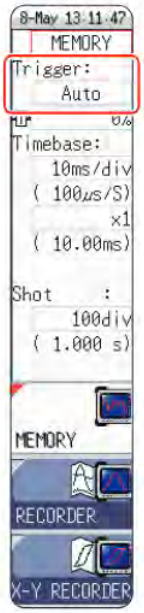
To display the screen

Press the **DISP** key to open the waveform screen.

1 **Move the cursor to the [Trigger] box.**

2 **Select the trigger mode.**

Single	Triggers on an event. Pressing the **START** key triggers recording the specified recording length of waveforms, and then the measurement stops.
Repeat	Triggers on events repeatedly. When no trigger events occur, the instrument waits for a trigger. Pressing the **STOP** key stops the measurement. (See below)
Auto	MEM FFT Triggers on events repeatedly. When no trigger events occur within approximately one second, records the specified recording length of waveforms automatically. Pressing the **STOP** key stops the measurement.



Available options vary depending on the function.

Trigger mode	Function	
	MEM FFT	REC
Single	✓	✓ (Default setting)
Repeat	✓	✓
Auto	✓ (Default setting)	–

To stop the measurement
Press the **STOP** key.
Press the key once: Records the recording length of waveforms, and then stops it.
Press the key twice: Stops the recording immediately.

When the trigger mode is set to **[Repeat]**
During the processing period (auto-save, auto-print, waveform display processing, numerical calculation) after recording stops until the instrument is set to wait for a trigger, the instrument does not trigger.

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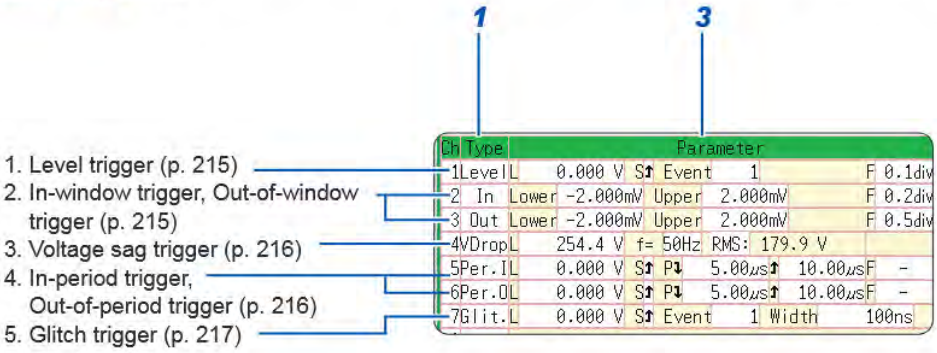
9.3 Triggering the Instrument Using Analog Signals

The section explains how to set the analog triggers and types of the analog triggers. You can configure these settings on the trigger settings window (**[Analog Trig]** sheet).

Procedure

To display the screen

Press the **DISP** key to display the waveform screen, and then press the **TRIG.SET** key to open the trigger settings window (**[Analog Trig]** sheet).



1 **Move the cursor to the [Type] box of the channel to be changed.**

2 **Select the trigger type with the F keys.**

3 **Move the cursor to the parameter to be changed with the CURSOR keys.**

4 **Select the parameter value with the F keys.**

To copy the setting to another channel

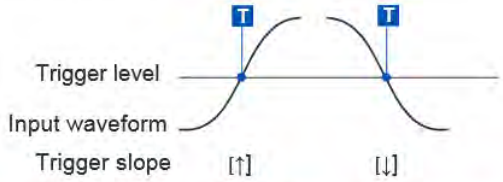
You can copy the settings on the trigger settings window (**[Analog Trig]** sheet).
Refer to “8.9 Copying Settings to Other Channels (Copy Function)” (p. 183).

When the FFT function is used, setting **[Reference]** to **[From Memory]** disables the analog triggers setting.

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1. Level trigger

When the input signal crosses the specified trigger level (voltage value) in the positive or negative direction, the instrument triggers.



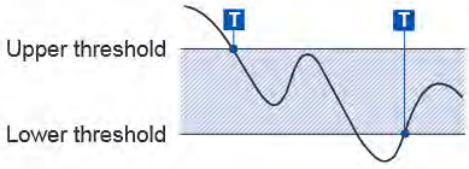
In this manual, the mark T represents the "trigger point," the time at which a trigger is applied.

Type	Parameter	
[Level]	[L] (Level)	Sets the trigger level (voltage value). (You can set the level in increments of 1/50 of the vertical axis [voltage axis] range.)
	[S] (Slope)	Selects which event the instrument triggers when the input voltage crosses the trigger level in the positive or negative direction. Selecting the icon ↕ enables the instrument to be triggered on both slopes. (↑, ↓, ↕)
	[Event]	Sets the number of times the signal crosses the trigger level in the positive or negative direction. The instrument triggers when the counted number reaches the specified number. (1 to 4000)
	[F] (Filter)	The instrument triggers when the input signals meet the trigger conditions during the specified filter width period. This is useful to prevent the instrument from triggering unintentionally due to noise. ([MEM] and [FFT]: OFF, 0.1 to10 div, [REC]: OFF, ON*) *: The filter width period is 10 ms.

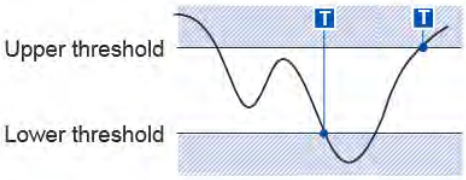
2. In-window trigger, Out-of-window trigger

Sets the range by specifying the upper and lower limit values. The instrument triggers when the input signal falls into the range (In) or outside the range (Out).

(In)



(Out)

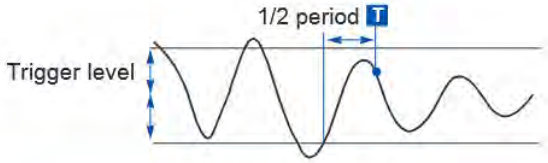


Type	Parameter	
[In] or [Out]	[Lower]	Sets the lower limit value. (You can set the level in increments of 1/50 of the vertical axis [voltage axis] range.)
	[Upper]	Sets the upper limit value. (You can set the level in increments of 1/50 of the vertical axis [voltage axis] range.)
	[F] (Filter)	The instrument triggers when the input signals meet the trigger conditions during the specified filter width period. This is useful to prevent the instrument from triggering unintentionally due to noise. ([MEM] and [FFT]: OFF, 0.1 div to 10 div, [REC]: OFF, ON*) *: The filter width period is 10 ms.

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3. Voltage drop trigger (MEM and FFT only)

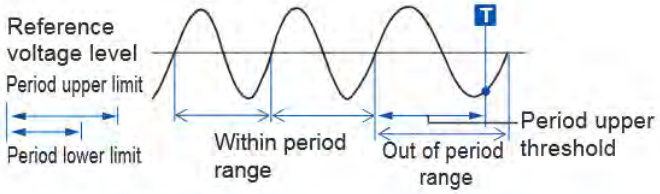
When the voltage peak drops below a preset level for the period of half a cycle or more, the instrument triggers. The available timebase range is between 20 µs and 50 ms/div.



Type	Parameter	
[VDrop]	[L] (Level)	Sets the trigger level (voltage value). (You can set the level in increments of 1/50 of the vertical axis [voltage axis] range.)
	[f=] (Frequency)	Selects between 50 Hz and 60 Hz.
	RMS: (Root-mean-squire value)	The indication of the RMS value Changes with the level setting.

4. In-period trigger, out-of-period trigger

The instrument measures the input voltage period, which is the time lag between consecutive two points at which the input voltage crosses the reference voltage in the positive or negative. The instrument triggers when the period falls within the specified range (In) or outside the range (Out).
Refer to "Setting the period range" and "Trigger position of the out-of-period trigger" (p. 219).



About the trigger point
The trigger point appears one sampling round late.

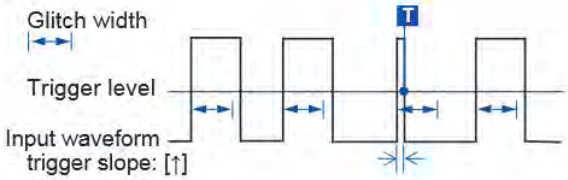
Type	Parameter	
[Per.I] or [Per.O]	[L] (Level)	Sets the trigger level (voltage value). (You can set the level in increments of 1/50 of the vertical axis [voltage axis] range.)
	[S] (Slope)	Selects which event triggers the instrument, occurring when the input voltage crosses the trigger level in the positive or negative direction (↑, ↓)
	[P↓] (Period lower limit)*1	Sets the lower limit, which can be set to zero and five times the sampling frequency or higher. The lower limit cannot be set to a value higher than the period upper limit. (When the lower limit is set to zero, the instrument ignores the lower limit and triggers using the higher limit only.)
	[↑] (Period upper limit)*1	Sets the upper limit, which can be set to 20,000 times the sampling frequency or lower. The upper limit cannot be set to a value lower than the period lower limit.
	[F] (Filter)	The instrument triggers when the input signals meet the trigger conditions during the specified filter width period. This is useful to prevent the instrument from triggering unintentionally due to noise. (MEM and FFT: OFF, 0.1 div to 10 div, REC: OFF, ON*) *: The filter width period is 10 ms.

*1 Changes with the timebase setting.

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5. Glitch trigger (MEM and FFT only)

The instrument triggers when the pulse width of the input signal that has crossed the trigger level (threshold voltage) is shorter than the specified width.



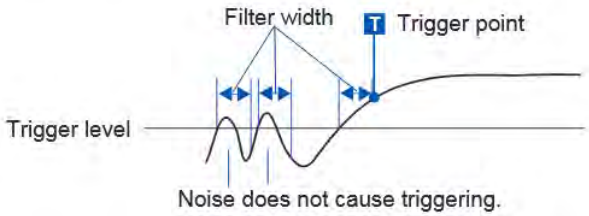
Type	Parameter	
[Glit.]	[L] (Level)	Sets the trigger level (voltage value). (You can set the level in increments of 1/50 of the vertical axis [voltage axis] range.)
	[S] (Slope)	Selects which event triggers the instrument, occurring when the input voltage crosses the trigger level in the positive or negative direction. (↑, ↓)
	[Event]	Sets the number of times the signal crosses the trigger level in the positive or negative direction. The instrument triggers when the counted number reaches the specified number. (1 to 4000)
	[Width]	Sets the pulse width (time), which is used to determine a glitch. Triggers when the width falls below this value. (The available setting range varies depending on the sampling frequency. Lower limit: sampling frequency × 2 or higher, upper limit: sampling frequency × 4000 or lower)

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When triggering using noisy signals

Method 1: Setting the trigger filter

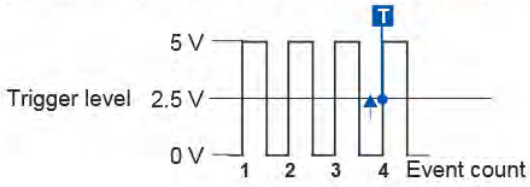
Setting the filter width prevents the instrument from triggering mistakenly due to noise, allowing it to trigger when the input meets the trigger conditions during the specified width (interval) or longer period.



Method 2: Setting the number of events

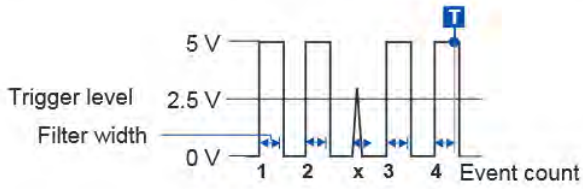
Setting the number of events prevents the instrument from triggering mistakenly due to noise, allowing it to trigger when the counted number reaches the specified number.

Example: When the event count is set to **[4]** (Slope : ↑)



To prevent the effects of noise

Noise at close to the trigger level can erroneously increment the event count. The trigger filter is useful to avoid this problem.



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Setting the period range

The period range setting of the period triggering varies depending on the sampling period (sampling rate). (The setting value of the period range also changes with the timebase setting.)
Check the [Sampling Rate] setting on the **[Status]** sheet of the status screen.
The upper limit value of the period range cannot be set to the value lower than the lower limit value; the lower limit value cannot be set to the value higher than the upper limit value;
Lower threshold: can be set to zero or five times the sampling period or higher.
Upper threshold: can be set to 20,000 times the sampling period or lower.

To trigger the instrument when the input frequency exceeds the upper limit value (when the period becomes shorter)

Set the period trigger to **[Per.l]** and the lower limit to **[0]**. The instrument ignores the lower limit and triggers when the input frequency exceeds the upper limit.

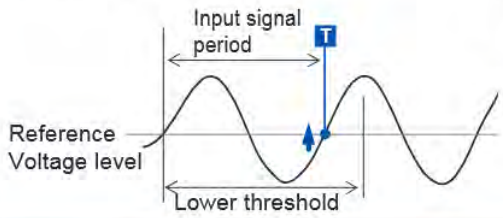
To trigger the instrument when the input frequency falls below the upper limit value (when the period becomes longer)

Set the period trigger to **[Peri.O]** and the lower limit to **[0]**. The instrument ignores the lower limit and triggers when the input frequency falls below the upper limit.

Trigger position of the out-of-period trigger

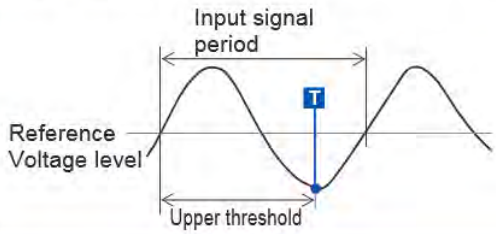
The instrument calculates periods by monitoring times when the input crosses the reference voltage value in the positive or negative direction and triggers when the period falls out of the specified period range. The trigger points vary depending on the specified period range and the period of the measuring object.

When the input signal period is shorter than the specified lower threshold (with the trigger slope set to positive [↑])



The instrument triggers when the rising edge (↑ trigger slope) of the input signal crosses the reference voltage level before the lower period threshold elapses.

When the input signal period is longer than the specified upper threshold (with the trigger slope set to positive [↑])



The instrument triggers when the upper threshold period elapses before the rising edge (↑ trigger slope) of the input signal crosses the reference voltage level.

Thus, the trigger point varies depending on the upper threshold of the period range.

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9.4 Triggering the Instrument Using Logic Signals (Logic Trigger)

The section explains how to set the logic triggers and types of the logic triggers. Press the **[DISP]** key to display the waveform screen, and then press the **[TRIG.SET]** key to open the trigger settings window (**[Logic Trig]** sheet).

- Input signals obtained through the logic channels serve as the trigger source.
  You can specify trigger patterns and logic trigger (AND and OR). When these conditions are met, the instrument triggers.
- You can choose whether the instrument triggers or not when the logic trigger conditions have been already met at the start of measurement.
- Using the trigger filter allows the instrument to trigger only when the logic trigger conditions are met during the specified filter width period.

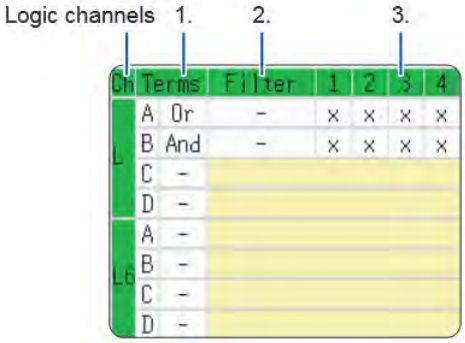
Procedure

To display the screen

Press the **DISP** key to display the waveform screen, and then press the **TRIG.SET** key to open the trigger setting window (**[Logic Trig]** sheet).

1 **Move the cursor to the channel for which you want to change the settings.**

2 **Use the F keys to configure the settings.**



1. Trigger

Sets the logic trigger connective (AND or OR).

OFF	Disables the logic trigger. (Default setting)
OR	Trigger the instrument when one of the logic input signals meets the trigger pattern.
AND	Triggers the instrument when all of the logic input signals meet the trigger pattern.

2. Filter

Sets the trigger filter width. (If necessary)
The trigger filter eliminates incorrect triggers caused by noise. (p. 218)

MEM	OFF	Disables the trigger filter. (Default setting)
	0.1 to 10	Enables the trigger filtering. The filter width can be set in terms of divisions.

REC	OFF	Disables the trigger filter. (Default setting)
	ON	Enables the trigger filtering. The filter width is set to 10 ms (5 ms with the sampling rate setting of 100 ns/S)

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3. Trigger pattern Sets the logic trigger pattern.

X	Ignores signals. (Default setting)
0	Triggers the instrument to trigger when the signal is at a low level.
1	Triggers the instrument when the signal is at a high level.

To copy the setting to another channel

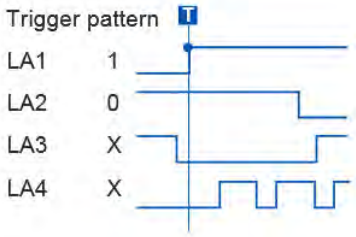
You can copy the settings on the trigger settings window (**[Logic Trig]** sheet).
Refer to "8.8 Inverting the Waveform (Invert Function)" (p. 182).

Setting examples

Example 1: To allow the instrument to trigger when one of the input signals meets each of the following patterns

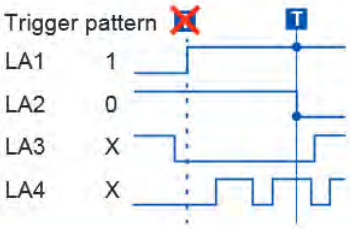
LA1: High level
LA2: Low level
Logic trigger connective: OR
LA[1, 2, 3, 4]: [1 0 X X]

The instrument triggers when LA1 or LA2 is met each of the logical trigger patterns.



Example 2: To allow the instrument to trigger when both of the input signals meet each of the following patterns

LA1: High level
LA2: Low level
Logic trigger connective: AND
LA[1, 2, 3, 4]: [1 0 X X]



- When the trigger conditions have been already met, pressing the **START** key does not allow the instrument to trigger. After all of the trigger sources have ceased to meet the trigger conditions, when they meet the trigger condition again, the instrument triggers.
- The triggers of the standard logic channels (LA, LB, LC, and LD) are available regardless of the logic waveform display and the module type.

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9.5 Triggering the Instrument at the Specified Time or at Regular Intervals (Timer Trigger)

The timer trigger allows you to trigger the instrument at the specified time.

- You can trigger the instrument at regular intervals during the period from the specified start time until the specified stop time.
- Check that the clock is set correctly before setting the timer trigger. If not, set the clock on **[Init]** sheet accessible from the system screen. (p. 54)

Procedure

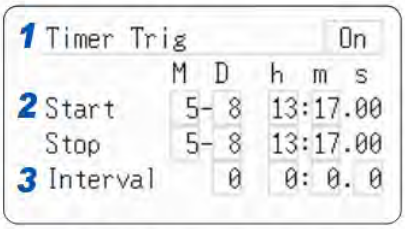
To display the screen

Press the **DISP** key to display the waveform screen, and then press the **TRIG.SET** key to display the trigger settings window.

1 Enable or disable the timer trigger.

Move the cursor to the [Timer Trig] box.

Off	Disables the timer trigger.
On	Enables the timer trigger.

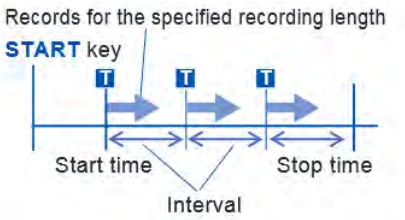


2 (When setting the timer trigger to [On])

Set the start and stop times.

Move the cursor to the **[M]**, **[D]**, **[h]**, and **[m]** boxes in turn. Set the start date and time as well as the stop date and time.

To set the start or stop times to the present date and time
Select **[Present Time]**.



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3 **(To trigger the instrument at regular intervals during the period between the start and the stop times)**

Set the interval.

Move the cursor to the **[D]**, **[h]**, **[m]**, and **[s]** boxes under **[Interval]** in turn.
Set the recording interval.

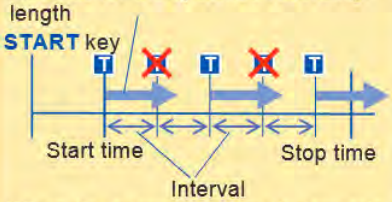
4 **Press the START key.**

Measurement starts, and the recording will start at the specified start time.

To stop the recording in progress immediately
Press the **STOP** key.

When the interval is shorter than the recording length

Records for the specified recording length



When the recording length exceeds the recording interval

The instrument does not trigger until having acquired the specified recording length of the data.

When the end of the recording length is set so as to be behind the stop time

The recording length varies depending on the operating function.
(p. 223)

When the interval is set to zero

With the trigger mode set to **[Repeat]**, the recording is repeated from the start time to the stop time.

The set time of the timer trigger and the time at which the instrument actually triggers may differ by up to three sampling rounds.

Start and stop times

- Set the start and stop times so as to be the later times than the time the **START** key was pressed.
- When the trigger mode is set to **[Single]** and the timer trigger is set to **[On]**, the instrument triggers at only the specified start time. The interval and stop time setting are ignored.

To perform recording at regular intervals during the period between the start and the stop times

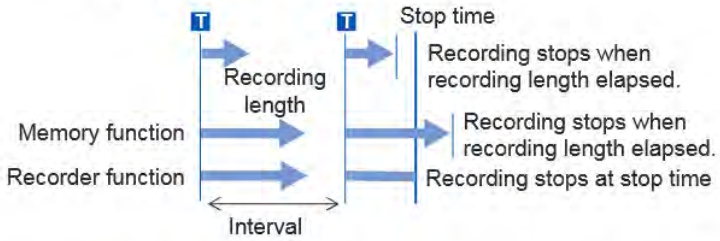
Set the trigger mode to **[Repeat]** all other trigger sources to **[Off]**.
However, since the instrument does not start waiting for a trigger while processing data (auto-save, auto-print, waveform display processing, calculation), which starts at the end of the previous round of recording, recordings may not start at the specified regular intervals depending on the measurement settings.

Stop time and recording length

The stop time varies depending on the functions.
Memory function: After acquiring the specified length of measurement data, the instrument stops the recording.
Recorder function: The instrument stops the recording at the specified stop time.

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Relationship between the last recording length and the stop time



To trigger the instrument using trigger sources in addition to the timer trigger

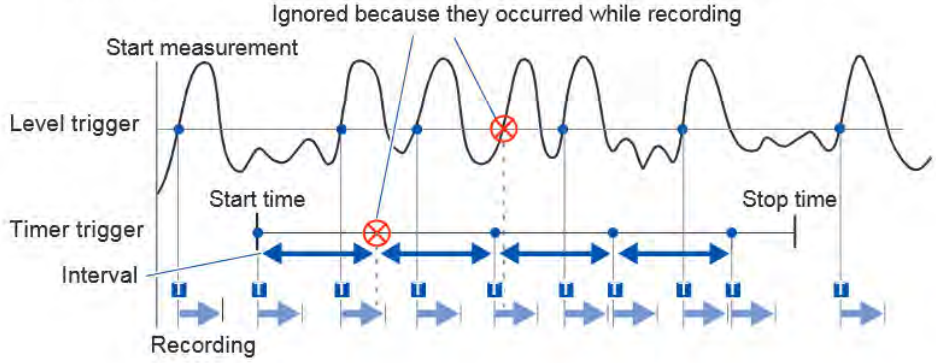
The trigger sources set to **[On]** are all enabled.
However, the trigger timing varies depending on the trigger source settings.

- **When the trigger logical connective among the trigger sources is set to logical disjunction (Trigger source: OR)**
  Depending on the other trigger source settings, the instrument can trigger before the specified trigger start time, after the specified stop time, or outside of the specified interval.

- **When the trigger logical connective among the trigger sources is set to the logical conjunction (Trigger source: AND)**
  The instrument triggers when all the trigger sources meet the trigger conditions during the specified intervals within the period between the specified start and stop times.
  When the interval is set to zero, the instrument triggers when all the trigger sources meet the trigger conditions within the period between the specified start and stop times.

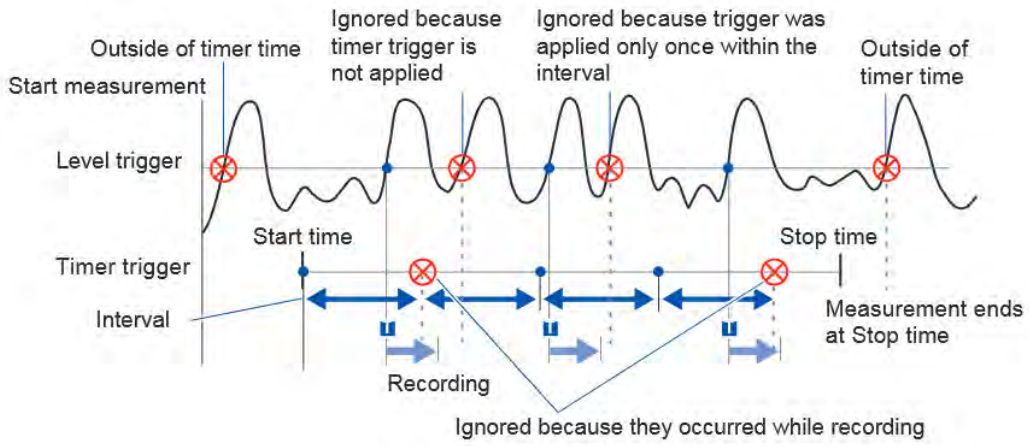
Example: When performing measurement with both the timer trigger and the level trigger (with the slope setting set to positive [↑]) are enabled.

When trigger criteria are combined with OR (Trigger Source: OR)



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When trigger criteria are combined with AND (Trigger Source: AND)



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9.6 Triggering the Instrument Externally (External Trigger)

External signals applied to the external control terminals can serve as the trigger sources.
The external signals can also be used to operate multiple instruments in synchronization with each other.

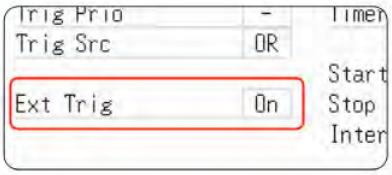
Procedure

To display the screen

Press the **DISP** key to display the waveform screen, and then press the **TRIG.SET** key to display the trigger settings window.

1 **Enable the external trigger.**

Move the cursor to the [Ext Trig] box.



Off	Disables the external trigger. (Default setting)
On	Enables the external trigger.

2 **Configure the external control terminals (EXT.TRIG) setting, and input the signals.**

Refer to "17.2.5 External Trigger Terminal (EXT.TRIG)" (p. 378).

9.7 Triggering the Instrument Manually (Manual Trigger)



Pressing the **Manual Trigger** key can trigger the instrument forcibly.
The manual trigger takes priority over all other trigger sources regardless of the settings.

To stop the recording
Press the **STOP** key.

Press the key once	Stops the recording after acquiring the recording length of waveforms.
Press the key twice	Stops the recording immediately.

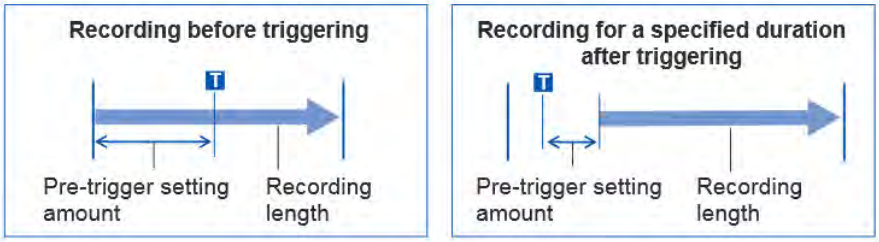
The same as other trigger types, the instrument does not trigger while filling the pre-trigger memory. Set the trigger priority function to **[On]**.
Refer to "9.8.2 Setting the Trigger Acceptance (Trigger Priority)" (p. 229).

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9.8 Setting the Pre-trigger

MEM FFT

This function can be used in the memory and FFT functions only.
Setting the pre-trigger recording length (number of divisions or percentage of the recording length) enables the instrument to record not only waveforms appearing after the trigger point but also those appearing before the trigger point.
You can also record waveforms appearing after the pre-trigger recording length elapses since the trigger point.



- Setting all the trigger sources (analog, timer trigger, etc.) to off disables the pre-trigger settings.
- In the FFT function, the pre-triggers cannot be set in terms of divisions.

9.8.1 Setting the Trigger Start Point (Pre-trigger)

Set the position of the trigger point relative to the specified recording length.
Two setting methods are available. (Setting the start point in terms of percent and divisions [div])

Procedure

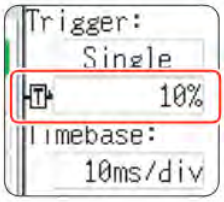
To display the screen

Press the **DISP** key to display the waveform screen.

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1 Select the unit used for setting the pre-trigger.

Move the cursor to the **[Pre-trigger]** box.



%	Sets the pre-trigger in terms of percent (%). (Default setting)
div	Sets the pre-trigger in terms of divisions (div). For the external sampling, set in terms of the number of samples.

2 Enter the numerical value.

(When [%] is selected)

With the recording start point set at 0%; the recording stop point set at 100%, set the percentage of the trigger point.

−95%, 100%, 95%, 90%, 80%, 70%, 60%, 50%, 40%, 30%, 20%, 10%, 5%, 2%, 0%

(When [div] is selected)

With the recording start point set at 0 div; the recording stop point at the time the set recording length has elapsed, set the number of divisions for the trigger point.

Negative recording length (divisions) to positive recording length (division)

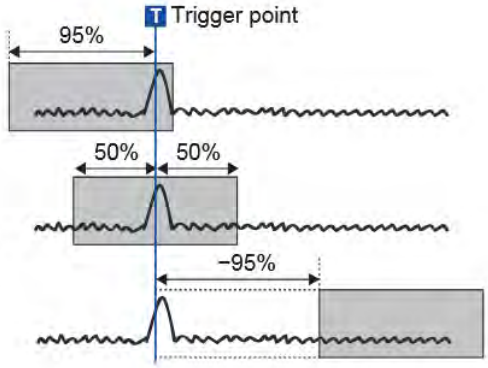
Pre-trigger and the recording period (recording length)

Pre-trigger setting examples

95% Records the recording length of the waveforms 95% of which appear before the trigger point.

50% Records the recording length of the waveforms 50% of which appear before the trigger point.

−95% Records the recording length of the waveforms that appear after 95% of the recording length has elapsed since the trigger point.



The instrument ignores trigger events while filling the pre-trigger memory. To trigger the instrument while it is filling the pre-trigger memory, set the trigger priority to **[On]**.
Refer to “9.8.2 Setting the Trigger Acceptance (Trigger Priority)” (p. 229).

Difference between [Pre-Trigger wait] and [Trigger wait]

When starting the measurement, the instrument starts filling the pre-trigger memory. During this period, the instrument displays the message **[Pre-Trigger wait]**.
After having filled the pre-trigger memory, the instrument displays the message **[Trigger wait]**, starting waiting for a trigger.
Refer to “Measurement and internal operations” (p. 80).

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9.8.2 Setting the Trigger Acceptance (Trigger Priority) MEM

This function can be used in the memory function only.
You can choose whether the instrument triggers or not when the trigger conditions are met while the instrument is filling the pre-trigger memory.

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

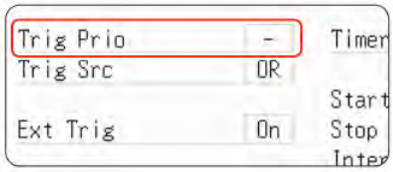
Procedure

To display the screen

Press the **DISP** key to display the waveform screen, and then press the **TRIG.SET** key to display the trigger settings window.

Move the cursor to the **[Trig Prio]** box.

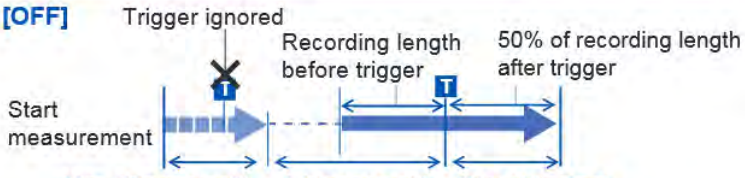
OFF	Does not trigger while being filling the pre-trigger memory. (Default setting)
ON	Triggers while being filling the pre-trigger memory.



When the trigger conditions are met during [Pre-Trigger wait]

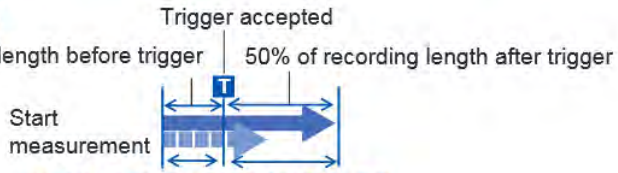
Example: When the pre-trigger period is set to 50%

Trig Prio: [OFF]



(After 50% of the recording length is recorded internally, the **[Trigger wait]** state begins)

Trig Prio: [ON]



(A trigger event occurs while 50% of the recording length is being recorded internally)

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

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9.9 Setting the Trigger Timing

REC

This function can be used in the recorder function only.
Follow the procedure described below to configure the operation settings when the instrument triggers.

Procedure

To display the screen

Press the **DISP** key to display the waveform screen, and then press the **TRIG.SET** key to display the trigger settings window.

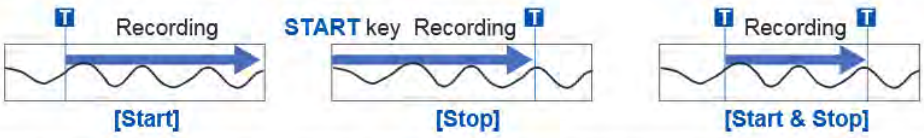
Move the cursor to the **[Timing]** box.



Start	Starts the recording when the instrument triggers, and stops the recording when having acquired the specified recording length of the waveforms. (Default setting)
Stop	Starts the recording when the **START** key is pressed, and stops the recording when the instrument triggers.
Start & Stop	Starts the recordings when the instrument triggers, and stops the recording when the instrument triggers again.

Trigger timing

The stopping behavior varies depending on the trigger modes.



	[Start]	[Stop]	[Start & Stop]
Starts the recording	Starts the recording when the instrument triggers.	Starts the recording when you press the **START** key.	Starts the recording when the instrument triggers while the instrument is not performing recording.
Stops the recording	↓	↓	↓
Trigger mode: **[Single]**	Stops the recording after acquiring the specified recording length of data.	Stops the recording when the instrument triggers.	Stops the recording when the instrument triggers while the instrument is performing the recording.
Trigger mode: **[Repeat]**	Starts the recording, stops the recording after having acquired the specified recording length of the data, and then waits for a trigger. When triggers again, starts the recording, stops the recording after having acquired the specified recording length of the data, and then waits for a trigger. (Repeats the sequence)	When triggers again, stops the recording, and then starts another recording. (Repeats the sequence)	When triggers, stops the recording, and then waits for a trigger. When triggers again, starts another recording until triggers one more time. (Repeats the sequence)

When the instrument does not trigger even after the specified recording length has elapsed

[Stop] or **[Start & Stop]:** Stops the recording after having acquired the specified recording length of the data.

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When the instrument does not trigger even after the specified recording length has elapsed

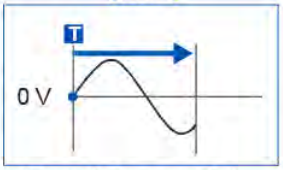
[Stop]: After having acquired the specified recording length of the data, the instrument starts another recording. The instrument repeats this sequence until it triggers.

[Start & Stop]: After having acquired the specified recording length of the data, the instrument starts waiting for a trigger. (Start trigger)

Example: When the trigger type is set to Level Trigger; Level to 0.000 V, and Slope to positive (↑)

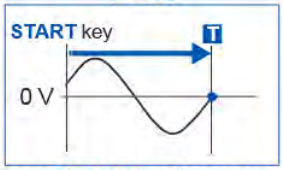
Setting of [Timing]

[Start]



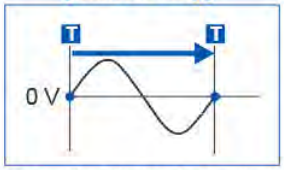
Records for specified recording length

[Stop]



Press **START** key to record. Records until a trigger occurs.

[Start & Stop]



Recording starts when a start trigger event occurs. Records until a stop trigger occurs.

The above sequences repeat when the trigger mode is **[Repeat]**.

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9.10 Setting the Trigger Logical Connective (AND/OR) Among the Trigger Sources

Set the trigger logical connective by choosing between AND and OR among the analog, logic, external, timer triggers.

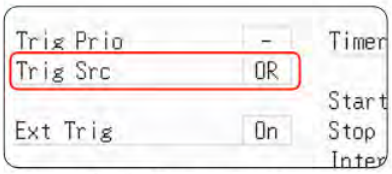
Procedure

To display the screen

Press the **DISP** key to display the waveform screen, and then press the **TRIG.SET** key to display the trigger settings window.

Move the cursor to the **[Trig Src]** box.

OR	Triggers when any one of the specified trigger source conditions is met. (Default setting)
AND	Triggers only when all of the specified trigger source conditions are met.



(When using the memory function)

When the trigger logical connective is set to [AND]

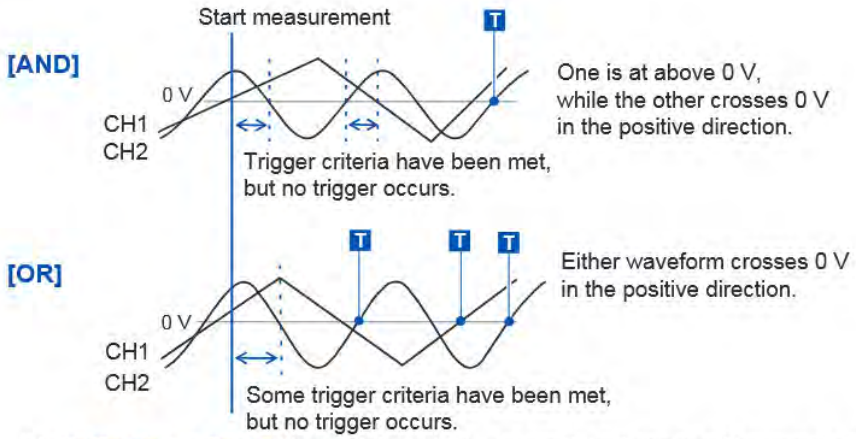
When the trigger conditions have been already met, pressing the **START** key does not allow the instrument to trigger. After all of the trigger sources have ceased to meet the trigger conditions, when they meet the trigger condition again, the instrument triggers.

Setting example:

To trigger the instrument when the waveform exceeds the zero volts

The instrument with the trigger logical connective set to each of AND and OR triggers as follows:

Channel	Trigger	Trigger level	Slope	Filter
CH1, CH2	Level	0.00 V	Positive (↑)	OFF



If both **[Start]** and **[Stop]** trigger timing criteria are combined, the simultaneous trigger sources are combined with a logical AND.

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9.11 Searching the Measured Data Using the Trigger Settings

MEM

The trigger settings can be used to search the measured data.
The instrument searches the trigger points, at which the measured data meet the trigger conditions, in the measured data in order and displays them.
You can set the search settings in the same way as the trigger settings, and search the trigger points under the different condition from the trigger settings.
Example 1: After performing measurement with the trigger level set to 0 V, to search the points at which the waveform exceeds 100 V in the measured data
Example 2: After performing measurement without the trigger setting, to search the points at which the waveform exceeds 100 V in the measured data

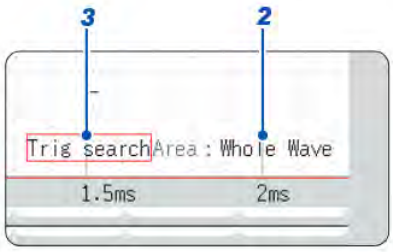
Procedure

To display the screen

Press the **DISP** key to display the waveform screen, and then press the **TRIG.SET** key to display the trigger settings window. (**[Analog Trig]** or **[Logic Trig]** sheet)

1 **After performing the measurement, set the searching condition.**

The setting method is the same as described in "9.3 Triggering the Instrument Using Analog Signals" (p. 214) and "9.4 Triggering the Instrument Using Logic Signals (Logic Trigger)" (p. 220).



2 **Specify the searching scope.**

Move the cursor to the **[Area]** field.

Whole Wave	Searches all the measured data. (Default setting)
A-B Wave	Searches the range between Cursor A and Cursor B.

(When using the memory division)

All Display Blocks	Searches all the data in all the displayed blocks. (Default setting)
A-B Display Blocks	Searches the range between Cursor A and Cursor B in the displayed blocks.
All Blocks	Searches all the data in all the blocks.
A-B All Blocks	Searches the range between Cursor A and Cursor B cursors in all the blocks.

- When the range between Cursor A and Cursor B is selected with only Cursor A displayed on the screen, the instrument searches the time range after Cursor A.
- The searching scope for the **[All Blocks]** setting will be defined by the start block and the number of blocks to be measured.

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3 Execute the search.

Move the cursor to the **[Trig search]** field.

Execute the searching.	Starts the search in the measurement data from the beginning.
Search next	Searches the subsequent point that meets the searching condition.
Move A cursor	Moves Cursor A to the searched point.
Move B cursor	Moves Cursor B to the searched point.
Clear	Clears the searched points.

[Search] and **[Search next]** can be executed by pressing the **Manual Trigger** key as well.

Search results

The point that meets the searching condition is displayed in the center of the screen and marked with an S.



When no points that meet the searching condition are found, the message **[No Matches Were Found]** is displayed.

- Pre-triggers, trigger priorities, external triggers, and timer triggers cannot be used as the searching conditions.
- The search results may not coincide with the trigger points.

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10 Numerical Calculation Functions

MEM

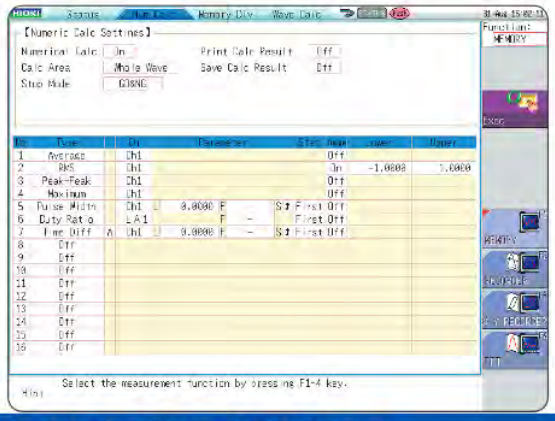
The numerical calculations can be used only with the memory function.
Results calculated from the acquired waveform are displayed as numerical values on the waveform screen. These calculation results can be judged for evaluation. The numerical calculation settings can be configured on the **[Num Calc]** sheet accessible from the status screen.
Numerical calculations can also be performed using the results of waveform calculations (Z1 to Z16).

To display the [Num Calc] sheet



Press the **STATUS** key repeatedly to switch the sheets.

[Status]
↓
[Num Calc]



Operations available on the [Num Calc] sheet

[Num Calc]

- Average
- RMS value
- P-P Value
- Maximum value
- Time to Maximum Value
- Minimum value
- Time to Minimum Value
- Period
- Frequency
- Rise Time
- Fall Time
- Standard Deviation
- Area
- X-Y Area
- Time to Level
- Level at Time
- Pulse Width
- Duty Ratio
- Pulses
- Four arithmetic operations of the numerical calculation results
- Time difference calculation (Time Diff)
- Phase difference calculation (Phase Diff)
- High Level
- Low Level

(24 types in total)

- Range-specified calculation between Cursors A and B

Calculations can be performed for the data the range of which is specified with Cursors A and B.
Calculation operator details: "10.6 Numerical Calculation Types and Descriptions" (p. 249)

Judging the numerical calculation results (p. 243)

You can judge the results of numerical calculations by comparing them with specified reference ranges, giving GO or NG (pass or fail) judgments.

There are 24 types of numerical calculations in total, 16 of which can be performed simultaneously.
When the scaling function is enabled, scaled values are calculated.

Saving/Printing numerical calculation results

- Automatically saving numerical calculation results
- Saving existing numerical calculation results specified freely

Refer to "10.4 Saving the Numerical Calculation Results" (p. 246).

- Automatically printing numerical calculation results
- Printing numerical calculation results freely specified

Refer to "10.5 Printing the Numerical Calculation Results" (p. 248).

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10.1 Numerical Calculation Procedure

There are two ways to perform the calculation.

- **Performing calculation during measurement:** Settings for numerical calculation must be chosen before starting measurement.
- **Calculating the existing data:** The calculation can be performed for the waveform data after the measurement is complete and the data saved on storage devices.

Performing calculation during measurement

Configuring the calculation settings

Configure the calculation settings on the [Num Calc] sheet. (p. 238)

To judge the calculation results (p. 243)

To automatically print or save the calculation results
Configure the printing and saving settings before starting measurement.
- Saving the calculation results automatically (p. 246)
- Printing the calculation results automatically (p. 248)

↓

Starting measurement

↓

Acquiring the data

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

↓

Performing calculation

[Measuring] appears on the screen's status bar.
Calculations are performed from No. 1 to No. 16 in order.
(To stop the calculation, press the **STOP** key.)

↓

Displaying the calculation results

The results are displayed on the waveform screen. (p. 242)

↓

(Judging the calculation results)

(Only when the judgment is enabled)

↓

(Printing or saving the result)

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

↓

Finishing the measurement

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Calculating the existing data

(Loading the data)	**(To load the measured data to be calculated from a storage device)**	(p. 110)
↓		
Configuring the calculation settings	**Configure the calculation settings on the [Num Calc] sheet.** To judge the calculation results	(p. 238) (p. 243)
↓		
Performing the calculation	**Select [Exec] to perform the calculation.** (To stop the calculation, press the **STOP** key.)	
↓		
Displaying the calculation results	**The results are displayed on the waveform screen.**	(p. 242)
↓		
(Judging the calculation results)	**(Only when the judgment is enabled)**	
↓		
(Printing or saving the result)	**Print (When Model U8350 Printer Unit is installed) or save the calculation results as needed.** • To Print the result, press the **PRINT** key. • To save the result, press the **SAVE** key **When [Print Calc Result] (p. 248) or [Save Calc Result] (p. 246) is set to [On], the results are automatically printed or saved.**	

To specify a waveform range for calculation

Before performing the calculation, specify the calculation range using Cursors A and B (the Div or Trace setting) on the waveform screen.

Set the calculation range on the **[Num Calc]** sheet to **[A-B Wave]**.

- The range setting cannot be used to specify the range.
- When one cursor is used, the calculation is performed for the range from the cursor point through the end of the data.

Refer to "7.2 Specifying the Waveform Range (Cursors A and B)" (p. 145) and "10.2 Setting the Numerical Value Calculation" (p. 238).

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10.2 Setting the Numerical Value Calculation

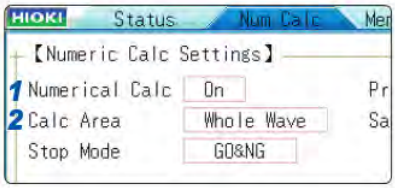
Procedure

To display the screen

Press the **STATUS** key to display the status screen, and then select the **[Num Calc]** sheet.

1 **Enable the numerical calculation function.**

Move the cursor to the **[Numerical Calc]** box and select **[On]**.



2 **Specify the waveform calculation range.**

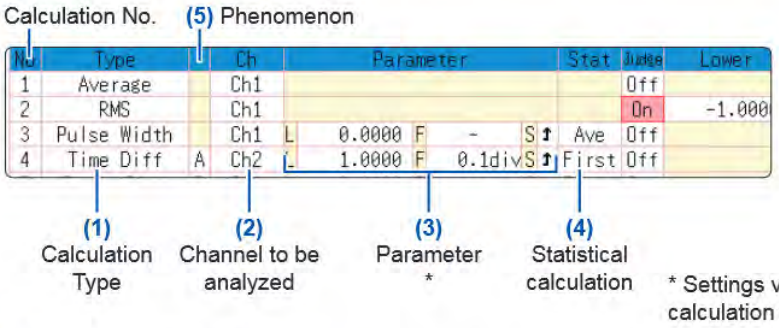
Move the cursor to the **[Calc Area]** box.

Whole Wave	Calculates the whole waveform. (Default setting)
A-B Wave	Calculates the data between Cursors A and B.
After Trigger	Calculates the waveform obtained after the trigger.

Refer to “7.2 Specifying the Waveform Range (Cursors A and B)” (p. 145).

When selecting **[A-B Wave]**, specify the calculation range using the Cursors A and B on the waveform screen.
When no measured data has been acquired by the instrument, perform measurement once. Doing so allows you to calculate the data obtained within the specified range.

3 **Choose calculation settings.**



* Settings vary depending on the calculation type.

(1) Select the calculation type.

Move the cursor to the number of the calculation type for which you want to choose settings. Select the calculation type.
(When **[List]** is selected, a list of calculation types appears. To clear the display, press the **TRIG.SET** key.)

Select **[Judge]** to judge the calculation results. (p. 243)

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OFF	No calculations are performed. (Default setting)	Area	Area enclosed by the zero-level line and the signal waveform
Average	Average value of the waveform data	X-Y Area	Area enclosed by the X-Y composite curve
RMS	RMS value of the waveform data	Time to Lev*	Time required from the trigger point to the time when the waveform data reached the specified level
P-P	Peak-to-peak value of the waveform data	Lev-time	Measures value when the specified time has elapsed from the trigger point
Maximum value	Maximum value of the waveform data		
Max-Time	Time required from the trigger point to the time of the maximum value	Pulse Width*	Pulse width of the waveform data
Minimum value	Minimum value of the waveform data	Duty Ratio*	Duty ratio of the waveform data
Min-Time	Time required from the trigger point to the time of the minimum value	Pulses*	Pulse count of the waveform data
Period*	Period of the signal waveform	Calculation	Four arithmetic operations of the numerical calculation results
Frequency*	Frequency of the signal waveform	Time Diff*	Time lag between Phenomena A and B.
Rise Time	Rise time of the waveform data	Phase Diff*	Time lag between Phenomena A and B represented as the phase difference.
Fall Time	Fall time of the waveform data	High Level	High-level value of the waveform data
Std Dev	Standard deviation of the waveform data	Low Level	Low-level value of the waveform data

*: The settings can also be configured for the logic channels.

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(2) Select the channel to be calculated.

Move the cursor to the channel column and select the channel to be calculated.
(The logic channels can also be selected for Time to Level, Pulse Width, Duty Cycle, and Pulse Count.)
The results of a waveform calculation (Z1 to Z16) can be selected as the target channel for a numerical calculation.

(3) Set the parameters.

Settings may not be necessary for some types of calculation.
When calculating time lag and phase difference, choose settings for both Channels A and B.
Move the cursor to the parameter column and set the parameter settings.
Refer to "Parameter table" (p. 241) and "8.1.3 Entering Alphanumeric Characters" (p. 163).

To print or save calculation results during measurement
Configuring the settings is required before the measurement.
Refer to "10.4 Saving the Numerical Calculation Results" (p. 246) and "10.5 Printing the Numerical Calculation Results" (p. 248).

To print or save the existing data
Press the PRINT key to print the data. Press the SAVE key to save the data.
Refer to "5.2.3 Saving Data Selectively (SAVE Key)" (p. 103) and "6.3 Manually Printing Data by Pressing the PRINT Key (Selection Print)" (p. 130).

(4) Set the statistical calculation.

Move the cursor to the **[Stat]** column.

First	Calculates the measurement data in the initial condition.
Average	Calculates the average value of the calculation results in the measured data.
Max	Finds the maximum value of the calculation results in the measured data.
Min	Finds the minimum value of the calculation results in the measured data.

(5) When you select Time difference calculation or Phase difference calculation, set the channels (Ch) and the parameters with respect to each A and B

4 Perform the calculations (To judge the calculation results, refer to (p. 243)).

To calculate the existing data
Select **[Exec]**.

To perform calculations automatically after measurement
Press the **START** key to start measurement.

To copy the calculation settings to another calculation
Use the **[Num Calc]** sheet.
Refer to "8.9 Copying Settings to Other Channels (Copy Function)" (p. 183).

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Parameter table

Calculation type	Parameter	Description of parameter
Period Frequency Pulse Width Pulses Duty Ratio* Time Diff Phase Diff * Level and Filter only	L (Level)	The calculation is performed based on the interval (time) when the waveform crossed the level specified here.
	F (Filter)	Only when the measured signal has crossed the level and has never crossed the level again within the specified filter width, the waveform is considered to have crossed the level. This is useful to exclude level crossing events caused by noise.
	S (Slope [↑, ↓])	The calculation is performed based on the interval (time) when the waveform crossed the specified level. Choose between using the time when the waveform crosses the level in the positive direction (↑) and using that in the negative direction (↓) to calculate the time.
Rise Time Fall Time	P (%)	Determines which portion of the waveform between the upper and lower limits is used for calculating the rise time (or fall time). The range is narrowed from the range between the upper and lower limit values by the percentage set here.
Time to Lev	L (Level)	Finds the time when the measured signal crossed the specified level.
	F (Filter)	Only when the measured signal has crossed the level and has never crossed the level again within the specified filter width, the waveform is considered to have crossed the level. This is useful to exclude level crossing events caused by noise.
	S (Slope [↑, ↓])	Choose between the time until the signal crosses the specified level in the positive and that in the negative direction.
Lev-time	Time or Measure (Calculation results)	Specifies the time for calculating the measurement value, using the trigger position as the zero position. To use the numerical calculation results, specify the numerical calculation number. Specifying range with Cursors A and B is not available.
Calculation	Numerical Calculation No.	Sets the numerical calculation number.
	+, -, ×, ÷	Sets operators for the four basic arithmetic operations.

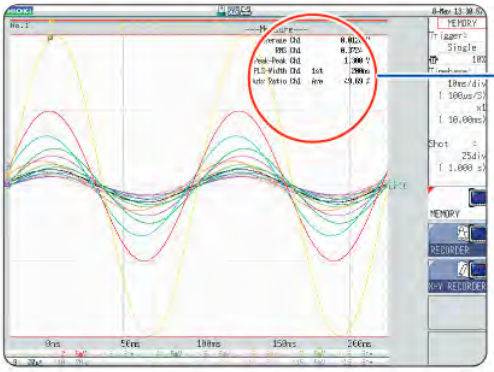
- Depending on signal waveforms, the period, frequency, rise time, and fall time may not be displayed.
- When the scaling is enabled, the waveform data is scaled before the numerical calculation is performed. The units for parameter values are those set in the scaling function.

For more information about the scaling, refer to "8.5 Converting Input Values (Scaling Function)" (p. 171)

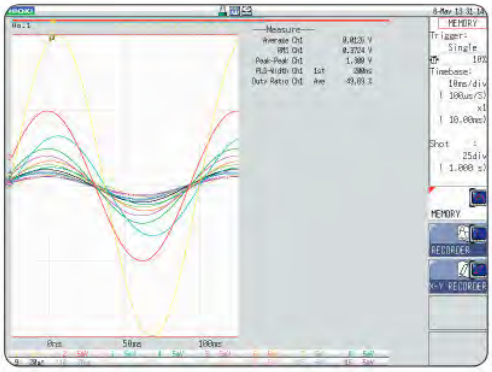
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10.2.1 Displaying the Numerical Calculation Results

Numerical calculation results are displayed on the waveform screen.



When the display is difficult to observe because the numerical values overlap the waveforms



Press the **DISP** key.
The numerical values and waveforms will be displayed separately from each other.
Refer to “7.7.3 Switching the Waveform Display Width” (p. 156).

To save the calculation results after the measurement

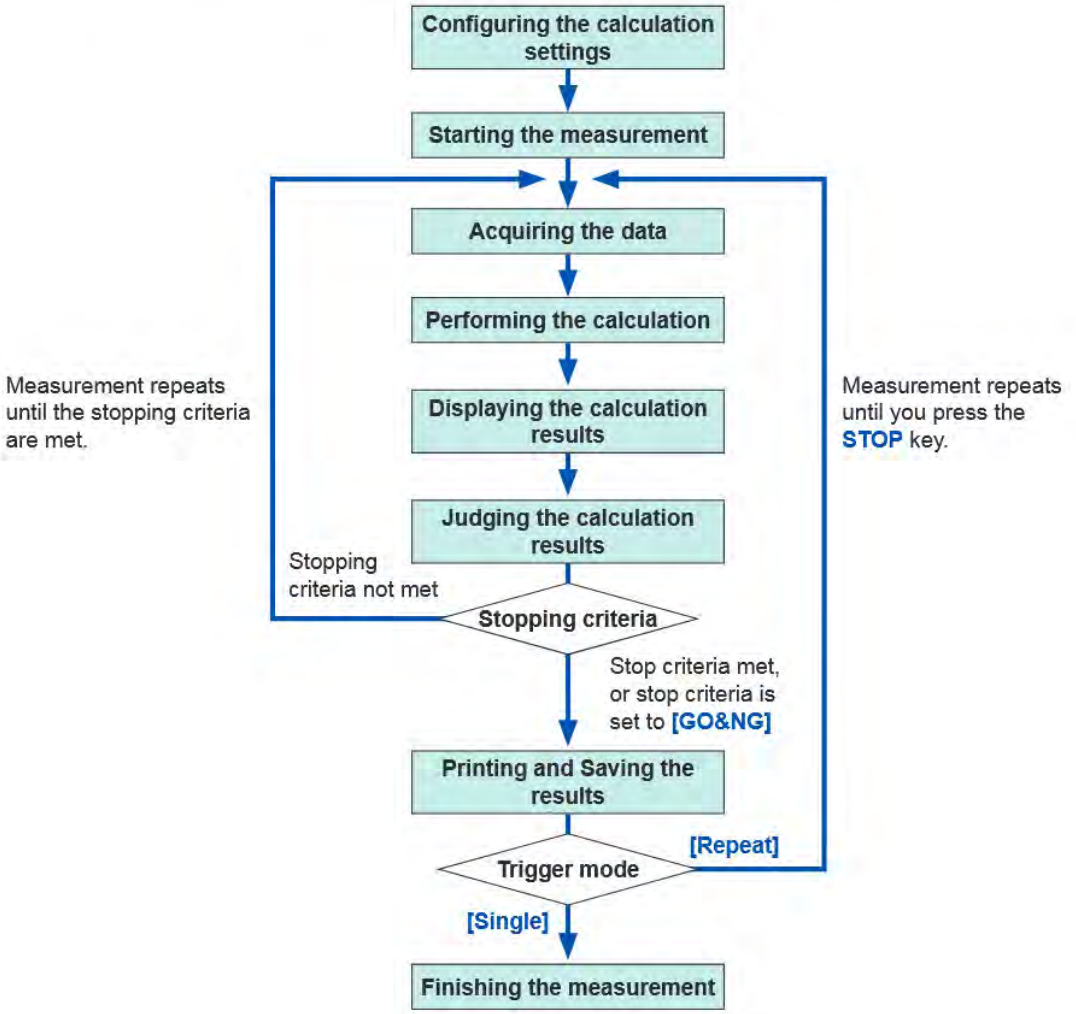
Pressing the **SAVE** key after measurement allows you to select the contents to be saved. (Select **[Calc Result]**.)
Refer to “5.2.3 Saving Data Selectively (SAVE Key)” (p. 103).

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10.3 Judging the Calculation Results

Set the judgment criteria (upper and lower threshold values) to judge the numerical calculation results. The judgment criteria can be set with respect to each of the numerical calculation.

The waveform acquisition processing varies depending on the trigger mode setting (Single or Repeat) and the criteria specified to stop measuring upon judgment ([GO], [NG], or [GO&NG]).



Automatic saving and automatic printing will not be carried out before the stopping criteria are met at the end of calculation evaluation.

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Procedure

To display the screen

Press the **STATUS** key to display the status screen, and then select the **[Num Calc]** sheet.

1 **Configure the calculation settings. (p. 238)**

2 **Enable the judgment function.**

Move the cursor to the **[Judge]** column of the row to be judged, and select **[On]**.

Off	Does not perform the judgment.
On	The fail judgment (NG) is given if the result exceeds the range. Any channel for which the fail judgment (NG) is given is shown in red.

3 **Specify the judgment thresholds.**

Move the cursor to the **[Lower]** and **[Upper]** columns in order.

Select an entry method and enter threshold values.

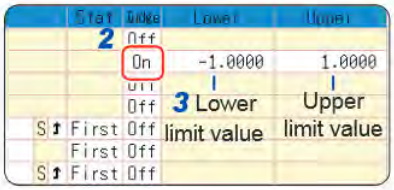
Valid range: −9.9999E+29 to +9.9999E+29

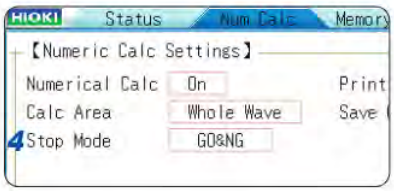
Refer to "8.1.3 Entering Alphanumeric Characters" (p. 163).

4 **Select the stop mode for the judgment.**

Move the cursor to the **[Stop Mode]** box.

GO	Performs the next process when the calculation result falls within the threshold range (Pass judgment).
NG	Performs the next process when the calculation result exceeds the threshold range (Fail judgment).
GO&NG	Performs the next process regardless of the judgment result.





Execute the calculation.

To judge the existing data

Select **[Exec]**.

To perform judgment automatically after the measurement

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

About upper and lower limit values

The upper limit value cannot be set to below the lower limit value, and vice-versa.

About performing the calculation

Processing varies depending on the trigger mode setting.

If calculating the data while acquiring waveforms, the instrument repeats measurements until the stopping criteria are met. (p. 243)

To record all of the calculation results

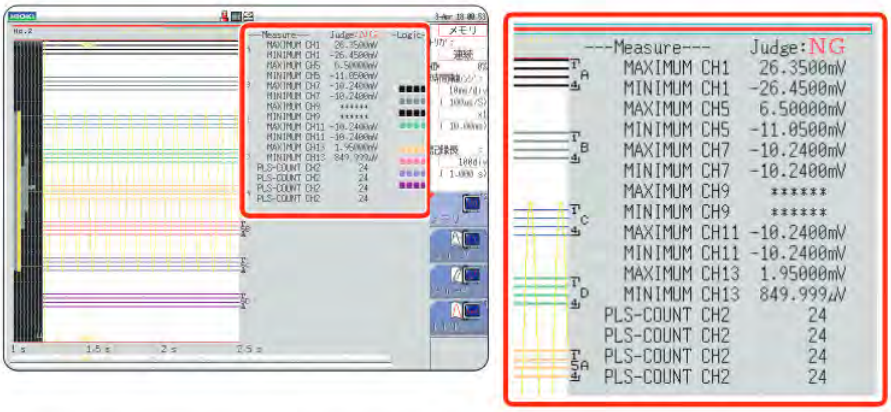
Set the Stop mode setting to **[GO&NG]**.

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10.3.1 Displaying the Judgment Results and Outputting the Signals

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

The result falling within the judgment threshold range: GO (pass) judgment
The result exceeding the judgment threshold range: NG (Fail) judgment (highlighted in red)



The judgment results for each parameter will also be printed.

When the GO (pass) judgment is given

- The Go signal is output through the (GO/EXT.OUT.1) terminal of the external I/O.

When the NG (fail) judgment is given

- The NG signal is output through the (NG/EXT.OUT.2) terminal of the external I/O. The NG (fail) judgment is given when any one of the channels is judged to be NG (fail).
- When the beeper is enabled, the instrument beeps when a result exceeds the threshold range.

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10.4 Saving the Numerical Calculation Results

The instrument can perform the calculation while acquiring the data and automatically save the results. Configuring the calculation settings is required before the measurement.

⚠CAUTION

When using the auto-save during measurement, do not remove the storage device specified as the save destination until the measurement operation is completely finished. Doing so may damage data on the storage device.

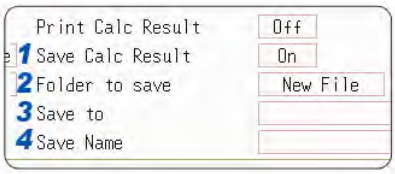
Procedure

To display the screen

Press the **STATUS** key to display the status screen, and then select the **[Num Calc]** sheet.

1 Enable the saving of numerical calculation results.

Move the cursor to the **[Save Calc Result]** box.
Select **[On]**. (Default setting: Off)



2 Select the file creation method.

Move the cursor to [Folder to save].

New File	Creates a new file for each measurement.
Existing File	Appends the calculation results to a single file.

3 Set the save destination.

Move the cursor to the **[Save to]** box.
Select **[Edit]**.
The folder browsing dialog box appears.
(Refer to the right figure.)



Move the cursor to the save target media.
Select **[Confirm]** to confirm the selection.

To create a new folder to be used as the save target, select **[New Folder]**. When the save destination is set to **[LAN]**, the setting **[New Folder]** is ignored, and a folder named with the current date is created.

HDD	Automatically saves the waveform data on the built-in drive. (When Model U8331 SSD Unit is installed)
CF	Automatically saves the waveform data on a CF card.
USB	Automatically saves the waveform data on a USB flash drive.
LAN	Automatically saves the waveform data on the computer connected via LAN. Model 9333 LAN Communicator is required.

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4 **Enter a file name.**

(when you want to use a different name)

Move the cursor to the **[Save Name]** box.
Enter a file name. (Default setting: MEAS)
Refer to "8.1 Adding Comments" (p. 160).
When **[LAN]** is set as the save destination, the name entered in the **[Save Name]** box is ignored and the file is named in the previously-determined format.
Refer to "Save operations (When the save destination is set to [LAN])" (p. 102).

Save Name
- The number of characters in the **[Save Name]** box is limited to 123. The number of characters of a path including a file name is limited to 255.
- A sequential number starting from 0001 is automatically appended to the save name. (When **[New File]** is selected)

5 **Confirm the measurement configuration and numerical calculation result settings, then start measurement.**

(Press the START key.)

After the data is acquired and the numerical calculation process is complete, the numerical calculation results (text) are automatically saved to the specified storage media.

Example of saving numerical calculation results

Saving the numerical calculation results converts characters or display items used on the instrument as shown below.

Characters used on the instrument	Saved characters
^{2}	^2
^{3}	^3
μ	~u
Ω	~o
ε	~e
°	~c
±	~+

<When calculation settings are as follows>
Calculation No. 1: Maximum value of analog channel 1
Calculation No. 2: Minimum value of analog channel 1
Calculation No. 3: Maximum value of analog channel 2
Calculation No. 4: Minimum value of analog channel 2

```
"Trig Time" ,"No1 Maximum Ch1" ,"No2 Minimum Ch1" ,"No3 Maximum Ch2" ,"No4 Minimum Ch2"   ← Line 1: Calculation Settings
"","V","V","V","V"                                                                        ← Line 2: Calculation Result Units
"15-12-22 17:40:33.351","+3.00078E-05","+2.12000E-04","+2.00000E-03","+1.30000E-03"       ← From Line 3: Calculation Results
"15-12-22 17:44:25.976","+3.06078E-05","+2.39996E-04","+2.00000E-03","+1.10000E-03"
```

Results are recorded in the order of the calculation settings of line 1.

If trigger time is not properly displayed when you open a file with Excel, follow the procedure described below.
(1) On the **[Format Cells]** dialog box, in the **[Format]** list, select **[Custom]**.
(2) In the **[Type]** box, enter "yy-mm-dd hh:mm:ss.000".

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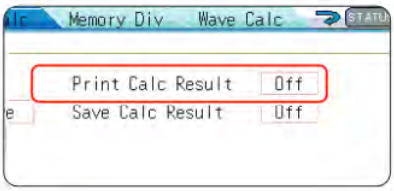
10.5 Printing the Numerical Calculation Results MEM

You can print the results of calculations.
When the auto-print is enabled, the instrument prints the result data after printing the waveforms.

Procedure

To display the screen
Press the **STATUS** key to display the status screen, and then select the **[Num Calc]** sheet.

Move the cursor to the [Print Calc Result] box, and select [On].

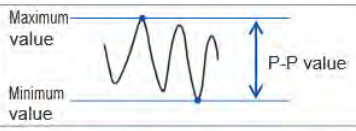
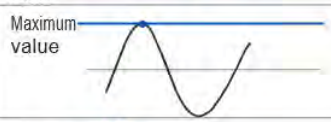
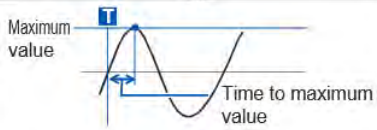
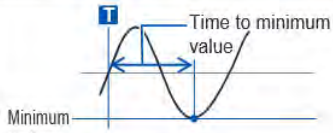
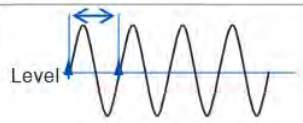


- The printing will also be carried out when the only calculation is performed without performing the measurement.
- The calculation results are output to the output destination specified for automatic printing.

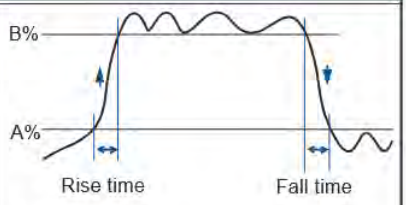
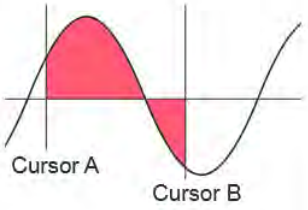
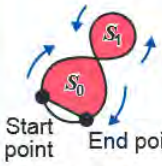
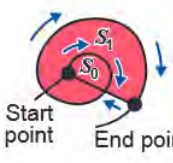
Refer to “6.2 Setting Auto-printing” (p. 127).

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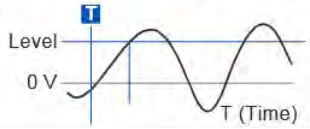
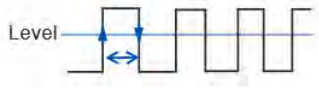
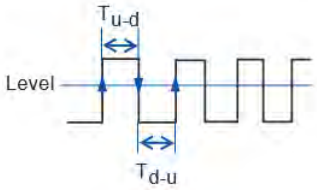
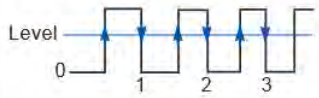
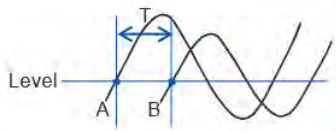
10.6 Numerical Calculation Types and Descriptions

Numerical calculation type	Description	
Average	Calculates the average value of the waveform data. $AVE = \frac{1}{n}\sum_{i=1}^{n} di$ AVE: Average n: Number of pieces of data di: i-th piece of data acquired through the channel	
Root-Mean-Square value (RMS)	Calculates the RMS value of the waveform data. If the scaling is enabled, calculations are performed after scaling the waveform. $RMS = \sqrt{\frac{1}{n}\sum_{i=1}^{n} di^2}$ RMS: RMS value n: Number of pieces of data di: i-th piece of data acquired through the channel	
Peak-to-Peak value (Peak-Peak)	Calculates the value of the difference (peak-to-peak value) between the maximum and minimum values of the waveform data.	
Maximum Value (Maximum)	Finds the maximum value of the waveform data.	
Time to Maximum Value (Max-Time)	Calculates the time required from the last trigger point to the maximum value (unit: s). When there are two or more points of the maximum value, the first point of the waveform to be calculated is used as the maximum value.	
Minimum Value (Minimum)	Finds the minimum value of the waveform data.	
Time to Minimum Value (Min-Time)	Calculates the time required from the trigger point to the minimum value (unit: s). When there are two or more points of the minimum value, the first point of the waveform to be calculated is used as the minimum value.	
Period/Frequency	Displays the waveform's period (unit: s) and frequency (unit: Hz). Calculates the period and frequency based on the time lag between when the waveform crossed the specified level in the positive (or negative) direction first time and when it crossed the level in the positive (or negative) direction next time.	

