SL1400
ScopeCorder LITE
USER'S MANUAL

YOKOGAWA
Yokogawa Electric Corporation

IM 701240-01E
2nd Edition

Product Registration

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Thank you for purchasing the SL1400 ScopeCorder LITE.
This user's manual contains useful information about the instrument's functions and operating procedures and lists the handling precautions of the SL1400. To ensure correct use, please read this manual thoroughly before operation. After reading the manual, keep it in a convenient location for quick reference whenever a question arises during operation.
The following manuals are provided for the SL1400. Please read all of them.

Manual Title	Manual No.	Description
SL1400 ScopeCorder LITE User's Manual	IM 701240-01E	This manual. Explains all functions and procedures of the SL1400 excluding the communication functions.
SL1400 ScopeCorder LITE Communication Interface User's Manual (CD-ROM)	IM 701240-17E	Describes the communication interface functions.

Notes

- The contents of this manual are subject to change without prior notice as a result of continuing improvements to the instrument's performance and functions. The figures given in this manual may differ from those that actually appear on your screen.
- Every effort has been made in the preparation of this manual to ensure the accuracy of its contents. However, should you have any questions or find any errors, please contact your nearest YOKOGAWA dealer.
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- The TCP/IP software of this product and the document concerning the TCP/IP software have been developed/created by YOKOGAWA based on the BSD Networking Software, Release 1 that has been licensed from University of California.

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Revisions

- 1st Edition: June 2006
- 2nd Edition: October 2006

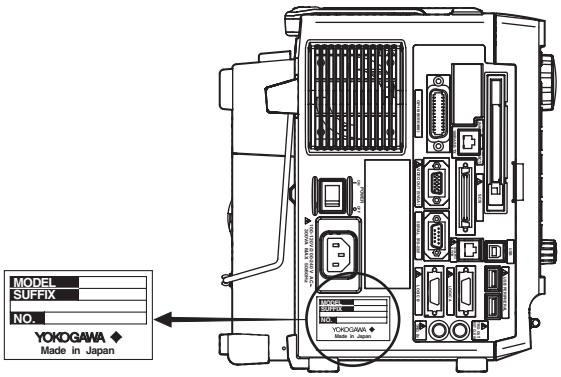
2nd Edition : October 2006(YK)

Checking the Contents of the Package

Unpack the box and check the contents before operating the instrument. If some of the contents are not correct, or if any items are missing or damaged, contact the dealer from whom you purchased them.

SL1400

Check that the model name and suffix code given on the name plate on the left side panel of the SL1400 match those on your order. When contacting the dealer from which you purchased the instrument, please give them the instrument number.



MODEL	Suffix Code	Description
701240 (SL1400)		The input module is not included with the instrument. See the next page for information on the input module.
Power cord	-D	UL/CSA Standard power cord (Part No.:A1006WD) [Maximum rated voltage: 125 V; Maximum rated current: 7 A]
	-F	VDE Standard Power Cord (Part No.: A1009WD) [Maximum rated voltage: 250 V; Maximum rated current: 10 A]
	-Q	BS Standard Power Cord (Part No.: A1054WD) [Maximum rated voltage: 250 V; Maximum rated current: 10 A]
	-R	AS Standard Power Cord (Part No.: A1024WD) [Maximum rated voltage: 250 V; Maximum rated current: 10 A]
	-H	GB Standard Power Cord (Part No.: A1064WD) [Maximum rated voltage: 250 V; Maximum rated current: 10 A]
Default language	-HE	English
	-HJ	Japanese
	-HC	Chinese
	-HK	Korean
	-HG	German
	-HF	French
	-HL	Italian
	-HP	Spanish
Built-in media drive	-J0	No built-in media drive
	-J3	PC card drive
Options	/C8	Internal hard disk 40 GB (FAT32)
	/C10	Ethernet interface
	/P4	Four probe power outputs

NO. (Instrument Number)

When contacting the dealer from which you purchased the instrument, please give them this number.

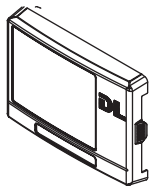
Standard Accessories

The standard accessories below are supplied with the instrument. Check that all contents are present and undamaged.

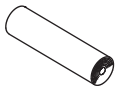
Power Cord (one of the following power cords is supplied according to the instrument's suffix codes)

UL/CSA Standard A1006WD — **D**
VDE Standard A1009WD — **F**
BS Standard A1054WD — **Q**
AS Standard A1024WD — **R**
GB Standard A1064WD — **H**

Front panel protection cover (transparent) B8023EA



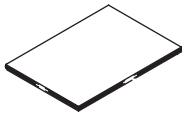
Printer roll paper 701966 1 roll



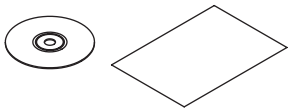
Roll paper flange B8024CA 2 pieces

AAA Alkaline batteries (for acquisition memory backup) A1070EB 4 cells

- **User's Manual**



- **Communication Interface User's Manual (CD-ROM) B8024YY**
- **Handling of the CD-ROM**



Cover panels B8023EN 8 pieces

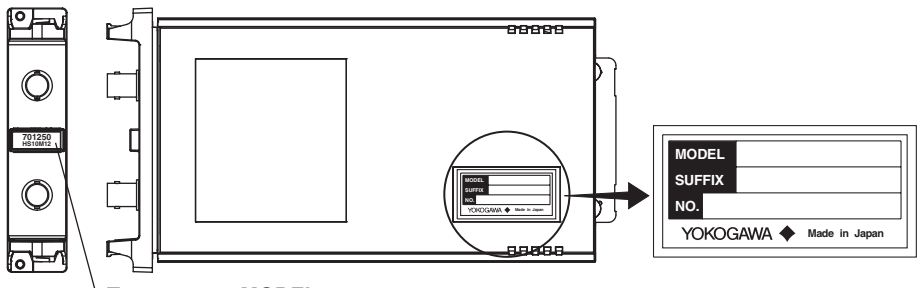
Rubber feet B9989EX 4 pieces (1 sheet)

Soft case B9946EB

Input Modules (Sold Separately)

Check that the MODEL indicated on the input module is what you ordered.

MODEL	Name	Abbreviation
701250	High-Speed 10 MS/s, 12-Bit Isolation Module	HS10M12
701251	High-Speed High-Resolution 1 MS/s, 16-Bit Isolation Module	HS1M16
701255	High-Speed 10 MS/s, 12-Bit Non-Isolation Module	NONISO_10M12
701260	High-Voltage 100 kS/s, 16-Bit Isolation Module (with RMS)	HV (with RMS)
701261	Universal (Voltage/Temp.) Module	UNIVERSAL
701262	Universal (Voltage/Temp.) Module (with AAF)	UNIVERSAL (AAF)
701265	Temperature, High Precision Voltage Isolation Module	TEMP/HPV
701270	Strain Module (NDIS)	STRAIN_NDIS
701271	Strain Module (DSUB, Shunt-Cal)	STRAIN_DSUB
701275	Acceleration/Voltage Module (with AAF)	ACCL/VOLT
701280	Frequency Module	FREQ



Top row: MODEL
Bottom row: Abbreviated name

This user's manual refers to the input modules by MODEL (abbreviation).
For example, the High-Speed 10 MS/s, 12-Bit Isolation Module is indicated as 701250 (HS10M12). However, the module may be indicated only by the model (701250) if a description about the same module is given immediately before it.

Optional Accessories (Sold Separately)

The optional accessories below are available for purchase separately. Check that all contents are present and undamaged. For information and ordering, contact your nearest YOKOGAWA dealer.

	Name	Model	Safety standard*1	Description
1.	Isolated probe	700929	1000 Vrms CAT II	10:1 safety probe, for the 701250/701251
2.	Current probe	701930	300 Vrms CAT III	DC to 10 MHz bandwidth. Used by connecting to the probe power terminal
3.	Current probe	701931	300 Vrms CAT III	DC to 2 MHz bandwidth. Used by connecting to the probe power terminal
4.	Current probe	701933	300 Vrms CAT I	DC to 50 MHz bandwidth. Used by connecting to the probe power terminal
5.	Differential probe	700924	1000 Vrms CAT III*2	Switchable between 1000:1 and 100:1Measurable voltage: 1400 Vpeak (1000 Vrms)
6.	10:1 passive probe	701940	–	For non-isolated input on the 701255: 600 V or less For isolated input other than above: 42 V or less
7.	1:1 BNC safety adapter lead	701901	1000 Vrms CATII	Used with the 701954, 701959, 758922, 758929, or 758921 sold separately
8.	Alligator clip (dolphin type)	701954	1000 Vrms CAT III	2 pieces in one set (red/black)
9.	Safety mini-clip (hook type)	701959	1000 Vrms CAT II	2 pieces in one set (red/black)
10.	Alligator clip adapter	758922	300 Vrms CAT II	2 pieces in one set
11.	Alligator clip adapter	758929	1000 Vrms CAT II	2 pieces in one set
12.	Fork terminal adapter	758921	1000 Vrms CAT II	2 pieces in one set (red/black), for 4-mm screws
13.	Cables*3	366926	–	For measuring low voltage of less than or equal to 42 V
14.	Banana-alligator clip cable	366961	–	For measuring low voltage of less than or equal to 42 V for the 701261, 701262, or 701265
15.	High-speed logic probe	700986	–	42 V or less, 8-bit non-isolated/response speed of 1 μs
16.	Isolated logic probe	700987	250 Vrms CAT II	8 bits, each channel isolated, response speed of 20 ms (for AC)
17.	Measurement lead for isolated logic	758917	1000 Vrms CAT II	2 pieces in one set, used with the 758922 or 758929 adapter sold separately
18.	Logic probe	702911	–	35 V or less, 8-bit non-isolated, response speed 3 μs, (lead length: 1 m)
		702912	–	35 V or less, 8-bit non-isolated, response speed 3 μs, (lead length: 3 m)
19.	Conversion adapter	366928	–	42 V or less, BNC (jack) to RCA (plug)
20.	Modular cable	366973	–	For external start/stop
21.	Safety BNC cable (1 m)	701902	1000 Vrms CAT II	–
22.	Safety BNC cable (2 m)	701903	1000 Vrms CAT II	–
23.	Safety BNC-to-banana adapter	758924	500 Vrms CAT II	–
24.	Bridge head	701955	–	NDIS, bridge resistance: 120 Ω
		701956	–	NDIS, bridge resistance: 350 W
		701957	–	DSUB, bridge resistance: 120 W, shunt-cal support
		701958	–	DSUB, bridge resistance: 350 Ω, shunt-cal support
25.	Soft carrying case	701967	–	With three pockets

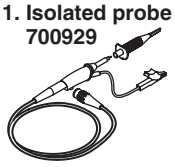
Sold in units of 1 piece.

*1 The actual voltage that can be used is the lower voltage of the specifications of the SL1400 and the cable.

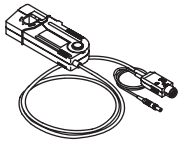
*2 Be sure to connect the GND lead provided with the 700924 to the functional ground terminal of the SL1400. A measurement of 1400 Vpeak is possible by connecting the GND lead to the SL1400.

*3 Use cables (366926) that YOKOGAWA has been shipping since February 4, 1998. Cables (366926) shipped before this date cannot be used in combination with the SL1400 input modules.

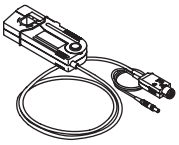
1. Isolated probe
700929



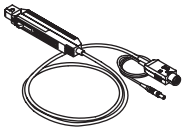
2. Current probe
701930



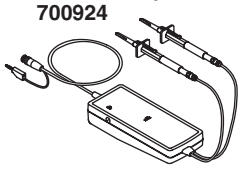
3. Current probe
701931



4. Current probe
701933

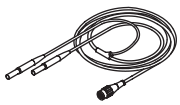


5. Differential probe
700924



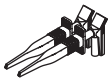
6. 10:1 passive probe
701940

7. 1:1 BNC safety adapter lead
701901*

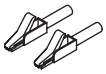


8. Alligator clip (dolphin type)
701954

9. Safety mini-clip (hook type)
701959



10. Alligator clip adapter (Rated voltage 300 V)
758922

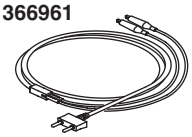


11. Alligator clip adapter (Rated voltage 1000 V)
758929

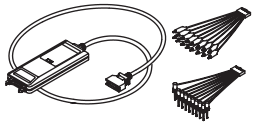
12. Fork terminal adapter
758921

13. Cable
366926

14. Banana-alligator clip cable
366961

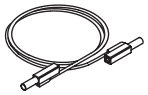


15. High-speed logic probe
700986

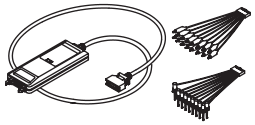


16. Isolated logic probe
700987

17. Measurement lead for isolated logic
758917*

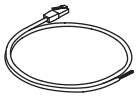


18. Logic probe
702911 (1 m)/702912 (3 m)



19. Conversion adapter
366928

20. GO/NO-GO cable
366973

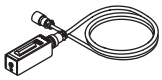


21. Safety BNC cable (1m) 701902

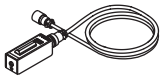
22. Safety BNC cable (2m) 701903

23. Safety BNC-to-banana adapter
758924

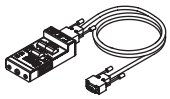
24. Bridge head
701955(NDIS, 120Ω)



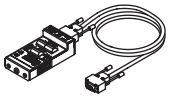
Bridge head
701956(NDIS, 350Ω)



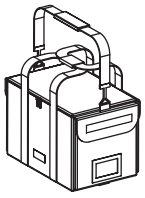
Bridge head
701957(DSUB, 120Ω)



Bridge head
701958(DSUB, 350Ω)



25. Soft carrying case
701967



* The 1:1 BNC safety adapter lead (701901) is used by combining the following accessories sold separately: alligator clip (dolphin type 701954), safety mini-clip (hook type: 701959), alligator adapter (758922 or 758929), and/or the fork terminal adapter (758921).

Spare Parts (Sold Separately)

The spare parts below are available for purchase separately. Check that all contents are present and undamaged.

For information about the spare parts and ordering, contact your dealer.

Name	Part No.	Minimum Q'ty	Note
Printer roll paper	701966	6	Thermal paper, 210mm × 20 m

Safety Precautions

This instrument is an IEC safety class I instrument (provided with a terminal for protective earth grounding).
The general safety precautions described herein must be observed during all phases of operation. If the instrument is used in a manner not specified in this manual, the protection provided by the instrument may be impaired. Yokogawa Electric Corporation assumes no liability for the customer's failure to comply with these requirements.

The following symbols are used on this instrument.


Warning: handle with care. Refer to the user's manual or service manual. This symbol appears on dangerous locations on the instrument which require special instructions for proper handling or use. The same symbol appears in the corresponding place in the manual to identify those instructions.


Protective ground terminal


Functional ground terminal (do not use this terminal as a protective ground terminal.)


Alternating current

ON (power)


OFF (power)

Be sure to comply with the precautions below. Not complying might result in injury or death.

WARNING

Use the Correct Power Supply

Before connecting the power cord, ensure that the source voltage matches the rated supply voltage of the instrument and that it is within the maximum rated voltage of the provided power cord.

Use the Correct Power Cord and Plug

To prevent electric shock or fire, be sure to use the power cord supplied by YOKOGAWA. The main power plug must be plugged into an outlet with a protective earth terminal. Do not disable this protection by using an extension cord without protective earth grounding.

Connect the Protective Grounding Terminal

Make sure to connect the protective earth to prevent electric shock before turning ON the power. The power cord that comes with the instrument is a three-prong type power cord. Connect the power cord to a properly grounded three-prong outlet.

Do Not Impair the Protective Grounding

Never cut off the internal or external protective earth wire or disconnect the wiring of the protective earth terminal. Doing so poses a potential shock hazard.

Do Not Operate with Defective Protective Grounding or Fuse

Do not operate the instrument if the protective earth or fuse might be defective. Also, make sure to check them before operation.

Do Not Operate in an Explosive Atmosphere

Do not operate the instrument in the presence of flammable liquids or vapors. Operation in such an environment constitutes a safety hazard.

Do Not Remove Covers

The cover should be removed by YOKOGAWA's qualified personnel only. Opening the cover is dangerous, because some areas inside the instrument have high voltages.

Ground the Instrument before Making External Connections

Securely connect the protective grounding before connecting to the item under measurement or to an external control unit. If you are going to touch the circuit, make sure to turn OFF the circuit and check that no voltage is present.

Precautions to Be Taken When Using the Modules

- Do not apply input voltage exceeding the maximum input voltage, withstand voltage, or allowable surge voltage.
- To prevent the possibility of electric shock, be sure to furnish protective earth grounding of the SL1400.
- To prevent the possibility of electric shock, be sure to fasten the module screws. Otherwise, the electrical protection function and the mechanical protection function will not be activated.
- Avoid continuous connection under an environment in which the allowable surge voltage or greater voltage may occur.

Precautions to Be Taken When Using the Probes

- When measuring high voltages using the 701250 (HS10M12) or the 701251 (HS1M16), use the isolated probe (700929), 1:1 safety cable (combination of 701901 and 701954), or differential probe (700924).
- Be sure to connect the GND lead of the differential probe (700924) to the functional ground terminal of the SL1400. High voltage may appear at the BNC connector of the differential probe. Be sure to connect the GND lead to the SL1400 before connecting the probe to the parameter to be measured.
- When using the 701255 (NONISO_10M12), be sure to fasten the module screws. Fastening the module screws activates the protection function and the non-isolation function. It is extremely dangerous if you do not fasten the screws. In addition, when measuring high voltage above 42 V, be sure to use the passive probe (701940).
- The BNC part of the passive probe (701940) is made of metal. Therefore, use the probe at 42 V or less for isolated inputs (701250 (HS10M12), 701251 (HS1M16), 701260 (HV (with RMS)), etc.) for safety reasons. (Do not connect voltage above 42 V to both the High and Low sides.)
  For non-isolated inputs (701255 (NONISO_10M12), etc.), fasten the module screws as described before.
- When applying high voltage using the 701260 (HV (with RMS)), use the 1:1 safety cable (combination of 701901 and 701954) or the isolated probe (700929).
- The measurement category of the 701260 (HV (with RMS)) is 400V-CAT II for the low side and 700V-CAT II for the high side. Use caution because the overvoltage tolerance differs between the low and high sides.

Conventions Used in This Manual

Markings

The following markings are used in this manual.

Improper handling or use can lead to injury to the user or damage to the instrument. This symbol appears on the instrument to indicate that the user must refer to the users manual for special instructions. The same symbol appears in the corresponding place in the user's manual to identify those instructions. In the manual, the symbol is used in conjunction with the word "WARNING" or "CAUTION."

WARNING Calls attention to actions or conditions that could cause serious or fatal injury to the user, and precautions that can be taken to prevent such occurrences.

CAUTION Calls attentions to actions or conditions that could cause light injury to the user or damage to the instrument or user's data, and precautions that can be taken to prevent such occurrences.

Note Calls attention to information that is important for proper operation of the instrument.

Notations Used in the Procedural Explanations

On pages that describe the operating procedure in Chapters 3 through 17, the following notations are used to distinguish the procedure from their explanations.

Procedure Follow the numbered steps. All procedures are written with inexperienced users in mind; experienced users may not need to carry out all the steps.

Explanation This section describes the setup items and the limitations regarding the procedures. A detailed description of the function is not provided in this section. For a detailed explanation of the function, see chapter 2.

Notation of User Controls

Panel Keys and Soft Keys
Bold characters used in the procedural explanations indicate characters that are marked on the panel keys or the characters of the soft keys or menus displayed on the screen.

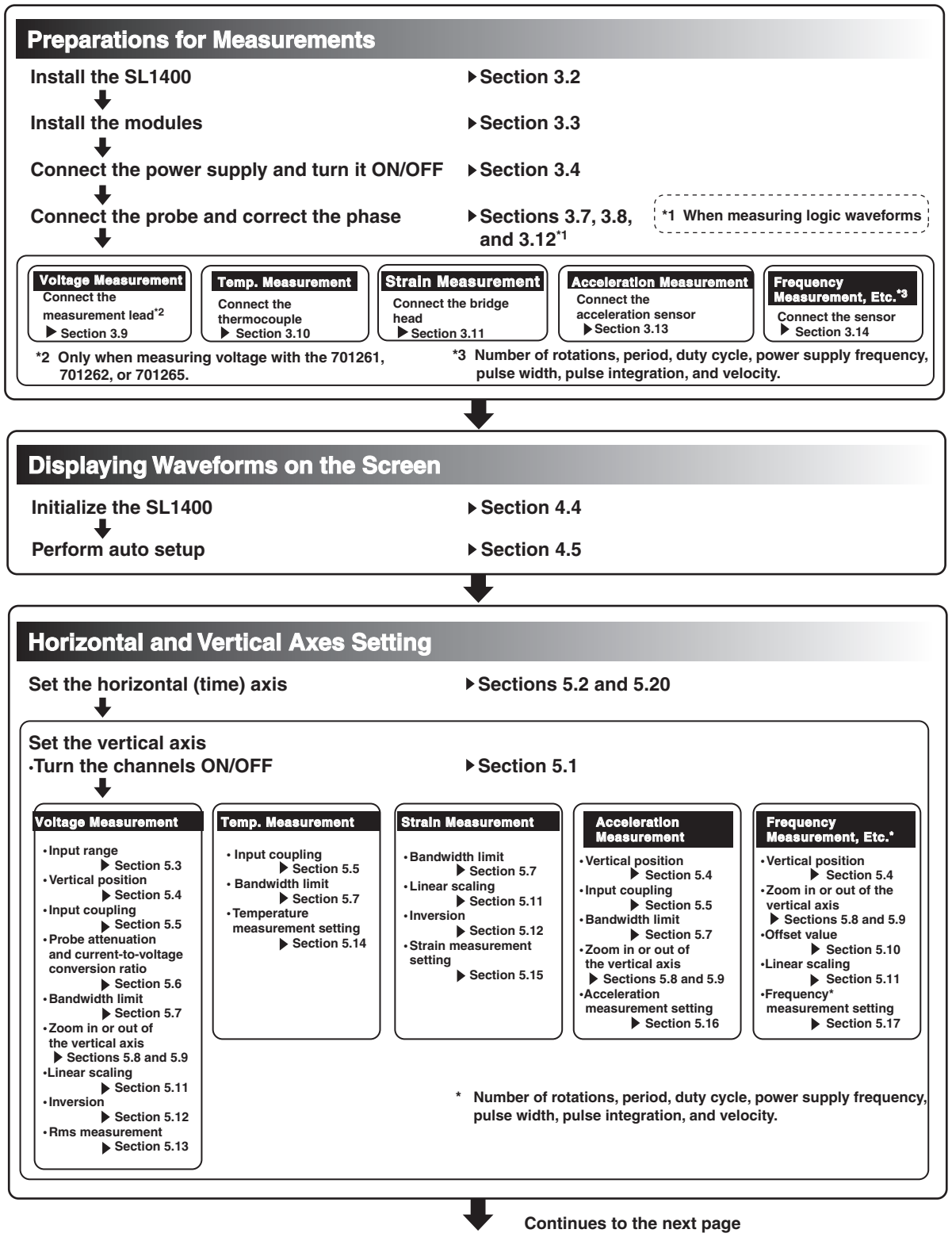
Jog Shuttle+SELECT
Jog shuttle+SELECT indicates selecting or setting parameters and entering values using the jog shuttle, the SELECT key, and other keys. For details on the procedure, see section 4.1 or 4.2.

