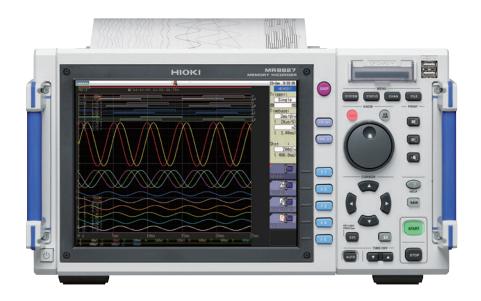


# MR8827

**Instruction Manual** 

# MEMORY HICORDER



■ Be sure to read this manual before using the instrument.
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When using the instrument for the first time

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Measurement Preparation ▶ p.27

**Troubleshooting** 

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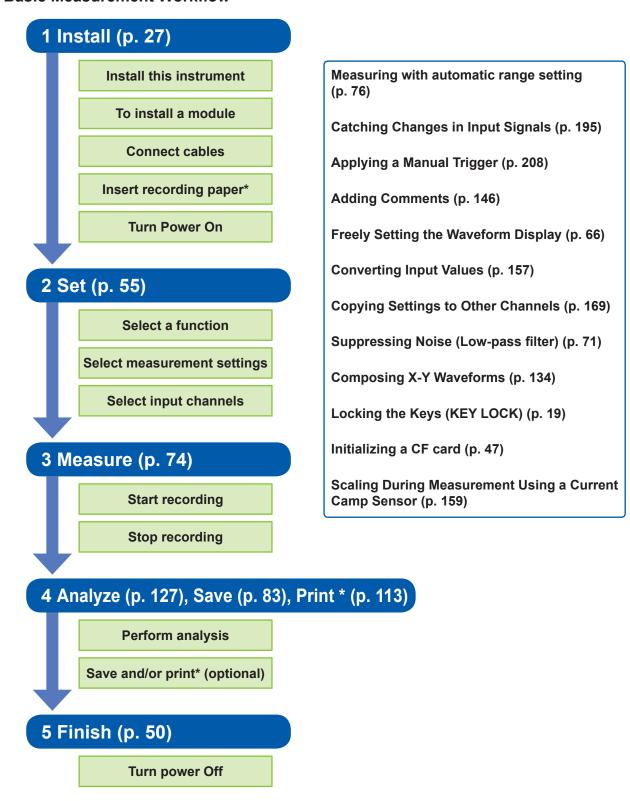
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# **Usage Index**

#### **Basic Measurement Workflow**



<sup>\*</sup> When Model U8350 Printer Unit is installed

# Introduction

Thank you for purchasing the HIOKI MR8827 Memory HiCorder. To obtain optimal performance from this instrument, please read this manual and keep it handy for future reference.

The optional clamps (p. A9) are called by a generic name of "clamp sensor."

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

Туре	Contents	Printed	CD-stored
Instruction Manual (This document)	Contains details and specifications regarding the functions and operations of this instrument.	<b>√</b>	-
Communication Command Instruction Manual	Contains a list of the communication commands and their explanations to control the instrument with a computer.	-	<b>✓</b>
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.	-	<b>~</b>

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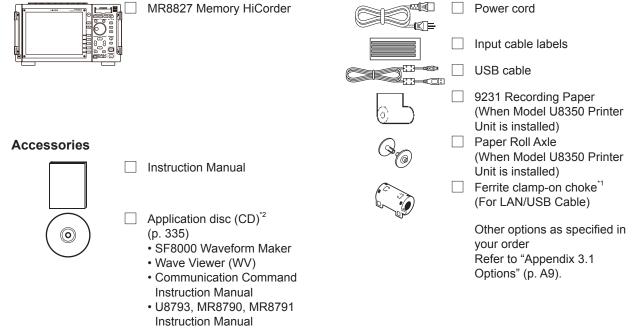
# **Package Contents**

When you receive your Memory HiCorder, inspect it carefully to ensure that no damage occurred during shipping. Please pay particular attention when checking the accessories, panel keys and switches, and connectors. If you find damage, or your HiCorder fails to operate according to specifications, contact your authorized Hioki distributor or reseller.

Keep the packing material used for the shipping of the instrument because you need to use it when transporting the instrument in the future.

#### **Unit and Accessories**

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



<sup>\*1:</sup> If one or more Model 8967 Temp Units are installed in the instrument, two ferrite clamp-on chokes (small) will be supplied per module.

<sup>\*2:</sup>The latest version can be downloaded from our website.

# **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 this instrument, read and understand the following safety notes.

# **ADANGER**



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.

# **MARNING**



Electricity presents risks of electric shock, heat generation, fire, and arc discharge due to short circuits. If anyone who is unfamiliar with electrical measuring instruments will use the instrument, a person familiar with such instruments must supervise operations.

## **Protective gear**

# **MARNING**



This instrument is measured on a live line. To prevent electric shock, use appropriate protective insulation and adhere to applicable laws and regulations.

#### **Notation**

In this manual, the seriousness of risks and 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 or malfunction of the instrument.
IMPORTANT	Indicates information related to the operation of the instrument or maintenance tasks with which the operators must be fully familiar.
A	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, be burned or even be fatally injured.
	Indicates prohibited actions.
0	Indicates actions which must be performed.
*	Additional information is presented below.

# **Symbols Affixed to the Instrument**

$\triangle$	Indicates cautions and hazards. When this symbol is printed on the instrument, refer to the corresponding topic in this Instruction Manual.
Ф	Indicates the ON or OFF side of the power switch.
<u></u>	Indicates a grounding terminal.
	Indicates DC (Direct Current).
$\sim$	Indicates AC (Alternating Current).
	Indicates a burn hazard if touched directly.

# **Standards Symbols**



This symbol indicates that the electrical and electronic appliance was put on the EU market after August 13, 2005, and producers of the Member States are required to display it on the appliance under Article 11.2 of Directive 2002/96/EC (WEEE).



This symbol 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 text)	Names of settings, buttons, and other screen elements are written in bold blue text.
	Unless otherwise specified, "Windows" refers to Windows 7, Windows 8, or Windows 10.
[ ]	Menus, commands, dialogs, buttons in a dialog, and other items on the screen and keys are enclosed in brackets.
MEM	Indicates Memory function support.
REC	Indicates Recorder function support.
X-Y	Indicates X-Y Recorder function support.
FFT	Indicates FFT Recorder function support.
	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.

# **Accuracy**

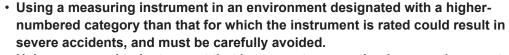
We define measurement tolerances in terms of f.s. (full scale), rdg. (reading) and setting values, with the following meanings:

f.s. (maximum display value or scale length)	The maximum displayable value or scale length. For this instrument, the maximum displayable value is the range (V/div) times the number of divisions (20) on the vertical axis. Example: When range is 1 V/div, f.s. = 20 V
rdg. (display 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**

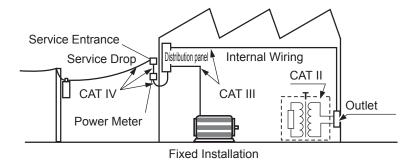
To ensure safe operation of measuring instruments, IEC 61010 establishes safety standards for various electrical environments, categorized as CAT II to CAT IV, called measurement categories.

# **DANGER**





- Using a measuring instrument that has no category rating in an environment designated with the CAT II to CAT IV category could result in severe accidents, and must be carefully avoided.
- CAT II: When directly measuring the electrical outlet receptacles of the primary electrical circuits in equipment connected to an AC electrical outlet by 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 by the module being used. Refer to "18.6 Module Specifications" (p. 368).

# **Operation Precautions**

#### **Before Use**

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

Ensure that your use of the product falls within the specifications not only of the instrument itself, but also of any accessories, options and other equipment being used.

# **MANGER**

If connection cables or instrument are damaged, there is a risk of electric shock. Before using the instrument, perform the following inspection.



- Before using the instrument, check that the insulation of the connection cables is not damaged and that no metal parts are exposed. Using the instrument under such conditions could result in electric shock. Replace the connection cable with those specified by our company.
- Verify that the instrument 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

# **MARNING**

To avoid accidents or damage to the instrument, do not install the instrument and modules in locations that are:

- Exposed to direct sunlight or high temperature
- 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

# **ACAUTION**

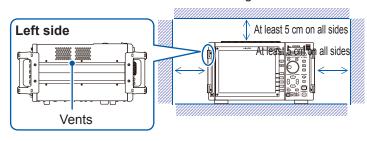


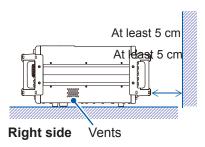
Do not place the instrument in a location that is unstable or inclined. Do not place the unit on another unit. Knocking-over or dropping the instrument can cause injury or damage to the instrument.

#### Installation

Be sure to keep the specified clearances around the instrument to prevent overheating.

- Do not install the instrument with any side except the bottom facing down.
- Do not obstruct vents.
- · Do not install the instrument at an angle.





#### **Handling the Instrument and Modules**

# **ADANGER**

• Do not exceed the range of the specifications and the rated value of the cable or the module.

Otherwise, the instrument may be damaged or may produce heat, resulting in personal injury.



The maximum rated voltage to earth does not change when an attenuator or similar is used at the input. Take the connection method into consideration and make sure that the rating is not exceeded.

 To avoid electric shock, ddo not remove the instrument's cover and the module case.

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.

# **MARNING**



- 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 electric shocks, confirm that the module is turned off and the connection cables are disconnected before removing or replacing a module.
- To avoid electric shocks, never operate the instrument with a module removed.
   To use the instrument after removing a module, install a blank panel over the opening of the removed module.



- To prevent instrument damage or electric shocks, use only the screws for securing the module in place that shipped with the instrument.
   If you lose any screw 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 (3.5 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.

# **ACAUTION**



- To avoid damaging modules, do not touch the module connectors on this instrument.
- 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 (3.5 mA, 22 V). Using a inapplicable sensor may cause damaging itself.
- To avoid damage to the instrument, protect it from physical shock during transport and handling. Be especially careful to avoid physical shock from dropping.
- The mounting screws must be firmly tightened or the module may not perform as specified or may fail.

- Before transporting the instrument, disconnect all cables and remove any CF cards, USB memory sticks, and recording paper.
- When there is no input, the waveform might be unstable due to the induced voltage, but this is not an error.
- 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.

#### **Handling the Printer and Recording Paper**

# **MARNING**



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

# **ACAUTION**



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 by the print head, which may result in paper jams or white streaks in the printing.

#### **Storing Data Recordings**

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

- To avoid discoloration, do not expose it to direct sunlight. Store below 40°C (104°F) and 90% RH.
- Store 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. Pressure sensitive tapes such as flexible PVC films and scotch tapes must be handled with care as they contain organic solvents.
- Also, the thermal recording paper is ruined by contact with wet Daizo copy paper.



Avoid exposure to direct sunlight.



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



Do not store thermal paper above 40°C and 90% RH.



Avoid contact with adhesive tapes like soft vinyl chloride and cellophane tape.



Avoid stacking with wet Diazo copy paper.

#### **Storing Recording Paper**

- Store thermal paper where its temperature will not exceed 40°C (104°F).
- The paper will deteriorate if exposed to light for a long time, so do not remove rolls from their wrappers until ready to use. Handling Media

#### **Handling Media**

# **ACAUTION**

- Do not remove the media while it is being accessed by the instrument (while the SAVE key is lit in blue). Data on the media could be lost.
- Do not turn off the power to the instrument while the media is being accessed by the instrument (while the **SAVE** key is lit in blue). Data on the media could be lost.



- Do not transport the instrument while a USB flash drive is connected. Damage could result.
- Exercise care when using such products because static electricity could damage the external media or cause a malfunction of the instrument.
- Do not subject the SSD to extreme shock or vibration. Doing so may damage the hard disk.

#### **IMPORTANT**

- No compensation is available for loss of data stored on the built-in drive (SSD) or removable
  media, regardless of the content or cause of damage or loss. Be sure to back up any important
  data stored on the built-in drive (SSD) or removable media.
- Use only CF Cards sold by Hioki. (No adapter will be required when the card is inserted into the instrument.)
- Compatibility and performance are not guaranteed for PC cards made by other manufacturers. You may be unable to read from or save data to such cards.
  - ■Hioki optional CF cards (The CF card includes an adapter.)
    Model 9728 PC Card 512M, Model 9729 PC Card 1G, Model 9830 PC Card 2G
- With some external media, the instrument may not start up if power is turned on while the external media is inserted. In such a case, turn power on first, and then insert the external media. Prior testing is recommended.
- Unusual USB flash drives, such as those that require fingerprint authentication or a password, cannot be used.
- When saving or loading data, insert the storage media before selecting it. If the media is not inserted, the file list display will not appear.
- All media (built-in drive, USB memory stick and CF card) have a limited service life. After
  extensive use over a long period, data retention and readout may become stop working. In
  such cases, you should procure new media.
- The built-in drive (SSD) is a consumable part. When the written data reaches the capacity (about 60 TB), no more data can be recorded. In such a case, the SSD should be replaced with a new one.
- When the instrument is turned off for a long time (more than one year), the data stored on the built-in drive (SSD) may be lost. Be sure to back up the data if the instrument is left turned off for a long time.
- Automatic saving of data is possible only on built-in drive (SSD), USB memory stick and CF card media.
- Data can also be saved to a USB flash drive in real time, but for data protection we recommend using Hioki's optional CF card instead.

#### **Before Connecting Cables**

# **ADANGER**

### When measuring power line voltage

- Connecting cables should only be connected to the secondary side of a breaker Even if there is a short circuit on the secondary side of the breaker, the breaker cuts off the electric supply. Do not connect to the primary side of a breaker because unrestricted current flow could damage the instrument and facilities if a short circuit occurs.
- To prevent electrical shocks and personal injury, do not touch any input terminals on the VT (PT), CT or the instrument when they are in operation.
- Do not permanently connect the instrument in an environment where voltage surges exceeding the maximum input voltage may occur. Failure to observe this precaution could result in damage to the instrument or personal injury.
- 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 short circuit or electric shock, do not touch the metal parts of the connecting cable clips.
- To avoid electrical shocks, be careful to avoid shorting live lines with the connection cables.

# **MARNING**

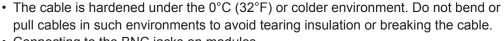


- To avoid electric shock and short-circuit accidents, use only the specified test leads to connect the instrument input terminals to the circuit to be tested.
- To avoid electric shock, do not exceed the lower of the ratings shown on the instrument and connection cords.



To prevent an electric shock accident, 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.

# **ACAUTION**





Connecting to the BNC jacks on modules
 Do not use a metal BNC connector. If you connect a metal BNC cable to an insulated BNC connector, the insulated BNC connector can be damaged 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. Using a non-specified cable may satisfy the specification requirements 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.

#### **Before Connecting a Logic Probe to the Measurement Object**

# **MDANGER**

To avoid electric shock and short circuit accidents or damage to the instrument, confirm the following:

The ground pin in the LOGIC connector (plug) of Models 9320-01 and 9327
 Logic Probes is not isolated from the instrument's ground (common ground).
 Use grounding-type polarized power cords for the measurement object and this instrument, and obtain power from the same mains circuit.
 Connecting to different mains circuits or using a non-grounding power cord may cause damage to the measurement object or this instrument because of current flow through the logic probes resulting from potential difference between the grounds of the different wiring systems.

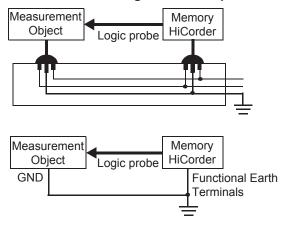
To avoid these problems, we recommend the following connection procedure:



Connect this instrument to the same outlet as the measurement object using the (supplied) grounding polarized power cord.

ground to the GND terminal (functional earth terminal) of this instrument. (Always obtain power from the same mains circuit.) See "2.5.2 Ground the Functional Earth of This Instrument" (page

Connect the measurement object's



## **Before Turning the Power Supply On**

49)

# **MARNING**



- To avoid electrical accidents and to maintain the safety specifications of this instrument, only connect the provided power cord 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.

# **ACAUTION**



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.



To avoid damaging the power cord, grasp the plug, not the cord, when unplugging it from the power outlet.

Turn off the power before connecting or disconnecting the power cord.

# **Before Connecting to an External Device**

# **ADANGER**

To avoid electrical hazards and damage to the instrument, do not apply voltage that exceeds the maximum input voltage to the external control terminals.



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

# **MARNING**

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



- Always turn off the power to the instrument and to any devices to be connected before making connections.
- Be careful to avoid exceeding the ratings of external control terminals and external connectors.
- Ensure that devices and systems to be connected to the external control terminals are properly isolated.

# **ACAUTION**



To avoid equipment failure, do not disconnect the USB cable while communication is in progress.

Use a common ground for both the instrument and the connection equipment.
 Use of different ground circuits will result in a potential difference between the instrument's ground and the connected equipment's ground. If the communications cable is connected while such a potential difference exists, it may result in equipment malfunction or failure.



- While connecting or disconnecting the communication cables, ensure that the power supply of the instrument and the device to be connected is cut off. This may cause damage or malfunctioning.
- 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**

- 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.
- 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 three or four test prints (printer check) before using a printer that has been in storage for a long period.

## **Precautions During Shipment**

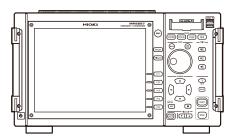
Keep the packing material that was used for shipping this instrument because you may need to use it when transporting the instrument in the future.

# **Overview**

# 1.1 Product Overview

The MR8827 Memory HiCorder is an instrument that allows simultaneous measurement of multiple signals. The MR8827 is easy to operate and allows quick and efficient measurement and analysis.

Its major uses are monitoring, facility diagnosis and various tests.



Isolated 32 analog channels

The unit is electrically isolated from the channels.

Measurement possible using up to 28 analog channels and 64 logic channels

All channels can be measured simultaneously.

Selectable module according to the measurement details

Modules can be selected from fourteen types.

High-speed sampling: 20 MS/s

Reliable response evaluation is possible.

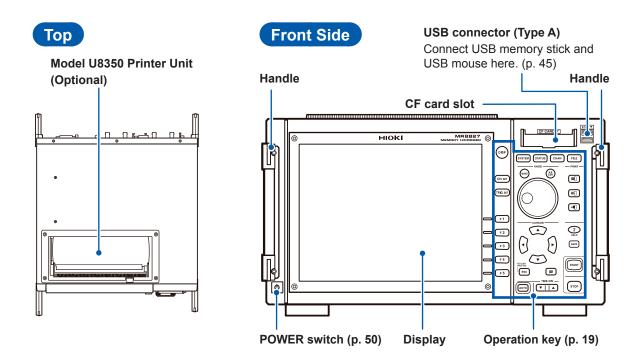
Easy loading of recording paper High-speed printing One-touch insertion allows quick and trouble-free operation.

Arbitrary Waveform Generator Unit can output the measured data

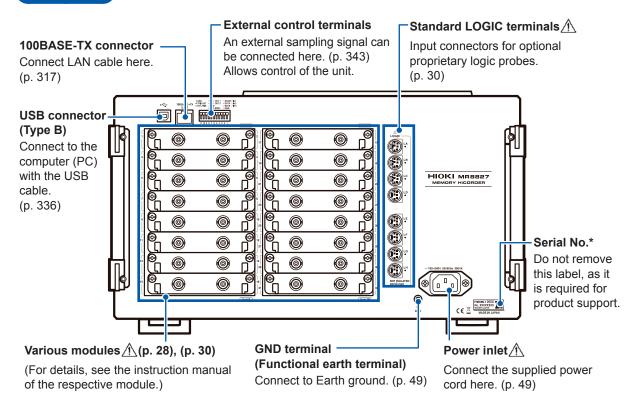
You can simulate actual waveforms.

(When Model U8350 Printer Unit is installed)

# 1.2 Part Names and Functions

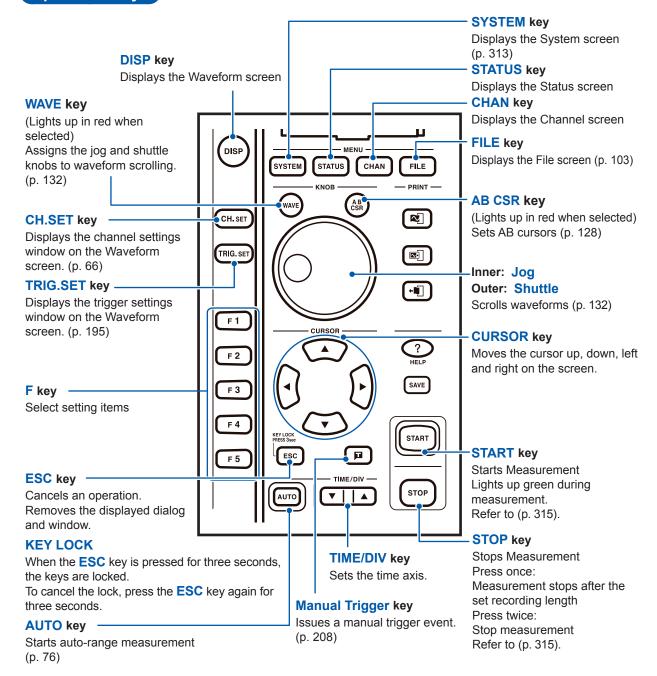


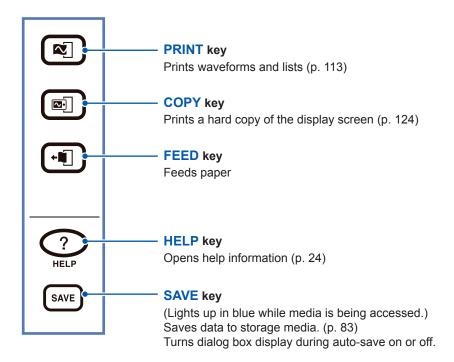
### **Back Side**



<sup>\*</sup>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 product control. Do not peel off the label.

# **Operation Keys**





# 1.3 Screen Organization

The screen configuration is as listed below. Each screen or window appears when the listed key is pressed.

The trigger settings window and channel settings window can be brought up on the Waveform screen.

#### Waveform Screen



Use this screen to view the waveform.

The settings window on the right displays the current measurement parameters.

# Trigger Settings Window, Channel Settings Window



View the trigger settings.



View the analog channel and logic channel settings.

#### Status Screen



View and update measurement and calculation settings.

Each push of the **STATUS** key cycles through the following sheets:

[Status] sheet, [Num Calc] sheet, [Memory Div] sheet, [Wave Calc] sheet.

#### **Channel Screen**



View and update channel, scaling, and comment settings.

Each push of the **CHAN** key cycles through the following sheets:

[Unit List] sheet, [Each Ch] sheet, [Scaling] sheet, [Comment] sheet.

# **System Screen**



View and update environment settings, save and print files, choose interface settings, and perform data initialization.

Each push of the **SYSTEM** key cycles through the following sheets:

[Environment] sheet, [File Save] sheet, [Printer] sheet, [Interface] sheet, [Init] sheet.

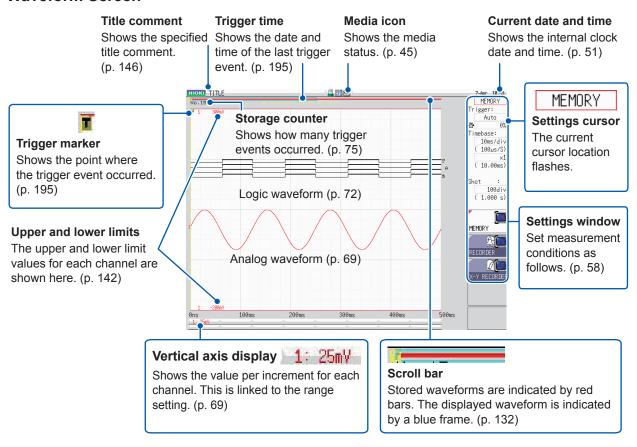
#### File Screen



View saved data files (CompactFlash cards, built-in drive, USB memory stick, internal memory).

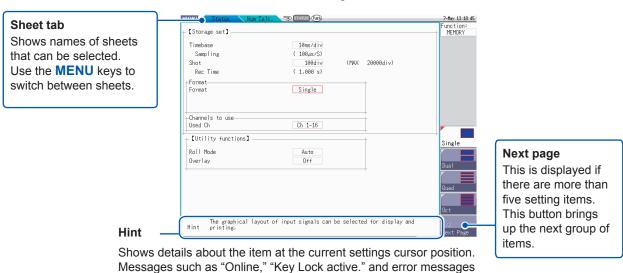
# **Explanation of Screen Contents**

#### **Waveform Screen**



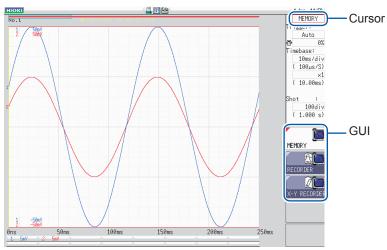
#### Elements Common to the Status, Channel, System, and File Screens

are also shown here.



# 1.4 Basic Key Operations

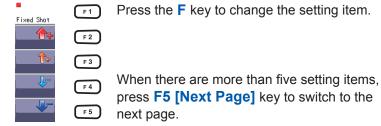
Press the CURSOR key and move the cursor to the item you want to change.



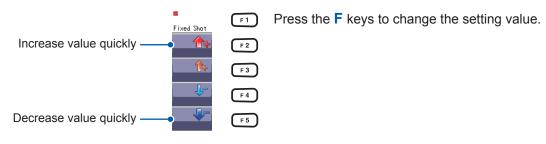
2 Check the interface and press the function key (F key) for the setting you want to change.

The assignment of the **F** keys is different for each item.

## Selecting a Setting Item



# Increasing or Decreasing a Setting Value



For some setting items, the CH.SET key selects [Exec] and the TRIG.SET key selects [Cancel].

#### To enter text or numbers

Refer to "8.1.3 Alphanumeric Input" (p. 149).

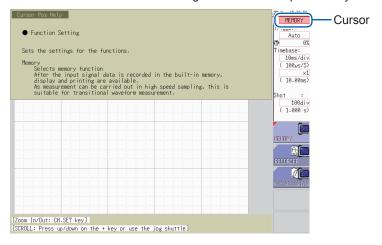
# 1.4.1 Using the HELP Key

When you press the Help key a simple explanation will appear at the cursor position.

## **Cursor Position Help**

- Move the cursor to the item for which you want to display help.
- Press the HELP key. A [Cursor Pos Help] sheet is displayed at the cursor position.

You can scroll the information using the CURSOR up/down keys or the jog knob.



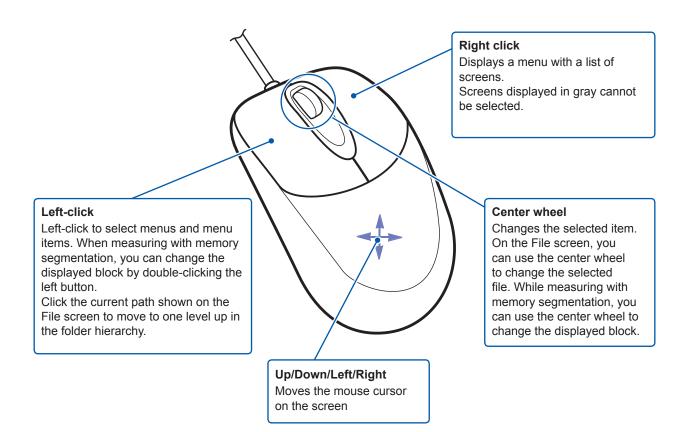
- You can change the size of the Help sheet with the **CH.SET** key. Available settings are full, top half, and bottom half. The example above is for top half.
- Pressing the **HELP** key toggles Cursor Position Help, on and off.

# 1.4.2 Use a Mouse to Perform Key Operations

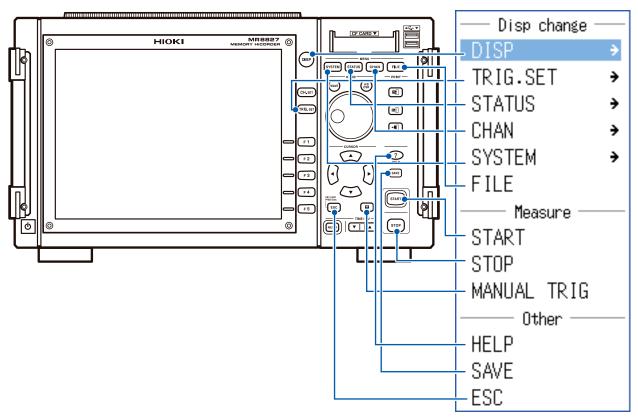
You can use a commercially available USB mouse to perform the same operations as the keys on the instrument.

- There are a variety of mice available, and not all devices will work with the instrument.
- The instrument's USB ports are designed exclusively for use with mice and USB memory sticks. Do not connect any other type of device.
- When operating the instrument with the mouse, you may experience temporary delayed operation or corrupted screen display.
- When using a mouse, do not change the interface on the System screen to anything other than "LAN." You may not be able to use the mouse while USB communications are in progress.
- External interference may cause the mouse to malfunction. Keep the mouse and mouse cable as far away as possible from sources of interference.

To perform operations with a mouse:



The operation keys of the instrument and the menu displayed when you right-click the mouse are related as follows:



To operate and carry out settings for CH.SET, WAVE, and AB CSR click the icons displayed when a mouse is connected. The operation keys and icons are related as follows.

lcon	Operation key
CH <sub>SET</sub>	CH.SET key
WAVE	WAVE key
AB CSR	AB CSR key

#### **Useful function**

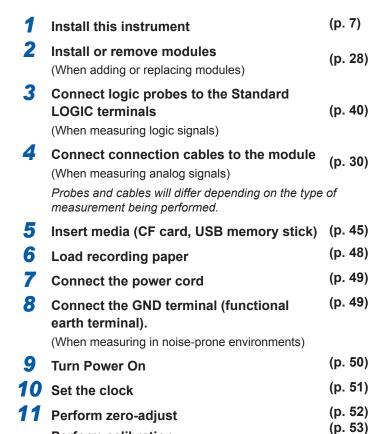
Dragging the right button of the mouse (Holding down the button, moving the mouse rightward, leftward, or upward, and then releasing the button) works the same as the following keys:

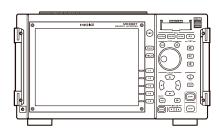
Rightward: START Leftward: STOP Upward: ESC

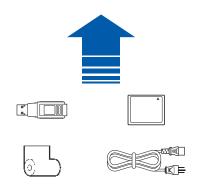
# 2

# **Measurement Preparation**

#### **Procedure**







When preparation is complete, start measurement. (p. 55)

#### To use communication functions

Perform calibration (When using Model MR8990)

Refer to "16 Connect to a PC" (p. 317).

#### To use external control functions

Refer to "17 External Control" (p. 343).

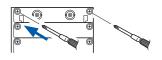
# 2.1 Install or Remove Modules

Read "Handling the Instrument and Modules" (p. 8) carefully. Modules specified when the instrument is ordered are supplied preinstalled. Use the following procedures to add, replace, or remove modules from the instrument.

- Up to two logic units can be installed as units 1 to 8. Logic units installed as the other units cannot be used. Other logic units being installed will be disabled.
- For information on the analog channel resolution when logic channels are used, refer to "8.10 Detailed Settings for Modules" (p. 170).

#### To Install a Module

#### Back side

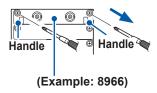


Required items: One Phillips-head screwdriver (No. 2)

- 1 Turn off the power to the instrument.
- Correctly orient the module and insert it firmly all the way in.
  Make certain that the labels on the module's panel face the same direction as the labels on the back side of the instrument.
- 3 Using a Phillips screwdriver, tighten the two module mounting screws (M3 × 7.5 mm).

#### To Remove a Module

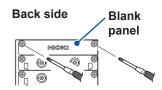
#### Back side



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

- 1 Turn off the power to the instrument.
- 2 Remove any connection cables or thermocouples connected to the module.
- 3 Remove the power cord.
- 4 Using a Phillips screwdriver, loosen the two module mounting screws (M3 × 7.5 mm).
- 5 Grasp the handles and pull the module out.

### If not Installing Another Module After Removal

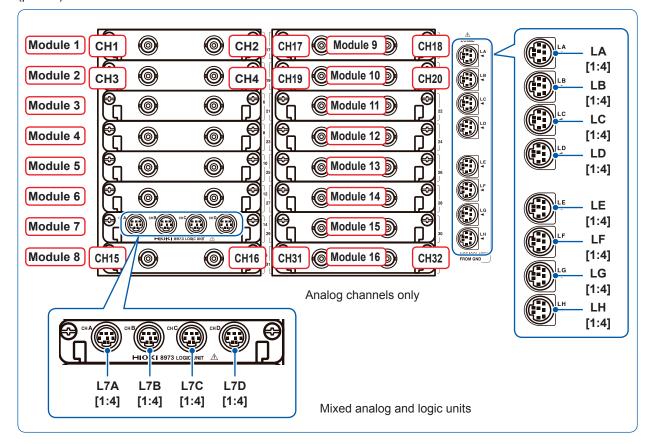


- 1 Install a blank panel.
- 2 Using a Phillips screwdriver, tighten the two mounting screws (M3 × 7.5 mm).

Measurements made without a blank panel installed may fail to meet specifications because of temperature instability within the module.

# **Channel Allocation**

Module number one is at the top, and channel number one is at the top left. Information about the modules installed in the instrument can be verified in the System Configuration list. (p. 405)



# **Connection Cables**

# **Measuring voltage**

Read Refer to "Before Connecting Cables" (p. 12). carefully.

For detailed precautions and instructions regarding connections, refer to the instruction manuals for your modules, connection cables, etc.

#### **Applicable Modules**

- Model 8966 Analog Unit
- Model 8968 High Resolution Unit
- Model 8972 DC/RMS Unit
- · Model U8979 Charge Unit

Connect to the BNC jack on a module.

Connect with: connection cables

• 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

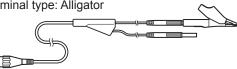


• Model L9217 Connection Cord (Maximum input voltage: 300 V) For measuring BNC output



• 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

If the voltage to be measured exceeds the maximum input rating of the 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

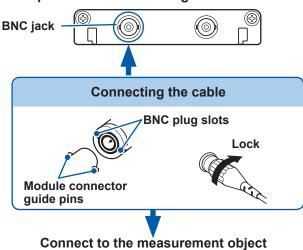
Example: Model P9000-02 Differential Probe



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

#### To Connect to a BNC Terminal

Example: Model 8966 Analog Unit



#### Required tools: One of the above cables

- 1 Connect the BNC plug on the cable to a BNC jack on the module.
- 2 Align the slots in the BNC plug with the guide pins on the jack on the module, then push in and twist the plug clockwise until it locks.
- 3 Connect the cable clips to the measurement object.

#### To disconnect BNC connectors

Push the BNC plug, twist it counterclockwise, then pull it out.

#### Measuring Frequency, Number of Rotations and Count

Refer to p. 31 for details about connecting to BNC terminals.

#### **Applicable Modules**

• Model 8970 Freq Unit

Connect to the BNC jack on a module.

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

#### Connect with: connection cables

 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

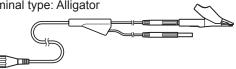


 Model L9217 Connection Cord (Maximum input voltage: 300 V)
 For measuring BNC output



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

Example: Terminal type: Alligator



If the voltage to be measured exceeds the maximum input rating of the module being used

- Model 9322 Differential Probe\*1
- Model P9000-01/-02 Differential Probe\*2

Example: Model P9000-02 Differential Probe



#### **Measuring temperature**

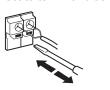
#### **Applicable Modules**

• Model 8967 Temp Unit

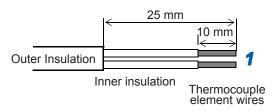
Connect to the terminal block on the module.

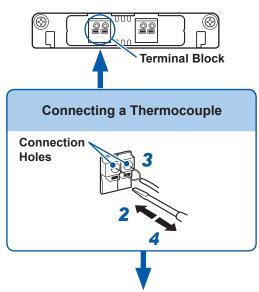
#### Connect with: thermocouples

Thermocouple (Compatible wire: 0.4 mm to 1.2 mm diameter) Connect to terminal block



#### To Connect to the Terminal Block





### **5** Connect to the measurement object

#### Required device and tool:

Thermocouple, flat-blade screwdriver (2.6-mm blade)

Recommended wire:

Compatible wire: Thermocouple element wires of from 0.4 mm to 1.2 mm in diameter Stripped length: 10 mm

- 1 Strip insulation from the thermocouple wires as shown at the left.
  - Stripped length: approx. 10 mm
- Push the blade of a flat screwdriver into the button on the terminal block of the module.
- Insert each thermocouple wire into the appropriate terminal hole while pressing the button. Confirm proper polarity.
- 4 Release the button.
  The thermocouple is connected.
- 5 Connect to the measurement object.

#### To remove a thermocouple

Hold the button while pulling the thermocouple wire out.

 If surrounding equipment is affected by noise, coil the thermocouple several times and then attach the included ferrite clamp-on choke (as seen in the diagram to the right).



 When connecting a thermocouple using a wire run of more than 3 meters, take into consideration the EMC environment including possible influence of external noise.

#### 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.

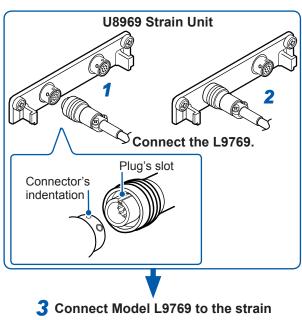
• Strain gauge transducer (Not available from Hioki)

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** 



gauge transducer.

a measurement object.



#### Required items:

Model L9769 Conversion Cable, strain gauge transducer

- Insert Model L9769 into a connector of Model U8969 with the slot of the plug aligned with the outward indentation of the connector.
- Insert the plug into the connector until they are locked together.
- 3 Connect Model L9769 to the strain gauge transducer.
- 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."

#### **Connector pin-out**





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

Model L9769 Co	onversion Cable
(Strain gauge t	ransducer end)
( ( ( ( ( ( ( ( ( ( ( ( ( ( ( ( ( ( (	Applied voltage: bridge voltage of 2 V

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

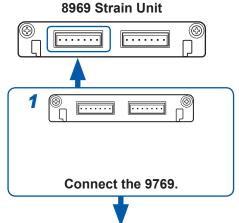
Pin mark	Description	
А	BRIDGE+	
В	INPUT-	
С	BRIDGE-	
D	INPUT+	
Е	FLOATING COMMON	
F	SENSE+	
G	SENSE-	
H, J	N.C.	

Pin mark	Description
А	BRIDGE+, SENSE+
В	INPUT-
С	BRIDGE-, SENSE-
D	INPUT+
Е	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.

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



- 2 Connect a strain gauge transducer to Model 9769.
- 3 Connect the strain gauge transducer to a measurement object.

#### Required items:

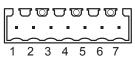
Model 9769 Conversion Cable, strain gauge transducer

- 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	
А	BRIDGE+	
В	INPUT-	
С	BRIDGE-	
D	INPUT+	
Е	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.

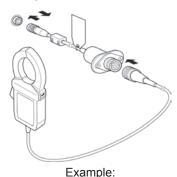
#### **Measuring current**

# Applicable Modules • Model 8971 Current Unit

Connect Model 9318 Conversion Cable to the module jack.

#### **Connect with: Clamp sensors**

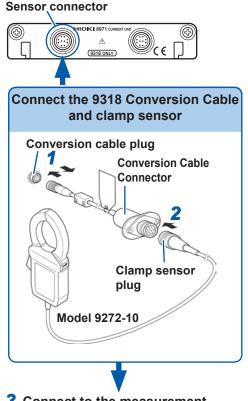
- Model 9272-10 Clamp on Sensor
- Models 9709, CT6862, CT6863, CT6865
   AC/DC Current Sensor
- Models CT6841, CT6843, CT6844, CT6845 AC/DC Current Probe



Model 9272-10 + Model 9318

#### To Connect to the Module's Terminals

Example: When connecting Model 9272-10 Clamp on Sensor



### 3 Connect to the measurement object

#### Required tools:

Model 9318 Conversion Cable, Model 9272-10 Clamp on Sensor

- 1 Align the grooves of the module's sensor connector and the conversion cable plug. Insert the plug until it locks.
- 2 Align the grooves of the conversion cable connector and the plug of the clamp sensor to be used. Insert the plug until it locks.
- **3** Connect the clamp sensor to the item to be measured.

#### To disconnect the conversion cable

Slide the plug to release the lock and then unplug the cable.

#### When Measuring Current With Model 9018-50 Clamp on Probe

When using Model 9018-50 you can use a voltage measurement unit such as Model 8966 Analog Unit to make current measurements.

For more information about how to configure the instrument for use in this type of application, refer to the example settings in "8.5.1 Scaling Examples" (p. 159).

#### **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

#### **ACAUTION**



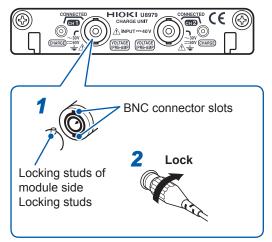
Use an acceleration sensor with a built-in pre-amplifier that conforms to the specification of Model U8979 Charge Unit. Using an inapplicable sensor may cause damaging itself.

Acceleration sensor type	Terminal the sensor is connected to	Note
With a built-in pre-amplifier	BNC connector	Drive power: 3.5 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.

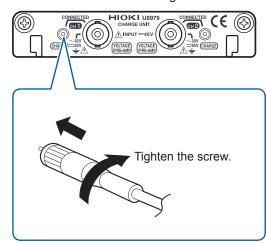
#### Connecting an acceleration sensor other than a sensor with a built-in pre-amplifier

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

#### Connecting a charge-output acceleration sensor

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





- 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.

#### **Measuring logic signals**

Read "Before Connecting a Logic Probe to the Measurement Object" (p. 13) carefully. For more information about logic probe specifications, see the instruction manual that came with the logic probe you plan to use.

# Applicable Modules • Model 8973 Logic Unit

LA to LH are supplied as standard equipment with the unit.

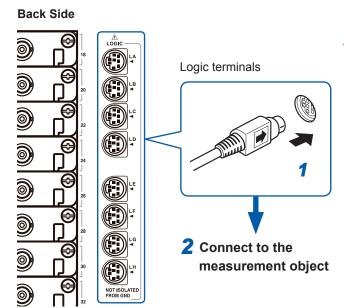
#### **Connect with: Logic Probes**

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



#### **To Connect to Logic Terminals**

**Example: Connecting the 9327 Logic Probe** 



#### Required tools:

Model 9327 Logic Probe

- 1 Connect the logic probe by aligning the grooves on the plug and Logic terminal.
- **2** Connect to the measurement object.

#### Measuring voltage with a high degree of accuracy (Digital Voltmeter)

#### **Applicable Modules**

 Model MR8990 Digital Voltmeter Unit

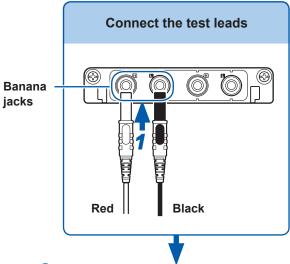
Connect with: Model L2200 Test Leads

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



Connect to the banana jacks on a module.

#### To Connect to Banana Jacks



2 Connect to the measurement object

#### Required tools: Test leads above

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 into the jacks.

Connect the test leads to the object to be measured.

#### Measuring high voltage

#### **Applicable Module**

 Model U8974 High Voltage Unit

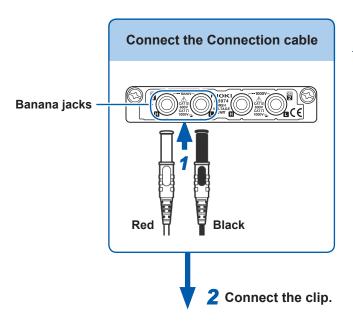
Connect to the banana jacks on a module.

#### Required item: Model L4940 Connection Cable Set

 Model L4940 Connection Cable Set: (Maximum input voltage: 1000 V)



#### To Connect to Banana Jacks



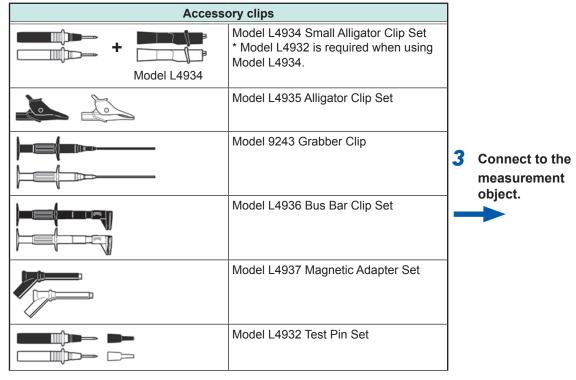
#### Required items:

#### **Model L4940 Connection Cable Set**

1 Connect the plug of the connection cable to the banana jacks on the module.

Connect the terminal and the plug of the same color.

- 2 Insert the accessory clip into cable clips.
- 3 Connect the cable clips to the measurement object.



#### **Output Waveform**

#### **Applicable Modules**

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

Connect to the SMB jack on a module.

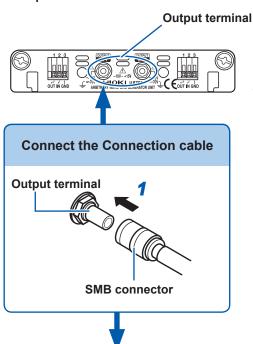
# Required item: Model L9795-01 / L9795-02 Connection Cable • Model L9795-01 Connection Cable (Electrical clips)

• Model L9795-02 Connection Cable (BNC output)



#### **To Connect to Output Terminals**

Example: Model U8793



2 Connect to the object to which the waveform is being applied.

### Required items: Connection cable mentioned above

- 1 Insert the SMB connector of connection cable in the output terminal of the module until you hear a click.
- 2 Connect the cable clips to the object to which the waveform is being applied.

#### To disconnect output connectors

Grip the head of the SMB connector (not the cable), and pull it out.

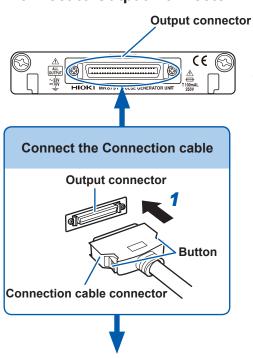
#### **Output Pulse Waveform**

#### **Applicable Module**

• Model MR8791 Pulse Generator Unit

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

#### **To Connect to Output Connector**



Required items: Commercially available cable

- 1 Connect the connection cable to Output Connector of module.
- 2 Connect the connection cable to the object to which the waveform is being applied.

#### To disconnect output connectors

Hold the button of connection cable while pulling the connector.

2 Connect to the object to which the waveform is being applied.

#### **Output connector**

10250-52A2PL: 3M products (SCSI-2 connector), (Centronics half-pitch 50 pin socket-contact) Refer to: "Output Connector Specifications" (p. 33)

- Metal shell of the connector 10250-52A2PL is the same as GND of the instrument (frame GND).
- Use lock type connectors for connecting the harness and the connector.

### **Prepare Storage Media**

Read "Handling Media" (p. 11) carefully.

#### Storage Media (Inserting a CF Card and USB Memory Stick) 2.3.1

#### Media icons



**USB** 

Memory







Built-in drive

Icons indicating the status of storage media are always shown at the top of the screen.







: Media is inserted







: Media is inserted and selected as save target (Icon is red)







: Media is not inserted but is selected as save target (Icon is black)

Storage media	Insertion procedure and notes
CF Card	To insert a CF card  With the Front mark (▲) pointing toward the slot, fully insert the card in the direction of the arrow.  When the Eject button has popped out, press it down first before inserting the CF card all the way in. Inserting the CF card when the Eject button is not pressed down may cause damage to the instrument. If the CF card cannot go all the way in, do not force it in. Press the Eject button so it pops out, then press it down again before fully inserting in the CF card.  Front side  CF card slot  Insert
CF Card	To remove a CF card Press the Eject button. Press the Eject button. When the button pops out, press it again to eject the CF card.
Built-in drive	Model U8330 SSD Unit (capacity: 128 GB, 1 GB=1,000,000,000 bytes)  The optional Model U8330 SSD Unit (factory option) is required.  The hard disk is formatted at the factory.
RAM (Internal memory) F3 Memory (INT)	<ul> <li>Memory integrated in the unit is used. Only settings files can be saved.</li> <li>Automatic saving of data is not possible.</li> </ul>

Storage media	Insertion procedure	and notes
	<ul> <li>Do not connect any devices other than USB memory</li> <li>Not all commonly available USB memory sticks are</li> <li>To use a USB memory stick, suitable unit settings m</li> </ul>	supported.
USB Memory FZ USB Stick	To insert a USB memory stick Ensure correct orientation of the USB memory stick and push it all the way into the connector.  To remove a USB memory stick Verify that the instrument is not accessing the USB memory stick (for saving or loading data, etc.). Then pull the USB memory stick out. (No special steps are required on the instrument.)	Front side  USB Connector (Type A)

Depending on the intended use of the USB memory stick, connector types and settings on the instrument will differ.

HOD	Connector	Instrument settings		Reference
USB use		Interface	USB setting	information
USB memory stick	Type A	LAN	USB Memory	See procedure below
To retrieve CF card or built-in drive files from a computer (PC) (using a USB cable)	Type B	LAN	Mass storage HDD, mass storage CF	"16.4" (p. 334)
For communication with a PC (using a USB cable)	Type B	USB	Interface	"16.6.1" (p. 336)

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

#### Procedure

Press the **SYSTEM** key to open the System screen, and then select the **[Interface]** sheet.

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



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

#### 2.3.2 To Format Storage Media

Possible targets for formatting are CF card, USB memory stick, built-in drive, and internal memory. During the formatting process, a folder named "HIOKI\_MR8827" will be created.

Note that formatting storage media deletes all the information on the storage media and deleted information is unrecoverable.

#### Procedure

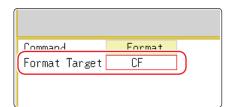
Press the **FILE** key to open the File screen.

- 1 Insert the storage media.
- 2 Select [Next Page].
  Select [Format].

The cursor moves to the [Format Target] item.

**3** Select the storage media to format, and select [Exec]. The specified storage media will be formatted.

A confirmation window will be displayed. Select **[Yes]** to proceed, or **[No]** to cancel.

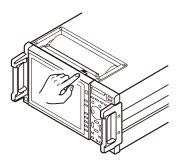


# 2.4 Load Instrument With Recording Paper (When Model U8350 Printer Unit is installed)

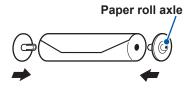
Read "Handling the Printer and Recording Paper" (p. 10) carefully.

Procedure

### Required items: Model MR9231 Recording Paper, Paper roll axle (Supplied with the instrument)



1 Press the button to open the printer cover.



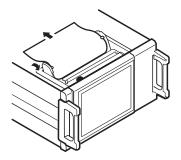
2 Insert the paper roll axles into the core of Model 9321 Recording Paper.



3 Load the instrument with the paper, putting it into the holder.

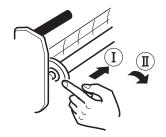
Put the right side of the paper first into the holder, and then press its left side until it clicks, pressing it rightward.

Face the print side of the paper frontward. Putting the paper in the holder without the paper roll axle installed will make the printer cover impossible to be opened, resulting in damage to the printer.



4 Pull out the edge of the paper toward the other side, and close the printer cover, pressing the edge face of the paper against the cover's side surface.

The surface of the paper may become sticky from the residue left behind by the adhesive tape and cause the printing on that area to become unreadable. 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, pressing the paper roll axle rightward.

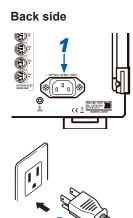
### 2.5 Power Supply

Read "Before Turning the Power Supply On" (p. 13) carefully.

#### 2.5.1 Connect the Power Cord

#### Procedure

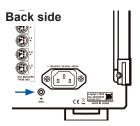
- 1 Connect the power cord to the power inlet on the instrument.
- Plug the power cord into the mains outlet.



#### 2.5.2 Ground the Functional Earth of This Instrument

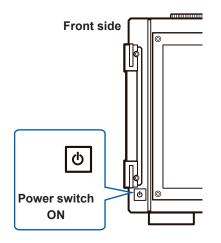
When measuring in a noisy environment, you can improve the noise immunity by connecting the GND terminal (functional earth terminal).

When using a potential transformer (PT) for AC power line measurements or similar, the GND terminal of the PT must also be grounded.



#### 2.5.3 Turn the Power On and Off

#### **Turn Power On**



#### Press the power switch.

The startup screen appears first, then the Waveform screen is displayed.

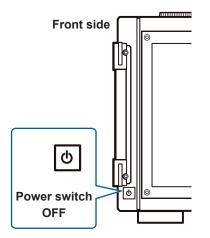
#### **Before Starting Measurement**

To obtain precise measurements, allow about 30 minutes for warm-up after turning power on to allow the internal temperature of the modules to stabilize. After warm-up, perform zero adjustment before taking measurements.

#### **Turn Power Off**

#### **Before Turning Power Off**

When the power switch is turned off, data recorded in the internal memory is erased. If you do not want to lose recorded data, save it first to a CF card or external storage media. Refer to "5 Save/Load Data and Manage Files" (p. 83).



#### Press the power switch.

The instrument is turned off.

When power is turned on again, the display appears with the same settings as when power was last turned off.

When the auto-setup function is enabled, settings will be loaded and established automatically. (p. 102)

### 2.6 Set 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.

- · Measurement with timer-based trigger
- Printout of data including count of trigger events
- Saving measurement data

#### Procedure

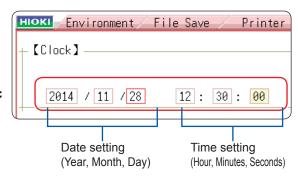
Press the **SYSTEM** key to open the System screen, and then select the **[init]** sheet.

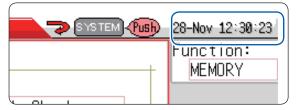
- 1 Move the cursor to the [Clock] item.
- 2 Select the digit to change and set the numeric value.



The clock is set to the current date and time values.

The date and time indication is shown at the top right of the screen.





### 2.7 Adjust the Zero Position (Zero-Adjust)

This procedure compensates for module differences and sets the reference potential of the instrument to 0 V.

The compensation procedure is performed for all channels and ranges.

#### **Before Performing Zero-Adjust**

- Before performing this procedure, allow the equipment to warm up for about 30 minutes after the power is turned on so the internal temperature of the modules can stabilize.
- · Note that zero-adjust cannot be performed during measurement.
- Key operations are not accepted during zero-adjust.
- The time required for zero-adjust varies depending on the type and number of modules installed in the instrument. (The procedure may take several seconds.)

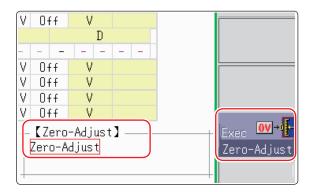
#### Procedure

Press the CHAN key to open the Channel screen, and then select the [Unit List] sheet.

Move the cursor to [Zero-Adjust].

Select [Exec Zero-Adjust].

The zero-adjust procedure is carried out.



Zero-adjustment has no effect on the 8969 and U8969 Strain Unit. (Perform zero-adjust using auto-balance. (p. 174))

#### Perform zero-adjust in the following cases.

- · When a module was changed.
- · When power was turned off and on again.
- When settings were initialized (system reset).
- When DC/RMS is switched at the 8971 Current Unit and the 8972 DC/RMS Unit
- · When measurement mode has been switched on Model U8979 Charge Unit
- When the ambient temperature has changed significantly.
   Zero-position drift\* may occur.
- \* Drift:

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

# 2.8 Perform Calibration (When Model MR8990 is installed)

This procedure compensates for MR8990 Digital Voltmeter Unit differences.

The compensation procedure is performed for all channels and ranges.

#### **Before Performing Calibration**

- Before performing this procedure, allow the equipment to warm up for about 30 minutes after the power is turned on so the internal temperature of the modules can stabilize.
- Note that calibration cannot be performed during measurement. However, if the calibration setting is set to ON, calibration is performed at the start of measurement.
- Key operations are not accepted during calibration.
- The time required for calibration varies depending on the type and number of modules installed in the instrument. (The procedure may take several seconds.)

#### Procedure

Press the CHAN key to open the Channel screen, and then select the [Unit List] sheet.

- 1 Move the cursor to [Zero-Adjust].
- 2 Select [Exec Zero-Adjust].
  Calibration will be performed.



#### In the following cases, calibration should be executed again.

- When a module was changed.
- · When power was turned off and on again.
- When settings were initialized (system reset).
- When the ambient temperature has changed significantly.

Perform Calibration (When Model MR8990 is installed)

### 3 Measurement

### 3.1 Measurement Workflow

#### 1 Pre-measurement Inspection

Refer to "3.2 Pre-measurement Inspection" (p. 57).

### 2 Basic Measurement Settings

Select a suitable recording method for the measurement target

"3.3.1 Measurement Function" (p. 58)

Refer to...

Set sampling rate

"3.3.2 Timebase and Sampling Rate" (p. 60)

Set recording length

"3.3.3 Recording Length (Number of Divisions)" (p. 63)

Set waveform display format and printing format

"3.3.4 Screen Layout" (p. 65)

#### **Application examples**

Refer to...

- "7.4 Perform Waveform X-Y Synthesis" (p. 134)
- "8.2 Display Waveforms During Recording (Roll Mode)" (p. 153)
- "8.3 Display New Waveforms Over Past Waveforms (Overlay)" (p. 154)
- "10 Numerical Calculation Functions" (p. 217)

### 3 Input Channel Settings

Choose analog channel settings

Refer to...

"3.4.2 Choose Analog Channel Settings" (p. 69)

**Choose logic channel settings** 

"3.4.3 Logic Channel Settings" (p. 72)

#### **Application examples**

Refer to...

- "8.1 Add Comments" (p. 146)
- "8.5 Convert Input Values (Scaling Function)" (p. 157)
- "8.6 Set the Waveform Position (Variable Function)" (p. 164)
- "8.7 Fine Adjustment of Input Values (Vernier Function)" (p. 167)
- "8.8 Invert the Waveform (Invert Function)" (p. 168)

### **4 Trigger Settings**

Refer to "9 Trigger Settings" (p. 195).

#### **5 Start Measurement**

Refer to...

- "3.5 Start and Stop Measurement" (p. 74)
- "5 Save/Load Data and Manage Files" (p. 83)
- "6 Printing (When Model U8350 Printer Unit is installed)" (p. 113)
- "7.1 Read Measurement Values (Using the AB Cursors)" (p. 128)
- "7.3.2 Scroll With Jog and Shuttle Knobs (Scroll)" (p. 132)
- "7.5 Magnify and Compress Waveforms" (p. 136)

#### **6 Stop Measurement**

Refer to "3.5 Start and Stop Measurement" (p. 74).

#### To check the input signal

Press the **AUTO** key. Input waveform timebase and vertical axis (voltage axis) range will be selected, zero-adjust performed and measurement started, all automatically.

"3.6 Measurement With Automatic Range Setting (Auto-ranging Function)" (p. 76)

#### To reuse previously stored settings

Load the settings file from the File screen.

Saving the settings for different measurement targets or applications makes operation more convenient. Refer to "5.3 Load Data" (p. 99).

#### To automatically restore previous settings at power-up

Stored measurement settings can be automatically loaded from a file when the unit is turned on. Simply insert a CF card with an auto-settings file before turning the unit on.

Refer to "5.4 Automatically Load Settings (Auto-setup Function)" (p. 102).

Make sure that the file is stored in the "HIOKI\_MR8827" folder of the CF card.

#### To return settings to their original (basic default) state

From the System screen, select the **[Init]** sheet to return the unit to the factory default settings. In this condition, the unit is set up to easily perform simple measurements.

If operation of the instrument seems unusual or overly complex, reinitialize the instrument.

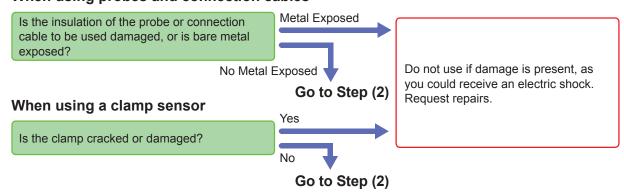
Refer to "19.2 Reset the Instrument" (p. 398).

### 3.2 Pre-measurement Inspection

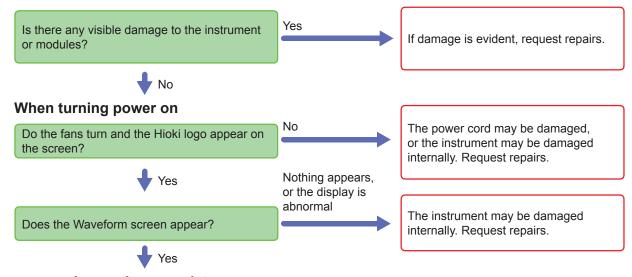
Verify that the instrument operates normally to ensure that no damage occurred during storage or shipping. If you find any damage, contact your authorized Hioki distributor or reseller.

#### (1) Peripheral Device Inspection

#### When using probes and connection cables



#### (2) Instrument and Module Inspection



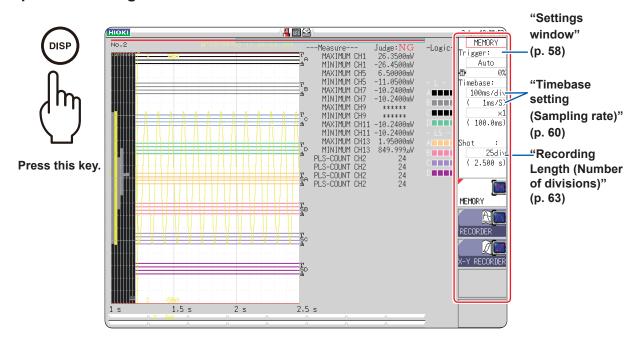
Inspection complete

### 3.3 Measurement Configuration

Set measurement conditions as follows.

You can immediately verify the effect of settings on the waveform by calling up the Waveform screen and using the Settings window to make basic settings. Basic settings can also be made by calling up the Status screen and selecting the **[Status]** sheet.

#### **Open the Settings Window**



#### 3.3.1 Measurement Function

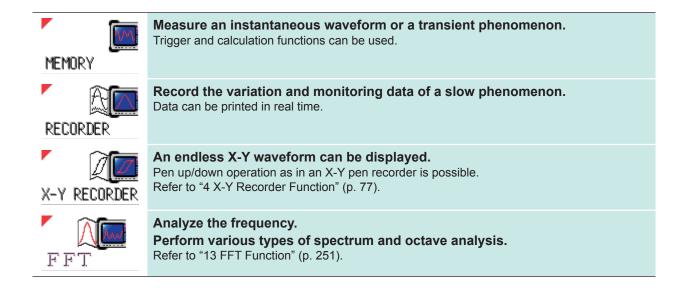
Select the function according to the target and type of measurement.

#### Procedure

Press the **DISP** key to open the Waveform screen.

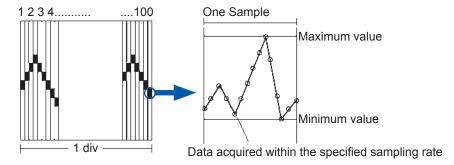
Move the cursor to the function item (the upper most column of the Settings window).

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

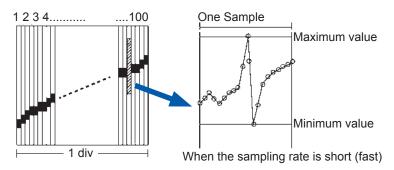


#### **Recorder Function Values**

With the Recorder function, each data sample consists of the maximum and minimum values acquired in the specified sampling rate. This means that each data sample has its own amplitude breadth.



When input waveform variation is slight, the difference between maximum and minimum values can be inordinately large if the sampling rate is short and severe fluctuations are present due to noise. This may be prevented by setting a longer sampling rate.



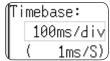
#### 3.3.2 Timebase and Sampling Rate

MEM REC

The timebase setting establishes the rate of input signal waveform acquisition, specified as time-perdivision on the horizontal axis (time/div).

The sampling setting specifies the interval from one sample to the next.

(The sampling rate is shown in brackets under the timebase for the Memory function (see illustration at right). The displayed sampling rate changes as the time axis range changes.)



#### **Procedure**

Press the **DISP** key to open the Waveform screen.

#### With the Memory Function

- 1 Move the cursor to the [Timebase] item.
- 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 sampling with an external signal, select **[External]** and input the signal from the external sampling terminal. To reset the setting to the internal sampling, select **[Internal]** and set the time.

When external sampling is selected, the number of samples per division can be set in the range from 10 - 1000 S/div.

"17.2.3 External Sampling (EXT.SMPL)" (p. 350).

#### With the Recorder Function

- 1 Move the cursor to the [Timebase] item.
- 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 [Sampling] item.
- 4 Set the sampling rate.

1 (*Default setting*), 10, 100  $\mu$ s 1, 10, 100 ms (Select a sampling rate less than 1/100 of the time

The range of choices depends on the selected timebase.

The higher the sampling rate, the more detailed the changes that can be observed.

#### MEM

#### To select the timebase

Refer to the table below when setting the timebase.

For example, to measure a 100 kHz waveform, the maximum display frequency setting range according to the table is 200 kHz - 800 kHz. If the maximum display frequency is set to 400 kHz, setting the time axis range to  $10 \, \mu s/div$  is recommended.

Timebase Sampling rate (Sp		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

S/s = Number of samplings / second

One Signal Period

#### What is the maximum display frequency?

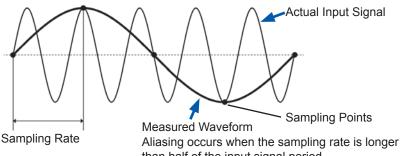
Displaying waveforms by their sampled values with adequate resolution of characteristics such as sine wave peaks requires a minimum of about 25 samples per waveform period.

Maximum display frequency is determined by the timebase.

#### What is aliasing (recording of non-existent waveforms)?

If the signal to be measured changes too fast relative to the sampling rate,

beginning at a certain frequency, non-existent slow signal fluctuations are recorded. This phenomena is aliasing.



than half of the input signal period.

With the Memory function, the sampling rate can be significantly affected by the timebase setting, so

care is necessary to avoid aliasing when selecting the timebase. Because the timebase determines the maximum display frequency, the fastest possible timebase setting should be used.

When the signal can be recorded repeatedly, the auto-ranging function (p. 76) may be used to select the optimum timebase.

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

If MR8990 Digital Voltmeter Unit is installed, that channel's sampling rate is automatically set to 1/50 of the selected timebase.

Example: When 8966 is installed as unit 1 (CH1 and CH2) and MR8990 as unit 2 (CH3 and CH4), and the timebase is set to 1 s/div

Sampling rate of unit 1 (8966): 10 ms Sampling rate of unit 2 (MR8990): 20 ms

#### To automatically set the timebase

When you press the **AUTO** key, a suitable timebase for the input signal is selected and measurement starts. (This applies only to the Memory Function.)

Refer to "3.6 Measurement With Automatic Range Setting (Auto-ranging Function)" (p. 76).

#### REC

- The timebase and sampling rate can be set independently. The sampling rate is selected depending on the timebase setting.
- When the following timebase values are selected, displayed waveforms are compressed in the horizontal (time axis) direction as shown.

20 ms/div  $\rightarrow$  ×1/2,

10 ms/div  $\rightarrow$  ×1/5

#### To minimize noise during measurement

If the sampling rate is too fast and the input waveform amplitude is small, the difference between maximum and minimum values may become quite large as a result of sudden fluctuations, such as those caused by noise. To prevent this, select a slower sampling rate or enable the module's lowpass filter (p. 69).

#### MEM REC Common

The data refresh rate is not allowed to exceed the maximum sampling rate of the module. During the period when data is not updated, the same data is measured, resulting in a stair-shaped waveform.

Even when the same signal is sampled simultaneously by two modules, the data may differ due to differences in sampling rate, frequency bandwidth, and frequency response.

Data refresh rate for various modules

Module	Max. timebase	Max. sampling rate or data refresh rate	Reference	
Model 8966	5 µs/div	50 ns (20 MS/s)	-	
Model 8967	Dependent on data refresh setting	Dependent on data refresh setting	Refer to "8.10.3" (p. 173).	
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	Dependent on setting	Dependent on setting	Refer to "8.10.5" (p. 175).	
Model 8971	100 µs/div	1 μs (1 MS/s)	Refer to "8.10.6" (p. 178).	
Model 8972	Dependent on response setting	Dependent on response setting	Refer to "8.10.7" (p. 178).	
Model 8973	5 μs/div	50 ns (20 MS/s)	-	
Model MR8990	Dependent on NPLC setting	Dependent on NPLC setting	-	
Model U8974	100 µs/div	Depends on response setting	Refer to "8.10.9" (p. 180).	

#### **Recording Length (Number of Divisions)** 3.3.3

MEM REC

Set the length (number of divisions) to record each time data is acquired.

#### Procedure

Press the **DISP** key to open the Waveform screen.

#### With the Memory Function

- Move the cursor to [Shot].
- Select the type.

Fixed Shot	Select from a range of preset values.
User Shot	Freely specify any value in 1-division units.

Set the recording length.

#### (Fixed Shot)

25, 50, 100, 200, 500, 1,000, 2,000, 5,000, 10,000, 20,000, 50,000, 100,000 div 200,000 div (in 4/8/16 ch mode) 500,000 div (in 4/8 ch mode) 1,000,000 div (in 4 ch mode)

#### (User Shot)

- 1 to 160,000 div (in 32 ch mode)
- 1 to 320,000 div (in 16 ch mode)
- 1 to 640,000 div (in 8 ch mode)
- 1 to 1,280,000 div (in 4 ch mode)

#### With the Recorder Function

- Move the cursor to [Shot].
- Select the type.

