HIOKI

INSTRUCTION MANUAL

9540-01

FUNCTION UP DISK

HIOKI E. E. CORPORATION

Contents

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Introduction

Thank you for purchasing this HIOKI "9540-01 FUNCTION UP DISK."
To get the maximum performance from the unit, please read this manual first, and keep this at hand.

Inspection

- When the unit is delivered, check and make sure that it has not been damaged in transit. In particular, check the accessories, panel switches, and connectors.
- If the unit is damaged, or fails to operate according to the specifications, contact your dealer or HIOKI representative.

Accessories

FUNCTION UP DISK	2
Instruction Manual	1
User registration card	1

Safety Notes

⚠ DANGER **This product is designed to conform to IEC 61010 Safety Standards, and has been thoroughly tested for safety prior to shipment. However, mishandling during use could result in injury or death, as well as damage to the product. Be certain that you understand the instructions and precautions in the manual before use. We disclaim any responsibility for accidents or injuries not resulting directly from product defects.**

This manual contains information and warnings essential for safe operation of the product and for maintaining it in safe operating condition. Before using the product, be sure to carefully read the following safety notes.

Safety symbols

	• This symbol is affixed to locations on the equipment where the operator should consult corresponding topics in this manual (which are also marked with the ⚠ symbol) before using relevant functions of the equipment. • In the manual, this mark indicates explanations which it is particularly important that the user read before using the equipment.
	Indicates a grounding terminal.
	Indicates AC (Alternating Current).
	Indicates DC (Direct Current).
	Indicates both DC (Direct Current) and AC (Alternating Current).
	Indicates the ON side of the power switch.
	Indicates the OFF side of the power switch.

Conventions used in this manual

The following symbols are used in this Instruction Manual to indicate the relative importance of cautions and warnings.

⚠ DANGER	Indicates that incorrect operation presents extreme danger of accident resulting in death or serious injury to the user.
⚠ WARNING	Indicates that incorrect operation presents significant danger of accident resulting in death or serious injury to the user.
⚠ CAUTION	Indicates that incorrect operation presents possibility of injury to the user or damage to the equipment.
NOTE	Denotes items of advice related to performance of the equipment or to its correct operation.

Measurement categories (Overvoltage categories)

The 8835-01 conforms to the safety requirements for CAT II measurement products.

To ensure safe operation of measurement instruments, IEC 61010 establishes safety standards for various electrical environments, categorized as CAT I to CAT IV, and called measurement categories. These are defined as follows.

CAT Ⅰ: Secondary electrical circuits connected to an AC electrical outlet through a transformer or similar device.

CAT Ⅱ: Primary electrical circuits in equipment connected to an AC electrical outlet by a power cord (portable tools, household appliances, etc.)

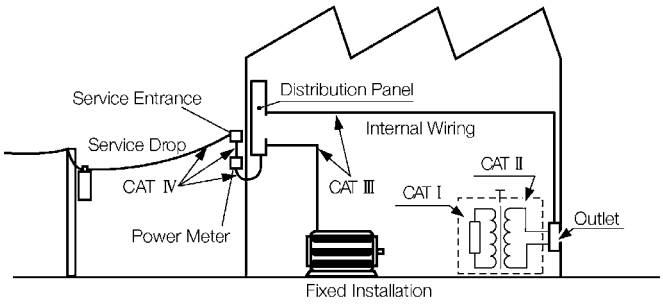
CAT Ⅲ: Primary electrical circuits of heavy equipment (fixed installations) connected directly to the distribution panel, and feeders from the distribution panel to outlets.

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

Higher-numbered categories correspond to electrical environments with greater momentary energy. So a measurement device designed for CAT III environments can endure greater momentary energy than a device designed for CAT II. Using a measurement instrument in an environment designated with a higher-numbered category than that for which the instrument is rated could result in a severe accident, and must be carefully avoided.

Never use a CAT I measuring instrument in CAT II, III, or IV environments.

The measurement categories comply with the Overvoltage Categories of the IEC60664 Standards.



Notes on Use

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

(1) Installation environment

⚠ WARNING **Do not use the 8835-01 where it may be exposed to corrosive or combustible gases. The product may be damaged or cause an explosion.**

⚠ CAUTION

- The 8835-01 should be installed and operated indoors only, between 5 and 40℃ and 35 to 80% RH.
- Do not store or use the product where it could be exposed to direct sunlight, high temperature or humidity, or condensation. Under such conditions, the product may be damaged and insulation may deteriorate so that it no longer meets specifications.
- The 8835-01 is not designed to be entirely water- or dust-proof. To avoid damage, do not use it in a wet or dusty environment.

(2) Power supply connections

⚠ WARNING

- **Before turning the 8835-01 on, make sure the source voltage matches that indicated on the product's power connector. Connection to an improper supply voltage may damage the product and present an electrical hazard.**
- **Before making connections, make sure the 9439 DC POWER ADAPTER is turned off. The 8835-01 could be damaged by a spark if it is connected to a voltage source while its power supply is on.**

・Check that the power supply is correct for the rating of the 8835-01. (The AC fuse is integrated in the 8835-01.)
・The AC power power switch on 8835-01 is for AC power. If DC power is being supplied and the switch on DC power adapter is set to ON, the 8835-01 will operate also if the power switch is set to OFF.

(3) Grounding the 8835-01

⚠ WARNING **To avoid electric shock and ensure safe operation, connect the power cable to a grounded (3-contact) outlet.**

(5) Probe Connection, Measurement Voltage Input

⚠ DANGER

- **Maximum input voltage ratings for the 8936 ANALOG UNIT, 8937 VOLTAGE/TEMP UNIT, 8938 FFT ANALOG UNIT, 8939 STRAIN UNIT 8940 F/V UNIT, 8946 4ch ANALOG UNIT, 8947 CHARGE UNIT and input terminals of the 8835-01 are shown below. To avoid the risk of electric shock and damage to the unit, take care not to exceed these ratings.**
- **The maximum rated voltage to earth of the 8936, 8937, 8938, 8939, 8940, 8946 and 8947 (voltage between input terminals and 8835-01 frame ground, and between inputs of other input units) is shown below. To avoid the risk of electric shock and damage to the unit, take care that voltage between channels and between a channel and ground does not exceed these ratings.**
- **The maximum rated voltage to earth rating applies also if an input attenuator or similar is used. Ensure that voltage does not exceed these ratings.**
- **When measuring power line voltages with the 8936 or 8938, always connect the probe to the secondary side of the circuit breaker. Connection to the primary side involves the risk of electric shock and damage to the unit.**
- **Always use the optional connection cables. Any exposed metal sections in a connection cable consist a risk of electric shock.**

<table>
<tr><th>Input/output terminal</th><th>Maximum input voltage</th><th>Maximum rated voltage to earth</th></tr>
<tr><td>8936 inputs</td><td>400 VDC max.</td><td>370 V AC/DC</td></tr>
<tr><td>8937 inputs</td><td>30 V rms or 60 VDC</td><td>30 V rms or 60 VDC</td></tr>
<tr><td>8938 inputs</td><td>400 VDC max.</td><td>370 V AC/DC</td></tr>
<tr><td>8939 inputs</td><td>10 VDC max.</td><td>40 VDC</td></tr>
<tr><td>8940 inputs</td><td>30 V rms or 60 VDC
(BNC and sensor connector terminals)</td><td>30 V rms or 60 VDC
(BNC terminal)
Not insulated
(Sensor connector terminal)</td></tr>
<tr><td>8946 inputs</td><td>30 V rms or 60 VDC</td><td>30 V rms or 60 VDC</td></tr>
<tr><td>8947 inputs</td><td>30 V rms or 60 VDC</td><td>30 V rms or 60 VDC</td></tr>
<tr><td>EXT TRIG</td><td rowspan="3">-5 to +10 VDC</td><td rowspan="6">Not insulated</td></tr>
<tr><td>START/STOP</td></tr>
<tr><td>PRINT/EXT SMPL</td></tr>
<tr><td>TRIG OUT</td><td rowspan="3">-20 V to +30 VDC
100 mA max.
200 mW max.</td></tr>
<tr><td>GO</td></tr>
<tr><td>NG</td></tr>
</table>

- **The external I/O terminal and the 8835-01 have a common GND.**

⚠ DANGER

- **Logic probe input and 8835-01 share the same GND. Separate power supply sources applied to the testing device and 8835-01 may result in risk of electric shock and damage to the unit.**
  Even with the same power supply source, certain ways of wiring may cause a variance in electric potential sending current that may damage testing device and 8835-01. The following shows proper wiring to avoid damage. For details, see Section 2.5.
  (1) Before connecting logic probe to testing device, connect grounded three-core power cord (attachment) to the device to be tested and 8835-01 and supply power from the same outlet.
  (2) Before connecting logic probe to device to be tested, connect GND of device to be tested with 8835-01 functional earth terminal. Make sure that power is supplied from the same outlet.
- **The maximum rated voltage to earth of the 9322 in the case of CAT II is 1,500V AC/DC when using a grabber clip, or 1,000V AC/DC when using an alligator clip.**
  In the case of CAT III, the voltage is 600V AC/DC with either clip.
  In order to avoid injury from electric shock and damage to the 8835-01, do not input voltages greater than those listed above between input channel terminals and the main unit, or between inputs with another 9322.
- **The maximum input voltage of the 9322 is 1000 VAC/2000 VDC (CAT II) or 600 VAC/DC (CAT III). Attempting to measure voltage in excess of the maximum input could destroy the 8835-01 and result in personal injury or death.**

⚠ CAUTION

The maximum input voltage of the 8947 CHARGE UNIT miniature connector terminal is ±500 pC (at range 6 high sensitivity), and ±50,000 pC (at range 6 low sensitivity).

NOTE

Use only the specified connection cord. Using a non-specified cable may result in incorrect measurements due to poor connection or other reasons.

(6) Replacing the input units

⚠ WARNING

- **To avoid electric shock accident, before removing or replacing an input module, confirm that the instrument is turned off and that the input cords and power cords are disconnected.**
- **To avoid the danger of electric shock, never operate the product with an input module removed. To use the product after removing an input module, install a blank panel over the opening of the removed module.**

(6) Recording paper

NOTE

- 8835-01 uses a thermal printer. The recording paper supplied has characteristics finely tuned for use with the printer.
  Using recording paper of a different specification may not only result in impaired printing quality, but even prevent the printer from operating.
  Always use the HIOKI specified product.
- Insert the paper with correct orientation (see Section 2.7 of the 8835-01 Instruction Manual).

(7) Using a printer

NOTE

Avoid using the printer in hot, humid environments, as this can greatly reduce printer life.

(8) Storing

⚠ CAUTION

For shipping or long-term storage, be certain that the recording head is in the raised position. Otherwise the rollers could be deformed and cause uneven printing.

(9) Shipping

⚠ CAUTION

- Remove the printer paper from the 8835-01. If the paper is left in the unit, paper support parts may be damaged due to vibrations.
- To avoid damage to the product, be sure to remove the PC card and floppy disk before shipping.
- Use the original packing materials when reshipping the product, if possible.

(10) Others

NOTE

- In the event of problems with operation, first refer to Section 16.3, "Troubleshooting."
- Carefully read and observe all precautions in this manual.

(11) Handling the CD-R

⚠ CAUTION

- Always hold the disc by the edges, so as not to make fingerprints on the disc or scratch the printing.
- Never touch the recorded side of the disc. Do not place the disc directly on anything hard.
- Do not wet the disc with volatile alcohol or water, as there is a possibility of the label printing disappearing.
- To write on the disc label surface, use a spirit-based felt pen. Do not use a ball-point pen or hard-tipped pen, because there is a danger of scratching the surface and corrupting the data. Do not use adhesive labels.
- Do not expose the disc directly to the sun's rays, or keep it in conditions of high temperature or humidity, as there is a danger of warping, with consequent loss of data.
- To remove dirt, dust, or fingerprints from the disc, wipe with a dry cloth, or use a CD cleaner. Always wipe radially from the inside to the outside, and do no wipe with circular movements. Never use abrasives or solvent cleaners.
- Hioki shall not be held liable for any problems with a computer system that arises from the use of this CD-R, or for any problem related to the purchase of a Hioki product.

Preliminary Checks

Before using the product the first time, verify that it operates normally to ensure that the no damage occurred during storage or shipping. If you find any damage, contact your dealer or HIOKI representative.

⚠ WARNING

Before using the product, make sure that the insulation on the cords and probes is undamaged and that no bare conductors are improperly exposed. Using the product under such conditions could result in electrocution. Replace the cords and probes specified by HIOKI.

Chapter Summary

Chapter 1 Product Overview

Contains an overview of the unit and its features.

Chapter 2 Installation Procedure

Chapter 3 Recorder and Memory Function

Chapter 4 FFT Function

Chapter 5 Other Functions

Chapter 6 Specifications

Appendix

Contains information that is necessary for using the 8835-01, including a description of error messages and a glossary.

Chapter 1
Product Overview

1.1 Outline

The 9540-01 FUNCTION UP DISK is provided exclusively for use in updating the 8835-01 MEMORY HiCORDER.
Installation is easy using the provided floppy.

1.2 Functions Added by the 9540-01 FUNCTION UP DISK

Functions added by the 9540-01 FUNCTION UP DISK are as follows.

Measurement functions	Recorder and memory function FFT function
Computation functions	Waveform processing calculation Averaging function
Waveform decision functions	Waveform area decision Waveform parameter decision
Memory segmentation functions	Sequential save function Multi-block function

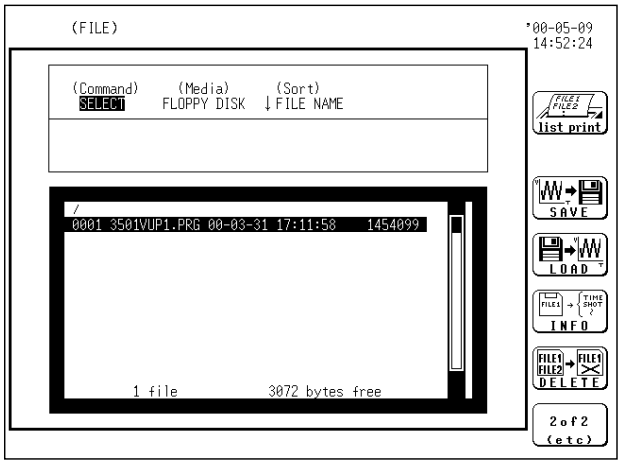
These topics are explained in later chapters.

Chapter 2
Installation Procedure

2.1 Installation Procedure

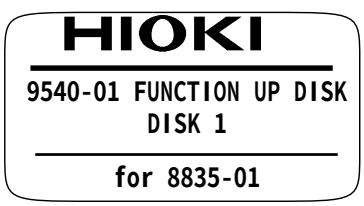
Functional update can be accomplished using the functional update disk.

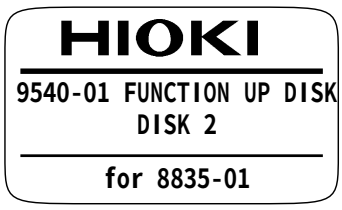
NOTE Never turn off the power during upgrade of the ROM version; the program becomes unusable.



1. Insert the FUNCTION UP DISK1.
2. Press the [FILE] key to call up the FILE screen.
3. Select "FD" as the media type.
4. Load the file named "3501VUP1.PRG".
5. When "Insert Disk 2 and press any key" appears, insert "FUNCTION UP DISK2" and press any key.
6. After loading program file, message is displayed -Version is updated. and the display screen appears.
   Installation is successful.

Functional update floppy disks





Chapter 3 Recorder and Memory Function

3.1 Outline

3.1.1 Outline of the Recorder and Memory Function

The recorder and memory function has the following features.

(1) While recording is in progress, recording by the memory can be initiated by trigger.

(2) All input channel data are recorded on the same time axis.
Since data for all channels can be superimposed, the relative relationship between input signals can be observed visually.

(3) Time axis setting
- 10 ms/DIV to 1 h/DIV (recorder)
- 100 μms/DIV to 5 min/DIV (memory)

(4) Time axis resolution 100 points/DIV

(5) Sampling period
For both recorder and memory functions, 1/100 of the memory time axis range setting

(6) Waveform magnification/compression display and printout
- Time axis direction: ×10 to ×1/8000 (memory recorder)
  : ×1 to ×1/200 (recorder)
- Voltage axis direction: ×10 to ×1/2

With the variable function

(7) Display format
Time axis waveform: single, dual, quad screen display

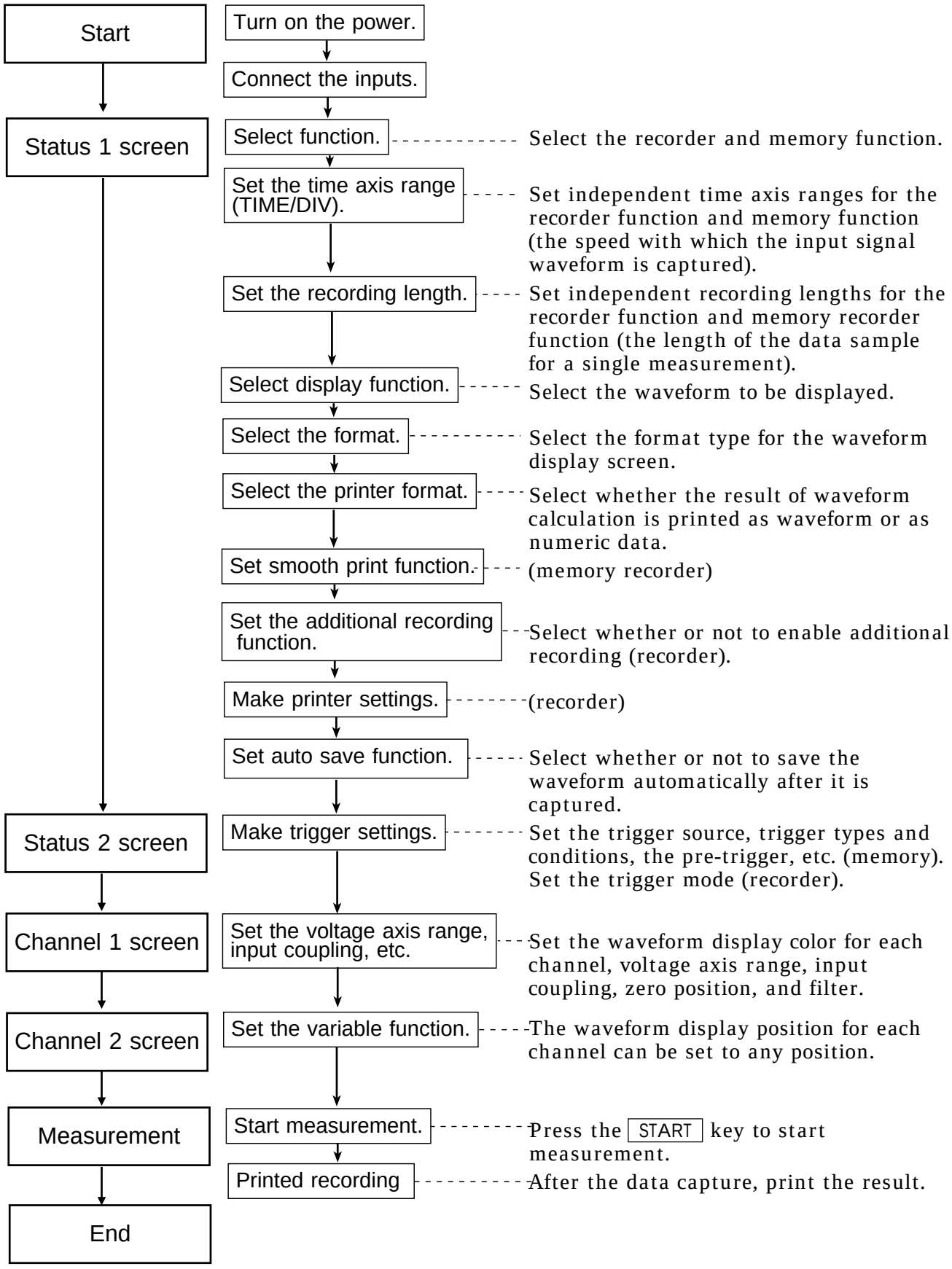
(8) Scrollable display
- The data for the specified recording length are stored in memory.
- It is possible to scroll back for easy review.

(9) Additional recording function

(10) Print output
Printed output of displayed recorder waveforms or memory waveforms

3.1.2 Operation Sequence

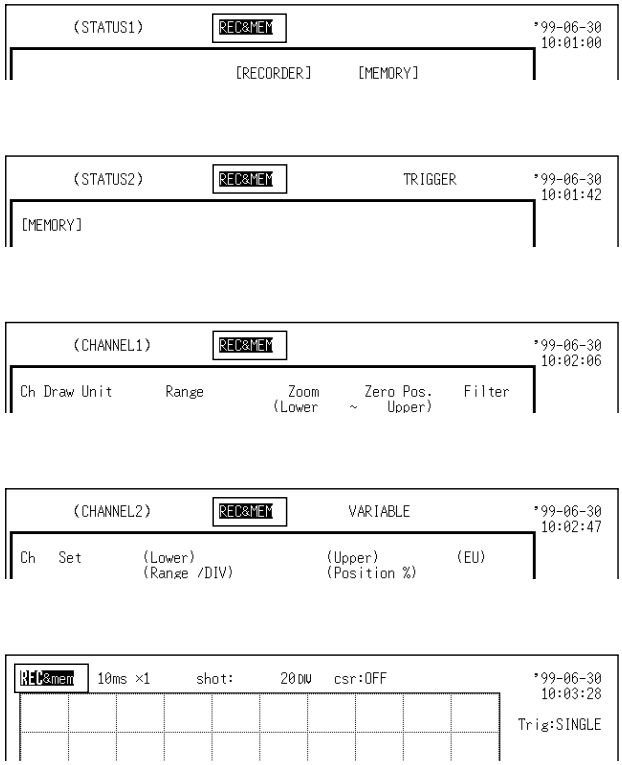
The flowchart below illustrates the sequence of operations involved in using the recorder and memory function.



3.2 Making Settings

3.2.1 Setting the Function Mode

Select the recorder and memory function.



Method

Screen: STATUS 1, 2, CHANNEL, DISPLAY

① Call up the STATUS 1, 2, CHANNEL or DISPLAY screen.
② Move the flashing cursor to the position shown in the figure on the left.
③ Press F4 [REC&MEM].

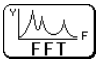
Selection

: Memory recorder function

: Recorder function

: RMS recorder function

: Recorder and memory function



: FFT function

NOTE

On the Display screen, the display position in the figure is different from that on other screens.

Recorder and memory function

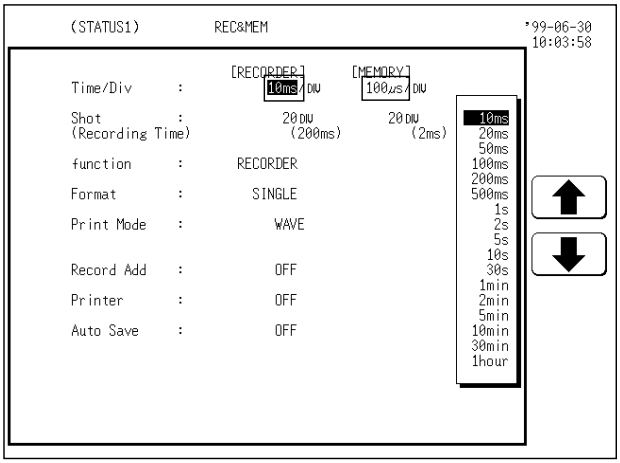
During real-time recording of a signal in the recorder function, if a fault is captured by a trigger, the relevant part of the signal is captured in parallel by the memory recorder at a high sampling rate. Thus the recorder operation is not interrupted by the memory recorder operation, and the normal recording is available in addition to the fault recording.
After multiple trigger events, the first trigger event is recorded in memory, and subsequent event recordings are appended in memory.
The memory recorder function can capture a maximum of 63 phenomena by memory segmentation.

Combined operation with Memory Segmentation

Only sequential saving (see Section 5.5.1) can be used. When sequential saving is enabled for combined operation, up to 63 memory recording phenomena can be stored in response to trigger events. Recording proceeds from the first block to the last, afterwhich memory recording is disabled. The recorder runs continuously. The number of memory segments determines the recording length. (Refer to the memory segmentation table in Section 5.5.1.)

3.2.2 Setting the Time Axis Range

- For both recorder and memory functions, set the speed for inputting and storing the waveform of the input signal.
- Time axis range setting expresses the time for 1 DIV.
- The sampling interval is 1/100 of the memory time axis range setting (100 samples/DIV).



Method 1

Screen: STATUS 1

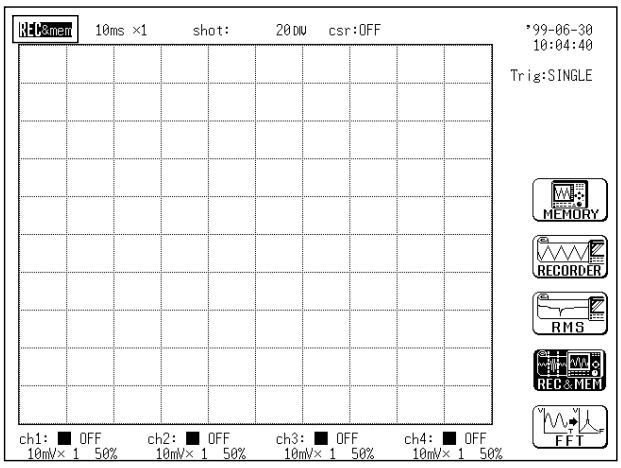
① Call up the STATUS 1 screen.
② Move the flashing cursor to the **time/div** item, as shown in the figure on the left.
③ Use the JOG control or the function keys to make the selection.
The TIME/DIV key modifies the recorder time axis range regardless of where the flashing cursor is located.

Selection

: Move the cursor up in the selection window.
: Move the cursor down in the selection window.

NOTE On the DISPLAY screen, the selection window is not displayed.

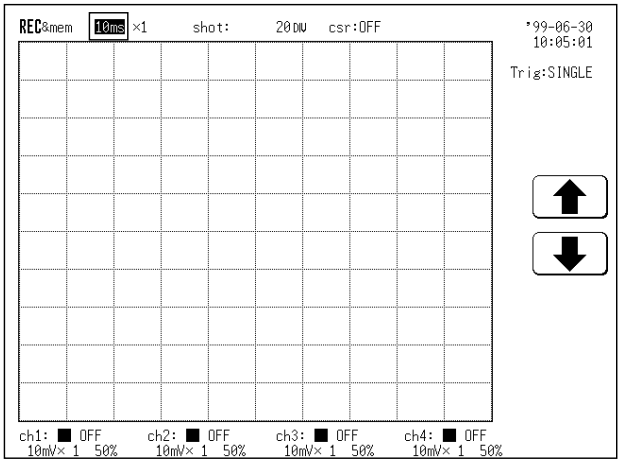
⚠ CAUTION The recorder sampling interval is determined by the sampling interval set in memory. However, some sampling intervals that can be set as a recorder time axis. See the table below for details.



Method 2

Screen: DISPLAY

① Call up the DISPLAY screen.
② Move the flashing cursor to the position shown in the figure on the left.
Select the time axis range function that you want to set.
Upon pressing the "Recorder & Memory" function key, the display changes where indicated in the figure, and you can set the waveform to be displayed.
REC&mem: Recorder waveform
rec&**MEM**: Memory waveform



③ Move the flashing cursor to the position shown in the figure on the left, and use the function keys to set the time axis range.
The TIME/DIV key can be used regardless of where the flashing cursor is located.

NOTE

- On the DISPLAY screen, the selection window is not displayed.
- In the recorder time axis range setting of 10 to 200 ms/DIV, the printer cannot be set ON.

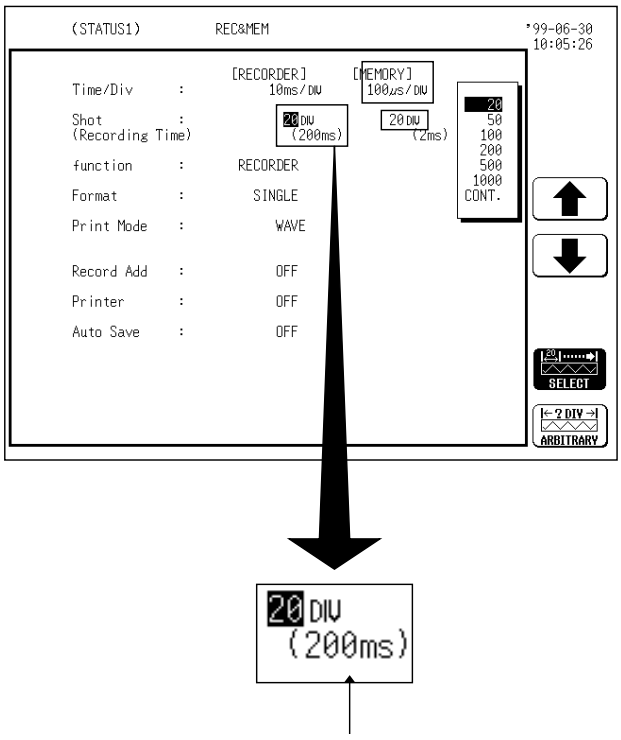
Combinations of recorder and memory time axis ranges

Vertical axis: Time axis (/DIV) of memory waveform
Horizontal axis: Time axis (/DIV) of recorder waveform

	10 ms	20 ms	50 ms	100 ms	200 ms	500	1 s	2 s	5 s	10 s	30 s	1 min	2 min	5min	10 min	30 min	1 hour
100 µs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
200 µs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
500 µs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1 ms	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2 ms	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
5 ms	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
10 ms	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
20 ms	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
50 ms	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
100 ms	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
200 ms	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
500 ms	No	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1 s	No	No	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2 s	No	No	No	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
5 s	No	No	No	No	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
10 s	No	No	No	No	No	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
30 s	No	No	No	No	No	No	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes
1 min	No	No	No	No	No	No	No	No	No	No	No	No	No	Yes	Yes	Yes	Yes
2 min	No	No	No	No	No	No	No	No	No	No	No	No	No	No	Yes	Yes	Yes
5 min	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	Yes	Yes

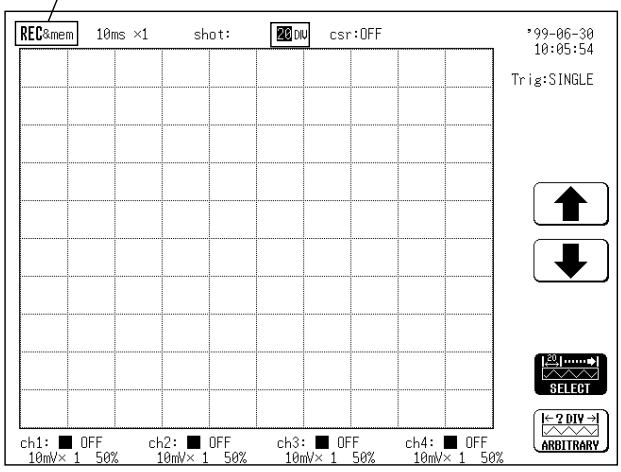
3.2.3 Setting the Recording Length

- For both recorder and memory functions, the length of recording for one measurement operation (number of DIV) can be set.
- Two types of recording length can be set.
  Fixed recording length mode:
  Any recording length mode: Any recording length can be selected by the user.



Shows the measurement time in the set time axis range and recording length.

Display function



Method 1 (Fixed recording length mode)

Screen: STATUS 1, DISPLAY

① Call up the STATUS 1 or DISPLAY screen.
② Move the flashing cursor to the **shot** item, as shown in the figure on the left.
③ Use the JOG control or the function keys to make the selection.

Selection

: Move the cursor up in the selection window.

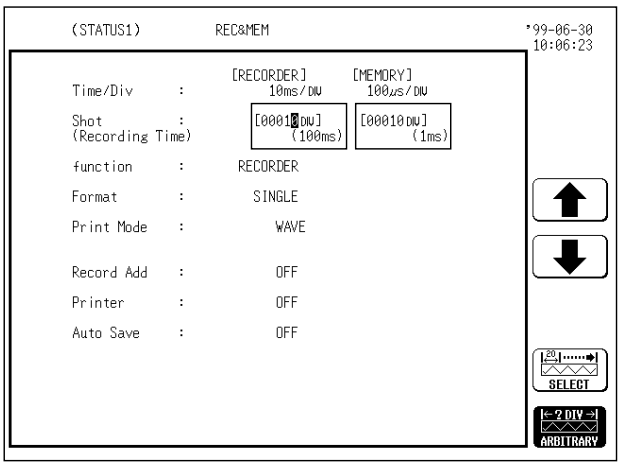
: Move the cursor down in the selection window.

: Set the fixed recording length mode.

: Set the any recording length mode.

NOTE

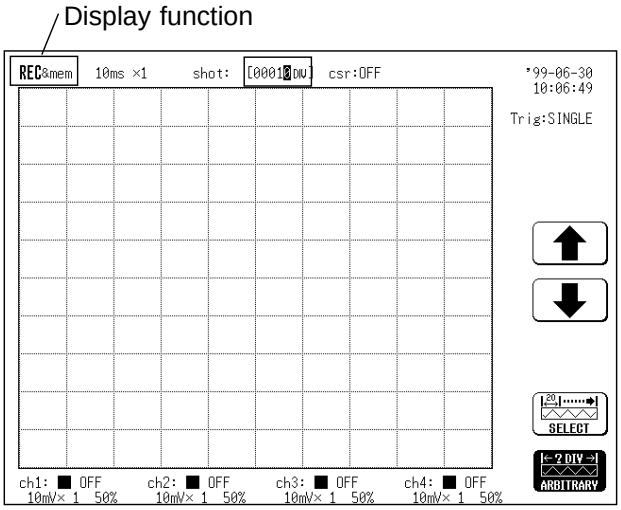
- On the DISPLAY screen, the selection window is not displayed.
- The setting on the DISPLAY screen is the same as in Section 3.2.2.



Method 2 (Any recording length mode)

Screen: STATUS 1, DISPLAY

① Call up the STATUS 1 or DISPLAY screen.
② Move the flashing cursor to the **shot** item, as shown in the figure on the left.
③ Set the any recording length mode.
④ Use the JOG control or the function keys to make the selection. Use the cursor keys to change the column.



Selection

: Value up

: Value down

: Set the fixed recording length mode.

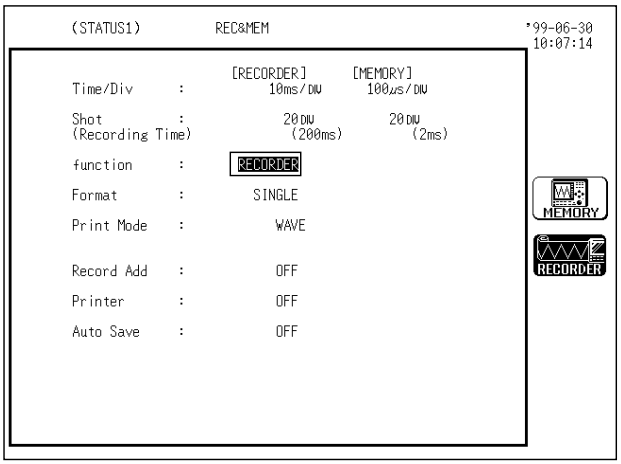
: Set the any recording length mode.

NOTE

- On the DISPLAY screen, the setting cannot be made with the JOG control.
- The setting on the DISPLAY screen is the same as in Section 3.2.2.

3.2.4 Setting the Display Function

- Select the waveform function to be used for display.
- During measurement, the display shows the recorder waveform.
- Function switching is used with display screen settings and displayed waveforms.



Method 1

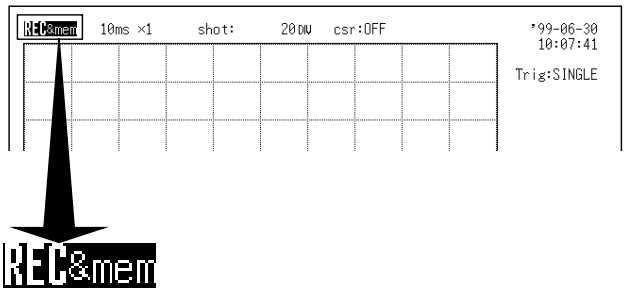
Screen: STATUS 1

① Call up the STATUS 1 screen.
② Move the flashing cursor to the position shown in the figure on the left.
③ Use the function keys to make the selection.

Selection

: Display the memory waveform.

: Display the recorder waveform.



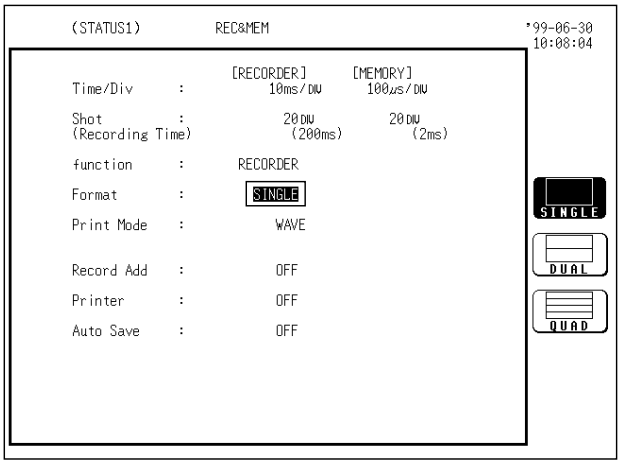
Method 2

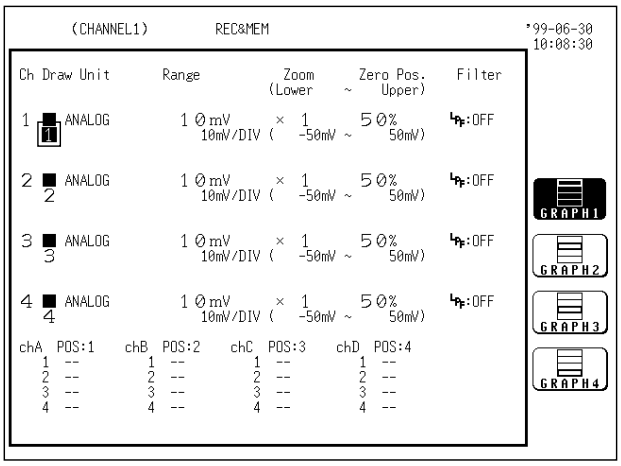
Screen: DISPLAY

① Call up the DISPLAY screen.
② Move the flashing cursor to the position shown in the figure on the left.
③ Upon pressing the "Recorder & Memory" function key, you can switch the display function.
REC&mem: Recorder waveform
rec&**MEM**: Memory waveform

3.2.5 Setting the Format

- The style can be set for showing input signals on the screen display and recording them on the printer.
- The styles single, dual, and quad are available.





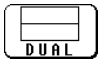
Method

Screen: STATUS 1

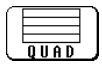
① Press the [STATUS] key to call up the STATUS 1 screen.
② Move the flashing cursor to the **format** item, as shown in the figure on the left.
③ Use the function keys to select the display format.

Selection

: Single



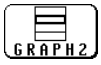
: Dual



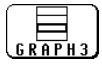
: Quad

④ If dual or quad screen display was chosen in step 3, determine which input channel to display on which graph. This setting is made with the CHANNEL 1 screen.
1. Press the [CHAN] key to call up the CHANNEL 1 screen.
2. Use the [CH SELECT] key to open selected channel screen.
3. Move the flashing cursor to the point shown in the illustration at left.
   - The illustration shows the setting for CH1.
   - Settings for CH2 - CH8 should be made in the same way.
4. Use the function keys to select the graph.

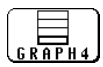
: Display the waveform on graph 1.



: Display the waveform on graph 2.



: Display the waveform on graph 3.*



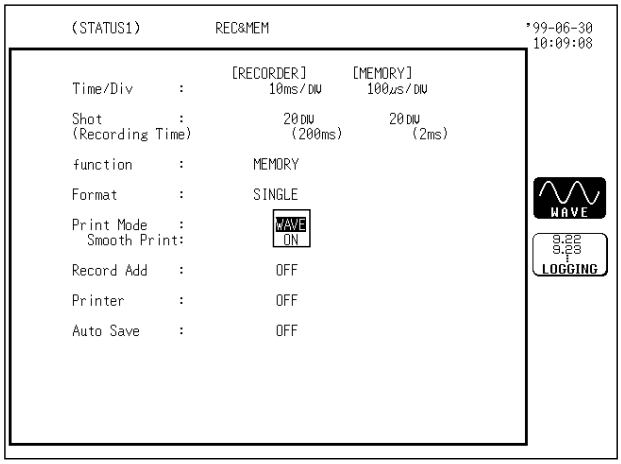
: Display the waveform on graph 4.*

*: when the quad screen display is selected

3.2.6 Setting the Printer Format

- Selects whether waveform data are printed as waveform or as numeric data.
- When numeric data are selected, the data spacing interval also must be set.

Printing as a waveform



Method

① Press the STATUS key to call up the STATUS 1 screen.
② Move the flashing cursor to the **print mode** item, as shown in the figure on the left.
③ Use the function keys to make the selection.

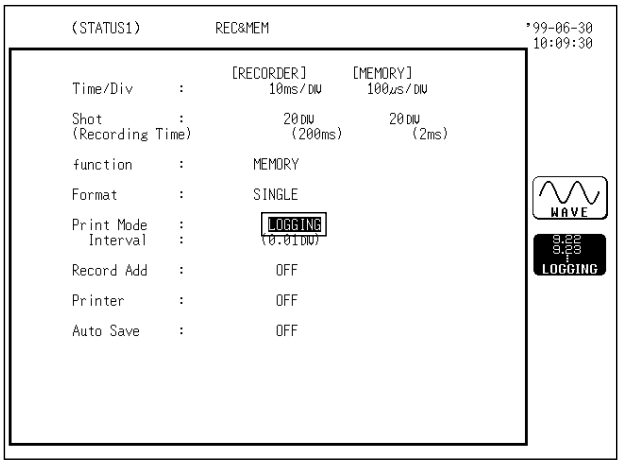
Selection

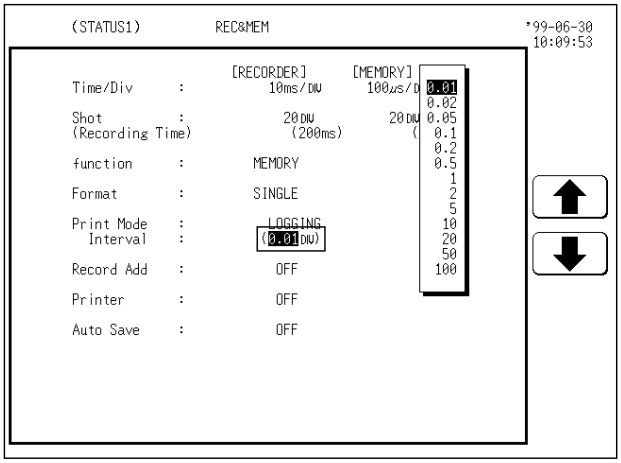
WAVE : Waveform data are printed as a waveform.
LOGGING : Waveform data are printed as numeric data.

④ Set the smooth print function (when the display function is Memory).

NOTE When the display function is Recorder, the "smooth print" item is not displayed.

Printing as numeric data





Method

① Press the STATUS key to call up the STATUS 1 screen.
② Move the flashing cursor to the **print mode** item, as shown in the figure on the left.
③ Use the function keys to select **numeric data**.

Selection

WAVE : Waveform data are printed as a waveform.
LOGGING : Waveform data are printed as numeric data.

④ Move the flashing cursor to the **print interval** item.
⑤ Use the JOG control or the function keys to select the print interval.

: Move the cursor up in the selection window.
: Move the cursor down in the selection window.

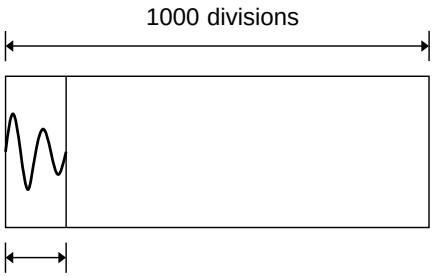
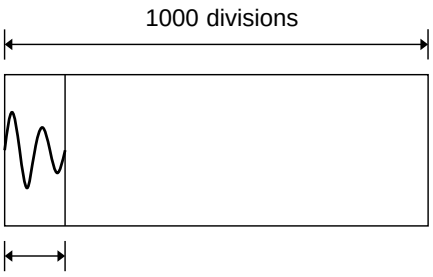
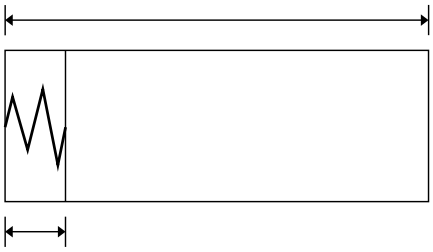
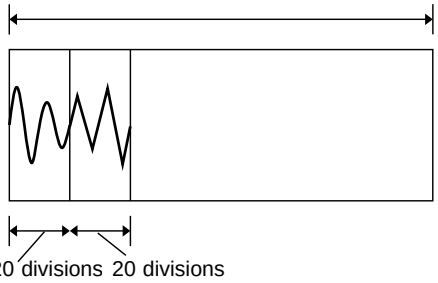
NOTE

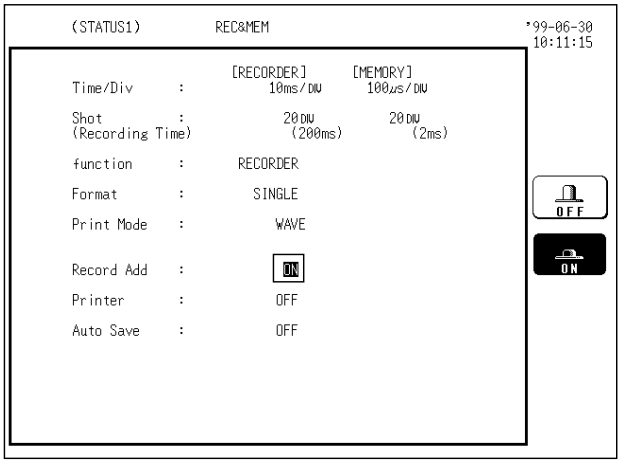
- When the print interval longer than the recording length is set, only the first dot is printed.
- In the recorder function, the maximum and minimum values are printed. (see Appendix 3.4 of the 8835-01 Instruction Manual.)
- In the recorder function, the print intervals of 0.01 to 0.5 DIV can be selected only when there are wavefom data present.

3.2.7 Setting the Additional Recording Function (Recorder Waveform Only)

- This records, regarding the memory as though it were recording paper.
- The last 1000 divisions of waveform can be held in memory.
- The waveform can be scrolled and printed.

Switching the additional recording on and off affects the use of memory as shown below.

Additional recording OFF	Additional recording ON
1. Recording 20 divisions of waveform	1. Recording 20 divisions of waveform
	
2. Recording another 20 divisions of waveform	2. Recording another 20 divisions of waveform
The first set of measurement data is discarded, and recording of the second set of measurement data starts again from the beginning of memory.	The first set of measurement data is preserved, and recording of the second set of measurement data starts after the first set.
	
	The first and seconfd sets of waveforms can be observed by scrolling or printing the waveform.



Method

① Press the STATUS key to call up the STATUS 1 screen.
② Move the flashing cursor to the **additional recording** item, as shown in the figure on the left.
③ Use the function keys to make the selection.

Selection

OFF : Additional recording is disabled.