Unit

k: Denotes 1000. Example: 100 kS/s (sampling rate)
K: Denotes 1024. Example: 459 KB (file data size)

Flow of Operation

The figure below provides an overview of the flow of operations described in this manual. For a description of each item, see the relevant chapter or section.



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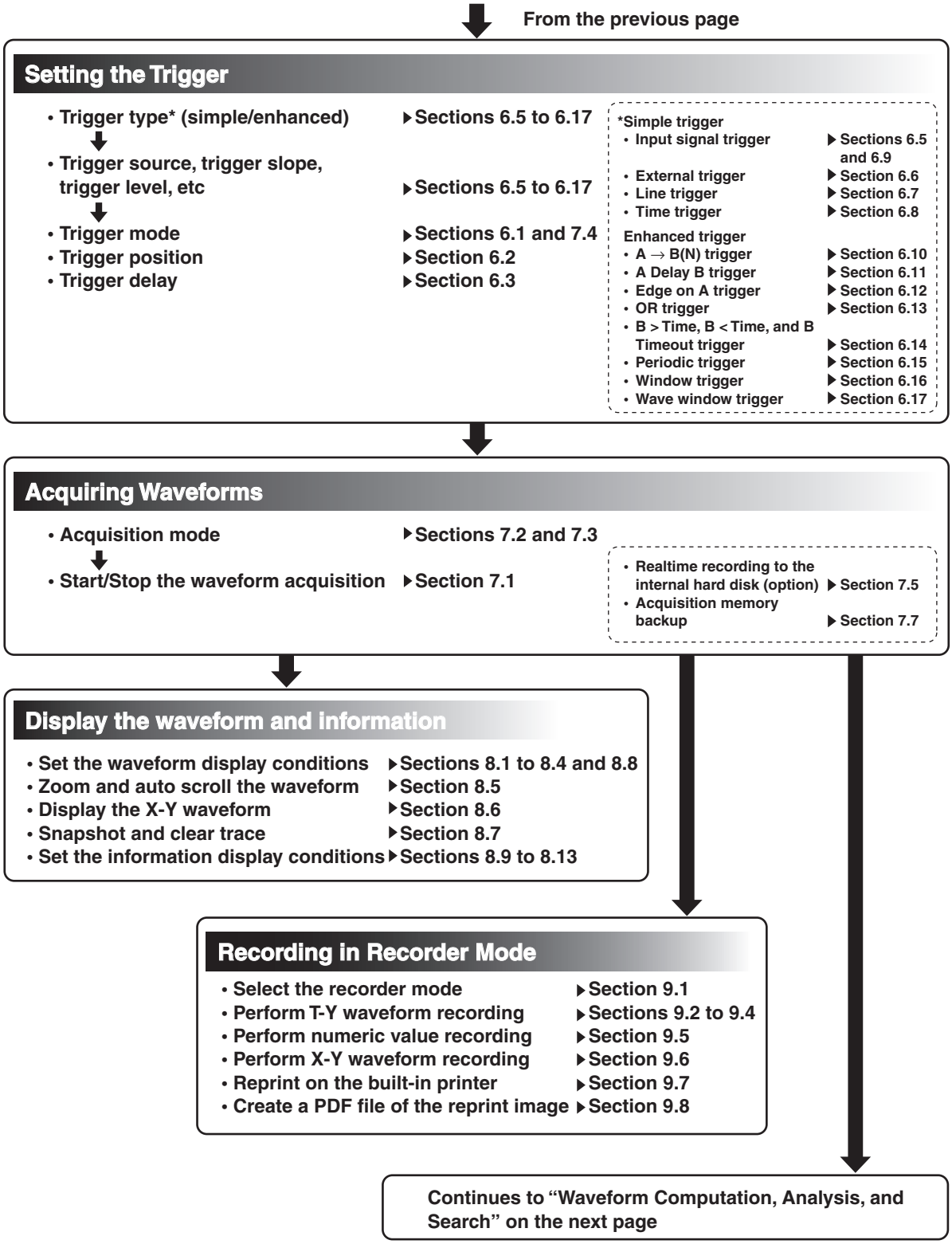
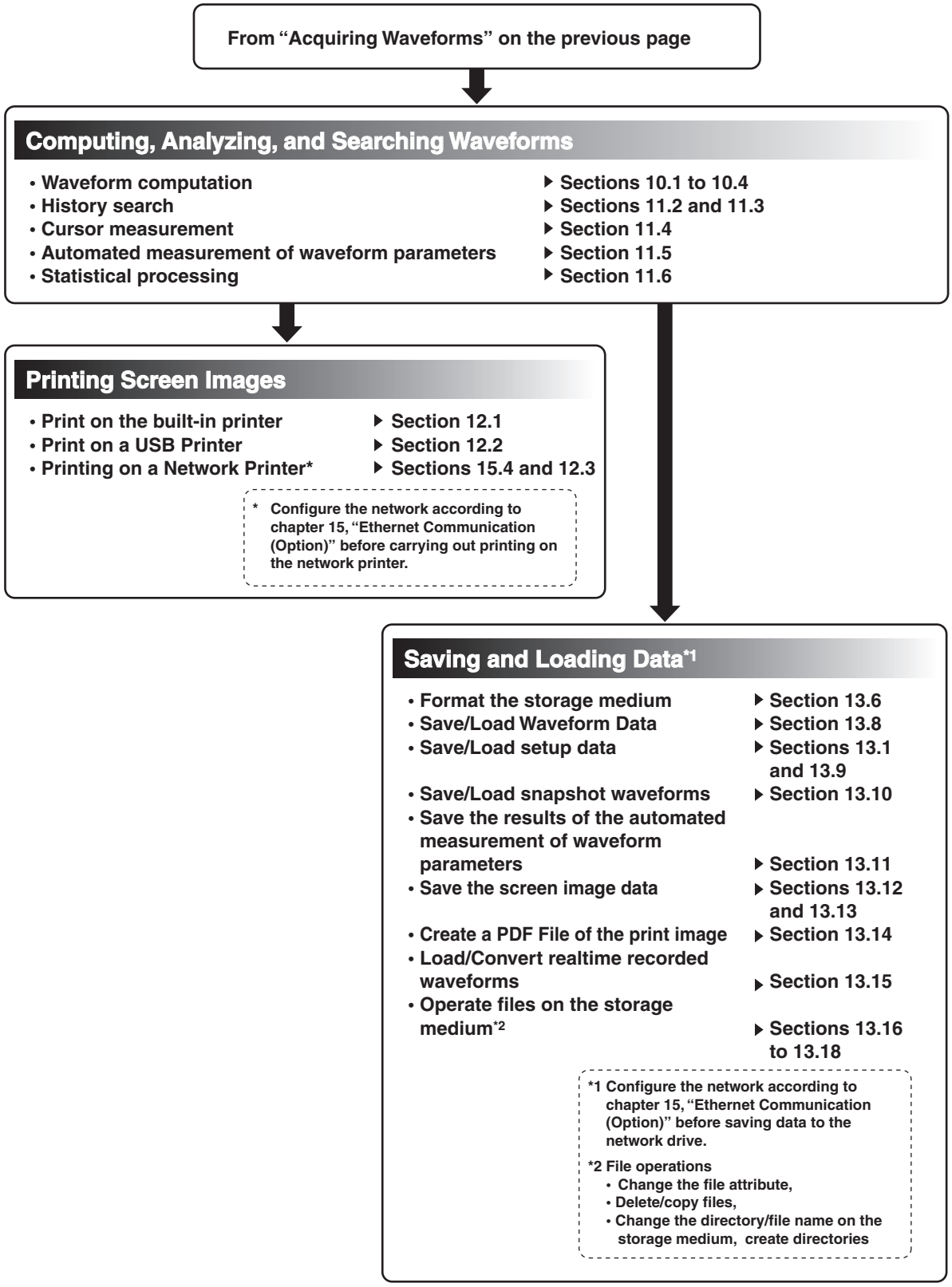

From the previous page
Setting the Trigger
• Trigger type* (simple/enhanced) ▶Sections 6.5 to 6.17
• Trigger source, trigger slope, trigger level, etc ▶Sections 6.5 to 6.17
• Trigger mode ▶Sections 6.1 and 7.4
• Trigger position ▶Section 6.2
• Trigger delay ▶Section 6.3
*Simple trigger
• Input signal trigger ▶Sections 6.5 and 6.9
• External trigger ▶Section 6.6
• Line trigger ▶Section 6.7
• Time trigger ▶Section 6.8
Enhanced trigger
• A → B(N) trigger ▶Section 6.10
• A Delay B trigger ▶Section 6.11
• Edge on A trigger ▶Section 6.12
• OR trigger ▶Section 6.13
• B > Time, B < Time, and B Timeout trigger ▶Section 6.14
• Periodic trigger ▶Section 6.15
• Window trigger ▶Section 6.16
• Wave window trigger ▶Section 6.17
Acquiring Waveforms
• Acquisition mode ▶Sections 7.2 and 7.3
• Start/Stop the waveform acquisition ▶Section 7.1
• Realtime recording to the internal hard disk (option) ▶Section 7.5
• Acquisition memory backup ▶Section 7.7
Display the waveform and information
• Set the waveform display conditions ▶Sections 8.1 to 8.4 and 8.8
• Zoom and auto scroll the waveform ▶Section 8.5
• Display the X-Y waveform ▶Section 8.6
• Snapshot and clear trace ▶Section 8.7
• Set the information display conditions ▶Sections 8.9 to 8.13
Recording in Recorder Mode
• Select the recorder mode ▶Section 9.1
• Perform T-Y waveform recording ▶Sections 9.2 to 9.4
• Perform numeric value recording ▶Section 9.5
• Perform X-Y waveform recording ▶Section 9.6
• Reprint on the built-in printer ▶Section 9.7
• Create a PDF file of the reprint image ▶Section 9.8
Continues to “Waveform Computation, Analysis, and Search” on the next page


From "Acquiring Waveforms" on the previous page
Computing, Analyzing, and Searching Waveforms
• Waveform computation ▸ Sections 10.1 to 10.4
• History search ▸ Sections 11.2 and 11.3
• Cursor measurement ▸ Section 11.4
• Automated measurement of waveform parameters ▸ Section 11.5
• Statistical processing ▸ Section 11.6
Printing Screen Images
• Print on the built-in printer ▸ Section 12.1
• Print on a USB Printer ▸ Section 12.2
• Printing on a Network Printer* ▸ Sections 15.4 and 12.3
* Configure the network according to chapter 15, "Ethernet Communication (Option)" before carrying out printing on the network printer.
Saving and Loading Data*1
• Format the storage medium ▸ Section 13.6
• Save/Load Waveform Data ▸ Section 13.8
• Save/Load setup data ▸ Sections 13.1 and 13.9
• Save/Load snapshot waveforms ▸ Section 13.10
• Save the results of the automated measurement of waveform parameters ▸ Section 13.11
• Save the screen image data ▸ Sections 13.12 and 13.13
• Create a PDF File of the print image ▸ Section 13.14
• Load/Convert realtime recorded waveforms ▸ Section 13.15
• Operate files on the storage medium*2 ▸ Sections 13.16 to 13.18
*1 Configure the network according to chapter 15, "Ethernet Communication (Option)" before saving data to the network drive.
*2 File operations
• Change the file attribute,
• Delete/copy files,
• Change the directory/file name on the storage medium, create directories

Ethernet interface and other operations do not have to be configured in order from previous chapter. They can be configured independently.

Ethernet Communication (Option)

- Connect the SL1400 to the PC* ▶ Section 15.1
- ⬇
- Set the TCP/IP ▶ Section 15.2
- ⬇
- Save/Load data on a network drive (FTP client function) ▶ Section 15.3
- Send e-mail ▶ Section 15.5
- Access the SL1400 from the PC* (FTP server function) ▶ Section 15.6
- Web server function ▶ Section 15.7
- Use the SL1400 as a Windows network drive ▶ Section 15.11

* Personal computer (PC) or workstation

Other Operations

- Set the menu/message language ▶ Section 16.1
- Turn the click sound ON/OFF ▶ Section 16.1
- Change the screen font size ▶ Section 16.2
- Set the screen color and intensity ▶ Section 16.3
- Set the backlight ▶ Section 16.4
- Lock the keys ▶ Section 16.5

Contents

Chapter 5 Horizontal and Vertical Axes

Voltage Measurement (Input Module 701250, 701251, 701255, 701260, 701261, 701262, 701265, or 701275)

Temperature Measurement (Input Module 701261, 701262, or 701265)

Strain Measurement (Input Module 701270 or 701271)

Acceleration Measurement (Input Module 701275)

Chapter 13 Saving and Loading Data

Chapter 14 External Trigger I/O, External Clock Input, and Video Signal Output

Chapter 15 Ethernet Interface (Option)

Chapter 16 Other Operations

Chapter 17 Troubleshooting, Maintenance, and Inspection

Chapter 18 Specifications

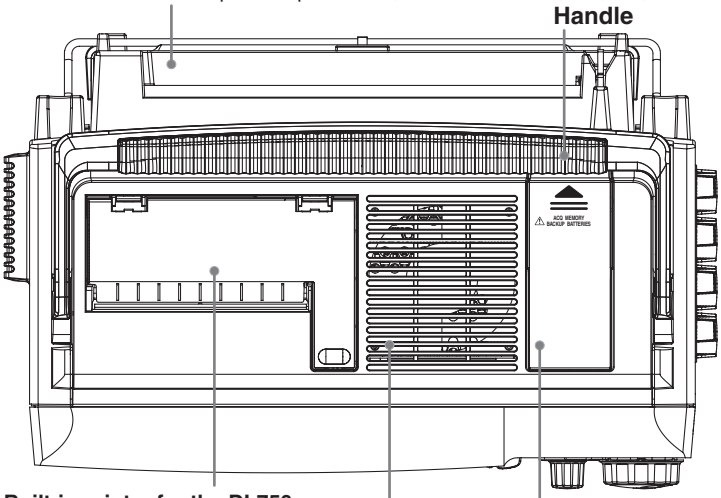
Appendix

Index

1.1 Panels

Top Panel

Built-in printer
Prints the displayed information.
For the procedure to set the roll paper, see section 3.5.
For the printout procedure, see sections 9.4, 9.6, 9.7, and 12.1.



Built-in printer for the DL750
A built-in printer for a separate model (DL750) is installed here. It is not used on the SL1400.

Vent holes

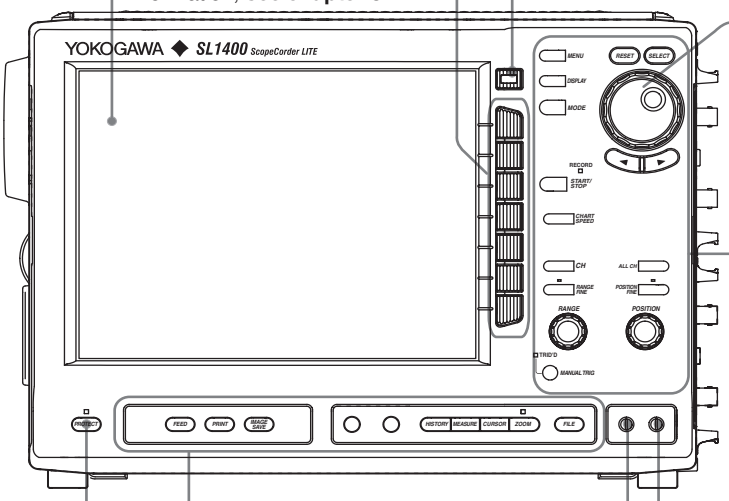
Battery box for memory backup
Stores batteries used to back up the contents of the acquisition memory when the power is OFF.
For the procedure to install the batteries, see section 7.7.

Front Panel

Soft keys
Used to select items on the soft key menu that appears when setting up the SL1400.

ESC key
Used to clear the soft key menu and pop-up menu.

LCD
For a description of the displayed information, **see chapter 8.**



Jog shuttle
Used to change settings and move the cursor. Turn the shuttle ring to vary the rate of change according to its angle.

Panel keys/knobs
For a description, **see section 1.2.**

Panel keys
For a description, **see section 1.2.**

PROTECT key
Locks the keys. **See section 16.5.**

Probe compensation signal output terminal (1 kHz/1 VP-P)
Outputs the probe compensation signal.
For the probe phase correction, **see section 3.8.**

Functional ground terminal
Connect the ground cable when be sure to perform phase correction the probe.

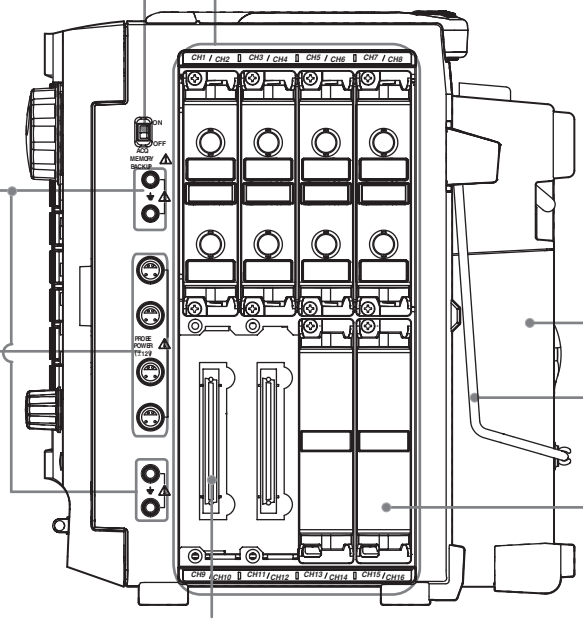
Right Side Panel

Acquisition memory backup ON/OFF
Turns ON/OFF the battery power for backing up the acquisition memory.
For the acquisition memory backup function, see section 7.7.

Input module installation slot
A total of eight slots in the top and bottom rows.
For the installation and removal procedure of input modules, see section 3.3.

Input channel arrangement

CH1	CH3	CH5	CH7
CH2	CH4	CH6	CH8
CH9	CH11	CH13	CH15
CH10	CH12	CH14	CH16



Functional ground terminal
Used to connect the ground line from the high-voltage differential probe or enhance the grounding of the measurement system. For the probe connection procedure, see section 3.7.

Probe power supply terminal
Used to supply power (±12 V) to the probes when using current probes.
For the probe connection procedure, see section 3.7.

Built-in printer

Stand
For the installation procedure, see section 3.2.

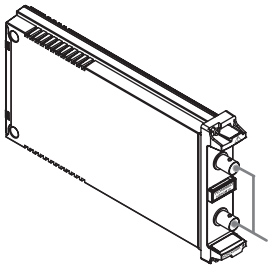
Empty slot protection cover panel
Attached to the slots that are not used.

Input module connector

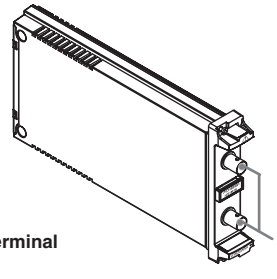
Input Modules

The following 11 input modules are available.