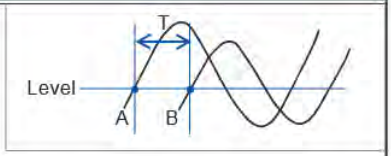
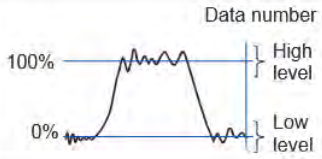
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Numerical calculation type	Description
Rise Time **Fall Time**	Calculates the A%-to-B% rise time (or the B%-to-A% fall time) based on the 0% and 100% levels of the acquired waveform calculated using the histogram (frequency distribution). Calculates the rise time (or fall time) of the first rising (or falling) edge in the acquired waveform data. When the range is specified with Cursors A and B, calculates the rise time (or fall time) of the first rising (or falling) edge appearing between the cursors. The value A can be specified in terms of percent. The value B is automatically determined based on the value A. When the value A is 5%, the value B is set to 95%; when the value A is 70%, the value is set to 30%.  A: 5% to 30% B: 95% to 70%
Standard Deviation (Std Dev)	Calculates the standard deviation of the waveform data. $\sigma = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(di - AVE)^2}$ σ: Standard Deviation AVE: Average n: Number of pieces of data di: i-th piece of data acquired through the channel
Area	Calculates the area value (V•s) enclosed by the zero-level (zero-potential) line and the signal waveform. When the range is specified with Cursors A and B, calculates the area enclosed by the zero-level line, waveform, Cursor A, and Cursor B. $S = \sum_{i=1}^{n} \lvert di \rvert \bullet h$ S: Area n: Number of pieces of data di: i-th piece of data acquired through the channel h=Δt: Sampling rate 
X-Y Area	Calculates the area (V^2) of the figure enclosed by the X-Y composite curve. Calculates the areas of the enclosed by the lines as illustrated below. The calculation can be performed even when the X-Y composite curve is not displayed. You can specify the range with Cursors A and B (voltage axis or trace) on the time-domain plot of each channel, and then calculate the area enclosed by the X-Y composite curve plotted using the waveform appearing in the range. (You cannot specify the range on the X-Y composite curve directly with Cursors A and B.) For details about Cursor A and B, Refer to "7.1 Reading Measured Values (Using Cursors A and B)" (p. 140). **When multiple loops are plotted**  $S = n \times S_0$ S: Area n: Number of loops **When an open curve is plotted**  $S = S_0$ S: Area (Closed area is created by connecting the start and end points with a straight line) **When a figure of eight is plotted**  $S = \lvert S_0 - S_1 \rvert$ S: Area **When a spiral loop is plotted**  $S = S_0 \times 2 + S_1$ S: Area (The number of overlapping segments increases with a loop count) Set contents: Assign the channels to X- and Y-axis.

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Numerical calculation type	Description	
Time to Level (Time-Lev)	Calculates the time required from the trigger point to the time when the signal crosses the specified level first time within the calculation range.	
Specified Time Level (Lev-Time)	Finds the level when the specified time has elapsed from the trigger point. The time can also be specified for the previously calculated results.	
Pulse Width	Calculates the pulse width based on the time lag between when the waveform crossed the specified level in the positive (or negative) direction and when it crossed the level in the negative (or positive) direction.	
Duty Ratio (%)	Calculates the duty ratio based on two of the time lags: one between when the waveform crossed the specified level in the positive direction and when it crossed the level in the negative direction next time and the other between when it crossed the level in the negative direction and when it crossed the level in the negative direction. Duty ratio (%) = $\frac{Tu\text{-}d}{Tu\text{-}d + Td\text{-}u}$ X *100(%)* $T_{u\text{-}d}$: The time lag between when the waveform crossed the level in the positive direction and when it crossed the level in the negative direction (unit: s). $T_{d\text{-}u}$: The time lag between when the waveform crossed the level in the negative direction and when it crossed the level in the positive direction (unit: s).	
Pulses	Counts the number of the pulses that crossed the specified level in the positive (or negative) direction. When the signal crossed the specified level in the positive (or negative) direction and then it crossed the level in the negative (or positive) direction, the pulse is determined to have crossed the level once.	
Four Arithmetic Operations (Calculation)	Performs arithmetic operations (+, − , ×, ÷) using the numerical calculations results freely selected.	
Time difference calculation (Time Diff)	Calculates T[s], the time difference that passes between rising above or dropping below the level specified for A and B waveforms. Time lag T = (Time when Waveform B crosses the level) − (Time when Waveform A crosses the level).	

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Numerical calculation type	Description
Phase difference calculation (Phase Diff)	Calculates the time lag between each of Waveforms A and B crosses the specified level in the positive (or negative) direction, calculating the phase difference (unit: degree [°]) with reference to Waveform A.  $\text{Phase contrast} = \frac{\text{Time difference of A and B waveform [T]}}{\text{Cycle of A waveform}} \times 360\ [°]$
High Level Low Level	After obtaining the histogram (frequency distribution) with 0% and 100% levels of the acquired waveform data as the Low and the High levels, respectively, calculates the Low and High levels using the histogram. 

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11 Waveform Calculation Function

MEM

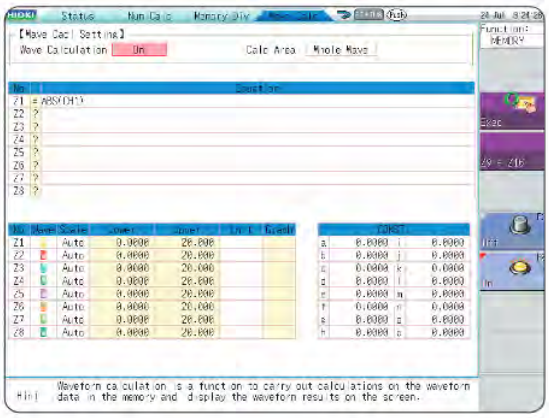
Waveform calculations can only be used with the Memory function.
A pre-specified calculation equation is applied to acquired waveform data and the calculated results are displayed as a waveform on the Waveform screen.
Waveform calculation settings are made in the **[Wave Calc]** sheet.

To Open the [Wave Calc] Sheet



Press this key repeatedly display the various sheets.





Operations Available From the [Wave Calc] Sheet

Waveform Calculations

- Four Arithmetic Operators (+, −, ×, /)
- Absolute Value (ABS)
- Exponent (EXP)
- Common Logarithm (LOG)
- Square Root (SQR)
- Moving Average (MOV)
- Parallel displacement along the time axis
- Differential Calculus: 1st derivative (DIF), 2nd derivative (DIF2)
- Integral Calculus: 1st integral (INT), 2nd integral (INT2)
- Trigonometric functions (SIN, COS TAN)
- Inverse Trigonometric functions (ASIN, ACOS ATAN)
- MR8990 Digital Voltmeter Unit PLC delay shift (PLCS)

(12 types in total)

- Specified calculation between AB cursors
  Waveform calculations can be limited to data within the range specified by AB cursors.

Calculation operator details:
"11.3 Waveform Calculation Operators and Results" (p. 264)

In addition to the four arithmetic operators, 11 types of functions can be used. It is possible to set up to 16 calculation formulas.
When Scaling is enabled, numerical calculations are performed on scaled values.

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11.1 Waveform Calculation Workflow

There are two different ways of performing calculation.

- **Calculate While Measurement:** Settings for waveform calculation must be chosen before starting measurement.
- **Apply Calculations to Existing Data:** Calculation can be performed on waveform data after measurement is completed, and for data saved on storage media.

Calculate While Measuring

Choose Calculation Settings

Choose calculation settings in the [Wave Calc] sheet. (p. 256)

To automatically print or save calculation results, choose printing and saving settings before starting measurement.
- Save calculation results automatically (p. 96)
- Print calculation results automatically (p. 127)

↓

Start Measurement

↓

Acquire Data

The instrument acquires data when the trigger criteria are met.
(If triggering is not enabled, the instrument acquires data when you press the **START** key.)

↓

Calculate

[Calculating...] appears on the screen.
Calculations are performed sequentially from No. 1 to No. 16.
(To interrupt calculation, press the **STOP** key to abort.)

↓

Display Calculation Results

Results will be displayed on the Waveform screen. (p. 258)

↓

(Print or Save)

(If auto-print or auto-save are set to [On].)
Calculation results are automatically printed or saved.

↓

Stop Measurement

- Waveform calculation is not available when using Roll Mode or Memory Division.
- If waveform calculation is performed during measurement and you force the instrument to stop during calculation, the result of calculations already performed when calculation is canceled will be displayed. To re-calculate, select the **[Exec]** button in the **[Wave Calc]** sheet.

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Apply Calculations to Existing Data

After measurement with calculation OFF (Or after loading data)

(To load measurement data from storage media for calculation) (p. 110)

↓

Choose Calculation Settings

Choose calculation settings on the [Wave Calc] sheet. (p. 256)

↓

Execute Calculation

Select [Exec] to execute calculations.
(To interrupt calculation, press the **STOP** key.)

↓

Display Calculation Results

Results will be displayed on the Waveform screen. (p. 258)

↓

(Print or Save)

Print or save calculation results as needed.
- Print: **PRINT** key
- Save: **SAVE** key

- The maximum recording length that can be calculated is given below.
  Model MR8847-51: 10,000 div (if using the U8975, U8977, or U8978: 5,000 div)
  Model MR8847-52: 40,000 div (if using the U8975, U8977, or U8978: 20,000 div)
  Model MR8847-53: 80,000 div (if using the U8975, U8977, or U8978: 40,000 div)
- To perform calculation on waveforms that are longer than the maximum recording length, save the files in sections with ranges shorter than the maximum recording length, then reload the files into the instrument, and perform the calculation.
- Up to 16 previously measured waveforms can be referenced when memory division is **[OFF]**. If waveform calculations have been conducted for these waveforms, waveform data will be deleted except for the currently referenced block (the block that includes calculation data).

To specify a waveform range for calculation

Before executing a calculation, specify the calculation range using the AB cursors (div or Trace cursors) on the Waveform screen. Set the calculation range on the **[Wave Calc]** sheet to **[A-B Cursor]**.
- Range cursors cannot be used to specify the range.
- When one cursor is used, the calculation range is from the cursor to the end of the data.

Post-measurement waveform calculation cannot be performed for waveforms measured in excess of the maximum recording length, even if a range is specified with the A and B cursors. To perform calculation on waveforms measured at long recording lengths, save the files in sections with ranges shorter than the maximum recording length, reload to the instrument then calculate.

Refer to "7.2 Specifying the Waveform Range (Cursors A and B)" (p. 145) and "11.2 Waveform Calculation Settings" (p. 256).

To change calculation settings and recalculate

Make changes to calculation contents on the **[Wave Calc]** sheet, and execute the calculation.
Refer to "11.2 Waveform Calculation Settings" (p. 256).

When calculation waveform is not displayed or when you want to display only a desired waveform

The displayed sheet and calculated waveform to be displayed can be selected on the **[Wave Calc]** sheet.
Refer to "11.2.3 Change the Display Method for Calculated Waveforms" (p. 261).

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11.2 Waveform Calculation Settings

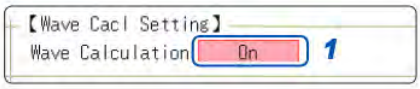
Procedure

To display the screen

Press the **STATUS** key to open the Status screen, and then select the **[Wave Calc]** sheet.

1 **Enable the Waveform Calculation function.**

Move the cursor to **[Wave Calculation]**, and select **[On]**.



2 **Specify the waveform calculation range.**

Move the cursor to **[Calc Area]**.

Whole Wave	Applies calculations to the whole waveform. (Default setting)
A-B Wave	Applies calculations to the data between AB cursors.

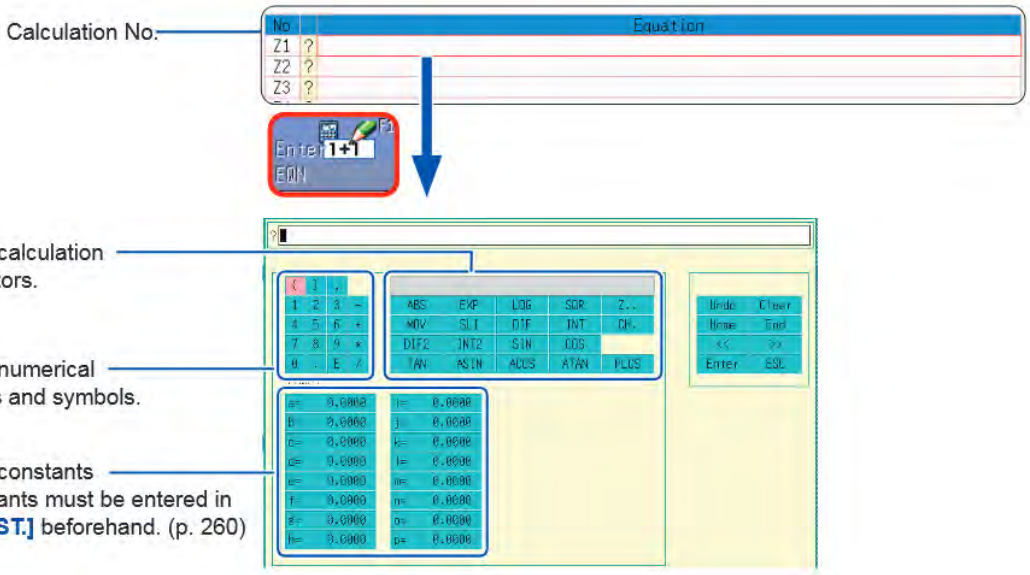
Refer to "7.2 Specifying the Waveform Range (Cursors A and B)" (p. 145).



When selecting **[A-B Wave]**, specify the calculation range using the AB cursors on the Waveform screen. If no measurement data has been acquired by the instrument, first measure once so that the range can be specified for calculations to be applied to subsequent measurements. The calculation result will be 0 for the part outside of the range of the AB cursor.

3 **Set a calculation equation.**

Move the cursor to the **[Equation]** column of the calculation to be set and select **[Enter EQN]**.
A dialog is displayed for entering a calculation equation.



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4 **Set a calculation equation.**

Refer to Waveform Equation Example: (p. 262).

5 **Select [Confirm] when entry is finished.**

The entered equation is displayed in the **[Equation]** column.
The scale (maximum and minimum values) of the calculation results has a default setting of **[Auto].** If you want to change the scale, set the maximum and minimum values under **[Manual].**
Refer to "Change the Display Method for Calculated Waveforms" (p. 261).

If "=" is displayed
The entered calculation equation is syntactically correct.
If "?" is displayed
The equation has a syntax error.
The cursor is placed at the location of the error to facilitate correction.
- Are parentheses correctly matched?
- Has a multiplication operator "*" been omitted?

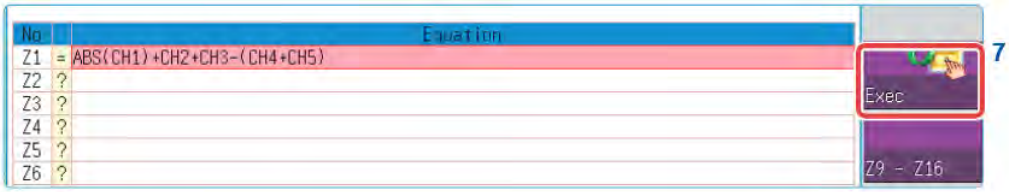
6 **(As needed)**

Set auto-save (p. 96) and auto-print (p. 127).

7 **Execute the calculation.**

Apply Calculations to Existing Data

In the **[Wave Calc]** sheet, select **[Exec]**.



To calculate while measuring

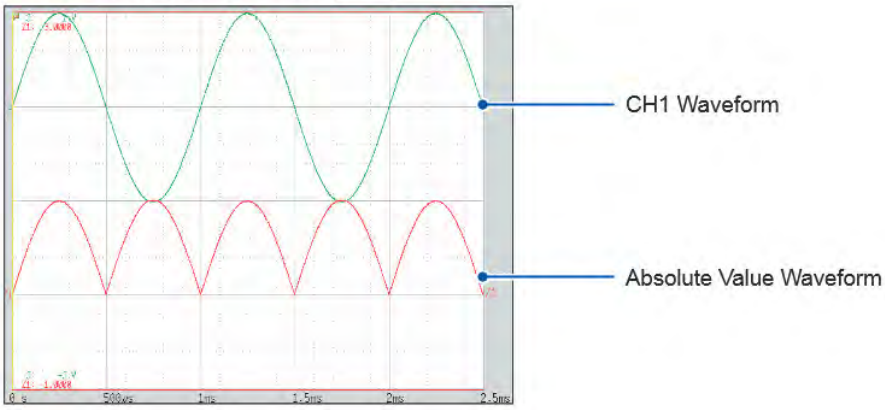
Press the **START** key to start measurement.
Calculation waveforms are displayed after loading waveforms.

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11.2.1 Displaying the Waveform Calculation Results

The results of waveform calculation are displayed on the Waveform screen.

Example: Calculate the absolute value of the waveform of CH1.
Calculation equation = ABS(CH1)



To copy settings from one calculation to another

Settings can be copied in the **[Wave Calc]** sheet.
Refer to “8.9 Copying Settings to Other Channels (Copy Function)” (p. 183).

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About Calculation Equations

Operators

Operators	Name	Operators	Name
ABS	Absolute Value	DIF2	2nd Derivative
EXP	SCI	INT2	2nd Integral
LOG	Common Logarithm	SIN	Sine
SQR	Square Root	COS	Cosine
MOV	Moving Average	TAN	Tangent
SLI	Parallel displacement along the time axis	ASIN	Inverse Sine
DIF	1st Derivative	ACOS	Inverse Cosine
INT	1st Integral	ATAN	Inverse Tangent
		PLCS	PLC delay shift

Refer to "11.3 Waveform Calculation Operators and Results" (p. 264).

To Enter Calculation Equations

- Each calculation equation may contain up to 80 characters.
- Each constant in a calculation equation may contain up to 30 digits.
- For multiplication, use [*]. For division, use [/].
- Entering a long, complex formula such as that shown below will cause **[?]** to be displayed. Separate the formula into two shorter formulas.

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

- If a formula tries to divide by 0, an overflow value will be output.
  (For positive values, +9.9999E+29. For negative values, −9.9999E+29.)
- The result of calculation Z_i can be used in other calculation equations. However, the Z_nth equation can only refer to the results of equations up to Z_{n-1}.
  (Example: Equation Z_4 can include the results of equations Z_1 through Z_3.)

Using the MOV, SLI, DIF and DIF2 operators in an equation (The second parameter)

Set a number after the comma within the parenthesis (_,#) for each of these calculation operators.

Operators	Settings	Setting Examples
MOV (Moving Average) **SLI** (Horizontal Movement)	**Set the number of moving points to average over.** Setting Range MOV (Moving Average): 1 to 5000 SLI: −5000 to 5000	Calculate the 10-point moving average of CH1: MOV(CH1,10)
DIF (Derivative) **DIF2** (2nd Derivative)	**Specify the sampling interval over which to calculate the derivative.** "1" is normally acceptable, but this should be set larger to capture fluctuation values of slowly changing waveforms. DIF and DIF2 Setting Range: 1 to 5000	Calculate the derivative of CH2 using a 20-point sampling interval: DIF(CH2, 20)

When calculation results overflow (OVER)

- The value at the AB cursor is not a correct value.
- When **[Scale]** is set to **[Auto]**, waveforms appear at the top or bottom edge of the screen. This makes calculation result overflow obvious.

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11.2.2 Setting Constants

Procedure

To display the screen

Press the **STATUS** key to open the Status screen, and then select the **[Wave Calc]** sheet.

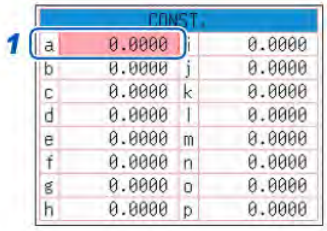
1 **Move the cursor to the No. that you want to set in the [CONST.] section.**

2 **Select an entry method, and enter the constant.**

Setting Range: −9.9999E+29 to +9.9999E+29

Refer to “8.1.3 Entering Alphanumeric Characters” (p. 163).

Defined constants are shown in the constant display of the calculation equation setting dialog.



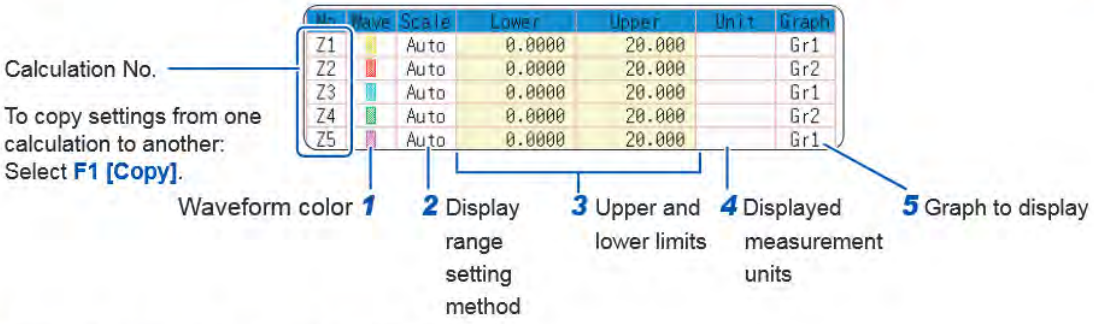
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11.2.3 Change the Display Method for Calculated Waveforms

Procedure

To display the screen

Press the **STATUS** key to open the Status screen, and then select the **[Wave Calc]** sheet.



1 Enable waveform display and display color.

Move the cursor to the **[Wave]** column.

ON-OFF	Selects show (ON [default setting]) or hide (OFF) for the waveform in the flash cursor column.
↑↓	Selects the waveform color.
ALL ON-OFF	Selects On to display all waveforms. Select Off to hide all waveforms.

2 Select a method to set scaling.

Move the cursor to the **[Scale]** column of the Calculation No. you want to set.

Depending on calculation results, automatic scaling settings may be unsatisfactory, in which case the limits must be entered manually.

Auto	Automatically sets the display range of the vertical axis. (After calculation, the upper and lower limits are obtained from the results, and set automatically.)
Manual	Upper and lower limits of the vertical axis display range are entered manually.

3 Set the upper and lower limits of the display range. (When [Manual] is selected)

Select **[Lower]** and **[Upper]**.
Select an entry method and enter the limit values.
Entry range: −9.9999E+29 to +9.9999E+29
Refer to “8.1.3 Entering Alphanumeric Characters” (p. 163).

4 Specify the physical units.

Move the cursor to the **[Unit]** column.
Select an entry method and enter the physical units.
Refer to “8.1.3 Entering Alphanumeric Characters” (p. 163).

5 Select the graph to be displayed.

(When the split screen [Format] item on the [Status] sheet is **[Dual]** or higher)
Move the cursor to the **[Graph]** column and select the graph number.

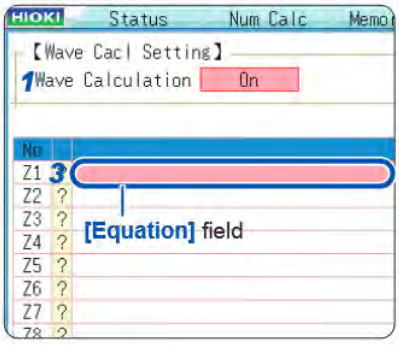
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Waveform Calculation Example: Calculate the RMS Waveform from the Instantaneous Waveform

This example shows how the RMS values of the waveform input on Channel 1 can be calculated and displayed.
The process below shows calculation on waveform data measured for one cycle over two divisions.

1 **Enable the Waveform Calculation function.**

Move the cursor to **[Wave Calculation]**, and select **[On]**.



2 **Specify the waveform calculation range.**

Move the cursor to the items in [Calc Area], and select **[Whole Wave]**.

3 **Set a calculation equation.**

Move the cursor to the **[Equation]** column of No. Z1 and then select **[Enter EQN]**.
A dialog is displayed for entering a calculation equation.

Characters are entered before the black cursor. Errors are indicated by red cursors.

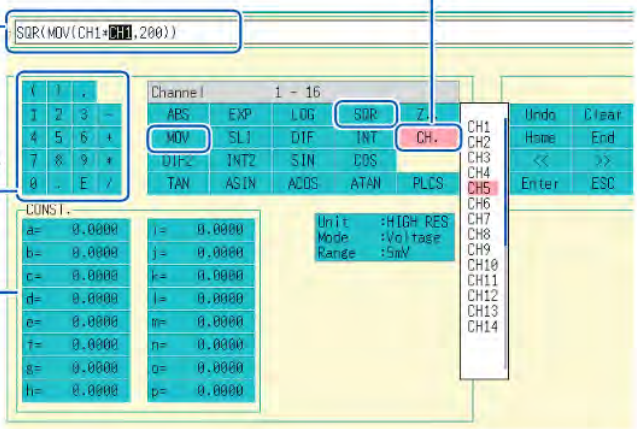
After selecting the channel number, select **[Enter Char]**.

Enter the calculation equation
SQR(MOV(CH1*CH1,200))

The number of samples per cycle (1 division = 100 samples).
Here, one cycle is two divisions (200 samples).

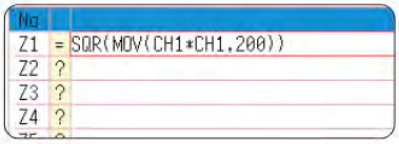
Enter numerical values and symbols.

It is convenient to set the constants beforehand on the **[CONST.]** section. (p. 260)



4 **Select [Confirm] when entry is finished.**

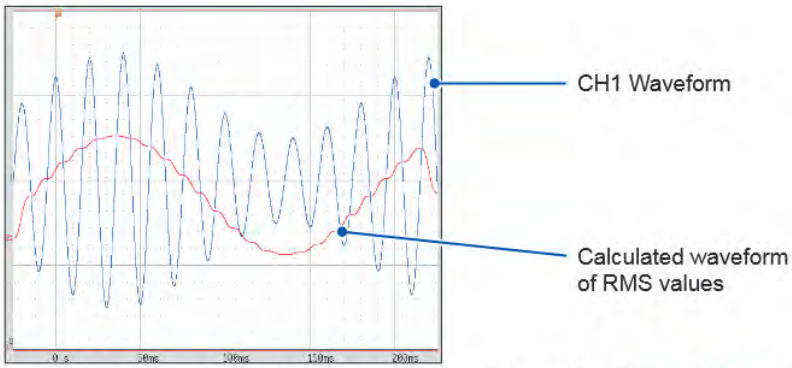
The entered equation is displayed in the [Equation] column.



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5 **Execute the calculation.**

Press the **START** key to start measurement.
The calculation waveform is displayed after acquiring the input waveform.



To view the calculated waveforms of loaded data, navigate to the **[Wave Calc]** sheet and select **[Exec]**.

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11.3 Waveform Calculation Operators and Results

b_i: i-th data of the calculation result, d_i: i-th data of the source channel

Waveform calculation type	Description
Four Arithmetic Operators (+, −, *, /)	Executes the corresponding arithmetic operation.
Absolute Value (ABS)	$b_i = \lvert d_i \rvert$ (i = 1, 2, ... n)
Exponent (EXP)	$b_i = \exp(d_i)$ (i = 1, 2, ... n)
Common Logarithm (LOG)	*When* $d_i > 0$ $b_i = \log_{10} d_i$ *When* $d_i = 0$ $b_i = -\infty$ (overflow value output) *When* $d_i < 0$ $b_i = \log_{10} \lvert d_i \rvert$ (i = 1, 2, ...n) Note: Use the following equation to convert to natural logarithm calculations. $LnX = \log_e X = \log_{10} X / \log_{10} e$ $1 / \log_{10} e$ 2.30
Square Root (SQR)	$d_i \geqq 0$ のとき $b_i = \sqrt{d_i}$ $d_i < 0$ のとき $b_i = -\sqrt{\lvert d_i \rvert}$ $(i = 1,2,\cdots n)$
Moving Average (MOV)	*When k* is an odd number $bi = \frac{1}{k}\sum_{t=i-\frac{k}{2}}^{i+\frac{k}{2}} (i=1,2,...n)$ *When k* is an even number $bi = \frac{1}{k}\sum_{t=i-\frac{k}{2}+1}^{i+\frac{k}{2}} (i=1,2,...n)$ *dt*: t-th data of the source channel *k*: number of points to move (1 to 5000) 1 div = 100 points. *k* is specified after a comma. (Ex.) To make Z1 the moving average of 100 points: MOV(Z1,100) For k/2 data at the beginning and end of the calculation section, the places that lack data are filled with 0s before calculation.
Parallel displacement along the time axis (SLI)	Moves waveforms along the time axis by the specified distance. $b_i = d_{i-k}$ (i = 1, 2, ... n) *k*: number of points to move (−5000 to 5000) *k* is specified after a comma. (Ex.) To slide Z1 by 100 points along the time axis: SLI(Z1,100) Note: When sliding a waveform, if there is no data at the beginning or end of the calculation result, the voltage value becomes zero. 1 div = 100 points.
Sine (SIN)	$b_i = \sin(d_i)$ (i = 1, 2, ... n) Trigonometric and inverse trigonometric functions employ radian (rad) units.
Cosine (COS)	$b_i = \cos(d_i)$ (i = 1, 2, ... n) Trigonometric and inverse trigonometric functions employ radian (rad) units.
Tangent (TAN)	$b_i = \tan(d_i)$ (i = 1, 2, ... n) Where $-10 \leq b_i \leq 10$ Trigonometric and inverse trigonometric functions employ radian (rad) units.
Arcsine (ASIN)	*When* $d_i > 1$ $b_i = \pi / 2$ When $-1 \leq d_i \leq 1$ $b_i = \text{asin}(d_i)$ *When* $d_i < 1$ $b_i = -\pi / 2$ Trigonometric and inverse trigonometric functions employ radian (rad) units.
Arccosine (ACOS)	*When* $d_i > 1$ $b_i = 0$ When $-1 \leq d_i \leq 1$ $b_i = \text{acos}(d_i)$ *When* $d_i < -1$ $b_i = \pi$ (i = 1, 2, ... n) Trigonometric and inverse trigonometric functions employ radian (rad) units.

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b_i: i-th data of the calculation result, d_i: i-th data of the source channel

Waveform calculation type	Description
Arctangent (ATAN)	$b_i = \text{atan}(d_i)$ (i = 1, 2, ... n) Trigonometric and inverse trigonometric functions employ radian (rad) units.
First derivative (DIF) **Second derivative (DIF2)**	The first and second derivative calculations use a fifth-order Lagrange interpolation polynomial to obtain a point data value from five sequential points. d_1 to d_n are the derivatives calculated for sample times t_1 to t_n. Note: Scattering of calculation results increases when a slowly changing waveform is differentiated. If scattering is excessive, try to increase the value of the second parameter of the function. Refer to "Using the MOV, SLI, DIF and DIF2 operators in an equation (The second parameter)" (p. 259). The following equations are the cases where the value of the second parameter is 1. **Formulas for the first derivative** Point t_1 $b_1 = (-25d_1 + 48d_2 - 36d_3 + 16d_4 - 3d_5) / 12h$ Point t_2 $b_2 = (-3d_1 - 10d_2 + 18d_3 - 6d_4 + d_5) / 12h$ Point t_3 $b_3 = (d_1 - 8d_2 + 8d_4 - d_5) / 12h$ ↓ Point t_i $b_i = (d_{i-2} - 8d_{i-1} + 8d_{i-1} - d_{i+2}) / 12h$ ↓ Point t_{n-2} $b_{n-2} = (d_{n-4} - 8d_{n-3} + 8d_{n-1} - dn) / 12h$ Point t_{n-1} $b_{n-1} = (-d_{n-4} + 6d_{n-3} - 18d_{n-2} + 10d_{n-1} + 3d_n) / 12h$ Point t_n $b_n = (3d_{n-4} - 16d_{n-3} + 36d_{n-2} - 48d_{n-1} + 25d_n) / 12h$ b_1 to b_n: calculation results $h = \Delta t$: Sampling period **Formulas for the second derivative** Point t_1 $b_1 = (35d_1 - 104d_2 + 114d_3 - 56d_4 + 11d_5) / 12h^2$ Point t_2 $b_2 = (11d_1 - 20d_2 + 6d_3 + 4d_4 - d_5) / 12h^2$ Point t_3 $b_3 = (-d_1 + 16d_2 - 30d_3 + 16d_4 - d_5) / 12h_2$ ↓ Point t_i $b_i = (-d_{i-2} + 16d_{i-1} - 30d_i + 16d_{i+1} - d_{i+2}) / 12h^2$ ↓ Point t_{n-2} $b_{n-2} = (-d_{n-4} + 16d_{n-3} - 30d_{n-2} + 16d_{n-1} - d_n) / 12h^2$ Point t_{n-1} $b_{n-1} = (-d_{n-4} + 4d_{n-3} + 6d_{n-2} - 20d_{n-1} + 11d_n) / 12h^2$ Point tn $bn = (11 - d_{n-4} - 56d_{n-3} + 114d_{n-2} - 104d_{n-1} + 35d_n) / 12h^2$

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b_i: i-th data of the calculation result, d_i: i-th data of the source channel

Waveform calculation type	Description
First integral (INT) **Second integral (INT2)**	First and second integrals are calculated using the trapezoidal rule. d_1 to d_n are the integrals calculated for sample times t_1 to t_n. **Formulas for the first integral** Point t_1 $I_1 = 0$ Point t_2 $I_2 = (d_1 + d_2)\, h / 2$ Point t_3 $I_3 = (d_1 + d_2)\, h / 2 + (d_2 + d_3)\, h / 2 = I_2 + (d_2 + d_3)\, h / 2$ ↓ Point t_n $I_n = I_{n-1} + (d_{n-1} + d_n)\, h / 2$ I_1 to I_n: calculation results $h = \Delta t$: Sampling period **Formulas for the second integral** Point t_1 $II_1 = 0$ Point t_2 $II_2 = (I_1 + I_2)\, h / 2$ Point t_3 $II_3 = (I_1 + I_2)\, h / 2 + (I_2 + I_3)\, h / 2 = II_2 + (I_2 + I_3)\, h / 2$ ↓ Point t_n $II_n = II_{n-1} + (I_{n-1} + I_n)\, h / 2$ II_1 to II_n: calculation results Note: Integration is greatly affected by subtle deviation in the zero position. Be sure to perform zero adjustment before measurement. In some cases, you may need to correct zero point deviation further. Example: To shift the zero position by 0.124 mV Z1 = INT (CH1-0.000124)
Digital Voltmeter Unit PLC delay shift (PLCS)	Shifts the time by the length the frequency (PLC) delay or NPLC delay set with the MR8990 Digital Voltmeter Unit. Since the Digital Voltmeter Unit obtains the average during the period set with the NPLC, it observes the waveform that delays half the period of the NPLC compared with the 8966 Analog Unit. The PLCS calculation shifts the time by the length of this delay to correct the deviation from the Analog Unit. Note: If there is no data at the end of the calculation result, the voltage value becomes zero.

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12 Memory Division Function MEM

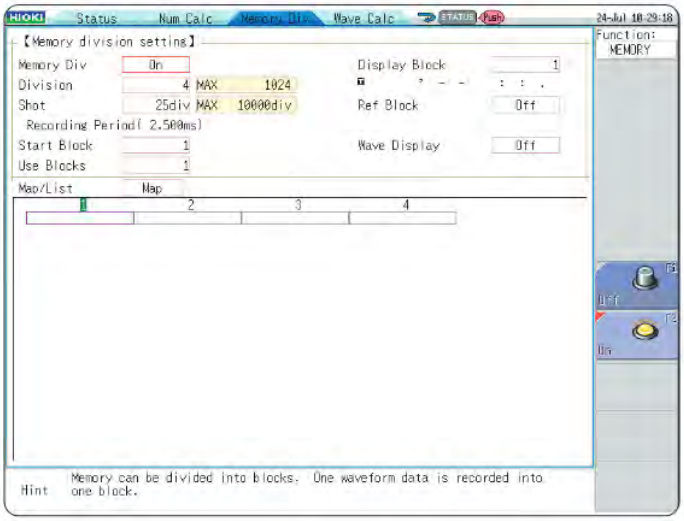
The Memory division function can only be used with the Memory function.
Memory division settings are made on the Status screen - **[Memory Div]** sheet.
Blocks to be displayed can also be selected on the Waveform screen. (p. 157)

To display the [Memory Div] sheet



Press this key repeatedly display the various sheets.

[Status] ← [Wave Calc]
↓ ↑
[Num Calc] → [Memory Div]

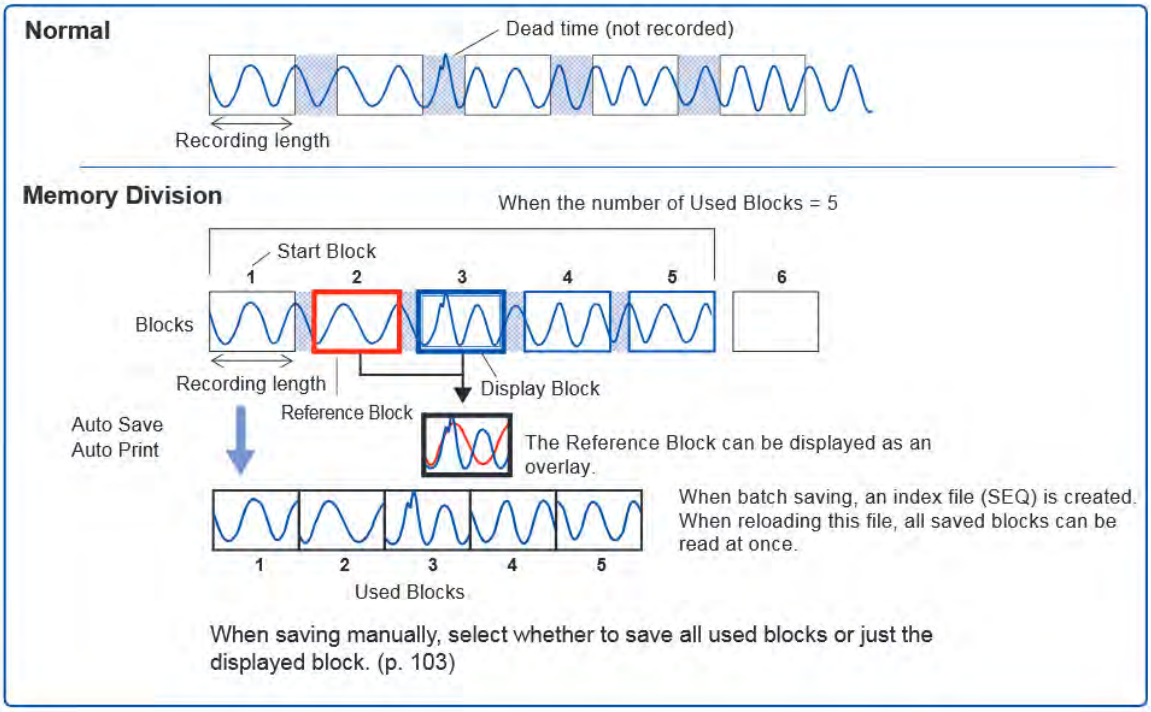


When using memory division, the trigger output (TRIG_OUT terminal output) may output the Low level or output erratically under the following conditions.
- The timebase is 5 µs/div to 100 µs/div.
- The record (measurement) time is 5 ms or less.
- Tracking wave display is **[OFF]**.

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Operations Available From the [Memory Div] Sheet

- Waveforms can be recorded into individual blocks by dividing memory space into multiple blocks.
- You can record waveforms beginning at any block (**Start Block**), choose which blocks to display (**Display Block**), or display multiple overlaid blocks (**Reference Block**).
- The maximum number of blocks for memory division depends on recording length. (The maximum is 1024 blocks [512 blocks when using Model U8975, U8977, or U8978].)
- Triggered waveform data can be acquired continuously and recorded sequentially in specified blocks (from the **Start Block**, for the specified Used Blocks). Dead time while displaying or printing (during which triggers are ignored) can be minimized.
- Even if you do not use the Memory Division function, up to 16 blocks of data (depending on the specified recording length) can be saved to each block so that previously recorded data can be selected for display on the Waveform Screen.
Refer to "7.8 Viewing Waveforms Divided Into Blocks" (p. 157).



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12.1 Configuring the Recording Settings

Procedure

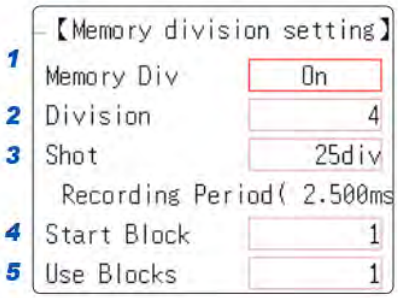
To display the screen

Press the **STATUS** key to open the Status screen, and then select the **[Memory Div]** sheet.

1 Enable the Memory Division function.

Move the cursor to **[Memory Div]**.
and select **[On]**.

Off	Memory Division is disabled. (Default setting)
On	Memory Division is enabled.



2 Set the number of divisions.

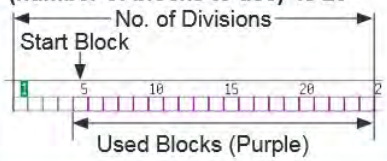
Move the cursor to **[Division]**.
Set the number of blocks for division.
Default setting: 4

3 Set the recording length.

(This is linked to the recording length setting on the **[Status]** sheet.)
Move the cursor to **[Shot]**.
Set the recording length.
The maximum recording length and number of divisions are determined automatically according to memory capacity and the number of channels used.
Setting Range: "Appx. 2.4 Maximum Recording Length and Number of Divisions (Memory Division Function)" (p. Appx.11)

Memory Division, Waveform Calculation, and Roll Mode cannot be enabled at the same time.

When the number of divisions is 32, the Start Block is 5, and the Used Block number (number of blocks to use) is 20



4 Set the start block.

Move the cursor to **[Start Block]**.
Set the block number at which to start recording.
Default setting: 1

5 Set the number of Used Blocks.

Move the cursor to **[Use Blocks]**.
Set the number of blocks to be used.
Default setting: 1

About Recording

When a faster timebase is selected, display, print and save operations are not available during measurement, until recording is done for all blocks. Selecting the displayed screen for auto-saving lengthens dead time.

To display any block on the waveform screen when measuring is completed

Set the number of blocks to display. (p. 270)
(This can also be set on the Waveform screen (p. 157))

To display overlaid waveforms

Set the number of blocks for reference. (p. 270)

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12.2 Configuring the Display Settings

Procedure

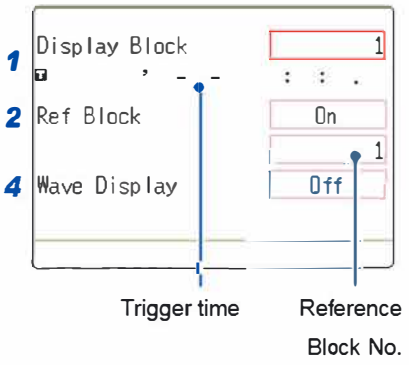
To display the screen

Press the **STATUS** key to open the Status screen, and then select the **[Memory Div]** sheet.

1 To display any block on the Waveform screen

Set the display blocks.

Set after measurement is complete. (This can also be set on the Waveform screen (p. 157).)
Move the cursor to **[Display Block]**.
Set the number of blocks to display on the Waveform screen.



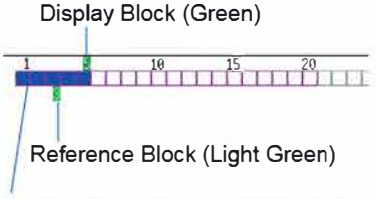
2 To display multiple blocks as overlaid waveforms

Enable the Reference Block function.

Move the cursor to **[Ref Block]**.
and select **[On]**.

Off	Reference Blocks are not displayed. (Default setting)
On	Reference block is overlaid on display block and then displayed.

When the Displayed Block is 5, and the Reference Block is 3



The colored blocks indicate blocks where measurement data has been recorded.

3 (When Reference Blocks are set to [ON])

Select whether to reference every block.

To overlay all waveforms, select **[All Blks ON]**.

All Blks Off	Turns off reference to all blocks.
All Blks On	Turns on reference to all blocks.

To overlay selected waveforms, move the cursor to the number column of the reference block and select the block number.

Ref On-Off	Sets On or Off. If **[On]** is selected, the block frame of the selected block number is displayed as a green square.
↑↓	Selects a block.

Reference Block Selection

Reference Blocks can also be selected and deselected using **[Ref Block]** on the [List] display.
Refer to "To get details on each block" (p. 271).

4 When displaying waveforms for each acquired waveform in the block

Enable tracking waveform display.

Move the cursor to **[Wave Display]**.
and select **[On]**.

Off	The waveform of the specified Display Block will be displayed after recording the specified number of Used Blocks. (Default setting)
On	Waveforms are displayed one block at a time as they are acquired at each trigger event.

Setting the Trace Waveform display to [ON] lengthens dead time.

About Dead Time:
Refer to "Difference between dead times during normal and memory division recording" (p. 272).

Even if the Roll Mode is enabled (other than **[OFF]**), it cannot be used when the Trace Waveform display is set to **[OFF]**.

To View Memory Division waveforms on the Waveform screen

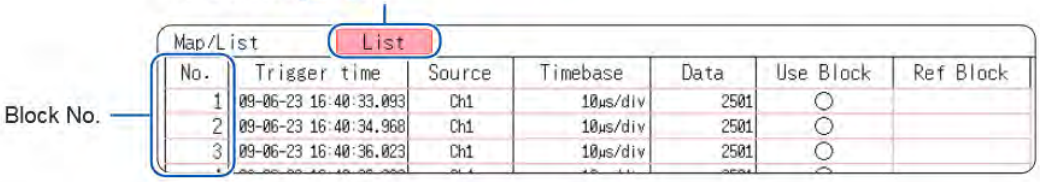
Refer to "7.8 Viewing Waveforms Divided Into Blocks" (p. 157).

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To get details on each block

The trigger time and measurement status of each block can be viewed on the list.

Move the cursor to the **[Map/List]**, and select **[List]**.

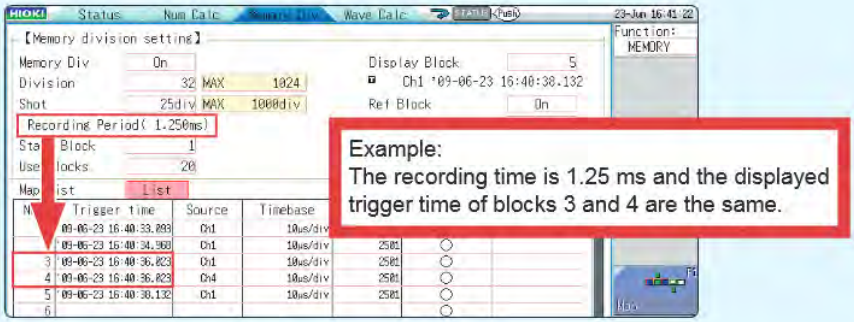


Blocks can be selected with the **Up/down CURSOR** or **F** keys.
You can move the cursor to the **[Ref Block]** column to set a block as a Reference Block.

To switch block waveforms on the Waveform screen

To select the block you want to see, press the **WAVE** key on the Waveform screen and switch Pos to Block.
Refer to "7.8 Viewing Waveforms Divided Into Blocks" (p. 157).

- When displaying memory division blocks as a list, blocks may have the same trigger times. This occurs because the minimum resolution of the clock used by this instrument is 1/128th of a second (7.8125 ms) and measurement occurs during this interval.

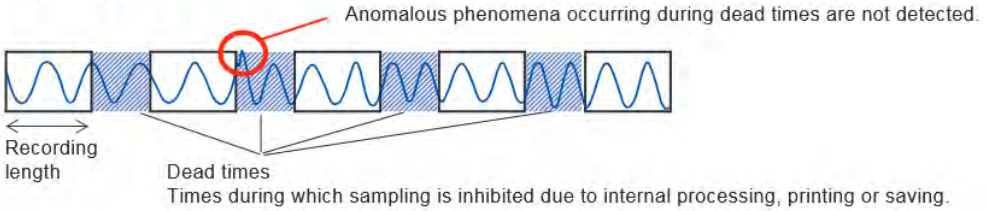


- If triggers occur continuously within an interval shorter than 500 µs, the displayed trigger time may indicate time slower than the actual triggers.

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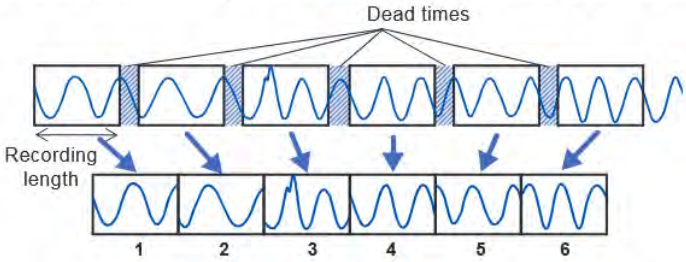
Difference between dead times during normal and memory division recording

When both printer recording (auto-print) and auto-save are set for continuous triggering [Repeat].



Times during which sampling is inhibited due to internal processing, printing or saving.

When the trace waveform display is [Off] during memory division recording



The waveform data of each recording length is recorded in one block.

When recording with memory division, dead time is shorter than with normal recording.

- The dead time (the period where no sampling occurs between blocks) of memory division is as follows.
  5 µs/div to 20 µs/div: 1 to 8 samples
  Timebase slower than 50 µs/div: 1 sample
  Note: Dead time is longer when you use calculation functions or when the timebase is set between 5 and 20 µs/div and tracking waveform display is **[ON]**.
- When measuring with a Model 8970 Freq Unit, dead time is approximately 230 ms. When measuring in [Count] mode, there are cases when the last data in a previous block is carried over to the first part of the next block.
- When tracking waveform display is **[Off]**, the roll mode function cannot be used, even when roll mode is enabled (other than **[Off]**).
- When triggering occurs very often, pressing the **STOP** key may not stop measurement until enough data has been acquired to fill the blocks specified for use.

Auto-save and auto-print for memory division recording

Measurement conditions	Auto-save and auto-print
With Numerical calculation ON	Auto-save, auto-print and Waveform Display are performed every time one block is measured (when Tracking wave display is ON).
When timebase is 5 µs/div to 20 µs/div and Tracking wave display is ON	Auto-save, auto-print and Waveform Display are performed every time one block is measured.
When timebase is 5 µs/div to 20 µs/div and Tracking wave display is OFF	Auto-save and auto-print are performed after all blocks are measured.
Other than above	Auto-save and auto-print and Waveform Display are performed simultaneously with measurement (when Tracking wave display is ON).

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13 FFT Function

FFT

13.1 Overview and Features

FFT analysis can only be used with the FFT function.
The FFT (Fast-Fourier Transform) functions perform frequency analysis on input signal data.
Use these functions for frequency analysis of measurement targets such as rotating objects, vibrations, and sounds.
For details about FFT, refer to "Appx. 4 FFT Definitions" (p. Appx.24).

Analysis can be performed on data as it is being measured, on pre-existing analog waveform data previously acquired with the Memory function, and on data output from waveform calculations.
When Model 8968 High Resolution Unit or Model U8979 Charge Unit, each of which is equipped with the anti-aliasing filter, is used, the cut-off frequency can be set automatically by linking with the frequency range setting.

Major Features

- FFT analysis frequency range: 133 mHz to 8 MHz (if using the U8975, U8977, or U8978: 4 MHz)
- FFT Analysis Modes (16 types)

- Storage Waveform
- Histogram
- Linear Spectrum
- RMS Spectrum
- Power Spectrum
- Power Spectrum Density*
- LPC Analysis (Power Spectrum Density)*
- Transfer Function
- Cross Power Spectrum
- Impulse Response
- Coherence Function
- Phase Spectrum
- Auto-correlation Function
- Cross-correlation Function
- 1/1 Octave Analysis*
- 1/3 Octave Analysis*

* Not available when using external sampling.

For phase spectra, only the required phase information is highlighted and displayed. (Highlight)
Refer to "13.3.8 Highlighting Analysis Results (Phase Spectra Only)" (p. 285).
When performing FFT analysis with the instrument connected to a sound level or vibration meter, scaling by dB can be set from the Channel Settings screen if you want to read values directly in calibrated units of measurement.
Refer to "Scaling" (p. 292).

To suppress the effects of aliasing distortion caused by sampling
We recommend using Model 8968 High Resolution Units that are equipped with anti-aliasing filtering to suppress the effects of aliasing distortion when sampling.
About aliasing distortion and anti-aliasing filters, refer to "Appx. 4 FFT Definitions" (p. Appx.24).

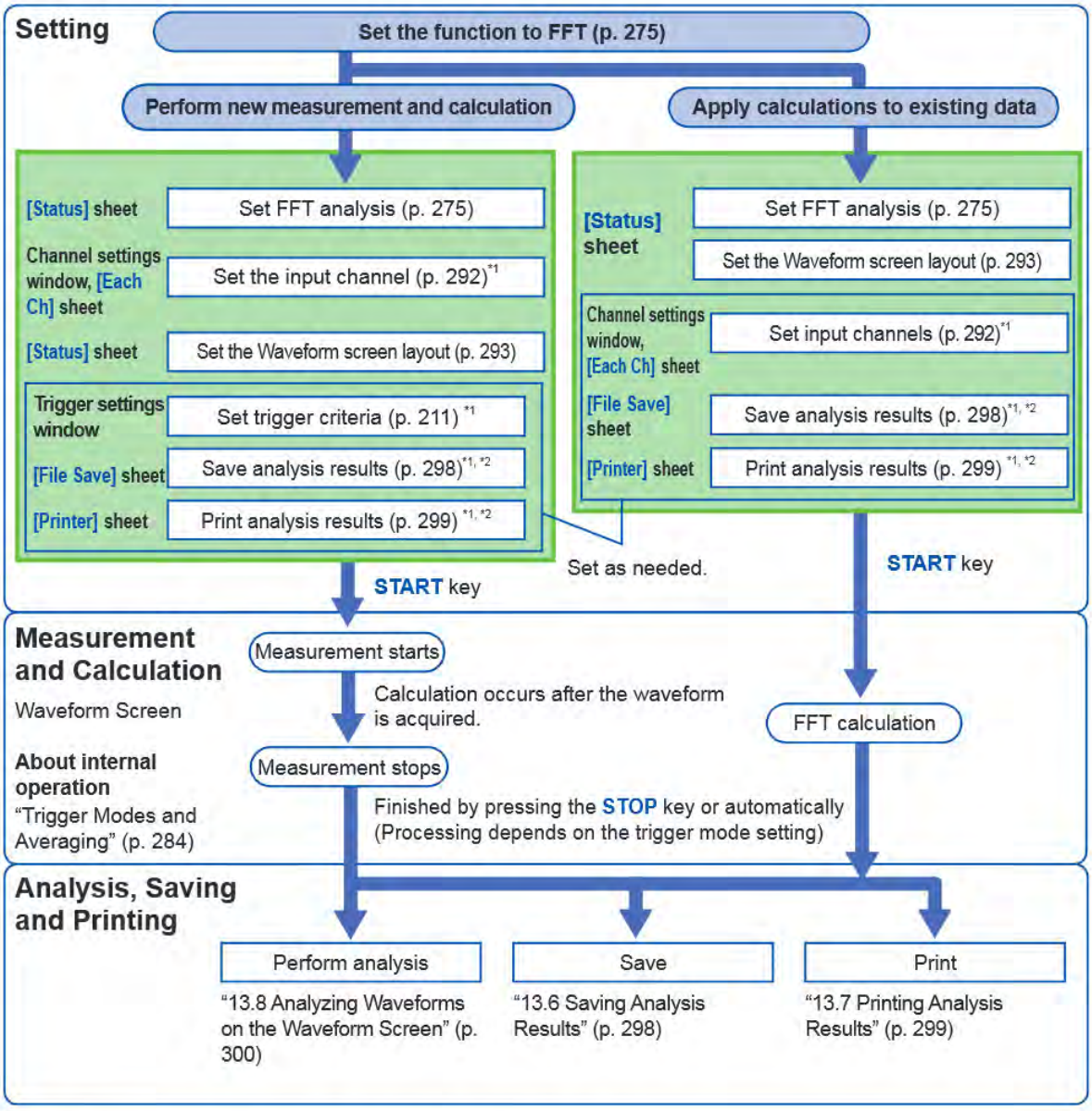
Refer to "18.3.4 FFT Function" (p. 387) for FFT function specifications.

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13.2 Operation Workflow (Reference Data)

Installation and Connection
"2 Preparing for Measurement" (p. 27)

Turn on the instrument



*1: Settings are the same as for the Memory function.
*2: Even after analysis, save and print settings can be set manually.

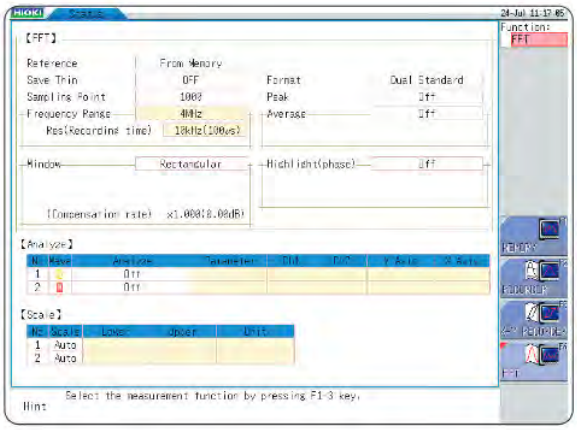
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13.3 Setting the FFT Analysis Conditions

You can choose basic measurement configuration settings on the Status screen - **[Status]** sheet. Measurement can also be configured from the Waveform screen. (p. 291)

To display the [Status] Sheet



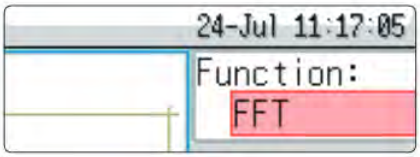


13.3.1 Selecting the FFT Function

The FFT function can be selected at screens other than the file screen.

Procedure

1. **Move the cursor to the function item (the upper most column of the Settings window).**
2. **Select [FFT].**



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13.3.2 Setting the Data Source for Analysis (Reference Data)

Select the data to be used for FFT analysis.
There are two analysis methods: analysis using new measurements and analysis of data measured using the memory function.

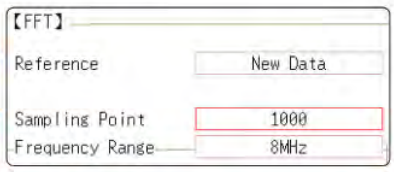
Procedure

To display the screen
Press the **STATUS** key to open the Status screen, and then select the **[Status]** sheet.
See "13.3.11 Setting and Changing Analysis Conditions on the Waveform Screen" (page 291)

1 **Select the reference data.**

Move the cursor to **[Reference]**.

New Data	Acquires a new waveform for analysis.
From Memory	Calculates data measured using the memory function.



When the input data [Reference] is [From Memory]
Analysis is performed until the specified number of FFT analysis points have been processed, then the data is shifted by that amount and analysis repeats until all of the previously acquired data has been processed. (If the amount of data is less than the specified number of FFT analysis points, no analysis occurs.)

2 **When you have finished choosing settings, press the START key.**

When using [New Data]

Measurement starts to acquire data for the number of analysis points specified as the **[Sampling Point]**, and FFT analysis is performed.

When using [From Memory]

Analysis is performed on the number of specified points from data previously recorded in memory (Memory function data).

The analysis starting point can also be specified.
Refer to "13.8.1 Calculating After Specifying the Calculation Starting Point" (p. 300).

The frequency range is selected automatically.
Refer to "Relationship between frequency range, resolution and number of analysis points" (p. 278).

When no trace is displayed after pressing the START key.
Analysis is not possible if **[From Memory]** is selected as the input data source and no recorded data exists in the instrument's memory.
Either select **[New Data]** as the input data source, or load the data to be analyzed before pressing the **START** key again.

When **[Reference]** is set to **[From Memory]**, the frequency is automatically set.
The setting cannot be changed.

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13.3.3 Setting the Frequency Range and Number of Analysis Points.

About the frequency range and number of analysis points

- The settings for the frequency range and number of analysis points determine the input signal acquisition time and frequency resolution.
- **The frequency range** setting for the FFT function corresponds to the timebase setting of the Memory function.
  Changing the frequency range also changes the data sampling period.
  Refer to "Relationship between frequency range, resolution and number of analysis points" (p. 278).
- The cut-off frequency of the anti-aliasing filter is the same as the frequency range setting.
  Refer to "Relationship between frequency range, resolution and number of analysis points" (p. 278).
- **The set number of analysis points** specifies the amount of data to be analyzed with each measurement.
  Increasing the number of analysis points increases the frequency resolution, but also increases the time required for calculations.
  Refer to "Number of Analysis Points" (p. Appx.26).

To perform calculations on external sampling

Set the Sampling Clock to **[External]**. (External sampling).
In this case, octave analysis, power spectrum density and LPC Analysis (power spectrum density) are not available.

When [Reference] is set to [From Memory], the frequency is automatically set. The setting cannot be changed.

Frequency range and number of analysis points setting: Use the operating keys

To display the screen

Press the **STATUS** key to open the Status screen, and then select the **[Status]** sheet.
Refer to "13.3.11 Setting and Changing Analysis Conditions on the Waveform Screen" (p. 291).

1 **Set the number of FFT analysis points.**

Move the cursor to **[Sampling Point]**.

1000 (Default setting), 2000, 5000, 10000

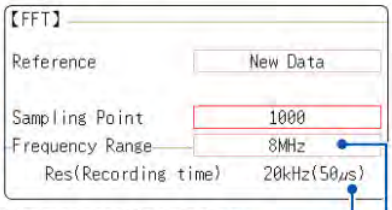
Refer to "Number of Analysis Points" (p. Appx.26).

2 **Select the frequency range.**

Move the cursor to **[Frequency Range]**.

8 MHz (Default setting), 4 MHz, 2 MHz, 800 kHz, 400 kHz, 200 kHz, 80 kHz, 40 kHz, 20 kHz, 8 kHz, 4 kHz, 2 kHz, 800 Hz, 400 Hz, 200 Hz, 80 Hz, 40 Hz, 20 Hz, 8 Hz, 4 Hz, 1.33 Hz, 800 mHz, 667 mHz, 400 mHz, 333 mHz, 133 mHz, External

If using Model U8975, U8977, or U8978, the 8 MHz range will not be available (the default setting will be 4 MHz).
Refer to "Relationship between frequency range, resolution and number of analysis points" (p. 278).



Frequency Resolution (during acquisition)
The resolution is affected by of the selected frequency range and number of analysis points.
Not displayed for external sampling.

To control sampling by an external signal, select **[External]**.

When the input data [Reference] is [From Memory]
The frequency range is set automatically when analysis is started.

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Relationship between frequency range, resolution and number of analysis points

Range [Hz]	Sampling frequency [Hz]	Timebase [/div] (MEM)	Sampling period	Number of FFT analysis points							
				1,000		2,000		5,000		10,000	
				Resolution [Hz]	Acquisition interval	Resolution [Hz]	Acquisition interval	Resolution [Hz]	Acquisition interval	Resolution [Hz]	Acquisition interval
8 M[*1*2]	20 M	5 µs	50 ns	20 k	50 µs	10 k	100 µs	4 k	250 µs	2 k	500 µs
4 M[*2]	10 M	10 µs	100 ns	10 k	100 µs	5 k	200 µs	2 k	500 µs	1 k	1 ms
2 M[*2]	5 M	20 µs	200 ns	5 k	200 µs	2.5 k	400 µs	1 k	1 ms	500	2 ms
800 k[*2]	2 M	50 µs	500 ns	2 k	500 µs	1 k	1 ms	400	2.5 ms	200	5 ms
400 k[*2]	1 M	100 µs	1 µs	1 k	1 ms	500	2 ms	200	5 ms	100	10 ms
200 k[*2]	500 k	200 µs	2 µs	500	2 ms	250	4 ms	100	10 ms	50	20 ms
80 k[*2]	200 k	500 µs	5 µs	200	5 ms	100	10 ms	40	25 ms	20	50 ms
40 k	100 k	1 ms	10 µs	100	10 ms	50	20 ms	20	50 ms	10	100 ms
20 k	50 k	2 ms	20 µs	50	20 ms	25	50 ms	10	100 ms	5	200 ms
8 k	20 k	5 ms	50 µs	20	50 ms	10	100 ms	4	250 ms	2	500 ms
4 k	10 k	10 ms	100 µs	10	100 ms	5	200 ms	2	500 ms	1	1 s
2 k	5 k	20 ms	200 µs	5	200 ms	2.5	400 ms	1	250 ms	500 m	2 s
800	2 k	50 ms	500 µs	2	500 ms	1	1 s	400 m	2.5 s	200 m	5 s
400	1 k	100 ms	1 ms	1	1 s	500 m	2 s	200 m	5 s	100 m	10 s
200	500	200 ms	2 ms	500 m	2 s	250 m	4 s	100 m	10 s	50 m	20 s
80	200	500 ms	5 ms	200 m	5 s	100 m	10 s	40 m	25 s	20 m	50 s
40	100	1 s	10 ms	100 m	10 s	50 m	20 s	20 m	50 s	10 m	100 s
20	50	2 s	20 ms	50 m	20 s	25 m	40 s	10 m	100 s	5 m	200 s
8[*3]	20	5 s	50 ms	20 m	50 s	10 m	100 s	4 m	250 s	2 m	500 s
4[*3]	10	10 s	100 ms	10 m	100 s	5 m	200 s	2 m	500 s	1 m	1 ks
1.33[*3]	3.33	30 s	300 ms	3.33 m	300 s	1.66 m	600 s	666 µ	1.5 ks	333 µ	3 ks
800 m[*3]	2	50 s	500 ms	2 m	500 s	1 m	1 ks	400 µ	2.5 ks	200 µ	5 ks
667 m[*3]	1.67	60 s	600 ms	1.66 m	600 s	833 µ	1.2 ks	333 µ	3 ks	166 µ	6 ks
400 m[*3]	1	100 s	1 s	1 m	1 ks	500 µ	2 ks	200 µ	5 ks	100 µ	10 ks
333 m[*3]	833 m	120 s	1.2 s	833 µ	1.2 ks	416 µ	2.4 ks	166 µ	6 ks	83.3 µ	12 ks
133 m[*3]	333 m	300 s	3 s	333 µ	3 ks	166 µ	6 ks	66.6 µ	15 ks	33.3 µ	30 ks

The cut-off frequency of the anti-aliasing filter is the same as the frequency range.

*1 If using Model U8975, U8977, or U8978, the 8 MHz range will not be available.

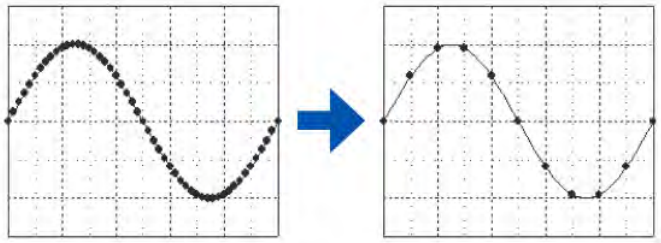
*2 The anti-aliasing filter is Off.

*3 Cut-off frequency is 20 Hz.

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13.3.4 Decimating and Calculating Data

When performing FFT analysis of data measured using the memory function, the measurement data can be decimated before calculation.
If the sampling frequency is too high and you get unexpected results, decimate the data before calculation to increase the frequency resolution.



Original waveform Thinned waveform

Procedure

To display the screen

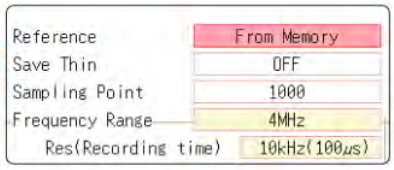
Press the **STATUS** key to open the Status screen, and then select the **[Status]** sheet.

1 **Select the reference data.**

Move the cursor to **[Reference]**, and select **[From Memory]**.

2 **Select the decimating rate.**

Move the cursor to **[Save Thin]**.



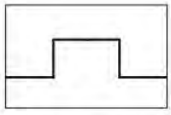
OFF	Does not decimate data. (Default setting)
1/10	Decimates points every 10 data points.
1/100	Decimates points every 100 data points.
1/1000	Decimates points every 1000 data points.

- The **[Save Thin]** setting can only be set when **[Reference]** is set to [From Memory].
- The range that can be set for thinning changes depending on the timebase measured by the memory function.
- The frequency is selected automatically. The setting cannot be changed.
- **When thinning, aliasing occurs and waveforms that did not originally exist may be observed. Make settings after sufficient consideration of the frequencies included in waveforms.**

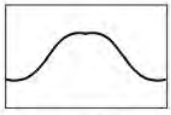
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13.3.5 Setting the Window Function

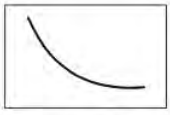
The window function defines the segment of the input signal to be analyzed.
Use the window function to minimize leakage errors (p. Appx.31).
There are three general types of window functions:



• Rectangular window



• Hann window
• Hamming window
• Blackman window
• Blackman-Harris window
• Flat top window



• Exponential window

The non-rectangular window functions generally produce lower-level analysis results. The attenuation introduced by the non-rectangular window functions can be corrected by applying attenuation correction to bring analysis results back levels similar to those of a rectangular window.

Procedure

To display the screen

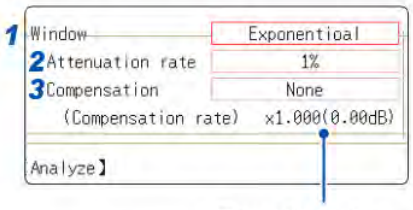
Press the **STATUS** key to open the Status screen, and then select the **[Status]** sheet.
See "13.3.11 Setting and Changing Analysis Conditions on the Waveform Screen" (page 291)

1 **Select the window function.**

Move the cursor to **[Window]**.

Rectangular (Default setting), Hanning, Exponential, Hamming, Blackman, Blackman Harris, Flat-top.

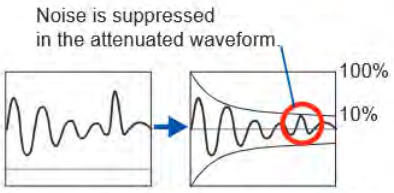
Refer to "Window Function" (p. Appx.31).



2 **When [Exponential] is selected**

Set the attenuation coefficient (percentage).

Move the cursor to **[Attenuation rate]**.
Set the attenuation coefficient as a percentage.



When the attenuation rate is 10%

3 **Set attenuation correction.**

Move the cursor to **[Compensation]**.

None	Attenuated window function values are not corrected. (Default setting)
Power	The window function multiplies the power levels of the time-domain waveform so that output levels are comparable to those of a rectangular window.
Average	The window function multiplies the average value of the time-domain waveform so that output levels are comparable to those of a rectangular window.

When a window function is rectangular
The correction value is always 1 (0 dB).

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13.3.6 Configuring the Analysis Result Peak Value Setting

You can display local or global maxima ([maximal]/ [maximum]) of the input signal and analysis results on the Waveform screen. However, if Nyquist display is selected on the Status screen - **[Status]** sheet, no peak values are displayed.

Procedure

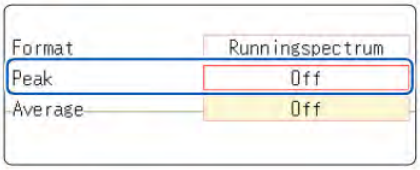
To display the screen

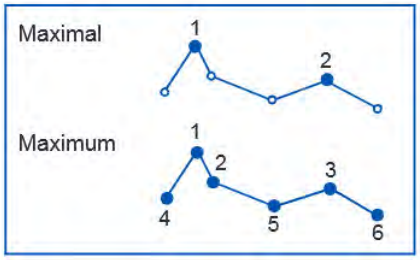
Press the **STATUS** key to open the Status screen, and then select the **[Status]** sheet.

To select peak value display.

Move the cursor to **[Peak]**.