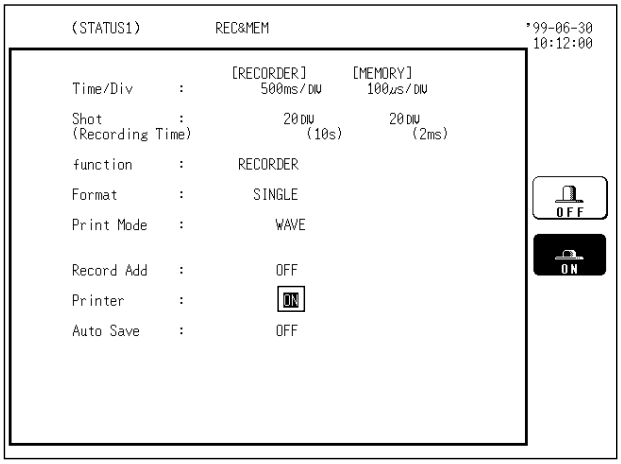
ON : Additional recording is enabled.

NOTE

- Time values output to the printer and displayed on the screen with the additional recording function enabled are equal to those of the most recently acquired waveforms. Therefore, when measuring waveforms in a different time axis range, always take that difference into consideration.
- The voltage axis range is determined by the most recently acquired waveforms.

3.2.8 Setting the Printer Function (Recorder Waveform Only)

The input waveform is continuously printed in real time.



Method

① Press the STATUS key to call up the STATUS 1 screen.
② Move the flashing cursor to the **printer** item, as shown in the figure on the left.
③ Use the function keys to make the selection.

Selection

OFF : Printing is disabled.

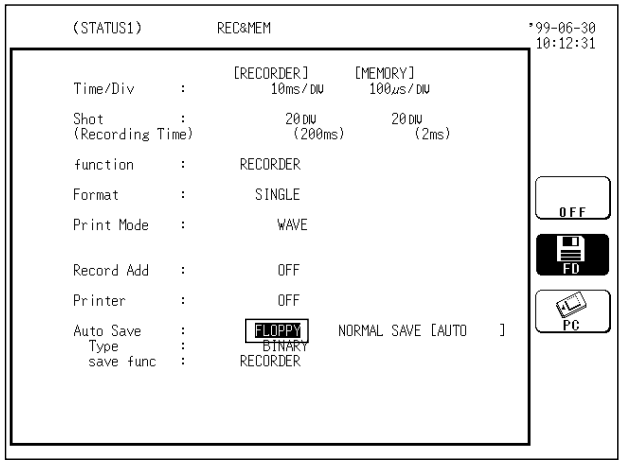
ON : Printing is enabled.

NOTE

- See Section 10.7.3. in the 8835-01 instruction manual.
- In the recorder time axis range setting of 10 to 200 ms, the printer cannot be set ON.
- Only the recorder waveform prints, regardless of the display function.
- Partial printing is disabled even when the A/B cursors are enabled.

3.2.9 Setting the Auto Save Function

When the function is enabled, waveform data are automatically stored on a floppy disk or PC card after they are captured.



Method

① Press the STATUS key to call up the STATUS 1 screen.
② Move the flashing cursor to the **auto save** item, as shown in the figure on the left.
③ Use the function keys to select the media.

Selection

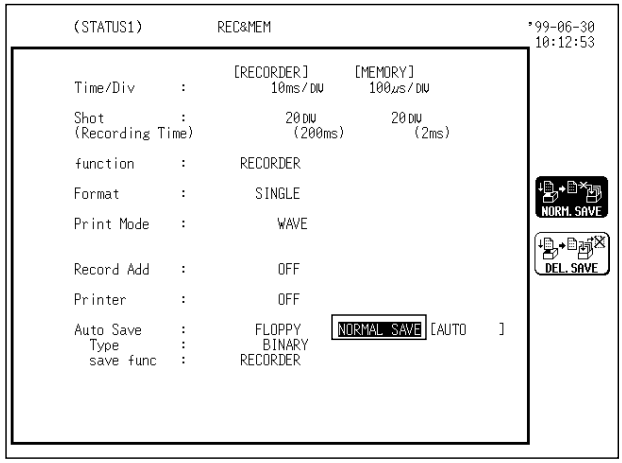
OFF : Auto save is disabled.

FD : Waveform data are automatically stored on floppy disk.

PC : Waveform data are automatically stored on PC card.

NOTE

The LAN selection is available only when a LAN is connected.



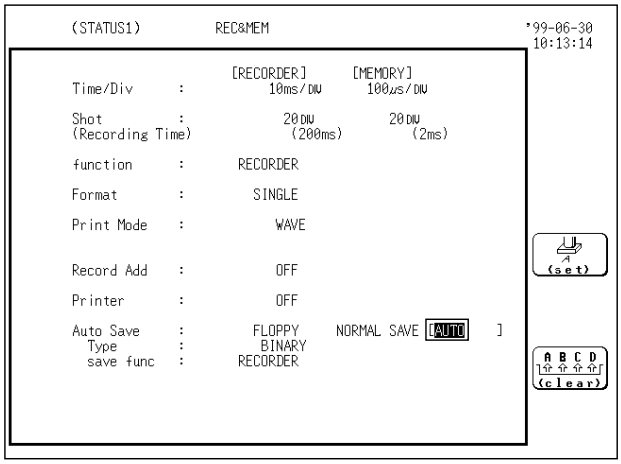
④ Selecting Media displays saving data options.

NORM. SAVE : Cancels automatic save when media is full.

DEL. SAVE : Deletes old files and automatically saves when media is full.

NOTE

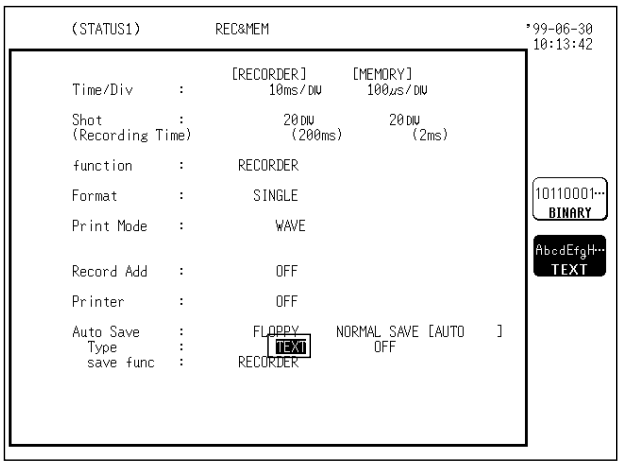
In binary format, file is deleted as MEM. or REC. extension file when individually saved and as MEM., REC. or R_M extension file when saved in Save All. In text format, deleted file is saved as TXT. extension file.



⑤ File naming
See Section 9.5.5 of the 8835-01 Instruction Manual for entry options.
In automatic save, file is titled with a number following the file name.
When file is left untitled during processing, AUTO automatically executes.

NOTE

File name contains eight alphanumeric characters. In automatic save the last character may be replaced with a number to designate the file.



⑥ Use the function keys to select the data store principle.

Selection

10110001··· BINARY : Data are stored as binary data.

AbcdEfgH··· TEXT : Data are stored as text data.

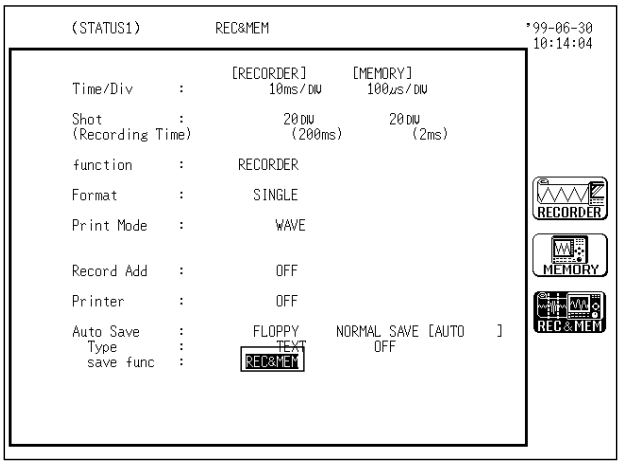
NOTE

TEXT format is intended for reading on a PC. Select BINARY format to read data on the 8835-01.

⑦ Selected TEXT in save options opens Thinning.
Use the JOG control or the function keys to make the selection.

NOTE

- In automatic save channels cannot be selected. Only current channel displaying waveform is saved.
- A file is stored in the directory currently selected on the file screen.
- Only a limited number of directories and files can be stored in the directory.



⑧ Use the function keys to select the function to be stored.

RECORDER : Only recorder waveforms are stored.

MEMORY : Only memory waveforms are stored.

REC&MEM : Both recorder and memory waveforms are stored.

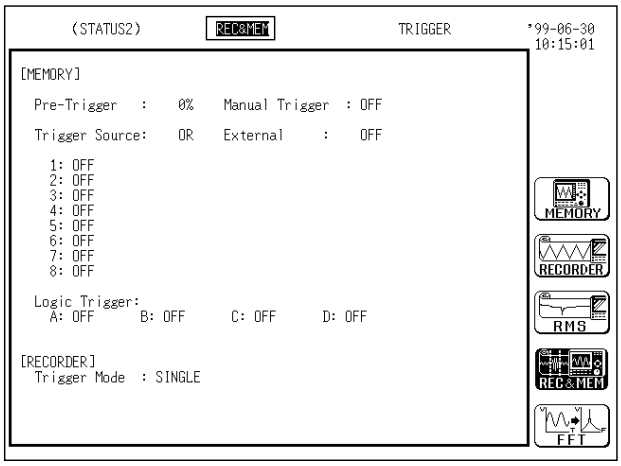
NOTE

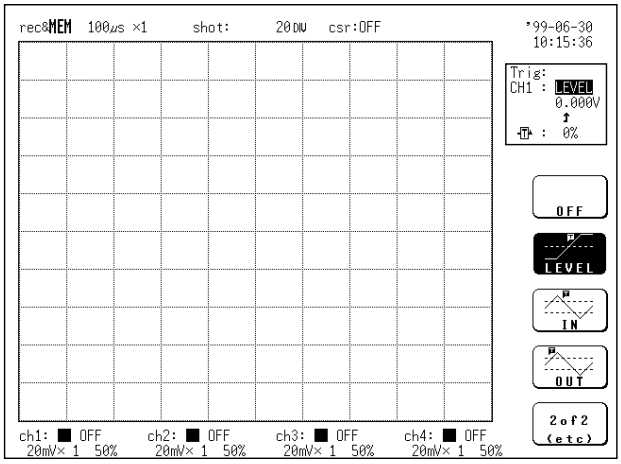
- When batch saving with the Recorder & Memory, the measurement data (with REC, MEM extensions) are created together with an index file (R_M). When only the measurement data are read, these are read to the respective functions. To read to the Recorder & Memory, read the index file (R_M).
- Do not change name of file created by Save All, neither delete nor move file to avoid unsuccessful loading.
- When the auto save function is used while the additional recording function is ON, only newly acquired waveform data is stored. (In this case, the A/B cursors are set OFF.)
- When saving only a Recorder waveform or Memory waveform, partial saving is possible with the A/B cursors. However, when saving Recorder & Memory waveforms, partial saving is disabled even when the A/B cursors are activated.

3.3 Setting the Trigger

3.3.1 Setting the Trigger

Set the trigger for the memory waveform.





Method

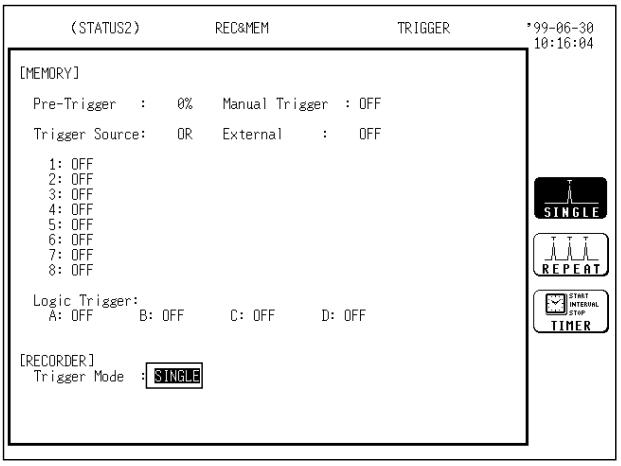
① Press the STATUS key to call up the STATUS 2 or DISPLAY screen.
② Same as the normal trigger setting.

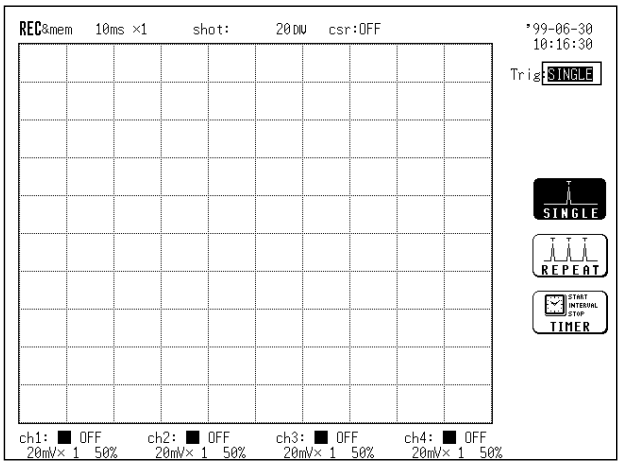
NOTE

On the DISPLAY screen, the setting is made in the memory waveform window.

3.3.2 Setting the Trigger Mode

The trigger mode determines the way triggering is used to control operation of the 8835-01.





Method

① Press the STATUS key to call up the STATUS 2 or DISPLAY screen.
② Move the flashing cursor to the position shown in the figure on the left, and use the function keys to make the selection.

Selection

SINGLE : Setting starts when the START key is pressed, and one measurement is taken.

REPEAT : Setting starts when the START key is pressed, and measuremens are taken repeatedly.

TIMER : Activate recording at preset times. Triggering can be performed at constant intervals within a preset start time and end time.

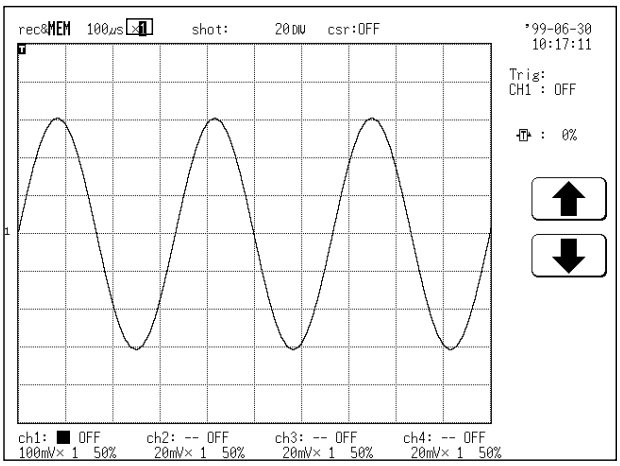
NOTE In the display screen, use recorder waveform window for settings.

3.4 Settings on the Display Screen

Explains the setting items on the Display screen.

3.4.1 Setting Magnification/Compression Along the Time Axis

- The magnification/compression ratio along the time axis can be set.
- By magnifying the waveform, detailed observations can be made. By compressing the waveform, an entire change can be promptly apprehended.
- Magnification/compression of the screen uses the left edge as reference, regardless of the status of the A/B cursor.



Method

① Move the flashing cursor to the position shown in the figure on the left.
② Use the function keys to select the magnification/compression ratio.

Selection

: Ratio up

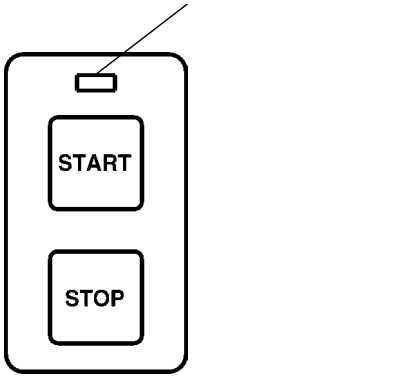
: Ratio down

NOTE

The magnification/compression factor can be changed also after measurement is completed.

Reference The HELP key can be used to check which position within the entire recording length is occupied by the currently shown waveform (see VIEW key in Section 3.1.7 of the 8835-01 instruction manual).

3.5 Start and Stop Measurement Operation



Method

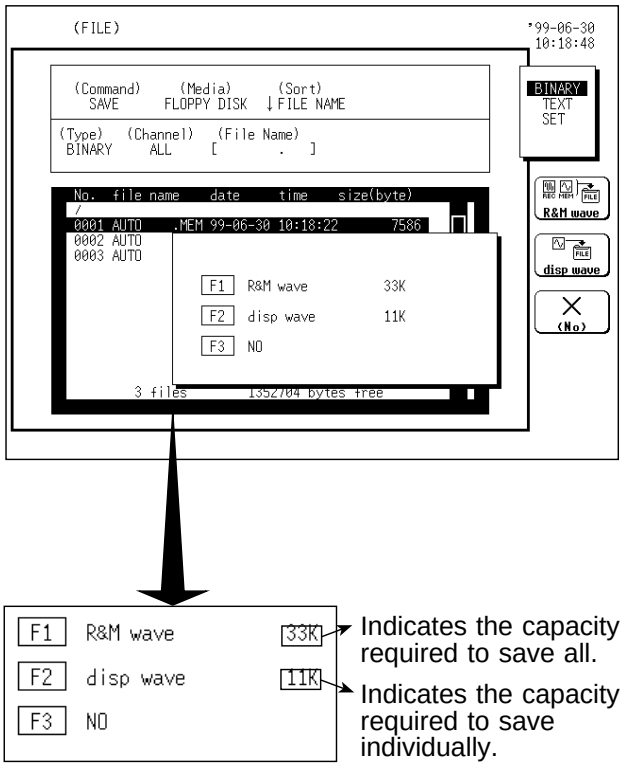
① Press the START key to initiate measurement or set the unit to trigger standby.
② Press the STOP key during measurement to stop the measurement.

During loading waveform memory, waveform loading status is displayed with messages below the window.
Displayed messages are as follows;
"MEMORY WAVE WAIT TRIG": Waiting for triggering.
"MEMORY WAVE STORING": Loading memory waveform.
"MEMORY WAVE STORE END": Completed loading waveform.

When sequential save is applied,
"MEMORY WAVE XXX/000": Loaded block is displayed. (XXX is the last block loaded and 000 is the memory segment.)

3.6 Procedures for Saving Data

- This section explains how to save data in binary or text form without using the auto-save function.
- Settings file considerations are the same as with other functions.



Method

① Press the FILE key to call up the FILE screen.
② Select the "Save" command; the display changes as shown below.
③ Use the function keys to make the selection.

Selection

R&M wave : Measurement data files (with REC and MEM extensions), and an index file (R_M extension) are created. Both memory and recorder waveforms are saved.

disp wave : Save individually (Saves the display function data.)

(No) : Cancel (Do not save)

NOTE

- When saving individually, partial saving is enabled if the A/B cursors have been activated.
- With the Save All mode, partial saving is disabled even if the A/B cursors have been activated.
- Individually saved data is loaded for each individual function. To load into the Recorder & Memory function, use the Save All mode and load the index (R_M) file.
- When batch saving with the Recorder & Memory, the measurement data (with REC, MEM extensions) are created together with an index file (R_M).
- Loading an index file automatically loads both memory and recorder waveforms. Loading an index file created with the Save All mode and sequential save (see Section 5.5.1) enabled loads all blocks.
- When Save all is selected, the partial save cannot be executed even when A and B cursors appear on the screen.
- Only a limited number of directories and files can be stored in the directory.

Chapter 4
FFT Function

4.1 Outline

4.1.1 Outline of the FFT Function

The recorder and memory function has the following features.

(1) FFT (Fast Fourier Transform) processing can be performed on input signal data for frequency analysis.

(2) Frequency range
133 mHz to 400 kHz, 20 steps, external

(3) Frequency resolution
1/400, 1/800, 1/2000 or 1/4000 of frequency range

(4) 12 types of analysis functions
Storage waveform, linear spectrum, RMS spectrum, power spectrum, auto-correlation function, histogram, transfer function, cross-power spectrum, cross-correlation function, unit-impulse response, coherence function, octave analysis

(5) Analysis modes
1-channel FFT, 2-channel FFT

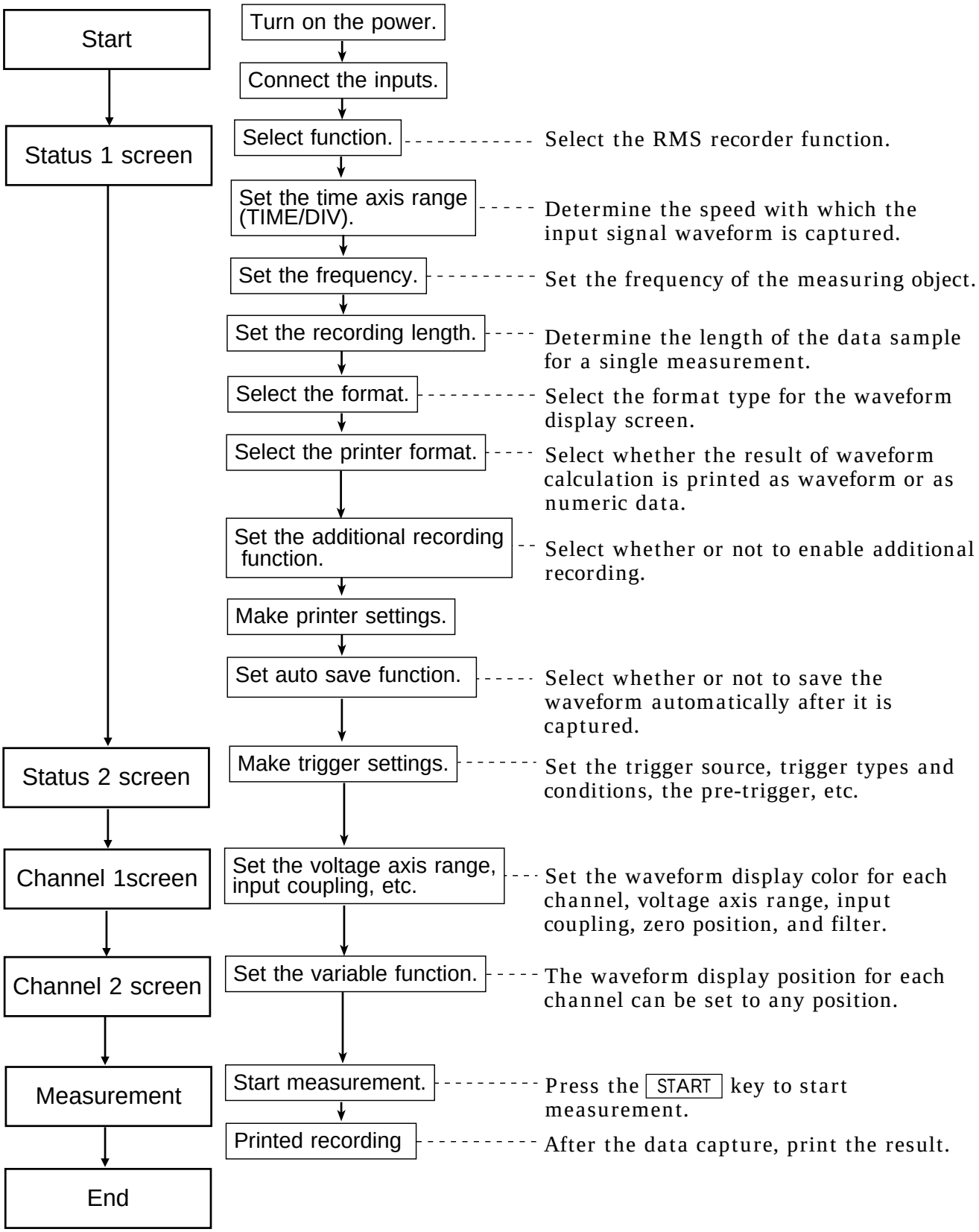
(6) Analysis of data stored with memory recorder function possible

(7) Switchable antialiasing filter
Automatic selection of cutoff frequency to match frequency range (8938 FFT ANALOG UNIT)

(8) Waveform evaluation function using evaluation area

4.1.2 Operation Sequence

The flowchart below illustrates the sequence of operations involved in using the FFT function.

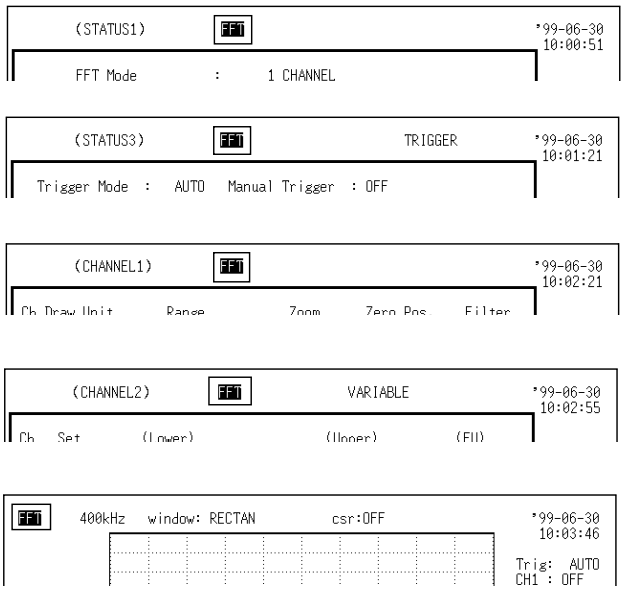


NOTE FFT function does not execute report printing.

4.2 Making Settings

4.2.1 Setting the Function Mode

Select the FFT function.



Method

Screen: STATUS 1, 3, CHANNEL, DISPLAY

① Call up the STATUS 1, 3, CHANNEL or DISPLAY screen.
② Move the flashing cursor to the position shown in the figure on the left.
③ Press F5 [FFT].

Selection

MEMORY : Memory recorder function

RECORDER : Recorder function

RMS : RMS recorder function

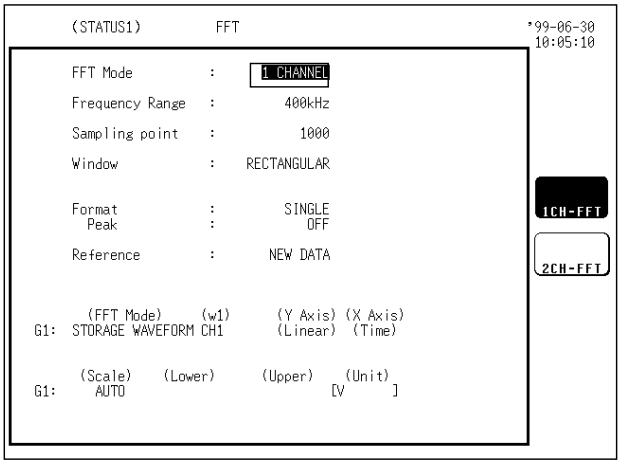
REC&MEM : Recorder and memory function

FFT : FFT function

NOTE In Channel 2 (variable) screen function settings are available but variable settings are not reflected.

4.2.2 Setting the FFT Channel Mode

- This setting determines whether only one channel (1ch-FFT) or two channels (2ch-FFT) are used for FFT processing.
- When "1ch-FFT" is selected, certain FFT analysis modes will not be available.



Method

Screen: STATUS 1

① Call up the STATUS 1 screen.
② Move the flashing cursor to the position shown in the figure on the left.
③ Use the function keys to make the selection.

Selection

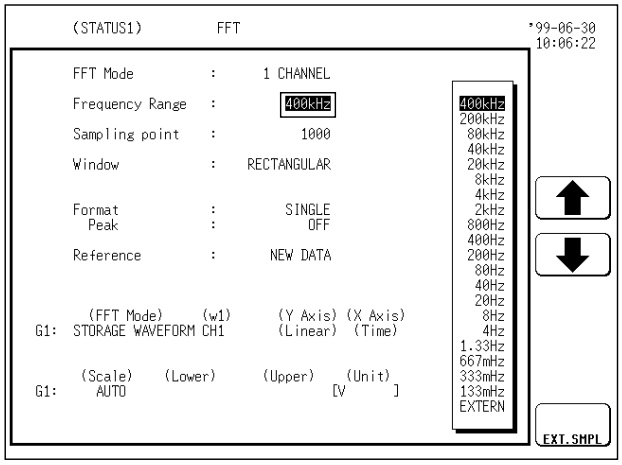
1CH-FFT : 1ch-FFT

2CH-FFT : 2ch-FFT

NOTE The following analysis functions are not possible in 1-channel FFT mode: Transfer function (TRF), cross-power spectrum (CSP), cross-correlation function (CCR), impulse response (IMP), coherence function (COH)

4.2.3 Setting the Frequency Range

- The frequency range (frequency axis maximum value) can be set as follows.
- The frequency range corresponds to the time axis range (TIME/DIV) setting of the memory recorder function.



Method

Screen: STATUS 1

① Call up the STATUS 1 screen.
② Move the flashing cursor to the position shown in the figure on the left.
③ Use the JOG control or the function keys to make the selection.

Selection

: Move the cursor up in the selection window.

: Move the cursor down in the selection window.

EXT.SMPL : External sampling

NOTE

- The antialiasing filter (8938 FFT ANALOG UNIT and 8947 CHARGE UNIT) cutoff frequency is the same as the selected frequency range.
- Before executing external sampling, pay close attention to PRINT EXT.SMPLE terminal settings. (see Section 9.3.2 of the 8835-01 Instruction Manual.)

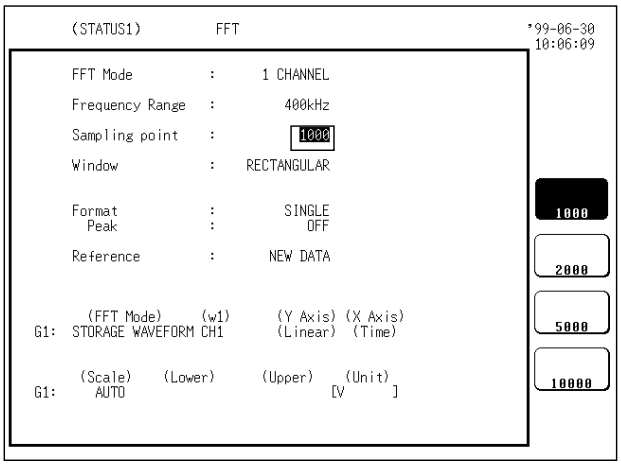
Frequency Range, Frequency Resolution, Window Width, Corresponding Time Axis Range (Number of FFT points: 1000)

Frequency range [Hz]	Frequency resolution [Hz]	Window width	Time axis [/DIV]
400 k *1	1 k	1 ms	100 µs
200 k *1	500	2 ms	200 µs
80 k *1	200	5 ms	500 µs
40 k	100	10 ms	1 ms
20 k	50	20 ms	2 ms
8 k	20	50 ms	5 ms
4 k	10	100 ms	10 ms
2 k	5	200 ms	20 ms
800	2	500 ms	50 ms
400	1	1 s	100 ms
200	500 m	2 s	200 ms
80	200 m	5 s	500 ms
40	100 m	10 s	1 s
20	50 m	20 s	2 s
8 *2	20 m	50 s	5 s
4 *2	10 m	100 s	10 s
1.33 *2	3.3 m	5 min	30 s
667 m *2	1.67 m	10 min	1 min
333 m *2	0.83 m	20 min	2 min
133 m *2	0.33 m	50 min	5 min

The cutoff frequency of the antialiasing filter is the same as the selected frequency range, except for the cases listed below.
*1: Antialiasing filter is OFF.
*2: Cutoff frequency is 20 Hz.

4.2.4 Setting the Number of FFT Points

- Set points for FFT processing.
- Settings at higher points increase frequency division capability but slow down processing speed.



Method

Screen: STATUS 1

① Call up the STATUS 1 screen.
② Move the flashing cursor to the position shown in the figure on the left.
③ Use the function keys to make the selection.

Selection

1000 : Execute FFT processing set at 1000 points.

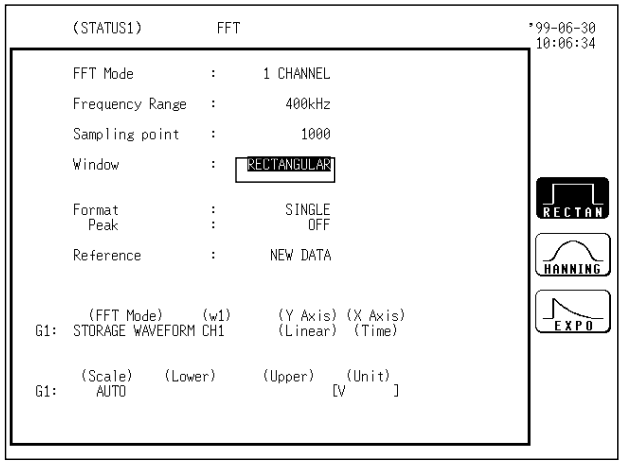
2000 : Execute FFT processing set at 2000 points.

5000 : Execute FFT processing set at 5000 points.

10000 : Execute FFT processing set at 10000 points.

4.2.5 Setting the Window Function

- The window function defines the segment of the input signal that will be processed.
- Window processing can be used to minimize leakage error.
  Rectangular (rectangular window function): effective on discrete waveforms.
  Hanning (hanning window function): effective on continuous waveforms.
  Exponential (exponential window function): effective on decaying waveforms.



Method

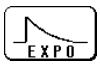
Screen: STATUS 1

① Call up the STATUS 1 screen.
② Move the flashing cursor to the position shown in the figure on the left.
③ Use the function keys to make the selection.

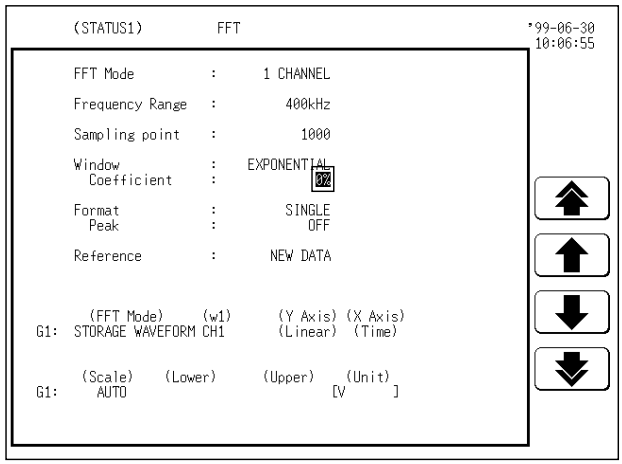
Selection

: Rectangular

: Hanning



: Exponential



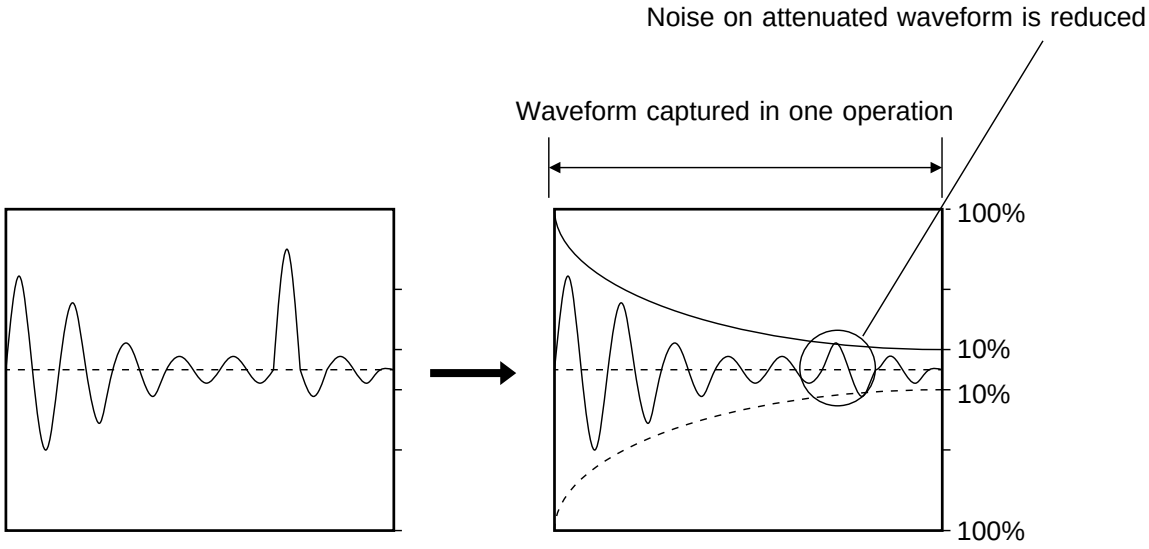
④ If **EXPO** was selected, the **coefficient** item is displayed. Select the attenuation ratio in percent, using the function keys or the JOG control.


: Value up, large step


: Value up, small step


: Value down, small step


: Value down, large step



Setting: Exponential window function
Attenuation ratio 10%

NOTE

- If **coefficient** (attenuation ratio) is set to 0%, processing will be carried out as 0.1%.
- When measurements are taken using the Hanning window or exponential window, note that the calculation results in the display of a value that is lower than the amplitude obtained when using a rectangular window.

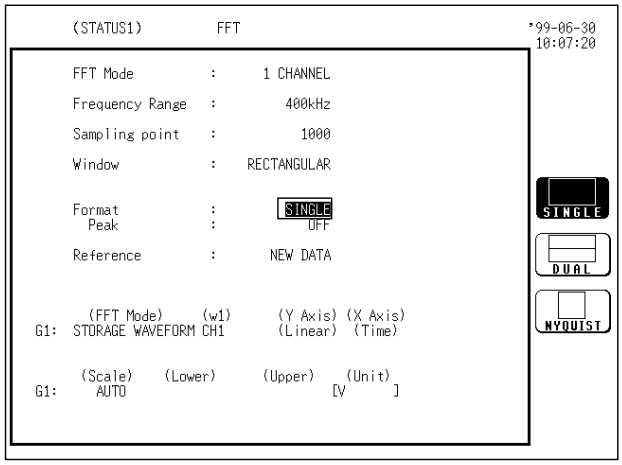
4.2.6 Setting the Display Format

- You can set the format for displaying input signal waveforms on the screen and recording them on the printer.
- The SINGLE, DUAL, and NYQUIST formats are available.

(1) Single
Displays the waveform on a single screen.

(2) Dual
Divides the waveform display screen into upper and lower screens.

(3) Nyquist
For the linear spectrum, cross power spectrum, and transfer function, displays the real-number portion of the data for the FFT calculation result on the X-axis, and the imaginary number portion of the data on the Y-axis.



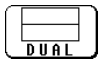
Method

Screen: STATUS 1

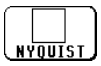
① Call up the STATUS 1 screen.
② Move the flashing cursor to the position shown in the figure on the left.
③ Use the function keys to make the selection.

Selection

: Single



: Dual



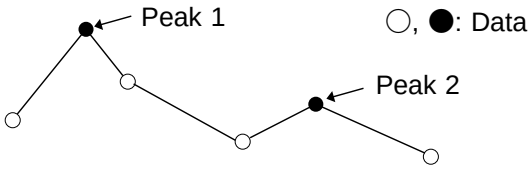
: Nyquist

4.2.7 Setting the Peak Display

- From the sampling points and FFT processing results, the 10 peak values or maximum values can be shown.
- This setting is available in single-screen and dual-screen mode.

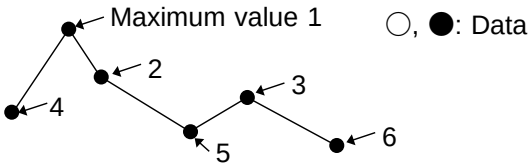
Peak value

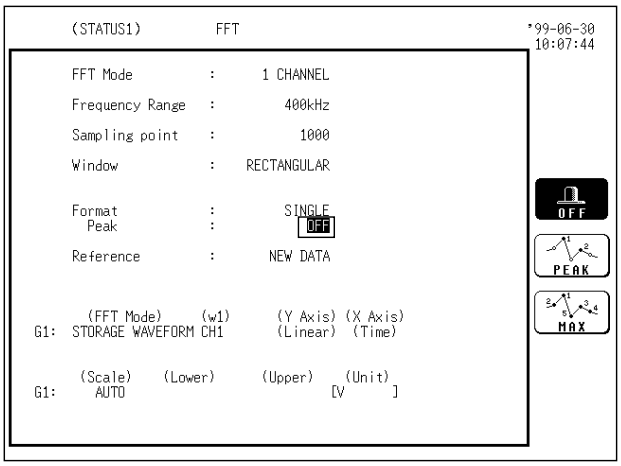
- When data at one point are higher than data within the vicinity, the point is a peak.
- The 10 highest peaks are shown.



Maximum value

Points with the 10 highest values are shown.





Method

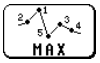
Screen: STATUS 1

① Call up the STATUS 1 screen.
② Move the flashing cursor to the position shown in the figure on the left.
③ Use the function keys to make the selection.

Selection

: Normal display

: Peak display



: Maximum value display

NOTE Peak value display is displayed in the display screen and printable, but not recorded as peak value in data saving.

4.2.8 Selecting Reference Data

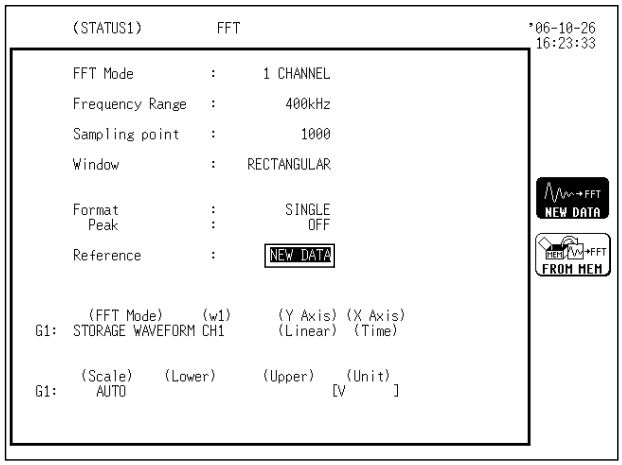
Select data to be used for FFT processing.

New data

When START key is pressed, data points are captured and used for FFT processing.

Memory waveform

- Press START key to execute FFT processing set at data points specified with FFT points on recorded data in memory (memory recorder data or memory waveform in recorder & memory).
- Start point for processing is specified by A/B cursors in the memory recorder or memory waveform in recorder & memory display screen.
- When the A/B cursors are used, data points specified with FFT points from the first cursor are used for FFT processing.
- Upon selecting memory waveform, frequency defaults to frequency in line with time axis as listed in chart in Section 4.2.3.



Method

Screen: STATUS 1

① Call up the STATUS 1 screen.
② Move the flashing cursor to the position shown in the figure on the left.

Selection

NEW DATA : Capture new waveform data for FFT processing

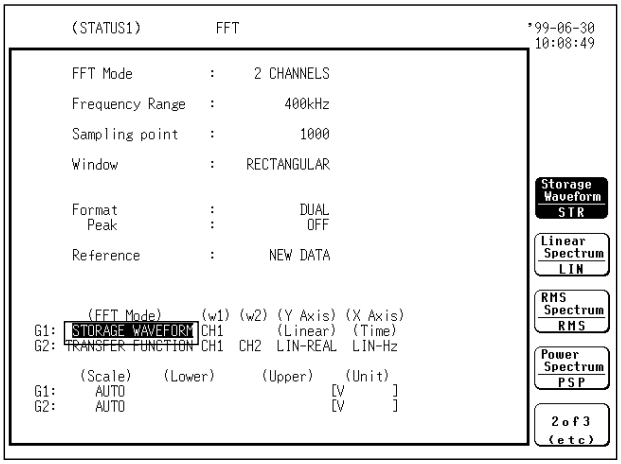
FROM MEM : Use stored waveform data for FFT processing

NOTE

When trigger mode is set to Continuous, Auto and reference data is set to memory, loaded waveform data in memory recorder function is processed by FFT processing shifted at specified points. (data less than FFT point range can not be processed.)

4.2.9 Setting the FFT Analysis Mode

Used to select the FFT calculation method.



Method

Screen: STATUS 1

① Call up the STATUS 1 screen.
② Move the flashing cursor to the position shown in the figure on the left.
③ Use the function keys to make the selection.

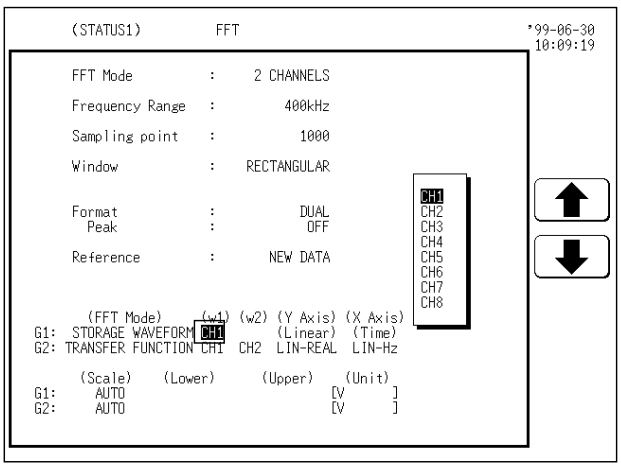
Selection

Storage Waveform STR	: Stored waveform	Transfer TRF	: Transfer function
Linear Spectrum LIN	: Linear spectrum	Cross Power Spectrum CSP	: Cross power spectrum
RMS Spectrum RMS	: RMS spectrum	Cross Correlation CCR	: Cross correlation function
Power Spectrum PSP	: Power spectrum	Impulse Response IMP	: Impulse response
Auto Correlation ACR	: Auto correlation function	Coherence COH	: Coherence function
Histogram HIS	: Histogram	Octave OCT	: Octave analysis

NOTE The transfer, cross-power spectrum, cross-correlation, unit-impulse response, and coherence functions use 2 channels.

4.2.10 Setting the Analysis Channel

Select the channel for FFT analysis.



Method

Screen: STATUS 1

① Call up the STATUS 1 screen.
② Move the flashing cursor to the position shown in the figure on the left.
③ Use the JOG control or the function keys to to make the selection.

Selection

: Move the cursor up in the selection window.

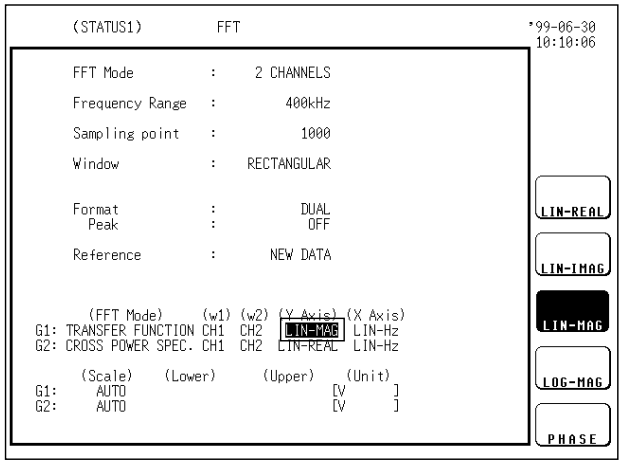
: Move the cursor down in the selection window.

NOTE

- For the transfer function and impulse response, calculation is performed from "(w2)/(w1)".
- To prevent distortion due to sampling aliasing from affecting analysis, it is recommended that the 8938 FFT ANALOG UNIT be used for channel input with FFT analysis.

4.2.11 Setting the X-axis and Y-axis Displays

- Set the X and Y axis for display of FFT calculation results.
- Different units can be selected for the X and Y axis.
- With some FFT analysis modes, one of the axis cannot be set.



Method

Screen: STATUS 1

① Call up the STATUS 1 screen.
② Move the flashing cursor to the position shown in the figure on the left.
③ Use the function keys to make the selection.