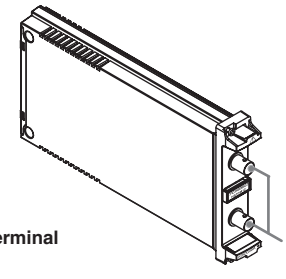
High-Speed 10 MS/s, 12-Bit Isolation Module HS10M12 (model: 701250)



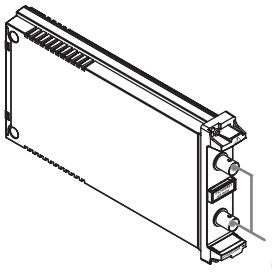
High-Speed High-Resolution 1 MS/s, 16-Bit Isolation Module HS1M16 (model: 701251)



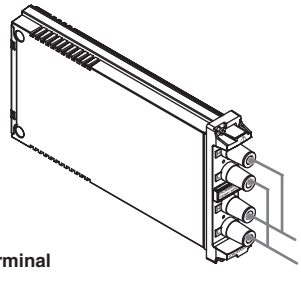
High-Speed 10 MS/s, 12-Bit Non-Isolation Module NONISO_10M12 (model: 701255)



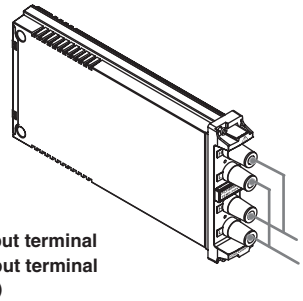
High-Voltage 100 kS/s, 16-Bit Isolation Module (with RMS) HV (with RMS) (model: 701260)



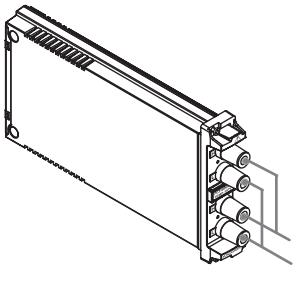
Universal (Voltage/Temp.) Module UNIVERSAL (model: 701261)



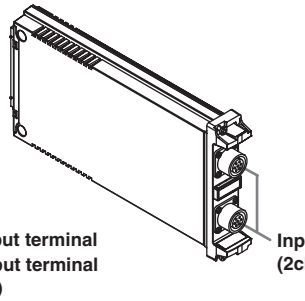
Universal (Voltage/Temp.) Module (with AAF) UNIVERSAL (AAF) (model: 701262)



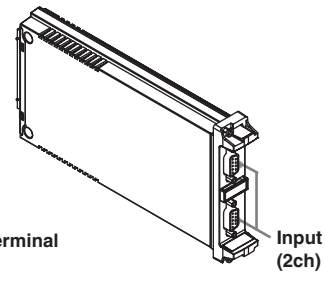
Temperature, High Precision Voltage Isolation Module TEMP/HPV (model: 701265)



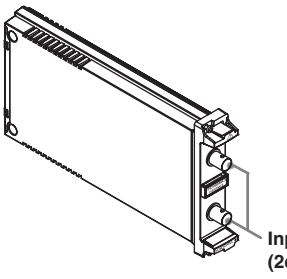
Strain Module (NDIS) STRAIN_NDIS (model: 701270)



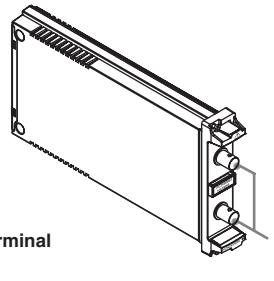
Strain Module (DSUB, Shunt-Cal) STRAIN_DSUB (model: 701271)



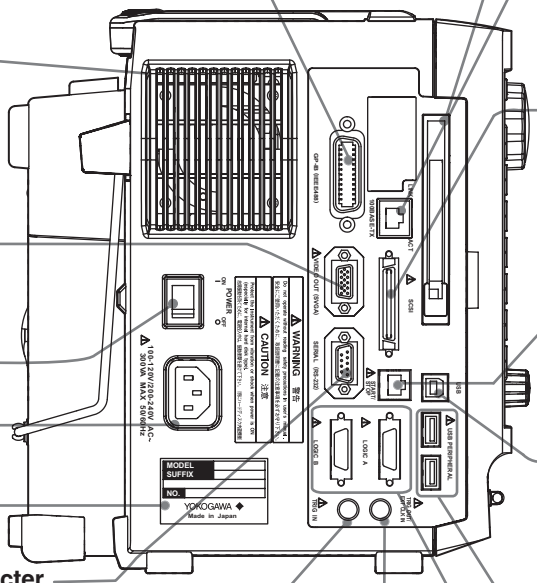
Acceleration/Voltage Module (with AAF) ACCL/VOLT (model: 701275)



Frequency Module FREQ (model: 701280)



Left Side Panel



GP-IB connector
Used to perform communications via the GP-IB interface. For a description on how to use the terminal, see the *Communication Interface User's Manual.*

Vent holes

Video signal output terminal
Outputs the displayed image using SVGA RGB signals. For a description on how to use the terminal, see section 14.4.

Main power switch
For the power ON/OFF operation, see section 3.4.

Power connector
For details on connecting the power, see section 3.4.

Name plate

RS-232 interface connecter
Used to perform communications with a personal computer (PC) via the RS-232 interface. For a description on how to use the terminal, see the *Communication Interface User's Manual.*

Trigger input terminal
Used to input external trigger signals. For a description on how to use the terminal, see section 14.1.

Trigger output/external clock input terminal
Used to output trigger signals or input clock signals.
For a description on how to use the terminal, see sections 14.2 and 14.3.

PC card slot
Used to save data to a PC card. For a description on how to use the terminal, see section 13.2.

Ethernet port (100BASE-TX)
Used to connect to a LAN.
For a description on how to use the terminal, see section 15.1.

SCSI interface connector
Used to connect to a SCSI device such as a SCSI hard disk.
For a description on how to use the terminal, see section 13.5.

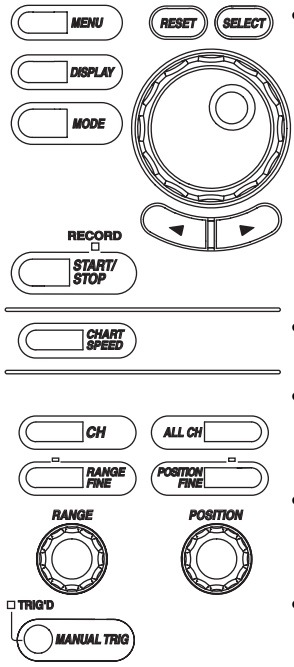
External start/stop input connector
Used to externally control the start/stop of the SL1400.
For a description on how to use the terminal, see section 14.5.

USB connector for a personal computer (PC)
Used to connect a PC with a USB interface.
For a description on how to use the terminal, see the *Communication Interface User's Manual.*

USB connector for peripherals
Used to connect a USB keyboard, USB printer, USB mouse, or USB storage.
For a description on how to use the terminal, see sections 4.3 and 12.2.

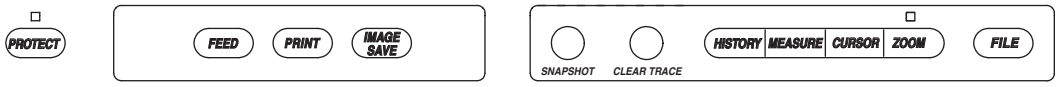
Logic signal input connector
Used to measure logic signals.
For a description on how to use the terminal, see section 3.12.

1.2 Panel Keys and Knobs



- **Menu Key (explained by function in each chapter and section)**
  Displays a setup menu for measurement conditions (sections 5.2, 5.20, 7.2, 7.3, and 7.5), record conditions (chapter 9), triggers (chapter 6), waveform computation (chapter 10), store and recall of setup parameters (section 13.1), screen image data printing (chapter 12) and saving (sections 13.12, 13.13, and 15.3), system configuration (sections 3.6, 16.1 to 16.3, and 17.4), initialization and calibration (sections 4.4 to 4.6), remote control (Communication Interface User's Manual), network (chapter 15), backlight (section 16.4), self-test (17.3), etc. The displayed menu varies depending on the mode selected using the MODE key.
- **DISPLAY Key (Chapter 8)**
  Displays a menu related to the screen display.
- **MODE Key (Section 9.1)**
  Displays a menu used to select the mode. Three modes are available: Memory, Chart Recorder, and X-Y Recorder.
- **START/STOP Key (Sections 7.1, 9.4, and 9.6)**
  Starts/Stops waveform acquisition (or waveform recording). Waveform acquisition (or waveform recording) is in progress when the indicator above the key is illuminated.
- **CHART SPEED Key (Section 9.2)**
  This key is valid only when Chart Recorder mode is selected with the MODE key. Press this key to display a menu used to set the chart speed.
- **CH Key (explained by function in each chapter and section)**
  Displays a menu used to select the channel.
  If you select a channel from CH1 to CH16, a menu is displayed that is used to turn the display of each channel ON/OFF (section 5.1), set the vertical position (section 5.4), coupling (section 5.5), Probe attenuation or current-to-voltage conversion ratio (section 5.6), bandwidth limit (section 5.7), vertical axis expansion/reduction (sections 5.8 and 5.9), linear scaling (section 5.11), inverted display of waveforms (section 5.12), and waveform label (section 8.10).
  If you select Logic A or Logic B, a menu is displayed that is used to set the vertical position (section 5.4), vertical axis expansion/reduction (section 5.8), logic probe (section 5.18), displayed bits (section 5.18), bit label (section 5.18), mapping (section 5.18), and logic waveform label (section 8.10).
- **ALL CH Key (Section 5.19)**
  Displays a pop-up window containing a list of settings similar to those displayed on the menu when the CH key is pressed.
- **RANGE FINE Key (Section 5.8)**
  Press the key to illuminate the indicator above the key. In this condition, you can turn the range knob to expand or reduce the vertical axis by specifying the magnification (zoom rate).
- **POSITION FINE Key**
  Press the key to illuminate the indicator above the key. In this condition, you can turn the position knob to set the vertical display position of the waveform in 0.1-division resolution.
- **RANGE Knob (Section 5.3)**
  Sets the voltage range. You select the target channel with the CH key before you turn this knob. If you change the setting when waveform acquisition is stopped, the new setting takes effect when you restart the waveform acquisition.

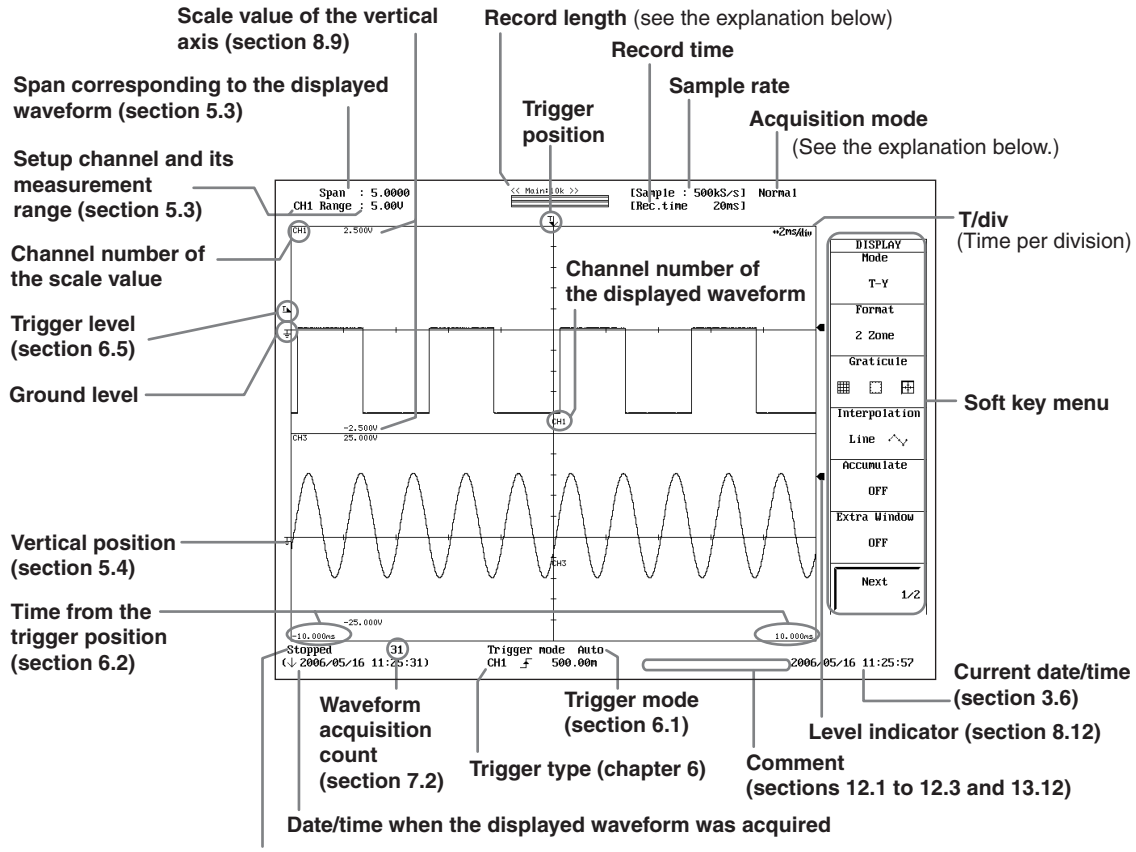
- **POSITION Knob (Section 5.4)**
  Sets the vertical display position of the waveform. You select the target channel with the CH key before you turn this knob.
- **MANUAL TRIG Key (Section 6.19)**
  Press the key to forcibly activate a trigger.
- **RESET Key**
  Resets the numeric entry to the default value.
- **SELECT Key**
  Applies the menu item that you selected using the jog shuttle.
- **Arrow Keys(◀ ▶ Keys)**
  Moves the numeric entry digit (cursor) left or right.



- **PROTECT Key (Section 16.5)**
  Pressing this key causes the LED above the key to illuminate, and the front panel keys to be disabled. Pressing the key again clears the condition.
- **Feed Key (Section 3.5)**
  Feeds the paper in the built-in printer.
- **PRINT Key (Section 12.1)**
  Executes the printing of the screen image. You can enter the print settings on the PRINT menu that appears when you press the MENU key.
- **Image Save Key (Section 13.12)**
  Saves the screen image data to a storage medium. You can enter the storage settings of the screen image data on the IMAGE menu that appears when you press the MENU key.
- **SNAPSHOT Key (Section 8.7)**
  Leaves the current displayed waveform on the screen in black and white. Waveforms acquired using the snapshot function can be saved and loaded.
- **CLEAR TRACE Key (Section 8.7)**
  Clears the waveform acquired using the snapshot function and accumulated waveforms.
- **HISTORY Key (Sections 11.1 to 11.3)**
  Displays a menu used to recall data using the history memory function.
- **MEASURE Key (Sections 11.5 and 11.6)**
  Displays a menu used to perform automated measurement of waveform parameters and statistical processing.
- **CURSOR Key (Section 11.4)**
  Displays a menu used to perform cursor measurements.
- **ZOOM Key (Section 8.5)**
  Displays a menu related to the zoom display of waveforms.
- **FILE Key (Chapter 13)**
  Displays a menu used to save various data to, recall various data, or execute file operations on a storage medium such as a PC card and external SCSI device (option).

1.3 Display Screens

Normal Display Screen



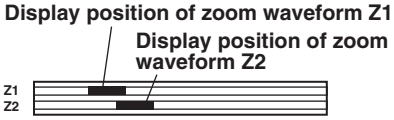
Waveform acquisition status

Stopped	Pre...: Acquiring pre data
Running	Post...: Acquiring post data
Waiting for trigger	
HD out: Continuous writing to hard disk	

Zoom Waveform Position on the Normal Waveform

<When displaying normal waveforms>

<When displaying zoom waveforms>



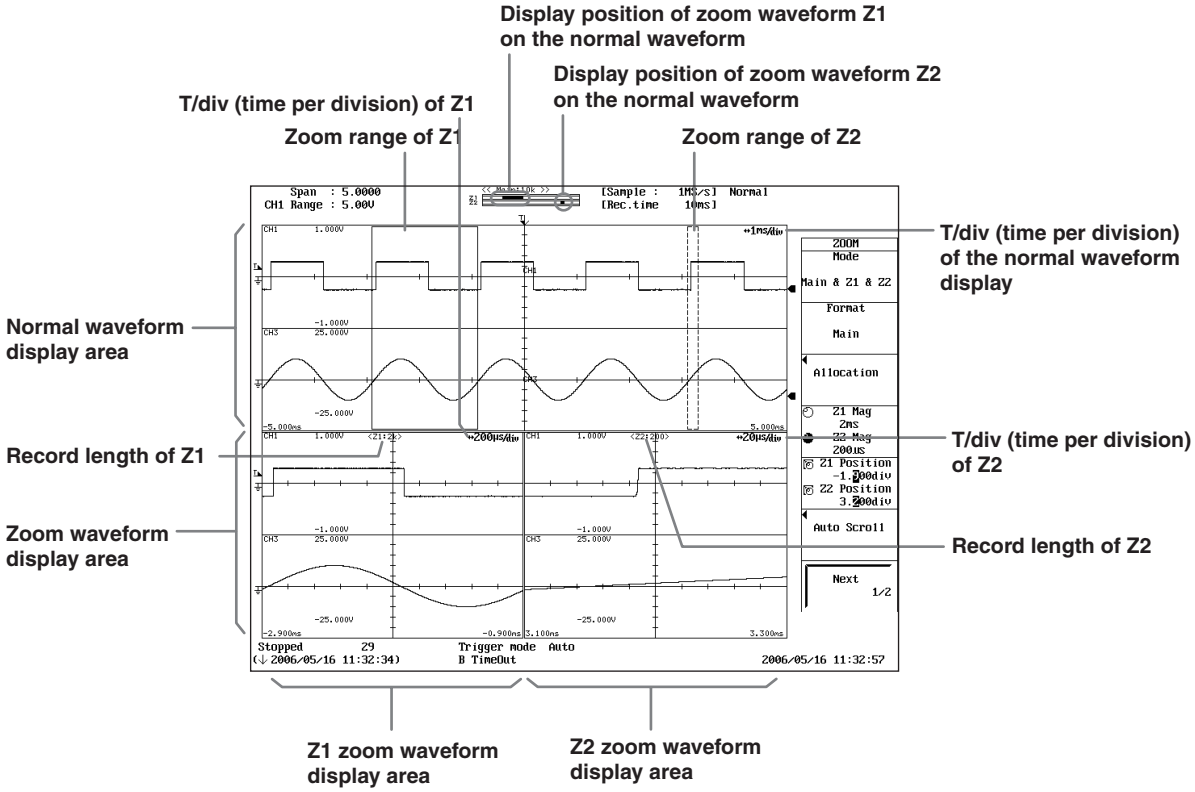
Acquisition Mode Display

Normal:	Normal mode
Env:	Envelope mode
Avg:	Average mode
BoxAvg:	Box average mode

Note

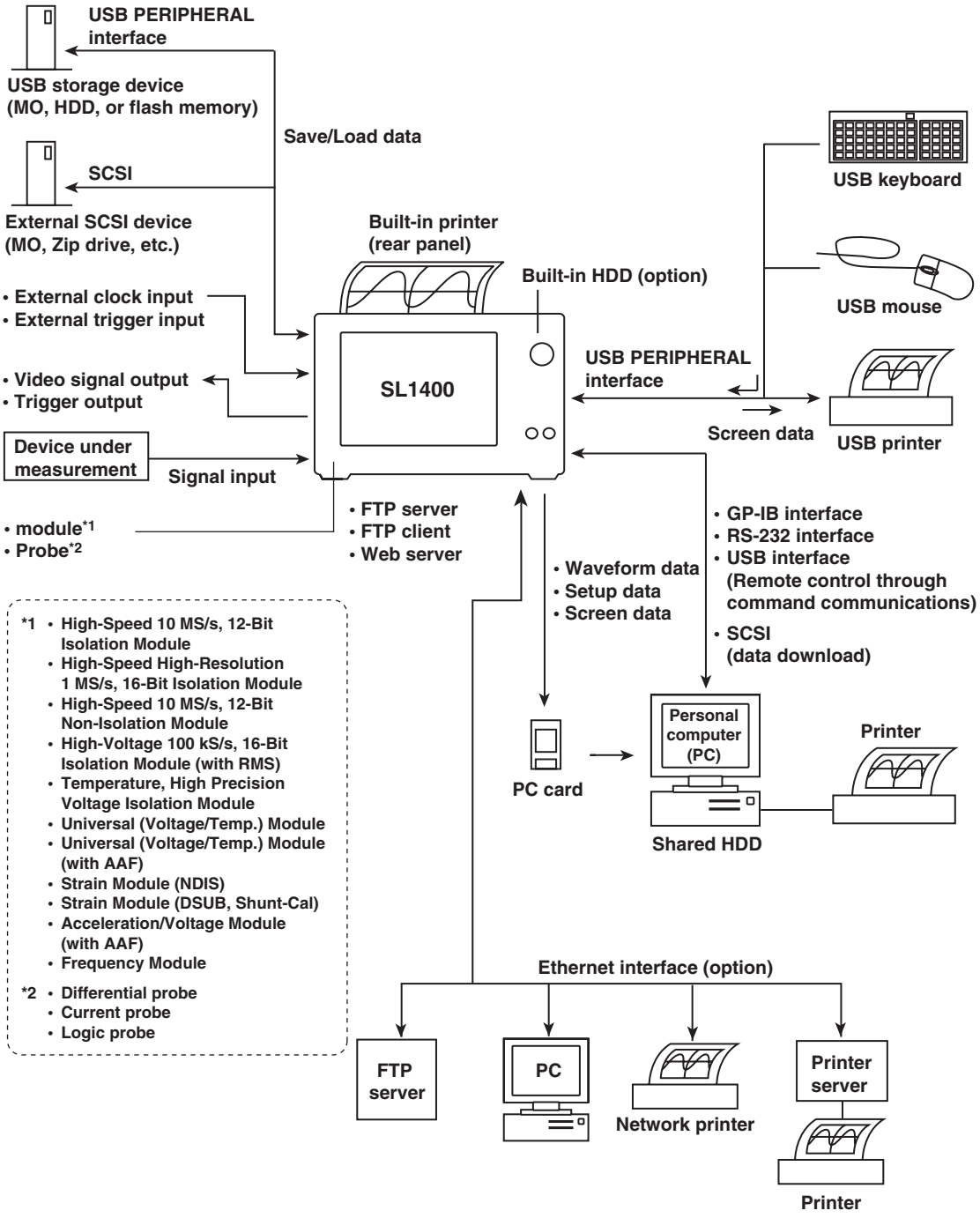
In some cases, the LCD on the SL1400 may include few defective pixels. For details, see section 18.4.