•				
			User Shot	Freely specify any value in 1-division units.
_	Select the typ	oe.	Fixed Shot	Select from a range of preset values.

Set the recording length.

#### (Fixed Shot)

#### Cont. On-Off

When [On] is selected, measurement is carried out while continuously overwriting the data in memory. Data from the point at which measurement was stopped back to the maximum recording length can be saved or printed.

25, 50, 100, 200, 500, 1,000, 2,000, 5,000, 10,000, 20,000, 50,000 div

#### (User Shot)

1 to 80,000 div

#### MEM

#### **Recording Length and Data Samples**

Each division of the recording length consists of 100 data samples. The total number of data samples for a specified recording length is: Set recording length (divisions)  $\times$  100 + 1.

However, if the MR8990 Digital Voltmeter Unit is installed, the number of data samples is as follows.

· When only MR8990 is installed

Number of data samples for each division: 50 data samples

Total number of data samples for recording length: Set recording length (divisions) × 50 + 1

· When a mix of MR8990 and other modules are installed

Channels for MR8990 units

Number of data samples for each division: 50 data samples

Total number of data samples for recording length: Set recording length (divisions) × 50 + 1

Channels for other modules

Number of data samples for each division: 100 data samples

Total number of data samples for recording length: Set recording length (divisions) × 100 + 2

#### REC

Each recording length division consists of 100 pairs of data points, with each pair composed of two values: the maximum and minimum measured values within each sampling period. The MR8990 data measured by the recorder function has a resolution of 16 bits.

#### When recording length is set to [Cont.]

- The instrument stores the maximum recording length of data back from the point at which measurement was stopped in its internal memory (80,000 divisions).
- For range settings of 10 ms/div to 200 ms/div, when the printer setting (real-time print) is On, the real-time print is not performed. Perform printing manually after measurement is completed. (p. 118)
- When Auto-saving is On, the saving is not performed during the measurement. When measurement is stopped, the data currently stored in the internal memory is saved.

#### When recording length is changed during measurement

Measurement data already stored in memory is discarded and measurement starts with the newly set recording length.

#### 3.3.4 Screen Layout



You can specify the format in which the input signal is shown on the Waveform screen. This setting will also affect how the waveform will be printed.

Selecting X-Y1 screen or X-Y4 screen allows waveform X-Y synthesis.

(This applies to the Memory and X-Y Recorder functions.)

Refer to "7.4 Perform Waveform X-Y Synthesis" (p. 134).

#### Procedure

Press the **STATUS** key to open the Status screen, and then select the **[Status]** sheet

#### With the Memory Function

#### Move the cursor to [Format].

Single	Display and record using 1 graph. (Default setting)				
Dual	Display and record using 2 graphs.				
Quad	Display and record using 4 graphs.				
Oct	Display and record using 8 graphs.				
Hex	Display and record using 16 graphs.				
X-Y Single	Set input signal to X-Y and display and record the correlation using 1 graph.				
X-Y Quad	Set input signal to X-Y and display and record the correlation using 4 graph.				

#### With the Recorder Function

#### Move the cursor to [Format].

Single	Display and record using 1 graph. (Default setting)
Dual	Display and record using 2 graphs.
Quad	Display and record using 4 graphs.
Oct	Display and record using 8 graphs.
Hex	Display and record using 16 graphs.

#### **Analog Channel Assignment**

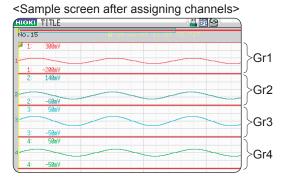
With 2, 4, 8 or 16 screens, analog channels can be freely assigned to the different graphs.

#### Procedure

Press the **CHAN** key to open the Channel screen, and then select the **[Unit List]** sheet.

- 1 Move the cursor to [Graph].
- 2 Select the display screen for each channel.

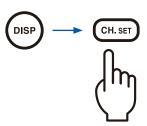
The graphs are numbered Gr1, Gr2, Gr3, etc. starting from the top.



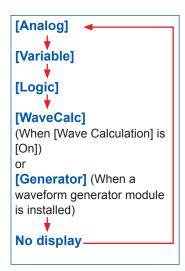
### 3.4 Select Input Channels

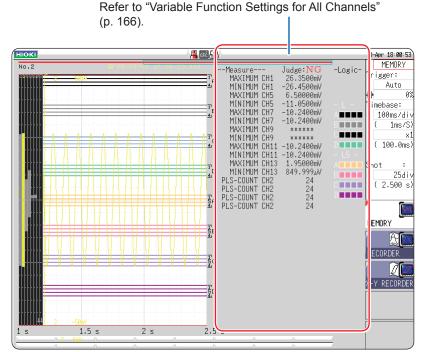
Set which channels are analog and logic.

#### To Open the Channel Settings Window



Pressing **CH.SET** repeatedly cycles through the available sheets.





If the channel setting screen is hard to see due to waveform overlap, narrow the waveform display width to divide the waveform display screen and trigger settings screen.

Refer to "7.7.3 Switch the Waveform Display Width" (p. 142).

#### To perform waveform interpolation

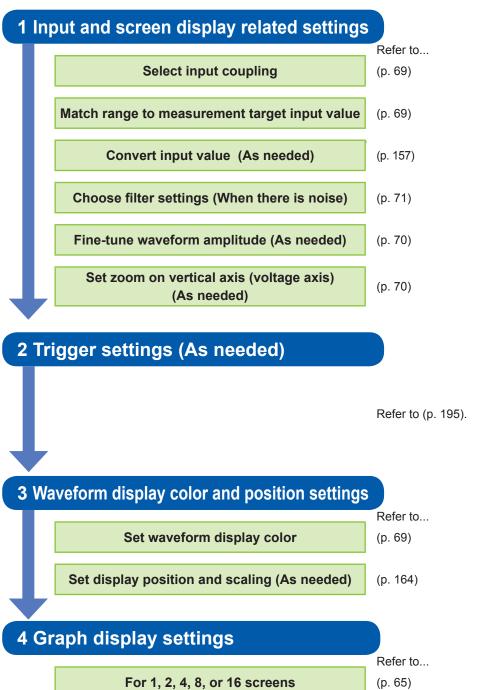
Set the waveform display color in the channel setting window to Off. Refer to "1. Waveform Display Color" (p. 69).

#### To copy the settings of one channel to another

Refer to "8.9 Copy Settings to Other Channels (Copy Function)" (p. 169).

#### 3.4.1 Channel Setting Workflow

The workflow below shows how to choose settings for analog channels (CH1 to CH32).

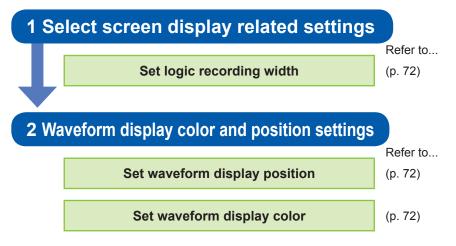


For X-Y1 or X-Y4 screens

(p. 135)

- When input coupling is set to GND, the waveform will have no amplitude and you cannot set the range.
- Due to the influence of filter attenuation, correct range setting may not be possible.
- When choosing trigger settings, set the vertical axis (voltage axis) range first. If the range is changed after specifying the trigger, the trigger setting may change.
- When using the Variable function, set the vertical axis (voltage axis) range first. If you change the range setting after applying the variable function observation with sufficient precision may not be possible.
- When using the Variable and Scaling functions together, apply the Scaling function first. If you apply the Scaling function after the Variable function, you may not get the intended display result.

The setting workflow for logic channels (standard LOGIC terminals LA - LH, expansion LOGIC terminals L1A to L8D) is explained below.



- Waveform display position can be specified in 1% increments.
- Not displayed for X-Y1 and X-Y4 screens.
- Up to two logic units can be installed as units 1 to 8. Logic units installed in other positions cannot be used.

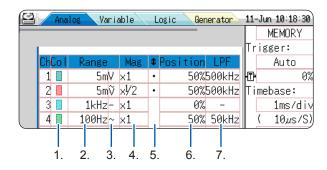
#### 3.4.2 Choose Analog Channel Settings

For information about specific settings for each module, refer to "8.10 Detailed Settings for Modules" (p. 170).

#### Procedure

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

- 1 Move the cursor to the channel for which you want to change the settings.
- 2 Select settings with the F keys.



#### To copy the setting to another channel

Refer to "8.9 Copy Settings to Other Channels (Copy Function)" (p. 169).

### 1. Waveform Display Color

Specifies the color in which the waveform of the selected channel is displayed. You can also select the same color as other channels.

Off	The waveform is not displayed. If the auto-save setting for <b>[Save Channel]</b> is <b>[Disp Ch]</b> , data for this channel will not be saved. Refer to "Select the channels to save." (p. 90).
On	The waveform is displayed. Select the display color with the <b>F</b> keys $[\uparrow]$ , $[\downarrow]$ .
All On-Off	Switches the waveform display of all channels to all On or all OFF

#### 2. Vertical Axis (Voltage Axis) Range

Sets the vertical axis (voltage axis) range for each channel. The value set here is the voltage of one increment on the vertical axis.

For information on the full-scale value for various modules, refer to the table in the section "6. Zero Position" (p. 70).

When the Variable function is **[On]** but variable auto-adjustment is **[Off]**, the size of the waveform on the screen will not change even if the vertical axis (voltage) range is changed.

#### When an over-range condition has occurred

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

#### 3. Coupling

Set the input signal coupling method. Normally, DC coupling should be selected.

DC (V, -)	Both DC components and AC components of the input signal will be measured. ( <i>Default setting</i> )
$AC\left(\widetilde{V}\right.,\sim)$	Only AC components of the input signal will be measured. DC components will be blocked.
GND ( ┤)	Input is shorted to ground. (Allows checking the zero position.)

#### 4. Vertical Axis (Voltage Axis) Zoom

Vertical axis (voltage axis) zoom-up or zoom-down settings can be selected separately for each channel. These settings will be used for display and printout. Zoom is based on the zero position. The measurement resolution does not change. Refer to "7.5.3 Vertical Axis (Voltage Axis) Magnification" (p. 138).

Use the Variable function for user-specified zoom.

The waveform can be inverted by reversing plus/minus.

Refer to "8.6 Set the Waveform Position (Variable Function)" (p. 164).

Refer to "8.8 Invert the Waveform (Invert Function)" (p. 168).

#### 5. Vernier

Fine adjustment of input voltage can be performed arbitrarily on the Waveform screen (display only).

When recording physical values such as noise, temperature and acceleration using sensors, amplitude can be adjusted to facilitate calibration.

Refer to "8.7 Fine Adjustment of Input Values (Vernier Function)" (p. 167).

#### 6. Zero Position

Sets the 0 V level display position. If the 0 V input level has shifted, perform zero-adjust.

Refer to "2.7 Adjust the Zero Position (Zero-Adjust)" (p. 52).

Refer to "2.8 Perform Calibration (When Model MR8990 is installed)" (p. 53).

The zero position of all channels can be changed at the same time using the zero position preset (press [Preset]).

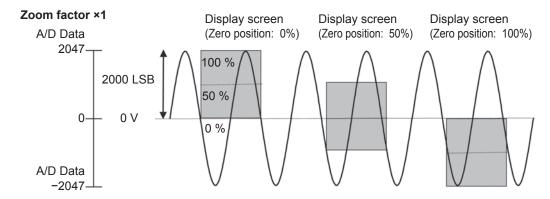
Ascending (3%→96%)	The zero position of CH1 is set to 3% and the following channels up to CH32 are increased by 3% each.
Descending (96%→3%)	The zero position of CH1 is set to 96% and the following channels up to CH32 are decreased by 3% each.
All Ch 0%	The zero position of all channels is set to 0%.
All Ch 50%	The zero position of all channels is set to 50%.

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. 174).

- · Only the display position is shifted. No offset is applied to the input.
- Vertical axis (voltage axis) zooming is based on the zero position.
- Zero position adjustment and vertical axis (voltage axis) zooming only change the voltage range as displayed on the Waveform screen. The actual measurement range does not change.

The zero position is as shown in the illustration below. (Example: 8966 Analog Unit)



Full-scale resolution for modules at various vertical axis zoom factors (LSB)

Madala	Zoom factor									
Module	×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)	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)	1200000	1200000	1200000	1000000	500000	200000	100000	50000	20000	10000

The brackets for the zoom factor indicate valid data ranges.

#### 7. Low-Pass Filter

Select settings for the module's low-pass filter. This is useful for eliminating unwanted high-frequency components.

The filter type depends on the module. Choose setting according to the input characteristics.

<sup>\*:</sup> With Model 8967 Temp Unit, the valid range differs depending on the thermocouple. For minimum resolution information, see the specifications of Model 8967 Temp Unit.

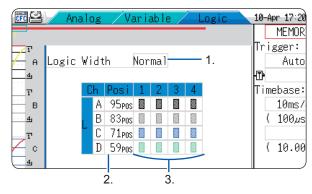
#### 3.4.3 Logic Channel Settings

The channel settings window (Logic sheet) is shown when the display format is 1, 2, 4, 8 or 16 screens.

#### Procedure

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

- 1 Move the cursor to the channel for which you want to change the settings.
- 2 Select settings with the F keys.



#### To copy the setting to another channel

Refer to "8.9 Copy Settings to Other Channels (Copy Function)" (p. 169).

#### 1. Logic Width

Change the display width of the logic waveform.

Making waveforms narrower can enhance the readability of the display when there are a high number of waveforms.

Wide	Make the waveform wider.
Normal	Display the waveform at normal width.
Narrow	Make the waveform narrower. (Default setting)

### 2. Waveform Display Position

Determines where on the screen the logic waveform is displayed. The position can be freely moved within the range of the display.

#### 3. Waveform Display Color

Specifies the color in which the waveform of the selected channel is displayed. You can also select the same color as other channels. For logic units, the color can be specified for each units and each channel separately.

, ,	
Off	The waveform is not displayed. If the auto-save setting for <b>[Save Channel]</b> is <b>[Disp Ch]</b> , data for this channel will not be saved. Refer to "Select the channels to save." (p. 90).
On	The waveform is displayed. Select the color with the <b>F</b> keys.
Probe On-Off	Switches the waveform display of the same probes to $$ ON or OFF simultaneously.
All On-Off	Switches the display of all logic waveforms to ON or OFF simultaneously. This can be selected when the cursor is on the waveform display position item.

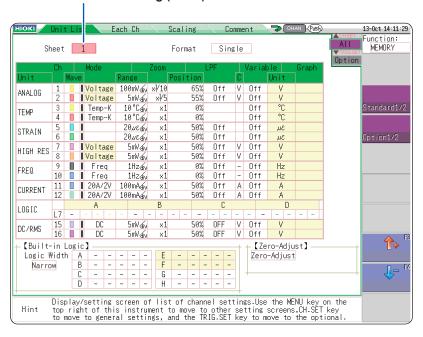
- When the standard logic display (LA, LB, LC, LD, LE, LF, LG, and LH) is [On], 8970 Freq Units installed as unit 1, 2, 9, or 10 cannot be used. Furthermore, the 16-bit resolution 8967 Temp Unit, 8968 High Resolution Unit, 8969 Strain Unit, U8969 Strain Unit, U8974 High Voltage Unit, and U8979 Charge Unit have their resolutions reduced to 12 bits. When Model MR8990 Digital Voltmeter Unit is installed as unit 1, 2, 9, or 10, the standard logic display cannot be used.
- Install logic units as units 1 to 8. Logic units installed as units 9 and above cannot be used.

#### 3.4.4 Displayed Sheet



The input channel settings can be set differently for each displayed sheet. Up to four sheets can be set. You can set desired waveforms for displaying to different sheets and switch them.

Sheet switching (1 to 4)



• Only the following display-related settings can be set to each displayed sheet.

Analog waveform: Display ON/OFF, waveform color, magnification, zero position, graph variable

(ON/OFF, upper/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 will be common to all displayed sheets. When the range is changed, the change is applied to all displayed sheets.

- When a settings file is saved, the settings of all displayed sheets are saved.
- A waveform file is saved based on the setting of the sheet displayed at the time of saving. When a
  waveform file is loaded, 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. Refer to "3.4 Select Input Channels" (p. 66).

#### 3.5 Start and Stop Measurement

#### Procedure

Press the **DISP** key to open the Waveform screen.

#### To Start Measurement

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

- When a measurement is started, waveform data displayed on the screen is cleared.
- Measurement can also be started by applying a signal to the external control terminal. Refer to "17 External Control" (p. 343).

#### To prevent inadvertently starting measurement

To prevent operation mistakes from unintentionally starting measurement, the **START** key operation method can be changed.

Refer to "Start Action" (p. 315).

#### To automatically save data during measurement

Refer to "5.2.2 Automatically Save Waveforms" (p. 88).

#### To print the waveform

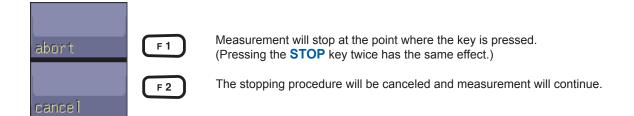
Refer to "6 Printing (When Model U8350 Printer Unit is installed)" (p. 113).

#### **To Stop Measurement**

Press the **STOP** key once to stop recording at the end of the specified recording length. Press the **STOP** key again to stop recording immediately.

The operation conditions for the **START** and **STOP** keys can be changed. Refer to "15 System Environment Settings" (p. 313).

When **STOP** is pressed, the following indication may appear on the screen.



When no key operation is made in this status, the measurement will stop at the end of the specified recording length and the display returns to the previous screen.

#### **Measurement and Internal Operations**

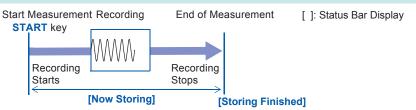
Measurement methods are normal measurement (start recording when measurement starts) and trigger measurement (start recording when trigger criteria are satisfied). In this manual, "Measurement start" means when you press the START key and "Recording start" means when recording begins on the waveform screen.

- · To record on either single or repeating trigger events
  - Select the Trigger mode. (p. 197)
- · To capture data measured prior to trigger events

Enable pre-triggering. (p. 209)

#### Normal Measurement

#### Without triggering



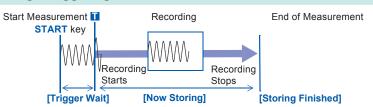
Terminates when measurement up to the recording length has made.

#### Trigger Measurement

Trigger modes: [Single]

Pre-triggering not enabled

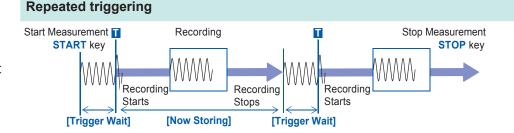
#### Single triggering



Recording starts when a trigger event occurs and continues for the specified recording length.

### Trigger modes: [Repeat]

Pre-triggering not enabled

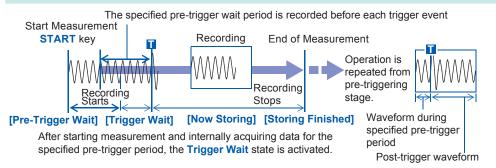


Recording starts when a trigger event occurs, continues for the specified recording length, and returns to the Trigger Wait state.

#### Repeated triggering and recording of phenomena before each event

Trigger modes: [Repeat]

Pre-triggering enabled



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

When the trigger mode is set to **[Repeat]** or **[Auto]** (Memory function only), the number of trigger events is shown in the top part of the screen (Storage Counter). Refer to "Explanation of Screen Contents" (p. 22).

### 3.6 Measurement With Automatic Range Setting (Auto-ranging Function) MEM

This applies only to the Memory function and analog modules.

When you press the **AUTO** key after inputting a signal to an analog unit, and select **[Auto Range]**, the horizontal axis range (timebase), vertical axis (voltage axis) range, and zero position will be selected and measurement started, all automatically.

The timebase will be set according to the lowest numbered channel among the channels where waveform display is on. It will be set automatically to record 1 to 2.5 cycles in 25 divisions.

When measuring using the auto-ranging function, the following items are adjusted.

Module-Related Conditions (For all channels)		
Vertical axis (Voltage axis) Range	Auto potup value	
Zero Position	Auto-setup value	
Vertical axis (Voltage axis) magnification	×1	
Low-pass filter	Off	
Input coupling	DC	

Trigger Criteria (For a single channel only)		
Trigger modes	Auto	
Trigger source AND/OR	OR	
Pre-Trigger	20%	
Internal Trigger	Only the lowest numbered channel for which waveform display is On will be On. (If the difference between maximum and minimum value is 8 divisions or less the next lowest numbered channel will be used)	
Trigger type	Level trigger: Slope, Rising Trigger level: Auto-setup value Filter: Off	

Status Screen - [Status] Sheet Conditions		
Timebase	Auto-setting value (time axis magnification: × 1)	

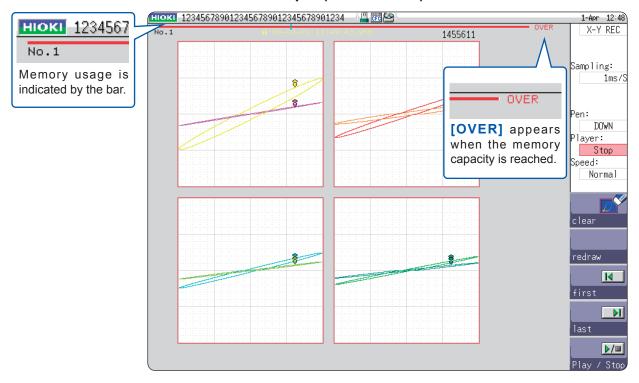
- When measurement is started with the auto-ranging setting, the trigger output signal is output to the
   external control terminal block's TRIG OUT terminal. Keep this in mind when performing auto-range
   measurement while using the trigger output terminal.
- The auto-ranging function automatically selects settings for the input signal that is present when the function is enabled. Start auto-ranging measurement after supplying the input signal (waveform).
- If the input signal of the lowest numbered channel selected for waveform display is extremely small, the timebase will be set according to the input signal of the next lowest channel.
- If range could not be set for any channel where waveform display is On, a warning message will appear and measurement will be interrupted.
- The auto-save and auto-print functions cannot be used when measuring with the auto-ranging function.
- For low-frequency signals of less than 10 Hz, the optimal range cannot be selected automatically. Set the range 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.

### 4

### X-Y Recorder Function

- The X-Y waveform generated from the input signal is displayed in real time.
- By saving the displayed data in memory, data can be stored as well as printed.
- Similar to an X-Y pen recorder, waveform drawing can be controlled by simulated pen up/down operation.
- Simultaneous observation of up to 8 X-Y phenomena is possible.
- Because waveform information is stored in memory, settings can be changed after measurement for repeated synthesis.

#### X-Y Recorder Waveform Screen Example (X-Y4 screen)



#### 4.1 Measurement Workflow

#### **1 Pre-measurement Inspection**

Refer to "3.2 Pre-measurement Inspection" (p. 57).

#### 2 Basic Measurement Settings

Select X-Y recorder as measurement function

Refer to...

"Function" (p. 79)

Set sampling rate

"Sampling" (p. 79)

**Determine screen layout format** 

"Format" (p. 79)

Determine whether to perform waveform interpolation

"Setting Descriptions" (p. 79)

Determine whether to clear previous waveform data

"Disp Clear" (p. 79)

#### 3 Input Channel Settings

Choose analog channel settings

Refer to "3.4.2 Choose Analog Channel Settings" (p. 69).

Logic channels cannot be used.

#### **Application examples**

Refer to...

- "8.6 Set the Waveform Position (Variable Function)" (p. 164)
- "8.7 Fine Adjustment of Input Values (Vernier Function)" (p. 167)
- "8.1 Add Comments" (p. 146)
- "8.5 Convert Input Values (Scaling Function)" (p. 157)

#### **4 Start Measurement**

Refer to...

"4.3 Start and Stop Measurement" (p. 80)

"7.1 Read Measurement Values (Using the AB Cursors)" (p. 128)

With the X-Y recorder function, the following operations are not available:

- Trigger setting
- Auto-saving
- Auto-printing

#### 5 Stop Measurement

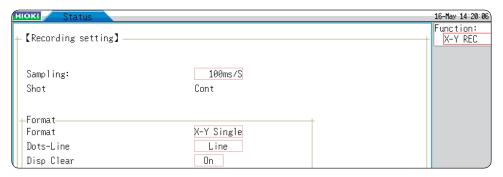
Refer to...

- "4.3 Start and Stop Measurement" (p. 80)
- "4 Redraw waveforms" (p. 80)
- "5.2.3 Save Data Selectively (SAVE Key)" (p. 94)
- "6.3 Manual Printing With the PRINT Key (Selective Printing)" (p. 118)

#### 4.2 Measurement Configuration

To set measurement parameters, press the **STATUS** key to bring up the Status screen and select the **[Status]** sheet. (Settings for measurement function and sampling rate can also be made on the Waveform screen.)

#### **Setting Descriptions**



**Function** 

Set the measurement function to X-Y recorder.

Sampling

Set the sampling rate.

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

[1 ms] can only be selected when [Dots-Line] is set to [Dots].

#### **Format**

Select the graph format for Waveform screen display or printout of the input signal. Up to 8 phenomena can be observed simultaneously.

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

### Dots-Line (interpolation)

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

Dots	Display and print sampling data as dots.
Line	Display and print sampling data using linear interpolation. (Default setting)

#### **Disp Clear**

If past waveforms remain at the start of measurement, you can either clear or keep them. If you keep them, the new waveforms will be displayed as an overlay.

Off	Overlay on existing waveforms
On	Clear existing waveforms (Default setting)

This completes the measurement configuration settings.

Next, choose analog channel settings.

For details, refer to "3.4.2 Choose Analog Channel Settings" (p. 69).

#### To set the channels for X-Y synthesis

Refer to "7.4 Perform Waveform X-Y Synthesis" (p. 134).

#### 4.3 Start and Stop Measurement

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

#### 1 Start measurement.

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

#### 2 Set the pen to Up/Down.

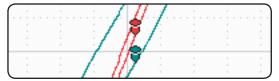
This setting can be chosen before or during measurement. When the pen is set to Down, the waveform is being drawn. When the pen is set to Up, the waveform is not drawn. This setting applies to all channels.

Move the cursor to [Pen] to change the setting.

Up Waveform is not drawn.

Down Waveform is drawn.

Up/Down operation is also possible using the TRIG.SET key or the Manual Trigger key.





Pen in Down position

Pen is shown in color and waveform is drawn.

Pen in Up position

Pen is shown in white and waveform is not drawn.

#### 3 Stop measurement

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

#### 4 Redraw waveforms

When measurement is stopped, waveform data for up to 16,000,000 samples before the current point can be played back (redrawn) by the pen, similar to using a video recorder, starting from any specified point. This setting applies to all channels. The playback speed can be specified. (It can also be changed during playback.) Waveform is only played back on the screen and will not affect the printout data. To print the same waveforms as shown on the screen, use the hard copy function (p. 124).

Move the cursor to [Player].

Clear	Clear only waveform display. (Waveform data will not be cleared.)
Redraw	Redraw measurement data. Measurement settings can also be changed for redrawing.
First	Move pen to start of waveform.
Last	Move pen to end of waveform.
Play/Stop	Start/stop waveform playback.

Move the cursor to [Speed]. With the [Normal] setting, playback occurs at the same speed as recording.

Very Fast/ Fast /Normal (Default setting)/ Slow/Very Slow

Measurement start/stop and pen up/down can be controlled via the external control terminal. (p. 346)

#### To Redraw With Different Waveform Display Settings

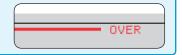
- After clearing the waveform display, waveform data is still retained by the unit. This makes it
  possible to change the settings for display format, display color, synthesis channels, channel
  zoom and offset before redrawing the waveform by selecting [Redraw]. When [Redraw] is
  executed, the screen and printout data will be renewed.
  - (As long as **[Redraw]** is not run, the screen and print data are not refreshed, even if the settings are changed.)
- The jog and shuttle knobs can also be used for redrawing.
   Jog Move back and forth in the redrawing process in increments of 1 sample.
   Shuttle Move back and forth in the redrawing process at a speed corresponding to the rotation angle.
- When moving backwards, the waveform will be drawn in the direction of earlier data. Erasing the waveform is not possible.
- If the measurement exceeds 16,000,000 samples, it is only possible to redraw up to 16,000,000 samples in the past, counting backwards from the point where measurement was stopped. Earlier waveform data is lost.
- Redrawing with the jog-shuttle is only reflected on the screen and will not affect the printout data. To print the same waveforms as shown on the screen, use the hard copy function (p. 124).

#### 4.4 Waveform Observation

Waveform data for up to 16,000,000 samples is stored in memory, and an A/B cursor pair can be used to trace measurement values. (p. 128)

The amount of memory used is indicated by the bar at the top of the screen.

When the number of samples exceeds 16,000,000, the indication **[OVER]** appears at the top of the screen.



#### 4.4.1 To Save and Print Waveforms

Saving

The **SAVE** key or the controls on the File screen can be used to save waveform data stored in memory as a file.

Refer to "5.2.3 Save Data Selectively (SAVE Key)" (p. 94).

Data stored as a file this way can be reloaded into the instrument, but cannot be read by a PC.

**Printing** 

The **PRINT** key can be used to print out waveforms.

Refer to "6.3 Manual Printing With the PRINT Key (Selective Printing)" (p. 118).

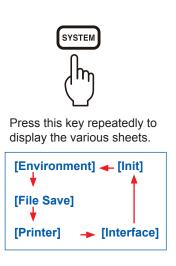
# 5

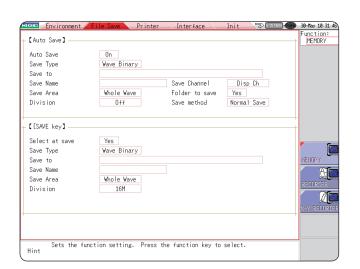
# Save/Load Data and Manage Files

This chapter explains how to save and load data and manage files on your Hioki Memory HiCorder.

Before saving data, configure the save settings on the **[File Save]** sheet. You can load data and manage files from the **File screen**.

#### To Open the [File Save] Sheet





#### Operations available from the [File Save] sheet

The following settings are available on the [File Save] sheet. (p. 87)

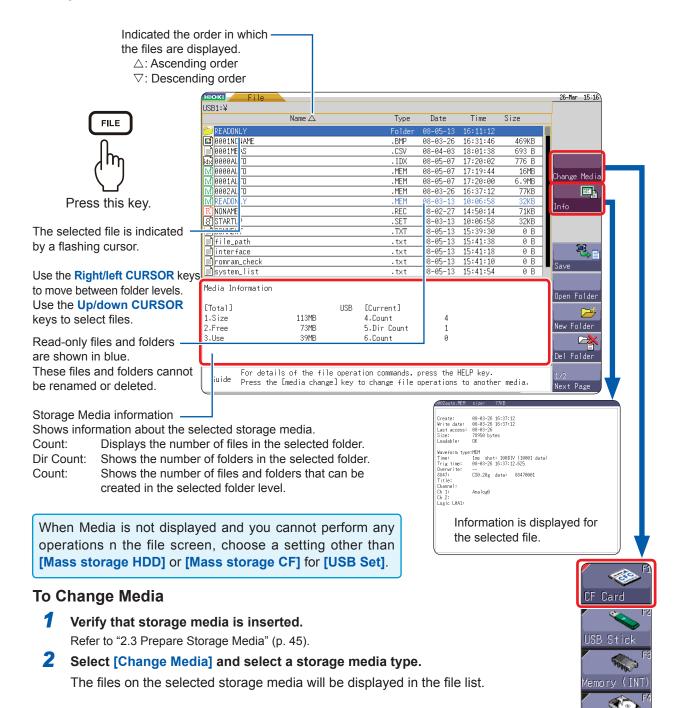
#### Auto-save settings

Set the method of automatic saving of waveform data.

#### **SAVE** key settings

Set the method of saving when the **SAVE** key is pressed.

#### To Open the File Screen



#### Operations available from the File screen

Format storage media	(p. 47)
Load data	(p. 99)
Save/load an auto-settings file	(p. 102)

Manage files	(p. 87)
<ul> <li>Save data (p. 104)</li> <li>Create new folders (p. 106)</li> <li>Copy files (p. 110)</li> <li>Sort files (p. 108)</li> <li>Delete files (p. 107)</li> <li>Rename files (p. 109)</li> <li>Print the File List (p. 111)</li> </ul>	

#### 5.1 Data That Can Be Saved and Loaded

✓: Possible, —: Not possible

	✓: Possible, —: Not pos							
File type	File format	lcon	File extension and description		Auto		Load	PC readable
Settings data <sup>*1</sup>	Binary	8	SET	Settings data (Measurement Configuration)	_	√ Mailuai	<b>✓</b>	_
*2		M	MEM	Memory Function waveform data	✓	✓	✓	*4
Waveform data <sup>*2</sup> Entire waveform acquired by the		R	REC	Recorder Function waveform data	<b>✓</b>	~	<b>✓</b>	*4
instrument or a section of the	Binary	ΧŸ	XYC	X-Y Recorder Function waveform data	_	<b>✓</b>	<b>✓</b>	_
waveform specified with the A and B		F	FFT	FFT Function data	✓	✓	<b>✓</b>	_
cursors.	Text		CSV	Text Data	✓	✓	_	✓
Waveform		idx	IDX	Index data for divided saving	✓	✓	✓	_
Management Data <sup>*3</sup> (Divided Saving)	(Index file)	SEÔ	SEQ	Index data for memory division (automatically created during batch saving)	<b>✓</b>	<b>✓</b>	<b>✓</b>	_
Captured Screen Image (Display/ Waveform screens)	BMP*5		ВМР	Image Data	_	<b>✓</b>	_	<b>✓</b>
Numerical Calculation Results	Text		CSV	Text Data	<b>✓</b>	<b>✓</b>	_	✓
Comments for Printing	Text		TXT	Text Data	_	_	✓*6	✓
Waveform evaluation setting data	Binary	Â	ARE	Settings data (Measurement conditions + waveform evaluation areas)	_	<b>✓</b>	<b>✓</b>	_
Waveform evaluation area	ВМР		ВМР	Waveform evaluation area image data	_	<b>✓</b>	<b>✓</b>	✓
Arbitrary waveform data	Binary	WFĜ	WFG	Arbitrary waveform data (For U8793)	_	<b>✓</b>	<b>✓</b>	_
Arbitrary waveform data	Text	TFĜ	TFG	Arbitrary waveform data (For U8793)	_	_	<b>✓</b>	✓
Pulse pattern data	Binary	PLŜ	PLS	Pulse pattern data (For MR8791)	_	<b>✓</b>	<b>✓</b>	_
Generation program data	Program	FGP	FGP	Generation program data (For U8793)	_	<b>✓</b>	<b>✓</b>	_

- \*1: Multiple data can be saved in the instrument, and loaded selectively. Automatic loading at power-on is also possible. (p. 102)
- \*2: When data is to be reloaded on the instrument, save it in binary format. Waveforms and some measurement settings can be saved for reloading.
  - When the data is to be loaded on a PC, save it in text format. (p. 87)
  - When saving a section of a waveform, use the A and B cursors to set the section to be saved. (p. 128), (p. 131)
- \*3: When you want to use memory division and load all blocks at the same time:
  Save measurement data using [All blocks]. A directory will be created automatically and waveform data for each block and index data (SEQ) will be created. When loading, load this index data.

  When loading waveform data from divided saving, import the IDX index data.
- \*4: Loading is possible with Wave Viewer (Wv).

- \*5: This is a standard Windows® graphics format. Files in this format can be handled by many graphics programs.
- \*6: It is possible to print out loaded waveforms with text files created on a PC. Other processing operations are not available.

Files larger than 2 GB cannot be saved.

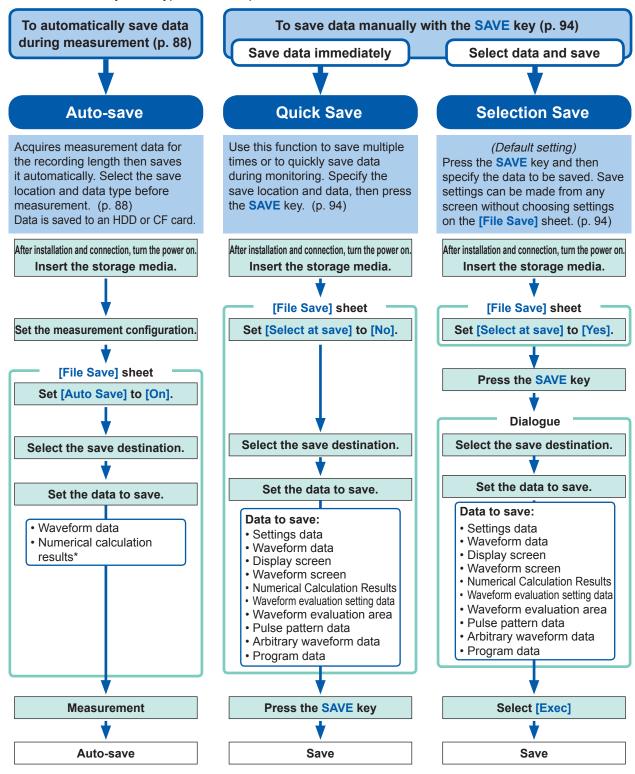
#### **Data That Cannot Be Loaded on the Instrument**

- · Data saved by other instruments.
- Image files other than waveform evaluation areas (iii)
- ? Files displayed with this icon.

#### 5.2 Save Data

#### 5.2.1 Save Types and Workflow

There are basically three types of save operations.



#### Check before saving:

- Is the storage media inserted and initialized? (p. 45), (p. 47)
- Is the save location specified correctly?
- · Is auto-save set to [On]? (For auto-saving)

### \* To save numerical calculation results

Refer to "10.4 Save Numerical Calculation Results" (p. 227).

#### 5.2.2 Automatically Save Waveforms

This function acquires measurement data for the recording length then saves the waveform data automatically. The save location and data to be saved must be selected before measurement starts.

#### Procedure

Press the **SYSTEM** key to open the System screen.  $\rightarrow$  [File Save] sheet

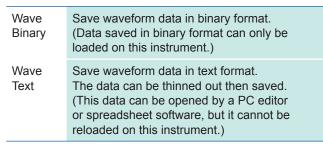
1 Enable auto-save.

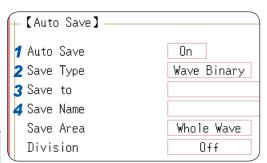
Move the cursor to [Auto Save], and select [On].

Default setting: Off (no automatic saving)

Set the data to be saved.

Move the cursor to [Save Type].





#### 3 Set the save destination.

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

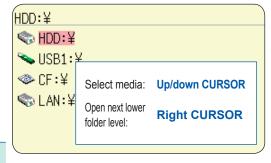
The Browse folders dialog box appears (at bottom right).

Move the cursor to the storage media you want to save the data to and confirm the setting with **[Confirm]**.

HDD	Automatically save the waveform data on the built-in drive. (When Model U8330 SSD Unit is installed)
CF	Automatically save the waveform data on a CF card.
USB	Automatically save the waveform data on a USB memory stick.
LAN	Automatically save the waveform data on a PC connected via LAN.  Model 9333 LAN Communicator required.

When the root directory (topmost folder on the storage media) is selected, a folder named "HIOKI\_MR8827" will be created automatically. (If the media was formatted by the instrument, the folder will already have been created.) This folder is then used as the save location.

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



#### To save the waveform data on a PC connected via LAN

The 9333 LAN Communicator must be installed on the PC 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 a PC, refer to the instruction manual of Model 9333 LAN Communicator.

 When setting the save destination to [LAN]

You must first set the IP addresses of the unit and the PC connected via LAN. For more information about how to set the IP addresses, refer to (p. 318).

#### 4 Set the file name.

Move the cursor to **[Save Name]**, and enter a file name. Refer to "8.1.3 Alphanumeric Input" (p. 149).

When **[LAN]** is set as the save destination, **[Save Name]** is ignored and the files will be named in the previously-determined format.

Refer to "Save Operations (When Setting the Save Destination to [LAN])" (p. 93).

#### File name

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

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

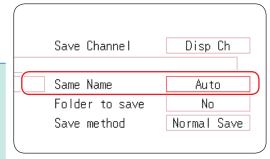
Move the cursor to [Same Name].

Auto

If no files with the same name exist, saves the file with the designated name. Otherwise, a 4-digit number is automatically added to the eginning of the file name (default setting). If the first character of the file name is a numeral, the added number will continue sequentially from that number.

Serial

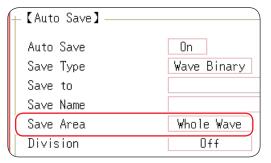
Unconditionally, a 4-digit number is automatically added to the beginning of the file name. If a file with the same name exists, saves the file, adding the 4-digit number that is increased by 1.



#### 6 Set the save area.

Move the cursor to [Save Area].

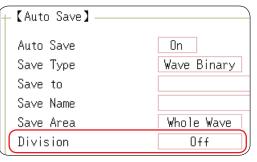
Whole Wave	Save all recorded data. (Default setting)
A-B Wave	Save the data between the A and B cursors. If only cursor A is set, all data after the cursor will be saved.  To specify the AB cursors (p. 128)



#### 7 (When the selected save type is [Wave Binary]) Select whether to save divided files.

Move the cursor to [Division].

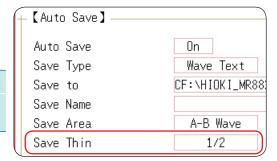
Off	Files are not divided when saved.
16M, 32M, 64M	Select the size for Divided Save.



### (When [Wave Text] is selected as the save type) Set the data thinning amount.

Move the cursor to [Save Thin].

Off	No data thinning (sub-sampling).
1/2 to 1/1000	Set the thinning amount (the fraction of the total data to retain).



#### About divided saving

- Large quantities of waveform data can be divided and saved as multiple files.
- Saving divided data automatically makes a folder then creates one or more waveform files and an index (IDX) file in that folder. The IDX file can be used to load the data in the waveform file(s) as a batch.
- When divided saving is selected, delete save (p. 76) is not available.
- Automatic divided saving is not possible when using the memory division function. Refer to "Divided files are loaded together." (p. 101) or "12 Memory Division Function" (p. 245).

#### **Thinning**

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

Example: When [1/2] is set, every second data item is saved.

The number of data items is reduced to 1/2 the original amount.

#### Save destination

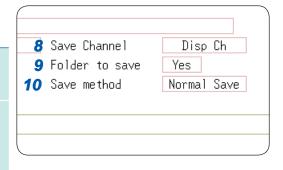
Data can also be saved to a USB flash drive in real time, but for data protection we recommend using Hioki's optional CF card instead.

#### 8 Select the channels to save.

Move the cursor to [Save Ch].

Disp Ch
Saves the channels of all sheets for which waveform display is set to [On]. (Default setting)

All Ch
Saves all measured channels (When using the memory function, saves channels which have been set as [Used Ch] on the Status settings screen).
Saves the channels for which waveform display is set to [Off].



#### 9 Set whether to create folders.

Move the cursor to [Folder to save].

No	A folder is not created when measurement starts.
Yes	A folder is created automatically when measurement starts and files are saved in this folder.

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

#### 10 Set the save method for when the storage media runs out of space.

Move the cursor to [Save method].

Normal Save	Automatic saving stops when the storage media is full.
Delete Save	Old files are deleted and automatic saving is continues when the storage media is full. (Waveform files only.)

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

### 11 Confirm the measurement configuration then start measurement.

Press the **START** key.

After the data is acquired, the screen image is saved automatically to the specified storage media.

#### Maximum number of files per folder

The combined maximum for files and folders created in one folder is 5,000. Refer to "Auto-save Operations (When Setting the Save Destination to Storage Media)" (p. 92).

[Preparing files] display

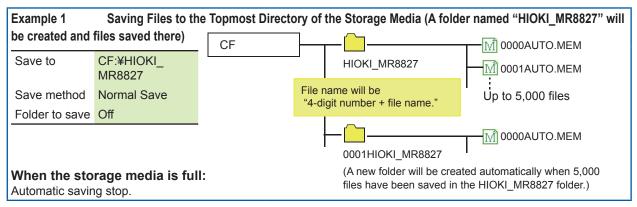
Sometimes [Preparing files] is displayed after measurement starts. This indicates that the instrument is checking the status of the destination where the file will be saved. The more the files exist in the destination folder, the longer the preparation takes.

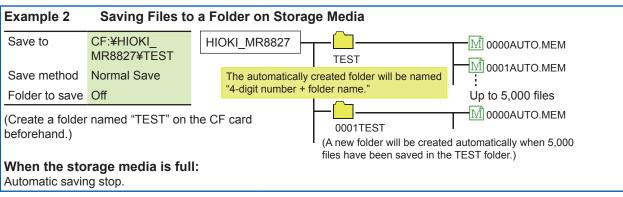
When printing is attempted simultaneously with saving, the printing may override the saving and **[Preparing files]** may be displayed longer.

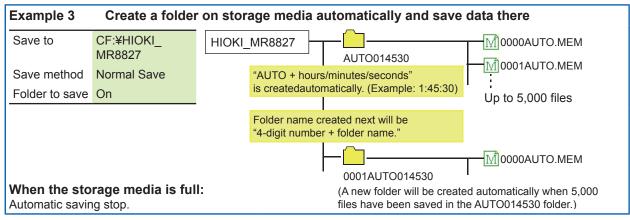
#### To clear the Auto Save dialog box

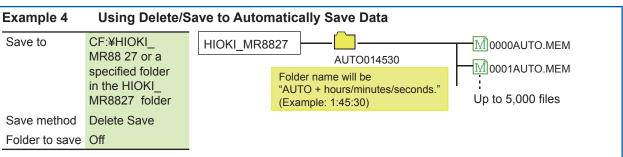
Press the **SAVE** key to toggle dialog box display.

#### **Auto-save Operations (When Setting the Save Destination to Storage Media)**



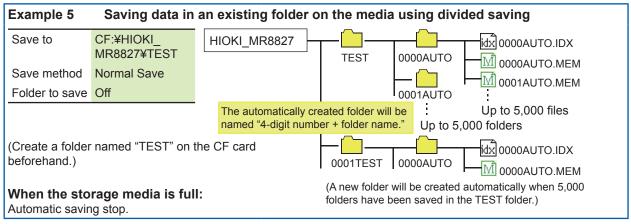


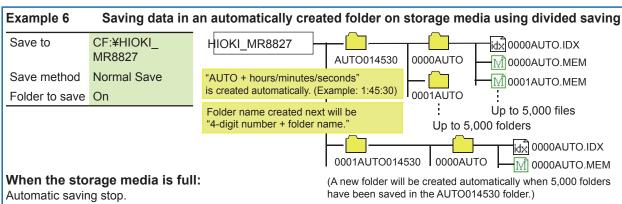




When the number of files in the folder has reached 5,000, or when the storage media is full, files in the AUTO014530 folder (or specified folder) will automatically be deleted in sequence, starting from the oldest file, and replaced by new files.

Only waveform files will be deleted.



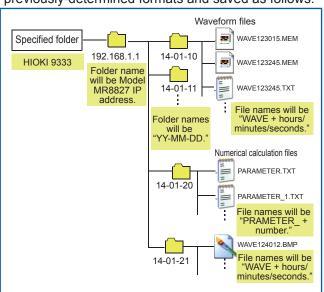


#### Save Operations (When Setting the Save Destination to [LAN])

The file is saved according to the method (on the right figure) specified under [Save Settings] using the 9333 LAN Communicator.

For more information about how to configure save settings, refer to the instruction manual for the 9333 LAN Communicator.

The destination folders and files are named in the previously-determined formats and saved as follows:





#### 5.2.3 Save Data Selectively (SAVE Key)

To use the **SAVE** key for quick saving, you first need to set the saving conditions.

The following types of data can be saved: setting data, waveform data, display screens, waveform screen, and numerical calculation results.

#### Procedure

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

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

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

Yes	After pressing the <b>SAVE</b> key, a dialog box will appear to select data before saving. ( <i>Default setting</i> ) Refer to "Selection Save" (p. 87).
No	The preset data is saved when you press the <b>SAVE</b> key. Refer to "Quick Save" (p. 87).

When **[Yes]** is selected, the following setting determines which dialog box appears when you press the **SAVE** key. (Middle screen at right)

This does not apply when other dialogs such as the "Folder Reference Dialog" are being displayed.

#### 2 Set the save destination.

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

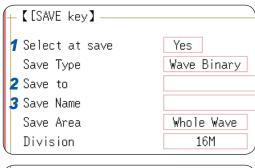
The Browse folders dialog box appears (at bottom right).

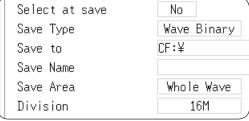
Move the cursor to the storage media you want to save the data to and confirm the setting with [Confirm].

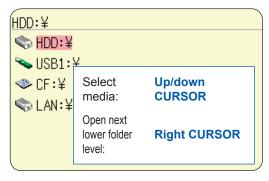
HDD	Automatically save the waveform data on the built-in drive. (When Model U8330 SSD Unit is installed)
CF	Automatically save the waveform data on a CF card.
USB	Automatically save the waveform data on a USB memory stick.
LAN	Automatically save the waveform data on a PC connected via LAN.  Model 9333 LAN Communicator required.

When the root directory (topmost folder on the storage media) is selected, a folder named "HIOKI\_MR8827" will be created automatically. (If the media was formatted by the instrument, the folder will already have been created.) This folder is then used as the save location.

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







#### 3 Set the file name.

Move the cursor to **[Save Name]**, and enter a file name. Refer to "8.1.3 Alphanumeric Input" (p. 149).

When **[LAN]** is set as the save destination, **[Save Name]** is ignored and the files will be named in the previously-determined format.

Refer to "Save Operations (When Setting the Save Destination to [LAN])" (p. 93).

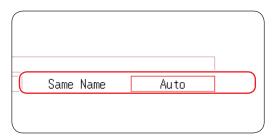
#### **File Name**

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

#### Specify the action if a file with the same name exists in the target folder.

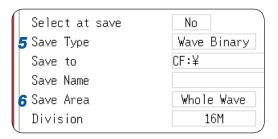
Move the cursor to [Same Name].

Auto	If no files with the same name exist, saves the file with the designated name.  Otherwise, a 4-digit number is automatically added to the beginning of the file name (default setting).  If the first character of the file name is a numeral, the added number will continue sequentially from that number.
Serial	Unconditionally, a 4-digit number is utomatically added to the beginning of the file name. If a file with the same name exists, saves the file, adding the 4-digit number that is increased by 1.



#### 5 Set to save.

Move the cursor to [Save Type].



Set	Save the settings data.
Wave Binary	Save waveform data in binary format. Select this to be able to reload the waveform on the instrument.
Wave Text	Save waveform data in text format. Select this to use the waveform data on a PC. (Memory/Recorder/FFT Function only)
Wave ALLWave Bin	Save data for all blocks in binary format. (Only when the memory division setting is ${f [On]}$ .)
Wave ALLWave Txt	Save waveform data in text format. (When the memory division setting is <b>[On]</b> )
Screen Copy	Save screen display data as a BMP file.  Data saved in BMP format can be displayed on a PC with image viewing software.
Wave Image	Save printer output data as a BMP file.  Data saved in BMP format can be displayed on a PC with image viewing software.
Numerical Calculation Results	Save numerical calculation results. (Memory Function only)
Waveform evaluation settings	Save settings data and waveform evaluation areas.
Waveform evaluation area	Save evaluation areas created with the waveform evaluation function as black-and-white BMP files. Saved data can be edited on a PC and loaded back into the instrument.  Edit images in black and white only.
Pulse pattern	Saves pulse patterns registerd in the MR8791.
Arbitrary waveform	Saves arbitrary waveforms registered in the U8793.
Program	Saves program data registered in the U8793.

### **6** (When Wave Binary or Wave Text has been selected) Move the cursor to [Save Area].

Whole Wave	Save all recorded data. (Default setting)
A-B Wave	Save the data between the A and B cursors. If only cursor A is set, all data after the cursor will be saved.  Refer to "7.2 Specify a Waveform Range (AB Cursor)" (p. 131).

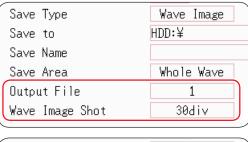
The channel displayed on the screen will be saved.

#### 7 Advanced settings

Available settings will differ depending on the save type.

Save types	Settings	Description
Setting	-	-
Wave	Division	(Off, 16 M, 32 M, 64 M)
Binary		Select this to divide large files into
		several files when saving.
		A folder with the specified name
		will be created and data saved as
Wave	Save	multiple files in that folder.
Text	Save Thin	(Off, 1/2 to 1/1000)
IEXL	rmn	Select this to use thinning (sub-
		sampling) when saving text data. Set the thinning amount (the fraction
		of the total data to retain).
Screen	Image	(Color, Gray, Mono, Mono [Rev])
Сору	Color	Specifies the color palette of the
(Hard		created image file.
сору	Image	(UnCompressed, Compressed)
of the	size	Determines whether the image file is
display)		compressed.
	Save	(Yes, No)
	GUI	Determines whether the GUI will be
		saved in the image.
Wave	Output	(All, 1 to 250)
Image	File	Specifies the number of files to save.
(Print		To specify a range, open the [Printer]
image)		sheet from the System screen and
		set the printing area to [A-B Wave].
		(Memory/Recorder Function only)
	Wave	(1 to 60 div)
	Image	Specifies the amount of data per file.
	Shot	If the amount of measurement
		data is lower than the entered
		number of divisions, only the actual measurement data amount will be
		saved. (Memory/Recorder Function
		only)
Calc	Folder	(New File, Existing File)
Result	to save	Determines whether data is saved
		under a new file name every time (with
		automatically incremented number
		if the same file name exists), or
		appended to the same file.

Save Type Save to Save Name Save Area Division	Wave Binary CF:¥ Whole Wave
Save Name Save Area	Whole Wave
Save Area	
Division	2
	Off
Save Type	Wave Text
Save to	CF:¥
Save Name	
Save Area	Whole Wave
Save Thin	OFF
Save Type	Screen copy
Save to	
Save Name	
Image Color	Color
Image size	Uncompressed
Save GUI	Yes
Save to Save Name Save Area Save Thin  Save Type Save to Save Name Image Color Image size	CF:¥  Whole Wave  OFF  Screen copy  Color Uncompressed



Save Type	Calc Result
Save to	CF:¥
Save Name	
Folder to save	New File

#### **8** (For memory function)

#### When using the memory division function

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

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

This completes the data save settings.

These settings will be used whenever the **SAVE** key is pressed.

If "Image size" is used when saving a display image file, the image may not be viewable with some image viewer applications.

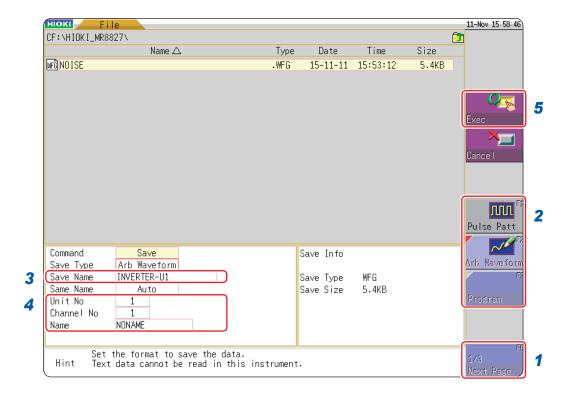
#### 5.2.4 Save Waveform Output Data to the Media

The pulse pattern data registered in Model MR8791, arbitrary waveform data registered in Model U8793, or program data is saved in the media.

Before attempting to save the data, make sure that the storage media is inserted and the loading target is correctly specified.

#### Procedure

To open the screen: press the FILE key to display the [File] sheet.



- 1 Press [Next Page].
- Select [Pulse Patt], [Arb Waveform], or [Program].
- 3 Enter a [Save Name].
- 4 Register a [Unit No], a [Channel No], and a [Name] of the MR8791 or the U8793.
- 5 Press [Exec].

The data registered in the module is saved to the media.

Refer to the instruction manual of Models U8793, MR8790, and MR8791 regarding each detailed save settings.

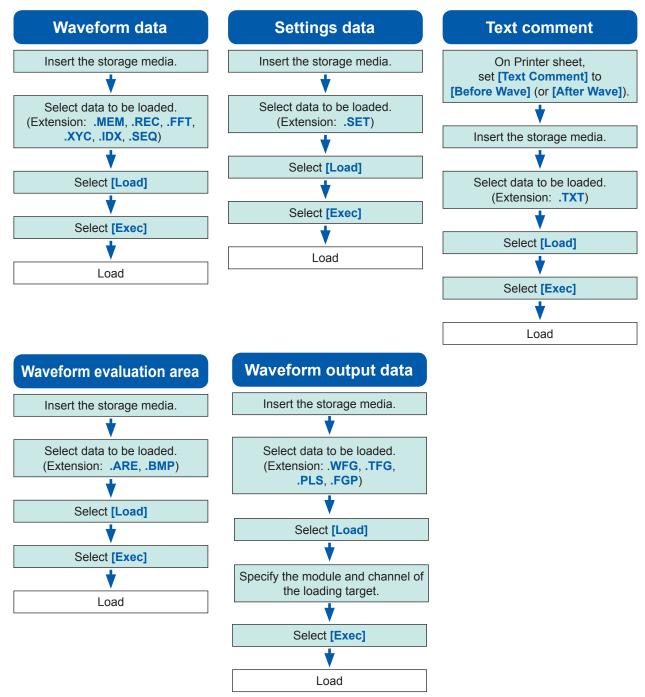
#### 5.3 Load Data

Data saved on storage media or in the internal memory of the instrument can be reloaded.

#### **Load Data Workflow**

Before attempting to load data, make sure that the storage media is inserted and the loading target is correctly specified.

Only settings and measurement data saved in binary format can be loaded on the instrument.



Refer to See "8.11 Register the Waveform in the U8793 ArbitraryWaveform Generator Unit" (page 191), or the instruction manual of Models U8793, MR8790, and MR8791 regarding the detailed settings for loading (registration) of pulse pattern data, arbitrary waveform data, program data.

#### Procedure

Press the FILE key to open the File screen.

#### 1 To load a text comment

Press the **SYSTEM** key and bring up the **[Printer]** sheet.

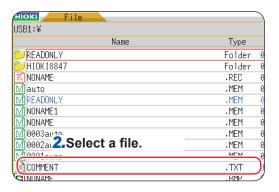
Move the cursor to [Text Comment], and select [Before Wave] (or [After Wave]).

# Up/Low Print 0-Pos Comment Text Comment Print Counter Off Off Off Off Off Off

#### 2 Select a file.

Use the **CURSOR** keys to select the file to load. (The file type is indicated by the extension)

Refer to "(Extension)" in the "Load Data Workflow" (p. 99).



#### **3** Carry out the loading operation.

Select [Exec]. The file will be loaded.

The name of the loaded file will appear on the screen.

To cancel loading, select [Cancel].

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

#### Other limitations

- Data saved with Memory HiCorders other than the MR8827 cannot be loaded.
- When loading waveform data, the settings for the unit will change to the same settings as when
  the data was saved. To reset the unit settings, carry out [Clear Wave Data] (p. 398) or start
  measurement.

#### **Batch Load of Waveform Data**

When the following index files are loaded, waveform data can be loaded as a batch. With the following settings, index files are created along with waveform files.

Extension	Explanation
IDX	Divided files are loaded together.  (To create index files, use [Division] on the [File Save] sheet of the System screen to set the dividing size before saving. Note: If [Save type] is not [Wave Binary], index files will not be created)  Refer to "5.2.2 Automatically Save Waveforms" (p. 88) or "5.2.3 Save Data Selectively (SAVE Key)" (p. 94).
SEQ	(When using the memory division function of the memory function) Waveform data of all blocks is loaded together. (To create index files, set [Memory Div] to [On] on the [Memory Div] sheet of the Status Screen, and then, set [Save Type] to [ALL-Wave Bin] on the [File Save] sheet of the System Screen.) Refer to "12.1 Recording Settings" (p. 247) or "5.2.3 Save Data Selectively (SAVE Key)" (p. 94).

#### **Load a Waveform Evaluation Area**

Files with the following two extensions can be loaded:

Extension	Explanation
ARE	Loads waveform evaluation areas and settings data (Files saved by selecting [Area settings] when saving the data).
ВМР	Loads waveform evaluation areas.  (Files saved by selecting [Area image] when saving the data can be edited on a PC and then loaded back into the instrument.)

#### Data Loading for Waveform Generation (Registration)

You can load data for generated modules.

Data loading is performed on Signal generator sheet of Channel screen (**CHAN** key) or FILE screen (**FILE** key).

For details, see the instruction manual of Models U8793, MR8790, and MR8791.

Extension	Explanation
WFG, TFG	Loads waveform evaluation areas and settings data (Files saved by selecting [Area settings] when saving the data). Refer to "8.11 Register the Waveform in the U8793 ArbitraryWaveform Generator Unit" (p. 191)
PLS	The data for pulse pattern generation is loaded in channels of a specified arbitrary wave generator module.  The pulse pattern waveform loaded (registered) is output from Model MR8791 Pulse Generator Unit.
FGP	The waveform generation program file is loaded in channels of a specified arbitrary waveform generator module.

### 5.4 Automatically Load Settings (Auto-setup Function)

When settings are saved as described below, they can be loaded automatically at power-up.

The auto-setup function is compatible with CF cards only.

If the STARTUP file is on the built-in drive, USB memory stick, or RAM (internal memory), it will not be referenced. Always create the STARTUP file on a CF card.

#### **Procedure**

Press the FILE key to open the File screen.

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

2 If a folder named "HIOKI\_MR8827" exists in the root directory (topmost folder on media), move the cursor to that folder.

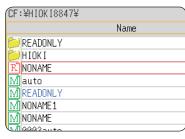
If the folder does not exist, go to the root directory. (A folder named "HIOKI\_MR8827" will be created automatically and used as the save location.)

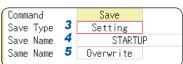
- 3 Select [Save] and set [Save Type] to [Setting].
- 4 Move the cursor to [Save Name], and enter "STARTUP." Refer to "8.1.3 Alphanumeric Input" (p. 149).
- **5** Move the cursor to [Same Name], and select [Overwrite].
- 6 Select [Exec].

To cancel setting, select [Cancel].

The next time the instrument is turned on, the settings will be loaded automatically.

To change the storage media: (p. 84)





# 5.5 Manage Files

Press the **FILE** key to display the File screen. Data saved to storage media can be managed on the File screen.

Use the **CURSOR** keys to select a file from the file list.

Before performing an operation, insert the storage media (except for the optional built-in drive). When no storage media is inserted, **[NO FILE]** appears in the file list of the File screen.

## **List of File Operations**

Operation key	Function indication (GUI)	Description	Reference page
CH.SET	Media Change	Change storage media.	(p. 84)
F1	Save	Select channels and save settings data and waveform data as files.	(p. 104)
	Sort	Sort the files in the file list in the selected order.	(p. 108)
F2	Open Folder	Open the selected folder.	
	Load	Load settings data or waveform data from a file.	(p. 99)
	Сору	Copy a file to a specified folder. If selected item is a folder, move to that folder.	(p. 110)
F3	New Folder	Create a new folder.	(p. 106)
	Rename	Change a file or folder name.	(p. 109)
F4	Delete	Delete a file or folder.	(p. 107)
	Format	Format selected storage media.	(p. 47)
F5	Next Page	Switch the operations assigned to the <b>F</b> keys (GUI).	

#### 5.5.1 Save Data

You can save settings data, waveform data, or waveform genaration data on storage media. Data will be saved in the folder indicated by the cursor.

By using the AB cursor pair, portions of waveform data can be saved.

#### Procedure

Press the FILE key to open the File screen.

**1** Select storage media. Refer to "To Change Media" (p. 84).

2 Move the cursor to the target folder.

3 Set the data to save.

Select [Save] then [Save Type].

Setting	Settings data		
Wave Binary	Waveform data (Binary)		
Wave Text	Waveform data (Text) (Memory/Recorder/FFT Function)		
Numeric value calculation results	Numeric value 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	Arbitrary waveform data registered in the U8793*		
Program Program data registered in the U8793*			

Refer to "5.2.4 Save Waveform Output Data to the Media" (p. 98)

Set the file name.

Move the cursor to [Save Name].

Enter a file name.

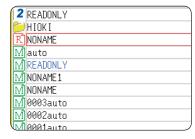
Refer to "8.1.3 Alphanumeric Input" (p. 149).

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

Move the cursor to [Same Name].

Auto	If a file with the same name exists, a 4-digit number is automatically added to the beginning of the file name.  If the first character of the file name is a numeral, the added number will continue sequentially from that number.	
Serial	Unconditionally, a 4-digit number is automatically added to the beginning of the file name. If a file with the same name exists, saves the file, adding the 4-digit number that is increased by 1.	
Overwrite	Saves the file with the designated name.	
Error	If a file with the same name exists, an error message will be displayed.	

To change the storage media: (p. 84)





- The "Text" option is only for loading the data on a PC.
   Data saved with this option cannot be loaded back into the instrument. To reload the data on the instrument at a later date use the "Binary" option.
- When [Memory (Int)] is selected as storage media, only settings data can be saved.
- Waveform evaluation areas can be saved as a black-andwhite BMP files.
- Saved data can be edited on a PC and loaded back into the instrument.
- Edit images in black and white only.

### 6 (When the selected save type is [Wave Binary])

Select whether to save divided files.

Move the cursor to [Division].

Off	Files are not divided when saved.
16M, 32M, 64M	Select the size for Divided Save.

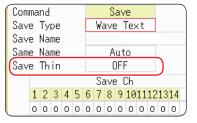
Refer to "About divided saving" (p. 105).

#### (When the selected save type is [Text])

#### Set the data thinning amount.

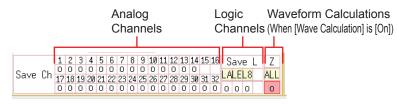
Move the cursor to [Save Thin].

Off	No data thinning (sub-sampling).
1/2 to 1/1000	Set the thinning amount (the fraction of the total data to retain).



#### 7 Select the channels to save.

Move the cursor to [Save Ch].



Cells for channels of logic modules or generator modules are left blank.

_	Channel will not be saved.
0	Channel will be saved.
All Ch	Saves waveforms acquired across all channels (analog, logic, calculated waveforms).
Reset	Return to previous settings.

When saving settings data, a settings file for automatic loading of settings can be created as follows: specify the folder [HIOKI\_MR8827] on the CF card as the save location folder and use [STARTUP] as [Save Name].

Refer to "5.4 Automatically Load Settings (Auto-setup Function)" (p. 102).

## Execute the save operation.

Select [Exec].

To cancel saving, select [Cancel].

#### File name

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

#### About divided saving

- · Large quantities of waveform data can be divided and saved as multiple files if necessary.
- Saving divided data creates one or more waveform files and an index (IDX) file.
- Then by loading the IDX file, the data in the waveform file(s) is loaded as a batch. Refer to "Batch Load of Waveform Data" (p. 101).
- Each file can be loaded as a separate waveform data file.

#### **Other limitations**

Text format data cannot be loaded on the instrument.

## 5.5.2 Check the Contents of a Folder (Open a Folder)

Opening a folder allows you to inspect its contents. (Moves to the folder.)

#### Procedure

Press the FILE key to open the File screen.

To change the storage media: (p. 84)

- Move the cursor to the folder whose contents you want to see.
- Select [Open Folder] or press the Right CURSOR key.
  A list with the folder contents will be displayed.

#### To return to a higher folder

Press the Left CURSOR key.

#### 5.5.3 Create New Folders

You can create a new folder in the currently displayed folder level.

#### Procedure

Press the **FILE** key to open the File screen.

To change the storage media: (p. 84)

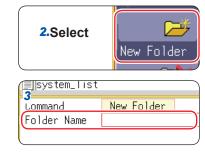
- Navigate to the folder level where you want to create a new folder.
- 2 Select [New Folder].
- 3 Enter [Folder Name].

Refer to "8.1 Add Comments" (p. 146).

4 Select [Exec].

A new folder will be created.

To cancel creating folder, select [Cancel].



#### Folder name

The maximum number of characters for [Save Name] is 127. The maximum path length including folder name is 255 characters.

#### 5.5.4 Delete Files and Folders

Follow this procedure when you need to delete files or folders from your Memory HiCorder.

#### Procedure

Press the **FILE** key to open the File screen.

- 1 Select the file or folder you want to delete.
- 2 Select [Del Folder]. [DeleteTarget] displays [DeleteOne].
- **3** (When multiple files are to be deleted) Select [Multi Files].

[DeleteTarget] displays [DeletePlural].

Slct/Deslct	Select the individual file or folder at the cursor. If something is currently selected, the selection will be cleared.
Slct/Deslct All	Select all files or folders. If something is currently selected, the selection will be cleared.
Rev Slct	Currently selected files or folders will be deselected, and currently unselected files or folders will be selected.

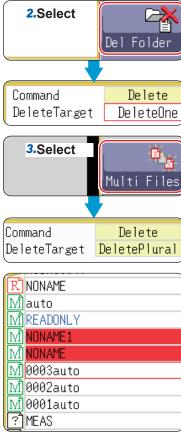
Selected files or folders are shown in red (see illustration at right).

# 4 Select [Exec].

The selected files or folders will be deleted.

To cancel deletion, select [Cancel].

To change the storage media: (p. 84)



#### 5.5.5 Sort Files

You can change the sort type and order of the file list.