Selection

• Y-axis

LIN-REAL : Real number part (linear display)

LIN-IMAG : Imaginary number part (linear display)

LIN-MAG : Amplitude (linear display)

LOG-MAG : Amplitude (decibel display)

PHASE : Phase (degree display)

• X-axis

LOG-Hz : Frequency (linear display)

LIN-Hz : Frequency (logalism display)

• Octave analysis

1/3 OCT : 1/3 octave

1/1 OCT : 1/1 octave

X and Y Axis Settings Available with each FFT Analysis Mode

FFT analysis mode		X-axis (horizontal axis)	Y-axis (vertical axis)
STR	Storage Waveform	(Time)	(Linear)
LIN	Linear Spectrum	LIN-Hz LOG-Hz	LIN-REAL LIN-IMAG LIN-MAG LOG-MAG PHASE
RMS	RMS Spectrum	LIN-Hz LOG-Hz	LIN-REAL LIN-IMAG LIN-MAG LOG-MAG PHASE
PSP	Power Spectrum	LIN-Hz LOG-Hz	LIN-MAG LOG-MAG
ACR	Auto Correlation Function	(Time)	(Linear)
HIS	Histogram	(Volt)	(Linear)
TRF	Transfer Function	LIN-Hz LOG-Hz	LIN-REAL LIN-IMAG LIN-MAG LOG-MAG PHASE
CSP	Cross Power Spectrum	LIN-Hz LOG-Hz	LIN-REAL LIN-IMAG LIN-MAG LOG-MAG PHASE
CCR	Cross Correlation Function	(Time)	(Linear)
IMP	Unit Impulse Response	(Time)	(Linear)
COH	Coherence Function	LIN-Hz LOG-Hz	(Linear)
OCT	Octave Analysis	1/3 OCT 1/1 OCT	LIN-MAG LOG-MAG

Parens surrounding an item indicate that those items are fixed.

NOTE When external sampling is used, the X-axis (horizontal axis) expresses the data count.

4.2.12 Setting the Display Scale

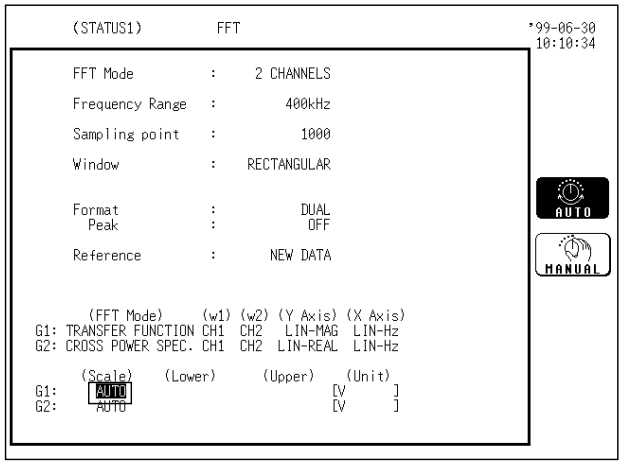
The display scale for showing the FFT processing result can either be set manually or automatically.

AUTO

The vertical axis (Y-axis) scale is set automatically, depending on the processing result.

MANUAL

The vertical axis (Y-axis) scale can be set as desired, to match the purpose of the measurement.
This is useful for enlarging or reducing the amplitude and for shifting the waveform up or down.



Method

Screen: STATUS 1

① Call up the STATUS 1 screen.
② Move the flashing cursor to the position shown in the figure on the left.
③ Use the function keys to make the selection.

Selection

AUTO : Scale set automatically.

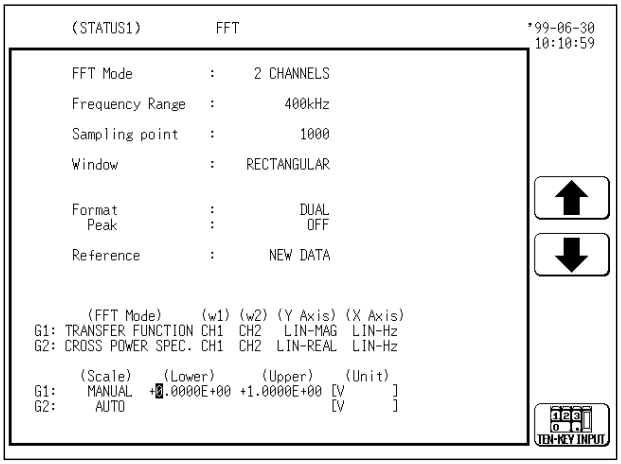
MANUAL : Scale set manually.

(1) When **AUTO** is selected

Upper and lower limits are set automatically, according to the processing result.

(2) When **MANUAL** is selected

- The upper and lower limits for the display scale can be set by the user.
- Setting range is -9.9999E+29 to 9.9999E+29. (exponent is E-29 to E+29).



Method

Screen: STATUS 1

① Call up the STATUS 1 screen.
② Move the flashing cursor to the position shown in the figure on the left.
③ Use the function keys etc. to enter the value.

Selection

: Value up

: Value down

: Enter the value using the numeric keys.

Displaying the display scale units

- The selected unit is displayed with "scaling" in the system screen.
- When scaling is turned OFF, the unit of the measurement range is displayed.

NOTE

The X-axis setting for the histogram can be changed on the channel setting page of the CHANNEL 1 screen (changing upper limit and lower limit modifies x axis).

4.2.13 Octave Filter Setting

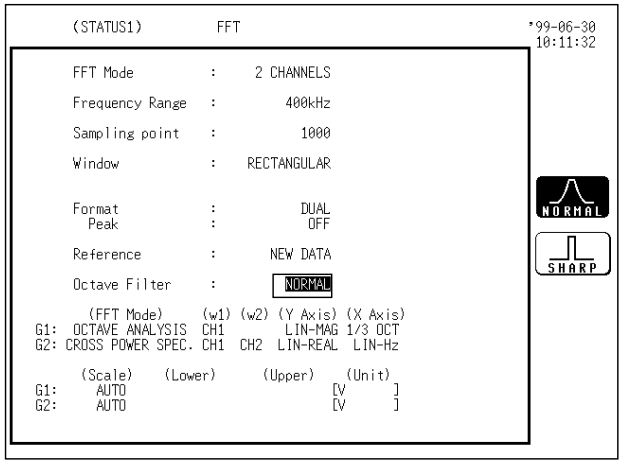
When octave analysis has been selected, two different filter types can be chosen.

- Normal

  Filter characteristics approximate the characteristics used for conventional octave analyzers with analog filters.

- Sharp

  Spectrum components outside the octave band are excluded totally and only the spectrum in the octave band is bundled and used for analysis.
  (The characteristics of both filter types are within ANSI CLASS 3 tolerance limits.)



Method

Screen: STATUS 1

① Call up the STATUS 1 screen.
② Move the flashing cursor to the position shown in the figure on the left.
③ Use the function keys to make the selection.

Selection

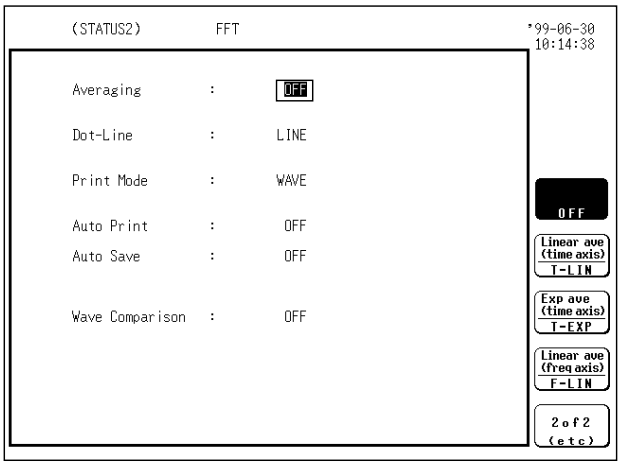
: Normal filter characteristics

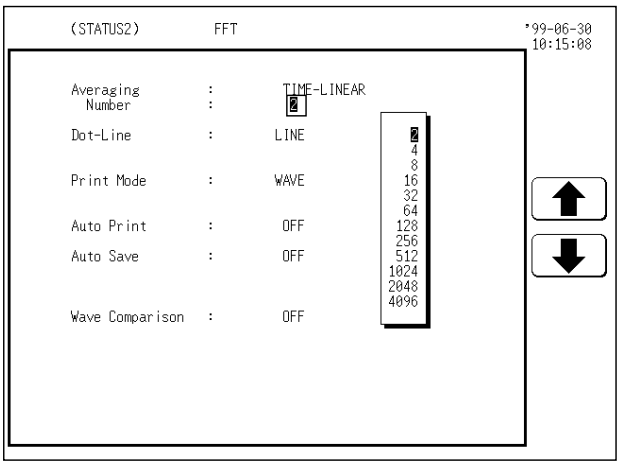
: Sharp filter characteristics

NOTE This unit does not use analog filters. It first determines the entire power spectrum and then uses weighting by bundling the spectrum to achieve the desired filter characteristics.

4.2.14 Setting the Averaging Function

- The averaging function allows capturing several instances of a waveform and determining the average.
- This makes it possible to eliminate noise and irregular signal components.
- Time axis waveform averaging
  Frequency axis waveform averaging





Method

Screen: STATUS 2

① Call up the STATUS 2 screen.
② Move the flashing cursor to the **average** item as shown in the figure on the left.
③ Use the function keys to select the type of averaging.

Selection

OFF : Disable averaging

Linear ave (time axis) T-LIN : Perform time axis waveform summing averaging

Exp ave (time axis) T-EXP : Perform time axis waveform exponential averaging

Linear ave (freq axis) F-LIN : Perform frequency axis waveform summing averaging

Exp ave (freq axis) F-EXP : Perform frequency axis waveform exponential averaging

Peak Hold (freq axis) F-PEAK : Frequency axis waveform peak hold

④ Move the flashing cursor to the count item, and use the function keys or the JOG control to set the averaging count.

↑ : Move the cursor up in the selection window.

↓ : Move the cursor down in the selection window.

NOTE

- For averaging equations, see Section Appendix 3.1.
- When averaging is used together with the waveform evaluation function, waveform evaluation is carried out after the specified averaging count is completed.
- After averaging was carried out, the scaling setting cannot be changed.
- After averaging, recalculation does not take place even if the analysis channel is changed.

FFT analysis mode and averaging

●: Setting is valid

—: Setting is invalid (has no effect)

FFT analysis mode	Y-axis	Time axis averaging	Frequency axis averaging	Peak hold
Storage waveform	(Linear)	●	●	—
Linear spectrum	LIN-REAL	●	●	—
	LIN-IMAG	●	●	—
	LIN-MAG	●	●	●
	LOG-MAG	●	●	●
	PHASE	●	—	—
RMS spectrum	LIN-REAL	●	●	—
	LIN-IMAG	●	●	—
	LIN-MAG	●	●	●
	LOG-MAG	●	●	●
	PHASE	●	—	—
Power spectrum	LIN-MAG	●	●	●
	LOG-MAG	●	●	●
Auto correlation function	(Linear)	●	●	●
Histogram	(Linear)	●	—	—
Transfer function	LIN-REAL	●	—	—
	LIN-IMAG	●	—	—
	LIN-MAG	●	●	●
	LOG-MAG	●	●	●
	PHASE	●	—	—
Cross power spectrum	LIN-REAL	●	●	—
	LIN-IMAG	●	●	—
	LIN-MAG	●	●	●
	LOG-MAG	●	●	●
	PHASE	●	—	—
Cross correlation function	(Linear)	●	●	●
Unit impulse response	(Linear)	●	●	●
Coherence function	(Linear)	●	●	●
Octave analysis	LIN-MAG	●	●	●
	LOG-MAG	●	●	●

∗ Same for linear spectrum, transfer function and cross-power spectrum with Nyquist display.

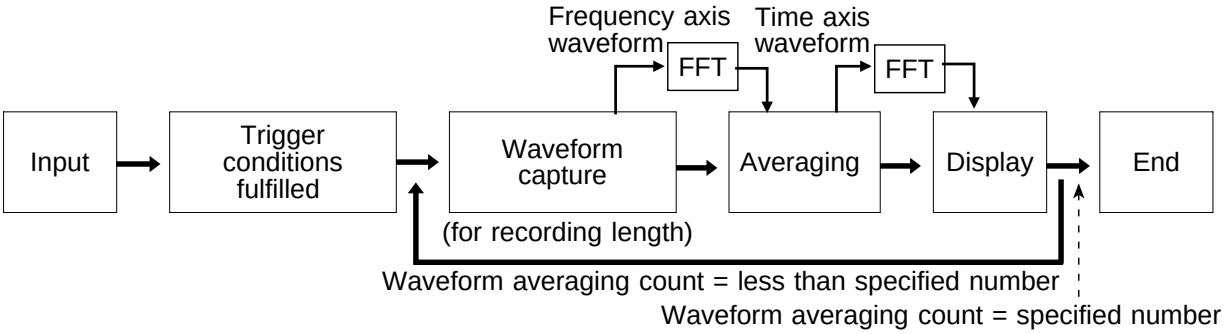
Averaging and trigger mode (FFT function)

Trigger mode: SINGLE

(1) After the START key was pressed, data are captured whenever the trigger conditions are fulfilled, averaging is carried out, and then the waveform is displayed.
Collected waveform data is averaged with the FFT time axis waveform and FFT processing is performed. FFT processing is performed on the frequency axis and the calculated result is averaged.

(2) Trigger occurs when the trigger conditions are fulfilled again.

(3) When the specified number of data has been captured, measurement stops automatically. If the measurement was stopped prematurely with the STOP key, the averaging result up to that point is displayed.

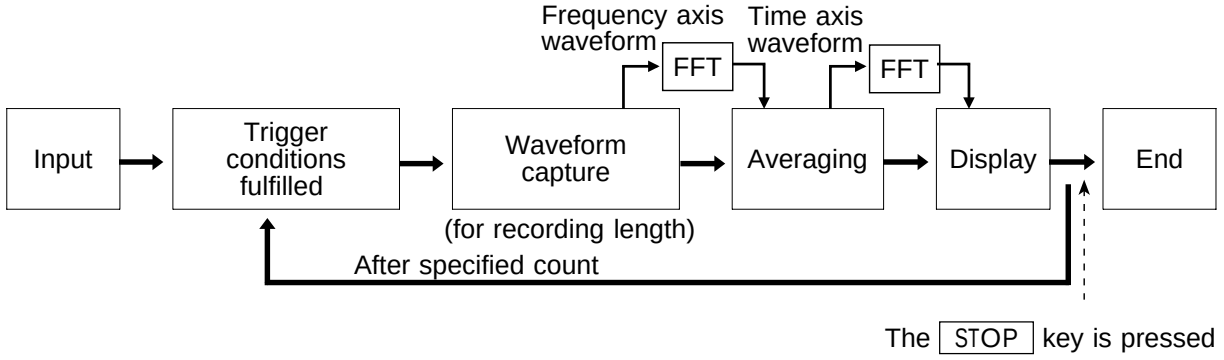


Trigger mode: REPEAT

(1) After the START key was pressed, data are captured whenever the trigger conditions are fulfilled, and averaging is carried out until the specified averaging count. The averaging result is shown on the display.

(2) Trigger occurs and the waveform is cleared when the trigger conditions are fulfilled again.

(3) When the specified averaging count is reached, data up to that point are discarded, and new data are captured for averaging. If the measurement was stopped prematurely with the STOP key, the averaging result up to that point is displayed.



Trigger mode: AUTO

(Time axis waveform)

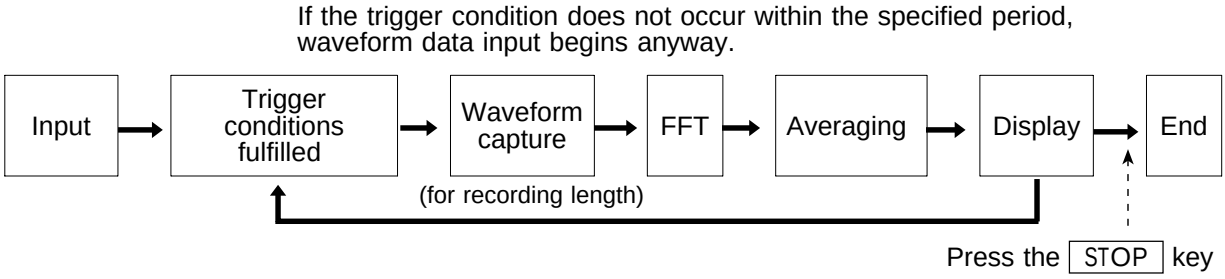
When the START key is pressed, data are captured even if trigger conditions are not fulfilled after a certain interval. If averaging is applied to unsynchronized input signals, the result will be meaningless.

(Frequency axis waveform)

(1) After the START key was pressed, data are captured whenever the trigger conditions are fulfilled, and averaging is carried out until the specified averaging count. The averaging result is shown on the display.

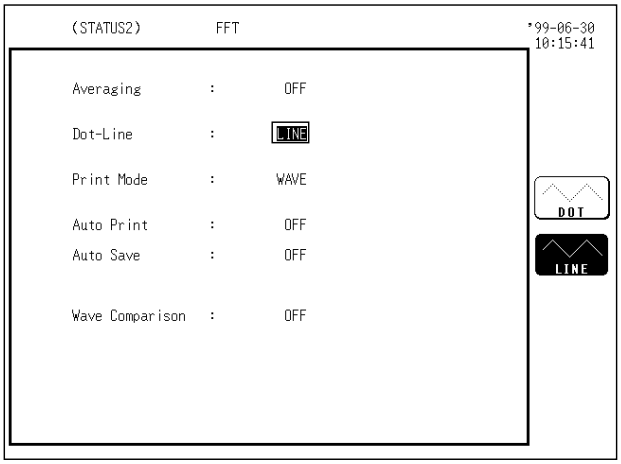
(2) When the specified number of data has been captured, measurement stops automatically.

(3) If the measurement was stopped prematurely with the STOP key, the averaging result up to that point is displayed.



4.2.15 Setting the Interpolation Function

The input signal (sampled data) and FFT waveform can be displayed and recorded as is, or after linear interpolation.



Method

Screen: STATUS 2

① Call up the STATUS 2 screen.
② Move the flashing cursor to the position shown in the figure on the left.
③ Use the function keys to make the selection.

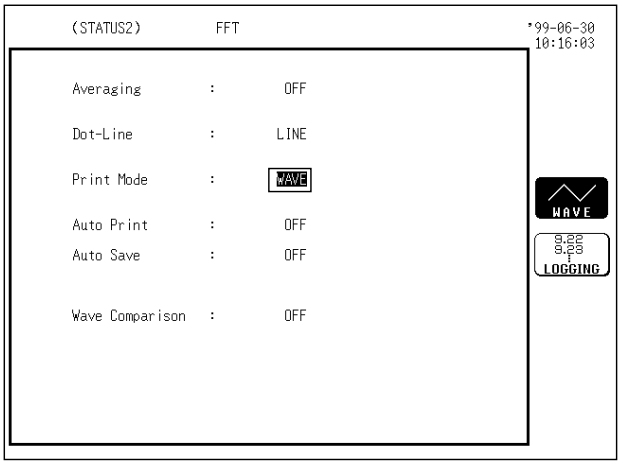
Selection

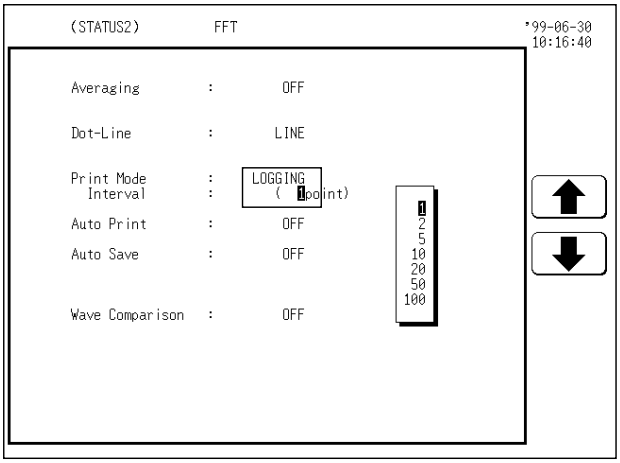
DOT : Linear interpolation is not

LINE : Linear interpolation is performed.

4.2.16 Setting the Printer Format

・Selects whether the result of FFT calculation is printed as waveform or as numeric data.





Method

Screen: STATUS 2

① Press the STATUS key to call up the STATUS 2 screen.
② Move the flashing cursor to the **print mode** item, as shown in the figure on the left
③ Use the function keys to select.

Selection

WAVE : The result of FFT calculation is printed as a waveform.

LOGGING : The result of FFT calculation is printed as numeric data.

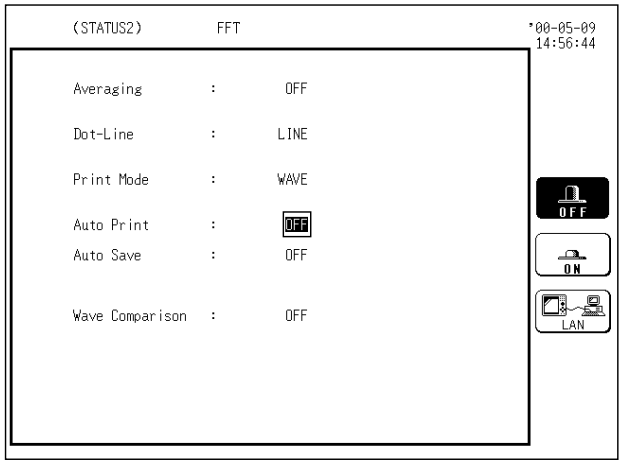
④ Move the flashing cursor to the **print interval** item.
⑤ Use the function keys to make the selection.

: Move the cursor up in the selection window.

: Move the cursor down in the selection window.

4.2.17 Setting the Auto Print Function

When the function is enabled, printout is carried out automatically after a waveform is captured.



Method

Screen: STATUS 2

① Press the STATUS key to call up the STATUS 2 screen.
② Move the flashing cursor to the **auto print** item, as shown in the figure on the left
③ Use the function keys to make the selection.

Selection

OFF : Auto print is disabled.

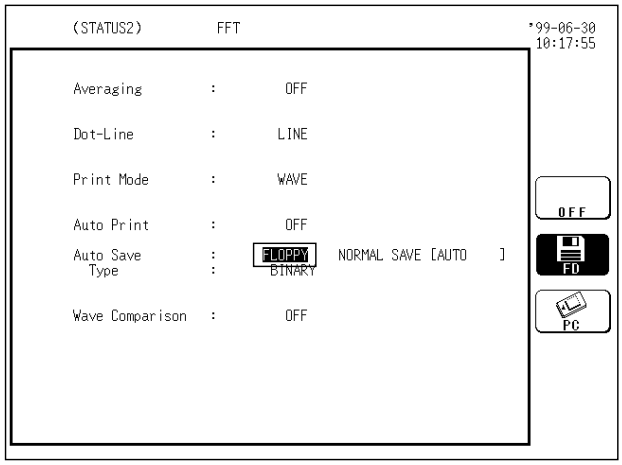
ON : Auto print is enabled.

LAN : Print data is automatically transferred to the data collection server on the LAN (when connected to a LAN).

NOTE Partial printing is disabled even when the A/B cursors are enabled.

4.2.18 Setting the Auto Save Function

When the function is enabled, waveform data are automatically stored on a floppy disk or PC card after they are captured.
A file is stored in the directory currently selected on the file screen.



Method

Screen: STATUS 2

① Press the STATUS key to call up the STATUS 2 screen.
② Move the flashing cursor to the **auto save** item, as shown in the figure on the left.
③ Use the function keys to select the media.

Selection

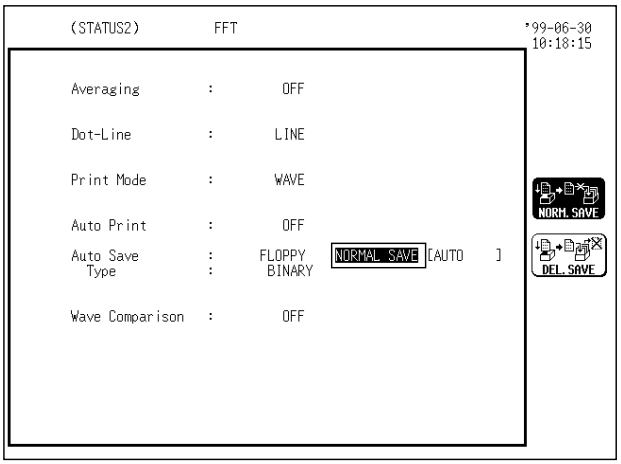
OFF : Auto save is disabled.

FD : Waveform data are automatically stored on floppy disk

PC : Waveform data are automatically stored on PC card.

NOTE

The LAN selection is available only when a LAN is connected.



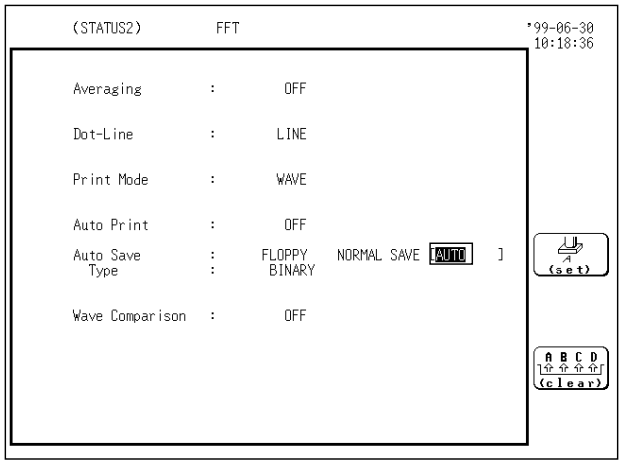
④ Selecting Media displays saving data options.

NORM. SAVE : Cancels automatic save when media is full.

DEL. SAVE : Deletes old files and automatically saves when media is full.

NOTE

In binary format, deleted file is saved as FFT. extension file. In text format, deleted file is saved as TXT. extension file.



⑤ File naming

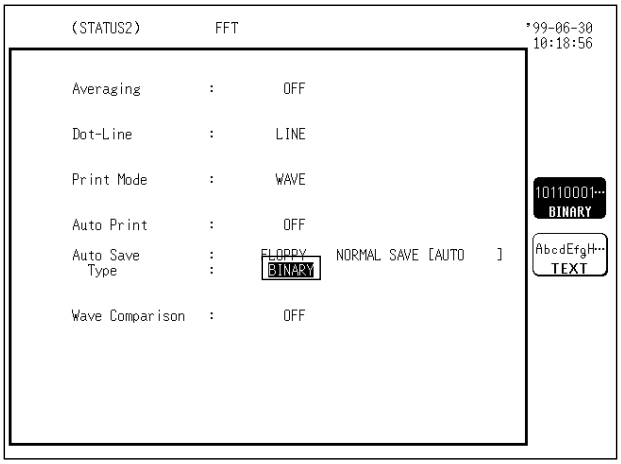
See Section 9.5.5 of the 8835-01 Instruction Manual for entry options.

In automatic save, file is titled with a number following the file name.

When file is left untitled during processing, AUTO automatically executes.

NOTE

File name contains eight alphanumeric characters. In automatic save the last character may be replaced with a number to designate the file.



⑥ Use the function keys to select the data store principle.

10110001··· BINARY : Data are stored as binary data.

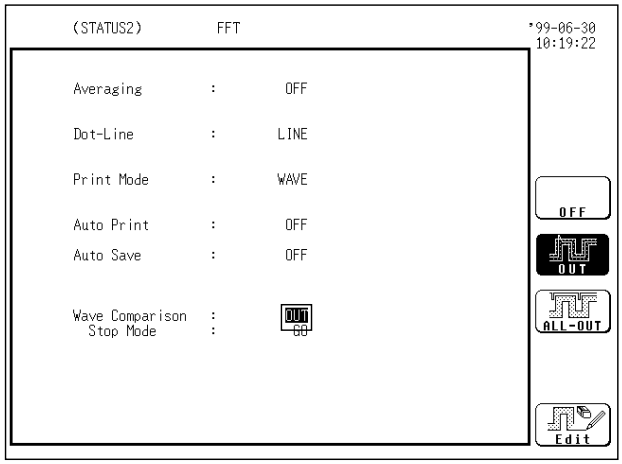
AbcdEfgH··· TEXT : Data are stored as text data.

NOTE

- The TEXT format is intended for reading by a PC. Select BINARY for reading by the 8835-01.
- In automatic save data cannot be selected. Only current processing result is saved.
- When Auto printing and Auto save are both set to ON, Auto save is executed prior to Auto printing.
- Only a limited number of directories and files can be stored in the directory.
- FFT data text format does not apply to save with thinning.
- Partial printing is disabled even when the A/B cursors are enabled.

4.2.19 Setting the Waveform Evaluation

- The waveform evaluation function can be used on the Single or Nyquist screen.
- GO (pass) or NG (fail) evaluation of the input signal waveform can be performed using an evaluation area specified by the user.
- This can serve to detect irregular waveforms.
- After the evaluation result is generated, signals are output from the GO/NG terminal.



Method

Screen: STATUS 2

① Press the STATUS key to call up the STATUS 2 screen.
② Move the flashing cursor to the **wave comparison** item, as shown in the figure on the left
③ Use the function keys to make the selection..

Selection

OFF : Disable waveform evaluation.
OUT : Return NG if any part of the waveform leaves the evaluation
ALL-OUT : Return NG if the entire waveform leaves the evaluation area.
Edit : Evaluation area is created.

NOTE

- Only one waveform evaluation area is saved in the internal memory. For example, when the memory recorder function is changed to the FFT function and the waveform evaluation area of the FFT is saved, the waveform evaluation area created using the memory recorder function is erased.
- For details on the waveform evaluation, refer to Section 5.4.
- For the GO and NG terminal, see Section 12.7 of the 8835-01 Instruction Manual.

4.2.20 Setting the Trigger

- Select the trigger that is suitable for the signal to be captured.
  For details, see Chapter 8 of the 8835-01 Instruction manual.
- The voltage drop trigger cannot be set in the ranges of 133 m to 400 Hz.

4.3 Analysis Function

4.3.1 Storage Waveform [STR]

Displays the time domain waveform of the input signal. Displays the time domain waveform of the input signal.

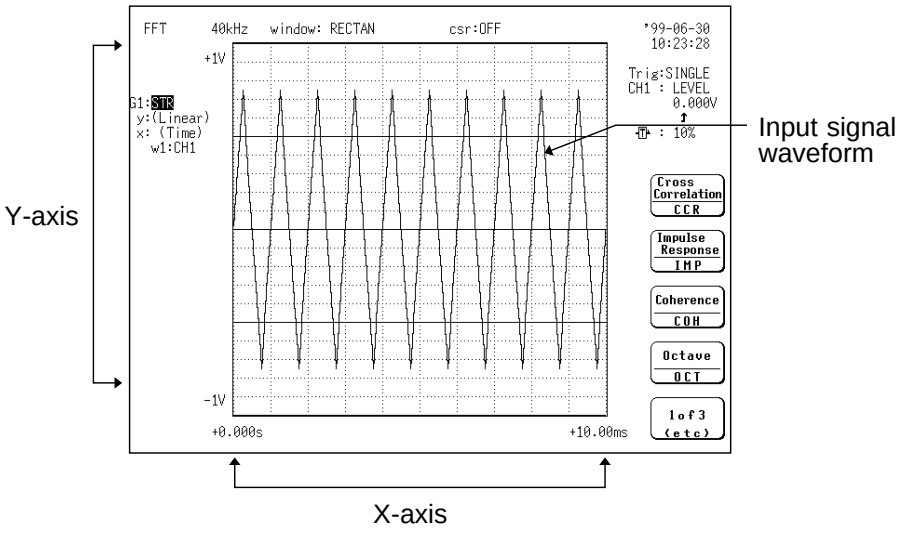
Function fa

Horizontal cursor Time Time axis display
Indicates the value of the specified TIME/DIV frequency range. (Refer to the table of the frequency range and time axis in Section 4.2.3.)

Vertical cursor Linear Indicates the value of the measurement range of the input unit in voltage units.

Vertical axis	Display
LIN-REAL (real-number part)	–
LIN-IMAG (imaginary-number part)	–
LIN-MAG (amplitude)	fa
LOG-MAG (logarithmic amplitude)	–
PHASE (phase)	–

Example Stored waveform



4.3.2 Linear Spectrum [LIN]

- The frequency domain waveform of the input signal, including magnitude and phase information.
- Major applications include:

・Determining the peaks of waveform frequency components
・Determining the levels of high and low harmonics

Function

$$Fa = \Im(fa)$$
$$= |Fa| \exp(j\theta a)$$
$$= |Fa|(\cos \angle\theta a + j \sin \angle\theta a)$$

Horizontal cursor

LIN-Hz — Frequency spectrum display as linear units.
The range is from DC to the maximum frequency range value.

LOG Hz — Frequency spectrum display as logarithmic units.
The number of FFT points and the range are as follows.

Number of FFT points	Rrange
1000	1/400 the maximum frequency range value to the maximum frequency range value
2000	1/800 the maximum frequency range value to the maximum frequency range value
5000	1/2000 the maximum frequency range value to the maximum frequency range value
10000	1/4000 the maximum frequency range value to the maximum frequency range value

Real — Linear display of real-number part of the data as voltage (Nyquist mode)

Vertical cursor

LIN-REAL — Linear display of real-number part of the data as voltage

LIN-IMAG — Linear display of imaginary-number part of the data as voltage

LIN-MAG — Linear display of analysis data as voltage

LOG-MAG — Logarithmic display of analysis data as dB
(0dB reference value: 1 V peak= α V p-p)

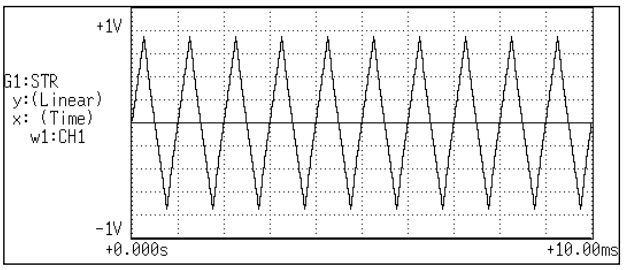
PHASE — Degrees (deg) display of phase component of data

Imag — Linear display of imaginary-number part of the data as voltage (Nyquist mode)

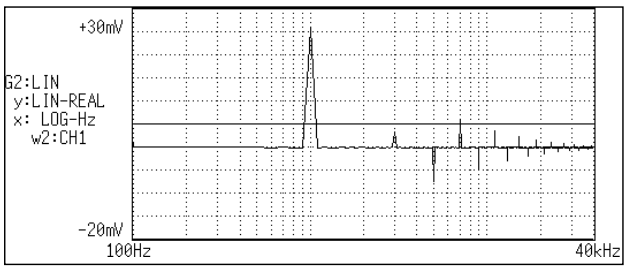
Vertical axis	Display
LIN-REAL (real-number part)	|Fa|・cos ∠θa
LIN-IMAG (imaginary-number part)	|Fa|・ sin ∠θa
LIN-MAG (amplitude)	|Fa|
LOG-MAG (logarithmic amplitude)	20・log |Fa|
PHASE (phase)	∠θa

Examples Linear spectra waveforms

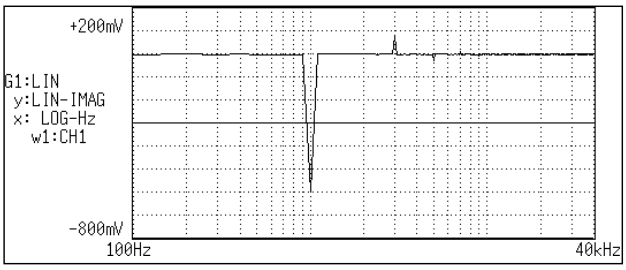
Stored waveform



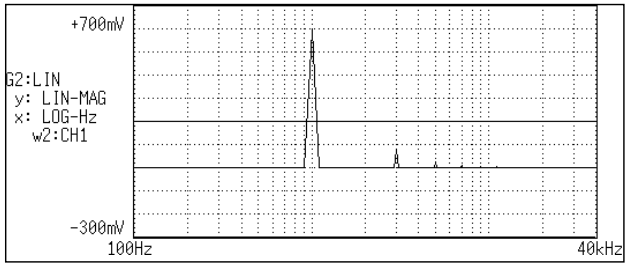
Y-axis: LIN-REAL (X-axis: LOG-Hz)



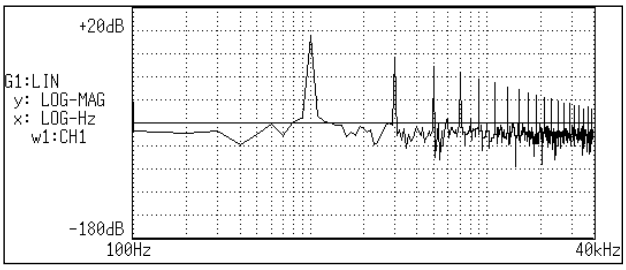
Y-axis: LIN-IMAG (X-axis: LOG-Hz)



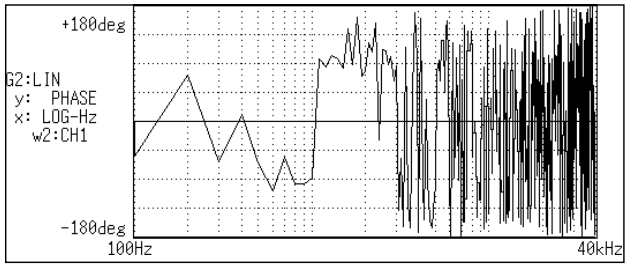
Y-axis: LIN-MAG (X-axis: LOG-Hz)



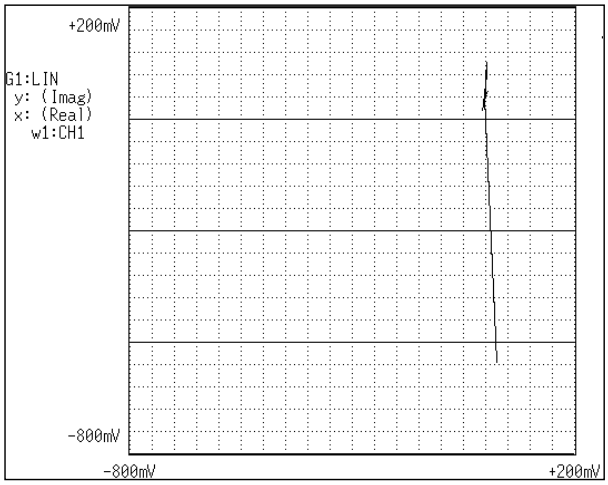
Y-axis: LOG-MAG (X-axis: LOG-Hz)



Y-axis: PHASE (X-axis: LOG-Hz)



Nyquist



4.3.3 RMS Spectrum [RMS]

- Displays the frequency domain waveform of the input signal, including magnitude (effective value) and phase information.
- Major applications include:

・Determining the peaks of waveform frequency components.
・Determining the effective values of frequency components.

Function

$$Ra = \frac{1}{\sqrt{2}} Fa$$
$$= |Ra| \exp(j\theta a)$$
$$= |Ra|(\cos \angle \theta a + j \sin \angle \theta a)$$

DC components: Ra = Fa

Horizontal cursor

LIN-Hz Frequency spectrum display as linear units. The range is from DC to the maximum frequency range value.

LOG-Hz Frequency spectrum display as logarithmic units.
The number of FFT points and the range are as follows.

Number of FFT points	Rrange
1000	1/400 the maximum frequency range value to the maximum frequency range value
2000	1/800 the maximum frequency range value to the maximum frequency range value
5000	1/2000 the maximum frequency range value to the maximum frequency range value
10000	1/4000 the maximum frequency range value to the maximum frequency range value

Vertical cursor

LIN-REAL Linear display of real-number part of the data as voltage

LIN-IMAG Linear display of imaginary-number part of the data as voltage

LIN-MAG Linear display of analysis data as voltage

LOG-MAG Logarithmic display of analysis data as dB (0dB reference value: 1 Vrms)

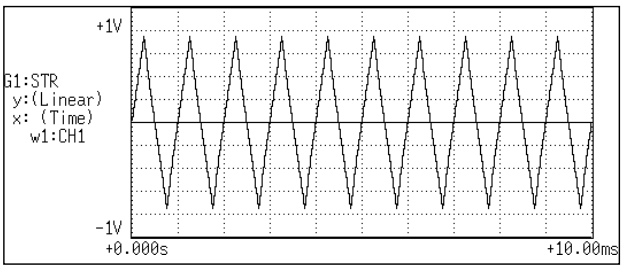
PHASE Degrees (deg) display of phase component of data

Vertical axis	Display
LIN-REAL (real-number part)	|Ra|・cos ∠θa
LIN-IMAG (imaginary-number part)	|Ra|・sin ∠θa
LIN-MAG (amplitude)	|Ra|
LOG-MAG (logarithmic amplitude)	20・log |Ra|
PHASE (phase)	∠θa

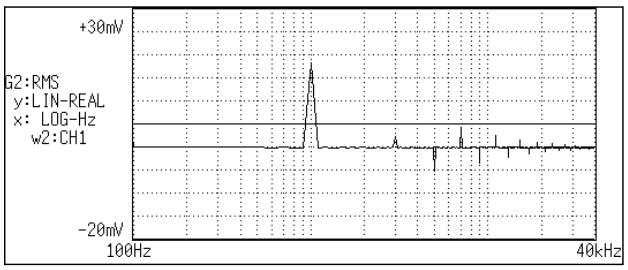
NOTE The RMS spectrum display and the LOG-MAG display express the same processing result.

Example RMS spectra waveform

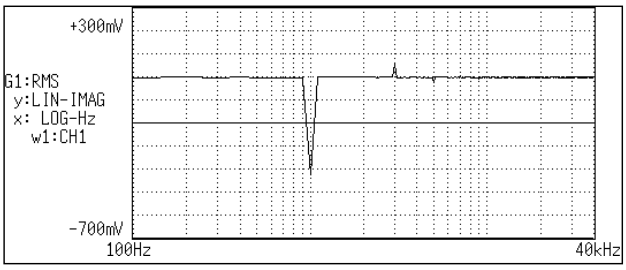
Stored waveform



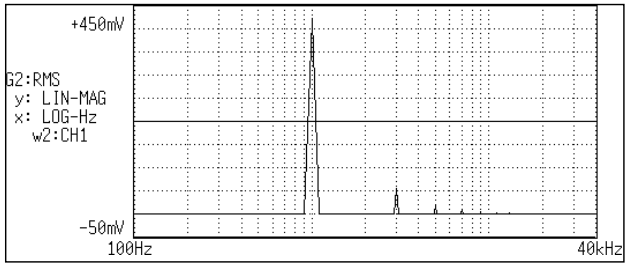
Y-axis: LIN-REAL (X-axis: LOG-Hz)



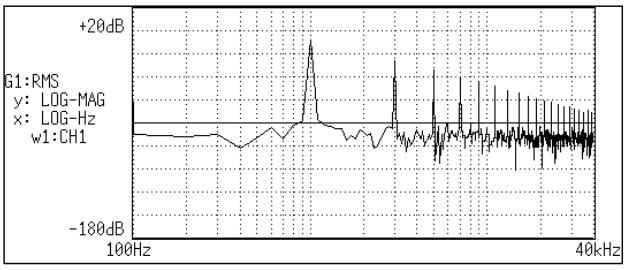
Y-axis: LIN-IMAG (X-axis: LOG-Hz)



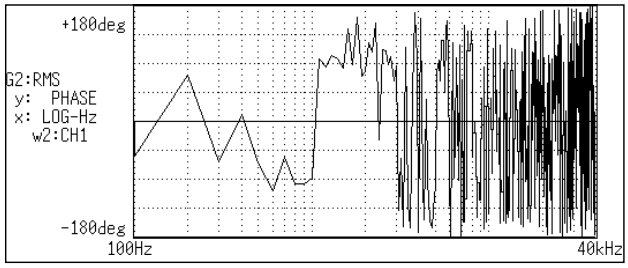
Y-axis: LIN-MAG (X-axis: LOG-Hz)



Y-axis: LOG-MAG (X-axis: LOG-Hz)



Y-axis: PHASE (X-axis: LOG-Hz)



4.3.4 Power Spectrum [PSP]

- Displays the energy spectrum of the input signal, consisting of only magnitude information.
- Major applications include:

・Determining the peaks of waveform frequency components
・Determining the energy levels of high and low harmonics

Function

$$Gaa = \frac{1}{2} Fa^* \cdot Fa$$
$$= \frac{1}{2}\{Re^2(Fa) + Im^2(Fa)\}$$
$$= \frac{1}{2}|Fa|^2$$

DC component:

$$Gaa = Fa^* \cdot Fa$$
$$= \{Re^2(Fa) + Im^2(Fa)\}$$
$$= |Fa|^2$$

Horizontal cursor

LIN-Hz Frequency spectrum display as linear units. The range is from DC to the maximum frequency range value.

LOG Hz Frequency spectrum display as logarithmic units.
The number of FFT points and the range are as follows.

Number of FFT points	Rrange
1000	1/400 the maximum frequency range value to the maximum frequency range value
2000	1/800 the maximum frequency range value to the maximum frequency range value
5000	1/2000 the maximum frequency range value to the maximum frequency range value
10000	1/4000 the maximum frequency range value to the maximum frequency range value

Vertical cursor

LIN-MAG Linear display of analysis data as binary exponential voltage This expresses the energy component.

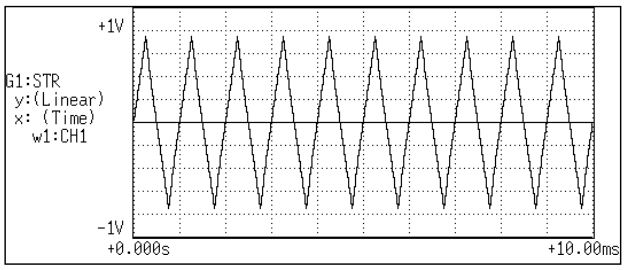
LOG-MAG Logarithmic display of analysis data as dB
(0dB reference value: 1 V^2 rms)

Vertical axis	Display
LIN-REAL (real-number part)	–
LIN-IMAG (imaginary-number part)	–
LIN-MAG (amplitude)	Gaa
LOG-MAG (logarithmic amplitude)	10 log |Gaa|
PHASE (phase)	–

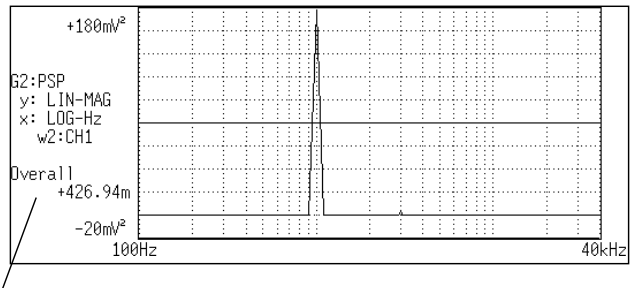
NOTE The LOG-MAG display and the RMS spectrum display express the same processing result.

Example Power spectra waveforms

Stored waveform

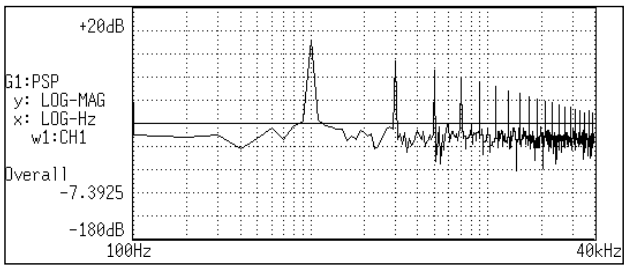


Y-axis: LIN-MAG (X-axis: LOG-Hz)



Overall value

Y-axis: LOG-MAG (X-axis: LOG-Hz)



Overall value

The overall value is the total effective value obtained from the frequency spectrum contained in the input signal. It is obtained by taking the square root of the total of power spectra for all frequencies.