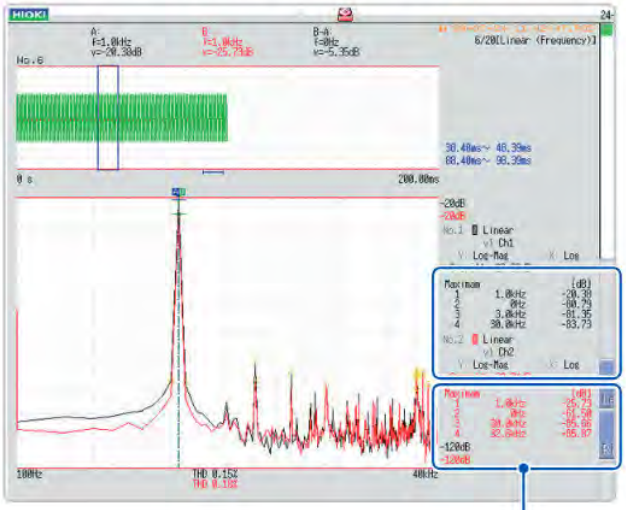
Off	Not displayed. (Default setting)
Maximal	(local maxima) When the value of data at a point is greater than that of the adjacent points, that point is considered a local maximum. The ten largest local maxima are displayed.
Maximum value	(global maxima) Among all data values, the ten points with the greatest values are displayed.





- No maxima will be displayed if peak values cannot be detected.
- Peak values on the Waveform screen can be displayed and printed, but cannot be saved as peak values in text files.
- Depending on the split screen status, it may not be possible to display ten peak values. In such cases, as many items as possible will be displayed, starting from the largest item.

Example: When the reference data setting is **[From Memory]**.



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13.3.7 Averaging Analysis Results (Waveform Averaging)

The averaging function calculates the average of the values obtained from multiple measurements of a periodic waveform.
This can reduce noise and other non-periodic signal components. Averaging can be applied to a time-domain waveform or to a spectrum.

Procedure

To display the screen
Press the **STATUS** key to open the Status screen, and then select the **[Status]** sheet.

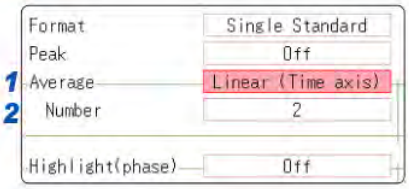
1 **Enable averaging.**

Move the cursor to **[Average].**

OFF	Averaging is disabled. (Default setting)
Linear (Time axis)	Time-domain waveforms are summed and averaged and then calculation is performed.
Expo. (Time axis)	The exponential mean of time-domain waveforms is determined and then calculation is performed.
Linear (Frequency)	Frequency-domain waveforms are summed and averaged and then the calculation result is output.
Expo. (Frequency)	The exponential mean of frequency-domain waveforms is determined and then the calculation result is output.
Peak (Frequency)	The maximum value of frequency-domain waveforms is retained.

2 **Select the count for averaging.**

Move the cursor to **[Number].**
Select the number of measurements to be averaged.
Setting range: 2 to 10000



About averaging calculation formulas
Refer to "Averaging" (p. Appx.30).

When averaging and auto-save or auto-print are enabled at the same time
Data is saved or printed after the specified number of values has been averaged.

Refer to "Trigger Modes and Averaging" (p. 284).

- After measuring with averaging enabled, display is not available when the channel is changed. Also, when the analysis mode is changed, the analysis modes that can be displayed are limited.
- When averaging is performed with analysis mode disabled (Off), no trace will be displayed when the analysis mode is changed after measurement.
- When **[Format]** is set to **[Running spectrum]**, **[Average]** cannot be used.

To average time-domain waveform values

Waveforms are acquired and averaged within the time domain. FFT calculation is performed after averaging.
When the trigger mode is **[Auto]**: When the **START** key is pressed, data will be acquired after a certain interval even if trigger criteria are not met. This means that if averaging is applied to an asynchronous signal, the resulting data is meaningless.
Synchronous signals have better SNR (signal-to-noise ratio) and are more suitable for analysis.

To average spectrum values

Acquired data is first subject to FFT analysis. After analysis, averaging is performed within the frequency range, and the result is displayed. This differs from time-domain averaging in that averaging can be performed without trigger synchronization. However, if the characteristics of the input waveform allow triggering, using the trigger for synchronization is recommended.

To retain peak value on spectrum (peak hold)

After performing FFT calculations on the acquired waveform, peak values are retained (held) and displayed within the frequency range.

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▪ FFT Analysis Modes and Averaging

✓: Can be set, –: Cannot be set, ○: Can be partially set

Analysis Mode	Averaging				
	Time-domain waveform averaging		Spectrum averaging		
	Simple	SCI	Simple	SCI	Peak hold
OFF	–	–	–	–	–
Storage Waveform	✓	✓	–	–	–
Histogram	✓	✓	–	–	–
Linear Spectrum	✓	✓	○*2	○*2	○*2
RMS Spectrum	✓	✓	○*2	○*2	○*2
Power Spectrum	✓	✓	✓	✓	✓
Power Spectrum Density *1	✓	✓	✓	✓	✓
LPC Analysis (Power Spectrum Density) *1	✓	✓	–	–	–
Transfer Function	✓	✓	○*2	○*2	○*2
Cross Power Spectrum	✓	✓	○*2	○*2	○*2
Impulse Response	✓	✓	✓	✓	✓
Coherence Function	–	–	✓	✓	–
Phase Spectrum	✓	✓	–	–	–
Auto-correlation Function	✓	✓	✓	✓	✓
Cross-correlation Function	✓	✓	✓	✓	✓
1/1 Octave Analysis *1	✓	✓	✓	✓	✓
1/3 Octave Analysis *1	✓	✓	✓	✓	✓

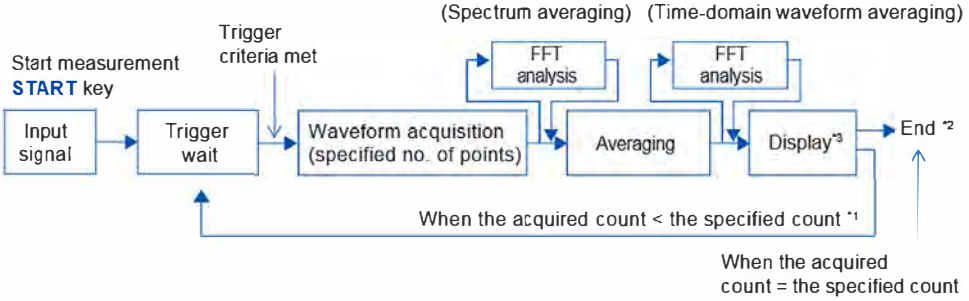
*1 Not available for external sampling
*2 Not available when the y axis is real (linear) or imaginary (linear), and for Nyquist plots

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▪ Trigger modes and averaging

If the trigger mode is [Single] or the calculation setting is [Once]

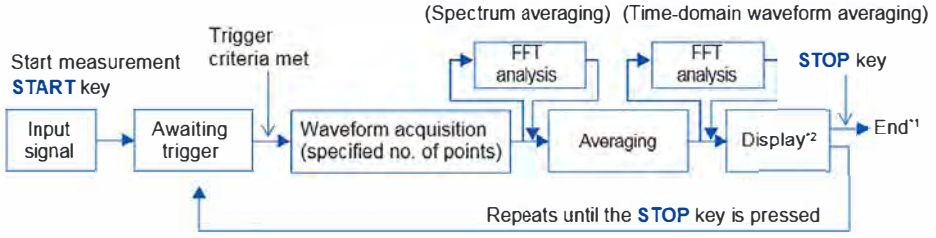
Measurement continues until the specified number of averaging points is acquired.



*1: Awaiting trigger continues until the specified count is reached.
*2: Measurement stops automatically when the specified count is reached.
If measurement was interrupted by the **STOP** key, the averaging result up to that point is displayed.
*3: If **[Reference]** is **[New Data]** and automatic saving or automatic print is **[On]**, data is saved or printed when the specified number of times is reached.

If the trigger mode is [Continue] or the calculation setting is [Repeat]

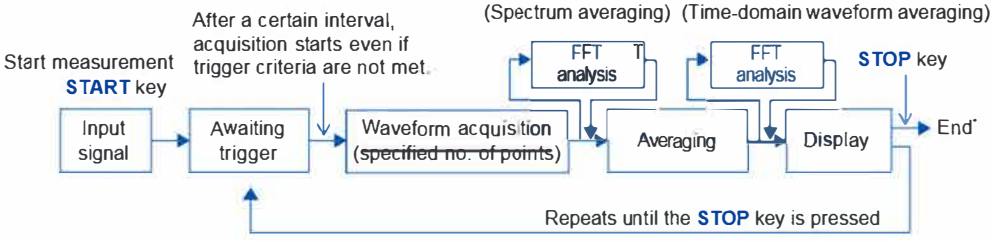
Measurement continues after the specified averaging count has been acquired.
When the specified averaging count is exceeded, averaging is repeated and measurement continues until the **STOP** key is pressed.



*1: When stopped before the specified count, the average up to that point is displayed.
*2: If **[Reference]** is **[New Data]** and automatic saving or automatic print is **[On]**, data is saved or printed when the specified number of times is reached.

When the trigger mode is [Auto]

- For time-domain waveforms
  When the **START** key is pressed, after a certain interval data will be acquired even if trigger criteria are not met. This means that if averaging is applied to an asynchronous signal, the resulting data is meaningless.
- For time-domain waveforms
  When the **START** key is pressed, measurement starts. Even if the trigger criteria are not met, the specified amount of data is acquired, and after FFT analysis, the results are averaged.
  When the specified averaging count is exceeded, averaging is repeated and measurement continues until the **STOP** key is pressed.

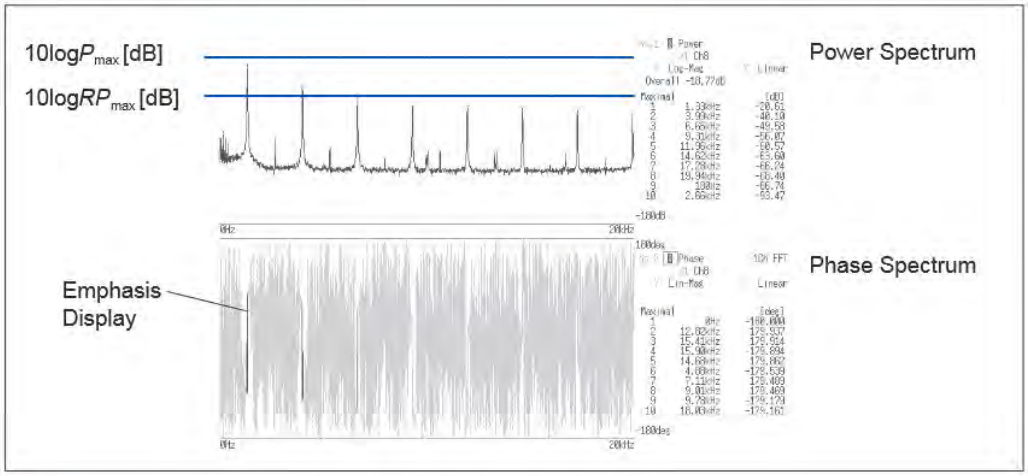


* When stopped before the specified count, the average up to that point is displayed.

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13.3.8 Highlighting Analysis Results (Phase Spectra Only)

By specifying a setting factor (rate) to be applied to the input signal, the display of data that exceeds the resulting threshold can be emphasized. This feature is useful for viewing waveforms that may otherwise be obscured by noise.
The reliability of phase spectrum values is poor when discrete Fourier transform values are extremely small. For example, in the case of a pure sine wave, almost all phase values at frequencies other than the input frequency result from calculation errors. By treating the maximum value of the power (or cross-power) spectrum of the input signal, P_{max}, as a reference value, data that exceeds that value multiplied by rate R can be displayed with emphasis.



Procedure

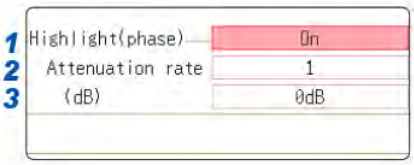
To display the screen

Press the **STATUS** key to open the Status screen, and then select the **[Status]** sheet.

1 **Enable the highlighting function.**

Move the cursor to **[Highlight (phase)]**.

Off	Emphasis display disabled. (Default setting)
On	Emphasis display enabled.



2 **Set the attenuation rate or attenuation value.**

To set an attenuation rate

Move the cursor to **[Attenuation rate]**.
Enter the attenuation rate.
Refer to "8.1.3 Entering Alphanumeric Characters" (p. 163).

To set an attenuation value [dB]

Move the cursor to **[Attenuation rate]**.
Enter the attenuation value.
Refer to "8.1.3 Entering Alphanumeric Characters" (p. 163).

Attenuation Rate and Value

Attenuation value: A [dB]
Attenuation rate: R

$-A = 10\log_{10}R$
$1x10^{-6} \leq R \leq 1$
$0 \leq A \leq 60$

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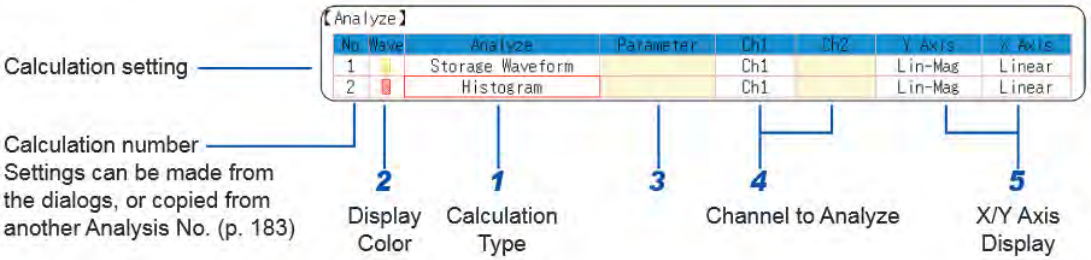
13.3.9 Configuring the Analysis Mode Settings

You can set the type of FFT analysis, channel(s), waveform display color and X and Y axes.

Procedure

To display the screen

Press the **STATUS** key to open the Status screen, and then select the **[Status]** sheet.
See "13.3.11 Setting and Changing Analysis Conditions on the Waveform Screen" (page 291)



1 **Select the FFT analysis mode.**

Move the cursor to the **[Analyze]** column of the Analysis No. you wish to set.

OFF	No analysis (Default setting)	Cross Power Spectrum	(p. 310)
Storage Waveform	(p. 302)	Impulse Response	(p. 311)
Histogram	(p. 302)	Coherence Function	(p. 312)
Linear Spectrum	(p. 303)	Phase Spectrum	(p. 313)
RMS Spectrum	(p. 305)	Auto-correlation Function	(p. 314)
Power Spectrum	(p. 306)	Cross-correlation Function	(p. 315)
Power Spectrum Density*	(p. 307)	1/1 Octave Analysis*	(p. 315)
LPC Analysis (Power Spectrum Density)*	(p. 308)	1/3 Octave Analysis*	(p. 315)
Transfer Function	(p. 309)		

*Not available with external sampling enabled. Refer to "13.9.2 Analysis Mode Functions" (p. 320).

(When **[List]** is selected, a list of calculation types appears. To clear the display, press the **CH.SET** key.)

2 **Select whether the waveform will be displayed and its color.**

Move the cursor to the **[Wave]** column.
Select whether to be display (ON/OFF) the waveform or not, and its color if displayed.

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3 **When [Parameter] setting contents are displayed**

Set the parameter.

Move the cursor to the **[Parameter]** column of the Analysis No.that you want to set.

Analysis Mode	Parameters	Settings
1/1 Octave Analysis, 1/3 Octave Analysis	Filter: Normal	Sets the octave filter. Refer to "Octave Filter Settings" (p. 288).
	Filter: Sharp	
Phase Spectrum	1ch FFT	Calculates the phase of **[Ch1]**.
	2ch FFT	Calculates the phase difference between **[Ch1]** and **[Ch2]**.
LPC (density)	Order: 2 to 64	Larger numerical values make finer spectrum components visible.

4 **Select the channel for analysis.**

Move the cursor to **[Ch1]**.
Select which channel number to use.

5 **Set the horizontal and vertical axes displaying the calculation results.**

Move the cursor to the **[X Axis]** or **[Y Axis]**.
Set the contents of the calculation results to be displayed on the horizontal and vertical axes.
(Selectable display contents vary by analysis mode.)
Refer to "Analysis Modes and X/Y Axis Display" (p. 288).

Analysis channel setting
For the following analysis modes, set both channels 1 and 2.
Transfer Function, Impulse Response, Cross-correlation Function, Cross Power Spectrum, Coherence Function, Phase Spectrum (2ch FFT)

Y-axis display

Lin-Mag	Displays analysis results as amplitude values.
Log-Mag	Displays analysis results as dB values. The dB reference is 1 eu. Example: For voltage, 1 V is displayed as 0 dB.
Lin-Real	Displays the real-number component of analysis values.
Lin-Imag	Displays the imaginary component of analysis values.

To analyze using external sampling
The horizontal axis (x-axis) displays the number of data points.

X-axis display

Linear	Frequency-axis is displayed linearly.
Log	Frequency-axis is displayed logarithmically. This is convenient when the data of interest is at the lower end of the frequency range, such as when measuring sound and vibration.

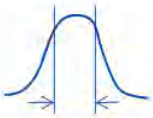
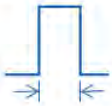
To copy settings to another calculation No.

Refer to "8.9 Copying Settings to Other Channels (Copy Function)" (p. 183).

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▪ Octave Filter Settings

Filter features are based on IEC61260 standards.

 Normal Filter characteristics approximate those of an analog filter.	 Sharp Only those spectral component within the octave band are used for analysis. Spectral components outside of the octave band are totally ignored.

After determining the entire power spectrum, the instrument performs octave analysis defined by the above filter characteristics.
Refer to "Octave Filter Characteristics" (p. Appx.35).

Analysis Modes and X/Y Axis Display

✓: Settable, –: Unsettable

Analysis Mode	X-axis		Y-axis				Nyquist Disp
	Linear	Log	Amplitude (Linear)	Amplitude (dB)	Lin-Real (Linear)	Lin-Imag	
OFF	–	–	–	–	–	–	–
Storage Waveform	✓	–	✓	–	–	–	–
Histogram	✓	–	✓	–	–	–	–
Linear Spectrum	✓	✓	✓	✓	✓	✓	✓
RMS Spectrum	✓	✓	✓	✓	✓	✓	–
Power Spectrum	✓	✓	✓	✓	–	–	–
Power Spectrum Density	✓	✓	✓	✓	–	–	–
LPC Analysis (Power Spectrum Density)	✓	✓	✓	✓	–	–	–
Transfer Function	✓	✓	✓	✓	✓	✓	✓
Cross Power Spectrum	✓	✓	✓	✓	✓	✓	✓
Impulse Response	✓	–	✓	–	–	–	–
Coherence Function	✓	✓	✓	–	–	–	–
Phase Spectrum	✓	✓	✓	–	–	–	–
Auto-correlation Function	✓	–	✓	–	–	–	–
Cross-correlation Function	✓	–	✓	–	–	–	–
1/1 Octave Analysis	–	✓	✓	✓	–	–	–
1/3 Octave Analysis	–	✓	✓	✓	–	–	–

The X/Y axes cannot be set when Nyquist Display is selected.

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▪ Total Harmonic Distortion (THD)

When the analysis mode is linear spectrum, RMS spectrum or power spectrum the cursor appears and the distortion rate is calculated.
(Linear spectrum, RMS spectrum, power spectrum)
The distortion rate calculates the cursor position as the fundamental wave. When two cursors appear, the A cursor becomes the fundamental wave.
When calculation results cannot be obtained, **[---%]** is displayed.
Note that distortion rate values may become higher depending on the window function settings.

$$\mathrm{THD} = \sqrt{\frac{\sum (V_n)^2}{(V_0)}} \times 100 \ [\%]$$

V_0 = fundamental wave

V_n = *next* higher harmonic

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13.3.10 Setting the Display Range of the Vertical Axis (Scaling)

The display range of the vertical (Y) axis can be set to automatically for analysis results and can be freely expanded and compressed.

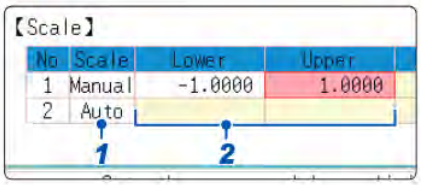
Procedure

To display the screen

Press the **STATUS** key to open the Status screen, and then select the **[Status]** sheet.

1 **Select automatic or manual scaling of the Y-axis display.**

Move the cursor to the **[Scale]** column of the Analysis No. you want to set.



Auto	Scaling of the vertical (Y) axis is automatically set according to analysis results. (Default setting)
Manual	Scaling of the vertical (Y) axis can be set as desired, to suit the measurement. This is useful for magnifying or reducing the displayed amplitude, and for shifting the displayed waveform up or down.

2 **When [Manual] is selected.**

Set the upper and lower limit value.

Move the cursor to **[Lower]** or **[Upper]**.
Set the upper and lower limits to display the analysis results.
Setting range: −9.9999E+29 to +9.9999E+29
(with exponent from E−29 to E+29)
Refer to “8.1.3 Entering Alphanumeric Characters” (p. 163).

To copy settings to another calculation No.

Refer to “8.9 Copying Settings to Other Channels (Copy Function)” (p. 183).

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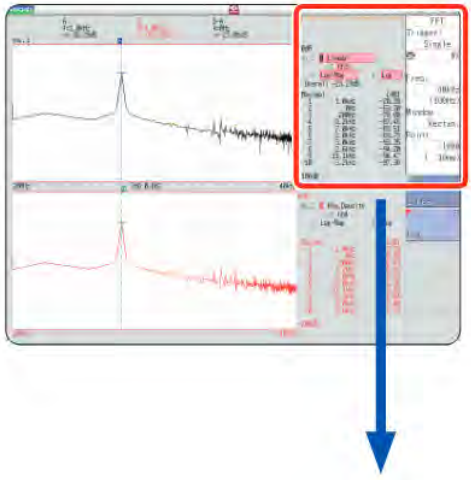
13.3.11 Setting and Changing Analysis Conditions on the Waveform Screen

The following settings can be made on the Waveform screen.
Changes to the displayed analysis results take effect when the settings are changed.

- Available settings are frequency range, number of analysis points, type of window function, trigger mode and pre-triggering.
- Available display type settings are analysis number, analysis mode, waveform color, analysis channel and X/Y-axis.
- Trigger settings (p. 214)
  (Note: If **[Reference]** is **[From Memory]**, triggers cannot be set.)

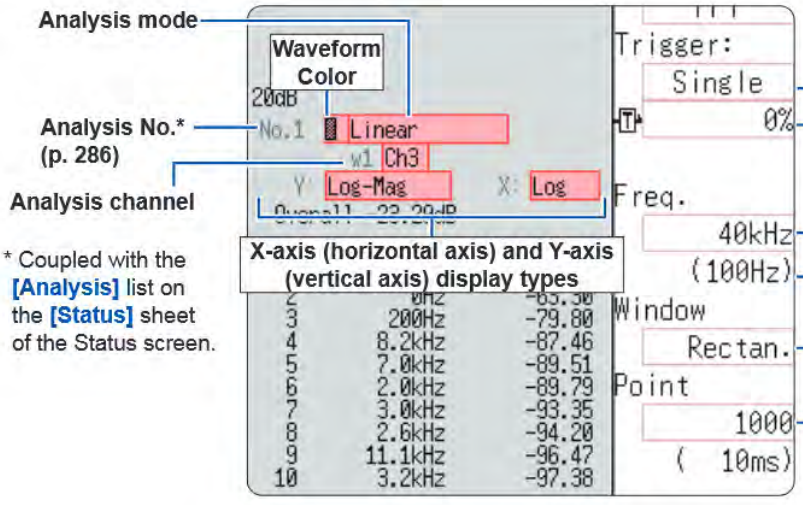
Setting Descriptions

To display the screen
Press the **DISP** key to open the Waveform screen.



Setting method
Use the CURSOR keys to move the cursor to each setting item, and select options the F keys.

Trigger mode and pre-trigger
Select the trigger mode and pre-triggering (same as when using the Memory function).
Trigger modes: Single, Repeat, Automatic
Pre-trigger: Select from list
Refer to "9.2 Setting the Trigger Mode" (p. 213) and "9.8 Setting the Pre-trigger" (p. 227).



* Coupled with the **[Analysis]** list on the **[Status]** sheet of the Status screen.

X-axis (horizontal axis) and Y-axis (vertical axis) display types

Select the frequency range. (133 mHz to 8 MHz) (p. 277)

Frequency Resolution (during acquisition)

FFT window function type (p. 280)

Number of analysis points (p. 277)
(1000, 2000, 5000, 10000)

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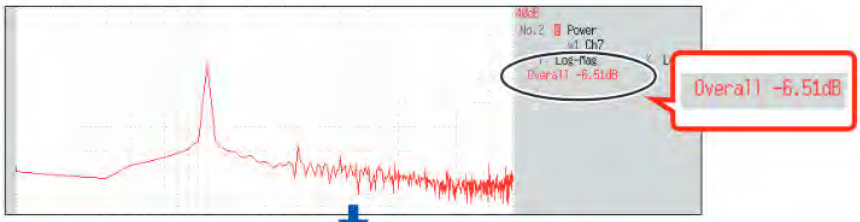
13.4 Configuring the Channel Settings

Channel selection is the same for all functions.
For the setting method, refer to “3.4 Configuring Input Channels Settings” (p. 70) and “8.10 Setting Details of Modules” (p. 184).

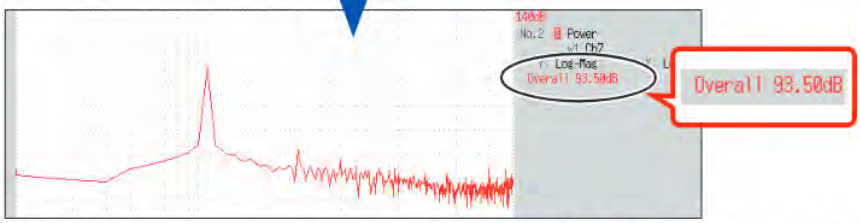
Scaling

The scaling setting allows values displayed on the instrument to match the actual values read directly on a sound level meter or vibration meter.

Without scaling

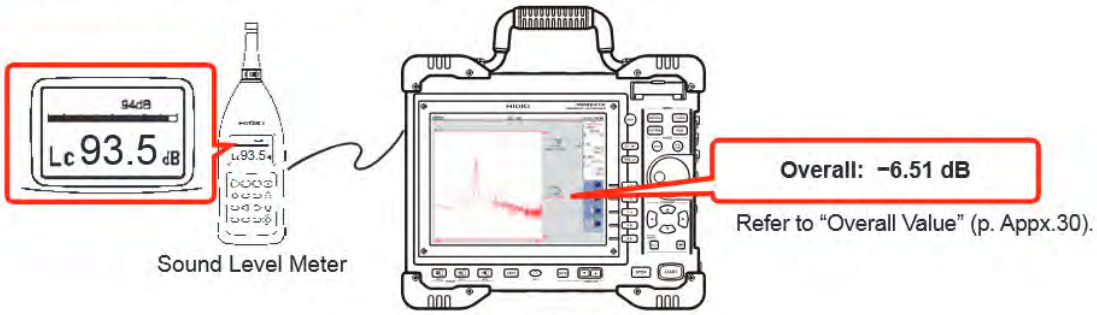


With scaling



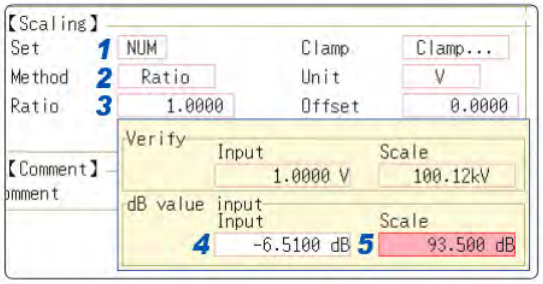
Setting example: To display measurement data on the instrument so that it corresponds with a sound level meter.

In this case the sound level meter displays 93.5 dB and the overall value displayed on the Waveform screen of the instrument is 6.51 dB.



Sound Level Meter

Refer to “Overall Value” (p. Appx.30).



0 dB reference differs depends on the physical quantity.
As an example for sound pressure, 20 µPa is 0 dB. In dB scaling, the dB value can be directly read; however, it may not be possible to directly read instantaneous values.
Refer to written standards and other materials regarding 0 dB references.

1. **Select [NUM].**
2. **Select [Ratio].**
3. **Move the cursor to [Ratio], and press the F1 [dB Scaling] key.**
   The dB Scaling dialog appears.
4. **Enter the (overall) value “−6.51” displayed on the instrument.**
5. **Enter the value “93.5” (from the sound level meter) that you want to read directly.**
6. **Press the F5 [Confirm] key to perform scaling.**
   Scaling will be performed automatically and the conversion value set in the conversion rate column.

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13.5 Configuring the Screen Display Settings

Set the display method for FFT calculation results.

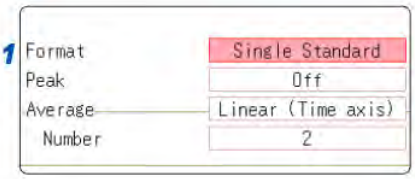
Procedure

To display the screen

Press the **STATUS** key to open the Status screen, and then select the **[Status]** sheet.

1 **Select the display format.**

Move the cursor to **[Format]**.
Select the format of data to be displayed.
The display format depends on the input data selected for analysis.



Single Standard	The FFT calculation results are displayed in one screen. If the calculations have multiple settings, waveforms will be overlaid. Note: Depending on the analysis mode settings, only analysis No.1 may be displayed.
Dual Standard	The FFT calculation results are displayed in two screens. If the calculations have multiple settings, waveforms are displayed for each specified calculation.
Single Nyquist*	If the analysis mode is linear spectrum, transfer function or cross power spectrum, the FFT calculation result is displayed in a Nyquist display on two screens. If the calculations have multiple settings, waveforms will be overlaid.
Dual Nyquist*	If the analysis mode is linear spectrum, transfer function or cross power spectrum, the FFT calculation result is displayed in a Nyquist display on one screen. If the calculations have multiple settings, waveforms are displayed for each specified calculation.
Running Spectrum	If the analysis mode is one of the following, analysis results will be displayed in three-dimensions: frequency, oscillation and time. (Linear spectrum, RMS spectrum, power spectrum, power spectrum density, LPC analysis, transfer function, cross power spectrum, 1/1 octave analysis, 1/3 octave analysis) If the calculations have multiple settings, display of No1 will take priority.

* The horizontal axis and vertical axis display the real parts and the imaginary parts of calculation results, respectively.

To use an existing memory waveform for analysis

Select **[From Memory]** as the input data source for **[Reference]**.
Refer to "13.3.2 Setting the Data Source for Analysis (Reference Data)" (p. 276).

To specify the analysis starting point

Specify the starting point on the memory waveform.
Refer to "13.8.1 Calculating After Specifying the Calculation Starting Point" (p. 300).

2 **Press the DISP key to display the Waveform screen.**

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When "Drawing failed" is displayed

- **NG: Nyquist, Running Spectrum**
  The display format settings and analysis mode do not match.

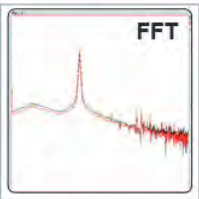
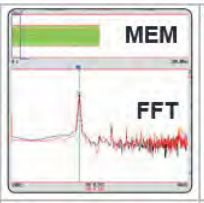
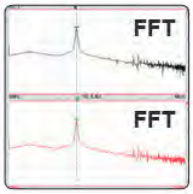
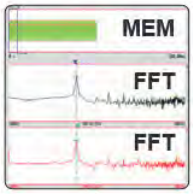
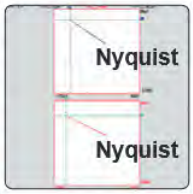
- **NG: X-Axis**
  Either change the **[Format]** setting and increase the number of screen divisions or change the display setting of the X-axis.
  Linear and logarithmic X-axes cannot be displayed on the same graph.

- **NG: X-unit**
  Set **[Format]** and increase the number of screen divisions. Different horizontal axis units cannot be displayed on the same graph.

- **NG: EXT**
  Analysis mode cannot perform external sampling.

Display Types and Split-Screen Settings

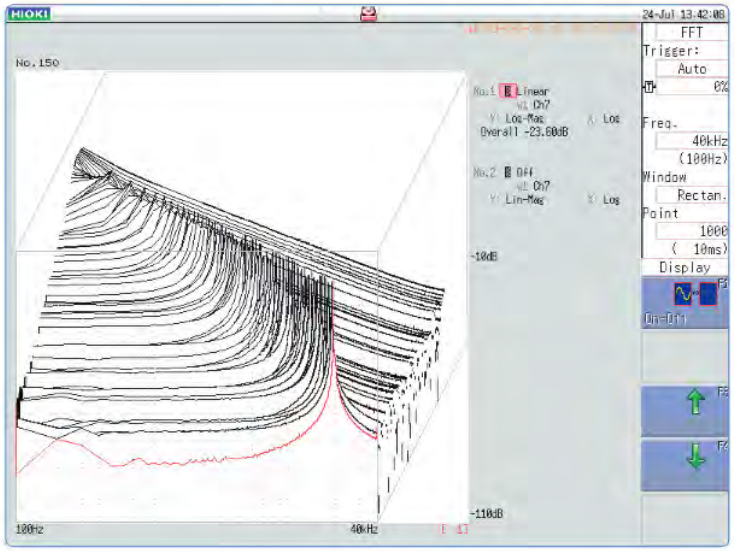
Nine display arrangements are available.

	Normal		Nyquist		Running Spectrum
	Single standard	Dual standard	Single Nyquist	Dual Nyquist	Running spectrum
[Reference] setting	**[New Data]**	**[From Memory]**	**[New Data]**	**[From Memory]**	**[New Data]**
One division					
Two divisions					

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13.5.1 Displaying the Running Spectrum

If **[Format]** is set to **[Running spectrum]**, you can observe changes in frequency over time.



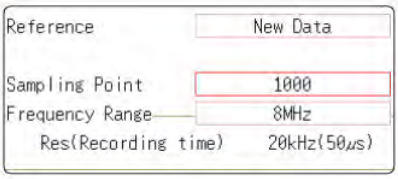
Procedure

To display the screen

Press the **STATUS** key to open the Status screen, and then select the **[Status]** sheet.

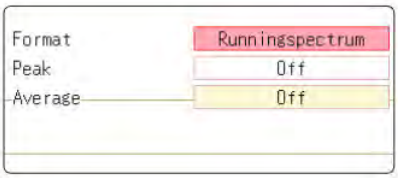
1 **Select the reference data.**

Move the cursor to **[Reference]**, and select **[New Data]**.



2 **Select the display format.**

Move the cursor to **[Format]**, and select **[Running spectrum]**.



- **[Running spectrum]** can only be set when **[Reference]** is **[New Data]**.
- The calculation interval (time interval of the running spectrum waveform and the waveform) is not regulated.
- Averaging cannot be used.
- Calculations that can be analyzed by running spectrum are limited to the following list. When other calculations are selected or calculation settings are changed after measurement stops, waveforms will not be displayed.
  (Linear spectrum, RMS spectrum, power spectrum, power spectrum density, LPC analysis, transfer function, cross power spectrum, 1/1 octave analysis, 1/3 octave analysis)
- When running spectrum is displayed, the auto-save/auto-print during measurement cannot be performed.

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Procedure

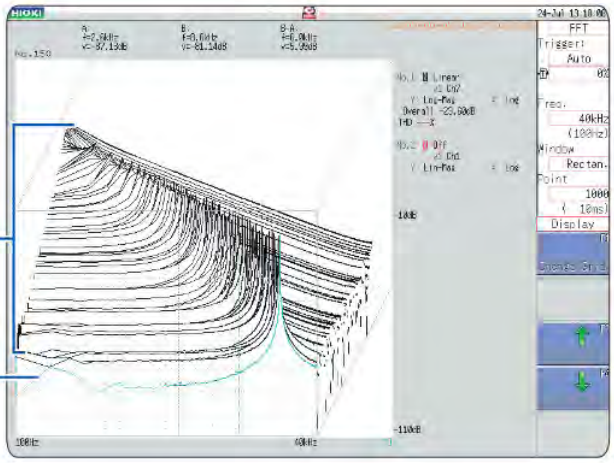
To display the screen

Press the **DISP** key to open the Waveform screen.

To stop waveform movement during measurement

Waveform movement can be stopped temporarily by pressing the **AUTO** key during measurement.
The latest calculation results are displayed in the foreground.

To restart, press the **AUTO** key again.



To read measurement values of past waveforms with the cursor

After measurement is finished, the values of each waveform can be read using the cursor.

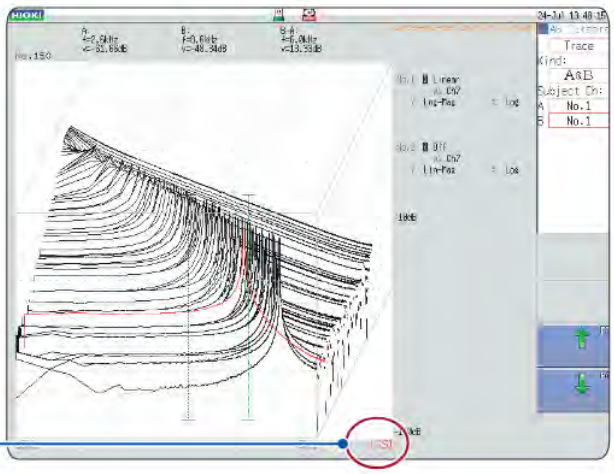
1 **Press the WAVE key on the panel of the instrument.**

2 **Select a waveform.**

Use the jog and shuttle knobs to select the waveform.
(The waveform number is displayed in the lower right of the screen.)

3 **Move the cursor.**

Press the **AB CSR** key, then rotate the jog and shuttle to read the cursor value.



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To change the grid display

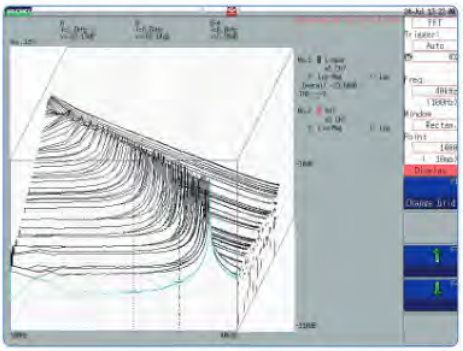
The display format of the grid can be selected.

1 **Press the WAVE key on the panel of the instrument.**

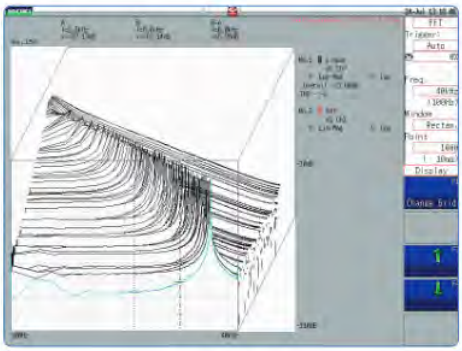
2 **Move the cursor to [Display].**

3 **To change the grid display**

Press the **F1 [Change Grid]** key and change the grid display.
Each time the key is pressed, the display format changes.



Grid Type 1



Grid Type 2



Change the number of waveforms to be displayed.

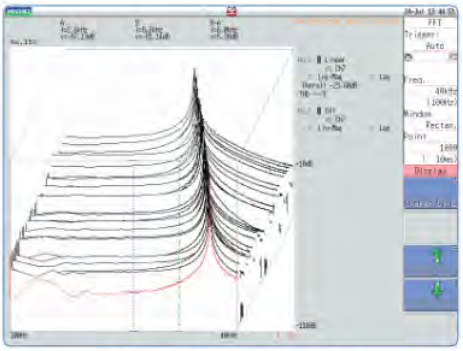
The number of waveforms to be displayed can be changed.
The following number of waveforms can be selected: 10, 20, 50, 100, and 200.

1 **Press the WAVE key on the panel of the instrument.**

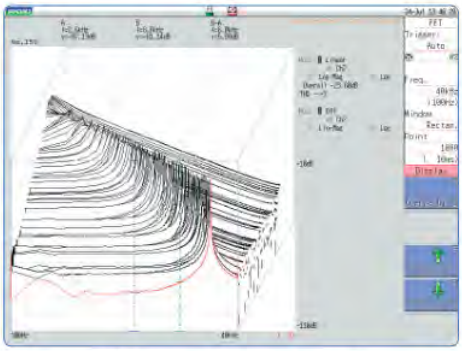
2 **Move the cursor to [Display].**

3 **Change the number of waveforms to be displayed.**

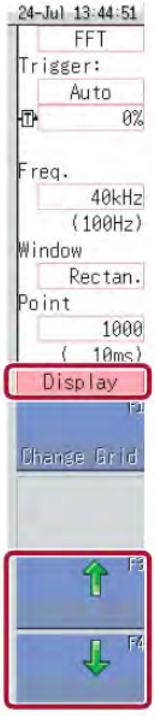
Using either the **F3 [↑]** or **F4 [↓]** key, adjust the number of waveforms to be displayed.



50 waveforms displayed



100 waveforms displayed



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13.6 Saving Analysis Results

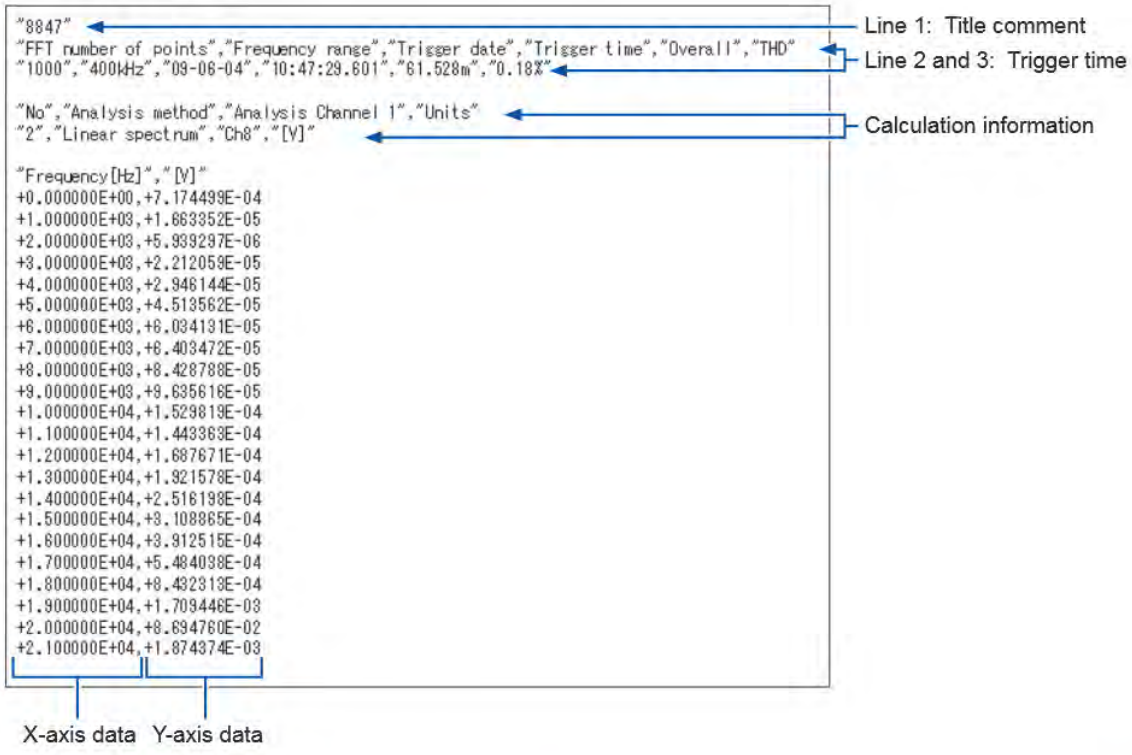
The procedure to save analysis results is the same as for the Memory and Recorder functions.
Refer to “5 Saving/Loading Data and Managing Files” (p. 91).

The size of saved files depends on the save format and analysis method.
Refer to “Appx. 2.1 Waveform File sizes” (p. Appx.2).

▪ When FFT analysis results are saved as text

Each calculation item is saved to a separate file.

Text save example



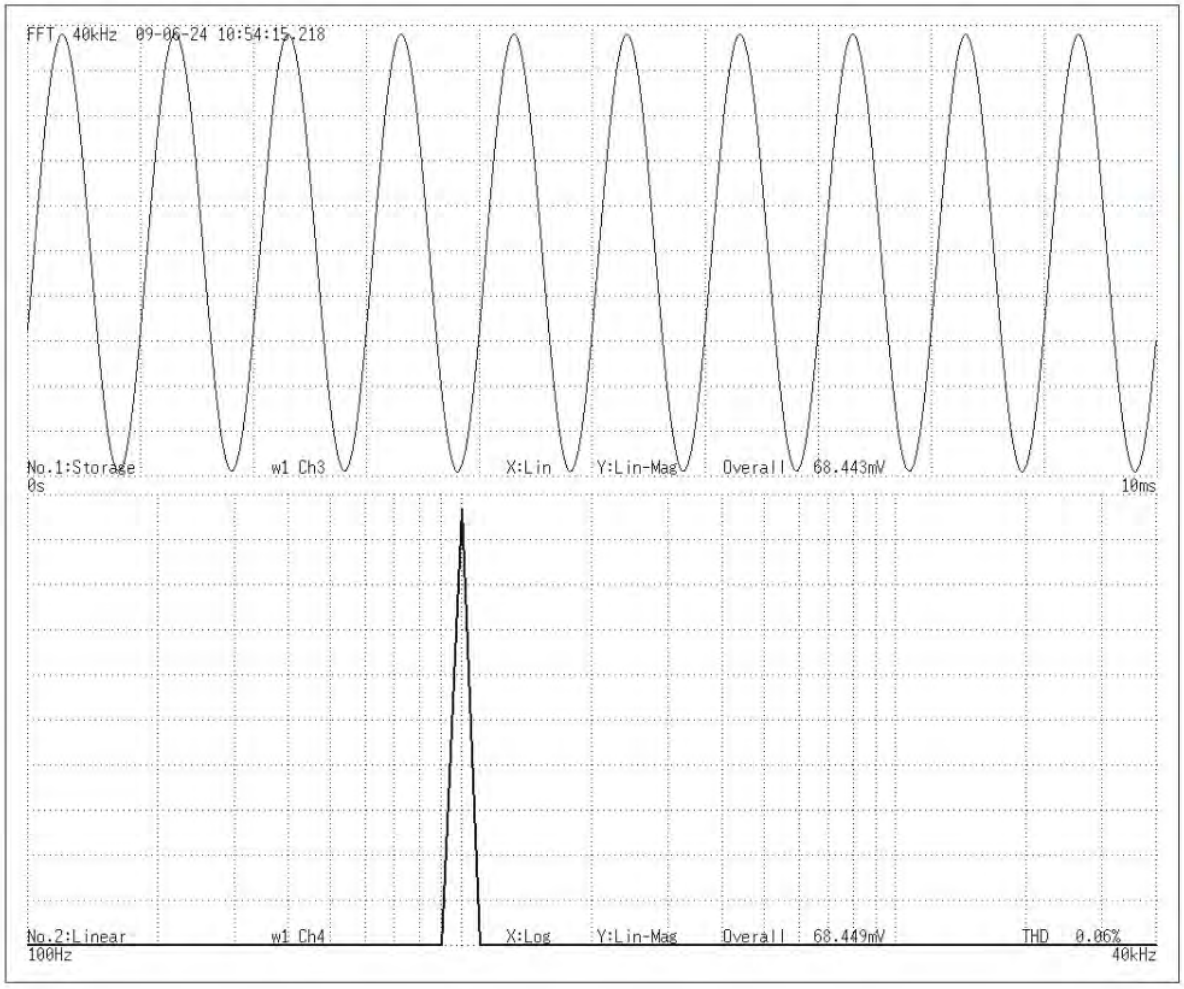
If trigger time is not displayed properly when you open a file with Excel, select “Custom” for [Format] of [Format Cells] and enter “hh:mm:ss.000” for Type.

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13.7 Printing Analysis Results

The printing procedure is the same as for the Memory and Recorder functions.
Refer to “6 Printing Data” (p. 125).

Example waveform print



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13.8 Analyzing Waveforms on the Waveform Screen

13.8.1 Calculating After Specifying the Calculation Starting Point

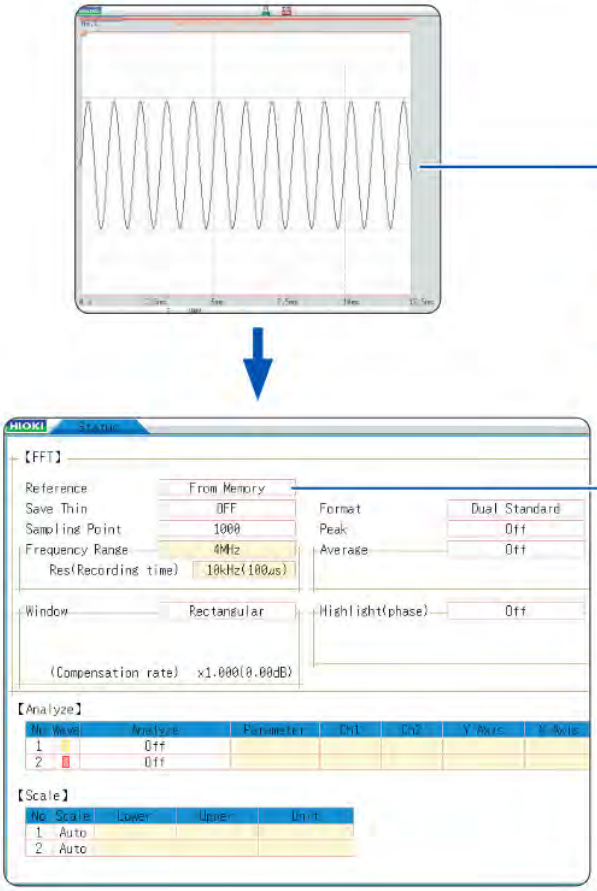
The FFT function can specify the calculation start point for waveforms previously measured using the memory function.

Operation differs depending on the calculation execution settings.
Refer to “Trigger Modes and Averaging” (p. 284).

- **Calculation execution: [Single]**
  The calculation is performed once on the specified number of calculation points beginning with the specified starting point, and the analysis results are displayed.
  This is convenient for calculating only data belonging a specific range. However, if the averaging is enabled, the calculations repeats for the specified averaging count.

- **Calculation execution: [Repeat]**
  The calculations are performed repeatedly on the specified number of calculation points beginning with the specified starting point and ending with end of waveform data, and final analysis results are displayed. (The calculations are performed for the number of specified points so a good end point becomes the final analysis result.)

To verify the calculation starting point while viewing analysis data



1 Display the waveform with the memory function.

2 Switch to the FFT function.

3 Press the **STATUS** key to display the **[Status]** sheet of the Status screen.

4 Set **[Reference]** to **[From Memory]**.

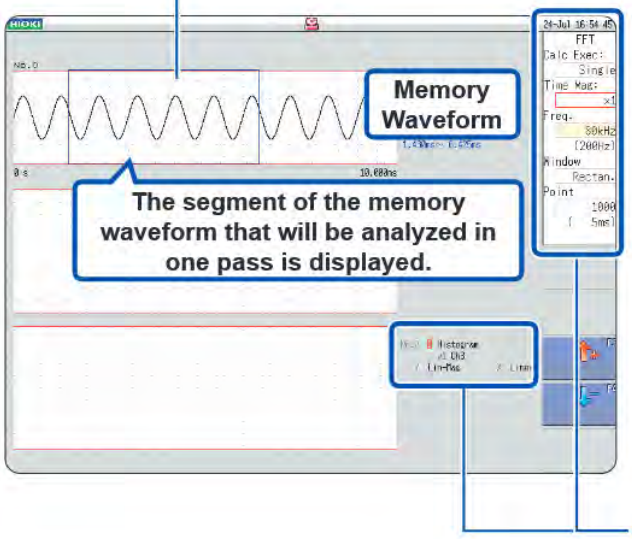
Set analysis conditions such as the analysis mode and number of calculation points (These can also be set on the Waveform screen).

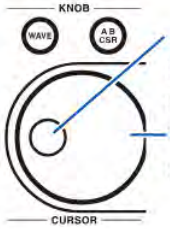
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5 Press the DISP key to display the Waveform screen.

The one-time calculation range is displayed for the memory waveform.

6 Specify the location of the analysis input data using the jog and shuttle controls.

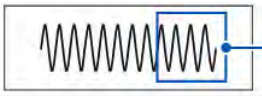




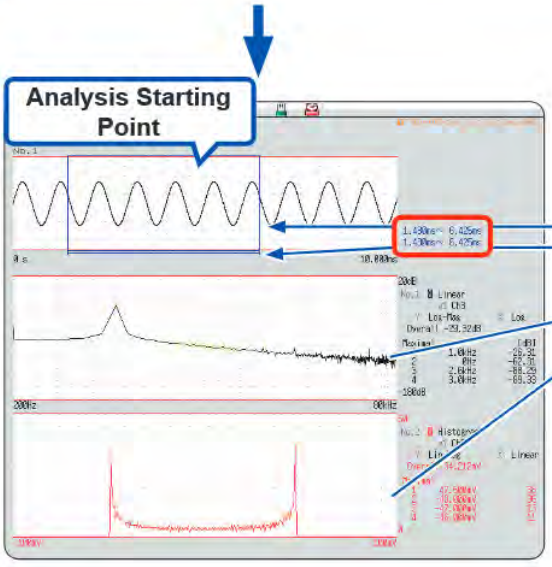
Jog
Moves the analysis starting point.

Shuttle
Scrolls the Memory waveform.

7 Select analysis conditions as needed.

To change the number of analysis points	The setting can be changed at the top of the Waveform screen. The range is determined by the number of analysis points. If the analysis range (number of points) goes past the end of the memory waveform as shown below, analysis will not be performed.  Analysis Segment Display
To analyze only a certain portion	If **[Exec]** is **[Single]** in the setting items at the right side of the screen, only the calculation range currently displayed will be calculated. For settings other than **[Single]**, calculation points are calculated until the end of the waveform data. To interrupt calculation, press the **STOP** key.

8 Use [Exec] or press the START key to perform analysis.



Calculation range (portion in square)
Last range calculated (line portion)

Analysis results are displayed on the lower graphs.

When the trigger mode is **[Auto]** or **[Repeat]**, the number of analysis points up to the end of the waveform data is analyzed, and the last data is displayed.

Memory waveforms are not printed.

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13.9 FFT Analysis Modes

13.9.1 Analysis Modes and Display Examples

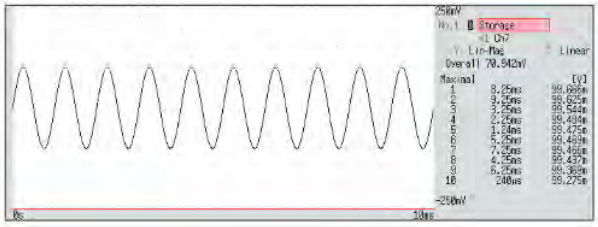
For the functions of each analysis mode, refer to “13.9.2 Analysis Mode Functions” (p. 320).

Storage

This displays the time-domain waveform of the input signal.
When the window function setting is other than rectangular, the window function is applied to the time-domain waveform before it is displayed.

Axis	Display type	Description
X-axis	Linear	Time-domain display Displays the value of the time-domain waveform corresponding to the set frequency range. Refer to “Relationship between frequency range, resolution and number of analysis points” (p. 278).
Y-axis	Lin-Mag	Displays the module waveform.

Waveform Example



Window: Rectangular
X-axis: Linear
Y-axis: Lin-Mag

Histogram

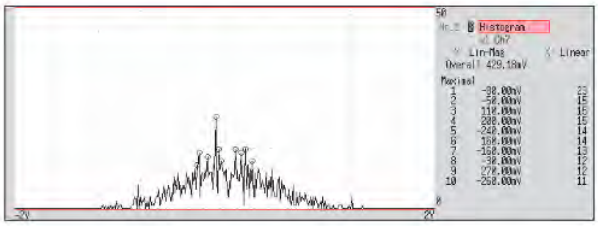
This acquires the amplitude distribution of the input signal.
Main uses:

- To inspect deviations in the amplitude range of a waveform
- To check analysis point distribution to ascertain whether a waveform is artificial or natural

About the Functions, refer to “13.9.2 Analysis Mode Functions” (p. 320).

Axis	Display type	Description
X-axis	Linear	Displays input level of the input signal.
Y-axis	Lin-Mag	Displays analysis data distribution.

Waveform Example



Normal display
X-axis: Linear
Y-axis: Lin-Mag

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Linear spectrum

The linear spectrum plots the input signal frequency. It can also be displayed as a Nyquist plot.
Main uses:

- To inspect the peak frequency contents of a waveform
- To inspect signal amplitudes at each frequency

About the Functions, refer to “13.9.2 Analysis Mode Functions” (p. 320).

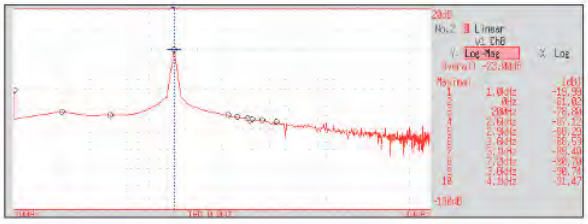
Axis	Display type	Description
X-axis	Linear	Displays the frequency on a linear scale.
	Log	Displays the frequency on a logarithm scale.
	Nyquist display	The real-number component of analysis values is displayed linearly.
Y-axis	Lin-Mag	Displays analysis values linearly.
	Log-Mag	Displays analysis results as dB values. (0 dB reference value: 1eu)*
	Lin-Real	Displays the real-number component of analysis values.
	Lin-Imag	Displays the imaginary component of analysis values.
	Nyquist display	Displays the imaginary component of analysis values.

* eu: engineering units that are currently set are the standard. (e.g., when the unit settings is volts, 0 dB = 1 V)

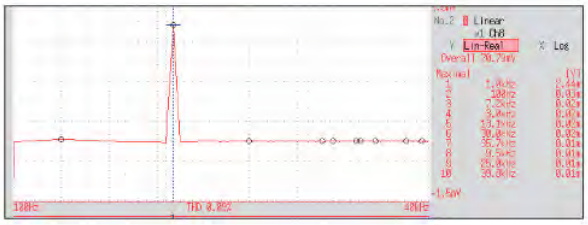
Waveform Example



Normal display
X-axis: Log
Y-axis: Lin-Mag



Normal display
X-axis: Log
Y-axis: Log-Mag

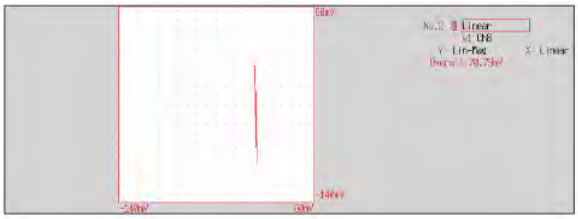


Normal display
X-axis: Log
Y-axis: Lin-Real



Normal display
X-axis: Log
Y-axis: Lin-Imag

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Nyquist display

- If the cursor is displayed, the total harmonic distortion (THD) with the fundamental wave set to the cursor position will be displayed. When two cursors appear, the A cursor becomes the fundamental wave. When results cannot be obtained, **[---%]** is displayed.
- When only sine waves are input, the level of this component becomes approximately 1.4 times (3 dB) larger than the overall value. To measure at a reference the same as the overall value, analyze using RMS spectrum or power spectrum.
  Refer to “RMS spectrum” (p. 305) and “Power spectrum” (p. 306).

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RMS spectrum

The oscillation component (actual value) is calculated from the frequency axis waveform of the input signal.
RMS and power spectra displays use the same analysis results displayed logarithmically (amplitude in dB).
Main uses:

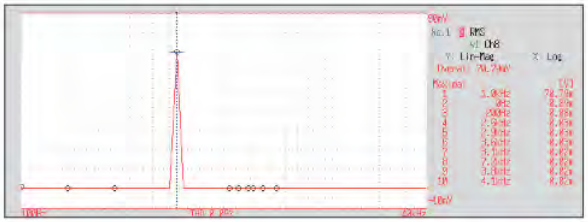
- To inspect the execution value of the frequency component of the waveform
- To inspect the RMS value of each frequency

About the Functions, refer to “13.9.2 Analysis Mode Functions” (p. 320).

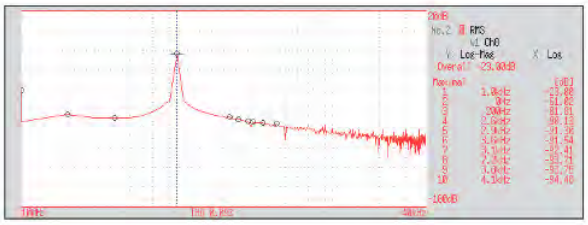
Axis	Display type	Description
X-axis	Linear	Displays the frequency on a linear scale.
	Log	Displays the frequency on a logarithm scale.
Y-axis	Lin-Mag	Displays analysis values linearly.
	Log-Mag	Displays analysis results as dB values. (0 dB reference value: 1eu)*
	Lin-Real	Displays the real-number component of analysis values.
	Lin-Imag	Displays the imaginary component of analysis values.

* eu: engineering units that are currently set are the standard. (e.g., when the unit settings is volts, 0 dB = 1 V)

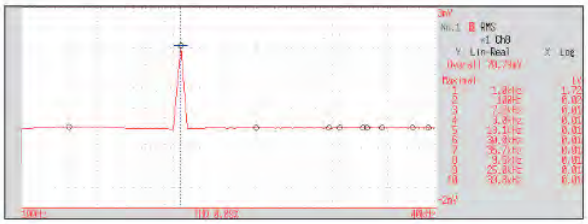
Waveform example



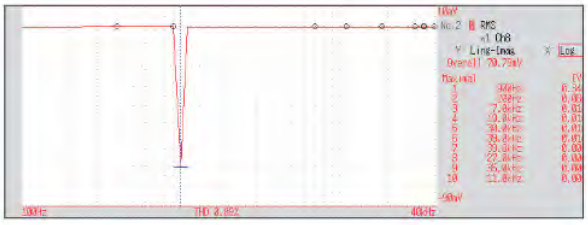
Normal display
X-axis: Log
Y-axis: Lin-Mag



Normal display
X-axis: Log
Y-axis: Log-Mag



Normal display
X-axis: Log
Y-axis: Lin-Real



Normal display
X-axis: Log
Y-axis: Lin-Imag

If the cursor is displayed, the total harmonic distortion (THD) with the fundamental wave set to the cursor position will be displayed. When two cursors appear, the A cursor becomes the fundamental wave. When results cannot be obtained, **[---%]** is displayed.

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Power spectrum

This displays input signal power as the amplitude component.
Main uses:

- To inspect the peak frequency contents of a waveform
- To inspect the power level of each frequency

About the Functions, refer to “13.9.2 Analysis Mode Functions” (p. 320).

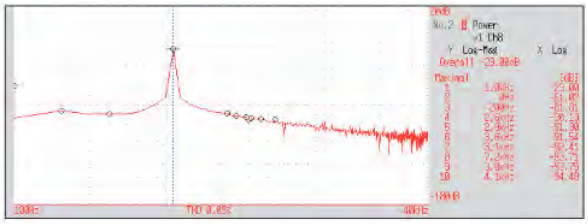
Axis	Display type	Description
X-axis	Linear	Displays the frequency on a linear scale.
	Log	Displays the frequency on a logarithm scale.
Y-axis	Lin-Mag	Analysis data is displayed linearly as squared values. Indicates the power component.
	Log-Mag (logarithm)	Displays analysis results as dB values. (0 dB reference value: $1eu^2$)*

* eu: engineering units that are currently set are the standard. (e.g., when the unit settings is volts, 0 dB = 1 V^2)

Waveform example



Normal display
X-axis: Log
Y-axis: Lin-Mag



Normal display
X-axis: Log
Y-axis: Log-Mag

If the cursor is displayed, the total harmonic distortion (THD) with the fundamental wave set to the cursor position will be displayed. When two cursors appear, the A cursor becomes the fundamental wave. When results cannot be obtained, **[---%]** is displayed.

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Power spectrum density

This indicates the power spectrum density of the input signal with only the amplitude component included. This is the power spectrum divided by the frequency resolution.

Main uses:

To acquire a power spectrum with 1 Hz resolution for highly irregular waveforms such as white noise

About the Functions, refer to "13.9.2 Analysis Mode Functions" (p. 320).

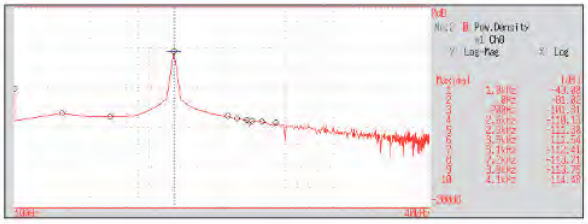
Axis	Display type	Description
X-axis	Linear	Displays the frequency on a linear scale.
	Log	Displays the frequency on a logarithm scale.
Y-axis	Lin-Mag	Displays analysis values linearly.
	Log-Mag (logarithm)	Displays analysis results as dB values. (0 dB reference value: $1eu^2/Hz$)*

* eu: engineering units that are currently set are the standard. (e.g., when the unit settings is volts, 0 dB = 1 V^2)

Waveform example



Normal display
X-axis: Log
Y-axis: Lin-Mag



Normal display
X-axis: Log
Y-axis: Log-Mag

Not available with external sampling enabled.

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Linear predictive cording (LPC) analysis (Power spectrum density)

When the spectrum shape is complex and hard to understand with either linear or power spectra, a rough spectrum structure can be obtained.

Main uses:

To obtain a spectral envelope using statistical methods

About the Functions, refer to “13.9.2 Analysis Mode Functions” (p. 320).

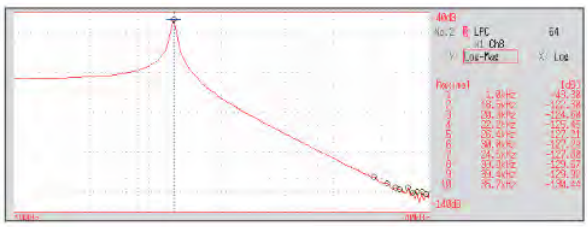
Axis	Display type	Description
X-axis	Linear	Displays the frequency on a linear scale.
	Log	Displays the frequency on a logarithm scale.
Y-axis	Lin-Mag	Displays analysis values linearly.
	Log-Mag (logarithm)	Displays analysis results as dB values. (0 dB reference value: $1eu^2/Hz$)*

* eu: engineering units that are currently set are the standard. (e.g., when the unit settings is volts, 0 dB = 1 V^2)

Waveform example



X-axis: Log
Y-axis: Lin-Mag



X-axis: Log
Y-axis: Log-Mag

- Always specify the order (from 2 to 64). Higher orders can expose finer spectral details.
- Amplitude values provided by LPC are not always the same as the power spectrum density.
- If an error occurs during analysis, no waveform will be displayed.
- Noise-like phenomena can strongly affect the spectrum shape.
- Not available with external sampling enabled.

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Transfer function

From the input and output signals, the transfer function (frequency characteristic) of a measurement system can be obtained. It can also be displayed as a Nyquist plot.

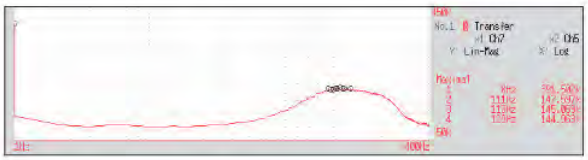
Main uses:

- To inspect a filter's frequency characteristic
- To inspect the stability of a feedback control system (using the Nyquist plot)
- To inspect the resonance characteristic of an object using an impulse hammer and pick-up sensor

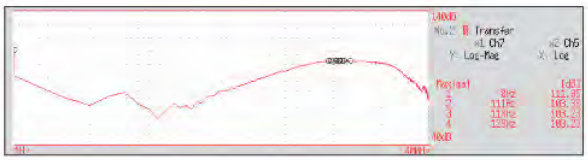
About the Functions, refer to "13.9.2 Analysis Mode Functions" (p. 320) and "Linear Time-Invariant Systems" (p. Appx.25).

Axis	Display type	Description
X-axis	Linear	Displays the frequency on a linear scale.
	Log	Displays the frequency on a logarithm scale.
	Nyquist display	Displays the real-number component of the input-output ratio.
Y-axis	Lin-Mag	Displays the input-output ratio linearly. (dimensionless units)
	Log-Mag (logarithm)	Displays the input-output ratio as dB values.
	Lin-Real	Displays the real-number component of the input-output ratio. (dimensionless units)
	Lin-Imag	Displays the imaginary component of the input-output ratio. (dimensionless units)
	Nyquist display	Displays the imaginary component of the input-output ratio.

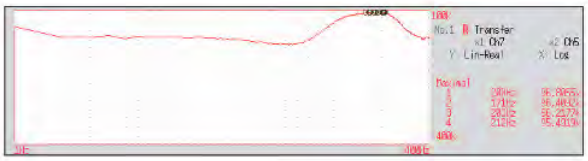
Waveform example



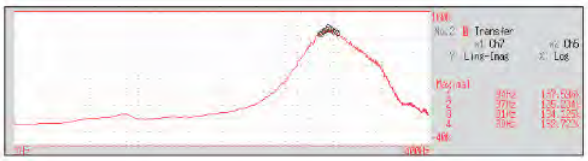
Normal display
X-axis: Log
Y-axis: Lin-Mag



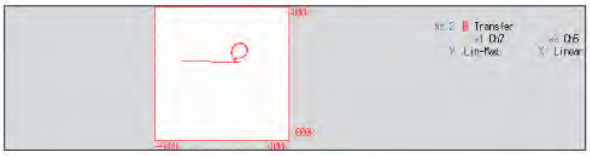
Normal display
X-axis: Log
Y-axis: Log-Mag



Normal display
X-axis: Log
Y-axis: Lin-Real



Normal display
X-axis: Log
Y-axis: Lin-Imag



Nyquist display

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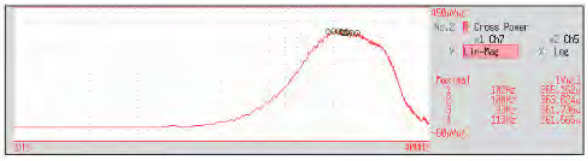
Cross power spectrum

The product of the spectra of two input signals can be obtained. Common frequency components of two signals can also be obtained.
Using the voltage and current waveforms as input signals, active power, reactive power and apparent power can be obtained for each frequency.
Main uses:
To inspect common frequency components of two signals
About the Functions, refer to "13.9.2 Analysis Mode Functions" (p. 320).

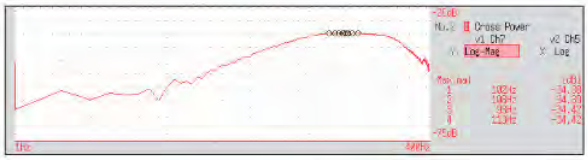
Axis	Display type	Description
X-axis	Linear	Displays the frequency on a linear scale.
	Log	Displays the frequency on a logarithm scale.
	Nyquist display	Displays the real-number component of the input-output ratio linearly.
Y-axis	Lin-Mag	Displays the squared value of amplitude contents of analysis data linearly.
	Log-Mag (logarithm)	Displays the dB value of amplitude contents of analysis data linearly. (0 dB: reference value: $1eu^2$)*
	Lin-Real	Displays the squared values of the real component of analysis data linearly.
	Lin-Imag	Displays the squared values of the imaginary component of analysis data linearly.
	Nyquist display	Displays the imaginary component of analysis data linearly.