Screen When Displaying Zoom Waveforms

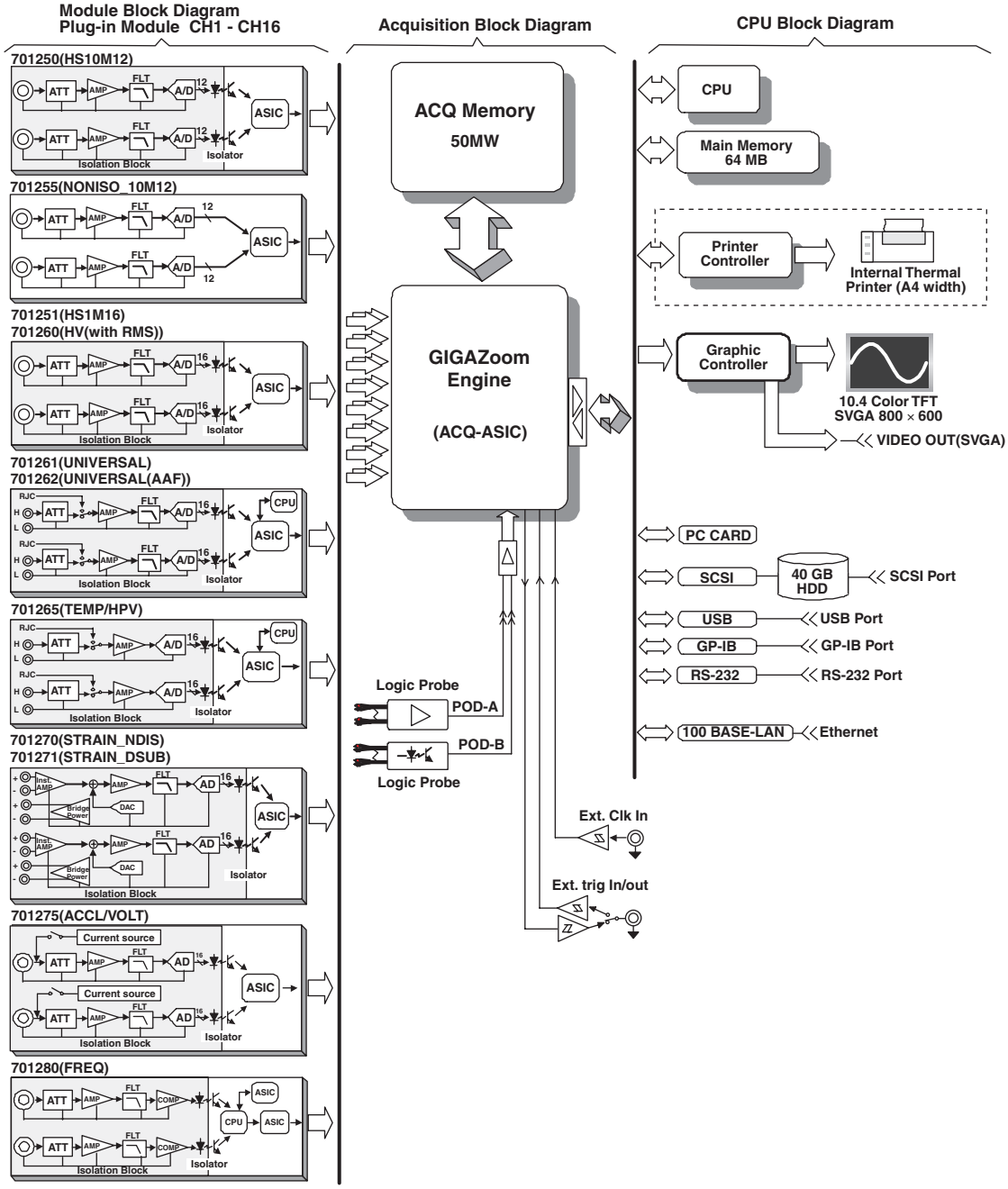


2.1 System Configuration and Block Diagram

System Configuration



Block Diagram



Signal Flow on the SL1400

The flow of the signal applied to the input signal varies depending on the input module. Here, the high-speed 10 MS/s, 12-bit isolation module (701250 (HS10M12)) is used as an example for the explanation. (For details on the flow of the signal of each module, see the block diagram.)

The signal applied to the two input terminals is first processed by the input section of each module.

On the 701250 (HS10M12), (1) the attenuator (ATT) attenuates and the amplifier (AMP) amplifies the input signal, (2) the filter (FLT) limits its bandwidth, and (3) the A/D converter samples the input signal at a sample rate of 10 MS/s (10 million times per second) and converts the signal to digital data. Then, the signal passes through the isolator and ASIC and enters the waveform processing ASIC (ACQ-ASIC).

The 16 channels of digital data collected at the CPU board passes through the waveform processing ASIC (ACQ-ASIC) and stored in the acquisition memory (ACQ Memory). The digital data stored in the ACQ memory is compressed at high speeds by the waveform processing ASIC (ACQ-ASIC), passes through the graphic controller, and shown on the SVGA TFT color display.

The SL1400 can acquire simultaneously up to 16 analog input channels and 16-bit logic data.

2.2 Setting the Horizontal and Vertical Axes

Horizontal (Time) Axis «For procedures, see section 5.2.»

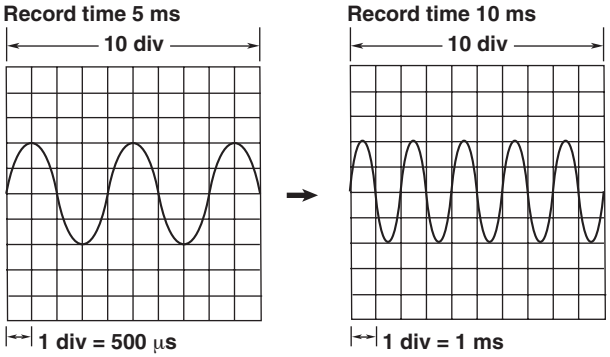
Record Time

When using the internal clock*, the time axis scale is set using the length of time within one screen. The record time is the length of time within one screen. The record time is set in units of second, minute, hour, and day. The transition from seconds to minutes to hours to days is automatically performed. The selectable record time varies depending on the maximum record length installed in the SL1400, the number of channels whose display is turned ON, and the specified sample rate.

* Internal clock and external clock (time base selection)
Under the initial setting, the sampling timing of waveform data is controlled by the clock signal generated from the time base circuit within the SL1400.
The sampling timing can also be controlled by a clock signal applied externally. External clock signals are input through the external clock input terminal on the left panel facing the SL1400. This external clock input is useful for observing a signal whose period varies or for observing waveforms by synchronizing to the clock signal of the signal being measured.

T/div

T/div is 1/10th the record time or the time per one grid square (1 div).

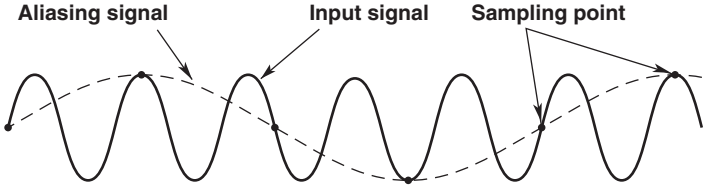


Sample Rate

The sample rate is the number of times the measured waveform is sampled (in unit of S/s). The sample rate is set according to the measurement purpose or the speed of variation.

The maximum sample rate varies depending on the module. The SL1400 can display waveforms correctly up to one-half the frequency of the sample rate as defined by the Nyquist sampling theorem.*

* If the sample rate is comparatively low with respect to the input signal frequency, the harmonics contained in the signal are lost. In this case, some of the harmonics will appear at low frequencies due to the effects described by the Nyquist sampling theorem. This phenomenon is called aliasing. You can prevent aliasing by acquiring waveforms with the acquisition mode set to envelope.

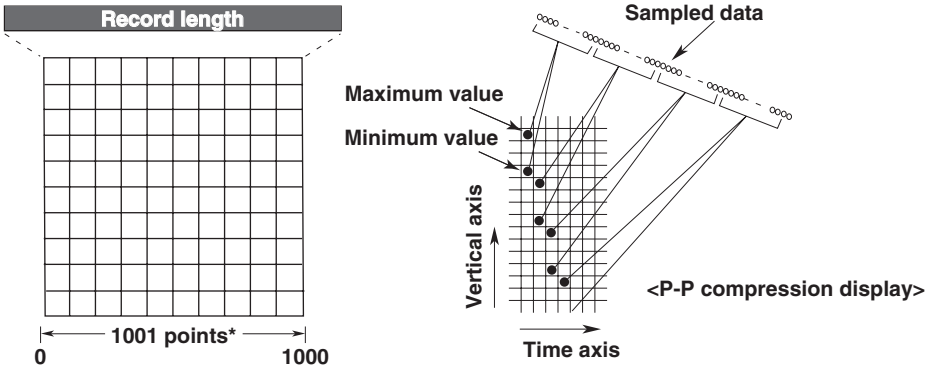


Record Length

The term *record length* normally refers to the number of data points acquired per channel in the acquisition memory. The record length changes when you change the record time or sample rate (see appendix 1). The following equation holds: record length = record time × sample rate. The maximum record length of the SL1400 is 50 MW. The measured waveform signal of a single channel can be acquired up to the maximum record length of 50 MW when only a single channel is displayed.
The record length that is stored in the acquisition memory and the record length of the displayed waveform are the same.

Display along the Time Axis

There are 10 divisions along the time axis, and 1001 points (logical number of points, not the dots on the screen) are used to draw the waveforms. Therefore, if the record length is exactly 1 kW (the number of acquired data points is 1001), the waveform is displayed using 1001 points. However, if the record length is greater than or equal to 2 kW, the maxim and minimum values are determined (P-P compression) and aligned at the same time position (total number of points: 2002) to draw the waveform.



Zooming Horizontally and Drawing Waveforms

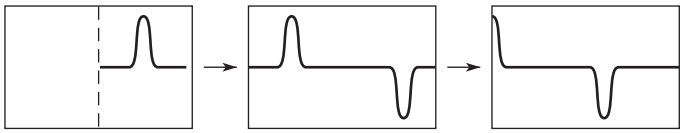
The SL1400 is capable of expanding (zooming) the waveform horizontally (see page 2-34). When the zoom rate of the waveform is increased, the number of displayed points decreases. The waveform is displayed P-P compressed until the number of display points falls to 2002 points. When the number of displayed points falls below 1001, the waveform can no longer be displayed using continuous lines. In this case, the display data is interpolated using the display interpolation function (see page 2-33) so that the number of displayed points is 1001 points.

Dot Display

By default, the display interpolation function works automatically. However, you can also disable the display interpolation in which case the waveform is displayed using dots. In this setting, up to 100100 points (100 kpoints) of the acquired data are displayed without using P-P compression. For example, if the display record length is 10 kW (the number of acquired data points is 10010 points), all the points of the waveform are drawn by aligning 10 points vertically at the same time axis positions. If the number of acquired data points exceeds 100100, only the data per given interval is displayed. In other words, the data is decimated down to 100100 points (100 k points) for displaying the waveform.

Record Time and Roll Mode Display

If the trigger mode is set to Auto, Auto Level, Single, or Log and the record time is set greater than or equal to 1 s/div, the waveform is displayed in roll mode. In roll mode, the displayed waveform is not updated using triggers (update mode). Rather, the oldest data is deleted as new data is acquired, and the waveform is shifted from right to left on the screen.

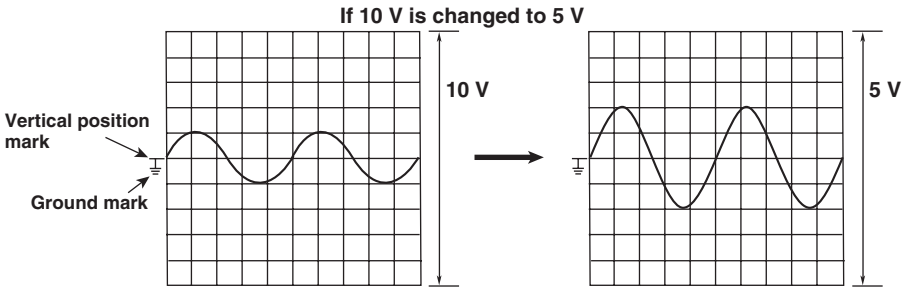


Roll mode display allows waveforms to be observed in the same way as on a pen recorder. It is useful in observing signals with a long period or signals that change slowly. It is also useful in detecting glitches (spikes in the waveform) that occur intermittently.

Vertical (Voltage) Axis (for Modules Other Than the Strain Module) «For procedures, see section 5.3.»

Setting the Voltage Range

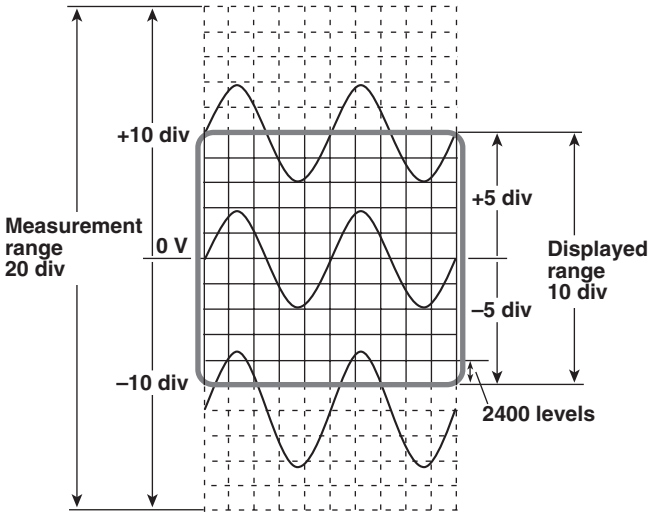
The voltage range setting is used to adjust the displayed amplitude of the waveform so that it can be easily observed. The voltage range is set using a voltage across the top and bottom edges of the waveform display area (10 divisions). The voltage range changes by switching the input section to an attenuator with different values of attenuation. The sensitivity is changed in steps as in 1 V to 2 V to 5 V.



Measurement Range and Display Range

The measurement range of the SL1400 is ±10 divisions (20 divisions of absolute width (span) around 0 V. The display range of the screen is ±5 divisions (10 divisions of span). The following functions can be used to move the displayed waveform and display the waveform outside the display range by expanding/reducing the displayed waveform.

- Move the vertical position → See page 2-7.
- Zoom in or out vertically (expand/reduce) → See page 2-7.

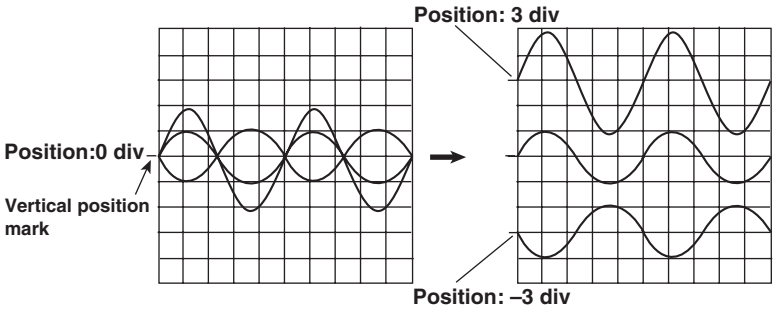


Note

- **For measuring the voltage with high accuracy**
  To measure the voltage with high accuracy, set the voltage range so that the input signal is measured with as large amplitude as possible.
- **Measurement Resolution**
  The measurement resolution varies depending on the module. For example, the 701250 (HS10M12) and 701255 (NONISO_10M12) sample the input signal using a 12-bit A/D converter at a resolution of 150 levels per division. The 701251 (HS1M16), 701260 (HV (with RMS)), 701261 (UNIVERSAL), 701262 (UNIVERSAL (AAF)), 701265 (TEMP/HPV), and 701275 (ACCL/VOLT) sample the input signal using a 16-bit A/D converter at a resolution of 2400 levels per division.

Vertical Position of Waveforms «For procedures, see section 5.4.»

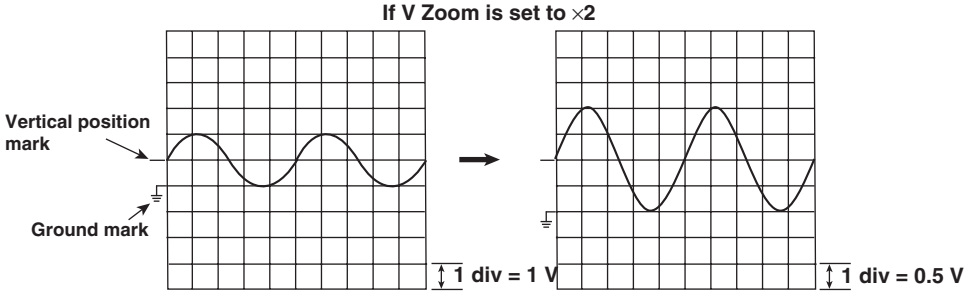
Since the SL1400 can display the waveforms of the analog input channels (CH1 to CH16) and computation waveforms (Math1 to Math8), the waveforms may overlap making them difficult to be observed. In this happens, you can change the vertical display position of waveforms for easier viewing.
The vertical position can be moved within a range of ± 5 div.
The voltage sensitivity per division switches around the vertical position mark.



Zooming in or out Vertically «For procedures, see sections 5.8 and 5.9.»

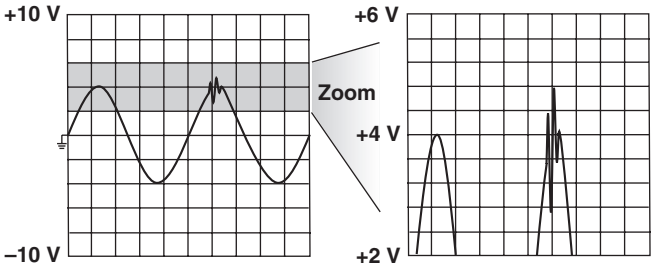
Zooming in or out by Setting the Magnification

You can expand or reduce the waveform display vertically in the range of ×0.1 to ×100 (varies depending on the input module) for each displayed waveform. The waveform display can be zoomed around the vertical position.



Zooming in or out According to the Upper and Lower Limits of the Display Range

You can zoom in on the desired section of the observed waveform by specifying the upper and lower limits of the vertical axis to change the display range to a narrower range for each displayed waveform. Conversely, you can widen the display range to view waveforms outside the display range.



Input Coupling «For procedures, see section 5.5.»

If you want to measure just the amplitude of an AC signal, it is best to remove the DC component from the input signal. On the other hand, there are times when you want to check the ground level or measure the entire input signal (both the DC and AC components). In these cases, you can change the input coupling setting. By changing the input coupling, the input method used to input the signal to the vertical control circuit (voltage axis) is switched. The following types of input coupling are available.

DC

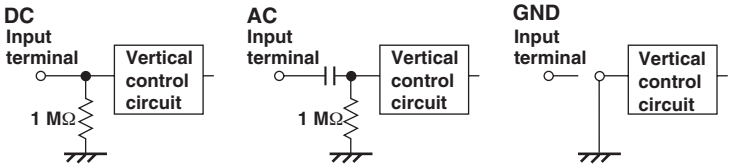
The input signal is directly coupled to the attenuator of the vertical control circuit. Select DC if you want to measure the entire input signal (DC and AC components).

AC (Only When Measuring the AC Voltage)

The input signal is coupled to the attenuator of the vertical control circuit through a capacitor. Select AC if you want to measure only the amplitude of the AC signal, eliminating the DC components from the input signal.

GND

Input signal is coupled to the ground not to the attenuator of the vertical control circuit. By selecting GND, you can check the ground level on the screen.



TC (Only When Measuring the Temperature)

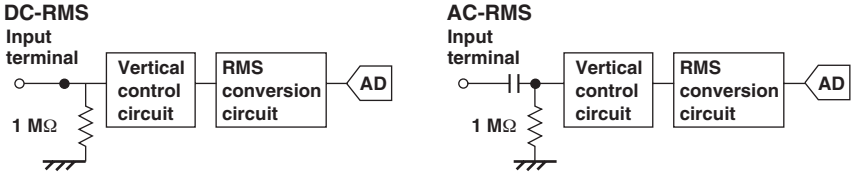
Select TC if you are measuring the temperature using the 701261 (UNIVERSAL), 701262 (UNIVERSAL (AAF)), or 701265 (TEMP/HPV).

DC-RMS

Using the 701260 (HV (with RMS)), both the DC and AC components of the signal are converted to rms values and displayed. An RMS conversion circuit is connected to the vertical control circuit of the same input coupling circuit used when the coupling is set to “DC.”

AC-RMS

Using the 701260 (HV (with RMS)), only the AC component of the signal is converted to rms values and displayed. An RMS conversion circuit is connected to the vertical control circuit of the same input coupling circuit used when the coupling is set to “AC.”



ACCL (Only When Measuring Acceleration)

Select ACCL if you are measuring acceleration on the 701275 (ACCL/VOLT).

Probe Attenuation or Current-to-Voltage Conversion Ratio «For procedures, see section 5.6.»

For voltage (current) measurement, a probe is normally used in connecting the circuit being measured to the signal input terminal. Using a probe has the following advantages.

- Prevents disturbing the voltage and current of the circuit being measured.
- Inputs the signal with no distortion.
- Expands the measurable voltage (current) range of the SL1400.

When using a probe, the attenuation setting on the SL1400 must be set equal to the probe attenuation or current-to-voltage conversion ratio so that the measured voltage (current) can be read directly.
The SL1400 has the following attenuation settings: 1:1, 10:1, 100:1, 1000:1, 10A:1V,*1 and 100A:1V.*2 If you are using a probe other than the ones provided as accessories (sold separately), set the attenuation ratio on the SL1400 according to the attenuation of the probe.

*1 Output voltage rate: 0.1 V/A
*2 Output voltage rate: 0.01 V/A

Note

Use a probe that matches the input capacity of each module. Otherwise, the capacity cannot be adjusted.

Bandwidth Limit «For procedures, see section 5.7.»

A bandwidth limit can be applied for each module. By limiting the bandwidth, you can eliminate high frequency components (such as high frequency noise) from the input signal for waveform observation.

Linear Scaling «For procedures, see section 5.11.»

When measuring the voltage (current), strain, or frequency (number of rotations, period, duty cycle, power supply frequency, pulse width, pulse integration, and velocity), there are two methods of linear scaling: “AX+B” and “P1-P2.”

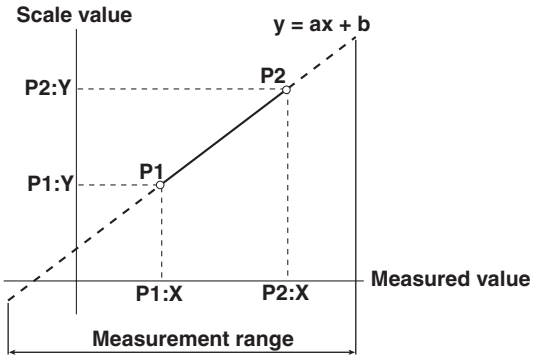
AX+B

Scaling is performed using the specified scaling coefficient A and offset B according to the equation shown below. Cursor measurement values and automated measurement values of waveform parameters are displayed using scaled values. You can also assign a unit to the linearly scaled value.