(Overall value) $\sqrt{PSPo + \sum_{i=1} PSPi}$ (Vrms)

PSPo DC component
PSPi ith AC component

NOTE

Compensation is applied to data captured before starting FFT processing, to achieve the same overall value, also when a window function other than rectangular window is used.

Window compensation value: γ

Square wave: $\gamma = 1$

Hanning: $\gamma = \sqrt{\frac{8}{3}}$

Exponential: $\gamma = \sqrt{\frac{2\log(\alpha/100)}{(\alpha/100)^2 - 1}}$

(α is a percentage with a range of $0 \leqq \alpha < 100$.)
If α is set to 0 with the exponential window function, processing will be carried with $\alpha = 0.1$.

4.3.5 Auto Correlation [ACR]

- Displays the degree of similarity between two points in the input signal separated by time difference (**τ**).
- Major applications:

・Detecting a periodic signal contained in a noisy signal with an improvement in signal-to-noise ratio.
・Checking the periodic signal components contained in a noisy waveform, and periodic noise.

Function

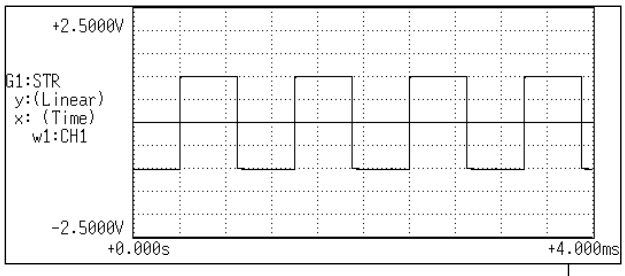
$$Raa(\tau) = \Im^{-1}(Gaa)$$
$$= \frac{1}{2\pi} \int_{-\infty}^{+\infty} Gaa(\omega) \exp(j\omega\tau) d\omega$$

Horizontal cursor	Time	Time display. The center indicates the reference (τ =0), the right side indicates time lag (+ τ), and the left side indicates time lead (- τ).
Vertical cursor	Linear	Readings are between +1 and -1 (without units). +1: the highest similarity for time differential τ 0: the lowest similarity, -1: the polarity is completely opposite. Due to the characteristics of the function, τ =0 always results in +1.

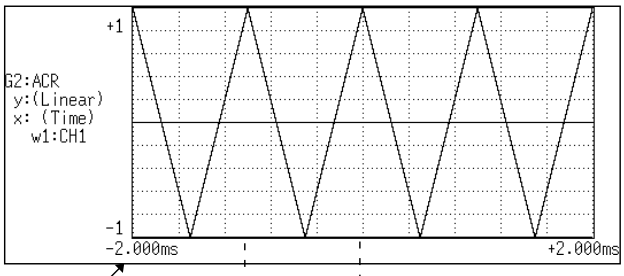
Vertical axis	Display
LIN-REAL (real-number part)	–
LIN-IMAG (imaginary-number part)	–
LIN-MAG (amplitude)	Raa
LOG-MAG (logarithmic amplitude)	–
PHASE (phase)	–

Example Auto correlation function waveforms

Stored waveform



Auto correlation function



Because the input waveform is the frequency waveform, peaks are repeated at regular intervals.

0 The time until the first peak is the input signal period.

4.3.6 Histogram [HIS]

- Displays the frequencies of the magnitudes of sampled points.
- Major applications include:
  - Determining waveform imbalance
  - Determining whether a waveform is artificial or natural from the waveform distribution (most natural waveforms are regular sine waves).

Function Pa

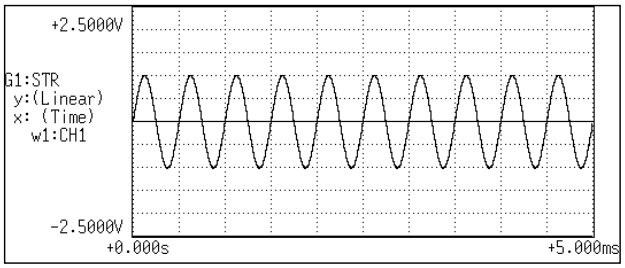
Horizontal cursor	Volt	Linear display of the measurement range of the input unit.
Vertical cursor	Linear	Number of sample points for the time axis data (total: 1000, 2000, 5000 or 10000 points).

Vertical axis	Display
LIN-REAL (real-number part)	–
LIN-IMAG (imaginary-number part)	–
LIN-MAG (amplitude)	Pa
LOG-MAG (logarithmic amplitude)	–
PHASE (phase)	–

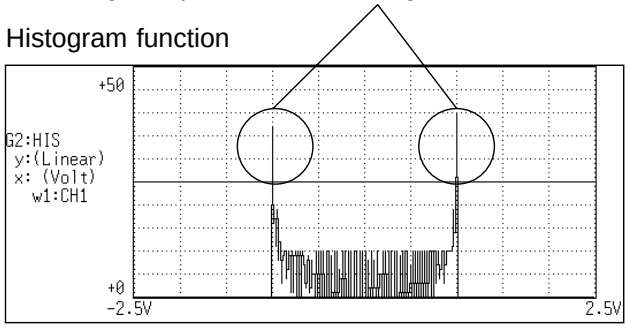
Example Histogram function waveforms

High amplitude indicates high number of data.

Stored waveform



Histogram function



4.3.7 Transfer Function [TRF]

- Displays the transfer function (frequency characteristics) of the system being measured calculated from input and output signals.
- Nyquist diagrams can also be displayed, including magnitude and phase information.
- Major applications include:

・Determining filter frequency characteristics.
・Determining feedback control system stability through Nyquist diagrams.
・Determining the physical resonant frequency using an impulse hammer and pick-up sensor.

Function

$$Hab = \frac{Fb}{Fa} = \frac{Fb \cdot Fa^*}{Fa \cdot Fa^*} = \frac{Gab}{Gaa}$$
$$= \frac{|Gab|}{|Gaa|}\{\cos(\angle\theta b - \angle\theta a) + j\sin(\angle\theta b - \angle\theta a)\}$$

a: input
b: output

Horizontal cursor

LIN-Hz Frequency spectrum display as linear units. The range is from DC to the maximum frequency range value.

LOG-Hz Frequency spectrum display as logarithmic units.
The number of FFT points and the range are as follows.

Number of FFT points	Rrange
1000	1/400 the maximum frequency range value to the maximum frequency range value
2000	1/800 the maximum frequency range value to the maximum frequency range value
5000	1/2000 the maximum frequency range value to the maximum frequency range value
10000	1/4000 the maximum frequency range value to the maximum frequency range value

Real Linear display of the real-number part of the input-to-output ratio (Nyquist mode)

Vertical cursor

RIN-REAL Linear display of the real-number part of the input-to-output ratio (no units).

LIN-IMAG Linear display of the imaginary-number part of the input-to-output ratio (no units).

LIN-MAG Linear display of input-to-output ratio (no units)
This expresses the amplitude component.

LOG-MAG Logarithmic display of input-to-output ratio as dB (no units)
This expresses the amplitude component.

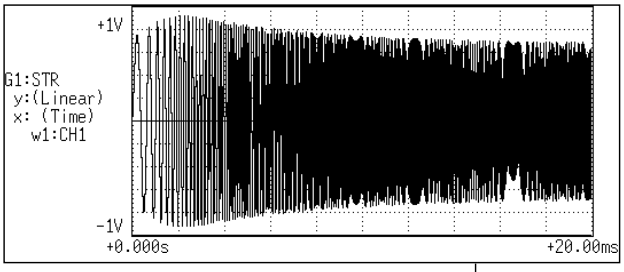
PHASE Degrees (deg) display of phase component of data of input-to-output ratio

Imag Linear display of the imaginary-number part of the input-to-output ratio (Nyquist mode).

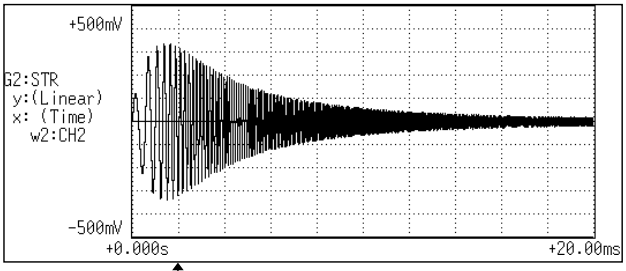
Vertical axis	Display
LIN-REAL (real-number part)	|Hab|·cos ∠θb−∠θa
LIN-IMAG (imaginary-number part)	|Hab|·sin ∠θb−∠θa
LIN-MAG (amplitude)	|Hab|
LOG-MAG (logarithmic amplitude)	20 log |Hab|
PHASE (phase)	∠θb−∠θa

Example Transfer function spectra waveform

Stored waveform (input signal)

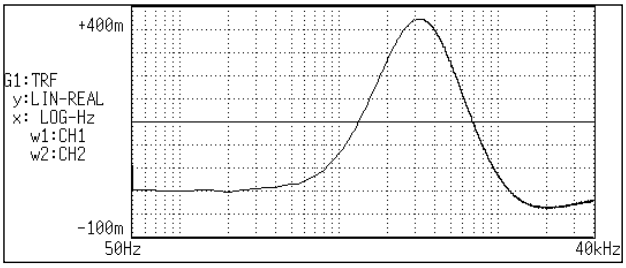


Stored waveform (output signal)

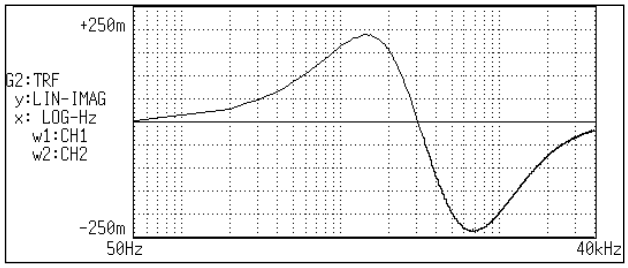


After bandpass filter

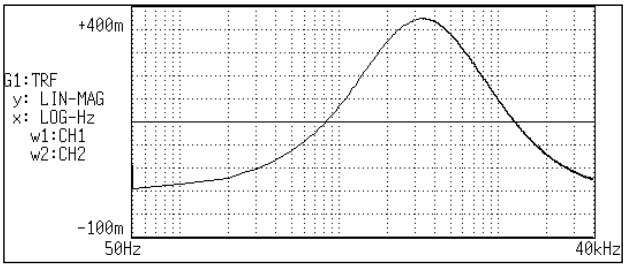
Y-axis: LIN-REAL (X-axis: LOG-Hz)



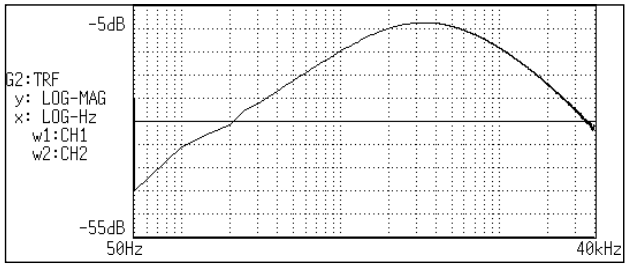
Y-axis: LIN-IMAG (X-axis: LOG-Hz)



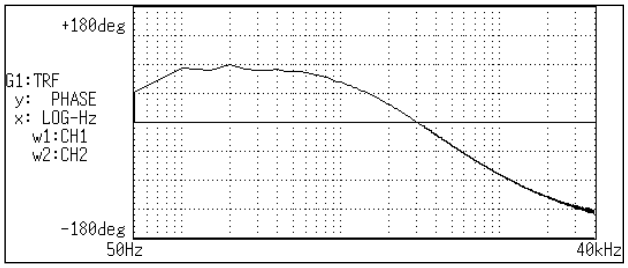
Y-axis: LIN-MAG (X-axis: LOG-Hz)



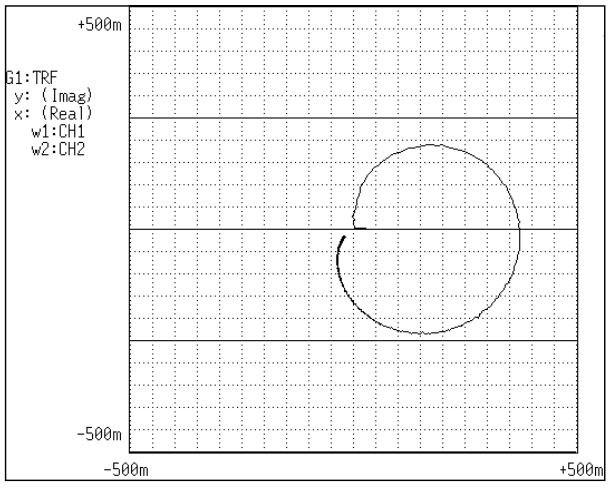
Y-axis: LOG-MAG (X-axis: LOG-Hz)



Y-axis: PHASE (X-axis: LOG-Hz)



Nyquist



4.3.8 Cross Power Spectrum [CSP]

- Displays the product of the spectra of two input signals.
- The magnitude and phase information of the frequency components that are common to both signals can be displayed.
- Major applications:
  Obtaining frequency components common to two signals.

Function

$$Gab = \frac{1}{2} Fa^* \cdot Fb$$

$$= \frac{1}{2} |Fa| \cdot |Fb| \{\cos(\angle\theta b - \angle\theta a) + j \sin(\angle\theta b - \angle\theta a)\}$$

Horizontal cursor

LIN-Hz — Frequency spectrum display as linear units. The range is from DC to the maximum frequency range value.

LOG Hz — Frequency spectrum display as logarithmic units.
The number of FFT points and the range are as follows.

Number of FFT points	Rrange
1000	1/400 the maximum frequency range value to the maximum frequency range value
2000	1/800 the maximum frequency range value to the maximum frequency range value
5000	1/2000 the maximum frequency range value to the maximum frequency range value
10000	1/4000 the maximum frequency range value to the maximum frequency range value

Real — Linear display of real-number part of the data as voltage (Nyquist mode).

Vertical cursor

LIN-REAL — Linear display of real-number part of the data as binary exponential voltage

LIN-IMAG — Linear display of imaginary-number part of the data as binary exponential voltage

LIN-MAG — Linear display of amplitude component as binary exponential voltage

LOG-MAG — Logarithmic display of the amplitude component as dB (0dB reference value; $1V^2$rms.)

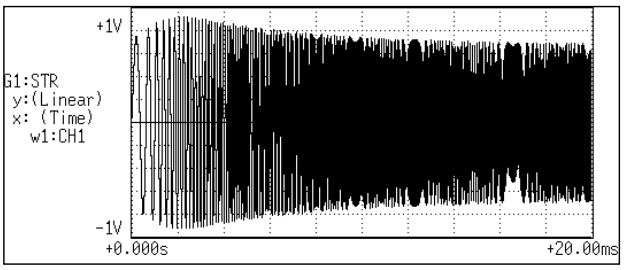
PHASE — Degrees (deg) display of phase component of data

Imag — Linear display of imaginary-number part of the data as binary exponential voltage (Nyquist mode)

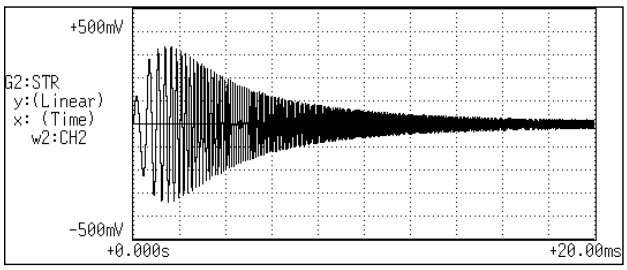
Vertical axis	Display
LIN-REAL (real-number part)	|Gab|・cos ∠θb−∠θa
LIN-IMAG (imaginary-number part)	|Gab|・sin ∠θb−∠θa
LIN-MAG (amplitude)	|Gab|
LOG-MAG (logarithmic amplitude)	10 log |Gab|
PHASE (phase)	∠θb−∠θa

Example Cross power spectra waveforms

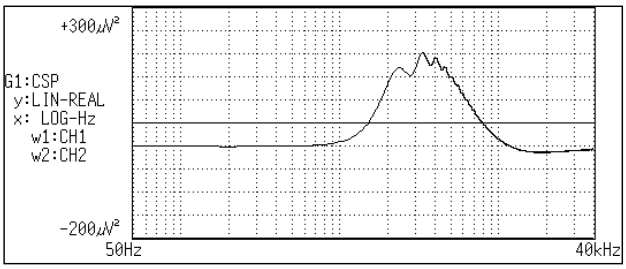
Stored waveform 1



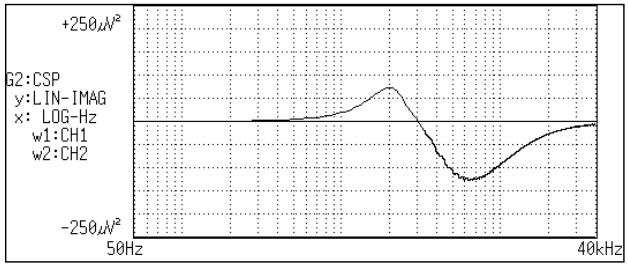
Stored waveform 2



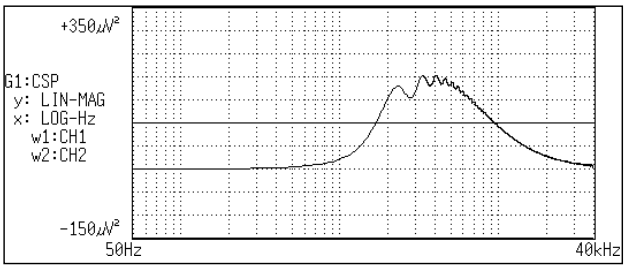
Y-axis: LIN-REAL (X-axis: LOG-Hz)



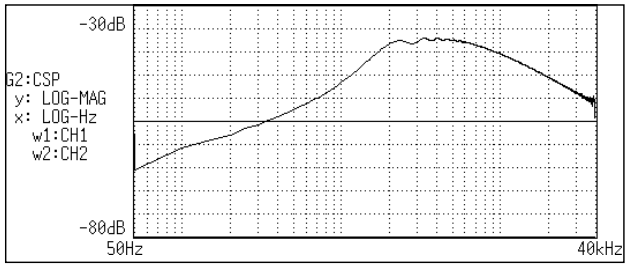
Y-axis: LIN-IMAG (X-axis: LOG-Hz)



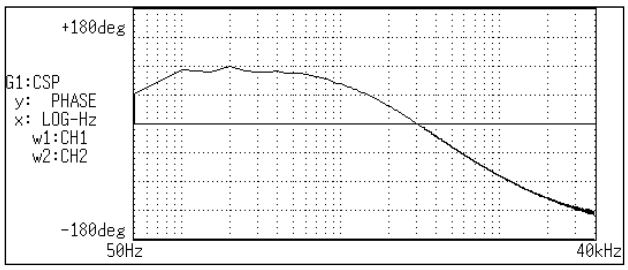
Y-axis: LIN-MAG (X-axis: LOG-Hz)



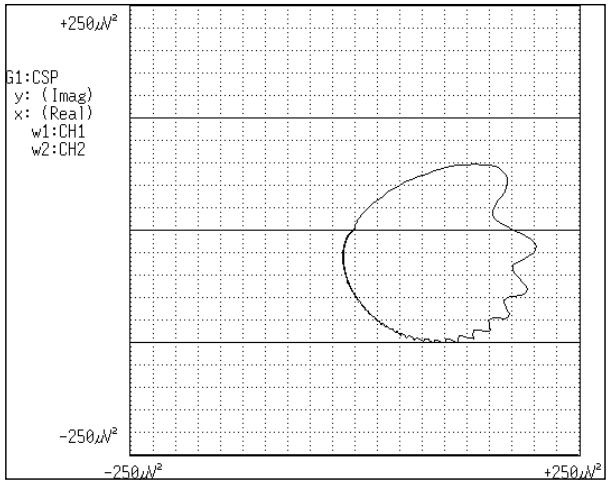
Y-axis: LOG-MAG (X-axis: LOG-Hz)



Y-axis: PHASE (X-axis: LOG-Hz)



Nyquist



4.3.9 Cross Correlation [CCR]

- Displays the degree of similarity between two points separated by a time difference (**τ**) on two signals.
- The degree of similarity is expressed as a function of the time difference (**τ**).
- Major applications:

・Obtaining the phase difference between two signals in time units.
・Obtaining a speed or distance by measuring the time delay.

Function

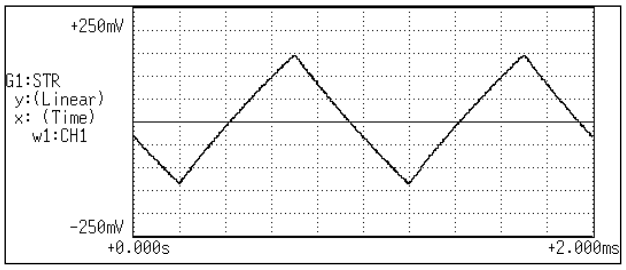
$$Rab(\tau) = \Im^{-1}(Gab)$$
$$= \frac{1}{2\pi} \int_{-\infty}^{+\infty} Gab(\omega) \cdot \exp(j\omega\tau) d\omega$$

Horizontal cursor	Time	Time display. The center indicates the reference (τ =0), the right side indicates time lag (+ τ), and the left side indicates time lead (- τ).
Vertical cursor	Linear	Readings are from +1 to -1 (no units). +1: the highest similarity between the input and output signals for time differential τ , 0: the lowest similarity, -1: the polarity is completely opposite

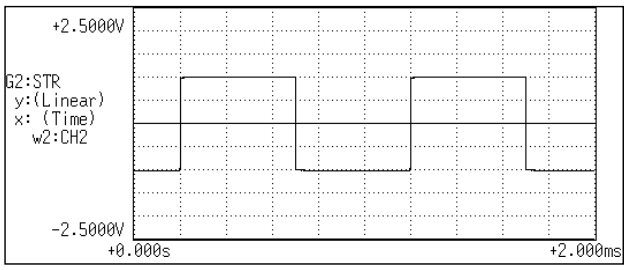
Vertical axis	Display
LIN-REAL (real-number part)	–
LIN-IMAG (imaginary-number part)	–
LIN-MAG (amplitude)	Rab
LOG-MAG (logarithmic amplitude)	–
PHASE (phase)	–

Example Cross correlation function waveforms

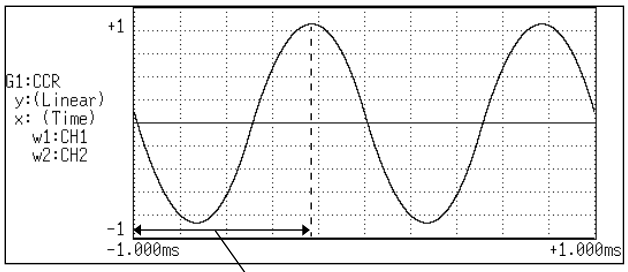
Stored waveform (input waveform)



Stored waveform (output waveform)



Cross correlation function



Phase differences between input signal and output signal

4.3.10 Unit Impulse Response [IMP]

- Displays the frequency response of a system in the time domain.
- A response waveform equivalent to the unit impulse function is obtained by analyzing the input and output signals of the system being measured.
- Major applications
  Checking circuit time constants.

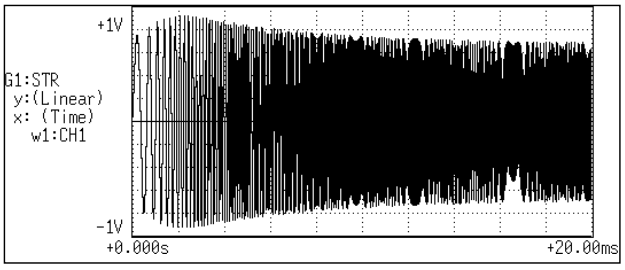
Function $IMP = \Im^{-1}(Hab)$

Horizontal cursor	Time	Time display. The center indicates the reference (τ =0), the right side indicates time lag (+ τ), and the left side indicates time lead (- τ).
Vertical cursor	Linear	Inverse Fourier conversion value of the transfer function (Hab) (no units).

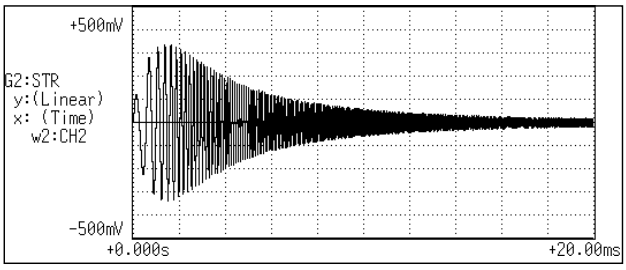
Vertical axis	Display
LIN-REAL (real-number part)	–
LIN-IMAG (imaginary-number part)	–
LIN-MAG (amplitude)	IMP
LOG-MAG (logarithmic amplitude)	–
PHASE (phase)	–

Example Unit impulse response waveforms

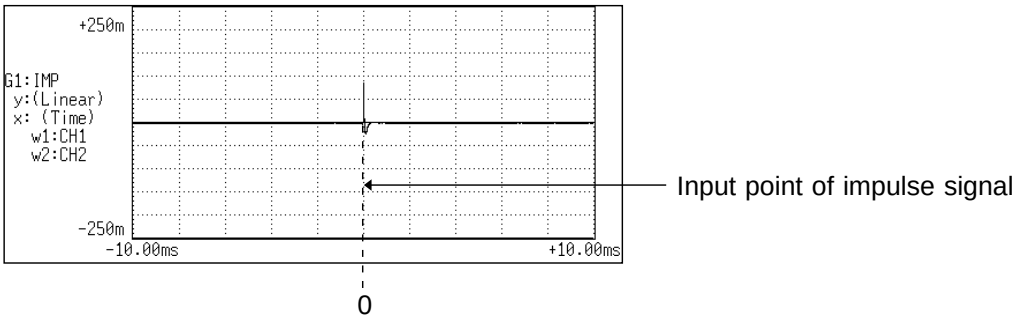
Stored waveform (input signal)



Stored waveform (output signal)



Unit impulse response



4.3.11 Coherence [COH]

- Displays the output signal component that is coherent (interference possible) to the input signal, yielding a value from 0 to 1.
- Major applications include:
  - Evaluation of transfer functions.
  - Determining the contribution of individual input lines to the output of multi-input systems.

Function $$COH = \frac{Gab^* \cdot Gab}{Gaa \cdot Gbb}$$

Horizontal cursor

LIN-Hz: Frequency spectrum display as linear units. The range is from DC to the maximum frequency range value.

LOG-Hz: Frequency spectrum display as logarithmic units.
The number of FFT points and the range are as follows.

Number of FFT points	Rrange
1000	1/400 the maximum frequency range value to the maximum frequency range value
2000	1/800 the maximum frequency range value to the maximum frequency range value
5000	1/2000 the maximum frequency range value to the maximum frequency range value
10000	1/4000 the maximum frequency range value to the maximum frequency range value

Vertical cursor

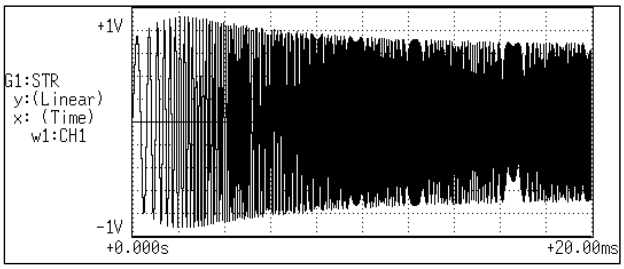
Linear: The relationship between the two input signals. The degree of relationship is indicated from 0 to 1 on a linear scale (no units).

Vertical axis	Display
LIN-REAL (real-number part)	–
LIN-IMAG (imaginary-number part)	–
LIN-MAG (amplitude)	COH
LOG-MAG (logarithmic amplitude)	–
PHASE (phase)	–

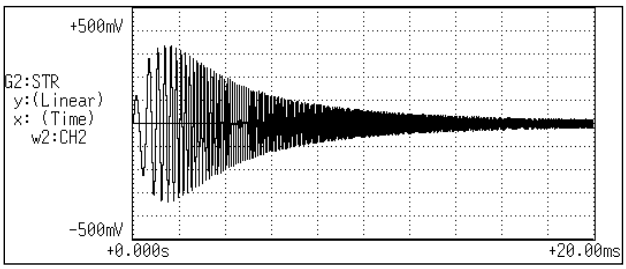
NOTE For a single measurement, the coherence function returns 1 for all frequencies. When measuring, be sure to use frequency averaging.

Example Coherence function waveforms

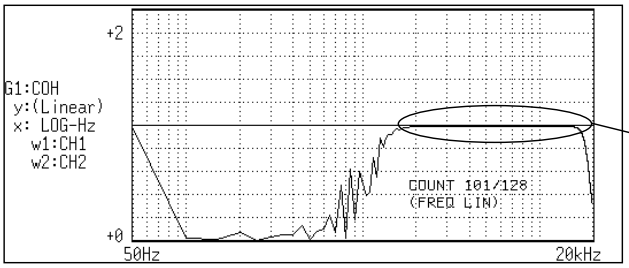
Stored waveform (input signal)



Stored waveform (output signal)



Coherence



Frequencies in this range have high coherence.

4.3.12 Octave Analysis [OCT]

- This function displays the spectrum of a noise signal or other signal, using 1/1-octave or 1/3-octave band filters with fixed ratio.
- Main uses
  Frequency analysis of noise

Function OCT

Horizontal cursor

1/1 OCT	1/1-octave band filtering
1/3 OCT	1/3-octave band filtering

Vertical cursor

LIN-MAG	Linear display of octave analysis value as voltage
LOG-MAG	Logarithmic display of octave analysis value as dB

Vertical axis	Display
LIN-REAL (real number)	–
LIN-IMAG (imaginary number)	–
LIN-MAG (amplitude)	OCT
LOG-MAG (logarithmic amplitude)	10log (OCT)
PHASE	–

- For frequency analysis of a noise signal or similar, the signal is passed through fixed-ratio band filters with 1/1-octave or 1/3-octave bandwidth.
- As opposed to the power spectrum function, where the signal is divided into bands of identical width and the power in each band is displayed, octave analysis divides the frequency axis evenly on a logarithmic scale and expresses the level as a bar for each band.
- In analog octave analysis, the octave band center frequencies and filter characteristics are determined according to the ANSI CLASS 3 standard. In the 8835-01, the power spectrum is measured first and bundling is then used to perform 1/1-octave or 1/3-octave analysis. This allows the following analysis functions:

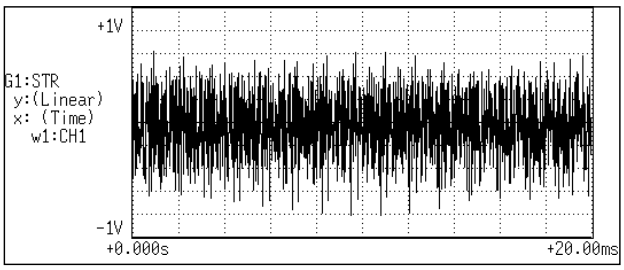
  5-band 1/1-octave analysis
  15-band 1/3-octave analysis
- 15-band 1/3-octave analysis and filter characteristics of the 8835-01 correspond to the ANSI CLASS 3 standard. However, in the upper bands of frequency analysis, there are no leak components from higher frequencies.

  For example, the 20 kHz band contains no leak components from the 25 kHz band or other bands.
- 15-band 1/3-octave analysis
  In this mode, the 400 spectrum lines of regular frequency analysis are bundled into 1/3 octave bands and shown as a bar graph.

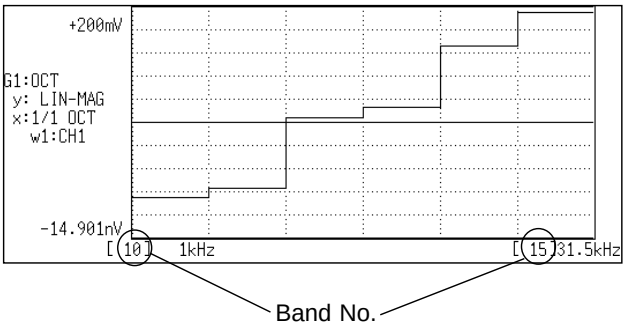
・5-band 1/1-octave analysis
In this mode, the 400 spectrum lines of regular frequency analysis are bundled into 1/1 octave bands and shown as a bar graph.

Example Octave analysis waveforms

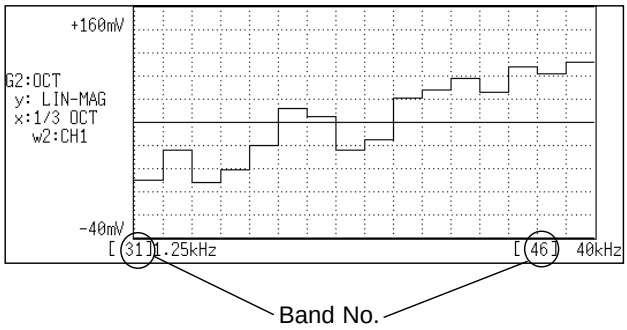
Stored waveform



1/1 octave analysis



1/3 octave analysis



Frequency ranges and measurable range widths (○: 1/1 OCT, △: 1/3 OCT)

Band No.		Center frequency (Hz)	Frequency ranges (Hz)																		
1/1	1/3		133 m	333 m	667 m	1.33	4	8	20	40	80	200	400	800	2 k	4 k	8 k	20 k	40 k	80 k	200 k	400 k
-8	-24 -23	4m 5m	○ △																			
-7	-22 -21 -20	6.3m 8m 10m	△ ○△ △	○ △																		
-6	-19 -18 -17	12.5m 16m 20m	△ ○△ △	△ ○△ △	○ △																	
-5	-16 -15 -14	25m 31.5m 40m	△ ○△ △	△ ○△ △	△ ○△ △	○ △																
-4	-13 -12 -11	50m 63m 80m	△ ○△ △	△ ○△ △	△ ○△ △	△ ○△ △																
-3	-10 -9 -8	100m 125m 160m	△ ○△ △	△ ○△ △	△ ○△ △	△ ○△ △	△ ○△ △															
-2	-7 -6 -5	200m 250m 315m		△ ○△ △	△ ○△ △	△ ○△ △	△ ○△ △	△ ○△ △														
-1	-4 -3 -2	400m 500m 630m			△ ○△ △	△ ○△ △	△ ○△ △	△ ○△ △	○ △													
0	-1 0 1	800m 1 1.25				△ ○△ △	△ ○△ △	△ ○△ △	△ ○△ △	○ △												
1	2 3 4	1.6 2 2.5					△ ○△ △	△ ○△ △	△ ○△ △	△ ○△ △	○ △											
2	5 6 7	3.15 4 5					△ ○△	△ ○△ △	△ ○△ △	△ ○△ △	△ ○△ △											
3	8 9 10	6.3 8 10						△ ○△	△ ○△ △	△ ○△ △	△ ○△ △	△ ○△ △										
4	11 12 13	12.5 16 20							△ ○△ △	△ ○△ △	△ ○△ △	△ ○△ △	△ ○△ △									
5	14 15 16	25 31.5 40								△ ○△ △	△ ○△ △	△ ○△ △	△ ○△ △	△ ○△ △								
6	17 18 19	50 63 80									△ ○△ △	△ ○△ △	△ ○△ △	△ ○△ △	△ ○△							
7	20 21 22	100 125 160										△ ○△ △	△ ○△ △	△ ○△ △	△ ○△	△ ○△						
8	23 24 25	200 250 315										△ ○	△ ○△ △	△ ○△ △	△ ○△	△ ○△	△ ○△					
9	26 27 28	400 500 630											△ ○	△ ○△ △	△ ○△	△ ○△	△ ○△	○ △				
10	29 30 31	800 1k 1.25k												△ ○	△ ○△	△ ○△	△ ○△	△ ○△	○ △			
11	32 33 34	1.6k 2k 2.5k													△ ○△	△ ○△	△ ○△	△ ○△	△ ○△	○ △		
12	35 36 37	3.15k 4k 5k														△ ○△	△ ○△	△ ○△	△ ○△	△ ○△		
13	38 39 40	6.3k 8k 10k															△ ○△	△ ○△	△ ○△	△ ○△	△ ○△	
14	41 42 43	12.5k 16k 20k																△ ○△	△ ○△	△ ○△	△ ○△	△ ○△

Band No.		Center frequency (Hz)	Frequency ranges (Hz)																	
1/1	1/3		133 m	333 m	667 m	1.33	4	8	20	40	80	200	400	800	2 k	4 k	8 k	20 k	40 k	80 k	200 k	400 k
15	44 45 46	25k 31.5k 40k																△ ○△ △		△ ○△ △	△ ○△ △	△ ○△ △
16	47 48 49	50k 63k 80k																		△ ○△ △	△ ○△ △	△ ○△ △
17	50 51 52	100k 125k 160k																			△ ○△ △	△ ○△ △
18	53 54 55	200k 250k 315k																			△ ○	△ ○△ △
19	56 57	400k 500k																				△ ○

Chapter 5
Other Functions

5.1 Outline

The following five functions are added by the 9540-01 FUNCTION UP DISK.

- Waveform processing calculation
- Waveform parameter decision
- Waveform area decision
- Memory segmentation functions
- Averaging function

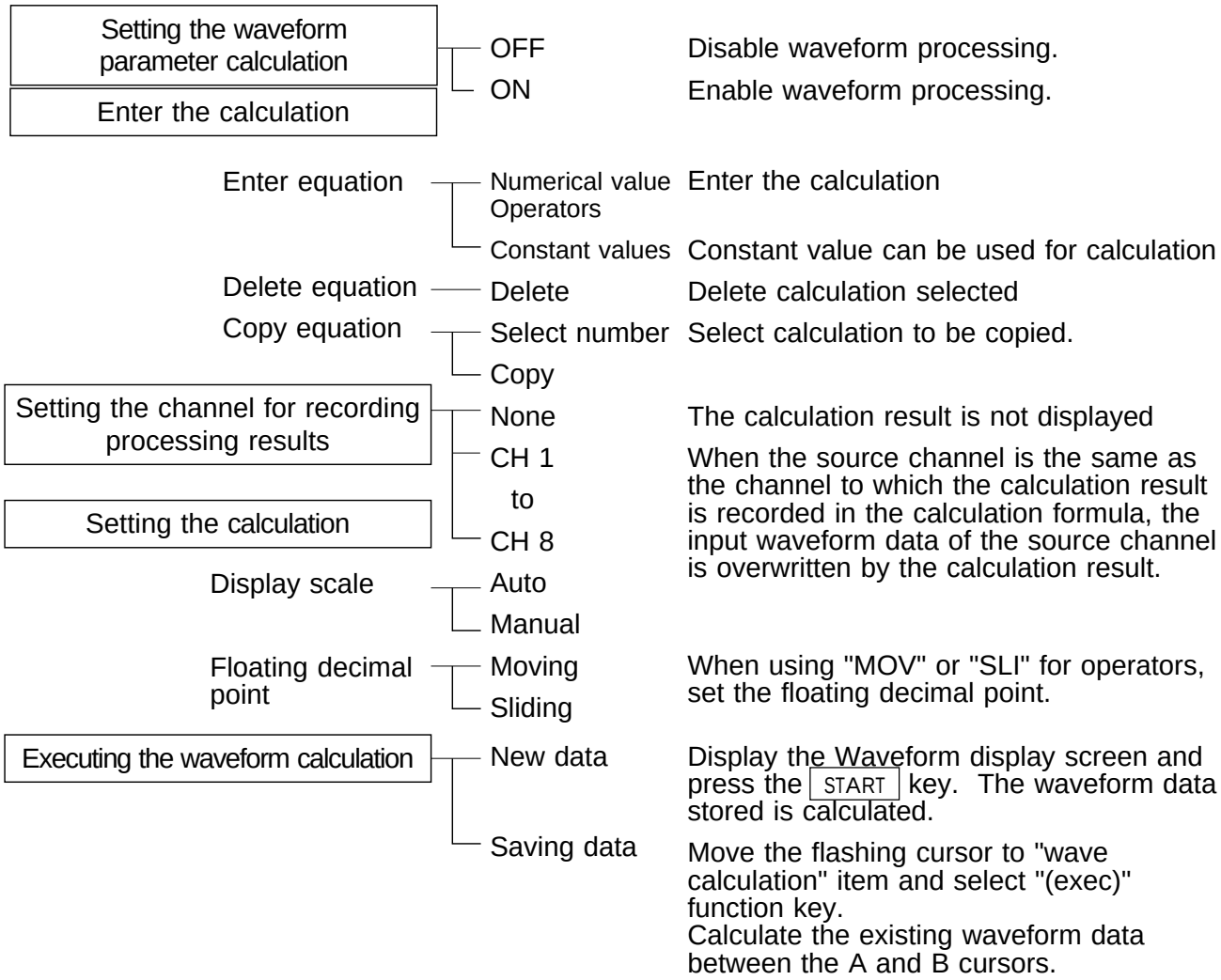
5.2 Calculating Waveform Data

- Waveform processing is possible only for the memory recorder function and memory waveform in recorder & memory.
- Memory waveform in recorder & memory is processed by memory recorder function.
- The values processed are those read between the trace cursors.
- Processing results are displayed as a waveform.
- Processing is only possible for waveforms for which the recording length was set at 1000 divisions or less.
- Use the A/B cursors (vertical or trace cursor) to specify the processing range for the waveform data.

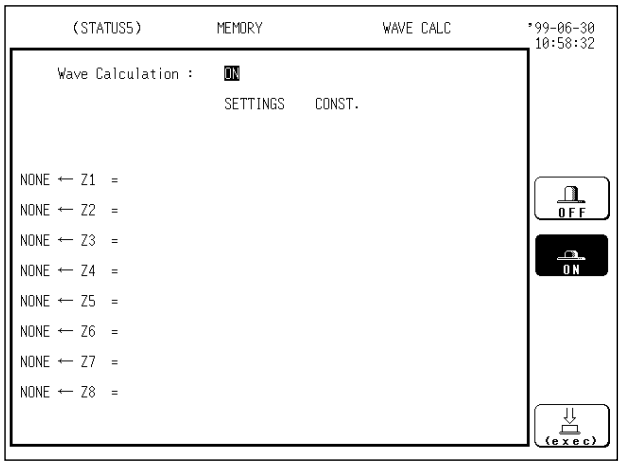
The following operators can be used to define processing equations.

(1) Arithmetic operators (+, -, ∗, /)
(2) Absolute value (ABS)
(3) Exponent (EXP)
(4) Logarithm (LOG)
(5) Square root (SQR)
(6) Displacement average (MOV)
(7) Parallel displacement on time axis (SLI)
(8) 1st and 2nd differential (DIF, DIF2)
(9) 1st and 2nd integral (INT, INT2)
(10) Trigonometric functions (SIN, COS, TAN)
(11) Reverse trigonometric functions (ASIN, ACOS, ATAN)

Waveform Processing Procedure



5.2.1 Preparing for Waveform Processing



Method

Screen: STATUS 5 (MEM)

① Press the STATUS key to call up the STATUS 5 screen.
② Move the flashing cursor to the position shown in the figure on the left.
③ Make the setting with the function keys.

Selection

OFF : Disable waveform processing.

ON : Enable waveform processing. The various setting items are displayed.

(exec) : Execute waveform processing.

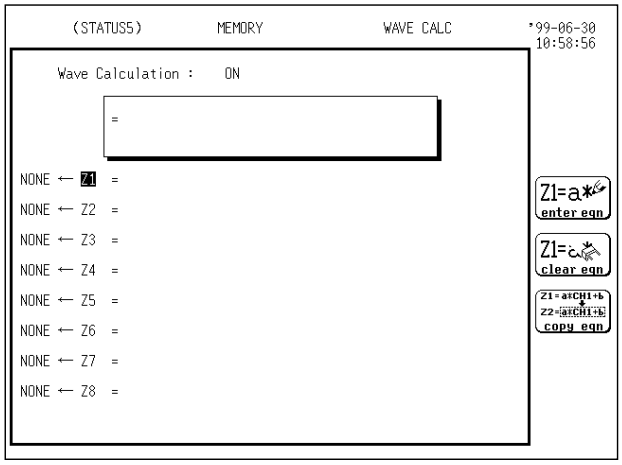
NOTE

- The maximum recording length at which waveform processing calculation is possible is 1000 divisions. If the waveform data size exceeds this upper limit, calculation is not possible.
- Range under 1000 DIV specified between A/B cursors is not available for processing when recording length is over 1000 DIV.
- When the memory segmentation function or roll mode is used, waveform processing is not possible.
- For scaling see Section 9.4 of the 8835-01 Instruction Manual.
- When subjecting the memory waveform of the recorder and memory function to waveform processing calculations, the recorder waveform data will be destroyed.
- Canceling waveform processing during loading data displays incomplete calculation result. Press Execute again to reprocess calculation.
- When set to averaging, load waveform before executing waveform processing.

5.2.2 Defining the Processing Equation

Eight processing equations (Z1 - Z8) can be defined.

Making the processing equation



Method

Screen: STATUS 5 (MEM)

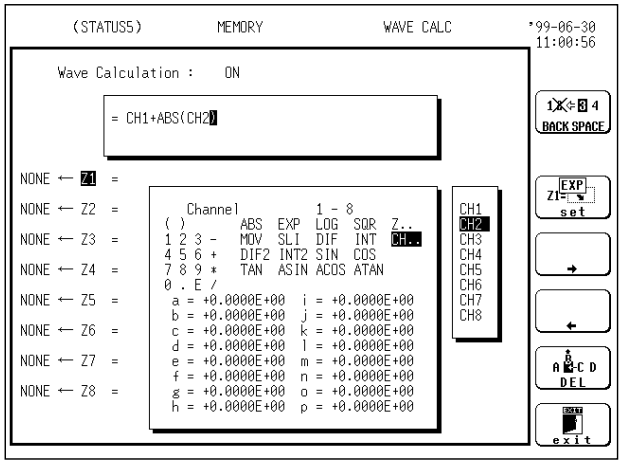
① Press the STATUS key to call up the STATUS 5 screen.
② Move the flashing cursor to " **Z1** to **Z8**".
③ Use the function keys to select the "**enter equ**".

Selection

Z1=a* enter eqn : Enter equation.

Z1=c clear eqn : Delete equation.

Z1=a*CH1+b Z2=a*CH1+b copy eqn : Copy equation.



④ Move the flashing cursor to the desired item with the JOG control or the CURSOR key, use the function keys to select the **set**. Use the function key to move the flashing cursor within the equation.

Selection

EXP Z1= set : Enter the item into selected equation.

→ : Move the equation cursor right.

← : Move the equation cursor left.

A C D DEL : Delete character under cursor in equation.

EXIT exit : Terminate equation input.

⑤ When the equations have been input, press the F5 [exit] key. If there are any syntax errors in the equations (incomplete bracketing, missing "*", more than eight MOV, SLI, DIF, DIF2, INT, INT2 operators, etc.), a "**?**" is displayed, and the cursor rests on the error, so that the problem can be corrected. When there are no syntax errors, a "**=**" is displayed.
⑥ Make settings for Z2 to Z8 as for Z1.

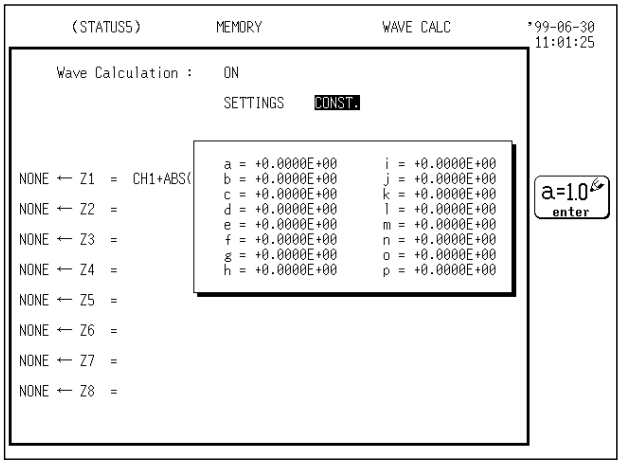
Operators (For details, see Appendix 3.3.)