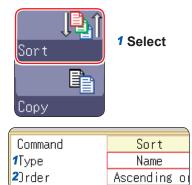
#### Procedure

Press the **FILE** key to open the File screen.

To change the storage media: (p. 84)

#### 1 Select [Sort] then select [Type].

Off	No sorting.
Name	Sorts files alphabetically by file name.
Туре	Sorts files by type of data (settings, MEM waveforms, etc.)
Date	Sorts files by creation date and time.
Size	Sorts files by size.



## 2 Move the cursor to [Order].

Ascending order	$A \rightarrow Z \rightarrow$ , Old $\rightarrow$ New, Small $\rightarrow$ Large
Descending order	Reverse sort order

Folders/files will be sorted in the specified order.

## 3 Select [OK].

The sort screen will close.

The order format will be displayed in the file list (with  $\triangle$ : Ascending order;  $\nabla$ : Descending order mark) and indicated in the GUI. When there are both files and folders, folders are listed at the top and files at the bottom.

#### 5.5.6 Rename Files and Folders

Follow this procedure when you want to rename a file or folder.

#### Procedure

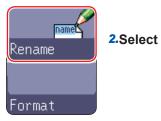
Press the **FILE** key to open the File screen.

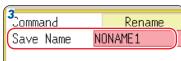
- 1 Select the file or folder you want to rename.
- 2 Select [Rename].
- 3 Select [Enter Char], and enter [Save Name]. Refer to "8.1 Add Comments" (p. 146).
- 4 Select [Exec].

The file or folder will be renamed.

To cancel renaming, select [Cancel].

To change the storage media: (p. 84)





## 5.5.7 Copy a File Into a Specified Folder

This function allows to organize your files by copying files into specified folders.

#### Procedure

Press the FILE key to open the File screen.

- 1 Move the cursor to the file you want to copy.
- 2 Select [Copy].
  Move the cursor to [Copy Place].
- 3 Select [Edit].

The Browse folders dialog box appears (at bottom right).

- 4 Move the cursor to the target folder and confirm the setting with [Confirm].
- 5 (When there are multiple copy targets) Select [Multi Files].

Slct/Deslct	Select the individual file or folder at the cursor. If something is currently selected, the selection will be cleared.
Slct/Deslct All	Select all files or folders. If something is currently selected, the selection will be cleared.
Rev Slct	Currently selected files or folders will be deselected, and currently unselected files or folders will be selected.

Selected files or folders are shown in red (see illustration at right).

Select [Select End].

6 Select [Exec].

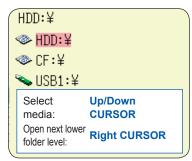
The file(s) will be copied to the specified target location.

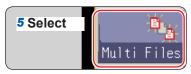
To cancel copying, select [Cancel].

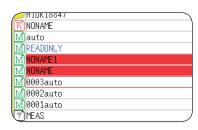
To change the storage media: (p. 84)











#### 5.5.8 Print the File List

The file list of the File screen can be printed. Details for all displayed items in the file list will print. Only folder names are printed for folders. Information on the contents of folders is not printed.

#### Before printing, make sure the recording paper is loaded correctly.

Refer to "2.4 Load Instrument With Recording Paper (When Model U8350 Printer Unit is installed)" (p. 48).

#### Procedure

Press the **FILE** key to open the screen  $\rightarrow$  File screen

To change the storage media: (p. 84)

#### Press the PRINT key.

The file list will print.

#### To cancel printing before it has finished:

Press the **STOP** key.

The file list will print as shown below.

#### **Print Example**

No.	File Name	Туре	Date	Size	Attribute
1 2			14-06-16 00:00:00 14-06-16 00:01:00		[ ]

File attributes are represented by single letters according to the table below.

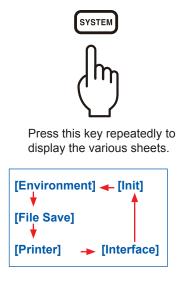
R	For Loading only
Н	Hidden File
S	System File
D	Folder
Α	Archive (Backup)

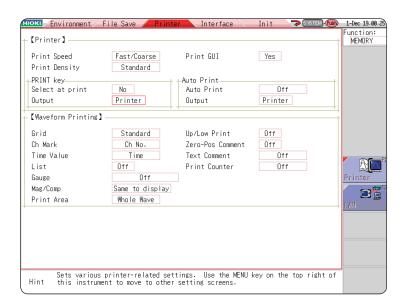
# 6

# Printing (When Model U8350 Printer Unit is installed)

The [Printer] sheet lets you set the print method and detailed printer options.

#### To Open the [Printer] Sheet





#### Operations available from the [Printer] sheet

#### To select the print method

Refer to "6.1 Print Type and Workflow" (p. 114).

- · Auto-print (p. 115)
- Manual Print (p. 118)

Refer to "6.6.1 Screen Hard Copy" (p. 124).

Refer to "6.6.2 Report Print (A4 Size Print)" (p. 124).

Refer to "6.6.3 List Print" (p. 125).

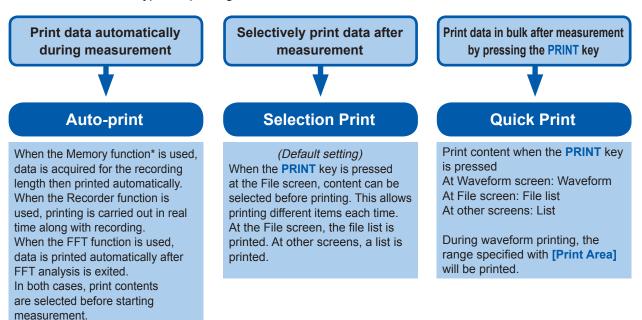
Refer to "6.6.4 Text Comment Printing" (p. 125).

#### **Printer settings**

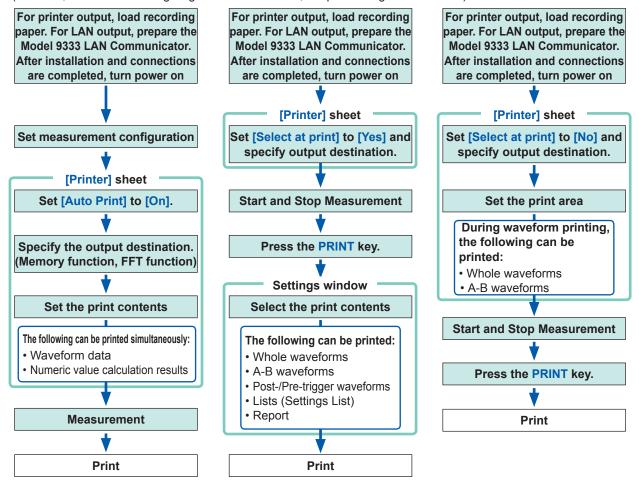
- Print Speed (p. 121)
- Grid Type (p. 121)
- Channel Marker Type (p. 121)
- List (p. 122)
- Gauge (p. 122)
- Printer Density (p. 121)
- Horizontal axis (Time axis) Zoom (Mag/Comp) (p. 122)
- Upper/Lower Limit Print (p. 123)
- Zero Position Comment Print (p. 123)
- Print Counter (p. 123)
- As much as possible, avoid printing in hot and humid environments. Otherwise, printer life may be severely shortened.
- When solid (100% black) printing is continued for a long time, the print head may become hot, resulting in smeared printing. In such a case, stop printing for a while until the print head cools.

# 6.1 Print Type and Workflow

There are three basic types of printing.



\*: When the Roll Mode function is used, printing can be carried out simultaneously with waveform display. (However, at timebase settings higher than 500 ms/div, the print timing will be slower.)



When both auto-print and auto-save are enabled, auto-save is executed first. However, when the Roll Mode function (default setting: [Auto]) is used with the Memory function, auto-print has priority.

# 6.2 Auto-print Settings



This applies to the Memory, Recorder, and FFT functions.

These settings must be set before starting measurement.

Measurement data will print automatically when you press the **START** key to start measurement. For printer output, make sure that the recording paper is loaded correctly. For LAN output, make sure that the PC connected via LAN is prepared.

#### Procedure

Press the **SYSTEM** key to open the System screen, and then select the [Printer] sheet.

#### 1 Enable auto-print.

#### (When using the Memory or FFT Functions)

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

Default setting: Off (no automatic printing)

(When using the Recorder Function) Move the cursor to [Realtime Print]. Select [On].

# 2 (When using the Memory or FFT Functions) Specify the output destination.

Move the cursor to [Output].

Printer:

LAN: The data is automatically output to the PC connected

via LAN.

Model 9333 LAN Communicator required.

Printer	The data is automatically printed by the internal printer. ( <i>Default setting</i> )
LAN:	The data is automatically output to the PC connected via LAN.  Model 9333 LAN Communicator required.

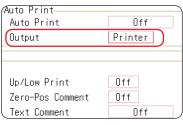
# 3 (When using the Memory Function) Choose print area settings as required.

Move the cursor to the [Print Area] item.

Whole Wave	Print all waveform data in internal memory of the unit. ( <i>Default setting</i> )
A-B Wave	Print only A and B cursors defined range of waveform data in the internal memory of the unit.

With the Recorder function, the whole waveform will be printed during measurement regardless of the print area setting.







- To output waveform data to the PC connected via LAN Model 9333 LAN Communicator must be installed on the PC 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 a PC, see the instruction manual of Model 9333 LAN Communicator.
- When setting the output destination to [LAN]
   The IP addresses of the instrument and the PC connected via LAN must be set. For more information about how to set the IP addresses, refer to (p. 318).

# 4 Set the margins in automatic print

Move the cursor to the [Feed].

Yes	Margin (Default setting)
No	No margins*

Print GUI Yes
Feed Yes
Auto Print
Auto Print
Output
Printer

[Feed] are also applicable to normal printing.

# 5 Check the measurement conditions and start the measurement.

(Press the START key.)

#### When using the Memory Function

Data is acquired for the recording length then printed automatically.

#### When using the Recorder Function

Printing is carried out in real time along with recording.

#### When using the FFT Function

Data is printed automatically after FFT analysis finishes.

#### To stop printing before it has finished

Press the **STOP** key. Measurement will also stop.

Printing can be paused and restarted using the F key during Real-Time Printing (Recorder Function).

Move the cursor to the [Realtime Print] item, and select On or Off.

When printing is carried out again after stopping, the range selection will be used.

- When both auto-print and auto-save are enabled, auto-save is executed first.
   However, when the Roll Mode function (default setting: [Auto]) is used with the Memory function, auto-print has priority.
- If AB cursors are on during manual printing after acquiring waveform data, the selected range will be printed.

Timebase (Time/div)	Measurement conditions	Printing
Up to 200 ms/div	Memory Function (Roll Mode: Off)	Data is acquired for the recording length then printed automatically
	Memory Function (Roll Mode: On) Recorder Function (Recording length: Other than Continuous [Cont.])	Print simultaneously with some delay from recording.
	Recorder Function (Recording length: Continuous [Cont.])	Printing disabled
More than 500 ms/ div	Memory Function (Roll Mode: Off)	Data is acquired for the recording length then printed automatically
	Memory Function (Roll Mode: On) Recorder Function	Print simultaneously with recording.

When performing waveform evaluation, the evaluation area will be printed at the same time.

To disable printing of the evaluation area, set waveform evaluation to [Off]. (p. 304)

If **[Output]** is set to **[LAN]**, realtime printing is disabled. The Auto Print prints automatically after data is acquired for the recording length regardless of the timebase setting.

<sup>\*</sup> There is a margin of about 2 mm.

## **Simultaneous Printing of Numerical Calculation Results**

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

Refer to "10.5 Print Numerical Calculation Results" (p. 229).

# 6.3 Manual Printing With the PRINT Key (Selective Printing)

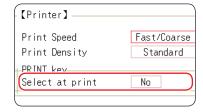
Using the **PRINT** key from the Waveform screen, you can specify a printing range and data type. This can help prevent inadvertent printing due to operator error.

#### Procedure

Press the **SYSTEM** key to open the System screen, and then select the **[Printer]** sheet.

1 Enable data selection at time of printing

Move the cursor to [Select at print]. Select [Yes].



2 Specify the output destination.

Move the cursor to [Output].

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

## **3** Start and stop the measurement.

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

Printing is not possible during measurement. Measurement must be stopped before printing is started.

## 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	Print all waveform data in internal memory of the unit. (Default setting)
A-B Wave	Print only A and B cursors defined range of waveform data in the internal memory of the unit. (Memory/ Recorder Function only)
About Trig	Print waveform data for 10 divisions before and after trigger position. (Memory Function only)
List	Print main settings.
Report	Print the report. Refer to "6.6.2 Report Print (A4 Size Print)" (p. 124).

When the selection (except for [Cancel]) has been made, printing starts.

To stop printing before it has finished, press the **STOP** key.

When performing waveform evaluation, the evaluation area will be printed at the same time. To disable printing of the evaluation area, set waveform evaluation to [Off]. (p. 304)



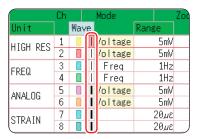
- To output waveform data to the PC connected via LAN Model 9333 LAN Communicator must be installed on the PC to which the data is to be output. For more information about how to operate and configure the Model 9333 LAN Communicator, as well as install it on a PC, see the instruction manual of Model 9333 LAN Communicator.
- When setting the output destination to [LAN]
   The IP addresses of the instrument and the PC connected via LAN must be set. For more information about how to set the IP addresses, refer to (p. 318).

# 6.4 Setting the Print Density of the Waveform

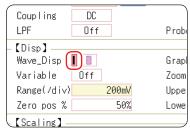
The printing density of the waveform can be set for each channel.

#### Procedure

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] or [Wave\_Disp].

Light, Midlight Standard (Default setting), Middark, Dark

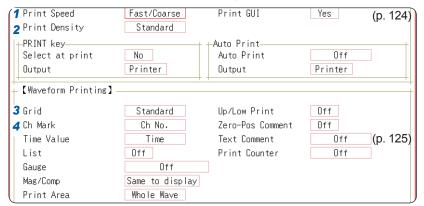
When the waveform print density is Light, a temporary drop in power voltage (for example, a momentary power failure) during printing may cause the print to fail.

# 6.5 Printer Settings

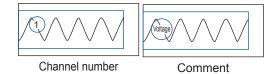
Choose settings on the [Printer] sheet of the System screen.

#### Printer Settings

To open the screen, press the **SYSTEM** key  $\rightarrow$  [Printer] sheet



- Select the print speed (quality).
  Move the cursor to [Print Speed].
- 2 Select the printer density.
  Move the cursor to [Printer Density].
- 3 Select the grid type.
  Move the cursor to [Grid].
- Select the channel marker type.
  Move the cursor to [Ch Mark].
  <Print Example>



Fast/Coars	Fast/Coarse (Default setting), Normal, Slow/Fine		
Light, Midl	Light, Midlight, Standard ( <i>Default setting</i> ), Middark, Dark		
Off, Standard (Default setting), Fine, Std Dark, Fine Dark			
Off	Do not print the channel number or comments.		
Ch No.	Print the channel number. (Default setting)		

Print the comments entered in the Channel Settings screen over the waveform. A comment must have been set. Refer to "8.1 Add Comments" (p. 146).

#### Grid Type

Grids displayed on the screen are not reflected in the printout.

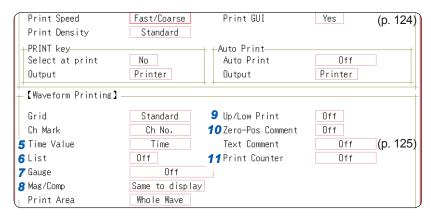
#### **Print Speed**

When [USB Set] is set to [Mass Storage HDD] or [Mass Storage CF], printing speed is always [Slow/Fine].

Comment

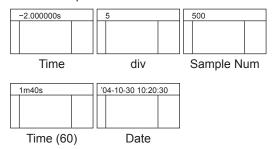
When the instrument is configured to automatically save data to USB memory, automatic printing will be performed at [Normal] speed, even if the print speed has been set to [Fast].

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.



# 5 Select the horizontal axis (time axis) display value.

Move the cursor to [Time Value]. <Print Example>



Time*	Print the time from trigger event (unit is fixed). (Default setting)
Time (60)*	Print the time from trigger event (sexagesimal (base-60) system).
div	Print the number of divisions from trigger event.
Date*	Print the date and time when waveform was acquired.
Sample Num	Print the number of samples from trigger event.

<sup>\*</sup> Printing for external sampling is done according to the [Sample Num] setting.

Do not print a list. (Default setting)

Print list after waveform.

Off

On

# 6 Print a list of settings

Move the cursor to the [List] item.

# 7 Select the type of gauge.

Move the cursor to **[Gauge]**. <Print Example>



Off	Do not print a gauge. (Default setting)
Before Wave	Print gauge before waveform.
After Wave	Print gauge after waveform.
Before&Aft Wave	Print gauge before and after waveform.

# Set the horizontal axis (time axis) magnification and compression.

Move the cursor to [Mag/Comp].

#### Horizontal axis (Time axis) zoom

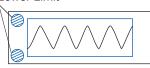
When time axis zoom has been set, printing will be carried out using this zoom setting, regardless of the zoom setting on the Waveform screen.

×10 to ×1/200000 (When using the Memory Function) ×1 to ×1/50000 (When using the Recorder Function)	Print using the magnification or compression ratio set here.
Same to display	Print using the magnification or compression ratio set for the waveform screen. ( <i>Default setting</i> )

#### Set the upper and lower limit value

Move the cursor to [Up/Low Print]. <Print Example>

Upper and Lower Limit



Off	Do not print upper and lower limits. ( <i>Default setting</i> )
On	Print upper and lower limits.

# 10 Set the zero-position comment

Move the cursor to [Zero-Pos Comment]. <Print Example>

Comr	ment	
6		     

Off Print the channel number. (Default setting) On Print zero position comment.

- The comment is not printed for X-Y display or FFT.
- The zero-position comment is not printed when the comment has not been set. Print Example> "8.1 Add Comments" (p. 146).

## 11 Select the counter print.

Move the cursor to [Print Counter].

Off	Do not print a counter. (Default setting)	
Date	Print the date of printing and the waveform acquisition count. (Example: 04-8-1-0001)	
Name	Print the counter name and the waveform acquisition count. (Example: Device A-0001)	

#### (When [Date] or [Name] is selected)

#### If you want to begin from an arbitrary count

Move the cursor to [Counter Num], and set an arbitrary count. Refer to "8.1.3 Alphanumeric Input" (p. 149).

The count is automatically cleared to zero when the instrument is powered on.

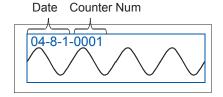
The count is increased by 1 each time a waveform is acquired. (Maximum count 9999)

#### (When [Name] is selected)

#### Enter a counter name.

Move the cursor to [Counter Name], and enter a counter name (up to 10 characters). Refer to "8.1.3 Alphanumeric Input" (p. 149).

<Example of Data and Counter>



<Example of Counter name and Counter>

Counter Name Counter Num

DeviceA-0001

# 6.6 Miscellaneous Printing Functions

You can print a hard copy of the screen display, reports, or lists.

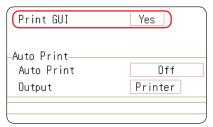
#### 6.6.1 Screen Hard Copy

Press **COPY** key while the screen you want to is displayed. The printer will produce a hard copy of the screen contents.

The GUI section can also be included in the print.

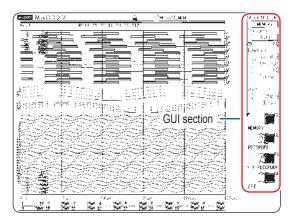
#### **GUI Print Setting**

Press the SYSTEM key to open the System screen, and then select the [Printer] sheet.



Set [Print GUI] to [Yes].

To stop printing before it has finished, press the **STOP** key.



## 6.6.2 Report Print (A4 Size Print)

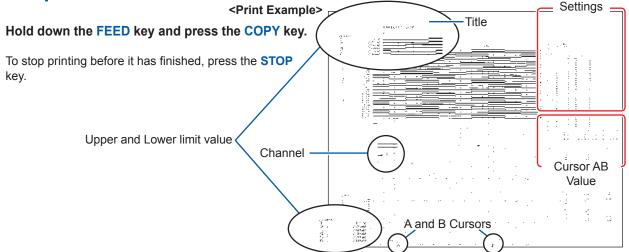
The waveform range as displayed on the Waveform screen, upper and lower limit values, and channel settings are printed in A4 size. When zoom display is enabled, two zoom display screens are printed. The AB cursor pair shown on the Waveform screen is also printed.

If 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 Add a Title Comment" (p. 146).

#### Procedure

Press the **DISP** key to open the screen  $\rightarrow$  Waveform screen, Press the **DISP** key  $\rightarrow$  Display Menu, Select the **[WAVE WIDTH]** menu



#### 6.6.3 List Print

This function prints out function status information and channel setting information in list format. The list settings are the same as for the List function. Refer to "Print a list of settings" (p. 122).

Press the **PRINT** key at a screen other than the Waveform screen.

To stop printing before it has finished, press the **STOP** key.

The printed list contains the setting parameters for the acquired waveform data. The list content will not change even if the settings were changed after the waveform data was acquired.

#### 6.6.4 Text Comment Printing

A text document edited on a PC can be printed together with a waveform.

1 Create a text file using [Notepad] or another suitable application on the PC.

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.

Press the SYSTEM key and set [Text Comment] on the [Printer] sheet.

Off	Text comment is not printed. (Default setting)	
Before Wave	Text comment is printed before waveform.	
After Wave	Text comment is printed after waveform.	

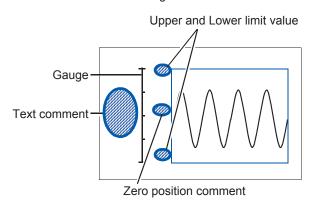
3 Press the FILE key and use the File screen to import the text file created on the PC into the instrument.

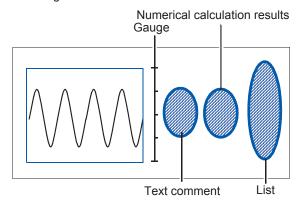
Refer to "5.3 Load Data" (p. 99).

The text file content will be printed along with the waveform when printing.

Print Example: Positioning with regard to other print items

<Printing before waveform selected> <Printing after waveform selected>



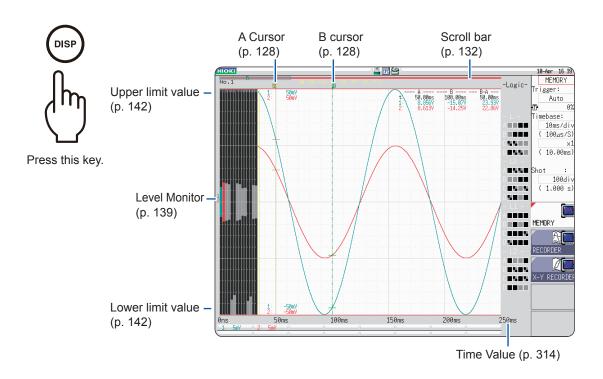


# 7

# **Waveform Screen Monitoring and Analysis**

Analytical operations such as display magnification, compression, and search are available on the Waveform screen. The measurement condition or other configuration can also be changed on this screen.

#### To Open the Waveform Screen



#### **Operations available from the Waveform screen**

#### **AB Cursor**

- Read measurement value (p. 128)
- Specify a waveform range (p. 131)

#### **Move the Waveform Display Position**

- Use the jog and shuttle knobs (p. 132)
- Move the position (p. 133)

Perform X-Y Synthesis (p. 134)

#### **Magnify and Compress Waveforms**

- Magnify and Compress Horizontal Axis (Time Axis) (p. 136)
- Zoom Function (Magnifying a Section of the Horizontal Axis (Time Axis))(p. 137)
- Magnify and Compress Vertical Axis (Voltage Axis) (p. 138)

**Monitor Input Levels** 

(p. 139)

#### Switch the Waveform Screen (p. 141)

- · Display upper and lower limit values
- Display comments
- · Switch the waveform display width

# 7.1 Read Measurement Values (Using the AB Cursors)

- Time difference, frequency and potential difference (and when scaling is enabled, scaling values) can be read as numerical values using the AB cursors on the Waveform screen. The cursors also allow you to specify the calculation and print X-Y synthesis range.
- When displaying the X-Y waveform, the AB cursors can be used to read measurement values. Also with
  a split screen, AB cursors can be used separately in the graphs to read the potential difference between
  the A and B points.

#### **AB Cursor Settings**

Press the **DISP** key to open the Waveform screen, and then press the **AB CSR** key to open the A/B cursors settings window.

1 Select the Cursor Type.

Move the cursor to [AB Cursors].

Off	AB cursors are not used.
div	Move in horizontal axis (time axis) direction (X axis for X-Y synthesis)
Range	Move in vertical axis (voltage axis) direction (Y axis for X-Y synthesis)
Trace	Trace waveform data.

2 Select the movement target for the AB cursors

Move the cursor to **[Kind]**.

Α	Use only cursor A.
A-b	Use AB cursors but move only cursor A.
а-В	Use AB cursors but move only cursor B.
A&B	Move both cursor A and B together.

3 Select the measurement target channel ([Subject CH]) for A and B

Move the cursor to [A] and [B].

Shows measurement values for all channels. (When cursor type is [Trace] or [Range])
Show measurement values in selected channels out of CH1 to CH32 (for 1, 2, 4, 8 screens).
Specify X-Y synthesis for Gr1 to Gr8 (for X-Y screen)
When there is data on which waveform calculation has been performed, the cursor target switches between analog channel and waveform calculation data.

4 Move the AB cursors with the jog and shuttle knobs.

(While the **AB CSR** key is lit, the cursors can be moved with the jog and shuttle knobs. Pressing a key other than the **AB CSR** key closes the setup screen.)

#### If numerical values are hard to read

Press the **DISP** key to display the waveform and measurement values separately.

Refer to "7.7.3 Switch the Waveform Display Width" (p. 142).

#### If AB cursors are activated but are not visible on screen

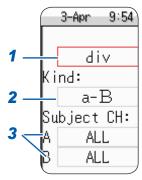
The position of the AB cursors can be checked on the scroll bar. (p. 132) Turning the jog and shuttle knobs will show the respective cursor on the screen.

If the cursor type is **[div]** or **[Trace]**, cursor measurements can be made even if the A or B cursor is off-screen.

To view the waveform before or after the AB cursors when they are off the screen

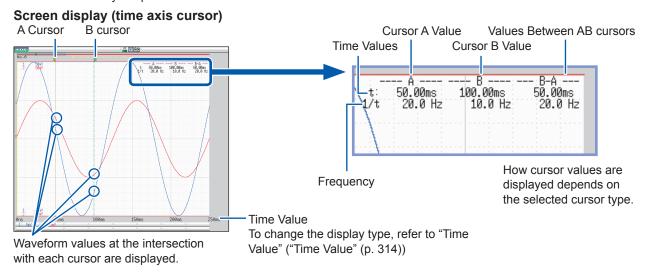
When using the AB cursors, the waveform at an off-screen cursor location can be displayed using the Jump function.

Refer to "7.3.3 Change Position (Jump Function)" (p. 133).



#### Read Measurement Values on Waveform Screen (for 1, 2, 4, 8 screens)

Press the **DISP** key to open the Waveform screen.



#### **Cursor Value**

Cursor types	Cursor value	Cursor value display example (with two cursors)	
<b>Div</b> (Time Value and Frequency)	t: A, B cursor values: Time from trigger point or recording start  B-A value: Time difference between AB cursors  A B B-A  1/t: Frequency for which t is 1 cycle	See "Screen display" above	
Range (Measurement Values)	A, B each cursor value: Measured value of channel B-A value: Difference between measured values at AB cursors  A B  B-A	1: -40.40mV -30.60mV 9.800mV 2: -40.40mV -30.60mV 9.800mV	
Trace (Time and Measurement Values)	Time Values A, B cursor values: Time from trigger point or recording start B-A value: Time difference between AB cursors Measurement Value A, B cursor values: (Memory function) measurement value (Recorder function) maximum, minimum values B-A value: Difference between measured values at AB cursors  A B B-A (Difference between measured values) B-A (Time difference)	Time Values  t: 50.00ms 100.00ms 50.00ms 1. 2.337V -11.35V 13.68V 2. 8.178V -14.08V 22.25V  Measurement Values	

You can press the **DISP** key to display the waveform and cursor values separately. Refer to "7.7.3 Switch the Waveform Display Width" (p. 142).

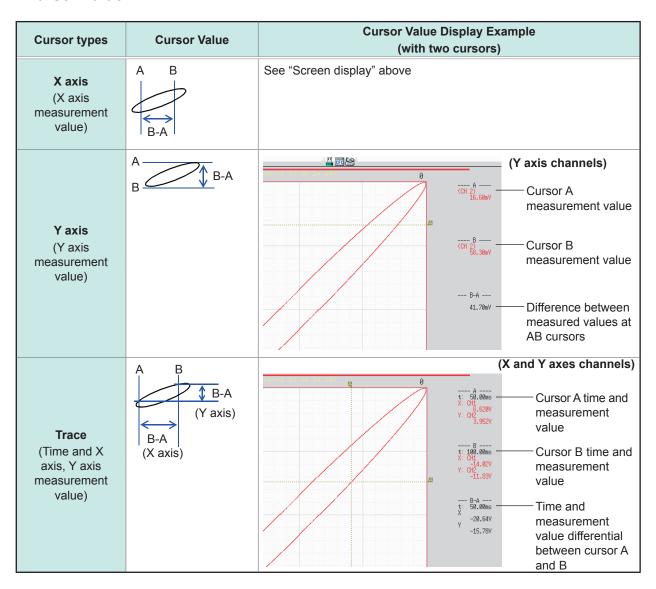
- When using external sampling: Value t is the number of samples.
- When the voltage range is changed during measurement by the recorder function or X-Y Recorder function, trace measurement values are acquired at the range settings when measurement was stopped. The data measured by MR8990 Digital Voltmeter Unit is updated after every 2 points the AB cursor moved.

#### Reading Measurement Values on Waveform Screen (for X-Y1, 4 screens)

Press the **DISP** key to open the Waveform screen.

#### <Screen display (X axis measurement value)> X-Y synthesis of CH1 and CH2 waveform Cursor A Value Channel A Cursor B cursor Measurement Value (CH 1) 116.6eV Difference between measured values at AB cursors 83,40nV --- B ---(CH 1) 116.6mV Cursor B Value B-A --83.40mV

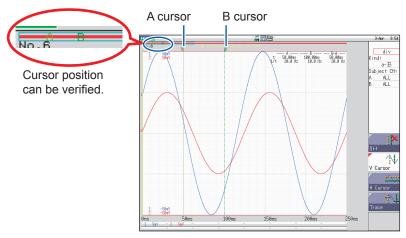
#### <Cursor Value>



# 7.2 Specify a Waveform Range (AB Cursor)

When the waveform is shown as a time display, the range can be specified with the div cursor or trace cursor.

The specified range will be used for file saving, printing, X-Y synthesis, and numerical calculation. The range selection will be retained when the waveform display format is changed.



The general procedure is as follows.

#### 1 Set AB cursors

Refer to "AB Cursor Settings" (p. 128).

#### 2 Specify a range

#### · For file saving

System screen - [File Save] sheet - [Save Area], and then select [A-B Wave].

Refer to "5.2.2 Automatically Save Waveforms" (p. 88) or "5.2.3 Save Data Selectively (SAVE Key)" (p. 94).

#### For printing

System screen - [Printer] sheet - [Slct Print Area], and then select [A-B Wave].

Refer to "6.2 Auto-print Settings" (p. 115) or "6.3 Manual Printing With the PRINT Key (Selective Printing)" (p. 118).

#### For X-Y synthesis

Status screen - [Status] sheet - [Combo Area], and then select [A-B Wave]. Refer to "7.1 Read Measurement Values (Using the AB Cursors)" (p. 128).

#### · For numerical calculation

Status screen - [Num Calc] sheet - [Calc Area], and then select [A-B Wave]. Refer to "6.2 Auto-print Settings" (p. 115).

#### About reading measurement values and cursor types

Refer to "7.1 Read Measurement Values (Using the AB Cursors)" (p. 128).

#### Available range for AB cursor

The available range depends on the function.

- · Memory function: Recorded measurement data for one measurement
- Recorder function: Up to the range of measurement data recorded during one measurement, or up to the range of measurement data that can be recorded internally, starting at the point at which measurement ended and going backwards in time.

The maximum measurement data that can be recorded internally is 80,000 divs.

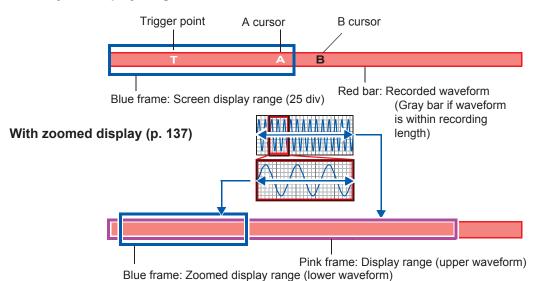
# 7.3 Move the Waveform Display Position MEM REC

This applies to the Memory and Recorder functions.

#### 7.3.1 About the Display Position

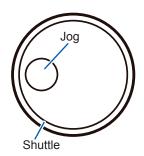
From the scroll bar you can verify the relative position and size of the displayed portion of a waveform within the overall recorded waveform. Trigger time, trigger position and AB cursor positions (When using voltage axis cursor or trace cursors) are also displayed.

#### To verify the display range on the scroll bar



# 7.3.2 Scroll With Jog and Shuttle Knobs (Scroll)

When measuring or displaying an existing waveform, use the jog and shuttle knobs to scroll.

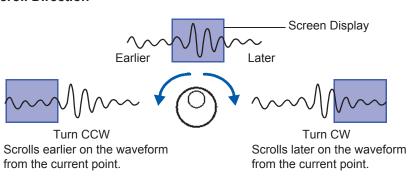


The scrolling speed is controlled by the rotation angle of the shuttle knob.

Press the **WAVE** key to assign the jog and shuttle knobs to waveform scrolling.

(While the **WAVE** key is lit, the jog and shuttle knobs can be used for scrolling.)

#### **Scroll Direction**



#### To see past waveforms in Roll Mode

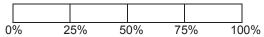
The jog and shuttle knobs can be used to view past waveforms during measurement. To redisplay a waveform, select [Scroll].

# 7.3.3 Change Position (Jump Function)

You can specify the portion to be displayed immediately.

Display location can be specified as follows:

- Trigger Point
- · AB cursor location
- Specified location (from the beginning [0%] to the end [100%] of the waveform)



#### Procedure

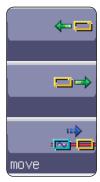
Press the **DISP** key to open the Waveform screen, and then press the **WAVE** key to open the WAVE settings GUI displays.

**1** Use the F keys  $[\leftarrow]$ ,  $[\rightarrow]$  to specify the position.

The yellow frame on the scroll bar indicates the position to change to.

2 Select [Move].

The selected display position appears on the screen.





#### To move the position when [Memory Div: On] with the Memory function

Press the **F1** key **[pos→block]**. With no block displayed in the upper part of the screen, move the position.

When a block is displayed in the upper part of the screen, the desired block can be selected and the recorded waveform can be displayed. (p. 143)

# 7.4 Perform Waveform X-Y Synthesis

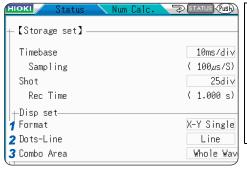


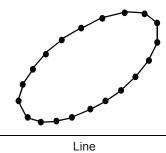
This applies to the Memory and X-Y Recorder functions.

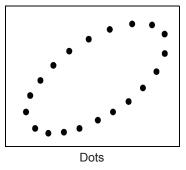
- Using the recorder function causes Model 8990 to acquire data with a resolution of 16 bits.
- To perform waveform X-Y synthesis, go to the Status screen, select the [Status] sheet, and set [Format] to X-Y1 screen or X-Y4 screen. By assigning any analog channel to the X axis and Y axis, up to 8 X-Y combo displays can be generated.
- Vertical axis (voltage axis) zoom also applies to X-Y synthesis.

#### Procedure

Press the **STATUS** key to open the Status screen, and then select the **[Status]** sheet.







Move the cursor to [Format].

X-Y Single The waveforms of graphs 1 - 8 are shown and recorded on a single screen.

X-Y Quad The waveforms of graphs 1 - 8 are shown and recorded on a four screens.

2 Move the cursor to the [Dots-Line] item.

Dots

Measurement data only are shown as dots.
Order stored in memory will not be displayed.

Line

Measurement data are linked by a line in the order stored in memory and shown as a waveform. (*Default setting*)

3 Move the cursor to [Combo Area].
Refer to "7.2 Specify a Waveform Range (AB Cursor)" (p. 131).

Whole Wave	All data are used for X-Y synthesis.
A-B waveforms	Only data range marked by AB cursors is used for X-Y synthesis.

#### To speed up the time between measurement and waveform display

- The waveform will be displayed faster when **[Dots]** is selected for the Dot-Line interpolation setting.
- · Specify a range using the AB cursors. (Memory Function only)

#### Procedure

Press the DISP key to open the Waveform screen, and then press the CH.SET key to open the X-Y settings window.

# 4 Set the waveform color in the graph display.

Move the cursor to the channel for which you want to set the color, and choose the selection.

You can also select the same color as other channels.

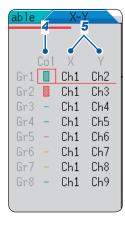
Off
The waveform is not displayed. When [Save Channel] is set to [Disp Ch], this channel will not be saved automatically. Refer to "Select the channels to save." (p. 90)

On
The waveform is displayed. Select the display color with the F keys [↑], [↓].

#### 5 Select the channels for X-Y synthesis.

Move the cursor to the items for the X (time axis) and Y (voltage axis) and assign a channel.

The same channel can be assigned multiple times.



#### To synthesize waveforms between A and B cursors

Perform the following steps.

- 1. Press the **STATUS** key to bring up the Status screen, and select the [Status] sheet.
- 2. Select 1, 2, 4, 8 or 16 screens as [Format].
- 3. Press the **DISP** key to display the Waveform screen.
- 4. Use the AB cursors to specify the range for synthesis. Refer to the following pages: (p. 128), (p. 131).
- 5. Press the STATUS key to bring up the Status screen, and select the [Status] sheet.
- 6. Select [X-Y Single] or [X-Y Quad] for [Format].

#### To move pen on synthesized waveform

Press the **WAVE** key so that the key is lit. The pen can now be moved over the entire waveform with the jog and shuttle knobs. The time at the pen position is shown at the top right of the screen.

# **Magnify and Compress Waveforms**

#### 7.5.1 **Magnify and Compress Horizontal Axis** (Time Axis)

MEM REC

This applies to the Memory and Recorder functions. (However, with the Recorder function, waveform magnification is not available.)

Data details can be observed by magnifying the waveform along the horizontal axis (time axis). Also, by compressing the time axis, overall waveform fluctuations can be observed easily.

On-screen magnification and compression is based on the left edge of the screen. However, when the AB cursors appear on the screen, use the cursor as the standard to expand or compress. The amount of magnification/compression can be changed after measurement.



#### **Procedure**

Press the **DISP** key to open the Waveform screen.

- Move the cursor to the Magnification.
- Select display magnification.

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

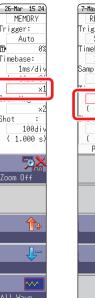
When [Zoom On] is selected, a section of the time axis will be

Refer to "7.5.2 Zoom Function (Magnifying a Section of the Horizontal Axis (Time Axis))" (p. 137).

When [All Wave] is selected, the entire recording length waveform will 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



# RECORDER igger: Single Γimebase: 10ms/di 10µs/ ( 10.00ms ( 1.000 s Print

#### To print at a different zoom ratio from the display

Specify the ratio on the [Printer] sheet.

Refer to "Set the horizontal axis (time axis) magnification and compression." (p. 122).

When a waveform loaded from media is displayed at a high compression ratio, the display may be slow to update.

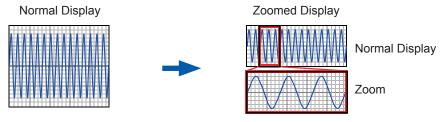
# 7.5.2 Zoom Function (Magnifying a S

M E M

# (Magnifying a Section of the Horizontal Axis [Time Axis])

This applies to the Memory function only. A magnified section of a waveform can be displayed together with the unmagnified view by splitting the screen horizontally.

With the waveform displayed normally on the upper half of the screen, a section magnified along the time axis can be displayed on the lower half.



When you press the **PRINT** key while using the Zoom function, the waveform displayed on the lower half of the screen is printed. (The print format will be as for a single screen waveform. If the AB cursors are used, the selected section will be printed.)

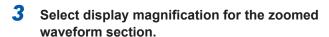
#### Procedure

Press the **DISP** key to open the Waveform screen.

- **1** Move the cursor to the magnification.
- 2 Select [Zoom On].

The Zoom function is enabled and the screen is split into upper and lower halves.

(Upper: waveform to be magnified; Lower: magnified (zoomed) section of waveform)



Move the cursor to the [Zoom Mag], and set the magnification.

The zoomed waveform section at the lower half of the screen is magnified.

When the same value or a smaller value than the magnification/compression ratio is specified, the ratio is automatically set to a setting one step higher than the [Zoom Mag] setting.

4 Scrolls the zoomed section of the waveform.

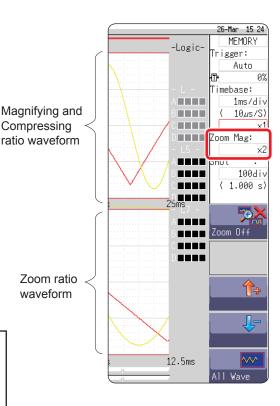
Refer to "7.3.2 Scroll With Jog and Shuttle Knobs (Scroll)" (p. 132).

#### To cancel Zoom

Move the cursor to the magnification, and select **[Zoom Off]**. (The condition is canceled while keeping the inherited zoom ratio.)

Example: When the zoom ratio was set to ×5 and zoom is canceled, the ratio setting will be [×5].





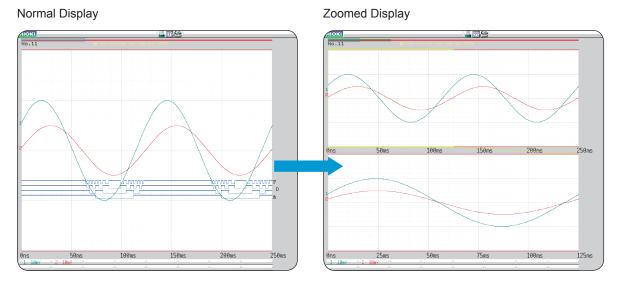
#### To view the entire waveform (Memory function only)

Move the cursor to the ratio item in the settings window and select **[All Wave]**. The waveform information for the entire recording length will be displayed.

#### About logic waveform display

When the Zoom function is enabled and the logic waveform display position is at less than [50pos], the logic waveform will not be displayed.

Example: Display position [30pos]



## 7.5.3 Vertical Axis (Voltage Axis) Magnification

M E M R E C

This applies to the Memory and Recorder functions.

Waveforms on each channel can be magnified or compressed along the vertical axis (voltage axis) for display or printing.

Magnification and compression are based on the zero position.



#### **Procedure**

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

Move the cursor to the [Mag] item of the channel to adjust.

×1/10, ×1/5, ×1/2, ×1, ×2, ×5, ×10, ×20, ×50, ×100

Selecting [Invert] will invert plus and minus in the waveform. Refer to "8.8 Invert the Waveform (Invert Function)" (p. 168).

Ana	alog	/arial	b la	e Log	ic
ChCo 1	Range	Mag	\$	Position	P.F.
1	5mV		٠	50%	-
2	5mV	×1	)٠	50%	-
3 -	5mV	×1	٠	50%	-
4 -	5mV	×1	٠	50%	-

#### To display at an arbitrary ratio

Refer to "8.6 Set the Waveform Position (Variable Function)" (p. 164).

### 7.6 Monitor Input Levels (Level Monitor)

#### 7.6.1 Level Monitor

All input waveform levels can be monitored in real time.

Analog channels and logic channels can be displayed at the same time.

#### Procedure

Press **DISP** to open the Menu → Display Menu

Selecting [Monitor] brings up the analog channel level display in the left part of the Waveform screen, and the logic channel level display in the right side of the Waveform screen.

Monitor values of logic channels

White the second second

Analog channel

To hide the level monitor Select [Monitor] again.

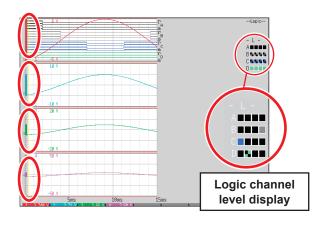
Monitor values of analog channels Display

Display Menu

Display format 2 - 16 screens (p. 65) Level monitors are displayed for each graph.

Upper and lower limit indication is combined with level monitor.

Refer to "7.7.1 Show Upper/Lower Limit on Waveform Screen" (p. 142).



#### **How to Interpret Level Monitors**

Analog channel level display

Input Waveform Display Range Full Span — Low

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.

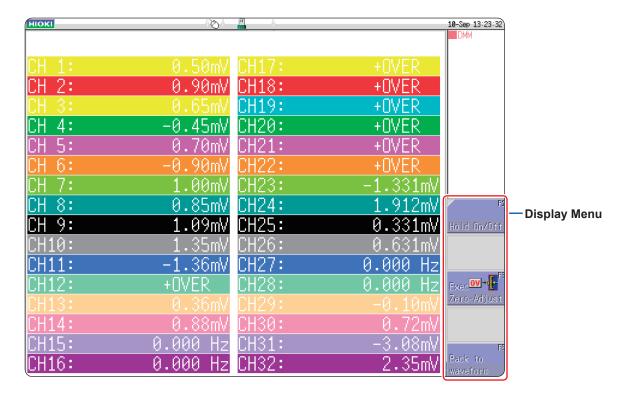
- Input levels are not displayed for channels that have no corresponding module installed.
- Channels higher than the number specified for [Used Ch] do not display analog input levels.
   (Example: When [Used Ch] is set to [Ch4], the levels for CH3 to Ch16 and Ch19 to Ch32 are not displayed.)

#### 7.6.2 Numerical Value Monitor

Input values can be monitored as numerical value same as in DMM (Digital multimeter).

#### Procedure

To open the screen: press the **DISP** key twice.



When mouse is connected, you can display numerical value (DMM) by clicking on **[DMM]** icon appears at the upper right of Waveform screen.



#### When returning to Waveform screen

Press the [Return to Waveform screen] appears at the right side of the Display menu screen or press DISP key.

#### To pause (hold) the display

Press [HOLD On/Off] appears at the right side of the Display menu screen. HOLD mark which indicates the HOLD status will be displayed on screen.

#### To cancel the pause (hold) of display

Press [HOLD On/Off] to cancel the HOLD status.

#### When executing Zero-adjust

Zero-adjust (calibration in Model MR8990) can also be run on Numerical value (DMM) display screen. Press the **[Exec. Zero-Adjust]** appears at the right side of the Display menu screen.

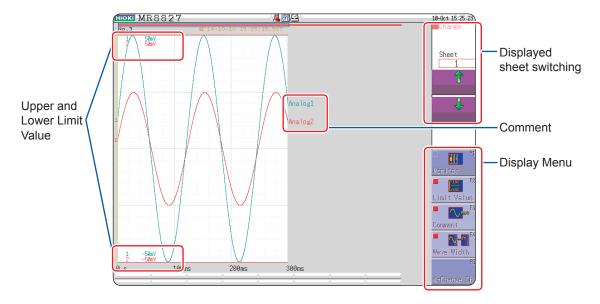
# 7.7 Switch the Waveform Screen Display (Display Menu)

The display menu allows you to bring up additional information such as upper/lower limit value indication and comment display. It also allows you to set the waveform display width.

Refer to "About level monitor" (p. 139).

#### Procedure

Press DISP to open the menu → File screen, Press DISP → Select the [WAVE WIDTH] menu



#### To hide the menu

Select the same menu again.

#### 7.7.1 Show Upper/Lower Limit on Waveform Screen

Select [Limit Value] to show the upper/lower limit value indication on the Waveform screen.

#### 7.7.2 Show Comments on Waveform Screen

Select [Comment] to show the comment indication on the Waveform screen.

- Comment information must have been entered via the [Comment] sheet on the Channel screen. Refer to "8.1 Add Comments" (p. 146).
- When they overlap with other displayed elements, the comments may not display properly. Hide the Channel Settings Window, Trigger Settings Window, Level Monitor, etc., or decrease the [Wave Width].

### 7.7.3 Switch the Waveform Display Width

Select [Wave Width] to change the display width of the Waveform screen.

If a waveform is hard to see because of numeric value and settings information, this function can be used to separate the waveform and other information.

The function is also active for the Channel settings window and Trigger settings window.

### 7.7.4 Switch the Channel Range Information Display

Each time you press the [<= Change Ch], the channel range information displayed at the lower part of the screen changes between CH1 to CH16 and CH17 to CH32.

#### 7.7.5 Switch the Displayed Sheet

Select  $\uparrow /[\downarrow]$  to switch the displayed sheet.

The settings of each displayed sheet can be specified on the Unit List tab of the Channel settings window. Refer to "3.4.4 Displayed Sheet" (p. 73).

### 7.8 View Block Waveforms

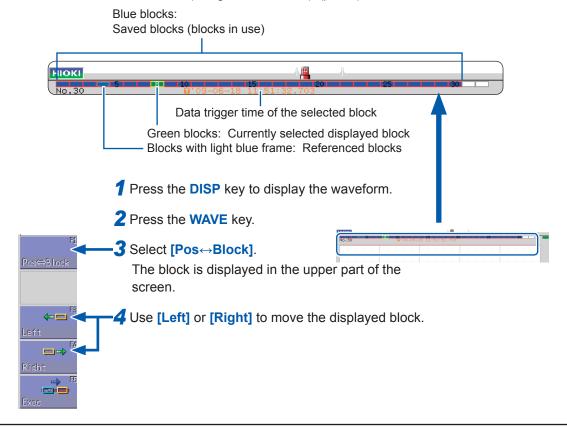
MEM

This applies to the Memory function only.

You can check if blocks have been used when recording with memory division. Furthermore, the desired block can be selected and the recorded waveform displayed.

When memory division is not used, depending on the recording length, it is possible to display the last 16 measured waveforms.

Refer to "7.1 Read Measurement Values (Using the AB Cursors)" (p. 128).



#### To overlap with other blocks (reference blocks)

Open the Status screen to the [Memory Div] sheet and set [Ref Block] to [On] and select [All Blks On].

Refer to "12.2 Display Settings" (p. 248).

# **Utility Functions**

Add Comments (p. 146)

Convert input values (Scaling) (p. 157)

Set the waveform display freely (p. 164)

Fine Adjustment of Input Values (p. 167)

Invert a waveform (p. 168)

Copy a setting to another channel (p. 169)

#### Applicable measurements and settings

- Display Waveforms During Recording (p. 153)
- Overlay with past recorded waveforms (p. 154)

#### Detailed module settings (p. 170)

- · Anti-aliasing filter settings
- Select the thermocouple type
- Reference point compensation settings
- Wire break detection settings
- Data updating settings
- Executing auto-balance
- Probe attenuation settings
- Response settings
- Measurement mode settings

### 8.1 Add Comments

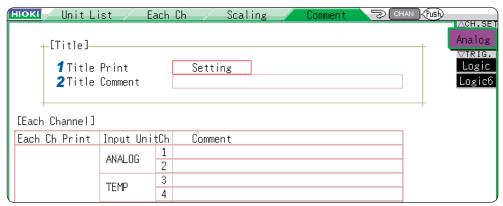
#### 8.1.1 Add a Title Comment

When you enter a title comment, it can be displayed at the top of the Waveform screen, and can also be printed.

(Allowed number of characters: up to 40) Refer to "6.6.2 Report Print (A4 Size Print)" (p. 124).

#### Procedure

Press the CHAN key to open the Channel screen, and then select the [Comment] sheet.



#### 1 Set the print title content

Move the cursor to [Title Print] for the title.

Off	Title comment not printed.
Setting	Equipment settings will be printed.
Comment	Title will be printed.
Set& Com	Both equipment settings and title will be printed.

#### 2 Enter a title comment.

Move the cursor to [Comment].

Input	Enter comment text. Refer to "Entering Text" (p. 149).
Clear	Clear entered information
Undo	Return to the state before the most recent change

#### To select from preset terms

Pressing the **WAVE** key after activating text input brings up a list of preset terms. It is also possible to select words from previously entered titles (History function). Refer to "Enter Text From a Term List or History List" (p. 151).

#### 8.1.2 Add a Channel Comment

Comments added for each channel can be displayed on-screen. Comments can also be printed on recording paper. (Allowed number of characters: up to 40)

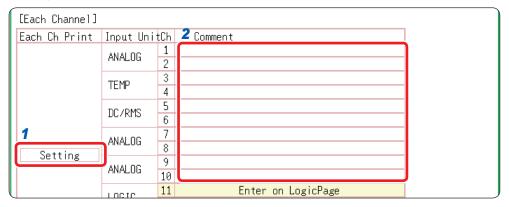
#### To copy a comment to another channel

The [Comment] sheet can be used to copy comments.

Refer to "8.9 Copy Settings to Other Channels (Copy Function)" (p. 169)

#### Procedure

Press the CHAN key to open the Channel screen, and then select the [Comment] sheet.



1 Select the print content for each analog channel.

Move the cursor to **[Each Ch Print]** for each channel.

Off	No channel comment will be printed.	
Setting	Settings for each channel will be printed. (Not displayed on screen)	
Comment	Comments for each channel will be printed.	
Set& Com	Both settings and comments for each channel will be printed.	

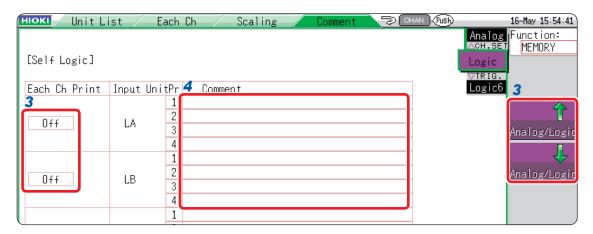
2 Enter comments for each analog channel.

Move the cursor to [Comment].

Input	Enter comment text. Refer to "Entering Text" (p. 149).
Clear	Clear entered information
Undo	Return to the state before the most recent change

#### To select from preset terms

Pressing the **WAVE** key after activating text input brings up a list of preset terms. It is also possible to select words from previously entered analog channels (History List). Refer to "Enter Text From a Term List or History List" (p. 151).



3 Select the print content for each logic channel.

Select [Analog/Logic] to display the logic channel page.

Off Comments are not printed.

Comment Comments are printed.

Move the cursor to [Each Ch Print].

4 Enter the comment for each logic channel.

Move the cursor to [Comment].

Input	Enter comment text. Refer to "Entering Text" (p. 149).	
Clear	Clear entered information	
Undo	Return to the state before the most recent change	

#### To select from preset terms

Pressing the **WAVE** key after activating text input brings up a list of preset terms. It is also possible to select words from previously entered logic channels (History List). Refer to "Enter Text From a Term List or History List" (p. 151).

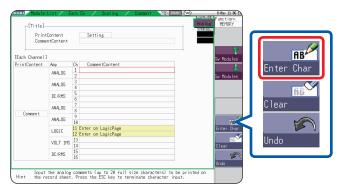
#### 8.1.3 Alphanumeric Input

Move the cursor to the setting item for which you with to input text and choose the content with the **F** keys.

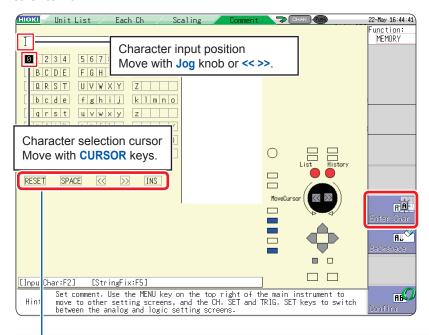
#### **Entering Text**

1 Move the cursor to the comment field and select [Enter Char].

The virtual keyboard will be displayed.



Select characters with the CURSOR keys from the virtual keyboard, and select [Enter Char] to enter it.



RESET	Deletes all entered characters (Move the cursor to <b>RESET</b> , and push <b>[Enter Char]</b> .)  Inserts a space (Move the cursor to SPACE, and push <b>[Enter Char]</b> .)		
SPACE			
OVWR/INS	Toggles between Overwrite (OVWR) and Insert (INS) mode (Move the cursor to [OVWR/INS], and push [Enter Char] to switch OVWR/INS)		
Move the character input position left.			
>>	Move the character input position right.		

3 Select [Confirm] to accept the entry.

The virtual keyboard will disappear.

Press the **ESC** key to cancel the input.

(Pressing the **ESC** key again closes the virtual keyboard)

#### To Enter units and symbols

Characters entered as units may be saved differently.

(Saving of numerical calculation results or text format information)  $^2\to ^2,\ ^3\to ^3,\ \mu\to ^{\tilde{}}u,\ \Omega\to ^{\tilde{}}o,\ \epsilon\to ^{\tilde{}}e,\ ^{\circ}\to ^{\tilde{}}c$  ,  $\pm\to ^{\tilde{}}+$ 

$$^{2} \rightarrow ^{\Lambda}2, ^{3} \rightarrow ^{\Lambda}3, \mu \rightarrow ^{\tilde{}}u, \Omega \rightarrow ^{\tilde{}}o, \epsilon \rightarrow ^{\tilde{}}e, ^{\circ} \rightarrow ^{\tilde{}}c, \pm \rightarrow ^{\tilde{}}H$$

Characters not allowed in file names can not be entered. (Please use only uppercase letters.)

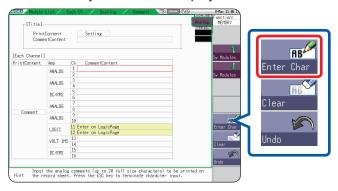
#### **Enter Text From a Term List or History List**

While the virtual keyboard is displayed, pressing the **WAVE** key brings up a "Term List" and pressing the **AB CSR** key brings up a "History List."

This can be used to enter preset terms or reuse text from previous input sessions.

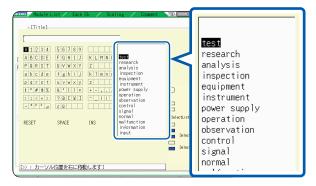
1 Move the cursor to the comment field and select [Enter Char].

The virtual keyboard will be displayed.

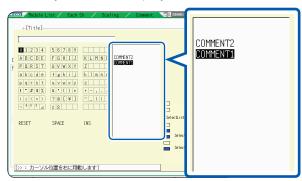


Press the WAVE key to select from preset terms.

A list of preset terms will be displayed.



Press the **AB CSR** key to select from the past inputs. A History list will be displayed.



Press the ESC key to cancel selection from the history list.

- 3 Use the Up/down CURSOR keys or the jog knob to select a term from the list, and select [Enter Char].
- Select [Confirm].

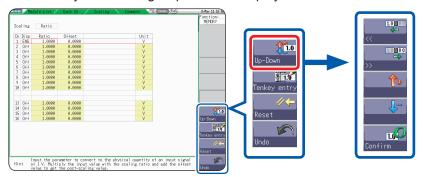
The entry is accepted.

The virtual keyboard will disappear.

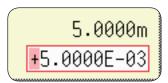
#### **Entering Numerals By Incrementing/Decrementing**

Move the cursor to the numeric input field and select [Up-Down].

A virtual keyboard for digit input will be displayed.



2 Enter numerals at the virtual keyboard. (Use F1 and F2 to move digit position, and use F3 and F4 to increase or decrease the value.)

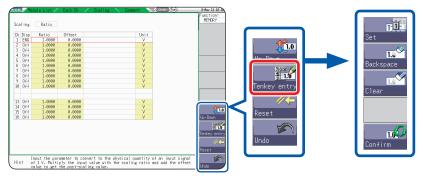


3 Select [Confirm] to accept the entry.
Press the ESC key to cancel the input.

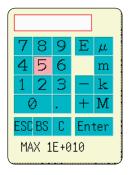
#### **Enter Numerals With a Numeric Keypad**

1 Move the cursor to the numeric input field and select [Tenkey Entry].

A virtual keyboard for numeric keypad input will be displayed.



Enter numeral at the virtual numeric keypad.



ESC: Cancel inputBS: Delete 1 characterC: Delete all charactersEnter: Accept the entry

3 Select [Confirm] to accept the entry.

Press the **ESC** key to cancel the input.

# 8.2 Display Waveforms During Recording (Roll Mode)

This applies to the Memory function only.

You can display and print the waveform at the same time as the data is acquired (if auto-print is enabled). (p. 115)

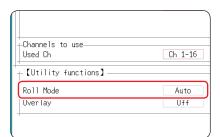
- If measurement is carried out at low sampling rate using the Memory function, a long time will be required until data for the entire recording length have been collected. Roll Mode is useful in these cases.
- The new waveform scrolls automatically.

#### Procedure

Press the **STATUS** key to open the Status screen, and then select the **[Status]** sheet.

#### Move the cursor to [Roll Mode].

OFF	Normal recording. Data is displayed only after acquiring the specified recording length.	
On	Waveforms are displayed while recording (with 10 ms and slower settings). When the timebase is set to 5 ms/div or faster, waveforms are not displayed until after acquisition has finished.	
AUTO	Regardless of the timebase setting, whether or not the waveform is displayed depends on the waveform display magnification settings while the data is being recorded. (Default setting) However, when the waveform is displayed using a time axis faster than 100 ms per division, or when the time base is 5 $\mu s/div$ , the waveform will be displayed after it has been captured.	



#### When the Roll mode function is [On]

- Roll Mode function and Overlay function cannot be used together.
   When the Roll Mode function is enabled, the Overlay function is automatically set to [Off]. And when the Overlay function is enabled, Roll mode is set to [Auto]. (p. 154)
- 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 one function is set to [On], the other functions are automatically set to [Off].

When auto-print (p. 115) is enabled, printing is available simultaneously with waveform display (if the
internal printer is installed). However, for X-Y waveforms, all data must be acquired before printing.
 In addition, during evaluation by numerical calculation, automatic printing is carried out according to the
evaluation conditions when numerical calculation finishes.

#### When the Roll Mode function is [Off]

Waveforms are displayed after the data has been acquired for the entire recording length, so with slow sampling there may be a long wait after starting measurement before the waveform is displayed.

# 8.3 Display New Waveforms Over Past Waveforms (Overlay)

This applies to the Memory function only.

Displayed waveforms are retained on-screen and overlaid with new waveforms.

- Use this to compare new waveforms with those recorded immediately before. (When the trigger mode is **[Repeat]** or **[Auto]**) (p. 197)
- · There are two overlay methods: automatic overlay during measurement and manual overlay.

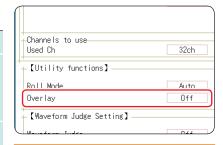
# Normal display Waveforms with the Overlay Function

#### Procedure

Press the **STATUS** key to open the Status screen, and then select the **[Status]** sheet.

#### Move the cursor to [Overlay].

Off	Overlay disabled. (Default setting)	
Auto	Each time a waveform is acquired, it is automatically displayed as an overlay.  When the trigger mode is <b>[Cont.]</b> or <b>[Auto]</b> , waveforms will be overlaid from measurement start to stop.	
Manual	Overlay waveforms on the screen manually. (See the next section for the method of overlay.)	



This mode cannot be used simultaneously with Roll Mode. Refer to "When the overlay function is enabled ([Auto] or [Manual])." (p. 155).

#### Manual Overlay (Any Waveform Can Be Retained On-Screen)

Press the **DISP** key to open the Waveform screen.

#### Move the cursor to [Overlay].

Overlay (F1 key)	The loaded waveform on the screen. The overlay is displayed until the waveform is cleared.
Clear ( <b>F5</b> key)	Clears the screen of all overlaid waveforms. Cleared waveforms cannot be displayed again.



#### When the overlay function is enabled ([Auto] or [Manual]).

- The Roll Mode function (p. 153) and Overlay function (p. 154) cannot be enabled at the same time. When the Roll Mode function is enabled, the overlay is automatically set to [Off]. And when the overlay function is enabled, roll mode is set to [Auto].
- Printing and AB Cursor tracing apply only to the last-acquired waveform.
- The following operations are not available on the waveform screen:
   Waveform scroll, Zoom function On/Off, Change horizontal axis (time axis) magnification/compression,
   Change zero position.
- · In the following cases, overlaid waveforms are cleared and only the most recent waveform is displayed.
  - When [Format] is changed on the [Status] sheet
  - When [Combo Area] has been changed ([Format] set to [X-Y Single] or [X-Y Quad])
  - Waveform display setting is changed on the [Unit List] or [Each Ch] sheets (Display magnification, zero position, variable, display on/off, waveform color)

# 8.4 Setting Channels to Use (Extending the Recording Length)

MEM

This applies to the Memory function only.

Select the analog and logic channels to use.

Maximum recording length is available when the fewest necessary channels are enabled for use.

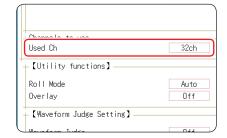
Minimizing the number of channels in use allows memory to be reallocated to those channels being used.

#### Procedure

Press the **STATUS** key to open the Status screen, and then select the **[Status]** sheet.

Move the cursor to the [Used	Ch], and	select the	number
of channels to use.			

4ch/ 8ch/ 16ch/ 32ch (Default setting)	
----------------------------------------	--



Standard logic channels LA to LD are stored by using 4 bits of analog channels CH1 to CH4, and standard logic channels LE to LH are stored by using 4 bits of analog channels CH9 to CH12.

# Available channels

When **[Used Ch]** is set, the available analog channels, standard logic channels, and the logic channels of Model 8973 Logic Unit are as follows.

Used channel	Analog	Standard logic	Model 8973 Logic Unit
4ch	CH1, CH2, CH17, CH18	LA, LB, LE, LF	L1
8ch	CH1 to CH4, CH17 to CH20	LA to LH	L1, L2
16ch	CH1 to CH8, CH17 to CH24	LA to LH	L1 to L4
32ch	CH1 to CH32	LA to LH	L1 to L8

Note that the maximum number of logic units that can be installed on the instrument is two.

#### Precautions for Installation of Model MR8791 Pulse Generator Unit

- · When the used channels is changed, the pattern data will be erased.
- The pattern output can be selected only when used channel is set to 32 ch.

# 8.5 Convert Input Values (Scaling Function)

#### **About the Scaling Function**

Use the scaling function to convert the measured voltage units output from a sensor to the physical units of the parameter being measured.

Hereafter, "scaling" refers to the process of numerical value conversion using the Scaling function.

Gauge scales, scale values (upper and lower limits of the vertical axis [voltage axis) and AB cursor measurement values can be displayed in scaled units.

Scaling is available for each channel.



#### **Scaling Examples**

Refer to "When using a clamp sensor" (p. 159) (Example: Converting [ V ] to [ A ]) or "When using the Strain Unit " (p. 160) (Example: Converting [  $\mu\epsilon$  ] to  $\rightarrow$  [ G ]).

#### **Scaling Methods**

Two scaling methods are available:

- · Conversion Ratio Setting
- · Two-Point Setting

#### Set with a Conversion Ratio

Set the physical value per volt (conversion ratio: eu/ V) of the input signal, an offset value and measurement unit name (eu: engineering units) for conversion, so measurement values acquired as voltage are converted to the specified units.

(Example)

Conversion ratio: A value per volt, Offset value: B

Unit name: A

# 

ratio) and offset value

Convert from slope (conversion

#### **Set with Two Points**

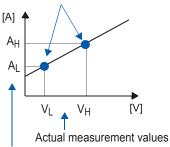
Set the voltage values of two points of the input signal, the converted unit value of these two points and the name of the converted measurement units, so measurement values acquired as voltage are converted to the specified units. (Example)

Voltage value at 2 points		Voltage of units to convert		
V <sub>H</sub> :	Higher potential point	A <sub>H</sub> :	Value for higher potential point	
V <sub>L</sub> :	Lower potential point	A <sub>L</sub> :	Value for lower potential point	

Unit name: A

Conversion ratio and offset value are calculated from the two points and converted

(Example: Converting [V] to [A])

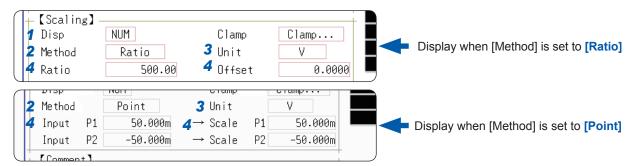


Converted unit values

When the conversion ratio setting is changed,  $V_L$  and  $V_H$  set with two points do not change but the values for  $A_L$  and  $A_H$  change.

#### Procedure

Press the CHAN key to open the Channel screen, and then select the [Each Ch] sheet.



Ratio

Point

1 Enable the Scaling function.

Move the cursor to [Disp].

Off	No scaling.
NUM	Displayed as a decimal and includes a unit (m, k, etc.).
SCI	Displayed as an exponent (power of ten)

Specify by conversion ratio.

- 2 Select the scaling conversion method. Move the cursor to [Method].
- 3 Specify the physical units.

Move the cursor to **[Unit]**, and enter the physical unit name. (Up to 7 characters) Refer to "Entering Text" (p. 149).

4 Enter the numerical values for conversion.

When you have selected [Ratio] (Set conversion ratio and offset)

Move the cursor to and enter values for [Ratio] and [Offset].

When you have selected [Point]
(Set input values for two points and the values after conversion)

Move the cursor to and enter values for [Input P1], [Scale P1], [Input P2], and [Scale P2].

Specify by two points.