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

P1-P2

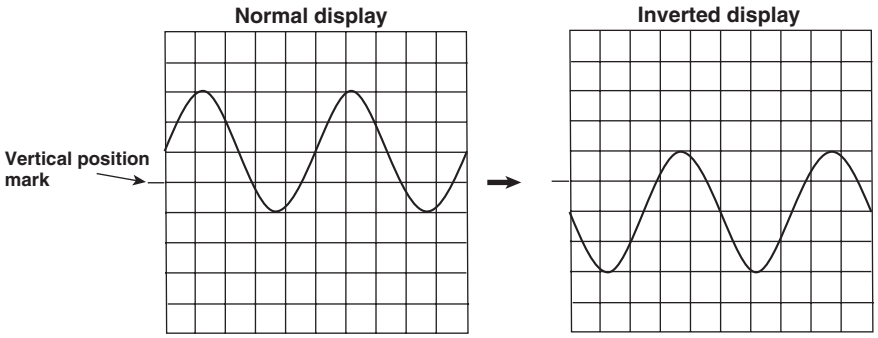
Specify arbitrary scale values (P1:Y and P2:Y) for the measured values of two arbitrary points (P1:X and P2:X). The conversion equation (y = ax + b) is derived from these four values.



In addition, the current input value can be loaded into P1:X or P2:X.

Inversion «For procedures, see section 5.12.»

When measuring voltage or strain, the waveform can be displayed with the vertical axis inverted around the vertical position as shown below.



Pulse/Rotate «For procedures, see section 5.20.»

When the time base is set to external clock, one data sample is captured to the acquisition memory when one pulse of the external clock signal is input. You can specify the number of pulses of the external signal (in other words, the number of data samples captured in the acquisition memory) that will correspond to one mechanical rotation (one cycle). The selectable range is from 1 to 24000 pulses. For example, if the pulse/rotate setting is set to 100 pulses, then 10 rotations of data samples will be acquired when the record length is set to 1 kW. When the pulse/rotate setting is set to 1 pulse, one data sample will correspond to one rotation (one cycle).

The pulse/rotate setting affects only the X-axis (horizontal) measurement values in cursor measurements and the time axis display on the screen. For example, if the pulse/rotate setting is 100 pulses and the record length is 1 kW, 1 division will be 1 rotation. In this case, moving the cursor by 1 division during cursor measurements causes the horizontal measured value to increase or decrease by “1.”

RMS Measurement «For procedures, see section 5.13.»

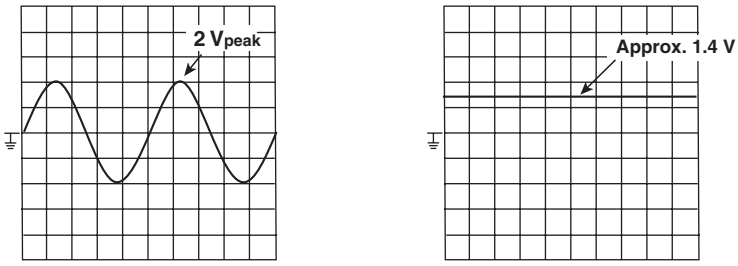
If the module of the selected channel is a 701260 (HV (with RMS)), the rms value of the input signal can be observed.

AC-RMS

This setting is used when you want to observe only the rms values of the AC signal, eliminating the DC components from the input signal.

Example

When the rms value of a 2-V_{peak} sinusoid input signal is measured, a DC waveform at approximately 1.4 V is displayed (see the right figure below).



The rms value is derived from the following equation:

$$\sqrt{\frac{1}{T}\int_0^T u(t)^2\,dt}$$ **Where u(t) is the input signal and T is one period of the input signal.**

If $u(t) = V_m \sin\omega t$ (where V_m is the peak value and ω is the angular velocity (= $2\pi f$, where f is the frequency of the sinusoid signal)), the rms value, V_{rms}, is derived from

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

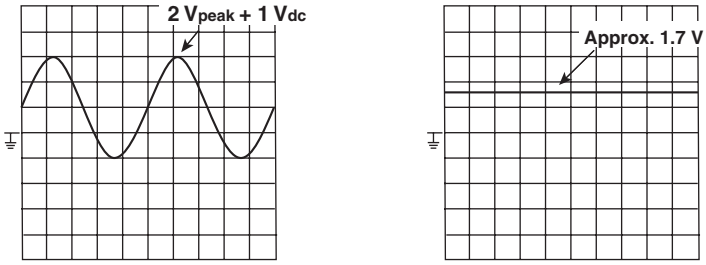
As in the above example, when V_m is 2 V, the rms value, V_{rms}, is approximately 1.4 V.

DC-RMS

This setting is used when you want to observe the rms values of both the DC and AC components of the input signal.

Example

When the rms value of a 2-V_{peak} sinusoid input signal riding on top of a 1-V DC component is measured, a DC waveform at approximately 1.7 V is displayed (see the right figure below).



If the DC component is expressed as V_{dc} and the AC component as $u(t) = V_m \sin\omega t$, the rms value, V_{rms} (+DC), of the sinusoid input signal riding on top of the DC component is derived from the following equation:

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

As in the above example, when V_{dc} is 1 V and V_m is 2 V, the rms value, V_{rms} (+DC), is approximately 1.7 V.

Temperature Measurement «For procedures, see section 5.14.»

Thermocouple Types

The following types of thermocouples are available.
K, E, J, T, L, U, R, S, B, N, W, and Au7Fe

Selectable Temperature Units

You can select °C or K.

Reference Junction Compensation (RJC)

The voltage generated by a thermocouple depends on the temperature of the spot of measurement and the reference junction temperature. In this case, the function used to compensate the temperature on the measurement instrument side to the cold junction is referred to as reference junction compensation. The SL1400 normally performs reference junction compensation with the built-in RJC circuit. The SL1400 allows you to turn ON or OFF the internal reference junction compensation.

Burnout

This function is used to accurately detect a burnout in the thermocouple. If the thermocouple measurement input detects a burnout, the measured value is fixed to the upper limit of the measurement range of each thermocouple.

Strain Measurement «For procedures, see section 5.15.»

Strain can be measured by connecting a strain gauge bridge (bridge head) or a strain gauge transducer to the strain module (701270 (STRAIN_NDIS) or 701271 (STRAIN_DSUB)).

Relationship between the Strain (μSTR) and the Transducer Output (mV/V)

The SL1400 allows the unit to be changed between “the strain unit (μSTR: $\times 10^{-6}$ strain)” and “the output unit of the strain gauge transducer (mV/V)*.” The following relationship exists between μSTR and mV/V.

* Unit corresponding to the output of the strain gauge transducer. A value expressing the transducer output per volt applied to the bridge in mV. You can set the bridge voltage (excitation: voltage applied to the bridge) from 2 V, 5 V, and 10 V. However, since the mV/V value is a converted value, the measured value is basically constant.

$$mV/V = 0.5 \times (\mu STR/1000)$$

Example

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

Gauge Factor (K) when mV/V Is Selected

You can set the gauge factor to an arbitrary value on the SL1400. However, if there are no specifications on the strain gauge transducer, set K to 2.
If K is not 2, e is derived within the SL1400 using the following equation.

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

- e: Measured value of the strain gauge transducer [mV/V]
- V: Voltage measured on the bridge [V]
- E: Voltage applied to the bridge [V]
- K: Gauge factor

Shunt Calibration

The 701271 (STRAIN_DSUB) supports shunt calibration.

* Shunt calibration refers to the act of correcting the gain of the strain measurement by connecting a known resistance (shunt calibration resistance) to the strain gauge in parallel.

For a description of the basic defining equation of strain, see appendix 9. For details on shunt calibration, see appendix 10.

Acceleration Measurement «For procedures, see section 5.16.»

The Acceleration/Voltage Module (with AAF) (701275 (ACCL/VOLT)) measures acceleration using the output signal from the acceleration sensor. Direction connection is possible to a built-in amplifier type acceleration sensor. Direct connection is not possible to a charge output type acceleration sensor that does not have a built-in amplifier.

Current Supply to Acceleration Sensors

The 701275 (ACCL/VOLT) can supply 4 mA of current to the acceleration sensor when measuring acceleration.

Filter

If you set the bandwidth limit to Auto, the anti-aliasing filter (AAF) and low-pass filter are enabled depending on the sample rate to eliminate high-frequency noise from the input signal. Using the anti-aliasing filter when measuring voltage allows elimination of aliasing noise resulting from FFT computation. The filter is effective not only during acceleration measurement but also during voltage measurement.

Frequency Measurement «For procedures, see section 5.17.»

The Frequency Module (701280 (FREQ)) measures frequency, number of rotations, period, duty cycle, power supply frequency, pulse width, pulse integration, and velocity.

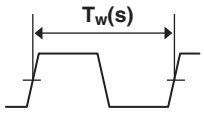
Measurement Items

Frequency

Frequency (Hz) = $1/T_w$ (s)

Period

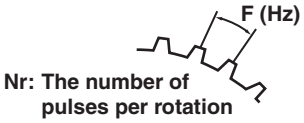
Period (s) = T_w (s)



RPMs/RPSs

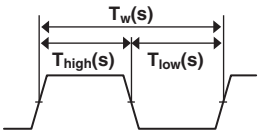
RPMs = Frequency (Hz)/the number of pulses per rotation (Nr) × 60

RPSs = Frequency (Hz)/the number of pulses per rotation (Nr)



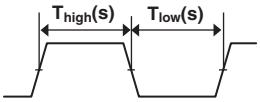
Duty Cycle

Duty cycle (%) = T_{high} (s)/T_w (s) or Duty (%) = T_{low} (s)/T_w (s)



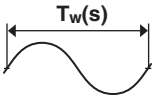
Pulse Width

Pulse width (s) = T_{high} (s) or Pulse width (s) = T_{low} (s)



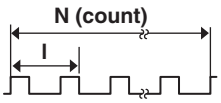
Power Supply Frequency

Power supply frequency (Hz) = 1/T_w (s)



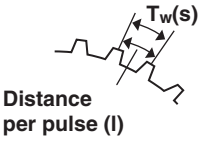
Pulse Integration (Distance/Flow Rate)

Pulse integrated value = N (count) × physical amount per pulse (I)
Set the physical amount per pulse (I) to distance or flow rate. A suitable user-defined unit can be assigned to the specified physical amount.



Velocity

Velocity (km/h) = Distance per pulse I (km)/T_w (s) × 3600
Velocity (m/s) = Distance per pulse I (m)/T_w (s)
The distance and unit can be user defined (angular velocity, etc.).



Deceleration Prediction and Stop Prediction

The 701280 (FREQ) automatically performs internal computation and displays waveforms by predicting the deceleration curve and stop point even when the input pulse is suddenly cut off. This function allows the measurement of waveforms of deceleration behavior that is close to the actual physical phenomenon in applications in which the deceleration behavior of an object that have inertia is measured such as in the brake test of automobiles.

Deceleration Prediction

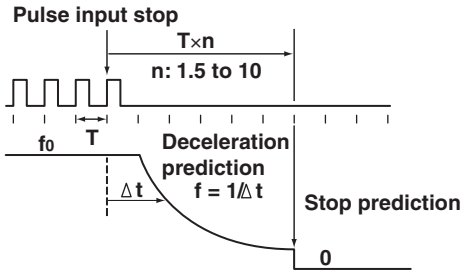
The deceleration curve is computed according to the following equation using the elapsed time after the pulse input stops (Δt).

Frequency (f) = 1/period (Δt)

The deceleration prediction starts after a pulse period (T) of the pulse one period before the pulse input stopped elapses after the pulse input stopped.

Stop Prediction

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



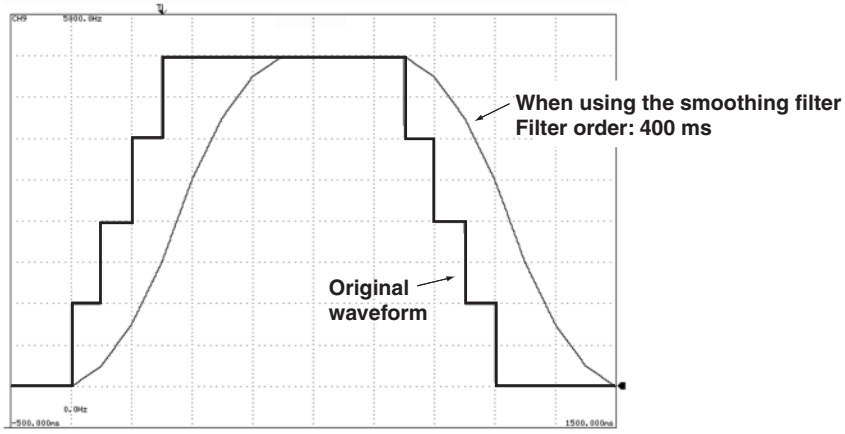
Filter

Smoothing Filter (Moving Average)

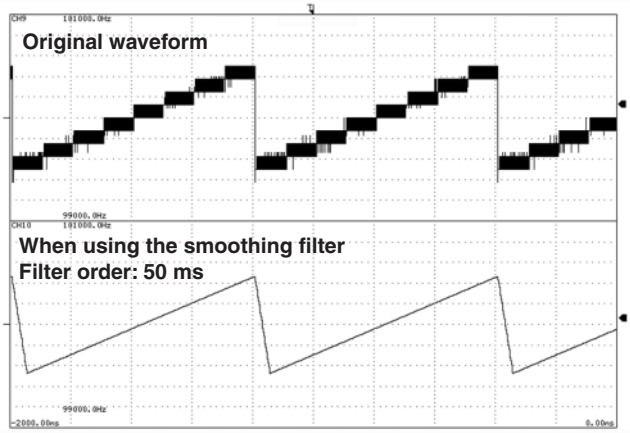
The frequency module can display waveforms by taking the moving average of the data in realtime. The order of moving average can be set in terms of time in the range of 0.1 ms to 1 s (up to 25000th order). The order of moving average is equal to the specified time divided by 40 μs.

The smoothing filter has the following characteristics.

- Converts a waveform that changes in steps to a smooth waveform.
- Improves the resolution by reducing the measurement jitter. The resolution improves especially when measuring high frequencies or when expanding the display using the offset function. Consequently, highly accurate measurements can be made.
- Can be used on all measurement parameters of the frequency module.



• When using the offset function (see this page) and making measurements by expanding near 100 kHz



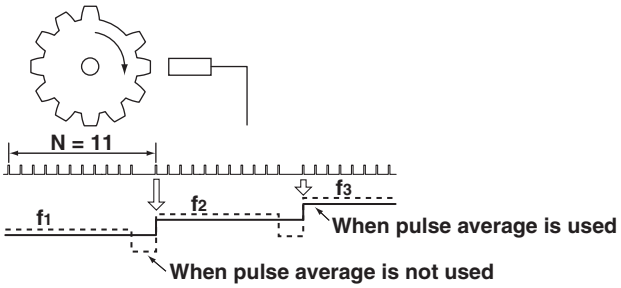
•Value/div: 200 Hz/div
•Upper display limit: 101 kHz
•Lower display limit: 99 kHz

The accuracy improves when the smoothing filter is used.

Pulse Average

Measures the input pulse by dividing the pulse by the specified number of pulses (1 to 4096 pulses). The pulse average has the following characteristics.

- If pulse dropouts are present or pulse interval is fluctuating within a period, measurements can be made by eliminating the effects from the dropout or fluctuation (fluctuating component of the waveform used to measure the frequency or period).
- The measured result is displayed as a value per input pulse even when pulse average is used. Therefore, there is no need to perform scaling again.
- Can be used when measuring frequency, number of rotations, power supply frequency, pulse integration, and velocity.



Offset Function

The 701280 (FREQ) allows you to set the center of observation (offset value) and expand the area around the offset value for close observation. It allows you to measure the fluctuation around a certain frequency.

Logic Waveforms «For procedures, see section 5.18.»

Logic waveforms can be measured by connecting logic probes to the logic signal input connectors (two connectors marked Logic A and Logic B) on the left side panel. A-1 to A-8 (8 bits) and B-1 to B8 (8 bits) can be applied to the Logic A and Logic B ports, respectively.

2.3 Setting the Trigger

Trigger Type «For procedures, see chapter 6.»

The trigger used on the SL1400 can be classified into two main types: simple trigger and enhanced trigger.

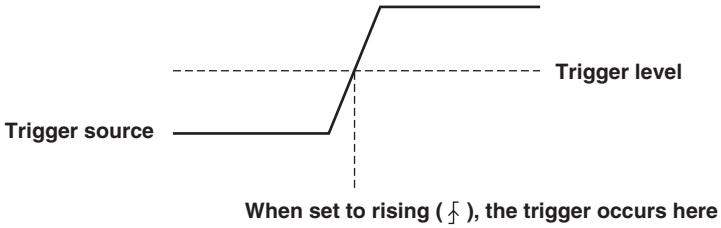
Simple Trigger

This function activates a trigger on a single trigger source.

Input Signal Trigger

A trigger is activated when the trigger source (input signal of CH1 to CH16, Logic A, or Logic B) reaches or exceeds the preset trigger level (rising) or falls to or below the trigger level (falling) or both.*

* A trigger is activated when the specified trigger condition is met. At this point, the waveform is ready to be displayed on the screen.
Trigger slope refers to the rising or falling edge of the signal.



External Trigger

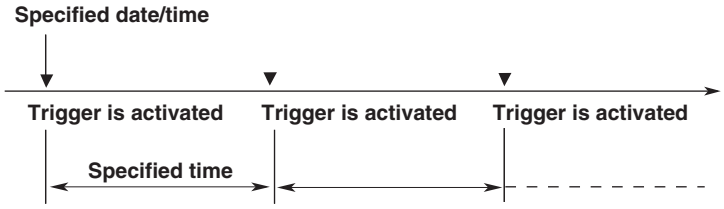
A trigger is activated using the external signal applied to the EXT TRIG IN terminal on the side panel of the SL1400.

Line Trigger

A trigger is activated on the rising edge of the power signal that is being supplied to the SL1400. Waveforms synchronized to the commercial power supply frequency (50 Hz or 60 Hz) can be observed.

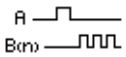
Timer Trigger

A trigger is activated at specified time intervals (1 min to 24 hours) from a specified time.

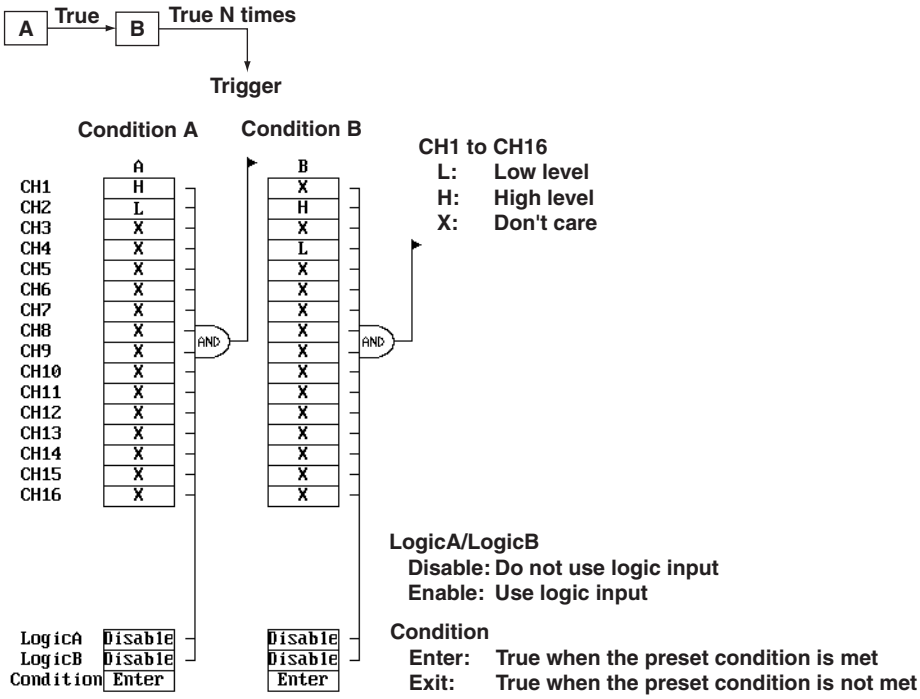


Enhanced Trigger

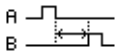
A –>B(N) Trigger



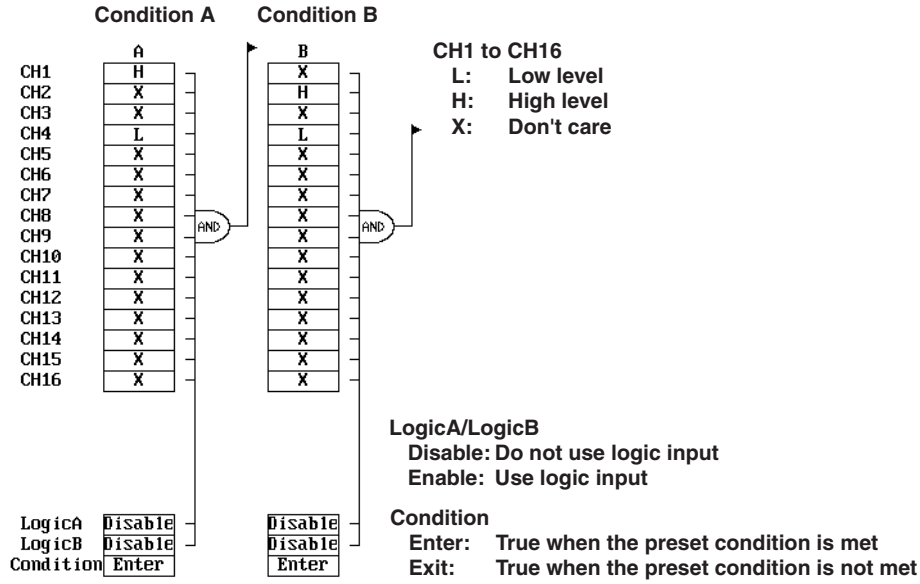
A trigger is activated the N[th] time condition B becomes true after condition A has become true.