ABS	Absolute value	DIF2	2nd differential
EXP	Exponential	INT2	2nd integral
LOG	Logarithm	SIN	Sine
SQR	Square root	COS	Cosine
MOV	Moving average	TAN	Tangent
SLI	Parallel displacement on time axis	ASIN	Arc-sine
DIF	1st differential	ACOS	Arc-cosine
INT	1st integral	ATAN	Arc-tangent

NOTE

- For multiplication, always use the "*" sign.
- Out of the MOV, SLI, DIF, DIF2, INT, and INT2 operators, up to eight can be used in the same equation (for example eight MOV operators or five MOV and three SLI operator, etc.).
- The maximum number of digits for a constant is 30.
- If division by 0 is specified (1/0), an overflow value is output.
- Equations are calculated in ascending order, from Z1 to Z8.
- The data that can be used in an operational equation (channel data and results of operation) must be smaller than in the preset operation numbers (for example, Z3 and Z4 cannot be used on Z2).

Entering the constant values



Method

Screen: STATUS 5 (MEM)

① Move the flashing cursor to the position shown in the figure on the left.
② Use the function keys to select the **enter**. The setting range is -9.9999E+29 to +9.9999E+29 (exponent: -29 to +29).

Selection

: Value up

: Value down

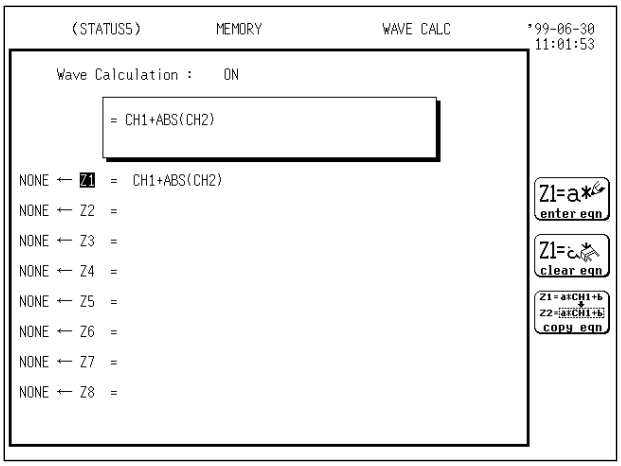
: Enter the value using the numeric keys.

: Close entering constant.

③ Move the flashing cursor to the desired item with the CURSOR key, enter the constant value with the function key or the JOG control.

④ Select **exit** after finishing entering constant.

Deleting an Equation



Method

Screen: STATUS 5 (MEM)

① Move the flashing cursor to one of the Z1 - Z8 items.
② Press the F2 [clear eqn].
③ Make the setting with the function keys.

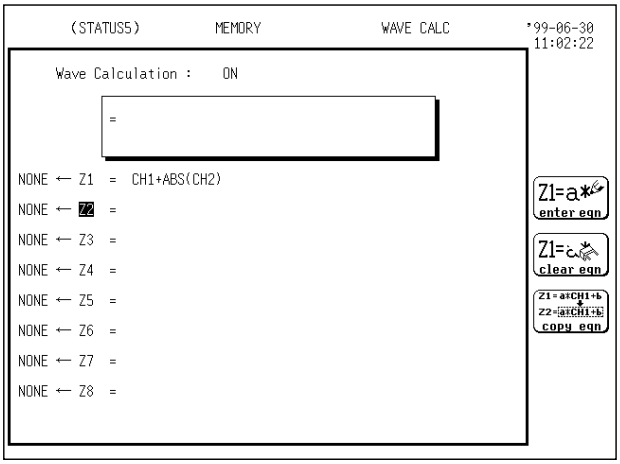
Selection

: Clear equation

: Do not clear equation

5.2.3 Copying an Equation

An equation to which an equation number has been assigned (copy source) can be copied to another equation number (copy target).



Method

Screen: STATUS 5 (MEM)

① Move the flashing cursor to one of the Z1 - Z8 items.
② Press the F3 [copy eqn].
③ Use the function keys or the JOG control to specify the number of the equation to be copied.

Selection

: Increase equation number.

: Decrease equation number.

: Execute copy.

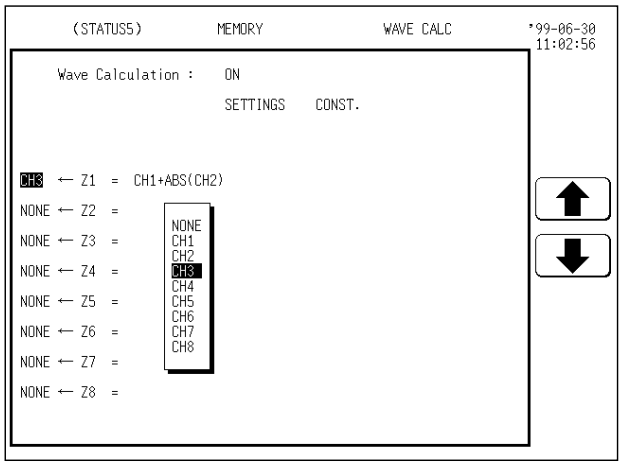
: Quit copy mode.

④ Press the F4 [exec] key. The copy source equation is copied to the copy target.

NOTE The calculation result output destination and calculation formula settings (display scale and number of moved points) are not copied.

5.2.4 Setting the Channel for Recording Processing Results

- The calculation result of equations Z1 - Z8 can be recorded and displayed in a specified channel.
- Processing results can be recorded also in channels where no input unit is installed (but the range of the "number of channels in use" setting cannot be exceeded).



Method

Screen: STATUS 5 (MEM)

① Move the flashing cursor to one of the Z1 - Z8 items.
② Move the flashing cursor to the position shown in the figure on the left.
③ Use the function keys or the JOG control to specify the number of the equation to be copied.

Selection

: Move the cursor up in the selection window.

: Move the cursor down in the selection window.

Equations not to be used should be set to **NONE** (calculation result is not recorded).

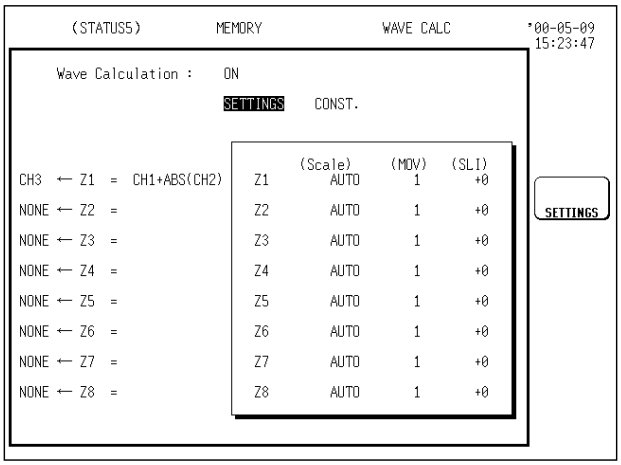
NOTE

- If the same channel is selected as source in the equation and as target for recording, the waveform data in the source channel are overwritten by the equation calculation result.
- In the following cases, the calculation result is displayed with in the same color set as the channel number for the first processing run:
  ① If results are recorded in a channel where no input unit is installed.
  ② If the display color for the channel selected for recording is set to OFF.
  When wishing to change the display color set, perform calculation once and then use the CHANNEL1 screen or DISPLAY screen to make the setting.
- The channel selected for recording is automatically set to variable display.

5.2.5 Setting the Display Scale and Floating Decimal Point

Set the scale and floating decimal point.

- Set the scale to display the waveform of the processed result.
- Display scale can be set automatically or manually.
- The channel selected for recording is automatically set to variable display.
  For the variable function, see Section 7.12 of the 8835-01 Instruction Manual.

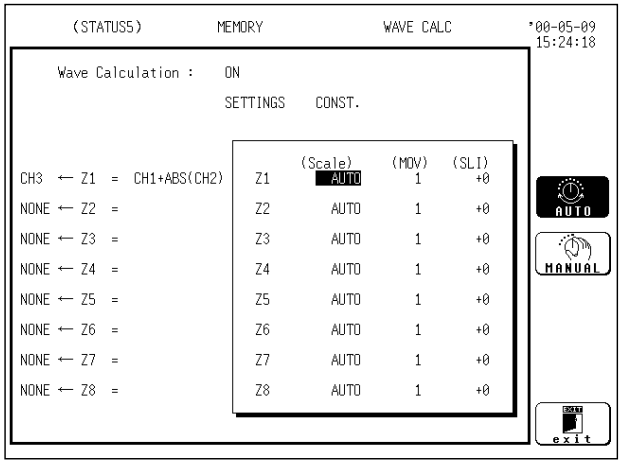


Method

Screen: STATUS 5 (MEM)

① Move the flashing cursor to the **settings** item, as shown in the figure on the left. The figure at the left shows the scaling window and movement point.

② Select Expression Setting on the function key display. The flashing cursor moves into the window.



③ Move the flashing cursor to the position shown in the figure on the left.

④ Make the setting with the function keys.

Selection

: Set display scale automatically.

: Set display scale manually.

: Close setting.

⑤ Select Finish when finished setting.

• Automatic setting

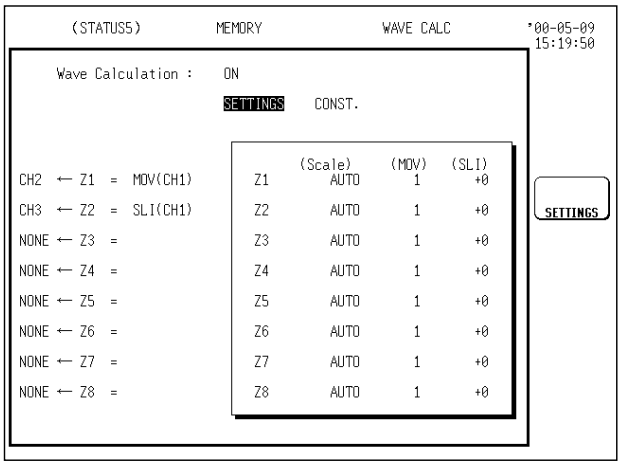
After calculation, the upper and lower limit is determined from the result, and the variable display settings are made accordingly.
Depending on the type of calculation, automatically display scale setting may not be satisfactory. In such a case, use the manual setting procedure.

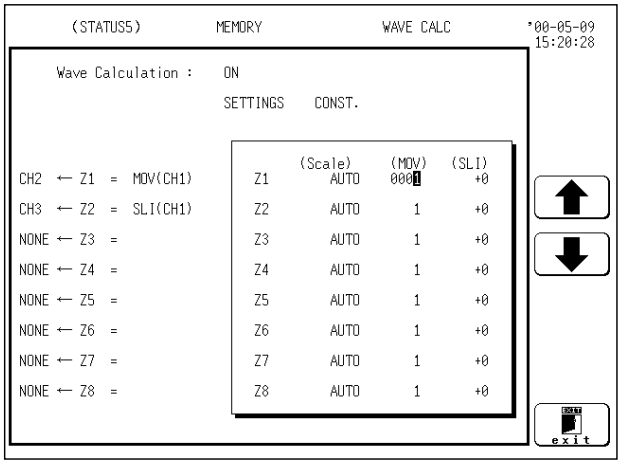
• Manual setting

Use the variable display setting function on the CHANNEL 2 screen to set the upper and lower limit.

• Calculation result with overflows

The values shown using cursors A and B and the printed values obtained when the printer recording type is set to "numerical value" are not accurate.
If the display scale is set to "**AUTO**," the waveform is shown at the top or bottom of the screen. This indicates that the calculation result has overflowed.





Method

Screen: STATUS 5 (MEM)

① Move the flashing cursor to the **settings** item, as shown in the figure on the left. The figure at the left shows the scaling window and movement point.

② Select Expression Setting on the function key display. The flashing cursor moves into the window.

③ Move the flashing cursor to the **settings** item, as shown in the figure on the left.

④ Move the flashing cursor to the various digits and make the setting with the function keys or the JOG control.
For MOV (moving average): 1 to 4000
For SLI (parallel displacement):
-4000 to +4000

Selection

 : Value up

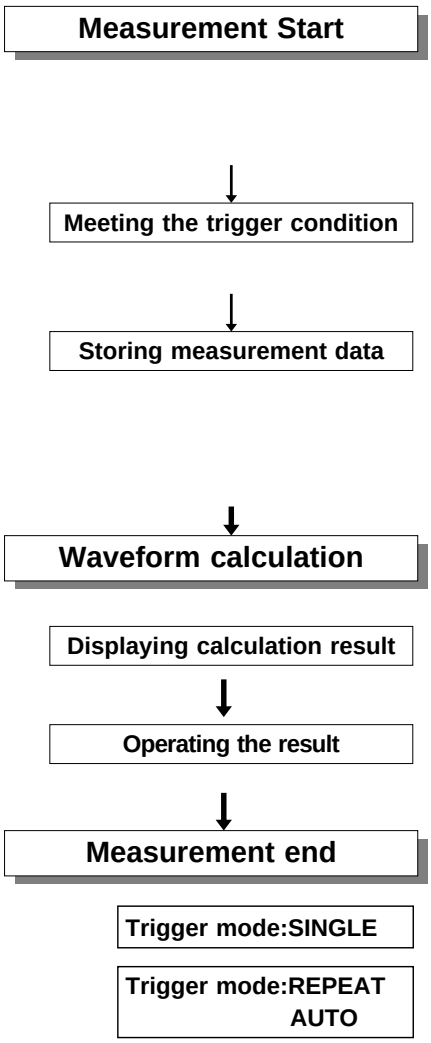
 : Value up

: Close setting.

⑤ Select Finish when finished setting.

5.2.6 Performing Waveform Processing

Waveform processing while capturing the waveform (Process waveforms as they are input)



- Press the START key and LED light.
- When the pre-trigger is set, the trigger will not be registered for a certain period after the start of measurement. (During this interval, **Pre-trigger standby** is shown on the display.)
- When the trigger can be registered, the indication **Waiting for trigger** is shown on the display.

- Data recording starts when trigger condition are met.
- When trigger mode selected AUTO, unit waits for about 1 second for trigger conditions to be met. After this interval, data recording starts, regardless of trigger state.

- Displays "**Storing**".
  Waveform displays after data corresponding to recording length have been stored in memory.
- When the STOP key is pressed twice during measurement, the 8835-01 is forcibly stopped. (Waveform calculation is not executed.)

- Displays "**Waveform calculating**".

- Displays waveform calculation result on the screen.

- Auto print : ON →Prints the measurement data.
- Auto save : ON →Saves the measurement data.

- End of measurement.

- Each time when trigger conditions are met, data are recorded and memory contents are overwritten.

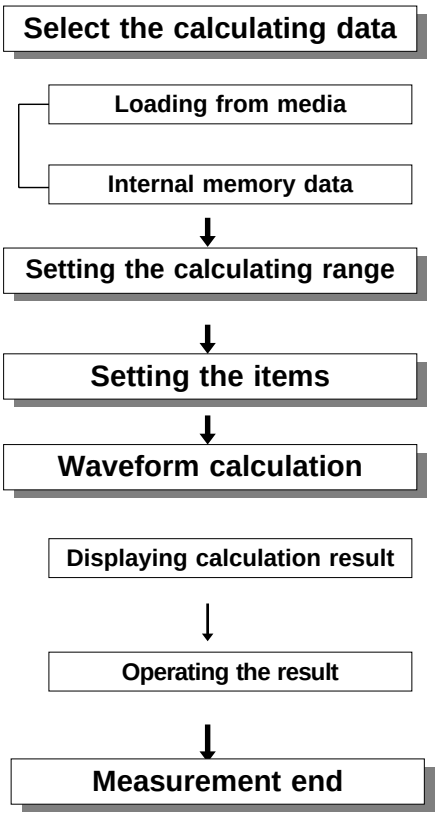
【 End of measurement in REPEAT and AUTO trigger modes 】

- When the STOP key is pressed once during measurement, the 8835-01 acquires measurement data in an amount corresponding to the set recording length, and the measurement is stopped. (Waveform display, Waveform calculation is executed.)

NOTE

- The maximum recording length allowing waveform processing calculation is 1000 divisions.
- The waveform range to be processed can be set with the A/B cursors (vertical or trace). The waveform between the cursors is processed.
- If the cursors are overlaid at one point, only that point is processed.
- The calculation range cannot be specified using the horizontal cursor.
- If only the A cursor is enabled, the range processed is from the A cursor to the end of measured data.

Waveform processing of data in internal memory or media (Process previously input waveforms)



- Press the FILE key to call up the FILE screen. (see Chapter 13 of the 8835-01 Instruction Manual.)
- Waveform calculation execute the stored measurement data.
- This setting calculates the measurement data between A and B cursors. When there is no A and B cursors, calculates all data.
- Press the STATUS key to call up the STATUS4 screen.
- Move the flashing cursor to **wave calculation**. And use the function key to select "**exec**".
- Displays "**Waveform calculating**".
- Displays waveform calculation result on the screen.
- Printout can be carried out.
- Saving can be carried out.

Recorder and memory waveform processing calculations

After measuring with the recorder and memory function and switching to the memory recorder function, the memory waveform data are transferred to the memory recorder function. (Following this, the process is the same as processing in the case of the internal memory.)
However, when subjecting the memory waveform of the recorder and memory function to waveform processing calculations, the recorder waveform data will be destroyed.

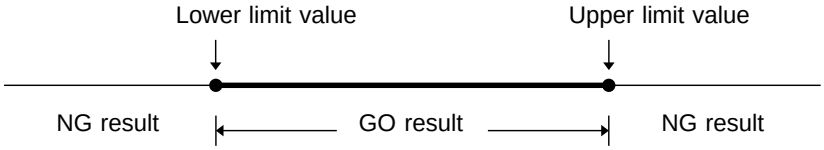
NOTE

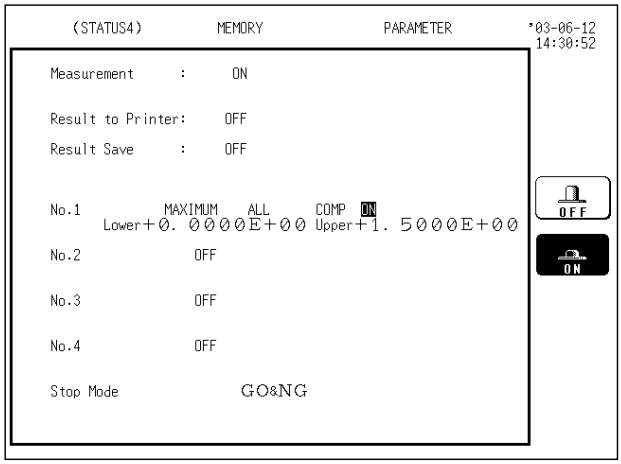
- The maximum recording length allowing waveform processing calculation is 1000 divisions.
- The waveform range to be processed can be set with the A/B cursors (vertical or trace). The waveform between the cursors is processed.
- When the cursors overlap, processing is carried out for that point.
- The line cursor (horizontal) cannot be used to specify the processing range.
- When only the cursor A is used, the waveform data from the position of cursor A to the end of the data is calculated.
- The result can be recalculated by altering the calculation process.

5.3 Waveform Parameter Evaluation

5.3.1 Making Settings for Waveform Parameter Evaluation

- Depending on the results of the waveform parameter calculation, a GO (pass) or NG (fail) result is returned.
- Evaluation criteria can be set independently for each of the calculation sets No. 1 - No. 4.





Method

Screen: STATUS 4 (MEM)

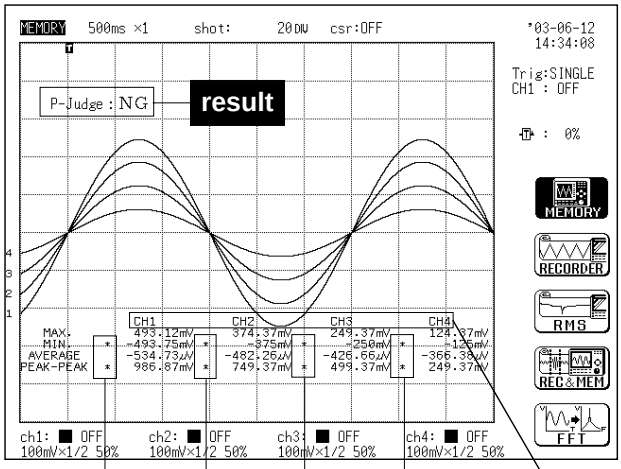
① Make the settings for waveform parameter calculation.

② Move the flashing cursor to the **COMP** item. And use the function key to select.

Selection

OFF : Disable evaluation function.

ON : Return NG if result is outside specified range.



NG channel marked with an "*"

Use CH SELECT key to switch to display CH 5 - CH 8 results.

③ Set the upper and lower limits.
The setting range is -9.9999E+29 to +9.9999E+29 (exponent: -29 to +29).
The upper limit must not be set to a value less than the lower limit.
Move the flashing cursor to the various digits and make the setting with the function keys, the JOG control or numeric keys. (see Section 7.12 of the 8835-01 Instruction Manual.)

④ Set stop conditions. Select whether GO or NG serves as the signal to stop recording.

Selection

GO : GO determination serves as the signal to stop recording.

NG : NG determination serves as the signal to stop recording.

GO&NG : GO or NG determination serves as the signal to stop recording.

NOTE

- When beep sound is set, it beeps at NG determination.
- When the evaluation result is NG, the calculation value for that channel is marked with an "*****" (on the display and the printout).
  The result of the evaluation is NG if any of the values is NG.
- While all evaluation results appear on the display screen, the evaluation results are printed out for each parameters in the print mode.
- Waveform parameter decision results can be acquired via the GO and NG terminals. For the variable function, see Section 7.12 of the 8835-01 Instruction Manual.

5.3.2 Executing Waveform Parameter Calculation

- Calculation is carried out in the order No.1 through No.4.
- Also for channels where no input unit is installed, parameter calculation is carried out if waveform processing results or data loaded from media are stored in the channel.
- The scaling setting has effect. (RMS value and area value are calculated after scaling.)
- When **measurement** is set to **ON**, waveform data after waveform processing are used for parameter calculation.

Parameter calculation while capturing the waveform

Measurement Start

- Press the START key and LED light.
- When the pre-trigger is set, the trigger will not be registered for a certain period after the start of measurement. (During this interval, **Pre-trigger standby** is shown on the display.)
- When the trigger can be registered, the indication **Waiting for trigger** is shown on the display.

↓

Meeting the trigger condition

- Data recording starts when trigger condition are met.
- When trigger mode selected AUTO, unit waits for about 1 second for trigger conditions to be met. After this interval, data recording starts, regardless of trigger state.

↓

Storing measurement data

- Displays "**Storing**".
  Waveform displays after data corresponding to recording length have been stored in memory.
- When the STOP key is pressed twice during measurement, the 8835-01 is forcibly stopped. (Parameter calculation is not executed.)

↓

Parameter calculation

- Displays "**Calculating**".

Displaying calculation result

- Displays parameter calculation result on the screen.

↓

Parameter evaluation

(When COMP setting: ON)

- Depending on the results of the waveform parameter calculation, a GO (pass) or NG (fail) result is returned.

【 When the evaluation result is GO 】

- Outputs GO signal.
- Continue measurements, until NG result appeared.

Measurement continues until stop conditions are met.

【 When the evaluation result is NG 】

- Outputs NG signal.
- The calculation value for that channel is marked with an "*****" (on the display and the printout).

↓

Operating the evaluation result

- Result to printer : ON →Prints the evaluation results.
- Result save : ON →Saves the evaluation results.
- Auto print : ON →Prints the measurement data.
- Auto save : ON →Saves the measurement data.

↓

Measurement end

Trigger mode:SINGLE

- End of measurement.

Trigger mode:REPEAT
AUTO

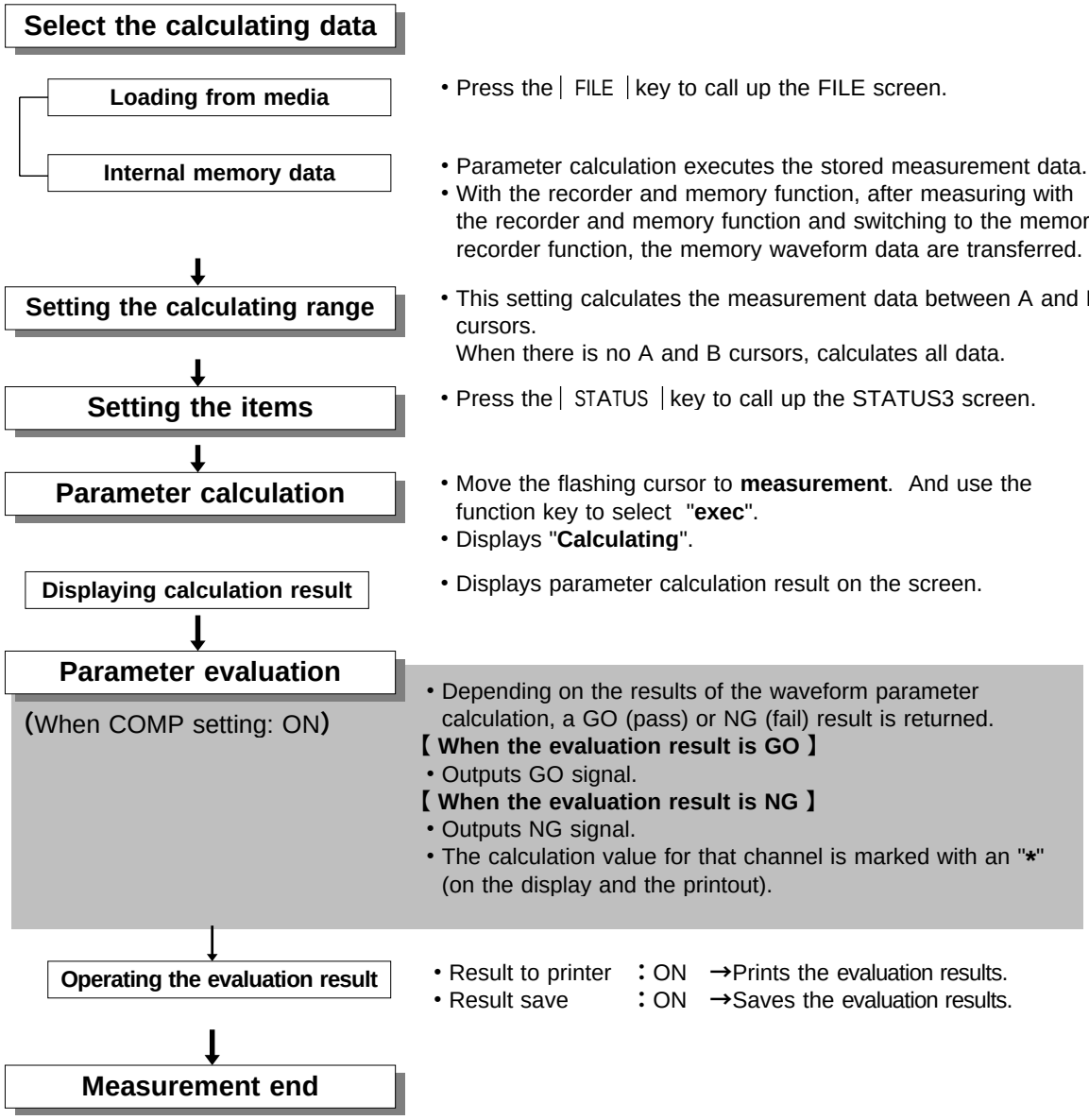
- Each time when trigger conditions are met, data are recorded and memory contents are overwritten.

【 End of measurement in REPEAT and AUTO trigger modes 】

- When the STOP key is pressed once during measurement, the 8835-01 acquires measurement data in an amount corresponding to the set recording length, and the measurement is stopped. (Waveform display and parameter calculation are

NOTE When simultaneously performing waveform parameter decision and waveform area decision, recording stops when either of the stop conditions are met.

Parameter calculation of measurement data loaded from media

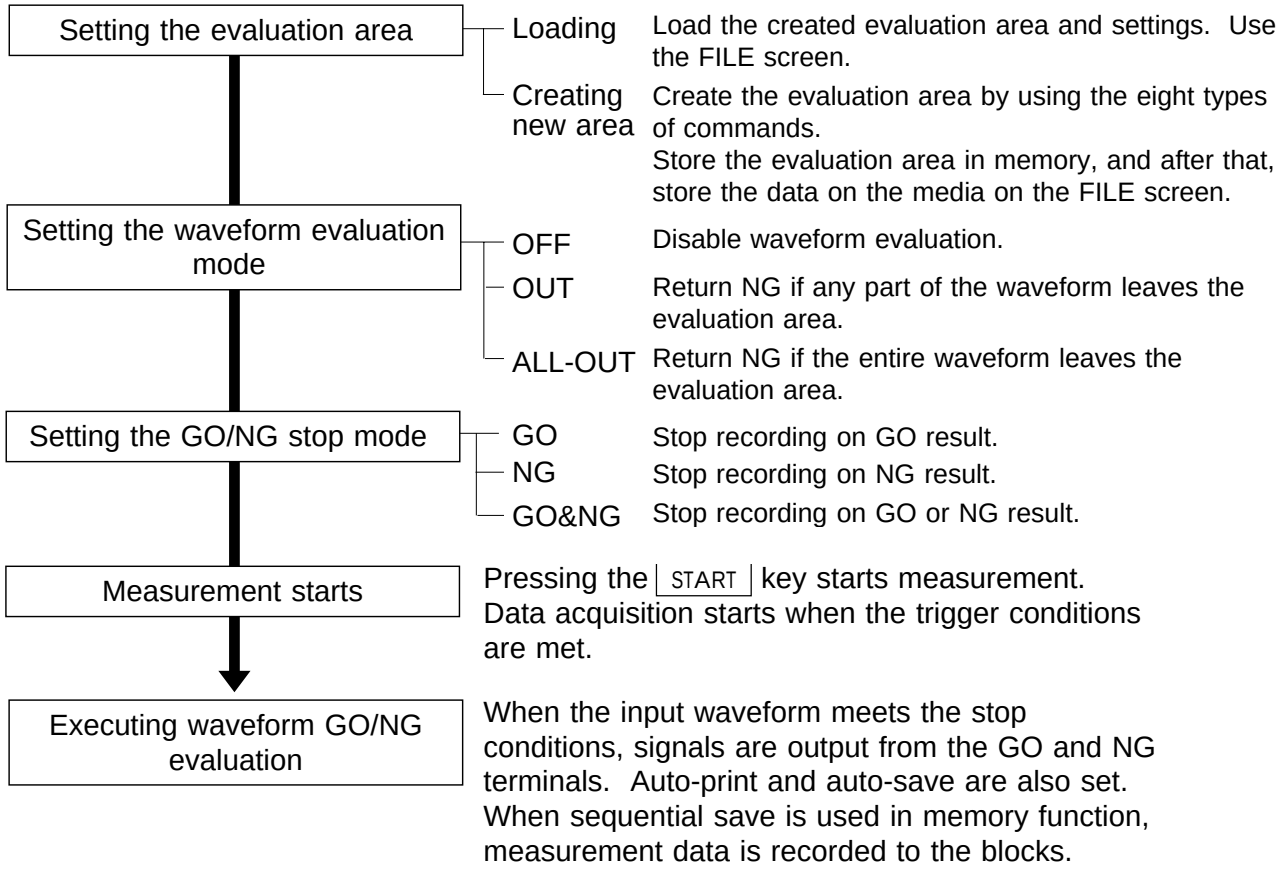


NOTE

- The line cursor (horizontal) cannot be used to specify the processing range.
- When only the cursor A is used, the waveform data from the position of cursor A to the end of the data is calculated.
- The result can be recalculated by altering the calculation process.

5.4 Waveform Area Evaluation

- The waveform evaluation function can be used from the Memory recorder (single screen, X-Y single screen) and FFT (single screen, nyquist screen).
- GO (pass) or NG (fail) evaluation of the input signal waveform can be performed using an evaluation area specified by the user.
- This can serve to detect irregular waveforms.
- Depend on evaluation result, GO and NG terminal output the signal.
- Displaying all channels can be used for GO/NG evaluation.
  For the GO and NG terminal, see Section 12.7 of the 8835-01 Instruction Manual.

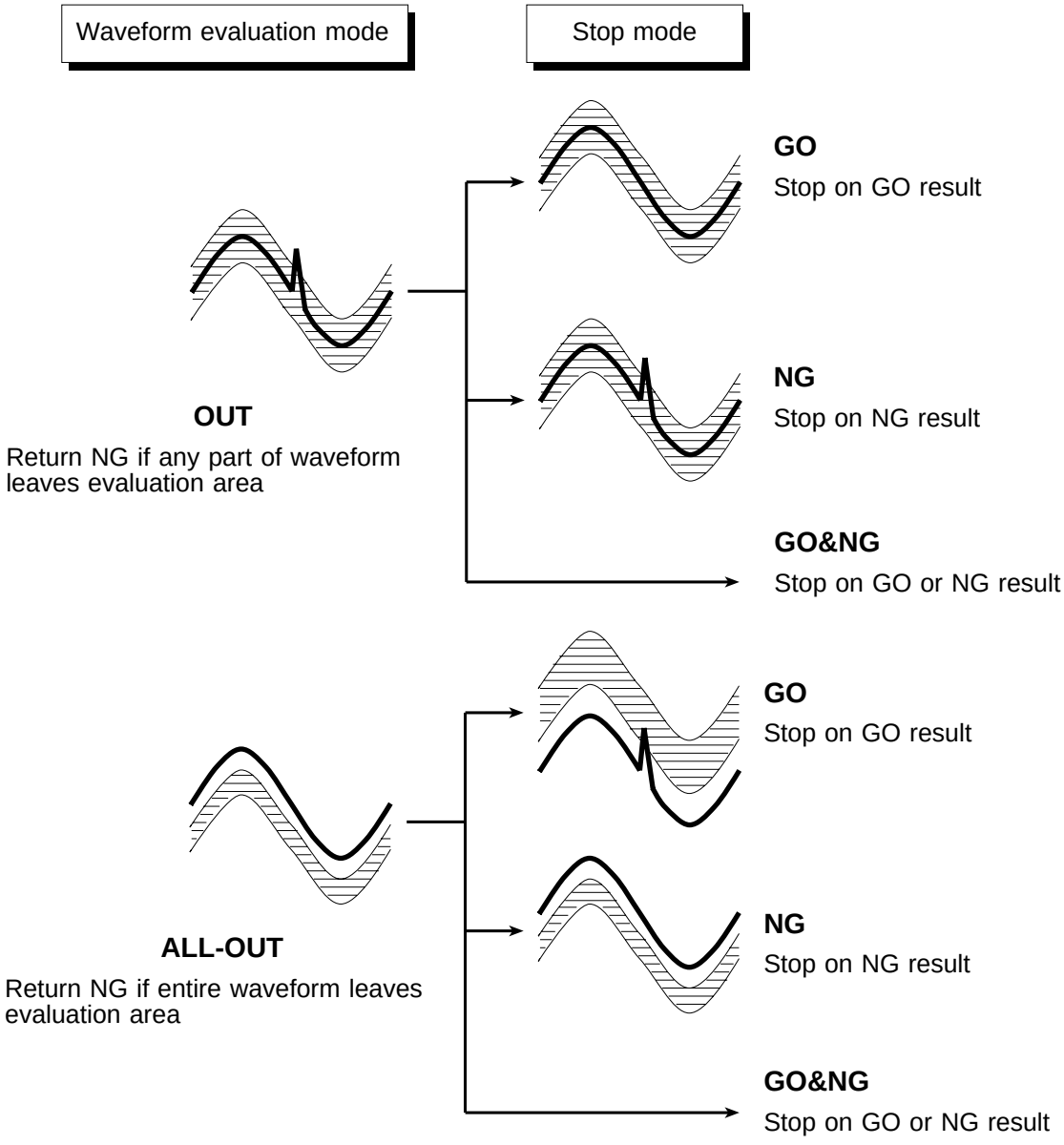


NOTE

- Trigger mode: SINGLE
  Measurement continues until stop conditions are fulfilled and then stops.
- Trigger mode REPEAT, AUTO
  Recording and waveform evaluation is carried out continuously. Press the STOP key to terminate the measurement.
- When **auto print** is set to **ON**, the waveform is printed out when operation stops.
- When **auto save** is set to **ON**, data are stored on media when operation stops.
- When memory segmentation (sequential save) is ON, data are stored in the memory block only when operation stops.

- Waveform evaluation consists of two actions, namely capturing data and performing the evaluation. These two actions are carried out in sequence, not simultaneously. (FFT processing also includes Processing time.) Therefore data are not captured while the evaluation is in progress, which means that the input signal is not being continuously monitored. The time required for evaluation is on the order of 20 ms.
- If a high setting is chosen for recording length or if compression is used, the evaluation cycle becomes slower.
- Waveform area made by other than the 8835-01, 8730-10 or 8731-10 cannot be used.
- On the waveform evaluation screen, A/B cursors can be used, but a partial printout cannot be made.
- When the waveform evaluation is specified, data equivalent to one screen (10 divisions) is printed out. When waveform data having a recording length of more than 10 divisions is to be printed out, the time axis should be compressed.

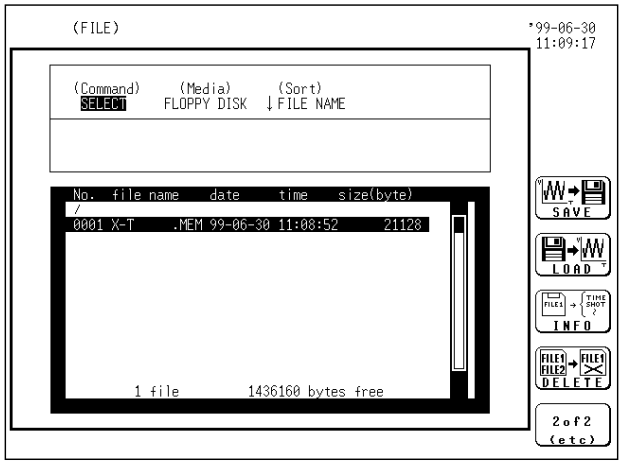
Waveform evaluation mode and stop mode



5.4.1 Setting the Waveform Area

To evaluate the waveforms, a evaluation area is required. Two methods are available: one is to load the already created evaluation area and settings, and the other is to create a new evaluation area.

Loading the already created evaluation area

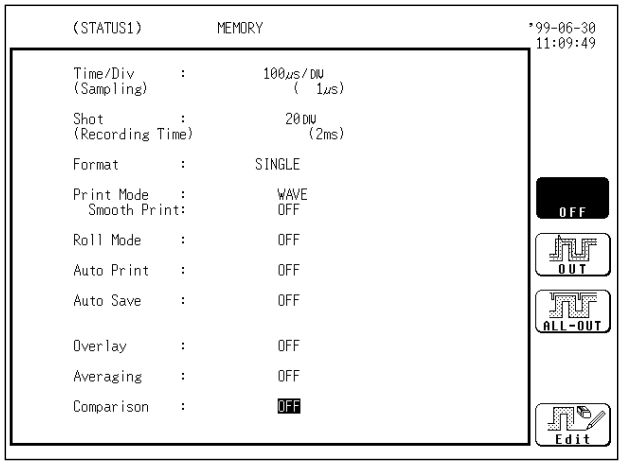


Method

Screen: FILE

① Press the FILE key to call the FILE screen.
② Select the media for loading.
③ Use the bar cursor to select the desired file.
④ Use the function key to select the **LOAD**.
⑤ Use the function key to select the **exec**.
⑥ When no more changes need be made to the loaded settings, press the DISP key to make the 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 display screen appear, and then press the START key to initiate measurement.

Creating a new evaluation area



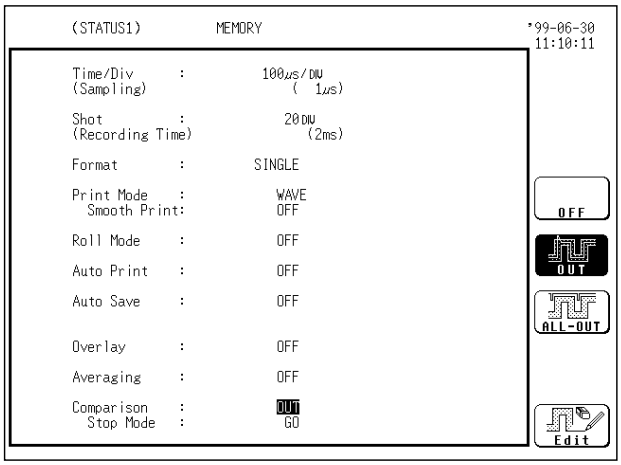
(MEM)

Method

Screen: STATUS 1 (MEM), STATUS 2 (FFT)

① Press the STATUS key to call the STATUS screen.
② Move the flashing cursor to the **comparison** item, as shown in the figure on the left.
③ Use the function key to select the **Edit**.
④ Make the new evaluation area.
⑤ Store the new evaluation area in the internal memory.
⑥ After setting the parameters for "**comparison**" and "**stop mode**," press the DISP key to make the display screen appear, and then press the START key to initiate measurement.
⑦ Save the evaluation area on the FILE

5.4.2 Setting the Waveform Evaluation Mode



(MEM)

Method

Screen: STATUS 1 (MEM), STATUS 2 (FFT)

① Move the flashing cursor to the position shown in the figure on the left.
② Make the setting with the function keys.

Selection

OFF : Disable waveform evaluation.

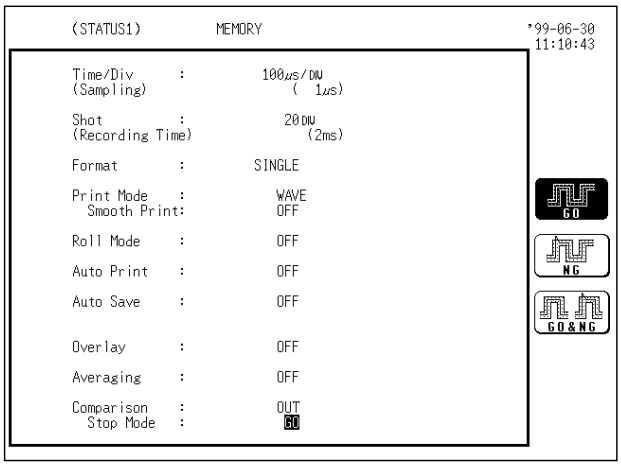
OUT : Return NG if any part of the waveform leaves the evaluation area.

ALL-OUT : Return NG if the entire waveform leaves the evaluation area.

Edit : Activate editor for setting up evaluation area.

5.4.3 Setting the GO/NG Stop Mode

When waveform evaluation is enabled (OUT or ALL OUT is selected), the "Stop Conditions" menu appears. Specify which evaluation option, GO or NG, should be used to stop the recording.



(MEM)

Method

Screen: STATUS1 (MEM), STATUS 2 (FFT)

① Move the flashing cursor to the position shown in the figure on the left.
② Make the setting with the function keys.

Selection

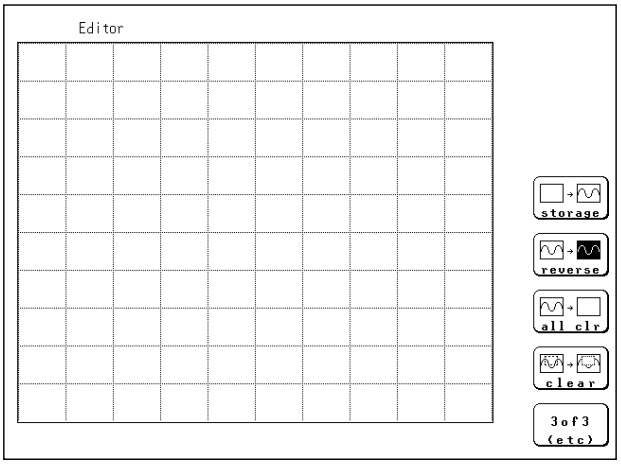
GO : Stop recording on GO result.

NG : Stop recording on NG result.

GO&NG : Stop recording on GO or NG result.

5.4.4 Creating the Evaluation Area

- The graphics editor serves to create the waveform evaluation area.
- The area is created by drawing it on screen.



Method

Screen: STATUS1 (MEM), STATUS 2 (FFT)

① Move the flashing cursor to the **comparison** item. Press the F5 [Edit].
② Use these commands to create the evaluation area.
③ When the area has been stored in memory, it can be used for waveform evaluation.
④ Press the F4 [end] function key to terminate the editor.
⑤ Serves to store the created area in memory.
⑥ Save the evaluation area through the file screen, if necessary.

Editor commands

When the editor is active, the following commands are assigned to the function keys.

paint	Fill in a closed area	all clr	Clear screen
paral	Parallel shift	clear	Clear area
line	Draw a straight line	(exec) undo	Undo immediately preceding command
erase	Erase	save	Store area in memory
storage	Import waveform into editor	edit end	Quit editor
reverse	Display filled-in area in reverse		

NOTE

- Only one waveform evaluation area can be saved in the internal memory.
- When an evaluation area has been created, it is not enabled until it has been saved to internal memory.

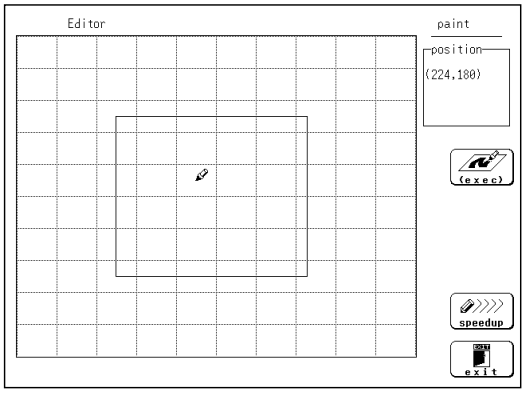
5.4.5 Editor Command Details

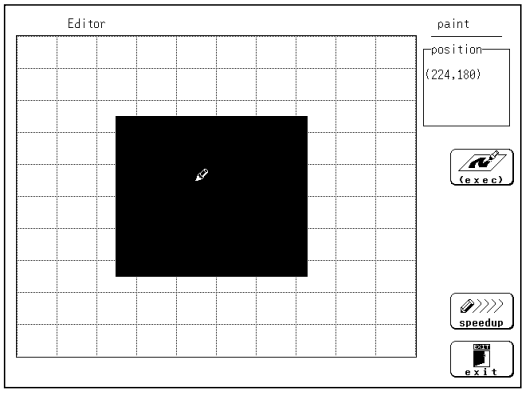
paint Function key display: 1/3
: Fills in an enclosed area.

① Press the F1 [paint].
② Use the CURSOR keys to move the mark to the area to be filled in. Pressing speedup accelerates the movement of the mark.
If the area is not completely enclosed, adjacent areas will also be filled in.

③ Press the F1 [exec] key. The area completely enclosed by lines is filled in.

④ Press the F5 [exit] key to terminate the paint mode.





parallel Function key display: 1/3
: Shifts the line pattern in parallel direction, to create an area.

・Can be set in steps of 0.025 DIV. (Will be 0.02 DIV or 0.03 DIV on the display.)

① Press the F2 [parallel].

② Set the amount of shift.

・Use the function keys or the JOG control to set the value.

・Use the F3 [move csr] key (or the CURSOR keys) to set the shift amount in the up/down/right/left directions.

③ Press the F4 [exec] key. The parallel shift is carried, thereby creating the evaluation area.