* eu: engineering units that are currently set are the standard. (e.g., when the unit settings is volts, 0 dB = 1 V^2)

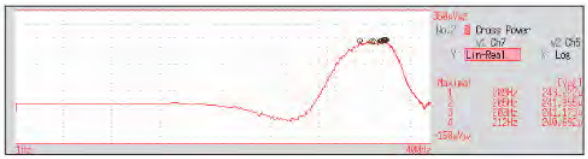
Waveform example



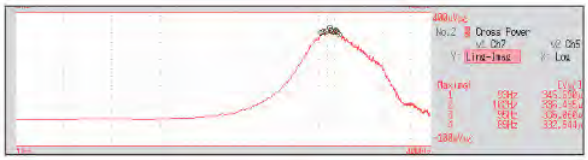
Normal display
X-axis: Log
Y-axis: Lin-Mag



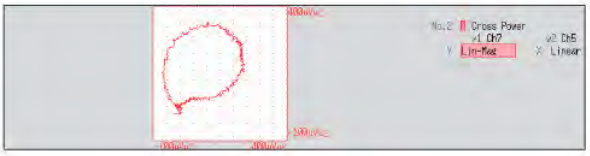
Normal display
X-axis: Log
Y-axis: Log-Mag



Normal display
X-axis: Log
Y-axis: Lin-Real



Normal display
X-axis: Log
Y-axis: Lin-Imag



Nyquist display

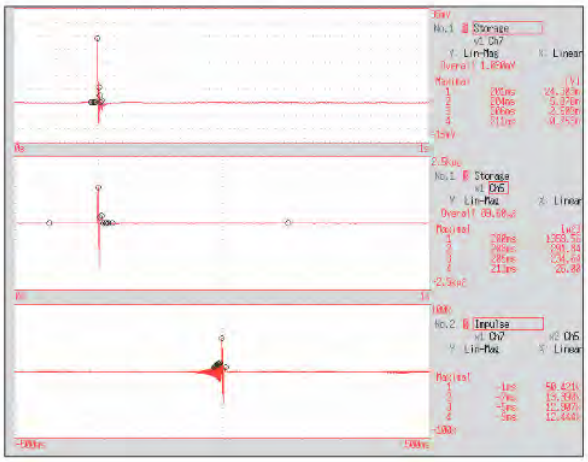
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Impulse response

This calculates the transfer characteristic of a system as a time-domain waveform.
By using both output and input signals of a measurement system, a unit impulse is applied to the system and the corresponding response waveform is obtained.
Main uses:
To inspect circuit time constants
About the Functions, refer to “13.9.2 Analysis Mode Functions” (p. 320) and “Linear Time-Invariant Systems” (p. Appx.25).

Axis	Display type	Description
X-axis	Linear	Time display The center (t = 0) is the reference. To the right is lag time ($+t$), and to the left is lead time ($-t$).
Y-axis	Lin-Mag	Displays the transfer function provided by inverse Fourier transformation.

Waveform example



Normal display
X-axis: Linear
Y-axis: Lin-Mag

Input signal 1

Input signal 2

Impulse Response

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Coherence function

This function gives a measure of the correlation (coherence) between input and output signals. Values obtained are between 0 and 1.

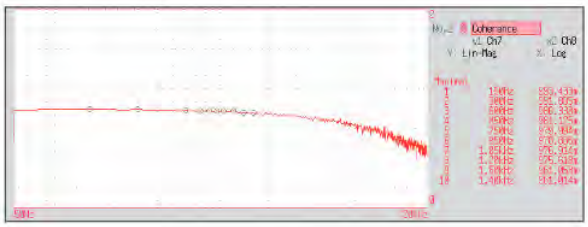
Main uses:

- To evaluate transfer functions
- In a system with multiple inputs, to inspect the effect of each input on the output

About the Functions, refer to “13.9.2 Analysis Mode Functions” (p. 320).

Axis	Display type	Description
X-axis	Linear	Displays the frequency on a linear scale.
	Log	Displays the frequency on a logarithm scale.
Y-axis	Lin-Mag	Displays the causal relationship and degree of relationship between two input signals, as a value between 0 and 1. (dimensionless units).

Waveform example



Normal display
X-axis: Log
Y-axis: Lin-Mag

- With a single measurement, the coherence function gives a value of one for all frequencies. Spectrum (frequency-domain) averaging should always be performed before measurement (analysis is not available with time-domain averaging).
- The coherence function has two general definition formulas. For the definition formulas, refer to “13.9.2 Analysis Mode Functions” (p. 320).

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Phase spectrum

This shows the phase characteristics of the input signal.
Main uses:

- To inspect the phase spectrum of channel 1 Displays the phase of a cosine waveform as a reference (0°).
- To inspect the phase difference between channels 1 and 2

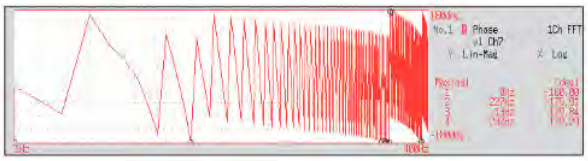
About the Functions, refer to “13.9.2 Analysis Mode Functions” (p. 320).

Although the unit for angle is [°], it is shown **[deg]** on the screen.

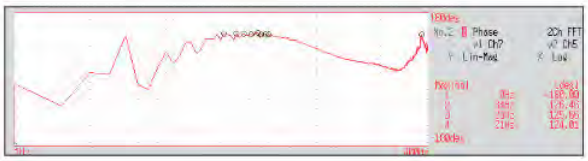
1ch FFT: Displays the phase of the signal on channel 1. Displays the phase of a cosine waveform as a reference (0°). Unless the waveform is synchronous, phase values are unstable.
2ch FFT: Displays the phase difference between channels 1 and 2. Positive values indicate that the phase of channel 2 is leading.

Axis	Display type	Description
X-axis	Linear	Displays the frequency on a linear scale.
	Log	Displays the frequency on a logarithm scale.
Y-axis	Lin-Mag	Displays analysis values linearly.

Waveform example



1ch FFT
X-axis: Log
Y-axis: Lin-Mag



2ch FFT
X-axis: Log
Y-axis: Lin-Mag

▪ Emphasizing only a specific portion (Highlighted display)

A specific portion of a phase spectrum can be emphasized and displayed.
Refer to “13.3.8 Highlighting Analysis Results (Phase Spectra Only)” (p. 285).

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Auto-correlation function

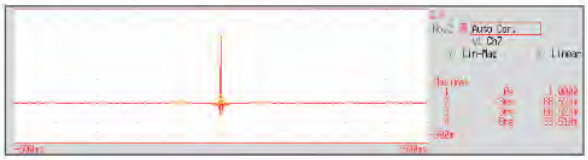
This shows the correlation of two points on the input signal at time differential t.
Main uses:

- To detect periodicity in irregular signals (improving and detecting SNR)
- To inspect periodic components in a noisy waveform

About the Functions, refer to “13.9.2 Analysis Mode Functions” (p. 320).

Axis	Display type	Description
X-axis	Linear	Time display The center (t = 0) is the reference. To the right is lag time ($+t$), and to the left is lead time ($-t$).
Y-axis	Lin-Mag	+1 to −1 (dimensionless units) The closest correlation at time differential t is +1, and the least correlation is 0. −1 indicates completely reversed polarity. Because of the characteristics of the function, t = 0 becomes +1.

Waveform example



X-axis: Linear
Y-axis: Lin-Mag

This instrument provides a circular auto-correlation function. Analysis results are normalized to the maximum value.

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Cross-correlation function

This shows the correlation of two points on tow input signals at time differential t. Output is displayed as a function of differential time *t*.

Main uses:

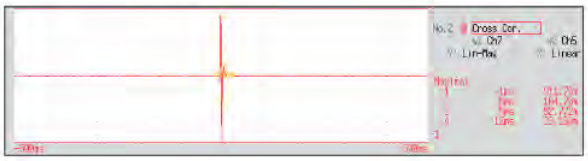
To determine the phase shift of two signals per unit of time

To determine the speed and distance of time lag between two signals

About the Functions, refer to "13.9.2 Analysis Mode Functions" (p. 320).

Axis	Display type	Description
X-axis	Linear	Time display The center (t = 0) is the reference. To the right is lag time ($+t$), and to the left is lead time ($-t$).
Y-axis	Lin-Mag	+1 to −1 is displayed in dimensionless units. At time differential t, this value is +1 when the correlation of input and output signals is the closest, and when correlation is the least the value is 0. −1 indicates completely reversed polarity.

Waveform example



X-axis: Linear
Y-axis: Lin-Mag

This instrument provides a circular cross-correlation function.
Analysis results are normalized to the maximum value.

1/1 octave, 1/3 octave

These analyze spectrums such as noise using fixed rate spectrum filters of 1/1 octave band or 1/3 octave band.

Main uses:

To analyze noise frequency

About the Functions, refer to "13.9.2 Analysis Mode Functions" (p. 320) and "Octave Filter Characteristics" (p. Appx.35).

Axis	Display type	Description
X-axis	Log	Displays the center frequency of each band.
Y-axis	Lin-Mag	Displays octave analysis values linearly.
	Log-Mag (logarithm)	Displays octave analysis values as dB values. (0 dB reference value: 1eu)*

* eu: engineering units that are currently set are the standard. (e.g., when the unit settings is volts, 0 dB = 1 V)

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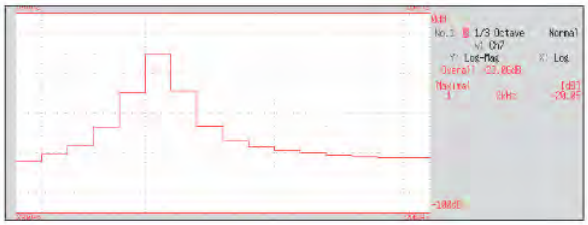
Waveform example



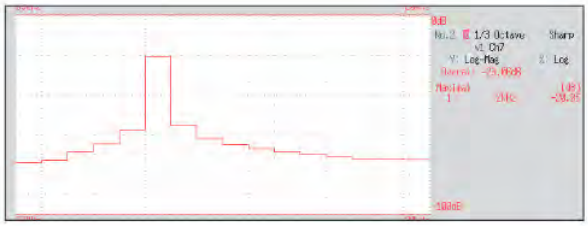
1/1 Octave Analysis
X-axis: Log
Y-axis: Log-Mag
Filter: Normal



1/1 Octave Analysis
X-axis: Log
Y-axis: Log-Mag
Filter: Sharp



1/3 Octave Analysis
X-axis: Log
Y-axis: Log-Mag
Filter: Normal



1/3 Octave Analysis
X-axis: Log
Y-axis: Log-Mag
Filter: Sharp

Not available with external sampling enabled.

▪ Octave analysis

Octave analysis consists of frequency analysis of the signal passed through a constant-width band-pass filter. The power spectrum displays the power level in each subband after dividing the spectrum into fixed-width segments (subbands), while octave analysis scales the spectrum logarithmically and displays each octave (subband) as a bar graph.

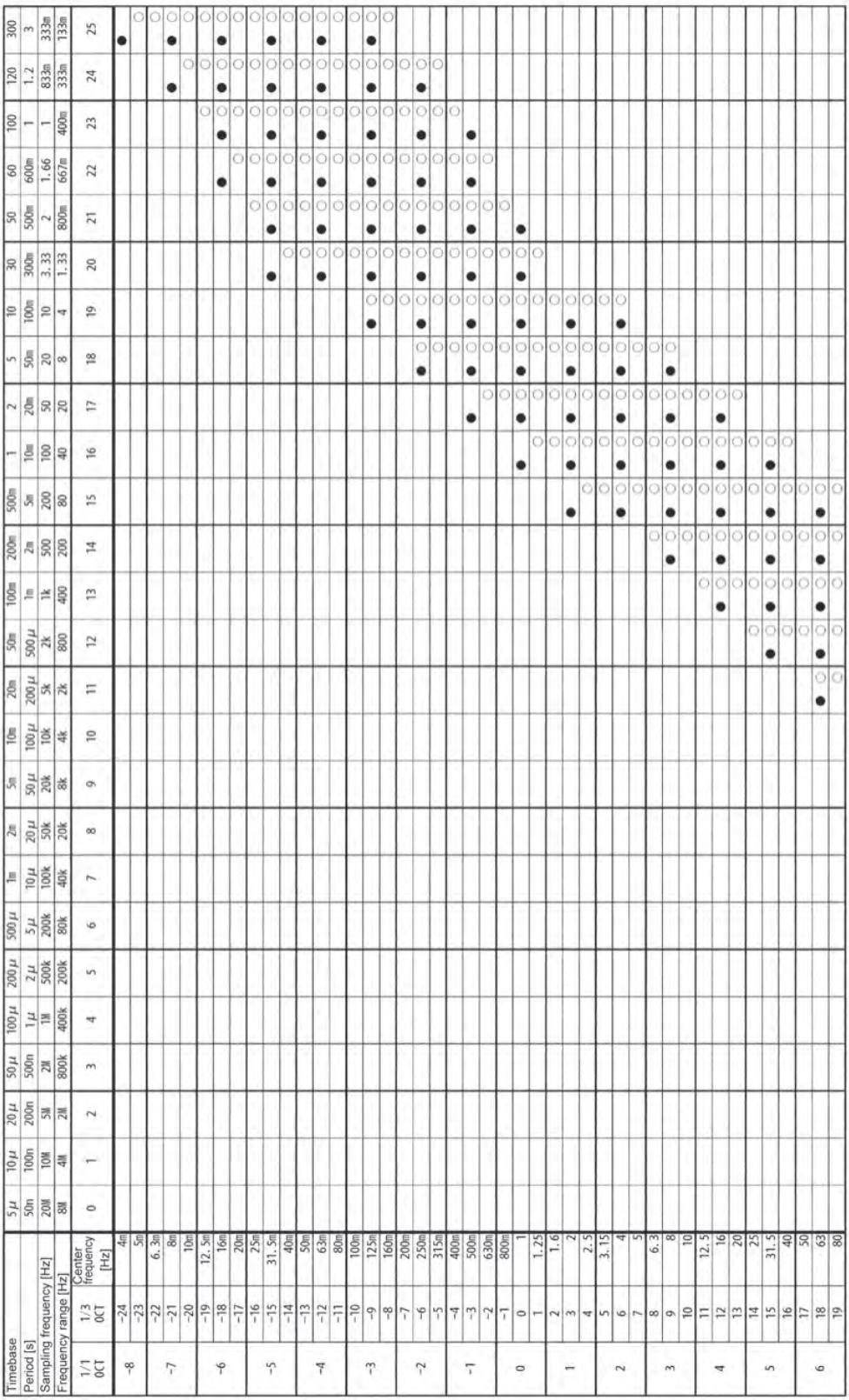
The center frequency of the octave bands and filter characteristics are determined according to IEC61260 standards. 1/1- and 1/3-octave analyses are calculated using power spectrum Analysis results.
1/1 Octave Analysis: 6 subbands
1/3 Octave Analysis: 16 subbands

The octave analysis results of this instrument are displayed based on the oscillation level as a reference. Therefore, when only sine waves are input, the value doubles (3.01 dB) versus the overall value. To directly read by energy base, adjust the level by the setting scaling in advance.
Refer to “8.5 Converting Input Values (Scaling Function)” (p. 171).

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Measurable ranges with octave analysis

(●: 1/1 OCT, ○: 1/3 OCT)



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(●: 1/1 OCT, ○: 1/3 OCT)

Timebase			5μ	10μ	20μ	50μ	100μ	200μ	500μ	1m	2m	5m	10m	20m	50m	100m	200m	500m	1	2	5	10	30	50	60	100	120	300
Period [s]			50n	100n	200n	500n	1μ	2μ	5μ	10μ	20μ	50μ	100μ	200μ	500μ	1m	2m	5m	10m	20m	50m	100m	300m	500m	600m	1	1.2	3
Sampling frequency [Hz]			20M	10M	5M	2M	1M	500k	200k	100k	50k	20k	10k	5k	2k	1k	500	200	100	50	20	10	3.33	2	1.66	1	833m	333m
Frequency range [Hz]			8M	4M	2M	800k	400k	200k	80k	40k	20k	8k	4k	2k	800	400	200	80	40	20	8	4	1.33	800m	667m	400m	333m	133m
1/1 OCT	1/3 OCT	Center frequency [Hz]	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
7	20	100												○	○	○	○											
	21	125											● ○	● ○	● ○	● ○	● ○											
	22	160											○	○	○	○	○											
8	23	200											○	○	○	○	○											
	24	250										● ○	● ○	● ○	● ○	● ○	●											
	25	315										○	○	○	○	○												
9	26	400										○	○	○	○	○												
	27	500									●	● ○	● ○	● ○	● ○	●												
	28	630									○	○	○	○	○													
10	29	800									○	○	○	○	○													
	30	1k								●	● ○	● ○	● ○	● ○	●													
	31	1.25k								○	○	○	○	○														
11	32	1.6k								○	○	○	○	○														
	33	2k							●	● ○	● ○	● ○	● ○	● ○														
	34	2.5k							○	○	○	○	○															
12	35	3.15k							○	○	○	○	○															
	36	4k							● ○	● ○	● ○	● ○	● ○															
	37	5k							○	○	○	○																
13	38	6.3k						○	○	○	○	○																
	39	8k						● ○	● ○	● ○	● ○	● ○																
	40	10k						○	○	○	○																	
14	41	12.5k					○	○	○	○	○																	
	42	16k					● ○	● ○	● ○	● ○	● ○																	
	43	20k					○	○	○	○	○																	
15	44	25k				○	○	○	○	○																		
	45	31.5k				● ○	● ○	● ○	● ○	● ○																		
	46	40k				○	○	○	○	○																		
16	47	50k				○	○	○	○																			
	48	63k			● ○	● ○	● ○	● ○	● ○																			
	49	80k			○	○	○	○	○																			
17	50	100k			○	○	○	○																				
	51	125k		● ○	● ○	● ○	● ○	● ○																				
	52	160k		○	○	○	○	○																				
18	53	200k		○	○	○	○	○																				
	54	250k	● ○	● ○	● ○	● ○	● ○	●																				
	55	315k	○	○	○	○	○																					
19	56	400k	○	○	○	○	○																					
	57	500k	● ○	● ○	● ○	● ○	●																					
	58	630k	○	○	○	○																						
20	59	800k	○	○	○	○																						
	60	1M	● ○	● ○	● ○	●																						
	61	1.25M	○	○	○																							
21	62	1.6M	○	○	○																							
	63	2M	● ○	● ○	● ○																							
	64	2.5M	○	○																								

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(●: 1/1 OCT, ○: 1/3 OCT)

Timebase			5μ	10μ	20μ	50μ	100μ	200μ	500μ	1m	2m	5m	10m	20m	50m	100m	200m	500m	1	2	5	10	30	50	60	100	120	300
Period [s]			50n	100n	200n	500n	1μ	2μ	5μ	10μ	20μ	50μ	100μ	200μ	500μ	1m	2m	5m	10m	20m	50m	100m	300m	500m	600m	1	1. 2	3
Sampling frequency [Hz]			20M	10M	5M	2M	1M	500k	200k	100k	50k	20k	10k	5k	2k	1k	500	200	100	50	20	10	3. 33	2	1. 66	1	833m	333m
Frequency range [Hz]			8M	4M	2M	800k	400k	200k	80k	40k	20k	8k	4k	2k	800	400	200	80	40	20	8	4	1. 33	800m	667m	400m	333m	133m
1/1 OCT	1/3 OCT	Center frequency [Hz]	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
22	65	3. 15M	○	○																								
	66	4M	● ○	● ○																								
	67	5M	○																									
23	68	6. 3M	○																									
	69	8M	● ○																									
	70	10M																										
24	71	12. 5M																										

13.9.2 Analysis Mode Functions

Analysis mode	Internal calculation formula (linear, real, imag [imaginary], log [logarithm])
OFF	No analysis
Storage waveform	Waveform obtained by applying the window function to a time-domain waveform
Histogram	Counts amplitude data.
Linear spectrum	$X(k)=\sum_{n=0}^{N-1}x(n)W^{kn}$ $F(k)=CX(k)$ $C\begin{cases}1/N(DC)\\2/N(AC)\end{cases}$ $linear=\lvert F(k)\rvert$ $real=\mathrm{Re}\{F(k)\}$ $imag=\mathrm{Im}\{F(k)\}$ $\log=20\log\lvert F(k)\rvert$
RMS spectrum	$F'(k)=C'F(k)$ $C'\begin{cases}1 & (DC)\\1/\sqrt{2} & (AC)\end{cases}$ $linear=\lvert F'(k)\rvert$ $real=\mathrm{Re}\{F'(k)\}$ $imag=\mathrm{Im}\{F'(k)\}$ $\log=20\log\lvert F'(k)\rvert$
Power spectrum	$P(k)=a\lvert F(k)\rvert^2$ $a=\begin{cases}1 & (DC)\\1/2 & (AC)\end{cases}$ $linear=P(k)$ $\log=10\log\lvert P(k)\rvert$
Power spectrum density	$P'(k)=P(k)/\delta f$ δf: Frequency resolution $linear=P'(k)$ $\log=10\log\lvert P'(k)\rvert$
LPC analysis (power spectrum density)	(Omission) Spectrum approximation from Linear Predictive Coding Refer to "Linear Predictive Coding (LPC)" (p. Appx.36).
Transfer function	$H(k)=Y(k)/X(k)$ $linear=\lvert H(k)\rvert$ $real=\mathrm{Re}\{H(k)\}$ $imag=\mathrm{Im}\{H(k)\}$ $\log=20\log\lvert H(k)\rvert$
Cross power spectrum	$S_{yx}(k)=X^*(k)Y(k)$: Cross spectrum $X_{power}(k)=AS_{yx}(k)$ $A=\begin{cases}1/N^2\\2/N^2\end{cases}$ $linear=\lvert X_{power}(k)\rvert$ $real=\mathrm{Re}\{X_{power}(k)\}$ $imag=\mathrm{Im}\{X_{power}(k)\}$ $\log=10\log\lvert X_{power}(k)\rvert$
Impulse response	$h(n)=\frac{1}{N}\sum_{k=0}^{N-1}\frac{Y(k)}{X(k)}W^{-kn}$
Coherence function	$coh(k)=\sqrt{\frac{S_{yx}(k)S_{yx}^*(k)}{S_{xx}(k)S_{yy}(k)}}$
Phase spectrum	$\theta(k)=180/\pi\times\tan^{-1}(\mathrm{Im}(F'(k))/\mathrm{Re}(F'(k))$ $\theta(k)=180/\pi\times\tan^{-1}(\mathrm{Im}(S_{yx}(k))/\mathrm{Re}(S_{yx}(k))$
Auto-correlation function	$R_{xx}(n)=\frac{1}{N}\sum_{k=0}^{N-1}\lvert X(k)\rvert^2W^{-kn}$ (recursive convolution)
Cross-correlation function	$R_{yx}(n)=\frac{1}{N}\sum_{k=0}^{N-1}S_{yx}(k)W^{-kn}$ (recursive convolution)
1/1 octave analysis	(Omission)
1/3 octave analysis	(Omission)

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14 Waveform Evaluation Function

14.1 Evaluating Waveforms and Giving GO/NG Judgments (MEM, FFT Function)

The waveform evaluation function can be used from the Memory function (single screen, X-Y single screen), FFT function (1 screen standard, 1 screen Nyquist).
GO (pass) or NG (fail) evaluation of the input signal waveform can be performed using an evaluation area specified by the user. This can detect irregular waveforms. Depending on evaluation results, signals will be output on the external control terminal.
All channels being displayed can be used for GO/NG evaluation.

Setting workflow (After the input and other settings have been finished)

Set the evaluation area

- **Load** — Load a previously created evaluation area and settings from the File screen.
- **Create a new area** — Create an evaluation area using the eight edit commands. Store the evaluation area in the internal memory and store the data to storage media from the File screen.

Set waveform evaluation

- **OFF** — Disable waveform evaluation.
- **Out** — Return NG if any part of the waveform leaves the evaluation area.
- **All out** — Return NG if the entire waveform leaves the evaluation area.

Set GO/NG stop mode

- **GO** — Stop recording on GO result.
- **NG** — Stop recording on NG result.
- **GO&NG** — Stop recording on GO or NG result.

Measurement starts

Press the **START** key to start the measurement.
Data acquisition will start when the trigger conditions are met.

Execute waveform GO/NG evaluation

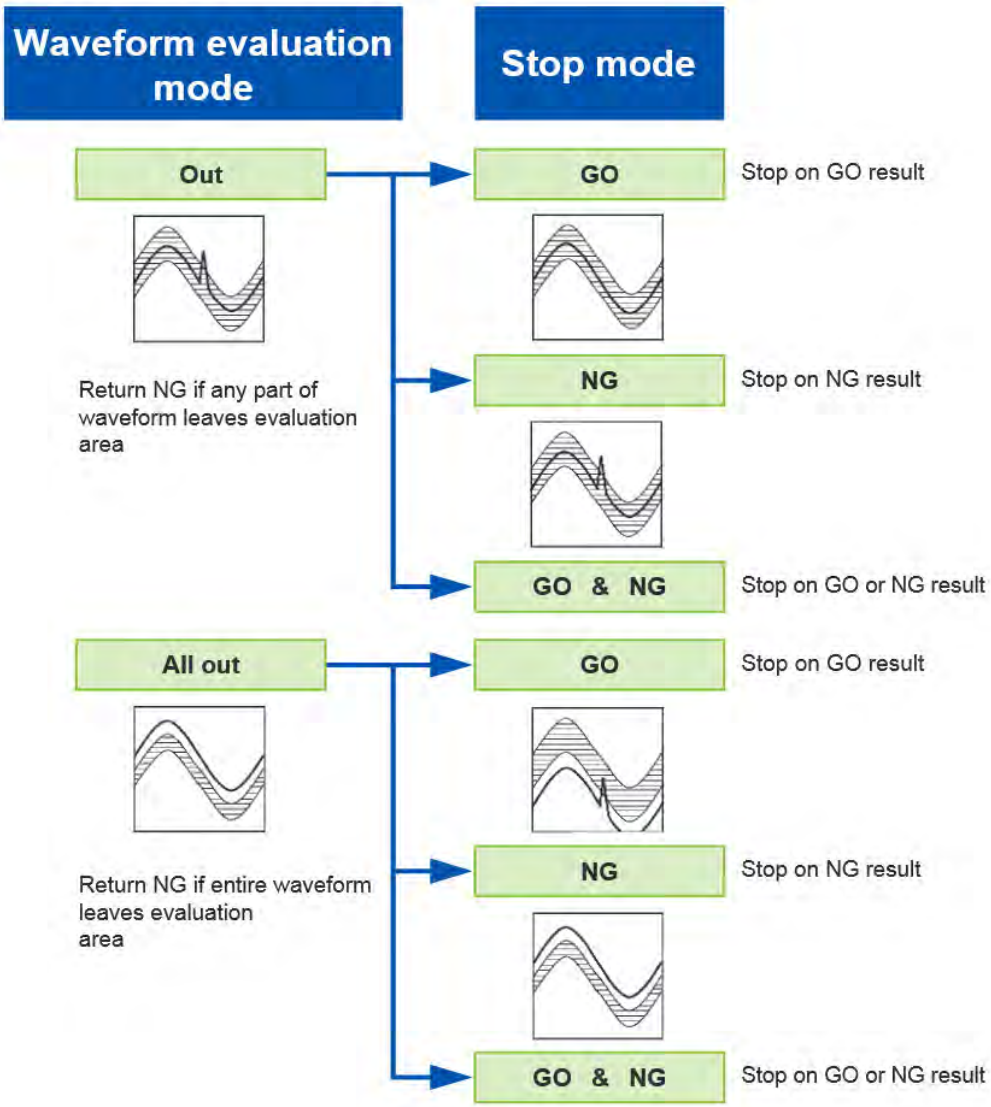
Judgment is performed once measurement of the set number of recording lengths completes. However, judgment is performed while measurement is ongoing when the time axis is 100 ms/div or less.
Once the evaluation process is complete, the result will be output as the signals from the external control terminals.
If the evaluation result satisfies the stop conditions, automatic saving and automatic printing will be performed, if enabled.
When using memory segmentation, the same block is repeatedly measured as long as the stop conditions are not satisfied. Once the stop conditions are satisfied, measurement moves to the next block.

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- When the trigger mode is **[Single]**, measurement continues until stop mode conditions are fulfilled, then stops.
- When the trigger mode is **[Repeat]** or **[Auto]**, waveform recording and evaluation are carried out continuously. Press the **STOP** key to stop measurement.
- When "Auto Print" is **[On]**, the waveform is printed when the stop conditions are satisfied.
- When "Auto Save" is **[On]**, the data is saved into the media when the stop conditions are satisfied.
- When "Memory Div" is **[On]**, data is recorded to the memory block only when the stop conditions are satisfied.
- The waveform evaluation is performed concurrently with measurement when "Roll Mode" is **[On]** and the timebase is slow as 100 ms/div or less, or when the "Roll Mode" is **[Auto]** and the display is equal to or less than 100 ms/div due to the time axis magnification. Otherwise, the evaluation is performed after measurement.
- When performing evaluation after measurement is complete, data capture and evaluation alternate repeatedly. Data is not captured while the evaluation is in progress. This means that the input signal is not being continuously monitored. The time required for evaluation is less than 100 ms. (not including time required to read data or update the display.)
- When performing evaluation and measurement concurrently, measurement continues while the waveform is displayed and evaluated. However, processing is not necessarily conducted in real time.
- If a high setting is chosen for recording length or if compression is used, the evaluation cycle becomes slower.
- Waveform scrolling is not available while "Waveform Judge" is ON (**[Out]** or **[All out]**). To use waveform scrolling, first turn **[OFF]** "Waveform Judge".
- When memory function waveform evaluation is specified, one screen of display data (25 divisions) is printed out. When you need to print waveform data with a recording length longer than 25 divisions, first set "Waveform Judge" to **[OFF]**.
- Although the waveform display will change if you change display-related settings after measurement completes, the waveform evaluation results from when the measurement was made will be retained. To repeat the evaluation process for the waveform after applying new settings, perform waveform evaluation on the Status basic settings screen.
  Refer to "7.5.1 Magnifying and Demagnifying Waveforms Horizontally (in the Time Axis Direction)" (p. 150).
- When using the highlight function with the FFT function, only the highlighted data is evaluated.

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Waveform evaluation mode and stop mode



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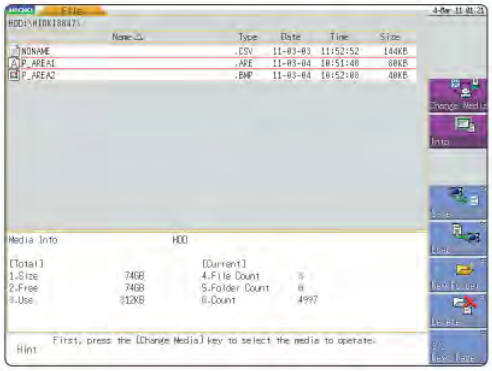
14.2 Setting the Evaluation Area

An evaluation area is required to evaluate waveforms. Two methods are available: one is to load a previously created evaluation area and settings, and the other is to create a new evaluation area.

Loading the previously created evaluation area

Procedure

Setting screen: File



1. **Press the FILE key to open the File screen.**
2. **Select the [Media] from which to load.**
3. **Use the bar cursor to select the desired file in the media.**
4. **Select a command.**
   Select **[Load]**.
5. **Choose [Exec] from the F key menu.**
6. **When no more changes need be made to the loaded settings, press the DISP key to make the Waveform screen appear, and then press the START key to initiate measurement.**
   To change the settings, first change the contents, then press the **DISP** key to make the Waveform screen appear, and then press the **START** key to initiate measurement.

   Refer to “5.3 Loading Data” (p. 110) for file loading.

Requirements for loading waveform evaluation area BMP files

Observe the following requirements when creating waveform evaluation areas on a PC and when loading waveform evaluation areas created on other equipment:

Items	Condition	Loading operation
Color	Black and white	White pixels are treated as background. Black pixels are treated as the evaluation area.
Size	501 horizontal pixels × 626 vertical pixels	The file will be used as the evaluation area for the Memory Function 1 screen.
	501 horizontal pixels × 501 vertical pixels	When using the FFT function, the file will be used as the FFT evaluation area. When using other functions, the file will be used as the memory function X-Y evaluation area.

Files that do not satisfy these requirements cannot be loaded properly.

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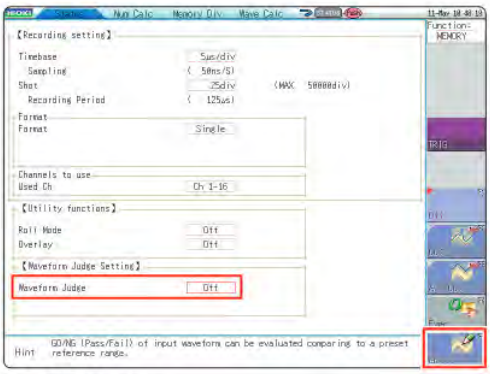
Creating a new evaluation area

Procedure

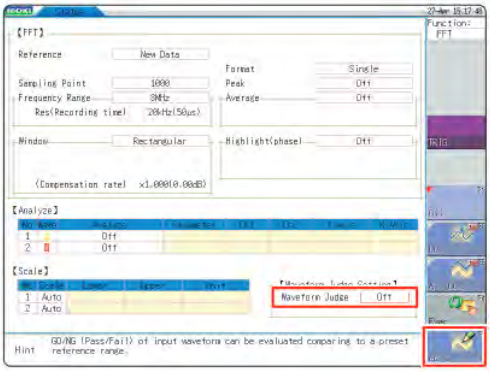
Setting screen: Status

1. **Press the STATUS key to display the Status screen.**
2. **Move the flashing cursor to [Waveform Judge].**
3. **Choose [edit] from the F key menu.**
4. **Create the evaluation area.**
   Refer to "14.5 Creating the Evaluation Area" (p. 329).
5. **Store the created area in the internal memory.**
6. **After setting "Waveform Judge setting" and "Stop Mode," press the DISP key to show the Waveform screen, then press the START key to begin measurement.**
7. **Save the evaluation area on the File screen, if necessary.**
   Refer to "5.2 Saving Data" (p. 95).

Memory Function



FFT Function



Only one waveform evaluation area may be stored in internal memory.
For example, when operation is changed from the Memory function screen to the X-Y screen and an X-Y screen waveform evaluation area is stored, a waveform evaluation area created for the Memory function will be lost.

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14.3 Configuring the Waveform Evaluation Setting

Procedure

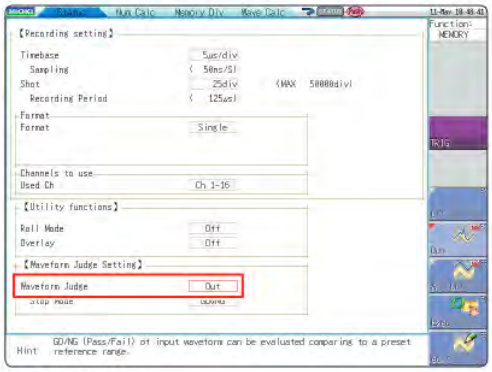
Setting screen: Status

1 **Move the flashing cursor to [Waveform Judge].**

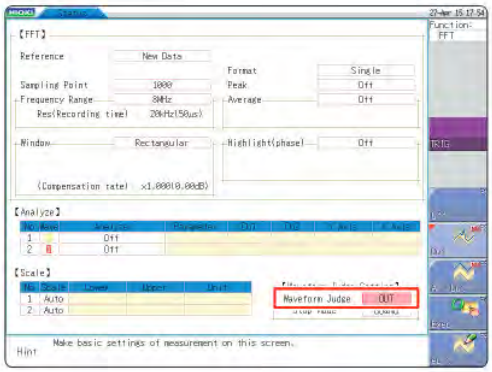
2 **Choose the required setting from the F key menu.**

OFF	Disables waveform evaluation.
Out	Returns NG if any part of the waveform leaves the evaluation area.
All out	Returns NG if the entire waveform leaves the evaluation area.
Execute	Enables waveform evaluation.
edit	Creates the evaluation area.

Memory Function



FFT Function



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14.4 Setting the Waveform Evaluation Stopping Conditions

When waveform evaluation is enabled (Out or All out is selected), the “Stop mode” menu appears.
Specify which evaluation option, GO or NG, should be used to stop the recording.
The auto-save and auto-print functions are only executed when interruption conditions are satisfied.

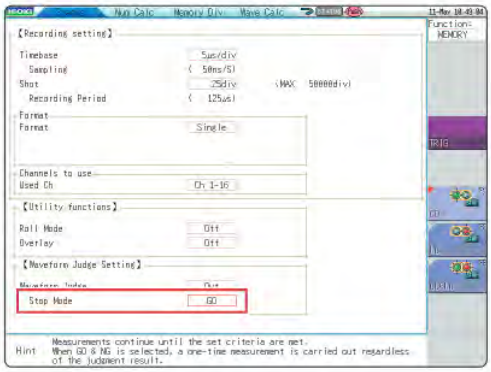
Procedure

Setting screen: Status

1 **Move the flashing cursor to [Stop Mode].**

2 **Choose the required setting from the F key menu.**

GO	Stops recording on GO result.
NG	Stops recording on NG result.
GO& NG	Stops recording on GO or NG result.



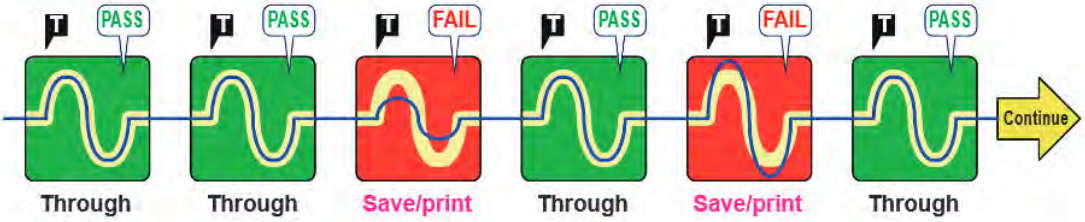
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Relationship between stop conditions and trigger mode

- There are three trigger modes: Single, Repeat, and Auto.
  Refer to "9.2 Setting the Trigger Mode" (p. 213).
- There are three stop conditions: GO (Pass), NG (Fail), and GO&NG (Pass & Fail)
- By combining a trigger mode and a stop condition, you can halt measurement when the desired comparison result is achieved. You can also automatically save, automatically print, or superimpose the waveform for the desired evaluation results.
  Automatic saving, automatic printing, and superimposition are performed when the stop conditions are met.

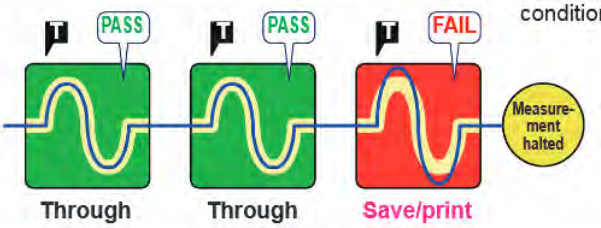
In case of "Repeat" trigger mode and "NG" stop condition.

Measurement continues until the user presses the STOP key.
Auto-save and auto-print is initiated only when the stop conditions are met.



In case of "Single" trigger mode and "NG" stop condition.

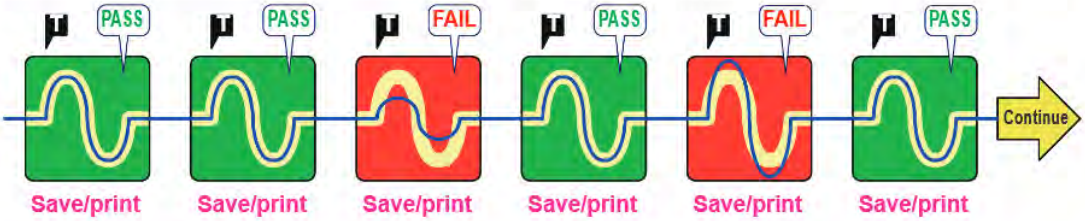
Measurement halts when a "FAIL" comparison result is returned.
Auto-save and auto-print is initiated only when the stop conditions are met.



Measurement halted because stop conditions are met.

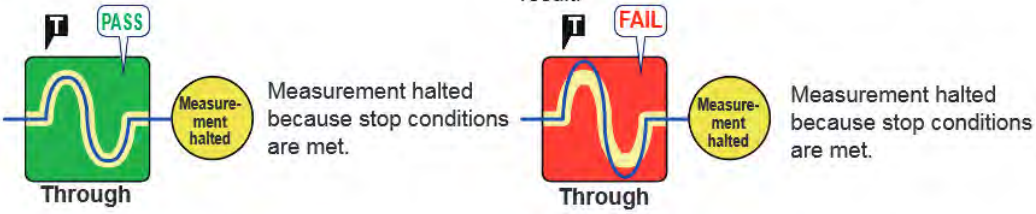
In case of "Repeat" trigger mode and "GO & NG" stop condition.

Measurement continues until the user presses the STOP key.
auto-save and auto-print is initiated each time, regardless of the comparison result



In case of "Single" trigger mode and "GO & NG" stop condition.

Measurement halts after a single operation, regardless of comparison result.
Auto-save and auto-print is initiated regardless of comparison result.



Measurement halted because stop conditions are met.

Measurement halted because stop conditions are met.

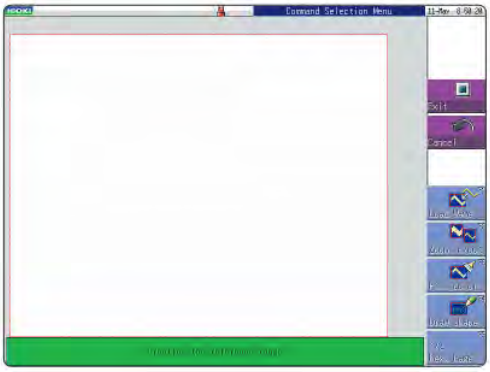
- When the trigger mode is [Single], the measurement finishes when the stop conditions are fulfilled. The measurement continues until stop conditions are fulfilled.
- When the trigger mode is [Repeat] or [Auto], the measurement continues until the **STOP** key is pressed (or the STOP signal is input) regardless of whether the stop conditions are fulfilled or not.

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14.5 Creating the Evaluation Area

Procedure

Setting screen: Status



1 **Move the flashing cursor to the [Waveform Judge] item and select [edit] from the F key menu.**

2 **Select appropriate editors from the F key menu and create an area to be used as the reference for the waveform evaluation.**

You can also use the mouse to create an area.
Refer to "1.4.2 Using Mouse to Enable Key Operation" (p. 25).

3 **Press the F key for [Exit] to exit the editor.**

4 **Store the created area in the internal memory.**

Save and End	Saves the created evaluation area in the instrument's internal memory and exits.
Discard and End	Discards the created evaluation area and exits.

5 **Save the evaluation area through the File screen or SAVE key, if necessary.**

Refer to "5.2 Saving Data" (p. 95).

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14.6 Details About the Editor Commands



Load Wave

Loads and displays the waveform shown on the Waveform screen in the editor.

Instructions

1 **Press the F key for [Load Wave].**

2 **Select the type of waveform capture to perform. The waveform displayed on the Waveform screen will be loaded into the editor.**

Waveform capture	Captures the storage waveform displayed on the Waveform screen.
Overlay capture	Captures the overlay waveforms shown on the Waveform screen, then connects the uppermost and lowermost positions with the same display color and fills in the resulting enclosed space. When the waveforms overlap, portions of the waveforms that are not displayed cannot be recognized. This option can be selected when an overlay has been drawn on the screen.
Memory segmentation reference waveform	Captures the memory segmentation reference waveform shown on the Waveform screen, then connects the uppermost and lowermost positions with the same display color and fills in the resulting enclosed space. When the waveforms overlap, portions of the waveforms that are not displayed cannot be recognized. This option can be selected when a memory segmentation reference waveform has been drawn on the screen.

3 **Press the F key for [Load Wave] to exit waveform capture mode.**



Zoom in/out

Magnifies or compresses the waveform shown on the screen in the horizontal and vertical directions.

Instructions

1 **Press the F key for [Zoom in/out].**

2 **Select whether to magnify or compress the waveform.**

3 **Set the amount of magnification or compression.**

- You can set values with the F keys, jog knob, or shuttle knob.
- The amount of movement can be set in increments of 0.04 div.

Execute	Performs magnification or compression processing based on the settings and creates an evaluation area.
Exit magnification/ compression	Exits magnification/compression mode.

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Fill color

Fills in an enclosed area.

Instructions

1 **Press the F key for [Fill color].**

2 **Use the cursor keys to move the paintbrush ⊞ mark to the area to be filled in.**

Press **[Speed up]** to accelerate the movement of the mark.
If the area is not completely enclosed, adjacent areas will also be filled in.

Execute	The area completely enclosed by lines is filled in.
Exit paint	Exits paint mode.



Draw shape

Draws a line, square or circle.

Instructions

1 **Press the F key for [Draw shape].**

2 **Select the figure you wish to draw.**

3 **Use the cursor keys to move the ⊞ mark to the origin of the figure.**

Press **[Speed up]** to accelerate the movement of the mark.

4 **Press the F key for [Set].**

The origin is set at the current position.

5 **Move the ⊞ mark.**

A figure is drawn between the origin and the ⊞ mark.

6 **Press [Set] again.**

The color of the figure changes and the figure is confirmed.
For straight lines, the origin is set at the accepted position.
For other types of figure, accepting the figure has the same effect as pressing **[Cancel]**.

7 **To draw another figure, press [Select], and select the figure type.**

8 **Repeat steps 3 through 7 to draw figures as desired.**

9 **Press the [Exit Draw shape] key to exit figure mode.**

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Eraser

Erases unwanted sections. Move the mark with the cursor keys to erase parts of the image.

Instructions

1. **Press the F key for [Eraser].**
2. **Using the cursor keys, move the mark to the origin of the area to be erased.**
   Press **[Speed up]** to accelerate the movement of the mark.
3. **Press the F key for [Set].**
   Now you can erase figures by moving the eraser. Press the **F** key for **[Cancel]** and you can move the eraser without erasing figures.
4. **Move the mark in the [Set] state to erase the parts of figures you do not need.**
5. **Press the [Exit Erase] key to exit erase mode.**



Clear all

Clears the entire editor screen.

Press the F key for [Clear all].
The editor screen is cleared.



Clear select area

Clears a specified rectangular area of the editor screen.

Instructions

1. **Press the F key for [Clear select area].**
2. **Using the cursor keys, move the mark to the origin of the area to be erased.**
   Press **[Speed up]** to accelerate the movement of the mark.
3. **Press the [Set] function key to set the position as the origin.**
4. **Move the mark.**
   A rectangle is drawn between the origin and the mark.
5. **Press [Set] again.**
   The area inside the rectangle is erased. Press **[Cancel]** and the position of the origin is canceled.
6. **Press the F key for [Exit Area Clear] to exit from the area clear mode.**

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Invert colors

Reverses the colors of a filled-in area and the surrounding area.

Press the F key for [Invert colors].
The filled in area is displayed in reverse.



Cancel

Undoes the last executed command.
Undo can be used with any command other than [Save and End] and [Discard and End].

Press the F key for [Cancel].



Exit

Exits the editor.

Instructions

1. **Press the F key for [Exit].**
2. **Select whether to store the evaluation area in memory or discard it before quitting the editor.**

Waveforms loaded into the editor will be displayed in different colors than those set with the original settings.

Save and End	Stores evaluation area in memory and quit editor. Refer to “5.2 Saving Data” (p. 95).
Discard and End	Quits the editor without storing the evaluation area in memory. The created area is discarded.

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15 Setting the System Environment

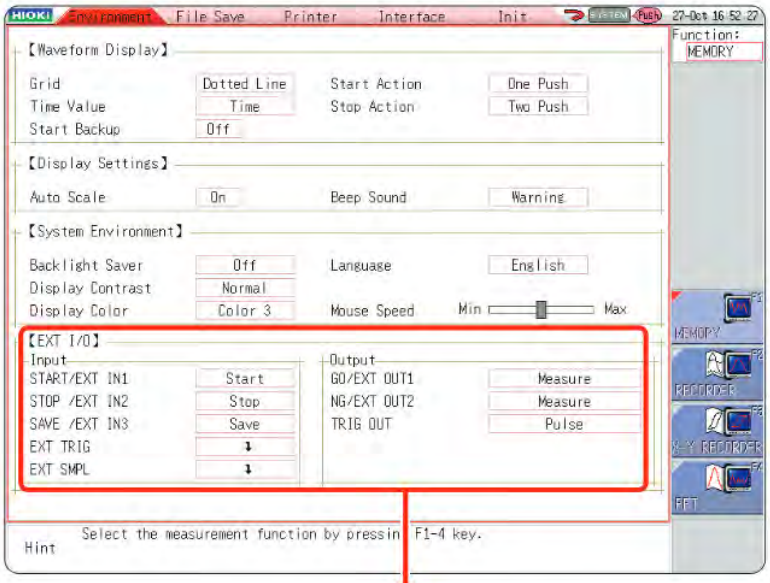
You can set the system environment on the **[Environment]** sheet of the system screen.

To display the [Environment] sheet



Press the **[SYSTEM]** key repeatedly to switch the sheets.

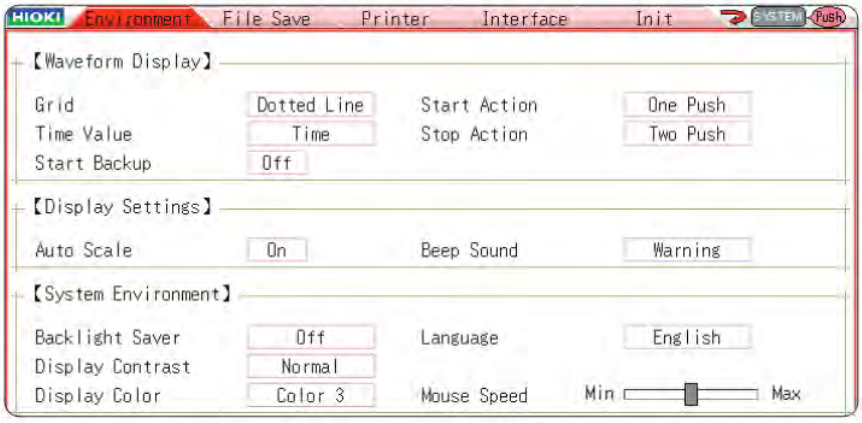
[Environment] ← **[Init]**
↓ ↑
[File Save]
↓ ↑
[Printer] → **[Interface]**



Refer to “17 Controlling the Instrument Externally” (p. 369).

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Description of the settings



Grid

Select the grid (graticule) type for the waveform screen.

Off	Does not display any grids.
Dotted Line	Displays the dotted-line grid. (Default setting)
Solid Line	Displays the solid-line grid.

Time Value

Display the time elapsed from the trigger point on the display.

Time	Displays the time elapsed from the trigger point (the unit is fixed). (Default setting)
Time (60)	Displays the time elapsed from the trigger point (in the sexagesimal [base-60] system).
div	Displays the number of divisions (div) from the trigger point.
Date	Displays the time when the waveform is acquired.
Sample Num	Displays the number of data points from the trigger point.

- During the external sampling, the number of points is fixed.
- These settings are also applied to the values of Cursors A and B.

Start Backup

The instrument preserves measurement condition settings. When the instrument is turned off during the recording due to a power outage or other reasons, the operation resumes automatically when the power is restored. When the triggering is enabled, the instrument is set to wait for a trigger.

Off (Default setting), On

- This function is valid only while the instrument is recording data.
- This function does not start automatically when the instrument is turned on.

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Backlight Saver

The screen blanks automatically when the instrument has been not in use for the specified period (unit: minutes).
The screen recovers when any key is pressed.

Off	Disables the backlight saver function. (Default setting) The screen remains visible at all times.
(Setting the time)	Setting range: 1 min to 30 min (in one-minute increments)

- When the backlight saver activated, pressing a key does not perform the function originally allotted to the key; but reactivates the backlight. Press the key again to perform the original function.
- Using the backlight saver conserves energy and extends the life of the backlight.

Display Contrast

Selects one of three backlight brightness levels.

Light, Normal, Dark

Display Color

You can set screen background and character colors on the waveform screen freely. Select **[Color Edit]**, and then change the values in the **[R]** (red), **[G]** (green), and **[B]** (blue) boxes of each item to change respective color. (p. 339)

Color 1, Color 2, Color 3, Color Edit

Beep Sound

The instrument can indicate warnings and operating conditions audibly.

OFF	Does not beep.
Warning	Beeps for error messages (warning displays) and NG (fail) judgments. (Default setting)
Warn+Act	In addition to the warning beeps described above, beeps when the instrument starts the measurement, triggers, stops the measurement, and completes the auto-saving.

Language

Selects the display language.

English (Default setting), Japanese, Korean, Chinese

Auto-scale

Variable values are automatically changed according to changes in scaling and voltage range.
Refer to "8.6 Setting the Waveform Position (Variable Function)" (p. 178).

Off, On (Default setting)

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Start Action

To prevent the instrument from starting measurement unintentionally due to operation mistakes, you can change the **START** key operation method. This setting does not affect the external control terminal function.

One Push	Starts the measurement by pressing the **START** key once. (Default setting)
Two Push	Starts the measurement by pressing the **START** key twice.
Hold 2s*	Starts the measurement by holding down the **START** key for two seconds.

When the **START** key is pressed, the message "Hold START key down." will be displayed.
After pressing the **START** key for two seconds, the message disappears, and the measurement starts.

Stop Action

Normally, pressing the **STOP** key once stops the measurement to after the specified recording length of the data is acquired, and pressing the key twice stops the measurement in progress immediately. This setting is provided to allow you to stop the measurement immediately by pressing the **STOP** key once.

Two Push	Stops the measurement by pressing the **STOP** key twice. (Default setting)
One Push	Stops the measurement by pressing the **STOP** key once.

Mouse Speed

You can set the mouse movement speed.
Dragging the slider handle while holding down the left mouse button allows you to set the mouse pointer speed. While sliding it towards "Min" enables the mouse pointer to move slowly, sliding it towards "Max" enables the pointer to move quickly.



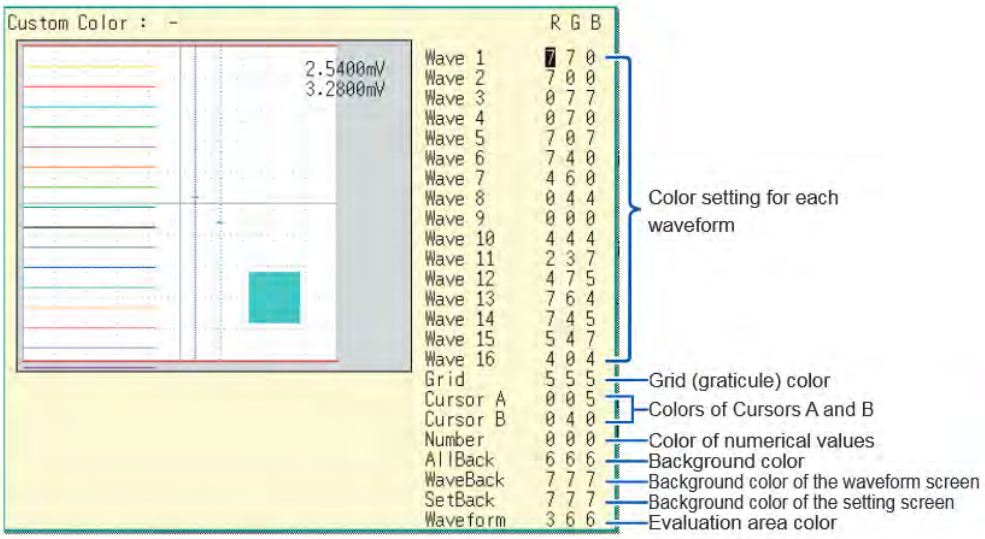
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Additional description

Customizing the screen color

Select **[Color Edit]** to display the **[Custom Color]** screen.
Change the values in the **[R]** (red), **[G]** (green), and **[B]** (blue) boxes of each item to change its color.
Refer to “8.1.3 Entering Alphanumeric Characters” (p. 163).

[Custom Color] screen



Done	Confirms the entered settings.
Reset	Restores the default settings.

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16 Connecting the Instrument to a Computer

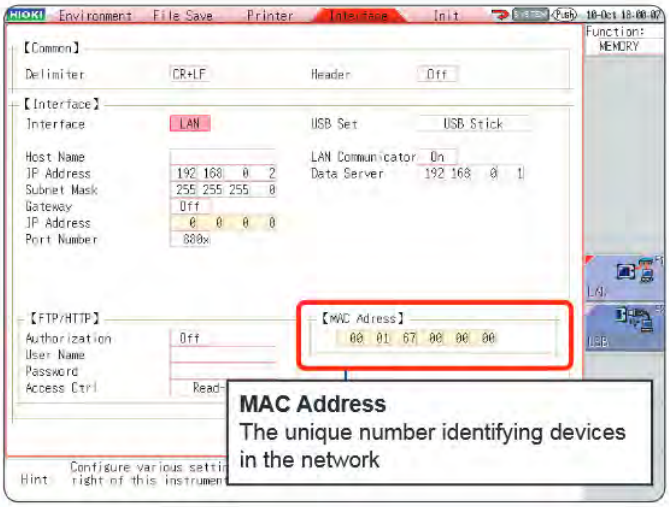
Read “Before connecting the instrument to an external device” (p. 14) carefully.
This instrument is equipped with the Ethernet 100BASE-TX interface for LAN communications.
You can control the instrument from a computer or other devices by connecting it to a network with 10BASE-T or 100BASE-TX cable (maximum length 100 m). It is also possible to directly connect the instrument to the computer via USB.

To display the [Interface] sheet



Press the **[SYSTEM]** key repeatedly to switch the sheets.

[Environment] ← **[Init]**
↓ ↑
[File Save]
↓
[Printer] → **[Interface]**



Operations available on the [Interface] sheet

Setting LAN, connecting the instrument via LAN (p. 342)
- Connecting the instrument to the computer via the network
- Connecting the instrument to the computer directly

Transferring data to the computer (p. 359)

Setting the USB, connecting the instrument via USB (p. 361)

Remotely control the instrument using an Internet browser (p. 348)

Operating the instrument remotely, acquiring data using Model 9333 LAN Communicator (p. 367).

Accessing the files on the instrument via the FTP (p. 355)
This instrument is equipped with the File Transfer Protocol (FTP, RFC959 compliant) server. You can use an FTP client software installed on the computer to transfer files in instrument media to the computer and manage the files.

Controlling the instrument with the command communications (p. 365)
You can control the instrument by creating programs and connecting to the command communications port using the TCP.
You can also control the instrument via USB.
For more information about the commands, refer to the Communications Command Instruction Manual on the supplied application disc.

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16.1 Setting LAN and Connecting the Instrument to the LAN Network (Before Using FTP/Internet Browser/Command Communications)

Before accessing the instrument from a computer using the FTP or an Internet browser, or using command communication, you must configure the instrument's LAN settings and connect it to your network with a LAN cable.

Always configure the LAN settings before connecting the instrument to the network. When you change the settings while connected to the network, the IP addresses may not be unique or invalid address data may be transmitted over the network.

16.1.1 Configuring the LAN Settings With the Instrument

Things to be checked before configuring the LAN settings

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

When connecting the instrument to the existing network

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

- **The host name and address of the instrument**
  Host name (up to 12 characters):
  IP address: ..... ___.___.___.___
  Subnet mask: ..... ___.___.___.___
- **Gateway**
  Whether to use a gateway: ..... Yes/No
  IP address (When used):..... ___.___.___.___
- **The TCP/IP port number to be used: ___X (default 880x)**
  (Specify the most significant 3 digits of the 4-digit number. The least significant digit, 0 through 9, is reserved for use by the instrument.
  Specify it when the default value, 8800 through 8809, cannot be used.)

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

(Use the instrument on the local network, which does not connect to any external network.)
When no administrator exists for your network, or you are entrusted with the settings, the following addresses are recommended.

(Example settings)

IP Address
computer: 192.168.0.1
Recorder 1: 192.168.0.2
Recorder 2: 192.168.0.3 . . . the same applies in sequence.
↓ ↓
Host name ..... Any name (Must be unique)
Subnet mask:.....255.255.255.0
Gateway .....OFF
Port number.....880X

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Setting details

Interface	Choose between LAN and USB.
Host Name	This name identifies the instrument on the network. Set a unique host name among those of other devices. This instrument does not support dynamic DNS. The name that you set is not registered with a DNS server.
IP Address	The IP addresses identify individual devices on the network. Set a unique address among those of other devices.
Subnet Mask	The subnet mask divides the IP address into the network address and the host address. Set the subnet mask in the same way as those of other devices on the network.
Gateway IP Address	**For network connections** When your computer (the communication device) is on another network than this instrument, set this setting to **[On]** and specify the gateway device. When the computer is on the same network, this setting is usually set to the same address as the default gateway in the computer communications settings.

Authorization user name and password

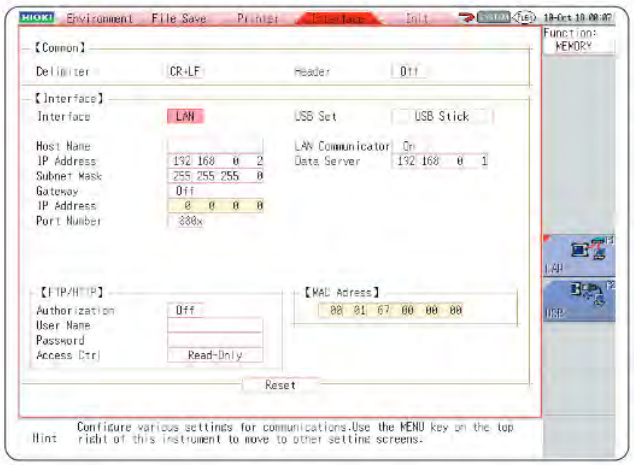
These are used when you log in to the instrument with the FTP or use a computer Internet browser (When authorization is **[On]**).
With the authorization set, you can log in only when entering a valid user name and password. Configure this setting when you want to restrict the users to access the instrument.
The password you entered is displayed as the character string ""**********."
Valid characters: Alphabetic characters and symbols (however, the colon (:) is prohibited.)

When you want to allow anyone to access the network, or you wish to log in as "anonymous" of the FTP client, leave the user name and password fields blank.

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Procedure of setting LAN

Press the **SYSTEM** key to display the **[Interface]** sheet. Follow the procedure as intended usage.



Press the **CURSOR** key to move the settings cursor and press the **F** key to select the setting.

Refer to “Setting details” (p. 343).

For the details on each setting
Refer to “Setting details” (p. 343).

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

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Intended use	Connecting the instrument to the existing network	Connecting the instrument to the computer directly
	Connecting the instrument to the network using the specified IP address	
	When you want to name the instrument, set **[Host Name]**.	
Settings when the instrument and the computer connects to the same network	Set **[IP Address]** of the instrument.	Set **[IP Address]** of the instrument.
	Set **[Subnet Mask]**.	Set **[Subnet Mask]**.
Settings when the instrument connects to the different network from the computer network (Using the gateway)	Set **[Gateway]** to **[On]**	Set **[Gateway]** to **[Off]**
	Set the gateway **[IP Address]**.	
Settings for remote operation and data acquisition using Model 9333 LAN Communicator	Set **[LAN Communicator]** to **[On]**.	Set **[LAN Communicator]** to **[On]**.
	Set IP address of **[Data Server]**.	Set IP address of **[Data Server]**.
Connecting the instrument	Execute **[Reset]**.	Execute **[Reset]**.
	Connect the straight-through cable. Refer to "16.1.2" (p. 346).	Connect the crossover cable. Refer to "16.1.2" (p. 346).

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16.1.2 Connecting the Instrument to the Computer With the LAN Cable

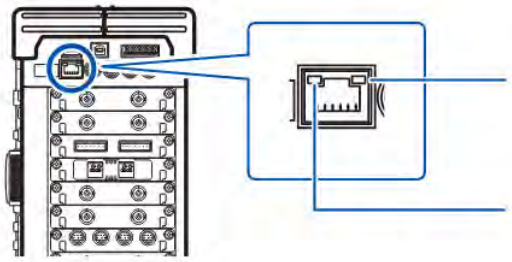
Connect the instrument to the computer with the LAN cable as follows.

⚠CAUTION

When connecting the instrument to your LAN using a LAN cable of more than 30 m or with a cable laid outdoors, take appropriate countermeasures that include installing a surge protector for LANs. Such signal wiring is susceptible to induced lighting, which can cause damage to the instrument.

1 Plug the LAN cable (100BASE-TX compliant) into the 100BASE-TX connector on the right side of the instrument.

Right side



RX/TX LED — Flashes while data is being sent or received.

LINK LED — Lights while the instrument can communicate with the destination device.

2 Connect the LAN cable to the computer.

There are two connection ways.

1. Connecting the instrument to the existing network

(Connect the Instrument to the hub)

You can control and monitor the instrument with the computer by connecting the instrument to the hub with the LAN cable (100BASE-TX cable).

Connection cable: Use one of the following.

- 100BASE-TX straight-through cable (maximum length 100 m, commercially available) (10BASE-T compatible cable can also be used for 10BASE communications)
- Model 9642 LAN Cable (optional)

100BASE-TX connector



Connect the cable to the 100BASE-TX connector on the instrument and hub.

Attach the connector to the hub

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2. Connecting the instrument to the computer directly

(Connect the instrument to the computer)

You can control and monitor the instrument with the computer by connecting the instrument to the computer with the LAN cable.

- Connection cable: Use one of the following.
- 100BASE-TX compatible crossover cable (maximum length 100 m)
- 100BASE-TX straight-through cable (maximum length 100 m)
- Model 9642 LAN Cable (optional, supplied with crossover connector)

This completes the connection procedure.

Access the files on the instrument from the computer.
Refer to the following pages:
"16.2 Controlling the Instrument Remotely (Using an Internet Browser)" (p. 348)
"16.3 Accessing Files on the Instrument From the Computer (Using the FTP)" (p. 355)
"16.7 Controlling the Instrument with Command Communications (LAN/USB)" (p. 365)

If noise affects surrounding equipment, wind the LAN cable once around the supplied ferrite clamp-on choke (for LAN cable), as shown in the illustration on the right.



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16.2 Controlling the Instrument Remotely (Using an Internet Browser)

You can control the instrument remotely from the computer using an Internet browser.

Attempting to control the instrument simultaneously from multiple computers may result in unintended operation. Use only one computer to operate the instrument remotely.

To use an Internet browser, you must set the instrument properly and connect it to the computer with LAN cable. (p. 342), (p. 346)
Internet Explorer 8 or later is recommended. Set the security level to "Medium."
If the commands, [Remote Control] and [Aquire data by FTP] do not work, install JRE included in the application disc. Turn off the pop-up blocker.

Procedure for installing JRE

1. **Insert the supplied application disc (CD) into the CD-ROM drive.**
   The top page appears automatically.
   If it does not appear, open the "index.htm" file with your web browser.
2. **Select the display language.**
   Click the **[English]** icon.
3. **Click the [JRE installation] icon.**
4. **Click the [Install] icon, then follow the prompts that appear to complete the installation.**

16.2.1 Setting HTTP With the Instrument

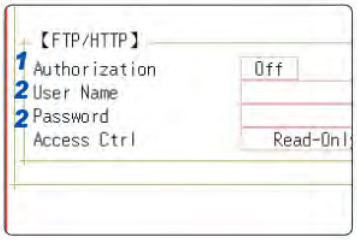
Procedure

To display the screen
Press the **SYSTEM** key to display the system screen, and then select the **[Interface]** sheet.

First, set the "LAN Communicator" setting to [Off].

1. **Choose authorization settings.**
   Move the cursor to the **[Authorization]** box.

Off	Enables you to operate the instrument without the web server authentication. (Default setting)
On	Enables you to operate the instrument with the web server authentication.



The user name and password for authentication are the same for the Internet browser and for the FTP.

2. **When [On] is selected**
   Set the user name and password.
   Move the cursor to the **[User Name]** and **[Password]** boxes in turn, and enter the user name and password.
   Refer to "8.1.3 Entering Alphanumeric Characters" (p. 163) and Authorization user name and password (p. 343).
3. **Confirm the settings.**
   Move the cursor to the **[Reset]** box.
   Select **[Reflect Set]**.

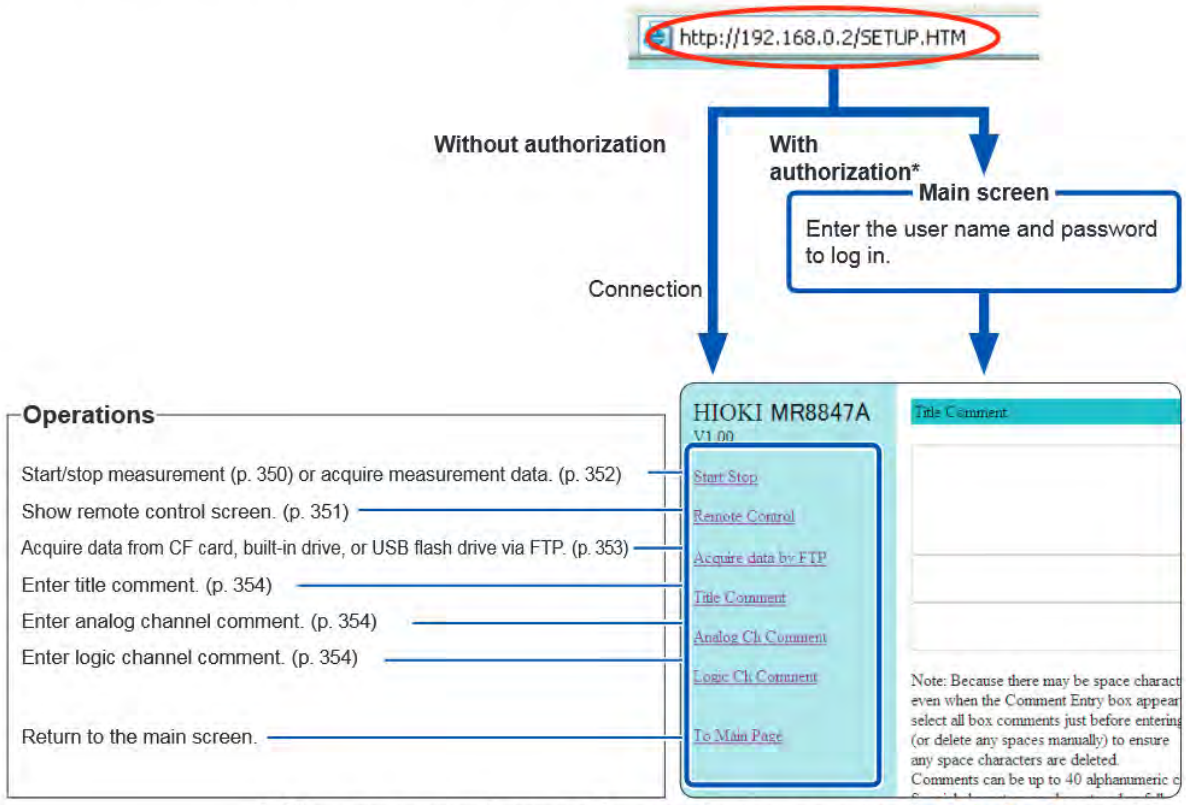
   The message "LAN was reconnected" appears at the bottom of the screen.

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16.2.2 Connecting the Computer to the Instrument With the Internet Browser

The following example shows how to use the Internet Explorer on Windows 7.
Start Internet Explorer on the computer and enter the character string “http://” followed by the IP address or host name of the instrument in the address bar.

When the IP address of the instrument is “192.168.0.2”



* When user name and password for authentication were set on the **[Interface]** sheet of the system screen of the instrument
Refer to “16.2.1 Setting HTTP With the Instrument” (p. 348).