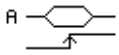


A Delay B Trigger



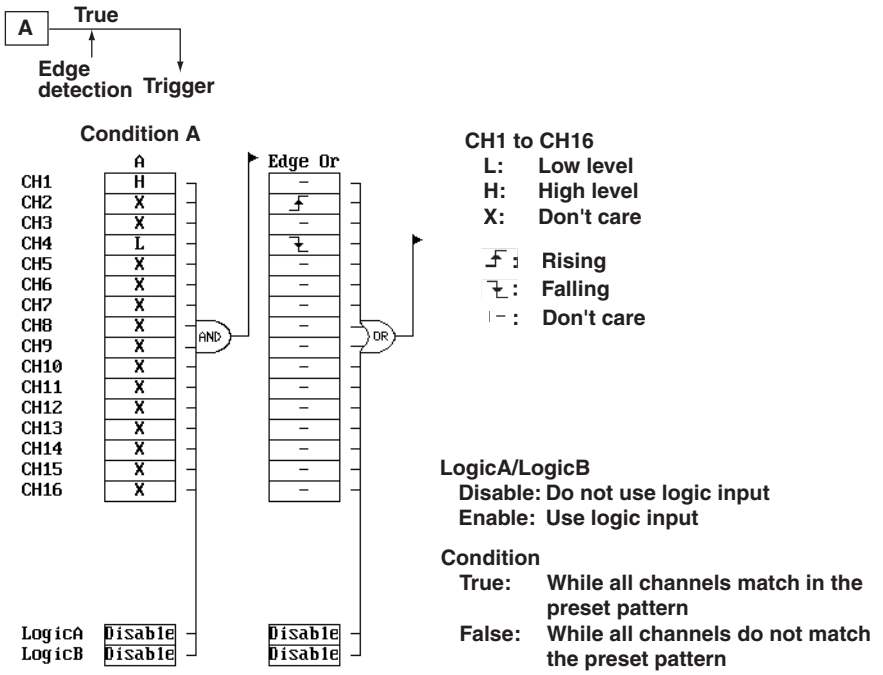
A trigger is activated the first time condition B becomes true after condition A has become true and a preset time has elapsed.

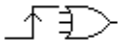




Edge on A Trigger

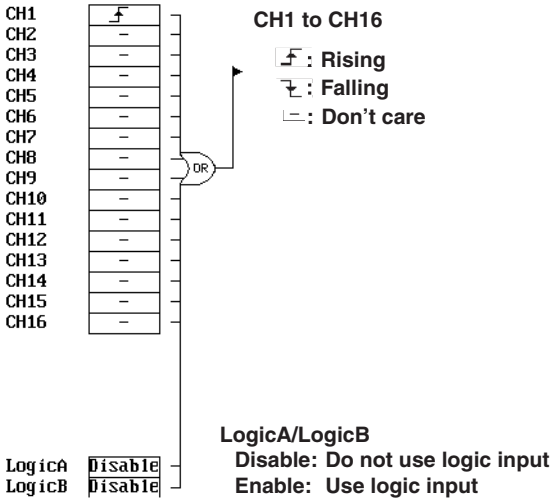
A trigger is activated when an edge trigger is detected on any of the channels set to edge trigger while condition A is true.





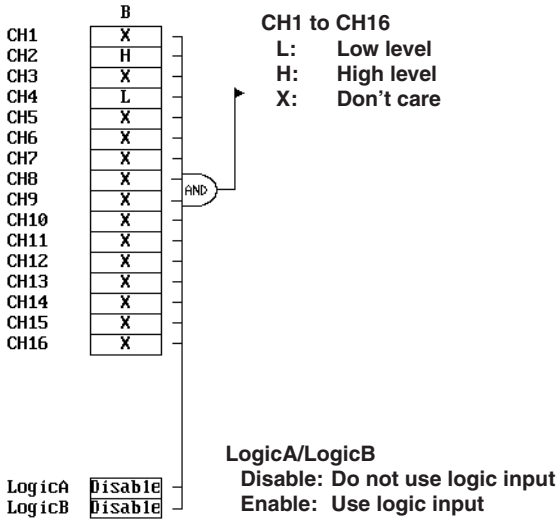
OR Trigger

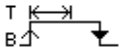
A trigger is activated when any of the channels set to edge trigger meets the condition. For example, a trigger can be activated on the rising edge of CH1 or CH2.



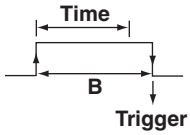
B > Time Trigger, B < Time Trigger, and B TimeOut Trigger

A trigger is activated on the falling or rising edge of the pulse when the pulse width (width over which condition B is met) exceeds (or drops below) a preset time. In the case of a timeout trigger, a trigger is activated when a preset time elapses.

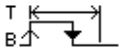




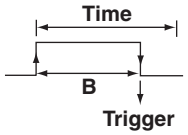
- B > Time Trigger

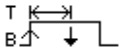


B: Pulse width

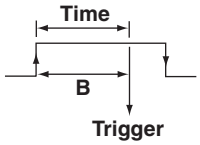


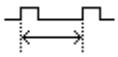
- B < Time Trigger





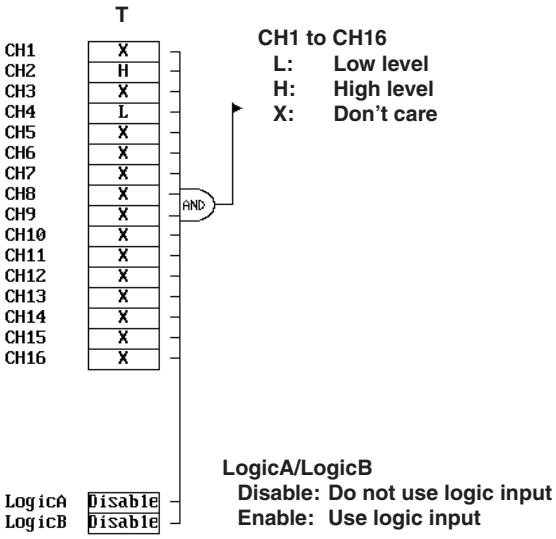
- B TimeOut Trigger





Period Trigger

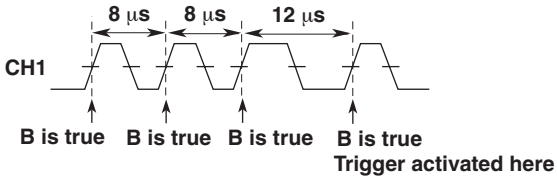
A trigger is activated by measuring the pulse period (period from the time condition T is met to the next time when condition T is met).



- **T > Time**

  A trigger is activated when condition B is met the second time, if the time (T) when condition B is met the second time is longer than a specified time.

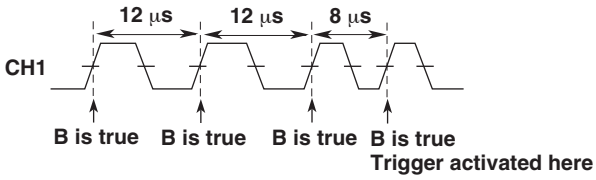
When condition B: CH1=H and Time=10 μs



- **T < Time**

  A trigger is activated when condition B is met the second time, if the time (T) when condition B is met the second time is shorter than a specified time.

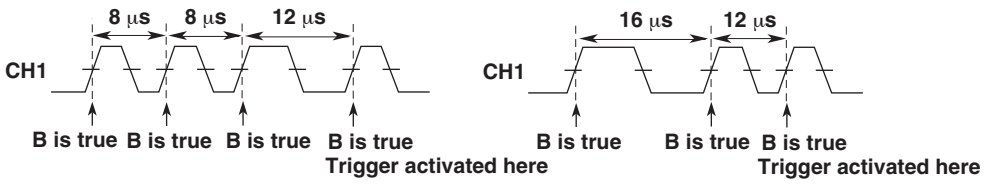
When condition B: CH1=H and Time=10 μs



- **T1 < T < T2**

  A trigger is activated when condition B is met the second time, if the time (T) when condition B is met the second time is within a specified time range (T1 to T2).

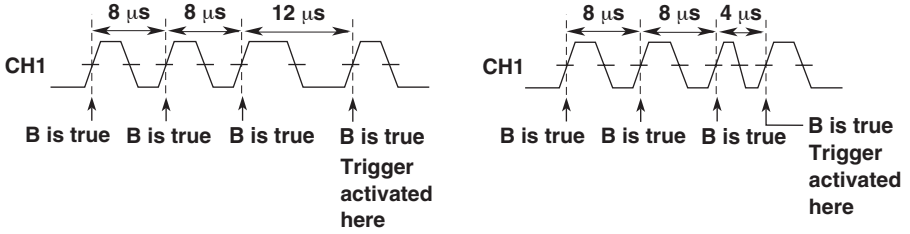
When condition B: CH1=H, Time1=10 μs, and Time2=14 μs



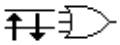
- **T < T1, T2 < T**

  A trigger is activated when condition B is met the second time, if the time (T) when condition B is met the second time is outside a specified time range (T1 to T2).

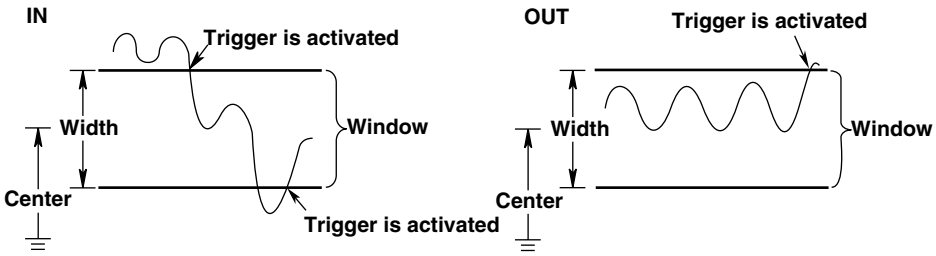
When condition B: CH1=H, Time1=6 μs, and Time2=10 μs

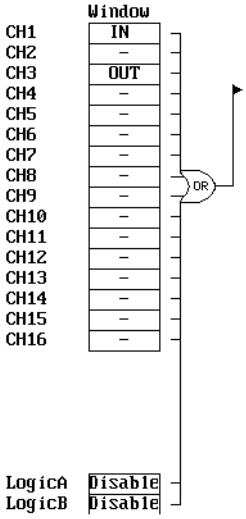


Window Trigger



A certain voltage range (window) is set and a trigger is activated when the trigger source level enters this voltage range (IN) or exits from this voltage range (OUT).

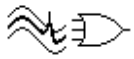




CH1 to CH16
IN: Enters the window
OUT: Exits from the window
: Don't care

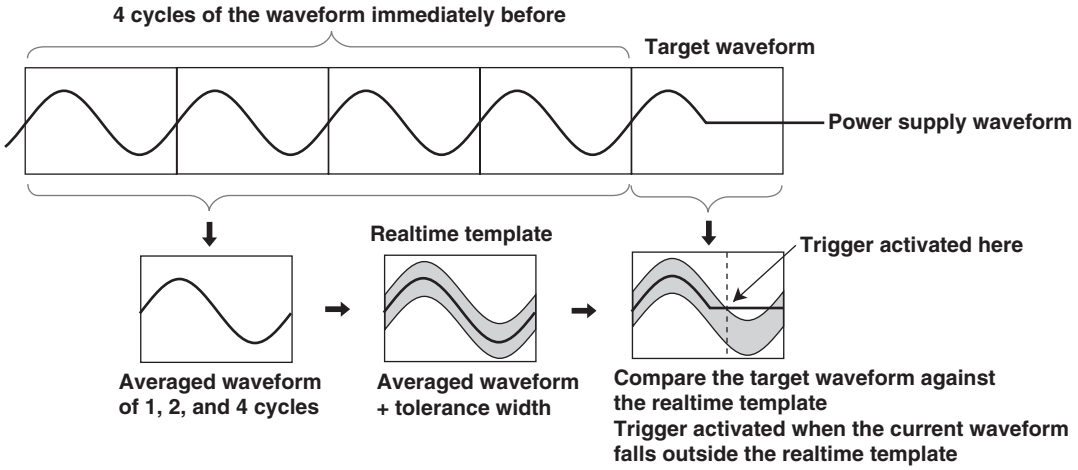
LogicA/LogicB
Disable: Do not use logic input
Enable: Use logic input

Edge trigger is used for the logic input.
: Don't care
: Falling edge
: Rising edge

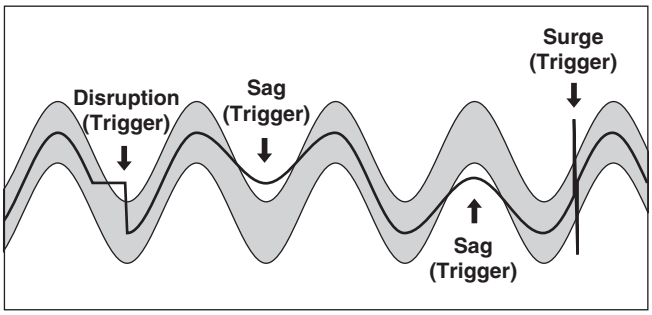


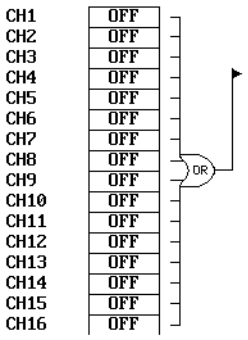
Wave Window Trigger

This trigger is used to monitor the power supply waveform. It detects abnormalities in the power supply (disruption, sag, surge, frequency fluctuation, voltage drop, etc.).
A reference waveform (realtime template) is created by setting a tolerance (window width) to a waveform derived by averaging 1 to 4 cycles of waveforms before the target cycle of the current waveform. The current waveform is compared against the realtime template. If the current waveform falls outside the realtime template, a trigger is activated.

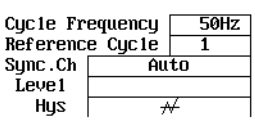


- **Wave Window Trigger Example**





CH1 to CH16
ON: Use as a trigger source
OFF: Not use as a trigger source



Cycle Frequency: Power supply frequency of the measured item
Reference Cycle
Sync. Ch: Synchronization channel[1] for starting triggers
Level: Level of the synchronization channel
Hys: Hysteresis of the synchronization channel

* Because waveform determination is performed per cycle in wave window trigger, synchronization signal must be retrieved from the reference channel, and the start and end points of comparison must be detected. This reference channel is called a synchronization channel. Sync.Ch is used to specify the synchronization channel, and Level is used to specify the start level of the synchronization channel. Normally, Sync.Ch is set to Auto (the channel with the smallest number among the modules that can perform wave window trigger). If the trigger is not activated adequately, specify an appropriate channel.

Trigger Mode «For procedures, see section 6.1.»

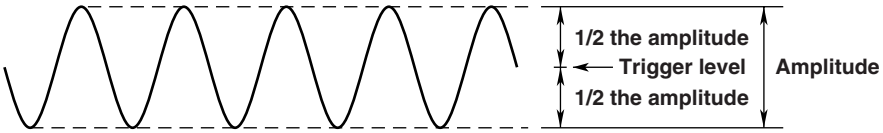
The trigger mode sets the conditions for updating the displayed waveforms. The following six trigger modes are available.

Auto Mode

If a trigger occurs within a specified amount of time (approximately 50 ms, referred to as the timeout period), the displayed waveforms are updated. If a trigger is not activated within the timeout period, the displayed waveforms are automatically updated.

Auto Level Mode

Within the timeout period (approximately 1 s), the waveforms are displayed in the same fashion as in the auto mode. If a trigger is not activated within the timeout period, then the center value of the amplitude of the trigger source is detected, and the trigger level is changed to that value. A trigger is activated using the new value, and the displayed waveforms are updated.



Normal Mode

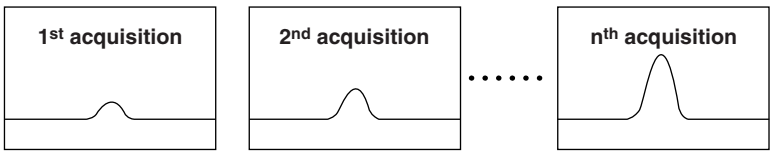
The waveform display is updated only when a trigger occurs. (The displayed waveforms are not updated if a trigger does not occur.)

Single Mode

When a trigger is activated, the displayed waveforms are updated only once, and acquisition stops. This mode is suitable for observing a single-shot signal.

Single (N) Mode (Sequential Store Function)

This mode is selected when using the sequential store function (see section 2.4). Waveforms are acquired and stored in different memory areas each time a trigger is activated the specified number of times. Then, acquisition is stopped, and all the acquired waveforms are displayed. Acquired waveforms can be displayed together, or they can be displayed individually. This mode is useful for detecting sudden abnormalities in a waveform.

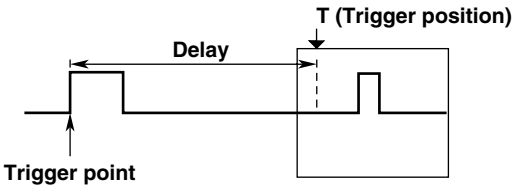


Log Mode

In this mode, the trigger settings are disabled. The specified record length of data is acquired once when acquisition is started, and the displayed waveforms are updated.

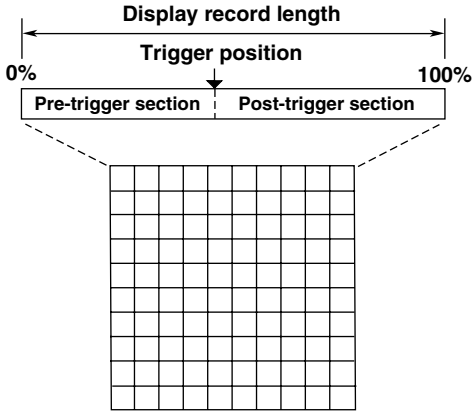
Trigger Delay «For procedures, see section 6.3.»

Normally, the waveform around the trigger point is displayed. However, by setting a trigger delay, you can display the waveform that is acquired a specified time after the trigger point.



Trigger Position «For procedures, see section 6.2.»

The trigger position specifies the position of the waveform captured in the acquisition memory to be displayed on the screen. The point at which the trigger occurred is called the *trigger point*. If the trigger delay described in the previous section is set to 0 s, the trigger point and the trigger position match. By moving the trigger position, you can observe the pre-trigger section of the waveform before the trigger point.



Trigger Source, Trigger Slope, and Trigger Level «For procedures, see sections 6.5 to 6.16.»

Trigger Source

Trigger source refers to the target channel on which trigger conditions are specified. You can set an external trigger signal or a commercial power supply as a trigger source.

Trigger Slope

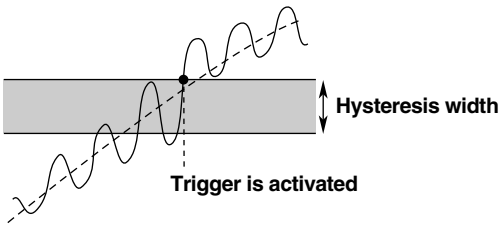
For an edge trigger, trigger slope specifies how the trigger source is to cross a specified level for activating the trigger. Select the trigger slope from ⨍ (rising), ⨏ (falling), and ⨍⨏ (both rising and falling).

Trigger Level

Trigger level refers to the voltage level that is used to determine the trigger slope (rising/falling edge of the signal) and the like.

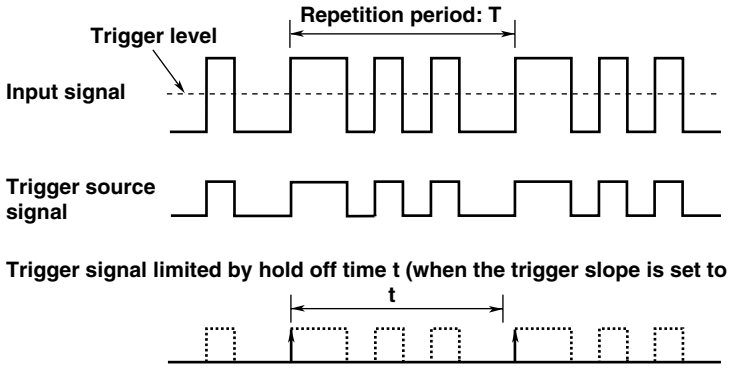
Trigger Hysteresis «For procedures, see sections 6.5, and 6.10 to 6.16.»

If there is insufficient trigger level width such as when noise is present in the trigger source, the trigger point fluctuates each time a trigger is activated. This causes the displayed waveforms to be unstable. To solve this problem, a specified margin (hysteresis) is added to the trigger level. You can select the trigger hysteresis from the following: , , and . The hysteresis width varies depending on the input module.



Trigger Hold-off «For procedures, see section 6.4.»

Trigger hold-off refers to the act of temporarily stopping the detection of the next trigger once a trigger has been activated. This function is useful when observing a pulse train signal, such as a PCM code, and you want to display the waveform in sync with repetitive cycles; or when using the history memory function described later and you want to change the waveform acquisition period.



Action-on-Trigger «For procedures, see section 6.18.»

A specified action can be executed each time a trigger is activated. The following five types of actions are available.

Print the Screen Image Data (PRINT)

Prints the screen image to a specified printer.

Save the Screen Image Data (Image)

Saves the screen image data to the save destination specified in the IMAGE menu.

Save Waveform Data (Save to File)

Saves the waveform data in binary, ASCII, or floating format to the save destination specified in the FILE menu.

Beep Sound (Buzzer)

Sounds a buzzer.

Send Mail

Sends an e-mail message to a specified address (when Ethernet interface option is installed).

Manual Trigger «For procedures, see section 6.19.»

You can activate a trigger regardless of the specified trigger condition by pressing the MANUAL TRIG key on the front panel.

2.4 Setting Waveform Acquisition Conditions and Display Conditions

Acquisition Mode «For procedures, see sections 7.2 and 7.3.»

When storing sampled data in the acquisition memory, it is possible to perform processing on data and display waveforms based on the processed data. The following four types of data processing are available.

Normal Mode

In this mode, sampled data are stored in the acquisition memory without data processing.

Averaging Mode

Averaging is a process in which waveforms are acquired repeatedly to obtain the average of waveform data at the same time point (the same time in relation to the trigger point).

The SL1400 takes the simple or exponential average of the waveform data and writes the results to the acquisition memory. The averaged data is then used to generate the display. You can set the attenuation constant to a value between 2 and 256 (in 2^n steps, where n is a natural number) and the averaging count to a value between 2 and 65536.