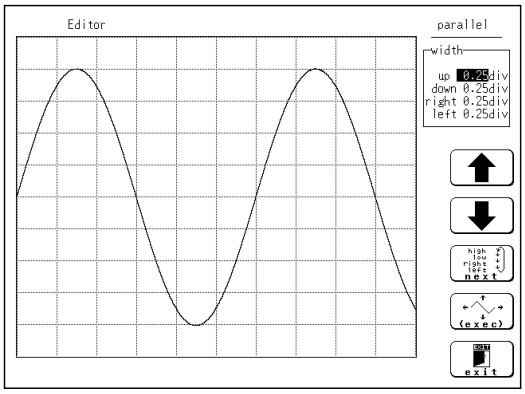
④ Press the F5 [exit] key to terminate the parallel shift mode.

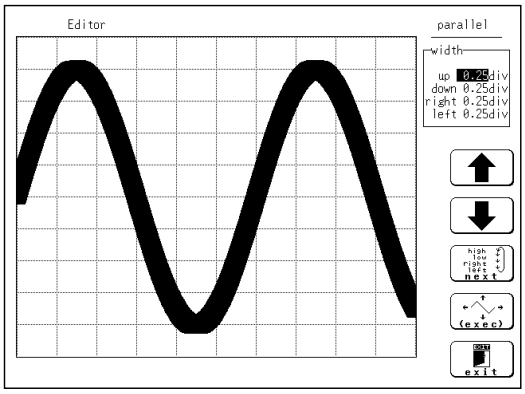
Selection


: Increase shift amount


: Decrease shift amount

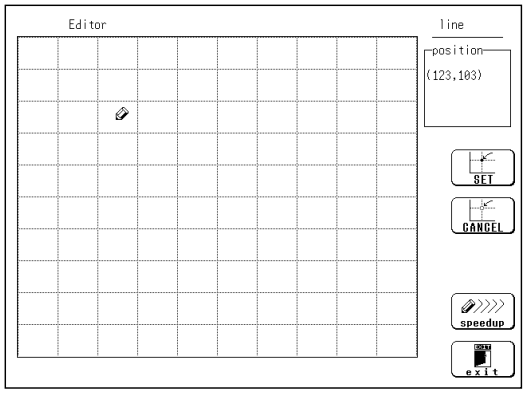
: Cycle the cursor through up/down/right/left

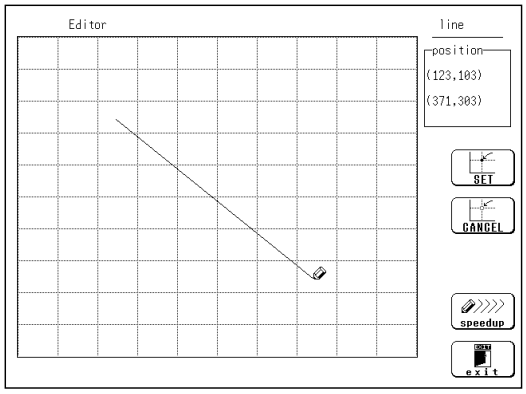




line Function key display: 1/3
: Serves to draw a straight or polygonal line.

① Press the F3 [line].
② Use the CURSOR keys to move the mark to the start point of the line.
Pressing speedup accelerates the movement of the mark.
If the area is not completely enclosed, adjacent areas will also be filled in.
③ Press the F1 [set] key.
④ Move the mark. A line is drawn between the set point and the mark.
⑤ Press the F1 [set] key again. The color of the line changes, and it is fixed.
Press the F2 [cancel] key. Cancel the immediately preceding set point.
⑥ Repeat steps ④ and ⑤ when wishing to draw a polygonal line.
⑦ Press the F5 [exit] key to terminate the line mode.

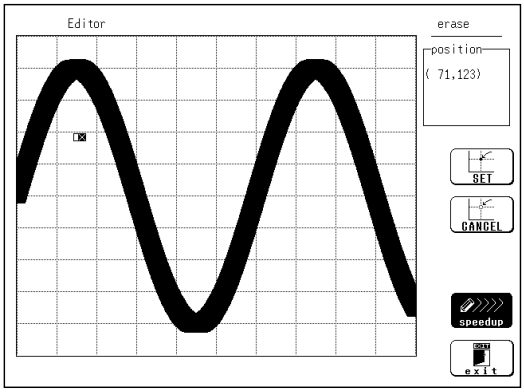


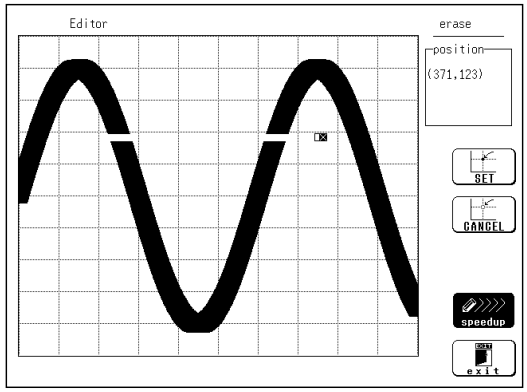


erase Function key display: 1/3
: Serves to erase unwanted sections.

① Press the F4 [erase].
② Use the CURSOR keys to move the ⊠ mark to the start point of the section to be erased.
Pressing speedup accelerates the movement of the mark.

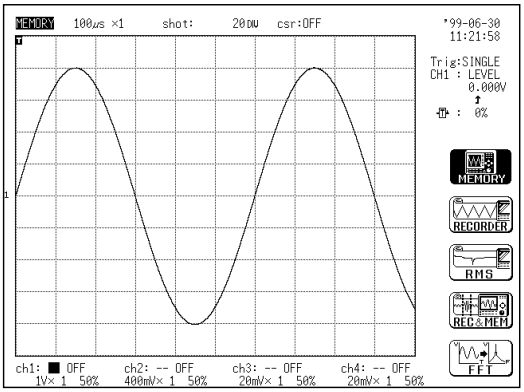
③ Press the F1 [set] key.
Press the F2 [cancel] key. Cancel the immediately preceding set point.
④ Move the ⊠ mark to erase the unwanted section.
⑤ Press the F5 [exit] key to terminate the erase mode.

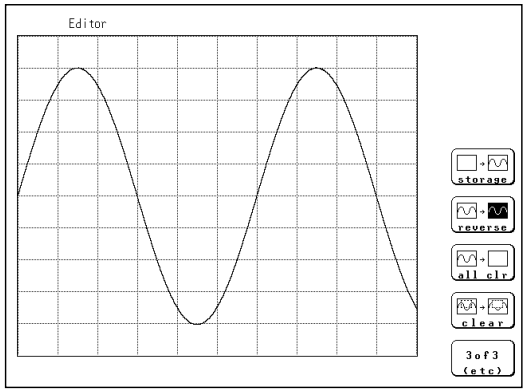




storage Function key display: 2/3
: Loads a waveform already stored in memory into the editor.

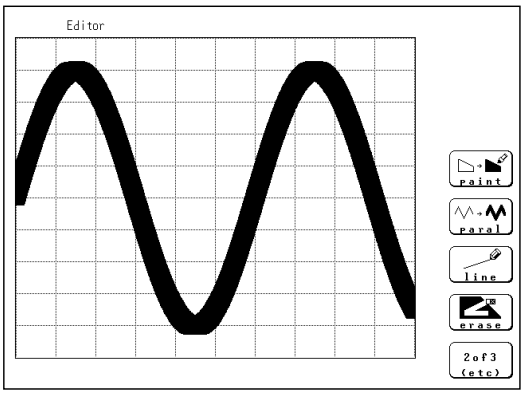
① Press the F1 [storage].
The waveform that was displayed on the screen is loaded into the editor. The imported waveform is shown in a different color from the original setting.

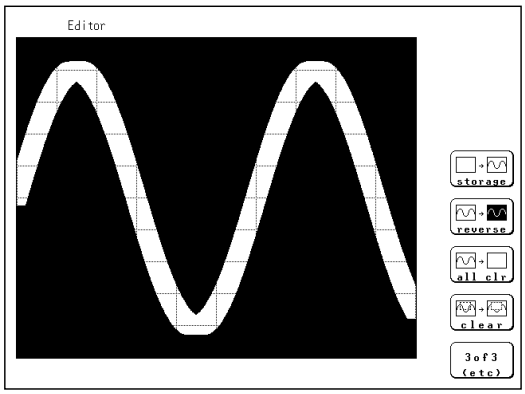


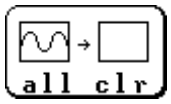


reverse Function key display: 2/3
: Reverses the colors of a filled-in area and the surrounding area.

① Press the F2 [reverse].
Displays filled in area in reverse.

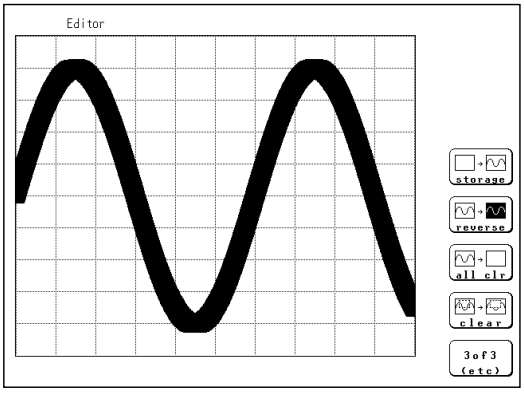


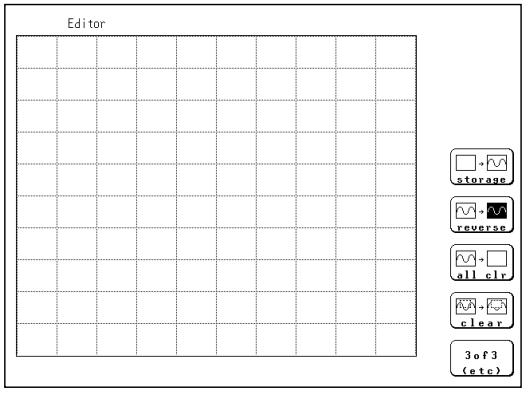




all clr Function key display: 2/3
: Clears the entire editor screen.

① Press the F3 [all clear].

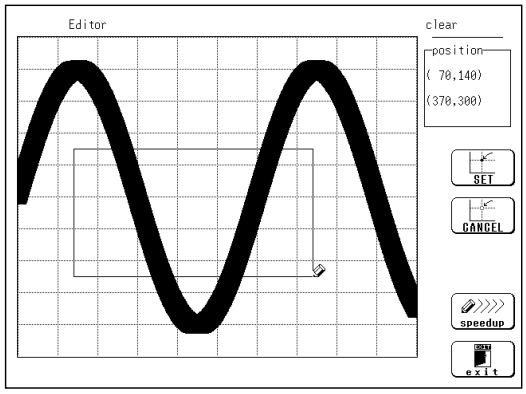


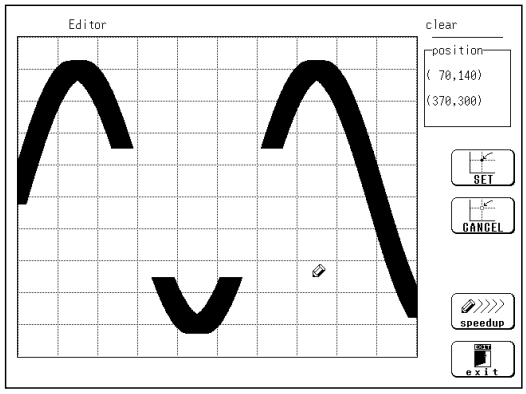


clear Function key display: 2/3

: Clears a specified rectangular area of the editor screen.

① Press the F4 [clear].
② Use the CURSOR keys to move the mark to the start corner of the area to be erased. Pressing speedup accelerates the movement of the mark.
③ Press the F1 [set].
④ Move the mark to the end corner of the area to be erased.
⑤ Press the F1 [set] key again. The rectangular area is cleared.
Press the F2 [cancel] key. Cancel the immediately preceding set point.
⑥ Press the F5 [exit] key to terminate the clear area mode.

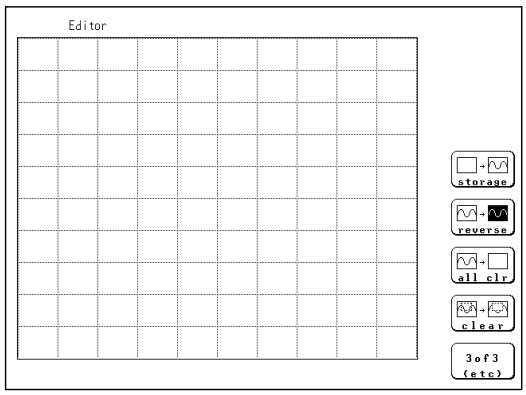




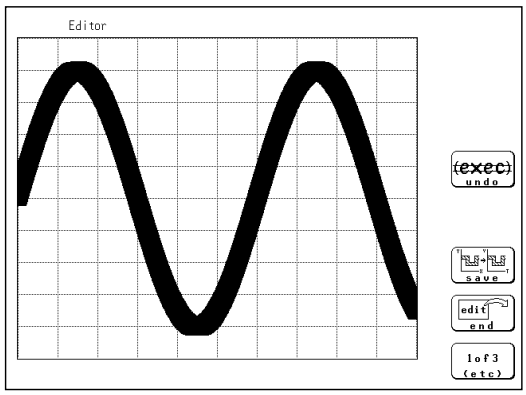
undo Function key display: 3/3

: Serves to undo the immediately preceding command.
Undo is applicable to all commands except **save** and **end**.

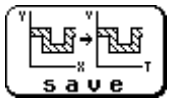
① Press the F1 [undo].



Clears the editor screen



Screen before "clear screen" is restored.



save function key display: 3/3
: Serves to store the created area in memory.
After an area has been stored, it can be used for waveform evaluation.

① Press the F3 [save] key.

end function key display: 3/3
: Terminates the editor.

(1) Store evaluation area in memory and quit editor
- Press the F4 [end] key and then the F3 [save] key.
- The stored area can be used for waveform evaluation.

(2) Quit editor without storing evaluation area in memory
- Press the F4 [end] key and then the F5 [kill area] function key.
- The created area will be discarded.

NOTE

If the F4 [end] key is pressed without having done any editing or immediately after using the store command, the editor is terminated without confirmation.

5.5 Memory Segmentation Function

- This function divides the memory into separate blocks, each of which can be used for waveform recording.
- The memory segmentation function has two modes: sequential save and multi-block (255 segments max).

Sequential save function

- The recording length (DIV) has priority over the number of memory blocks.
- Input signal capture is carried out continuously using the trigger, storing waveform data successively in each block.
- During recording, no display or printout is carried out.
- This reduces dead time (non-sensitivity periods due to display and printing delays).

Multi-block function

- The number of memory blocks has priority over the recording length (DIV).
- Waveform data can be stored in a selected block.
- Data from two different blocks can be overlayed on screen for easy comparison. (it can be printed out)

Memory Segmentation Function Settings

Setting the Sequential save function

Setting the recording length

↓

Setting the start block

↓

Setting the end block

↓

Setting the following waveform display (MEM only)

Set whether waveforms are displayed on the screen after they are recorded to the respective blocks.

↓

Setting the display block

Set the memory blocks to display on the screen after measurement is completed.

Setting the Multi-block function

Set the number of segmentation

Set the number of blocks to divide.

↓

Set the block to use

Set the memory blocks for recording.

↓

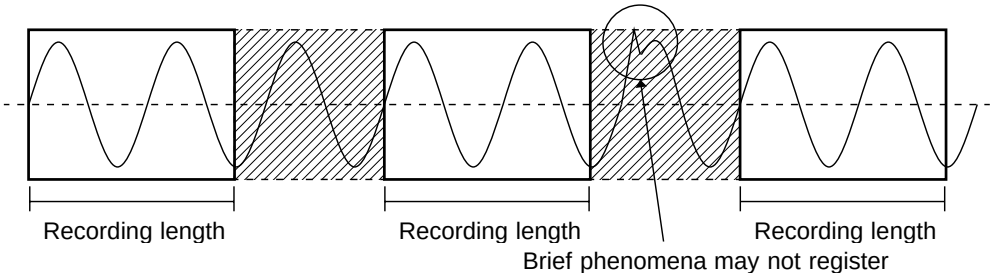
Set the reference block

Set the block for reference to superimpose two memory blocks.

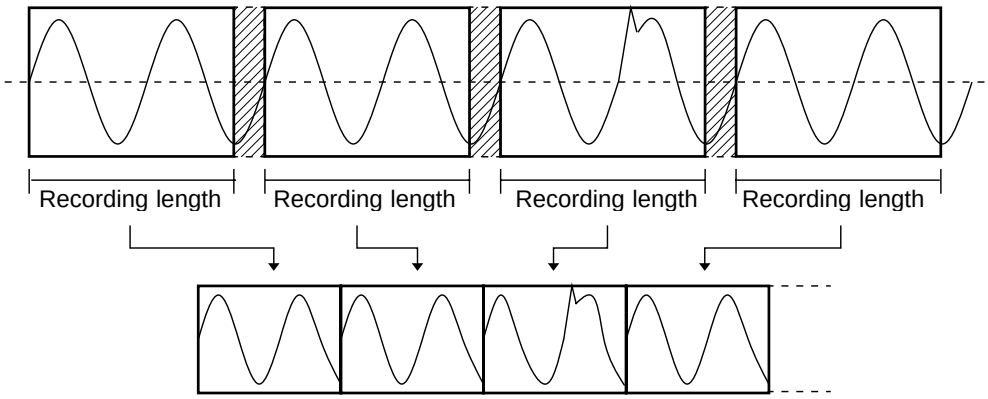
5.5.1 Using the Sequential Save Function (Memory Recorder, Recorder & Memory)

- Input signal capture is carried out continuously using the trigger, storing waveform data successively in each block.
- Any block in which an input signal is recorded can be called up on the display. During measurement, the display, print and save functions are disabled until data have been recorded in all blocks.

■ When continuous print (auto print) is being performed in REPEAT trigger mode



■ Using sequential save

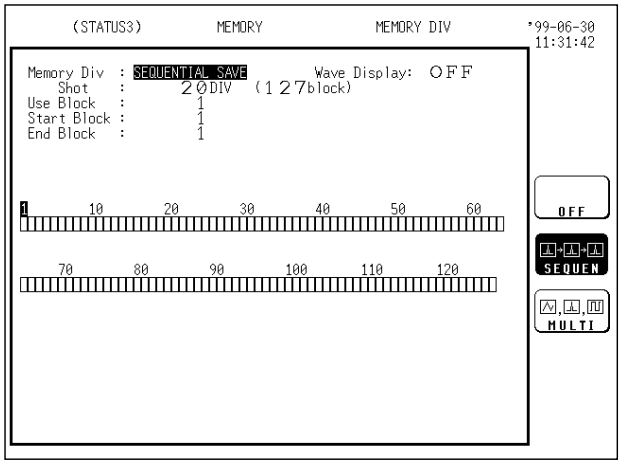


Data are divided into blocks and recorded in memory.

: ・・・Dead time (interval in which no sampling occurs due to display and print processing)

NOTE

- With the memory recorder function, dead time (interval in which no sampling occurs due to display and print processing after data is recorded in one block) is approximately 5 ms when no blocks are displayed, and approximately 15 ms when the blocks are displayed.
  With the recorder and memory function, maximum dead time is equivalent to the recorder sampling time × 2 +15 ms.
- While the sequential save function is being used in the memory recorder function, the waveform processing calculation and averaging functions are disabled.
- While the roll mode is being used in the memory recorder function, the sequential save function in the status is disabled.



Method

Screen: STATUS 3

(1) Select the Memory Segmentation

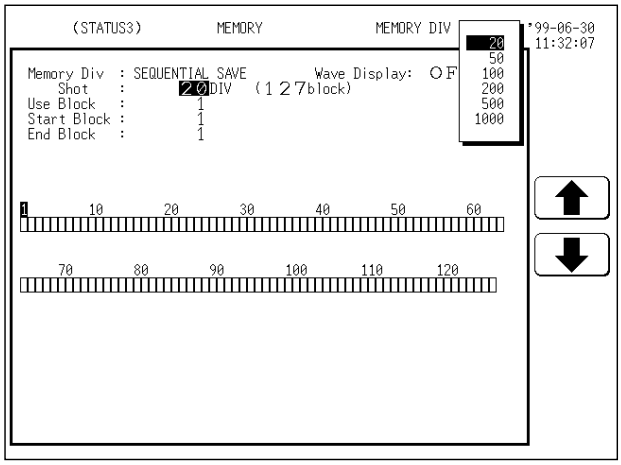
① Press the STATUS key to call up the STATUS 3 screen.
② Move the flashing cursor to the position shown in the figure on the left.
③ Press the F2 [SEQUEN].

Selection

OFF : Disable memory segmentation.

SEQUEN : Enable sequential save function.

MULTI : Enable multi-block function.



(2) Setting the Recording Length

① Move the flashing cursor to the **shot** item, as shown in the figure on the left.
② Use the JOG control or the function keys to make the selection.

Selection

: Move the cursor up in the selection window.

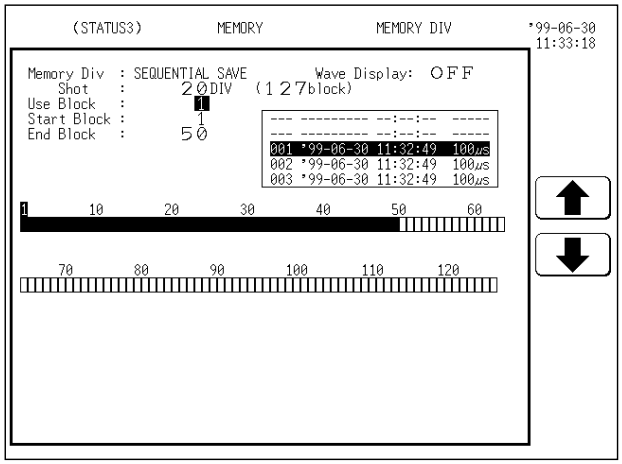
: Move the cursor down in the selection window.

When the recording length is set to the arbitrary recording-length mode, recording-length setting cannot be performed on the memory segmentation screen.
When the recording length is changed to one for which memory segmentation is not permitted on the STATUS1 or the DISPLAY screen, sequential saving is automatically set to OFF.

■ The recording length and maximum number of divisions are automatically determined according to the set memory capacity and number of available channels.

Maximum number of divisions

Recording length	Number of available channels				Recorder& memory Memory waveform
	8 ch	4 ch	2 ch	1 ch	
20	127	255	255	255	63
50	63	127	255	255	31
100	31	63	127	255	15
200	15	31	63	127	7
500	7	15	31	63	3
1000	3	7	15	31	–
2000	–	3	7	15	–
5000	–	–	3	7	–
10000	–	–	–	3	–



(3) Display block setting

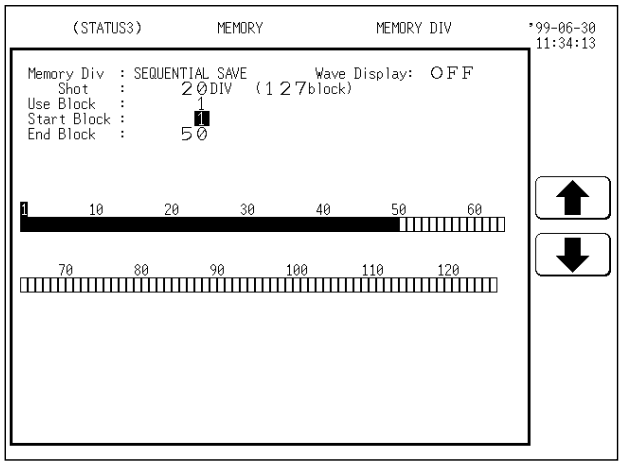
① Move the flashing cursor to the **use block** item, as shown in the figure on the left.
② Use the JOG control or the function keys to make the selection.

Selection

: Move the cursor up in the selection window.

: Move the cursor down in the selection window.

After measurement starts, the displayed block is updated by the recorded block.
When measurement is completed, the most recently recorded block is displayed.



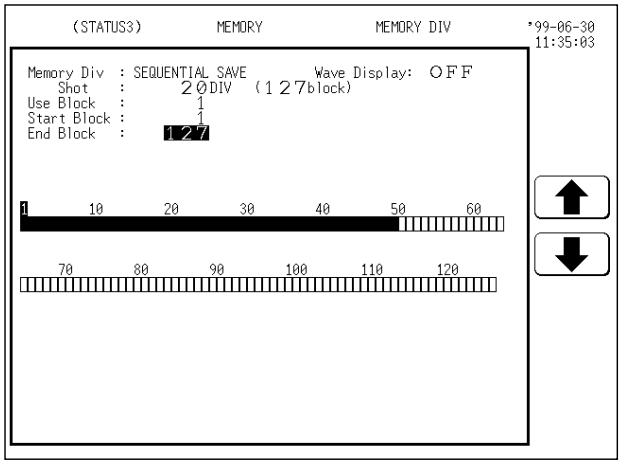
(4) Start block setting

① Move the flashing cursor to the **start block** item, as shown in the figure on the left.
② Use the JOG control or the function keys to make the selection.

Selection

: Move the cursor up in the selection window.

: Move the cursor down in the selection window.



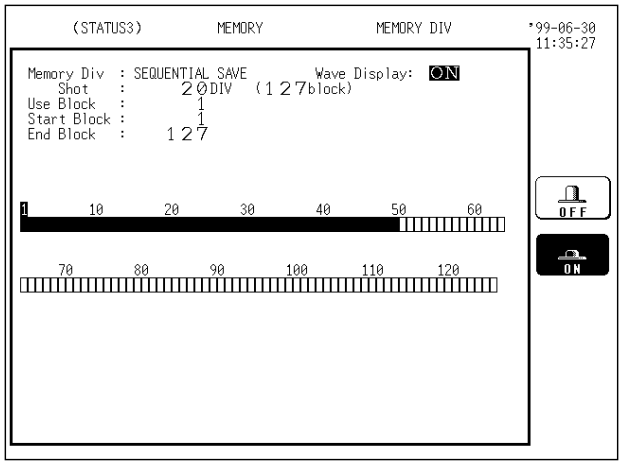
(5) End block setting

① Move the flashing cursor to the **end block** item, as shown in the figure on the left.
② Use the JOG control or the function keys to make the selection.

Selection

: Move the cursor up in the selection window.

: Move the cursor down in the selection window.



(6) Setting the follow-up waveform display

Waveforms acquired for each block by triggering during the sequential saving process are displayed one by one.
(As a result, the dead time is increased.)

① Move the flashing cursor to the **wave display** item, as shown in the figure on the left.
② Use the the function keys to make the selection.

Selection

: After all blocks are recorded, the waveform of the last block only is displayed.

: Each block is recorded and displayed.

NOTE

- The colored blocks indicate that measured data has been saved to the blocks.
- The displayed block settings and block status are shown on the display screen. (see Section 5.5.4)

Relation between trigger mode and sequential save function

Measurement Start

- Press the START key and LED light.
  Data recording starts when trigger condition are met.

start block

- Start block is stored.
  wave display O N: start block waveform is displayed.
  wave display OFF: waveform is not displayed.

end block

- End block is stored.
  wave display O N: end block waveform is displayed.
  wave display OFF: waveform is not displayed.

Measurement end

- Displays end block waveform.

Auto print

- When auto printing is enabled, all blocks are printed from the start block while individual blocks are displayed.

Auto save

- When auto saving is enabled, waveforms in all blocks are saved in a batch.

Recording end

Trigger mode: SINGLE

- End of measurement
  When the STOP key is pressed twice during measurement, the 8835-01 is forcibly stopped. (Auto printout and auto save are not executed.)

Trigger mode: REPEAT AUTO

- Each time when trigger conditions are met, data are recorded and memory contents are overwritten.

【End of measurement in REPEAT and AUTO trigger modes】

- When the STOP key is pressed once during measurement, the 8835-01 acquires measurement data in an amount corresponding to the set recording length, and the measurement is stopped. (Waveform display, auto printout, and auto save are executed.)
- When the STOP key is pressed twice during measurement, the 8835-01 is forcibly stopped.(Auto printout and auto save are not executed.)

Trigger mode: TIMER
(REC&MEM only)

When recording with a preset time interval, recording continues until the preset stop time.
If the STOP key is pressed during measurement, measurement is terminated.
The memory waveform is cleared after each preset time period.

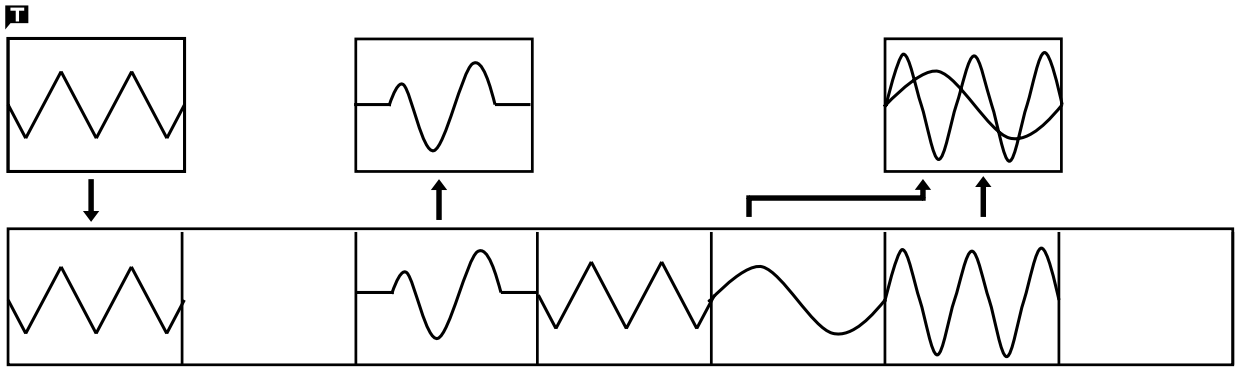
5.5.2 Using the Multi-Block Function (Memory Recorder)

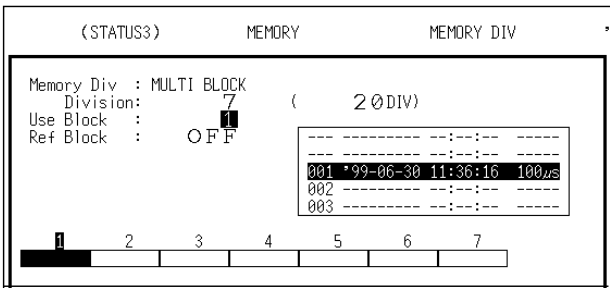
- Memory is divided into blocks which can be freely selected by the user for storing measurement data.
- Data stored in any block can be called up on the display.
- Data from two different blocks can be overlayed on screen for easy comparison. (it can be printed out)

(1) Store in memory

(2) Any block can be called up on display

(3) Overlayed display of data from 2 blocks



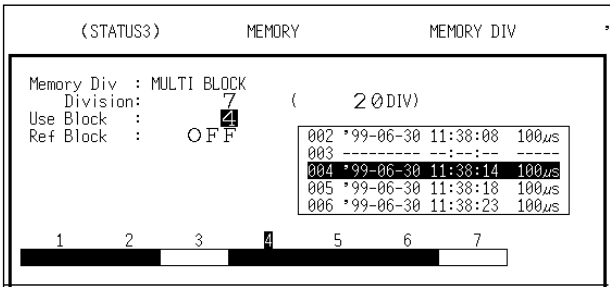


(1) Recording the waveform data in an arbitrary block

① Set the number of memory divisions.

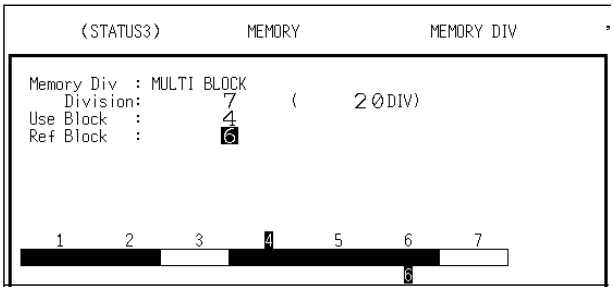
② Select the block to be used for saving the waveform data, from among the divided blocks on the "use block" menu.

③ Press the START key to conduct measurement and save waveform data to the specified block.



(2) Displaying an arbitrary block

Select the block to be used to display the waveform data, from among the recorded blocks on the "use block" menu.



(3) Displaying two arbitrary blocks in duplicate

① Save at least two waveform data items.

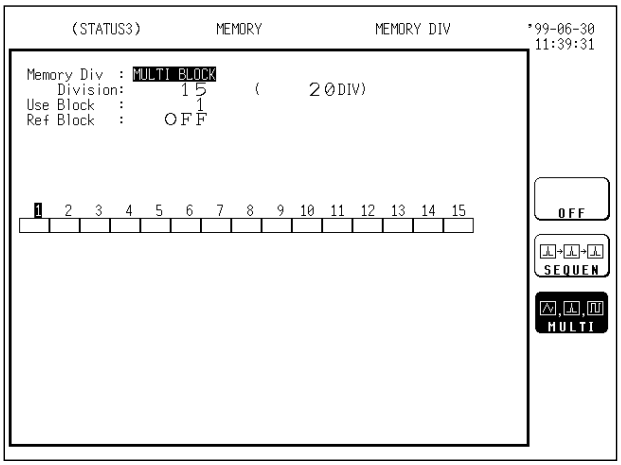
② Select the block to be used to display waveform data, from among the recorded blocks on the "use block" menu.

③ Select the block to be to displayed in duplicate on the "ref block" menu.

④ Display the block selected from the "use block" menu and the block selected from the "ref block" menu, in duplicate.
Note that waveform data cannot be saved while blocks are overlapping.

NOTE

- While the multi-block function is being used, the waveform processing calculation and averaging functions are disabled.
- If the blocks have different recording lengths, the overlap block display is disabled.
- The VIEW key can be used to change the displayed memory block or to call up information about the usage status of memory blocks. (see Section 5.5.4)



Method

Screen: STATUS 3

(1) Select the Memory Segmentation

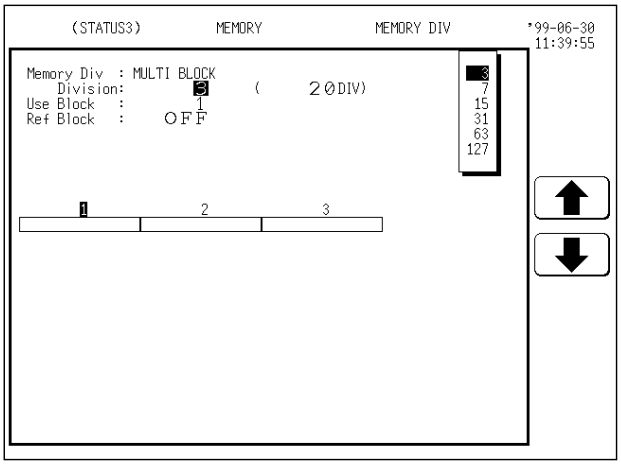
① Press the STATUS key to call up the STATUS 3 screen.
② Move the flashing cursor to the position shown in the figure on the left.
③ Press the F3 [MULTI].

Selection

OFF : Disable memory segmentation.

SEQUEN : Enable sequential save function.

MULTI : Enable multi-block function.



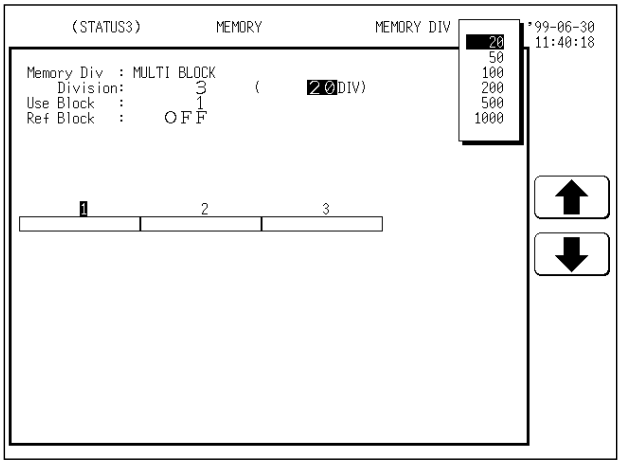
(2) Set the number of memory block

① Move the flashing cursor to the **division** item, as shown in the figure on the left.
② Use the JOG control or the function keys to make the selection.

Selection

: Move the cursor up in the selection window.

: Move the cursor down in the selection window.



(3) Setting the Recording Length

① Move the flashing cursor to the position shown in the figure on the left.
② Use the JOG control or the function keys to make the selection.

Selection

: Move the cursor up in the selection window.

: Move the cursor down in the selection window.

When the recording length is set to the arbitrary recording-length mode, recording-length setting cannot be performed on the memory segmentation screen.
When the recording length is changed to one for which memory segmentation is not permitted on the STATUS1 or the DISPLAY screen, multi-block saving is automatically set to OFF.

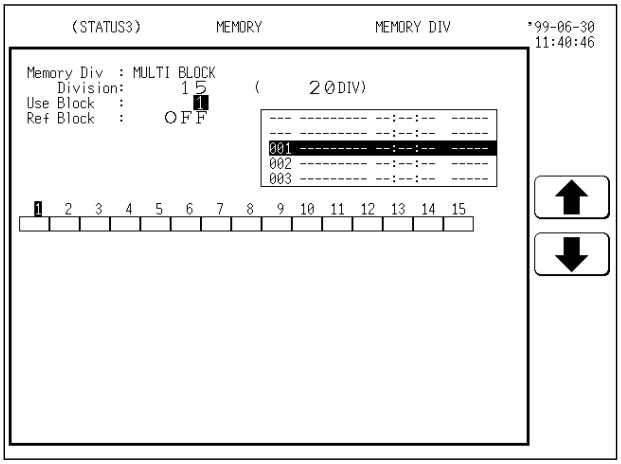
■ The maximum number of divisions and the maximum recording length are automatically determined according to the set memory capacity and number of available channels.

Memory recorder function

Number of divisions	Number of available channels			
	8 ch	4 ch	2 ch	1 ch
No divisions	5000	10000	20000	40000
3	1000	2000	5000	10000
7	500	1000	2000	5000
15	200	500	1000	2000
31	100	200	500	1000
63	50	100	200	500
127	20	50	100	200
255	–	20	50	100

NOTE

When using the multi-block function, the number of memory blocks has priority over the recording length (DIV). When the number of memory blocks is changed, the recording length may automatically be adjusted.



(4) Setting the using block

- Select the number of the memory block for display and recording of the input signal waveform.

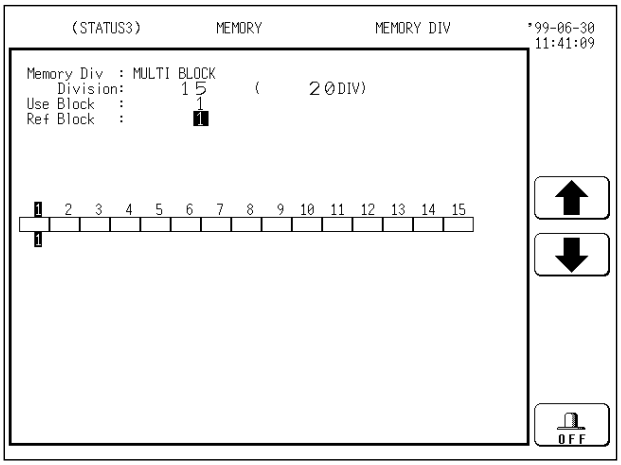
① Move the flashing cursor to the **use block** item, as shown in the figure on the left.

② Use the JOG/SHUTTLE control or the function keys to make the selection.

Selection

: Value up.

: Value down.



(5) Setting the ref block

- Select a memory block whose waveform data are to be overlayed on screen with the memory block selected for display.

① Move the flashing cursor to the **ref block** item, as shown in the figure on the left.

② Use the JOG/SHUTTLE control or the function keys to make the selection.

Selection

: Value up.

: Value down.

: Disable ref block

5.5.3 SAVE

What Can Be Recorded And How Much

Memory block (SEQ: sequential, MUL: multiblock)

① Using the memory segmentation function, the recorded waveform data can be saved to the memory block.

② Batch saving of all blocks can be selected.

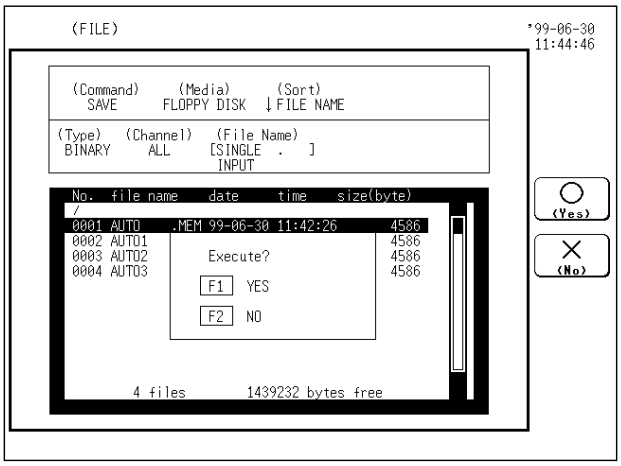
Evaluation area (AREA)

① The area created using the waveform evaluation editor can be saved.

② The setup conditions are saved together with the evaluation area.

③ The recording capacity varies depending on the evaluation area.

Executing the saving

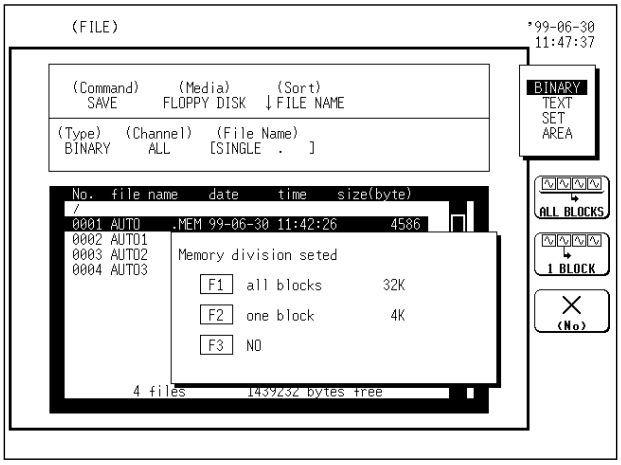


① Configure setting items and select Execute in the function key display.

Selection

(Yes) : Saves file.

(No) : Cancels save.



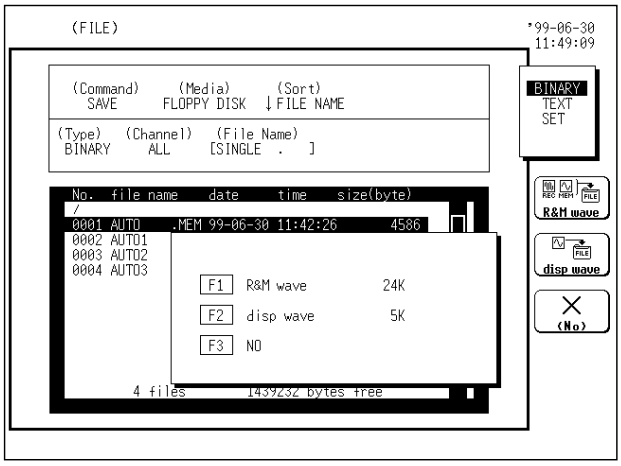
② When the waveform data is selected and the memory segmentation function is used, select block saving.

Selection

ALL BLOCKS : In sequential saving, all data, from the starting block through the ending block, is saved.

1 BLOCK : Save the waveform data on the selected blocks (displayed block, use block)

(No) : Cancels save.



③ Select from data saving format options in recorder & memory.

Selection

R&M wave : Saves All (recorder & memory index files).

disp wave : Saves individually. (saves displayed waveform in the display screen.)

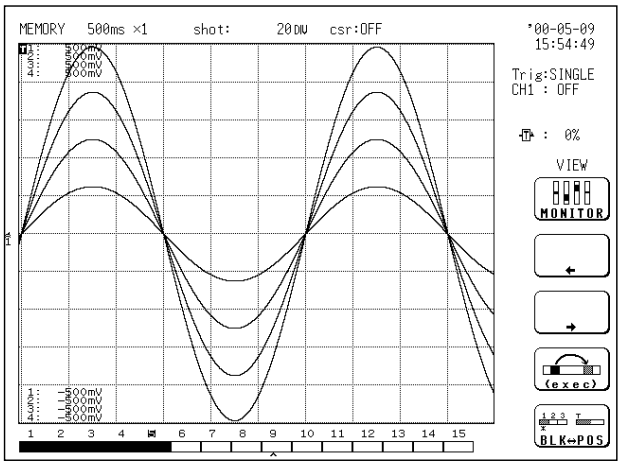
(No) : Cancels save.

NOTE

- When "**ALL BLOCKS**" is selected, files for all blocks as well as a index file for reading the data in one operation are created.
- Only a limited number of directories and files can be stored in the directory.

5.5.4 Block Display

- When memory segmentation is enabled, the usage state of each memory block is displayed.
- Either sequential save or multi-block mode can be used.
- Displayed blocks can be changed.



Method

Screen: DISPLAY

① Press the VIEW key on the screen.

② Either Position Display (refer to Section 3.1.7 in the 8835-01 Instruction Manual) or Block Display appears near the bottom of the screen. Select from the following function keys.

Selection

: Level Monitor (refer to Section 7.13 of 8835-01 Instruction Manual)


: Moves the destination to the left.


: Moves the destination to the right.

: Executes the move.

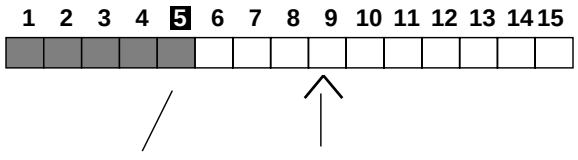
: Toggles between Position Display and Block Display

③ Press the VIEW key again to return.

NOTE

- Block Display is not available when memory segmentation is disabled.
- Memory segmentation can be used with the Memory Recorder and Recorder & Memory functions.
- Block Display is available when the display function is set to Memory in the Recorder & Memory function.

Changing the Displayed Block (The number of blocks depends on the segmentation)



Currently displayed block Move destination

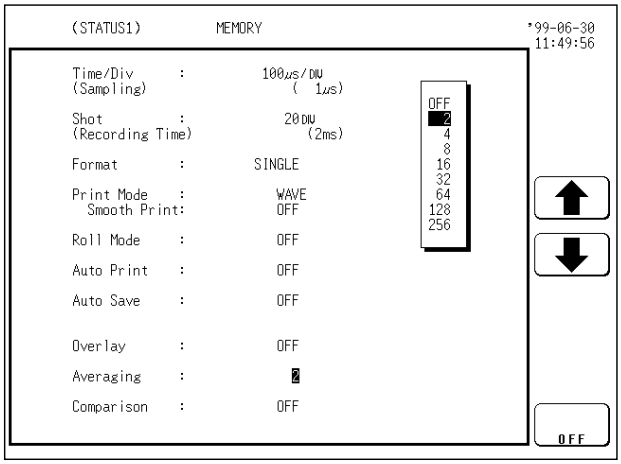
- Used blocks are filled.
- Unused blocks are empty.
- The number of the currently displayed block is shown in reverse.

① The move destination (^ mark) can be set with the function keys.

② Pressing the Execute function key moves the block.

5.6 Setting the Averaging Function

- The averaging function allows capturing several instances of a waveform and determining the average.
- This makes it possible to eliminate noise and irregular signal components.
- The higher the number of averaging instances, the more effectively will noise be suppressed.