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16.2.3 Operating the Instrument With the Internet Browser

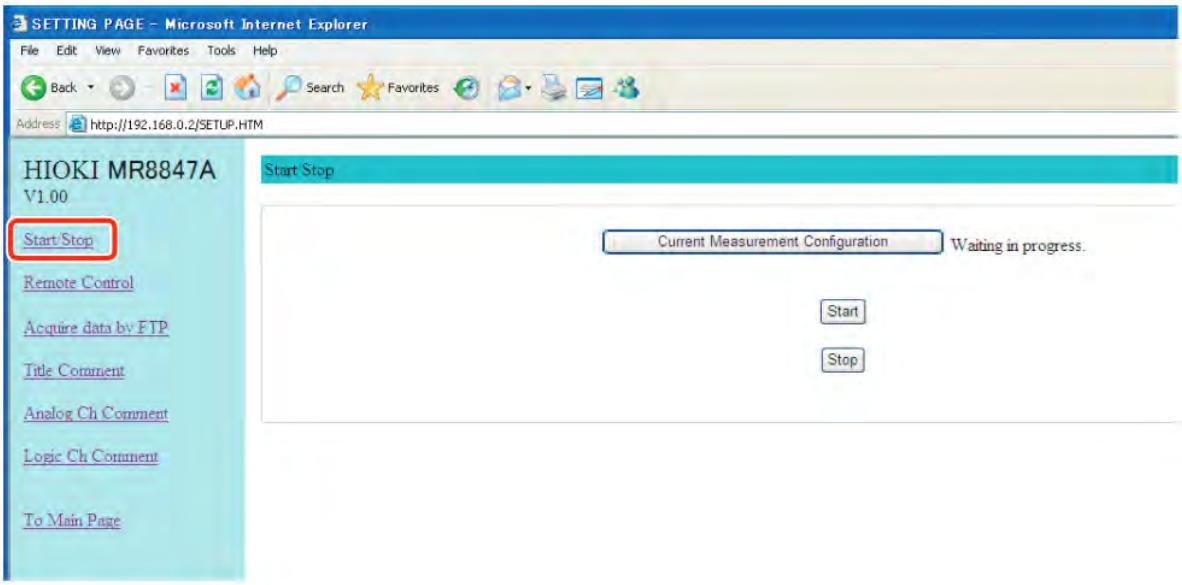
Starting/Stopping the measurement

You can start and stop the measurement.

Start/Stop screen

To display the screen

Click **[Start/Stop]** in the operation list.



Procedure

Click **[Start]** to start the measurement.
Click **[Stop]** to stop the measurement.

Click **[Current Measurement Configuration]** to display the present measurement information acquired from the instrument.

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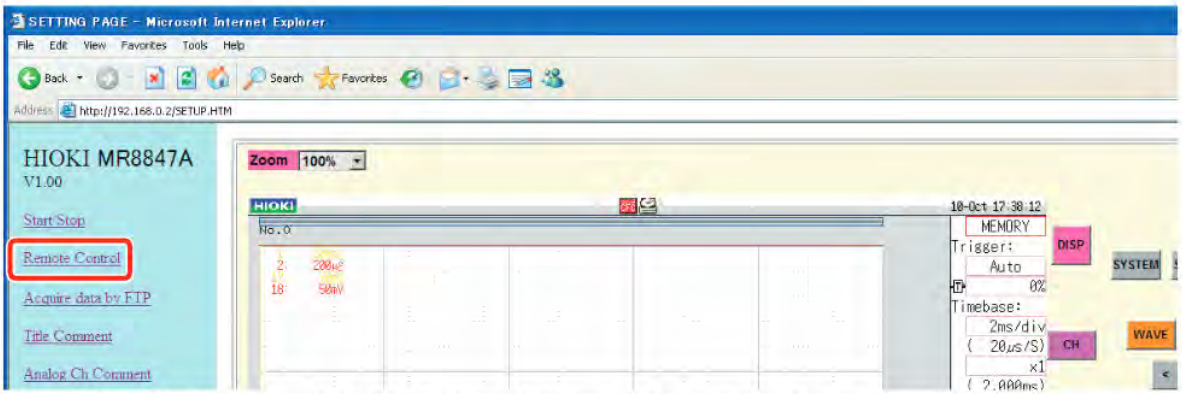
Remotely operating the instrument

You can operate the instrument remotely. (This remote operation is mainly intended for monitoring the screen. When you want to perform the remote control of the instrument more smoothly, use Model 9333 LAN Communicator.)

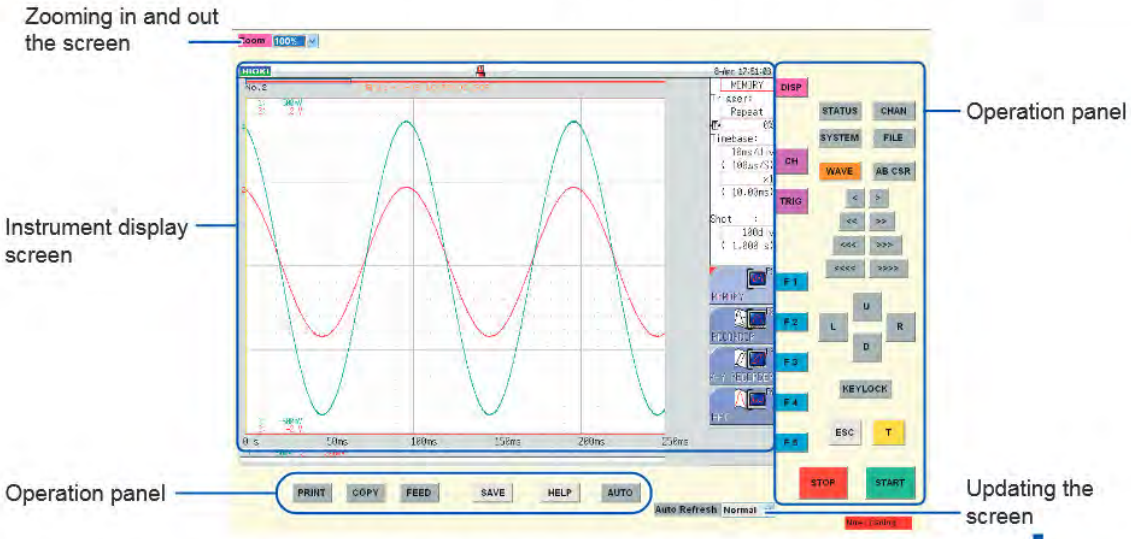
Remote Control screen

To display the screen

Click **[Remote Control]** in the operation list.



The remote control screen consists of the instrument display section and operation panel section.



When the auto-update is enabled, the screen information is sent from the instrument to the computer at regular intervals to keep the display updated.



Setting the display update interval

Available settings:
Normal, Slow, Very Slow

Basic operation

When you click a button on the operation panel, the instrument performs the same action as if the corresponding key on the instrument was pressed. However, simultaneously activating more than one button is not possible. You can directly click inside the screen to move the flashing cursor onto the item or click the GUI figure directly to set it. You can also operate the instrument directly during the remote operation.

- You may not be able to control the instrument remotely without installing JRE. (p. 348)
- Printing during remote operation may be interrupted. Set the display updating speed to a slower option.

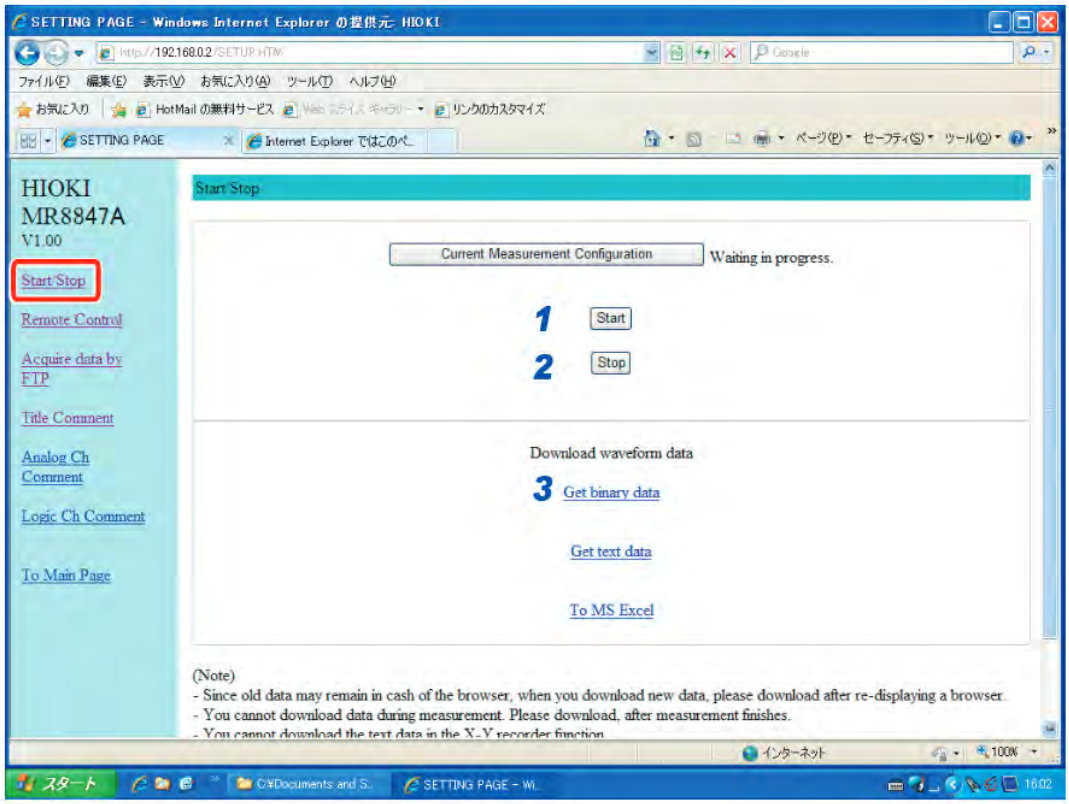
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Acquiring the data stored in the memory of the Instrument

You can acquire the measured data.
You can select the data format among binary, text, and MS Excel*.
* Excel

Start/Stop screen

To display the screen
Click **[Start/Stop]** in the operation list.



Procedure

1. **Start the measurement.**
2. **Stop the measurement.**
3. **Select one of the options under [Download waveform data].**

Get binary data	Downloads the data in binary format.
Get text data	Downloads the data in text format.
To MS Excel	Displays the data in Microsoft Excel. (The data can be opened with Microsoft Excel.)

- You may not be able to acquire data without installing JRE. (p. 348)
- You cannot acquire measured data during the measurement. Stop the measurement and then acquire the data.
- When you press **[To MS Excel]** and select **[Open]** using Internet Explorer, an error may occur during transmission. In such a case, select **[Save]**.

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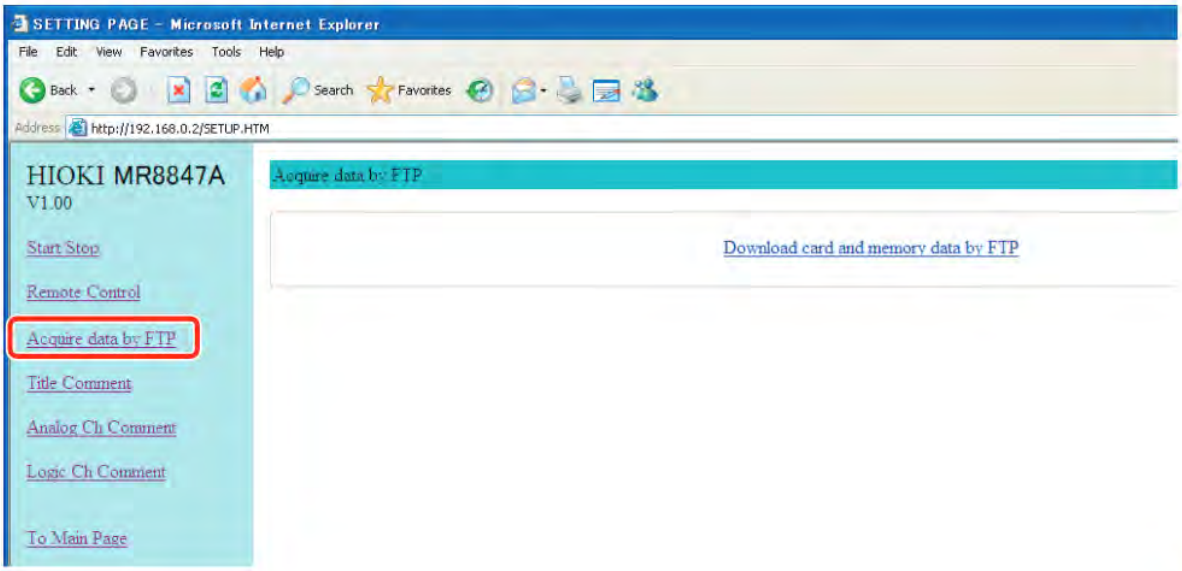
Acquiring the data using the FTP

You can acquire the data using the FTP from the CF card, built-in drive, or USB flash drive.

Acquire data by FTP screen

To display the screen

Click **[Acquire data by FTP]** in the operation list.



Procedure

Click [Acquire data by FTP].

The list of folders is displayed.

For information on how to perform file operations, refer to “16.3.3 Managing Files With the FTP” (p. 358).

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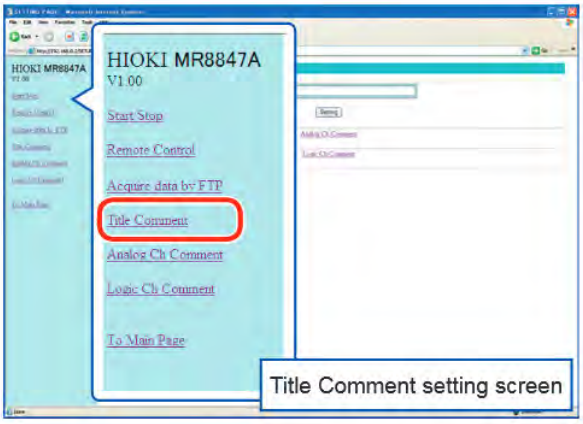
Entering the Comment

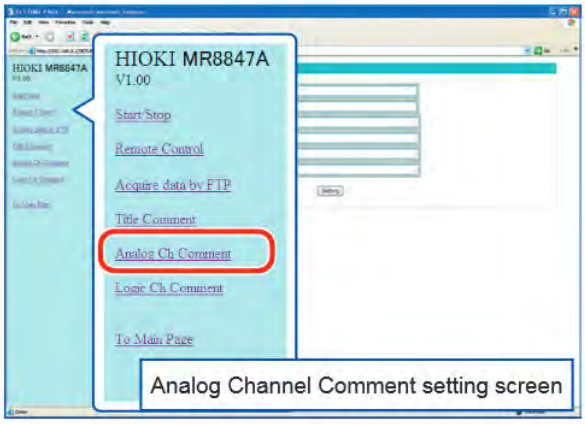
You can specify character strings to be used as title comments, logic channel comments, and analog channel comments.
Information about the module type and channel (installation location in the module) can be obtained and displayed only for used channels.

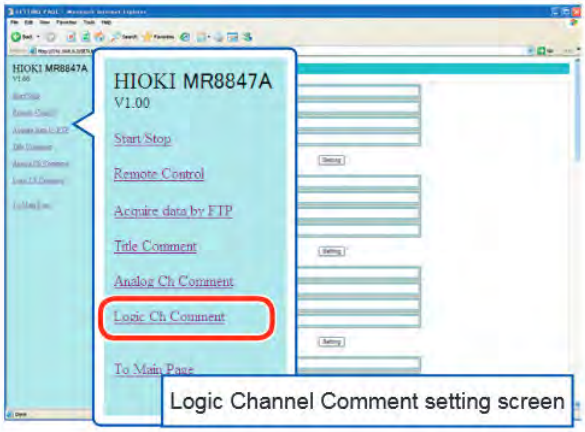
Comment setting screens

To display the screen

Click **[Title Comment]**, **[Analog Ch Comment]**, or **[Logic Ch Comment]** in the operation list.



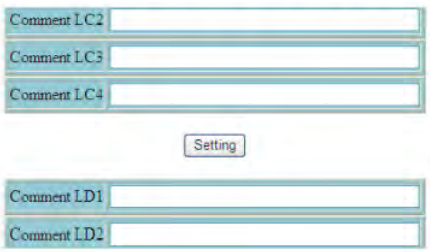




Procedure

Enter the title in the comment input box and click [Setting].

The comment string can be up to 40 characters long.



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16.3 Accessing Files on the Instrument From the Computer (Using the FTP)

Using the FTP client software of the computer allows you to transfer files from the instrument's storage media to the computer, and manage the files.

- This instrument is equipped with the File Transfer Protocol (FTP, RFC959 compliant) server.
- You can use Internet Explorer or other popular FTP clients.

- The FTP server of the instrument allows only one connection at a time. More than one computer cannot access the server simultaneously.
- If no command is sent from the computer for more than one minute after connecting to the FTP server, the FTP may disconnect the computer. If this occurs, reconnect the computer via the FTP.
- Starting the measurement interrupts the FTP connection.
- Before inserting or removing a CF card or USB flash drive, terminate the FTP connection.
- Do not manage files while the FTP is being used.
- With Internet Explorer, the refresh date of files may not match those of the instrument.
- With Internet Explorer, temporary internet files created at the previous access may retain; thus, the previous data may be obtained instead of the updated data.

To use the FTP, you must set the instrument properly and connect it to the computer with the LAN cable.

Refer to "16.1.1 Configuring the LAN Settings With the Instrument" (p. 342) and "16.1.2 Connecting the Instrument to the Computer With the LAN Cable" (p. 346).

Be careful when moving files via the FTP, as some FTP client/browser programs may delete all selected files or folders from the source if you cancel the transfer before its completion. We recommend you to copy (download) the files and then delete them from the original place manually.

Things to be checked before using the FTP

Relationship between the storage media and directories

Each of the storage media appears as a directory on the FTP server.

/CF..... CF card
/HDD .....Built-in drive
/RAM.....Internal memory
/USB1 .....USB flash drive
/STORAGE .....Storage memory

Limitations

You cannot access files during measurement.

Even when the SSD built-in drive is installed, it is recognized as an HDD.

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16.3.1 Setting the FTP With the Instrument

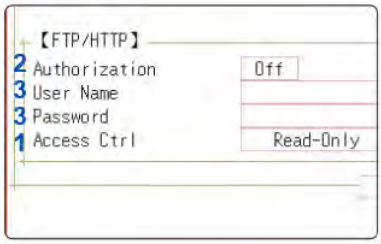
Procedure

To display the screen

Press the **SYSTEM** key to display the system screen, and then select the **[Interface]** sheet.

1 **Set the access restrictions.**

Move the cursor to the **[Access Ctrl]** box.



Read/ Write	Enables you to delete and rename files.
Read-Only	Enables you to read files only. This setting prevents files from being deleted or changed from outside the instrument.

2 **Set the authorization setting.**

Move the cursor to the **[Authorization]** box.

Off	Enables you to operate the instrument without the web server authentication. (Default setting)
On	Enables you to operate the instrument with the web server authentication.

3 **When [On] is selected**

Set the user name and password.

Move the cursor to the **[User Name]** and **[Password]** boxes in turn, and enter the user name and password.

The user name and password for authentication are the same for the Internet browser and for the FTP.

Refer to "8.1.3 Entering Alphanumeric Characters" (p. 163) and Authorization user name and password (p. 343).

4 **Confirm the settings.**

Move the cursor to the **[Reset]** box.
Select **[Reflect Set]**.

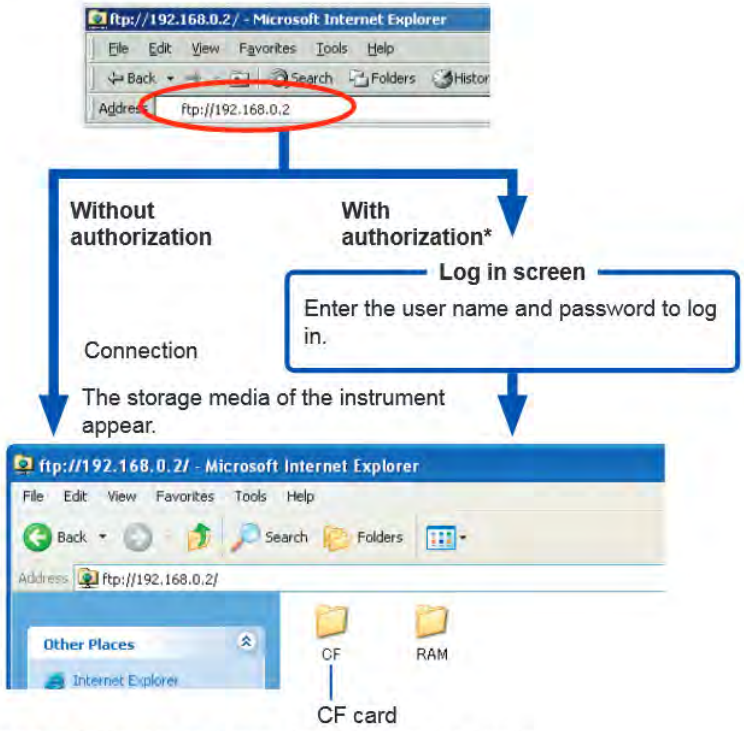
The message "LAN was reconnected" appears at the bottom of the screen.

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16.3.2 Connecting the Computer to the Instrument Using the FTP

The following example shows how to use the Internet Explorer on Windows 7.
Start Internet Explorer on the computer and enter the character string "http://" followed by the IP address of the instrument in the address bar.

When the IP address of the instrument is "192.168.0.2"



Click a folder icon to display files stored on the media.

* An authorization user name and password have been set on the **[Interface]** sheet of the system screen. Refer to "16.3.1 Setting the FTP With the Instrument" (p. 356).

You can also enter the user name and password delimited by the colon (:) and the at sign (@) in front of the normal IP address directly.

[ftp://Username: Password@instrument IP address]

Example: When the user name is "hioki" and the password is "1234", enter [ftp://hioki:1234@192.168.0.2].

If the connection fails

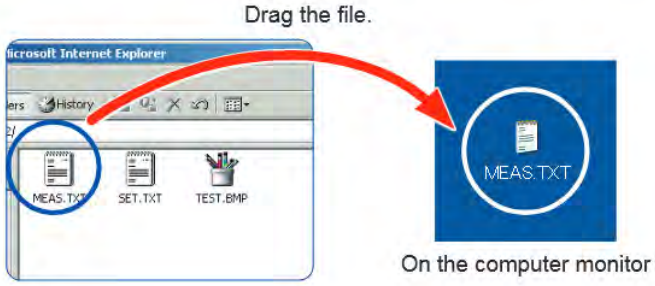
Check the communication settings of the instrument.
Refer to "Procedure of setting LAN" (p. 344).

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16.3.3 Managing Files With the FTP

Acquiring Files

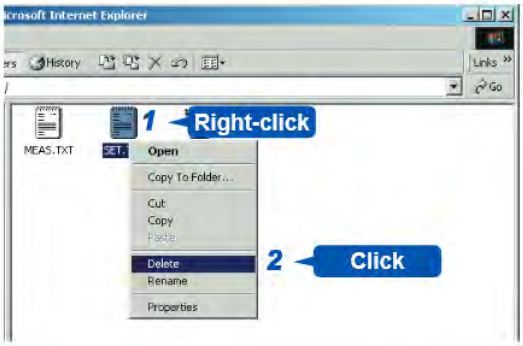
Select the file to be acquired on the folder list and drag* it to the download destination (the desktop or a folder outside the Internet Explorer window).
* Click the file and hold the button down. Move the mouse pointer to the target destination, and then release the button.



Minutes and seconds on the timestamp (date and time) may not be reflected.

Deleting and renaming files

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



You cannot upload any files from the computer to the instrument. To copy a file to the built-in drive of the instrument, use a USB flash drive or CF card.

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16.4 Transferring Data to the Computer

You can transfer the data stored on the built-in drive or in a CF card to the computer using the supplied USB cable.
For more information on how to analyze the data using the supplied application software, refer to the application's help function.
For details about installing and starting the application, refer to "16.5 Wave Viewer (Wv)" (p. 360).

System requirements: The computer running Windows 7, Windows 8, or Windows 10

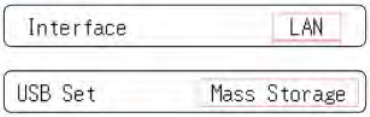
Setting the instrument

Procedure

To display the screen
Press the **SYSTEM** key to display the system screen, and then select the **[Interface]** sheet.

1 **Move the cursor to the [Interface] box, and select [LAN].**

2 **Move the cursor to the [USB Set] box, and select [Mass storage HDD] or [Mass storage CF].**

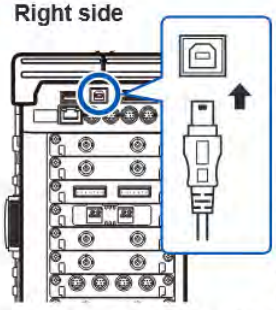


You cannot access the USB flash drive, built-in drive, or CF card from the instrument with the **[Mass Storage]** setting. Furthermore, the printer prints at **[Slow/Fine]**, regardless of the **[Print Speed]** setting.

Connecting the USB cable

Preparation
Stop the measurement in progress and make sure that the file screen is not displayed.

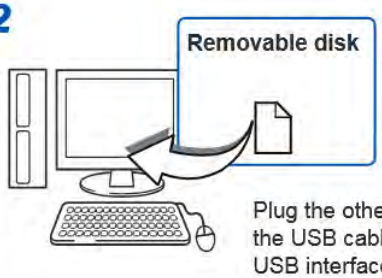
1 **Right side**



USB connector (Type B)

Insert the USB cable into the USB connector on the instrument, being careful to orient the connector correctly.

2



Plug the other end of the USB cable into a USB interface on the computer.

When the connection is established, the computer recognizes the instrument as a removable disk.
The computer can now access the data stored on the built-in drive or CF card of the instrument.

Disconnecting the USB Cable

To disconnect the USB cable from the computer that is presently running, click the **[Safely Remove Hardware]** icon and follow the prescribed steps.

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16.5 Wave Viewer (Wv)

The program, Wave viewer is equipped with the CSV conversion function. You can open the converted files with spreadsheets.
This section explains how to install, uninstall, start, and exit Wave Viewer.

System requirements: The computer running Windows 7, Windows 8, or Windows 10

Installing Wave viewer (for the computer running Windows 7)

1. **Insert the supplied application disc (CD) into the CD-ROM drive.**
   The top page appears automatically.
   If it does not appear, open the "index.htm" file with your web browser.
2. **Select the display language.**
   Click the **[English]** icon.
3. **Click the [Wave viewer (Wv)] icon.**
   The Wv specifications and revision history are displayed.
4. **Click the [Install] icon at the top right of the page.**
   The **[File Download]** dialog appears.
5. **Click [Open].**
   The confirmation dialog box appears.
6. **Click [Next].**
   The window for selecting the installation destination opens.
   Click **[Browse]** to change the installation folder.
7. **Click [Next].**
   The installation starts.

Starting Wave viewer

Before using Wave viewer, read the "READ ME."

Click the Start button of Windows, select [Programs], click [HIOKI], and then [Wv].

Wave Viewer is started.

Exiting Wave viewer

On the [File] menu of Wave Viewer, click [Exit].

Alternatively, you can click the Close button at the top right of the screen.

Uninstalling Wave viewer

1. **Click the Windows Start button, click [Control Panel], and then click [Uninstall a program].**
2. **Select [HIOKI Wave Viewer (Wv)] to uninstall Wave viewer.**
   When updating Wave Viewer to a later version, uninstall the earlier version of it before installing the new version.

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16.6 Configuring the USB Settings and Connecting the Instrument to the Computer (Before Performing Command Communications)

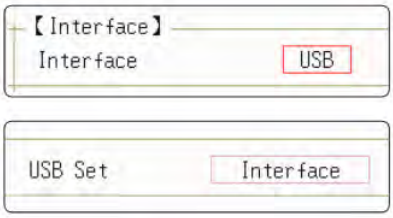
Connecting the instrument and the computer to each other with the USB cable, supplied with the instrument, allows you to control the instrument from the computer.
Before performing command communications, configure the USB settings and establish the connection.

16.6.1 Configuring the USB Settings With the Instrument

Procedure

To display the screen
Press the **SYSTEM** key to display the system screen, and then select the **[Interface]** sheet.

Move the cursor to the [Interface] box, and select [USB].
The **[USB Set]** setting is automatically set to **[Interface]**.



When the interface has been set to **[USB]**, the following functions are not available.
- Using a USB flash drive
- Viewing the data saved on the instrument with a computer

16.6.2 Installing the USB Driver

Before connecting the instrument via the USB interface, install the USB driver.

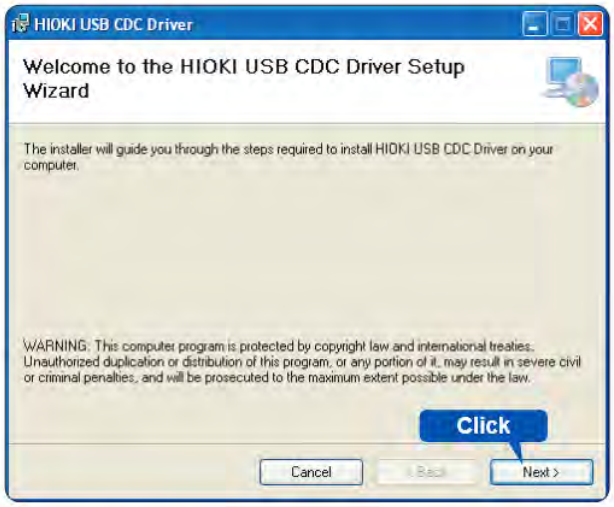
Log on to the computer with an administrator privilege to install the driver.

1 **Run [HiokiUsbCdcDriver.msi] in the CD X:\Driver folder.**
(**[X]** represents the CD-ROM drive. The letter will differ depending on your computer.)

Depending on the environment, it may take some time before the dialog box appears.

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2 Click **[Next]**.

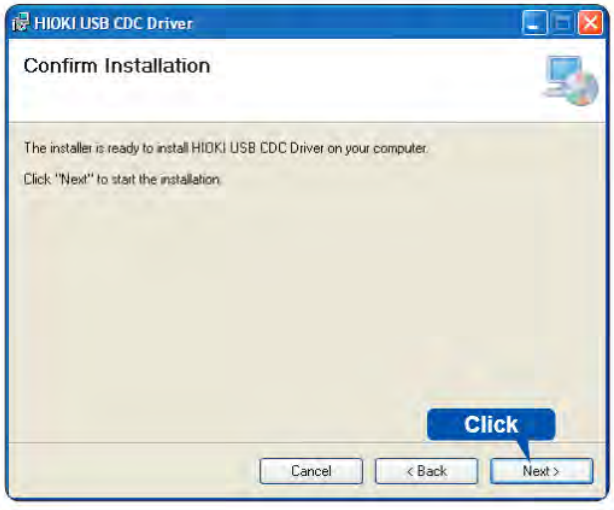


3 Click **[Next]**.

To change the installation destination
Click **[Browse...]** to change the driver installing folder.
Normally, there is no need to change.

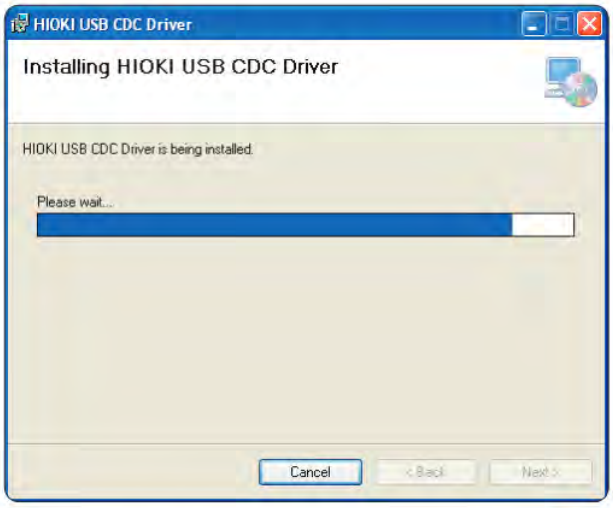


4 Click **[Next]**.

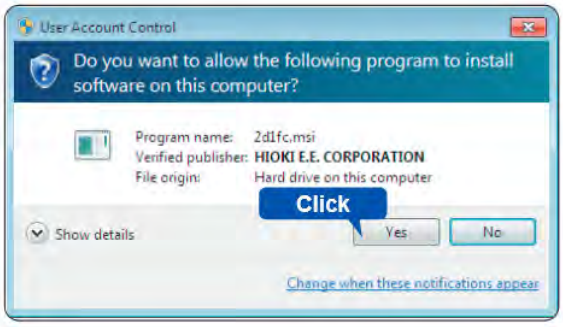


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The installation starts.

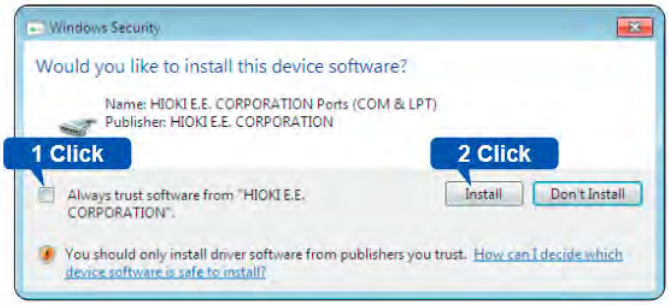


When the dialog box requesting your permission to continue the installation appears, click **[Yes]**.



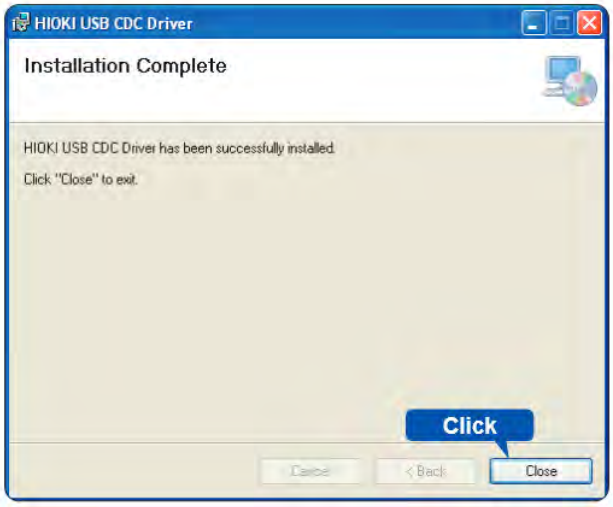
Sometimes another dialog box requesting your permission to install the software may appear.

When it appears, select **[Always trust software from "HIOKI E.E. CORPORATION"** check box and click **[Install]** to continue the installation.



5 **When the dialog box appears on completion of the installation, click [Close] to exit it.**

This completes the driver installation.

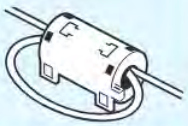


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Connecting the Instrument to the computer on which the driver is installed

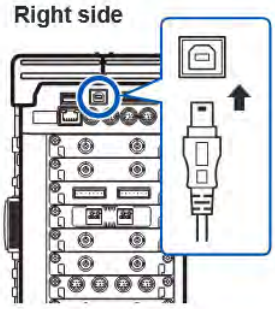
System requirements: The computer running Windows 7, Windows 8, or Windows 10

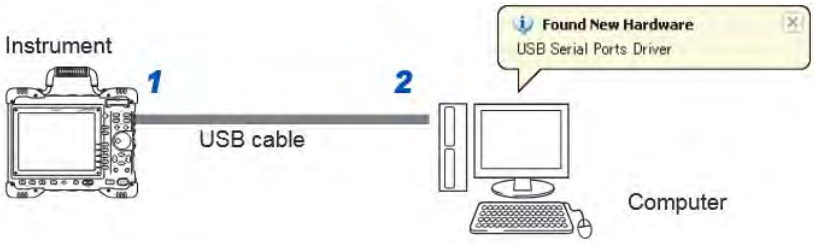
- If you connect the USB cable while both the instrument and the computer are turned off, be sure to turn on the computer first. If you turn them on in the wrong order, the instrument and computer cannot communicate with each other.
- If noise emitted from the USB cable affects other equipment in the vicinity, wind the USB cable once around the supplied ferrite clamp-on choke (for LAN/USB cable), as shown in the illustration on the right.



1 **Plug the USB cable supplied with the instrument into the USB connector (Type B) on the right side of the instrument.**

2 **Connect the other end of the cable to a USB port on the computer.**





The instrument will be recognized, and the device is ready to use automatically.

Uninstalling the USB Driver

When the USB driver is no longer needed, uninstall it by following the procedure below (for the computer running Windows 7).

1 **Click the Windows Start button, click [Control Panel], and then click [Uninstall a program].**
The list of the installed programs appears.

2 **Click [HIOKI USB CDC Driver], and then, click [Uninstall].**

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16.7 Controlling the Instrument with Command Communications (LAN/USB)

You can control the instrument remotely using commands via the communications interface (LAN or USB).

- For details, see the Communication Command Instruction Manual on the supplied application disc.
- Before using the command communications, the LAN or USB setting and connections must be configured properly.

Refer to LAN "16.1" (p. 342) and USB "16.6" (p. 361).

⚠CAUTION

In an environment where noise from inverters or similar devices is present, errors may occur when controlling the instrument remotely. Ensure that the environment is not subject to excessive noise.

Setting Details

Delimiter	Set the newline delimiter, used in the command response messages, to LF or CR+LF. The instrument accepts both of the LF and CR+LF settings.
Header	The header is used for controlling the instrument with the communications commands. The header setting specifies whether to prefix the header to the command response messages. For more information about commands, refer to the Communications Command Instruction Manual on the supplied CD.
Command Port (Port number) (LAN only)	The instrument uses the TCP/IP protocol for the communications. The TCP/IP protocol allows communicating devices to establish multiple connections, which are distinguished by the port numbers. By default, the instrument uses the port numbers 8800 through 8809. • 8800 through 8801: Reserved • 8802 (the instrument servers as the server): For the communications command control • 8803 through 8809: Reserved Normally, these port numbers do not need to be changed. You can change them if certain ports cannot be used for security reasons, or if certain ports are not available on the computer to be communicated. Set only the most significant three digits. The least significant digit (0 through 9) is used by the instrument or reserved for use by the instrument.

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16.7.1 Setting the Instrument

Configure the command communications settings.

Procedure

To display the screen

Press the **SYSTEM** key to display the system screen, and then select the **[Interface]** sheet.

1 **Set the delimiter.**

Move the cursor to the **[Delimiter]** box.

LF	Sends the character code 0x0a.
CR+LF	Sends the character codes 0x0d and 0x0a.

2 **Select the header.**

Move the cursor to the **[Header]** box.

Off	Does not add any header to response data.
On	Adds the header to response data.

3 **Set the communications command port. (LAN only)**

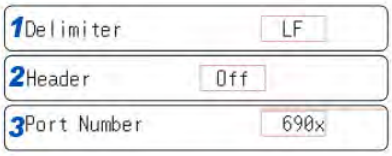
Move the cursor to the **[Port Number]** box and enter the port number.

About the header

The response to the `[:FUNCTION?]` query sent from the computer differs according to the header setting.
With the **[On]**setting
`[:FUNCTION MEM]`
With the **[OFF]**setting `[MEM]`

About the port number

Specify only the most significant 3 digits of the 4-digit port number.
If you specify "880x," the port number 8802 will be used. (p. 365)



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16.8 Operating the Instrument Remotely and Acquiring Data Using the Model 9333 LAN Communicator

The Model 9333 LAN Communicator, which is the optional communication program for computers, allows you to control the instrument from the computer remotely and store data directly on the computer. Additionally, Model 9333 enables you to print waveforms with the printer connected to the computer.

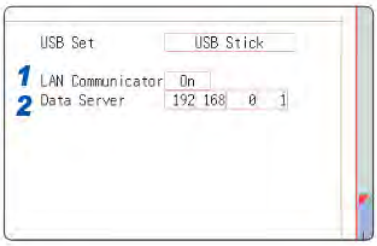
Procedure

1 **Configure the LAN Communicator setting.**

On	Allows you to use LAN Communicator.
OFF	Does not allow you to use LAN Communicator.

2 **Set the data collection server.**

Specify the IP address of the computer on which Model 9333 LAN Communicator is running to communicate with the instrument.
The IP address is required to acquire data using the Model 9333 LAN Communicator.
If necessary, set "**LAN:**" as the save destination on the **[File Save]** screen and set **[LAN]** as the output destination of the Print Key operation and the auto-print setting.



3 **Confirm the settings.**

Move the cursor to the **[Reset]** box.
Select **[Reflect Set]**.

The message "LAN was reconnected" appears at the bottom of the screen.

For the settings of the 9333 LAN Communicator, see the instruction manual of Model 9333 LAN Communicator.

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17 Controlling the Instrument Externally

Read “Before connecting the instrument to an external device” (p. 14) carefully.

This chapter describes how to exchange signals through the terminals, enabling you to control the instrument externally.
We use the term “external control terminals” to refer to all of those terminals.

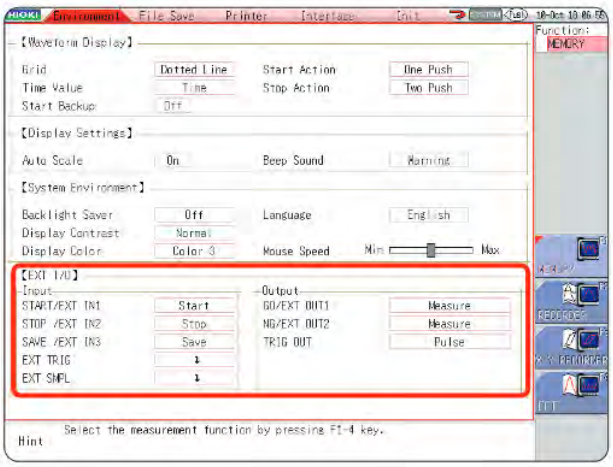
Signals input into the external control terminals take effect even when the key lock function is engaged.

To display the [Environment] Sheet



Press the **[SYSTEM]** key repeatedly to switch the sheets.

[Environment] ← **[Init]**
↓ ↑
[File Save]
↓ ↑
[Printer] → **[Interface]**



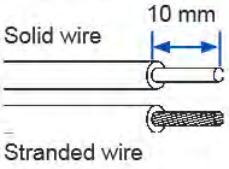
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17.1 Connection of the External Control Terminals

The method for connecting wires to the external control terminals is as follows.

Procedure

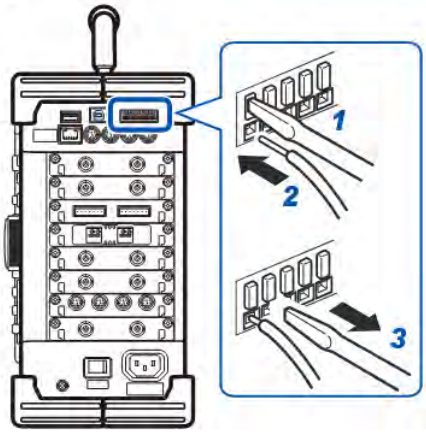
Cables to be connected



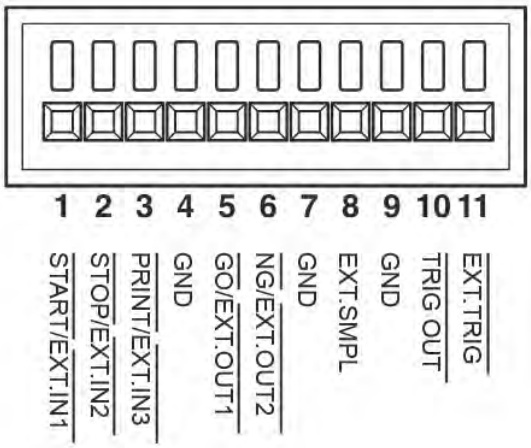
Supporting wire:	Solid wire 0.65 mm in diameter (AWG22) Stranded wire 0.32 mm^2 (AWG22)
Compatible wire:	Solid wire 0.32 mm to 0.65 mm in diameter (AWG28 to 22) Stranded wire 0.08 mm to 0.32 mm^2 (AWG28 to 22) Strand diameter 0.12 mm or more (per wire)
Stripped length:	9 mm to 10 mm
Button pressing tool:	Flat-blade screwdriver (shaft diameter: 3 mm, tip width: 2.6 mm)

Wire Connecting procedure

Right side



1. **Depress the button on the connector with the flat-blade screwdriver or another tool.**
2. **While depressing the button, insert the cable into the cable connection hole.**
3. **Release the button.**
   The cable is locked.



Terminal No.	Operation
1	Executes the following operations when signals are input externally. • Starts/ends the measurement. • Prints/saves the data. • Sets the X-Y curve plotting setting to on/off (for X-Y recorder function)
2	
3	
4	GND (common with the instrument's ground)
5	Outputs signals depending on the instrument state.
6	
7	GND (common with the instrument's ground)
8	Sets the sampling rate when a signal is input externally.
9	GND (common with the instrument's ground)
10	Outputs a signal when triggers.
11	Triggers when a signal is input externally.

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17.2 External I/O

17.2.1 External Input (START/EXT.IN1) (STOP/EXT.IN2) (PRINT/EXT.IN3)

Externally inputting signals can start and stop the measurement as well as print and save the data. The factory-default settings are **[Start]**, **[Stop]**, and **[Print]**.

Signal inputting procedure

1 **Connect each of the START/EXT.IN1, STOP/EXT.IN2, PRINT/EXT.IN3, and GND terminals to an external signal-outputting device using the wires.**

Refer to "17.1 Connection of the External Control Terminals" (p. 370).

2 **Press the SYSTEM key to display the [Environment] sheet and move the cursor to the [START/EXT. IN1], [STOP/EXT. IN2], or [PRINT/EXT. IN3] box.**

3 **Select the operation to be performed by the instrument in response to the external input signal.**

START	Starts the measurement. (Regardless of **[Start Action]** [p. 338]).
STOP	Stops the measurement. (Post-measurement processes such as numerical calculations and automatic saving are performed.)
START/STOP	Starts measurement when the low-level signal is input; stops the measurement when the high-level signal is input.
ABORT	Stops the measurement immediately. (Post-measurement processes such as numerical calculations and automatic saving are performed.)
PRINT	Performs the same operation as that when the **PRINT** key is pressed. (**[Select at print]** [p. 130] is disabled.)
SAVE	Saves the data to the specified media under the specified condition, both of which are specified with the **SAVE** key. (**[Select at save]** [p. 103] is disabled
Pen Up/Down	Plots the X-Y composite curves when the low-level signal input; does not plot them when the high-level signal is input. (for X-Y recorder function)
RUN/STOP	Outputs the waveforms when the low-level signal is input; stops outputting the waveforms when the high-level signal is input.
PAUSE	Pauses the outputting of the waveforms.

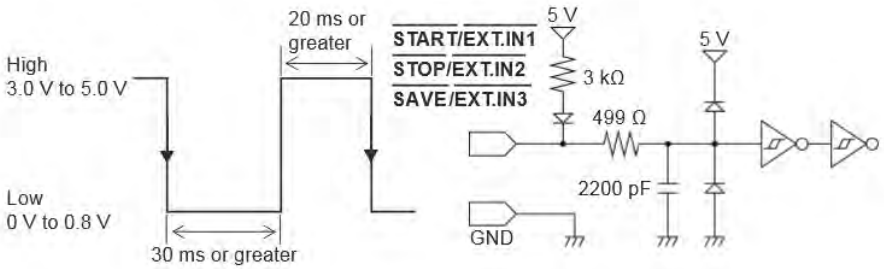
- When the STOP signal is input, the instrument stops the measurement along the **[STOP Action]** setting, in the same manner as when the **[STOP]** key is pressed (p. 338).
- The instrument ignores external inputs while displaying the HELP screen or a dialog box.

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4 **Short-circuit the terminal and GND with each other, or the input pulse wave or rectangular wave to the terminal. The signal shall be with a high-level voltage of between 3.0 V and 5.0 V and a low-level voltage of between 0 V and 0.8 V.**

The low level of the input waveform controls the instrument.

Available voltage range	High level: 3.0 V to 5.0 V; Low level: 0 V to 0.8 V
Pulse width	High level: 20 ms or longer; Low level: 30 ms or longer
Maximum input voltage	−0.5 V to 7 V



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17.2.2 External Output (GO/EXT.OUT1) (NG/EXT.OUT2)

The instrument can output various signals depending on its state.

Signal inputting procedure

1 **Connect each of the GO/EXT.OUT1, NG/EXT.OUT2, and GND terminals to an external signal-inputting device using the wires.**

Refer to "17.1 Connection of the External Control Terminals" (p. 370).

2 **Press the SYSTEM key to display the [Environment] sheet, and move the cursor to the [GO/EXT. OUT1] or [NG/EXT. OUT2] box.**

3 **Select the conditions under which the instrument outputs a signal.**

(When using the **[GO/EXT. OUT1]** setting)

Measure	Outputs the low-level signal when giving a GO (pass) judgment to the numerical calculation result.
Waveform Evaluation	Outputs the low-level signal when giving a GO (pass) judgment to the waveform evaluation result.
Value Evaluation or Waveform Evaluation	Outputs the low-level signal when giving a GO (pass) judgment to either the value calculation or waveform calculation evaluation result.
Value Evaluation and Waveform Evaluation	Outputs the low-level signal when giving GO (pass) judgments to both the value calculation and waveform evaluation result.
Error	Outputs a low-level signal when an error occurs.
BUSY	Outputs a low-level signal when rejecting a START signal because the instrument is in the busy state such as performing the measurement, saving the data, and printing the data.
Trigger	Outputs a low-level signal while waiting for a trigger.

The instrument keeps outputting the signal for a GO (pass) judgment (low-level output) until it starts the next measurement.

(When using the **[NG/EXT. OUT2]** setting)

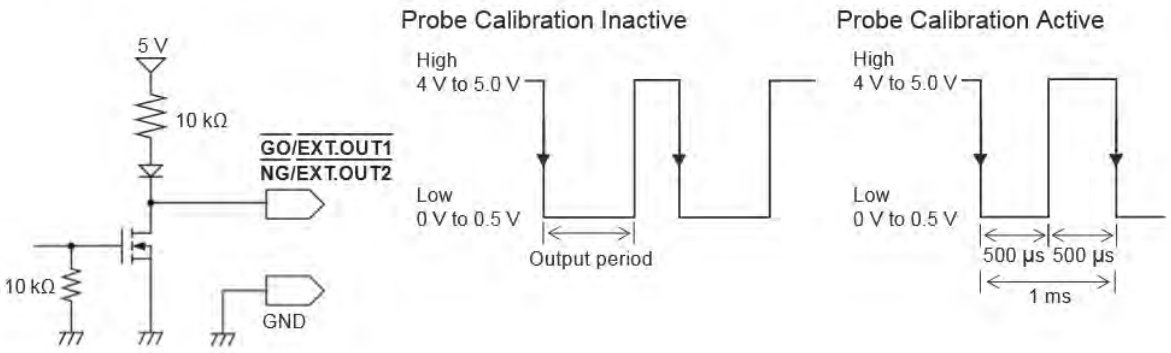
Measure	Outputs the low-level signal when giving an NG (fail) judgment to the numerical calculation result.
Waveform Evaluation	Outputs the low-level signal when giving an NG (fail) judgment to the waveform evaluation result.
Value Evaluation or Waveform Evaluation	Outputs the low-level signal when giving an NG (fail) judgment to either the value calculation or waveform calculation evaluation result.
Value Evaluation and Waveform Evaluation	Outputs the low-level signal when giving NG (fail) judgments to both the value calculation and waveform evaluation result.
Error	Outputs a low-level signal when an error occurs.
BUSY	Outputs a low-level signal when being in the busy state such as performing the measurement, saving the data, and printing the data. Switches to the high level when coming out of the busy state.
Trigger	Outputs a low-level signal while waiting for a trigger.
Probe Calibration	Outputs the signal (1 kHz) that can be used for the calibration of Model 9665 10:1 Probe and Model 9666 100:1 Probe.

The instrument keeps outputting the signal for an NG (fail) judgment (low-level output) until it starts the next measurement.

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The instrument can output various signals depending on its state.

Output signal	Open-drain output (with voltage output), active low
Output voltage range	High level: 4.0 V to 5.0 V low level: 0 V to 0.5 V (current value of 15 mA)
Maximum input voltage	50 V DC, 50 mA DC, 200 mW



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17.2.3 External Sampling (EXT.SMPL) MEM

This function can be used in the memory function only.
Externally inputting the signal can control the sampling rate.

Signal inputting procedure

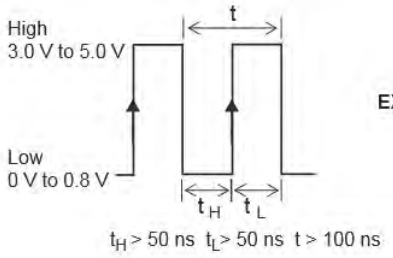
1. **Connect each of the EXT.SMPL and GND terminals to an external signal-outputting device using the wires.**
2. **Press the SYSTEM key to display the [Environment] sheet, and move the cursor to the [EXT. SMPL] box.**
3. **Select whether the instrument triggers on the rising edge (↑) or falling edge (↓) of the waveform.**
4. **Input the pulse wave or rectangular wave to the EXT.SMPL terminal. Make sure that the signal is with a high-level voltage of between 3.0 V and 5.0 V and a low-level voltage of between 0 V and 0.8 V.**

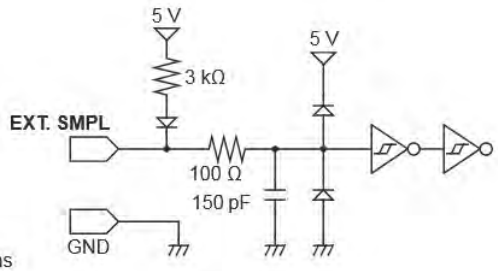
   The instrument samples the data on the rising edge or falling edge of the input waveform. Note that the sampling rate is limited depending on the selected edge. For proper operation, pulse width must be at least that shown in the following table.

Minimum pulse width of the external sampling

Setting (EXT.SMPL)	Pulse width					
	When Roll mode is set to [On]			When Roll Mode is set to [Off]		
	t_H	t_L	t	t_H	t_L	t
Rising edge (↑)	> 5 µs	> 5 µs	> 10 µs	> 50 ns	> 50 ns	> 100 ns
Falling edge (↓)	> 5 µs	> 5 µs	> 10 µs	> 50 ns	> 50 ns	> 100 ns

Available voltage range	High level: 3.0 V to 5.0 V; Low level: 0 V to 0.8 V
Pulse width	High level, low level: 50 ns or longer
Response frequency	10 MHz or lower
Maximum input voltage	−0.5 V to 7 V





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- If a sampling signal of 5 MHz or higher is input, trigger points are delayed by one sample.
- The Roll mode setting of **[Auto]** and **[On]** are valid even when the external sampling is used: however, if the frequency of the external sampling signal is higher than 100 kHz, set Roll mode to **[Off]**. Failure to do so will make the instrument unable to sample the data correctly.
- The anti-aliasing filter (A.A.F) is disabled regardless of its setting.
  Refer to "8.10.1 Setting the Anti-aliasing Filter (A.A.F)" (p. 186).
- When Roll mode is set to **[Auto]** or **[On]**, the instrument ignores external sampling signals during the following periods:
  (1) The period between 150 µs and 200 µs after the first sampling clock has been entered
  (2) Two clock periods after the dead time described in item (1)
- When the external sampling setting is valid, you cannot change the output settings of Models MR8790, MR8791, and U8793.

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17.2.4 Trigger Output (TRIG OUT)

The instrument output the signal when triggering. This feature allows multiple instruments to be controlled, achieving the synchronous operation.

Signal outputting procedure

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

Refer to "17.1 Connection of the External Control Terminals" (p. 370).

2 **Press the SYSTEM key to display the [Environment] sheet, and move the cursor to the [TRIG. OUT] box.**

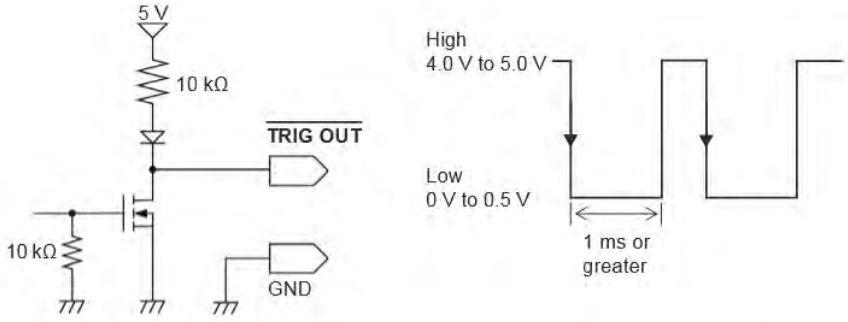
3 **Select the output signal type for the trigger output terminal.**

Pulse	Outputs the low-level signal, and then switches to the high level after the specified time has elapsed.
Level	Outputs the low-level signal after triggering, keeping outputting it during the measurement.

When triggering, the instrument outputs the pulse, which switches from the high level (4.0 V to 5.0 V) to the low level (0 V to 0.5 V) via the TRIG OUT terminal.

Output signal	Open drain output (with voltage output), active low*
Output voltage range	High level: 4.0 V to 5.0 V low level: 0 V to 0.5 V (current value of 15 mA)
Pulse width	When using the pulse setting: 2 ms ± 0.1 ms When using the level setting: (Sampling rate) × (Number of pieces of data after trigger) or longer
Maximum input voltage	50 V DC, 50 mA DC, 200 mW

* The instrument triggers when the signal voltage level switches from high to low.



- When the auto-ranging function is used in the memory function, the instrument triggers, outputting the TRIG OUT signal. Keep this in mind when performing auto-range measurement while using the TRIG OUT signals.
- When using the memory division function, the instrument may output the TRIG_OUT signals irregularly under the following conditions:
  - The timebase is set to one between 5 µs/div and 100 µs/div
  - The record (measurement) time is set to 5 ms or less
  - **[Wave display]** is set to **[OFF]**.

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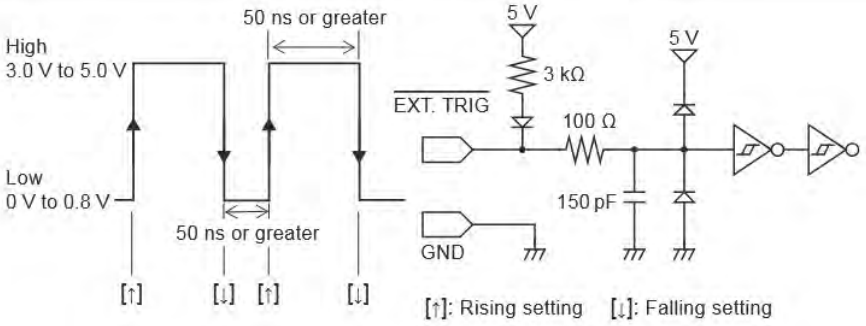
17.2.5 External Trigger Terminal (EXT.TRIG)

Externally inputting the trigger signal can trigger the instrument. This feature allows multiple instruments to be controlled, achieving the synchronous operation.

Signal inputting procedure

1. **Connect each of the EXT.TRIG and GND terminals to an external signal-outputting device using the wires.**
   Refer to "17.1 Connection of the External Control Terminals" (p. 370).
2. **In the Trigger Settings window, set the external trigger to [On].**
3. **Press the SYSTEM key to display the [Environment] sheet, and move the cursor to the [EXT. TRIG] box.**
4. **Select whether the instrument triggers on the rising edge (↑) or falling edge (↓) of the waveform.**
5. **Short-circuit the EXT.TRIG terminal and GND with each other, or input the pulse wave or rectangular wave to the EXT.TRIG terminal. The signal shall be with a high-level voltage of between 3.0 V and 5.0 V and a low-level voltage of between 0 V and 0.8 V.**
   The instrument triggers on the rising or falling edge of the input waveform.

Available voltage range	High level: 3.0 V to 5.0 V; Low level: 0 V to 0.8 V
Pulse width	High level: 50 ns or greater, low level: 50 ns or longer
Maximum input voltage	−0.5 V to 7 V



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18 Specifications

18.1 General Specifications of the Instrument

Basic specifications

Measurement functions	• Memory function • Recorder function • X-Y recorder function • FFT function
Maximum number of channels	Analog 16 channels + logic 16 channels at a maximum, or analog 32 channels + logic 16 channels at a maximum (when 8 modules of Model U8975 4CH Analog Unit or U8978 4CH Analog Unit are installed), or analog 10 channels + logic 64 channels at a maximum (Together with the logic channels the instrument provides, when 3 modules of Model 8973 Logic Unit are installed) or analog 20 channels + logic 64 channels at a maximum (Together with the logic channels the instrument provides, when 5 modules of Model U8975 4CH Analog Unit or U8978 4CH Analog Unit and 3 modules of Model 8973 Logic Unit are installed)
Number of modules	Up to 8 modules Restrictions • Up to 4 modules of Model 8971 Current Unit can be installed. • Up to 3 modules of Model 8973 Logic Unit can be installed. • Up to 3 modules of Model U8977 3CH Current Unit
Number of the instrument logic channels	16 (The input connectors of logic channels share the ground with the instrument.) • Installing Model MR8990 Digital Voltmeter Unit in both slots for Unit 1 and Unit 2 disables the instrument logic channels. • Restrictions imposed when the logic instrument channels are used (when the logic measurement is set to on) Measurement resolution of each measuring module decreases to 12 bits when the module is installed in a slot for Unit 1 or Unit 2. No frequency measuring modules are available when the module is installed in the slots for Unit 1 or Unit 2.
Sampling rate	20 MS/s (Simultaneously sampling all channels)
Memory capacity	Model MR8847-51 (Total memory: 64 MW) 2 MW/ch (in 32-channel mode), 4 MW/ch (in 16-channel mode), 8 MW/ch (in 8-channel mode), 16 MW/ch (in 4-channel mode), 32 MW/ch (in 2-channel mode) Model MR8847-52 (Total memory: 256 MW) 8 MW/ch (in 32-channel mode), 16 MW/ch (in 16-channel mode), 32 MW/ch (in 8-channel mode), 64 MW/ch (in 4-channel mode), 128 MW/ch (in 2-channel mode) Model MR8847-53 (Total memory: 512 MW) 16 MW/ch (in 32-channel mode), 32 MW/ch (in 16-channel mode), 64 MW/ch (in 8-channel mode), 128 MW/ch (in 4-channel mode), 256 MW/ch (in 2-channel mode)
Operating environment	Indoors, Pollution Degree 2, altitude up to 2000 m (6562 ft.)
Operating temperature and humidity	Temperature: −10°C to 40°C (14°F to 104°F) Humidity: 20% RH to 80% RH (no condensation) When the printer and the internal drive (Model U8331 SSD Unit) are used Temperature: 0°C to 40°C (32°F to 104°F) Humidity: 20% RH to 80% RH (no condensation)
Storage temperature and humidity	−20°C to 50°C (−4°F to 122°F), 90% RH or less (no condensation)
Standards	Safety EN61010 EMC EN61326 Class A

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Power supply	Rated supply voltage:	100 V to 240 V AC (continuous input) (Voltage fluctuations of ±10% from the rated supply voltage are taken into account.)
	Rated supply frequency:	50 Hz / 60 Hz
	Anticipated transient overvoltage:	2500 V
	DC power supply input	
	Rated supply voltage:	10 V to 28 V DC (Model 9784 DC Power Supply Unit) (Voltage fluctuations of ±10% from the rated supply voltage are taken into account.)
Maximum rated power	220 VA (When the printer is used) 130 VA (When the printer is not used)	
Clock	Automatic calendar, automatic leap year adjustment, 24-hour clock Accuracy: ±100 ppm (Operated within the operating temperature range) Reference value: ±10 ppm (at 25°C)	
Backup battery life	Approx. 10 years (reference duration at 25°C) for clock and settings	
Interface	LAN, USB, External control terminals	
Dimensions	Approx. 351W × 261H × 140D mm (13.82″W × 10.28″H × 5.51″D) (excluding protrusions) Approx. 365W × 307H × 160D mm (14.37″W × 12.09″H × 6.30″D) (including protrusions)	
Mass	Approx. 7.6 kg (268.1 oz.) (Model MR8847A with no modules is installed) Approx. 9.6 kg (338.6 oz.) (Model MR8847A with Model 8966 Analog Unit is installed)	
Product warranty period	3 years U8331 SSD UNIT : 1 year	

Specifications for accuracy

Conditions of guaranteed accuracy	Guaranteed accuracy period:	1 year
	Temperature and humidity for guaranteed accuracy:	23°C ±5°C (73°F ±9°F), 20% RH to 80% RH
	Warm-up time:	At least 30 minutes
Time axis accuracy	±0.01% (represents the relative error between the grid and time)	
Paper feeding accuracy	±1% (25°C, 60% RH)	

Display

Display type	10.4-inch SVGA TFT color LCD (800 × 600 dots)	
Display resolution	T-Y waveform display:	25 div (horizontal axis [time axis]) × 20 div (vertical axis [voltage axis])
	X-Y composite curve display:	20 div (X-axis) × 20 div (Y-axis)
Dot pitch	0.264 (horizontal) × 0.264 (vertical) mm	
Backlight operating life	Approx. 80,000 hours (until brightness of LED light source decreases by half)	

Printer

Recording method	Thermosensitive recording method using the thermal line head	
Recording paper	Approx. 216 mm × 30 m (8.50" × 98.43 ft.) roll-type thermosensitive paper (Model 9231 Recording Paper)	
Recording width	Overall recording width:	Approx. 208 mm
	Waveform part:	Approx. 200 mm
Recording speed	Approx. 50 mm/s (at a maximum)	
Recording paper loading method	One-touch system	

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External storage device

CF card

CF card slot	50-pin, 1 slot
Card type	CompactFlash
Compatible CF card	Model 9728 PC Card 512M Model 9729 PC Card 1G Model 9830 PC Card 2G
Data format	FAT, FAT32
Storage contents	Setting conditions, measured data (binary or text, saving data within the period between Cursors A and B is available), screen images (BMP), printing images (BMP), numerical calculation results, data decimation saving (text: simple), waveform evaluation conditions (evaluation area and setting conditions), user-defined waveform data (when Model U8793 is installed), generation program data (when Model U8793 is installed), pulse pattern data (when Model MR8791 is installed)

Built-in drive (Model U8331 SSD Unit, which is a factory-option, is installed)

Storage system	2.5-inch SSD (MLC)
Storage capacity	128 GB
Data format	FAT32
Storage contents	Setting conditions, measured data (binary or text, saving data within the range between Cursors A and B is available), screen images (BMP), printing images (BMP), numerical calculation results, data decimation saving (text: simple), waveform evaluation conditions (evaluation area and setting conditions), user-defined waveform data (when Model U8793 is installed), generation program data (when Model U8793 is installed), pulse pattern data (when Model MR8791 is installed)

Specifications of interface

LAN interface

Compliant standards	IEEE802.3 Ethernet 100BASE-TX
Function	FTP server, HTTP server
Connector	RJ-45

USB interface

Compliant standards	Compliant with USB2.0
Host	Connector: Series-A receptacle Connecting device: USB flash drive, mouse
Functions	Number of ports: 1 Connector: Series-B receptacle Connecting device: Computer Functions: Mass storage device class (for transferring contents from built-in drive or CF card to computer) Communications device class (computer-controlled)

Accessories and options

Accessories	Refer to “Instrument and accessories” (p. 3).
Options	Refer to “Appx. 3.1 Options” (p. Appx.15).

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18.2 Common Functions

Module settings / Waveform display settings

Measurement mode	Depends on modules
Measurement range	Depends on modules
Input coupling	Depends on modules
Low-pass filter	Depends on modules
Probe settings	Automatic scaling based on probes (by entering model or voltage division ratio)
Displayed graphs	Graph display setting with multi-screen and multi-printing function enabled (up to 16 graphs)
Waveform display	Off or selectable from among 16 colors
Display sheet	1 through 4 It is possible to set settings related to waveform display with respect to each display sheet, and switch a display sheet to another.
Print density	4 levels
Waveform display position	In 1% increments Preset position (selectable from ascending order, descending order, 0%, or 50%)
Zero adjust	Executable collectively for all ranges of all channels
Waveform display magnification/ reduction	Horizontal axis (Time axis): ×10, ×5, ×2, ×1, (Magnification is available for the memory function only) ×1/2, ×1/5, ×1/10, ×1/20, ×1/50, ×1/100, ×1/200, ×1/500, ×1/1000, ×1/2000, ×1/5000, ×1/10000, ×1/20000, ×1/50000, ×1/100000, ×1/200000 Vertical axis (Voltage axis): ×100, ×50, ×20, ×10, ×5, ×2, ×1, ×1/2, ×1/5, ×1/10
Variable (user-defined display range)	Settable between by specifying upper and lower values and by specifying a voltage per division
Scaling	Automatic scaling (10:1, 100:1, 1000:1, predetermined ratios based on current probes selectable) Manual scaling (conversion ratio setting, two-point setting, measurement unit settings)
Invert function	Polarity reversal
Vernier function	Yes
Comment entry	Alphanumeric, Japanese characters (title, each analog channel, each logic channel)
Comment entry method	Simple input with the keys of the Memory HiCorder, mouse, keyboard Previously saved strings and past input strings entry (previously saved and past input strings can be recalled, inserted and edited)
Channel setting copy	Copy and paste, paste all
Logic setting	Width: Selectable from three options: wide, standard, and narrow Display position: Freely settable in 1% increments Display bits: Off or selectable from among 16 colors, settable with respect to each bit
Zoom function	Screen horizontally split into two, and the lower portion displays zoomed waveforms.

Trigger function

Trigger method	Digital comparison
Trigger mode	Single, repeat, automatic (memory function, FFT function) Single, repeat (recorder function)

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Trigger source	Analog module (CH1 through CH32), 16 logic channels included as standard and logic modules (up to 3 modules, 48 channels) External trigger, manual trigger, timer trigger
Trigger conditions	Logical AND or OR of each of trigger sources
Analog trigger	Level trigger: The instrument triggers when an input signal voltage exceeds or falls below a predetermined voltage. Voltage sag trigger: The instrument triggers when the peak voltage of an input signal falls below a user-defined voltage. (dedicated to 50 Hz / 60 Hz commercial power) Window trigger: A range provided by upper and lower levels is previously set. The instrument triggers when an input signal voltage falls within (IN) or outside (OUT) the user-defined range. Period trigger: A period-measuring level and a period range are previously set. Periods between when a voltage exceeds or falls a predetermined level are measured, and the instrument triggers when the period falls outside the user-defined range. Glitch trigger: A voltage level and a pulse width (glitch width) are previously set. Pulse widths from when rising or falling edges crosses the predetermined level are measured, and the instrument triggers when a signal pulse width becomes narrower than the predetermined pulse width. Event trigger: The number of events (numerical value) is previously set. The instrument triggers when the number of events exceeds the predetermined number. Applicable for the level trigger and the glitch trigger
Logic trigger	Pattern trigger specified by 1, 0, or × (× represents that either of them is accepted.)
External trigger	The instrument triggers when an external signal is input.
Manual trigger	The instrument triggers when the manual trigger key is pressed.
Timer trigger	The instrument triggers on event based on the time and interval settings
Trigger filter	Off, 0.1, 0.2, 0.5, 1.0, 1.5, 2.0, 2.5, 5.0, 10.0 div (memory function, FFT function) Off On (10 ms fixed, recorder function)
Trigger level resolution	0.1% f.s. (f.s. = 20 div)
Pre-trigger	Applicable for memory function and FFT function Setting in percent: 0, 2, 5, 10, 20, 30, 40, 50, 60, 70, 80, 90, 95, 100, −95% Setting in divisions: Settable in one division increments Trigger priority: Off, on
Trigger output	Open collector output With 5-volt outputs, active low, low output level: 0 V to 0.5 V (current of 15 mA) Pulse width for level setting: [(sampling rate) × (number of data points after trigger)] or more Pulse width for pulse setting: 2 ms ±1 ms
Trigger input and output terminals	Terminal block
Trigger marker	Trigger marks indicate positions of trigger events
Trigger timing (behavior on trigger)	Start (all functions), stop (recorder function), start & stop (recorder function)
Trigger search function	After a measurement, the position that meets a trigger condition is searched for.