Input example:

Decimal 1.2345 mV Exponent 1.2345E-03 V

Enter numerical values in each field.

-9.9999E+9 to 9.9999E+9

Refer to "Alphanumeric Input" (p. 149).

Enter numerical values in each field.

-9.9999E+9 to 9.9999E+9

Refer to "Alphanumeric Input" (p. 149).

 When saving text or the results of numerical calculation, some characters and symbols used for display on the instrument will be converted as follows.

("MR8827 display" to "saved string")

•  $^2$  to  $^2$ ,  $^3$  to  $^3$ ,  $\mu$  to  $^u$ ,  $\Omega$  to  $^o$ ,  $\epsilon$  to  $^e$ ,  $^o$  to  $^c$ ,  $\pm$  to  $^+$ 

To enter the current input value as is for P1 or P2

Select [Monitor Val].

#### To reset scaling settings

Move the cursor to [Setting], and select [Reset].

#### To copy the scaling setting to another channel

The Channel screen - **[Scaling]** sheet can be used to copy a setting. Refer to "8.9 Copy Settings to Other Channels (Copy Function)" (p. 169)

#### To use a combination of the Scaling and Variable functions (p. 164)

The full span of output from a sensor can be displayed. (p. 166)

At factory shipping, automatic correction of the variable function (p. 315) is set to [On].

At this time, the Variable setting is altered so that it is linked to (dependent upon) the vertical axis (voltage axis) range and scaling settings.

If you want the Variable function setting to take priority, use either of the following procedures:

- Set Scaling first, then set the Variable function
- Set a Variable value before Scaling, then set Scaling.

When automatic correction of the Variable function (variable auto-adjustment) is disabled [Off], the Scaling and Variable settings are unlinked (independent of one another).

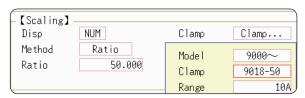
#### 8.5.1 Scaling Examples

#### When using the clamp sensor

#### Example 1

# Measure with the 10 A range of the Model 9018-50 Clamp on Probe and display the measured data in units of [A] (Amperes)

The 9018-50 Clamp on Probe provides 0.2 V output when measuring 10 A. So Scaling should be set to display 10 A with 0.2 V input (and 0 A with 0 V input).



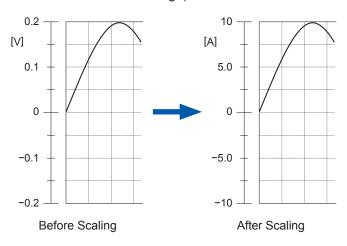
Setting	Selection	
Set	NUM or SCI	
Clamp	9018-50	
Unit*	Α	
Method*	Ratio	
Ratio*	50.000	

<sup>\*:</sup> Set automatically when clamp sensor is selected.

#### To Select a Clamp Sensor

- Move the cursor to [Clamp], and select [Select].
  The cursor moves to [Model].
- 2. Select [9000~]. The cursor moves to [Clamp].
- 3. Select [9018-50] from the clamp list with F key, and select [Confirm]. Units, scaling method, and ratio will be set automatically.
- 4. Select the same range of the clamp sensor when using the range selection type. Select [10A] here.

However, you may need to switch the vertical axis (voltage axis) range to suit actual input values. For example, to display 0.2 V at full scale, set the vertical display to 20 mV per division (the instrument's 20 mV/div range)



With scaling, signals from the sensor are acquired as current rather than voltage. AB cursors and gauges are displayed and printed as current (Ampere) values. Refer to "Gauge" (p. 122) or "Cursor AB Value" (p. 115).

#### When using Model 8969 or U8969 Strain Unit

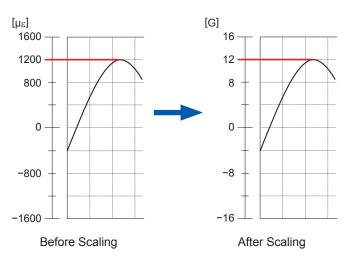
#### Example 2

To display data measured with the strain gauge transducer with a rated capacity of 20 G and a rated output of 1000  $\mu$ V/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:



Setting	Selection
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. 122) or "Cursor AB Value" (p. 115).

Set the parameters such that the rated capacity divided by two times the rated output is less than or equal to  $9.9999 \times 10^9$ .

# When the strain gauge transducer's inspection record provides the calibration factor

Set [Method] on the [Scaling] sheet to [Ratio].

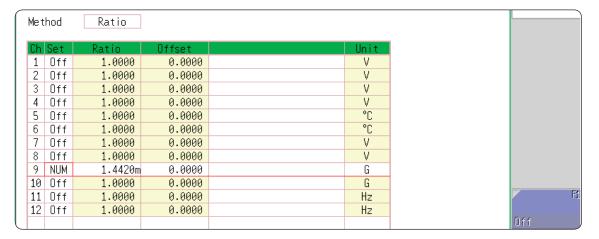
#### Example 3

# To display the data measured with the strain gauge transducer with a calibration factor of $0.001442 \text{ G} / 1 \times 10-6 \text{ strain}^*$ in terms of gees (G).

The value of the calibration factor (0.001442 [G]) is set as the conversion ratio. (\*  $10^{-6}$  strain =  $\mu\epsilon$ )

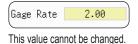
Move the cursor to the appropriate channel, and set as follows.

Setting	Selection
Se	NUM
Unit	G
Ratio (Conversion ratio)	0.001442 [G] (Displays as 1.4420m)



#### Using a Strain Gauge With a Gauge Rate Other Than 2.0

The Model 8969 or U8969 Strain Unit measures the gauge rate as 2.0. When using other strain gauges, 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).

#### Example 4

#### Measure using a strain gauge (gauge rate: 2.1), and display the measured data in units of G.

The scaling (conversion ratio) needs to be calculated to include both gauge rate and physical value conversions. In this case, the conversion ratio setting is the product of the conversion ratios of the gauge rate and measurement unit scaling.

The gauge rate component of the conversion ratio is 0.952, and the physical value component is 0.001442\*

Conversion Ratio = 0.952 × 0.001442 = 0.0013728

As in Example 3, enter [0.0013728] as the conversion ratio.

To convert measurement values to physical values when using a strain gauge, calculate using the Young's modulus or Poisson's ratio of the measurement object. The conversion method depends on the conditions in which the strain gauge is used.

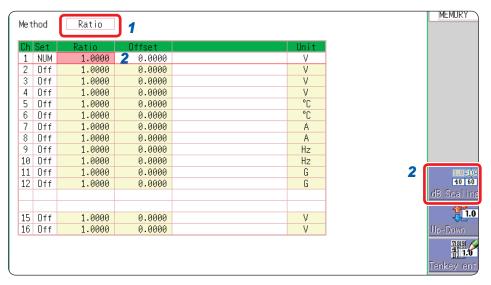
Refer to "Appendix 2.5 Scaling Method for Strain Gauges" (p. A8).

#### When using the dB value

#### Example 5

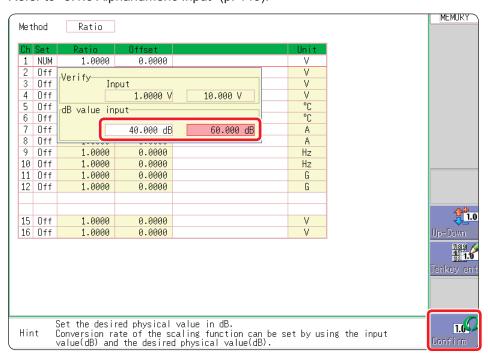
#### Acquiring the conversion rate to convert 40 dB input to 60 dB

- 1 For scaling, set the [Method] to [Ratio].
- 2 Move the cursor to the conversion rate setting. Select [dB Scaling] in the function column.

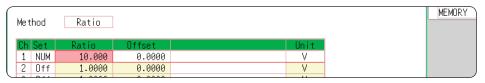


- In the displayed entry field and physical quantity field, enter 40 dB and 60 dB, respectively.
- 4 After entering the values, select [Confirm].

Refer to "8.1.3 Alphanumeric Input" (p. 149).



The conversion rate for the entered dB value will be entered. (The offset becomes 0.)



## 8.6 Set the Waveform Position (Variable Function)

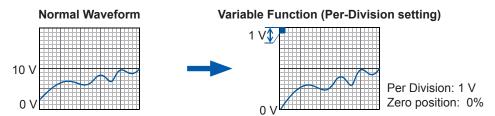
The waveform height and display position can be arbitrarily set along the vertical axis (voltage axis).

#### **Precautions when using the Variable Function**

- Verify that the vertical axis (voltage axis) range is set properly for the input signal.
- The vertical axis (voltage axis) range is unaffected by changes to the upper and lower limits made by the Variable setting.

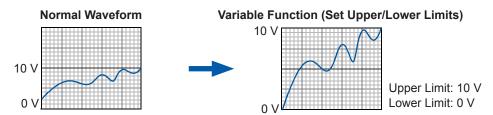
The following two setting methods are available:

• Set the displayed amplitude per division (1 div setting)
Set the amplitude to be displayed per vertical division and the zero position of the waveform on the vertical axis (voltage axis).



· Set the Upper and Lower Limits (Upper-Lower setting)

The upper and lower limits on the vertical axis (voltage axis) can be set to display the waveform amplitude full-screen.



Settings for the Variable function can be made for each individual channel, using the **[Each Ch]** sheet accessed from the Channel screen (p. 165), or for all channels using the Display range window (p. 166).

#### **Variable Function Settings per Channel**

#### Procedure `

Press the CHAN key to open the Channel screen, and then select the [Each Ch] sheet.

#### 1 Enable the Variable function.

Move the cursor to [Variable], and select [On].

#### Set the display range per division

Move the cursor to [Range(div)], and enter a numerical value. (Measurement units depend on the measurement mode of the module.) (When this is changed, the upper/lower limit values for the display also change accordingly.)



Move the cursor to [Zero pos%], and enter a numerical [%] value

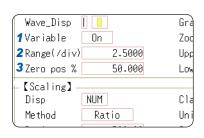
(When this is changed, the upper/lower limit values for the display also change accordingly.)

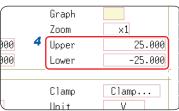
#### 4 (When setting upper and lower values)

Move the cursor to **[Upper]** and **[Lower]**, and specify the values. (When these are changed, the display range and zero position values also change accordingly.)

- When upper and lower values are set, waveforms can be displayed at full span on the screen.
- Depending on the scaling setting, the upper and lower display values may be less than 1. In such cases, set [Variable] to [On] then select [Auto Set].

Easy-to-read upper and lower limit values are set based on the current set values.





#### To reset the settings

Select [Reset] to return the settings to their default values.

- For information on numeric input, refer to "8.1.3 Alphanumeric Input" (p. 149).
- The [Unit List] sheet accessed from the Channel screen also lets you turn the Variable function On or Off individually for each channel.
- By using the Scaling and Variable functions together, the full span of a sensor's output can be displayed. (p. 166)
- When Scaling is enabled, values are displayed in scaling units. When these settings are changed, the numerical values indicating the display range on the level monitor are changed accordingly.

#### **Variable Function Settings for All Channels**

#### Procedure

Press the **DISP** key to open the Waveform screen, and then press the **CH.SET** key to open the display range window.

1 Enable the Variable function.

Move the cursor to [Variable], and select [On].

2 Set the upper and lower limits.

Move the cursor to **[Upper]** and **[Lower]** and enter numerical values.

	1	2	
ChVa	ariable	Lower	Upper
1	0n	-50.000m	50.000m
2	-	-50m	50m
3	-	-50m	50m
4	-	-50m	50m
5	-	-50m	50m)

#### When Using the Scaling and Variable Functions Together

#### When auto-correction of the variable function (p. 315) is enabled (On) (Default setting)

The Variable function settings change according to Scaling and vertical axis (voltage axis) range settings. Set Scaling before setting the Variable function.

If you change Scaling settings after enabling the Variable function, the Variable setting voltage is automatically corrected so that the displayed size of waveforms is unchanged.

#### When auto-correction of the Variable function is disabled (Off)

Set the Variable function after setting Scaling.

If you set the Variable function first, enter post-scaling values (converted physical values).

#### To display the full span of output from a sensor

By using the Scaling and variable functions in combination, voltage from a sensor can be converted to the physical units of the measurement object.

(Example)

Set Scaling as follows:

Scaling: Decimal or exponent, Two-Point Setting

Units: A

Sensor Output (Input 1): 1.23 [V] $\rightarrow$ (Scale 1): 0 [A] Sensor Output (Input 2): 5.78 [V] $\rightarrow$ (Scale 2): 10 [A]

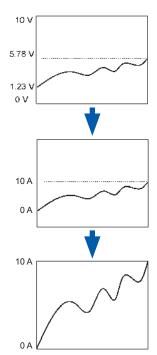
(With Variable function Off)

Voltage from the sensor is displayed as voltage.

It is displayed with the vertical axis (voltage axis) range and at the zero position set on the Channel settings window ([Analog] sheet).

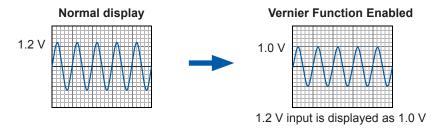
The Variable function is set as follows: Variable: On, Set Upper/Lower Limits Lower Limit: 0 [A] Upper Limit: 10 [A]

The full span of output from the sensor is displayed.



# 8.7 Fine Adjustment of Input Values (Vernier Function)

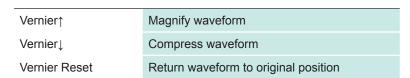
Fine adjustment of input voltage can be performed arbitrarily on the Waveform screen. When recording physical values such as noise, temperature and acceleration using sensors, amplitude can be adjusted to facilitate calibration.



#### Procedure

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

- Move the cursor to the [♣] vernier setting of the channel you want to adjust.
- Make the adjustment with the F keys while watching the waveform.





- The adjustment range is 50 to 200% of the original waveform. The magnification/compression ratio is not displayed.
- Vernier adjustments cannot be verified on printed waveforms or lists.
- The waveform data (print data, saved file data) is adjusted by the Vernier function.

## 8.8 Invert the Waveform (Invert Function)

This applies to analog channels only. You can invert the positive and negative sides of waveforms.

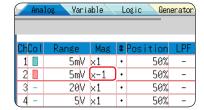
#### Example:

- 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

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

Move the cursor to [Mag] for the channel whose waveform you want to invert.



2 Select [Invert].

The waveform data (print data, saved file data) will be adjusted by the Invert function.

# 8.9 Copy Settings to Other Channels (Copy Function)

Settings can be copied to other channels and calculations (When using the FFT function) at the following screens.

- · Channel settings window
- · Display range window
- · Trigger settings window
- Status screen-[Status] sheet- [Analysis] list and [Scale] list (With 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 from the Display range window. The same procedure can be used for calculations as well as channels.

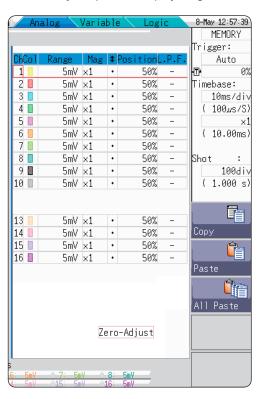
#### Procedure

Press the **DISP** key to open the Waveform screen, and then press the **CH.SET** key to open the display range window.

- 1 Move the cursor to the copy source channel number (calculation No.).
- 2 Select [Copy].
- 3 Move the cursor to the channel number (calculation No.) where you want to paste the settings.
- 4 Select [Paste].

To copy to all channels (calculations), move the cursor to a channel number (calculation No.) other than the copy source and select [All Paste].

When you want to copy all the settings on the Unit list/ Scaling/Variable sheets, select the [All setting Paste] button or [All setting All paste] button.

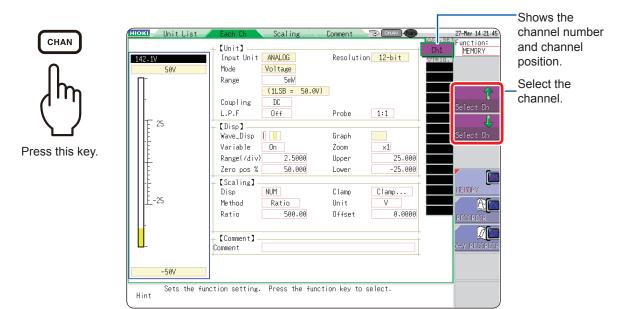


When channel settings are copied among different model modules, settings other than scaling cannot be copied. (Scaling copy is possible.)

# 8.10 Detailed Settings for Modules

Using the **[Each Ch]** sheet accessed from the Channel screen, you can make detailed settings for each module.

#### To Open [Each Ch] and Make a Channel Selection



#### Logic channel allocation when using Standard LOGIC terminals

	Maria	Memory for each channel (16 bits)			
	Module	4 bit	4 bit	4 bit	4 bit
CH1*	Analog	Analog CH1 LA			LA
CH2*	Allalog	Analog CH2			LB
CH3*	Logio	L2A	L2B		LC
CH4*	Logic	L2C	L2D		LD
CH5	Analog	Analog CH5 Analog CH6			
CH6	Analog				
CH7	Lasia	L4A	L4B		
CH8	Logic	L4C	L4D	_	_
CH9	A1		Ana	log CH9	
CH10	Analog		Anal	og CH10	
CH11	Angles	Analog CH11			
CH12	Analog		Anal	og CH12	
CH13	Angles		Anal	og CH13	
CH14	Analog	Analog CH14			
CH15	01	Analog CH15			
CH16	Analog	Analog CH16			
CH17	01	Analog CH17 LE			LE
CH18	Analog	Analog CH18 LF			LF
CH19	A1	Analog CH19		LG	
CH20	Analog	Analog CH20 LH			LH
CH21	A1	Analog CH21			
CH22	Analog	Analog CH22			
CH23	Analog		Anal	og CH23	
CH24	Analog	Analog CH24			
CH25	A I	Analog CH25			
CH26	Analog	Analog CH26			
CH27	Angles		Anal	og CH27	
CH28	Analog		Anal	og CH28	
CH29	Angles		Anal	og CH29	
CH30	Analog	Analog CH30			
CH31	0		Anal	og CH31	
CH32	Analog	Analog CH32			

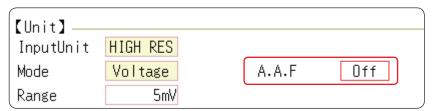
CH1 to CH4 and CH17 to CH20 provide 12-bit precision when logic channels LA to LH are used.
When Model 8970 Freq Units are installed as CH1 to CH4 and CH17 to CH20 and standard logic
channels LA to LH are in use, the modules of corresponding channels cannot be used. When Model
MR8990 Digital Voltmeter Units are installed as CH1 to CH4 and CH17 to CH20, the standard logic
channels corresponding to the table above cannot be used.

#### 8.10.1 Settings for the Anti-Aliasing Filter (A.A.F)

[M E M]

The anti-aliasing filter (A.A.F) setting is configurable for Model 8968 High Resolution Unit and Model U8979 Charge Unit only.

Refer to "To Open [Each Ch] and Make a Channel Selection" (p. 170).



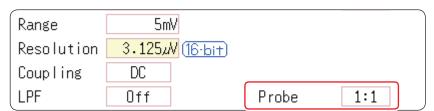
A.A.F

Enable the anti-aliasing filter to remove aliasing distortion. The cutoff frequency automatically changes according to the timebase or, when the FFT function is used, the frequency range setting.

Off	The anti-aliasing filter is disabled. (Default setting)
On	The anti-aliasing filter is enabled. (When external sampling is used, the antialiasing filter (AAF) is not available.)

#### 8.10.2 Probe Attenuation Selection

Refer to "To Open [Each Ch] and Make a Channel Selection" (p. 170).



**Probe** 

Set this when performing measurement with a connection cable or probe.

1:1	Model L9197, L9198 or L9217 Connection Cord connected to the input module. ( <i>Default setting</i> )
10:1	Model 9665 10:1 Probe connected to the input module.
100:1	Model 9666 100:1 Probe, P9000-01/-02 Differential Probe connected to the input module.
1000:1	Model 9322 Differential Probe, P9000-01/-02 Differential Probe connected to the input module.

#### **Setting Model 8967 Temp Unit** 8.10.3

Refer to "To Open [Each Ch] and Make a Channel Selection" (p. 170).

InputUnit	TEMP		
Mode	Temp-K	RJC	INT
Range	10°C	Burn Out	Off
Resolution	0.01°C	<u>16-bit</u> Renew Data	Normal

#### Mode

Choose the option that matches the type of thermocouple being used.

Selections	Measurement range	Selections	Measurement 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		

### Junction Compensation)

RJC (Reference When connecting a thermocouple directly to the module, select [Int]. Reference junction compensation is performed within the module.

When connecting through a reference junction device (e.g., a 0°C control tank), select [Ext].

INT	Reference junction compensation is provided within the module. (Default setting) (Measurement Accuracy: The sum of the accuracies of the temperature measurement and the reference junction compensation.)
EXT	Reference junction compensation is not provided within the module. (Measurement Accuracy: The accuracy of temperature measurement only)

#### **Burn Out**

A broken thermocouple wire can be detected during temperature measurement. Normally when a thermocouple wire breaks, measured values exhibit random instability.

Off	Broken wires not detected.
On	Broken wires detected.  Wire breakage is detected by sensing a miniscule current flow (about 100 nA) through the thermocouple. If the thermocouple wires are long or composed of a high-resistance material, set [Burn Out] to [Off] to avoid measurement errors.

#### **Renew Data** (Data Refresh)

The data refresh rate can be set to Fast, Normal, or Slow.

The default setting is [Normal]. This allows stable measurement while eliminating noise. For quicker response, select [Fast], but note that this will make the measurement more susceptible to noise. For further improved measurement stability, select [Slow].

Fast	Data is updated approximately every 1.2 ms.
Normal	Data is updated approximately every 100 ms. (Default setting)
Slow	Data is updated approximately every 500 ms.

#### 8.10.4 Setting Model 8969 and U8969 Strain Unit

The Model 8969 or U8969 Strain Unit can perform 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 Auto-balance**

- Turn power on and wait 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.
- · Auto-balance cannot execute during measurement.
- · Key operations are not accepted while auto-balance is executing.

#### To Execute Auto-balance

Refer to "To Open [Each Ch] and Make a Channel Selection" (p. 170).



#### Setting Item: [Range]

Auto Bal All Chs	Auto-balance will be executed for all channels where a Model 8969 or U8969 Strain Unit is installed.
Auto Bal Ch 1	Auto-balance will be executed for the currently selected channel.

Auto-balance can also be executed from the Channel settings window (Analog sheet) (if the range of a channel with an installed Model 8969 Strain Unit is selected).

#### To Open the Channel settings window ([Analog] sheet)

Refer to "3.4.2 Choose Analog Channel Settings" (p. 69).

#### In the following cases, auto-balance should be executed again.

- After changing the vertical axis (strain axis) range
- · After a module has been removed or inserted
- After the strain gauge transducer has been replaced
- After power has been turned off and on
- After performing a system reset
- When ambient temperature has changed significantly (the zero position may drift)

#### If "Warning: Auto balance failed." appears

The channel on which auto-balance failed is displayed.

Verify the following, and execute 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?

#### 8.10.5 **Setting Model 8970 Freq Unit**

When the standard logic display (LA, LB, LC, LD, LE, LF, LG, and LH) is on, 8970 Freq Units installed as unit 1, 2, 9, or 10 cannot be used.

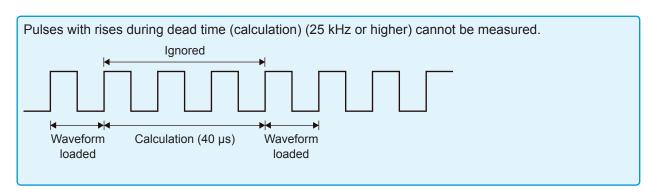
Refer to "To Open [Each Ch] and Make a Channel Selection" (p. 170).

InputUnit	FREQ	VRange	±10V
Mode	Count	Threshold	+2.5V
Range	2k	Timing	Start
Resolution	1.00 (16-	bit Count O∨er	Hold
Coupling	DC	Slope	Î
LPF	Off	Divide	1

# Mode

Changes the measurement mode.

Frequency	Measure the frequency of the measurement waveform (Hz hertz) (Default setting		
RPM	Measure the number of rotations of the measurement target (r/min: rotations/minutes)		
Power Frequency	Measure the power frequency variation (Hz hertz)		
Count	Add up the number of input pulses		
Duty	Measure the duty rate of the measurement waveform (% percent)		
Pulse width	Measure the pulse width (s second)		



# VRange (Input voltage)

Set the maximum level for the input signal.

±10 V (Default setting), ±20 V, ±50 V, ±100 V, ±200 V, ±400 V

Select the value using the F keys.

- Threshold value When the measurement waveform exceeds the threshold value, the measurement value is acquired based on the time interval and the number of times the threshold was exceeded.
  - The threshold value upper and lower limits and increases and decreases in width depend on the input voltage ([VRange]) setting.
  - While setting the threshold, the voltage level is displayed on the level monitor.
  - Select the value using the F keys.

To prevent measurement errors due to noise, the threshold has a hysteresis of approximately 3% versus the input voltage.

(When [VRange] is [ ±10V], it is around ±0.3 V.)

Set a threshold in excess of the hysteresis width versus the voltage peak.

### Slope

For each measurement mode, set the direction in which the specified level is crossed.

<b>1</b>	Rises above the specified level are detected. (Default setting)
$\downarrow$	Drops below the specified level are detected.

### Divide

Determines the frequency for each set pulse.

1(Default setting) to 4096

Select the value using the F keys.

Example: When the encoder is at 360 pulses per rotation, the frequency of each rotation can be measured by setting the number of divisions to [360]. When frequency dividing is not needed, set to [1].

## **Timing**

This is enabled only when **[Mode]** is **[Count]**. Sets the start timing for the sum count.

Start	When the <b>START</b> key is pressed, counting starts. (Default setting)
Trigger	When a trigger is applied, counting starts.

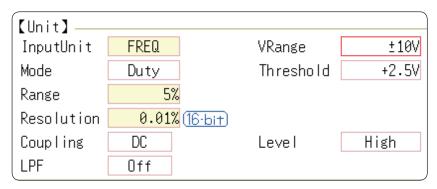
- When [Start] is set, there is some internal processing time between pressing of the START key and
  the start of measurement. Therefore, the count value is not zero at the start point.
- When **[Start]** is set and the trigger level is exceeded while waiting for the pre-trigger, the trigger is not enacted. Furthermore, the time for internal processing at start and the trigger priority setting may cause the trigger not to be enacted at the specified trigger level.
- When memory division is used, there are cases when the last data in the previous block remains in the first part of the block.

# **Count Over**

This is enabled only when [Mode] is [Count].

Hold	Counting is performed to the maximum (at 2 k range, 65535) and no higher.
Back	If counting is performed up to 25 times the range (at 2 k range, up to 50000) the count value returns to 0.

Refer to "To Open [Each Ch] and Make a Channel Selection" (p. 170).



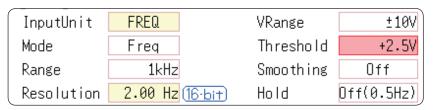
# Level

This is enabled only when [Mode] is [Pulse Width] or [Duty].

In pulse width/duty rate measurements, set which level is detected when the threshold is exceeded.

HIGH	Measures above the threshold value. (Default setting)	
LOW	Measures below the threshold value.	

Refer to "To Open [Each Ch] and Make a Channel Selection" (p. 170).



# **Smoothing**

This is enabled only when [Mode] is [Freq] or [RPM].

Set smoothing.

Off	The measured data is recorded as is. (A step waveform.) (Default setting)
On	The measured data is interpolated so that the waveform is smooth before it is output. (Upper limit: 10 kHz, further delayed from Off.)

# Hold

This is enabled only when [Mode] is [Freq] or [RPM].

Set hold for frequency and count.

Off (1Hz/0.5Hz/ 0.2Hz/0.1Hz)	When the frequency reaches the value in the brackets but is not settled, it is defined as a stopped item and the measurement value becomes 0 Hz (0 rpm). (Default setting)
On	The value defined last time is retained.

# 8.10.6 Setting Model 8971 Current Unit

There is no need to change the setting since it is set when the clamp sensor is automatically recognized.

Refer to "To Open [Each Ch] and Make a Channel Selection" (p. 170).

InputUnit	CURRENT
Mode	20A/2V
Range	100mA <sub>div</sub>

### Mode

20A/2V	Sets this option when Model 9272-10 (20 A range), 9277, or CT6841 Clamp Sensor is connected. (Default setting)
200A/2V	Sets this option when Model 9272-10 (200 A range), 9278, CT6863, or CT6843 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*, or CT6865* Clamp Sensor is connected.

<sup>\*</sup> When Model CT6846 or CT6865 is connected to Model 8971 Current Unit through Model 9318 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

# 8.10.7 Setting Model 8972 DC/RMS Unit

Refer to "To Open [Each Ch] and Make a Channel Selection" (p. 170).

InputUnit	DC/RMS		
Mode	DC	Response	Normal
Range	5mV		

### Mode

Switches between voltage measurement and RMS measurement.

DC	Voltage measurement (Default setting)	
RMS	RMS measurement	

# Response

The response time for RMS measurement can be set to three speeds: Fast, Normal and Slow.

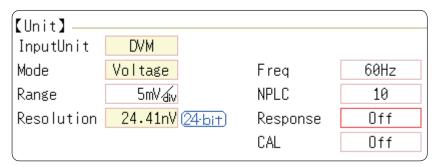
While it is normally set to **[Fast]**, this can be changed to **[Normal]** or **[Slow]** to stabilize the measured value when the frequency is low or when severe fluctuations are present.

Fast	Response time about 100 ms. (Default setting)	
Normal	Response time about 800 ms.	
Slow	Response time about 5 s.	

# 8.10.8 Setting Model MR8990 Digital Voltmeter Unit

- When the Model MR8990 Digital Voltmeter Unit is installed as unit 1, 2, 9, or 10, the standard logic channels cannot be used.
- The resolution of the data measured by the recorder function is 16 bits.

Refer to "To Open [Each Ch] and Make a Channel Selection" (p. 170).



# Frequency

Set the power frequency.

Set 50 Hz or 60 Hz according to the power frequency for your region.

50Hz	Cycle 20 ms (Default setting)
60Hz	Cycle 16.67 ms

If the power frequency setting is not configured correctly, measurement values will be unstable.

### **NPLC**

PLC (Power Line Cycle) is the time equivalent to one cycle 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  $\times$  10 = 200 ms.

The measurement data refresh rate becomes 200 ms.

# Fast response

Data can be refreshed 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 up to 9.  Refreshes the data at 1 PLC when NPLC is 10 or above.

### Calibration

This setting is used for performing calibration or synchronization between channels automatically when measurement is started. Performing synchronization between channels enables matching the timing for the start of integration.

Off	No calibration and synchronization. (Default setting)	
On	Perform calibration and synchronization.	
Synchronization	Perform only synchronization between channels.	

- The calibration time is approximately 150 ms. During this period measurement is not performed.
- If synchronization between channels is performed, a signal to stop integration is sent to each module when measurement is started and the wait process is performed 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.

    If synchronization is not performed, the above wait time will also be required for measurement performed immediately after the settings of the Model MR8990 Digital Voltmeter Unit are changed. However, there will be no wait time when measurement is performed with the same settings.
- When this is set to [Off] (Default setting), perform calibration manually.
   Refer to "2.8 Perform Calibration (When Model MR8990 is installed)" (p. 53).

# 8.10.9 Setting Model U8974 High Voltage Unit

Refer to: "To Open [Each Ch] and Make a Channel Selection" (p. 170)



## **Mode** Switches between voltage measurement and RMS measurement.

DC	Voltage measurement (Default setting)	
RMS	RMS measurement	

## Response

The response time for RMS measurement can be set to three speeds: Fast, Normal and Slow.

The response time can be set to **[Slow]** to stabilize the measured value when the frequency is low or when severe fluctuations are present.

Fast	Response time is set to 150 ms.	
Normal	Response time is set to 500 ms. (Default setting)	
Slow	Response time is set to 2.5 s.	

# 8.10.10 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

# **MARNING**



Setting the measurement mode to [Preamp] allows Model U8979 Charge Unit to constantly provide power (3.5 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 "To Open [Each Ch] and Make a Channel Selection" (p. 170)

InputUnit	CHARGE		
Mode	Charge	A.A.F	Off
Range	500mM/s²4iv	Sens.	1.000

### **Mode** Switches the measurement mode.

Mode	Measurement target	Measurement sensitivity
Voltage	Voltage	_
Charge (Default setting)	Charge-output acceleration sensor	0.1 pC/(m/s <sup>2</sup> ) to 10 pC/(m/s <sup>2</sup> )
Preamp	Acceleration sensor with a built-in preamplifier	0.1 mV/(m/s <sup>2</sup> ) to 10 mV/(m/s <sup>2</sup> )

(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.

# 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/s²)	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<sup>2</sup>.

Sensor sensitivity	(setting value)
For sensor sensitivity of 64 pC/G 64.0 / 9.8 = 6.53061 pC/(m/s²)	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 Convert Input Values (Scaling Function)" (p. 157)

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		

# 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 Save Waveforms" (p. 88)

**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<sup>2</sup>)

Specify 10 pC/(m/s²), 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 <sup>2</sup>

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 <sup>2</sup>		

## Example 2

# For sensor sensitivity of 0.05 pC/(m/s<sup>2</sup>)

Specify 0.1 pC/(m/s²), 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

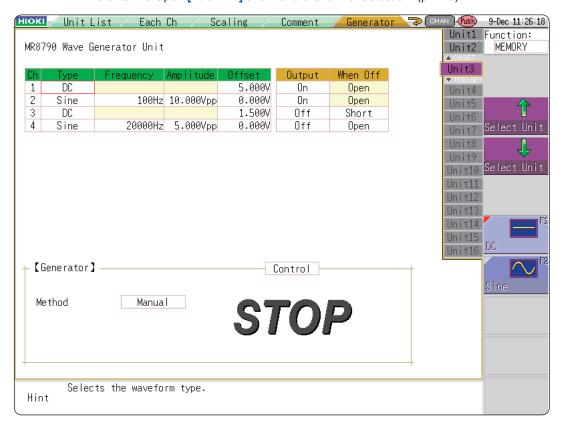
Ratio	2.0000E+00 (= 0.1/0.05)
Offset	0.0000E+00
Units	m/s <sup>2</sup>

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 <sup>2</sup>		

# 8.10.11 Setting Model MR8790 Waveform Generator Unit

Channels installed with Model MR8790 cannot be measured.



Refer to "To Open [Each Ch] and Make a Channel Selection" (p. 170).

# **Type** Selects the waveform type.

DC	DC output (Default setting)
Sine	Sine wave output

### Frequency

Sets the frequency of output signal.

0 Hz to 20000 Hz

### **Amplitude**

Sets the amplitude of output signal.

The output voltage with guaranteed accuracy is the sum of the amplitude and the offset, between -10 V and +10 V. If the sum of the amplitude and the offset is set outside 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

### Offset

For DC output: Sets DC voltage.

For sine wave output: Sets the offset voltage.

The output voltage with guaranteed accuracy is the sum of the amplitude and the offset, between -10 V and +10 V. If the sum of the amplitude and the offset is set outside 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 terminal status when the output is off.

Open	Opens the output terminals, separating them from internal circuits.
Short	Short-circuits the output terminals, separating them from internal circuits.

## Output

Turns waveform output On/Off.

On	Outputs waveform.
Off	Does not output the waveform.

### Control

Sets the waveform output.

RUN	Starts output.
PAUSE	Pauses output. While output is paused, the output at the time [PAUSE] was pressed will be output.
STOP	Stops output.

# Method

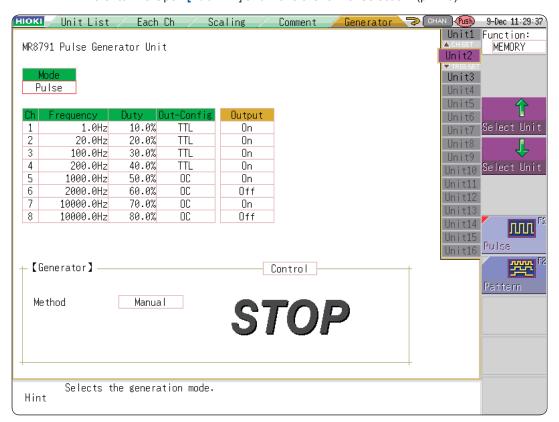
Selects the control method for waveform output.

Manual	Restricts control of signal output to Signal Generation screen.
Sync.	Augments manual control with signal output in synchronization with the start and end of measurement.  START key: Starts output when measurement starts.  STOP key: Stops output when measurement stops.
Keys	Augments manual control by allowing signal output to be manipulated using the instrument's keys.  START key: Starts output.  STOP key: Stops output.  Manual Trigger key: Pauses output.

(For details, see the instruction manual of Models U8793, MR8790, and MR8791.)

# 8.10.12 Setting Model MR8791 Pulse Generator Unit

Channels installed with Model MR8791 cannot be measured.



Refer to: "To Open [Each Ch] and Make a Channel Selection" (p. 170)

### Mode

Select the type of output.

Pulse	Pulse output (Default settings)
Pattern	Pattern output

Refer to the instruction manual of Models U8793, MR8790, and MR8791 regarding the detailed settings for pattern output.

- The pattern output can be selected only when used channel is set to 32 ch.
- When the used channels is changed, the pattern data will disappear. Setting Channels to Use

Refer to: Refer to "8.4 Setting Channels to Use (Extending the Recording Length)" (p. 156)

# Frequency

Sets the frequency for pulse output.

0 Hz to 20000 Hz

### Duty

Sets the pulse duty.

0% to 100%

# Out-Config Sets the output status.

TTL	TTL output
OC	Open collector output

# Output Turns waveform output On/Off.

On	Outputs waveform.
Off	Does not output the waveform.

# **Control** Sets the waveform output.

RUN	Starts output.	
PAUSE	Pauses output. While output is paused, the output at the time [PAUSE] was pressed will be output.	
STOP	Stops output.	

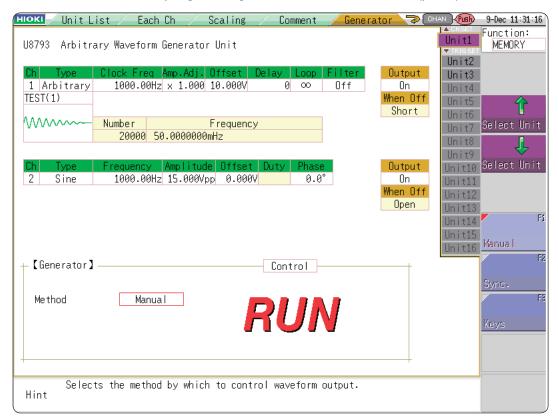
# **Method** Selects the control method for waveform output.

Manual	Restricts control of signaRefer to "8.4 Setting Channels to Use (Extending the Recording Length)" (p. 156)I output to Signal Generation screen.	
Sync.	Augments manual control with signal output in synchronization with the start and end of measurement.  START key: Starts output when measurement starts.  STOP key: Stops output when measurement stops.	
Keys	Augments manual control by allowing signal output to be manipulated using the instrument's keys.  START key: Starts output.  STOP key: Stops output.  Manual Trigger key: Pauses output.	

(For details, see the instruction manual of Models U8793, MR8790, and MR8791.)

# 8.10.13 Setting Model U8793 Arbitrary Waveform Generator Unit

Channels installed with U8793 cannot be measured.



Refer to: "To Open [Each Ch] and Make a Channel Selection" (p. 170)

# **Type** Selects the waveform type.

DC	DC output (Default setting)	
Sine	Sine wave output	
Square	Rectangular wave output	
Pulse	Pulse wave output	
Triangle	Triangular wave output	
Ramp-up	Ramp-up wave output	
Ramp-down	Ramp-down wave output	
Arbitrary	Outputs the created waveform	
Program	Outputs the waveform set in the program	

Refer the instruction manuals of Model U8793, MR8790, and MR8791 for the settings at the time of program selection.

## **Frequency** Sets the frequency of output signal.

0 Hz to 100000 Hz

# 8

### **Amplitude**

Sets the amplitude of output signal.

The output voltage with guaranteed accuracy is the sum of the amplitude and the offset, between -10 V and +15 V. If the sum of the amplitude and the offset is set outside 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 DC voltage.

For sine wave output: Sets the offset voltage.

The output voltage with guaranteed accuracy is the sum of the amplitude and the offset, between -10 V and +15 V. If the sum of the amplitude and the offset is set outside 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 when selecting pulse wave.

0.1% to 99.9%

### When Off

Sets the terminal status when the output is off.

Open	Opens the output terminals, separating them from internal circuits.	
Short	Short-circuits the output terminals, separating them from internal circuits.	

# Output

Turns waveform output On/Off.

On	Outputs waveform.
Off	Does not output the waveform.

### Control

Sets the waveform output.

RUN	Starts output. (Output indicator: Red)	
PAUSE	Pauses output. While output is paused, the output at the time [PAUSE] was pressed will be output. (Output indicator: Red)	
STOP	Stops output. (Output indicator: Off)	

Manual	Restricts control of signal output to Signal Generation screen.
Sync.	Augments manual control with signal output in synchronization with the start and end of measurement.  START key: Starts output when measurement starts.  STOP key: Stops output when measurement stops.
Keys	Augments manual control by allowing signal output to be manipulated using the instrument's keys.  START key: Starts output.  STOP key: Stops output.  Manual Trigger key: Pauses output.

# Settings when selecting arbitrary waveform

Data name	Register/delete the data	of the outputted waveform.	. Maximum eight waveforms can

be registered.

**Filter** Filter 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 waveform generation. When the delay value is positive, the phase is

progressive.

-250,000 data to 250,000 data (Default settings: 0)

**Loop** Set the repetition count for generating waveforms.

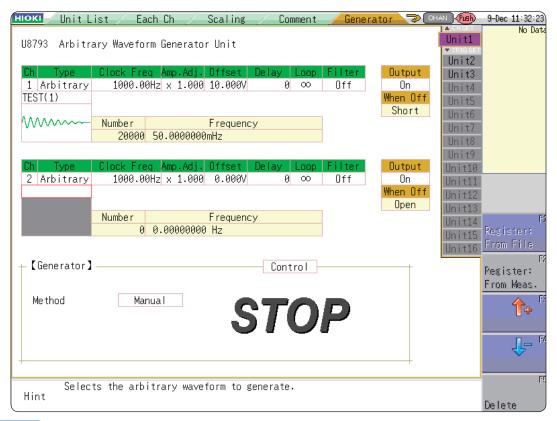
1 to 50,000, ∞ (Default setting: ∞)

**Amp Adj** Set the amplitude level for waveform output.

**Offset** Set the offset voltage for waveform.

# 8.11 Register the Waveform in the U8793 ArbitraryWaveform Generator Unit

ou can register waveform in the Model U8793. Registered waveforms can be output from the Model U8793.



# Procedure

To open the screen: press the CHAN key to open the Channel screen, and then select [Generator] sheet

1 Set the type to random waveform.

Move the cursor to [Type] on the settings screen, and select [Arbitrary] using the F keys.

2 Register the waveform.

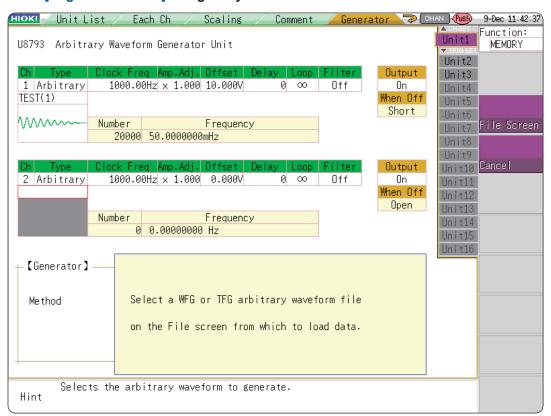
Move the cursor to the item listed below [Arbitrary] on the settings screen.

3 Select a reading source of the waveform.

Resister: From File	Registers from data saved in the media.	
Register: From Meas.	Registers the data measured using memory function. You can also register after reading the MEM files from media to the instrument.	
↑ or ↓	Select arbitrary waveform data registered in the Model U8793. (Use when selecting/deleting output waveforms.)	
Delete	Deletes the data registered in the U8793 memory. If eight waveforms are already registered in the memory, delete any of them and then register.	

# **Register From Files**

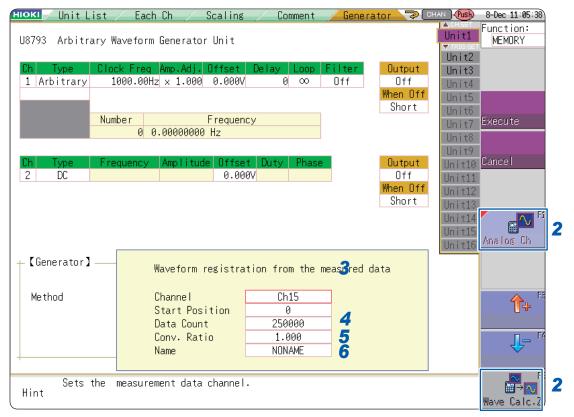
1 Select [Register..from file] using F keys



- 2 Select [to File scrn] using the CH.SET key. Move to the file screen.
  - Select arbitrary waveform file WFG or TFG on the file screen and then register.

# **Register From Measured Data**

1 Select [Register..from measurement data] using F keys



Select the waveform to be registered using F keys.

Analog Ch	Registers the waveform of the measured analog channel.
Wave Calc. Z	Registers the waveforms with waveform calculation result.

3 Select the waveform channels to register.

Analog waveform

Ch1 to Ch32

Waveform calculations

Z1 to Z16

4 Set the data count to be registered.

Whole waveforms	Registers the whole wave.*
A-B waveforms	Registers the waveforms between AB cursors.*
Tenkey input	Randomly sets data lead position and data count in the numeric keypad input.

<sup>\*</sup> Data count more than 250,000 (maximum registerable data count) cannot be registered.

# 5 Set the conversion ratio.

Amplify or attenuate a voltage value of the measured data to register it.

0.001 times to 100 times

### 6 Enter a data name.

Register as an arbitrary waveform data in the U8793 memory. Enter a [Name].

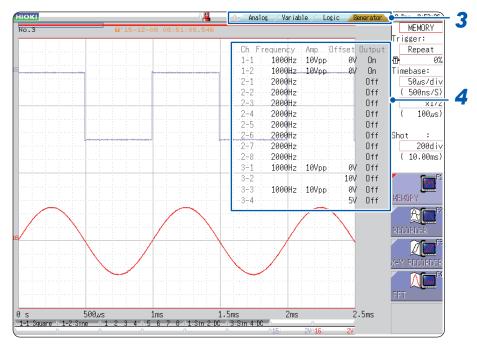
When a data name is not entered, the data will be registered as [NONAME].

# 8.12 Save the Waveforms Registered in the Model U8793 in the Media

You can save the arbitrary waveform data registered in U8793 in the media. For saving methods, refer to "5.2.4 Save Waveform Output Data to the Media" (p. 98).

# 8.13 Setting Output Waveform Parameters

Parameters (frequency, amplitude, and offset) for the output waveform that was configured on the Generator screen (signal generation setting screen) can be changed on the Waveform screen. The ability to configure and change these settings while outputting and measuring the resulting waveform provides a convenient way to measure a waveform while varying its parameters.



- 1 Display the Waveform screen (if viewing another screen, press DISP to display the Waveform screen).
- Press CH.SET (to display the tabs).
- Press CH.SET or select the [Generator] tab with the mouse.
- 4 Set the following parameters as desired.

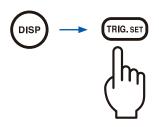
Frequency	Sets the frequency.
Amp	Sets the amplitude
Offset	Sets the offset.
Output	Turns output on or off.

(For details, see the instruction manual of Models U8793, MR8790, and MR8791.)

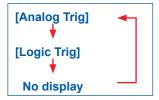
# **Trigger Settings**

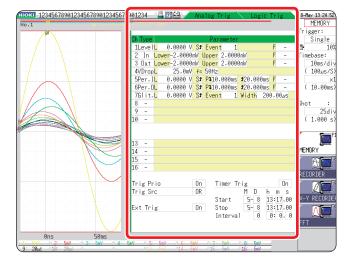
Triggering allows you to start and stop measurement using signals or conditions. When recording is started or stopped by a specific signal, we say the trigger is "applied" or "triggering occurs." You can configure triggers inform the Trigger settings window of the Waveform screen. Triggers cannot be set with the X-Y Recorder function.

# To Open the Trigger Settings Window



Pressing **TRIG.SET** repeatedly cycles through the following sheets.





If the trigger setting screen is hard to see due to waveform overlap, narrow the waveform display width to divide the waveform display screen and trigger settings screen.

Refer to "7.7.3 Switch the Waveform Display Width" (p. 142)

# Operations available from the Trigger settings window

### **Trigger Settings**

- Trigger mode settings (p. 197)
- Combined trigger logic (AND/OR) for multiple trigger sources (p. 214)
- Pre-trigger settings (p. 209)
- Trigger timing settings (p. 212)

# **Trigger Source Settings**

### **Analog Trigger Settings**

(p. 198)

- · Level Trigger
- Window trigger
- Period trigger
- Glitch trigger
- Voltage sag trigger

Timer Trigger Settings (p. 205)

External Trigger Settings (p. 208)

Manual Trigger Settings (p. 208)

## **Logic Trigger Settings**

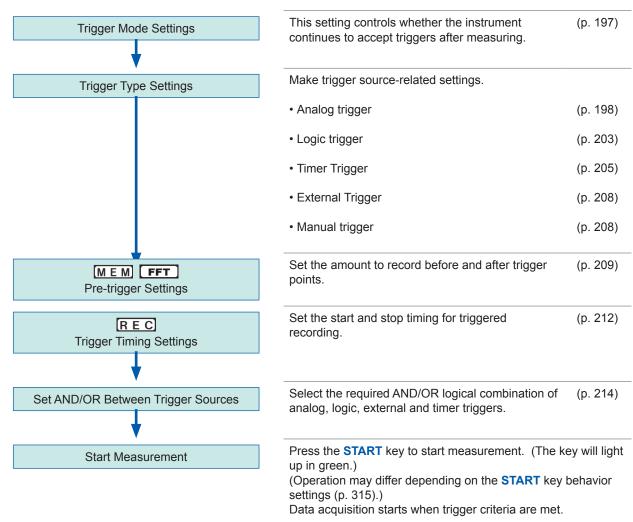
(p. 203)

- · Combined trigger logic settings
- Trigger filter settings
- Trigger pattern settings

Trigger Output (p. 351)

Search for trigger positions (p. 215)

# 9.1 Setting Workflow



- To stop measurement, press the **STOP** key.
- Press once: Recording will stop at the end of the specified recording length.

Press twice: Recording stops when the key is pressed.

Available settings for the respective items depend on the function.

- Except for manual trigger, triggering is based on the logical combination of trigger sources (AND/OR).
   (p. 214)
- When triggering occurs, the TRIG OUT terminal for control of external devices carries an output signal. (p. 351)

# 9.2 Set the Trigger Mode

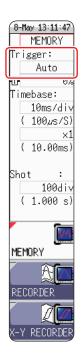
This setting controls whether the instrument continues to accept triggers after measuring. If all trigger sources are disabled (Off, with no trigger setting), measurement starts immediately (free-running).

# Procedure

Press the **DISP** key to open the Waveform screen.

- **1** Move the cursor to [Trigger].
- 2 Select the trigger mode.

Single	Only one trigger is recognized. After pressing the <b>START</b> key, once a trigger is applied, a waveform is recorded for the specified recording length, then measurement stops.
Repeat	Triggers are accepted continuously.  When no trigger is applied, the instrument enters the Trigger Wait state. Press the <b>STOP</b> key to stop measurement. (See below)
Auto	Triggers are accepted continuously.  If no trigger is applied within about one second, a waveform of the specified recording length is automatically recorded.  Press the STOP key to stop measurement.



Available options depend on the function.

Trimmon mondon	Function	
Trigger modes	M E M FFT	REC
Single	0	O (Default setting)
Repeat	0	0
Auto	O (Default setting)	-

To Stop Measurement, press the **STOP** key.

Press once: Recording will stop at the end of the specified recording length.

Press twice: Recording stops when the key is pressed.

# When the trigger mode is set to [Repeat]

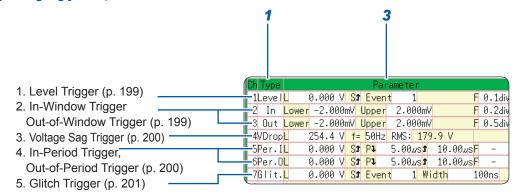
During the processing interval (auto-save, auto-print, waveform display processing, numerical calculation) from the end of recording until next entering the Trigger Wait state, triggering will not be accepted.

# 9.3 Analog Signal Triggers

The process below explains how to set up the different types of analog triggers. These settings can be configured on the Trigger settings window ([Analog Trg.] sheet).

### Procedure

Press the **DISP** key to open the Waveform screen, and then press the **TRIG.SET** key to open the trigger settings window (**[Analog Trg.]** sheet).



- 1 Move the cursor to [Type] for the channel for which you want to change the settings.
- Select the trigger type with the F keys.
- **3** Move the cursor to the parameter item with the CURSOR keys.
- 4 Select the parameter value with the F keys.

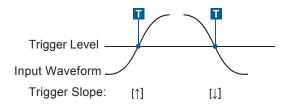
# To copy the setting to another channel

The Trigger settings window ([Analog Trig] sheet) can be used to copy a setting. Refer to "8.9 Copy Settings to Other Channels (Copy Function)" (p. 169).

Analog triggers cannot be set when the FFT function is used and [Reference] is set to [From Memory] on the [Status] sheet.

# 1. Level Trigger

A trigger is applied when the input signal crosses the specified trigger level (threshold voltage).

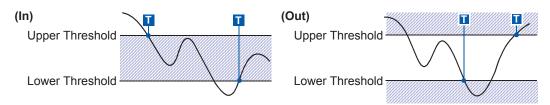


In this manual,  $\intercal$  indicates a "trigger point," the time at which a trigger is applied.

Type	Parameters	
[Level]	[L] (Level)	Sets the level (voltage value) for the trigger. (The setting can be made in 1/50 increments.)
	[S] (Slope)	Determines whether triggering occurs when the signal crosses the threshold (trigger level) on the rising or falling edge. With the [] setting, triggering occurs in both directions. $(\uparrow,\downarrow,\updownarrow)$
	[Event]	The number of signal rising or falling edge events is counted and triggering occurs when the Event number set here is exceeded. (1 to 4000)
	[F] (Filter)	Triggering occurs when the trigger criteria are met within the specified filter width. This is useful to prevent spurious triggering due to noise. (MEM) FFT: OFF, 0.1 - 10 div REC: OFF, ON*) *: Filter width 10 ms.

# 2. In-Window Trigger, Out-of-Window Trigger

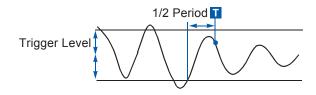
By setting upper and lower limit values for the trigger, a trigger will be applied when the input signal enters (In) or leaves (Out) this range.



Туре	Parameters	
[ln] or	[Lower]	Set the lower limit value. (The setting can be made in 1/50 increments.)
	[Upper]	Set the upper limit value. (The setting can be made in 1/50 increments.)
[Out]	[F] (Filter)	Triggering occurs when the trigger criteria are met within the specified filter width.  This is useful to prevent spurious triggering due to noise.  (MEM) FFT: Off, 0.1 - 10 div, REC: Off, On*)  *: Filter width 10 ms

# 3. Voltage Sag Trigger (MEM FFT Only)

Triggering occurs when the voltage peak drops below a preset level for more than half a cycle. The allowable timebase is 20 µs to 50 ms/div.

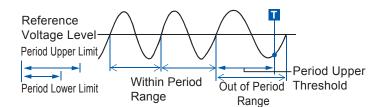


Type	Parameters	
	[L] (Level)	Sets the level (voltage value) for the trigger. (The setting can be made in 1/50 increments.)
[VDrop]	[f=] (Frequency)	Select 50 or 60 Hz.
	RMS: (actual value)	The target actual value. Changes when the level setting changes.

# 4. In-Period Trigger, Out-of-Period Trigger

The rising edge and falling edge cycle of the reference voltage is measured, and triggering occurs when the cycle enters the preset range (In) or leaves the preset range (Out).

Refer to "About period range settings", "About the trigger point of the Out-of-Period trigger" (p. 202).



# **About the Trigger Point**

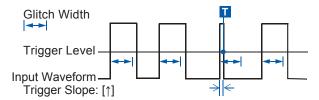
The trigger point occurs one sample after the criterion is met.

Туре	Parameters	
[Per.I] or [Per.O]	[L] (Level)	Sets the level (voltage value) for the trigger. (The setting can be made in 1/50 increments.)
	[S] (Slope)	Determines whether triggering occurs when the signal crosses the threshold (trigger level) on the rising or falling edge. $(\uparrow,\downarrow)$
	[P↓] (Period lower limit)*1	Available settings are 0 and more than 5 times the sampling frequency. This cannot be set to be higher than the Period upper limit setting. (When the setting is 0, the lower limit is disregarded, and triggering occurs only on the upper limit.)
	[↑] (Period upper limit)*1	The setting range extends to 20,000 times the sampling frequency. This cannot be set to be lower than the Period lower limit setting.
	[F] (Filter)	Triggering occurs when the trigger criteria are met within the specified filter width. This is useful to prevent spurious triggering due to noise.  (MEM FFT: Off, 0.1 - 10 div, REC: Off, On*) *: Filter width 10 ms.

<sup>\*1</sup> Changes when the timebase changes.

# 5. Glitch Trigger (M E M FFT Only)

Triggering occurs when the input signal crosses the trigger level (threshold voltage) if its pulse width is shorter than the specified width.

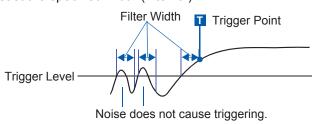


Туре	Parameters	
	[L] (Level)	Sets the level (voltage value) for the trigger. (The setting can be made in 1/50 increments.)
	[S] (Slope)	Determines whether triggering occurs when the signal crosses the threshold (trigger level) on the rising or falling edge. $(\uparrow,\downarrow)$
[Glit.]	[Event]	The number of signal rising or falling edge events is counted and triggering occurs when the Event number set here is exceeded. (1 to 4000)
	[Width]	Sets the pulse width (time) that is used to determine a glitch. Triggering occurs when the width is lower than this value. (The available setting range depends on the sampling frequency. Lower limit: sampling frequency × 2, upper limit: sampling frequency × 4000)

# When Using Noisy Signals for Triggering

# Method 1: Enable the trigger filter

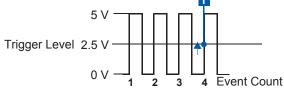
By setting the filter width to prevent triggering on noise, triggering occurs only when the trigger criteria continue to be met for at least the specified width (interval).



# **Method 2: Setting an Event Count**

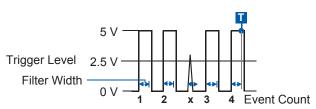
If triggering occurs too frequently, an event count can be specified so that a trigger is accepted only after the specified number of trigger events has occurred.

Example: When the event count is set to **[4]** (Slope: ↑)



# To Suppress the Effects of Noise

Noise near the trigger level can erroneously increment the event count. Use the trigger filter to avoid this problem.



### About period range settings

The period range settings for period triggering depend on the sampling period (sampling rate). (Changing the timebase also changes the period setting range.)

The [Sampling Rate] setting can be verified on the Status screen - [Status] sheet.

The upper threshold of the period range cannot be set below the lower threshold, and vice-versa.

Lower threshold: can be set either to zero, or to at least five times the sampling period.

Upper threshold: can be set to no more than 20,000 times the sampling period.

To apply a trigger when the frequency increases (shorter period) above the upper threshold Set the period trigger type to [Per.I] and the lower threshold to [0]. The lower threshold will be ignored and triggering will occur when the frequency exceeds the upper threshold.

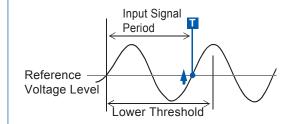
To apply a trigger when the frequency decreases (longer period) below the upper threshold Set the period trigger type to [Per.O] and the lower threshold to [0]. The lower threshold will be ignored and triggering will occur when the frequency drops below the upper threshold.

### About the trigger point of the Out-of-Period trigger

Triggering occurs when the period of sequential crossings of the specified reference voltage exceeds the period range.

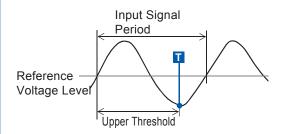
The point at which triggering occurs depends on the specified period range and the period of the measured signal.

## When the input signal period is shorter than the specified lower threshold (Trigger Slope: ↑)



Triggering occurs when the rising edge (↑ trigger slope) of the input signal crosses the reference voltage level, before reaching the lower period threshold.

# When the input signal period is longer than the specified upper threshold (Trigger Slope: ↑)



Triggering occurs when the upper threshold period is reached, before the rising edge (↑ trigger slope) of the input signal crosses the reference voltage level.

The trigger point is determined by the upper threshold of the period range.

# 9.4 Logic Signal Triggers (Logic Trigger)

Follow the steps for below to configure logic triggers. These settings can be configured from the **[Logic Trig]** sheet of the Trigger settings window.

- Input signals on logic channels serve as the trigger source.
   Triggering occurs when the specified trigger pattern and logical probe combination criteria (AND/OR) are met.
- The trigger detection method can be selected according to whether a trigger is applied or not when the criteria are already met at the start of measurement.
- By using the trigger filter, triggering can be limited so as to occur only when trigger criteria are met for at least the specified filter width.

# Procedure

Press the **DISP** key to open the Waveform screen, and then press the **TRIG.SET** key to open the trigger settings window ([Logic Trg.] sheet).

Move the cursor to the channel for which you want to change the settings.

2 Use the F keys to select the settings.

Logic Channels 1. 2. 3.

Ch Terms Filter 1 2 3 4

A Or - x x x x x

B And - x x x x x

C - D - A - L6 B - C -

D

**1. Trigger** Sets the trigger probe logic (AND/OR).

Off	Logic triggering is disabled. (Default setting)
OR	Triggering occurs when the input signal logic matches any setting in the trigger pattern.
AND	Triggering occurs only when the input signal logic matches all settings in the trigger pattern.

2. Filter Sets the filter width (trigger filter) for triggering. (If necessary) Suppresses triggering from noise. (p. 201)

MEM	Off	Trigger filtering disabled. (Default setting)
	0.1 to 10	Trigger filtering enabled. The filter width is set as a number of divisions.
REC	Off	Trigger filtering disabled. (Default setting)
	On	Trigger filtering enabled. Filter width 10 ms (5 ms when the sampling rate is 100 ns/S)

# 3. Trigger Pattern Set the logic trigger pattern.

X	Ignore signal. (Default setting)
0	Trigger at LOW signal level.
1	Trigger at HIGH signal level

## To copy the setting to another channel

The Trigger settings window ([Logic Trig] sheet) can be used to copy the settings between channels.

Refer to "8.9 Copy Settings to Other Channels (Copy Function)" (p. 169).

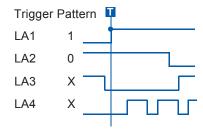
# Setting Examples

# Example 1: Trigger when the input signal matches any of the following criteria

LA1: HIGH level LA2: LOW level Trigger: OR

LA [1, 2, 3, 4]: [1 0 X X ]

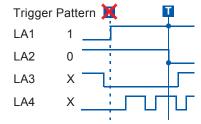
Triggering occurs when the LA1 or LA2 trigger criteria are met.



# Example 2: Triggering occurs when the input signal matches both of the following criteria

LA1: HIGH level LA2: LOW level Trigger: AND

LA [1, 2, 3, 4]: [1 0 X X ]



- If the criteria are already met when **START** is pressed (AND: all trigger patterns are met, OR: one trigger pattern is met), triggering will not occur.
- Triggering only occurs if the conditions are changed and then the criteria are met again.
- Triggers for standard logic channels (LA, LB, LC, LD, LE, LF, LG, and LH) are enabled regardless of the logic waveform display or module type.

# 9.5 Trigger by Timer or Time Interval (Timer Trigger)

This trigger allows you to record at fixed times.

- Triggering occurs at the specified interval from the specified Start time until the Stop time.
- Before setting up a Timer Trigger, verify that the clock is set to the correct time. If not, set the clock on the System screen [Init] sheet. (p. 51)

## Procedure

Press the **DISP** key to open the Waveform screen, and then press the **TRIG.SET** key to open the trigger settings window.

1 Enable or disable the timer trigger.
Move the cursor to the [Timer Trig] item.

Off	Timer triggering disabled.
On	Timer triggering enabled.

2 (When [On] is selected)

Move the cursor to [M], [D], [h] and [m] to set recording Start and Stop times.

Set the date and time.

Set Start and Stop times.

To set to the current date and time, select [Present Time].

3 (To apply a trigger through the specified interval, from Start to Stop)

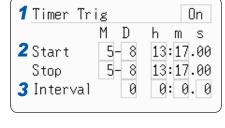
Set the Interval.

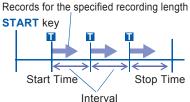
Move to cursor to [D], [h], [m] and [s] of [Interval]. Set the recording interval.

4 Press the START key.

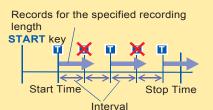
Measurement starts and recording will start at the specified Start time.

To stop recording early, press the **STOP** key.





When the specified interval is shorter than the specified recording length:



When the recording length exceeds the specified interval

The next trigger is not applied until the data for the specified recording length has been acquired.

When the recording length exceeds the stop time

Recording time depends on the operating function. (p. 206)

When the interval is set to zero

If the [Repeat] trigger mode is selected, or the REC or MEM functions are used, recording is repeated from Start to Stop times.

The timer trigger time and the time at which the trigger is actually fired may differ by up to 3 sample times.

### About start and stop times

- Start and Stop times should be set as times elapsed since the START key was pressed.
- When the trigger mode is **[Single]** and the timer trigger is **[On]**, only one timer trigger specified as the Start trigger will be recognized. Interval and Stop time triggers are ignored.

# To record an interval with specified Start and Stop times

Set the trigger mode to [Repeat], and set all other trigger sources [Off].

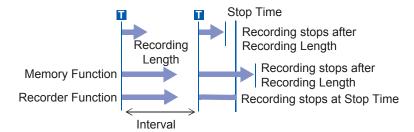
However, triggering is disabled during processing (auto-save, auto-print, waveform display processing and calculation) from the end of recording to the next Trigger Wait state, so depending on measurement settings, recording may not occur within the specified interval.

### **About Stop Time and Recording Length**

The stop time is function-dependent.

Memory function: Measurement data is acquired for the specified recording length, then recording stops. Recorder function: Measurement data continues to be acquired until the specified Stop time.

Relationship Between Last Recording Length and Stop Time



# When a trigger is applied from a trigger source other than a timer trigger

Trigger sources set to [On] are all enabled.

However, trigger timing depends on the trigger source settings.

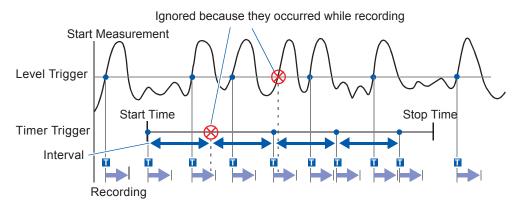
- When trigger criteria are combined with OR (Trigger Source: OR)
   Depending on the other trigger sources, triggering can occur before the specified trigger Start time, after the specified Stop time, or outside of the specified Interval.
- When trigger criteria are combined with AND (Trigger Source: AND)

Triggering occurs between the specified Start and Stop times when criteria for all trigger sources set within the specified interval are satisfied.

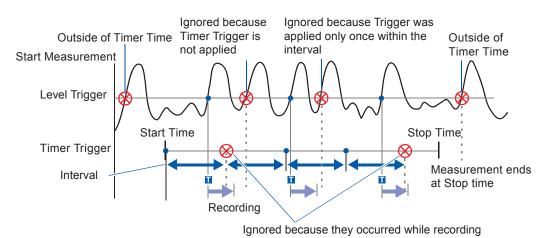
If the interval is set to zero, triggering occurs when criteria for all trigger sources set between specified Start and Stop times are satisfied.

Example: measuring when both timer trigger and level triggers (Slope: ↑) are enabled.

# When trigger criteria are combined with OR (Trigger Source: OR)



### When trigger criteria are combined with AND (Trigger Source: AND)



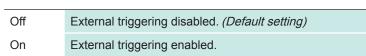
# 9.6 Apply an External Trigger (External Trigger)

An external signal applied to the External Control terminal can serve as a trigger source. It can also be used to drive synchronized parallel triggering of multiple instruments.

### Procedure

Press the **DISP** key to open the Waveform screen, and then press the **TRIG.SET** key to open the trigger settings window.

1 Enable external triggering.
Move the cursor to [Ext Trig].





2 Apply the input signal to the external trigger (EXT.TRIG) terminal.

Refer to "17.2.5 External Trigger Terminal (EXT.TRIG)" (p. 352).

# 9.7 Trigger Manually (Manual Trigger)



Triggers can be applied manually by pressing the **Manual Trigger** key. Manual triggering takes priority over all other trigger sources, regardless of settings.

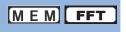
To stop recording, press the STOP key.

Press the key once	Recording is carried out for one recording length and then stops.
Press the key twice	Recording stops when the key is pressed.

As for other trigger types, triggering does not occur during pre-trigger standby. Set the trigger priority function to **[On]**.