Method

Screen: STATUS1

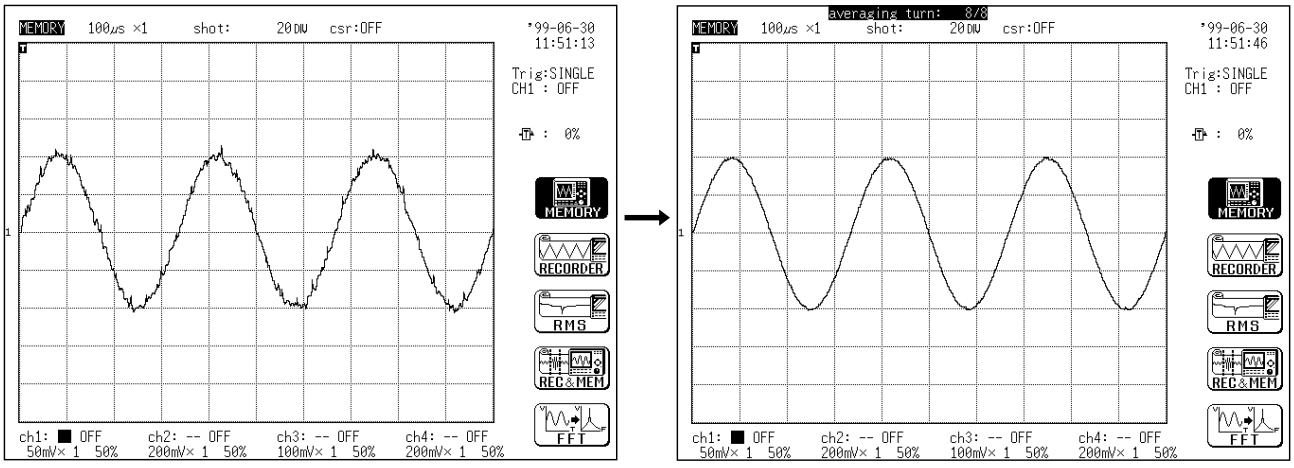
① Press the STATUS key to call up the STATUS1 screen.
② Move the flashing cursor to the **averaging** item, as shown in the figure on the left.
③ Use the JOG control or the function keys to set the averaging count.

Selection

: Move the cursor up in the selection window.

: Move the cursor down in the selection window.

After starting the measurement, the averaging count and the current waveform data count are shown on the screen.



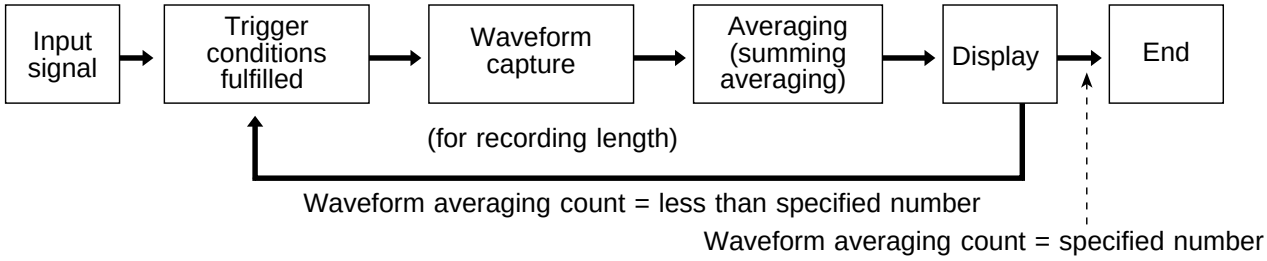
NOTE

- When the averaging function is used, logic waveform is not displayed.
- When the memory segmentation function is used, averaging is not available.
- Averaging and waveform processing cannot be carried out simultaneously.
- The averaged waveform becomes available for waveform processing when the averaging setting is turned OFF following measurement.
- When the averaging function is used, the maximum recording length is reduced to 25% of the normal value.

Averaging and trigger mode (Memory recorder function)

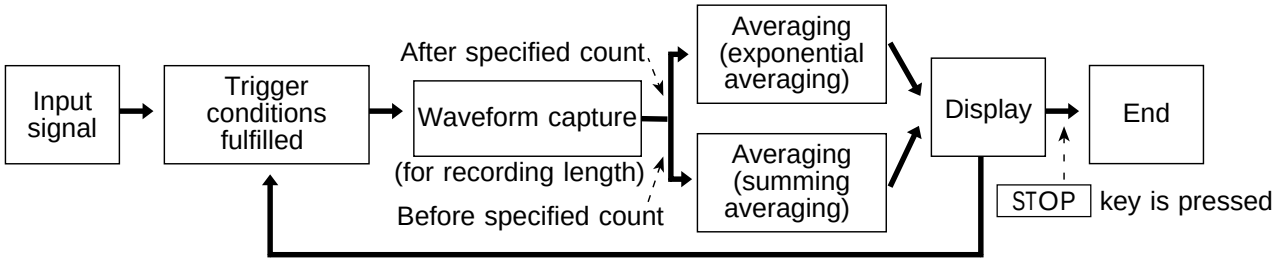
Trigger mode: SINGLE

(1) After the START key was pressed, data are captured whenever the trigger conditions are fulfilled, and summing averaging is carried out.
(2) When the specified number of data has been captured, measurement stops automatically.
(3) If the measurement was stopped prematurely with the STOP key, the averaging result up to that point is displayed.



Trigger mode: REPEAT

(1) After the START key was pressed, data are captured whenever the trigger conditions are fulfilled, and summing averaging is carried out until the specified averaging count. The averaging result is shown on the display.
(2) After the specified averaging count was reached, exponential averaging is carried out whenever data are captured, and the averaging result is shown on the display.
(3) If the measurement was stopped prematurely with the STOP key, the averaging result up to that point is displayed.



Trigger mode: AUTO and AUTO STOP

When the START key is pressed, data are captured even if trigger conditions are not fulfilled after a certain interval. If averaging is applied to unsynchronized input signals, the result will be meaningless.

NOTE For averaging equations, see Appendix 3.1.

Chapter 6 Specifications

6.1 8835-01 General Specifications

6.1.1 Basic Specifications

Measurement functions

Measurement function	Feature	Version
Memory recorder	High-speed data saving	Basic version
Recorder	Real time recording	
RMS recorder	For commercial power supplies	
Recorder & Memory	Real time recording & High-speed data saving	Advanced version
FFT	Frequency analysis	

Number of channels (maximum)	8 analog channels + 16 logic channels (The logic channels are standard equipment for the 8835-01, common ground with main unit)
Memory capacity	4 M words When 1 channel is in use: 12 bits × 4 M words /channel When 2 channels are in use: 12 bits × 2 M words /channel When 4 channels are in use: 12 bits × 1 M words /channel When 8 channels are in use: 12 bits × 500 K words /channel
Maximum sampling period	1 µs (all channels simultaneously) (Maximum sampling speed: 1 MS/s, all channels simultaneously)
Time axis accuracy	±0.01% (difference between grid and actual time)
Input method	Plug-in analog units
External control connections	External trigger input, trigger output, GO/NG output, external start/stop, print input
Time measurement functions	Auto calendar with automatic leap year, 24 hour clock
Backup battery and lifetime	Used for clock and to preserve settings, approx. 10 years (reference value at 25℃) To preserve waveforms, approximately one hour after shutting down MEMORY HiCORDER power (requires a minimum of two minutes upon power up) (reference value at 25℃)

Operational ranges for temperature and humidity	Temperature: 5℃ to 40℃ (41°F to 104°F) Relative humidity: 35% to 80%RH (with no condensation)
Operating place	Max. 2000 m (6562 feet) height, indoors
Temperature and humidity ranges for assured accuracy Guaranteed accuracy period	Temperature: 23±5℃ (73±9°F) Relative humidity: 35% to 80%RH (with no condensation) For 1 year
Temperature and humidity ranges for storage	Temperature: -10℃ to 50℃ (14°F to 122°F) Relative humidity: 20% to 90%RH (with no condensation)
Insulation resistance	At least 100 MΩ/500 VDC
Dielectric strength	One minute at 1.35 kVAC between the main unit and the power supply One minute at 3.7 kVAC between the input units and the main unit, and between the input units (see Section 15.2 of the 8835-01 Instruction Manual.)
Power supply	Rated power voltage 100 to 120 VAC, 200 to 240 VAC (auto-switching) Rated power frequency 50/60 Hz 10 to 28 VDC (the optional DC power adapter is used) (Voltage fluctuations of 10% from the rated supply voltage are taken into account.)
Maximum rated power	AC: 150 VA (55 W) (when 2 8936 ANALOG UNITs are installed) DC: 80 VA (80 W) (when 2 8936 ANALOG UNITs are installed) AC: 230 VA (95 W) (when 2 8940 F/V UNITs are installed) DC: 80 VA (80 W) (when 2 8940 F/V UNITs are installed and 2 ch current testing is ON)
Dimensions	Approx. 285W×220H×132D mm (11.22"W×8.66"H×5.20"D) (excluding projections)
Mass	Approx. 4.5 kg (158.73 oz.)
Standards applying	EMC EN61326 ClassA EN61000-3-2 EN61000-3-3 Safety EN61010 Pollution Degree 2, Measurement Category Ⅱ (anticipated transient overvoltage: 4000 V)

6.1.2 Recorder

Method of recording	Thermosensitive recording method using a thermal line head
Recording paper	Roll type thermosensitive paper, 110 mm × 30 m (long)
Width of recording	Total recording width: 104 mm±0.3 mm (832 dots) Waveform portion: 100 mm±0.3 mm f.s. (1 DIV=10 mm)
Recording speed	Approx. 25 mm/s max.
Paper feed accuracy	±1% (25℃, 60%RH)

6.1.3 Display

Display language	Japanese/English (selectable)
Screen	6.4 inch TFT color LCD display (640 × 480 dots)
Display resolution	In the memory recorder, recorder and RMS recorder functions (1 DIV = 50 (horizontally) × 40 (vertically) dots) ・Waveform: 10 DIV × 10 DIV f.s. ・Text: 40 characters × 30 lines In X-Y format (1 DIV = 40 dots) ・Waveform: 10 DIV × 10 DIV f.s. ・Text: 40 characters × 30 lines
Dots spacing	0.204 (H) × 0.202 (V) mm
Backlight lifetime	Approx. 50000 hours

NOTE

TFT color LCDs characteristically have a few defective pixels that do not always light, or that remain lit.
We do not consider the presence of six or fewer such defects to indicate a damaged or faulty display. Please be aware of this in advance.

6.1.4 External Data Storage

(1) Floppy disk

Device	3.5-inch floppy disk drive
Capacity	・1.44 MB (2HD) (IBM PC/AT compatible or NEC PC-9801 series with 3-mode drive) ・1.2 MB (2HD) (NEC PC-9801 series) ・720 KB (2DD) (IBM PC/AT compatible)
Data format	MS-DOS format*1
Data stored	Settings, measurement data, waveform decision area (advanced version), screen data (Measurement data can be saved between cursors A and B.)

(2) PC card

Expansion slot	・PC card standard (1 slot) ・Accepts TYPE I, II, III PC cards
Card types	SRAM card, flash ATA card, hard disk drive card (HDD) Use only PC Cards sold by HIOKI.
Card capacity	32 MB max. (SRAM), 1 GB max. (flash, HDD)
Data format	MS-DOS format*1
Data stored	Settings, measurement data, waveform decision area (advanced version), screen data (Measurement data can be saved between cursors A and B.)

*1: MS-DOS is the registered trademark of Microsoft Corporation.

6.1.5 Interface

GP-IB	・Complies with IEEE 488.2-1987 ・Remote control including input unit is possible. ・The optional 9558 GP-IB CARD is used.
RS-232C	・Complies with EIA RS-232C ・Remote control including input unit is possible. ・The optional 9557 RS-232C CARD is used.
LAN	・Complies with IEEE 802.3i (Ethernet 10BASE-T) ・Remote control including input unit is possible. ・The optional 9578 10BASE-T LAN CARD is used. (Option) ・Commercially available LAN cards (compatible cards) can be used. ・Remote measurement and data collection are possible using the 9333 LAN COMMUNICATOR.
Printer	・Complies with PC-AT centronics ・Color printing available with connection to external printer ・The optional 9559 PRINTER CARD is used.

6.1.6 Others

Accessories	Grounded three-core power cord	1
	Ground adapter	1
	Recording paper	1
	Protective cover	1
	Roll paper attachment	2
	PC card protector	1
	Instruction Manual	1
	Waveform viewer(Wv)FD	1

Options

9540-01 FUNCTION UP DISK
8936 ANALOG UNIT
8937 VOLTAGE/TEMP UNIT
8938 FFT ANALOG UNIT
8939 STRAIN UNIT
8940 F/V UNIT
8946 4 ch ANALOG UNIT
8947 CHARGE UNIT
9439 DC POWER ADAPTER
9221 RECORDING PAPER (10 rolls)
9557 RS-232C CARD
9558 GP-IB CARD
9559 PRINTER CARD
9333 LAN COMMUNICATOR
9335 WAVE PROCESSOR
9578 10BASE-T LAN CARD
9626 PC CARD 32 M
9627 PC CARD 64 M
9726 PC CARD 128 M
9727 PC CARD 256 M
9728 PC CARD 512 M
9729 PC CARD 1 G
9388 CARRYING CASE
9320 LOGIC PROBE
9321 LOGIC PROBE
9322 DIFFERENTIAL PROBE
9324 POWER CORD (for logic connector)
9325 POWER CORD (for the 8940 F/V UNIT sensor connector)
9303 PT *
9197 CONNECTION CORD (for high voltage, maximum input voltage 500 V)
9198 CONNECTION CORD (for low voltage, maximum input voltage 300 V)
9199 CONVERSION ADAPTOR
9217 CONNECTION CORD (insulated BNC to insulated BNC)
9318 CONVERSION CABLE (for 9270, 9271, 9272, 9277, 9278 and 9279)
9319 CONVERSION CABLE (for 3273)
9305 TRIGGER CORD
220H PAPER WINDER
3273 CLAMP ON PROBE
9018-10 CLAMP ON PROBE (10 to 500 A, 40 Hz to 3 kHz)
9132-10 CLAMP ON PROBE * (20 to 1000 A, 40 Hz to 1 kHz)
9270 CLAMP ON SENSOR * (20 A, 5 Hz to 50 kHz)
9271 CLAMP ON SENSOR * (200 A, 5 Hz to 50 kHz)
9272 CLAMP ON SENSOR * (20/200 A, 5 Hz to 10 kHz)
9277 UNIVERSAL CLAMP ON CT (20 A, DC to 100 kHz)
9278 UNIVERSAL CLAMP ON CT (200 A, DC to 100 kHz)
9279 UNIVERSAL CLAMP ON CT * (500 A, DC to 20 kHz)
9555 SENSOR UNIT * (used with the 9270 to 9272, and the 9277 to 9279)
*: Not complied with the CE marking

6.2 Trigger Unit

Trigger Method	Digital comparison
Trigger modes	<table><tr><th>Function</th><th>Available trigger modes</th><th>Version</th></tr><tr><td>Memory recorder</td><td>Single, repeat, auto</td><td rowspan="3">Basic version</td></tr><tr><td>Recorder</td><td>Single, repeat</td></tr><tr><td>RMS recorder</td><td>Single, repeat</td></tr><tr><td>Recorder & Memory</td><td>Single, repeat</td><td rowspan="2">Advanced version</td></tr><tr><td>FFT</td><td>Single, repeat, auto</td></tr></table>
Trigger source	CH1 to CH8, logic CHA to CHD ・External trigger ・Manual trigger ・Timer trigger Sources can be set on or off. When all sources are off, the unit is in the free-run state. Trigger conditions can be set for each channel individually. With an external trigger, the triggering occurs on a falling edge of 2.5 V, or when the terminals are shorted together.
Trigger conditions	Logical AND or OR of any trigger sources
Trigger types (analog)	(1) Level trigger ・Digital setting of voltage values for full scale ・Triggering occurs at rising edge (falling edge) of set value. (2) Window-in, window-out trigger ・Upper and lower trigger levels can be set. ・Triggering occurs when the waveform enters or leaves the defined area. (3) Voltage drop trigger Triggering occurs when the peak of the voltage falls lower than the setting level (for commercial power supplies). (4) RMS level trigger Digital setting of rms values Triggering occurs at rising edge (falling edge) of set value (for commercial power supplies and DC). (5) Period trigger The period trigger setting determines the period reference voltage and period range beyond which the measured rise (or fall) of the set voltage results in tripping of the period trigger.
Trigger type (logic)	Pattern trigger specified by 1, 0, and × (× means that either 1 or 0 is fine.)
Trigger filter	・Memory recorder and recorder & memory functions OFF, 0.1, 0.2, 0.5, 1.0, 1.5, 2.0, 2.5, 5.0, 10.0 DIV ・Recorder and X-Y CONT recorder functions (advanced version) ON, OFF
Trigger level resolution	0.25 % f.s. (f.s. = 10 DIV)
Pre-trigger	Memory recorder function, recorder & memory function (advanced version) 0, 2, 5, 10, 20, 30, 40, 50, 60, 70, 80, 90, 95, 100, -95 % RMS recorder function 0, 5, 10 DIV
Trigger timing	Start, stop, start and stop (recorder function)
Trigger output	・Open collector output (with 5 V output voltage, active low) ・Pulse width 10 ms min.
Trigger input and output connectors	Mini-jack (3.5 mm dia.)

6.3 Memory Recorder Function

Time axis	100, 200, 500 µs/DIV 1, 2, 5, 10, 20, 50, 100, 200, 500 ms/DIV 1, 2, 5, 10, 30 s/DIV 1, 2, 5 min/DIV External
Time axis resolution	100 points/DIV
Sampling period	1/100 of the time axis
Recording length	Any setting(*1) or preset setting (see below) 20, 50, 100, 200, 500, 1000, 2000, 5000, 10000(*2), 20000(*3), 40000(*4) DIV
Screen • print format	Single, dual, quad screen display, X-Y (dot), X-Y (line)
Recording line display	12-color
Superimposition function	Provided
Waveform magnification/ compression	・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, ×1/5000 ・Voltage axis ×10, ×5, ×2, ×1, ×1/2
Waveform scrolling	Available in the left/right directions
Auto-print	ON/OFF switchable. Automatically prints the memorized waveform
Manual print	Available
Partial print	Prints between the A and the B cursors
Print smoothing function	When set, a smoothed waveform is printed, with twice the density in the time axis direction.
Logging function	Records measured data as digital values
Variable function	Provided
Vernier function	Provided

*1: Set from 1 division to the maximum number of divisions at 1-division intervals

*2: When 4 channels are in use

*3: When 2 channels are in use

*4: When 1 channel is in use

6.4 Recorder Function

Time axis	10(*1), 20(*1), 50(*1), 100(*1), 200(*1), 500 ms/DIV 1, 2, 5, 10, 30 s/DIV 1, 2, 5, 10, 30 min/DIV 1 h/DIV
Time axis resolution	100 points/DIV (with the printer)
Sampling period	1, 10, 100 µs, 1, 10, 100 ms (Can be selected, from 1/100 of the time axis setting)
Recording length	Any setting (*2) or preset setting (see below) 20, 50, 100, 200, 500, 1000, 2000 DIV, continuous(*3)
Screen • print format	Single, dual, quad screen display X-Y screen display
Interpolation function	Line (other than X-Y), dot, line (X-Y)
Recording line display	12-color
Spatial resolution	40 dots/DIV (with the display) 100 dots/DIV (horizontally), 80 dots/DIV (vertically) (with the printer)
X-Y sampling period	Dot: 100 µs fixed, line: 100 µs to 6 ms
Waveform magnification/ compression	・Time axis ×1, ×1/2, ×1/5, ×1/10, ×1/20, ×1/50, ×1/100, ×1/200 ・Voltage axis ×10, ×5, ×2, ×1, ×1/2
Waveform storage	Last 2000 divisions of data saved in memory Can be checked by reverse scrolling and reprinted
Print function	Can be set to ON, OFF, or reprint.
Additional recording function	ON/OFF (*4)
Logging function	Records measured data as digital values
Variable function	Provided
Vernier function	Provided

*1: Although real-time recording to the recording paper is not possible in the high-speed range (10 to 200 ms/DIV), the waveforms are stored to the memory and can therefore be monitored on the screen. The last 2000 divisions of each waveform are retained in memory before the measurement is complete. If the recording length is not set to "continuous," the printer can also be operated, enabling the waveforms to be printed out later.

*2: Set from 1 division to the maximum number of divisions at 1-division intervals

*3: With time axis 10 to 200 ms/DIV, "continuous" is not possible with printer ON.

*4: Additional recording function (recording data without paper)

・When enabled, the memory is regarded as printer paper. Recording starts at the end of previous data, without erasing them. When the recording length has been reached, old data will be overwritten.

・When OFF, previous data will be erased. Set to ON if erasing is not desired.

6.5 RMS Recorder Function

Time axis	5, 10, 30 s/DIV 1, 2, 5, 10, 30 min/DIV 1 h/DIV
Time axis resolution	100 lines/DIV (with the printer)
Sampling period	20 rms data/s (200 μs fixed)
RMS accuracy	±3% f.s. (at 50/60 Hz±2 Hz, DC) (f.s.=10 DIV)
Measuring object	Commercial power supplies (50/60 Hz), DC
Recording length	Any setting (*1) or preset setting (see below) 20, 50, 100, 200, 500, 1000, 2000 DIV, continuous
Screen • print format	Single, dual, quad screen display
Recording line display	12-color
Waveform magnification/ compression	・Time axis ×1, ×1/2, ×1/5, ×1/10, ×1/20, ×1/50, ×1/100, ×1/200 ・Voltage axis ×10, ×5, ×2, ×1, ×1/2
Waveform storage	Last 2000 divisions of data saved in memory Can be checked by reverse scrolling and reprinted
Print function	Can be set to ON, OFF, or reprint.
Additional recording function	ON/OFF (*2)
Logging function	Records measured data as digital values
Variable function	Provided
Vernier function	Provided

*1: Set from 1 division to the maximum number of divisions at 1-division intervals

*2: Additional recording function (recording data without paper)

When enabled, the memory is regarded as printer paper. Recording starts at the end of previous data, without erasing them. When the recording length (2000 DIV) has been reached, old data will be overwritten.

6.6 Recorder & Memory Function

Time axis	・Recorder 500 ms/DIV 1, 2, 5, 10, 30 s/DIV 1, 2, 5, 10, 30 min/DIV 1 h/DIV ・Memory 100, 200, 500 µs/DIV 1, 2, 5, 10, 20, 50, 100, 200, 500 ms/DIV 1, 2, 5, 10, 30 s/DIV 1, 2, 5 min/DIV
Time axis resolution	100 points/DIV
Sampling period	1/100 of the time axis.....memory waveform
Recording length	Any recording length (*1) or preset setting (see below) 20, 50, 100, 200, 500, 1000 DIV, continuous (recorder) 20, 50, 100, 200, 500, 1000, 2000 DIV (memory)
Screen • print format	Single, dual, quad screen display
Display	Switchable between recorder and memory waveforms
Printer output	During measurement operation, recorder waveform only. After data capture, printout of recorder waveform as on display or memory waveform.
Waveform storage (recorder)	Last 1000 divisions of data saved in memory Can be checked by reverse scrolling and reprinted
Additional recording function	ON/OFF (*2)
Trigger source	CH1 to CH8, CHA to CHD and external trigger (memory)
Trigger mode	Single, repeat, timer (recorder)
Ancillary function	Sequential save
Variable function	Provided
Vernier function	Provided

*1: Set from 1 division to the maximum number of divisions at 1-division intervals

*2: Additional recording function (recording data without paper)

6.7 FFT Function

FFT channel mode	1 channel FFT, 2 channel FFT
FFT range setting	133 mHz to 400 kHz, external
Dynamic range	72 dB (logical value)
Number of sampling points	1000, 2000, 5000, 10000
Frequency resolution	1/400, 1/800, 1/2000, 1/4000
Antialiasing filter	Automatic cutoff frequency selection linked to frequency range
Analysis channel setting	1 channel FFT, 2 channel FFT for any channel
FFT analysis mode setting	Storage waveform, linear spectrum, RMS spectrum, power spectrum, cross-power spectrum, auto-correlation function, histogram, transfer function, cross-correlation function, unit-impulse response, coherence function, octave analysis
Display format setting	Single, dual screen display, Nyquist display
Window functions	Rectangular, hanning, exponential
Display scale	Linear scale, log scale, phase
Print function	As per the memory recorder function, excluding partial print function
Averaging function	Additive average of time and frequency domains, exponential averaging, peak hold (2, 4, 8 to 4096 samples)
Variable function	Provided
Vernier function	Not provided

6.8 Others

It is possible to upgrade the basic version to the advanced version, using the 9540-01 FUNCTION UP DISK available as an option.

Measurement functions	Recorder & Memory (real time recording & high-speed data saving) FFT (frequency analysis)
Computation functions (memory recorder function)	
Waveform processing calculations	Arithmetic operations, absolute value, exponents, common logarithms, square roots, moving average, 1st and 2nd derivatives, 1st and 2nd integrals, time axis parallel shift
Averaging function	Memory recorder function: Additive averaging (2, 4, 8 to 256 samples) FFT function: Simple averaging, exponential averaging, peak hold (2, 4, 8 to 4096 samples)
Waveform decision (memory recorder function)	
① Waveform area decision	Waveform decision based on reference area for Y-T waveform, X-Y waveform, or FFT results
Decision modes	Out: fail if any part of waveform is outside reference area All out: fail if whole of waveform is outside reference area
Stop conditions	GO (pass) stop, NG (fail) stop, GO & NG stop Printer output or waveform save at stop
Decision output	GO and NG outputs on side panel: open collector outputs (with 5 V output, active low, pulse width 10 ms min.)
② Waveform parameter decision	Decision based on setting minimum and maximum values for waveform parameter calculation results
Graphics editor	Provided, used for defining an arbitrary reference area for waveform decisions
Editor commands	Paint, parallel shift, lines, eraser, loading waveform, reverse, screen clear, delete within area, cancel, save new area, close editor
Memory segmentation	
Memory segmentation function	Memory can be segmented among channels.
Number of segments	Maximum 255 Multi-block Sequential saving
Waveform parameter calculations	Average value, effective value, peak-to-peak value, maximum value, time to maximum value, minimum value, time to minimum value, period, frequency, rise time, fall time, area value, XY area value, standard deviation

Comment printing	Function, channel, input range, zero position, trigger time, DIV and other information can be printed.
Cursor measurement function	Time difference, voltage difference or number of cycles between cursors A and B, voltage at each cursor, time from trigger
Scaling function	Specifiable for each channel
Comment input function	Provided
Display copy function	Provided
List • gauge functions	ON, OFF
Waveform backup function	Provided (more than approximately one hour after shutting down MEMORY HiCORDER power, requires a minimum of two minutes upon power up)
Starting status backup function	Provided
Auto setup function	When the power is turned on, settings and a waveform decision area stored on a floppy disk can be automatically loaded. (waveform decision area: advanced version)
Auto save function	Provided
Remote control	Start, stop and print control terminals (threshold value: 2.5 V ±1 V, active low, or terminal short)
Auto-range function	Provided, selects optimum time axis and voltage axis for input waveform
VIEW function	・In memory recorder and recorder functions, shows relative positions of displayed data within recording length and to full-scale point. ・In memory recorder function, when memory segmentation is used, usage condition of each block is shown (advanced version).
On-line help	Pressing the HELP key brings up a brief explanation of procedures for using the current function or feature.
GP-IB	・Complies with IEEE 488.2-1987 ・Remote control including input unit is possible. ・The optional 9558 GP-IB CARD is used.
RS-232C	・Complies with EIA RS-232C ・Remote control including input unit is possible. ・The optional 9557 RS-232C CARD is used.
Key lock function	Locks all keys except the KEY LOCK key
LCD back lighting	ON, OFF (with the auto OFF function)
List print function	・Settings output after waveform data print (selectable on/off) ・Output by pressing PRINT key other than on display screen
Zoom function	Provided (memory recorder function only)
Customer color setting	Provided

6.9 9439 DC POWER ADAPTER Specifications

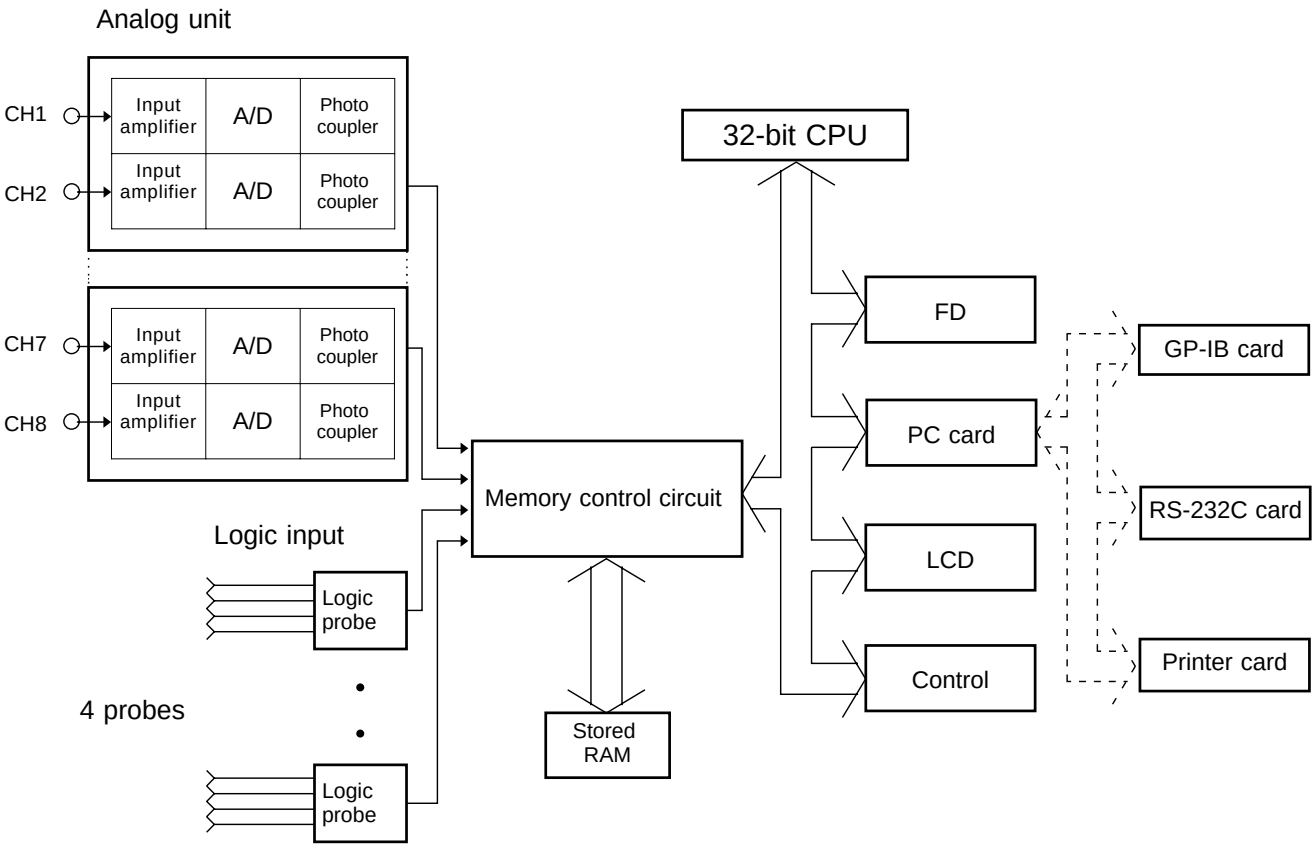
- Used for operating the unit on DC power.
- Connect DC power adapter output to 8835-01, and connect DC source (battery etc.) to adapter input.
- Accuracy at 23°C±5°C (73°F±9°F), 35% to 80%RH after 30-minute warming-up time
- Accuracy guaranteed for 1 year

Input voltage range	10 to 28 VDC
Rated output voltage	24 VDC
Output voltage accuracy	24±1 VDC
Rated output current	2.2 A
Efficiency	70% min. (under rated output conditions)
Output over-current protection	Detected at 110%+15% or -5% of rated output current (output shutoff)
Output over-voltage protection	Detected at 115%±5% of rated output voltage (output shutoff)
Maximum rated power	80 VA
Operational ranges for temperature and humidity	Same as the 8835-01 MEMORY HiCORDER
Temperature and humidity ranges for storage	-10°C to 50°C (14°F to 122°F), 20% to 90%RH (with no condensation)
Operating place	Same as the 8835-01 MEMORY HiCORDER
Output indication	Output indicated by the red LED
When used together with AC power supply	When both AC power and the 9439 DC POWER ADAPTER are connected to the 8835-01, AC power has priority. When AC power shuts off, the 8835-01 switches to DC.
Dielectric strength	One minute at 700 VDC (between the input and the output, and between the input and the main unit)
Insulation resistance	100 MΩ/500 VDC
Dimensions	Approx. 152W×92H×54D mm (5.98"W×3.62"H×2.13"D) Input cable: Approx. 2000 mm (78.74") Output cable: Approx. 300 mm (11.81"")
Mass	Approx. 770 g (27.2 oz.)
Accessories	None

6.10 System Operation

System operation is explained according to the block diagram.

(1) All system operations are controlled by a 32-bit RISC CPU.
(2) Each input unit incorporates high-speed 12-bit A/D converters which are connected to the main unit via a photocoupler integrated in each input unit. Each channel has its own power supply, to assure electrical isolation from the main unit.
(3) Measurement data stored in memory are processed by the CPU, displayed on the LCD screen, and output to the printer. Output to floppy disk, the SRAM card, flash ATA card, GP-IB card, RS-232C card or printer card is also provided.



Block Diagram

Table 1

Sampling period and maximum recording length for various time axis settings

1. Memory recorder function

Time axis range [/DIV]	Sampling period	Max. recording length (*1) (40000 DIV)
100 µs	1.00 µs	4 s
200 µs	2.00 µs	8 s
500 µs	5.00 µs	20 s
1 ms	10.0 µs	40 s
2 ms	20.0 µs	1 min 20 s
5 ms	50.0 µs	3 min 20 s
10 ms	100 µs	6 min 40 s
20 ms	200 µs	13 min 20 s
50 ms	500 µs	33 min 20 s
100 ms	1.00 ms	1 h 6 min 40 s
200 ms	2.00 ms	2 h 13 min 20 s
500 ms	5.00 ms	5 h 33 min 20 s
1 s	10.0 ms	11 h 6 min 40 s
2 s	20.0 ms	22 h 13 min 20 s
5 s	50.0 ms	2 d 7 h 33 min 20 s
10 s	100 ms	4 d 15 h 6 min 40 s
30 s	300 ms	13 d 21 h 20 min 0 s
1 min	600 ms	27 d 18 h 40 min 0 s
2 min	1.20 s	55 d 13 h 20 min 0 s
5 min	3.00 s	138 d 21 h 20 min 0 s

Time axis resolution: 100 points/DIV

(*1): When using one channel only

Table 2

Time axis resolution and maximum recording length for various time axis settings

2. Recorder function

Time axis range [/DIV]	Recording paper feeding speed	Approximate recording time on one roll (30 m) of recording paper
10 ms	20 mm/s	30 s
20 ms	20 mm/s	1 min
50 ms	20 mm/s	2.5 min
100 ms	20 mm/s	5 min
200 ms	20 mm/s	10 min
500 ms	20 mm/s	25 min
1 s	10 mm/s	50 min
2 s	5 mm/s	1 h 40 min
5 s	2 mm/s	4 h 10 min
10 s	1 mm/s	8 h 20 min
30 s	20 mm/min	1 d 1 h
1 min	10 mm/min	2 d 2 h
2 min	5 mm/min	4 d 4 h
5 min	2 mm/min	10 d 10 h
10 min	1 mm/min	20 d 20 h
30 min	20 mm/h	62 d 12 h
1 h	10 mm/h	125 d

Time axis resolution: 100 points/DIV

Appendix

Appendix 1 Error and Warning Messages

The unit produces two levels of message to indicate problems. These are distinguished as follows.

Error messages

(1) The "ERROR" indication appears at the bottom of the screen, followed by the message. This remains until the cause of the error is removed, or the STOP key is pressed.

(2) If the "beep sound" item on the system screen is set to ON, then the beeper sounds intermittently while the message is displayed.

Warning messages

(1) The "WARNING" indication is displayed on the bottom line of the screen, followed by the message, but disappears after a few seconds.

(2) Warning messages also disappear if any key is pressed.

(3) If the "beep sound" item on the system screen is set to ON, then the beeper sounds once only when the message is displayed.

Appendix 1.1 Error Messages

ERROR 1: Set printer paper.	Printer paper has run out. Reload.
ERROR 2: Set printer lever.	The head up/down lever has been left in the up position. Lower it.
ERROR 11: Waint printer initiarize.	Make sure that the external printer is ready to print.
ERROR 12: Set printer power on	Make sure that the external printer is connected or the unit is powered on.
ERROR 13: Paper End	Printer paper has run out. Reload.
ERROR 14: Printer Error.	This indicates an internal printer error.

Appendix 1.2 Warning Messages

WARNING 70: Insert Floppy disk.	No disk is present in the floppy disk drive. Insert one.
WARNING 71: Cannot load. (not 8835 data)	Data cannot be loaded, because it is not a set of data created by the 8835-01.
WARNING 72: Illegal format.	The floppy disk is not a correctly formatted MS-DOS disk, or is a 2DD, 640 KB format disk.
WARNING 73: Write Protected.	The floppy disk is write-protected. Change the write-protect setting or use a different disk.
WARNING 74: Disk full.	There is insufficient space remaining.
WARNING 75: File is read only.	File cannot be written or deleted, because it is read-only.
WARNING 76: General failure.	Access to disk is not possible because of some low-level error, such as in formatting or file saving.
WARNING 80: Insert PC card.	No card is present in the PC card slot. Insert one.
WARNING 81: Cannot load. (not 8835 data)	Data cannot be loaded, because it is not a set of data created by the 8835-01.
WARNING 82: Illegal format.	The PC card is not a correctly formatted MS-DOS disk.
WARNING 83: Write Protected.	The PC card is write-protected. Change the write-protect setting or use a different card.
WARNING 85: File is read only.	File cannot be written or deleted, because it is read-only.
WARNING 86: General failure.	Access to card is not possible because of some low-level error, such as in formatting or file saving.
WARNING 90: File already exists.	File cannot be saved because a file of the same name already exists. Change the file name.
WARNING 91: Directory full	Only a limited number of files and directories can be created in the root directory.
WARNING 92: Directory not empty	The directory is not empty. Delete files in it.
WARNING 93: Disk full	Delete files or use a different media.
WARNING 94: Path name error.	Make sure that the path name does not exceed 127 characters.
WARNING 95: Empty directory name.	Specify a directory name.
WARNING 96: Directory already exists.	A directory of the same name already exists. Change the directory name.
WARNING 97: 2DD type FD.	The floppy disk is a 2DD media. Select the appropriate disk format.
WARNING 98: 2HD type FD.	The floppy disk is a 2HD media. Select the appropriate disk format.
WARNING 99: Conditions for OVERWRITE are not satisfied.	Set the instrument's measurement data, file function, and time axis range settings.
WARNING 201: Set printer paper.	Printer paper has run out. Reload.
WARNING 202: Set printer lever.	The head up/down lever has been left in the up position.
WARNING 207: AUTO RANGE failure	The auto ranging function has failed. Check the input signal.
WARNING 208: Cannot SAVE. (Write Protected)	Move the write-protect tab to the unset position.

WARNING 209: Cannot SAVE. (Disk Full)	Delete files or use a different media.
WARNING 213: Invalid. (MEASUREMENT)	Pressed key is invalid, because parameter processing is ON.
WARNING 214: Invalid. (Pre Trigger)	The pre-trigger cannot be set, because the additional recording function is set.
WARNING 300: Cannot START.	Cannot start measurement from SYSTEM screen.
WARNING 301: Invalid (SYSTEM)	The key pressed is not valid on the system screen.
WARNING 310: Change auto print	When operating DC power supply, auto printing and roll mode are set to ON, current cannot be tested in more than 3 ch. Current testing in more than 3 ch turned auto printing OFF.
WARNING 311: Change print	When operating DC power supply, printer is set to ON, voltage cannot be tested in more than 3 ch. Voltage testing in more than 3 ch turned printer OFF.
WARNING 312: Cannot set. (Auto Print)	When operating DC power supply, auto printing cannot be set, because current testing is set in more than 3 ch.
WARNING 313: Cannot set. (Print)	When operating DC power supply, printer cannot be set, because current testing is set in more than 3 ch.
WARNING 324: Ignore in running. (AVERAGE)	Because averaging is used, waveform processing is not carried out during the start operation.
WARNING 325: Ignore in running. (WAVE CALC.)	Because a waveform processing calculation is carried out, vernier adjustment cannot be carried out.
WARNING 327: Invalid. (COMPARISON)	Pressed key is invalid, when waveform evaluation is being carried out.
WARNING 328: Invalid. (OVER LAY)	Operation is not possible, since the overlay function is enabled.
WARNING 329: Wrong format for Comparison	Since the format is not SINGLE or XYsing, a waveform decision is not possible.
WARNING 330: Cannot set. (SHOT too long)	The recording length is too long for the memory segmentation function or a waveform processing calculation to be carried out.
WARNING 334: Cannot set. (AVERAGE)	The memory segmentation function cannot be set together with the averaging function.
WARNING 335: Cannot set. (SEQUENTIAL)	Waveform processing cannot be carried out, because memory segmentation function is active.
WARNING 336: Cannot set. (MULTI BLOCK)	Waveform processing cannot be carried out, because memory segmentation function is active.
WARNING 337: Cannot set. (ROLL MODE)	Superimpose and waveform decision cannot be carried out, because roll mode is active.
WARNING 338: Cannot set. (OVER LAY)	Waveform processing cannot be carried out, because overlay function is active.
WARNING 339: Invalid. (STATUS)	On the status screen, the key pressed is invalid.
WARNING 345: Cannot set. (AND logic trigger)	'AND' cannot be set between the trigger sources using the logic trigger and the RMS level trigger
WARNING 346: Cannot set. (AND rms level)	'AND' cannot be set between the trigger sources using the RMS level trigger and the logic trigger.
WARNING 347: Invalid. (Pre Trigger)	When the trigger is not set, the pre-trigger is invalid.
WARNING 348: Invalid. (V-drop Trigger)	In the time axis range of 100 ms to 5 min, the voltage drop trigger is invalid.
WARNING 351: Cannot set. (Free run)	The pre-trigger setting cannot be made, since all trigger sources are switched off (free run).

WARNING 352: Invalid. (CHAN)	On the CHANNEL screen, the key pressed is invalid.
WARNING 353: Cannot set. (time/div:100ms-5min)	The time axis range whithin which the voltage drop trigger can be used is 100 μs to 50 ms/DIV.
WARNING 380: No data in Ref. Block	When using the memory segmentation function (multi-block), there is no data in the reference block.
WARNING 381: Ref. block = Using block	When using the memory segmentation function (multi-block), the reference block and the block specified by the "using block" item are the same.
WARNING 382: No waveform data.	Because there is no waveform data present, it cannot be displayed. Start measurement operation to capture data.
WARNING 384: Different Ref. shot.	The recording lengths are different for the reference block and the block specified by the "using block" item. Capture data with the recording lengths set the same.
WARNING 386: Invalid. (RECORDER)	In the recorder function, the key pressed is invalid.
WARNING 387: Invalid. (X-Ycont)	In the X-Y recorder function, the key pressed is invalid.
WARNING 388: No comparison AREA	No waveform evaluation area. Create waveform evaluation area.
WARNING 389: Cannot use Printer.	The printer cannot be used when the time axis range is 10 ms to 200 ms/DIV, and the recording length is "continuous."
WARNING 390: Cannot set over up level.	Setting cannot be higher than upper limit.
WARNING 391: Cannot set under low level.	Setting cannot be lower than lower limit.
WARNING 392: Cannot set. (Using unit 2ch)	Recording length cannot be set to higher value because 2 channels are being used. Reduce number of channels.
WARNING 396: Out of range. (variable)	The settable range for the variable function (captured voltage range full-scale value×±500) was exceeded. When this warning appears, the upper and lower value setting is automatically changed to be within range.
WARNING 397: Out of range. (scaling)	POINT was set for scaling and the settable range (shown on Section 9.4.2) was exceeded.
WARNING 398: A/B cursor positions invalid.	Move A/B cursors to appropriate position.
WARNING 421: Equation contains a syntax error.	Correct equation.
WARNING 422: Cannot copy the equation. (Zxx)	Copy function cannot be carried out, because the copy source equation contains a Z number higher than the copy target equation.
WARNING 423: Upper value has to be bigger than lower value.	Upper limit must be higher than lower limit.
WARNING 610: No interface card.	Insert the interface card (PC card).
WARNING 799: Invalid. (shot:CONT.)	Operation is not possible, because the recording length is set to continuous.

Appendix 2 Glossary

A/D	Conversion of an analog quantity into a digital quantity
Aliasing	Phantom signal components; a phenomenon that occurs if sampling frequency is low in relation to the frequency of the sampled signal (see Section Appendix 3.2).
Variance at aliasing	In FFT processing when input signal has more than 1/2 frequency component in sampling frequency, non-existing frequency spectrum is observed caused by aliasing.
Analog	Continuous physical quantity such as voltage or current
Attenuator	Device for reducing the level of a signal
Bit	Smallest unit of binary information
Byte	Unit of information. 1 byte is made up of 8 bits.
Channel (CH)	Input signal route
Chassis	Metal frame of the unit
Comment	A string input by the user. Also measurement conditions and other information printed for all functions.
Common mode	Voltage between ground and measurement input line
Cutoff frequency	Point where the filter output amplitude is $1/\sqrt{2}$ of the input.
Digital	Discrete physical quantity
DIV (division)	Increment on display or printout
Dynamic range	Ratio of maximum vs. minimum amplitude that can be displayed
File	A collection of data on a medium such as tape
LED	Abbreviation of "light-emitting diode"
Logic-level	Waveform expressed as High and Low level
Low-pass filter	Filter that passes through only signals below a certain frequency
Memory	A device for storing digital data
MS-DOS	Personal computer operating system. MS-DOS is a registered trademark of Microsoft Corporation.
Offset	Amount of shift in relation to 0 V when scaling is used
Open collector	Transistor output format. Requires an output increase.
Pre-trigger	The condition of the signal before triggering occurred
Probe	Signal line for supplying the signal to the input
PT	Abbreviation of (voltage) "potential transformer"
Recording length	Total amount of sampling data expressed as number of increments
Ripple component	AC component of noise
Sampling	Measuring an analog waveform at regular intervals (☞ Appendix 2.1)

Sampling rate	Rate at which sampling carried out; sampling frequency
Scaling	Conversion of voltage value into a specified unit
Storage	Storing measurement data in the internal memory
Thermal head	Print head of thermal printer
Threshold value	When turning an analog signal into a logic signal, the level at which the measured value is divided between High and Low.
Trigger	An event that causes a certain action (such as starting or stopping a measurement) to happen.
Unbalanced input	Using a two-pole input in such a way that one pole carries the signal referenced to the other pole
Word	A unit for expressing digital data. The digital data for one input signal point after conversion.

Appendix 3 Reference

Appendix 3.1 Averaging Equations

For time axis averaging, summing averaging is synchronized by the trigger. If trigger synchronization is not performed, the results will be meaningless. Unlike time axis averaging, results are valid also if no trigger synchronization is used. But if the characteristics of the input waveform allow triggering, using the trigger for synchronization is recommended.

■ Summing averaging

Captured data are added sequentially and the sum is divided by the number of samples.

Equation: $A_n = \{ (n - 1)A_{n-1} + Z_n \} / n$

n : *Averaging count*
A_n : *Result of n times averaging*
Z_n : *n-th measurement data*

■ Exponential averaging

Most recent data are given greatest weighting, and the weighting of older data is reduced with an exponential function.

Equation $A_n = \{ (N - 1)A_{n-1} + Z_n \} / N$

N : *Specified averaging count*
n : *Averaging count*
A_n : *Result of n times averaging*
Z_n : *n-th measurement data*

■ Peak hold (frequency axis: FFT)

The specified number of samples are captured, and the peak value is held (stored) for each frequency.