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18.3 Measurement Functions

18.3.1 Memory Function

Timebase (time axis)	5*, 10, 20, 50, 100, 200, 500 µs/div 1, 2, 5, 10, 20, 50, 100, 200, 500 ms/div 1, 2, 5, 10, 30, 50, 100 s/div 1, 2, 5 min/div External sampling (100 samples/div, freely settable) * If using Model U8975, U8977, or U8978, 5 µs/div will not be available.
Time axis resolution	100 points/div
Sampling rate	1/100 of timebase setting
Recording length	• Model MR8847-51 (Total memory: 64 MW) Fixed recording length: 25, 50, 100, 200, 500, 1,000, 2,000, 5,000, 10,000, 20,000 div (in 2-, 4-, 8-, 16-, 32-channel mode), 50,000 div (in 2-, 4-, 8-channel mode), 100,000 div (in 2-, 4-channel mode), 200,000 div (in 2-channel mode) User-defined recording length: Settable in one div increments (up to 320,000 div) • Model MR8847-52 (Total memory: 256 MW) Fixed recording length: 25, 50, 100, 200, 500, 1,000, 2,000, 5,000, 10,000, 20,000, 50,000 div (in 2-, 4-, 8-, 16-, 32-channel mode), 100,000 div (in 2-, 4-, 8-, 16-channel mode), 200,000 div (in 2-, 4-, 8-channel mode), 500,000 div (in 2-, 4-channel mode), 1,000,000 div (in 2-channel mode) User-defined recording length: Settable in one division increments (up to 1,280,000 div) • Model MR8847-53 (Total memory: 512 MW) Fixed recording length: 25, 50, 100, 200, 500, 1,000, 2,000, 5,000, 10,000, 20,000, 50,000, 100,000 div (in 2-, 4-, 8-, 16-, 32-channel mode), 200,000 div (in 2-, 4-, 8-, 16-channel mode), 500,000 div (in 2-, 4-, 8-channel mode), 1,000,000 div (in 2-, 4-channel mode), 2,000,000 div (in 2-channel mode) User-defined recording length: Settable in one division increments (up to 2,560,000 div) If using Model U8975, U8977, or U8978, the setting is fixed to 32-channel mode (2-, 4-, 8-, 16-channel mode will not be available).
Screen and printing settings	1 screen, 2 screens, 4 screens, 8 screens, 16 screens, X-Y 1 screen, or X-Y 4 screens
Interpolation function	Line, line and dot (X-Y display)
Waveform scrolling	Horizontally scrolling the display is available. Backward scrolling is available in roll mode.
Overlay function	Automatic: Always overlays waveforms when starting measurements and clears when restarting measurements Manual: Overlays necessary waveforms only, and clears them as needed
Automatic printing	Automatically prints waveforms after measurements (At relatively slower sampling rate, printing waveforms is available while recording them.)
Manual printing	By pressing the **PRINT** key (prints waveforms at up to 50 mm/s, depending on print coverage)
Partial printing	Prints waveforms within the range between Cursors A and B (Whole, A-B)
Automatic saving	Automatically saves data on a CF card, a USB flash drive, or the built-in drive after measurements (in binary or text format). At relatively slower sampling rate, saving waveforms is available while recording them.
Report printing	Yes
Channel modes	Selectable between 2-, 4-, 8-, and 16-channel modes If using Model U8975, U8977, or U8978, the setting is fixed to 32-channel mode.

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18.3.2 Recorder Function

Timebase (time axis)	10, 20, 50, 100, 200, 500 ms/div 1, 2, 5, 10, 30, 50, 100 s/div 1, 2, 5, 10, 30 min/div 1 h/div
Time axis resolution	100 points/div
Sampling rate	1, 10, 100 µs 1, 10, 100 ms (select from periods that are 1/100 or less of the timebase setting)
Recording length	• Model MR8847-51 (Total memory: 64 MW)

Fixed recording length:	25, 50, 100, 200, 500, 1,000, 2,000, 5,000, 10,000, 20,000* div
User-defined recording length:	Settable in one division increments (up to 20,000 div)
Repeat	

• Model MR8847-52 (Total memory: 256 MW)

Fixed recording length:	25, 50, 100, 200, 500, 1,000, 2,000, 5,000, 10,000, 20,000, 50,000* div
User-defined recording length:	Settable in one division increments (up to 80,000 div)
Repeat	

• Model MR8847-53 (Total memory: 512 MW)

Fixed recording length:	25, 50, 100, 200, 500, 1,000, 2,000, 5,000, 10,000, 20,000, 50,000, 100,000* div
User-defined recording length:	Settable in one division increments (up to 160,000 div)
Repeat	

* Not available if using Model U8975, U8977, or U8978

Screen and printing settings	1, 2, 4, 8, 16 screens
Waveform storage	Model MR8847-51: The most recent 20,000 divisions of measured data are written in the internal memory (if using Model U8975, U8977, or U8978: 10,000 div). Model MR8847-52: The most recent 80,000 divisions of measured data are written in the internal memory. (if using Model U8975, U8977, or U8978: 40,000 div). Model MR8847-53: The most recent 160,000 divisions of measured data are written in the internal memory. (if using Model U8975, U8977, or U8978: 80,000 div).
Waveform scrolling	Scrolling horizontally the display is available with the jog dial and shuttle ring. Backward scrolling during measurement is available.
Real-time printing	Available with the timebase set to 500 ms/div or slower. (Even during measurement, pressing the specific **F** key starts and stops printing.) With the timebase set to one between 10 ms/div and 200 ms/div, prints waveforms simultaneously with some delay from recording (Any of the recording length settings except continuous is available). With the timebase set to one between 10 ms/div and 200 ms/div, manually printing waveforms is required after measurement stops.
Automatic printing	Automatically prints waveforms after measurement (At relatively slower sampling rate, printing waveforms is available while recording them.)
Manual printing	By pressing the **PRINT** key (prints waveforms at up to 50 mm/s, depending on print coverage)
Partial printing	Prints waveforms within the range between Cursors A and B (Whole, A-B)
Automatic saving	Automatically saves data on a CF card, a USB flash drive, or the built-in drive after measurement (in binary or text format). At relatively slower sampling rate, saving waveforms is available while recording them.
Report printing	Yes

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18.3.3 X-Y Recorder Function

Sampling rate	1, 10, 100 ms
Recording length	Repeat
Screen and printing settings	1 screen, 4 screens
Number of X-Y display	Up to 8 phenomena
X-Y setting	Select 8 channels out of 32 for each of X-axis and Y-axis
Interpolation function	Dot, line
Clearing waveforms	On, off
Waveform storage	The most recent 4,000,000 samples of measured data are written in the internal memory (if using Model U8975, U8977, or U8978: 2,000,000 samples).
Raising/lowering pen (plotting/not plotting waveforms)	Yes (for all phenomena simultaneously)
External pen control	Controllable by inputting a signal into the external control terminal (all phenomena simultaneously)
Automatic printing	No
Manual printing	By pressing the **PRINT** key (prints waveforms at a speed of up to 50 mm/s, depending on print coverage rates)
Automatic saving	No

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18.3.4 FFT Function

Frequency range	133 mHz to 8 MHz, 133 mHz to 4 MHz (if using U8975, U8977, or U8978), external
Dynamic range	72 dB (theoretical value), 96 dB (theoretical value) with Model 8968 High Resolution Unit used
Number of sampling points	1000 points, 2000 points, 5000 points, 10000 points
Frequency resolution	1/400, 1/800, 1/2000, 1/4000
Anti-aliasing filters	The cutoff frequency is automatically set along with frequency ranges. (Available only with Model 8968 High Resolution Unit or Model U8979 Charge Unit used)
Analysis channel setting	Freely selectable between the channels
FFT analysis mode	Storage waveform, linear spectrum*, RMS spectrum*, power spectrum*, cross power spectrum, auto-correlation function, histogram, transfer function, cross-correlation function, impulse response, coherence function, 1/1 octave analysis, 1/3 octave analysis, LPC analysis, phase spectrum *Setting the cursors to on enables the total harmonic distortion (THD) to appear.
Display formats	Single, dual, Nyquist display, running spectrum display
Window function	Rectangular window, Hanning, exponential, Hamming, Blackman, Blackman-Harris, flat top
Display scale	Linear scale, logarithmic scale
Print function	In accordance with the specifications of the memory function. Note: Partial printing is not available.
Peak hold	Yes
Averaging	Simple average in the time domain and the frequency domain, exponential moving average, peak hold (frequency axis) Number of averaging (2, 4, 8, . . . , 10,000)

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18.4 Other Functions

Numerical calculation function

Function supporting numerical calculation	Memory function
Number of calculations	Up to 16 calculations for freely-selected channels
Calculation range	Selectable between the entire range, the range between Cursors A and B, and the range after the trigger
Calculation types	Average, RMS value, peak-to-peal value, maximum value, time to maximum value, minimum value, time to minimum value, period, frequency, rise time, fall time, standard deviation, area, X-Y area, time to user-defined level, level at user-defined time, pulse width, duty ratio, pulse count, four basic arithmetic operations, time lag, phase difference, high level, low level
Statistical calculation	Selectable between first, average, maximum, and minimum
Printing calculation results	Yes
Automatically saving calculation results	Automatically saves on a CF card, a USB flash drive, or the built-in drive (in text format) after measurement.
Judging calculation results	Calculation results can be judged based on user-defined maximum/minimum value Stop condition: GO, NG, GO&NG
Judgment result output	Generates a GO or NG result and outputs a signal from the external control terminal. Open collector output With 5-volt outputs, active low, low output level: 0 V to 0.5 V (current of 15 mA) Pulse width: 1.8 ms or more

Waveform calculation function

Function supporting waveform calculation	Memory function
Number of calculations	Up to 16 calculations for freely-selected channels
Calculation range	Selectable between the entire range and the range between Cursors A and B
Calculation recording length	Up to 1/4 of the maximum memory length
Calculation types	Four arithmetic operations, absolute values, indexes, common logarithms, square root, moving average, differential (primary, secondary), integral (primary, secondary), parallel displacement in time axis direction, trigonometric function, reverse trigonometric function, integration time correction based on NPLC setting
Printing calculation results	Yes
Automatically saving calculation results	Automatically saves to a CF card, a USB flash drive, or the built-in drive (in binary or text format) after measurement.

Memory dividing function

Function supporting memory dividing	Memory function
Number of divided memories	2 to 1024 (if using the U8975, U8977, or U8978: 2 to 512)

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Recording length consisting of the divided memories	Freely settable (depends on the number of divided memories)
Sequential saving	Specifying a start and end blocks enables the sequential saving.
Sequential saving dead time	With the block display set to off: 1 to 8 samples (with the timebase set to 5 µs/div to 20 µs/div) 1 sample (with the timebase set to 50 µs/div or more) With the block display set to on: 40 ms or more (with the timebase set to 5 µs/div to 20 µs/div) 1 sample (with the timebase set to 50 µs/div or more)
Multi-block saving	Freely specifying divided blocks enables the multi-block saving.
Block display	On, off
Overlaying waveforms belonging to blocks	Specified blocks or entire blocks

Cursor measurement function

Functions supporting cursor measurement	Memory function, recorder function, X-Y recorder function, FFT function
Number of cursors	Two (Cursors A and B)
Cursor types	Line cursor (vertical or horizontal), trace cursor
Cursor movements	Cursor A, Cursor B, Cursors A and B
Measurement functions	Cursor A: Potential at each cursor, time from trigger event Cursors A and B: Difference in time, difference in potential, frequency (period)
Supported channels	Specify the entire channels (default setting), or any one channel
Included functions	Specify a range for partial printout or partial saving

Monitor function

Monitor display	Level monitor: Pressing the **DISP** key enables the level monitor, displaying levels and numerical values. DMM display: Pressing the **DISP** key displays numerical values.
Numerical value display	Displaying instantaneous values, equipped with the hold function
Level monitor sampling	Fixed at 10 kS/s
Refresh rate	0.5 s or more, depends on the NPLC settings when Model MR8990 Digital Voltmeter Unit is used

Position display (VIEW) function

Display function	Position: Displays a present position with respect to the entire recording length Blocks: Blocks of divided memories (with the memory division set to on)
Position display	Presently displayed position (linked to scrolling), positions of Cursors A and B, trigger position, waveform search results position
Block display	Block usage status (with the memory dividing set to on) Waveform history status (with the memory dividing set to off) Display of freely-selected blocks with respect to the entire blocks

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Jump function	Jump to a trigger position or cursor positions Jump to user-defined blocks (with the memory dividing set to on) Jump to previously observed waveforms (with the memory dividing set to off) Jump to searched waveform positions

Waveform judgment function

Function supporting waveform judgment	Memory function (Y-T waveform, X-Y composite curve), FFT function Compares captured waveforms with a user-defined waveform area, and determines whether the captured waveform falls within or outside the user-defined waveform area.
Judgment modes	Out: If any part of a waveform falls outside the area, generates an NG (fail) result. All out: If the entire waveform falls outside the area, generates an NG (fail) result.
Measurement stopping conditions based on judgment	GO, NG, GO&NG Stopping measurement based on judgments enables printer output to be generated and waveforms to be saved.
Judgment result output	Generates a GO or NG result and output a signal from the external control terminal Open collector output With 5-volt outputs, active low, low output level: 0 V to 0.5 V (current of 15 mA) Pulse width: 1.8 ms or more
Waveform judgment time	Judgment time: 100 ms or less, evaluation period: 250 ms or less* * Number of judgment channels: 1, Timebase: 5 µs/div, recording length: 25 div, magnification: × 1, for 2 periods of input waveform A relatively slower sampling setting enables waveforms to be judged during measurement.
Graphic editor	Instrument: An editor is provided to create waveform judgment reference areas. External: Waveform judgment reference areas, which are created in BMP format with graphic applications installed in a computer, can be loaded onto the instrument.
Editor commands	Load wave, Zoom in/out, Fill color, Draw shape, Eraser, Clear all, Clear select area, Invert colors, Cancel, Exit

Waveform generation function

The detailed hardware functions are in accordance with the generator module specifications of Models MR8790, MR8791, and U8793

Waveform generation mode	Based on generator modules of Models MR8790, MR8791, and U8793
Waveform output control	Output control RUN (generation), STOP (stop), PAUSE (suspension) Output control method Manual: Controls output by pressing the **F** keys on the settings screen. Measurement and synchronization: Outputs a waveform in synchronization with the start of measurement Keys: Controls output by pressing the **START** key and the **STOP** key (measurement disabled)
Output waveform	Model MR8790 Waveform Generator Unit: DC, Sine wave Model MR8791 Pulse Generator Unit: Pulse, pattern Model U8793 Arbitrary Waveform Generator Unit: DC, sine wave, triangular wave, rectangular wave, pulse, ramp-up, ramp-down, user-defined waveform, program
Supporting waveform for output (Model U8793 only)	Refer to “Specifications of user-defined waveform generation function” (p. 418).

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Other functions

Online help function	Pressing the **HELP** key displays help for the presently selected (flashing) item. (Does not occupy the entire screen) Basic help (When enabled, displays a brief description of the selected [flashing] item on the bottom of the screen.)
Grid types	Waveform screen: Off, dotted line, solid line Printout: Off, normal, fine, normal (dark), fine (dark)
Comment display	Channel number comments are displayed on the screen and included in printouts.
Time axis label	Time, time in base 60 system, scale, date, number of samples
Start backup function	Off, on
START key acceptance conditions	Pressing the key once, pressing the key twice, holding the key for two seconds
STOP key acceptance conditions	Pressing the key once, pressing the key twice
Auto-variable scale	Off, on
Beep	Off, warnings, warnings and operation
Backlight saver	Off, 1 min. to 30 min.
Display brightness	3 levels
Display color combination	Color 1 to 3, user-defined color combination
Language	English, Japanese, Chinese, Korean
Mouse speed	Set the speed when using it.
External control terminals	Trigger control terminals (EXT.TRIG, TRIG OUT), External sampling input terminal (EXT.SMPL) Remote control input terminals (START/EXT.IN1, STOP/EXT.IN2, PRINT/EXT.IN3), Judgment output terminals (GO/EXT.OUT1, NG/EXT.OUT2)
Remote control	Assign the following tasks to each of the three remote control terminals: START/EXT.IN1, STOP/EXT.IN2, and PRINT/EXT.IN3. **[START], [STOP], [START/STOP], [ABORT], [PRINT], [SAVE], [Pen Up/Down], [RUN/STOP], [Pause]**
Internal status output	Assign the following status to each of the two judgment terminals: GO/EXT.OUT1, NG/EXT.OUT2. **[Error], [BUSY], [Trigger]**
Probe calibration output	Assign the status **[Probe Calibration] to the judgment output terminal NG/EXT.OUT2.**
Judgment result output	Assign the following status to each of the two judgment terminals: GO/EXT.OUT1, NG/EXT.OUT2. **[Measure], [Waveform Evaluation], [Value Evaluation or Waveform Evaluation], [Value Evaluation and Waveform Evaluation]**
Key lock function	Press and hold the **ESC** key for 3 seconds. (Engage the key lock function, disengage the key lock function)
Print speed	Fast (coarse), normal, slow (fine)
Print density	Light, Midlight, Standard, Middark, Dark
Print key operation	Select whether to generate print output or not (Yes, No) Print output destination (printer, LAN)
Automatic printing setting	Automatic printing (off, on) Print output destination (printer, LAN)

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Channel marker	Off, channel number, comment
List	Off, on (Prints a list including setting information)
Gauge	Off, on (includes gauges of measured channels in printouts*, displays gauges on the screen) * If both range and zero position of a channel are set to the same as those of other channels, a single gauge is included in printouts, shared by those channels.
Printout scaling	Prints waveforms magnified or compressed on the time axis, regardless of the screen display settings
Print range	Selectable between the entire range and the range between Cursors A and B
Includes upper/lower limits in printouts	Off, on
Zero-position comments	Off, on (shall not be overlaid with others)
Text comment printing	Loads a text file and includes comments at the beginning of a printout.
Counter printing	Off, date, counter name and count value
GUI saving	Off, on (Decide whether to include the GUI when saving a screen image in BMP format.)
Waveform backup function	No
Automatic setup function	Automatically loads the setting file STARTUP.SET on a CF card on start-up
Automatic range select function	Pressing the **AUTO** key engages the automatic range select function, which automatically selects an optimal timebase and voltage axis based on an input waveform.
Backlight brightness	Selectable from three levels
Time setting	Year, month, day, hour, minute
Initialization	Clears waveform data System reset (Settings/System settings 1 [Environment]/System settings 2 [Interface])
Self-check function	ROM/RAM, printer, display, keys, system configuration

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18.5 File

Data saving

Storage device	CF card, built-in drive*, USB flash drive, internal RAM, LAN (Model 9333 LAN Communicator)
Data that can be saved	Setting data, measured data, analysis data, screen image, print image, waveform judgment condition, waveform evaluation area
Data saving format	• Setting data (.SET) (The internal RAM is dedicated to setting data.) • Measured data Binary format (.MEM, .REC, .XYC, .FFT), text format (.TXT) • Index Memory division (.SEQ), division save (.IDX) • Screen image (.BMP) • Print image (.BMP) • Startup (STRATUP.SET) • Waveform judgment conditions (.ARE) (Judgment areas and setting conditions are saved.) • Waveform judgment area (.BMP) (Judgment areas are saved.) • User-defined waveform data (.WFG) (when Model U8793 is installed) • Generation program data (.FGP) (when Model U8793 is installed) • Pulse pattern data (.PLS) (when Model MR8791 is installed)
File name entry	Alphanumeric, Japanese characters
Waveform saving range	Selectable between the entire range and the range between Cursors A and B
Data decimation saving	Available in text format Off, 1/2, 1/5, 1/10, 1/20, 1/50, 1/100, 1/200, 1/500, 1/1000
Division saving	Available in binary format 16 MB, 32 MB, 64 MB
Handling of a duplicate file	Auto: If a file is tried to be saved in a folder containing a file that has the same name, saves it as another file by adding a 4-digit number at the beginning of the file name. Serial: Saves files, adding a 4-digit number at the beginning of the file name without condition. Overwrite: If a file is tried to be saved in a folder containing a file that has the same name, overwrites the existing file. Error: If a file is tried to be saved in a folder containing a file that has the same name, an error message will be displayed.
Selection of blocks to be saved	Saves data in selected blocks if the memory is divided.
Selection of channels to be saved	Saves data acquired through selected channels (measured data, calculation data), all channels

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Data loading

Supported storage devices	CF card, built-in drive*, USB flash drive, internal RAM
Loadable data types	Setting data, measured data, analysis data, text comments, waveform judgment conditions, waveform judgment area
Loadable data formats	• Setting data (.SET) (The internal RAM is dedicated to setting data.) • Measured data Binary (.MEM, .REC, .XYC, .FFT) • Index Memory division (.SEQ), division save (.IDX) • Text comment (.TXT) • Startup (STRATUP.SET) • Waveform judgment conditions (.ARE) • Waveform judgment area (.BMP) • User-defined waveform data (when Model U8793 is installed) In binary format (.WFG), in text format (.TFG) • Generation program data (.FGP) (when Model U8793 is installed) • Pulse pattern data (.PLS) (when Model MR8791 is installed)
Data Loading method	Newly loads data

* When Model U8331 SSD Unit is installed.

Other functions

File information display	Yes
Data deletion	Selected file, multiple selected files
File sorting	By name, date, size, extension Ascending order, descending order
File renaming	Yes
Directory	Can be created, renamed, and deleted.
File copy	Copy files to other storage devices
Print list	Prints file lists
One-touch saving	User-defined data items in a predetermined format can be saved by pressing the **SAVE** key or clicking the mouse button.

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18.6 Specifications of Modules

18.6.1 Model 8966 Analog Unit

The accuracy has been specified under the following conditions: installed in a Memory HiCorder and operated at 23°C ±5°C (73°F ±9°F) in the range of 20% to 80% RH after a half-hour (at least) warm-up and execution of zero-adjustment.

Product warranty period	3 years
Guaranteed accuracy period	1 year
Number of input channels	2 channels
Measurement range	5, 10, 20, 50, 100, 200, 500 mV, 1, 2, 5, 10, 20 V/div
Measurement accuracy	±0.5% f.s. (with the low-pass filter set to 5 Hz)
Temperature characteristic	±0.06% f.s./°C
Frequency characteristic	DC coupling: DC to 5 MHz, −3 dB AC coupling: 7 Hz to 5 MHz, −3 dB (lower cut-off frequency: 7 Hz ±50%)
Noise	1.5 mV p-p (typ.), 2 mV p-p (max.) (highest sensitivity range, with input terminals short-circuited)
Common mode rejection ratio	80 dB or more (at 50 Hz / 60 Hz, a signal source resistance of 100 Ω or less)
Low-pass filter	OFF, 5 ±50%, 50 ±50%, 500 ±50%, 5 k ±50%, 50 k ±50%, 500 k ±50% (Hz) −3 dB
Input type	Unbalanced input (floating)
Input coupling	AC/DC/GND
Input resistance	1 MΩ ±1%
Input capacitance	30 pF ±10 pF (at 100 kHz)
A/D resolution	12 bits
Maximum sampling rate	20 MS/s
Input terminals	Insulated BNC terminal
Maximum input voltage	400 V DC
Maximum rated voltage to earth	300 V AC, DC (between each input channel and enclosure, between any two of input channels) Measurement category II (anticipated transient overvoltage: 2500 V)
Operating temperature and humidity	In accordance with the specification of the Memory HiCorder in which Model 8966 is installed
Operating environment	In accordance with the specification of the Memory HiCorder in which Model 8966 is installed
Storage temperature and humidity	−10°C to 50°C (14°F to 122°F), 80% RH or less (no condensation)
Dimensions	Approx. 106W × 19.8H × 196.5D mm (4.17"W × 0.78"H × 7.74"D)
Mass	Approx. 250 g (8.8 oz.)

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Effect of radiated radio-frequency electromagnetic field	±15% f.s. (at a maximum) at 3 V/m
Effect of conducted radio-frequency electromagnetic field	±45% f.s. (at a maximum) at 3 V (100 mV/div range, with 1-volt DC input)
Standards	Safety EN61010 EMC EN61326 Class A
Options	Model L9197 Connection Cord (CAT IV 300 V, CAT III 600 V, 1 A) Model L9198 Connection Cord (CAT III 300 V, CAT II 600 V, 0.2 A) Model L9217 Connection Cord (CAT III 300 V, CAT II 600 V, 0.2 A) Model L9790 Connection Cord (with Model L9790-01 or 9790-03: CAT III 300 V, CAT II 600 V, 1 A) (with Model 9790-02: CAT III 150 V, CAT II 300 V, 1 A) Model 9322 Differential Probe (with grabber clips attached: CAT II 1000 V) (with alligator clips attached: CAT III 600 V, CAT II 1000 V) Model P9000-01 Differential Probe (CAT III 1000 V) Model P9000-02 Differential Probe (CAT III 1000 V) Model 9665 10:1 Probe (CAT II 300 V) Model 9666 100:1 Probe (CAT II 300 V)

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18.6.2 Model 8967 Temp Unit

The accuracy has been specified under the following conditions: installed in a Memory HiCorder and operated at 23°C ±5°C (73°F ±9°F) in the range of 20% to 80% RH after a half-hour (at least) warm-up and execution of zero-adjustment.

Product warranty period	3 years
Guaranteed accuracy period	1 year
Number of input channels	2 channels
Input terminals	Push-button type terminal block (2 terminals/channel)
Measurement device	Thermocouple (K, J, E, T, N, R, S, B, W)

Measurement range
Measurable range
Resolution
Measurement accuracy (f.s.=20 div)

Measurement device	Measurement range		Measurable range	Resolution	Measurement accuracy
Thermocouple (not including reference junction compensation accuracy)	K *1	10°C/div	−100°C to 200°C	0.01°C	±0.1% f.s.±1°C (0°C or higher) ±0.1% f.s.±2°C (−200°C or higher but lower than 0°C)
		50°C/div	−200°C to 1000°C	0.05°C	
		100°C/div	−200°C to 1350°C	0.1°C	
	J *1	10°C/div	−100°C to 200°C	0.01°C	
		50°C/div	−200°C to 1000°C	0.05°C	
		100°C/div	−200°C to 1100°C	0.1°C	
	E *1	10°C/div	−100°C to 200°C	0.01°C	
		50°C/div	−200°C to 800°C	0.05°C	
		100°C/div	−200°C to 800°C	0.1°C	
	T *1	10°C/div	−100°C to 200°C	0.01°C	
		50°C/div	−200°C to 400°C	0.05°C	
		100°C/div	−200°C to 400°C	0.1°C	
	N *1	10°C/div	−100°C to 200°C	0.01°C	
		50°C/div	−200°C to 1000°C	0.05°C	
		100°C/div	−200°C to 1300°C	0.1°C	
	R *1	10°C/div	0°C to 200°C	0.01°C	±0.1% f.s.±3.5°C (0°C or higher but lower than 400°C) (For Type B, accuracy is not specified at a temperature below 400°C) ±0.1% f.s.±3°C (400°C or higher)
		50°C/div	0°C to 1000°C	0.05°C	
		100°C/div	0°C to 1700°C	0.1°C	
	S *1	10°C/div	0°C to 200°C	0.01°C	
		50°C/div	0°C to 1000°C	0.05°C	
		100°C/div	0°C to 1700°C	0.1°C	
	B *1	50°C/div	400°C to 1000°C	0.05°C	
		100°C/div	400°C to 1800°C	0.1°C	
	W *2 (WRe5-26)	10°C/div	0°C to 200°C	0.01°C	
		50°C/div	0°C to 1000°C	0.05°C	
		100°C/div	0°C to 2000°C	0.1°C	

*1: JIS C 1602-1995, *2: ASTM E-988-96

Reference junction compensation accuracy	±1.5°C (When the reference junction compensation is set to internal, add the figure to thermocouple measurement accuracy)
Reference junction compensation	Selectable between internal or external (during temperature measurement with thermocouples)
Temperature characteristics	Add [(measurement accuracy) × 0.1]/°C to the measurement accuracy

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Data refreshing	Selectable between normal, fast, and slow
Wire break detection	Selectable between on or off
Input resistance	5 MΩ or more (both with the wire break detection is set to on and off)
Common mode rejection ratio	80 dB or more (at 50 Hz / 60 Hz, a signal source resistance of 100 Ω or less, with the data refresh set to Fast) 100 dB or more (at 50 Hz / 60 Hz, a signal source resistance or 100 Ω or less, with the data refresh set to Normal)
Input type	Unbalanced input (floating)
Maximum rated voltage to earth	300 V AC, DC (between each input channel and enclosure, between any two of input channels) Measurement category II (anticipated transient over-voltage: 2500 V)
Operating temperature and humidity	In accordance with the specifications of Memory HiCorder in which Model 8967 is installed
Storage temperature and humidity	−20°C to 50°C (−4°F to 122°F), 90% RH or less (no condensation)
Operating environment	In accordance with the specifications of Memory HiCorder in which Model 8967 is installed
Dimensions	Approx. 106W × 19.8H × 204.5D mm (4.17"W × 0.78"H × 8.05"D)
Mass	Approx. 240 g (8.5 oz.)
Effect of radiated radio-frequency electromagnetic field	±2% f.s. (at a maximum) at 3 V/m
Effect of conducted radio-frequency electromagnetic field	±2% f.s. (at a maximum) at 3 V
Standards	Safety EN61010 EMC EN61326 Class A
Accessories	Ferrite clamp-on choke (2 pieces)
Options	Model 9810 Thermocouples (K)

	Fast	**Normal**	**Slow**
Data refresh rate	Approx. 1.2 ms	Approx. 100 ms	Approx. 500 ms

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18.6.3 Model 8968 High Resolution Unit

The accuracy has been specified under the following conditions: installed in a Memory HiCorder and operated at 23°C ±5°C (73°F ±9°F) in the range of 20% to 80% RH after a half-hour (at least) warm-up and execution of zero-adjustment.

Product warranty period	3 years
Guaranteed accuracy period	1 year
Number of input channels	2 channels
Measurement range	5, 10, 20, 50, 100, 200, 500 mV, 1, 2, 5, 10, 20 V/div
Measurement accuracy	±0.3% f.s. (with the low-pass filter setting set to 5 Hz, operated after the zero-adjustment)
Temperature characteristics	±0.045% f.s./°C
Frequency characteristic	DC coupling: DC to 100 kHz, −3 dB AC coupling: 7 Hz to 100 kHz, −3 dB (lower cut-off frequency: 7 Hz±50%)
Noise	500 µV p-p (typ.), 1 mV p-p (max.) (highest sensitivity range, with input short-circuited)
Common mode rejection ratio	80 dB or more (at 50 Hz / 60 Hz, a signal source resistance of 100 Ω or less)
Low-pass filter	Off, 5±50%, 50±50%, 500±50%, 5 k±50%, 50 k±50% (Hz) −3 dB
Anti-aliasing filters	Cutoff frequency (fc) 20, 40, 80, 200, 400, 800, 2 k, 4 k, 8 k, 20 k, 40 k (Hz) (Automatically set if the anti-aliasing filter is set to on) Attenuation property: −66 dB or higher at 1.5 fc
Input type	Unbalanced input (floating)
Input coupling	AC/DC/GND
Input resistance	1 MΩ±1%
Input capacitance	30 pF ±10 pF (at 100 kHz)
A/D resolution	16 bits
Maximum sampling rate	1 MS/s
Input terminals	Insulated BNC terminal
Maximum input voltage	400 V DC
Maximum rated voltage to earth	300 V AC, DC (between each input channel and enclosure, between any two of input channels) Measurement category II (anticipated transient overvoltage: 2500 V)
Operating temperature and humidity	In accordance with the specifications of Memory HiCorder in which Model 8968 is installed
Operating environment	In accordance with the specifications of Memory HiCorder in which Model 8968 is installed
Storage temperature and humidity	−10°C to 50°C (14°F to 122°F), 80% RH or less (no condensation)
Dimensions	Approx. 106W × 19.8H × 196.5D mm (4.17"W × 0.78"H × 7.74"D)
Mass	Approx. 250 g (8.8 oz.)

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Effect of radiated radio-frequency electromagnetic field	±15% f.s. (at a maximum) at 3 V/m
Effect of conducted radio-frequency electromagnetic field	±20% f.s. (at a maximum) at 3 V (100 mV/div range, with 1 V DC input)
Standards	Safety EN61010 EMC EN61326 Class A
Options	Model L9197 Connection Cord (CAT IV 300 V, CAT III 600 V, 1 A) Model L9198 Connection Cord (CAT III 300 V, CAT II 600 V, 0.2 A) Model L9217 Connection Cord (CAT III 300 V, CAT II 600 V, 0.2 A) Model L9790 Connection Cord (with Model L9790-01 or 9790-03: CAT III 300 V, CAT II 600 V, 1 A) (with Model 9790-02: CAT III 150 V, CAT II 300 V, 1 A) Model 9322 Differential Probe (with grabber clips attached: CAT II 1000 V) (with alligator clips attached: CAT III 600 V, CAT II 1000 V) Model P9000-01 Differential Probe (CAT III 1000 V) Model P9000-02 Differential Probe (CAT III 1000 V) Model 9665 10:1 Probe (CAT II 300 V) Model 9666 100:1 Probe (CAT II 300 V)

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18.6.4 Model 8969 Strain Unit, U8969 Strain Unit

	Model 8969	Model U8969
Product warranty period	1 year	3 years
Conditions of guaranteed accuracy	• Guaranteed accuracy period: 1 year • Temperature and humidity for guaranteed accuracy: 23°C ±5°C (73°F ±9°F), 20% RH to 80% RH • Warm-up time: At least 30 minutes • Specified after performing the auto-balance	• Guaranteed accuracy period: 1 year • Temperature and humidity for guaranteed accuracy: 23°C ±5°C (73°F ±9°F), 80% RH or less • Warm-up time: At least 30 minutes • Specified after performing the auto-balance
Number of input channels	2 channels	
Input terminals	Weidmüller SL3.5/7/90G	NDIS connector EPRC07-R9FNDIS
Measurement device	Strain gauge transducer	
Gauge ratio	2.0	
Bridge voltage	2 V ±0.05 V	
Bridge resistance	120 Ω to 1 kΩ	
Balance adjustment range	±10000 με or less	
Balancing method	Electronic auto-balancing	
Measurement range	20, 50, 100, 200, 500, 1000 με/div	
Measurement accuracy	±0.5% f.s. ±4 με (with the low-pass filter set to 5 Hz)	
Temperature characteristics	Gain: ±0.05% f.s./°C Zero position: ±2.5 με/°C	
Frequency characteristic	DC to 20 kHz +1/−3 dB	
Low-pass filter	Off, 5±30%, 10±30%, 100±30%, 1 k±30% (Hz) −3 dB	
A/D resolution	16 bits (±f.s. equals ±25000 pieces of data)	
Maximum sampling rate	200 kS/s	
Maximum rated voltage to earth	33 V rms AC or 70 V DC (between each input channel and enclosure, between any two of input channels) Anticipated transient overvoltage: 330 V (Based on EN61010-2-030:2010)	30 V rms AC or 60 V DC (between each input channel and enclosure, between any two of input channels) Anticipated transient overvoltage: 330 V
Operating temperature and humidity	In accordance with the specifications of Memory HiCorder in which Model 8969 is installed	Temperature: −10°C to 40°C (14°F to 104°F) Humidity: 90% RH or less (no condensation)
Storage temperature and humidity	In accordance with the specifications of Memory HiCorder in which Model 8969 is installed	Temperature: −20°C to 50°C (−4°F to 122°F) Humidity: 80% RH or less (no condensation)
Operating environment	In accordance with the specifications of Memory HiCorder in which Model 8969 is installed	Indoors, Pollution Degree 2, altitude up to 2000 m (6562 ft.)
Dimensions	Approx. 106W × 19.8H × 196.5D mm (4.17"W × 0.78"H × 7.74"D)	
Mass	Approx. 220 g (7.8 oz.)	Approx. 245 g (8.6 oz.)

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Accessories	Model 9769 Conversion Cable × 2 (Compatible connector: NDIS connector PRC03-12A10-7M10.5)	Model L9769 Conversion Cable × 2 (Compatible connector: NDIS connector PRC03-12A10-7M10.5)
Effect of radiated radio-frequency electromagnetic field	±10% f.s. (at a maximum) at 3 V/m (with the low-pass filter set to 5 Hz)	
Effect of conducted radio-frequency electromagnetic field	±10% f.s. (at a maximum) at 3 V (with the low-pass filter set to 5 Hz)	
Standards	Safety: EN61010 EMC: EN61326 Class A	

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18.6.5 Model 8970 Freq Unit

The accuracy has been specified under the following conditions: installed in a Memory HiCorder and operated at 23°C ±5°C (73°F ±9°F) in the range of 20% to 80% RH after a half-hour (at least) warm-up.

Product warranty period	3 years
Measurement functions	The following types of measurement based on voltage input: frequency, rotation speed, power frequency, count, pulse duty ratio, and pulse width
Input terminals	Insulated BNC terminal
Input resistance	1 MΩ±1%
Input capacitance	30 pF±10 pF
Maximum input voltage	400 V DC
Maximum rated voltage to earth	300 V AC, DC (Measurement category II) Anticipated transient overvoltage: 2500 V (between each input channel and enclosure, between any two of input channels)
Input type	Unbalanced input (floating)
Guaranteed accuracy period	1 year
Frequency mode	
Measurement range	1, 5, 10, 50, 100, 500, 1 k, 5 kHz/div (f.s.= 20 div)
Measurement accuracy	±0.1% f.s. (except for 5 kHz/div range) ±0.7% f.s. (5 kHz/div range)
Measurable range	DC to 100 kHz (minimum pulse width: 2 µs
Rotation speed mode	
Measurement range	100, 500, 1 k, 5 k, 10 k, 50 k, 100 kr/min /div (f.s.= 20 div)
Measurement accuracy	±0.1% f.s. (except for 100 kr/min range) ±0.7% f.s. (100 kr/min range)
Measurable range	0 Mr/min to 2 Mr/min (minimum pulse width 2: µs)
Power frequency mode	
Measurement range	50 Hz (40 Hz to 60 Hz), 60 Hz (50 Hz to 70 Hz), 400 Hz (390 Hz to 410 Hz) (f.s. = 20 div)
Measurement accuracy	±0.03 Hz (50 Hz, 60 Hz), ±0.1 Hz (400 Hz)
Count mode	
Measurement range	2 k, 10 k, 20 k, 100 k, 200 k, 1 M counts/div
Measurement accuracy	±(range/2000)
Measurable range	DC to 100 kHz (minimum pulse width: 2 µs)
Duty ratio mode	
Measurement range	5%/div (f.s.= 20 div)
Measurement accuracy	±1% (10 Hz to 10 kHz) ±4% (10 kHz to 100 kHz)
Measurable range	10 Hz to 100 kHz (minimum pulse width: 2 µs)
Pulse width mode	
Measurement range	500 µ, 1 m, 5 m, 10 m, 50 m, 100 ms/div (f.s.= 20 div)
Measurement accuracy	±0.1% f.s.
Measurable range	2 µs to 2 s

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Measurement resolution	Count mode: 2000LSB/div (f.s. = 20 div) Except for count mode and power frequency mode: 500LSB/div (f.s. = 20 div) Power frequency mode: 100LSB/div (f.s. = 20 div)
Response time	Within 40 µs + (sampling interval of instrument in which the module is installed)
Input voltage range	±10 V, ±20 V, ±50 V, ±100 V, ±200 V, ±400 V
Threshold value	±10 V range: Variable in the range between −10 V and +10 V (in 0.1 V increments) ±20 V range: Variable in the range between −20 V and +20 V (in 0.2 V increments) ±50 V range: Variable in the range between −50 V and +50 V (in 0.5 V increments) ±100 V range: Variable in the range between −100 V and +100 V (in 1 V increments) ±200 V range: Variable in the range between −200 V and +200 V (in 2 V increments) ±400 V range: Variable in the range between −400 V and +400 V (in 5 V increments)
Slope	Rising, falling (frequency mode, rotation speed mode, power frequency mode, count mode)
Level	High, low (duty ratio mode, pulse width mode)
Hold	Frequency mode, rotation speed mode: On, off (1 Hz, 0.5 Hz, 0.2 Hz, 0.1 Hz) Behavior with the hold function not engaged: If a subsequent measured value is not determined within the waiting time period, the frequency or the rotation speed will be determined and recorded using the value that is calculated based on the time period between the timing of the previous measurement and the timing of the sampling. If these calculated values are less than a user-defined value, then the value will be assumed to be zero.
Smoothing	Off, on (The permissible smoothing frequency is up to 10 kHz.) (Frequency mode, rotation speed mode)
Low-pass filter	Off, 5, 50, 500, 5 k, 50 kHz
Input coupling	DC, AC (Lower frequency cut-off in AC-coupled mode: 7 Hz)
Frequency dividing function	Setting range: 1 to 4096, in one increments (frequency mode, rotation speed mode, count mode)
Counting start timing	Start, trigger (count mode)
Count over handling	Hold, back (count mode)
Operating temperature and humidity	In accordance with the specifications of Memory HiCorder in which Model 8970 is installed
Operating environment	In accordance with the specifications of Memory HiCorder in which Model 8970 is installed
Storage temperature and humidity	In accordance with the specifications of Memory HiCorder in which Model 8970 is installed
Standards	Safety EN61010 EMC EN61326 Class A
Dimensions	Approx. 106W × 19.8H × 196.5D mm (4.17″W × 0.78″H × 7.74″D)
Mass	Approx. 250 g (8.8 oz.)
Options	Model L9197 Connection Cord (CAT IV 300 V, CAT III 600 V, 1 A) Model L9198 Connection Cord (CAT III 300 V, CAT II 600 V, 0.2 A) Model L9217 Connection Cord (CAT III 300 V, CAT II 600 V, 0.2 A) Model L9790 Connection Cord (with Model L9790-01 or 9790-03: CAT III 300 V, CAT II 600 V, 1 A) (with Model 9790-02: CAT III 150 V, CAT II 300 V, 1 A) Model 9322 Differential Probe (with grabber clips attached: CAT II 1000 V) (with alligator clips attached: CAT III 600 V, CAT II 1000 V) Model P9000-01 Differential Probe (CAT III 1000 V) Model P9000-02 Differential Probe (CAT III 1000 V) Model 9665 10:1 Probe (CAT II 300 V) Model 9666 100:1 Probe (CAT II 300 V)

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18.6.6 Model 8971 Current Unit

The accuracy has been specified under the following conditions: installed in a Memory HiCorder and operated at 23°C ±5°C (73°F ±9°F) in the range of 20% to 80% RH after a half-hour (at least) warm-up and execution of zero-adjustment.

Product warranty period	3 years
Guaranteed accuracy period	1 year
Number of input channels	2 channels
Supported current sensors	• Connect a sensor with Model 8971 using Model 9318 Conversion Cable Models 9272-10, 9277, 9278, 9279, 9709, CT6862, CT6863, CT6865*2, CT6841, CT6843, CT6844, CT6845, CT6846*2 • Connect a sensor with Model 8971 using Model 9318 Conversion Cable and Model CT9901 Conversion Cable Models 9272-05, 9709-05, CT6862-05, CT6863-05, CT6865-05*2, CT6841-05, CT6843-05, CT6844-05, CT6845-05,CT6846-05*2, CT6875, CT6876*2,CA6841A, CT6843A, CT6844A, CT6845A, , CT6846A, , CT6872, CT6872-01, CT6873, CT6873-01, CT6875A, CT6875A-1, CT6876A*2, or CT6876A-1*2 • Hioki current sensors with RM515EPA-10PC (Hirose) installed Supported conversion ratios: 2 V/20 A, 2 V/50 A, 2 V/200 A, 2 V/500 A, 2 V/1000 A*2
Measurement range	• When Model 9272-10 (20 A), 9272-05 (20 A), 9277, CT6841, CT6841-05 or CT6841A is used: 100 m, 200 m, 500 m, 1, 2, 5 A/div • When Model CT6862, CT6862-05, CT6872, or CT6872-01 is used 200 m, 500 m, 1, 2, 5, 10 A/div • When Model 9272-10 (200 A), 9272-05 (200 A), 9278, CT6863, CT6863-05, CT6843, CT6843-05, CT6873, CT6873-01, or CT6843A is used 1, 2, 5, 10, 20, 50 A/div • When Model 9279, 9709, 9709-05, CT6865*2, CT6865-05*2, CT6844, CT6844-05, CT6845, CT6845-05, CT6846*2, CT6846-05*2, CT6875, CT6876*2, CT6844A, CT6845A, CT6846A*2, CT6875A, CT6875A-1, CT6876A*2, or CT6876A-1*2 is used: 2, 5, 10, 20, 50, 100 A/div
Measurement accuracy*1	±0.65% f.s. (with the low-pass filter set to 5 Hz) ±0.85% f.s. (with the low-pass filter set to 5 Hz, when Model 9278 or 9279 is used)
RMS accuracy*1	±1% f.s. (DC, 30 Hz to 1 kHz), ±3% f.s. (1 kHz to 10 kHz) (Sine wave input, with the low-pass filter set to 5 Hz, crest factor: 2)
Response time*1	100 ms (rising from 0% of f.s. to 90% of f.s.)
Temperature characteristic*1	±0.075% f.s./°C
Frequency characteristic*1	DC coupling: DC to 100 kHz ±3 dB AC coupling: 7 Hz to 100 kHz ±3 dB (lower cut-off frequency: 7 Hz ±50%)
Noise*1	10 mA p-p max. (Highest sensitivity range, with input terminals short-circuited) (for 20 A/2V range)
Low-pass filter	OFF, 5, 50, 500, 5 k, 50 k±50% (Hz) −3 dB
Input type	Unbalanced input (Not isolated)
Input coupling	AC/DC/GND
Input resistance	1 MΩ±1%
A/D resolution	12 bits
Maximum sampling rate	1 MS/s
Input terminals	Sensor connector HR10A-10R-S (Hirose)

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Operating temperature and humidity	In accordance with the specifications of Memory HiCorder in which Model 8971 is installed
Operating environment	In accordance with the specifications of Memory HiCorder in which Model 8971 is installed
Storage temperature and humidity	−10°C to 50°C (14°F to 122°F), 80% RH or less (no condensation)
Dimensions	Approx. 106W × 19.8H × 196.5D mm (4.17″W × 0.78″H × 7.74″D)
Mass	Approx. 250 g (8.8 oz.)
Standards	Safety EN61010 EMC EN61326 Class A
Accessories	(for connecting the clamp sensor) Model 9318 Conversion Cable ×2
Options	Model 9318 Conversion Cable, Model CT9901 Conversion Cable
Number of installable modules	Up to 4 modules

*1 For current measurement, add the accuracy and characteristic of the clamp sensor used with Model 8971.

*2 The instrument recognizes this as a 500 A AC/DC sensor is connected; setting the ratio of the scaling function to 2 is required.

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18.6.7 Model 8972 DC/RMS Unit

The accuracy has been specified under the following conditions: installed in a Memory HiCorder and operated at 23°C ±5°C (73°F ±9°F) in the range of 20% to 80% RH after a half-hour (at least) warm-up and execution of zero-adjustment.

Product warranty period	3 years
Guaranteed accuracy period	1 year
Number of input channels	2 channels
Measurement range	5, 10, 20, 50, 100, 200, 500 mV, 1, 2, 5, 10, 20 V/div
Measurement accuracy	±0.5% f.s. (with the low-pass filter set to 5 Hz)
RMS accuracy	±1% f.s. (DC, 30 Hz to 1 kHz), ±3% f.s. (1 kHz to 100 kHz) (Sine wave input, response time setting: Slow)
Response time	Slow: 5 s (rising from 0% of f.s. to 90% of f.s.) Normal: 800 ms (rising from 0% of f.s. to 90% of f.s.) Fast: 100 ms (rising from 0% of f.s. to 90% of f.s.)
Crest factor	2
Temperature characteristics	±0.045% f.s./°C
Frequency characteristics	DC coupling: DC to 400 kHz, −3 dB AC coupling: 7 Hz to 400 kHz, −3 dB (lower cut-off frequency: 7 Hz ±50%)
Noise	500 µV p-p (typ.), 750 µV p-p (max.) (Highest sensitivity range, with input shorted)
Common mode rejection ratio	80 dB or more (at 50 Hz / 60 Hz, a signal source resistance of 100 Ω or less)
Low-pass filter	Off, 5±50%, 50±50%, 500±50%, 5 k±50%, 100 k±50% (Hz) −3 dB
Input type	Unbalanced input (floating)
Input coupling	AC/DC/GND
Input resistance	1 MΩ±1%
Input capacitance	30 pF ±10 pF (at 100 kHz)
A/D resolution	12 bits
Maximum sampling rate	1 MS/s
Input terminals	Insulated BNC terminal
Maximum input voltage	400 V DC
Maximum rated voltage to earth	300 V AC, DC (between each input channel and enclosure, between any two of input channels) Measurement category II (anticipated transient overvoltage: 2500 V)
Operating temperature and humidity	In accordance with the specifications of Memory HiCorder in which Model 8972 is installed
Operating environment	In accordance with the specifications of Memory HiCorder in which Model 8972 is installed
Storage temperature and humidity	−10°C to 50°C (14°F to 122°F), 80% RH or less (no condensation)
Dimensions	Approx. 106W × 19.8H × 196.5D mm (4.17"W × 0.78"H × 7.74"D)

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Mass	Approx. 250 g (8.8 oz.)
Effect of radiated radio-frequency electromagnetic field	±15% f.s. (at a maximum) at 3 V/m
Effect of conducted radio-frequency electromagnetic field	±20% f.s. (at a maximum) at 3 V (100 mV/div range, with 1 V DC input)
Standards	Safety EN61010 EMC EN61326 Class A
Options	Model L9197 Connection Cord (CAT IV 300 V, CAT III 600 V, 1 A) Model L9198 Connection Cord (CAT III 300 V, CAT II 600 V, 0.2 A) Model L9217 Connection Cord (CAT III 300 V, CAT II 600 V, 0.2 A) Model L9790 Connection Cord (with Model L9790-01 or 9790-03: CAT III 300 V, CAT II 600 V, 1 A) (with Model 9790-02: CAT III 150 V, CAT II 300 V, 1 A) Model 9322 Differential Probe (with grabber clips attached: CAT II 1000 V) (with alligator clips attached: CAT III 600 V, CAT II 1000 V) Model P9000-01 Differential Probe (CAT III 1000 V) Model P9000-02 Differential Probe (CAT III 1000 V) Model 9665 10:1 Probe (CAT II 300 V) Model 9666 100:1 Probe (CAT II 300 V)

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18.6.8 Model 8973 Logic Unit

Product warranty period	3 years
Number of input channels	4 probes (16 channels)
Input terminals	Mini DIN
Supported probes	Model 9320-01 Logic Probe, Model MR9321-01 Logic Probe, Model 9327 Logic Probe
Operating temperature and humidity	In accordance with the specifications of Memory HiCorder in which Model 8973 is installed
Operating environment	In accordance with the specifications of Memory HiCorder in which Model 8973 is installed
Storage temperature and humidity	−20°C to 50°C (−4°F to 122°F), 80% RH or less (no condensation)
Dimensions	Approx. 106W × 19.8H × 196.5D mm (4.17″W × 0.78″H × 7.74″D)
Mass	Approx. 190 g (6.7 oz.)
Standards	Safety EN61010 EMC EN61326 Class A

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18.6.9 Model MR8990 Digital Voltmeter Unit

The accuracy has been specified under the following conditions: installed in a Memory HiCorder and operated at 23°C ±5°C (73°F ±9°F) in the range of 20% to 80% RH after a half-hour (at least) warm-up and execution of calibration.

Product warranty period	3 years
Guaranteed accuracy period	1 year
Number of input channels	2 channels
Measurement item	DC voltage
Measurement range	

Measurement range	Effective input range*	Maximum resolution	Input resistance
5 mV/div (f.s.= 100 mV)	−120 mV to 120 mV	0.1 µV	100 MΩ or more
50 mV/div (f.s.= 1000 mV)	−1200 mV to 1200 mV	1 µV	
500 mV/div (f.s.= 10 V)	−12 V to 12 V	10 µV	
5 V/div (f.s.= 100 V)	−120 V to 120 V	100 µV	10 MΩ ±5%
50 V/div (f.s.= 1000 V)	−500 V to 500 V	1 mV	

* Guaranteed range of measurement accuracy

Measurement accuracy

Measurement range	NPLC < 1	NPLC ≥ 1
5 mV/div (f.s.= 100 mV)	±0.01% rdg.±0.015% f.s.	±0.01% rdg.±0.01% f.s.
50 mV/div (f.s.= 1000 mV)	±0.01% rdg.±0.0025% f.s.	
500 mV/div (f.s.= 10 V)		
5 V/div (f.s.= 100 V)	±0.025% rdg.±0.0025% f.s.	
50 V/div (f.s.= 1000 V)		

Temperature characteristics	±(0.002% rdg. + 0.00025% f.s.)/°C
A/D conversion measurement method	Delta-sigma modulation method
Integration time	

Power frequency	Integration time
50 Hz	20 ms × NPLC
60 Hz	16.67 ms × NPLC

NPLC Settable from 0.1 to 0.9 (in 0.1 increments), 1 to 9 (in 1 increments), and 10 to 100 (in 10 increments)

Response time	Within [2 ms + 2 × (integration time)] (rising from negative f.s. to positive f.s., or falling from positive f.s. to negative f.s.)
Faster response	On/off
Common mode rejection ratio	100 dB or more (at 50 Hz / 60 Hz, a signal source resistance of 100 Ω or less)
Input type	Unbalanced input (floating)
Input terminals	Banana jacks
Maximum input voltage	500 V DC
Maximum rated voltage to earth	300 V AC, DC (between each input channel and enclosure, between any two of input channels) Measurement category II (anticipated transient overvoltage: 2500 V)
Operating temperature and humidity	In accordance with the specifications of Memory HiCorder in which Model MR8990 is installed

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Operating environment	In accordance with the specifications of Memory HiCorder in which Model MR8990 is installed
Storage temperature and humidity	−10°C to 50°C (14°F to 122°F), 80% RH or less (no condensation)
Dimensions	Approx. 106W × 19.8H × 196.5D mm (4.17″W × 0.78″H × 7.74″D)
Mass	Approx. 260 g (9.2 oz.)
Effect of radiated radio-frequency electromagnetic field	±0.1% f.s. (at maximum) at 3 V/m (in 5 mV/div range)
Standards	Safety EN61010 EMC EN61326 Class A
Option	Model L2200 Test Lead (CAT IV 600 V, CAT III 1000 V, 10 A)

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18.6.10 Model U8974 High Voltage Unit

The accuracy has been specified under the following conditions: installed in a Memory HiCorder and operated at 23°C ±5°C (73°F ±9°F) in the range of 20% to 80% RH after a half-hour (at least) warm-up and execution of zero-adjustment.

Product warranty period	3 years
Guaranteed accuracy period	1 year
Number of input channels	2 channels
Measurement functions	Instantaneous value, r.m.s. value (Each channel can have a different setting.)
Measurement range	200 mV, 500 mV, 1 V, 2 V, 5 V, 10 V, 20 V, 50 V/div (mode DC) 500 mV, 1 V, 2 V, 5 V, 10 V, 20 V, 50 V/div (mode RMS)
Measurement accuracy	±0.25% f.s. (with the low-pass filter set to 5 Hz)
RMS measurement accuracy	±1.5% f.s. (DC, 30 Hz of higher but lower than 1 kHz, sine waves, response time: slow) ±3% f.s. (1 kHz to 10 kHz , sine waves) Crest factor: 2 (sine waves, the peak voltage is up to 1000 V)
RMS measurement response time	Fast: 150 ms (rising from 0% of f.s. to 90% of f.s.) Normal: 500 ms (rising from 0% of f.s. to 90% of f.s.) Slow: 2.5 s (rising from 0% of f.s. to 90% of f.s.)
Temperature characteristics	±0.05% f.s./°C
Frequency characteristics	DC to 100 kHz, −3 dB
Noise	30 mV p-p (typ.), 50 mV p-p (max.) (highest sensitivity range, with input short-circuited)
Common mode rejection ratio	80 dB or more (50 Hz / 60 Hz, with input terminals short-circuited)
Low-pass filter	Off, 5±50%, 50±50%, 500±50%, 5 k±50%, 50 k±50% (Hz) −3 dB
Input type	Unbalanced input (floating)
Input coupling	DC/GND
Input resistance	4 MΩ±1%
Input capacitance	5 pF or less (at 100 kHz)
A/D resolution	16 bits
Maximum sampling rate	1 MS/s
Input terminals	Banana jacks
Maximum input voltage	1000 V DC, 700 V AC
Maximum rated voltage to earth	1000 V AC, DC measurement category III, 600 V AC, DC measurement category IV (between each input channel and enclosure, between any two of input channels) Anticipated transient overvoltage: 8000 V
Operating temperature and humidity	In accordance with the specifications of Memory HiCorder in which Model U8974 is installed
Operating environment	In accordance with the specifications of Memory HiCorder in which Model U8974 is installed

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Storage temperature and humidity	Temperature	−20°C to 50°C (−4°F to 122°F)	
	Humidity	−20°C or higher but lower than 40°C (−4°F or higher but lower than 104°F)	80% RH or less (no condensation)
		40°C or higher but lower than 45°C (104°F or higher but lower than 113°F)	60% RH or less (no condensation)
		45°C to 50°C (113°F to 122°F)	50% RH or less (no condensation)
Dimensions	Approx. 106W × 19.8H × 196.5D mm (4.17″W × 0.78″H × 7.74″D)		
Mass	Approx. 230 g (8.1 oz.)		
Effect of radiated radio-frequency electromagnetic field	±5% f.s. (at a maximum) at 3 V/m		
Effect of conducted radio-frequency electromagnetic field	±5% f.s. (at a maximum) at 3 V (500 mV/div range, with 1 V DC input)		
Standards	Safety EN61010 EMC EN61326 Class A		
Options	Model L4940 Connection Cable Set (1.5 m) Model L4935 Alligator Clip Set (attachable on the tips of L4940, CAT IV 600 V, CAT III 1000 V, 10 A) Model L9243 Grabber Clip (attachable on the tips of L4940, CAT II 1000 V, 1 A) Model L4936 Bus Bar Clip Set (attachable on the tips of L4940, CAT III 600 V, 5 A) Model L4937 Magnetic Adapter Set (attachable on the tips of L4940, CAT III 1000 V, 2 A) Model L4931 Extension Cable (for L4940, 1.5 m, CAT IV 600 V, CAT III 1000 V, 10 A) Model L4932 Test Pin Set (attachable on the tips of L4940, CAT IV 600 V, CAT III 1000 V, 10 A) Model L4934* Small Alligator Clip Set (CAT III 300 V, CAT II 600 V, 3 A) * Model L4932 is required to use Model L4934.		

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18.6.11 Model U8979 Charge Unit

1. General specifications

Operating environment	Indoors, Pollution Degree 2, Operating altitude: up to 2000 m (6562 ft.)
Operating temperature and humidity	0°C to 40°C (32°F to 104°F), 80% RH or less (no condensation)
Storage temperature and humidity	−10°C to 50°C (14°F to 122°F) For −10°C or higher but lower than 40°C (14°F or higher but lower than 104°F), 80% RH or less (no condensation) For 40°C or higher but lower than 45°C (104°F or higher but lower than 113°F), 60% RH or less (no condensation) For 45°C to 50°C (113°F to 122°F), 50% RH or less (no condensation)
Standards	Safety: EN61010 EMC: EN61326 Class A
Dimensions	Approx. 106W × 19.8H × 196.5D mm (4.17″W × 0.78″H × 7.74″D)
Mass	Approx. 250 g (8.8 oz.)
Product warranty period	3 years
Guaranteed accuracy period	1 year
Option	Model 9166 Connection Cord (for voltage measurement)

2. Specifications of input, output, and measurement

-1. Common specifications

Number of channels	2 channels
Measurement mode	Charge, pre-amplifier, voltage (selectable for each channel)
Input type	Unbalanced input (floating) In each channel, the voltage input terminal has the same-potential ground as the charge input terminal.
Common-mode rejection ratio	80 dB or more (at 50 Hz / 60 Hz, a signal source resistance of 100 Ω)
Anti-aliasing filters	Cutoff frequency (fc): 20, 40, 80, 200, 400, 800, 2 k, 4 k, 8 k, 20 k, 40 k (Hz) Switchable between on and off; the instrument automatically chooses a cutoff frequency along with the sampling rate. Attenuation property: −66 dB or higher at a cutoff frequency of 1.5 fc
Maximum sampling rate	200 kS/s
A/D resolution	16 bits (± f.s. = ±25,000 data points)
Maximum rated voltage to earth	30 V AC, 60 V DC (between each input channel and the enclosure, between any two of input channels) Anticipated transient overvoltage: 330 V

-2. Voltage input

Measurement range	10, 20, 40, 100, 200, 400 mV f.s., 1, 2, 4, 10, 20, 40 V f.s.
Maximum input voltage	40 V DC

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Frequency characteristics	DC to 50 kHz −3 dB (DC-coupled) 1 Hz to 50 kHz −3 dB (AC-coupled, lower cutoff frequency: 1 Hz ±50%)
Noise	80 μV p-p (typ.), 120 μV p-p (max.), with the highest sensitivity range and the terminals of each input connector connected with each other
Input resistance	1 MΩ ±1%
Input capacitance	200 pF or less (at 100 kHz)
Input coupling	AC/DC/GND
Input terminals	Metallic BNC terminal

-3. Charge input

Supported detector	Charge-output acceleration detector
Measurement sensitivity	0.1 pC/(m/s^2) to 10 pC/(m/s^2)
Measurement range	40, 100, 200, 400, 1 k, 2 k, 4 k, 10 k, 20 k, 40 k, 100 k, 200 k m/s^2 f.s. Measurement sensitivity: 0.1 pC/(m/s^2) to 0.25 pC/(m/s^2) 20, 40, 100, 200, 400, 1 k, 2 k, 4 k, 10 k, 20 k, 40 k, 100 k m/s^2 f.s. Measurement sensitivity: 0.251 pC/(m/s^2) to 0.5 pC/(m/s^2) 10, 20, 40, 100, 200, 400, 1 k, 2 k, 4 k, 10 k, 20 k, 40 k m/s^2 f.s. Measurement sensitivity: 0.501 pC/(m/s^2) to 1.0 pC/(m/s^2) 4, 10, 20, 40, 100, 200, 400, 1 k, 2 k, 4 k, 10 k, 20 k m/s^2 f.s. Measurement sensitivity: 1.001 pC/(m/s^2) to 2.5 pC/(m/s^2) 2, 4, 10, 20, 40, 100, 200, 400, 1 k, 2 k, 4 k, 10 k m/s^2 f.s. Measurement sensitivity: 2.501 pC/(m/s^2) to 5.0 pC/(m/s^2) 1, 2, 4, 10, 20, 40, 100, 200, 400, 1 k, 2 k, 4 k m/s^2 f.s. Measurement sensitivity: 5.001 pC/(m/s^2) to 10.0 pC/(m/s^2)
Frequency characteristics	1.5 Hz to 50 kHz −3 dB
Maximum input charge	±500 pC (when one of the higher six ranges is chosen) ±50,000 pC (when one of the lower six ranges is chosen)
Input coupling	AC/GND
Input terminals	Miniature connector (#10-32UNF)

-4. Input from acceleration sensor with the built-in pre-amplifier

Supported detector	Acceleration detector with built-in pre-amplifier
Measurement sensitivity	0.1 mV/(m/s^2) to 10 mV/(m/s^2)
Measurement range	40, 100, 200, 400, 1 k, 2 k, 4 k, 10 k, 20 k, 40 k, 100 k, 200 k m/s^2 f.s. Measurement sensitivity: 0.1 mV/(m/s^2) to 0.25 mV/(m/s^2) 20, 40, 100, 200, 400, 1 k, 2 k, 4 k, 10 k, 20 k, 40 k, 100 k m/s^2 f.s. Measurement sensitivity: 0.251 mV/(m/s^2) to 0.5 mV/(m/s^2) 10, 20, 40, 100, 200, 400, 1 k, 2 k, 4 k, 10 k, 20 k, 40 k m/s^2 f.s. Measurement sensitivity: 0.501 mV/(m/s^2) to 1.0 mV/(m/s^2) 4, 10, 20, 40, 100, 200, 400, 1 k, 2 k, 4 k, 10 k, 20 k m/s^2 f.s. Measurement sensitivity: 1.001 mV/(m/s^2) to 2.5 mV/(m/s^2) 2, 4, 10, 20, 40, 100, 200, 400, 1 k, 2 k, 4 k, 10 k m/s^2 f.s. Measurement sensitivity: 2.501 mV/(m/s^2) to 5.0 mV/(m/s^2) 1, 2, 4, 10, 20, 40, 100, 200, 400, 1 k, 2 k, 4 k m/s^2 f.s. Measurement sensitivity: 5.001 mV/(m/s^2) to 10.0 mV/(m/s^2)
Frequency characteristics	1 Hz to 50 kHz −3 dB

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Power supply for detector	3.0 mA ±20%, 22 V ±5%
Input coupling	AC/GND
Input terminals	Metallic BNC terminal

-5. Specifications for accuracy

Conditions of guaranteed accuracy	Guaranteed accuracy period: 1 year Temperature and humidity for guaranteed accuracy: 23°C ±5°C (73°F ±9°F), 80% RH or less Warm-up time: 30 minutes or more Specified after execution of zero-adjustment
Accuracy of voltage measurement	±0.5% f.s. (with the filter set at 5 Hz)
Temperature characteristic of voltage measurement	±0.05% f.s./°C
Accuracy of amplitude with charge inputted	±2% f.s. (1 kHz)
Temperature characteristic with charge inputted	±0.2% f.s./°C
Accuracy of amplitude inputted from acceleration detector with built-in pre-amplifier	±2% f.s. (1 kHz)
Temperature characteristics of input from acceleration sensor with the built-in pre-amplifier	±0.2% f.s./°C
Effect of radiated radio-frequency electromagnetic field	±10% f.s. (max.) at 3 V/m (with the filter set at 5 Hz)
Effect of conducted radio-frequency electromagnetic field	±10% f.s. (max.) at 3 V (with the filter set at 5 Hz)

3. Specifications of functions

Low-pass filter	Off, 5 ±50% (voltage input only), 500 ±50%, 5k ±50% (Hz) −3 dB
TEDS	IEEE1451.4 Class 1 compliant The instrument reads out sensor information to automatically configure the sensitivity setting.

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18.6.12 Model U8793 Arbitrary Waveform Generator Unit

General specifications

Operating environment	In accordance with the specifications of Memory HiCorder in which Model U8793 is installed
Operating temperature and humidity	In accordance with the specifications of Memory HiCorder in which Model U8793 is installed
Storage temperature and humidity	−20°C to 50°C (−4°F to 122°F), 80% RH or less (no condensation)
Standards	Safety EN61010 EMC EN61326 Class A
Dimensions	Approx. 106W × 19.8H × 196.5D mm (4.17″W × 0.78″H × 7.74″D) (excluding protrusions)
Mass	Approx. 250 g (8.8 oz.)
Product warranty period	3 years
Options	Model L9795-01 Connection Cable (terminal type: SMB terminal/mini-alligator clip) Model L9795-02 Connection Cable (terminal type: SMB terminal/BNC terminal)

Specifications of output

Basic specifications (common to both FG function and user-defined waveform generation function)

Conditions of guaranteed accuracy	Guaranteed accuracy period: 1 year Temperature and humidity for guaranteed accuracy: 23°C±5°C (73°F±9°F), 80% RH or less Warm-up time: at least 30 min. Power supply frequency range for Memory HiCorder in which Model U8793 is installed: 50 Hz / 60 Hz ±2 Hz
Number of output channels	2 channels
Output terminals	SMB terminals
Output type	Unbalanced output (floating)
Maximum rated voltage to earth	30 V rms AC or 60 V DC (between individual output channels and enclosure/external I/O terminals as well as between individual output channels) Anticipated transient overvoltage: 300 V
Maximum output voltage	−10 V to 15 V
Amplitude setting range	0 V p-p to 20 V p-p (setting resolution: 1 mV)
DC offset setting range	−10 V to 15 V (setting resolution: 1 mV)
Output impedance	1 Ω or less
Maximum output current	±10 mA (per channel)
Allowable load resistance	1.5 kΩ or more
Output configuration	Waveform output/open/short

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Specificationsof FG function

Output waveform	Sine wave, rectangular wave, pulse wave (variable duty ratio), triangular wave, ramp wave, DC
Output frequency range	0 Hz to 100 kHz (setting resolution: 10 mHz)
Output frequency accuracy	±0.015% of setting
DC output accuracy	±0.05% of setting ±10 mV
DC output temperature characteristic	(±0.005% of setting ±1 mV)/°C
Amplitude accuracy	±0.5% of setting ±10 mV p-p (10 mHz to 10 kHz) ±0.8% of setting±10 mV p-p (higher than 10 kHz but not higher than 50 kHz) ±1.0% of setting±10 mV p-p (higher than 50 kHz but not higher than 100 kHz)
Amplitude temperature characteristic	(±0.05% of setting ±1 mV p-p)/°C
DC offset accuracy	±0.5% of setting ±10 mV
DC offset Temperature characteristics	(±0.05% of setting ±1 mV)/°C
Phase difference setting range	−360° to 360° (setting resolution: 0.1°)
Jitter	Within 50 ns p-p (rectangular waves, pulse waves, triangular waves, ramp waves)
Pulse waves duty ratio setting range	0.1% to 99.9% (setting resolution: 0.1%) Valid with a pulse width of 500 ns or more
Pulse waves duty ratio accuracy	±0.1% of period (10 mHz to 5 kHz) ±0.5% of period (higher than 5 kHz but not higher than 20 kHz) ±1.0% of period (higher than 20 kHz but not higher than 100 kHz)

Specifications of user-defined waveform generation function

Output waveform	Waveforms measured with Model 8847, MR8847, MR8847A, MR8827, MR8740 or MR8741 Memory HiCorder (Logic waveforms are not supported.) Waveforms measured with Model PW3198 Power Quality Analyzer (via Model SF8000) Waveforms saved by Model 7075 Waveform Generator (via Model SF8000) Waveforms created in CSV format (via Model SF8000) Waveforms created with Model SF8000 Waveform Maker
Voltage axis resolution	16 bits
Waveform memory capacity	256 kW/channel × 8 blocks
Low-pass filter	2nd-order LPF, 50 Hz to 1 MHz (14 steps based on 1-2-5 series)
D/A refresh rate	2 MHz at a maximum (setting resolution:10 mHz)
Clock frequency accuracy	±150 ppm
Clock frequency jitter	Within 50 ns p-p
Delay	−250,000 to 250,000 (in 1 data point increments)
Loop count	1 to 50,000 or infinity

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Specifications of sweep function

Sweep waveforms	Non-DC FG waveforms, user-defined waveforms	
Sweep form	Linear	
Sweep target	FG waveforms:	Frequency, amplitude, offset, duty ratio (pulse waves only) (Simultaneously sweeping frequency, amplitude, and offset is available.)
	User-defined waveforms:	Clock frequency, amplitude, offset (Simultaneously sweeping clock frequency, amplitude, and offset is available.)
Sweep time setting range	10 µs to 1000 s (setting resolution: 10 µs)	

Specifications of program function

Sequence length	Links up to 128 steps into a single sequence, outputting that.
Step control	A waveform type of each step can be set to FG waveform, sweep waveform, or user-defined waveform. An output period of each step can be set to the number of loops (for sweep waveforms) or an output time (for FG and user-defined waveforms).
Hold settings	Each step can be set to on or off.
Output time setting range	10 µs to 1000 s (for FG waveform and user-defined)
Step loop count setting range	1 to 1,000 (for sweep waveform)
Overall loop count setting range	1 to 50,000 or infinity
Monitor function	The step number and loop count of the step being presently executed, and the overall loop count can be displayed.

Other specifications

Inter-channel synchronization	The phase difference between channels on a module and that between modules can be set.
Self-test function	Output voltage values can be monitored. Monitor resolution: 10 mV Monitor accuracy: ±3.0% of f.s. (f.s.=15 V)
Starting/stopping output	Controllable by operating the key on the Memory HiCorder or inputting a signal to the unit's external control terminal
External input	While using the program function, externally inputting a low-level signal disengages the hold, proceeding to the next step. Control voltage level: 3.5 V to 5.0 V (high level), 0 V to 0.8 V (low level) Response pulse width: 100 µs or more (low level)
External output	Output signals during waveform output Output type: Open-drain output (with 5-volt outputs, active low) Output voltage level: 4.0 V to 5.0 V (high level), 0 V to 0.5 V (low level) Contact capacity: 5 V to 30 V DC, 50 mA
External I/O terminals	Push-button type terminal block
Waveform output indicator	The red LED is turned on when a waveform is output; and turned off when no waveforms output.

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18.6.13 Model MR8790 Waveform Generator Unit

The accuracy has been specified under the following conditions: installed in a Memory HiCorder and operated at 23°C ±5°C (73°F ±9°F) in the range of 20% to 80% RH after a half-hour (at least) warm-up.