Refer to "9.8.2 Set Trigger Acceptance (Trigger Priority)" (p. 211).

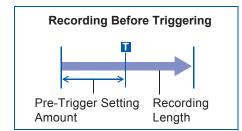
# 9.8 Pre-trigger Settings

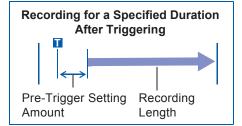


This applies to the Memory and FFT functions only.

By setting a portion (number of divisions or percentage) of the recording length to occur before triggering, the waveform can be recorded before as well as after the trigger point.

You can also set the duration of a waveform to be recorded after a trigger point.





- When all trigger sources (analog, timer trigger, etc.) are disabled (Off), pre-trigger settings are ignored.
- Pre-triggers cannot be set by div with the FFT function.

# 9.8.1 Set the Trigger Start Point (Pre-trigger)

Set the position of the trigger point relative to the specified recording length. There are two setting methods. (Setting by percent and setting by div)

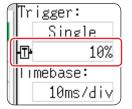
### Procedure

Press the **DISP** key to open the Waveform screen.

1 Select the unit to use when setting the pre-trigger.

Move the cursor to [Pre-trigger].

%	Set the pre-trigger in %. (Default setting)
div	Set the pre-trigger in number of divs. For external sampling, set by number of samples.



# 2 Enter the numerical value.

### (When [%] is selected)

With the recording start point as 0% and the recording end point as 100%, set the % for the trigger point.

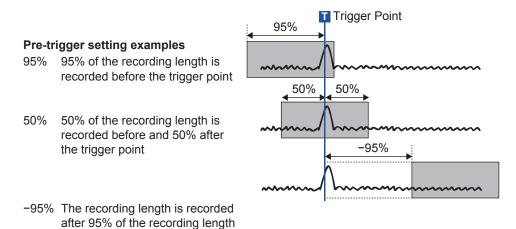
-95%, 100%, 95%, 90%, 80%, 70%, 60%, 50%, 40%, 30%, 20%, 10%, 5%, 2%, 0%

## (When [div] is selected)

With the recording start point as 0 div and the recording end point as the set recording length, set the number of div for the trigger point.

-Recording length (div) to +Recording length (div)

# About pre-triggering and the recording period (recording length)



Trigger events during the specified pre-trigger recording period are ignored. To enable recognition of such triggers, set Trigger Priority to [On].

Refer to "9.8.2 Set Trigger Acceptance (Trigger Priority)" (p. 211).

# Difference between [Pre-Trigger wait] and [Trigger wait]

after the trigger point

When measurement is started, the specified pre-trigger length is recorded. This period is indicated as [Pre-Trigger wait].

After the specified pre-trigger length has been recorded, **[Trigger wait]** continues until a trigger occurs. Refer to "Measurement and Internal Operations" (p. 75).

# 9.8.2 Set Trigger Acceptance (Trigger Priority)

MEM

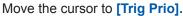
This applies to the Memory function only.

You can set whether triggers are recognized (accepted) if trigger criteria are met during the Pre-trigger wait period.

- When pre-triggering is enabled, trigger events are normally ignored for a certain period after measurement starts (while recording the specified pre-trigger period).
- [Pre-Trigger wait] is displayed on the screen.

#### Procedure

Press the **DISP** key to open the Waveform screen, and then press the **TRIG.SET** key to open the trigger settings window.

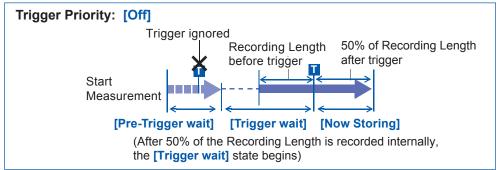


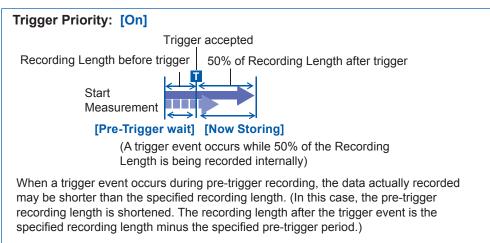




# When trigger criteria are met during [Pre-Trigger wait]

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





# 9.9 Set Trigger Timing



This applies to the Recorder function only.

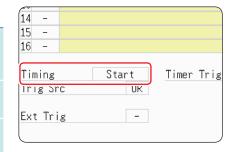
Use the below procedure to control waveform recording operation when a trigger event occurs.

## Procedure

Press the **DISP** key to open the Waveform screen, and then press the **TRIG.SET** key to open the trigger settings window.

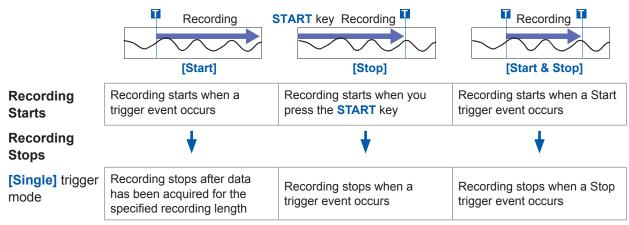
# Move the cursor to [Timing].

Start	Start recording when a trigger event occurs, and stop after the specified recording length. (Default setting)
Stop	Start recording when the <b>START</b> key is pressed, and stop when a trigger event occurs.
Start & Stop	Record the interval from one trigger event until the next trigger event.



### About trigger timing

The selected trigger mode determines how recording stops.



#### If no trigger event occurs before the specified recording length elapses

**[Stop]** or **[Start & Stop]**: Recording stops after data has been acquired for the specified recording length

# [Repeat] trigger mode

The Trigger Wait state begins after data has been acquired for the specified recording length When another trigger event occurs, data is again acquired for the specified recording length, then Trigger Wait

resumes (repeats)

When a trigger event occurs, recording stops and then starts again (repeats)

When a trigger event occurs, recording stops and the instrument re-enters the Trigger Wait state.
When another trigger event occurs, recording continues until the next trigger occurs (repeats)

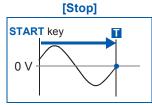
## If no trigger event occurs before the specified recording length elapses

[Stop]: After data is acquired for the specified recording length, recording restarts. This repeats until a trigger event occurs.

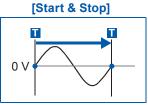
[Start & Stop]: The Trigger Wait state begins after data has been acquired for the specified recording length (Start Trigger)

[Start]

Records for specified recording length



Press **START** key to record. Records until a trigger occurs.



Recording starts when a Start trigger event occurs. Records

# 9.10 Combined Trigger Logic (AND/OR) for Multiple **Trigger Sources**

Analog, logic, external and timer trigger criteria can be combined using AND/OR logic to define complex trigger criteria.

## Procedure

Press the DISP key to open the Waveform screen, and then press the TRIG.SET key to open the trigger settings window.

Move the cursor to [Trig Src].		Trig Prio -	Timer
OR	Triggering occurs when any one of the specified trigger source criteria is met. (Default setting)	Trig Src OR	
AND	Triggering occurs only when all of the specified	Ext Trig On	Start Stop
	trigger source criteria are met.	(When using the Memory Fur	Inter/ nction)

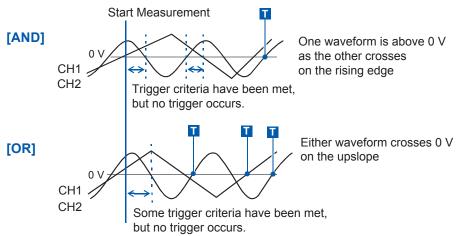
## When the trigger combination logic is set to [AND]

If trigger criteria are already met when you press the START key, no triggering occurs. Triggering occurs only after all trigger sources have ceased to meet the criteria then meet the criteria again.

#### **Setting Example:**

To apply a trigger when the upslope (↑) of the waveform crosses zero volts Triggering occurs as follows when combined using AND and OR.

Channel	Trigger	Trigger Level	Slope	Filter
CH1, CH2	Level	0.00 V	<b>↑</b>	Off



If both [Start] and [Stop] trigger timing criteria are combined, the simultaneous trigger sources are combined with a logical AND.

# 9.11 Use Trigger Settings to Search Measurement Data MEM

Trigger settings can be used to search measurement data.

Locations that match the set trigger criteria in the measurement data are searched for and displayed sequentially.

Using the same method as setting triggers, it is possible to search for criteria different from the triggers set at the time of measurement.

Example 1: The measurement trigger criteria was trigger level of 0 V but the data search condition is level 100 V.

Example 2: After measurement with a free run without a trigger, search for locations that exceed 100 V (level 100 V).

# Procedure

Press the **DISP** key to open the Waveform screen.

→ Press the TRIG.SET key → Trigger settings window ([Analog Trig] or [Logic Trig] sheet)

# 1 After measurement is finished, set the search criteria.

The setting method is the same as described in "9.3 Analog Signal Triggers" (p. 198) and "9.4 Logic Signal Triggers (Logic Trigger)" (p. 203).

# 2 Specify the search range.

Move the cursor to the [Area] item.

Whole Wave	Search all measured data. (Default setting)
A-B Wave	Search in the range between AB cursor.

Trig searchArea: Whole Wave

2ms

1.5ms

## (When using memory division)

All Display Blocks	Searched all data in all displayed blocks. (Default setting)	
A-B Display Blocks	When setting the AB cursors on the displayed blocks, searches the range between the A and B cursors on the displayed blocks.	
All Blocks	Searched all data in all whole blocks.	
A-B All Blocks	When setting the AB cursors for the all blocks, searches the range between the A and B cursors for all blocks.	

- When selecting AB range and only the A cursor is shown on the screen, search will be performed on the data after A cursor.
- The search range for [All Blocks] will be defined as the start block up to the number of blocks to be measured.

# 3 Execute search.

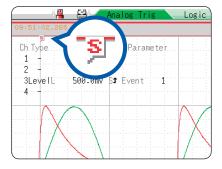
Move the cursor to [Trig search].

Execute search	Start the search from the beginning of the measurement data.
Search next	Searches for the next search condition after the most recent search position.
Move A cursor	Move A cursor to the search position.
Move B cursor	Move B cursor to the search position.
Clear	Clear the search position.

[Search] and [Search next] can be performed using the Manual Trigger key as well.

### Search results

Locations that match the criteria are displayed in the center of the screen and marked with an S.



When no matches are found, a message stating that **[No Matches Were Found]** is displayed.

- Pre-triggers, trigger priorities, external triggers and timer triggers cannot be used as search conditions.
- The trigger position and search results may not match.

# 10

# Numerical Calculation Functions



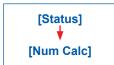
Numerical calculations can only be used with the Memory function.

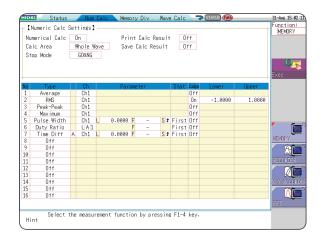
Results calculated from the acquired waveform are displayed as numerical values on the Waveform screen. These calculation results can be judged for evaluation. Numerical calculation settings are made on the Status screen - [Num Calc] sheet.

# To Open the [Num Calc] Sheet



Press this key repeatedly to display the various sheets.





# **Operations Available From the [Num Calc] Sheet**

#### **Numerical Calculations**

- Average
- RMS (Root-Mean-Square) value
- Peak-to-Peak 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 (%)
- Pulse Count
- Four Arithmetic Operations

- Time difference calculation
- Phase differnce calculation
- · High level calculation
- Low level calculation (24 types in total)
- Specified calculation between AB cursors

Waveform calculations can be limited to data within the range specified by the AB cursors.

Calculation operator details: "10.6 Numerical Calculation Type and Description" (p. 230)

# Numerical Calculation Judgment (p. 224)

The result of a numerical calculation can be compared to a preset reference range, for GO/NG (Pass/Fail) evaluation.

There are 24 types of numerical calculations in total, 16 of which can be performed simultaneously. When the Scaling function is used, numerical calculation is performed on scaled values.

#### **Save/Print Numerical Calculation Results**

- · Auto-save numerical calculation results
- Save specified existing numerical calculation result Refer to "10.4 Save Numerical Calculation Results" (p. 227).
- Auto-print
- Arbitrary printing

Refer to "10.5 Print Numerical Calculation Results" (p. 229).

# 10.1 Numerical Calculation Workflow

There are two different ways of performing calculation.

• Calculate While Measurent: Settings for numerical calculation must be chosen before

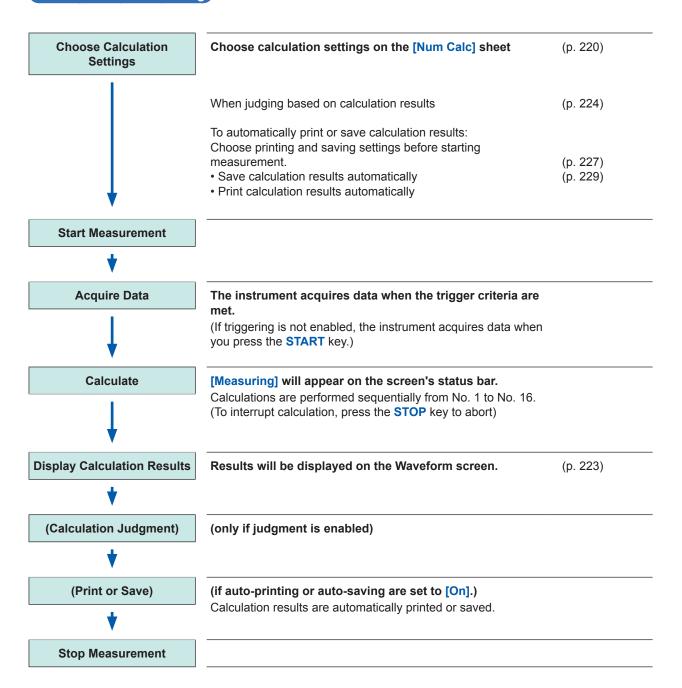
starting measurement.

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**



# Apply Calculations to Existing Data

(Load Data) (To load measurement data from storage media for (p. 99) calculation) **Choose Calculation** Choose calculation settings on the [Num Calc] sheet (p. 220) **Settings** When judging based on calculation results (p. 224) **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. 223) (Calculation Judgment) (only if judgment is enabled) (Print or Save) Print (When Model U8350 Printer Unit is installed) or save calculation results as needed. • Print: PRINT key Save: SAVE key When [Print Calc Result] (p. 229) or [Save Calc Result] (p. 227) is set to [On], results are automatically printed or saved.

#### To specify a waveform range for calculation

Before executing the calculation, specify the calculation range using the AB cursors (div or Trace cursors) on the Waveform screen. Set the calculation range on the [Num Calc] sheet to [A-B Wave].

- · 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. Refer to "7.2 Specify a Waveform Range (AB Cursor)" (p. 131) or "10.2 Numerical Value Calculation Settings" (p. 220).

# 10.2 Numerical Value Calculation Settings

### Procedure

Press the STATUS key to open the Status screen, and then select the [Num Calc] sheet.

**1** Enable the Numerical Calculation function.

Move the cursor to [Numerical Calc]. Select [On].

2 Specify the waveform calculation range.

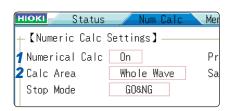
Move the cursor to [Calc Area].

Whole Wave Applies calculations to the whole waveform. (Default setting)

A-B Wave Applies calculations to the data between AB cursors.

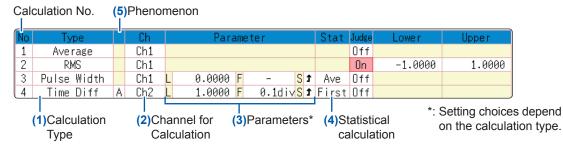
After Trigger Applies calculations to the waveform after trigger.

Refer to "7.2 Specify a Waveform Range (AB Cursor)" (p. 131).



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.

# 3 Choose calculation settings.



# (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] if you require judgment of calculation results. (p. 224)

Off	No calculation. (Default setting)	Area	Area enclosed by zero position and signal waveform
Average	Average valu x e of waveform data	X-Y Area	Area of X-Y composite waveform
Rms	RMS value of waveform data	Time to Lev*	Time from trigger to specified level
Peak-Peak	Peak-to-peak value of waveform data	I ev-time	Measurement value at a specified time point after
Maximum	Maximum value of waveform data	Lev-(IIIIe	triggering
Max-Time	Time from trigger to maximum value	Pulse Width*	Pulse width of waveform data
Minimum	Minimum value of waveform data	Duty Ratio*	Duty of waveform data
Min-Time	Time from trigger to minimum value	Pulses*	Pulse count of waveform data
Period*	Period of signal waveform	Calculation	Four arithmetic operations on numerical calculation results
Frequency*	Frequency of signal waveform	Time Diff*	Time difference between phenomenon A and B.
RiseTime	Rise time of waveform data	Phase Diff*	Time difference between phenomenon A and B displayed as a phase differnce.
FallTime	Fall time of waveform data	High Level	High level value for waveform data
Std Dev	Standard deviation of waveform data	Low Level	Low level value for waveform data

<sup>\*:</sup> This setting can also be made for logic channels

#### (2) Select the channel for calculations.

Move the cursor to the item for the calculation target, and select the channel.

(Logic channels can also be selected for Time to Level, Pulse Width, Duty Cycle, and Pulse Count.)

#### (3) Set parameters.

Settings may not be necessary for some types of calculation. When calculating time differences and phase difference, choose settings for both A and B channels.

Move the cursor to the parameter items, and make the appropriate parameter settings.

Refer to "Parameter Table" (p. 222).

Refer to "8.1.3 Alphanumeric Input" (p. 149).

#### (4) Set the statistical calculation.

Move the cursor to the [Stat] column.

First	Calculate at the first condition of the measurement data.
Average	Acquire the average value of the calculation results in the measurement data.
Max	Acquire the maximum value from the calculation results in the measurement data.
Min	Acquire the minimum value from the calculation results in the measurement data.

# When printing or saving calculation results during measurement

Settings must be made before the measurement.

Refer to "10.4 Save Numerical Calculation Results" (p. 227) or "10.5 Print Numerical Calculation Results" (p. 229).

When printing or saving existing data

Use PRINT key or SAVE key.

Refer to "5.2.3 Save Data Selectively (SAVE Key)" (p. 94) or "6.3 Manual Printing With the PRINT Key (Selective Printing)" (p. 118).

# (5) When time difference calculation or phase difference calculation has been selected, set Ch (channel) and parameters for A and B.

# 4 Execute the calculations. (When judging calculations (p. 224))

Apply Calculations to Existing Data Select **[Exec]**.

When calculating automatically after measurement

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

#### To copy calculation settings to another calculation

Use the [Num Calc] sheet.

Refer to "8.9 Copy Settings to Other Channels (Copy Function)" (p. 169).

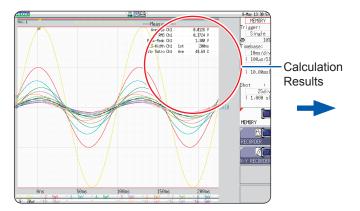
# **Parameter Table**

Calculation type	Parameter	Parameter description
Period Frequency	L (Level)	Calculation is based on the interval (time) when the level is crossed.
Pulse Width Pulses Duty Ratio* Time Diff Phase Diff  * Level and Filter only	F (Filter)	Only when the measurement signal has crossed the level and has not crossed the level again within the specified filter width, it is taken as a valid event. This is useful to exclude level crossing events caused by noise.
	S (Slope [↑, ↓])	Calculation is based on the interval (time) when the level is crossed.  Depending on this setting, either crossing on the upward slope (↑) or downward slope (↓) is used for calculation.
Risetime Falltime	P (%)	Determines which section of the waveform between the upper and lower limits is used for risetime (or falltime) calculation.  The range is narrowed from the upper and lower limit values by the percentage set here.
	L (Level)	Calculates the time specified level is crossed.
Time to Lev	F (Filter)	Only when the measurement signal has crossed the level and has not crossed the level again within the specified filter width, it is taken as a valid event. This is useful to exclude level crossing events caused by noise.
	S (Slope [↑, ↓])	Determines whether the time is calculated until the signal crosses the specified level on the upward slope or on the downward slope.
Lev-time	Time or Measure (Calculation results)	Specifies the time for calculating the measurement value, using the trigger position as zero.  To use numerical calculation results, specify the numerical calculation number.  The range specified by AB cursors is not available.
Calculation	Numerical Calculation No.	Sets the numerical calculation number.
	+, - , ×, ÷	Sets operators for the four basic arithmetic operations.

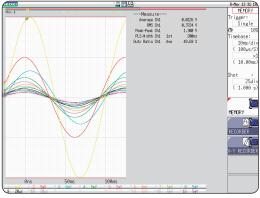
- Depending on the signal waveform, calculation values for the Period, Frequency, Risetime, and Falltime parameters may not be displayed.
- When Scaling is enabled, the waveform data is scaled before numerical calculation. The units for parameter values are derived from the units set for the Scaling function.
   About Scaling, refer to: "8.5 Convert Input Values (Scaling Function)" (p. 157).

# 10.2.1 Display Numerical Calculation Results

Numerical calculation results are displayed on the Waveform screen



If the display is hard to view because the numerical values and waveforms overlap,



Press the **DISP** key. Numerical values and waveforms will be displayed separately. Refer to "7.7.3 Switch the Waveform Display Width" (p. 142).

## To save calculation results after measuring

Set the [Select at save] item to **[Yes]**. When you press the **SAVE** key after measurement, you can select the content to be saved.

(Select [Calc Result].)

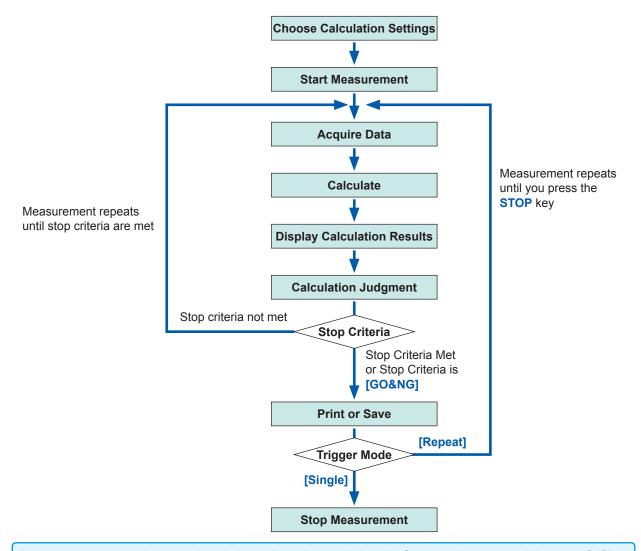
Refer to "5.2.3 Save Data Selectively (SAVE Key)" (p. 94).

# 10.3 Calculation Result Judgment

Set the judgment criteria (upper and lower threshold values) to use when judging numerical calculation results.

Judgment criteria can be set for every numerical calculation.

Waveform acquisition processing depends 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 termination conditions are fulfilled at the end of calculation evaluation.

## Procedure

Press the STATUS key to open the Status screen, and then select the [Num Calc] sheet.

- 1 Choose calculation settings. (p. 220)
- **2** Enable the judgment function.

Move the cursor to [Judge] for the Calculation on which you want to use judgement, and select [On].

Off	Judgment not carried out.
On	Result will be NG (Fail) if judgment range is exceeded. Any channel for which the result was NG will be shown in red.

3 Specify the judgment thresholds.

Move the cursor to **[Lower]** and **[Upper]**. Select an entry method and enter threshold values. Input range: -9.9999E+29 to +9.9999E+29 Refer to "8.1.3 Alphanumeric Input" (p. 149).

# **4** Select the Stop Criteria upon judgment.

Move the cursor to [Stop Mode].

GO	Continue to the next process when within the threshold range (Pass judgment)	
NG	Continue to the next process when outside of the threshold range (Fail judgment)	
GO&NG	Continue to the next process regardless of judgment result.	



#### Execute the calculation.

When judging the existing data Select [Exec].

When using automatic judgment after measurement Press the **START** key to start measurement.

#### About upper and lower threshold

The upper threshold cannot be set below the lower threshold, and vice-versa.

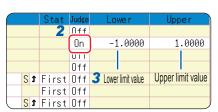
### About executing the calculation

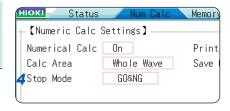
Processing depends on the Trigger Mode setting.

If calculating while acquiring waveforms, measurement will be repeated until the Stop Criteria are met. (p. 224)

## To record all calculation results

Set the Stop Mode item to [GO&NG].



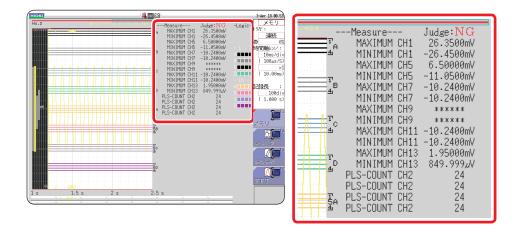


# 10.3.1 Display Judgment Results and Signal Output

Numerical calculation judgment results are displayed on the Waveform screen.

Within the judgment threshold range: GO judgment

Out of the judgment threshold range: NG judgment (displayed in red)



When printing, judgment results for each parameter will also be printed.

## When the judgment result is GO

• The GO signal is output at the GO/EXT.OUT.1 external I/O terminal.

## When the judgment result is NG

- The NG signal is output at the NG/EXT.OUT.2 external I/O terminal. The NG judgment is asserted when any channel is judged as NG.
- When the beeper is enabled, a beep sounds when a result is out of the threshold range.

# 10.4 Save Numerical Calculation Results

By choosing measurement settings before starting measurement you can calaculate then automatically save the results during measurement.

# **ACAUTION**



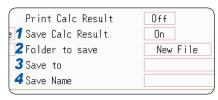
When using auto-save during measurement, do not remove the storage media specified as the save destination until the measurement operation is completely finished. Doing so may damage data on the storage media.

# Procedure

Press the STATUS key to open the Status screen, and then select the [Num Calc] sheet.

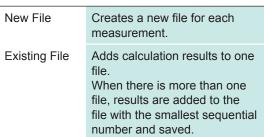
1 Enable the saving of numerical calculation results.

Move the cursor to [Save Calc Result]. Select [On]. (default setting: Off)



2 Select the file creation method.

Move the cursor to [Folder to save].



HDD:¥ ❤≫ HDD:¥

SB1:¥

◆ CF:¥

🔷 LAN:¥

3 Set the save destination.

Move the cursor to [Save To]. Select [Edit].

The Browse folders dialog box appears (at bottom right).

Move the cursor to the save target media. Select [Confirm] to confirm the selection.

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

HDD	Automatically save the waveform data on the built-in drive. (When Model U8330 SSD Unit is installed)
CF	Automatically save the waveform data on a CF card.
USB	Automatically save the waveform data on a USB memory stick.
LAN	Automatically save the waveform data on a PC connected via LAN.  Model 9333 LAN Communicator

Select storage media: **Up/down CURSOR**Open next folder level down: **Right CURSOR** 

4 Enter a filename (if you want to use a different name).

Move the cursor to [Save Name].

Enter a file name. (default setting: MEAS) Refer to "8.1 Add Comments" (p. 146).

When **[LAN]** is set as the save destination, **[Save Name]** is ignored and the files will be named in the previously-determined format.

Refer to "Save Operations (When Setting the Save Destination to [LAN])" (p. 93).

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 completes, the numerical calculation results (text) are automatically saved to the specified storage media.

#### **Save Name**

- The maximum number of characters for [Save Name] is 123. The maximum path length including file name is 255 characters.
- A sequential number starting from 0001 is automatically appended to the Save Name (When [New File] is selected).

# **Example of Saving Numerical Calculation Results**

When you save numerical calculation results, characters or display items used on the instrument are converted as shown below.

Characters used on the instrument	Saved characters
2	^2
3	^3
μ	~u
Ω	~O
3	~e
٥	~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","V"

"08-04-11 17:44:25.976","+3.06078E-05","+2.12000E-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 displayed properly when you open a file with Microsoft Excel<sup>®</sup>, select "Custom" for [Format] of [Format Cells] and enter "yy-mm-dd hh:mm:ss.000" for Type.

# 10.5 Print Numerical Calculation Results



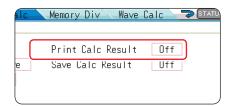
You can print the results of calculations.

When auto-print is enabled, the result data is printed after the waveform prints.

# Procedure

Press the STATUS key to open the Status screen, and then select the [Num Calc] sheet.

Move the cursor to [Print Calc Result], and select [On].



- Printing will also be carried out when only calculation was performed with no measurement.
- Calculation results are output to the output destination specified for automatic printing. Refer to "6.2 Auto-print Settings" (p. 115)

# 10.6 Numerical Calculation Type and Description

Numerical calculation type	Description	
	Calculates the average value of waveform data.	
Average	$AVE = \frac{1}{n} \sum_{i=1}^{n} di$ $AVE$ : Average $n$ : Data count $di$ : Data on channel number i	
	Calculates the RMS value of waveform data. If Scaling is enabled, calculations are applied to the waveform after scaling.	
RMS (Root-Mean- Square) value (RMS)	$RMS = \sqrt{\frac{1}{n} \sum_{i=1}^{n} di^2} $ RMS: RMS value n: Data count di: Data on channel number i	
Peak-to-Peak value (Peak-Peak)	Calculates the value of the difference (peak-to-peak value) between maximum and minimum values of waveform data.  Maximum value  Minimum value	
Maximum Value (Maximum)	Finds the maximum value of waveform data.  Maximum value	
Time to Maximum Value (Max-Time)	Finds the time (in seconds) from the last trigger point to the maximum value.  When there are two or more points with the maximum value, the first point of the first waveform used for the calculation is treated as the maximum value.  Maximum value  Time to Maximum Value	
Minimum Value (Minimum)	Obtains the minimum value of waveform data.  Minimum value	
Time to Minimum Value (Min-Time)	Finds the time (s) from the trigger point to the minimum value.  When there are two or more points with the minimum value, the first point of the first waveform used for the calculation is treated as the minimum value.  T Time to Minimum Value	
Period/Frequency	Displays the waveform's period (s) and frequency (Hz). Calculated based on the time difference between when the waveform first rises above or falls below the set level until it crosses again in the same direction.	

Numerical calculation	Description
Rise Time and Falltime	The rise time of the acquired waveform from A% to B% (or fall time from B% to A%) is calculation using a histogram (frequency distribution) of the 0 and 100% levels of the acquired waveform.  As waveform data is acquired, the rise time (or fall time) is determined from the first rising (or falling) edge.  When calculating over the range specified by the AB cursors, the rise time (or fall time) is based on the first rising (or falling) edge between the cursors.  The % value for A can be specified. The value for B is determined automatically based on the value of A, such as 95% when A is 5% and 70% when A is 30%.
Standard Deviation (Std Dev)	Calculates the standard deviation of the waveform data. $\sigma = \sqrt{\frac{1}{n} \sum_{i=1}^{n} (di - AVE)^2} \begin{array}{c} \sigma \colon \text{Standard Deviation} \\ AVE \colon \text{Average} \\ n \colon \text{Data count} \\ di \colon \text{Data on channel number i} \end{array}$
Area	Calculates the area value (V•s) enclosed by the zero position (point of zero potential) and the signal waveform. When calculating over the range specified by the AB cursors, the calculated area is constrained to the waveform between the cursors. $S = \sum_{i=1}^{n}  di  \bullet h  area \\ S: \text{ Area} \\ n: \text{ Data count} \\ di: \text{ Data on channel number i} \\ h = \Delta t: \text{ Sampling rate}$
X-Y Area	Calculates the area ( $V^2$ ) of an X-Y composite waveform. In the following figures, the areas within the lines are calculated. The calculation is available even if the X-Y composite waveform is not intended for display. To enable area calculation, specify the calculation range using the AB cursors (Voltage axis or Trace) on the time-domain waveform of each channel for X-Y composition. (The area cannot be specified directly by AB cursors on the X-Y waveform.) About AB Cursor, refer to "7.1 Read Measurement Values (Using the AB Cursors)" (p. 128).  When multiple loops are plotted  When an open curve is plotted  S = $N \times S_0$ S: Area (Closed area is created by connecting the start and end points with a straight line)  When a figure of eight is plotted  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)  Setting Choices: Set the X- and Y-axis channels.

Numerical calculation type	Description	
Time to Level (Time- Lev)	Finds the point where the signal crosses a specified level from the start of the calculation range, and calculates the time elapsed from the last trigger event.	Level 0 V
Specified Time Level (Lev-Time)	Finds the level at a specified time point after the trigger event.  The time can also be specified using previously calculated results.	Level T (Time)
Pulse Width	Calculates the pulse width as the time difference between one rising or falling intersection of the waveform through a specified level to the next intersection (with opposite slope).	Level
Duty Ratio (%)	Calculates the duty percentage based upon the ratio of the time from a rising intersection to the next falling intersection at a specified level, to the time from the same falling intersection to the next rising intersection at the same level.	Level $\longrightarrow$ $T_{d-u}$
Pulses	Counts the pulses from the number of rising or falling intersections with a specified level.  One pulse is counted when the signal falls back below the specified level after rising through it (or vice versa)	Level 1 2 3
Four Arithmetic Operations (Calculation)	Performs arithmetic operations (+, - , ×, ÷) upon arb calculations.	oitrarily selected results of numerical
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 difference T = B waveform (time when the level was exceeded) - A waveform (time when the level was exceeded).	Level A B
Phase differnce calculation (Phase Diff)	Calculates the time difference between rising above or dropping below the level specified for A and B waveforms and then calculates the phase difference [°], based on waveform A.  Phase contrast = Time difference of A and B waveform Cycle of A waveform	Level A B
High Level Low Level	With 0% of the loaded waveform data as the Low level and 100% as the High level, a histogram (frequency distribution) is used for calculation.	Data number  100% High Level  Low Level

# 11

# **Waveform Calculation Functions**

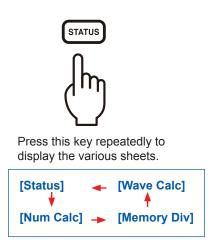
MEM

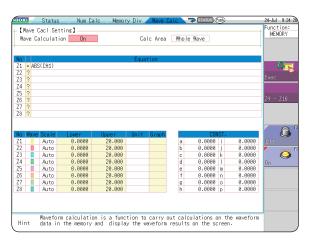
Waveform calculations can only be used with the Memory function.

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 on the Status screen - [Wave Calc] sheet.

# To Open the [Wave Calc] Sheet





# **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. 242)

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.

# 11.1 Waveform Calculation Workflow

There are two different ways of performing calculation.

Calculate While Measuring:
 Settings for waveform calculation must be chosen before

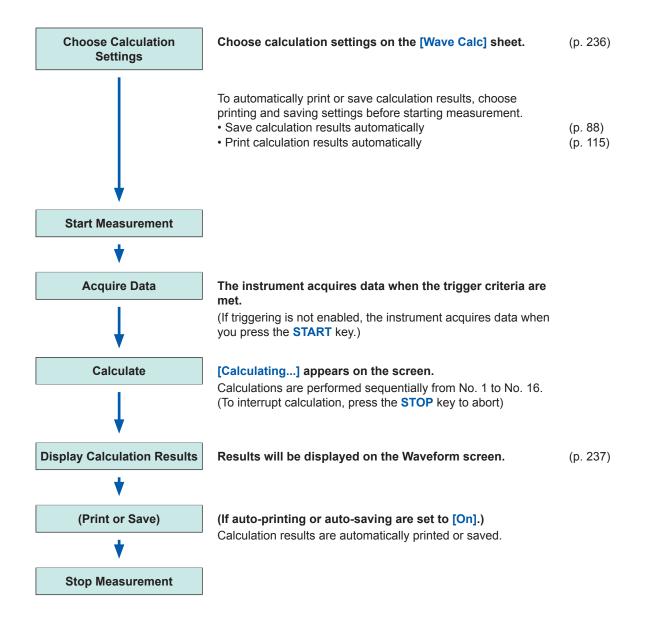
starting measurement.

• 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



- 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 at the [Wave Calc] sheet.

# **Apply Calculations to Existing Data**

After measurement with (To load measurement data from storage media for (p.99)calculation OFF (Or after calculation) loading data) **Choose Calculation** Choose calculation settings on the [Wave Calc] sheet (p. 236) **Settings 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. 237)(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 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 Wave].

- 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 waveform calculation for waveforms with a longer recording length, save a subset of the waveform that is shorter than the maximum recording length to a separate file, load that file back into the instrument, and then perform the calculation.

Refer to "7.2 Specify a Waveform Range (AB Cursor)" (p. 131) or "11.2 Waveform Calculation Settings" (p. 236).

## 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. 236).

# When calculation waveform is not displayed or when you want to display only a desired waveform

The displayed sheet and calculation 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. 240).

# 11.2 Waveform Calculation Settings

#### Procedure

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].

- [Wave Cacl Setting] Wave Calculation On 1

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.

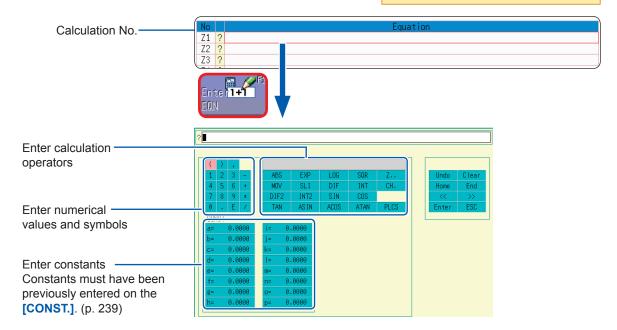
Refer to "7.2 Specify a Waveform Range (AB Cursor)" (p. 131).

# 3 Perform calculation settings.

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.



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.



# **4** Select a calculation equation.

Refer to "Waveform Calculation Example: Calculate the RMS waveform from the instantaneous waveform" (p. 241).

# 5 Select [Confirm] when entry is finished.

The entered equation is displayed in the **[Equation]** field. The scale (maximum and minimum values) of the calculation results has a default setting of **[Auto]**. If you want to scale the results, set the maximum and minimum values under **[Manual]**.

Refer to "Change the Display Method for Calculated Waveforms" (p. 240).

#### If "=" is displayed

The entered calculation equation is syntactically correct.

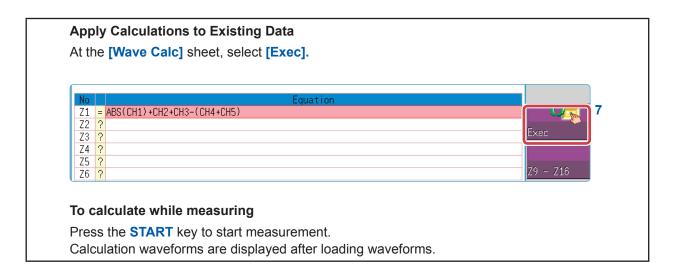
#### If "?" is displayed

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?

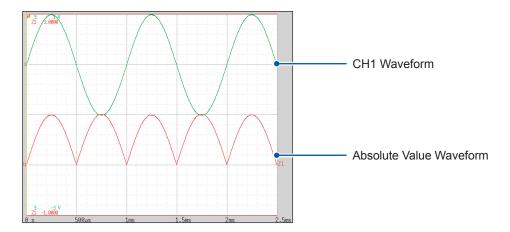
- 6 (If necessary) Set auto-saving (p. 88) and auto-printing (p. 115).
- 7 Execute the calculation.



# 11.2.1 Display the Trigger Settings to Search Measurement Data

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 at the [Wave Calc] sheet.

Refer to "8.9 Copy Settings to Other Channels (Copy Function)" (p. 169)

# **About Calculation Equations**Operators

Operators	Name	Operators	Name
ABS	Absolute Value	DIF2	2nd Derivative
EXP	Exponent	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. 242).

## **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.

$$\frac{\mathsf{ABS}(\mathsf{CH1})}{\mathbf{1}} + \frac{\mathsf{CH2*CH3}}{\mathbf{2}} - \frac{(\mathsf{CH4+CH5})*\mathsf{AB}}{\mathbf{3}}$$

- 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  $Z_n$ th 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 <u>a number after the comma within the parenthesis</u> (\_,#) 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.

# 11.2.2 Setting Constants

# Procedure

Press the STATUS key to open the Status screen, and then select the [Wave Calc] sheet.

- Move the cursor to the No. in the [CONST.] section you want to set.
- 2 Select an entry method, and enter the constant.

Setting Range: -9.9999E+29 to +9.9999E+29 Refer to "8.1.3 Alphanumeric Input" (p. 149).

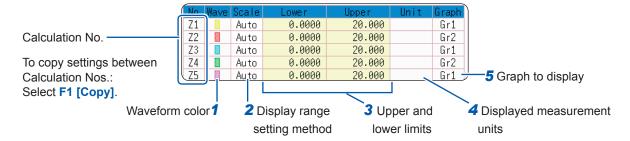
Defined constants are shown in the constant display of the calculation equation setting dialog.

		CON	ŞT	
1 (	a	0.0000	)i	0.0000
	b	0.0000	j	0.0000
	С	0.0000	k	0.0000
	d	0.0000	1	0.0000
	е	0.0000	m	0.0000
	f	0.0000	n	0.0000
	g	0.0000	0	0.0000
	h	0.0000	р	0.0000

#### **Change the Display Method for Calculated Waveforms** 11.2.3

### Procedure

Press the STATUS key to open the Status screen, and then select the [Wave Calc] sheet.



# Enable waveform display and display color

Move the cursor to the [Wave] column.

On-Off	Set On to display the waveform of the calculation No. for the currently selected row ( <i>Default setting</i> ). Set to Off to not display this waveform.
$\uparrow\downarrow$	Select the waveform color.
All On-Off	Select On to display all waveforms. Select Off to hide all waveforms.

# Select a method to set scaling

Move the cursor to the [Scale] column for the Calculation No. you want to adjust.

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.

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 Alphanumeric Input" (p. 149).

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 Alphanumeric Input" (p. 149).

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.

Depending on calculation results, automatic scaling settings may be unsatisfactory, in which case the limits must be entered manually.

# 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].

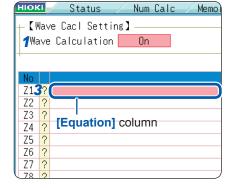
2 Specify the waveform calculation range.

Move the cursor to [Calc Area], and select [Whole Area].

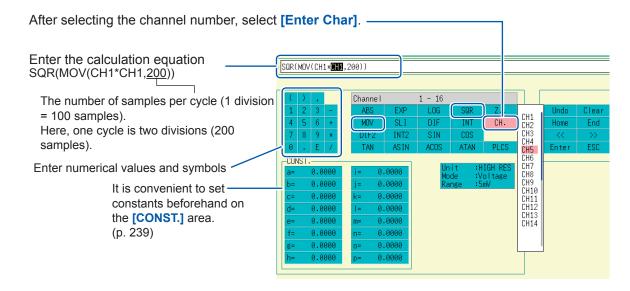
3 Set a calculation equation.

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.



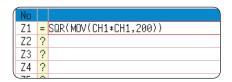
4 Select [Confirm] when entry is finished.

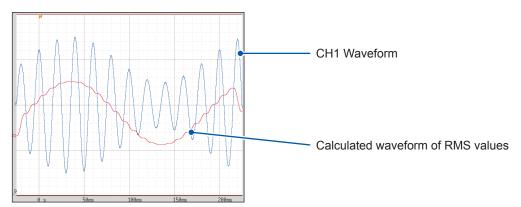
The entered equation is displayed in the [Equation] field.

5 Execute the calculation.

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

The calculation waveform is displayed after acquiring the input waveform.





To view calculated waveforms of loaded data, navigate to the [Wave Calc] sheet and select [Exec].

# 11.3 Waveform Calculation Operators and Results

b<sub>i</sub>: ith member of calculation result data, d<sub>i</sub>: ith member of source channel data

	b <sub>i</sub> : ith member of calculation result data, d <sub>i</sub> : ith member of source channel data
Waveform calculation type	Description
Four Arithmetic	Executes the corresponding arithmetic operation.
Operators ( +, -, *, / )	
Absolute Value (ABS)	$b_i =  d_i $ (i = 1, 2, n)
Exponent (EXP)	$b_i = exp(d_i)$ (i = 1, 2, n)
Common Logarithm (LOG)	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}  d_i $ ( $i = 1, 2, n$ ) Note: Use the following equation to convert to natural logarithm calculations. $LnX = log_e X = log_{10} X / log_{10} e$ $1 / log_{10} e \approx 2.30$
Square Root (SQR)	When $d_i \ge 0$ $b_i = \sqrt{d_i}$ When $d_i < 0$ $b_i = \sqrt{ d_i }$ $(i = 1, 2, n)$
Moving Average (MOV)	When $k$ is odd $bi = \frac{1}{k} \sum_{t=i-\frac{k}{2}}^{i+\frac{k}{2}} (i=1,2,n)$ $bi = \frac{1}{k} \sum_{t=i-\frac{k}{2}+1}^{i+\frac{k}{2}} (i=1,2,n)$ $dt: \text{ th member of source channel data } k: \text{ number of points to move (1 to 5000)}$ $1 \text{ div} = 100 \text{ points.}$ $k \text{ is specified after a comma. (Ex.) To make Z1 the moving average of 100 points: } MOV(Z1,100)$ 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 $-10 \le bi \le 10$ Trigonometric and inverse trigonometric functions employ radian (rad) units.
Arcsine (ASIN)	When $d_i > 1$ $b_i = \pi / 2$ When $-1 \le d_i \le 1$ $b_i = asin(d_i)$ 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 $-1 \le d_i \le 1$ $b_i = acos(d_i)$ When $d_i < -1$ $b_i = \pi$ $(i = 1, 2, n)$ Trigonometric and inverse trigonometric functions employ radian (rad) units.
Arctangent (ATAN)	$b_i = atan(d_i)$ ( $i = 1, 2, n$ ) Trigonometric and inverse trigonometric functions employ radian (rad) units.

 $b_{i}$ : ith member of calculation result data,  $d_{i}$ : ith member of source channel data

Waveform calculation type	Description	
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. 238).  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 $t_3$ , $b_3 = (d_1 - 8d_2 + 8d_4 - d_5)/12h$ Point $t_3$ , $b_3 = (d_{n-2} - 8d_{n-1} + 8d_{n-1} - d_{n-2})/12h$ Point $t_{n-2}$ , $b_{n-2} = (d_{n-4} - 8d_{n-3} + 8d_{n-2} - d_n)/12h$ Point $t_{n-2}$ , $b_{n-2} = (d_{n-4} - 6d_{n-3} + 36d_{n-2} - 48d_{n-1} + 25d_n)/12h$ Point $t_3$ , $b_3 = (3d_{n-4} - 16d_{n-3} + 36d_{n-2} - 48d_{n-1} + 25d_n)/12h$ Point $t_3$ , $b_3 = (3d_{n-4} - 16d_{n-3} + 36d_{n-2} - 48d_{n-1} + 25d_n)/12h^2$ Point $t_3$ , $b_3 = (-d_1 + 16d_2 - 30d_3 + 16d_4 - d_3)/12h^2$ Point $t_3$ , $b_3 = (-d_{n-4} + 16d_{n-3} - 30d_{n-2} + 16d_{n-1} - d_{n})/12h^2$ Point $t_1$ , $b_1 = (-d_{n-2} + 16d_{1-1} - 30d_1 + 16d_{1+1} - d_{n-2})/12h^2$ Point $t_{n-2}$ , $b_{n-2} = (-d_{n-4} + 16d_{n-3} - 30d_{n-2} + 16d_{n-1} - d_{n})/12h^2$ Point $t_{n-2}$ , $b_{n-2} = (-d_{n-4} + 16d_{n-3} - 30d_{n-2} + 16d_{n-1} - d_{n})/12h^2$ Point $t_{n-2}$ , $b_{n-2} = (-d_{n-4} + 4d_{n-3} + 6d_{n-2} - 20d_{n-1} + 11d_n)/12h^2$ Point $t_{n-1}$ , $t_{n-1}$ ( $t_{n-1}$ ), $t_{n-1}$ ( $t_{n-1}$ ), $t_{n-1}$ ( $t_{n-1}$ ), $t_{$	

 $b_{i:}$  ith member of calculation result data,  $d_{i:}$  ith member of source channel data

Waveform calculation type	Description
	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
First integral (INT) Second integral (INT2)	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 $t_n \ II_n = II_{n-1} + (I_{n-1} + I_n)h/2$ $II_1 \text{ to } II_n$ : 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.

# **Memory Division Function MEM**



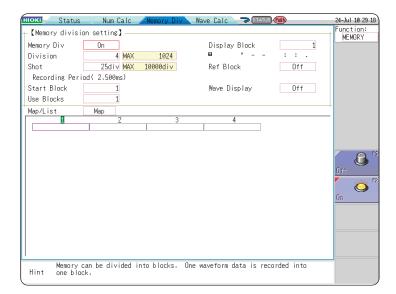
The Memory division function can only be used with the Memory function. Memory division settings are made on the Status screen - [Memory Div] sheet. Blocks to be displayed can also be selected on the Waveform screen (p. 143).

# To Open the [Memory Div] Sheet



Press this key repeatedly to display the various sheets.





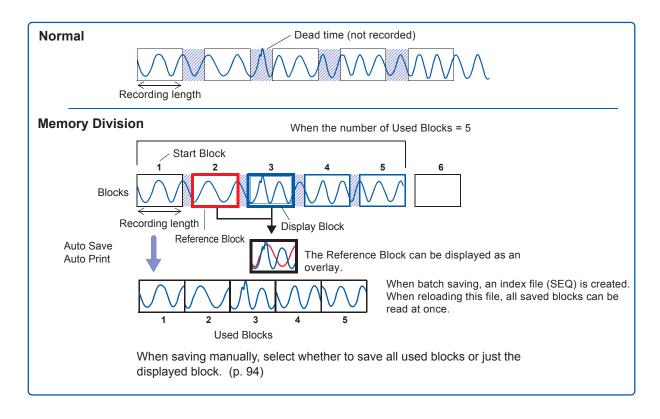
When using memory division, the trigger output (TRIG\_OUT terminal output) may output the Low level or output erratically under the following conditions.

- The timebase is 5 μs/div to 100 μs/div
- The record (measurement) time is 5 ms or less
- Tracking wave display is [Off].

# 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 the installed memory board and recording length (up to 1024 divisions).
- 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 View Block Waveforms" (p. 143).



# 12.1 Recording Settings

## Procedure

Press the STATUS key to open the Status screen, and then select the [Memory Div] sheet.

## Enable the Memory Division function.

Move the cursor to [Memory Div]. 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: "Appendix 2.4 Maximum recording length and number of divisions (Memory division function)" (p. A7)

# 4 Set the start block.

Move the cursor to [Start Block].

Set the block number at which to start recording.

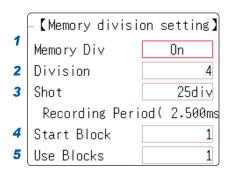
Default setting: 1

# 5 Set the number of Used Blocks.

Move the cursor to [Use Blocks].

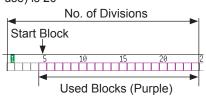
Set the number of blocks to use.

Default setting: 1



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



#### **About Recording**

When a faster timebase is selected, display, print and save operations are not available during measurement. Selecting the displayed screen for auto saving lengthens dead time.

#### To display any block on the waveform screen when finished measuring

Set the number of blocks to display (p. 248)

(This can also be set on the Waveform screen (p. 143).)

#### To display overlaid waveforms

Set the number of blocks for reference (p. 248).

# 12.2 Display Settings

#### Procedure

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. 143).)

Move the cursor to [Display Block].

Set the number of blocks to display on the Waveform screen.

# To display multiple blocks as overlaid waveforms

#### **Enable the Reference Block function**

Move the cursor to [Ref Block]. Select [On].

Off	Reference Blocks are not displayed (Default setting)
On	Reference Blocks overlay Display blocks on the display.

# (When Reference Blocks are enabled [On]) Select whether to reference every block

To overlay all waveforms, select [All Blks On].

All Blks Off	Turn off reference to all blocks.		
All Blks On	Turn 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	Set On or Off. If <b>[On]</b> is selected, the block frame of the selected block number is displayed as a green square.
<b>A</b> I	Calant a black
$\uparrow\downarrow$	Select a block.

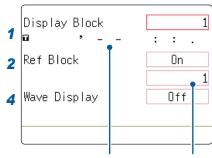
# 4 To display every block as its waveform is acquired Enable tracking waveform display.

Move the cursor to [Wave Display]. 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.

# To View Memory Division waveforms on the Waveform screen

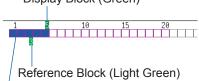
Refer to "7.8 View Block Waveforms" (p. 143)



Trigger time Reference Block No.



Display Block (Green)



The colored blocks indicate blocks where measurement data has been recorded.

#### 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. 249).

# Setting the Trace Waveform display to [On] lengthens dead time.

About Dead Time:

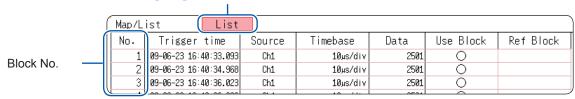
Refer to "Difference Between Dead Times During Normal and Memory Division Recording" (p. 250).

Even if the Roll Mode is enabled (other than [Off]), it is not usable when the Trace Waveform display is set to [Off].

#### 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 [Map/List], and select [List].



Blocks can be selected with the **Up/down CURSOR** or **F** keys.

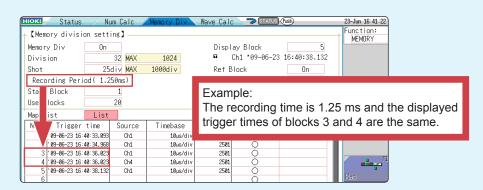
You can move the cursor to the [Reference Block] column to set a block as a Reference Block.

#### To switch block waveforms on the Waveform screen

To select the block you want to see, press the **WAVE** key at the Waveform screen and switch Pos to Block.

Refer to "7.8 View Block Waveforms" (p. 143).

• 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.

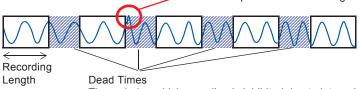


• If triggers occur continuously within an interval shorter than 500 μs, the displayed trigger time may indicate times slower than the actual triggers.

# **Difference Between Dead Times During Normal and Memory Division Recording**

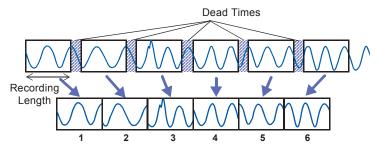
When both printer recording (Auto Print) and Auto Save are set for continuous triggering [Repeat]

Anomalous phenomena occurring during dead times are not detected.



Times during which sampling is inhibited due to internal processing, printing or saving

# When the Trace Waveform Display is disabled ([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  $\mu$ s/div and tracking waveform display is [On].

- When measuring with an Model 8970 Freq Unit, dead time is approximately 230 ms. When measuring in integral value ([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 (not **[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 and Auto-print are performed every time one block is measured. When Tracking wave display is ON, the Waveform is also displayed.	
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 are performed simultaneously with measurement. When Tracking wave display is ON, the Waveform is also displayed.	

# **FFT Function**



# 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, refer to "Appx. 4 FFT Definitions" (p. A13).

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
- 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. Refer to "13.3.8 Emphasize Analysis Results (Phase Spectra Only)" (p. 263).

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. 270).

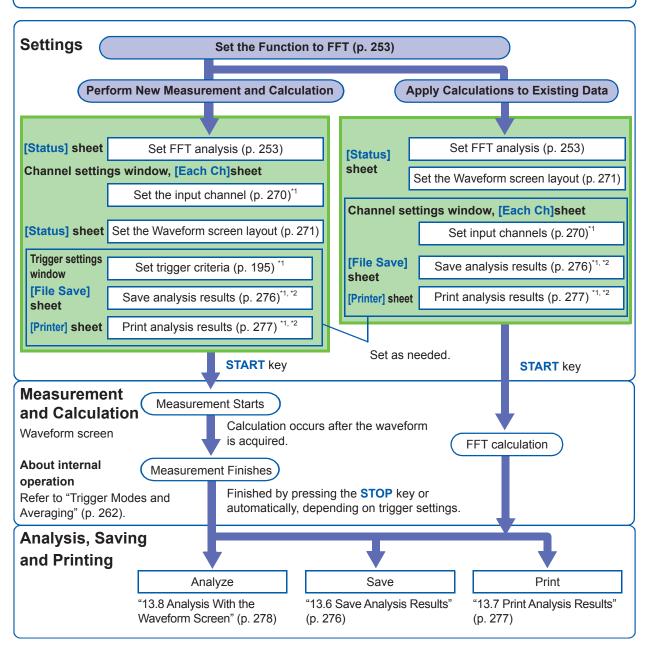
#### To suppress the effects of aliasing distortion caused by sampling

We recommend using Model 8968 High Resolution Units that are equipped with anti-aliasing filtering to suppress the effects of aliasing distortion when sampling. Refer to "Appx. 4 FFT Definitions" (p. A13).

Refer to "18.3.4 FFT Function" (p. 360) for FFT function specifications.

# 13.2 Operation Workflow (Reference Data)

# Installation and Connection Turn Power On "2 Measurement Preparation" (p. 27)



<sup>\*1:</sup> Settings are the same as for the Memory function.

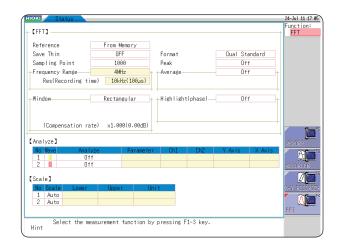
<sup>\*2:</sup> Even after analysis, save and print settings can be set manually.

# 13.3 FFT Analysis Condition Settings

You can choose basic measurement configuration settings on the Status screen-[Status] sheet. Measurement is configured from the Waveform screen (p. 269).

# To Open the [Status] Sheet



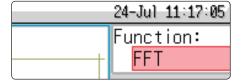


# 13.3.1 Select the FFT Function

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].



# 13.3.2 Select 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

Press the **STATUS** key to open the Status screen, and then select the **[Status]** sheet. To set from the Waveform screen, refer to (p. 269).

1 Select the reference data.

Move the cursor to [Reference].

New Data	Acquire a new waveform for analysis.
From Memory	Calculates data measured using the memory function.

When you have finished choosing settings, press the START key

#### When using [New Data]

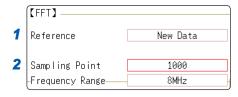
Measurement starts to acquire data for the number of analysis points specified as the [Sampling Point], and FFT analysis is performed.

## 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 Analyze After Specifying an Analysis Starting Point" (p. 278).

The frequency range is selected automatically. Refer to "Relationship Between Frequency Range, Resolution and Number of Analysis Points" (p. 256).



# 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.)

# When no trace is displayed after pressing the START key

Analysis is impossible 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.

# 13.3.3 Set the Frequency Range and Number of Analysis Points

# **About the Frequency Range and Nnumber 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. 256).

- 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. 256).
- 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. A15).

## 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 )

Press the **STATUS** key to open the Status screen, and then select the **[Status]** sheet. Refer to "13.3.11 Set and Change Analysis Conditions on the Waveform Screen" (p. 269).

1 Set the number of FFT analysis points.

Move the cursor to [Sampling Point].

1000 (Default setting), 2000, 5000, 10000

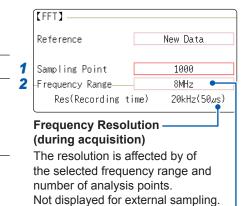
Refer to "Number of Analysis Points" (p. A15).

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

Refer to "Relationship Between Frequency Range, Resolution and Number of Analysis Points" (p. 256).



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.

# Relationship Between Frequency Range, Resolution and Number of Analysis Points

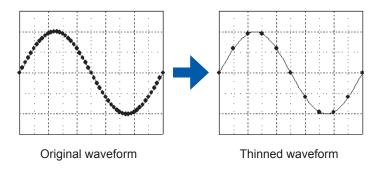
	Sampling	Timebase	Sampling	Number of FFT analysis Points							
Range	frequency		period	1,0	00	2,0	00	5,0	00	10,	000
[Hz]	[Hz]	[/div] (MEM)		Resolution [Hz]	Acquisition interval	Resolution [Hz]	Acquisition interval	Resolution [Hz]	Acquisition interval	Resolution [Hz]	Acquisition interval
8 M*1	20 M	5 µs	50 ns	20 k	50 µs	10 k	100 µs	4 k	250 µs	2 k	500 µs
4 M*1	10 M	10 µs	100 ns	10 k	100 µs	5 k	200 µs	2 k	500 µs	1 k	1 ms
2 M*1	5 M	20 µs	200 ns	5 k	200 µs	2.5 k	400 µs	1 k	1 ms	500	2 ms
800 k*1	2 M	50 µs	500 ns	2 k	500 µs	1 k	1 ms	400	2.5 ms	200	5 ms
400 k*1	1 M	100 µs	1 µs	1 k	1 ms	500	2 ms	200	5 ms	100	10 ms
200 k*1	500 k	200 µs	2 µs	500	2 ms	250	4 ms	100	10 ms	50	20 ms
80 k*1	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*2	20	5 s	50 ms	20 m	50 s	10 m	100 s	4 m	250 s	2 m	500 s
4*2	10	10 s	100 ms	10 m	100 s	5 m	200s	2 m	500 s	1 m	1 ks
1.33 <sup>*2</sup>	3.33	30 s	300 ms	3.33 m	300 s	1.66 m	600s	666 µ	1.5 ks	333 μ	3 ks
800 m*2	2	50 s	500 ms	2 m	500 s	1 m	1 ks	400 µ	2.5 ks	200 μ	5 ks
667 m <sup>*2</sup>	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*2	1	100 s	1 s	1 m	1 ks	500 μ	2 ks	200 μ	5 ks	100 μ	10 ks
333 m <sup>*2</sup>	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 <sup>*2</sup>	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. The anti-aliasing filter is off. \*2. Cut-off frequency is 20 Hz.

# 13.3.4 Thin Out and Calculating Data

When performing FFT analysis of data measured using the memory function, the measurement data can be thinned before calculation.

If the sampling frequency is too high and you get unexpected results, thin the data before calculation to increase the frequency resolution.



# Procedure

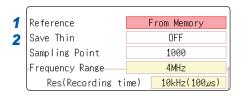
Press the **STATUS** key to open the Status screen, and then select the **[Status]** sheet.

Select the reference data.
Move the cursor to [Reference], and select [From Memory].

Select the thinning amount.

Move the cursor to [Save Thin].

Off	Do not thin data. (Default setting)
1/10	Skip every 10 data points.
1/100	Skip every 100 data points.
1/1000	Skip 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.

#### **Window Function Settings** 13.3.5

The window function defines the segment of the input signal to be analyzed.

Use the window function to minimize leakage errors (p. A20).

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

Press the **STATUS** key to open the Status screen, and then select the **[Status]** sheet. To set from the Waveform screen, refer to (p. 269).

# Select the window function.

Move the cursor to [Window].

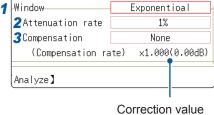
Rectangular (Default setting), Hanning, Exponential, Hamming, Blackman, Blackman Harris, Flat-top, Exponential

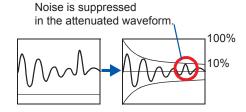
Refer to "Window Function" (p. A20).

# When [Exponential] is selected

Set the attenuation coefficient (percentage).

Move the cursor to [Attenuation rate]. Set the attenuation coefficient as a percentage.





# 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.

For the rectangular window function, the correction value is always 1 (0 dB).

# 13.3.6 Analysis Result Peak Value Settings

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

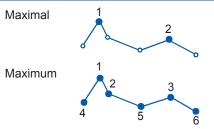
Press the STATUS key to open the Status screen, and then select the [Status] sheet.

#### To select peak value display.

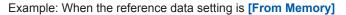
Move the cursor to [Peak].

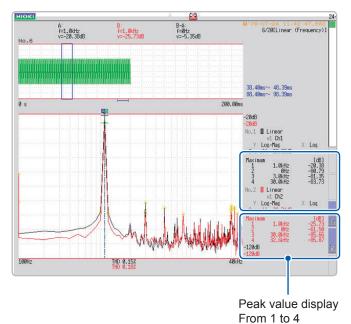
Off	Not displayed. (Default setting)
Maximal	(local maxima) When the value of data at a point is greater than that of the adjacent points, that point is considered a local maximum. The ten largest local maxima are displayed.
Maximum	(global maxima) Among all data values, the ten points with the greatest values are displayed.

	Format	Runningspectrum
- 1	Peak	Off
	-Average	Uff
П		
	Maximal 1	2



- 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.





# 13.3.7 Average 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.

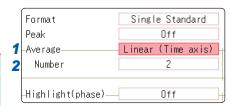
## Procedure

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.



# About averaging calculation formulas

Refer to "Averaging" (p. A19).

When averaging and auto-saving or auto-printing are enabled at the same time

Data is saved or printed after the specified number of values has been averaged.

# 2 Select the count for averaging.

Move the cursor to [Number].

Select the number of measurements to be averaged.

Setting range: 2 to 10,000

Refer to "Trigger Modes and Averaging" (p. 262).

- 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.

# ■ FFT Analysis Modes and Averaging

✓: Can be set, —: Cannot be set, O: Can be partially set

	Averaging				
Analysis mode	Time-domain waveform averaging		Spectrum averaging		
	Simple	Exponential	Simple	Exponential	Peak hold
OFF	_	_	_	_	_
Storage Waveform	✓	✓	_	_	_
Histogram	✓	✓	_	_	_
Linear Spectrum	✓	✓	O*2	O*2	O*2
RMS Spectrum	✓	✓	O*2	O*2	O*2
Power Spectrum	✓	✓	✓	✓	✓
Power Spectrum Density *1	✓	✓	✓	✓	✓
LPC analysis (Power Spectrum Density) 1	✓	✓	_	_	_
Transfer Function	✓	✓	O*2	O*2	O*2
Cross Power Spectrum	✓	✓	O*2	O*2	O*2
Impulse Response	✓	✓	✓	✓	✓
Coherence Function	_	_	✓	✓	_
Phase spectrum	✓	✓	_	_	_
Auto-correlation Function	✓	✓	✓	✓	✓
Cross-correlation Function	✓	✓	✓	✓	✓
1/1 Octave Analysis *1	✓	✓	✓	✓	✓
1/3 Octave Analysis *1	✓	✓	✓	✓	✓

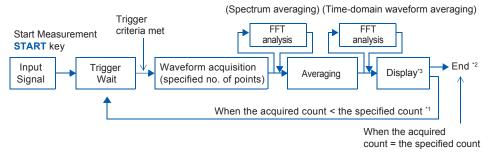
<sup>\*1.</sup> Not available for external sampling

<sup>\*2.</sup> Not available when the y axis is real (linear) or imaginary (linear), and for Nyquist plots

# Trigger Modes and Averaging

## If the trigger mode is [Single] or the calculation setting is [Once]

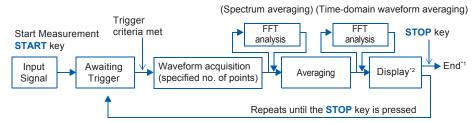
Measurement continues until the specified number of averaging points is acquired



- \*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]

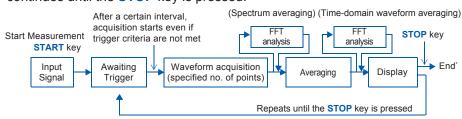
Measurement continues after the specified averaging count has been acquired. When the specified averaging count is exceeded, averaging is repeated and measurement continues until the **STOP** key is pressed.



- \*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.

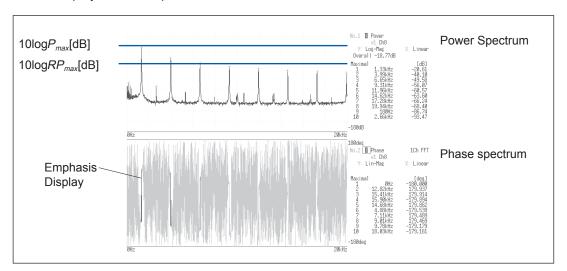


\* When stopped before the specified count, the average up to that point is displayed.

# 13.3.8 Emphasize 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.



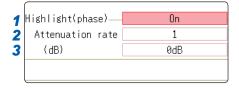
# Procedure

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.



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 Alphanumeric Input" (p. 149).

To set an attenuation value [dB]

Move the cursor to [(db)]. Enter the attenuation value. Refer to "8.1.3 Alphanumeric Input" (p. 149).

# Attenuation Rate and Value Attenuation value: A [dB]

Attenuation rate: R

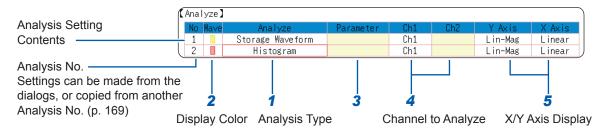
 $-A = 10\log_{10}R$   $1 \times 10^{-6} \le R \le 1$  $0 \le A \le 60$ 

# 13.3.9 Analysis Mode Settings

You can set the type of FFT analysis, channel(s), waveform display color and X and Y axes.

# Procedure

Press the **STATUS** key to open the Status screen, and then select the **[Status]** sheet. To set from the Waveform screen, refer to (p. 269).



# 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. 287)
Storage Waveform	(p. 280)	Impulse Response	(p. 288)
Histogram	(p. 280)	Coherence Function	(p. 289)
Linear Spectrum	(p. 281)	Phase spectrum	(p. 290)
RMS Spectrum	(p. 282)	Auto-correlation	(p. 291)
Power Spectrum	(p. 283)	Cross-correlation	(p. 292)
Power Spectrum density*	(p. 284)	1/1 Octave*	(p. 292)
LPC (density)*	(p. 285)	1/3 Octave*	(p. 292)
Transfer Function	(p. 286)		

<sup>\*</sup>Not available with external sampling enabled. Refer to "13.9.2 Analysis Mode Functions" (p. 297).