Exponential average (when set to infinite)

$$An = \frac{1}{N}\{(N-1)A_{n-1} + X_n\}$$

An : n^{th} averaged value
Xn : n^{th} measured value
N : Attenuation (2 to 256, 2^n steps)

Simple average (when set to 2 to 65536)

$$A_N = \frac{\sum_{n=1}^{N} X_n}{N}$$

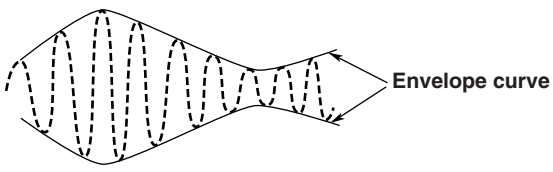
Xn : n^{th} measured value
N : Average count (acquisition count, 2^n steps)

Averaging is effective such as when eliminating the random noise riding on the signal.

Envelope Mode

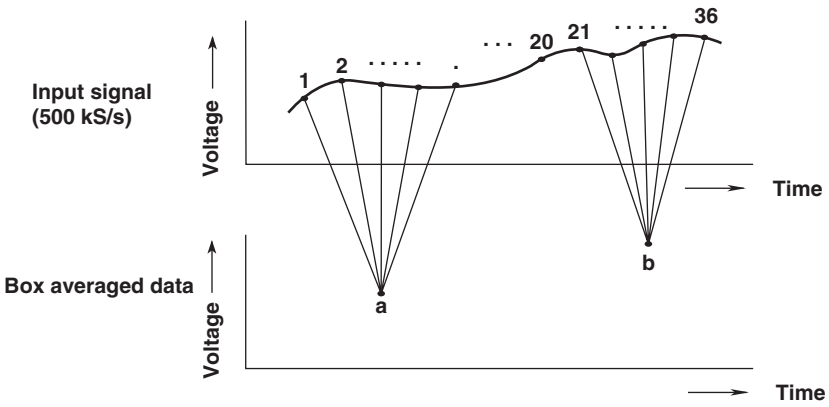
In normal mode and averaging mode, if you increase the record time, you must reduce the sample rate (the number of times data is acquired per second in the acquisition memory) to keep the record length of the acquisition memory the same (see appendix 1). However, in the envelope mode, the maximum and minimum values are determined at every time interval from the data sampled at the maximum sample rate of each input module. The time interval used to determine the values is twice the sample rate of the normal mode. The maximum and minimum values are paired and stored in the acquisition memory.

Envelope mode is effective when you want to avoid aliasing, since the sample rate is kept high irrespective of the time axis setting. It is also effective when you want to detect glitches (pulse signals which rise very fast) or display an envelope of a modulating signal.



Box Average Mode

This mode is valid on the 701250 (HS10M12) and 701255 (NONISO_10M12). The rolling average of the data sampled at the maximum sample rate is determined. The resultant data is stored in the acquisition memory and used to generate the display. Box averaging is effective in eliminating small amounts of noise from the input signal. It can also remove noise from a single-shot signal.

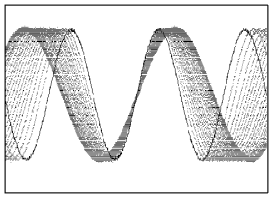


Sequential Store «For procedures, see section 7.4.»

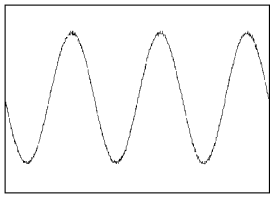
In the case of the history memory function describe in the next subsection, the waveform data of each block is updated in order until the measurement is stopped. However, in the sequential store function, you specify the waveform acquisition count (number of blocks), and the measurement stops when the specified count is reached. The updating of the waveform display is carried out after acquiring the entire waveform data. To acquire waveforms using this function, set the trigger mode to Single(N). The maximum Single(N) count is equal to N that is explained in the history memory function. The stored waveform data can be recalled using the history memory function.
The figure below shows an example when data is sequentially stored 100 times.

Display example when the acquisition count is 100

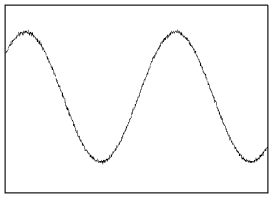
- **Displays all waveforms (When All display is executed)**



- **Displays only the newest waveform(When Selected Record No. = 0)**

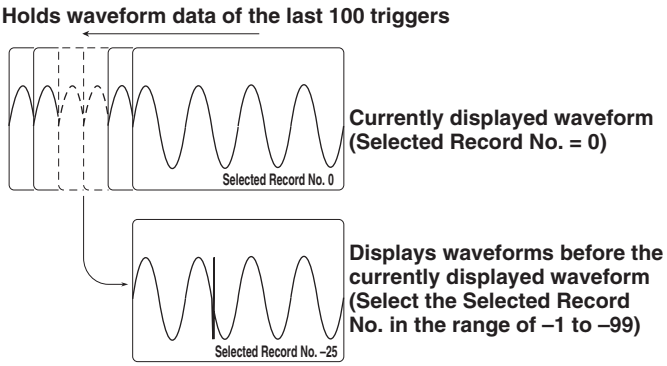


- **Displays only the oldest waveform(When Selected Record No. = –99)**



History Memory «For procedures, see section 11.1.»

If the record length is set short on the SL1400, the memory is divided into blocks, and waveform data is saved to the individual blocks each time a trigger occurs. If N represents the maximum number of blocks determined by the record length, the oldest waveform data block is cleared when the number of activated triggers exceeds N. If you stop the measurement, you can recall the waveform data stored in each block and display the data on the screen. Once the specified number of waveforms have been stored, you can display any of the waveforms individually or all of them together. This function is useful when capturing the changes in the waveform over time.
The following figure indicates an example when N = 100.



You can also search a particular waveform from the past waveforms that are held (history search function). For details, see “History Search” in section 2.7.

Realtime Recording to the Internal Hard Disk (Option) «For procedures, see section 7.5.»

The data can be recorded in realtime to the internal hard disk (option). The stored data can be recalled. The realtime recording area is allocated on the internal hard disk in advance (the default value is 50% of the entire capacity of the internal hard disk). You can set the realtime recording area in the range of 30% to 70% of the entire capacity of the internal hard disk when you format the internal hard disk (see section 13.6).

The time axis range and the maximum sample rate that allow realtime recording vary depending on the number of channels to be recorded in realtime. For details, see appendix 3.

The following two modes of realtime recording operation are available.

Single: Starts realtime recording with the start of waveform acquisition and stops realtime recording when the specified record time is reached.

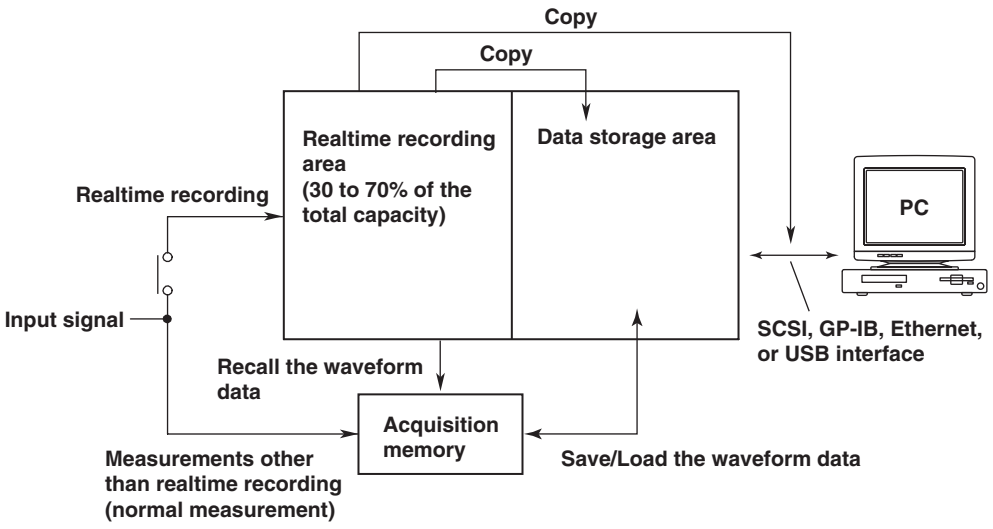
Continue: Starts realtime recording with the start of waveform acquisition and stops realtime recording when the specified record time is reached. This sequence is repeated the specified number of times (count).

If you select Single, Auto or Log trigger modes are available. If you select Continue, only Log is valid.

Auto: Acquisition is started by pressing START. If the specified record time is exceeded, old data is overwritten. Acquisition continues until you press STOP.

Log: Acquisition is started by pressing START. When the specified record time is reached, acquisition stops.

How the Internal Hard Disk (Option) Is Used



Action-on-Stop «For procedures, see section 7.6.»

A specified action can be carried out when the waveform is displayed after acquiring the specified record length of data after the measurement is started or when measurement is stopped. The following five types of actions are available.

Print the Screen Image Data (PRINT)

Prints the screen image to a specified printer.

Save the Screen Image Data (Image)

Saves the screen image data to the save destination specified in the IMAGE menu.

Save Waveform Data (Save to File)

Saves the waveform data in binary, ASCII, or floating format to the save destination specified in the FILE menu.

Beep Sound (Buzzer)

Sounds a buzzer.

Send Mail

Sends an e-mail message to a specified address (when Ethernet interface option is installed).

Backing Up the Acquisition Memory «For procedures, see section 7.7.»

If the ACQ MEMORY BACKUP switch on the right side panel of the SL1400 is turned ON, the history memory data in the acquisition memory is backed up even when the power supply is cut off. The data held in the acquisition memory is backed up immediately before the power is turned OFF. This function protects the data in the acquisition memory from sudden power failures.
Alkaline dry cells or nickel hydride rechargeable batteries (four AAA batteries) are required for the backup. The backup time varies depending on the operating environment.
For reference values of the backup time, see section 18.5.

Display Format and Waveform Mapping «For procedures, see section 8.1.»

Display Format

Waveforms can be displayed in divided windows to facilitate the viewing of multi-channel waveforms and computed waveforms.

Waveform Mapping

You can select the mapping of the input channels to the divided windows from the following:

- Auto: The input channels whose display is turned ON are assigned in order by the channel numbers.
- Fixed: Waveforms are assigned in order from the top regardless of whether the input channel display is turned ON/OFF.
- User: The channels can be assigned arbitrarily to the divided windows regardless of whether the input channel display is ON/OFF.

Display Interpolation «For procedures, see section 8.2.»

In areas where less than 1000 points of data exist in the 10 divisions along the time axis (referred to as interpolation areas), a continuous waveform cannot be displayed because there is not enough sampled points. In this case, waveform is displayed by interpolating between data points. You can select the interpolation method from the following:

Linear Interpolation

Linearly interpolates between two points.

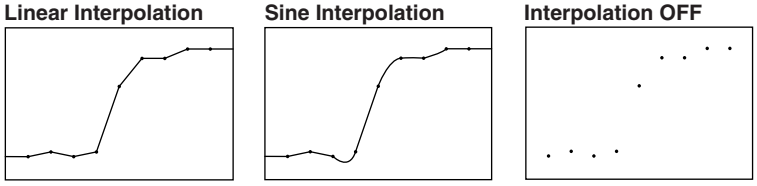
Sine Interpolation

$\frac{\sin x}{x}$ Generates interpolation data using the function sin(x)/x then interpolates between two dots using the resulting sine curve. Sine interpolation is suitable for observing sine waves or similar waves.

Interpolation OFF

Displays discrete dots without performing interpolation.

Linear Interpolation **Sine Interpolation** **Interpolation OFF**



If the interpolation is OFF, waveforms are displayed using dots. In this setting, up to 100100 points (100 kpoints) of the acquired data are displayed without using P-P compression (page 2-4). For details, see page 2-5.

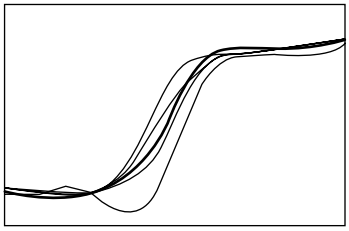
Graticule «For procedures, see section 8.3.»

You can change the type of graticule that is displayed to suit your needs. For example, you can show a grid on the screen or show only the frame.

Accumulated Display «For procedures, see section 8.4.»

This mode holds each waveform on the screen for a time that is longer than the update cycle, so that newer waveforms appear overlapped on older waveforms. If you select Persist, the waveforms are accumulated.

Accumulated display is useful when you want to observe jitters and temporary turbulence in waveforms. Accumulated display is also possible on waveforms that are recalled using the history memory function.



Zooming in on the Waveform Horizontally «For procedures, see section 8.5.»

The displayed waveform can be expanded along the time axis. This function is useful when the waveform acquisition time is set long and you want to observe a particular section of the waveform closely. Zooming is not possible if the number of displayed points on the screen is less than or equal to 10 (less than or equal to 50 for FFT waveforms). The zoom position is set in units of divisions of the grid.

Display Format When the Waveform Is Zoomed

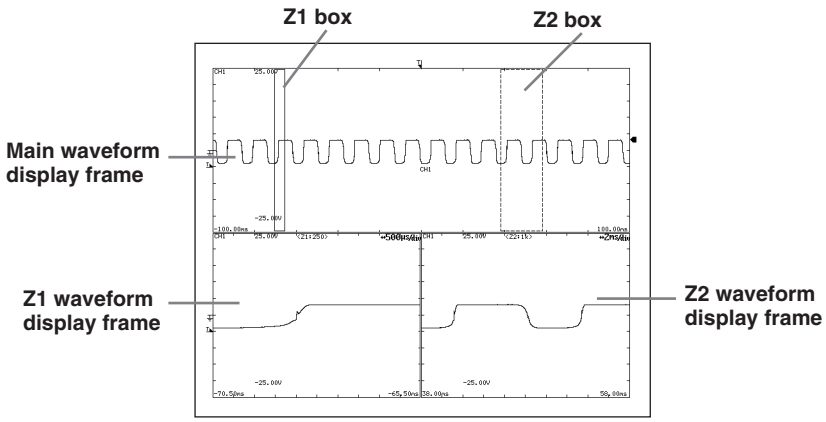
Zoomed waveforms of two locations can be displayed simultaneously (dual zoom). Below are the combinations of the display methods of zoom waveforms.

Main: Main waveform display frame

Z1, Z2: Zoom waveform display frame

<Main>		<Main>	<Z1>	<Z1> or <Z2>
<Z1>	<Z2>	<Z1> or <Z2>	<Z2>	

When displaying Main (main waveform) and Z1 or Z2 (zoomed waveform) simultaneously, a zoom box indicating the zoom position is displayed within the main waveform display frame. The center of the zoom area corresponds to the center of the zoom box.



Auto Scroll

The zoom box automatically moves (scrolls) in the specified direction. You can scroll while viewing the expanded waveform.

X-Y Waveform «For procedures, see section 8.6.»

The voltage relationship between signals can be observed by assigning the voltage of the input signal of the specified channel on the horizontal axis (X-axis) and the voltage of another input signal (signal that has the display turned ON) on the vertical axis (Y-axis). Simultaneous observation of X-Y waveforms and normal T-Y waveforms (waveform display using voltage axis and time axis) is possible.

You can use the X-Y waveform display function to measure the phase angle between two sine wave signals. For example, the waveform that appears when two sine waveforms are shown on the X-Y display is called a Lissajous waveform. From this waveform, the phase angle can be read.

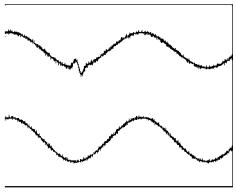
Lissajous waveform

Phase angle 0°			
Phase angle 45°			
Phase angle 90°			
Frequency ratio (X:Y)	**1:1**	**1:2**	**1:3**

Snapshot «For procedures, see section 8.7.»

If the trigger mode is set to a mode other than single, the displayed waveforms are periodically updated or displayed in roll mode.

The snapshot function allows you to temporarily hold the waveform that would be cleared when the screen is updated (snapshot waveform) on the screen. The snapshot waveform is displayed in white, allowing for easy comparison against the updated waveform. The snapshot waveform is a screen image waveform. You can save, load, and print the screen image data, but cursor measurements, automated measurement of waveform parameters, zoom, and computation cannot be performed on it.



Clear Trace «For procedures, see section 8.7.»

You can clear the snapshot waveform and restart averaging and accumulation using one key operation.

Pressing the CLEAR TRACE key temporarily clears the measured waveforms from the screen. Pressing the ESC key redisplays them.

Translucent Display «For procedures, see section 8.8.»

The pop-up menu is shown translucent so that the display under the pop-up menu can be seen.

Scale Values «For procedures, see section 8.9.»

The upper and lower limits (scale values) of the vertical and horizontal axes of each channel can be displayed.

Waveform Labels «For procedures, see section 8.10.»

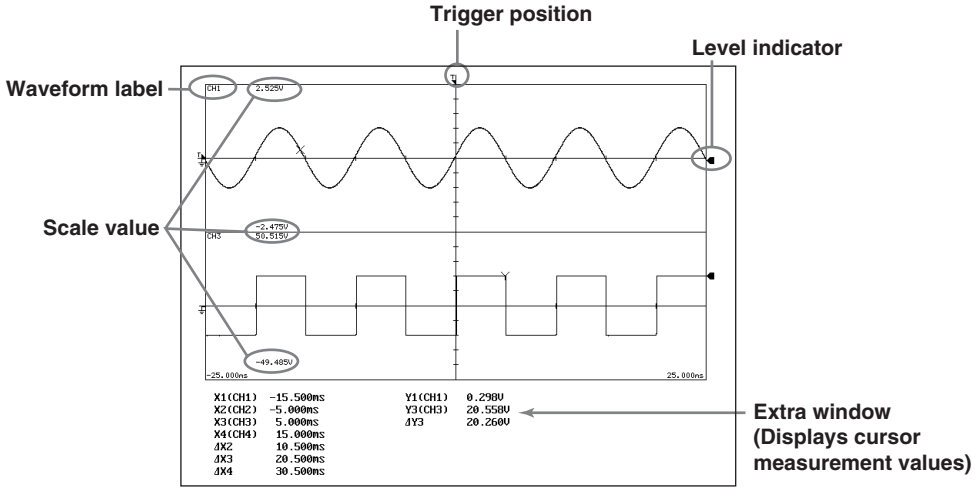
A waveform label can be assigned arbitrarily to the input waveform of each channel using up to eight characters.

Extra Window «For procedures, see section 8.11.»

This area displays data such as cursor measurement values and values resulting from automated measurement of waveform parameters. The extra window is useful when reading of the values is difficult because waveforms are overlapping them.

Level Indicators «For procedures, see section 8.12.»

The level of each waveform is displayed using an indication mark to the right of the waveform display frame.



Channel Information, Numeric Monitor, and Waveform Display Area Expansion «For procedures, see section 8.13.»

If you clear the setup menu by pressing ESC, channel information is displayed such as the voltage/division, input coupling, probe attenuation (type), bandwidth limit, temperature/division , thermocouple type, μSTR/division (or [mV/V]/division), measurement range, acceleration/div, gain, bias, value/division, measurement mode, and preset settings. However, some items are skipped when the number of displayed channels increases.

Pressing ESC once when the channel information is displayed clears the channel information and shows the numeric monitor.

Pressing ESC once when the numeric monitor is displayed expands the waveform display area horizontally to cover the entire screen.

If you press SELECT when the channel information or waveform monitor is displayed or when the waveform display area is expanded and an item is under jog shuttle control in the setup menu that was showing immediately before you pressed ESC, the item is displayed at the upper right of the display and can be controlled using the jog shuttle.

2.5 Recording in Recorder Mode

The SL1400 is equipped with an A-4 size printer. If Chart Recorder mode is selected in the menu that appears when MODE is pressed and waveform acquisition is started, T-Y waveforms (T-Y waveform recording) or numeric values can be recorded in realtime. In addition, if X-Y Recorder mode is selected and waveform acquisition is started and stopped, the X-Y waveform over the interval in which waveform was acquired can be recorded (X-Y waveform recording).

Chart Recorder Mode «For procedures, see sections 9.1 to 9.5.»

Print Style

In Chart Recorder mode, the print style can be selected from the following two styles.

T-Y Waveform Recording

In T-Y waveform recording, recording is performed at the specified chart speed (10 mm/h to 20 mm/s). The scale used in T-Y waveform recording is fixed to 10 mm per division on the horizontal axis (time axis). The scale on the vertical axis (voltage axis) can be set to 10 mm per division or [1 division of the 10 equally divided chart recording zone] per division. The recording can also be stopped automatically after recording a specified length (shot recording).

Numeric Value Recording

Numeric values can be recorded at the specified time interval (1 s to 60 min). Up to 16 channels can be recorded. If waveform acquisition is started on more than 16 channels, 16 channels are recorded in the following order: CH1 to CH6, Logic A, and Logic B.

Acquisition Mode during Chart Recorder Mode

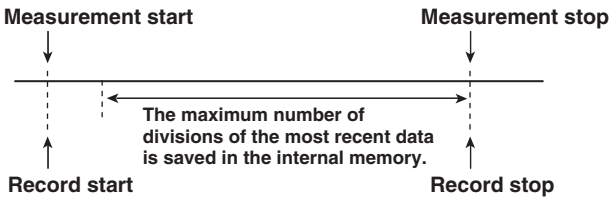
During Chart Recorder mode, the acquisition mode is set to envelope. The acquisition mode cannot be changed using the ACQ menu as with the normal operation. However, the acquisition mode can be changed to normal using other menus. Select normal mode if you are using the acquired waveform as numeric data such as in an analysis.

Selectable Trigger Modes in Chart Recorder Mode

The following four trigger modes are available.

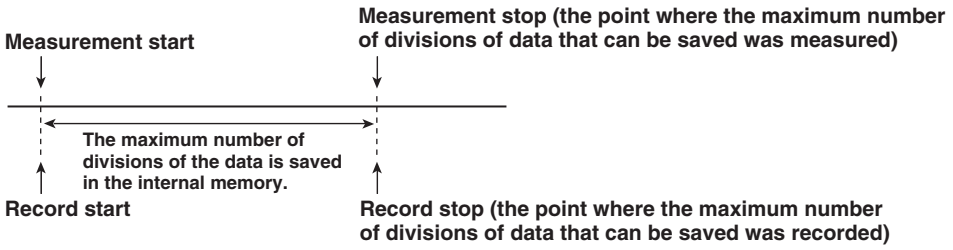
Auto

Recording on the built-in printer starts at the same time measurement is started by pressing START/STOP. Recording continues until measurement is stopped by pressing START/STOP again. The maximum number of divisions of the most recent data that can be saved (see page 2-39) is saved in the internal memory.