Appendix 3.2 "2-point Method" Scaling Equation

$$Y = \{ (SC_H - SC_L)/(V_H - V_L) \} X + \{ (V_H \times SC_L - V_L \times SC_H)/(V_H - V_L) \}$$

V_H : *Voltage high point* SC_H : *Scaling high point*

V_L : *Voltage low point* SC_L : *Scaling low point*

The ranges for the parts enclosed in dotted lines are as follows.

-9.9999E+9 ≦ { } value of enclosed part ≦ **-1.0000E-9**

{ } value of enclosed part = **0**

+1.0000E-9 ≦ { } value of enclosed part ≦ **+9.9999E+9**

- When a setting outside of the above range is attempted, a warning indication is given and the setting becomes "converted value" = "voltage value" (no scaling).
- For channels in which waveform processing result data are recorded, only the unit is valid (scaling is invalid).
- The scaling value is used for the gauge scale, upper and lower display limits, and for A/B cursor readings.

Appendix 3.3 Details on Operators

This section describes the operators used in waveform operation. The parameter "b_i" shows the operational result, and "d_i" shows the source channel, respectively, in which "i" indicates the serial number of data.

(1) The four arithmetical operations (+, −, ∗, ／)

According to the operators set, the four arithmetical operations are performed.

(2) Absolute value (ABS)

【 *Equation* 】

$b_i = | d_i |$ *(i = 1, 2, ... n)*

(3) Exponential (EXP)

【 *Equation* 】

$b_i = exp(d_i)$ *(i = 1, 2, ... n)*

(4) Common logarithm (LOG)

【 *Equation* 】

When $d_i > 0$, $b_i = log_{10} d_i$

When $d_i = 0$, $b_i = -\infty$ *(overflow value is output)*

When $d_i < 0$, $b_i = log_{10} | d_i |$ *(i = 1, 2, ... n)*

【*Reference*】 Use the following equation to convert to natural logarithm:

$LnX = logeX = log10X / log10e$

$1 / log10e \quad 2.33E + 0$

(5) Square root (SQR)

【 *Equation* 】

When $d_i \geqq 0$, $b_i = \sqrt{d_i}$

When $d_i < 0$, $b_i = -\sqrt{|d_i|}$ *(i = 1, 2, ... n)*

(6) Moving average (MOV)

【 *Equation* 】

$$b_i = 1/k \sum_{t=i-k/2}^{i+k/2} dt \quad (i = 1, 2, ... n)$$

dt : *t-th data of source channel*

k : *number of points for averaging (1 to 4000)*

【*Reference*】 1 DIV = 100 points

(7) Parallel displacement on time axis (SLI)

Shifts the value on the time axis by a certain number of points.

【 *Equation* 】

$b_i = d_{i-k}$ *(i = 1, 2, ... n)*

k : *number of points for averaging (-4000 to 4000)*

【*Reference*】 After shifting the waveform, the part right or left without source channel data becomes 0 V. 1 DIV = 100 points

(8) Differentiation once (DIF)

(9) Differentiation twice (DIF2)

・1st and 2nd differential are calculated using the 5th-order Lagrange interpolation equation, whereby data from a range of five surrounding points are used to determine the value of the current point.

・Data corresponding to sample time t_1 - t_n are taken as d_1 - d_n and used for calculating the differential.

【*Reference*】When the input voltage becomes small, processing results will show little variation. In such a case, apply the MOV operator.

【 *Equation for 1st differential* 】

$Point\ t_1\ b_1 = (-25d_1 +48d_2 -36d_3 +16d_4 -3d_5)/12h$
$Point\ t_2\ b_2 = (-3d_1 -10d_2 +18d_3 -6d_4 +d_5)/12h$
$Point\ t_3\ b_3 = (d_1 - 8d_2 + 8d_4 - d_5)/12h$
↓
$Point\ t_i\ b_i = (d_{i-2} -8d_{i-1} +8d_{i+1} -d_{i+2})/12h$
↓
$Point\ t_{n-2}\ b_{n-2} = (d_{n-4} -8d_{n-3} +8d_{n-1} -d_n)/12h$
$Point\ t_{n-1}\ b_{n-1} = (-d_{n-4} +6d_{n-3} -18d_{n-2} +10d_{n-1} +3d_n)/12h$
$Point\ t_n\ b_n = (3d_{n-4} -16d_{n-3} +36d_{n-2} -48d_{n-1} +25d_n)/12h$
b_1 *to* b_n : *data of calculation result*
$h = \Delta t$: *sampling period*

【 *Equation for 2st differential* 】

$Point\ t_1\ b_1 = (35d_1 -104d_2 +114d_3 -56d_4 +11d_5)/12h^2$
$Point\ t_2\ b_2 = (11d_1 -20d_2 +6d_3 +4d_4 -d_5)/12h^2$
$Point\ t_3\ b_3 = (-d_1 +16d_2 -30d_3 +16d_4 -d_5)/12h^2$
↓
$Point\ t_i\ b_i = (-d_{i-2} +16d_{i-1} -30d_i +16d_{i+1} -d_{i+2})/12h^2$
↓
$Point\ t_{n-2}\ b_{n-2} = (-d_{n-4} +16d_{n-3} -30d_{n-2} +16d_{n-1} -d_n)/12h^2$
$Point\ t_{n-1}\ b_{n-1} = (-d_{n-4} +4d_{n-3} +6d_{n-2} -20d_{n-1} +11d_n)/12h^2$
$Point\ t_n\ b_n = (11d_{n-4} -56d_{n-3} +114d_{n-2} -104d_{n-1} +35d_n)/12h^2$

(10) 1st integral (INT)

(11) 2nd integral (INT2)

・The 1st and 2nd integral calculation uses the trapezoidal rule.

・Data corresponding to sample time t_1 - t_n are taken as d_1 - d_n and used for calculating the integral.

【*Equation for 1st 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 : *processing result data*
$h = \Delta t$: *sampling period*

【*Equation for 2st integral*】

$Point\ t_1\ II_1 = 0$

$Point\ t_2\ II_2 = (I_1 + I_2)h/2$

$Point\ t_3\ II_3 = (I_1 + I_2)h/2 + (I_2 + I_3)h/2 = II_2 + (I_2 + I_3)h/2$

↓

$Point\ t_n\ II_n = II_{n-1} + (I_{n-1} + I_n)h/2$

II_1 *to* II_n : *processing result data*

(12) Sine (SIN)

【 *Equation* 】

$b_i = sin(d_i)\ (i = 1, 2, ... n)$

(13) Cosine (COS)

【 *Equation* 】

$b_i = cos(d_i)\ (i = 1, 2, ... n)$

(14) Tangent (TAN)

【 *Equation* 】

$b_i = tan(d_i)\ (i = 1, 2, ... n)$

$-10 \leqq b_i \leqq 10$

(15) Arc-sine (ASIN)

【 *Equation* 】

$b_i = \pi/2 \quad d_i > 1$

$b_i = asin(di) \quad -1 \leqq d_i \leqq 1$

$b_i = -\pi/2 \quad d_i < 1$

(16) Arc-cosine (ACOS)

【 *Equation* 】

$b_i = 0 \quad d_i > 1$

$b_i = acos(di) \quad -1 \leqq d_i \leqq 1$

$b_i = \pi \quad d_i < -1\ (i = 1, 2, ... n)$

(17) Arc-tangent (ATAN)

【 *Equation* 】

$b_i = atan(di)\ (i = 1, 2, ... n)$

【*Reference*】 The unit for the Trigonometric and inverse trigonometric functions (12) - (17) is rad (radian).

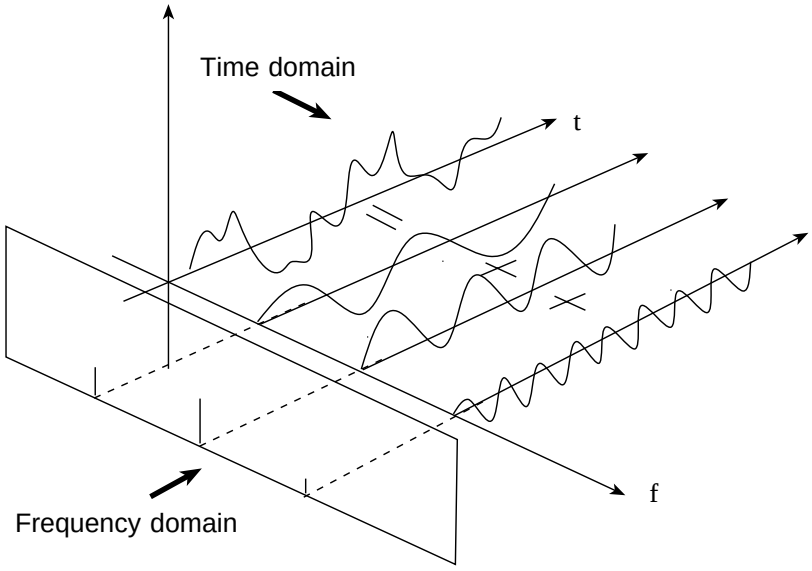
Appendix 3.4 FFT

FFT stands for Fast Fourier Transformation, which is a calculation method used to decompose a time-domain waveform into frequency components.
By performing FFT calculation, various calculations can be performed.

• Concept of time domain and frequency domain

The signals measured by this memory recorder have values which correspond to time, that is the signals are functions of time.

Waveform in the figure below is an example of such a signal.
Signals which are expressed as a function of time are called time domain signals.
In reality, a signal consists of a number of sine-waves of different frequencies, called frequency components, which combine to create the final shape of the waveform. Expressing waveform the source signal, as a function of its frequency components yields a frequency domain representation.
Often, the characteristics of a signal which cannot be easily analyzed in the time domain, can be clearly revealed by the frequency domain representation.



• Fourier transformation and the Inverse Fourier transformation

The following equations define the Fourier transformation and the Inverse Fourier transformation.

$$F(\omega) = \Im[f(t)] = \int_{-\infty}^{+\infty} f(t) \cdot \exp(-j\omega t)dt \qquad ②$$

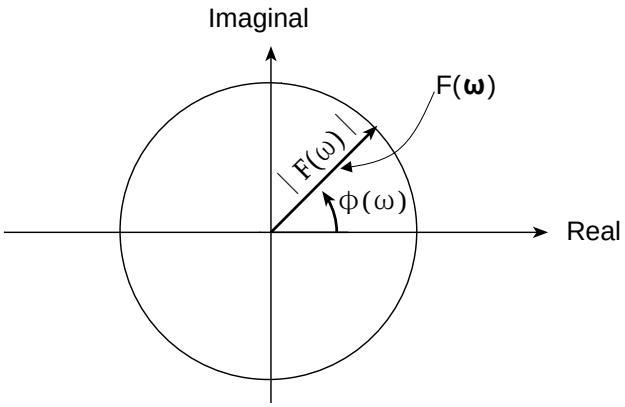
$$f(t) = \Im^{-1}[F(\omega)] = \frac{1}{2\pi}\int_{-\infty}^{+\infty} F(\omega) \cdot \exp(j\omega t)d\omega \qquad ③$$

The function $F(\omega)$generally results in a complex number, and can be expressed as follows.

$$F(\omega) = |F(\omega)| \cdot \exp(j\phi(\omega)) = |F(\omega)|\angle\phi(\omega) \qquad ④$$

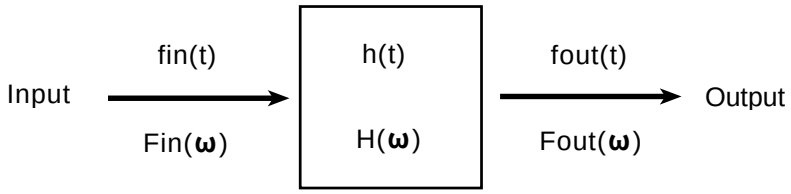
$|F(\omega)|$: Absolute value spectrum of f(t)
$\phi(\omega)$: Unit spectrum of the phase of f(t)

When conversion is made from the time domain to the frequency domain, the magnitude information and phase information are clearly expressed as indicated in equation (④). The figure below shows $F(\omega)$ in vector form.



• Application of Fourier transform (transfer function, unit-impulse response)

As an application of Fourier transform, this section describes a steady-state response in a static linear system.



Stationary Linear System

fin(t): time function of input (source signal)
fout(t): time function of output (response function)
h(t): unit impulse response of linear system
t , τ : time

$$fout(t) = \int_{-\infty}^{\infty} fin(\tau) \cdot h(t-\tau) d\tau \quad ⑤$$

The relationship between the input and output is expressed as follows: This indicates that the response of the linear system can be determined just by knowing the unit impulse response h(t) of the system.

In the frequency domain, Fin(ω), Fout(ω), H(ω), and ω are defined as follows
Fin(ω): Fourier transformation of fin(t)
Fout(ω): Fourier transformation of fout(t)
H(ω): Fourier transformation of h(t)
ω: Angular frequency
Fout (ω) = Fin(ω)･H(ω) ⑥

Therefore, when fin(t) and fout(t) are measured, the system transfer function H (ω) and the unit impulse response h(t) can be obtained by performing an FFT operation and an inverse FFT operation.

• Aliasing

When the frequency of the signal to be measured approaches the sampling frequency, beyond a certain point the measured signal frequency will be lower than the actual signal frequency. In such a case, frequency components that do not exist will appear in the waveform along the frequency axis. This phenomenon is called aliasing, and it occurs if sampling is carried out at a frequency lower than the so-called Nyquist frequency determined by Nyquist's sampling theorem.

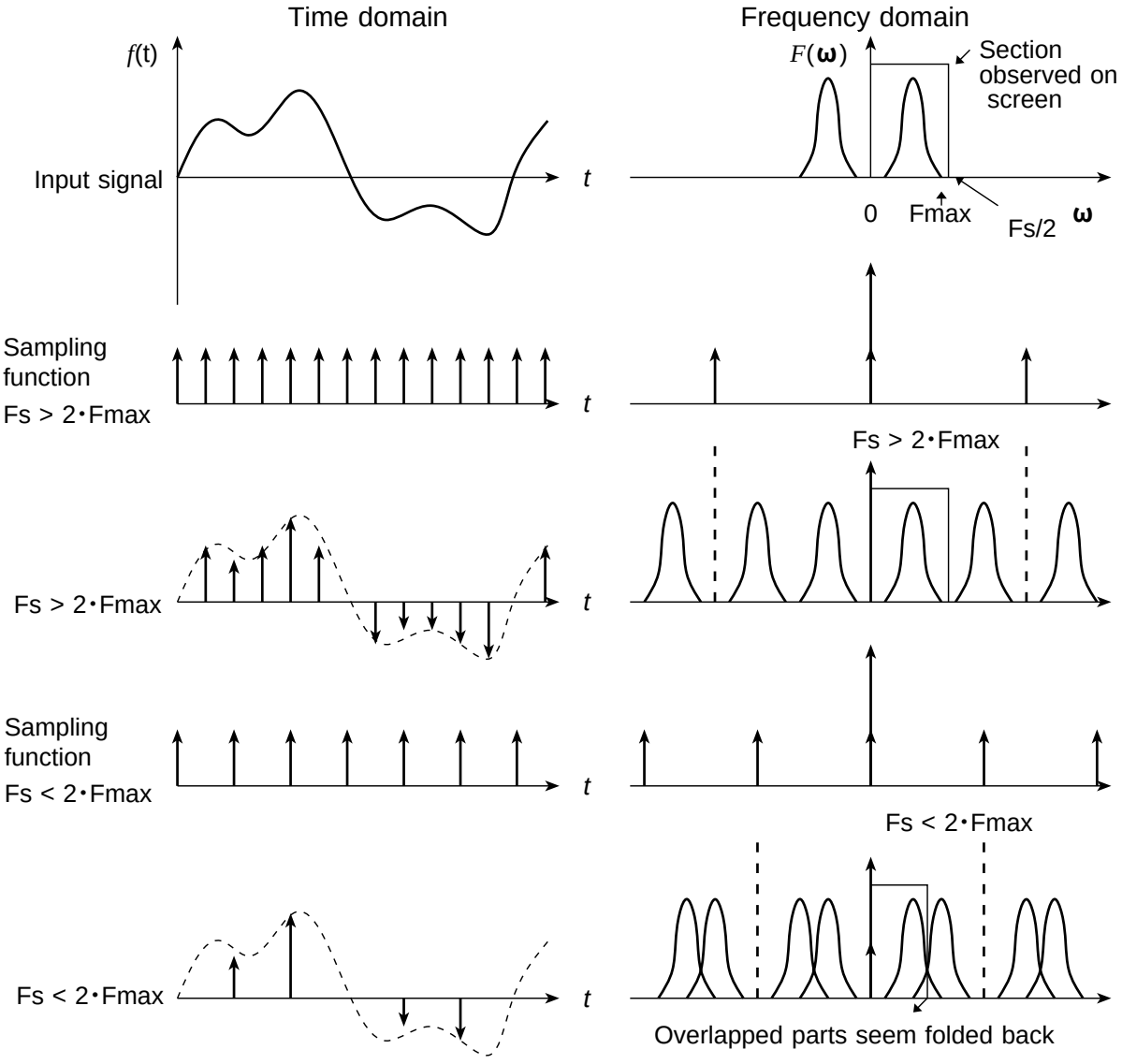
Sampling theorem

Fs = 2・Fmax ①

Fmax: Highest frequency component to be measured

Fs: Sampling frequency (Nyquist frequency)

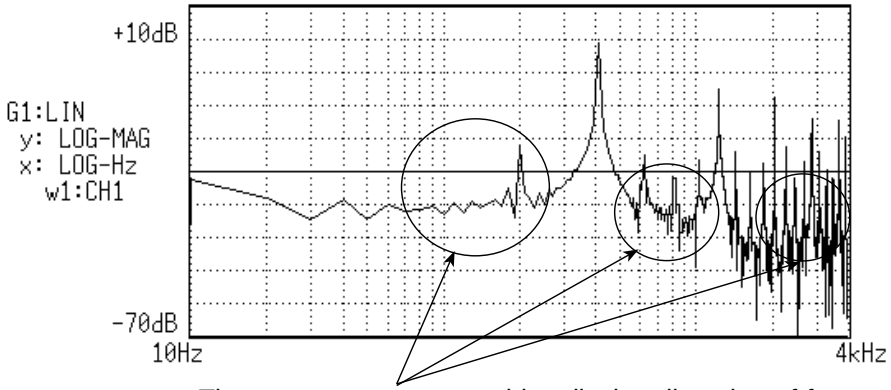
- In order to be able to restore the original waveform from the sampling data, the sampling frequency must be at least twice as high as the signal frequency.
- If sampling is carried out at a frequency lower than the Nyquist frequency, frequency components above 1/2 of the sampling frequency will be aliased to lower frequencies, and the measured signal will appear to contain frequency components that actually do not exist.



• Anti-aliasing filter (A.A. Filter)

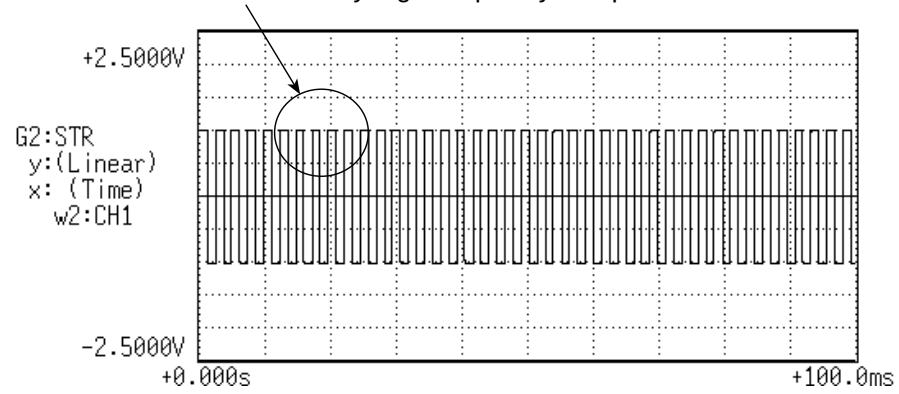
- If the input signal is regarded as having an unlimited bandwidth, aliasing distortion is an unavoidable consequence of sampling.
- For an FFT operation, a consequence of aliasing distortion is that a number of frequency spectra appear that do not actually exist in the original input signal.
- This problem can be solved by passing the input signal through a low-pass filter whose cut-off frequency is one-half the sampling frequency before sampling. This filter is referred to as an anti-aliasing filter.
- The 8938 FFT ANALOG UNIT available for the 8835-01 has such an anti-aliasing filter.

When an anti-aliasing filter is not used



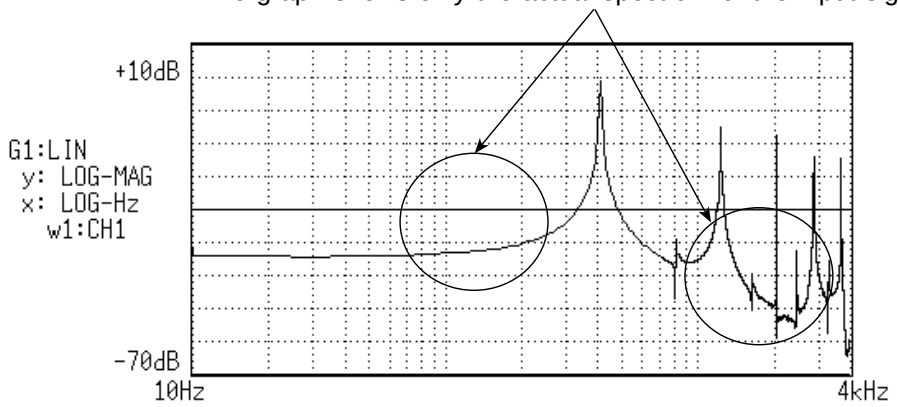
These spectra are caused by aliasing distortion of frequency components which are higher than half the sampling frequency of the A/D converter. They do not exist in the original input signal, yet they appear in the spectrum.

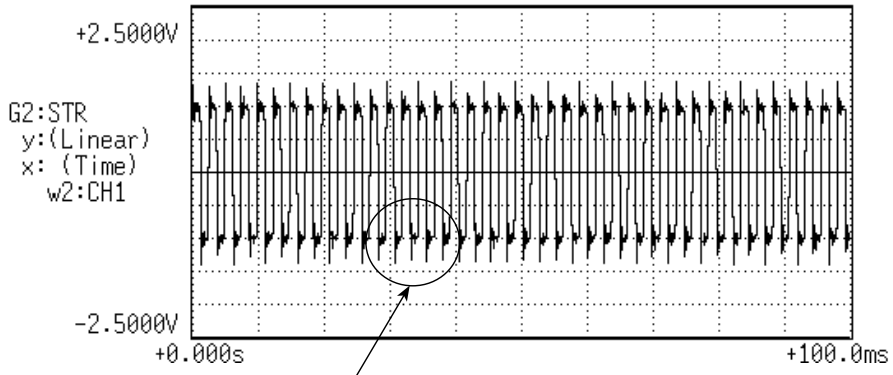
Since an anti-aliasing filter is not used for this square wave, a sharp edge is observed through a wide-band amplifier. The edge of the square wave contains very high-frequency components.



When an anti-aliasing filter is used

Spectra caused by aliasing distortion are clearly eliminated.
The graph shows only the actual spectrum of the input signal.



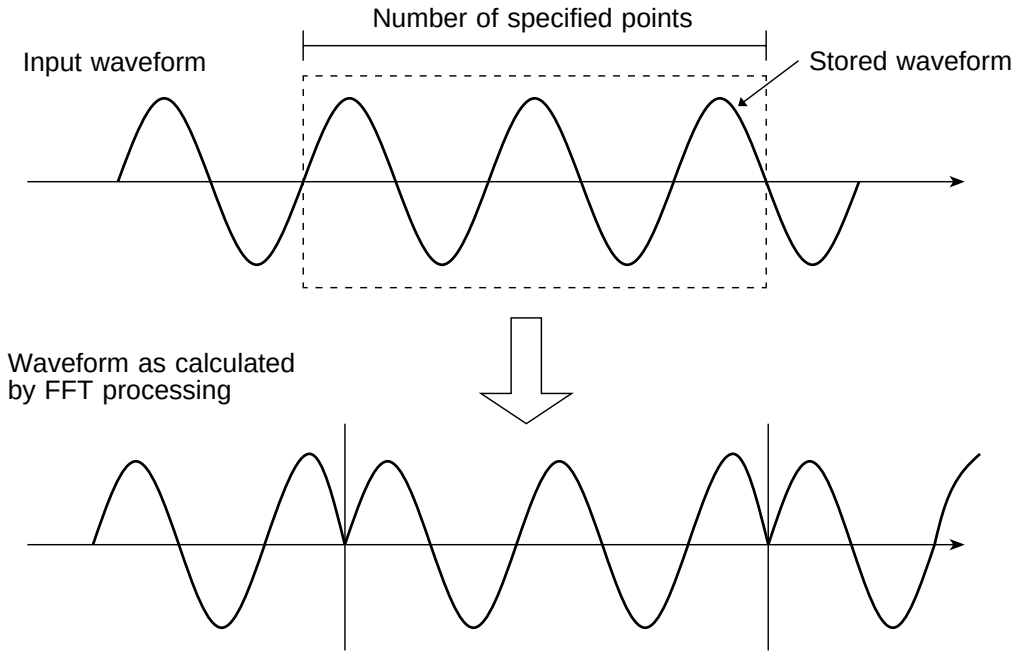


Due to the sharp cut-off characteristic of the anti-aliasing filter,
the edge of the square wave contains a ripple.

• Window processing

Fourier transform is defined as the integration from negative infinity to positive infinity, but in actual measurement this calculation is not possible. Therefore only a limited segment of the continuous signal is taken for processing. This is called window processing.

The FFT algorithm assumes that the data of that limited segment are repeated and defines the input signal using a periodic function for determining the frequency spectrum.
Depending on the phase at the start and end of the stored waveform, there may be a difference between the waveform as calculated by FFT processing and the actual input waveform.



Leakage error

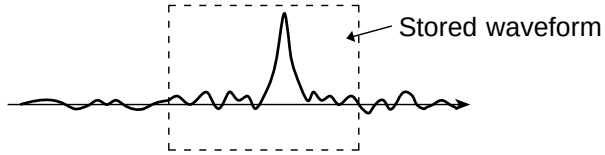
When the signal waveform as assumed by the FFT algorithm and the actual waveform are different, the processing result will contain an error. This error is called the leakage error.

Window function

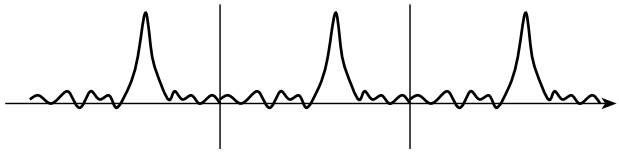
- When a limited segment of the input signal is captured, a function can be applied to reduce the leakage error.
- This function is called the window function.
- To minimize the leakage error, a suitable window should be chosen which matches the type of input signal.
- Possible window types include rectangular, Hanning, exponential, flat-top, minimum, force, etc. In the 8835-01, three window functions (rectangular, Hanning, exponential) are available.
- Generally, the rectangular window function is most useful for single waveforms, the Hanning window function for continuous waveforms, and the exponential window function for attenuated waveforms.

- **Rectangular window**

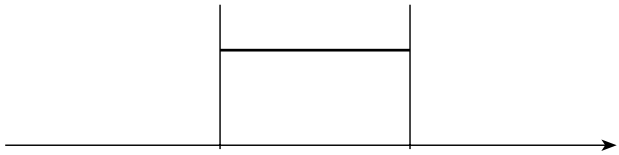
Input waveform



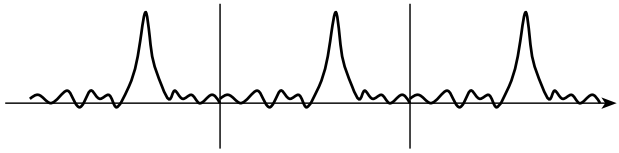
Waveform assumed by FFT processing



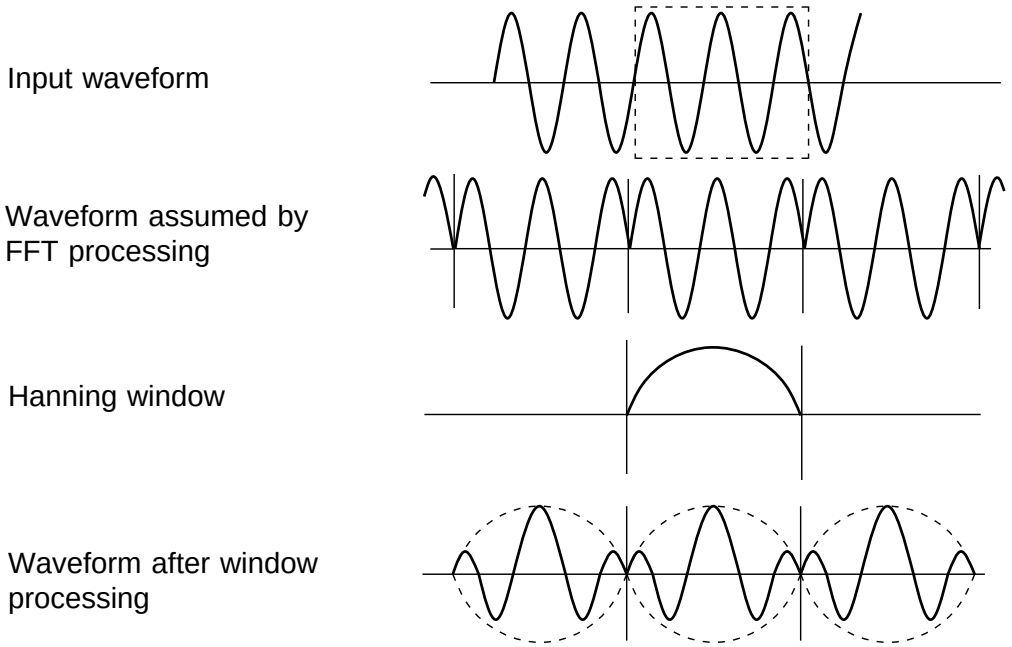
Rectangular window



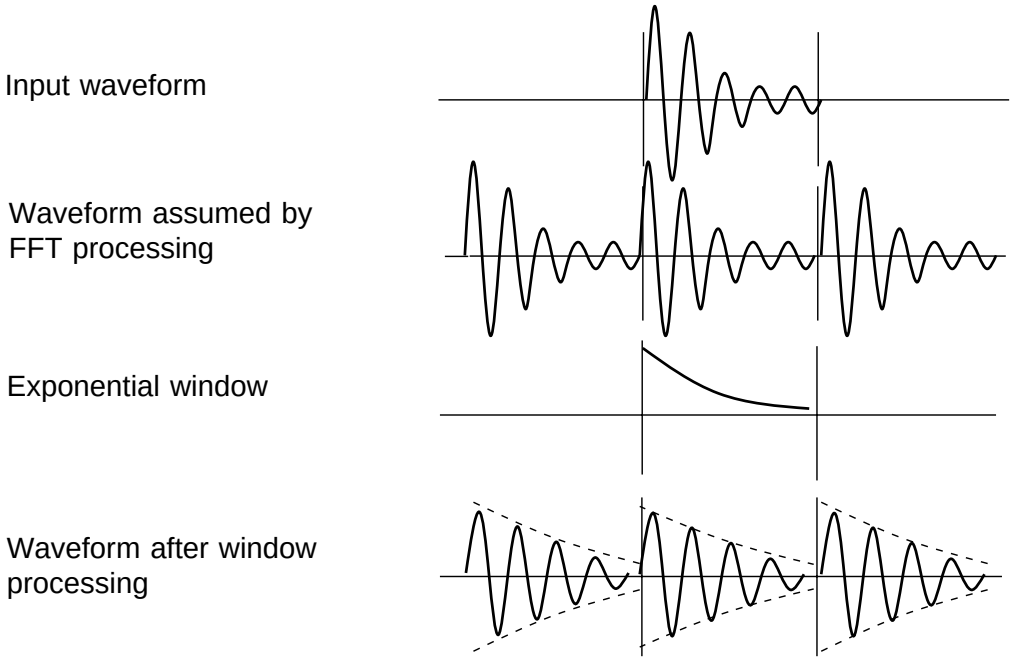
Waveform after window processing



- **Hanning window**



- **Exponential window**



Appendix 4 Size of a Waveform File

Appendix 4.1 Binary Data

・Recording length is the number of division.
・Truncates the decimal portion of the quotient of division.

In the memory recorder and recorder & memory functions (∗.MEM)

File size = header size + data size
Header size = 512 × (6 + number of saved anolog channels + number of saved logic probes)
Data size = (2 × number of saved anolog channels + (number of saved logic probes + 1) /2) × (recording length × 100 + 1)

	Number of saved logic probes				
	0				
	Number of saved analog channels				
Recording length	0	1	2	4	8
20		7,586	12,100	21,128	39,184
50		13,586	24,100	45,128	87,184
100		23,586	44,100	85,128	167,184
200		43,586	84,100	165,128	327,184
500		103,586	204,100	405,128	807,184
1000		203,586	404,100	805,128	1,607,184
2000		403,586	804,100	1,605,128	3,207,184
5000		1,003,586	2,004,100	4,005,128	8,007,184
10000		2,003,586	4,004,100	8,005,128	
20000		4,003,586	8,004,100		
40000		8,003,586			

	Number of saved logic probes				
	1				
	Number of saved analog channels				
Recording length	0	1	2	4	8
20	5,585	10,099	14,613	23,641	41,697
50	8,585	19,099	29,613	50,641	92,697
100	13,585	34,099	54,613	95,641	177,697
200	23,585	64,099	104,613	185,641	347,697
500	53,585	154,099	254,613	455,641	857,697
1000	103,585	304,099	504,613	905,641	1,707,697
2000	203,585	604,099	1,004,613	1,805,641	3,407,697
5000	503,585	1,504,099	2,504,613	4,505,641	8,507,697
10000	1,003,585	3,004,099	5,004,613	9,005,641	
20000	2,003,585	6,004,099	10,004,613		
40000	4,003,585	12,004,099			

	Number of saved logic probes				
	2				
	Number of saved analog channels				
Recording length	0	1	2	4	8
20	6,097	10,611	15,125	24,153	42,209
50	9,097	19,611	30,125	51,153	93,209
100	14,097	34,611	55,125	96,153	178,209
200	24,097	64,611	105,125	186,153	348,209
500	54,097	154,611	255,125	456,153	858,209
1000	104,097	304,611	505,125	906,153	1,708,209
2000	204,097	604,611	1,005,125	1,806,153	3,408,209
5000	504,097	1,504,611	2,505,125	4,506,153	8,508,209
10000	1,004,097	3,004,611	5,005,125	9,006,153	
20000	2,004,097	6,004,611	10,005,125		
40000	4,004,097	12,004,611			

	Number of saved logic probes				
	3				
	Number of saved analog channels				
Recording length	0	1	2	4	8
20	8,610	13,124	17,638	26,666	44,722
50	14,610	25,124	35,638	56,666	98,722
100	24,610	45,124	65,638	106,666	188,722
200	44,610	85,124	125,638	206,666	368,722
500	104,610	205,124	305,638	506,666	908,722
1000	204,610	405,124	605,638	1,006,666	1,808,722
2000	404,610	805,124	1,205,638	2,006,666	3,608,722
5000	1,004,610	2,005,124	3,005,638	5,006,666	9,008,722
10000	2,004,610	4,005,124	6,005,638	10,006,666	
20000	4,004,610	8,005,124	12,005,638		
40000	8,004,610	16,005,124			

	Number of saved logic probes				
	4				
	Number of saved analog channels				
Recording length	0	1	2	4	8
20	9,122	13,636	18,150	27,178	45,234
50	15,122	25,636	36,150	57,178	99,234
100	25,122	45,636	66,150	107,178	189,234
200	45,122	85,636	126,150	207,178	369,234
500	105,122	205,636	306,150	507,178	909,234
1000	205,122	405,636	606,150	1,007,178	1,809,234
2000	405,122	805,636	1,206,150	2,007,178	3,609,234
5000	1,005,122	2,005,636	3,006,150	5,007,178	9,009,234
10000	2,005,122	4,005,636	6,006,150	10,007,178	
20000	4,005,122	8,005,636	12,006,150		
40000	8,005,122	16,005,636			

NOTE Four logic channels are assigned to each unit (Unit: byte).

In the recorder, RMS recorder and recorder & memory functions (∗.REC, ∗.RMS)

File size = header size + data size

Header size = 512 × (6 + number of saved anolog channels + number of saved logic probes)

Data size = (4 × number of saved anolog channels + number of saved logic probes) × (recording length × 100 + 1)

	Number of saved logic probes				
	0				
	Number of saved analog channels				
Recording length	0	1	2	4	8
20		11,588	20,104	37,136	71,200
50		23,588	44,104	85,136	167,200
100		43,588	84,104	165,136	327,200
200		83,588	164,104	325,136	647,200
500		203,588	404,104	805,136	1,607,200
1000		403,588	804,104	1,605,136	3,207,200
2000		803,588	1,604,104	3,205,136	6,407,200

	Number of saved logic probes				
	1				
	Number of saved analog channels				
Recording length	0	1	2	3	4
20	5,585	14,101	22,617	39,649	73,713
50	8,585	29,101	49,617	90,649	172,713
100	13,585	54,101	94,617	175,649	337,713
200	23,585	104,101	184,617	345,649	667,713
500	53,585	254,101	454,617	855,649	1,657,713
1000	103,585	504,101	904,617	1,705,649	3,307,713
2000	203,585	1,004,101	1,804,617	3,405,649	6,607,713

	Number of saved logic probes				
	2				
	Number of saved analog channels				
Recording length	0	1	2	3	4
20	8,098	16,614	25,130	42,162	76,226
50	14,098	34,614	55,130	96,162	178,226
100	24,098	64,614	105,130	186,162	348,226
200	44,098	124,614	205,130	366,162	688,226
500	104,098	304,614	505,130	906,162	1,708,226
1000	204,098	604,614	1,005,130	1,806,162	3,408,226
2000	404,098	1,204,614	2,005,130	3,606,162	6,808,226

	Number of saved logic probes				
	3				
	Number of saved analog channels				
Recording length	0	1	2	3	4
20	10,611	19,127	27,643	44,675	78,739
50	19,611	40,127	60,643	101,675	183,739
100	34,611	75,127	115,643	196,675	358,739
200	64,611	145,127	225,643	386,675	708,739
500	154,611	355,127	555,643	956,675	1,758,739
1000	304,611	705,127	1,105,643	1,906,675	3,508,739
2000	604,611	1,405,127	2,205,643	3,806,675	7,008,739

	Number of saved logic probes				
	4				
	Number of saved analog channels				
Recording length	0	1	2	3	4
20	13,124	21,640	30,156	47,188	81,252
50	25,124	45,640	66,156	107,188	189,252
100	45,124	85,640	126,156	207,188	369,252
200	85,124	165,640	246,156	407,188	729,252
500	205,124	405,640	606,156	1,007,188	1,809,252
1000	405,124	805,640	1,206,156	2,007,188	3,609,252
2000	805,124	1,605,640	2,406,156	4,007,188	7,209,252

NOTE Four logic channels are assigned to each unit (Unit: byte).

In the FFT function (∗.FFT)

Number of points	Averaging OFF		Averaging ON	
	1 ch FFT	2 ch FFT	1 ch FFT	2 ch FFT
1000	14,096	24,608	16,100	38,620
2000	24,096	44,608	28,100	72,620
5000	54,096	104,608	64,100	174,620
10000	104,096	204,608	124,100	344,620

Appendix 4.2 Text File

・Recording length is the number of division.
・Truncates the decimal portion of the quotient of division.

In the memory recorder and recorder & memory functions (∗.TXT) (Reference values)

File size = header size + data size
Header size = 170 + 27 × saved anolog channels + 64 × number of saved logic probes
Data size = (14 + 13 × saved anolog channels + 9 × number of saved logic probes) × (recording length × 100 + 1)

	Number of saved logic probes				
	0				
	Number of saved analog channels				
Recording length	0	1	2	4	8
20		58,226	84,266	136,346	240,506
50		145,226	210,266	340,346	600,506
100		290,226	420,266	680,346	1,200,506
200		580,226	840,266	1,360,346	2,400,506
500		1,450,226	2,100,266	3,400,346	6,000,506
1000		2,900,226	4,200,266	6,800,346	12,000,506
2000		5,800,226	8,400,266	13,600,346	24,000,506
5000		14,500,226	21,000,266	34,000,346	60,000,506
10000		29,000,226	42,000,266	68,000,346	
20000		58,000,226	84,000,266		
40000		116,000,226			

	Number of saved logic probes				
	1				
	Number of saved analog channels				
Recording length	0	1	2	4	8
20	50,259	76,299	102,339	154,419	258,579
50	125,259	190,299	255,339	385,419	645,579
100	250,259	380,299	510,339	770,419	1,290,579
200	500,259	760,299	1,020,339	1,540,419	2,580,579
500	1,250,259	1,900,299	2,550,339	3,850,419	6,450,579
1000	2,500,259	3,800,299	5,100,339	7,700,419	12,900,579
2000	5,000,259	7,600,299	10,200,339	15,400,419	25,800,579
5000	12,500,259	19,000,299	25,500,339	38,500,419	64,500,579
10000	25,000,259	38,000,299	51,000,339	77,000,419	
20000	50,000,259	76,000,299	102,000,339		
40000	100,000,259	152,000,299			

	Number of saved logic probes				
	2				
	Number of saved analog channels				
Recording length	0	1	2	4	8
20	68,332	94,372	120,412	172,492	276,652
50	170,332	235,372	300,412	430,492	690,652
100	340,332	470,372	600,412	860,492	1,380,652
200	680,332	940,372	1,200,412	1,720,492	2,760,652
500	1,700,332	2,350,372	3,000,412	4,300,492	6,900,652
1000	3,400,332	4,700,372	6,000,412	8,600,492	13,800,652
2000	6,800,332	9,400,372	12,000,412	17,200,492	27,600,652
5000	17,000,332	23,500,372	30,000,412	43,000,492	69,000,652
10000	34,000,332	47,000,372	60,000,412	86,000,492	
20000	68,000,332	94,000,372	120,000,412		
40000	136,000,332	188,000,372			

	Number of saved logic probes				
	3				
	Number of saved analog channels				
Recording length	0	1	2	4	8
20	86,405	112,445	138,485	190,565	294,725
50	215,405	280,445	345,485	475,565	735,725
100	430,405	560,445	690,485	950,565	1,470,725
200	860,405	1,120,445	1,380,485	1,900,565	2,940,725
500	2,150,405	2,800,445	3,450,485	4,750,565	7,350,725
1000	4,300,405	5,600,445	6,900,485	9,500,565	14,700,725
2000	8,600,405	11,200,445	13,800,485	19,000,565	29,400,725
5000	21,500,405	28,000,445	34,500,485	47,500,565	73,500,725
10000	43,000,405	56,000,445	69,000,485	95,000,565	
20000	86,000,405	112,000,445	138,000,485		
40000	172,000,405	224,000,445			

	Number of saved logic probes				
	4				
	Number of saved analog channels				
Recording length	0	1	2	4	8
20	104,478	130,518	156,558	208,638	312,798
50	260,478	325,518	390,558	520,638	780,798
100	520,478	650,518	780,558	1,040,638	1,560,798
200	1,040,478	1,300,518	1,560,558	2,080,638	3,120,798
500	2,600,478	3,250,518	3,900,558	5,200,638	7,800,798
1000	5,200,478	6,500,518	7,800,558	10,400,638	15,600,798
2000	10,400,478	13,000,518	15,600,558	20,800,638	31,200,798
5000	26,000,478	32,500,518	39,000,558	52,000,638	78,000,798
10000	52,000,478	65,000,518	78,000,558	104,000,638	
20000	104,000,478	130,000,518	156,000,558		
40000	208,000,478	260,000,518			

NOTE Four logic channels are assigned to each unit (Unit: byte).

In the recorder, RMS recorder and recorder & memory functions (∗.TXT) (Reference values)

File size = header size + data size
Header size = 170 + 64 × number of saved anolog channels + 165 × number of saved logic probes
Data size = (14 + 26 × number of saved anolog channels + 18 × number of saved logic probes) × (recording length × 100 + 1)

	Number of saved logic probes				
	0				
	Number of saved analog channels				
Recording length	0	1	2	4	8
20		84,276	136,366	240,546	448,906
50		210,276	340,366	600,546	1,120,906
100		420,276	680,366	1,200,546	2,240,906
200		840,276	1,360,366	2,400,546	4,480,906
500		2,100,276	3,400,366	6,000,546	11,200,906
1000		4,200,276	6,800,366	12,000,546	22,400,906
2000		8,400,276	13,600,366	24,000,546	44,800,906

	Number of saved logic probes				
	1				
	Number of saved analog channels				
Recording length	0	1	2	4	8
20	68,369	120,459	172,549	276,729	485,089
50	170,369	300,459	430,549	690,729	1,211,089
100	340,369	600,459	860,549	1,380,729	2,421,089
200	680,369	1,200,459	1,720,549	2,760,729	4,841,089
500	1,700,369	3,000,459	4,300,549	6,900,729	12,101,089
1000	3,400,369	6,000,459	8,600,549	13,800,729	24,201,089
2000	6,800,369	12,000,459	17,200,549	27,600,729	48,401,089

	Number of saved logic probes				
	2				
	Number of saved analog channels				
Recording length	0	1	2	4	8
20	104,552	156,642	208,732	312,912	521,272
50	260,552	390,642	520,732	780,912	1,301,272
100	520,552	780,642	1,040,732	1,560,912	2,601,272
200	1,040,552	1,560,642	2,080,732	3,120,912	5,201,272
500	2,600,552	3,900,642	5,200,732	7,800,912	13,001,272
1000	5,200,552	7,800,642	10,400,732	15,600,912	26,001,272
2000	10,400,552	15,600,642	20,800,732	31,200,912	52,001,272

	Number of saved logic probes				
	3				
	Number of saved analog channels				
Recording length	0	1	2	4	8
20	140,735	192,825	244,915	349,095	557,455
50	350,735	480,825	610,915	871,095	1,391,455
100	700,735	960,825	1,220,915	1,741,095	2,781,455
200	1,400,735	1,920,825	2,440,915	3,481,095	5,561,455
500	3,500,735	4,800,825	6,100,915	8,701,095	13,901,455
1000	7,000,735	9,600,825	12,200,915	17,401,095	27,801,455
2000	14,000,735	19,200,825	24,400,915	34,801,095	55,601,455

	Number of saved logic probes				
	4				
	Number of saved analog channels				
Recording length	0	1	2	4	8
20	176,918	229,008	281,098	385,278	593,638
50	440,918	571,008	701,098	951,278	1,481,638
100	880,918	1,141,008	1,401,098	1,921,278	2,961,638
200	1,760,918	2,281,008	2,801,098	3,841,278	5,921,638
500	4,400,918	5,701,008	7,001,098	9,601,278	14,801,638
1000	8,800,918	11,401,008	14,001,098	19,201,278	29,601,638
2000	17,600,918	22,801,008	28,001,098	38,401,278	59,201,638

NOTE

Four logic channels are assigned to each unit (Unit: byte).

In the FFT function (∗.TXT) (Reference values)

Number of points	Analysis mode			
	STR, ACR, CCR, IMP	LIN, RMS, PSP, HIS, TRF, CSP, CHO	OCT (1/1)	OCT (1/3)
1000	27,190	11,017	320	580
2000	54,190	21,817		
5000	135,190	54,217		
10000	270,190	108,217		

The size in case of one screen. In the case of two screens, add the respective graph sizes.

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HIOKI 9540-01 FUNCTION UP DISK

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