(When [List] is selected, a list of calculation types appears. To clear the display, press the CH.SET key.)

# Select whether the waveform will be displayed and its color.

Move the cursor to the [Wave] column.

Select whether to be display (On) the waveform or not, and its color if displayed.

# **3** When [Parameter] setting contents are displayed

## Set the parameter.

Move the cursor to the [Parameter] column of the Analysis No. you want to set.

Analyze	Parameter	Settings
1/1 Octave,	Filter: Normal	Set the octave filter.
1/3 Octave	Filter: Sharp	Refer to "Octave Filter Settings" (p. 266).
	1ch FFT	Calculates the phase of [Ch1].
Phase Spectrum	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. 266).

#### Y-axis display

Lin-Mag	Display analysis results as amplitude values.
Log-Mag	Display analysis results as dB values. The dB reference is 1 eu. Example: For voltage, 1 V is displayed as 0 dB.
Lin-Real	Display the real-number component of analysis values.
Lin-Imag	Display the imaginary component of analysis values.

# 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.

# 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)

# To analyze using external sampling

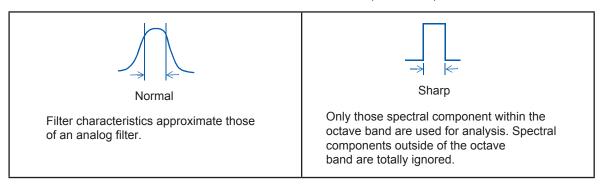
The horizontal axis (x-axis) displays the number of data points.

## To copy settings to another calculation No.?

Refer to "8.9 Copy Settings to Other Channels (Copy Function)" (p. 169).

# ■ Octave Filter Settings

Filter features are based on JIS C1513-2002 class 1, class 2 (IEC61260).



After determining the entire power spectrum, the instrument performs octave analysis defined by the above filter characteristics.

Refer to "Octave Filter Characteristics" (p. A24).

# **Analysis Modes and X/Y Axis Display**

✓: Settable, —: Unsettable

Analysis mode	Χa	ixis	Y axis		Nyquist			
Analysis mode	Linear	Log	Lin-Mag	Lin-Mag	Lin-Real	Lin-Imag	display	
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	_	✓	✓	✓	_	_	_	
1/3 Octave	_	✓	✓	✓	_	_	_	

The X/Y axes cannot be set when Nyquist Display is selected.

# ■ 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 2 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.

THD = 
$$\sqrt{\frac{\sum (V_n)^2}{(V_0)} \times 100}$$
 [%]

 $V_0$  =fundamental wave

 $V_n$  =next higher harmonic

# 13.3.10 Set the Display Range of the Vertical Axis (Scaling)

The display range of the vertical (Y) axis can be set to automatically fir analysis results and can be freely expanded and compressed.

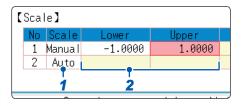
## Procedure

Press the **STATUS** key to open the Status screen, and then select the **[Status]** sheet.

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 limits.

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 Alphanumeric Input" (p. 149).

#### To copy settings to another calculation No.

Refer to "8.9 Copy Settings to Other Channels (Copy Function)" (p. 169).

# 13.3.11 Set and Change Analysis Conditions on the Waveform Screen

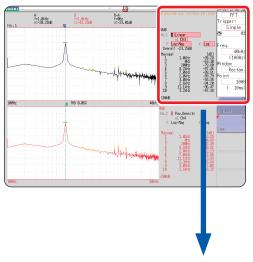
The following settings can be made on the Waveform screen.

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. 198)
   (Note: If [Reference] is [From Memory], triggers cannot be set.)

## Setting Descriptions

Press the **DISP** key to open the Waveform screen.

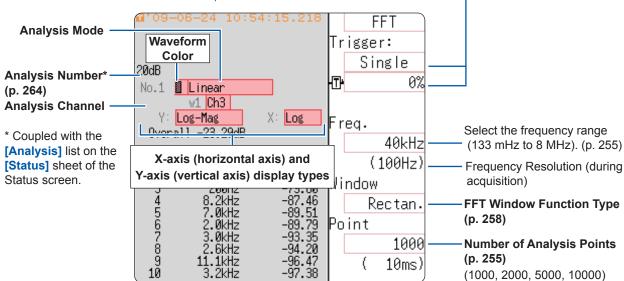


#### Setting method

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 Mode: Single, Repeat, Auto Pre-trigger: Select from list Refer to "9.2 Set the Trigger Mode" (p. 197). Refer to "9.8 Pre-trigger Settings" (p. 209).



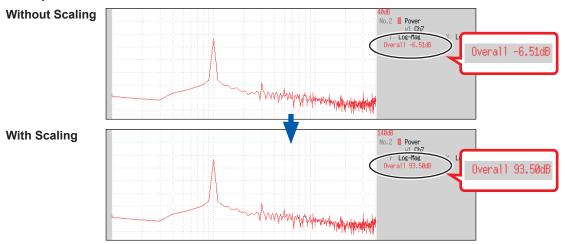
# 13.4 Select Channels

Channel selection is the same for all functions.

For the setting method, refer to "3.4 Select Input Channels" (p. 66) and "8.10 Detailed Settings for Modules" (p. 170).

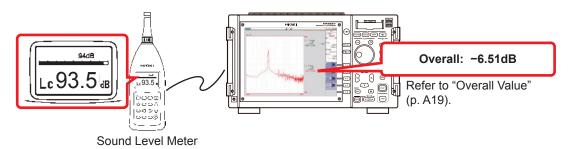
# **Scaling**

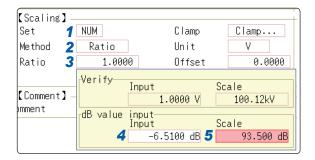
The scaling setting allows values displayed on the instrument to match the actual values read directly on a sound level meter or vibration meter.



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.





0 dB reference differs depends on the physical quantity.

As an example for sound pressure, 20  $\mu$ Pa 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.

- Select [Num].
- 2 Select [Ratio].
- 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.
- Press the F5 [Confirm] key to perform scaling.

Scaling will be performed automatically and the conversion value set in the conversion rate column.

# 13.5 Screen Display Settings

Set the display method for FFT calculation results.

# Procedure

Press the **STATUS** key to open the Status screen, and then select the **[Status]** sheet.

# Select the display format.

Move the cursor to [Format]. Select the format of data to be displayed.

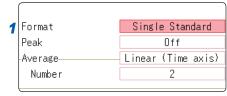
The display format depends on the input data selected for

The display lonnal (	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 No1 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, 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.

<sup>\*</sup> The horizontal axis and vertical axis display the real parts and the imaginary parts of calculation results, respectively.

# Press the DISP key to display the Waveform screen.



#### To use an existing memory waveform for analysis

Select [From Memory] as the input data source for [Reference]. Refer to "13.3.2 Select the Data Source for Analysis (Reference Data)" (p. 254).

#### To specify the analysis starting point

Specify the starting point on the memory waveform. Refer to "13.8.1 Analyze After Specifying an Analysis Starting Point" (p. 278).

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

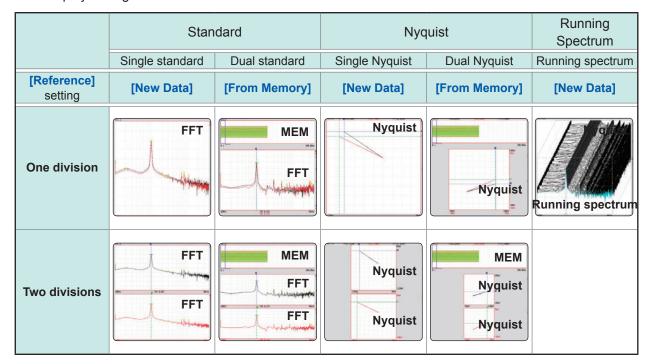
Set **[Format]** and increase the number of screen divisions. Different horizontal axis units cannot be displayed on the same graph.

## • NG: EXT

Analysis mode cannot perform external sampling.

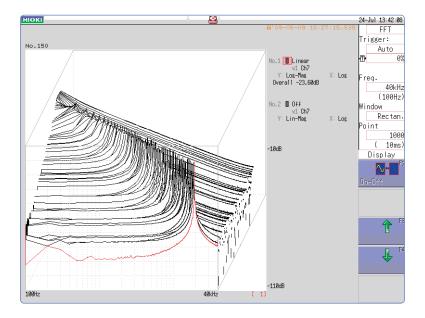
# **Display Types and Split-Screen Settings**

Nine display arrangements are available.



# 13.5.1 Display Running Spectrums

If [Format] is set to [Running spectrum], you can observe changes in frequency over time.



# Procedure

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].

Reference New Data

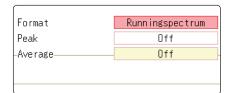
Sampling Point 1000

Frequency Range 8MHz

Res(Recording time) 20kHz(50µs)

2 Select the display format.

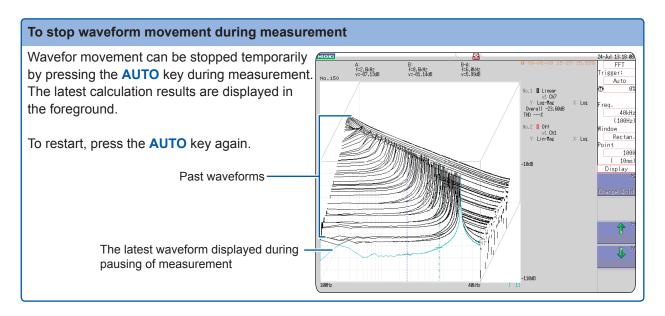
Move the cursor to **[Format]**, and select **[Running spectrum]**.



- [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-saving/auto-printing during measurement cannot be performed.

# Procedure

Press the **DISP** key to open the Waveform screen.



## 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 unit.
- 2 Select a waveform.

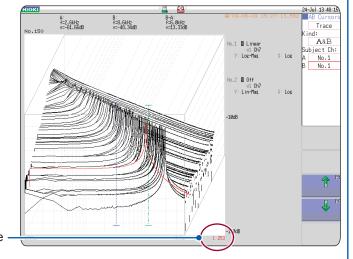
Use the jog and shuttle knobs to select the waveform.
(The waveform number is displayed in the wavefor

(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.

Older waveforms have larger numbers.



4-Jul 13:22:00

0%

40kHz (100Hz)

Rectan.

1000 10ms)

rigger:

req.

Window

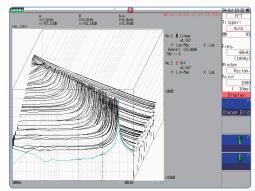
oint

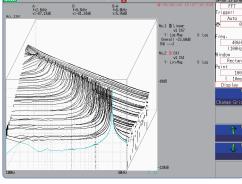
## To change the grid display

The display format of the grid can be selected.

- 1 Press the WAVE key on the panel of the unit.
- **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

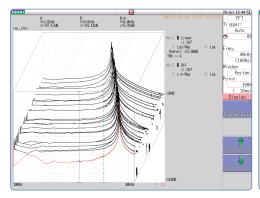
# To change the number of waveforms to be displayed.

The number of waveforms to be displayed can be changed.

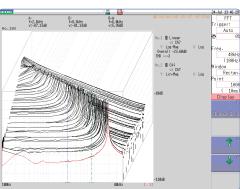
The following number of waveforms can be selected: 10, 20, 50, 100, and 200.

- 1 Press the WAVE key on the panel of the unit.
- 2 Move the cursor to [Display].
- 3 Change the number of waveforms to be displayed.

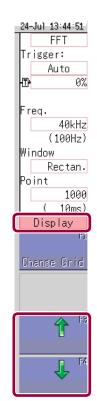
Using either the F3 [ $\uparrow$ ] or F4 [ $\downarrow$ ] key, adjust the number of waveforms to be displayed.



50 waveforms displayed



100 waveforms displayed



# 13.6 Save Analysis Results

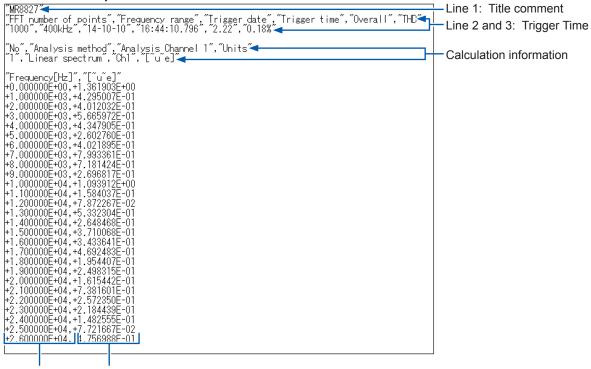
The procedure to save analysis results is the same as for the Memory and Recorder functions. Refer to "5 Save/Load Data and Manage Files" (p. 83).

The size of saved files depends on the save format and analysis method. Refer to "Appendix 2.1 Waveform File Sizes" (p. A2).

# ■ When FFT Analysis Results are Saved as Text

Each calculation item is saved to a separate file.

#### **Text Save Example**



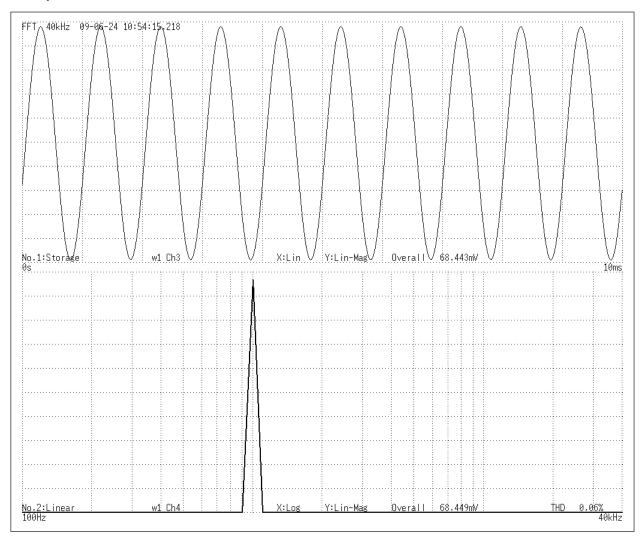
X-axis data Y-axis data

If trigger time is not displayed properly when you open a file with Microsoft Excel<sup>®</sup>, select "Custom" for **[Format]** of **[Format Cells]** and enter "hh:mm:ss.000" for Type.

# 13.7 Print Analysis Results

The printing procedure is the same as for the Memory and Recorder functions. Refer to "6 Printing (When Model U8350 Printer Unit is installed)" (p. 113).

# **Example Waveform Print**



# 13.8 Analysis With the Waveform Screen

# 13.8.1 Analyze After Specifying an Analysis Starting Point

The FFT function can specify the calculation start position for waveforms previously measured using the memory function.

Operation differs depending on the calculation execution settings. Refer to "Trigger Modes and Averaging" (p. 262).

## Calculation execution: [Single]

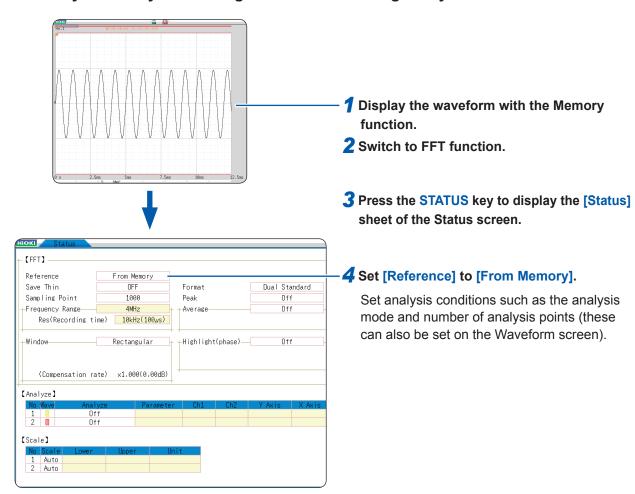
Analysis is performed once on the specified number of analysis points beginning with the specified starting point, and analysis results are displayed.

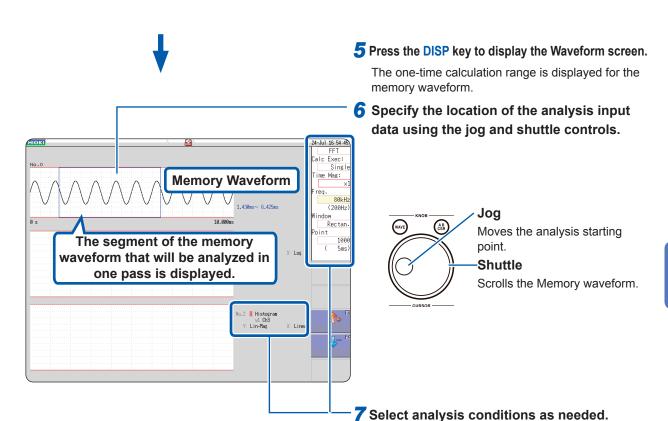
This is convenient for analyzing only a specific range. However, if averaging is enabled, analysis repeats for the specified averaging count.

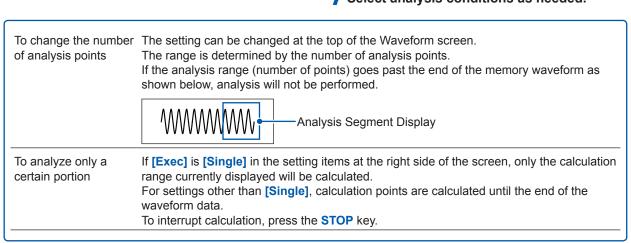
## Calculation execution: [Repeat]

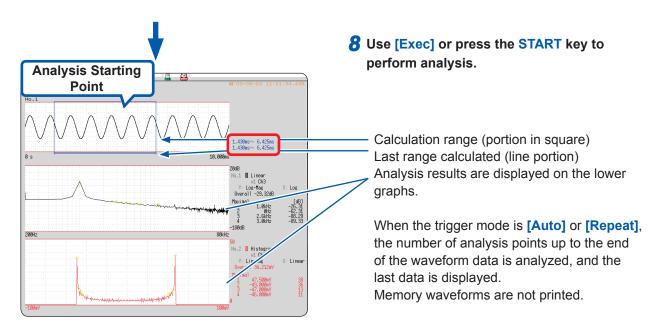
Analysis is performed repeatedly on the specified number of analysis points beginning with the specified starting point and ending with end of waveform data, and final analysis results are displayed (Calculation is performed for the number of specified points so a good end point becomes the final analysis result).

# To Verify the Analysis Starting Point While Viewing Analysis Data









# 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. 297).

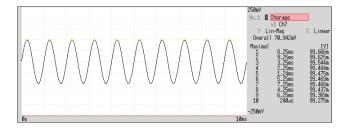
# Storage

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. 256).
Y axis	Lin-Mag	Displays the module waveform

#### **Waveform Example**



Window: Rectangular X axis: Linear Y axis: Lin-Mag

# Histogram

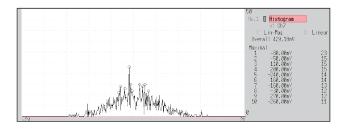
Acquires the amplitude distribution of the input signal.

#### Main uses:

- To inspect deviations in the amplitude range of a waveform
- Uses analysis point distribution to ascertain whether a waveform is artificial or natural About the Functions, refer to "13.9.2 Analysis Mode Functions" (p. 297).

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

# **Linear Spectrum**

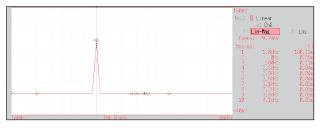
The linear spectrum plots the input signal frequency. It can also be displayed as a Nyquist plot. Main uses:

- 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. 297).

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	Display analysis results as dB values. (0 dB reference value: 1eu)*
	Lin-Real	Display the real-number component of analysis values.
	Lin-Imag	Display the imaginary component of analysis values.
	Nyquist display	Display the imaginary component of analysis values.

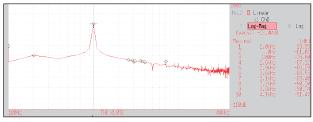
<sup>\*</sup> eu: engineering units that are currently set are the standard (e.g., when the unit settings is volts, 0 dB = 1 V)

# **Waveform Example**



# Normal display

X axis: Log Y axis: Lin-Mag



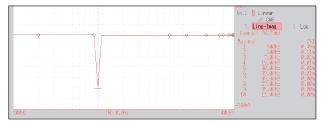
# Normal display

X axis: Log Y axis: Log-Mag



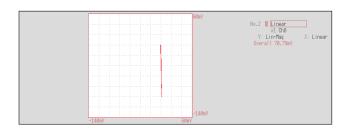
# Normal display

X axis: Log Y axis: Lin-Real



#### Normal display

X axis: Log Y axis: Lin-Imag



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 2 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. 282) or "Power Spectrum" (p. 283).

# **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:

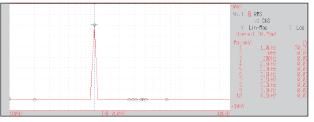
- To inspect the execution value of the frequency component of the waveform
- To inspect the RMS value of each frequency

About the Functions, refer to "13.9.2 Analysis Mode Functions" (p. 297).

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	Display analysis results as dB values. (0 dB reference value: 1eu)*
	Lin-Real	Display the real-number component of analysis values.
	Lin-Imag	Display the imaginary component of analysis values.

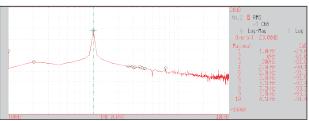
<sup>\*</sup> eu: engineering units that are currently set are the standard (e.g., when the unit settings is volts, 0 dB = 1 V)

#### **Waveform Example**

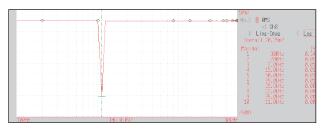


## Normal display

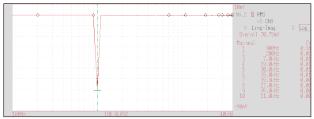
Normal display X axis: Log Y axis: Lin-Mag



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 2 cursors appear, the A cursor becomes the fundamental wave. When results cannot be obtained, [---%] is displayed.

#### **Power Spectrum**

Displays input signal power as the amplitude component. Main uses:

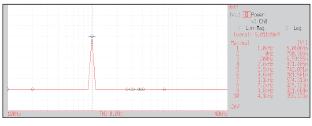
- To inspect the peak frequency contents of a waveform
- To inspect the power level of each frequency

About the Functions, refer to "13.9.2 Analysis Mode Functions" (p. 297).

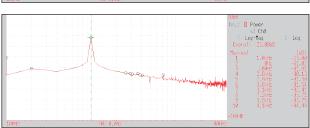
Axis	Display type	Description
X axis	Linear	Displays the frequency on a linear scale
A axis	Log	Displays the frequency on a logarithm scale
Y axis	Lin-Mag	Analysis data is displayed linearly as squared values. Indicates the power component.
T axis	Log-Mag(logarithm)	Display analysis results as dB values. (0 dB reference value: 1eu²)*

<sup>\*</sup> eu: engineering units that are currently set are the standard (e.g., when the unit settings is volts,  $0 \text{ dB} = 1 \text{ V}^2$ )

#### **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 2 cursors appear, the A cursor becomes the fundamental wave. When results cannot be obtained, [---%] is displayed.

#### **Power Spectrum Density**

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.

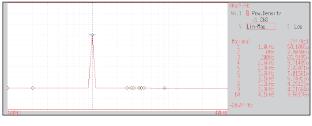
Main uses:

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. 297).

Ах	ris	Display type	Description
	axis	Linear	Displays the frequency on a linear scale
	axis	Log	Displays the frequency on a logarithm scale
	axis	Lin-Mag	Displays analysis values linearly.
1	axis	Log-Mag(logarithm)	Display analysis results as dB values. (0 dB reference value: 1eu²/Hz)*

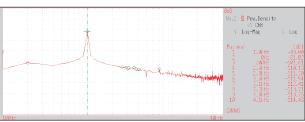
<sup>\*</sup> eu: engineering units that are currently set are the standard (e.g., when the unit settings is volts, 0 dB = 1 V²/Hz)

#### **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.

#### **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.

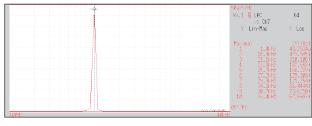
#### Main uses:

To obtain a spectral envelope using statistical methods About the Functions, refer to "13.9.2 Analysis Mode Functions" (p. 297).

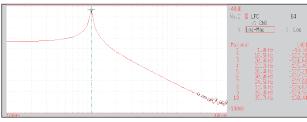
Axis	Display type	Description
V avia	Linear	Displays the frequency on a linear scale
X axis	Log	Displays the frequency on a logarithm scale
V avia	Lin-Mag	Displays analysis values linearly.
Y axis	Log-Mag(logarithm)	Display analysis results as dB values. (0 dB reference value: 1eu²/Hz)*

<sup>\*</sup> eu: engineering units that are currently set are the standard (e.g., when the unit settings is volts, 0 dB =  $1 \text{ V}^2/\text{Hz}$ )

#### **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.

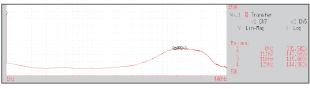
#### **Transfer Function**

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. 297) or Refer to "Linear Time-Invariant Systems" (p. A14).

Axis	Display type	Description
	Linear	Displays the frequency on a linear scale
X axis	Log	Displays the frequency on a logarithm scale
	Nyquist display	Displays the real-number component of the input-output ratio.
	Lin-Mag	Displays the input-output ratio linearly (dimensionless units).
	Log-Mag(logarithm)	Displays the input-output ratio as dB values.
Y axis	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**



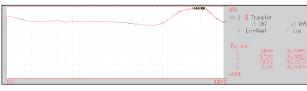
#### Normal display

X axis: Log Y axis: Lin-Mag



#### **Normal display**

X axis: Log Y axis: Log-Mag



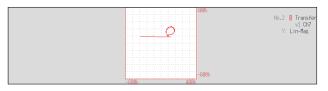
#### Normal display

X axis: Log Y axis: Lin-Real



#### Normal display

X axis: Log Y axis: Lin-Imag



#### Nyquist display

#### **Cross Power Spectrum**

The product of the spectra of two input signals or common frequency components of two signals can be obtained.

Using the voltage and current waveforms as input signals, active power, reactive power and apparent power can be obtained for each frequency.

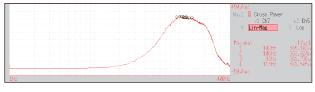
Main uses:

To inspect common frequency components of two signals About the Functions, refer to "13.9.2 Analysis Mode Functions" (p. 297).

Axis	Display type	Description
	Linear	Displays the frequency on a linear scale
X axis	Log	Displays the frequency on a logarithm scale
	Nyquist display	Displays the real-number component of the input-output ratio linearly.
	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: 1eu²)*
Y axis	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.

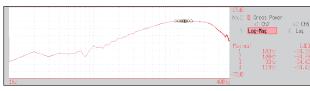
<sup>\*</sup> eu: engineering units that are currently set are the standard (e.g., when the unit settings is volts,  $0 \text{ dB} = 1 \text{ V}^2$ )

#### **Waveform Example**



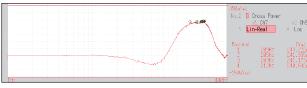


X axis: Log Y axis: Lin-Mag



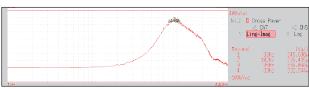
#### Normal display

X axis: Log Y axis: Log-Mag



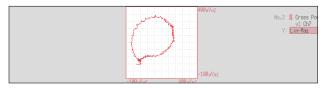
#### Normal display

X axis: Log Y axis: Lin-Real



#### Normal display

X axis: Log Y axis: Lin-Imag



#### Nyquist display

#### Impulse Response

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.

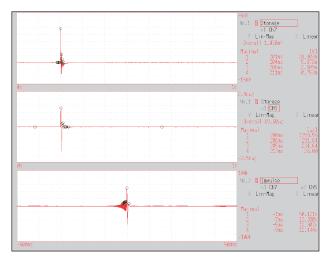
#### Main uses:

To inspect circuit time constants

About the Functions, refer to "13.9.2 Analysis Mode Functions" (p. 297) or "Linear Time-Invariant Systems" (p. A14).

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

#### **Coherence Function**

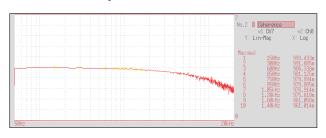
This function gives a measure of the correlation (coherence) between input and output signals. Values obtained are between 0 and 1.

#### 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. 297).

Axis	Display type	Description
X axis	Linear	Displays the frequency on a linear scale
A dxis	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. 297).

#### **Phase Spectrum**

#### 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. 297).

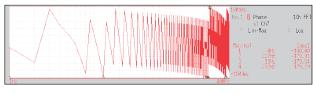
Although the unit for angle is [ ° ], it is shown [deg] on the screen.

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.

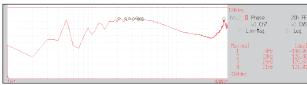
2ch FFT: Displays the phase difference between channels 1 and 2. Positive values indicate that the phase of channel 2 is leading.

Axis	Display type	Description
X axis	Linear	Displays the frequency on a linear scale
A axis	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 Emphasize Analysis Results (Phase Spectra Only)" (p. 263).

#### **Auto-correlation Function**

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. 297).

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 <i>t</i> is +1, and the least correlation is 0. −1 indicates completely reversed polarity. Because of the characteristics of the function, <i>t</i> = 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.

#### **Cross-Correlation Function**

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:

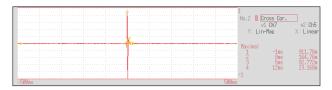
To determine the phase shift of two signals per unit of time

To determine the speed and distance of time lag between two signals

About the Functions, refer to "13.9.2 Analysis Mode Functions" (p. 297).

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 <i>t</i> , this value is +1 when the correlation of input and output signals is the closest, and 0 when correlation is the least1 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

Analyze spectrums such as noise using fixed rate spectrum filters of 1/1 octave band or 1/3 octave band.

#### Main uses:

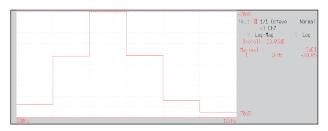
To analyze noise frequency

About the Functions, refer to "13.9.2 Analysis Mode Functions" (p. 297), "Octave Filter Characteristics" (p. A24)

Axis	Display type	Description
X axis	Log	Displays the center frequency of each band.
Vavia	Lin-Mag	Displays octave analysis values linearly.
Y axis	Log-Mag(logarithm)	Displays octave analysis values as dB values. (0 dB reference value: 1eu)*

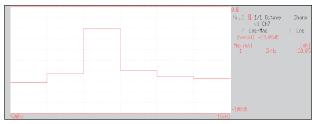
<sup>\*</sup> eu: engineering units that are currently set are the standard (e.g., when the unit settings is volts, 0 dB = 1 V)

#### **Waveform Example**



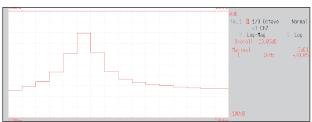
#### 1/1 Octave

X axis: Log Y axis: Log-Mag Filter: Normal



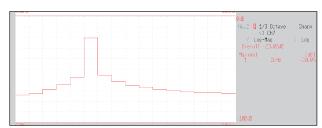
#### 1/1 Octave

X axis: Log Y axis: Log-Mag Filter: Sharp



#### 1/3 Octave

X axis: Log Y axis: Log-Mag Filter: Normal



#### 1/3 Octave

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 subbands1/3 Octave Analysis: 16 subbands

The octave analysis results of this unit 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 Convert Input Values (Scaling Function)" (p. 157).

### **Measurable Ranges With Octave Analysis**

(●: 1/1 OCT, ○: 1/3 OCT)

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(●: 1/1 OCT, ○: 1/3 OCT)

(•: 1/1 OCT, o: 1/3 OCT)

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10	100m	10	4	19									
5	50m	70	8	18									
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1	10m	100	40	16									
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10m	100L	10k	44	10									
2ш	50 µ	20k	8	6									
2m	20 µ	50k	20k	80	Γ								
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7 00S	5 µ	200k	80k	9									
200 H	2μ	500k	200k	5									
100 H	1μ	1,1	400k	4									
n 05	500n	2,11	800k	3									
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Timebase	Period [s]	Sampling frequency [Hz]	Frequency range [Hz]	1/1 0CT		77			23			54	

## 13.9.2 Analysis Mode Functions

Analysis mode	Internal analysis 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	$X(k) = \sum_{n=0}^{N-1} x(n)W^{kn} \qquad F(k) = CX(k) \qquad C \begin{cases} 1/N(DC) \\ 2/N(AC) \end{cases}$ $linear =  F(k)  \qquad real = \operatorname{Re}\{F(k)\} \qquad imag = \operatorname{Im}\{F(k)\} \qquad \log = 20\log F(k) $
RMS Spectrum	$F'(k) = C'F(k) \qquad \qquad C' \begin{cases} 1 & (DC) \\ 1/\sqrt{2}(AC) \end{cases}$ $linear =  F'(k)  \qquad real = \operatorname{Re}\{F'(k)\} \qquad log = 20\log F'(k) $
Power Spectrum	$P(k) = a F(k) ^2 \qquad a = \begin{cases} 1 & (DC) \\ 1/2 & (AC) \end{cases}$ $linear = P(k) \qquad log = 10log P(k) $
Power Spectrum Density	$P'(k) = P(k)/\delta f$ $\delta f$ : Frequency resolution $linear = P'(k)$ $log = 10log P'(k) $
LPC analysis (Power	(Omission) Spectrum approximation from Linear Predictive Coding
Spectrum Density)	Refer to "Linear Time-Invariant Systems" (p. A14). $H(k) = Y(k)/X(k)$
Transfer Function	$linear =  H(k)   real = \text{Re}\{H(k)\}  imag = \text{Im}\{H(k)\}  \log = 20\log H(k) $
Cross Power Spectrum	$\begin{split} S_{yx}(k) &= X^*(k)Y(k) \colon \text{ Cross spectrum} \\ X_{power}(k) &= AS_{yx}(k) & A = \begin{cases} 1/N^2 \\ 2/N^2 \end{cases} \\ linear &= \left  X_{power}(k) \right   real = \text{Re}\{X_{power}(k)\} \\ imag &= \text{Im}\{X_{power}(k)\}  \log = 10\log \left  X_{power}(k) \right  \end{split}$
Impulse Response	$imag = \operatorname{Im}\{X_{power}(k)\} \qquad \log = 10\log X_{power}(k) $ $h(n) = \frac{1}{N} \sum_{k=0}^{N-1} \frac{Y(k)}{X(k)} W^{-kn}$
Coherence Function	$coh(k) = \sqrt{\frac{S_{yx}(k)S_{yx}^*(k)}{S_{xx}(k)S_{yy}(k)}}$
Phase Spectrum	$\theta(k) = 180/\pi \times \tan^{-1}(\text{Im}(F'(k))/\text{Re}(F'(k))$ $\theta(k) = 180/\pi \times \tan^{-1}(\text{Im}(S_{yx}(k))/\text{Re}(S_{yx}(k))$
Auto-correlation Function	$R_{xx}(n) = \frac{1}{N} \sum_{k=0}^{N-1}  X(k) ^2 W^{-kn}$ (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)

## 14 Waveform Evaluation Function

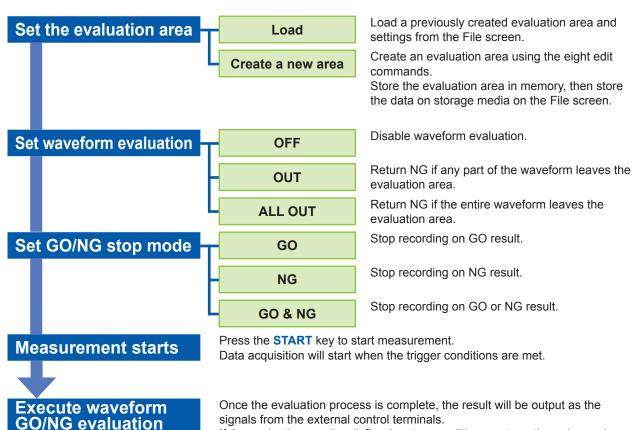
### 14.1 Waveform GO/NG Evaluation (MEM, FFT **Function**)

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 terminals.

All channels being displayed can be used for GO/NG evaluation.

#### Setting Workflow (After the Input and Other Settings Have Been Finished)

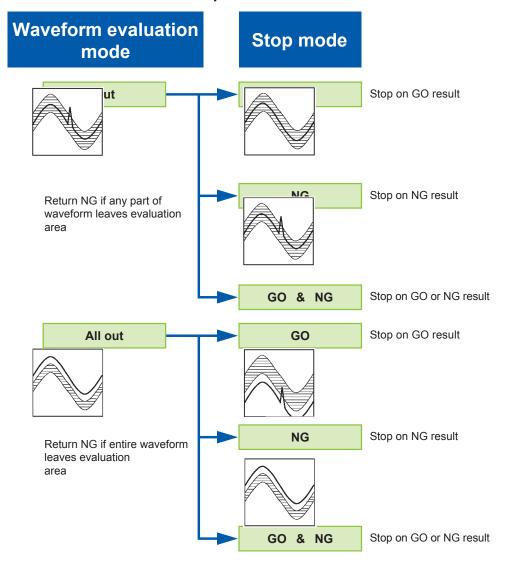


If the evaluation result satisfies the stop conditions, automatic saving and automatic printing will be performed, if enabled.

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.

- Trigger mode: [Single] Measurement continues until stop mode conditions are fulfilled, then stops.
- Trigger mode [Repeat], [Auto] Recording and waveform evaluation is 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 100 ms/div or less 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 on the order of 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 Magnify and Compress Horizontal Axis (Time Axis)" (p. 136).
- When using the highlight function with the FFT function, only the highlighted data is evaluated.

#### **Waveform Evaluation Mode and Stop Mode**



### 14.2 Set the Waveform 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**

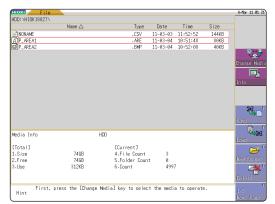
#### Setting method

Setting screen: File

- 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.
- 4 Select a command.
  Select [Load].
- 5 Choose [Exec] from the F key menu.
- When no more changes need be made to the loaded settings, press the DISP key to make the Waveform display screen appear, and then press the START key to initiate measurement.

To change the settings, first change the contents, press the **DISP** key to make the Waveform display screen appear, and then press the **START** key to initiate measurement.

Refer to "5.3 Load Data" (p. 99).



#### 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 XY evaluation area.

Files that do not satisfy these requirements cannot be loaded properly.

#### **Creating a New Evaluation Area**

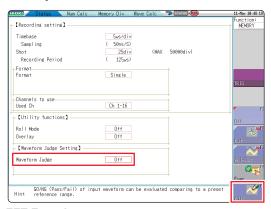
#### Setting method

Setting screen: Status

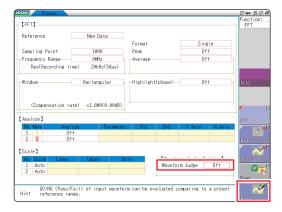
- 1 Press the STATUS key to display the Status screen.
- 2 Move the flashing cursor to [Waveform Judge].
- 3 Choose [edit] from the F key menu.
- **Activate editor to set up the evaluation area.** Refer to "14.5 Create the Evaluation Area" (p. 307).
- 5 Store the created area in memory.
- 6 After setting "Waveform Judge setting" and "Stop Mode," press the DISP key to show the Waveform display screen, then press the START key to begin measurement.
- Save the evaluation area on the File screen, if necessary.

Refer to "5.2 Save Data" (p. 87).

#### **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.

## 14.3 Set the Waveform Evaluation Mode

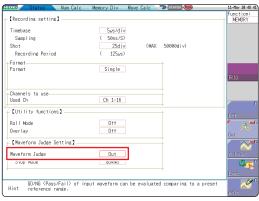
#### Setting method

Setting screen: Status

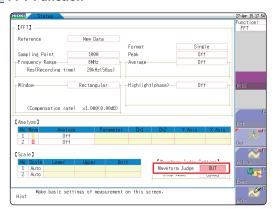
- 1 Move the flashing cursor to [Waveform Judge].
- Choose the required setting from the F key menu.

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.
exec	Enable waveform evaluation.
edit	Activate editor to set up the evaluation area.

#### **Memory Function**



**FFT Function** 



## 14.4 Set Waveform Evaluation Stop Mode

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.

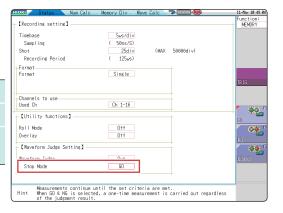
The auto-save and auto-print functions are only executed when interruption conditions are satisfied.

#### Setting method

Setting screen: Status

- **1** Move the flashing cursor to [Stop Mode].
- Choose the required setting from the F key menu.

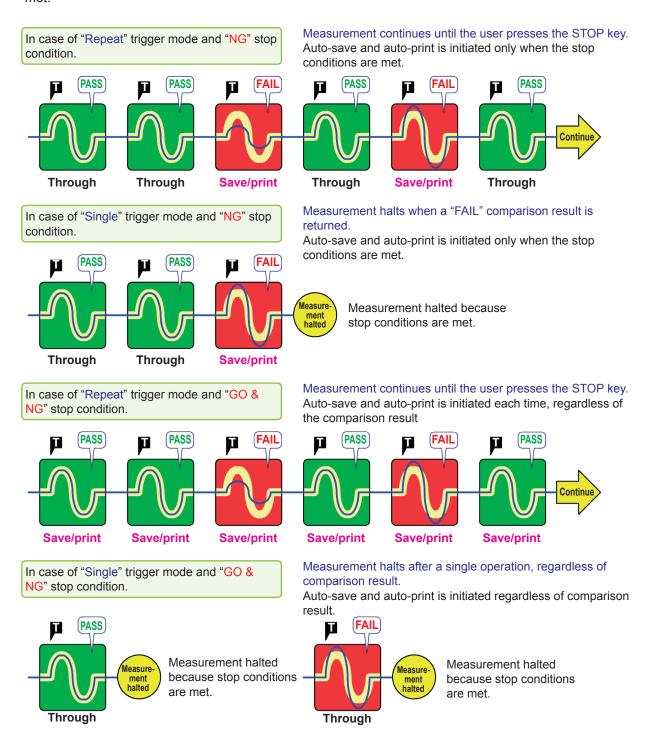
GO	Stop recording on GO result.
NG	Stop recording on NG result.
GO& NG	Stop recording on GO or NG result.



#### Relationship Between Stop Conditions and Trigger Mode

- There are three trigger modes: Single, Repeat, and Auto. Refer to "9.2 Set the Trigger Mode" (p. 197).
- 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.



- 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.

## 14.5 Create the Evaluation Area

#### Setting method

Setting screen: Status

- Move the flashing cursor to the [Waveform Judge] item and select [edit] from the F key menu.
- Select appropriate editors from the F key menu and create an area to be used as the reference for the waveform evaluation.

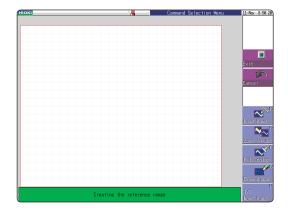
You can also use the mouse to create an area. Refer to "1.4.2 Use a Mouse to Perform Key Operations" (p. 25).

- **3** Press the F key for [Exit] to exit the editor.
- 4 Store the created area in memory.

Save and End	Saves the created evaluation area in the instrument's internal memory and exits.
Discard Changes 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 Save Data" (p. 87).



### 14.6 Editor Command Details



#### **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 0.04 div steps.

Execute	Performs magnification or compression processing based on the settings and creates an evaluation area.
Exit magnification/ compression	Exits magnification/compression mode.



#### 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  $\bigoplus$  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	Exit paint mode.



#### **Draw shape**

Draw a line, square or circle.

#### Instructions

- Press the F key for [Draw shape].
- Select the figure you wish to draw.
- 3 Use the cursor keys to move the  $\prod$  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  $\bigoplus$  mark.

A figure is drawn between the origin and the  $\overline{\coprod}$  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.
- Repeat steps 3 through 7 to draw figures as desired.
- 9 Press the [Exit Draw shape] key to exit figure mode.



#### **Eraser**

Erase unwanted sections. Move the **M** 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

Press the F key for [Clear select are
---------------------------------------

2	Using the cursor keys, move the $\coprod$ 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.

Press the F key for [Exit Area Clear] to exit from the area clear mode.



#### **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

Undo 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	Store evaluation area in memory and quit editor. Refer to "5.2 Save Data" (p. 87).
Discard and End	Quit the editor without storing the evaluation area in memory. The created area is discarded.

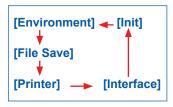
## 15 System Environment Settings

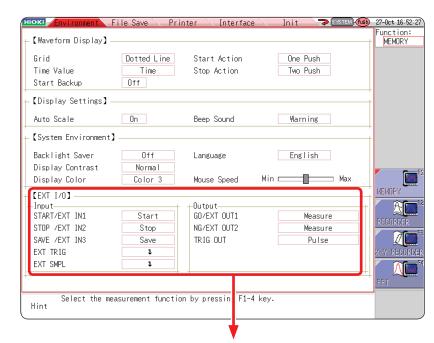
You can set the system environment on the [Environment] sheet of the system screen.

#### To Open the [Environment] Sheet



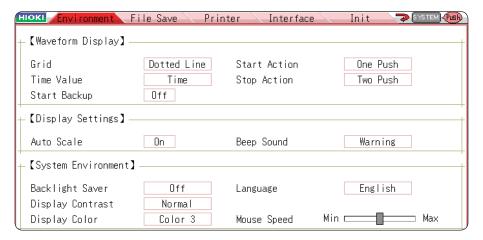
Press this key repeatedly to display the various sheets.





Refer to "17 External Control" (p. 343).

#### **Setting Descriptions**



#### Grid

Select the grid (graticule) type for the waveform screen.

Off	No grid displayed.
Dotted Line	Display a dotted-line grid. (Default setting)
Solid Line	Display a solid-line grid.

#### **Time Value**

Display the time from the trigger point on the display.

Time	Display the time from the trigger point (unit is fixed). (Default setting)
Time (60)	Display the time from the trigger point (sexagesimal (base-60) system).
div	Display the number of divisions (div) from the trigger point.
Date	Display time of waveform acquisition.
Sample Num	Display the number of data points from the trigger point.

- · During external sampling, the number of points is fixed.
- These settings affect the values read at the AB cursors.

#### **Start Backup**

Preserves measurement condition settings. If the power is turned off during recording due to power outage or other reasons, the operation resumes automatically when the power is restored.

When triggering is enabled, the awaiting-trigger state is activated.

#### Off (Default setting)/On

- · Valid only during recording.
- This function does not start automatically when the instrument is turned on.

## Backlight Saver

The screen blanks automatically after the specified period (minutes) with no key operation. The screen reappears 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 to 30 min (in whole minutes)

- When the screen is blanked by the backlight saver, pressing a key only reactivates the backlight; the normal key function is ignored. Press the key again for its normal 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**

Screen background and character colors on the Waveform screen can be set as desired. Select [Color Edit] then change the [R] (red), [G] (green) and [B] (blue) values of each item to change its color. (p. 316)

Color 1 / Color 2 / Color 3 / Color Edit

#### **Beep Sound**

This function audibly indicates warnings and operating conditions with beeps.

Off	Beep are disabled.
Warning	Beeps for error messages (warning displays) and NG (fail) judgments. (Default setting)
Warn+Act	In addition to the warning beeps above, beeps to indicate start, trigger, stop and auto-save-finish.

#### 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 Set the Waveform Position (Variable Function)" (p. 164).

Off/On (Default setting)

#### **Start Action**

To prevent operation mistakes from unintentionally starting measurement, the **START** key operation method can be changed. This setting does not affect external control terminal functions.

One Push	Measurement starts with on press. (Default setting)
Two Push	Measurement starts with two presses.
Hold 2s*	Measurement starts when pressed and held for two seconds.

<sup>\*</sup> When the **START** key is pressed, "Hold START key down." will be displayed.

After pressing for two seconds, the message disappears and measurement starts.

#### **Stop Action**

Normally, pressing the **STOP** key once causes measurement to stop after the specified recording length is completed, and pressing it twice stops measurement immediately. This setting is provided to allow a single press to stop measurement.

Two Push	Press the key twice to stop measurement. (Default setting)
One Push	Press the key once to stop measurement.

#### Mouse Speed

Sets the mouse movement speed.

Use the mouse to move the slider handle while holding down the left mouse button.

Sliding it towards "Min" makes the mouse pointer move more slowly slowly, while sliding it towards "Max" makes the pointer move more quickly.

Mouse Speed Min Max

#### **Additional Description**

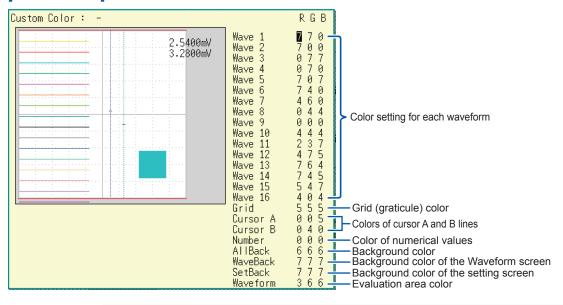
#### Select a Screen Color

Select [Color Edit] to display the [Custom Color] screen.

Change the [R] (red), [G] (green) and [B] (blue) values of each item to change its color.

Refer to "8.1.3 Alphanumeric Input" (p. 149).

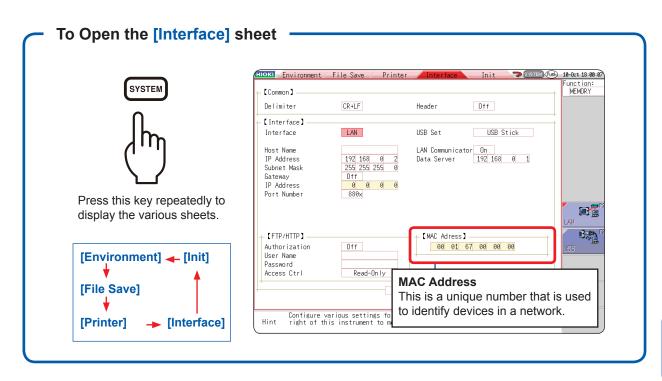
#### [Custom Color] screen



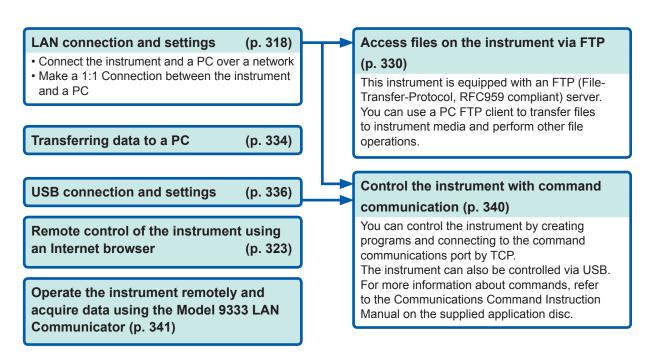
Done	Applies the settings.
Reset	Reverts to the default settings.

## 16 Connect to a PC

This instrument is equipped with an Ethernet 100BASE-TX interface for LAN communications. You can control the instrument from PCs and 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 a PC via USB.



#### **Operations Available From the [Interface] Sheet**



# 16.1 LAN Connection and Settings (Before Using FTP/Internet Browser/Command Communications)

Before accessing the instrument from a PC using 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 make LAN settings before connecting to the network. If you change settings while connected to the network, IP addresses may overlap or invalid address data may be transmitted over the network.

#### 16.1.1 LAN Settings on the Instrument

#### Things to Check Before Configuring LAN Settings

The required settings are different depending on whether the instrument is to be connected to an existing network or whether a new network consisting only of the instrument and one PC is to be configured.

#### When Connecting the instrument to an Existing Network

The following items must be assigned in advance by your network administrator. Be sure 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:
Specify the most significant 3 digits of the 4-digit number. The least significant digit (0 to 9) is reserved for use by the instrument.  Specify when the default value (8800 to 8809) cannot be used.

#### When Configuring a New Network with a PC and the Instrument

(Use as a local network without external connections)

If there is no administrator for your network, or if you have been entrusted with settings, the following addresses are recommended.

#### (Example settings)

#### **Setting Details**

Interface	Select LAN or USB.
Host Name	This name identifies the instrument on the network. Assign an address that is different from the addresses of all other devices.  This instrument does not support dynamic DNS. The name that you set is not registered with a DNS server.
IP Address	This address identifies an individual device on a network. Assign an address that is different from the addresses of all other devices.
Subnet Mask	This setting divides an IP address shown to the network into a network address and a host address.  Use the same subnet mask for all devices in the same network.
Gateway IP Address	For network connections When your PC (or the communicating device) is on another network than this instrument, set this to [On] and specify the gateway device. When the PC is on the same network, this is usually set to the same address as the default gateway in the PC communications settings.

## Authorization User Name and Password

These are used when you login to the instrument by FTP, or use a PC Internet browser (When authorization is **[On]**).

When authorization is enabled, login is only possible when a valid user name and password are entered. This setting is recommended if you wish to restrict the users to access the instrument.

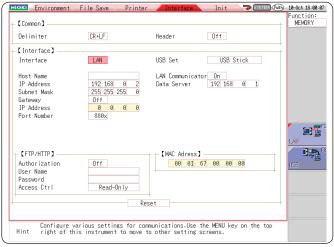
The "Password" is displayed as "\*\*\*\*\*\*\*\*.".

Valid characters: Alphabetic characters and symbols (however, ":" (colon) cannot be used)

If you want to allow anyone to access, or you wish to login as "anonymous" with a FTP client, leave the user name and password fields blank.

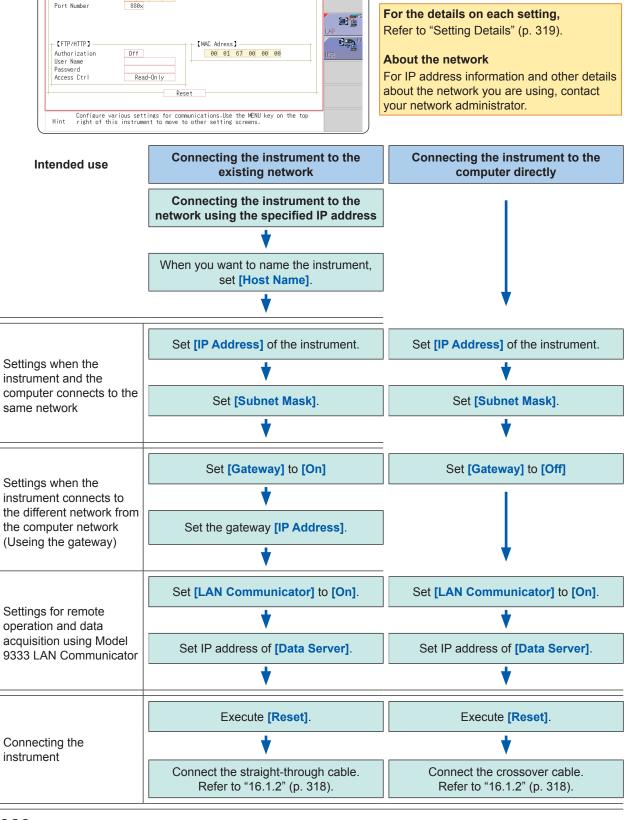
#### **LAN Setup Workflow**

Press the **SYSTEM** key and bring up the **Communications** sheet. Make settings as outlined below to suit your intended use.



Use the **CURSOR** keys to move the settings cursor and use the F keys to select a value for that setting.

Refer to "8.1.3 Alphanumeric Input" (p. 149).



#### 16.1.2 Connect the Instrument to a PC With a LAN Cable

## **ACAUTION**

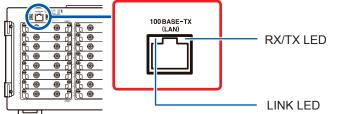


When connecting the instrument to your LAN using a LAN cable of more than 30 m or with a cable laid outdoors, take appropriate countermeasures that include installing a surge protector for LANs. Such signal wiring is susceptible to induced lighting, which can cause damage to the instrument.

Connect the instrument to a PC with a LAN cable as follows.

1 Plug the LAN cable (100BASE-TX compliant) into the 100BASE-TX connector on the back side of the instrument.





Flashes while data is being sent or received.

Lights while the instrument is capable of communications with a destination device.

#### Connect the above LAN cable to the PC.

There are two ways to do this.

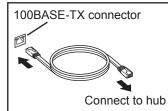
#### 1. Connect the Instrument to a Network

(Connecting the Instrument to a Hub)

You can monitor and control the instrument from a PC by connecting the instrument to a hub with a 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 cable may also be used for 10BASE communications)
- 9642 LAN Cable (optional)



Connect the cable to the 100BASE-TX connector on the instrument and hub.

#### 2. Make a 1:1 Connection Between the Instrument and a PC

(Connect the Instrument to a PC)

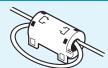
You can monitor and control the instrument from a PC by connecting the instrument to the PC with a LAN cable (100BASE-TX cable)

- Connection cable: Use one of the following.
- 100BASE-TX crossover cable (maximum length 100 m)
- 100BASE-TX straight-through cable (maximum length 100 m)
- 9642 LAN Cable (optional, supplied with crossover adapter)

This completes the connection procedure.

Files on the instrument can now be accessed from the PC. Refer to "16.2 Perform Remote Operations on the Instrument (Use an Internet Browser)" (p. 323), "16.3 Access Files on the Instrument From a PC (Using FTP)" (p. 330), or "16.7 Controlling the Instrument with Command Communications (LAN/USB)" (p. 340).

If there is a possibility of interference from other equipment in the vicinity, wind the LAN cable once around the supplied ferrite clamp-on choke (for LAN/USB cable), as shown in the illustration at right.



# 16.2 Perform Remote Operations on the Instrument (Use an Internet Browser)

You can perform remote operations on the instrument from a PC using an Internet browser.

Attempting to control the instrument simultaneously from multiple PCs may result in unintended operation. Use only one PC to perform remote operations.

To use an Internet browser, the instrument must be properly set up and connected via LAN cable to the PC. (p. 318), (p. 321)

Microsoft<sup>®</sup> Internet Explorer<sup>®</sup> 8 or later is recommended. Set the security level to "Medium." If [REMOTE CONTROL] and [MEMORY DATA GET] do not work, install JRE from the application disc. Turn off the pop-up blocker.

#### **Installing JRE**

1 Insert the 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 Selects the display language. Click the English icon.
- **3** Click on the [JRE installation] icon.
- 4 Click on the [Install] icon, then follow the prompts that appear to complete the installation.

## 16.2.1 HTTP Settings on the Instrument

#### Procedure

Press the **SYSTEM** key to open 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 [Authorization].

Off	Web server authentication not used. (Default setting)
On	Web server authentication used.

(When [On] is selected)

Set the user name and password for authentication.

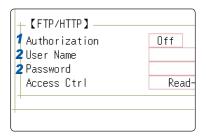
Move the cursor to **[User Name]** and **[Password]** and enter suitable information.

Refer to "8.1.3 Alphanumeric Input" (p. 149) or "Authorization User Name and Password" (p. 319).

**3** Apply the settings.

Move the cursor to [Reset]. Select [Reflect Set].

The "LAN was reconnected" message will appear at the bottom of the screen.

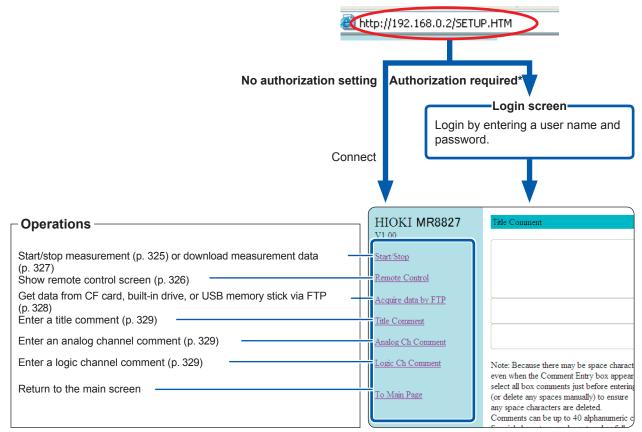


The user name and password for authentication are the same for the Internet browser and for FTP.

#### 16.2.2 Connect to the Instrument With an Internet Browser

The following example shows how to use the Internet Explorer® browser on Windows 7. Launch Internet Explorer® on the PC and enter "http://" plus the IP address of the instrument in the address bar.

#### If the IP address of the instrument is "192.168.0.2"



<sup>\*</sup> When user name and password for authentication were set via System screen - [Interface] sheet.

Refer to "16.2.1 HTTP Settings on the Instrument" (p. 323).

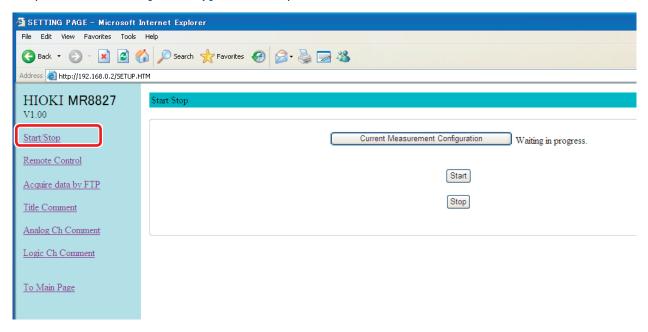
## 16.2.3 Operate the Instrument With an Internet Browser

#### **Start/Stop Measurement**

You can start and stop measurement.

#### Measurement Start/Stop Screen

To open the screen, click [Start/Stop] in the list of operations.



#### Procedure

Click [Start] to start the measurement.

Click [Stop] to stop the measurement.

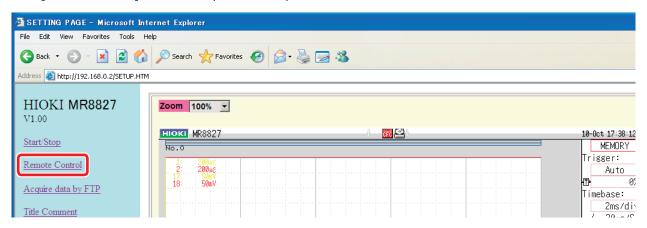
Click [Current Measurement Configuration] to display up information about the current measurement configuration.

#### **Remote Operation**

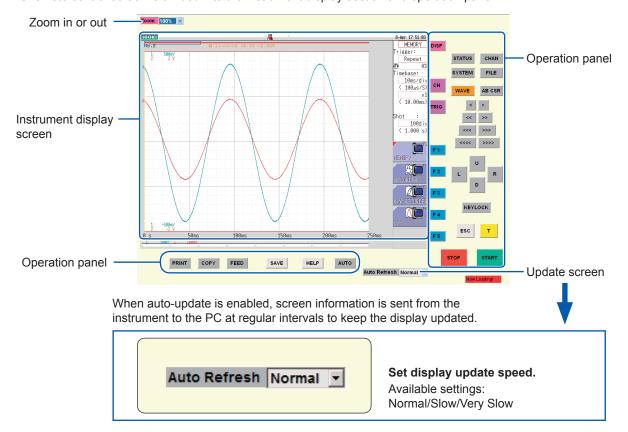
The instrument can be controlled from a remote location. (This remote operation is mainly intended for monitoring the screen. If you want more nimble remote operation, use Model 9333 LAN Communicator.)

#### **Remote Control Screen**

Click [Remote Control] in the list of operations to open the screen.



The remote control screen is divided into the instrument display section and operation panel.



#### **Basic Operations**

When you click a button on the operation panel, the instrument performs the same action is if the corresponding key on the unit 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 a GUI figure directly to set it.

The keys and controls on the instrument are active also during remote operation.

- Remote control may not be possible when JRE has not been installed. (p. 323)
- Printing may be interrupted if it occurs during remote operation. Set display update speed to [Slow] or [Very Slow].

#### **Download Memory Data From the unit**

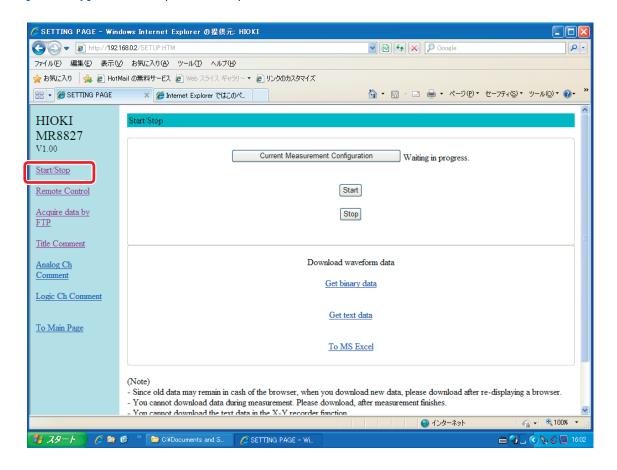
You can download measured data.

The data format can be binary, text, or Excel\*.

\* Microsoft Excel®

#### Measured Data Download Screen

Click [Start/Stop] in the list of operations to open the screen.



#### Procedure

- 1 Start measurement.
- 2 Stop measurement.
- 3 Select one of the options below the measured data display.

Get binary data	Retrieve binary data.
Get text data	Retrieve text data.
To MS Excel	Display data in Excel. cursors. (Data can be opened with Microsoft Excel)

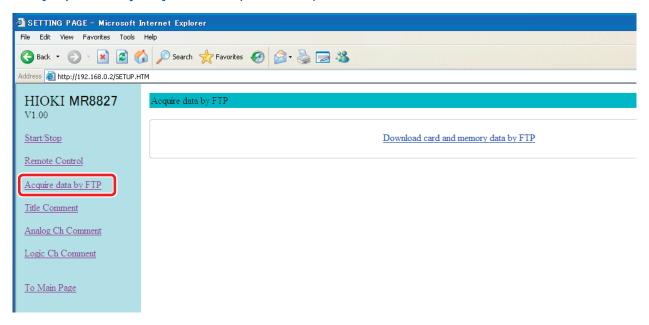
- It may not be possible to retrieve data when JRE has not been installed on your PC. (p. 323)
- You cannot download measured data during measurement. Stop measurement and then download data.
- When you use Internet Explorer and press [To MS EXCEL] and select [Open], an error may occur during transmission. In such a case, select [Save].

#### **Download Data by FTP**

You can use FTP to download data from the CF card, built-in drive, or a USB memory stick.

#### Data Download Screen for FTP

Click [Acquire data by FTP] in the list of operations to open the screen.



#### Procedure

#### Click [Acquire data by FTP].

A list of folders is displayed.

For information on how to perform file operations, refer to "16.3.3 Use FTP for File Operations" (p. 333).

#### **Entering a Comment**

You can specify strings to be used as title comments, logic channel comments, and analog channel comments.

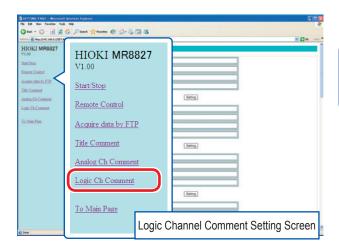
Information about the module type and channel (installation location in the module) can be obtained and used only for the respective channel.

#### Comment Setting Screen

Click [Title Comment], [Analog Ch Comment], or [Logic Ch Comment] in the list of operations to open the screen.







#### Procedure

Enter a string in the comment input field and click [Setting].

The comment string can be up to 40 characters long.



## 16.3 Access Files on the Instrument From a PC (Using FTP)

By using a PC FTP client, you can transfer files from the instrument's storage media to the PC and perform other file operations.

- This instrument is equipped with an FTP (File-Transfer-Protocol, 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 PC cannot access the server simultaneously.
- If no command is sent from a PC for more than one minute after connecting to the FTP server, the FTP may disconnect the PC. If this occurs, reconnect via your FTP client.
- FTP operation will be interrupted when measurement is started.
- Before inserting or removing a CF card or USB memory stick, terminate the FTP connection.
- · Do not perform file operations while FTP is being used.
- With Internet Explorer®, the refresh date of files may not match those of the main unit.
- With Internet Explorer<sup>®</sup>, temporary internet files may retain data from a previous access, so previous data may be obtained instead of the newest data.

To use FTP, the instrument must be properly set up and connected via LAN cable to the PC. Refer to "16.1.1 LAN Settings on the Instrument" (p. 318) or "16.1.2 Connect the Instrument to a PC With a LAN Cable" (p. 321).

Be careful when moving files by FTP, as some FTP client/browser programs may delete all selected files or folders from the source if you cancel a transfer before completion. Rather than moving files in one step, we recommend copying (downloading) and then manually deleting from the source.

#### Things to Check Before Using FTP

## Storage Media and **Directories**

the FTP server.

/CF	CF card
/HDD	Built-in drive
/RAM	Internal memory
/USB1	USB memory stick
/STORAGE.	Storage memory

**Limitations** During measurement you cannot access files.

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

## 16.3.1 FTP Settings at the Instrument

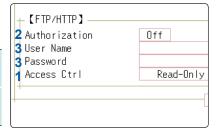
#### Procedure

Press the SYSTEM key to open the System screen, and then select the [Interface] sheet.

#### 1 Set the access restrictions.

Move the cursor to [Access Ctrl].

Read/ Write	File deletion and renaming are permitted.
Read- Only	Only file reading is permitted. This prevents files from being deleted or changed from outside the instrument.