General specifications

Product warranty period	3 years
Guaranteed accuracy period	1 year
Number of output channels	4 channels (Every channel is isolated from the unit and outputs. Each channel is isolated from each other)
Self-test function	Yes (by utilizing the voltage and current monitors)
Voltage and current monitor function (switchable)	Resolution: 5 µA (current monitor) 10 mV (voltage monitor) Monitor accuracy:±3.0% of f.s. (f.s. = 10 V [voltage monitor] or 5 mA [current monitor])
Maximum output current	±5 mA
Allowable load resistance	2 kΩ or more
Output terminals	SMB terminals
Output configuration	Waveform output/open/short-circuit
Output relay switching time	5 ms or less
Output protection	Output current limited to 40 mA (with output short-circuited)
Maximum rated voltage to earth	30 V rms AC or 60 V DC (between each output channel and enclosure, between any two of output channels) Anticipated transient overvoltage: 330 V
Operating temperature and humidity	In accordance with the specifications of Memory HiCorder in which Model MR8790 is installed
Operating environment	In accordance with the specifications of Memory HiCorder in which Model MR8790 is installed
Storage temperature and humidity	−20°C to 50°C (−4°F to 122°F), 90% RH or less (no condensation)
Dimensions	Approx. 106W × 19.8H × 196.5D mm (4.17″W × 0.78″H × 7.74″D) (excluding protrusions)
Mass	Approx. 230 g (8.1 oz.)
Standards	Safety EN61010 EMC EN61326 Class A
Effect of radiated radio-frequency electromagnetic field	±3% of f.s. (at maximum) at 3 V/m (f.s.=10 V)
Effect of conducted radio-frequency electromagnetic field	±1% of f.s. (at maximum) at 3 V (f.s.=10 V)
Options	Model L9795-01 Connection Cable (terminal type: SMB terminal/mini-alligator clip) Model L9795-02 Connection Cable (terminal type: SMB terminal/BNC terminal)

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Specifications of voltage output

Maximum output voltage	±10 V	
Resolution	16 bits	
Output frequencies	Output frequencies:	DC, 0 Hz to 20 kHz (sine waves)
	Setting resolution:	1 Hz
	Frequency accuracy:	±0.01% of setting
Amplitude	Setting range:	0 V p-p to 20 V p-p
	Setting resolution:	1 mV
	Amplitude accuracy:	±0.25% of setting ±2 mV p-p (1 Hz to 10 kHz) ±0.6% of setting ±2 mV p-p (higher than 10 kHz but not higher than 20 kHz)
DC offset	Setting range:	−10 V to 10 V Peak value including amplitude and DC offset is limited to ±10 V.
	Setting resolution:	1 mV
	Offset accuracy:	±3 mV
DC output	Output accuracy:	±0.6 mV

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18.6.14 Model MR8791 Pulse Generator Unit

General specifications

Temperature and humidity for guaranteed accuracy	23°C±5°C (73°F±9°F), 80% RH or less (no condensation) (When installed in the Memory HiCorder)
Guaranteed accuracy period	1 year
Product warranty period	3 years
Operating temperature and humidity	In accordance with the specifications of Memory HiCorder in which Model MR8791 is installed
Operating environment	In accordance with the specifications of Memory HiCorder in which Model MR8791 is installed
Storage temperature and humidity	−20°C to 50°C (−4°F to 122°F), 90% RH or less (no condensation)
Maximum rated voltage to earth	30 V rms AC or 60 V DC (between output channels and enclosure) Anticipated transient overvoltage: 330 V
Dimensions	Approx. 106W × 19.8H × 196.5D mm (4.17″W × 0.78″H × 7.74″D) (excluding protrusions)
Mass	Approx. 230 g (8.1 oz.)
Number of output channels	8 channels (Every channel is isolated from the unit. Each channel is isolated from each other) (Every channel is not isolated from one another [common GND]) (Every channel is not isolated from output connector frame [common GND])
Output mode 1	Pattern output/pulse output (8 channels switch at the same time)
Output mode 2	Logic output/open-collector output (can be set with respect to each of eight channels) Logic output: Output voltage level: 0 V to 5 V (high level 3.8 V or more, low level 0.8 V or less) Rated current: ±5 mA Open collector Output: Collector-emitter absolute maximum rated voltage: 50 V Over-current protection: 100 mA
Output mode 3	Output/open (= self-test) (8 channels switch at the same time)
Open-collector output spec (rising time [10% to 90%])	5 µs (at maximum) (a load capacity of 1000 pF, a pull-up resistance of 1 kΩ)
Self-test function	Detected voltages: High level: 3.4 V or more, low level: 1.6 V or less
Relay switching time	5 ms or less (switchable between logic and open collector, switchable between output and open [self-test])
Standards	Safety EN61010 EMC EN61326 Class A

Specifications of pulse output

Output frequency	Setting range: 0 Hz to 20 kHz (can be set with respect to each of eight channels) Setting resolution: 0.1 Hz Frequency accuracy: ±100 ppm
Duty ratio	Setting range: 0.1% to 99.9%, 0, 100% (DC) Setting resolution: 0.1% Duty ratio accuracy: [±100 ppm (setting period) ±150 ns] of setting “Minimum pulse width” and “Open collector output regulation” specifications have priority.

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Minimum pulse width	1 µs

Specifications of pattern output

Clock frequency	Range:	0 Hz to 120 kHz (Common to 8 channels)
	Setting resolution:	10 Hz
	Frequency accuracy:	± 100 ppm of setting
Memory (Pattern)	2,048 words (16,384 bits = 2,048 words × 8 bits/word)	

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Specifications of output connector

10250-52A2PL: Manufactured by Sumitomo 3M (SCSI-2 connector), (Centronics half-pitch 50-pin socket-contact)

Pin	Signal name	Pin	Signal name
1	I_GND	26	I_GND
2	CH1	27	I_GND
3	CH2	28	I_GND
4	CH3	29	I_GND
5	CH4	30	I_GND
6	I_GND	31	I_GND
7	CH5	32	I_GND
8	CH6	33	I_GND
9	CH7	34	I_GND
10	CH8	35	I_GND
11	I_GND	36	I_GND
12	NC	37	I_GND
13	NC	38	I_GND
14	NC	39	I_GND
15	NC	40	I_GND
16	I_GND	41	I_GND
17	NC	42	I_GND
18	NC	43	I_GND
19	NC	44	I_GND
20	NC	45	I_GND
21	I_GND	46	I_GND
22	TEST2 (DIN03)	47	I_GND
23	TEST3 (DIN02)	48	I_GND
24	NC	49	I_GND
25	NC	50	I_GND
Frame	F_GND		

CH1 to CH8:	Pulse output
I_GND:	Isolation GND (isolated GND)
F_GND:	Non-Isolation GND (main unit GND)
NC:	Not Connected
TESTn:	Test pin, Do NOT connect any signal to them.

Recommended connection cable: KB-SHH2: Sanwa Supply (SCSI-2 connector) (Centronics half 50-pin male)

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18.6.15 Model U8975 4CH Analog Unit

The accuracy has been specified under the following conditions: installed in a Memory HiCorder and operated at 23°C ±5°C (73°F ±9°F) in the range of 20% to 80% RH after a half-hour (at least) warm-up and execution of zero-adjustment..

Operating environment	Indoors, pollution degree 2, operating altitude: up to 2000 m (6562 ft.)
Operating temperature and humidity range	0°C to 40°C (32°F to 104°F), 80% RH or less (no condensation)
Storage temperature and humidity range	−10°C to 50°C For −10°C or higher but lower than 40°C (14°F or higher but lower than 104°F), 80% RH or less (no condensation) For 40°C or higher but lower than 45°C (104°F or higher but lower than 113°F), 60% RH or less (no condensation) For 45°C to 50°C (113°F to 122°F), 50% RH or less (no condensation)
Standards	Safety: EN61010 EMC: EN61326 Class A
Dimensions	Approx. 106W × 19.8H × 196.5D mm (4.17″W × 0.78″H × 7.74″D)
Weight	Approx. 250 g (8.8 oz.)
Product warranty period	3 years
Measurement range	4, 10, 20, 40, 100, 200 V f.s.
Maximum input voltage	200 V DC
Maximum rated terminal-to-ground voltage	300 V AC, DC, Measurement category II (between each input channel and the enclosure, between any two of input channels) Anticipated transient overvoltage: 2500 V
Measurement terminals	Insulated BNC terminal
Number of channels	4 channels
Frequency characteristics	DC to 2 MHz, −3 dB
Noise	5 mV p-p (typ.), 10 mV p-p (max.) (with the highest sensitivity range and input terminals connected with each other)
Input type	Unbalanced input (floating)
Input coupling	DC/GND
Input resistance	1 MΩ ±1%
Input capacitance	30 pF ±10 pF (at 100 kHz)
A/D resolution	16 bits (± f.s. = ±32,000 data points)
Maximum sampling rate	5 MS/s
Accuracy guarantee period	1 year
Measurement accuracy	±0.1% f.s. (with the filter set at 5 Hz)
Temperature characteristics	±0.02% f.s./°C

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Effect of radiated radio-frequency electromagnetic field	±5% f.s. (max.) at 3 V/m (with the filter set at 5 Hz)
Effect of conducted radio-frequency electromagnetic field	±5% f.s. (max.) at 3 V (in the 10 V range, with the filter set at 5 Hz, with 1 V DC inputted)
Common-mode rejection ratio	80 dB or more (at 50 Hz / 60 Hz, a signal source resistance of 100 Ω)
Low-pass filter	Off, 5 ±50%, 500 ±50%, 5 k ±50%, 200 k ±50% (Hz) −3 dB
Options	Model L9197 Connection Cord (CAT IV 300 V, CAT III 600 V, 1 A) Model L9198 Connection Cord (CAT III 300 V, CAT II 600 V, 0.2 A) Model L9217 Connection Cord (CAT III 300 V, CAT II 600 V, 0.2 A) Model L9790 Connection Cord (with Model L9790-01 or 9790-03: CAT III 300 V, CAT II 600 V, 1 A) (with Model 9790-02: CAT III 150 V, CAT II 300 V, 1 A) Model 9322 Differential Probe (with grabber clips attached: CAT II 1000 V) (with alligator clips attached: CAT III 600 V, CAT II 1000 V) Model P9000-01 Differential Probe (CAT III 1000 V) Model P9000-02 Differential Probe (CAT III 1000 V) Model 9665 10:1 Probe (CAT II 300 V) Model 9666 100:1 Probe (CAT II 300 V)

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18.6.16 Model U8977 3CH Current Unit Current Unit

The accuracy has been specified under the following conditions: installed in a Memory HiCorder and operated at 23°C ±5°C (73°F ±9°F) in the range of 20% to 80% RH after a half-hour (at least) warm-up and execution of zero-adjustment.

Operating environment	Indoors, pollution degree 2, operating altitude: up to 2000 m (6562 ft.)
Operating temperature and humidity range	0°C to 40°C (32°F to 104°F), 80% RH or less (no condensation)
Storage temperature and humidity range	−10°C to 50°C (14°F to 122°F) For −10°C or higher but lower than 40°C (14°F or higher but lower than 104°F), 80% RH or less (no condensation) For 40°C or higher but lower than 45°C (104°F or higher but lower than 113°F), 60% RH or less (no condensation) For 45°C to 50°C (113°F to 122°F), 50% RH or less (no condensation)
Standards	Safety: EN61010 EMC: EN61326 Class A
Dimensions	Approx. 106W × 19.8H × 196.5D mm (4.17″W × 0.78″H × 7.74″D)
Weight	Approx. 250 g (8.8 oz.)
Product warranty period	3 years
Options	Model CT9900 Conversion Cable (PL23 receptacle–ME15W plug) Model CT9920 Conversion Cable (PL14 receptacle–ME15W plug)
Number of input channels	3 channels
Supported current sensors	• Directly connectable current sensors Model 9272-05 Clamp on Sensor (20 A/200 A AC) Model CT6841-05 AC/DC Current Probe (20 A) Model CT6843-05 AC/DC Current Probe (200 A) Model CT6844-05 AC/DC Current Probe (500 A, ϕ20 mm) Model CT6845-05 AC/DC Current Probe (500 A, ϕ50 mm) Model CT6846-05 AC/DC Current Probe (1000 A) Model CT6862-05 AC/DC Current Sensor (50 A) Model CT6863-05 AC/DC Current Sensor (200 A) Model 9709-05 AC/DC Current Sensor (500 A) Model CT6904 AC/DC Current Sensor (500 A) Model CT6865-05 AC/DC Current Sensor (1000 A) Model CT6875 AC/DC Current Sensor (500 A) Model CT6876 AC/DC Current Sensor (1000 A) Model CT6877 AC/DC Current Sensor (2000 A) Model CT6830 AC/DC Current Probe (2 A) Model CT6831 AC/DC Current Probe (20 A) Model CT6841A AC/DC Current Probe (2 A) Model CT6843A AC/DC Current Probe (200 A) Model CT6844A AC/DC Current Probe (500 A, ϕ20 mm) Model CT6845A AC/DC Current Probe (500 A, ϕ50 mm) Model CT6846A AC/DC Current Probe (1000 A) Model CT6872 AC/DC Current Sensor (50 A) Model CT6872-01 AC/DC Current Sensor (50 A) Model CT6873 AC/DC Current Sensor (200 A) Model CT6873-01 AC/DC Current Sensor (200 A) Model CT6875A AC/DC Current Sensor (500 A) Model CT6875A-1 AC/DC Current Sensor (500 A) Model CT6876A AC/DC Current Sensor (1000 A) Model CT6876A-1 AC/DC Current Sensor (1000 A) Model CT6877A AC/DC Current Sensor (2000 A) Model CT6877A-1 AC/DC Current Sensor (2000 A) Model CT6904A AC/DC Current Sensor (500 A)

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Supported current sensors	• Current sensors that require Model CT9920 for connection Model CT7631 AC/DC Current Sensor (100 A) Model CT7636 AC/DC Current Sensor (600 A) Model CT7642 AC/DC Current Sensor (2000 A) Model CT7731 AC/DC Auto-Zero Current Sensor (100 A) Model CT7736 AC/DC Auto-Zero Current Sensor (600 A) Model CT7742 AC/DC Auto-Zero Current Sensor (2000 A) Model CT7044 AC Flexible Current Sensor (6000 A, ϕ100 mm) Model CT7045 AC Flexible Current Sensor (6000 A, ϕ180 mm) Model CT7046 AC Flexible Current Sensor (6000 A, ϕ254 mm)
Measurement range	• For the directly connectable current sensors, the instrument automatically recognizes the rating of the current sensor. 10 mA, 20 mA, 50 mA, 100 mA, 200 mA, 500 mA/div (rating: 2A) 100 mA, 200 mA, 500 mA, 1 A, 2 A, 5 A/div (rating: 20 A) 200 mA, 500 mA, 1 A, 2 A, 5 A, 10 A/div (rating: 50 A) 1 A, 2 A, 5 A, 10 A, 20 A, 50 A/div (rating: 200 A) 2 A, 5 A, 10 A, 20 A, 50 A, 100 A/div (rating: 500 A) 5 A, 10 A, 20 A, 50 A, 100 A, 200 A/div (rating: 1000 A) 10 A, 20 A, 50 A, 100 A, 200 A, 500 A/div (rating: 2000 A) • For the current sensors that require Model CT9920 for connection, choose a conversion rate or a model number. 10 A/div (Model CT7631, CT7731) 10 A, 20 A, 50 A/div (Model CT7636, CT7736) 100 A, 200 A/div (Model CT7044, CT7045, CT7046) 100 A, 200 A, 500 A/div (Model CT7642, CT7742) 100 A, 200 A, 500 A, 1000 A, 2000 A, 5000 A/div (0.1 mV/A) 10 A, 20 A, 50 A, 100 A, 200 A, 500 A/div (1 mV/A) 1 A, 2 A, 5 A, 10 A, 20 A, 50 A/div (10 mV/A) 100 mA, 200 mA, 500 mA, 1 A, 2 A, 5 A/div (100 mV/A) 10 mA, 20 mA, 50 mA, 100 mA, 200 mA, 500 mA/div (1000 mV/A)
Frequency characteristics	DC to 2 MHz (±3 dB)
Noise	10 mA p-p (max.) (using the 20-A sensor, with the 2 A f.s. range and input terminals connected with each other)
Low-pass filter	Off, 5 Hz, 500 Hz, 5 kHz, 200 kHz ±50% (−3 dB)
Input type	Current sensor
Measurement terminal	LR10-DC12BR (Hirose connector)
Input coupling	DC/GND
Input resistance	1 MΩ ±1%
Maximum input current	Depends on a sensor.
Maximum rated terminal-to-ground voltage	Non-isolated
Maximum sampling rate	5 MS/s
A/D resolution	16 bits
Accuracy guarantee period	1 year
Measurement accuracy	±0.3% f.s. + (accuracy of current sensor)
Temperature characteristics	±0.045% f.s./°C

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Effect of radiated radio-frequency electromagnetic field	±5% f.s. (max.) at 3 V/m (with the filter set at 5 Hz)
Effect of conducted radio-frequency electromagnetic field	±5% f.s. (max.) at 3 V (using the 20-A sensor, with the 20 A f.s. range, with the filter set at 5 Hz, with a current of 2 A DC inputted)

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18.6.17 Model U8978 4CH Analog Unit

The accuracy has been specified under the following conditions: installed in a Memory HiCorder and operated at 23°C ±5°C (73°F ±9°F) in the range of 20% to 80% RH after a half-hour (at least) warm-up and execution of zero-adjustment.

Operating environment	Indoors, pollution degree 2, operating altitude: up to 2000 m (6562 ft.)
Operating temperature and humidity range	0°C to 40°C (32°F to 104°F), 80% RH or less (no condensation)
Storage temperature and humidity range	−10°C to 50°C (14°F to 122°F) For −10°C or higher but lower than 40°C (14°F or higher but lower than 104°F), 80% RH or less (no condensation) For 40°C or higher but lower than 45°C (104°F or higher but lower than 113°F), 60% RH or less (no condensation) For 45°C to 50°C (113°F to 122°F), 50% RH or less (no condensation)
Standards	Safety: EN61010 EMC: EN61326 Class A
Dimensions	Approx. 106W × 19.8H × 196.5D mm (4.17″W × 0.78″H × 7.74″D)
Weight	Approx. 250 g (8.8 oz.)
Product warranty period	3 years
Measurement range	100, 200, 400 mV f.s., 1, 2, 4, 10, 20, 40 V f.s.
Maximum input voltage	(Direct input) 40 V DC (In combination with Model 9665) 400 V DC
Maximum rated terminal-to-ground voltage	(Direct input) 30 V AC, 60 V DC (between each input channel and the enclosure, between any two of input channels) (In combination with Model 9665) 300 V AC, DC, Measurement category II (between each input channel and the enclosure,between any two of input channels)
Measurement terminals	Insulated BNC terminal
Number of channels	4 channels
Frequency characteristics	DC to 2 MHz, −3 dB
Noise	500 µV p-p (typ.), 1 mV p-p (max.) (with the highest sensitivity range and the terminals of each input connector connected with each other)
Input type	Unbalanced input (floating)
Input coupling	DC/GND
Input resistance	1 MΩ ±1%
Input capacitance	30 pF ±10 pF (at 100 kHz)
A/D resolution	16 bits (± f.s. = ±32,000 data points)
Maximum sampling rate	5 MS/s
Accuracy guarantee period	1 year
Measurement accuracy	±0.3% f.s. (with the filter set at 5 Hz)

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Temperature characteristics	±0.045% f.s./°C
Effect of radiated radio-frequency electromagnetic field	±5% f.s. (max.) at 3 V/m (with the filter set at 5 Hz)
Effect of conducted radio-frequency electromagnetic field	±5% f.s. (max.) at 3 V (in the 10 V range, with the filter set at 5 Hz, with 1 V DC inputted)
Common-mode rejection ratio	80 dB or more (at 50 Hz / 60 Hz, a signal source resistance of 100 Ω)
Low-pass filter	Off, 5 ±50%, 500 ±50%, 5 k ±50%, 200 k ±50% (Hz) −3 dB
Options	Model L9197 Connection Cord (CAT IV 300 V, CAT III 600 V, 1 A) Model L9198 Connection Cord (CAT III 300 V, CAT II 600 V, 0.2 A) Model L9217 Connection Cord (CAT III 300 V, CAT II 600 V, 0.2 A) Model L9790 Connection Cord (with Model L9790-01 or 9790-03: CAT III 300 V, CAT II 600 V, 1 A) (with Model 9790-02: CAT III 150 V, CAT II 300 V, 1 A) Model 9322 Differential Probe (with grabber clips attached: CAT II 1000 V) (with alligator clips attached: CAT III 600 V, CAT II 1000 V) Model P9000-01 Differential Probe (CAT III 1000 V) Model P9000-02 Differential Probe (CAT III 1000 V) Model 9665 10:1 Probe (CAT II 300 V) Model 9666 100:1 Probe (CAT II 300 V)

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19 Maintenance and Service

⚠WARNING

Do not touch the internal parts of this instrument as high voltage is generated in some parts. Customers are not allowed to modify, disassemble, or repair the instrument. Doing so may cause fire, electric shock, or injury.

The recording paper can be purchased via authorized Hioki distributor or reseller.

Calibrations

The frequency of calibration varies depending on the status of the instrument and installation environment. We recommend that the frequency of calibration be determined in accordance with the status of the instrument and installation environment and that you request that calibration be performed periodically.

Precautions during shipment

Be sure to observe the following precautions:

- To avoid damage to the instrument, remove all accessories and optional equipment from the instrument. Use the original packing materials in which the product was shipped. Damage that occurs during transport is not covered by the warranty.
- When sending the instrument for repair, be sure to include details of the problem.

To avoid straining some parts of the printer, and to prevent dirt adhering to the print head, close the printer cover.

Replaceable parts and operating lifespan

The characteristics of some parts used in the product may deteriorate due to long time of use.
To ensure the product can be used over the long term, it is recommended to replace these parts on a periodic basis.
Contact your authorized Hioki distributor or reseller for replacement.
The service life of parts varies with the operating environment and frequency of use. Parts are not guaranteed to operate throughout the recommended replacement cycle.

Part	Recommended replacement cycle	Remarks/conditions
Fan motor	Approx. 4 years	
Print head	After using approx. 1000 rolls of recording paper	
LCD backlight (Half-life of brightness)	Approx. 70,000 hours	At an ambient temperature of 25°C (77°F) The service life varies greatly depending on the ambient environment. The service life becomes shorter under high temperature in particular.
Model U8331 SSD Unit	Approx. 20,000 hours (continuous writing)	In ambient environment of 25°C (77°F) Total bytes written (TBW): Approx. 60 TB Data retention period: Approx. one year (When power is OFF) It is recommended to back up the data at regular intervals.
Electrolytic capacitors	Approx. 4 years	If used under the severe environment (ambient temperature 40°C [104°F]), it will get deteriorated in approx. four years.
Lithium battery	Approx. 10 years	The instrument contains an built-in lithium battery for memory backup, which offers a service life of about 10 years. If the date and time deviate substantially when the instrument is switched on, the battery should be replaced. Contact your authorized Hioki distributor or reseller.

The fuse is housed in the power unit of the instrument. If the power does not turn on, the fuse may be blown. If this occurs, replacement or repair cannot be performed by the customer. Please contact your authorized Hioki distributor or reseller.

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19.1 Troubleshooting

If damage is suspected, check the "Troubleshooting" section before contacting your authorized Hioki distributor or reseller.

Before having the instrument repaired

Power and operating keys malfunction

Condition	Check for	Remedy and reference
Turning on the instrument does not cause the screen to display something.	Is the power cord connected? Are connections made correctly?	Verify that the power cord is connected properly. "2.5 Supplying Power" (p. 52)
Keys do not work.	• Is any key being held down? • Is the key lock engaged (Is the key lock message displayed)?	Check if the keys are stuck. Disengage the key lock. (Hold down the **ESC** key for three seconds)

Display or operation malfunction

Condition	Check for	Remedy and reference
Blank screen	Is the backlight saver engaged? Press any key.	Set the backlight saver set to **[Off]**.
Pressing the **START** key does not allow any waveforms to appear on the screen.	• Is the message "Pre-Trigger Wait" displayed? • Is the message "Trigger Wait" displayed?	When the pre-trigger is engaged, the instrument does not trigger while the pre-trigger memory is being filled. Recording starts when the instrument triggers.
The displayed waveforms do not change.	• Is the clamp sensor or connection cable connected correctly? • Is the vertical axis (voltage axis) range set properly? • Is the low-pass filter enabled?	Check the clamp sensor or connection cable for disconnection. Check the input channels for improper settings.
While measuring a signal with the memory function, the displayed frequency is much lower than the actual frequency.	Aliasing may be occurring.	Change the timebase setting to a faster sampling rate. Press the **AUTO** key to execute the automatic setting. "3.3.2 Timebase and Sampling Rate" (p. 62)
Changing the input range setting does not cause the displayed waveform size to change.	Is the variable function set to **[On]**?	Set the variable function set to **[Off]**. "8.6 Setting the Waveform Position (Variable Function)" (p. 178)

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No printing or printing malfunction

Condition	Check for	Remedy and reference
Nothing is printed on the paper.	Is the paper loaded reversely (backside front)?	Check if the recording paper is loaded reversely. "2.4 Loading Recording Paper" (p. 50)
The printout is too light.	• Is the recording paper genuine? • Is the print density set correctly? • Is the print head clean?	Change the print density setting. "6.5 Configuring the Printer Settings" (p. 133) Clean the print head. "Cleaning the print head" (p. 448)
The recorded trace is too wide.	The input signal may have a ripple component.	Enable the filter in the module settings. "3.4.2 Configuring Analog Channels Settings" (p. 73)
The recorded trace is doubled.	Is the waveform printing density set to **[Light]**? In this case, printed dots are spaced out in the vertical direction. Thus, a slightly varying signal is printed as the waveform that can seem to be one line or two lines.	Set the waveform printing density to any setting other than **[Light]**. (**[Printer]** sheet) "6.5 Configuring the Printer Settings" (p. 133)

Saving data is not possible

Condition	Check for	Remedy and reference
Saving data on the storage device is not possible.	• Is your CF card Hioki genuine? • Is the storage device inserted properly? • Is the storage device formatted? • Is the remaining capacity of the storage device enough? • Is the number of files in the folder reached the limit?	"2.3 Preparing Storage Devices" (p. 48) "To change storage devices" (p. 92)
The USB flash drive cannot be used.	Has the USB flash drive settings been configured?	"USB usage" (p. 49)

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Other

Condition	Check for	Remedy and reference
The USB communications cannot be used.	Have the USB communication settings been configured?	"16.6.1 Configuring the USB Settings With the Instrument" (p. 361)
The USB driver cannot be installed.	Is **[Interface]** set to **[USB]**?	Set **[Interface]** to **[USB]**. "16.6.1 Configuring the USB Settings With the Instrument" (p. 361)
	Has the USB driver been installed successfully?	Access **[device manager]** on the computer and delete **[Other Devices]**, then reconnect the USB cable.
The response of remote control is very slow.	Check the Java settings.	For more information about Java settings, see the application disc supplied with the instrument. This remote operation through a browser is mainly intended for monitoring the screen. If you want the faster operation, use Model 9333 LAN Communicator.
In remote control operation, the keys are displayed, but the screen is not displayed.	Delete Java cache files.	Configure the Java setting from the Control Panel of the computer. For more information, start the application disc supplied with the instrument and open the page of Java (installing JRE), which describes how to delete cache files.

If the cause is unknown

Perform the system reset. All settings are returned to their factory defaults.
Refer to "19.2 Resetting the Instrument" (p. 437).

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19.2 Resetting the Instrument

19.2.1 Resetting System Settings

Select configured settings on the instrument and reset them to the factory defaults. The Initialization returns the instrument to its factory default state. By default, the various settings (status, channels, and triggers) and the system settings (environment) can be selected to be initialized on this screen.

The program or arbitrary waveform data of Model U8793 Arbitrary Waveform Generator Unit is written in ROM of module. So it will not get erased even is main instrument is reset.

Procedure

To display the screen

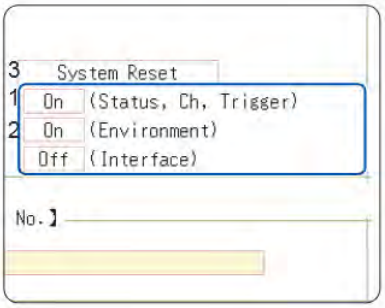
Press the **SYSTEM** key to display the system screen, and then select the **[Init]** sheet.

1 **Move the cursor to the item you want to reset.**

2 **Select [On].**

Select [Off] for the settings you do not want to reset.

(Status, Ch, Trigger)	Settings on each of the status screens, channel screen, and trigger setting window (Default setting: ON)
(Environment)	Settings on the **[Environment]** sheet, **[File Save]** sheet, and **[Printer]** sheet (Default setting: ON)
(Interface)	Settings on the **[Interface]** sheet (Default setting: OFF)



3 **Move the cursor to [System Reset].**

4 **Select [Exec].**

A confirmation dialog box is displayed.



5 **Select [YES].**

To cancel the reset action

Select [NO].

When the resetting is completed, the message “System initialized” is displayed.

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19.2.2 Resetting Waveform Data

Discard the waveform data saved in the memory and reset the data.

Procedure

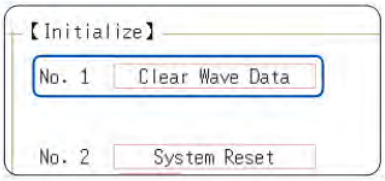
To display the screen

Press the **SYSTEM** key to display the system screen, and then select the **[Init]** sheet.

1 **Move the cursor to the [Clear Wave Data] box.**

2 **Select [Exec].**

When the resetting is completed, the message “Waveform data erased.” is displayed.



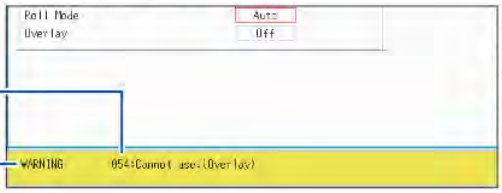
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19.3 Error Messages

If an error is displayed on screen when power supply is switched ON, it is necessary to repair. Contact your authorized Hioki distributor or reseller.
A message is displayed whenever an error occurs. When an error occurs, take the remedial action indicated below.

A beep may sound if the beeper setting on the **[Environment]** sheet is set to **[Warn]** or **[Warn+Action]**.
Refer to "15 Setting the System Environment" (p. 335).

Warning display



Displayed message number (Msg No.)

Message

Appears just once when an error occurs. Disappears within a few seconds.
Also disappears when any key is pressed.

Warning messages

Disp No.	Message	Remedy	References
3	Out of paper.	Load another roll of paper.	"2.4 Loading Recording Paper" (p. 50)
4	Printer cover is open.	Close the printer cover.	
5	Recording length is set to Continuous.	When the recording length (Shot) is set to **[Cont.]** or **[On]**, real-time printing is not available with a fast timebase setting.	"3.3.3 Setting the Recording Length (Number of Divisions)" (p. 66)
6	Cannot set. (Time/Div 10 ms to 200 ms)	When the recording length (Shot) is set to **[Cont.]** or **[On]**, the printer cannot be used.	
10	Set the recording media.	Set the storage device.	"2.3 Preparing Storage Devices" (p. 48)
11	Wrong recording format.	The storage device was formatted in an unsupported format. Format the storage device.	"2.3.2 Formatting Storage Devices" (p. 50)
12	Cannot write.	The write protection is engaged of the storage device. Disable it.	–
13	Disk full while accessing the file.	Saving files is not possible because of insufficient space on the storage device. Delete files or change the storage device. If the instrument is performing measurement, stop the measurement, and then change the storage device.	"5.5.4 Deleting Files and Folders" (p. 119)
14	File is read only.	The file is read-only. Deleting the file is prohibited.	–
15	Access to the file was denied.	An internal fault may have occurred in the instrument. Cycle the instrument.	–
16	The file name already exists: cannot save.	Change the file name.	"5.5.6 Renaming Files and Folders" (p. 121)
17	The folder name already exists.	Change the folder name.	

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Disp No.	Message	Remedy	References
18	Not enough free space in the folder to create file.	Either delete files in the saving destination folder or change the destination to another folder.	–
19	Folder not empty.	The folder contains files. Be careful not to delete the necessary files.	–
20	The maximum length of a file name, including its path, is 255 characters.	Reduce the number of characters of the path name including the filename to 255 or less.	–
21	Internal error.	An internal error occurred. Check the storage device.	–
22	No waveform data to save.	Acquire waveform data.	–
24	There is no calculation result.	There is no calculation result. After performing calculation, print the results.	"10 Numerical Calculation Functions" (p. 235)
25	Cannot select this media.	You cannot select this storage device as a destination of auto-saving. Select another device.	–
26	Invalid folder path.	The root folder cannot be specified.	–
27	When executing, select "No" as the save property.	Since other dialogs are displayed, the selective saving cannot be carried out. Either the selective saving during execution to **[No]** or close the dialog and save data again.	"5.2.3 Saving Data Selectively (SAVE Key)" (p. 103)
28	Pressed key invalid (waveform evaluation).	Unable to perform the operation because the waveform evaluation is enabled. Set the waveform evaluation set to **[Off]**.	"14.3 Configuring the Waveform Evaluation Setting" (p. 326)
29	The recording length was restricted.	–	–
30	Auto-ranging failed.	Check the input signal.	"3.6 Measurement in Automatic Range Setting (Auto-Range Function)" (p. 82)
31	AB cursor positions invalid.	Cursors A and B are at the same position. Check the cursor positions.	"7.2 Specifying the Waveform Range (Cursors A and B)" (p. 145)
32	Zero-adjustment needed.	Perform the zero-adjustment.	"2.7 Adjusting the Zero Position (zero-adjustment)" (p. 55)
33	Disabled key.	Close the dialog.	–
34	Invalid key pressed (Overlay)	The key operation is prohibited because the overlay is enabled. Set the overlay to **[Off]**.	"8.3 Overlaying New Waveforms With Past Waveforms" (p. 168)
36	No trigger has been set.	Set the trigger conditions.	"9 Setting the Trigger" (p. 211)
38	Use of logic channels has reduced analog waveform resolution from 16 to 12 bits.	Using channels LA to LD reduces the resolution of CH1 to CH4 to 12 bits.	"8.10 Setting Details of Modules" (p. 184)
39	Auto balance failed.	Check if no load is applied to the strain gauge transducer and the strain gauge transducer is correctly connected to a measuring object.	"8.10.4 Setting Model 8969 and U8969 Strain Unit" (p. 188)

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Disp No.	Message	Remedy	References
40	Voltage Sag triggering is disabled. (Valid time base range: 20 µs/div to 50 ms/div)	You can use the voltage sag triggering only when setting the timebase to one between 20 µs/div and 50 ms/div.	"8.10.4 Setting Model 8969 and U8969 Strain Unit" (p. 188)
41	Channels that are not measurable will be assigned to X-Y.	The channel not specified in the **[Used Ch]** box is selected. Change the channel selection.	"8.4 Setting Channels to Be Used (Extending the Recording Length)" (p. 170)
42	There is not enough data in the memory.	Measure the necessary amount of data required for the calculation.	"11.1 Waveform Calculation Workflow" (p. 254)
43	Stopped.	–	–
44	Current clamp/sensor was recognized.	–	–
45	Current clamp/sensor was disconnected.	Check the connection of the current clamps and the current sensors.	–
46	Channels may no longer be able to be used by frequency units due to logic channel use.	If LA to LE are used, the frequency units cannot be used at CH1 to CH4.	"3.4.3 Configuring Logic Channel Settings" (p. 76)
47	This module cannot be used because it is not AAF aligned.	Press the **SYSTEM** key to display the **[Init]** sheet. Execute **[System Information]** and check the software items. If **[Not AAF aligned]** is displayed, send the module for repairs.	–
48	There are module on which AAF cannot be set to On because of lack of adjustment.		
50	Roll Mode is not available.	Roll mode cannot be used when the overlay is enabled.	"8.2 Displaying Waveforms During the Writing in the Memory Simultaneously (Roll Mode)" (p. 167)
51	Cannot use. (Pre Trigger)	The pre-trigger function is not available when using the external sampling.	"17 Controlling the Instrument Externally" (p. 369)
52	Cannot use. (Roll Mode, Memory Division)	If the waveform calculation function is in use, these functions cannot be used.	"11.1 Waveform Calculation Workflow" (p. 254)
53	Cannot use. (Roll Mode, Memory Division, Wave Calculation)	If one of the functions is in use, the other functions cannot be used.	"8 Displaying Waveforms During the Writing in the Memory Simultaneously (Roll Mode)" (p. 167)
54	Cannot use. (Overlay)	The overlay function is not available when using the roll mode.	"8.3 Overlaying New Waveforms With Past Waveforms" (p. 168)
55	Cannot use. (Overlay, Memory Division, Wave Calculation)	If roll mode is in use, these functions cannot be used.	"8.2 Displaying Waveforms During the Writing in the Memory Simultaneously (Roll Mode)" (p. 167)
56	Real-time printing is not available.	The recording length (Shot) is set to **[Cont.]** or **[On]**. Real-time printing is not available when using the recorder function with a faster timebase setting.	"3.3.3 Setting the Recording Length (Number of Divisions)" (p. 66) "6.2 Setting Auto-printing" (p. 127)

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Disp No.	Message	Remedy	References
57	Cannot set.(External sampling)	Cannot use roll mode when using the external sampling.	"8.2 Displaying Waveforms During the Writing in the Memory Simultaneously (Roll Mode)" (p. 167)
58	Rated capacity/rated output error.	The value calculated from the rated capacity and rated output exceed the selected range. Input correct values.	(p. 175)
59	Cannot use. (Roll Mode, Wave Calculation)	If the memory division function is in use, these functions cannot be used.	"12.1 Configuring the Recording Settings" (p. 269)
60	No waveform data.	Acquire waveform data.	–
65	Dot interpolation may takes place for sampling speed 1 ms/S.	Set the sampling rate to 1 ms/S or longer.	"4.2 Setting Measurement Conditions" (p. 87)
68	Recording length is too long.	Shorten the measurement recording length. The maximum recording length that can be calculated is given below: Model MR8847-51: 10,000 div Model MR8847-52: 40,000 div Model MR8847-53: 80,000 div	"3.3.3 Setting the Recording Length (Number of Divisions)" (p. 66)
80	In key lock.	The key lock function is engaged. Disengage the key lock function.	19KEY LOCKKEY LOCK19KEY LOCK
91	LAN: Bad IP address.	Check the IP address.	"16.1 Setting LAN and Connecting the Instrument to the LAN Network (Before Using FTP/Internet Browser/Command Communications)" (p. 342)
93	LAN: Can not connect to server.	Verify that the LAN cable is securely connected.	
		Verify that the 9333 LAN Communicator (data collection application) on the connected computer is in the standby state.	"16.8 Operating the Instrument Remotely and Acquiring Data Using the Model 9333 LAN Communicator" (p. 367)
		Verify that the LAN communication setting is enabled.	
		Verify that the connected computer's IP address is set correctly.	
95	LAN: Connection timed out.	Check the transmission settings.	"16.1 Setting LAN and Connecting the Instrument to the LAN Network (Before Using FTP/Internet Browser/Command Communications)" (p. 342)
97	LAN: Network error.	Check the connection between the instrument and connection destination.	
100	Inappropriate setting of time axis for waveform data.	Set the timebase to the setting with which the waveform was measured.	"3.3.2 Timebase and Sampling Rate" (p. 62) "9.11 Searching the Measured Data Using the Trigger Settings" (p. 233)
101	Some blocks are different in time axis setting from the others.	Set the same timebase setting for all search target blocks. If they cannot be the same, set the search range to the displayed blocks only.	

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Disp No.	Message	Remedy	References
102	Some blocks are different in modules configuration from the others.	Unify the modules configuration of the search target blocks. If they cannot be the same, set the search range to the displayed blocks only.	"9.11 Searching the Measured Data Using the Trigger Settings" (p. 233)
103	No data matching your search condition.	Check the trigger setting.	
104	There is no data in the search target channel.	Select the channels including measured data as the search target.	
105	There is a block including no data in the search target channel.	Select the blocks including measured data as the search target.	
106	Some blocks are different in measurement mode of modules from the others.	Blocks created with different measurement modes cannot be searched.	–
108	Some blocks are different in measurement mode of modules from the others.	Set the search range to the displayed blocks.	"9.11 Searching the Measured Data Using the Trigger Settings" (p. 233)
110	No space to store waveform data at copy location.	Create empty space by deleting the waveform data from the copy location.	(p. 206)
111	No space to register arbitrary waveform data.	Create empty space by deleting waveform data from registration location.	(p. 206)

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19.4 Self-Test (Self-Diagnostics)

The following self-test checks are available.

Procedure

To display the screen

Press the **SYSTEM** key to display the system screen, and then select the **[Init]** sheet.

No. 1	ROM/RAM Check	Checks the instrument's internal memory (ROM and RAM). The results are displayed on the screen. (p. 444)
No. 2	Printer Check	Checks printing and cleans the print head. (p. 445), (p. 448)
No. 3	Display Check	Checks the display condition of the screen. (Solid color check, gradation check). (p. 445)
No. 4	Key Check	Check whether the instrument keys are functioning correctly. (p. 446)
No. 5	System Information	Check the system configuration. (p. 446)

19.4.1 ROM/RAM Check

This check tests the instrument's internal memory (ROM and RAM).

Performing the ROM/RAM check erases measured data.
Save the measured data to another storage device before performing the ROM/RAM check.

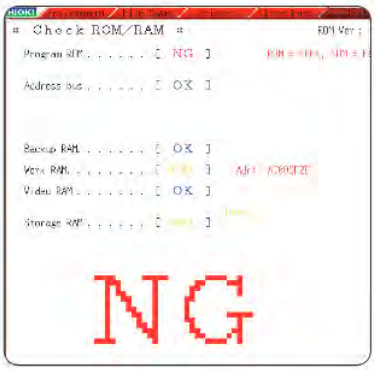
1 **Move the cursor to the [ROM/RAM Check] box.**

2 **Select [Exec].**

The ROM/RAM check is started.

The following checks are performed in the following order:
Program ROM, Address bus, Backup RAM, Work RAM, Video RAM, and Storage RAM

Do not turn off the instrument during the check.



To cancel the check,
Press the STOP key.

The present check is interrupted, and the next one starts.
All operation keys (except **STOP** key) are disabled.

The judgment results are displayed when the checks finish.
OK: Normal
NG: Error
ABORT: When the check is interrupted

If the message NG is displayed, send the instrument for repair.

Press any key to return to the previous screen.

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Procedure (Common to printer check, display check, key check, system configuration check)

To display the screen

Press the **SYSTEM** key to display the system screen, and then select the **[Init]** sheet.

19.4.2 Printer Check

This check tests the condition of the printer.

Before executing the printer check, check that the recording paper is loaded.

1 **Move the cursor to the [Printer Check] box.**

2 **Select [Exec].**

The test pattern is printed.
Approximately 5 cm of each of the following patterns is printed in the following order: Checkerboard, vertical lines, slanted lines, and characters.

To cancel the check

Press the STOP key.

After the printer check

Check the printed recording paper for white streaks.
If there are any white streaks, clean the print head. (p. 448)

The print quality (print speed) and print density settings is reflected in the test printout.

19.4.3 Display Check

This check tests the condition of the display screen.

1 **Move the cursor to the [Display Check] box.**

2 **Select [Exec].**

The screen becomes uniformly red.

3 **Press any key to check the display condition.**

The screen changes each time you press an operation key.

Pressing any key repeatedly to return to the previous screen.

Screen changing order

Color check (Red, Green, Blue, Black, White) → Gradation check (Red, Green, Blue, Black, White) → Color pattern → Original screen.

If the display screen seems abnormal, send the instrument for repair.

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19.4.4 Key Check

This check tests the keys, jog dial, and shuttle ring for proper operation.

1. **Move the cursor to the [Key Check] box.**
2. **Select [Exec].**
   Operation keys are displayed.
3. **Press each operation key once or several times.**
   The corresponding key is highlighted.

   Jog dial: Turn it clockwise and counterclockwise, one or several revolutions each.
   Shuttle ring: Turn slowly clockwise and counterclockwise all the way each.
   (The **START** key check also functions as the LED check.)

   Operating all of the keys completes the check.

   To cancel the check
   Press the START and STOP keys simultaneously.

   Pressing any key repeatedly to return to the previous screen.

The key check will not finish if there is a problem that prevents even one of the keys from being recognized. If this occurs, press the **STOP** and **START** keys simultaneously to display the previous screen.
There may be a malfunction in the instrument. Send the instrument for repair.

If there is a problem with the **STOP** or **START** key, you cannot return to the previous screen. Turn off the instrument. Send it for repair.

19.4.5 System Configuration Check

The list of installed options and other system information is displayed on the separate window.

1. **Move the cursor to the [System Information] box.**

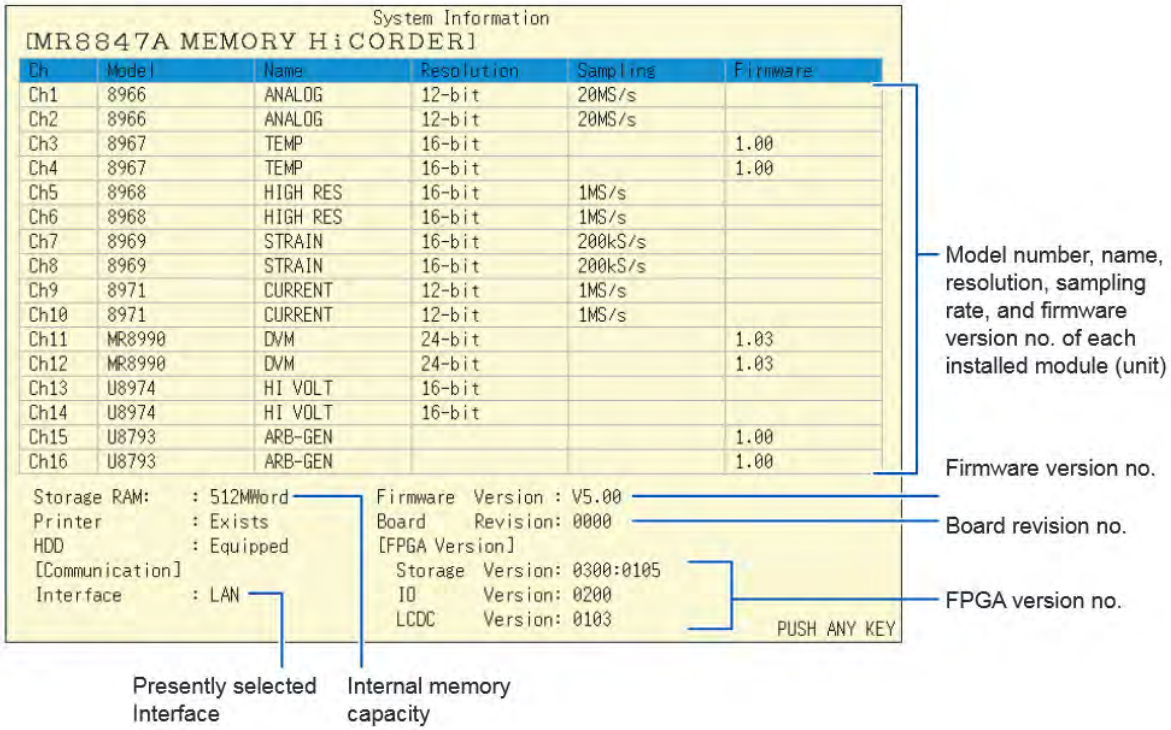
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2 **Select [Exec].**

The **[System Information]** list is displayed.

To return to the previous screen

Press any key.



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19.5 Cleaning the Instrument

Cleaning the print head

⚠WARNING

The print head and surrounding metal parts can become hot. Perform cleaning only after making sure that the parts have cooled fully. Be careful to avoid touching these parts.

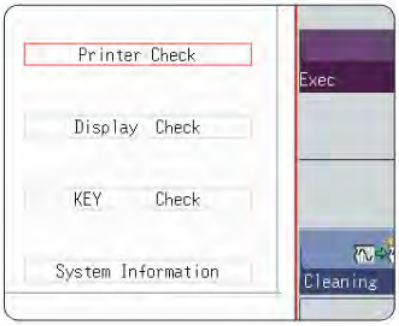
Normally, no maintenance is required. However, depending on usage conditions, dirt and paper dust may accumulate on the thermal head over long periods, which can cause light or smeared printing. In this case, clean the head by following the procedure below.

Checking the print head

Before cleaning the print head
The recording paper is required to clean the print head. Check that the recording paper is loaded properly.

1. **Press the SYSTEM key to display the [Init] sheet.**
2. **Move the cursor to the [Printer Check] box.**
3. **Select [Exec].**
   If the printing is blurred, clean the print head.

   Executing **[Cleaning]** remove the paper dust readily. If sufficient improvement is not obtained even after cleaning the print head several times, cleaning the print head is required.



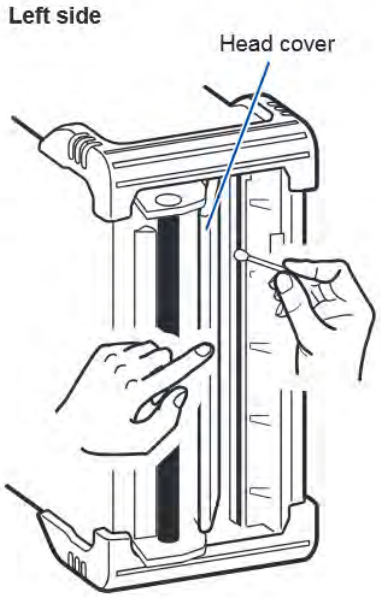
To clean the print head

Required items: Undiluted alcohol, cotton swab

1. **Moisten the end of the cotton swab with undiluted alcohol.**

   Be careful not to apply too much undiluted alcohol.

2. **Open the head cover and wipe the print head with the tip of the cotton swab.**



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About the print head

Note the following precautions to avoid discoloration or deformation.

- Do not use organic solvents such as thinner or benzene.
- After washing, be certain that the printer is completely dry before use.

About the roller surface

- White powder such as paper dust may accumulate on the roller surface after long-term use. A small amount of the dust should have no effect on printing; however, you can remove it with a commercially available camera blower brush if it causes concern.
- Always use the paper cutter to cut the printed paper. Excessive paper dust can accumulate on the roller if the paper is cut with the print head.

To clean the instrument and modules

To clean the instrument and modules, wipe it gently with a soft cloth moistened with water or mild detergent. Wipe the LCD gently with a soft, dry cloth.

IMPORTANT

Never use solvents such as benzene, alcohol, acetone, ether, ketone, thinners or gasoline. Doing so could deform and discolor the instrument.

⚠CAUTION

Clean the vents periodically to avoid blockage.
If the vents become clogged, the instrument's internal cooling will be impeded, which may result in damage.

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19.6 Disposing of the Instrument (Removing Lithium Battery)

The instrument contains the lithium battery for memory backup. Remove this battery before disposing of the instrument.

⚠WARNING

- **To avoid electric shock, turn off the power and disconnect the power cord and connection cables before removing the lithium battery.**
- **Keep batteries away from children to prevent accidental swallowing.**

Do not short-circuit, recharge, disassemble or dispose of in fire. The battery may explode if mistreated.

When disposing of this instrument, remove the lithium battery and dispose of battery and instrument in accordance with local regulations.

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Removing the lithium battery

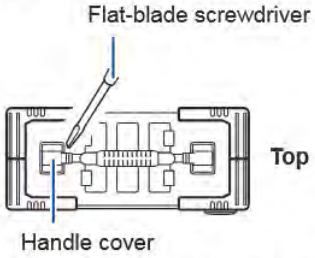
Required items:

Flat-blade screwdriver, phillips screwdriver, nippers, box-end wrench, and needle-nose pliers (one each)

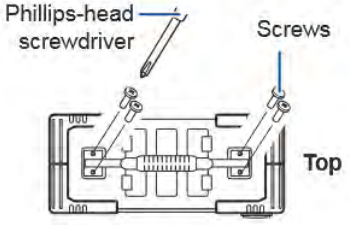
1 Ensure that the instrument is turned off, and then remove the connection cables and power cord.

2 Remove screws and each part in following shown sequence.

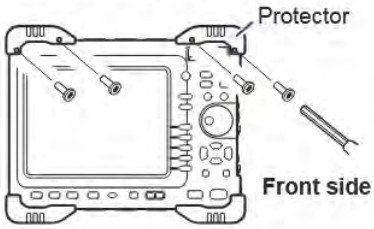
1 Remove the handle covers.



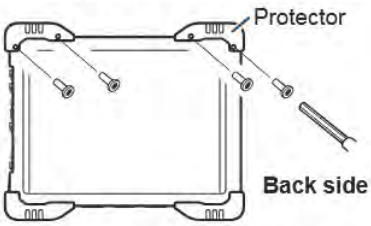
2 Remove the screws securing the handle.



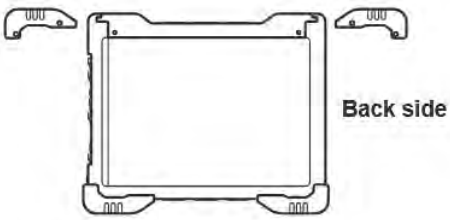
3 Remove the screws on the front side of the protectors. (8 total, top and bottom)



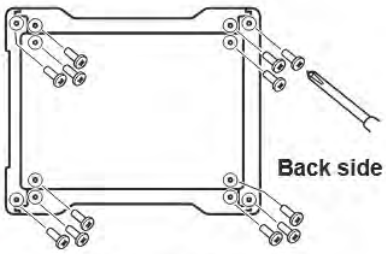
4 Remove the screws on the back side of the protectors. (8 total, top and bottom)



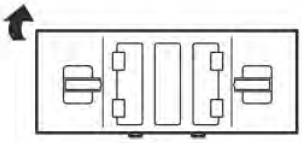
5 Remove all protectors.



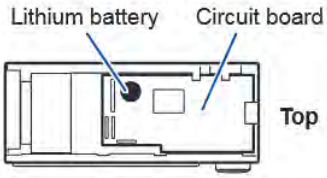
6 Remove the screws on the back (twelve) and front (four).

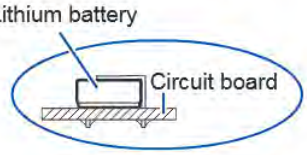


7 Remove the top, bottom, side, and front panels.



8 Remove the sheet metal on top.





3 Pull the lithium battery up from the circuit board, and cut the two leads, positive and negative, with the nippers.

4 Remove the battery from the board.

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Appendix

Appx. 1 Default Values for Major Settings

Screen	Sheet/ Window	Items	Settings
Status	Status	Timebase (Memory)	5 µs/div
		Timebase (Recorder)	10 ms/div
		Sampling (X-Y recorder)	100 ms/S
		Recording length	25 div
		Format (Memory/Recorder)	Single
		Format (X-Y recorder)	X-Y Single
		Roll Mode (Memory)	Auto
		Used Ch (Memory)	Ch 1-16 ch
		Dots-Line (X-Y recorder)	Line
	Num Calc.	Numerical Calc	OFF
System	Environment	Grid Type	Dotted Line
		Time Value	Time
		Beep Sound	Warning
		Auto Scale	ON
	File Save	Auto Save	OFF
	Printer:	Auto print	OFF
		Grid Type	Normal
		Ch Mark	Ch No.
		Time Value	Time
		Mag/Comp	Same to display
		Copy GUI	Yes
		Print Area	All Wave
	Interface	Interface	LAN
		USB setting	USB Memory
Channel	Unit List	Wave_Disp (analog)	Color 1 to 16
		Wave Density	Standard
		Wave_Disp (Logic)	OFF
		Logic Width	Normal
		Range	Highest sensitivity
		Coupling	DC
	Scaling	Setting method	Ratio
		Each channel	OFF
	Comment	Print Comment (Title)	Setting
		Print Comment (Analog)	Setting
		Print Comment (Logic)	OFF
Wave	Trigger settings window	Trigger Mode (Memory)	Auto
		Trigger Mode (Recorder)	Single
		Pre Trigger (Memory)	0%
		Trigger source	OR
		Timing	Start
		Trigger for each module	OFF
		Timer Trigger	OFF
		External Trigger	OFF

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Appx. 2 For Reference

Appx. 2.1 Waveform File sizes

References

File type	Function	Size	Calculation method
MEM file	Memory function	(p. Appx.2)	(p. Appx.4)
REC file	Recorder function	(p. Appx.2)	(p. Appx.4)
FFT file	FFT function	(p. Appx.3)	(p. Appx.4)
XYC file	X-Y recorder function	(p. Appx.3)	(p. Appx.4)
CSV (Text) file	Memory function	(p. Appx.3)	(p. Appx.5)
	Recorder function	(p. Appx.4)	(p. Appx.5)

References of the file size

MEM file size (Memory function)

(File size) = (Setting size) + (Data size)
Calculation method: "MEM file" (p. Appx.4)

Recording length (div)	Data count	Number of saved channels					
		1	2	4	8	16	32
100	10,001	43 KB	63 KB	103 KB	183 KB	344 KB	649 KB
1,000	100,001	219 KB	415 KB	806 KB	1.6 MB	3.0 MB	6.2 MB
10,000	1,000,001	1.9 MB	3.8 MB	7.7 MB	15 MB	31 MB	62 MB
100,000	10,000,001	19 MB	38 MB	76 MB	152 MB	305 MB	611 MB
1,000,000	100,000,001	191 MB	381 MB	762 MB	–	–	–

REC file size (Recorder function)

(File size) = (Setting size) + (Data size)
Calculation method: "REC file" (p. Appx.4)

Recording length (div)	Data count	Number of saved channels					
		1	2	4	8	16	32
100	10,001	63 KB	102 KB	181 KB	340 KB	656 KB	1.3 MB
1,000	100,001	414 KB	805 KB	1.6 MB	3.1 MB	6.1 MB	12 MB
10,000	1,000,001	3.8 MB	7.7 MB	15 MB	31 MB	61 MB	122 MB
20,000	2,000,001	7.7 MB	15 MB	31 MB	61 MB	122 MB	244 MB
100,000	10,000,001	38 MB	76 MB	152 MB	305 MB	610 MB	–

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FFT file size (FFT function)

(File size) = (Header size) + (Size of time axis data) + (Size of mid-term data)
Calculation method: "FFT file" (p. Appx.4)

Number of pieces of data	Number of calculations	
	1	2
1,000	360 KB	694 KB
2,000	692 KB	1.3 MB
5,000	1.6 MB	3.3 MB
10,000	3.3 MB	6.5 MB

XYC file size (X-Y recorder function)

(File size) = (Setting size) + (Data size)
Calculation method: "XYC file" (p. Appx.4)

Number of pieces of data	Number of saved channels					
	1	2	4	8	16	32
10,000	44 KB	64 KB	104 KB	184 KB	345 KB	650 KB
100,000	220 KB	416 KB	807 KB	1.6 MB	3.1 MB	6.2 MB
1,000,000	1.9 MB	3.9 MB	7.7 MB	15 MB	31 MB	62 MB
2,000,000	3.8 MB	7.7 MB	15 MB	31 MB	61 MB	123 MB

CSV (Text) file size (Memory function)

File size = header size + data size
Calculation method: "CSV (Text) file" (p. Appx.5)

Recording length (div)	Number of pieces of data	Number of saved channels					
		1	2	4	8	16	32
100	10,001	313 KB	450 KB	723 KB	1.2 MB	2.3 MB	4.5 MB
1,000	100,001	3.1 MB	4.4 MB	7.1 MB	12 MB	23 MB	45 MB
10,000	1,000,001	31 MB	44 MB	71 MB	124 MB	231 MB	445 MB
100,000	10,000,001	305 MB	439 MB	706 MB	1.1 GB	2.1 GB	4.3 GB
1,000,000	100,000,001	3.1 GB	4.4 GB	7.1 GB	–	–	–

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CSV (Text) file size (Recorder function)

File size = header size + data size
Calculation method: "Recorder function" (p. Appx.5)

When saving, a CSV (text) file the size of which exceeds 2 GB is divided into multiple files with a size of 2 GB each.

Recording length	Number of pieces of data	Number of saved channels					
		1	2	4	8	16	32
100	10,001	450 KB	723 KB	1.2 MB	2.3 MB	4.4 MB	8.8 MB
1,000	100,001	4.4 MB	7.1 MB	12 MB	23 MB	44 MB	87 MB
10,000	1,000,001	44 MB	71 MB	124 MB	231 MB	444 MB	872 MB
20,000	2,000,001	88 MB	141 MB	248 MB	432 MB	889 MB	1.7 GB
100,000	10,000,001	391 MB	619 MB	1.1 GB	1.9 GB	3.7 GB	–

Calculation method of waveform file size

MEM file

(File size [bytes]) = (Setting size*1) + (Data size*2)
*1: (Setting size) = 23552 + 512 × [(Number of analog channels) + 4 × (Number of logic units) + (Number of waveform calculation channels)]
*2: (Data size) = 2 × [(Number of analog channels) + (Number of logic units) + 2 × (Number of waveform calculation channels)] × (Number of data)

REC file

(File size [bytes]) = (Setting size*1) + (Data size*2)
*1: (Setting size) = 23552 + 512 × [(Number of analog channels) + 4 × (Number of logic units)]
*2: (Data size) = 4 × [(Number of analog channels) + (Number of logic units)] × (Number of data)

FFT file

(File size [bytes]) = (Header size*1) +(Size of time axis data*2) + (Size of mid-term data*3)
*1: (Header size) = 25600 + 512 × [(Number of analog channels) + (Number of waveform calculation channels) + (Number of FFT calculation channels) + 1]
*2: (Size of time axis data) = [(Number of analog channels) + 2 × (Number of waveform calculation channels)] × (Number of data) (*4)
*3: (Size of mid-term data) = [346 × (Number of FFT points) + 836] × (Number of FFT calculation channels) (*4)
(The file size may also increase or decrease from the calculation formula results depending on the measurement conditions.)

XYC file

(File size [bytes]) = (Header size*1) + (Data size*2)
*1: (Header size) = 24576 + 512 × (Number of analog channels)
*2: (Data size) = 2 × (Number of saved analog channels) × (Number of data)

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CSV (Text) file
Memory function
(File size [bytes]) = (Header size*1) + (Data size*2) *1: (Header size) = 194 + 103 × [(Number of saved analog channels) + (Number of saved logic channels)] *2: (Data size) = [18 + 14 × (Number of saved analog channels) + 2 × (Number of logic channels)] × (Number of data)
Recorder function
(File size [bytes]) = (Header size*1) + (Data size*2) *1: (Header size) = 194 + 130 × [(Number of saved analog channels) + (Number of saved logic channels)] *2: (Data size) = [18 + 28 × (Number of saved analog channels) + 4 × (Number of logic channels)] × (Number of data)

Appx. 2.2 Files Size of Setting and Image Files

File	Size
Setting file	33 KB
BMP (Not color-compressed)	470 KB
BMP (Gray scale, not compressed)	470 KB
BMP (B/W, not compressed)	59 KB
BMP (B/W reverse, not compressed)	59 KB

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Appx. 2.3 Timebase and Maximum Recordable Time

The maximum available recording time varied depending on the selected timebase.
The maximum recording time can be obtained by the following formula.

(Recordable Time) = Timebase (Recording length)

You can check the recordable time on the **[Status]** sheet of the status screen. (**[Recording period]**)

- **Setting a slower timebase may result in an excessively long recording time (over a year) that exceeds the guarantee period or product life, in which case we cannot guarantee operation.**
- **When using the memory function, the maximum recording length varies depending on the number of used channels.**
- **When using the X-Y recorder function, the maximum number of samples is 4,000,000 (if using the U8975, U8977, or U8978: 2,000,000).**

Recorder function

Timebase/div	Model MR8847-51 Maximum recording length: 20,000 div*	Model MR8847-52 Maximum recording length: 80,000 div*	Model MR8847-53 Maximum recording length: 160,000 div*
10 ms	3 min 20 s	13 min 20 s	26 min 40 s
20 ms	6 min 40 s	26 min 40 s	53 min 20 s
50 ms	16 min 40 s	1 h 6 min 40 s	2 h 13 min 20 s
100 ms	33 min 20 s	2 h 13 min 20 s	4 h 26 min 40 s
200 ms	1 h 6 min 40 s	4 h 26 min 40 s	8 h 53 min 20 s
500 ms	2 h 46 min 40 s	11 h 6 min 40 s	22 h 13 min 20 s
1 s	5 h 33 min 20 s	22 h 13 min 20 s	1 d 20 h 26 min 40 s
2 s	11 h 6 min 40 s	1 d 20 h 26 min 40 s	3 d 16 h 53 min 20 s
5 s	1 d 3 h 46 min 40 s	4 d 15 h 6 min 40 s	9 d 6 h 13 min 20 s
10 s	2 d 7 h 33 min 20 s	9 d 6 h 13 min 20 s	18 d 12 h 26 min 40 s
30 s	6 d 22 h 40 min 0 s	27 d 18 h 40 min 0 s	55 d 13 h 20 min 0 s
50 s	11 d 13 h 46 min 40 s	46 d 7 h 6 min 40 s	92 d 14 h 13 min 20 s
1 min	13 d 21 h 20 min 0 s	55 d 13 h 20 min 0 s	111 d 2 h 40 min 0 s
100 s	23 d 3 h 33 min 20 s	92 d 14 h 13 min 20 s	185 d 4 h 26 min 40 s
2 min	27 d 18 h 40 min 0 s	111 d 2 h 40 min 0 s	222 d 5 h 20 min 0 s
5 min	69 d 10 h 40 min 0 s	277 d 18 h 40 min 0 s	
10 min	138 d 21 h 20 min 0 s		
30 min			
1 h			

(d: days, h: hours, min: minutes, s: seconds)
* Even when the recording length is set to **[Cont.]**, the maximum recording length does not change.