### 2 Choose authorization settings.

Move the cursor to [Authorization].

Off	Web server authentication not used. (Default setting)
On	Web server authentication used.

#### 3 When [On] is selected

#### Set up a user name and password.

Move the cursor to **[User Name]** and **[Password]** and enter suitable information.

Refer to "8.1.3 Alphanumeric Input" (p. 149) or "Authorization User Name and Password" (p. 319).

## 4 Apply the settings.

Move the cursor to [Reset]. Select [Reflect Set].

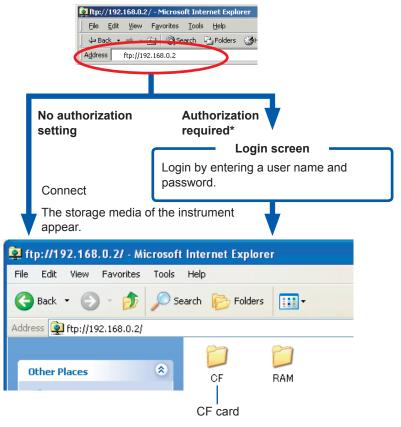
The "LAN was reconnected" message will appear at the bottom of the screen.

The user name and password for authentication are the same for the Internet browser and for FTP.

#### 16.3.2 Use FTP to Connect to the Instrument

The following example shows how to use the Internet Explorer<sup>®</sup> browser on Windows 7. Launch Internet Explorer<sup>®</sup> on the PC and enter "ftp://" followed by the IP address of the instrument in the address bar.

#### If the IP address of the instrument is "192.168.0.2"



Click to display files stored on the media.

You can also enter the user name and password, delimited by ":" and "@," in front of the normal IP address.

#### [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 "LAN Setup Workflow" (p. 320).

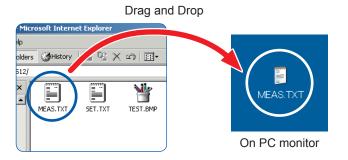
<sup>\*</sup> An authorization user name and password have been set in the System screen - [Interface] sheet. Refer to "16.3.1 FTP Settings at the Instrument" (p. 331).

### 16.3.3 Use FTP for File Operations

#### To Download Files

Select the file to download from the folder list and drag and drop\* it on the download destination (the desktop or a folder outside the Internet Explorer® window).

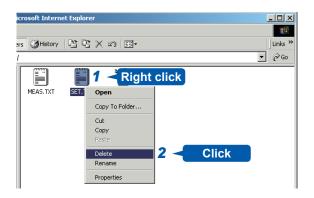
\* Click the file and hold the button down. Move the mouse pointer to the target destination, and then release the button



Minutes and seconds may not be reflected on the time stamp (date) of the file.

#### To Delete or Rename Files

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



Files cannot be uploaded to the instrument from the PC. To copy a file to the built-in drive of the instrument, use a USB memory stick or CF card.

## 16.4 Transferring Data to the PC

The supplied USB cable can be used to transfer data from the built-in drive or CF card to a PC.

For information on how to use the supplied application software for data analysis, refer to the application's Help function.

To Install and startthe application software, refer to "16.5 Wave Viewer (Wv)" (page 335).

#### System requirements

The computer running Windows 7, Windows 8, or Windows 10

## **ACAUTION**



To avoid equipment failure, do not disconnect the USB cable while communication is in progress.



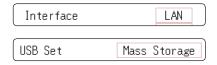
Use a common ground for the instrument and PC. Use of different ground circuits will result in a potential difference between the instrument's ground and the PC's ground. If the USB cable is connected while such a potential difference exists, it may result in equipment malfunction or failure.

#### **Instrument Settings**

#### Procedure `

Press the SYSTEM key to open the System screen, and then select the [Interface] sheet.

- 1 Move the cursor to [Interface], and select [LAN].
- 2 Move the cursor to [USB Set], and select [Mass storage HDD] and [Mass storage CF].

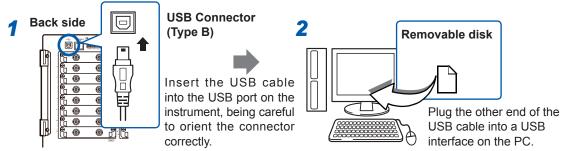


Operations to the USB memory stick, built-in drive or CF card from the unit are restricted during [Mass Storage]. Furthermore, the printer prints at [Slow/Fine], regardless of the [Print Speed] setting.

#### **To Connect the USB Cable**

#### **Preparations**

Stop measurement and make sure that the File screen is not displayed.



When the connection is established, the PC will recognize the instrument as a removable disk. The PC can now access data on the built-in drive or CF card of the instrument.

#### **Disconnecting the USB Cable**

To disconnect the USB cable of the instrument from a PC that is currently running, use the **[Safely Remove Hardware]** icon and follow the prescribed steps.

## 16.5 Wave Viewer (Wv)

The viewer has a CSV conversion function. Converted files may be read by a spreadsheet program. This section explains how to install, uninstall, start and quit Wave Viewer.

#### System requirements

The computer running Windows 7, Windows 8, or Windows 10

#### **Installation (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** Selects 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].

A confirmation dialog appears. Proceed with installation.

6 Click [Next].

A window for selecting the installation destination opens. Click the **[Browse]** to change the installation folder.

7 Click [Next].

The installation starts.

#### Startup

Before using the program, review the "READ ME" text file.

From the Windows® Start menu, select [Programs] - [HIOKI] - [Wv.]

This will start the Wave Viewer application.

#### **Shutdown**

Access the menu of the Wave Viewer application and select [File] - [Exit] to shut down the program.

Alternatively, you can click the Close button at the top right of the screen.

#### Uninstallation

- 1 Click the Windows® Start button, click [Control Panel], and then click [Uninstall a program].
- 2 Select [HIOKI Wave Viewer (Wv)] and uninstall the application.

When upgrading to a newer version of Wave Viewer, uninstall the old version before installing the new version.

# 16.6 USB Connection and Settings (Before Command Communication)

Use the USB cable supplied with the instrument to connect the instrument to the PC. The instrument can then be controlled from the PC.

Before command communication is possible, USB settings must be configured and the connection established.

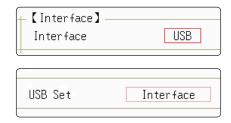
#### 16.6.1 USB Settings on the Instrument

#### Procedure

Press the SYSTEM key to open the System screen, and then select the [Interface] sheet.

Move the cursor to [Interface], and select [USB].

The **[USB Set]** item is automatically set to **[Interface]**.



When the interface has been set to [USB], the following functions are not available.

- · Using a USB memory stick
- · Viewing data of the unit on a PC

#### 16.6.2 Install the USB Driver

Before connecting the instrument by USB, perform the following procedure to install the USB driver.

Perform the installation with administrator privileges.

1 Run [HiokiUsbCdcDriver.msi] in the CD X:\Driver folder.
([X] indicates the CD-ROM drive. The letter will differ depending on your PC.)

Depending on the environment, the dialog box may take some time to appear.

HIOKI USB CDC Driver

2 Click [Next].

Welcome to the HIOKI USB CDC Driver Setup
Wizard

The installer will guide you through the steps required to install HIOKI USB CDC Driver on your computer.

WARNING: This computer program is protected by copyright law and international treaties.
Unauthorized duplication or distribution of this program, or any portion of it, may result in severe civil or criminal penalties, and will be prosecuted to the maximum extent possible under the law.

Click

Cancel 

Cancel 

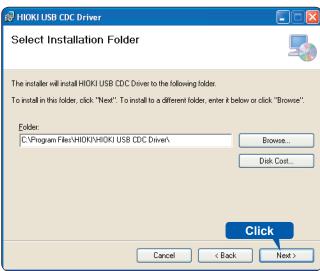
Next>

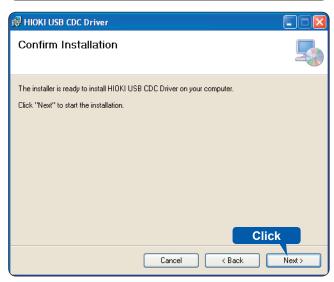
3 Click [Next].

To change the installation destination Click [Browse...] to change the folder to install into.

Normally, there is no need to change.

4 Click [Next].





The installation starts.



When a dialog box requesting your permission to continue the program appears, click [Yes].

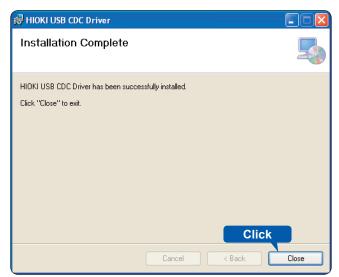


Sometimes another dialog box requesting your permission to install the software may appear. When it does, select [Always trust software from "HIOKI E.E. CORPORATION."] checkbox and click [Install] to continue.



When installation is complete and the dialog box appears, click [Close] to exit.

This completes the driver installation.



#### To Connect the Instrument and PC on Which the Driver is Installed

System requirements

The computer running Windows 7, Windows 8, or Windows 10

## **ACAUTION**



To avoid equipment failure, do not disconnect the USB cable while communication is in progress.

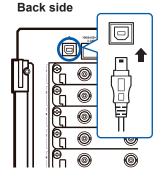


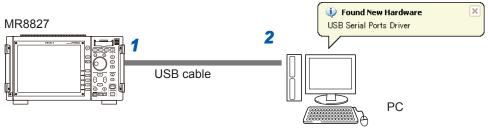
Use a common ground for the instrument and PC. Use of different ground circuits will result in a potential difference between the instrument's ground and the PC's ground. If the USB cable is connected while such a potential difference exists, it may result in equipment malfunction or failure.

- If you connect the USB cable while both the instrument and the PC are off, be sure to turn on the PC first. If you turn them on in the wrong order, communication between the instrument and PC will not be possible.
- If there is a possibility of interference from 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 at right.



- 1 Plug the USB cable supplied with the instrument into the USB connector (Type B) on the back side of the instrument.
- 2 Connect the other end of the cable to a USB port on the PC.





The instrument will be recognized and preparation to use the device will complete automatically.

#### **To Uninstall 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].

## 16.7 Controlling the Instrument with Command Communications (LAN/USB)

You can control the instrument remotely via the communications interface (LAN or USB).

- For details, see the Communication Command Instruction Manual on the supplied application disc.
- Before using command communications, the LAN settings or USB settings and connection must have been configured properly.

Refer to LAN "16.1" (p. 318) and USB "16.6" (p. 336).

## **ACAUTION**



In an environment where noise from inverters or similar devices is present, errors may occur when controlling the instrument remotely. Take care to ensure that the environment is not subject to excessive noise.

#### **Setting Details**

Delimiter	The Delimiter item specifies LF or CR+LF as the newline delimiter in command response messages. The instrument understands both settings: LF or CR+LF.
Header	Use for control of communications commands.  The Header item specifies whether to prefix headers to command response messages.  For more information about commands, refer to the Communications operation manual on the supplied CD.
Command Port (Port number) (LAN only)	The instrument uses the TCP/IP protocol for communications. TCP/IP allows communicating devices to establish multiple connections, which are distinguished by port number. By default the instrument uses port numbers 8800 to 8809.  • 8800 to 8801 reserved  • 8802 (instrument is server): For communications command control  • 8803 to 8809 reserved  Normally these ports 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 communicating PC. Set only the most significant three digits. The least significant digit (0 to 9) is used by the instrument, or reserved for use by the instrument.

## 16.7.1 Settings on the Instrument

Set items related to command communications.

#### **Procedure**

Press the **SYSTEM** key to open the System screen, and then select the **[Interface]** sheet.

1 Set the delimiter.
Move the cursor to [Delimiter].

LI	Seria character code oxoa.
CR+LF	Send character codes 0x0d and 0x0a.
Off	Do not add a header to response data.
On	Add a header to response data.

Send character code 0v0a

2 Select header settings.
Move the cursor to [Header].

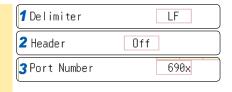
3 Set the communications command port. (LAN only)

Move the cursor to [Port Number] and enter the port number.

#### **About headers**

#### **About port numbers**

Specify only the most significant 3 digits of the 4-digit port number. If you specify "880x," port number 8802 will be used. (p. 340)



# 16.8 Operate the Instrument Remotely and Acquire Data Using the Model 9333 LAN Communicator

The Model 9333 LAN Communicator, which is the optional communication program for PCs, allows the PC to control the instrument remotely and to store data directly. Additionally, Model 9333 enables waveforms to be printed from a printer connected to the PC.

#### Procedure

#### 1 Set the LAN Communicator.

On	Use the LAN Communicator.
Off	Do not use the LAN Communicator.

#### 2 Set the data collection server

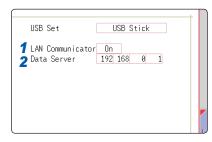
Specify the IP address of the PC on which Model 9333 LAN Communicator is running to communicate with the instrument. The IP address is required to acquire data using the Model 9333 LAN Communicator.

If necessary, set "LAN:\" as the save destination on the [File Save] sheet, and set [LAN] as the output destination of the Print Key operation and the auto-print setting.

## 3 Apply the settings.

Move the cursor to [Reset]. Select [Reflect Set].

The "LAN was reconnected" message will appear at the bottom of the screen.



For the settings of the Model 9333 LAN Communicator, see the instruction manual of Model 9333 LAN Communicator.

Controlling the Instrument with Command Communications (LAN/USB)

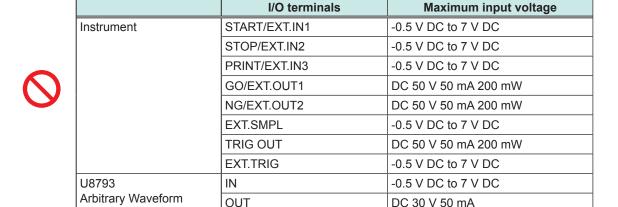
# 17

## **External Control**

This chapter describes how to operate the instrument using the external control terminals. We use the term external control terminals to refer to all of the terminals.

## **MDANGER**

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



## **MARNING**

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



Generator Unit

- Always turn off the power to the instrument and to any devices to be connected before making connections.
- Be careful to avoid exceeding the ratings of external control terminals and external connectors.
- Ensure that devices and systems to be connected to the external control terminals are properly isolated.

## **ACAUTION**

Use a common ground for both the instrument and the connection equipment.
 Use of different ground circuits will result in a potential difference between the instrument's ground and the connected equipment's ground. If the communications cable is connected while such a potential difference exists, it may result in equipment malfunction or failure.



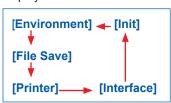
- While connecting or disconnecting the communication cables, ensure that the power supply of the instrument and the device to be connected is cut off. This may cause damage or malfunctioning.
- After connecting the communications cable, tighten the screws on the connector securely. Failure to secure the connector could result in equipment malfunction or damage.

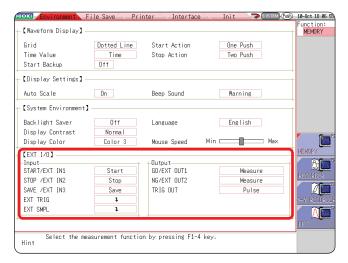
Signals input to the external control terminals take effect even when the operating keys are locked.

## To Open the [Environment] Sheet



Press this key repeatedly to display the various sheets.



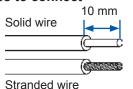


## 17.1 Connect to External Control Terminals

The method for connecting to the external control terminals is as follows.

#### Procedure

#### Cables to connect



Recommended wire

Solid wire: 0.65 mm dia. (AWG22) Stranded wire: 0.32 mm<sup>2</sup> (AWG22)

Compatible wire:

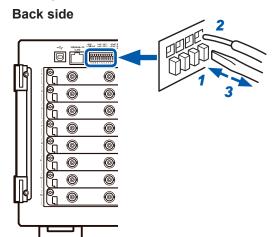
Solid wire: 0.32 to 0.65 mm dia. (AWG28 to 22) Stranded wire: 0.08 to 0.32 mm<sup>2</sup> (AWG28 to 22) Strand diameter: 0.12 mm or more (per wire)

Stripped length: 9 to 10 mm

Button pressing tool: Flat-blade screwdriver (shaft diameter: 3 mm, tip

width: 2.6 mm)

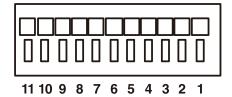
#### **Connection procedure**



- 1 Push in the button on the connector with a flat-blade screwdriver or other tool.
- With the button held in, insert the cable into the cable connection hole.
- 3 Release the button.

The cable is locked.

9 GND 5 GO / OUT 1 1 START / IN 1 10 TRIG OUT 6 NG / OUT 2 2 STOP / IN 2 11 EXT. TRIG 7 GND 3 SAVE / IN 3 8 EXT. SMPL 4 GND



Terminal No.	Operation
1	Input external signal and execute the
2	following  • Start/end measurement
3	Print/save data Pen Up/Down Operation (for X-Y recorder operation)
4	_
5	Output instrument status as a signal
6	Output instrument status as a signal
7	_
8	Input external signal and set sampling rate
9	_
10	Output signal when triggering occurs
11	Input external signal as trigger source

## 17.2 External I/O

## 17.2.1 External Input (START/IN1) (STOP/IN2) (SAVE/IN3)

External control signals can be applied to start and stop measurement and to print and save data. The factory-default settings are [Start], [Stop], and [Save].

#### **Signal Input Procedure**

- 1 Connect the cables for the corresponding external input signals to the START/IN1, STOP/IN2, SAVE/.IN3, and GND terminals.
  - Refer to "17.1 Connect to External Control Terminals" (p. 345).
- Press the SYSTEM key to open the [Environment] sheet, and move the cursor to [START/EXT. IN1], [STOP/EXT. IN2], or [SAVE/EXT. IN3].
- 3 Select the operation to be performed by the instrument in response to external signal input.

Start	Start measurement. (not affected by [START Action] (p. 315))
Stop	Stop measurement. (Operations after measurement, such as numerical calculations and automatic saving will be carried out)
Start/Stop	Start measurement on LOW level, and stop measurement on HIGH level.
Abort	Stop measurement immediately. (Operations after measurement, such as numerical calculations and automatic saving will not be carried out)
Print	Same operation as <b>PRINT</b> key (cannot be used with Selective Printing (p. 118))
Save	Save to the media specified for the <b>SAVE</b> key, according to the specified conditions. (cannot be used with Selective Printing (p. 94))
Pen Up/Down	A LOW level signals "pen-down" operation and a HIGH level signals "pen-up" operation (for X-Y recording).
RUN/STOP	Runs/stops waveform output. (RUN at LOW level, STOP at HIGH level).
PAUSE	Stops waveform output temporarily.

- For STOP operation, follows the configured [STOP Action] (p. 315).
- External input is not available when the HELP screen or a dialog window is displayed.

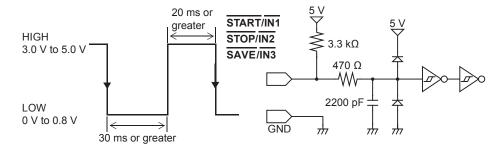
4 Short circuit the terminal and GND, or input a HIGH level (3.0 V to 5.0 V) or LOW level (0 V to 0.8 V) pulse wave or rectangular wave to the terminal.

Control with the LOW level of the input waveform.

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 greater, LOW level: 30 ms or greater

Maximum input voltage -0.5 V to 7 V



### 17.2.2 External Output (GO/OUT1) (NG/OUT2)

Signals can be output that indicate the instrument's judgment state.

#### **Signal Output Procedure**

1 Connect the GO/OUT1, NG/OUT2, and GND terminals to the device(s) to be controlled by single wires.

Refer to "17.1 Connect to External Control Terminals" (p. 345).

- **2** Press the SYSTEM key to open the [Environment] sheet, and move the cursor to [GO/EXT. OUT1] or [NG/EXT. OUT2].
- 3 Select the conditions under which the instrument outputs a signal.

(When the [GO/EXT. OUT1] item is selected)

Measure	A LOW signal is output when the judgment result is GO (pass).
Waveform Evaluation	A LOW signal is output when the waveform evaluation result is GO (pass).
Value Evaluation or Waveform Evaluation	A LOW signal is output when either the value calculation or waveform calculation evaluation result is GO (pass).
Value Evaluation and Waveform Evaluation	A LOW signal is output when both the value calculation and waveform evaluation result are GO (pass).
Error	Output a LOW level signal when an error occurs.
Busy	A LOW signal is output when external start operation is disabled, such as during startup, saving, and printing.
Trigger	Output a LOW level signal while instrument is waiting for a trigger.

GO evaluation result output (low level output) is held until the next measurement starts.

#### (When the [NG/EXT. OUT2] item is selected)

Measure	A LOW signal is output when the judgment result is NG (fail).
Waveform Evaluation	A LOW signal is output when the waveform evaluation result is NG (fail).
Value Evaluation or Waveform Evaluation	A LOW signal is output when either the value calculation or waveform calculation evaluation result is NG (fail).
Value Evaluation and Waveform Evaluation	A LOW signal is output when both the value calculation and waveform evaluation result are NG (fail).
Error	Output a LOW level signal when an error occurs.
Busy	A LOW signal is output during measurement, saving, and printing, and a HIGH signal is output when finished.
Trigger	Output a LOW level signal while instrument is waiting for a trigger.
Probe Calibration	1 kHz output for calibrating Model 9665 10:1 Probe and the 9666 100:1 Probe.

NG evaluation result output (low level output) is held until the next measurement starts.

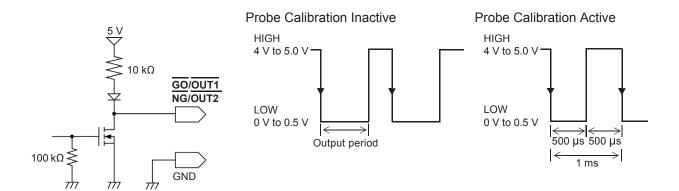
The signal for the specified state is output.

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: 15 mA)

Maximum input voltage 50 V DC, 50 mA, 200 mW



## 17.2.3 External Sampling (EXT.SMPL)

MEM

This applies to the Memory function only.

The sampling rate can be controlled by applying an external signal.

#### **Signal Input Procedure**

- Connect the cables for the corresponding output signals to the EXT.SMPL and GND terminals.
- Press the SYSTEM key to open the [Environment] sheet, and move the cursor to [EXT. SMPL].
- 3 Select whether the sampling event occurs on the rising edge (↑)or falling edge (↓) of the waveform.
- 4 Input HIGH level (3.0 V to 5.0 V) and LOW level (0 V to 0.8 V) pulse waves or rectangular waves to the EXT.SMPL terminal.

Data is sampled on the rising edge or falling edge of the input waveform. Note that the sampling frequency is limited by the selected edge.

For proper operation, pulse width must be at least that shown in the following table.

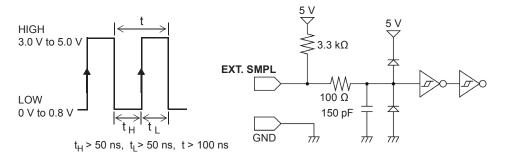
Minimum external sampling pulse width

Setting (EXT.SMPL)	Pulse width					
	When Roll Mode is [On]			When Roll Mode is [Off]		
	t <sub>H</sub>	t <sub>L</sub>	t	t <sub>H</sub>	t <sub>L</sub>	t
<b>↑</b>	> 5 µs	> 5 µs	> 10 µs	> 50 ns	> 50 ns	> 100 ns
$\downarrow$	> 5 µs	> 5 µs	> 10 µs	> 50 ns	> 50 ns	> 100 ns

Voltage range High level: 3.0 V to 5.0 V, LOW level: 0 V to 0.8 V

Pulse width HIGH, LOW level: 50 ns or greater

Response frequency 10 MHz or lower Maximum input voltage -0.5 V to 7 V



- When a sampling signal of 5 MHz or greater is input, trigger points are delayed by 1 sample.
- When set to [Auto] or [On], Roll Mode can be used with external sampling. However, it is set to [Off] if the external sampling input is faster than 100 kHz to avoid degraded sampling accuracy.
- The anti-aliasing filter (A.A.F) is disabled regardless of its setting.
   See "8.10.1 Settings for the Anti-Aliasing Filter (A.A.F)" (page 172)
- When Roll Mode is set to [Auto] or [On], externally sampled signals will not be accepted for the following periods:
  - (1) 150 µs to 200 µs after the first sampling clock has been entered
  - (2) 2 clock periods after dead time of (1)
- When external sampling is valid, the output settings of Models MR8790, MR8791, and U8793 can not be updated.

## 17.2.4 Trigger Output (TRIG OUT)

You can output a signal when a trigger event occurs. This feature allows multiple instruments to be controlled for parallel synchronous operation.

#### **Signal Output Procedure**

- 1 Connect the cables for the output signals to the TRIG OUT and GND terminals.

  Refer to "17.1 Connect to External Control Terminals" (p. 345).
- Press the SYSTEM key to open the [Environment] sheet, and move the cursor to [TRIG OUT].
- **3** Select the output signal type for the trigger output terminal.

Pulse	After LOW level output, the signal goes HIGH after a specified interval.
Level	After the trigger occurs, a LOW level signal will be output during waveform retrieval.

When a trigger event occurs, a pulse wave changing from HIGH (4.0 V to 5.0 V) to LOW (0 V to 0.5 V) will be output from 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: 15 mA)

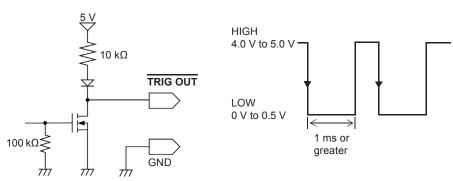
Pulse width Pulse width at pulse setting time:  $2 \text{ ms} \pm 1 \text{ ms}$ 

Pulse width at level setting time: (sampling rate × no. of data points after

trigger) or more

Maximum input voltage 50 V DC 50 mA 200 mW

<sup>\*</sup> Triggering should occur when the signal voltage level changes from HIGH to LOW.



- Trigger events occur and signals are output when the auto-ranging function is used with the Memory Function. Keep this in mind when performing auto-range measurement while using the trigger output terminal
- 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].

### 17.2.5 External Trigger Terminal (EXT.TRIG)

You can input external signals as trigger sources. This feature allows multiple instruments to be controlled for parallel synchronous operation.

#### **Signal Input Procedure**

1 Connect the cables for the corresponding external input signals to the EXT.TRIG and GND terminals.

Refer to "17.1 Connect to External Control Terminals" (p. 345).

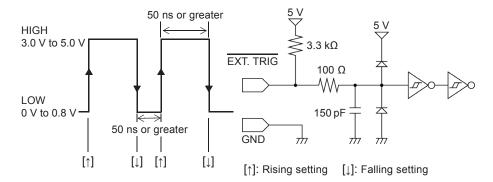
- 2 In the Trigger Settings window, set External trigger to [On].
- 3 Press the SYSTEM key to open the [Environment] sheet, and move the cursor to [EXT. TRIG].
- Select whether the trigger event occurs on the rising edge (↑)or falling edge (↓) of the waveform.
- 5 Short-circuit the EXT.TRIG terminal and GND, or input a HIGH level (3.0 V to 5.0 V) or LOW level (0 to 0.8 V) pulse wave or rectangular wave to the EXT.TRIG terminal.

A trigger event occurs on the rising or falling edge of the input waveform.

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 greater

Maximum input voltage -0.5 V to 7 V



## 18 Specifications

## 18.1 General Specifications of the Unit

## **Basic Specifications**

Measurement functions	<ul> <li>Memory function</li> <li>Recorder function</li> <li>X-Y recorder function</li> <li>FFT function</li> </ul>
Maximum number of channels	Analog 32 channels + Logic 32 channels, Analog 28 channels + Logic 64 channels (Together with the logic channels the instrument provides, when 2 modules of Model 8973 Logic Unit are installed)
Number of modules	Up to 16 modules Restrictions • Up to 4 modules of Model 8971 Current Unit can be installed. • Up to 2 modules of Model 8973 Logic Unit can be installed in every slot except those for Unit 9 through Unit 16.
Number of the instrument logic channels	<ul> <li>32 (The input connectors of logic channels share the ground with the instrument.)</li> <li>Installing Model MR8990 Digital Voltmeter Unit in every slot for Unit 1, Unit 2, Unit 9, and Unit 10 disables the instrument logic channels.</li> <li>Restrictions imposed when the instrument logic channels are used (when the logic measurement is set to on)</li> <li>Measurement resolution of each measuring module decreases to 12 bits when the module is installed in any of the slots for Unit 1, Unit 2, Unit 9, and Unit 10.</li> <li>No frequency measuring module is available when the module is installed in any of the slots for Unit 1, Unit 2, Unit 9, and Unit 10.</li> </ul>
Memory capacity	Total memory 512 MW 16 MW/ch (in 32 ch mode), 32 MW/ch (in 16 ch mode), 64 MW/ch (in 8 ch mode), 128 MW/ch (in 4 ch mode)
Maximum sampling rate	20 MS/s (All channels simultaneously)
Time axis accuracy	± 0.01% (shows the relative error between the grid and time)
External control terminals	External trigger input, trigger output, external sampling input, GND External output 2 terminals (GO, NG), External input 3 terminals (START/IN1, STOP/IN2, SAVE/IN3)
Clock functions	Auto-calendar, auto-leap year judgment, 24-hour timer Accuracy: ±100 ppm (within the operating temperature range) Reference value: ± 10 ppm (25°C)
Backup battery life	Approx. 10 years for clock and settings (Reference value: 25°C)
Operating environment	Indoors, pollution degree 2, altitude up to 2000 m (6562 ft.)
Operating temperature and humidity	0°C to 40°C (32°F to 104°F), 20% RH to 80% RH (no condensation)
Storage temperature and humidity	−10°C to 50°C (14°F to 122°F), 90% RH or less (no condensation)
Temperature and humidity for guaranteed accuracy	23°C ± 5°C (73°F ± 9°F), 20% RH to 80% RH (no condensation)
Guaranteed accuracy period	1 year
Product warranty period	3 years (1 year for Model U8330 SSD Unit)

Withstand voltage	Between chassis and power line: 1.69 kV AC for 1 min at least 50 M $\Omega$ at 500 V DC Between module and chassis: 3 kV AC for 1 min at least 100 M $\Omega$ at 500 V DC
Power source	Rated power supply voltage: 100 V to 240 V AC (continuous input) (Voltage fluctuations of ±10% from the rated supply voltage are taken into account.) Rated power supply frequency: 50Hz/60Hz Anticipated transient overvoltage: 2500 V
Maximum rated power	350 VA max. (When using the printer) 220 VA max. (When not using the printer)
Dimensions	Approx. $401W \times 233H \times 388D$ mm (15.79"W $\times$ 9.17"H $\times$ 15.28"D) (including protrusions except for the handle) Approx. $400W \times 220H \times 388D$ mm (15.75"W $\times$ 8.66"H $\times$ 15.28"D) (excluding protrusions)
Mass	Approx. 12.6 kg (444.4 oz.) (Model MR8827 only) Approx. 16.6 kg (585.5 oz.) (When Model 8966 Analog Unit is installed)
Standards	Safety EN61010 EMC EN61326 Class A

## Printer Recording Section (For Model 8827 With Optional Model U8350 Printer Unit, Which Shall be Specified at the Time of Placement of Order, Installed)

Recording system	Thermosensitive recording system using thermal line head
Recording paper	Approx. 216 mm $\times$ 30 m (8.50" $\times$ 98.43 ft.) roll-type thermosensitive paper (Model 9231 Recording Paper)
Recording width	Overall recording width: Approx. 208 mm (8.19") Waveform portion: Approx. 200 mm (7.87")
Recording speed	Approx. 50 mm/s (Maximum)
Paper feeding accuracy	± 1% (25°C, 60% RH)
Recording paper loading	One-touch system

## Display

Display type	10.4-in 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 waveform display: 20 div (X axis) × 20 div (Y axis)
Dot pitch	0.264 (Vertical) × 0.264 (Horizontal) mm
Backlight	On/Off
Backlight operating life	Approx. 80,000 hours (LED light source half-life of brightness)

#### **External Interfaces**

#### LAN

Number of ports	1
Compliant standards	IEEE802.3 Ethernet 100BASE-TX FTP server, HTTP server
Connector	RJ-45
Maximum cable length	100 m

#### USB

Compliant standards	USB2.0 compliant
Host	Number of ports: 2 Connector: Series-A receptacle Connecting device: USB memory stick, Mouse
Function	Connector: Series-B receptacle Connecting device: Computer Functions: mass storage device (for file transfer from built-in drive or CF card to computer) Communications support (PC-controlled)

### **External Storage**

#### **CF Card**

CF card slot	50-pin, 1 slot
Card types	CompactFlash
Compatible CF card	Model 9728 PC Card: 512 MB Model 9729 PC Card: 1 GB Model 9830 PC Card: 2 GB
Data format	FAT, FAT32
Storage contents	Setting configurations, Measurement data (binary or text, part between the A and B cursors can be saved), Screen images (BMP), Printing images (BMP), Numerical calculation results, Thinned storage (simple text), Waveform evaluation conditions (evaluation area + setting conditions), Arbitrary 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 U8330 SSD Unit with an option which must be specified when ordering, installed)

Storage system	2.5-inch SSD (MLC)
Storage capacity	128 GB
Data format	FAT32
Storage contents	Setting configurations, Measurement data (binary or text, part between the A and B cursors can be saved), Screen images (BMP), Printing images (BMP), Numerical calculation results, Thinned storage (simple text), Waveform evaluation conditions (evaluation area + setting conditions), Arbitrary waveform data (when Model U8793 is installed), Generation program data (when Model U8793 is installed), Pulse pattern data (when Model MR8791 is installed)

### **Accessories, Options**

Accessories	Refer to "Unit and Accessories" (p. 3).
Options	Refer to "Appendix 3.1 Options" (p. A9).

# **18.2 Common Functions**

## Modules, Waveform Display

Measurement mode	Depends on module used
Measurement range	Depends on module used
Input coupling	Depends on module used
Low-pass filter	Depends on module used
Displayed graphs	Displayed graph setting with multi-screen and multi-printing function enabled (up to 16 graphs)
Waveform display	Off or selectable from among 16 colors
Printer density	4 levels
Waveform display position	In increments of 1% Preset (ascending, descending, 0%, 50%)
Zero adjust	All channels and ranges together
Waveform display magnification	Horizontal axis (Time axis): ×10, ×5, ×2, ×1, ×1/2, ×1/5, ×1/10, ×1/20, ×1/50, ×1/100, ×1/200, ×1/500, ×1/1000, ×1/2000, ×1/2000, ×1/20000 (expansion only with Memory function)  Vertical axis (Voltage axis): ×100, ×50, ×20, ×10, ×5, ×2, ×1, ×1/2, ×1/5, ×1/10
Variable display function	Specified by upper and lower limit values, by displayed amplitude per division
Scaling	Automatic scaling (10:1, 100:1, 1000:1, Various probes selectable) Manual scaling (conversion ratio setting, two-point setting and unit settings)
Invert function	Polarity reversal
Vernier function	Included
Commenting	Alphanumeric and Japanese characters (title for each analog and logic channel)
Comment entry method	Simple input by using the keys of the Memory HiCorder, mouse, and keyboard Stored string and historical string entry (pre-stored and previously used strings can be recalled, inserted and edited)
Copy channel settings	Copy and paste, or paste all
Logic setting	Width: Selectable from three types: wide, standard, and narrow Display position: Freely settable in increments of 1% Display bits: Off or selectable from among 16 colors, settable individually for each bit
Zoom function	The waveform screen is divided vertically in two, and the lower portion displays zoomed waveforms.

### **Trigger Function**

Trigger method	Digital comparison
Trigger modes	<ul><li>Memory function, FFT function: Single, Repeat, Automatic</li><li>Recorder function: Single, Repeat</li></ul>
Trigger source	Analog Unit (CH1 to CH32), Standard Logic 32 Channels Independent trigger criteria settable for each channel Free-run operation occurs when all trigger types are off. External Trigger occurs by applying a 2.5 V falling edge signal, shorted terminals Manual trigger, Timer trigger
Trigger criteria	AND or OR of each trigger source

Trigger types (analog)	<ul> <li>Level trigger Triggering occurs at the signal rising (or falling) through a specified voltage level.</li> <li>Voltage Sag Trigger (Drop) Triggering occurs when peak voltage falls below the specified level. (for 50 Hz/60 Hz commercial power)</li> <li>Window trigger Upper and lower trigger threshold levels are specified Triggering occurs when the signal enters or exits the defined threshold range.</li> <li>Period trigger A trigger period reference voltage level and period range are specified The period of the signal rising (or falling) through the specified level is measured, and triggering occurs when the period is outside of the specified range.</li> <li>Glitch trigger Set voltage level and pulse width (glitch width) Triggering occurs when the signal pulse width is narrower than the specified pulse width beginning at the moment when rising or falling across a specified voltage level.</li> <li>Event trigger Set the event count for the level trigger or glitch trigger. The number of signal rising (or falling) through the specified voltage level is counted, and triggering occurs when the specified event count is exceeded.</li> </ul>
Trigger types (logic)	Pattern (mask) trigger by 1, 0, × (×: do not care)
Trigger types (external trigger)	External signal is used as trigger.
Trigger types (timer trigger)	Triggering occurs at a preset time.
Trigger filter	• Memory function, FFT function: Off, 0.1, 0.2, 0.5, 1.0, 1.5, 2.0, 2.5, 5.0, 10.0 div Off/On (10 ms fixed)
Trigger level resolution	0.1%f.s. (f.s. = 20 div)
Pre-trigger	Applicable to memory function or FFT function % setting: 0, 2, 5, 10, 20, 30, 40, 50, 60, 70, 80, 90, 95, 100, -95% div setting: 1 div increments
Trigger priority	Off/On
Trigger marker	Trigger marks indicate positions of trigger events
Trigger timing	Start (Memory function, FFT function), Stop (Recorder function), Start & Stop (Recorder function)
Trigger search function	After measurement, searches for positions that meet trigger criteria
Trigger output	Open-collector output With 5 V voltage output, active low, low output level: 0 V to 0.5 V (current value of 15 mA) Pulse width at level setting time: (sampling rate × number of data points after trigger) or more Pulse width at pulse setting time: 2 ms ± 1 ms
Trigger input and output terminals	Terminal block
Level display function	Included

# **18.3 Measurement Functions**

# 18.3.1 Memory Function

Timebase	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 S/div, arbitrary settings)
Time axis resolution	100 points/div
Sampling period	1/100 of timebase
Recording length	<ul> <li>Fixed recording length:</li> <li>25, 50, 100, 200, 500, 1000, 2000, 5000, 10000, 20000, 50000, 100000 div (in 4, 8, 16, 32 channel mode), 200000 div (in 4, 8, 16 channel mode), 500000 div (in 4, 8 channel mode), 1000000 div (in 4 channel mode)</li> <li>Arbitrary recording length:</li> <li>Can be set in units of divisions (up to 1,280,000 div)</li> </ul>
Screen and printing settings	1, 2, 4, 8, 16, X-Y1 or X-Y4 screens
Interpolation function	Line, line and dot (with X-Y)
Waveform scrolling	Left-right scrolling by jog and shuttle knobs, Backward scrolling is available during Roll Mode display
Overlay function	Auto: Always overlays when starting, and clears by restarting Manual: Overlays waveforms only when necessary, and clears as needed
Auto-print*	Automatically prints recording waveforms after the measurement (At slow sampling rate, printing is available while recording.)
Manual print*	By pressing the PRINT key (prints up to 50 mm/s, depending on print coverage)
Selection printing*	Included, Prints the waveform between A and B cursors (Print All and Print Selection)
Auto-save	Automatically saves data on the CF card, built-in drive, USB memory stick after measuring (binary or text) At slow sampling rate, saving starts during recording.
Report printing*	Included
Channel modes	Select from 32, 16, 8, 4 ch modes

<sup>\*</sup> When Model U8350 Printer Unit is installed

### 18.3.2 Recorder Function

Timebase	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 period	1, 10, 100 $\mu s$ 1, 10, 100 ms (select from periods that are 1/100 or less of the timebase)
Recording length	<ul> <li>Fixed recording length:</li> <li>25, 50, 100, 200, 500, 1000, 2000, 5000, 10000, 20000, 50000 div</li> <li>Arbitrary recording length:</li> <li>Can be set in units of divisions (up to 80,000 div)</li> <li>Continuous</li> </ul>
Screen and printing settings	1, 2, 4, 8, 16 screens
Waveform storage	The most recent 80,000 divisions of measurement data is retained in internal memory
Waveform scrolling	Left-right scrolling by jog and shuttle knobs.  Backward scrolling during measurement is possible
Real-time printing*	Available with timebase set to 500 ms/div or longer (Start and stop printing by Function key while recording) With 10 ms/div to 200 ms/div recording, prints simultaneously with some delay from recording (Continuous recording length not available) During continuous recording at 10 ms/div to 200 ms/div, print manually after measurement stops
Manual print*	By pressing the PRINT key (prints up to 50 mm/s, depending on print coverage)
Selection printing*	Included, Prints the waveform between A and B cursors (Print All and Print Selection)
Report printing*	Included
Auto-save	Automatically saves data on the CF card, built-in drive, USB memory stick after measuring (binary or text) When sampling is slow, saving starts during recording.
	* When Model LI8350 Printer Unit is installed

<sup>\*</sup> When Model U8350 Printer Unit is installed

### 18.3.3 X-Y Recorder Function

Sampling cycle	1, 10, 100 ms
Recording length	Continuous
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 X axis and Y axis
Interpolation function	Dot/Line (smooth trace)
Waveform clear	On/Off
Waveform storage	The last 16,000,000 samples of measurement data is retained in internal memory
Pen up/down	Included (all phenomena simultaneously)
External pen control	Controllable by external control terminals (all phenomena simultaneously Up/Down)
Auto-print	None
Manual print*	By pressing the <b>PRINT</b> key (prints up to 50 mm/s, depending on print coverage)
Auto-save	None

<sup>\*</sup> When Model U8350 Printer Unit is installed

### 18.3.4 FFT Function

Frequency range	133 mHz to 8 MHz, external
Dynamic range	$72~\mathrm{dB}$ (theoretical value), 96 dB (theoretical value) when Model 8968 High Resolution Unit is 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	Coupled with the frequency range, the cutoff frequency is automatically set. (Only when using the Model 8968 High Resolution Unit or Model U8979 Charge Unit)
Analysis channel setting	Can be selected from desired channels
FFT analysis modes	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  * The total harmonic distortion (THD) is displayed when the cursor display is ON.
Display formats	Single, Dual, Nyquist display, Running spectrum display
Window	Rectangular window, Hanning, Exponential, Hamming, Blackman, Blackman Harris, Flat top
Display scale	Linear, Log
Print function	Based on the memory function. Note: Sectional printing is not possible.
Peak hold	Included
Averaging	Simple average of time-domain waveform and spectrum, indexed average, peak hold (frequency axis)  Number of times (2, 4, 8, to 10,000)

# **18.4 Other Functions**

#### **Calculation-Related Functions**

Calculation support function	Memory function
Number of calculations	Up to a maximum of 16 calculations for desired channels
Calculation range	All range, between A and B cursors, after trigger
Calculation types	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, squared value, X-Y squared value, time to level, level at time, pulse width, duty ratio, pulse count, four basic arithmetic operations, time difference, phase difference, High level, Low level
Printing of calculation results	Included
Automatic saving of calculation results	After measuring, automatically saves to CF card, USB memory stick, built-in drive (text format)
Judgment of calculation results	Calculation results can be judged based on the specified maximum/minimum value Stop condition: GO, NG, GO&NG
Evaluation output	GO, NG signal output from external control terminal Open-collector output With 5-V voltage output, active low, low output level: 0 V to 0.5 V (current value of 15 mA) Pulse width: at least 1.8 ms

<sup>\*</sup> When Model U8350 Printer Unit is installed

#### **Waveform Calculation Functions**

Calculation support function	Memory function	
Number of calculations	Up to a maximum of 16 calculations for desired channels	
Calculation range	All range, between AB cursor selections	
Calculation recording length	Up to 1/4 of maximum memory length	
Operators	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 of calculation results*	Included	
Automatic saving of calculation results	After measurement, automatic saving to CF card, USB memory stick, built-in drive (binary, .TXT file)	

<sup>\*</sup> When Model U8350 Printer Unit is installed

### **Memory Division Functions**

Memory division support function	Memory function
Number of memory divisions	2 to 1024
Divided recording length	Can be set as desired (but depends on the number of divisions)

Sequential saving	Possible by specifying start and end blocks
Sequential saving dead time	When block display is OFF: 1 to 8 samples (timebase: 5 μs/div to 20 μs/div) 1 sample (timebase: 50 μs/div or more) When block display is ON: 40 ms or more (timebase 5 μs/div to 20 μs/div) 1 sample (timebase: 50 μs/div or more)
Multi-block saving	Saving of waveforms is possible by specifying the desired blocks of divisions
Block display	Display can be set to ON or OFF
Block overlaying	Desired blocks or all blocks

#### **Cursor Measurement Functions**

<b>Cursor functions</b>	All functions supported
Number of cursors	Two (Cursors A and B)
Cursor types	Line (vertical or horizontal), trace
Cursor movements	A Cursor, B Cursor, A&B Cursors
Measurement functions	A Cursor: Potential at each cursor, time from trigger event A&B Cursors: Time differences between cursors, potential, frequency (period)
Cursor-supported channels	All channels (default), any specified channel
Included functions	Partial printout*, partial saving

<sup>\*</sup> When Model U8350 Printer Unit is installed

#### **Monitor Functions**

Monitor display	Level monitor: Display the level and numerical value by selecting the level monitor with the DISP key  DMM display: Display the numerical values by pressing the DISP key
Numerical value display	Instantaneous value display, with hold function
Level monitor sampling	10 kS/s (fixed)
Refresh rate	0.5 s or more, depends on the NPLC settings when using the Model MR8990 Digital Voltmeter Unit

### Position Display (VIEW) Functions

Display function	All types of positions Memory division blocks (When using memory division) Waveform search results Past waveform history (When memory division is OFF, depends on recording length)
Position display	Displays the relative position of the currently displayed waveform within the overall recording length, as well as locations of cursors and trigger events
Block display	Block usage status (When memory division is ON) Past waveform history status (When memory division is OFF) Displayed block position
Jump function	Jump to trigger position/cursor position Jump to desired block (When using memory division) Jump to past waveform (When memory division is OFF) Jump to waveform search position

### **Waveform Evaluation Function**

Waveform evaluation functionality	Compares memory functions (Y-T waveform, X-Y waveform) and FFT function Created waveform area with captured waveforms and determines whether the captured waveform falls inside or outside the corresponding area.	
Evaluation modes	Out: NG (fail) if any part of the waveform falls outside the area.  All out: NG (fail) if the entire waveform falls outside the area.	
Evaluation stop conditions	GO, NG, GO&NG Printer output can be generated or the waveform can be saved when evaluation stops.	
Evaluation output	GO/NG output from external control terminal Open collector output With 5-V voltage output, active LOW, LOW output level: 0 V to 0.5 V (Current value of 15 mA) Pulse width: 1.8 ms or more	
Waveform evaluation time	Evaluation time: 100 ms or less; evaluation period: 250 ms or less*  * 1 channel, timebase of 5 µs/div, recording length of 25 div, magnification factor of 1, 2 input waveform periods  When sampling is slow, waveforms can be evaluated during measurement.	
Graphic editor	Unit: Includes an editor for creating waveform evaluation reference areas.  External: Waveform evaluation reference areas (BMP data) created with third-party software on a PC can be loaded into 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 conform to the generator module specifications of Models MR8790, MR8791, and U8793

Waveform generation mode	Depends on generator modules of Models MR8790, MR8791, and U8793	
Waveform output control	Output control RUN (generation), STOP (stop), PAUSE (suspension) Output control method	
	Manual: Measurement an	Controls output by using the <b>F</b> key on the settings screen.  d synchronization:
	Keys:	Outputs in synchronization with measurement start START key, STOP key for output control (disable measurement)
Output waveform	form Model MR8790 Waveform Generator Unit:	
		DC, Sine waves
	Model MR8791 Pul	se Generator Unit:
		Pulse, pattern
	Model U8793 Arbiti	ary Waveform Generator Unit:
		DC, sine waves, triangular waves, rectangular waves,
		pulse, ramp up, ramp down, arbitrary waveform, program
Waveform compatible for output (Only U8793)	Refer to: "Specifications for Arbitrary Waveform Generation Function" (p. 387)	

### **Miscellaneous**

On-line help function	Pressing the <b>HELP</b> key displays help for the currently selected (blinking) item (The all screen is not used)  Basic help (When making settings, displays a brief description of the selected (blinking) item along the bottom of the screen)	
Grid types	Display: Off, normal or normal (dark) Printouts: Off, normal, fine, normal (dark), fine (dark)	
Comment display	Comments are displayed with channel numbers on the screen and in printouts (channel markers)	
Time scale display	Time (seconds, base-60), divisions, date, sample number (screen and printouts)	
Variable auto-compensation	Included	
Start backup function	Included	
Backlight saver	Off, 1 to 30 min	
Display color	Color 1 to 3, user-defined	
Beep sound	Off, warnings, warnings and operations	
Language	English, Japanese, Chinese, Korean	
START key function	Press once, twice, hold for two seconds	
STOP key function	Press once or twice	
External I/O terminals	Trigger control terminals (EXT.TRIG, TRIG OUT), External sampling input terminal (EXT.SMPL) Remote control input terminal (START/IN1, STOP/IN2, SAVE/IN3), Evaluation output terminals (GO/OUT1, NG/OUT2)	
Remote control	Select from among terminals for remote input (START/IN1, STOP/IN2, SAVE/ IN3):  [START] [STOP] [START/STOP] [ABORT] [PRINT] [SAVE] [Pen Up/Down]  [RUN/STOP] [PAUSE]	
Internal status output	Select from among evaluation output terminals (GO/ OUT1, NG/ OUT2): [Error], [BUSY], [Trigger]	
Probe calibration output	Select evaluation output terminal (NG/ OUT2):  [Probe Calibration]	
Evaluation output	Select from among evaluation output terminals (GO/OUT1, NG/OUT2): [Measure], [Waveform Evaluation], [Value Evaluation or Waveform Evaluation], [Value Evaluation and Waveform Evaluation]	
Key-lock function	Press the <b>ESC</b> key for 3 seconds. (Key-lock, unlock)	
Printout scaling*	Prints waveforms magnified or compressed on the time axis, regardless of Waveform screen display	
Print density*	Light, Midlight, Standard, Middark, Dark	
Print speed*	Fast (coarse), Normal, Slow (fine)	
Print area	Whole waveforms, waveforms between A and B cursors	
Upper/lower limit printing*	Off/On	
Zero-position comments	Off/On, but not overlaid	
Text comment printing*	Load a text file and print comment at printing start time.	
Counter printing*	Off, date, counter name and count value	
GUI partial printing/ saving	Off/On	

List*	Off/On Prints a list of settings
Gauge*	Off/On Prints gauges for measurement channels (If both range and zero position of a channel are set to the same as those of other channels, a single gauge is printed and shared by those channels.) Gauges can be displayed on the screen.
Waveform backup function	None
Auto-setup function	When switched on, settings are automatically loaded from a file on the CF card.
Auto-range function	Execute by pressing the <b>AUTO</b> key (Automatically selects the optimal timebase and voltage axis for the input waveform)
Backlight brightness	Selectable from 3 levels
Time setting	Year, Month, Day, Hour, Minutes
Initialization	Clear waveform data System reset (Settings/System settings 1 [Environment] /System settings 2 [Interface])
Self-check function	ROM/RAM, display, printer*, keys, system status
Print key operation	Select whether to print or not (Yes, No) Print destination (printer*, LAN)
Auto-print setting	Auto-print (OFF, ON) Print destination (printer*, LAN)
Channel marker	OFF, CH No., Comments

<sup>\*</sup> When Model U8350 Printer Unit is installed

# 18.5 File

### **Data Saving**

Supported storage media	CF card, built-in drive*, USB memory stick, internal RAM, LAN (Model 9333 LAN Communicator)	
Saved data	Setting data, measurement data, analysis data, screen image, print image waveform evaluation conditions, waveform evaluation areas	
Save types	<ul> <li>Setting data (.SET) (Only setting configurations can be saved to internal RAM)</li> <li>Measurement data Binary format (.MEM, .REC, .FFT, .XYC), Text format (.TXT)</li> <li>Index Memory division (.SEQ), Division save (.IDX)</li> <li>Screen image (.BMP)</li> <li>Print image (.BMP)</li> <li>Startup (STRATUP.SET)</li> <li>Waveform evaluation conditions (.ARE) (Saving of evaluation area + setting conditions)</li> <li>Waveform evaluation area (.BMP) (Saving of evaluation area)</li> <li>Arbitrary waveform data (.WFG) (when Model U8793 is installed)</li> <li>Generation program data (.PLS) (when Model MR8791 is installed)</li> <li>Pulse pattern data (.PLS) (when Model MR8791 is installed)</li> </ul>	
File name entry	Alphanumeric and Japanese characters	
Save range	All range, between AB cursors	
Data thinning save	When saved in text format Off, 1/2, 1/5, 1/10, 1/20, 1/50, 1/100, 1/200, 1/500, 1/1000	
Division save	When saved in binary format 16 MB, 32 MB, 64 MB	
Duplicate file name handling	Auto: If a file with the same name exists, saves the file, adding a 4-digit number at the beginning of the file name.  Serial: Saves the file, adding a 4-digit number at the beginning of the file name.  Overwrite: If a file with the same name exists, overwrites the file.  Error: If a file with the same name exists, an error message will be displayed.	
Selection of blocks to be saved	Saves the selected blocks when dividing the memory	
Selection of channels to be saved	Selects the channels to save (measurement data, calculation data), all channels	

### **Data Loading**

Supported storage media	CF card, built-in drive*, USB memory stick, internal RAM	
Loadable data types	Setting data, measurement data, analysis data, text comments, waveform evaluation conditions, waveform evaluation area	
Loadable data formats	<ul> <li>Setting data (.SET) (Setting configurations can only be loaded to internal RAM)</li> <li>Measurement data Binary format (.MEM, .REC, .FFT, .XYC), text comments (.TXT)</li> <li>Index memory division (.SEQ), Division save (.IDX)</li> <li>Startup (STRATUP.SET)</li> <li>Waveform evaluation conditions (.ARE)</li> <li>Waveform evaluation area (.BMP)</li> <li>Arbitrary waveform data (when Model U8793 is installed), in binary format (.WFG), in text format (.TFG)</li> <li>Generation program data (.FGP) (when Model U8793 is installed)</li> <li>Pulse pattern data (.PLS) (when Model MR8791 is installed)</li> </ul>	
Loading method	New	

### Other

File management	File information display, copy, renaming File deletion (Single and multiple file selections) Directory management (Create, rename, delete) File sorting (By name, date, size, extension; in ascending or descending order)
One-touch saving	The saving format and data specified in advance can be saved with a single action (One-Touch saving via <b>SAVE</b> key or a mouse click).

# **18.6 Module Specifications**

## 18.6.1 Model 8966 Analog Unit

The accuracy is provided for the condition where the module is installed on the Memory HiCorder at  $23^{\circ}C\pm5^{\circ}C$  ( $73^{\circ}F\pm9^{\circ}F$ ), 20% RH to 80% RH, and zero adjustment is executed 30 minutes after power on.

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. (Filter 5 Hz On)
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 (low cut-off frequency: 7 Hz±50%)
Noise	1.5 mV p-p (typ.), 2 mV p-p (max.) (highest sensitivity range, with input shorted)
Common mode rejection ratio	80 dB or more (at 50 Hz/60 Hz and with signal source resistance 100 $\Omega$ 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 individual input channels and enclosure as well as between individual input channels) Measurement category II (anticipated transient overvoltage: 2500 V)
Operating temperature and humidity	As per the Memory HiCorder in which Model 8966 is installed
Operating environment	As per 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.)
Effect of radiated radio-frequency electromagnetic field	±15% f.s. (max.) at 3 V/m

Effect of conducted radio-frequency electromagnetic field

Standards

Safety EN61010 EMC EN61326 Class A

### 18.6.2 **Model 8967 Temp Unit**

Accuracy figures assume installation in a Memory HiCorder and operation after a 30-minute warm-up period at 23°C  $\pm 5$ °C (73°F  $\pm 9$ °F) and 80% RH (no condensation).

Product warranty period	3 years					
Guaranteed accuracy period	1 year					
Number of input channels	2 channels					
Input terminals	Push button-type t	erminal blo	ock (2 termin	als/channel)		
Measuring object	Thermocouple (K,	J, E, T, N,	R, S, B, W)			
Measurement ranges	Measuring object	Ra	nge	Measurable range	Resolution	Measurement accuracy
Measurable range			10°C/div	-100°C to 200°C	0.01°C	
Resolution		K *1	50°C/div	-200°C to 1000°C	0.05°C	
Measurement accuracy			100°C/div	-200°C to 1350°C	0.1°C	
(f.s.=20 div)			10°C/div	-100°C to 200°C	0.01°C	
,		J *1	50°C/div	-200°C to 1000°C	0.05°C	
			100°C/div	-200°C to 1100°C	0.1°C	±0.1% f.s.±1°C
			10°C/div	-100°C to 200°C	0.01°C	(0°C or higher)
		E *1	50°C/div	-200°C to 800°C	0.05°C	±0.1% f.s.±2°C (not lower than -200°C but lower than 0°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	
	Thermocouple (not including		100°C/div	-200°C to 400°C	0.1°C	
	reference junction compensation accuracy)	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	
			10°C/div	0°C to 200°C	0.01°C	
		R *1	50°C/div	0°C to 1000°C	0.05°C	
			100°C/div	0°C to 1700°C	0.1°C	±0.1% f.s.±3.5°C (not lower than
			10°C/div	0°C to 200°C	0.01°C	0°C but lower than
		S *1	50°C/div	0°C to 1000°C	0.05°C	400°C) (For B, accuracy
			100°C/div	0°C to 1700°C	0.1°C	is not guaranteed
		B *1	50°C/div	400°C to 1000°C	0.05°C	below 400°C)
			100°C/div	400°C to 1800°C	0.1°C	±0.1% f.s.±3°C
		W * <sup>2</sup> (WRe5-26)	10°C/div	0°C to 200°C	0.01°C	(400°C or higher)
			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

 $\pm 1.5^{\circ}\text{C}$  (Reference junction compensation: When internal, add to thermocouple measurement accuracy)

Reference junction compensation	Selectable internal or external (during thermocouple measurement)				
Temperature characteristic	Add (measurement accuracy × 0.1)/°C to measurement accuracy				
Renew Data (Data	Selectable from normal, fast, slow		Fast	Normal	Slow
Refresh)		Data Refresh Rate	Approx. 1.2 ms	Approx. 100 ms	Approx. 500 ms
Wire break detection	Selectable from On or Off				
Input resistance	5 $\mbox{M}\Omega$ or more (Both when wire break	detection is ON and	OFF)		
Common mode rejection ratio	80 dB or more (at 50 Hz/60 Hz, with signal source 100 $\Omega$ or less, Fast data refresh setting) 100 dB or more (at 50 Hz/60 Hz, with signal source 100 $\Omega$ or less, Normal data refresh setting)				
Input type	Unbalanced input (floating)				
Maximum rated voltage to earth	300 V AC, DC (between individual input channels and enclosure as well as between individual input channels) Measurement category II (anticipated transient over-voltage: 2500 V)				
Operating temperature and humidity	As per 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	As per 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. (max.) at 3 V/m				
Effect of conducted radio-frequency electromagnetic field	±2% f.s. (max.) at 3 V				
Standards	Safety EN61010 EMC EN61326 Class A				
Accessories	Ferrite clamp-on choke (2 pieces)				
Options (sold separately)	Model 9810 Thermocouples (K)				

### 18.6.3 Model 8968 High Resolution Unit

Accuracy figures assume installation in a Memory HiCorder and operation after a 30-minute warm-up period at  $23^{\circ}\text{C}\ \pm 5^{\circ}\text{C}\ (73^{\circ}\text{F}\ \pm 9^{\circ}\text{F})$  and  $80\%\ \text{RH}$  (no condensation).

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. (Filter 5 Hz On, after zero adjustment)
Temperature characteristic	±0.045% f.s./°C
Frequency characteristic	DC Coupling: DC to 100 kHz -3 dB AC Coupling: 7 Hz to 100 kHz -3 dB (low cut-off frequency: 7 Hz±50%)
Noise	500 μV p-p (typ.), 1 mV p-p (max.) (highest sensitivity range, with input shorted)
Common mode rejection ratio	80 dB or more (at 50 Hz/60 Hz and with signal source resistance 100 $\Omega$ 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) (Automatic setting when the anti-aliasing filter is 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 individual input channels and enclosure as well as between individual input channels) Measurement category II (anticipated transient overvoltage: 2500 V)
Operating temperature and humidity	As per Memory HiCorder in which Model 8968 is installed
Operating environment	As per 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.)
Effect of radiated radio-frequency electromagnetic field	±15% f.s. (max.) at 3 V/m

Effect of conducted radio-frequency electromagnetic field	±20% f.	s. (max.) at 3 V (100 mV/div range, with 1 V DC input)
Standards	Safety EMC	EN61010 EN61326 Class A

# 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 autobalance	<ul> <li>Guaranteed accuracy period: 1 year</li> <li>Guaranteed accuracy period from adjustment made by Hioki: 1 year</li> <li>Temperature and humidity for guaranteed accuracy: 23°C ±5°C (73°F ±9°F), 80% RH or less</li> <li>Warm-up time: At least 30 minutes</li> <li>Specified after performing the autobalance</li> </ul>		
Number of input channels	2 cha	annels		
Input terminals	Weidmüller SL3.5/7/90G	NDIS connector EPRC07-R9FNDIS		
Measurement device	Strain gaug	ge transducer		
Gauge ratio	2	2.0		
Bridge voltage	2 V ±0.05 V			
Bridge resistance	120 $\Omega$ to 1 k $\Omega$			
Balance adjustment range	±10000 με or less			
Balancing method	Electronic auto-balancing			
Measurement range	20, 50, 100, 200, 500, 1000 με/div			
Measurement accuracy	$\pm 0.5\%$ f.s. $\pm 4~\mu\epsilon$ (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 AC rms 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 AC rms 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.)		
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		

# 18.6.5 Model 8970 Freq Unit

Accuracy figures assume installation in a Memory HiCorder and operation after a 30-minute warm-up period at 23°C  $\pm 5$ °C (73°F  $\pm 9$ °F) and 80% RH (no condensation).

Product warranty period	3 years
Measurement functions	The following measurements 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 individual input channels and enclosure as well as between individual input channels)
Input type	Unbalanced input (floating)
Guaranteed accuracy period	1 year
Frequency mode Measurement range Measurement accuracy Measurable range	1, 5, 10, 50, 100, 500, 1 k, 5 kHz/div (f.s.= 20 div)  ±0.1% f.s. (except for 5 kHz/div range) ±0.7% f.s. (5 kHz/div range) DC to 100 kHz (minimum pulse width: 2 µs
Rotation speed mode Measurement range Measurement accuracy Measurable range	100, 500, 1 k, 5 k, 10 k, 50 k, 100 kr/min /div (f.s.= 20 div)  ±0.1% f.s. (except for 100 kr/min range) ±0.7% f.s. (100 kr/min range) 0 Mr/min to 2 Mr/min (minimum pulse width 2: μs)

Power frequency mode 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 range Measurement ±0.03 Hz (50 Hz, 60 Hz), ±0.1 Hz (400 Hz) accuracy Count mode Measurement 2 k, 10 k, 20 k, 100 k, 200 k, 1 M counts/div range Measurement ±range/2000 accuracy Measurable range DC to 100 kHz (minimum pulse width: 2 µs) **Duty ratio mode** Measurement range 5%/div (f.s.= 20 div) Measurement ±1% (10 Hz to 10 kHz) accuracy Measurable range ±4% (10 kHz to 100 kHz) 10 Hz to 100 kHz (minimum pulse width: 2 μs) Pulse width mode 500 μ, 1 m, 5 m, 10 m, 50 m, 100 ms/div (f.s.=20 div) Measurement range Measurement ±0.1% f.s. accuracy Measurable range  $2 \mu s$  to 2 sMeasurement Count mode: 2000LSB/div (f.s. = 20 div) resolution 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: −10 V to +10 V variable (0.1-V step) ±20 V range: −20 V to +20 V variable (0.2-V step) ±50 V range: −50 V to +50 V variable (0.5-V step) ±100 V range: -100 V to +100 V variable (1-V step) ±200 V range: −200 V to +200 V variable (2-V step) ±400 V range: -400 V to +400 V variable (5-V step) Slope Rising, falling (Frequency, rotation speed, power frequency, 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) When OFF is selected: If the next measurement value is not determined within the waiting time period, the frequency or the rotation speed will be determined using the value that is calculated based on the time period between the timing of the last measurement and the timing of the sampling. If these calculated values are less than the specified values, then use 0. **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 (Low frequency cut-off in AC-coupled mode: 7 Hz) Frequency dividing Setting range: 1 to 4096, by one step (Frequency, rotation speed, count mode) function Counting start timing Start, trigger (Count mode) Count over handling Hold, back (Count mode) Operating As per Memory HiCorder in which Model 8970 is installed temperature and humidity

Operating environment	As per Memory HiCorder in which Model 8970 is installed
Storage temperature and humidity	As per 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.)

### 18.6.6 Model 8971 Current Unit

Accuracy figures assume installation in a Memory HiCorder and operation after a 30-minute warm-up period at 23°C  $\pm$ 5°C (73°F  $\pm$ 9°F) and 80% RH (no condensation).

Product warranty period	3 years
Guaranteed accuracy period	1 year
Number of input channels	2 channels
Applicable current sensors	Model 9272-10, 9277, 9278, 9279, 9709, CT6841, CT6843, CT6844, CT6845, CT6846, CT6862, CT6863, CT6865 Hioki current sensors with RM515EPA-10PC (Hirose) installed (Supported conversion ratios: 20 A/2 V, 50 A/2 V, 200 A/2 V, 500 A/2 V, 1000 A/2 V*²) (Model 9318 Conversion Cable is required to connect a sensor with Model 8971.)
Measurement range	When Model 9272-10 (20 A), 9277, or CT6841 is used:  100 m, 200 m, 500 m, 1, 2, 5 A/div  When Model CT6862 is used: 200 m, 500 m, 1, 2, 5, 10 A/div  When Model 9272-10 (200 A), 9278, CT6843, or CT6863 is used: 1, 2, 5, 10, 20, 50 A/div  When Model 9279, 9709, CT6844, CT6845, CT6846*², or CT6865*² is used: 2, 5, 10, 20, 50, 100 A/div
Measurement accuracy*	±0.65% f.s. (Filter 5 Hz On) ±0.85% f.s. (Filter 5 Hz On, for using with Model 9278 or 9279)
RMS accuracy*	±1% f.s. (DC, 30 Hz to 1 kHz), ±3% f.s. (1 kHz to 10 kHz) (Sine wave input, filter 5 Hz On, crest factor 2)
Response time*	100 ms (rising from 0% f.s. to 90% f.s.)
Temperature characteristic*	±0.075% f.s./°C
Frequency characteristic*	DC Coupling: DC to 100 kHz ±3 dB AC Coupling: 7 Hz to 100 kHz ±3 dB (low cut-off frequency: 7 Hz±50%)
Noise*	10 mA p-p max. (Highest sensitivity range, with input shorted) (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 insulated)
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)
Operating temperature and humidity	As per Memory HiCorder in which Model 8971 is installed
Operating environment	As per 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
Number of the 8971 available for Memory HiCorder	Up to 4 modules

<sup>\*1</sup> For current measurement, add the accuracy and characteristic of the clamp sensor used with Model 8971.

### 18.6.7 Model 8972 DC/RMS Unit

Accuracy figures assume installation in a Memory HiCorder and operation after a 30-minute warm-up period at 23°C  $\pm 5$ °C (73°F  $\pm 9$ °F) and 80% RH (no condensation).

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. (Filter 5 Hz On)
RMS accuracy	±1% f.s. (DC, 30 Hz to 1 kHz), ±3% f.s. (1 kHz to 100 kHz) (Sine wave input, response time: Slow)
Response time	Slow 5 s (rising from 0% f.s. to 90% f.s.) Normal 800 ms (rising from 0% f.s. to 90% f.s.) Fast 100 ms (rising from 0% f.s. to 90% f.s.)
Crest factor	2
Temperature characteristic	±0.045% f.s./°C
Frequency characteristic	DC Coupling: DC to 400 kHz -3 dB AC Coupling: 7 Hz to 400 kHz -3 dB (low cut-off frequency: 7 Hz±50%)
Noise	500 $\mu V$ p-p (typ.), 750 $\mu V$ p-p (max.) (Highest sensitivity range, with input shorted)
Common mode rejection ratio	80 dB or more (at 50 Hz/60 Hz and with signal source resistance 100 $\Omega$ 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)

<sup>\*2</sup> The instrument recognizes this as a 500 A AC/DC sensor is connected; setting the ratio of the scaling function to 2 is required.

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 individual input channels and enclosure as well as between individual input channels) Measurement category II (anticipated transient overvoltage: 2500 V)
Operating temperature and humidity	As per Memory HiCorder in which Model 8972 is installed
Operating environment	As per 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)
Mass	Approx. 250 g (8.8 oz.)
Effect of radiated radio-frequency electromagnetic field	±15% f.s. (max.) at 3 V/m
Effect of conducted radio-frequency electromagnetic field	±20% f.s. (max.) at 3 V (100 mV/div range, with 1 V DC input)
Standards	Safety EN61010 EMC EN61326 Class A

# 18.6.8 Model 8973 Logic Unit

Product warranty period	3 years		
Number of input channels	4 probes (16 channels)		
Input terminals	Mini DIN		
Applicable probes	Model 9320-01 Logic Probe, Model MR9321-01 Logic Probe, Model 9327 Logic Probe		
Operating temperature and humidity	As per Memory HiCorder in which Model 8973 is installed		
Operating environment	As per 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		

## 18.6.9 Model MR8990 Digital Voltmeter Unit

3 years

**Product warranty** 

Accuracy figures assume installation in a Memory HiCorder and operation after a 30-minute warm-up period at 23°C  $\pm 5$ °C (73°F  $\pm 9$ °F) and 80% RH (no condensation).

period	o youre						
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 12	20 mV	0.1 μV		
	50 mV/div (f.s.= 100	00 mV)	-1200 mV to 12	200 mV	1 μV	100 MΩ or more	
	500 mV/div (f.s.= 10		-12 V to 12	2 V	10 μV		
	5 V/div (f.s.= 100 V)		-120 V to 12		100 μV	10 MΩ±5%	
	50 V/div (f.s.= 1000		-500 V to 50		1 mV		
	* Guaranteed rar	nge of me	easurement acc	uracy			
Measurement	Measurement i	ange	NPLC: Les	s than 1	NPL	C: 1 or more	
accuracy	5 mV/div (f.s.= 100	mV)	±0.01% rdg.±0	0.015% f.s	. ±0.01%	rdg.±0.01% f.s.	
	50 mV/div (f.s.= 100		_	±0.01% r	dg.±0.0025% f.	S.	
	500 mV/div (f.s.= 10						
	5 V/div (f.s.= 100 V)	<u> </u>	±0.025% rdç		rdg.±0.0025% f	lg.±0.0025% f.s.	
	50 V/div (f.s.= 1000	V)					
Temperature characteristic	±(0.002% rdg. + 0	.00025%	f.s.)/°C				
A/D conversion measurement method	$\Delta \Sigma$ modulation me	ethod					
Integration time	Power Integration time						
	50 Hz	20	ms × NPLC				
	60 Hz	16.67	.67 ms × NPLC				
	NPLC: Settable fr 100 (in increments		o 0.9 (in increme	ents of 0.	1), 1 to 9 (in ir	ncrements of 1), 10	) to
Response time	Within 2 ms + 2 ×	integration	on time (rising fr	om -f.s. t	o +f.s., falling	from +f.s. to -f.s.)	)
Fast response	ON/ OFF						
Common mode rejection ratio	100 dB or more (at 50 Hz/60 Hz and with signal source resistance 100 $\Omega$ 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 individual input channels and enclosure as well as between individual input channels) Measurement category II (anticipated transient overvoltage: 2500 V)						
Operating temperature and humidity	As per Memory HiCorder in which Model MR8990 is installed						

Operating environment	As per 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. (max.) at 3 V/m (in 5 mV/div range)
Standards	Safety EN61010 EMC EN61326 Class A
Option	Model L2200 Test Lead

## 18.6.10 Model U8974 High Voltage Unit

The accuracy is provided for the condition where the module is installed on the Memory HiCorder at  $23^{\circ}C\pm5^{\circ}C$  ( $73^{\circ}F\pm9^{\circ}F$ ), 20% RH to 80% RH, and zero adjustment is executed 30 minutes after power on.

Product warranty period	3 years
Guaranteed accuracy period	1 year
Number of input channels	2 channels
Measurement functions	Instantaneous value, r.m.s. value (can be changed for each channel)
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. (Filter 5 Hz On)
RMS measurement accuracy	±1.5% f.s. (DC, 30 Hz to 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% f.s. to 90% f.s.)  Normal: 500 ms (rising from 0% f.s. to 90% f.s.)  Slow: 2.5 s (rising from 0% f.s. to 90% f.s.)
Temperature characteristic	±0.05% f.s./°C
Frequency characteristic	DC to 100 kHz -3 dB
Noise	30 mV p-p (typ.), 50 mV p-p (max.) (highest sensitivity range, with input shorted)
Common mode rejection ratio	80 dB or more (50 Hz/60 Hz input shorted)
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 chassis, between input channels) Anticipated transient overvoltage: 8000 V
Operating temperature and humidity	As per Memory HiCorder in which Model U8974 is installed
Operating environment	As per Memory HiCorder in which Model U8974 is installed

Storage temperature and humidity	Temperature Humidity	-20°C to 50°C (-4°F to 122°F) not lower than -20°C but lower than 40°C (not lower than -4°F but lower than 104°F) not lower than 40°C but lower than 45°C (not lower than 104°F but lower than 113°F) not lower than 45°C but not higer than 50°C (not lower than 113°F but not higer than 122°F)	80% RH or less (no condensation) 60% RH or less (no condensation) 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. (max.	±5% f.s. (max.) at 3 V/m		
Effect of conducted radio-frequency electromagnetic field	±5% f.s. (max.) at 3 V (500 mV/div range, with 1 V DC input)			
Standards	Safety EN61 EMC EN61	1010 1326 Class A		
Options	Model L4935 A Model 9243 G Model L4936 I Model L4937 I Model L4931 I Model L4932 Model L4934*	Connection Cable Set (1.5 m) Alligator Clip Set (mounted on the tips of L4940, CAT rabber Clip (mounted on the tips of L4940, CAT III 1 Bus Bar Clip Set (mounted on the tips of L4940, CAT Magnetic Adapter Set (mounted on the tips of L4940 Extension Cable (for L4940, 1.5 m) Test Pin Set (mounted on the tips of L4940, CAT IV 6 Small Alligator Clip Set (CAT III 300 V, CAT II 600 V 2 is necessary when using Model L4934.	000 V) F III 600 V) F, CAT III 1000 V)	

### 18.6.11 Model U8979 Charge Unit

### 1. General specifications

Indoors, Pollution Degree 2, Operating altitude: up to 2000 m (6562 ft.)		
0°C to 40°C (32°F to 104°F), 80% RH or less (no condensation)		
-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)		
Safety: EN61010 EMC: EN61326 Class A		
Approx. 106W × 19.8H × 196.5D mm (4.17"W × 0.78"H × 7.74"D)		
Approx. 250 g (8.8 oz.)		
3 years		
1 year		

### 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 $\Omega$ )		
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

Frequency characteristics	DC to 50 kHz
Noise	80 $\mu V$ p-p (typ.), 120 $\mu V$ 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 <sup>2</sup> ) to 10 pC/(m/s <sup>2</sup> )
Measurement range	40, 100, 200, 400, 1 k, 2 k, 4 k, 10 k, 20 k, 40 k, 100 k, 200 k m/s² f.s. Measurement sensitivity: 0.1 pC/(m/s²) to 0.25 pC/(m/s²) 20, 40, 100, 200, 400, 1 k, 2 k, 4 k, 10 k, 20 k, 40 k, 100 k m/s² f.s. Measurement sensitivity: 0.251 pC/(m/s²) to 0.5 pC/(m/s²) 10, 20, 40, 100, 200, 400, 1 k, 2 k, 4 k, 10 k, 20 k, 40 k m/s² f.s. Measurement sensitivity: 0.501 pC/(m/s²) to 1.0 pC/(m/s²) 4, 10, 20, 40, 100, 200, 400, 1 k, 2 k, 4 k, 10 k, 20 k m/s² f.s. Measurement sensitivity: 1.001 pC/(m/s²) to 2.5 pC/(m/s²) 2, 4, 10, 20, 40, 100, 200, 400, 1 k, 2 k, 4 k, 10 k m/s² f.s. Measurement sensitivity: 2.501 pC/(m/s²) to 5.0 pC/(m/s²) 1, 2, 4, 10, 20, 40, 100, 200, 400, 1 k, 2 k, 4 k m/s² f.s. Measurement sensitivity: 5.001 pC/(m/s²) to 10.0 pC/(m/s²)
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 <sup>2</sup> ) to 10 mV/(m/s <sup>2</sup> )	
Measurement range	<ul> <li>40, 100, 200, 400, 1 k, 2 k, 4 k, 10 k, 20 k, 40 k, 100 k, 200 k m/s² f.s. Measurement sensitivity: 0.1 mV/(m/s²) to 0.25 mV/(m/s²)</li> <li>20, 40, 100, 200, 400, 1 k, 2 k, 4 k, 10 k, 20 k, 40 k, 100 k m/s² f.s. Measurement sensitivity: 0.251 mV/(m/s²) to 0.5 mV/(m/s²)</li> <li>10, 20, 40, 100, 200, 400, 1 k, 2 k, 4 k, 10 k, 20 k, 40 k m/s² f.s. Measurement sensitivity: 0.501 mV/(m/s²) to 1.0 mV/(m/s²)</li> <li>4, 10, 20, 40, 100, 200, 400, 1 k, 2 k, 4 k, 10 k, 20 k m/s² f.s. Measurement sensitivity: 1.001 mV/(m/s²) to 2.5 mV/(m/s²)</li> <li>2, 4, 10, 20, 40, 100, 200, 400, 1 k, 2 k, 4 k, 10 k m/s² f.s. Measurement sensitivity: 2.501 mV/(m/s²) to 5.0 mV/(m/s²)</li> <li>1, 2, 4, 10, 20, 40, 100, 200, 400, 1 k, 2 k, 4 k m/s² f.s. Measurement sensitivity: 5.001 mV/(m/s²) to 10.0 mV/(m/s²)</li> </ul>	
Frequency characteristics	1 Hz to 50 kHz -3 dB	

Power supply for detector	3.5 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 Guaranteed accuracy period after adjustment made by Hioki: 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.	
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.	
Temperature characteristics of input from acceleration sensor with the built-in preamplifier	±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 $\pm$ 50% (voltage input only), 500 $\pm$ 50%, 5k $\pm$ 50% (Hz) $-$ 3 dB	
TEDS	IEEE1451.1.4 Class 1 compliant The instrument reads out sensor information to automatically configure the sensitivity setting.	

## 18.6.12 U8793 Arbitrary Waveform Generator Unit

### **General Specifications**

Operating environment	As per Memory HiCorder in which Model U8793 is installed	
Operating temperature and humidity	As per 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)	

### **Output Specifications**

#### Basic Specifications (common for FG function and arbitrary waveform generation function)

Conditions of guaranteed accuracy	Guaranteed accuracy period: 1 year Guaranteed accuracy period from adjustment made by Hioki: 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	33 V rms AC or 70 V DC (between individual output channels and enclosure/external I/O terminals as well as between individual output channels) Anticipated transient overvoltage: 330 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 greater	
Output format	Waveform output/open/short	

### **FG** Function Specifications

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 (not lower than 10 mHz but not higher 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 characteristic	(±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 greater	
Pulse waves duty ratio accuracy	±0.1% of period (not lower than 10 mHz but not higher than 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 for Arbitrary Waveform Generation Function**

Output waveform	Waveforms measured with the 8847, MR8847, MR8847A, MR8827, MR8740, or MR8741 Memory HiCorder (Logic waveforms are not supported.) Waveforms measured with the PW3198 Power Quality Analyzer (via SF8000) Waveforms saved by the 7075 Waveform Generator (via SF8000) Waveforms created in CSV format (via 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 in 1-2-5 progression)
D/A refresh rate	Max. 2 MHz (setting resolution:10 mHz)
Clock frequency accuracy	±150 ppm
Clock frequency jitter	Within 50 ns p-p
Delay	-250,000 to 250,000 (settable in increments of 1 data point)
Number of loops	1 to 50,000 or ∞

## **Sweep Function Specifications**

Sweep waveforms	Non-DC FG waveforms, arbitrary waveforms	
Sweep form	Linear	
Sweep target	FG waveforms: Arbitrary waveforms:	Frequency, amplitude, offset, duty ratio (pulse waves only) (Simultaneous sweeping of frequency, amplitude, and offset) Clock frequency, amplitude, offset (Simultaneous sweeping of clock frequency, amplitude, and offset)
Sweep time setting range	10 μs to 1000 s (setting resolution: 10 μs)	

### **Program Function Specifications**

Sequence length	Output by connecting up to 128 steps	
Step control	Ability to set an FG waveform, sweep waveform, or user waveform for each step Ability to set the number of loops (for sweep waveforms) or output time (for FG and arbitrary waveforms) for each step	
Hold settings	ON/OFF setting for each step	
Output time setting range	10 μs to 1000 s (FG waveforms, arbitrary waveforms)	
Step loop count setting range	1 to 1,000 (for sweep waveforms)	
Overall loop count setting range	1 to 50,000 or ∞	
Monitor functions	Display of step number being executed, step loop count, and overall loop count	

### **Other Specifications**

Channel synchronization	Ability to set the phase between channels on the same module and between modules	
Self-test function	Ability to monitor output voltage value  Monitor resolution: 10 mV  Monitor accuracy: ±3.0% f.s. (f.s.=15 V)	
Output start/stop	By operating key on the Memory HiCorder or applying a signal to the unit's external control terminal	
External input	Cancel hold and transition to next step on low-level signal input from an external source while using the program function.  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 greater (low level)	
External output	Output during waveform output  Output format: Open-drain output (with 5 V voltage output, active low)  Output voltage level: 4.0 V to 5.0 V (high level), 0 V to 0.5 V (low level)  Maximum switching capacity: 5 V DC to 30 V DC, 50 mA	
External I/O terminals	Push-button type terminal block	
Waveform output indicator	Red LED on during waveform output and off when output is off	

### 18.6.13 MR8790 Waveform Generator Unit

The accuracy is provided for the condition where the module is installed on the Memory HiCorder at  $23^{\circ}C\pm5^{\circ}C$  ( $73^{\circ}F\pm9^{\circ}F$ ), 80% RH or less (no condensation), and 30 minutes after power on.

#### **General Specifications**

Product warranty	3 years	
period		
Guaranteed accuracy period	1 year	
Guaranteed accuracy period from adjustment made by Hioki	1 year	
Number of output channels	4 channels (all channels isolated from each other and from the enclosure and outputs)	
Self-test function	Included (with voltage and current monitor)	
Voltage and current monitoring function (switchable)	Resolution: 5 µA (current monitor) 10 mV (voltage monitor)  Monitor accuracy:±3.0% f.s. (f.s. = 10 V [voltage monitor] or 5 mA [current monitor])	
Maximum output current	±5 mA	
Allowable load resistance	$2~\text{k}\Omega$ 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 (when output is shorted)	
Maximum rated voltage to earth	33 V rms AC or 70 V DC (between individual output channels and enclosure as well as between individual output channels) Anticipated transient overvoltage: 330 V	
Operating temperature and humidity	As per Memory HiCorder in which Model MR8790 is installed	
Operating environment	As per 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% f.s. (max.) at 3 V/m (f.s.=10 V)	
Effect of conducted radio-frequency electromagnetic field	±1% f.s. (max.) 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)	

## **Voltage Output Specifications**

Maximum output voltage	±10 V	
Resolution	16 bits	
Output frequencies	·	DC, 0 Hz to 20 kHz (sine waves) 1 Hz ±0.01% of setting
Amplitude	Setting range: Setting resolution: Amplitude accuracy:	0 V p-p to 20 V p-p 1 mV ±0.25% of setting ±2 mV p-p (not lower than 1 Hz but not higher than 10 kHz) ±0.6% of setting ±2 mV p-p (higher than 10 kHz but not higher than 20 kHz)
DC offset	3 - 3 - 3	
DC output	Output accuracy: ±0.6 mV	

## 18.6.14 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	As per Memory HiCorder in which Model MR8791 is installed		
Operating environment	As per 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	33 V rms AC or 70 V DC (between output channel 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 (output channels and enclosure isolated; output units isolated) (channels not isolated from each other [common GND]) (channels not isolated from output connector frame [common GND])		
Output mode 1	Pattern output/pulse output (switched for all 8 channels at once)		
Output mode 2	Logic output/open-collector output (set separately for each of 8 channels)		
Logic output:	Output voltage level: 0 V to 5 V (high level 3.8 V or greater, low level 0.8 V or less) Rated current: ±5 mA		
Open collector Outpu	t: Collector/emitter absolute maximum rated voltage: 50 V Over-current protection: 100 mA		
Output mode 3	Output/open (= self-test) (switched for all 8 channels at once)		
Open-collector output definition (rising time [10% to 90%])	5 µs (max.) (load capacity of 1000 pF, pull-up resistance of 1 k $\Omega$ )		
Self-test function	Detected voltages: High level 3.4 V or greater, low level 1.6 V or less		
Relay switching time	5 ms or less (logic/open collector switching, output/open [self-test] switching)		
Standards	Safety EN61010 EMC EN61326 Class A		

## **Pulse Output Specifications**

Output frequency	Setting range: Setting resolution: Frequency accuracy:	0 Hz to 20 kHz (set separately for each of 8 channels) 0.1 Hz ±100 ppm
Duty ratio	Setting range: Setting resolution: Duty ratio accuracy:	0.1% to 99.9%, 0, 100% (DC) 0.1% {±100 ppm (setting period) ±150 ns} of setting Priority to the "Minimum pulse width" and "Open collector output regulation" specifications
Minimum pulse width	1 µs	

## **Pattern Output Specifications**

Clock frequency Range: 0 Hz to 120 kHz (Common for 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)

## **Output Connector Specifications**

10250-52A2PL: 3M products (SCSI-2 connector), (Centronics half-pitch 50 pins 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 (insulated GND)

F\_GND: Non-Isolation GND (main instrument GND)

NC: No Connect

TESTn: Test pin DO NOT CONNECT

(Recommended) Connection cable KB-SHH2: Sanwa Supply products (SCSI-2 connector), (Centronics half-pitch 50 pins, pin-contact)

# **Maintenance and Service**

## **MARNING**



- 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.
- 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. 50,000 hours	_	
Power supply	Approx. 40,000 hours	When Model U8350 Printer Unit is installed	
Print head	After using approx. 1,000 rolls of recording paper	_	
LCD backlight (Half-life of brightness)	Approx. 80,000 hours	At ambient temperature of 25°C The service life varies greatly depending on the ambient environment. The service life becomes shorter under high temperature in particular.	
Model U8330 SSD Unit	Approx. 20,000 hours (continuous writing)	In ambient environment of 25°C TBW (Total Byte Written): 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. 50,000 hours	PCBs on which an electrolytic capacitor must be replaced.	

Part	Recommended replacement cycle	Remarks/conditions
Lithium Battery	Approx. 10 years	The instrument contains a built-in backup lithium battery 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 dealer or Hioki representative.

# 19.1 Trouble Shooting

If damage is suspected, check this section before contacting your authorized Hioki distributor or reseller.

## **Before Having the Instrument Repaired**

## If Power and Operating Keys Malfunction

Symptom	Cause or Item to check	Remedy and reference
The display does not appear when you turn the power on.	Is the power cord disconnected? Are connections made correctly?	Verify that the power cord is connected properly. "2.5 Power Supply" (p. 49)
	Is any key being held down?	Verify key operation.
Keys do not work.	Is the key-lock state active (Key-Lock message displayed)?	Deactivate the key-lock state. (Hold the ESC keys for three seconds)

## If the Display or Operations Malfunction

Symptom	Cause or Item to check	Remedy and reference
Blank screen	Is the backlight saver active? Press any key to check.	Turn the backlight saver off.
No waveform appears when you press the <b>START</b> key.	<ul> <li>Is the "Pre-Trigger wait" message displayed?</li> <li>Is the "Trigger wait" message displayed?</li> </ul>	When pre-triggering is enabled, triggering is ignored until the pre-trigger portion of the waveform has been acquired. Recording starts when a trigger occurs.
No changes occur in the displayed waveform.	<ul> <li>Is the clamp sensor or connection cable connected correctly?</li> <li>Is the vertical axis (voltage axis) range set properly?</li> <li>Is the low-pass filter enabled?</li> </ul>	Verify that the clamp sensor or connection cable is connected correctly. Verify the input channel settings.
While measuring with the memory function, the displayed frequency is much lower than the actual frequency.  Aliasing may be occurring.		Change the timebase to use a faster sampling rate. Press the <b>AUTO</b> key to try automatic setting.  "3.3.2 Timebase and Sampling Rate" (p. 60)
The displayed waveform size does not change when the input range is changed.	Is the Variable function [On]?	Turn the Variable function [Off]. "8.6 Set the Waveform Position (Variable Function)" (p. 164)

## **Cannot Print, or Printing Malfunctions**

Symptom	Cause or Item to check	Remedy and reference
Nothing prints on the paper.	Is the paper reversed (back to front)?	Verify that the recording paper is loaded correctly.  "2.4 Load Instrument With Recording Paper (When Model U8350 Printer Unit is installed)" (p. 48)
Printout is too light.  • Is the specified recording paper being used? • Is the print density setting correct? • Is the print head dirty?		Try changing the print density setting.  "6.4 Setting the Print Density of the Waveform" (p. 120) Clean the print head.  "Print Head Cleaning (When Model U8350 Printer Unit is installed)" (p. 406)
Recording traces are too wide.  The input signal may have a ripp component.		Enable the filter in the module settings. "3.4.2 Choose Analog Channel Settings" (p. 69)
Recording traces are doubled.	Is the waveform printing density set to [Light]? In this case, printed dots are spaced out in the vertical direction. Therefore, a slightly varying waveform prints sometimes as one line, and sometimes as two.	Change to waveform printing density setting to something other than [Light]. ([Printer] sheet) "6.4 Setting the Print Density of the Waveform" (p. 120)

## If Saving is Not Possible

Symptom	Cause or Item to check	Remedy and reference
If saving is not possible to the storage media.	<ul> <li>Is your CF card Hioki certified?</li> <li>Is the storage media inserted properly?</li> <li>Is the storage media formatted?</li> <li>Is the remaining capacity of the storage media too low?</li> <li>Has the number of files in the folder reached the limit?</li> </ul>	"2.3 Prepare Storage Media" (p. 45) "To Change Media" (p. 84)
Cannot use USB memory stick	Have the USB memory stick settings been configured?	"USB use" (p. 46)

## Other

Symptom	Cause or Item to check	Remedy and reference
Cannot use USB communications	Have the USB communication settings been configured?	"16.6.1 USB Settings on the Instrument" (p. 336)
Cannot install USB driver	Is [Interface] set to [USB]?	Set [Interface] to [USB]. "16.6.1 USB Settings on the Instrument" (p. 336)
Carriot install OSB driver	Has driver installation failed?	Access [device manager] on the PC and delete [Other Devices]. Then reconnect the USB cable.
The response of remote control is very slow.	Check the java settings.	For more 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 more nimble 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 PC. 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

Try performing a system reset. All settings will be returned to their factory defaults. Refer to "19.2 Reset the Instrument" (p. 398).

## 19.2 Reset the Instrument

## 19.2.1 Reset System Settings

Select groups of active settings on the instrument and reset them to their factory defaults. Initialization returns the instrument to its factory default state. By default, the setting of (Status, Ch, Trigger) and [(Environment)] are selected for initialization in this screen.

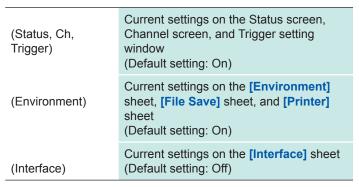
The program or arbitrary waveform data of Model U8793 Arbitrary Waveform Generator Unit is written in ROM of module. So it will not get erased even is main instrument is reset.

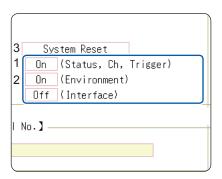
### Procedure

Press the **SYSTEM** key to open the System screen, and then select the **[init]** sheet.

- Move the cursor to the item you want to reset.
- 2 Select [On].

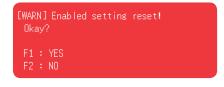
Select [Off] for the groups of settings that you do not want to reset.





- **3** Move the cursor to [System Reset].
- 4 Select [Exec].

A confirmation dialog box will appear.



5 Select [YES].

To cancel resetting, select [NO].

Resetting is complete when "System initialized" is displayed.

#### 19.2.2 Reset Waveform Data

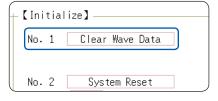
Discard the waveform data saved in memory and reset the data.

#### Procedure

Press the SYSTEM key to open the System screen, and then select the [init] sheet.

- 1 Move the cursor to [Clear Wave Data].
- 2 Select [Exec].

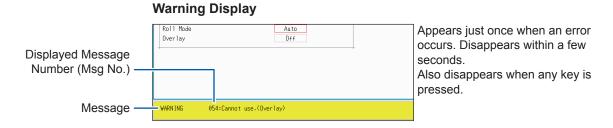
Resetting is complete when "Waveform data erased." is displayed.



## 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 beep may sound if the beeper setting on the **[Environment]** sheet is **[Warn]** or **[Warn+Action]**. Refer to "15 System Environment Settings" (p. 313).



## **Displayed Warnings**

Msg No.	Message	Remedy	References
3	Out of paper.	Load more paper.	"2.4 Load Instrument With
4	Printer lever is open.	Close the printer lever.	Recording Paper (When Model U8350 Printer Unit is installed)" (p. 48)
5	Recording length is set to Continuous.	When the Recording Length (Shot) is set to Continuous ([Cont.] [On]), real-time printing is not available with fast timebase settings.	"3.3.3 Recording Length (Number of Divisions)" (p. 63)
6	Cannot set. (Time/Div 10ms to 200ms).	When the Recording Length (Shot) is set to Continuous ([Cont.] [On]), the printer cannot be used.	
10	Mount media.	Set the recording media.	"2.3 Prepare Storage Media" (p. 45)
11	Illegal format.	Wrong recording format. Reformat the media.	"2.3.2 To Format Storage Media" (p. 47)
12	Cannot write.	Write-protection is enabled on the storage media. Disable it.	_
13	Disk full while accessing the file.	Saving is not possible because of insufficient space on the storage media. Delete files or replace the storage media.  If measuring, stop measurement then replace the storage media.	"5.5.4 Delete Files and Folders" (p. 107)
14	File is read only.	File is read only. Deletion is not permitted.	_
15	Access to the file was denied.	An internal fault may have occurred in the instrument. Turn the instrument off and back on	_
16	The file name already exists: cannot save.	Change the file name.	"5.5.6 Rename Files and Folders" (p. 109)
17	The folder name already exists.	Change the folder name.	

Msg 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 to another saving destination.	_
19	Folder not empty.	The folder is not empty, be sure you want to delete.	_
20	The maximum length of a file name, including its path, is 255 characters.	File names including the path must not exceed 255 characters.	_
21	Internal error.	An internal error occurred. Check the storage media.	_
22	No waveform data to save.	Acquire waveform data.	_
24	There is no calculation result.	There is no calculation result. Print results after performing calculation.	"10 Numerical Calculation Functions" (p. 217)
25	Cannot select this media.	You cannot select this medium as a destination of auto-saving. Select another medium.	_
26	Invalid folder path.	Route cannot be specified.	_
27	When executing, select "No" as the save property.	As other dialogs are displayed, selective saving cannot be carried out. Either set selective saving during execution to [No] or close the dialog and re-save.	"5.2.3 Save Data Selectively (SAVE Key)" (p. 94)
28	Pressed key invalid (waveform evaluation).	Unable to perform operation because waveform evaluation is enabled. Turn [Off] waveform evaluation.	"14.3 Set the Waveform Evaluation Mode" (p. 304)
29	The recording length was restricted.	_	_
30	Auto-ranging failed.	Check the input signal.	"3.6 Measurement With Automatic Range Setting (Auto-ranging Function)" (p. 76)
31	AB cursor positions invalid.	The AB cursors overlap. Check the cursor positions.	"7.2 Specify a Waveform Range (AB Cursor)" (p. 131)
32	Zero-adjustment needed.	Perform zero-adjustment.	"2.7 Adjust the Zero Position (Zero-Adjust)" (p. 52)
33	Disabled key.	Close the dialog.	_
34	Invalid key pressed (Overlay)	The key operation is prohibited because Overlay is enabled. Set Overlay to [Off].	"8.3 Display New Waveforms Over Past Waveforms (Overlay)" (p. 154)
36	No trigger has been set.	Set trigger criteria.	"9 Trigger Settings" (p. 195)
38	Use of logic channels has reduced analog waveform resolution from 16 to 12 bits.	Using channels LA - LD reduces the resolution of CH1 to CH4 to 12 bits. Using channels LE - LH reduces the resolution of CH17 to CH20 to 12 bits.	"8.10 Detailed Settings for Modules" (p. 170)
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. 174)

		T		
Msg No.	Message	Remedy	References	
40	Voltage Sag triggering is disabled. (Valid time base range: 20 µs/div to 50 ms/div)	Voltage Sag triggering can be used only when the time base is between 20 µs/div to 50 ms/div	"9.3 Analog Signal Triggers" (p. 198)	
41	Channels that are not measurable will be assigned to X-Y.	Channel with specification exceeding [Used Ch] is selected. Change channel selection.	"8.4 Setting Channels to Use (Extending the Recording Length)" (p. 156)	
42	There is not enough data in the memory.	Measure the correct amount data required for calculation.	"11.1 Waveform Calculation Workflow" (p. 234)	
43	Stopped.	_	_	
44	Current clamp/sensor was recognized.	_	_	
45	Current clamp/sensor was disconnected.	Check the connection of the current clamp/sensor.	_	
46	Channels may no longer be able to be used by frequency units due to logic channel use.	If LA to LE or LD to LH are used, the frequency units cannot be used at channels CH1 to CH4 or CH17 to CH20 respectively.	"3.4.3 Logic Channel Settings" (p. 72)	
47	This module cannot be used because it is not AAF aligned.	Press the <b>SYSTEM</b> key to display the <b>[Init]</b> sheet.		
48	There are module on which AAF cannot be set to On because of lack of adjustment.	Execute [System Information] and check the software items.  If [Not AAF aligned] is displayed, send the module for repairs.	_	
50	Roll Mode is not available.	Roll Mode cannot be used when Overlay is enabled.	"8.2 Display Waveforms During Recording (Roll Mode)" (p. 153)	
51	Cannot use. (Pre Trigger)	The pre-trigger function is not available when using external sampling.	"17 External Control" (p. 343)	
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. 234)	
53	Cannot use. (Roll Mode, Memory Division, Wave Calculation)	If one function is in use, the other functions cannot be used.	"8.2 Display Waveforms During Recording (Roll Mode)" (p. 153)	
54	Cannot use.(Overlay)	The overlay function is not available when using the Roll mode.	"8.3 Display New Waveforms Over Past Waveforms (Overlay)" (p. 154)	
55	Cannot use. (Overlay, Memory Division, Wave Calculation)	If roll mode is in use, these functions cannot be used.	"8.2 Display Waveforms During Recording (Roll Mode)" (p. 153)	
56	Real-time printing is not available.	Recording Length (Shot) is set to Continuous ([Cont.] [On]). Real-time printing is not available when using the Recorder function and a fast timebase setting.	"3.3.3 Recording Length (Number of Divisions)" (p. 63) "6.2 Auto-print Settings" (p. 115)	

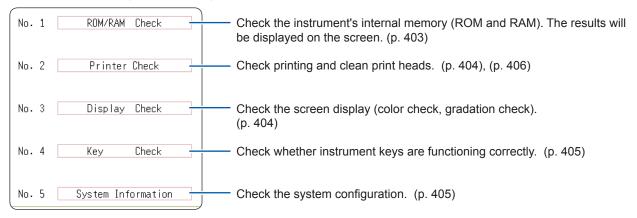
Msg No.	Message	Remedy	References	
57	Cannot set.(External sampling)	Cannot use roll mode when using external sampling.		
58	Rated capacity/rated output error.	Rated capacity/Rated output has exceeded selected range. Input correct value.	(p. 160)	
59	Cannot use. (Roll Mode, Wave Calculation)	If the memory division function is in use, these functions cannot be used.	"12.1 Recording Settings" (p. 247)	
60	No waveform data.	Acquire waveform data.	_	
68	Recording length is too long.	Shorten the measurement recording length. The maximum recording length that can be calculated is 40,000 div.	"3.3.3 Recording Length (Number of Divisions)" (p. 63)	
80	In key lock.	Keylock is engaged. Cancel the Key-Lock function.	"KEY LOCK" (p. 19)	
91	LAN: Bad IP address.	Check the IP address.	"16.1 LAN Connection and Settings	
95	LAN: Connection timed out.	Check the transmission settings.	(Before Using FTP/ Internet Browser/Command	
97	LAN: Network error.	Check the connection between the instrument and connection destination.	Communications)" (p. 318)	
100	Inappropriate setting of time axis for waveform data.	Return the timebase to the timebase setting when the waveform was measured.	"3.3.2 Timebase and Sampling Rate" (p. 60) "9.11 Use Trigger Settings to	
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 display blocks only.	Search Measurement Data" (p. 215)	
102	Some blocks are different in modules configuration from the others.	Unify the modules configuration of search target blocks. If they cannot be the same, set the search range to display blocks only.	"9.11 Use Trigger Settings to Search Measurement Data" (p. 215)	
103	No data matching your search condition.	Check the trigger setting.		
104	There is no data in the search target channel.	Select channels with measurement data in the search target.		
105	There is a block with no data in the search target channel.	Select blocks with measurement data in the search target.		
106	Some blocks are different in measurement mode of modules from the others.	Blocks with varying measurement modes cannot be searched.	_	
108	Some blocks are different in measurement mode of modules from the others.	Set the search range within the display blocks.	"9.11 Use Trigger Settings to Search Measurement Data" (p. 215)	
110	No space to store waveform data at copy location.	Create empty space by deleting waveform data from copy location.	(p. 191)	
111	No space to register arbitrary waveform data.	Create empty space by deleting waveform data from registration location.	(p. 191)	

## 19.4 Self-Test (Self Diagnostics)

The following self-test checks are available.

#### Procedure

Press the **SYSTEM** key to open the System screen, and then select the [init] sheet.



#### 19.4.1 ROM/RAM Check

This check tests the instrument's internal memory (ROM and RAM).

Performing a ROM/RAM check will erase measurement data.

Save measurement data to other media before performing the ROM/RAM check.

- Move the cursor to [ROM/RAM Check].
- 2 Select [Exec].

The ROM/RAM check will start.

The following checks are performed in the sequence shown.

Program ROM  $\rightarrow$  Address bus  $\rightarrow$  Backup RAM  $\rightarrow$  Work RAM  $\rightarrow$  Video RAM  $\rightarrow$  Storage RAM

Do not turn the power off during the check.

#### To cancel the check, press the STOP key.

The current check will be interrupted and the next one will start.

All operation keys (except **STOP** key) are disabled during execution of the check.

The judgment results appear when the checks finish.

**OK**: Normal

NG: Error

**ABORT**: When a check is interrupted

If "NG" appears, ask to have the instrument repaired.

Press any key to return to the original screen.



#### Procedure (Common to Printer Check, Display Check, Key Check, System Configuration Check)

Press the SYSTEM key to open the System screen, and then select the [init] sheet.

## 19.4.2 Printer Check (When Model U8350 Printer Unit is Installed)

This check tests the condition of the printer.

Before executing, check to be sure that recording paper is loaded.

- **1** Move the cursor to [Printer Check].
- 2 Select [Exec].

A test pattern will be printed.

About 5 cm of each of the following patterns will be printed, in order: Checkerboard  $\rightarrow$  Vertical lines  $\rightarrow$  Slanted lines  $\rightarrow$  Characters

To cancel the check, press the STOP key.

## Things to check after the printer check

Check the printed recording paper for white streaks.

If there are any white streaks, clean the print heads (p. 406)

Print quality (print speed) and print density settings will be reflected in the test printout.

## 19.4.3 Display Check

This check tests the condition of the display screen.

- 1 Move the cursor to [Display Check].
- 2 Select [Exec].

A red screen will appear.

3 Press any key to check the display condition.

The screen changes each time you press an operation key.

You will be returned to previous screen.

#### **Screen Changes**

Color check (Red, Green, Blue, Black, White) → Gradation check (Red, Green, Blue, Black, White) → Color pattern → Original screen.

If the display screen seems abnormal, request repairs.

## **19.4.4** Key Check

This check tests operation of the keys and jog/shuttle controls.

- 1 Move the cursor to [Key Check].
- Select [Exec].
  Operation keys will be displayed.
- **3** Press each operation key once or more.

The corresponding key will be highlighted over.

Jog: Rotate to the left and right, one time or more in each direction. Shuttle: Turn slowly all the way in each direction.

(The **START** key also functions as an LED light check key.)

The check is finished when you have operated all the keys.

To cancel the check, press the START and STOP keys simultaneously

You will be returned to 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, please request repairs.

If there is a problem with the **STOP** or **START** key, you cannot return to the previous screen. Power the instrument off and request repairs.

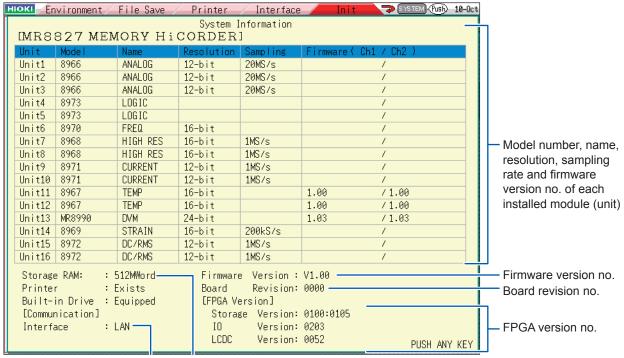
## 19.4.5 System Configuration Check

The list of installed options and other system information will be displayed in a separate window.

- **1** Move the cursor to [System Information].
- 2 Select [Exec].

The [System Configuration] List will be displayed.

To return to the previous screen, press any key.



Currently selected Internal memory interface capacity

# 19.5 Cleaning

## Print Head Cleaning (When Model U8350 Printer Unit is installed)

## **MARNING**



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.

## **To Clean the Print Head**

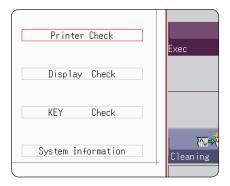
#### **Before Cleaning**

Recording paper is required to clean the print head. Verify that the recording paper is loaded correctly.

- 1 Press the SYSTEM key to display the [Init] sheet.
- 2 Move the cursor to [Printer Check].
- 3 Select [Exec].

If printing is blurred, wash the printer head.

By selecting [Cleaning], paper dust can be cleared readily. If sufficient improvement is not obtained even after cleaning several times, wash the print head.



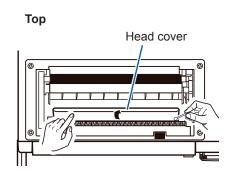
### **To Wash the Print Head**

Required item: Undiluted alcohol, Cotton swab

1 Moisten the end of a cotton swab with undiluted alcohol.

Be careful not to apply too much undiluted alcohol.

Open the head cover and wipe the print head with the tip of the cotton swab.



#### **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 should have no effect on printing, but can be removed with a commonly 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 by the print head.

### **To Clean the Instrument and Modules**

## **ACAUTION**



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.

- 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.

# 19.6 Dispose of the Instrument (Lithium Battery Removal)

The instrument contains a lithium battery for memory backup. Remove this battery before disposing of the instrument.

## **MARNING**



- 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.



• The battery may explode if mistreated. Do not short-circuit, recharge, disassemble or dispose of in fire.

When disposing of this instrument, remove the lithium battery and dispose of battery and instrument in accordance with local regulations.

#### **CALIFORNIA, USA ONLY**

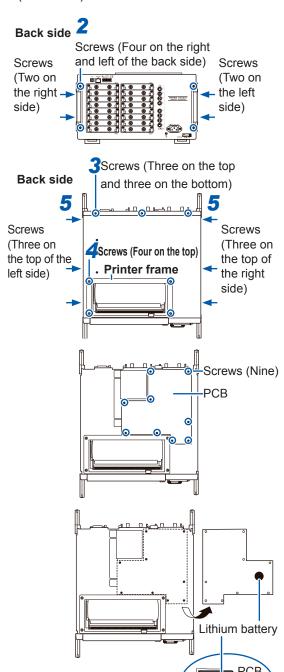
Perchlorate Material - special handling may apply. See www.dtsc.ca.gov/hazardouswaste/perchlorate

## **Removing the Lithium Battery**

Required items: Philips screwdriver, wire cutter, hex wrench (One each)

- 1 Ensure that the power is off, and remove the connection cables and power cord.
- 2 Remove the handle by removing the screws securing it (four on the right and left of the back side, two on the right side, two on the left side).
- 3 Remove the back side cover by removing three screws on the top and bottom respectively.
- 4 Remove the printer frame by removing the screws securing it (four on the top).
- 5 Remove the top cover by removing three screws on the top of the right side and the top of the left side respectively.
- 6 Remove the nine screws securing the circuit board.

- 7 Flip the circuit board.
- Pull the lithium battery up from the circuit board, and cut the two leads at the positive and negative electrodes with a wire cutter.
- 9 Remove the battery from the board.



Dispose of the Instrument (Lithium Battery Removal)



# **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
		Shot	25 div
		Format (Memory / Recorder)	Single
		Format (X-Y Recorder)	X-Y Single
		Roll Mode (Memory)	Auto
		Used Ch (Memory)	32 channels
		Dots-Line (X-Y Recorder)	Line
	Num Calc.	Numerical Calc	Off
System	Environment	Grid	Dotted Line
		Time Val	Time
		Beep Sound	Warn
		Auto Scal	On
	File Save	Auto Save	Off
	Printer	Auto Print	Off
		Grid	Standard
		Ch Mark	Ch No.
		Time Val	Time
		Mag/Comp	Same to display
		Copy GUI	Yes
		Print Area	All Wave
	Interface	Interface	LAN
		USB Set	USB Memory
Channel	Unit List	Wave_Disp (analog)	Color 1 - 16
		Wave Density	Standard
		Wave_Disp (Logic)	Off
		Logic Width	Normal
		Range	Maximum sensitivity
		Coupling	DC
	Scaling	Disp	Ratio
		Each channel	Off
	Comment	Print Comment (Title)	Setting
		Print Comment (Analog)	Setting
		Print Comment (Logic)	Off
Waveform	Trigger settings window	Trigger Mode (Memory)	Auto
		Trigger Mode (Recorder)	Single
		PreTrigger (Memory)	0%
		Trigger Source	OR
		Timing	Start
		Trigger for each module	Off
		Timer Trigger	Off
		External Trigger	Off

# **Appx. 2 For Reference**

## Appendix 2.1 Waveform File Sizes

#### References

File Type	Function	Size	Calculation method
MEM File	Memory Function	(p. A2)	(p. A4)
REC File	Recorder Function	(p. A2)	(p. A4)
FFT File	FFT Function	(p. A3)	(p. A4)
XYC File	X-Y Recorder Function	(p. A3)	(p. A4)
CSV (Text) File	Memory Function	(p. A3)	(p. A4)
	Recorder Function	(p. A4)	(p. A4)

### References of the File Size

**MEM File Size (Memory Function)** 

File size = setting size + data size Calculation method: "MEM File" (p. A4)

Recording Saved channels					hannels		
length (div)	Data quantity	1	2	4	8	16	32
100	10,001	48 KB	68 KB	108 KB	188 KB	349 KB	669 KB
1,000	100,001	224 KB	420 KB	811 KB	1.6 MB	3.1 MB	6.1 MB
10,000	1,000,001	1.9 MB	3.8 MB	7.7 MB	15 MB	31 MB	61 MB
100,000	10,000,001	19 MB	38 MB	76 MB	153 MB	305 MB	610 MB
1,000,000	100,000,001	191 MB	381 MB	763 MB	-	-	-

## REC File Size (Recorder Function)

Filesize = setting size + data size Calculation method: "REC File" (p. A4)

Recording	Data quantity	Saved channels					
length (div)	Data quantity	1	2	4	8	16	32
100	10,001	68 KB	107 KB	186 KB	345 KB	661 KB	1.3 MB
1,000	100,001	419 KB	810 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
50,000	5,000,001	19 MB	38 MB	76 MB	153 MB	305 MB	610 MB

## FFT File Size (FFT Function)

File size = header size + size of time axis data + size of mid-term data Calculation method: "FFT File" (p. A4)

Data quantity	Number of calculations				
Data quantity	1	2			
1,000	388 KB	729 KB			
2,000	728 KB	1.4 MB			
5,000	1.7 MB	3.4 MB			
10,000	3.4 MB	6.7 MB			

## **XYC File Size (X-Y Recorder Function)**

File size = setting size + data size Calculation method: "XYC File" (p. A4)

Data quantity	Saved channels							
Data quantity	1	2	4	8	16			
10,000	49 KB	69 KB	109 KB	189 KB	350 KB			
100,000	225 KB	421 KB	812 KB	1.6 MB	3.1 MB			
1,000,000	1.9 MB	3.8 MB	7.7 MB	15 MB	31 MB			
2,000,000	3.8 MB	7.7 MB	15 MB	31 MB	61 MB			
16,000,000	31 MB	61 MB	122 MB	244 MB	488 MB			

## CSV (Text) File Size (Memory Function)

File size = header size + data size Calculation method: "CSV (Text) File" (p. A4)

Recording	Pote quantity Saved channels						
length (div)	Data quantity	1	2	4	8	16	32
100	10,001	313 KB	450 KB	723 KB	1.2 MB	2.3 MB	4.4 MB
1,000	100,001	3.1 MB	4.4 MB	7.1 MB	12 MB	23 MB	44 MB
10,000	1,000,001	31 MB	44 MB	71 MB	124 MB	231 MB	444 MB
100,000	10,000,001	305 MB	439 MB	706 MB	1.2 GB	2.3 GB	4.3 GB
1,000,000	100,000,001	3.0 GB	4.3 GB	6.9 GB	-	-	-

Appx.

## **CSV** (Text) File Size (Recorder Function)

File size = header size + data size

Calculation method: "Recorder Function" (p. A4)

When saving, CSV (text) files longer than 2 GB are segmented into files of 2 GB each.

Recording	Data quantity		Saved channels				
length (div)	Data quantity	1	2	4	8	16	32
100	10,001	450 KB	723 KB	1.2 MB	2.3 MB	4.4 MB	8.7 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
50,000	5,000,001	219 MB	353 MB	620 MB	1.1 GB	2.2 GB	4.3 GB

#### Waveform File Size Calculation Method

#### **MEM File**

## File size (bytes) = setting size\*1 + data size\*2

- \*1: (Setting size) =28672 + 512 × [(number of analog channels) + 4 × (number of logic units) + (number of waveform calculation channels)]
- \*2: (Data size) =  $2 \times [(number of analog channels) + (number of logic units) + <math>2 \times (number of waveform calculation channels)] \times (number of data)$

#### **REC File**

#### File size (bytes) = setting size\*1 + data size\*2

- \*1: (Setting size) = 28672 + 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) = 30720 + 512 × [(number of analog channels) + (number of waveform calculation channels) + (number of FFT calculation channels) + 1]
- \*2: (Size of time axis data) =  $[(number of analog channels) + 2 \times (number of waveform calculation channels)] \times (number of data) (*4)$
- \*3: (Size of mid-term data) = [346 × (number of FFT points) + 836] × (number of FFT calculation channels) (\*4) (Depending on the measurement conditions, the file size may also increase or decrease from calculation formula results)

#### **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)

#### **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) =  $[18 + 28 \times (number of saved analog channels) + 4 \times (number of logic channels)] \times (number of data)$

# Appx.

## Appendix 2.2 Configuration and Image Data File Size Settings

File	Size
Setting file	33 KB
BMP (No color compression)	470 KB
BMP (Gray scale/No compression)	470 KB
BMP (B/W/No compression)	59 KB
BMP (B/W Reverse/No compression)	59 KB

## **Appendix 2.3** Timebase and Maximum Recordable Time

The maximum available recording time of the Memory function depends on the selected timebase. The maximum recording time can be obtained by the following formula.

Recordable Time
= Timebase × Recording Length

Recordable time can be verified on the Status screen - [Status] sheet. ([Recording period])

- Setting a slow timebase may result in a very long recording time (over a year) which may exceed the guarantee period or product life, in which case we cannot guarantee operation.
- The maximum recording length also depends on the number of channels used.
- When using the X-Y Recorder function, the maximum number of samples is 16,000,000.

## **Recorder Function**

Timebase/div	Maximum recording length: 80,000 div
10 ms	13 min 20 s
20 ms	26 min 40 s
50 ms	1 h 6 min 40 s
100 ms	2 h 13 min 20 s
200 ms	4 h 26 min 40 s
500 ms	11 h 6 min 40 s
1 s	22 h 13 min 20 s
2 s	1 d 20 h 26 min 40 s
5 s	4 d 15 h 6 min 40 s
10 s	9 d 6 h 13 min 20 s
30 s	27 d 18 h 40 min 0 s
50 s	46 d 7 h 6 min 40 s
1 min	55 d 13 h 20 min 0 s
100 s	92 d 14 h 13 min 20 s
2 min	111 d 2 h 40 min 0 s
5 min	277 d 18 h 40 min 0 s
10 min	
30 min	
1 h	

(d: days/h: hours/min: minutes/s: seconds)

\* When recording length is set to [Cont.], the maximum recording length is 80,000 div.

## **Memory Function**

		Maximum recording
I	Sampling rate	Maximum recording length
Timebase/div		32 channels
		160,000 div
5 µs	50 ns	0.8 s
10 µs	100 ns	1.6 s
20 µs	200 ns	3.2 s
50 µs	500 ns	8 s
100 µs	1 µs	16 s
200 μs	2 µs	32 s
500 µs	5 µs	1 min 20 s
1 ms	10 µs	2 min 40 s
2 ms	20 µs	5 min 20 s
5 ms	50 µs	13 min 20 s
10 ms	100 µs	26 min 40 s
20 ms	200 µs	53 min 20 s
50 ms	500 µs	2 h 13 min 20 s
100 ms	1 ms	4 h 26 min 40 s
200 ms	2 ms	8 h 53 min 20 s
500 ms	5 ms	22 h 13 min 20 s
1 s	10 ms	1 d 20 h 26 min 40 s
2 s	20 ms	3 d 16 h 53 min 20 s
5 s	50 ms	9 d 6 h 13 min 20 s
10 s	100 ms	18 d 12 h 26 min 40 s
30 s	300 ms	55 d 13 h 20 min 0 s
50 s	500 ms	92 d 14 h 13 min 20 s
1 min	600 ms	111 d 2 h 40 min 0 s
100 s	1 s	185 d 4 h 26 min 40 s
2 min	1.2 s	222 d 5 h 20 min 0 s
5 min	3 s	

(d: days/h: hours/min: minutes/s: seconds)

# Appx.

# Appendix 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 divisions.

## Desired Recording length

The number of divisions (blocks)	Maximum recording length (div)
2	80,000
4	40,000
8	20,000
16	10,000
32	5,000
64	2,500
128	1,200
256	600
512	300
1024	150

## Fixed Recording length

The number of divisions (blocks)	Maximum recording length (div)
2	50,000
4	20,000
8	20,000
16	10,000
32	5,000
64	2,000
128	1,000
256	500
512	200
1024	100

## **Appendix 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 for stress depends on how the strain gauges are used. Three methods are available depending on whether one, two or four strain gauges are used for measurement. The two-gauge method is used for temperature compensation.

E: Young's modulus, v: Poisson's ratio,  $\epsilon$ : Distortion measurement value

Tensile and Compressive Stress Measurement: Stress ( $\sigma$ ) = E ×  $\epsilon$ 

For temperature compensation with two or four gauges, position the gauges perpendicularly. Stress ( $\sigma$ ) is obtained by 1 / (1 +  $\nu$ ) for two gauges, and by 1 / {2 (1 +  $\nu$ )} for four gauges.

Bending Stress Measurement: Stress ( $\sigma$ ) = E ×  $\epsilon$ 

For temperature compensation with two or four gauges, stress ( $\sigma$ ) is obtained as a multiple of  $\frac{1}{2}$  or  $\frac{1}{4}$ , respectively.

Torsional Stress Measurement: Stress ( $\sigma$ ) = E / {2 (1 +  $\nu$ )} ×  $\epsilon$  (with two gauges) When using four gauges, that 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 for an aluminum measurement object with a Young's modulus of 73 (GPa) according to the following calculation:

- $\sigma = 73 \times 10^9 \times \text{Measurement Value (in } \mu\epsilon \text{ units)} \times 10^{-6} \text{ (in } \mu\epsilon \text{ units)}$ 
  - = 73 × Measurement Value (in kPa units)
  - = 7.44\* × Measurement Value (in gf/mm² units)
  - \* 1 Pa =  $1.01971621 \times 10^{-7} \text{ kgf/mm}^2 = 1 \text{N/m}^2$

Unit: gf/mm<sup>2</sup>, Conversion Ratio = 7.44 gf/mm<sup>2</sup>

Enter this value as the scaling conversion ratio

#### Mechanical properties of industrial materials

Material	Modulus of Elasticity (Young's Modulus)	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 Convert Input Values (Scaling Function)" (p. 157).

## **Appx. 3 About Options**

## **Appendix 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.

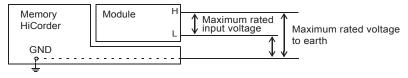
For details of cables and clamp sensors for connecting to the modules and the instrument, refer to manual supplied with them. Items indicated "specify when ordering" are not user-installable. For new purchases, contact your Hioki distributor.

#### **Modules (Measurement amplifiers)**

These are installed by insertion into the compartments on the right side of the instrument. Modules can be swapped out as needed.

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)
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.
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	2	200 K3/S	TO DIES	-	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 preamplifier, 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 Module Specifications" (p. 368).



## **Module (for generation)**

These modules can be installed along with a measurement module.

Application	Model	Number of channels	Maximum output frequency	Output voltage
Arbitrary 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 V to 5 V

## Measurement probes, cords, and clamp sensors

Application	Model	Description	Maximum input voltage	Maximum rated voltage to earth
	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		300 V AC, DC	600 V AC, DC
	Model L9790 Connection Cable	For low voltage	600 V AC, DC	600 V AC, DC (CAT II) 300 V AC, DC (CAT III)
	Model L9217 Connection Cable	Isolated BNC-Isolated BNC	300 V AC, DC	-
Voltage measurement	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 (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 (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 9320-01 Logic Probe	Four channels, for detecting voltage and closed/open contact points	-	-
Logic signal input	Model MR9321-01 Logic Probe	Four isolated channels, for detecting voltage and closed/open contact points (for small terminal types and 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)	-	-

Application	Model	Description	Maximum input voltage	Maximum rated voltage to earth
	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	-	-
AC/DC	Model CT6844 AC/DC Current Probe	500 A, DC to 200 kHz	-	-
Model CT955X or 9318	Model CT6845 AC/DC Current Probe	500 A, DC to 100 kHz	-	-
is required for connection.	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	-	-
Dedicated for AC  Model CT955X or 9318 is required for connection.	Model 9272-10 Clamp On Sensor	20 A / 200 A, 1 Hz to 100 kHz	-	-
Dedicated for	Model 9018-50 Clamp On Probe	10 A to 500 A, 40 Hz to 3 kHz	-	-
AC	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)	-	-
Others For connecting to a module for voltage measurement	Model CT9555, CT9556, and CT9557 Sensor Unit	For Model 9272-10, 9709, CT6841, CT6843, CT6844, CT6845, CT6846, CT6862, CT6863, CT6865	-	-
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	-	-

For more information on the output rate of a clamp sensor, see the indication on each clamp sensor or the instruction manual.

## Printer

i illitoi			
Printer Unit	Model U8350 Printer Unit	Specify when ordering	
Recording Paper	Model 9231 Recording Paper	A4 width × 30 m, one set of 6 rolls	

## Storage media

SSD Unit	Model U8330 SSD Unit	Built-in SSD drive (specify when ordering)
	Model 9728 PC Card 512M	512MB, with adapter
CF Card	Model 9729 PC Card 1G	1GB, with adapter
	Model 9830 PC Card 2G	2GB, with adapter

## Software

Application Software	Model 9333 LAN Communicator
Application Software	Model 9335 Wave Processor

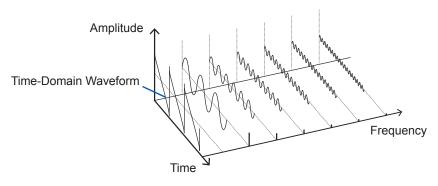
## **Appx. 4 FFT Definitions**

#### ■ 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:

$$X(k) = DFT\{x(n)\} = \sum_{n=0}^{N-1} X(n)W_N^{kn} \quad ....$$
 (1)

$$x(n) = IDFT\{X(k)\} = \frac{1}{N} \sum_{n=0}^{N-1} X(k) W_N^{-kn} .....(2)$$

$$W_N = \exp\left(-j\frac{2\pi}{N}\right)....(3)$$

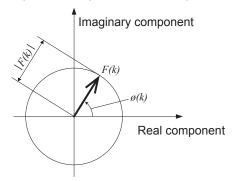
X(k) is typically a complex number, so expression (1) can be transformed again and written as follows:

$$F(k) = |F(k)| \exp\{j\phi(k)\} = |F(k)| \angle \phi(k)$$
 (4)

$$\phi(k) = \tan^{-1} \frac{\text{Im}\{X(k)\}}{\text{Re}\{X(k)\}}$$
 (5)

|F(k)|: Amplitude spectrum,  $\phi(k)$ : Phase spectrum

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  $y_i(n) = L[x_i(n)]$ .

$$L[A_1x_1(n) + A_2x_2(n)] = A_1y_1(n) + A_2y_2(n) .....$$
 (6)

If the system function of an LTI system is h(n), the input/output relationship can be obtained by the next expression.

$$y(n) = \sum_{m=0}^{\infty} h(n)x(n-m) = \sum_{m=-\infty}^{\infty} h(n-m)x(m) .....(7)$$

Therefore, when a unit impulse  $\delta(n)$  (which is 1 when n = 0, and 0 when  $n \neq 0$ ) is applied to x(n), the input/output relationship is:

$$y(n) = h(n)....$$
(8)

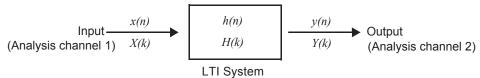
This means that when the input signal is given as a unit impulse, the output is the LTI system characteristic itself. The response waveform of a system to a unit impulse is called the **impulse response**.

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:

$$Y(k) = X(k)H(k). (9)$$

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).



#### ■ 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.

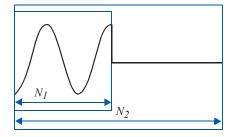
A. When measurements are made with the averaging function disabled (Off)

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.

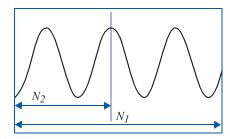
#### (1) When $N_1 < N_2$

- 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.



Appx.

#### 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:

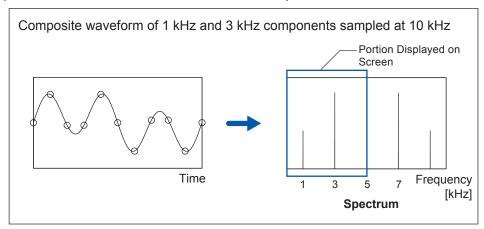
$$f_s = 2f_{max} (10)$$

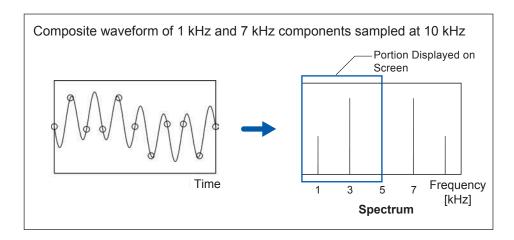
Therefore, if the input includes a frequency component higher than  $f_s/2$ , it is observed as a lower frequency (alias) that does not really exist.

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 fs 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 and 7 kHz components is indiscernible.

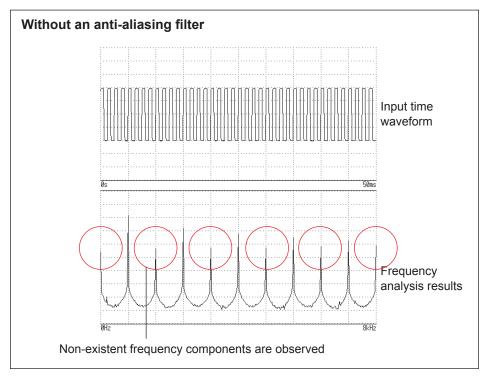


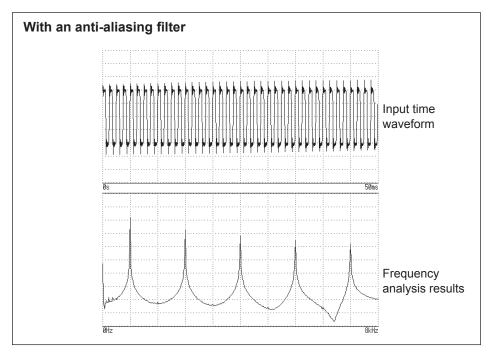


# ■ Anti-Aliasing Filters

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.

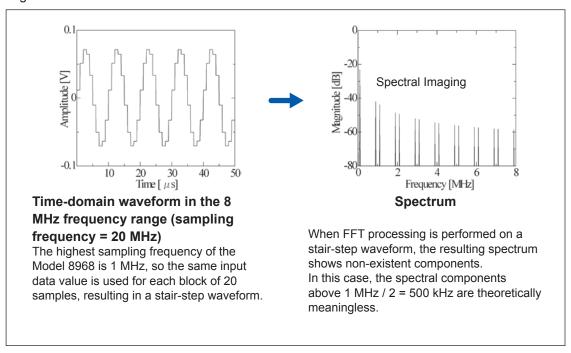


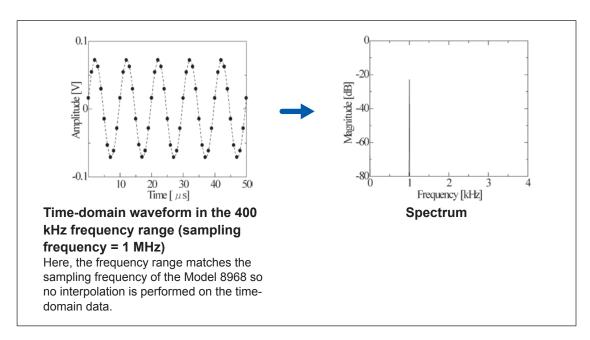


#### **Imaging**

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.





To avoid imaging phenomena when analyzing waveforms with the FFT function, verify the maximum sampling frequency of the module before measuring.

# Appx.

## 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.

$$A_n = \frac{(n-1)A_{n-1} + Z_n}{n}$$
 (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.

$$A_n = \frac{(N-1)A_{n-1} + Z_n}{N}$$
 (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

$$(Over all) = \sum_{i=0}^{\infty} P_i$$
 (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

$$(Over all) = \sqrt{\sum_{i=0} P_i}$$
 (13-2)

*P<sub>i</sub>*: 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.

THD = 
$$\sqrt{\frac{\sum (V_n)^2}{(V_0)}} \times 100 \text{ [\%]}...$$
 (14)

 $V_0$  = fundamental wave

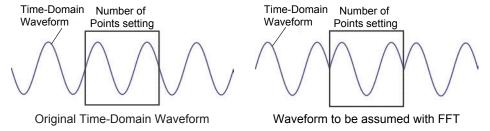
 $V_n$  = next higher harmonic

#### **■** Window Function

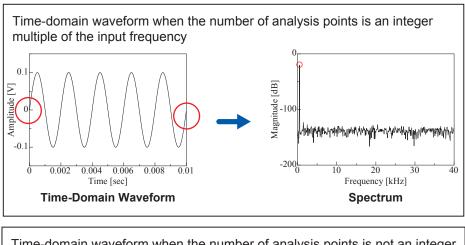
The Fourier transform of a continuous system is defined by the integral Calculus in expression (15) for the time range from minus infinity to plus infinity.

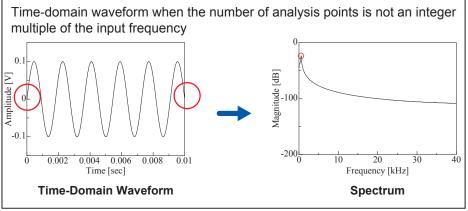
$$X(f) = \int_{-\infty}^{\infty} x(t) \, \varepsilon^{-2\pi f t} dt \qquad (15)$$

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).



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).

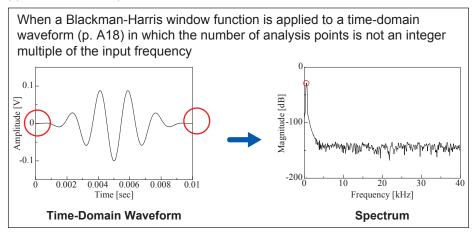




The window function was created to suppress such leakage errors. The window function smoothly connects each end of the time-domain waveform where it is cut off.

The following figure presents an example of spectral analysis by applying a window function to a time-domain waveform.

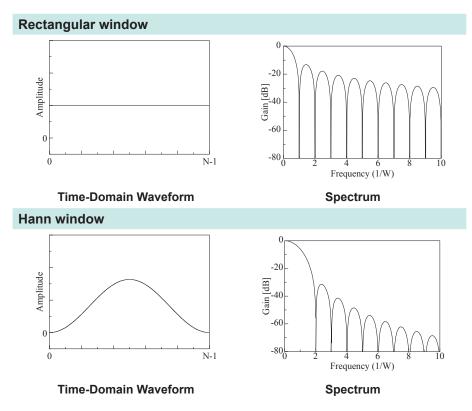
Using the window function, discontinuous points on the time-domain waveform are eliminated, so the wave shape approaches a line spectrum.

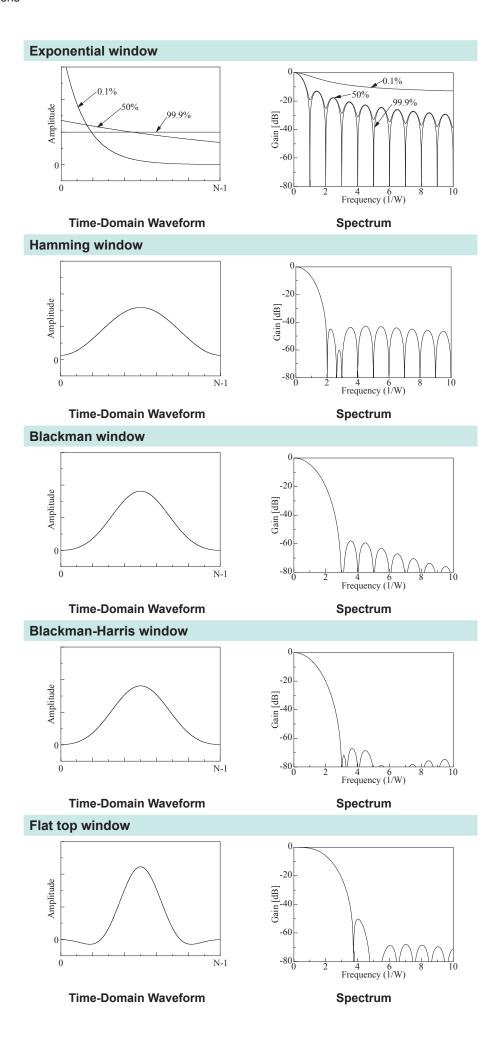


The following figure shows the time-domain waveform of the window function and its spectrum. Each spectrum shows a large peak at a low frequency, and many smaller peaks at higher frequencies. The largest peak is called the **main lobe**, and the smaller peaks are the **side lobes**.

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.

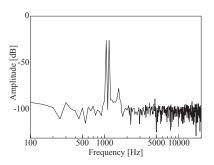
However, the main lobe width is proportional to the width (1/W) of the window so increasing the number of analysis points increases the frequency resolution.



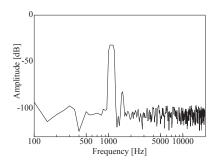


The following example shows input sine waves of 1050 and 1150 Hz analyzed with different window functions.

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.



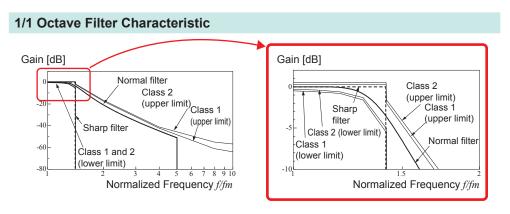


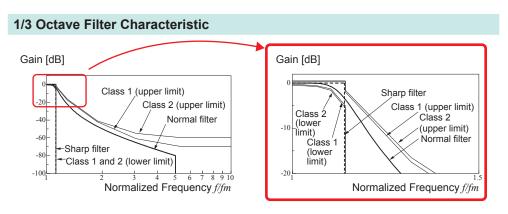


Analysis Using a Hann Window

#### ■ 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.

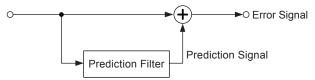




# ppx.

## ■ 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  $\Delta T$ , LPC analysis presumes the following relationship between current sample value  $x_t$  and the value of previous sample p.

$$x_{t} + \alpha_{t}x_{t-1} + \alpha_{2}x_{t-2} + \dots + \alpha_{p}x_{t-p} = \varepsilon_{t}.$$
 (16)

However,  $\{\varepsilon_t\}$  is an uncorrelated random variable with average value 0 and the dispersion  $\sigma^2$ . Expression (16) shows how current sample value  $x_t$  can be "linearly predicted" from previous sample values.

values.  $^{\land}$  If the predicted value of  $x_t$  is actually  $_{x_t}$ , expression (16) can be transformed as follows.

$$x_t = \sum_{t=1}^{n} \alpha_t x_t + \varepsilon_t = \sum_{t=1}^{p} \alpha_t x_{t-t} + \varepsilon_t$$
 (17)

Here,  $\alpha i$  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**



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.



Call us: 400-806-2189