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If using the U8975, U8977, or U8978

Timebase/div	MR8847-51 Maximum recording length: 10,000 div*	MR8847-52 Maximum recording length: 40,000 div*	MR8847-53 Maximum recording length: 80,000 div*
10 ms	1 min 40 s	6 min 40 s	13 min 20 s
20 ms	3 min 20 s	13 min 20 s	26 min 40 s
50 ms	8 min 20 s	33 min 20 s	1h 6 min 40 s
100 ms	16 min 40 s	1h 6 min 40 s	2h 13 min 20 s
200 ms	33 min 20 s	2h 13 min 20 s	4h 26 min 40 s
500 ms	1 h 23 min 20 s	5h 33 min 20 s	11h 6 min 40 s
1 s	2h 46 min 40 s	11h 6 min 40 s	22h 13 min 20 s
2 s	5h 33 min 20 s	22h 13 min 20 s	1d 20h 26 min 40 s
5 s	13h 53 min 20 s	2d 7h 3 min 20 s	4d 15h 6 min 40 s
10 s	1d 3h 46 min 40 s	4d 15h 6 min 40 s	9d 6h 13 min 20 s
30 s	3d 11h 20 min 00 s	13d 21h 20 min 00 s	27d 18h 40 min 00 s
50 s	5d 18h 53 min 20 s	23d 3h 33 min 20 s	46 d 7 h 06 min 40 s
1 min	6d 22h 40 min 00 s	27 d 18 h 40 min 00 s	55 d 13 h 20 min 00 s
100 s	11d 13h 46 min 40 s	46 d 7 h 06 min 40 s	92 d 14 h 13 min 20 s
2 min	13d 21h 20 min 00 s	55 d 13 h 20 min 00 s	111 d 2 h 40 min 00 s
5 min	34 d 17 h 20 min 00 s	138 d 21 h 20 min 00 s	277 d 18 h 40 min 00 s
10 min	69 d 10 h 40 min 00	277 d 18 h 40 min 00 s	
30 min	208 d 8 h 00 min 00 s		
1 h			

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Memory function

For Model MR8847-51 (Total memory: 64 MW)

Time-base/ div	Sampling rate	Number of used channels Maximum recording length				
		32 channels	16 channels	8 channels	4 channels	2 channels
		20,000 div	40,000 div	80,000 div	160,000 div	320,000 div
5 µs	50 ns		0.2 s	0.4 s	0.8 s	1.6 s
10 µs	100 ns	0.2 s	0.4 s	0.8 s	1.6 s	3.2 s
20 µs	200 ns	0.4 s	0.8 s	1.6 s	3.2 s	6.4 s
50 µs	500 ns	1 s	2 s	4 s	8 s	16 s
100 µs	1 µs	2 s	4 s	8 s	16 s	32 s
200 µs	2 µs	4 s	8 s	16 s	32 s	1 min 4 s
500 µs	5 µs	10 s	20 s	40 s	1 min 20 s	2 min 40 s
1 ms	10 µs	20 s	40 s	1 min 20 s	2 min 40 s	5 min 20 s
2 ms	20 µs	40 s	1 min 20 s	2 min 40 s	5 min 20 s	10 min 40 s
5 ms	50 µs	1 min 40 s	3 min 20 s	6 min 40 s	13 min 20 s	26 min 40 s
10 ms	100 µs	3 min 20 s	6 min 40 s	13 min 20 s	26 min 40 s	53 min 20 s
20 ms	200 µs	6 min 40 s	13 min 20 s	26 min 40 s	53 min 20 s	1 h 46 min 40 s
50 ms	500 µs	16 min 40 s	33 min 20 s	1 h 6 min 40 s	2 h 13 min 20 s	4 h 26 min 40 s
100 ms	1 ms	33 min 20 s	1 h 6 min 40 s	2 h 13 min 20 s	4 h 26 min 40 s	8 h 53 min 20 s
200 ms	2 ms	1 h 6 min 40 s	2 h 13 min 20 s	4 h 26 min 40 s	8 h 53 min 20 s	17 h 46 min 40 s
500 ms	5 ms	2 h 46 min 40 s	5 h 33 min 20 s	11 h 6 min 40 s	22 h 13 min 20 s	1 d 20 h 26 min 40 s
1 s	10 ms	5 h 33 min 20 s	11 h 6 min 40 s	22 h 13 min 20 s	1 d 20 h 26 min 40 s	3 d 16 h 53 min 20 s
2 s	20 ms	11 h 6 min 40 s	22 h 13 min 20 s	1 d 20 h 26 min 40 s	3 d 16 h 53 min 20 s	7 d 9 h 46 min 40 s
5 s	50 ms	1 d 3 h 46 min 40 s	2 d 7 h 33 min 20 s	4 d 15 h 6 min 40 s	9 d 6 h 13 min 20 s	18 d 12 h 26 min 40 s
10 s	100 ms	2 d 7 h 33 min 20 s	4 d 15 h 6 min 40 s	9 d 6 h 13 min 20 s	18 d 12 h 26 min 40 s	37 d 0 h 53 min 20 s
30 s	300 ms	6 d 22 h 40 min 0 s	13 d 21 h 20 min 0 s	27 d 18 h 40 min 0 s	55 d 13 h 20 min 0 s	111 d 2 h 40 min 0 s
50 s	500 ms	11 d 13 h 46 min 40 s	23 d 3 h 33 min 20 s	46 d 7 h 6 min 40 s	92 d 14 h 13 min 20 s	185 d 4 h 26 min 40 s
1 min	600 ms	13 d 21 h 20 min 0 s	27 d 18 h 40 min 0 s	55 d 13 h 20 min 0 s	111 d 2 h 40 min 0 s	222 d 5 h 20 min 0 s
100 s	1 s	23 d 3 h 33 min 20 s	46 d 7 h 6 min 40 s	92 d 14 h 13 min 20 s	185 d 4 h 26 min 40 s	
2 min	1.2 s	27 d 18 h 40 min 0 s	55 d 13 h 20 min 0 s	111 d 2 h 40 min 0 s	222 d 5 h 20 min 0 s	
5 min	3 s	69 d 10 h 40 min 0 s	138 d 21 h 20 min 0 s	277 d 18 h 40 min 0 s		

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For Model MR8847-52 (Total memory: 256 MW)

Time-base/ div	Sampling rate	Number of used channels Maximum recording length				
		32 channels	16 channels	8 channels	4 channels	2 channels
		80,000 div	160,000 div	320,000 div	640,000 div	1,280,000 div
5 µs	50 ns		0.8 s	1.6 s	3.2 s	6.4 s
10 µs	100 ns	0.8 s	1.6 s	3.2 s	6.4 s	12.8 s
20 µs	200 ns	1.6 s	3.2 s	6.4 s	12.8 s	25.6 s
50 µs	500 ns	4 s	8 s	16 s	32 s	1 min 4 s
100 µs	1 µs	8 s	16 s	32 s	1 min 4 s	2 min 8 s
200 µs	2 µs	16 s	32 s	1 min 4 s	2 min 8 s	4 min 16 s
500 µs	5 µs	40 s	1 min 20 s	2 min 40 s	5 min 20 s	10 min 40 s
1 ms	10 µs	1 min 20 s	2 min 40 s	5 min 20 s	10 min 40 s	21 min 20 s
2 ms	20 µs	2 min 40 s	5 min 20 s	10 min 40 s	21 min 20 s	42 min 40 s
5 ms	50 µs	6 min 40 s	13 min 20 s	26 min 40 s	53 min 20 s	1 h 46 min 40 s
10 ms	100 µs	13 min 20 s	26 min 40 s	53 min 20 s	1 h 46 min 40 s	3 h 33 min 20 s
20 ms	200 µs	26 min 40 s	53 min 20 s	1 h 46 min 40 s	3 h 33 min 20 s	7 h 6 min 40 s
50 ms	500 µs	1 h 6 min 40 s	2 h 13 min 20 s	4 h 26 min 40 s	8 h 53 min 20 s	17 h 46 min 40 s
100 ms	1 ms	2 h 13 min 20 s	4 h 26 min 40 s	8 h 53 min 20 s	17 h 46 min 40 s	1 d 11 h 33 min 20 s
200 ms	2 ms	4 h 26 min 40 s	8 h 53 min 20 s	17 h 46 min 40 s	1 d 11 h 33 min 20 s	2 d 23 h 6 min 40 s
500 ms	5 ms	11 h 6 min 40 s	22 h 13 min 20 s	1 d 20 h 26 min 40 s	3 d 16 h 53 min 20 s	7 d 9 h 46 min 40 s
1 s	10 ms	22 h 13 min 20 s	1 d 20 h 26 min 40 s	3 d 16 h 53 min 20 s	7 d 9 h 46 min 40 s	14 d 19 h 33 min 20 s
2 s	20 ms	1 d 20 h 26 min 40 s	3 d 16 h 53 min 20 s	7 d 9 h 46 min 40 s	14 d 19 h 33 min 20 s	29 d 15 h 6 min 40 s
5 s	50 ms	4 d 15 h 6 min 40 s	9 d 6 h 13 min 20 s	18 d 12 h 26 min 40 s	37 d 0 h 53 min 20 s	74 d 1 h 46 min 40 s
10 s	100 ms	9 d 6 h 13 min 20 s	18 d 12 h 26 min 40 s	37 d 0 h 53 min 20 s	74 d 1 h 46 min 40 s	148 d 3 h 33 min 20 s
30 s	300 ms	27 d 18 h 40 min 0 s	55 d 13 h 20 min 0 s	111 d 2 h 40 min 0 s	222 d 5 h 20 min 0 s	
50 s	500 ms	46 d 7 h 6 min 40 s	92 d 14 h 13 min 20 s	185 d 4 h 26 min 40 s		
1 min	600 ms	55 d 13 h 20 min 0 s	111 d 2 h 40 min 0 s	222 d 5 h 20 min 0 s		
100 s	1 s	92 d 14 h 13 min 20 s	185 d 4 h 26 min 40 s			
2 min	1.2 s	111 d 2 h 40 min 0 s	222 d 5 h 20 min 0 s			
5 min	3 s	277 d 18 h 40 min 0 s				

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For Model MR8847-53 (Total memory: 512 MW)

Time-base/ div	Sampling rate	Number of used channels Maximum recording length				
		32 channels	16 channels	8 channels	4 channels	2 channels
		160,000 div	320,000 div	640,000 div	1,280,000 div	2,560,000 div
5 µs	50 ns		1.6 s	3.2 s	6.4 s	12.8 s
10 µs	100 ns	1.6 s	3.2 s	6.4 s	12.8 s	25.6 s
20 µs	200 ns	3.2 s	6.4 s	12.8 s	25.6 s	51.2 s
50 µs	500 ns	8 s	16 s	32 s	1 min 4 s	2 min 8 s
100 µs	1 µs	16 s	32 s	1 min 4 s	2 min 8 s	4 min 16 s
200 µs	2 µs	32 s	1 min 4 s	2 min 8 s	4 min 16 s	8 min 32 s
500 µs	5 µs	1 min 20 s	2 min 40 s	5 min 20 s	10 min 40 s	21 min 20 s
1 ms	10 µs	2 min 40 s	5 min 20 s	10 min 40 s	21 min 20 s	42 min 40 s
2 ms	20 µs	5 min 20 s	10 min 40 s	21 min 20 s	42 min 40 s	1 h 25 min 20 s
5 ms	50 µs	13 min 20 s	26 min 40 s	53 min 20 s	1 h 46 min 40 s	3 h 33 min 20 s
10 ms	100 µs	26 min 40 s	53 min 20 s	1 h 46 min 40 s	3 h 33 min 20 s	7 h 6 min 40 s
20 ms	200 µs	53 min 20 s	1 h 46 min 40 s	3 h 33 min 20 s	7 h 6 min 40 s	14 h 13 min 20 s
50 ms	500 µs	2 h 13 min 20 s	4 h 26 min 40 s	8 h 53 min 20 s	17 h 46 min 40 s	35 h 33 min 20 s
100 ms	1 ms	4 h 26 min 40 s	8 h 53 min 20 s	17 h 46 min 40 s	1 d 11 h 33 min 20 s	2 d 23 h 6 min 40 s
200 ms	2 ms	8 h 53 min 20 s	17 h 46 min 40 s	1 d 11 h 33 min 20 s	2 d 23 h 6 min 40 s	5 d 22 h 13 min 20 s
500 ms	5 ms	22 h 13 min 20 s	1 d 20 h 26 min 40 s	3 d 16 h 53 min 20 s	7 d 9 h 46 min 40 s	14 d 19 h 33 min 20 s
1 s	10 ms	1 d 20 h 26 min 40 s	3 d 16 h 53 min 20 s	7 d 9 h 46 min 40 s	14 d 19 h 33 min 20 s	29 d 15 h 6 min 40 s
2 s	20 ms	3 d 16 h 53 min 20 s	7 d 9 h 46 min 40 s	14 d 19 h 33 min 20 s	29 d 15 h 6 min 40 s	59 d 6 h 13 min 20 s
5 s	50 ms	9 d 6 h 13 min 20 s	18 d 12 h 26 min 40 s	37 d 0 h 53 min 20 s	74 d 1 h 46 min 40 s	148 d 3 h 33 min 20 s
10 s	100 ms	18 d 12 h 26 min 40 s	37 d 0 h 53 min 20 s	74 d 1 h 46 min 40 s	148 d 3 h 33 min 20 s	296 d 7 h 6 min 40 s
30 s	300 ms	55 d 13 h 20 min 0 s	111 d 2 h 40 min 0 s	222 d 5 h 20 min 0 s		
50 s	500 ms	92 d 14 h 13 min 20 s	185 d 4 h 26 min 40 s			
1 min	600 ms	111 d 2 h 40 min 0 s	222 d 5 h 20 min 0 s			
100 s	1 s	185 d 4 h 26 min 40 s				
2 min	1.2 s					
5 min	3 s					

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Appx. 2.4 Maximum Recording Length and Number of Divisions (Memory Division Function)

The maximum recording length is automatically determined when you set the number of the used channels and number of divisions.

Freely specified recording length

For Model MR8847-51 (Total memory: 64 MW)

The number of divisions (blocks)	Number of used channels				
	1 to 2 channels	1 to 4 channels	1 to 8 channels	1 to 16 channels	1 to 32 channels
	Maximum recording length (div)				
2	160,000	80,000	40,000	20,000	10,000
4	80,000	40,000	20,000	10,000	5,000
8	40,000	20,000	10,000	5,000	2,500
16	20,000	10,000	5,000	2,500	1,200
32	10,000	5,000	2,500	1,200	600
64	5,000	2,500	1,200	600	300
128	2,500	1,200	600	300	150
256	1,200	600	300	150	70
512	600	300	150	70	30
1024	300	150	70	30	-

For Model MR8847-52 (Total memory: 256 MW)

The number of divisions (blocks)	Number of used channels				
	1 to 2 channels	1 to 4 channels	1 to 8 channels	1 to 16 channels	1 to 32 channels
	Maximum recording length (div)				
2	640,000	320,000	160,000	80,000	40,000
4	320,000	160,000	80,000	40,000	20,000
8	160,000	80,000	40,000	20,000	10,000
16	80,000	40,000	20,000	10,000	5,000
32	40,000	20,000	10,000	5,000	2,500
64	20,000	10,000	5,000	2,500	1,200
128	10,000	5,000	2,500	1,200	600
256	5,000	2,500	1,200	600	300
512	2,500	1,200	600	300	150
1024	1,200	600	300	150	-

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For Model MR8847-53 (Total memory: 512 MW)

The number of divisions (blocks)	Number of used channels				
	1 to 2 channels	1 to 4 channels	1 to 8 channels	1 to 16 channels	1 to 32 channels
	Maximum recording length (div)				
2	1,280,000	640,000	320,000	160,000	80,000
4	640,000	320,000	160,000	80,000	40,000
8	320,000	160,000	80,000	40,000	20,000
16	160,000	80,000	40,000	20,000	10,000
32	80,000	40,000	20,000	10,000	5,000
64	40,000	20,000	10,000	5,000	2,500
128	20,000	10,000	5,000	2,500	1,200
256	10,000	5,000	2,500	1,200	600
512	5,000	2,500	1,200	600	300
1024	2,500	1,200	600	300	-

Fixed recording length

For Model MR8847-51 (Total memory: 64 MW)

The number of divisions (blocks)	Number of used channels				
	1 to 2 channels	1 to 4 channels	1 to 8 channels	1 to 16 channels	1 to 32 channels
	Maximum recording length (div)				
2	100,000	50,000	20,000	20,000	10,000
4	50,000	20,000	20,000	10,000	5,000
8	20,000	20,000	10,000	5,000	2,000
16	20,000	10,000	5,000	2,000	1,000
32	10,000	5,000	2,000	1,000	500
64	5,000	2,000	1,000	500	200
128	2,000	1,000	500	200	100
256	1,000	500	200	100	500
512	500	200	100	50	25
1024	200	100	50	25	-

For Model MR8847-52 (Total memory: 256 MW)

The number of divisions (blocks)	Number of used channels				
	1 to 2 channels	1 to 4 channels	1 to 8 channels	1 to 16 channels	1 to 32 channels
	Maximum recording length (div)				
2	500,000	200,000	100,000	50,000	20,000
4	200,000	100,000	50,000	20,000	20,000
8	100,000	50,000	20,000	20,000	10,000
16	50,000	20,000	20,000	10,000	5,000
32	20,000	20,000	10,000	5,000	2,000
64	20,000	10,000	5,000	2,000	1,000
128	10,000	5,000	2,000	1,000	500
256	5,000	2,000	1,000	500	200
512	2,000	1,000	500	200	100
1024	1,000	500	200	100	-

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For Model MR8847-53 (Total memory: 512 MW)

The number of divisions (blocks)	Number of used channels				
	1 to 2 channels	1 to 4 channels	1 to 8 channels	1 to 16 channels	1 to 32 channels
	Maximum recording length (div)				
2	1,000,000	500,000	200,000	100,000	50,000
4	500,000	200,000	100,000	50,000	20,000
8	200,000	100,000	50,000	20,000	20,000
16	100,000	50,000	20,000	20,000	10,000
32	50,000	20,000	20,000	10,000	5,000
64	20,000	20,000	10,000	5,000	2,000
128	20,000	10,000	5,000	2,000	1,000
256	10,000	5,000	2,000	1,000	500
512	5,000	2,000	1,000	500	200
1024	2,000	1,000	500	200	-

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Appx. 2.5 Scaling Method for Strain Gauges

This section describes how to determine the scaling conversion ratio when performing measurement with strain gauges and the 8969 and U8969 Strain Unit.

The appropriate conversion formula into stress varies depending on how the strain gauges are used. There are three methods: the one-gauge, two-gauge, and four-gauge methods. The two-gauge method is used for temperature compensation.

E: Young's modulus, ν: Poisson's ratio, ε: Distortion measurement value

Measuring tensile and compressive stress: Stress (σ) = E × ε
When performing temperature compensation with two or four gauges, position the gauges perpendicularly with each other.
Stress (σ) is calculated according to 1 / (1 + ν) for two gauges, and according to 1 / {2 (1 + ν)} for four gauges.

Measuring bending stress: Stress (σ) = E × ε
When performing temperature compensation with two or four gauges, stress (σ) is calculated as a multiple of 1/2 or 1/4, respectively.

Measuring torsional stress: Stress (σ) = E / {2 (1 + ν)} × ε (with two gauges)
When using four gauges, the values are halved.

Refer to the strain gauge instruction manual for combinations of strain gauges for each measurement.

Example: Measuring compressive stress
Using the one-gauge method; material of measured object: aluminum; Young's modulus: 73 (GPa) (refer to the table below)
$\sigma = 73 \times 10^{9} \times$ (Measured Value) $\times 10^{-6}$ [unit: $\mu\varepsilon$]

= 73 × (Measured value) [unit: kPa]
= 7.44* × (Measured value) [unit: gf/mm^2]
* 1 Pa = 1.01971621 × 10^{-7} kgf/mm^2 = 1 N/m^2

Conversion ratio: 7.44; Unit: gf/mm^2
Enter this value as the scaling conversion ratio.

Mechanical properties of industrial materials

Material	Module of longitudinal elasticity (Young's module)	Poisson's ratio
	E (GPa)	ν
Carbon steel (0.1 to 0.25% C)	205	0.28 to 0.3
Carbon steel (> 0.25% C)	206	0.28 to 0.3
Spring steel (Quenched)	206 to 211	0.28 to 0.3
Nickel steel	205	0.28 to 0.3
Cast iron	98	0.2 to 0.29
Brass (Cast)	78	0.34
Phosphor bronze	118	0.38
Aluminum	73	0.34
Concrete	20 to 29	0.1

Refer to "8.5 Converting Input Values (Scaling Function)" (p. 171).

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Appx. 3 About Options

Appx. 3.1 Options

The following options are available for the instrument. Contact your authorized Hioki distributor or reseller when ordering. The options are subject to change. Visit our website for updated information.
For details of cables and clamp sensors for connecting to the modules and the instrument, refer to the manuals supplied with them.
The products marked "factory option" are not user-installable. To order these products additionally, contact your authorized Hioki distributor or reseller.

Module (for generation)

These modules can be installed along with a measurement module.

Application	Model	Number of channels	Maximum output frequency	Output voltage
User-defined waveform generation	Model U8793 Arbitrary Waveform Generator Unit	2	100 kHz	−10 V to 15 V
Sine wave and DC generation	Model MR8790 Waveform Generator Unit	4	20 kHz	±10 V
Pulse generation	MR8791 Pulse Generator Unit	8	100 kHz	0 to 5 V

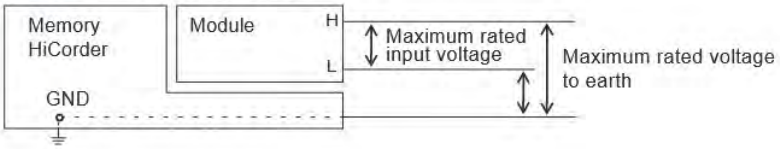
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Modules (Measurement amplifiers)

The modules listed below can be inserted into the right side of the instrument. You can install these modules freely.

Application	Model	Number of channels	Maximum sampling rate	A/D Resolution	Maximum input voltage	Maximum rated voltage to earth
Voltage measurement	Model 8966 Analog Unit	2	20 MS/s	12 bits	400 V DC	300 V AC, DC (CAT II)
	Model 8968 High Resolution Unit	2	1 MS/s	16 bits	400 V DC	300 V AC, DC (CAT II)
	Model MR8990 Digital Voltmeter Unit	2	500 S/s	24 bits	500 V DC	300 V AC, DC (CAT II)
	Model U8975 4CH Analog Unit	4	5 MS/s	16 bit	200 V DC	300 V AC, DC (CAT II)
	Model U8978 4CH Analog Unit	4	5 MS/s	16 bit	40 V DC (Direct input) 400 V DC (with Model 9665 10:1 Probe used)	30 V AC, 60 V DC (Direct input) 300 V AC, DC (CAT II) (with Model 9665 10:1 Probe used)
RMS voltage measurement	Model 8972 DC/RMS Unit	2	1 MS/s	12 bits	400 V DC	300 V AC, DC (CAT II)
	Model U8974 High Voltage Unit	2	1 MS/s	16 bits	1000 V DC 700 V AC	1000 V AC, DC (CAT III) 600 V AC, DC (CAT IV)
Temperature (Thermocouple) measurement	Model 8967 Temp Unit	2	–	16 bits	–	300 V AC, DC (CAT II)
Frequency, count, pulse duty, and pulse width measurements	Model 8970 Freq Unit	2	–	16 bits	400 V DC	300 V AC, DC (CAT II)
Current measurement	Model 8971 Current Unit	2	1 MS/s	12 bits	–	Not insulated.
	Model U8977 3CH Current Unit	3	5 MS/s	16 bit	–	Not insulated.
Strain (Strain-gauge type converter) measurement	Model 8969 Strain Unit	2	200 kS/s	16 bits	–	33 V rms AC or 70 V DC
	Model U8969 Strain Unit					30 V rms AC or 60 V DC
Digital signals and contact signal measurement	Model 8973 Logic Unit	16	20 MS/s	–	–	Not insulated.
Acceleration measurement (sensor with built-in pre-amplifier, charge-output sensor)	Model U8979 Charge Unit	2	200 kS/s	16 bits	40 V DC	30 V AC, 60 V DC

Refer to “18.6 Specifications of Modules” (p. 395).



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Measurement probes, cords, and clamp sensors

Application	Model	Description	Maximum input voltage	Maximum rated voltage to earth
Voltage measurement	Model L9197 Connection Cable	For high voltage	600 V AC, DC	600 V AC, DC (CAT III) 300 V AC, DC (CAT IV)
	Model L9198 Connection Cable	For low voltage	300 V AC, DC	600V AC,DC (CAT II) 300 V AC,DC (CAT III)
	Model L9790 Connection Cable		600 V AC, DC	With Model L9790-01 Alligator Clip or Model 9790-03 Contact Pin attached: 600 V AC, DC (CAT II) 300 V AC, DC (CAT III) With Model 9790-02 Grabber Clip attached: 300 V AC, DC (CAT II) 150 V AC, DC (CAT III)
	Model L9217 Connection Cable	Isolated BNC-Isolated BNC	300 V AC, DC	600V AC,DC (CAT II) 300 V AC,DC (CAT III)
	Model 9322 Differential Probe	For high voltage • Model 9418-15 AC Adapter is required when connecting to the module for voltage measurement.	2000 V DC, 1000 V AC	With grabber clips attached: 1000 V AC, DC (CAT II) With alligator clips attached: 1000 V AC, DC (CAT II) 600 V AC, DC (CAT III)
	Model P9000-01 Differential Probe Model P9000-02 Differential Probe	The Model Z1008 AC Adapter or a commercially available USB cable is required.	1000 V AC, DC	1000 V AC, DC (CAT III)
	Model 9665 10:1 Probe	Maximum rated voltage above ground is that of the module.	1 kV rms (up to 500 kHz)	–
	Model 9666 100:1 Probe	Maximum rated voltage above ground is that of the module.	5 kV peak (up to 1 MHz)	–
	Model 9166 Connection Cord	For inputting voltage to Model U8979	30 V AC, 60 V DC	–
	Model L4940 Connection Cord	For Model U8974 High Voltage Unit	1000 V DC	With Model L4935 Alligator Clip Set or Model L4932 Test Pin Set attached: 600 V AC, DC (CAT IV) 1000 V AC, DC (CAT III, CAT II)
				With Model L9243 Grabber Clip attached 1000 V AC (CAT II)
				With Model L4936 Bus Bar Clip Set attached: 600 V AC, DC (CAT III)
				With Model L4937 Magnetic Adapter Set attached: 1000 V AC, DC (CAT III)
				With Model L4934 Small Alligator Clip Set attached: 300 V AC, DC (CAT III) 600 V AC, DC (CAT II)

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Application	Model	Description	Maximum input voltage	Maximum rated voltage to earth
Logic signal input	Model 9320-01 Logic Probe	Four channels, for detecting voltage and closed/open contact points	–	–
	Model MR9321-01 Logic Probe	Four isolated channels, for detecting voltage and closed/open contact points (small-terminal types, for lines)	High range 250 V rms Low range 150 V rms	250 V rms (CAT II)
	Model 9327 Logic Probe	Four channels, for detecting voltage and closed/open contact points (high-speed type)	–	–
AC/DC current Model CT955X or 9318 is required for connection.	Model 9709 AC/DC Current Sensor	500 A, DC to 100 kHz	–	–
	Model CT6841 AC/DC Current Probe	20 A, DC to 1 MHz	–	–
	Model CT6843 AC/DC Current Probe	200 A, DC to 500 kHz	–	–
	Model CT6844 AC/DC Current Probe	500 A, DC to 200 kHz	–	–
	Model CT6845 AC/DC Current Probe	500 A, DC to 100 kHz	–	–
	Model CT6846 AC/DC Current Probe	1000 A, DC to 20 kHz	–	–
	Model CT6862 AC/DC Current Sensor	50 A, DC to 1 MHz	–	–
	Model CT6863 AC/DC Current Sensor	200 A, DC to 500 kHz	–	–
	Model CT6865 AC/DC Current Sensor	1000 A, DC to 20 kHz	–	–
AC/DC current	Model CT6875 AC/DC Current Sensor	500 A, DC to 2 MHz	–	–
	Model CT6876 AC/DC Current Sensor	1000 A, DC to 1.5 MHz	–	–
	Model CT6877 AC/DC Current Sensor	2000 A, DC to 1 MHz	–	–
	Model CT6830 AC/DC Current Probe	2 A, DC to 100 kHz	–	–
	Model CT6831 AC/DC Current Probe	20 A, DC to 500 kHz	–	–

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Application	Model	Description	Maximum input voltage	Maximum rated voltage to earth
AC/DC current Model CT9920 is required for connection	Model CT7631 AC/DC Current Sensor	100 A, DC to 10 kHz	–	–
	Model CT7636 AC/DC Current Sensor	600 A, DC to 10 kHz	–	–
	Model CT7642 AC/DC Current Sensor	2000 A, DC to 10 kHz	–	–
	Model CT7731 AC/DC Auto-Zero Current Sensor	100 A, DC to 5 kHz	–	–
	Model CT7736 AC/DC Auto-Zero Current Sensor	600 A, DC to 5 kHz	–	–
	Model CT7742 AC/DC Auto-Zero Current Sensor	2000 A, DC to 5 kHz	–	–
AC current Model CT955X or 9318 is required for connection.	Model 9272-10 Clamp On Sensor	20 A/200 A, 1 Hz to 100 kHz	–	–
AC current	Model 9018-50 Clamp On Probe	10 A to 500 A, 40 Hz to 3 kHz	–	–
	Model 9132-50 Clamp On Probe	20 A to 1000 A, 40 Hz to 1 kHz	–	–
Leakage current	Model 9657-10 Clamp On Leak Sensor	10 A AC (Leakage current, 50 Hz/60 Hz)	–	–
Voltrage generation	Model L9795-01 Connection Cable	Alligator clip	±30 V	30 V rms AC, 42.4 V peak AC or 60 VDC
	Model L9795-02 Connection Cable	BNC output		
Others For voltage-measuring modules	Model CT9555, CT9556, and CT9557 Sensor Unit	For Model 9272-05, 9709-05, CT6841-05, CT6843-05, CT6844-05, CT6845-05, CT6846-05, CT6862-05, CT6863-05	–	–
For connecting to the Model 8971 Current Unit	Model 9318 Conversion Cable	For Model 9272-10, 9709, CT6841, CT6843, CT6844, CT6845, CT6846, CT6862, CT6863, CT6865	–	–
	Model 9318 + CT9901 Conversion Cable	For Model 9272-05, 9709-05, CT6862-05, CT6863-05, CT6865-05, CT6841-05, CT6843-05, CT6844-05, CT6845-05, CT6846-05, CT6875, CT6876, CT6841A, CT6843A, CT6844A, CT6845A, CT6846A, CT6872, CT6872-01, CT6873, CT6873-01, CT6875A, CT6875A-1, CT6876A, CT6876A-1	–	–

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Application	Model	Description	Maximum input voltage	Maximum rated voltage to earth
For connecting to the Model U8977 3CH Current Unit	Model CT9900 Conversion Cable	For Model 9272-10, 9709, CT6841, CT6843, CT6844, CT6845, CT6846, CT6862, CT6863, CT6865	–	–
	Model CT9920 Conversion Cable	For Model CT7631,CT7731, CT7636, CT7736, CT7642, CT7742, CT7044, CT7045, CT7046	–	–

For more information on the output rate of a clamp sensor, see the indication on each clamp sensor or the instruction manual.

Printer

Recording paper	Model 9231 Recording Paper	A4-size width × 30 m, one set of 6 rolls

Storage media

SSD Unit	Model U8331 SSD Unit	Built-in SSD drive (specify when ordering)
USB flash drive	Model Z4006 USB Drive	16 GB
CF cards	Model 9728 PC Card 512M	512 MB, with adapter
	Model 9729 PC Card 1G	1 GB, with adapter
	Model 9830 PC Card 2G	2 GB, with adapter

Software

Application software	Model 9333 LAN Communicator
	Model 9335 Wave Processor

Other

Power supply	Model 9784 DC Power Unit	Device to supply DC power to the instrument (factory option)
Case	Model 9783 Carrying Case	Equipped with casters

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Appx. 3.2 Model 9783 Carrying Case

The product warranty period of Model 9783 Carrying Case is one (1) year.

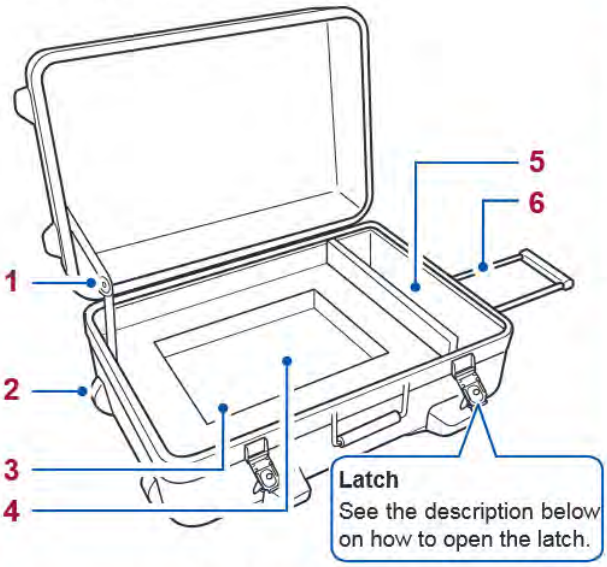
⚠WARNING

- The case may fall and cause injury or get damaged. Take care of the following to avoid any injury or damage.
  - Do not stand or sit on the case.
  - Do not use the casters on any unstable or uneven platform, or on soft grounds.
- Take care while mounting/removing casters to prevent any injury.

⚠CAUTION

- The case may get damaged. Take care of the following to avoid any damage.
  - Do not exceed the load capacity of the case (maximum 15 kg).
  - Do not open or close the case in vertical position.
- Do not place the case near fire or in places exceeding a temperature of 100°C because the case uses a flammable material. Doing so may cause a fire.

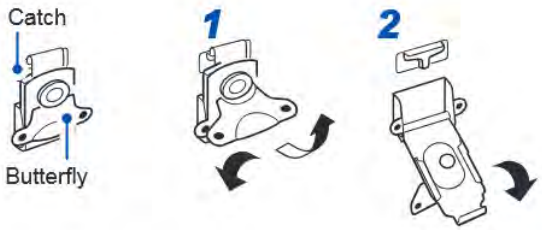
Part names



1	Hinge stopper
2	Caster
3	Room for the MR8847A
4	Room for instruction manual
5	Room for recording paper, accessories and options
6	Pull-out handle How to pull out the handle Pull out the handle while pressing the button on the handle.

How to open the latch

1. Pull up the butterfly and rotate it counterclockwise.
   (half turn)
2. Once the catch is open, pull the latch.



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Appx. 3.3 Model 9784 DC Power Unit

The instrument can be operated on a DC power supply such as batteries.
If both of an AC power supply and Model 9784 DC Power Unit are connected to the instrument, the AC power supply supplies the power preferentially. Note that when the instrument is operated on AC power supply and Model 9784 is turned on, Model 9784 will be in standby state but consume electricity.
Turn off Model 9784 when not in use.
The input voltage of Model 9784 ranges between 10 V and 28 V DC.

⚠WARNING

Before making connections, make sure Model 9784 DC Power Unit is turned off. The instrument could be damaged by a spark if it is connected to a voltage source while its power supply is on.

⚠CAUTION

Check polarity (positive/negative) and firmly connect Model 9784 to a DC power supply. Model 9784 may break down if the polarity is reversed.

Specifications of Model 9784 DC Power Unit

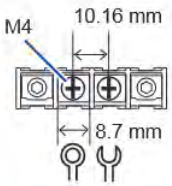
The accuracy is provided at 23°C±5°C (73.4F±9F), 20% to 80% RH, 30 minutes after power on.

Rated input voltage	12 V DC
Input voltage range	10 V to 28 V DC
Maximum rated power	200 VA
Operating temperature and humidity	As per Memory HiCorder in which Model 9784 is installed
Storage temperature and humidity	As per Memory HiCorder in which Model 9784 is installed
Operating environment	As per Memory HiCorder in which Model 9784 is installed
Dielectric strength	700 V DC for 1 minute (between input and output as well as input and enclosure)
Insulation voltage	100 MΩ or more/500 V DC (between input and output as well as between input and enclosure)
Dimensions	Approx. 290W × 220H × 32D mm (11.42"W × 8.66"H × 1.26"D)
Mass	Approx. 1.2 kg (42.3 oz.)

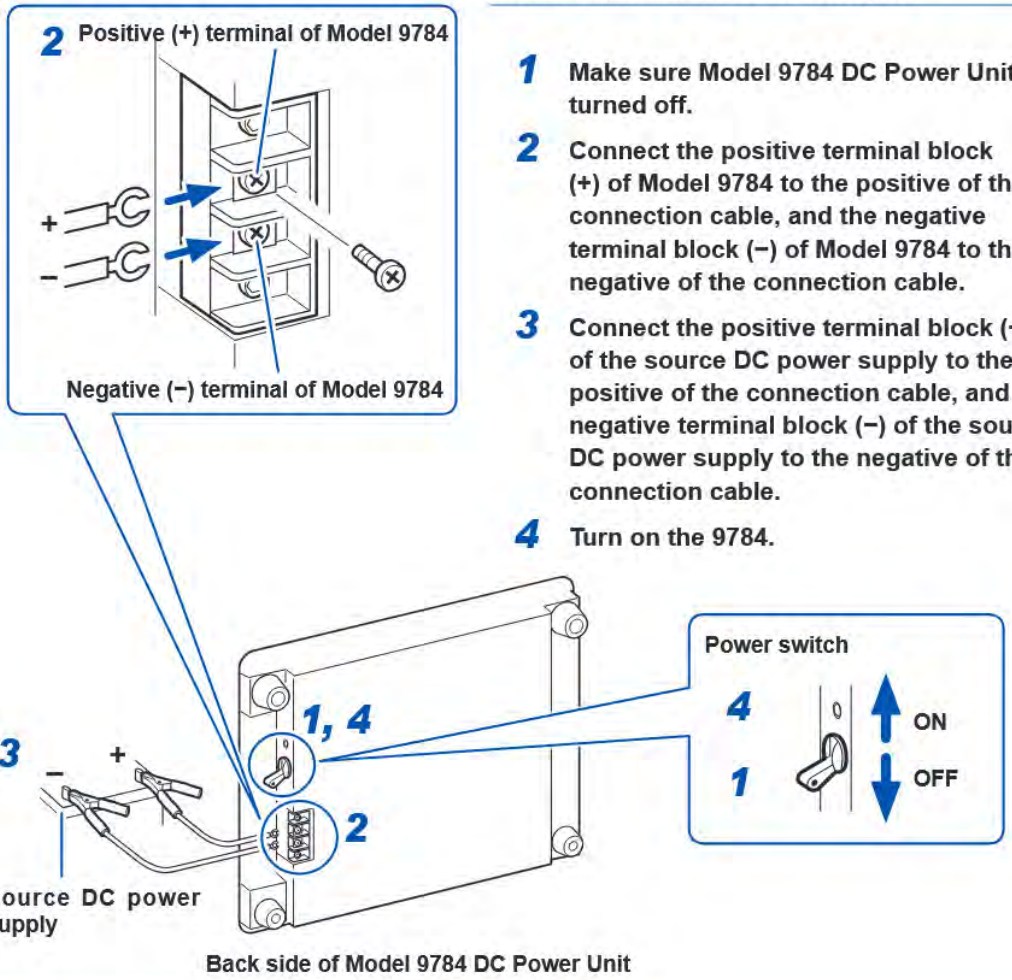
- **When using a DC power supply, the specifications of the printer will change as follows:**
  1. **The paper feeding speed decreases to 1 cm/s at the fastest: thus, real time prints for consecutive recording length will be enabled for ranges 1 s/div or later.**
  2. **[Print Speed] setting will be disabled.**
- **The input voltage should not fall below 10 V DC when using the printer. It may prevent the printing to work properly.**

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Connecting procedure



Required items:
A connection cable to connect the source DC power supply and Model 9784 DC Power Unit with each other.
Recommended rated value of the cable:
Permissible electric current of 25 A or more
Cable termination: Compatible with connection terminal block shown in the left figure.



Back side of Model 9784 DC Power Unit

1. **Make sure Model 9784 DC Power Unit is turned off.**
2. **Connect the positive terminal block (+) of Model 9784 to the positive of the connection cable, and the negative terminal block (–) of Model 9784 to the negative of the connection cable.**
3. **Connect the positive terminal block (+) of the source DC power supply to the positive of the connection cable, and the negative terminal block (–) of the source DC power supply to the negative of the connection cable.**
4. **Turn on the 9784.**

- **This device cannot charge any external battery.**
- **Take care against battery over-discharge when using a battery to run the instrument.**
- **If the device detects over-current or over-voltage, it blocks off the output. In such cases, turn off Model 9784 and after approximately one minute, turn it on again.**

Instrument operating time when a battery is used

(Reference values at room temperature)
Battery to be used: 12 V 38 Ah, fully charged

	Model 8966, fully charged
When the printer is not in use (Trigger standby, etc.)	Approx. 9 hours
When the printer is in use (Recorder function, 1 s/div solid printing)	Approx. 5 hours

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The values indicated above may vary depending on the number of times the battery is used, charging state, or ambient temperature.
If the instrument is running on AC power supply and the DC power unit is kept on standby (switch is in the on position), the instrument will consume the battery of the unit. In this case, the operating duration of the battery is approximately 5000 hours.

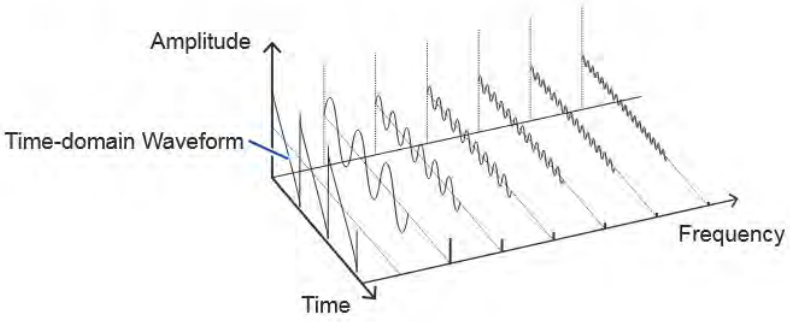
Appx. 4 FFT Definitions

■ What Is FFT?

FFT is the abbreviation for Fast Fourier Transform, an efficient method to calculate the DFT (Discrete Fourier Transform) from a time-domain waveform. The reverse process of transforming frequency data obtained by the FFT back into its original time-domain waveform is called the IFFT (Inverse FFT). The FFT functions perform various types of analysis using FFT and IFFT.

■ Time and frequency domain considerations

All signals are input to the instrument as a function of the time domain. This function can be considered as a combination of sine waves at various frequencies, such as in the following diagram. The characteristics of a signal that may be difficult to analyze when viewed only as a waveform in the time domain can be easier to understand by transforming it into a spectrum (the frequency domain).



■ Discrete fourier transforms and inverse FFT

For a discrete signal $x(n)$, the DFT is $X(k)$ and the number of Analysis points is N, which are related as follows:

$$X(k) = DFT\{x(n)\} = \sum_{n=0}^{N-1} x(n) W_N^{kn} \quad \text{..... (1)}$$

$$x(n) = IDFT\{X(k)\} = \frac{1}{N} \sum_{k=0}^{N-1} X(k) W_N^{-kn} \quad \text{..... (2)}$$

$$W_N = \exp\left(-j\frac{2\pi}{N}\right) \text{..... (3)}$$

$X(k)$ is typically a complex number, so expression (1) can be transformed again and written as follows:

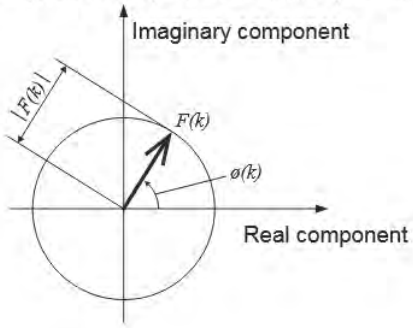
$$F(k) = |F(k)|\exp\{j\phi(k)\} = |F(k)|\angle\phi(k) \text{..... (4)}$$

$$\phi(k) = \tan^{-1}\frac{\mathrm{Im}\{X(k)\}}{\mathrm{Re}\{X(k)\}} \quad \text{..... (5)}$$

$|F(k)|$: Amplitude spectrum, $\phi(k)$: Phase spectrum

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Representing the above relationship on a complex flat surface produces the following figure.



■ Linear time-invariant systems

Consider a linear time-invariant (LTI) system $y(n)$ that is a response to discrete time-domain signal $x(n)$.

In such an **LTI system**, the following expression applies to any integer Ai when the response to $xi(n)$ is $y_i(n) = L[x_i(n)]$.

$$L[A_1x_1(n) + A_2x_2(n)] = A_1y_1(n) + A_2y_2(n) \quad \text{(6)}$$

If the system function of an LTI system is $h(n)$, the input/output relationship can be obtained by the next expression.

$$y(n) = \sum_{m=0}^{\infty} h(m)x(n-m) = \sum_{m=-\infty}^{\infty} h(n-m)x(m) \quad \text{(7)}$$

Therefore, when a unit impulse $\delta(n)$ (which is 1 when n = 0, and 0 when n ≠ 0) is applied to $x(n)$, the input/output relationship is:

$$y(n) = h(n) \quad \text{(8)}$$

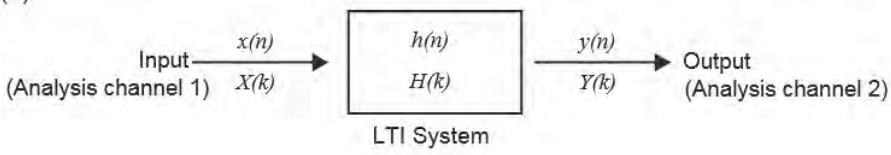
This means that when the input signal is given as a unit impulse, the output is the LTI system characteristic itself. The response waveform of a system to a unit impulse is called the **impulse response**.

On the other hand, when the discrete Fourier transforms of $x(n)$, $y(n)$, and $h(n)$ are $X(k)$, $Y(k)$, and $H(k)$, respectively, expression (7) gives the following:

$$Y(k) = X(k)H(k) \quad \text{(9)}$$

H(k) is also called the transfer function, calculated from $X(k)$ and $Y(k)$. Also, the inverse discrete Fourier transform function of $H(k)$ is the unit impulse response $h(n)$ of the LTI system.

The impulse response and transfer function of this instrument are calculated using the relationships of expression (9).



Appx.

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■ Number of analysis points

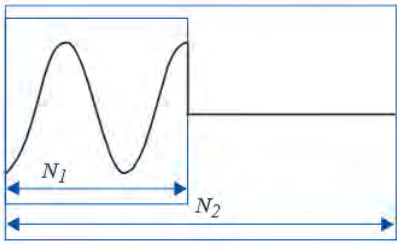
The FFT functions of this instrument can perform frequency analysis of time-domain waveforms consisting of 1000, 2000, 5000, or 10,000 points. However, when the following conditions are satisfied, previously analyzed data can be reanalyzed with a different number of analysis points.

A. When measurements are made with the averaging function disabled (Off)
B. When measurements are made with the averaging function enabled for time-domain averaging (simple or exponential).

When the number of analysis points at measurement time is N_1 and the number of analysis points is changed to N_2 after measurement, the instrument performs as follows.

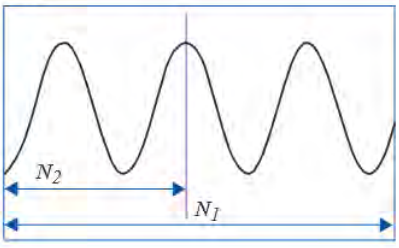
(1) When $N_1 < N_2$

- Because not enough data has been collected, zero is inserted for time after the end of the measured waveform.
- The window function applies only to the N_1 segment.
- Frequency resolution is increased. For example, if N_1= 1000 and N_2 = 2000, frequency resolution is doubled.
- The average energy of the time-domain waveform is reduced, so the amplitude of the linear spectrum is also reduced.



(2) When $N_1 > N_2$

- The specified (N_2) segment is extracted from the head of the (N_1) data.
- The window function applies only to the N_2 segment.
- Frequency resolution is decreased. For example, if N_1 = 2000 and N_2 = 1000, frequency resolution is halved.
- The average energy of the time-domain waveform is unchanged, so the amplitude of the linear spectrum is not significantly affected.



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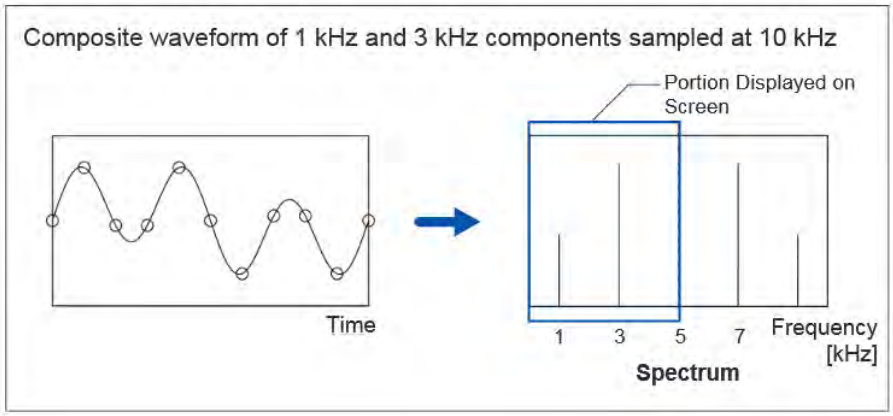
■ Aliasing

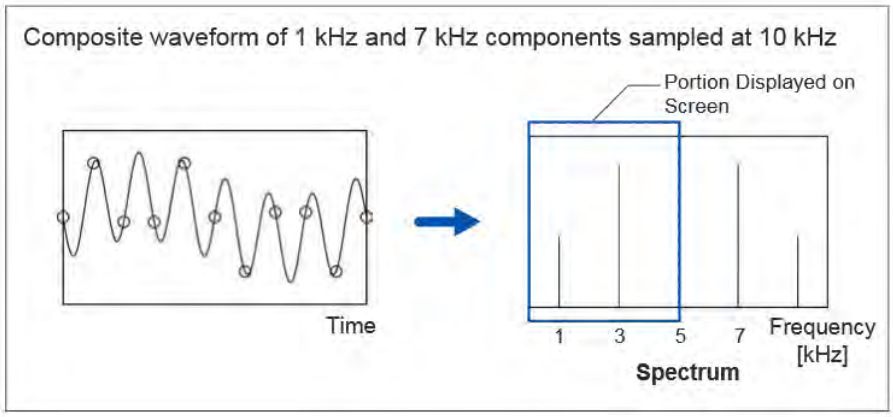
When the frequency of a signal to be measured is higher than the sampling rate, the observed frequency is lower than that of the actual signal, with certain frequency limitations. This phenomena occurs when sampling occurs at a lower frequency than that defined by the Nyquist-Shannon sampling theorem, and is called **aliasing**.
If the highest frequency component of the input signal is f_{max} and the sampling frequency is f_s, the following expression must be satisfied:

$$f_s = 2f_{max} \quad \text{(10)}$$

Therefore, if the input includes a frequency component higher than $f_s/2$, it is observed as a lower frequency (alias) that does not really exist.

The following diagrams show the results of spectrum analysis of composite waveforms having components of 1 kHz and 3 kHz, and of 1 kHz and 7 kHz.
If sampling frequency f_s is 10 kHz, the spectral component of an input frequency above 5 kHz (in this case, 7 kHz) is observed as an alias at 5 kHz or below.
In this example the difference between the 3 kHz and 7 kHz components is indiscernible.



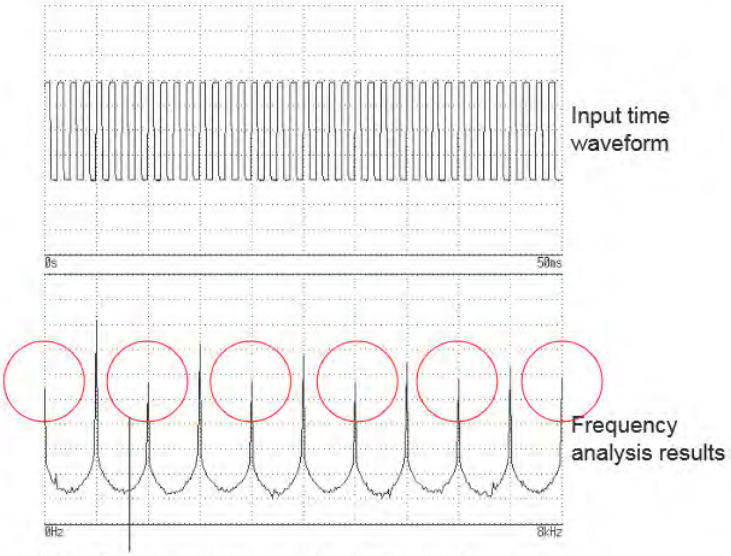


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■ Anti-aliasing filters

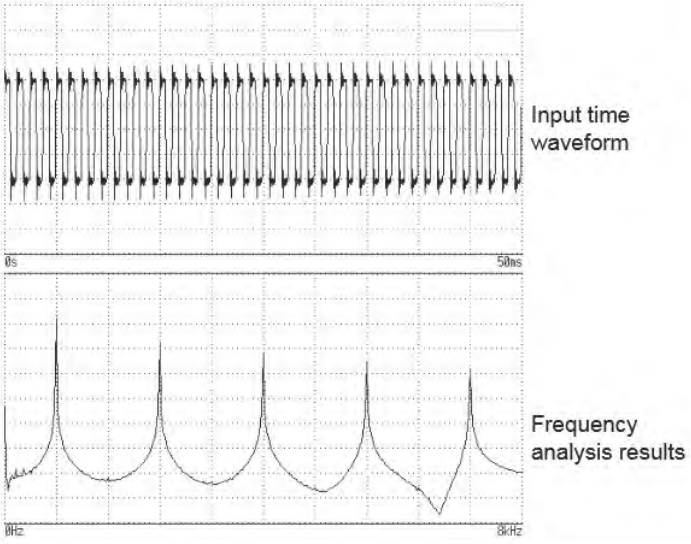
When the maximum frequency component of the input signal is higher than one-half of the sampling frequency, aliasing distortion occurs. To eliminate aliasing distortion, a low-pass filter can be used that cuts frequencies higher than one-half of the sampling frequency. Low-pass filters used this way are called **anti-aliasing filters**.
The following figures show the effect of application of an anti-aliasing filter on a square wave input waveform.

Without an anti-aliasing filter



Non-existent frequency components are observed.

With an anti-aliasing filter

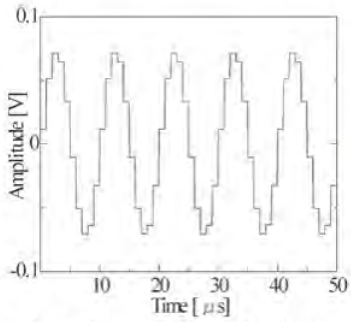


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■ Imaging

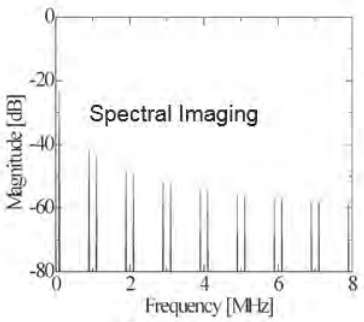
When the instrument is set to a measurement frequency range that requires a higher sampling rate than the maximum capability of the module, intermediate data points are interpolated between successive data samples. In this case, the time-domain waveform exhibits a stair-step shape. When FFT analysis is performed in this situation, non-existent high frequency spectral components appear. This phenomena is called zero-order hold characteristic **imaging**.

The following figures show the time-domain waveform and spectrum of a sine wave applied to the Model 8968 High Resolution Unit.



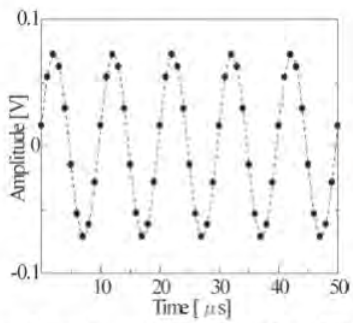
Time-domain waveform in the 8 MHz frequency range (sampling frequency = 20 MHz)

The highest sampling frequency of the Model 8968 is 1 MHz, so the same input data value is used for each block of 20 samples, resulting in a stair-step waveform.



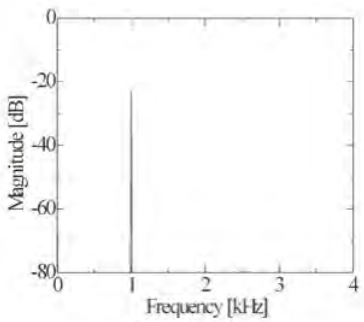
Spectrum

When FFT processing is performed on a stair-step waveform, the resulting spectrum shows non-existent components.
In this case, the spectral components above 1 MHz / 2 = 500 kHz are theoretically meaningless.



Time-domain waveform in the 400 kHz frequency range (sampling frequency = 1 MHz)

Here, the frequency range matches the sampling frequency of the Model 8968 so no interpolation is performed on the time-domain data.



Spectrum

To avoid imaging phenomena when analyzing waveforms with the FFT function, verify the maximum sampling frequency of the module before measuring.

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■ Averaging

With the FFT function, averaging is performed according to the following analytical expressions. Averaging in the time domain produces meaningless data if performed with inconsistent trigger criteria.

(1) Simple Averaging (Time and Frequency Domains)
Sequences of acquired data are summed and divided by the number of acquisitions.

$$A_n = \frac{(n-1)A_{n-1} + Z_n}{n} \quad \text{..... (11)}$$

n: count of measurements to average
An: averaging results of n counts
Zn: measurement data of n counts

(2) Exponential Averaging (Time and Frequency Domains)
Before averaging, newer data is given exponentially greater significance than older data.

$$A_n = \frac{(N-1)A_{n-1} + Z_n}{N} \quad \text{..... (12)}$$

N: specified number of counts to average
n: count of measurements to average
An: averaging results of n counts
Zn: measurement data of n counts

■ Overall value

The overall value is the sum of the power spectrum at each frequency. This value is nearly equal to the positive sum of the squares of the (RMS) input signals, except when frequency averaging is performed. The FFT function of the instrument calculates and displays the RMS values for stored waveforms and the overall value from the sum of the power spectrum for the frequency domain. Any FFT analysis modes other than the power spectrum, however, take the root square of the overall value to match the unit.

With the FFT analysis mode set to the power spectrum

$$(Over\ all) = \sum_{i=0} P_i \quad \text{..... (13-1)}$$

With the FFT analysis mode set to the histogram, linear spectrum, RMS spectrum, impulse response, 1/1 octave analysis, or 1/3 octave analysis

$$(Over\ all) = \sqrt{\sum_{i=0} P_i} \quad \text{..... (13-2)}$$

P_i: power spectrum of value i

■ Total harmonic distortion (THD)

Total harmonic distortion (THD) indicates the proportion of the higher harmonics to the fundamental harmonic.
This means that the larger the value, the more distorted the waveform.

$$\mathrm{THD} = \sqrt{\frac{\sum (V_n)^2}{(V_0)}} \times 100\ [\%] \quad \text{..... (14)}$$

V_0 = fundamental wave
V_n = *next* higher harmonic

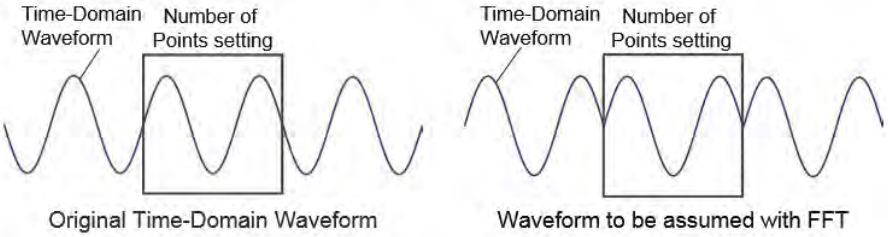
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■ Window function

The Fourier transform of a continuous system is defined by the integral calculus in expression (15) for the time range from minus infinity to plus infinity.

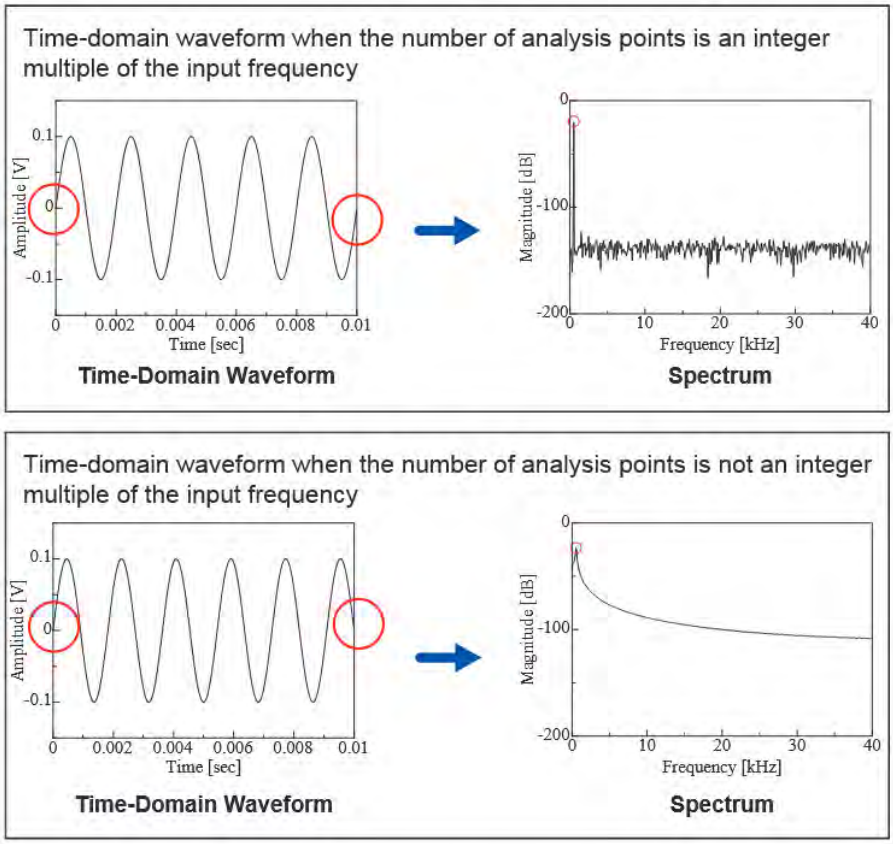
$$X(f) = \int_{-\infty}^{\infty} x(t)\,\varepsilon^{-2\pi f t} dt \quad \text{..... (15)}$$

However, because expression (15) cannot be calculated with actual measurements, the Analysis is performed on a segment between finite limits. Processing the waveform segment within these limits is called **window processing**. For FFT analysis, the waveform segment within these limits is assumed to repeat periodically (as shown below).



Original Time-Domain Waveform　　Waveform to be assumed with FFT

When the number of points for FFT analysis is an integer multiple of the input signal frequency, a single-line spectrum is obtained. However, if it is not an integer multiple of the frequency (When the waveform assumed with FFT includes discontinuous points), the spectrum is scattered, and a line spectrum cannot be obtained. This phenomenon is called leakage error (as shown below).

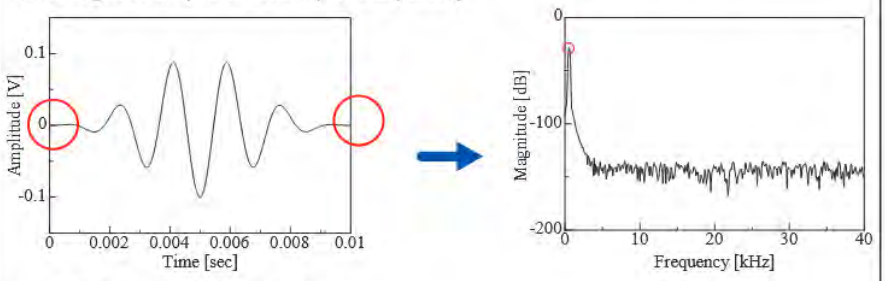


The window function was created to suppress such leakage errors. The window function smoothly connects each end of the time-domain waveform where it is cut off.

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The following figure presents an example of spectral analysis by applying a window function to a time-domain waveform.
Using the window function, discontinuous points on the time-domain waveform are eliminated, so the wave shape approaches a line spectrum.

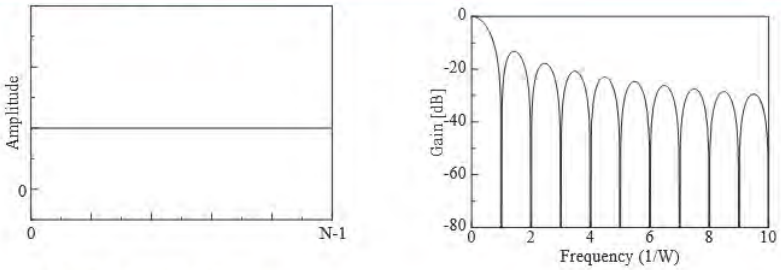
When a Blackman-Harris window function is applied to a time-domain waveform (p. Appx.31) in which the number of analysis points is not an integer multiple of the input frequency.



Time-Domain Waveform **Spectrum**

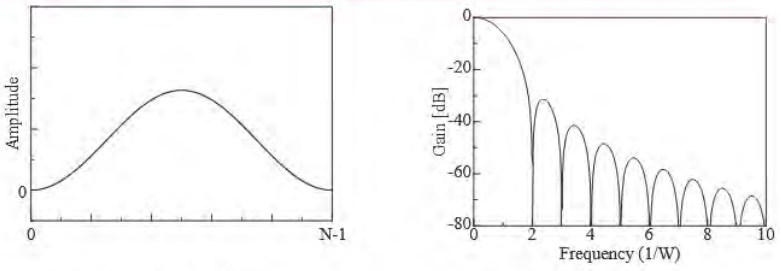
The following figure shows the time-domain waveform of the window function and its spectrum.
Each spectrum shows a large peak at a low frequency, and many smaller peaks at higher frequencies.
The largest peak is called the **main lobe**, and the smaller peaks are the **side lobes**.
The most accurate results of the FFT function are obtained when the width of the main lobe and the amplitude of the side lobes are minimized, although both conditions cannot be satisfied at the same time.
Therefore, a window function with a wide main lobe is used when amplitude values are important, while a window function with a small main lobe is used to observe fine spectral details, and a window function with small side lobe amplitudes is used to exclude the effects of the surrounding spectrum.
However, the main lobe width is proportional to the width (1/W) of the window so increasing the number of analysis points increases the frequency resolution.

Rectangular window



Time-Domain Waveform **Spectrum**

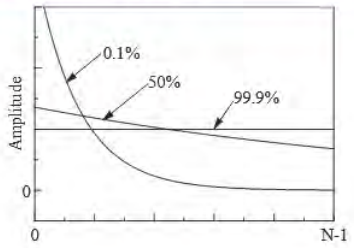
Hann window



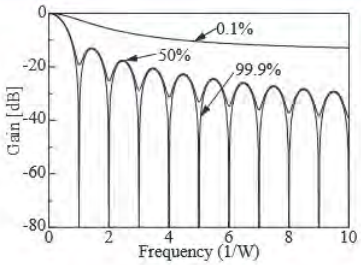
Time-Domain Waveform **Spectrum**

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Exponential window

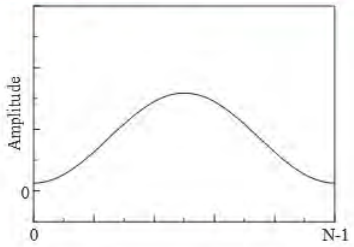


Time-Domain Waveform

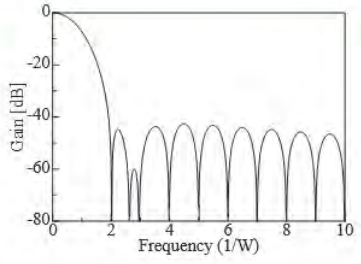


Spectrum

Hamming window

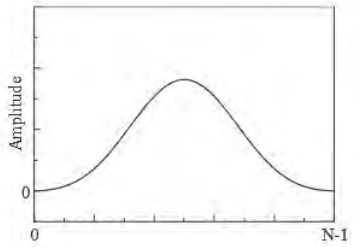


Time-Domain Waveform

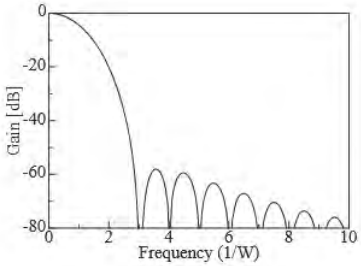


Spectrum

Blackman window

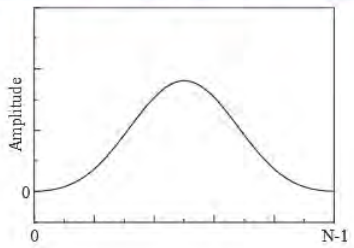


Time-Domain Waveform

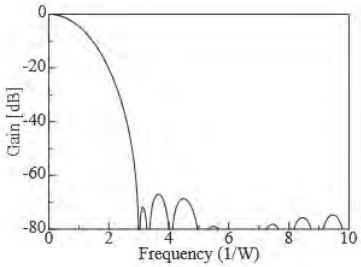


Spectrum

Blackman-Harris window

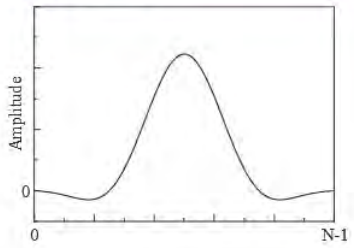


Time-Domain Waveform

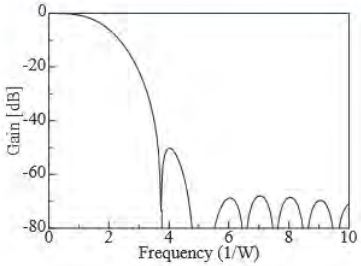


Spectrum

Flat top window



Time-Domain Waveform

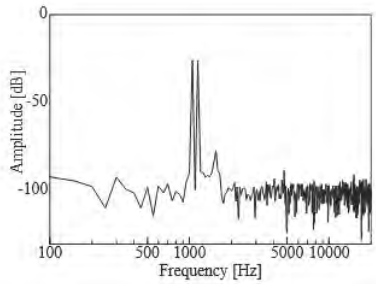


Spectrum

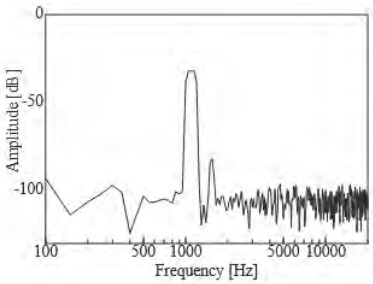
Appx.

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The following example shows input sine waves of 1050 Hz and 1150 Hz analyzed with different window functions. Because the frequencies in this example are close to one another, a rectangular window with a narrow main lobe is able to separate and display both frequencies, but a Hann window with a wide main lobe displays the two as a single spectral component.



Analysis Using a Rectangular Window



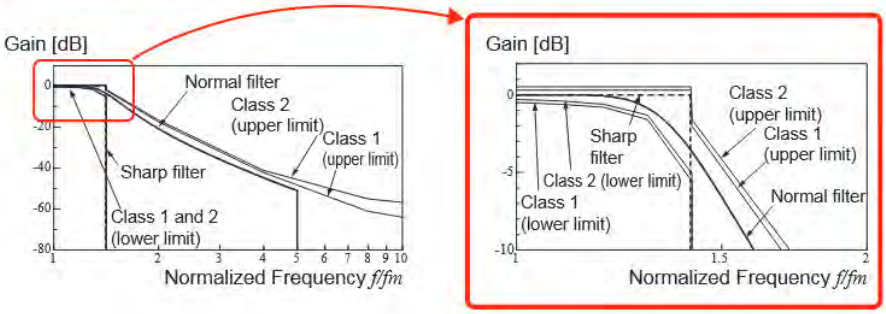
Analysis Using a Hann Window

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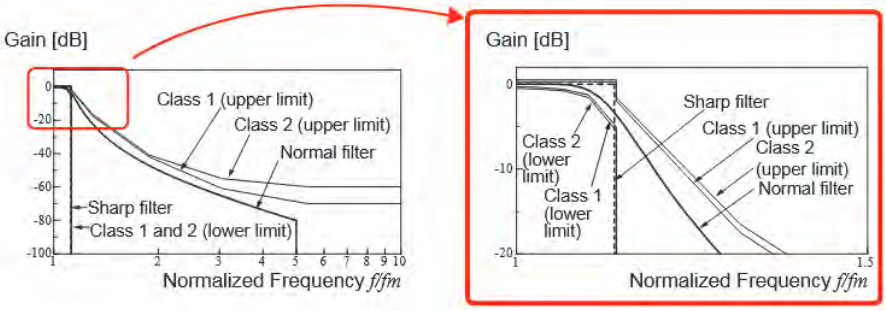
■ Octave filter characteristics

Octave filter characteristics are determined according to the IEC61260 standard.
The figures below show these standards and the filter characteristics of this instrument.

1/1 octave filter characteristic



1/3 octave filter characteristic

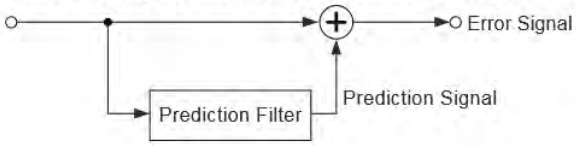


Appx.

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■ Linear predictive coding (LPC)

In the following figure, linear predictive coding is implemented by passing a sample of the input signal through the prediction filter while altering the filter so as to minimize errors in the original signal.



Given a time-discrete signal $\{x_t\}$ (t is an integer) where the input signal is sampled at interval ΔT, LPC analysis presumes the following relationship between current sample value x_t and the value of previous sample p.

$$x_t + a_1 x_{t-1} + a_2 x_{t-2} + \ldots + a_p x_{t-p} = \varepsilon_t \quad \ldots\ldots (16)$$

However, $\{\varepsilon_t\}$ is an uncorrelated random variable with average value 0 and the dispersion σ^2.
Expression (16) shows how current sample value x_t can be "linearly predicted" from previous sample values.
If the predicted value of x_t is actually $\hat{x}_t$, expression (16) can be transformed as follows.

$$x_t = \hat{x}_t + \varepsilon_t = \sum_{i=1}^{P} \alpha_1 x_{t-i} + \varepsilon_t \quad \ldots\ldots (17)$$

Here, αi is called the **linear predictor coefficient**.
For LPC analysis, this coefficient is calculated using the Levinson-Durbin algorithm, and a spectrum is obtained. In this instrument, the order of the coefficient can be set from 2 to 64. Larger orders reveal fine spectral components, while small orders reveal the overall spectrum shape.

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Warranty Certificate

HIOKI

Model	Serial number	Warranty period Three (3) years from date of purchase (___ / ___)

Customer name: _____

Customer address: _____

Important

- Please retain this warranty certificate. Duplicates cannot be reissued.
- Complete the certificate with the model number, serial number, and date of purchase, along with your name and address. The personal information you provide on this form will only be used to provide repair service and information about Hioki products and services.

This document certifies that the product has been inspected and verified to conform to Hioki's standards.
Please contact the place of purchase in the event of a malfunction and provide this document, in which case Hioki will repair or replace the product subject to the warranty terms described below.

Warranty terms

1. The product is guaranteed to operate properly during the warranty period (three [3] years from the date of purchase). If the date of purchase is unknown, the warranty period is defined as three (3) years from the date (month and year) of manufacture (as indicated by the first four digits of the serial number in YYMM format).
2. If the product came with an AC adapter, the adapter is warrantied for one (1) year from the date of purchase.
3. The accuracy of measured values and other data generated by the product is guaranteed as described in the product specifications.
4. In the event that the product or AC adapter malfunctions during its respective warranty period due to a defect of workmanship or materials, Hioki will repair or replace the product or AC adapter free of charge.
5. The following malfunctions and issues are not covered by the warranty and as such are not subject to free repair or replacement:
   -1. Malfunctions or damage of consumables, parts with a defined service life, etc.
   -2. Malfunctions or damage of connectors, cables, etc.
   -3. Malfunctions or damage caused by shipment, dropping, relocation, etc., after purchase of the product
   -4. Malfunctions or damage caused by inappropriate handling that violates information found in the instruction manual or on precautionary labeling on the product itself
   -5. Malfunctions or damage caused by a failure to perform maintenance or inspections as required by law or recommended in the instruction manual
   -6. Malfunctions or damage caused by fire, storms or flooding, earthquakes, lightning, power anomalies (involving voltage, frequency, etc.), war or unrest, contamination with radiation, or other acts of God
   -7. Damage that is limited to the product's appearance (cosmetic blemishes, deformation of enclosure shape, fading of color, etc.)
   -8. Other malfunctions or damage for which Hioki is not responsible
6. The warranty will be considered invalidated in the following circumstances, in which case Hioki will be unable to perform service such as repair or calibration:
   -1. If the product has been repaired or modified by a company, entity, or individual other than Hioki
   -2. If the product has been embedded in another piece of equipment for use in a special application (aerospace, nuclear power, medical use, vehicle control, etc.) without Hioki's having received prior notice
7. If you experience a loss caused by use of the product and Hioki determines that it is responsible for the underlying issue, Hioki will provide compensation in an amount not to exceed the purchase price, with the following exceptions:
   -1. Secondary damage arising from damage to a measured device or component that was caused by use of the product
   -2. Damage arising from measurement results provided by the product
   -3. Damage to a device other than the product that was sustained when connecting the device to the product (including via network connections)
8. Hioki reserves the right to decline to perform repair, calibration, or other service for products for which a certain amount of time has passed since their manufacture, products whose parts have been discontinued, and products that cannot be repaired due to unforeseen circumstances.

HIOKI E.E. CORPORATION

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HIOKI

All regional contact information

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