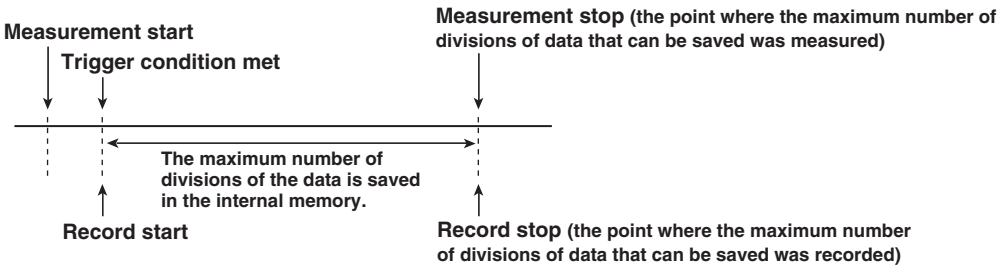
Log

Recording on the built-in printer starts at the same time measurement is started by pressing START/STOP. Measurement and recording stop automatically when the maximum number of divisions of measured values that can be saved is recorded. The maximum number of divisions of measured data that can be saved is saved in the internal memory.



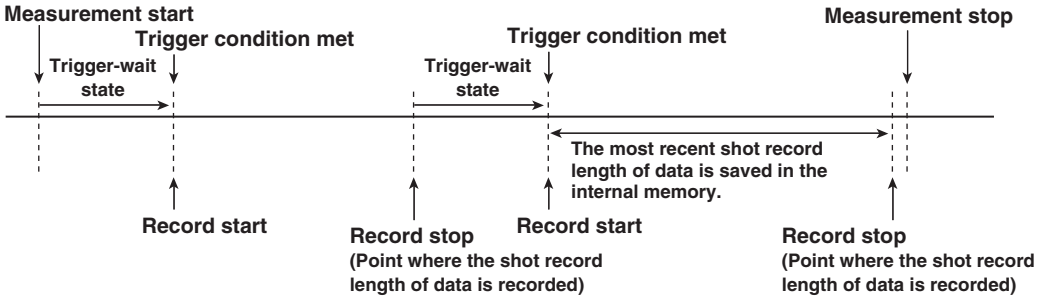
Single (Only during T-Y Waveform Recording)

Recording on the built-in printer starts when the trigger condition is met after measurement is started by pressing START/STOP. The data is saved to the internal memory at the same time recording is started. Measurement and recording stop when the maximum number of divisions of measured values that can be saved is recorded. The maximum number of divisions of measured data that can be saved is saved in the internal memory.



Repeat (Only during T-Y Waveform Recording)

Recording on the built-in printer starts when the trigger condition is met after measurement is started by pressing START/STOP. The data is saved to the internal memory at the same time recording is started. Recording stops when the shot record length of measured values is recorded. Then, the SL1400 enters the trigger-wait state. The most recent shot record length of measured data is saved to the internal memory.



Saving Data in the Internal Memory

In Chart Recorder mode, up to 1000 divisions of the recorded data are automatically saved in the internal memory. The required section of the data that has been cleared from the screen can be redisplayed after the recording is finished by using functions such as zoom (limited to the data in the range defined by “Number of Data Points That Can Be Saved” below). As with the normal data (data when the recorder mode is OFF), cursor measurements, automated measurement of waveform parameters, normal statistical processing*, zoom, and display setting modification in the DISPLAY menu can be performed on the redisplayed data. The redisplayed data can also be saved as waveform data in the same fashion as normal data.
Furthermore, the redisplayed data can be reprinted by changing the print conditions or a PDF file of the reprint image can be created (see “Reprinting on the Built-in Printer” or “Creating a PDF File of the Reprinted Image” on page 2-40).

* Cyclic statistical processing and statistical processing of history data cannot be performed in Chart Recorder mode.

Number of Data Points That Can Be Saved

If the chart speed is slow, the number of data points that can be saved in the internal memory is reduced. For example, if the chart speed is 10 mm/h, up to 100 divisions of data (up to 4 days of data) are saved. If the chart speed is 20 mm/s, up to 1000 divisions of data (up to 8 minutes 20 seconds of data) are saved. The maximum number of divisions that can be saved for each chart speed is as follows:

Chart Speed	Maximum Number of Divisions That Can Be Saved
20 [mm/s] to 1 [mm/s]	1000
100 [mm/min] to 2 [mm/min]	1000
1 [mm/min]	500
100 [mm/h]	1000
50 [mm/h]	500
25 [mm/h]	250
20 [mm/h]	200
10 [mm/h]	100

For the relationship between the chart speed and sample rate, see appendix 2.

Functions That Cannot Be Used in Chart Recorder Mode

When making measurements in Chart Recorder mode, functions of history memory and waveform computation cannot be used (The HISTORY key and MENU key > MATH menu cannot be used).

Measured Data Compatibility

The measured data in Chart Recorder mode is not compatible with the measured data in Memory mode. The measured/saved data in Chart Recorder mode cannot be loaded in Memory mode, and vice versa.

X-Y Recorder Mode «For procedures, see section 9.6.»

X-Y Waveform Recording:

In X-Y waveform recording, the X-Y waveform display starts when waveform acquisition is started. If reprint is executed from the Reprint Setup menu after the record length of waveform (fixed to 1 MW) is acquired or after stopping waveform acquisition, the X-Y waveform acquired up to the point immediately before the measurement was stopped is recorded on paper.
The scale of the X-Y waveform recording is 10 mm per division for both X- and Y-axes, and the waveform recording area is ±10 divisions (20 divisions). The screen also shows the X-Y waveform. Recording to paper can also be started automatically when waveform acquisition is stopped (auto print).

Acquisition Mode during X-Y Recorder Mode

The acquisition mode is automatically set to normal mode during X-Y record mode. The acquisition mode cannot be changed using the Menu key > ACQ menu as with the normal operation.

Saving Data in the Internal Memory

In X-Y recorder mode, up to 1 MW of data is automatically saved in the internal memory. Also, a PDF file of the reprint image can be created.

Functions That Cannot Be Used during X-Y Recorder Mode

When making measurements in X-Y Recorder mode, functions of history memory and waveform computation cannot be used (The HISTORY key and MENU key > MATH menu cannot be used). In addition, items set using the MENU key > ACQ menu cannot be changed.

Measured Data Compatibility

The measured data in X-Y Recorder mode is not compatible with the measured data in Memory mode. The measured/saved data in X-Y Recorder mode cannot be loaded in Memory mode, and vice versa.

Reprinting on the Built-in Printer (Only during T-Y Recording) «For procedures, see section 9.7.»

After the T-Y recording in Chart Recorder mode is finished, the data stored in the internal memory can be recalled and reprinted by changing the print conditions.

Creating a PDF File of the Reprint Image «For procedures, see section 9.8.»

After the waveform recording in Chart Recorder mode or X-Y Reorder Mode is finished, the data stored in the internal memory can be recalled and a PDF file of the reprint image can be created.
In X-Y Recorder Mode, the most recent 1 MW of data stored in the internal memory are output to the PDF file. If data exceeding 1 MW is recalled, the waveform displayed on the screen and the waveform recorded on the printer may differ from the waveform output to the PDF file.

2.6 Waveform Computation

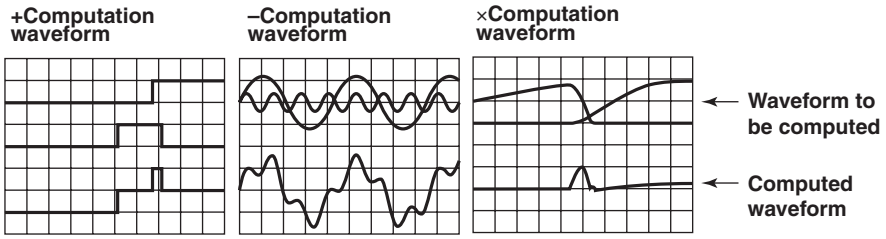
Various computations can be performed on up to 800 kW of data on the SL1400. (If a waveform greater than 800 kW is displayed, computation cannot be performed over all the data at once.) The computed results become Math1 to Math8 waveforms.

Addition, Subtraction, Multiplication, and Division «For procedures, see section 10.1.»

Addition, subtraction, multiplication, and division can be performed between two arbitrary waveforms of CH1 to CH16 and Math1 to Math7. These computations are useful in the following cases.

Addition and subtraction: Comparison with the standard signal, confirmation of the signal logic, phase comparison, etc.

Multiplication and division: Confirmation of the power waveform by applying the voltage and current signals, etc.

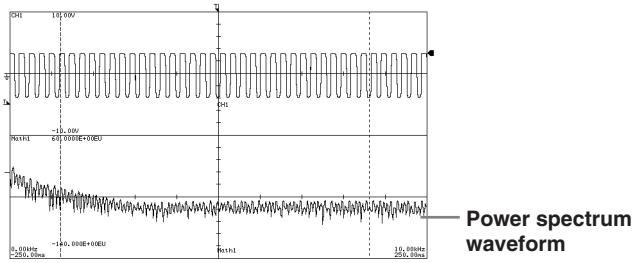


Binary Computation «For procedures, see section 10.2.»

The specified waveform is converted to a digital waveform of 0s and 1s with respect to the specified threshold level. The computation can be performed on CH1 to CH16 and Math1 to Math7.

Power Spectrum Display «For procedures, see section 10.3.»

The power spectrum of the input signal can be displayed by taking the FFT (Fast Fourier Transform). This is useful when you wish to check the frequency distribution of the input signal.



The following three FFT windows are available.

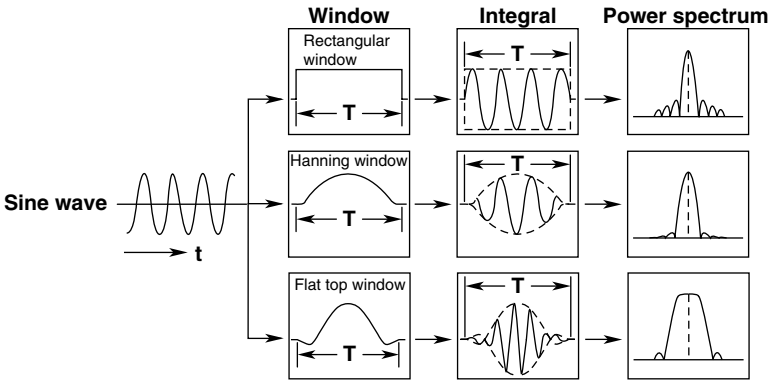
Rectangular (Rect)

The rectangular window is best suited to transient signals, such as impulse waves, which attenuate completely within the time window.

Hanning and FlatTop

The Hanning and flattop windows allow continuity of the signal by gradually attenuating the parts of the signal located near the ends of the time window down to the 0 level. Hence, it is best suited to continuous signals. With the Hanning window, the frequency resolution is high compared to the flattop window. However, the flattop window has a higher level of accuracy. When the waveform being analyzed is a continuous signal, select the proper window for the application.

FFT is performed on 1000, 2000, 5000, 10000, 20000, 50000, or 100000 points of measured data. The data is converted to half the specified number of points and displayed.



Rectangular window : $W(t) = u(t) - u(t - T)$ U(t): Step function

Hanning window : $W(t) = 0.5 - 0.5 \cos(2\pi \frac{t}{T})$

Flat top window : $W(t) = \{0.54 - 0.46 \cos(2\pi \frac{t}{T})\} \frac{\sin\{2\pi(1 - 2t/T)\}}{2\pi(1 - 2t/T)}$

FFT Function

Given that the complex function resulting after the FFT is G = R + jI, the power spectrum can be expressed as follows:

Power spectrum = $10 \log \left(\frac{R^2 + I^2}{2}\right)$

R: Real Part, I: Imaginary Part

Reference value (0 dB) of the logarithmic magnitude (Log mag): 1 $Vrms^2$

Phase Shift «For procedures, see section 10.4.»

You can shift the phase of CH1 to CH16 and Math1 to Math7 waveforms and display the resultant waveforms or perform computation using the phase-shifted data.

Scaling of Computed Waveforms «For procedures, see chapter 10.»

Normally, the SL1400 performs auto scaling when computed waveforms are displayed. However, you can also select manual scaling. When auto scaling, the upper and lower limits suitable for displaying the waveform are determined from the first computed waveform. If you select manual scaling, you can arbitrarily set the upper and lower limits of the computed waveform display.

2.7 Waveform Analysis and Search

Displaying History Waveforms «For procedures, see section 11.1.»

Past waveform data (history waveforms) stored in the acquisition memory can be displayed when waveform acquisition is stopped. You can display a specified history waveform from the data (up to 2000 waveforms, or the number of triggers) stored in the acquisition memory.

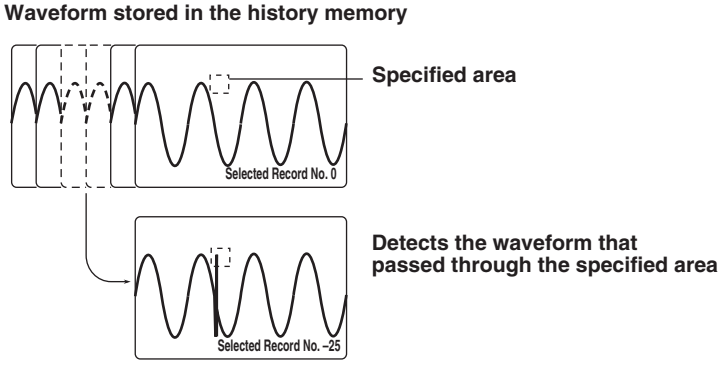
The number of waveforms N that can be acquired and held as history waveforms varies from 1 to 2000 depending on the record length and acquisition mode settings. The waveform currently displayed on the screen (most recent waveform) is counted as the 1st waveform, and up to N–1 waveforms in the past can be displayed.

History Search «For procedures, see sections 11.2 and 11.3.»

You can search history waveforms that meet specified conditions when waveform acquisition is stopped.

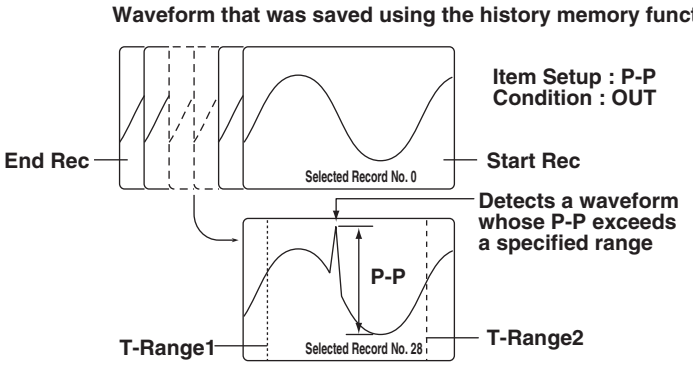
Zone Search

You can search history waveforms that pass or do not pass a specified search zone.



Waveform Parameter Search

You can search history waveforms that meet or do not meet the specified search parameter conditions.



Cursor Measurement «For procedures, see section 11.4.»

The following cursors are available for analyzing the values of each waveform data.

H (Horizontal) Cursors

Two broken lines (H cursors) are displayed on the X-axis (horizontal axis). The voltage of each H cursor and the voltage difference between the H cursors are measured.

V (Vertical) Cursor

Two broken lines (V cursors) are displayed on the Y-axis (vertical axis). The time from the trigger position to each V cursor and the time difference between the V cursors are measured. The voltage value of the signal at each cursor position and the voltage difference between the cursors are also measured.

H&V Cursors

H cursors and V cursors are displayed simultaneously.

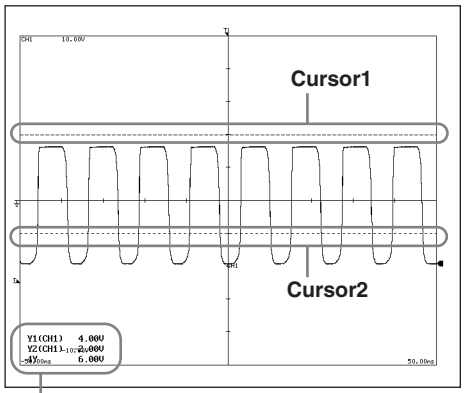
Marker Cursors

Four markers are displayed on the specified waveform. The voltage and the time from the trigger position of each marker as well as the voltage difference and time difference between markers are measured.

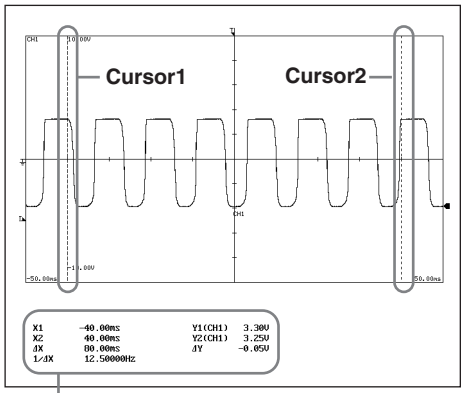
Degree Cursors

Measures the angle between two angle cursors with respect to a reference angle corresponding to the width between the zero point and the end point, which are measurement references.

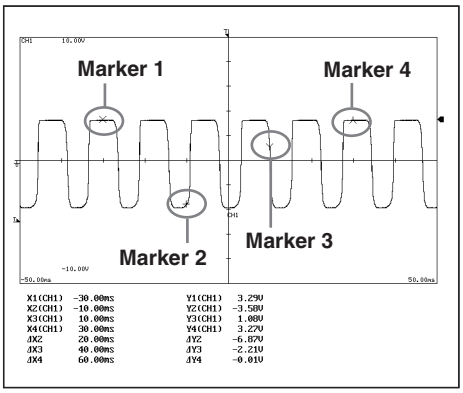
• H cursor



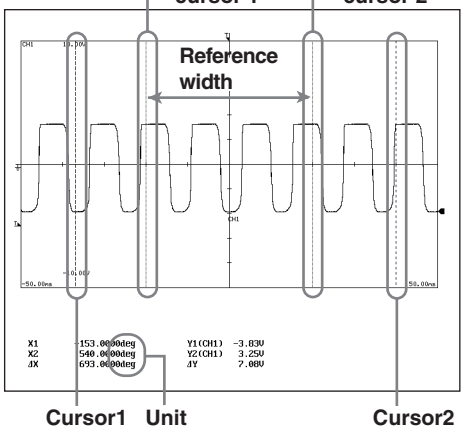
• V cursor



• Marker cursor

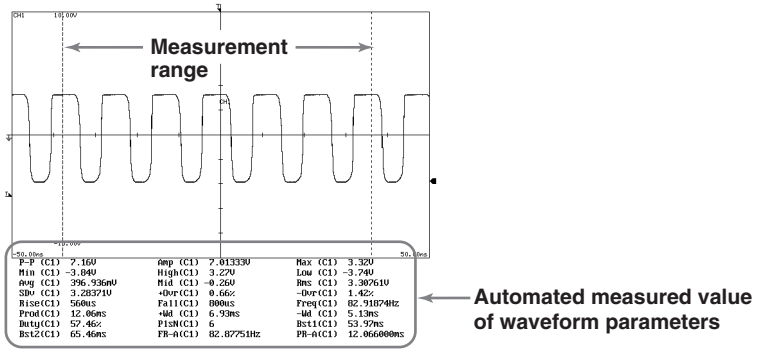


• Angle cursor



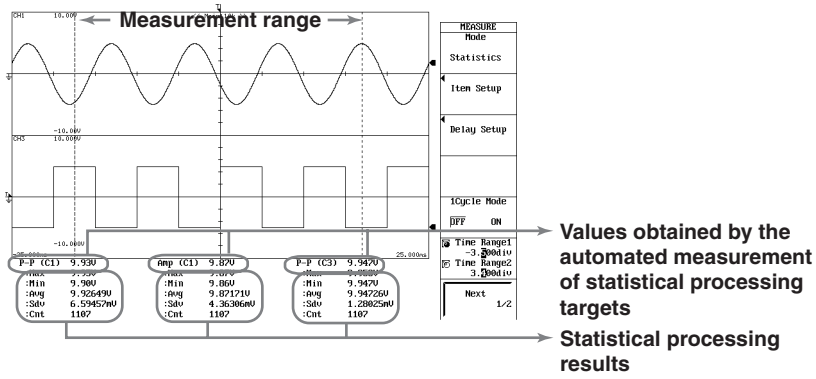
Automated Measurement of Waveform Parameters «For procedures, see section 11.5.»

Automated measurement can be performed on parameters such as the rise time and pulse width on the specified channel. There are 29 measurement parameters. Up to 24 parameters from the selected parameters of all channels can be displayed. The measurement range is up to 10 MW from the measurement start point (Time Range1).



Statistical Processing «For procedures, see section 11.6.»

Statistical processing is performed on the measured values of automated waveform parameters described on the previous item. The following five statistics are determined on the three measured values of automated measurement parameters.
The number of measured values used to determine the maximum value, minimum value, average value, standard deviation, and statistical processing.



The following three statistical processing modes are available.

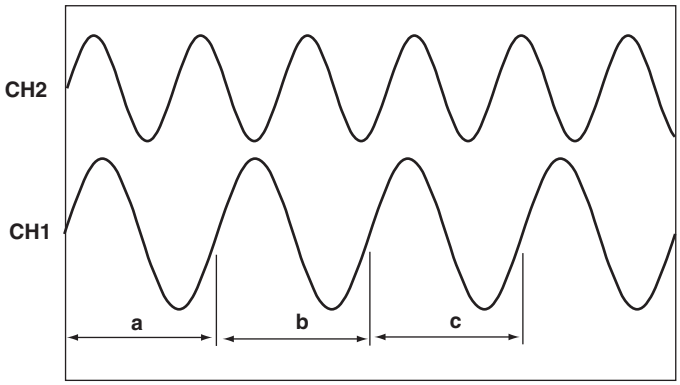
Normal Statistical Processing

Statistical processing is performed on all acquired waveforms while acquiring waveforms.

Cyclic Statistical Processing

Divides the displayed waveform using a cycle that is automatically calculated and determined and performs statistical processing on the values obtained through the automated measurement of waveform parameters over the determined cycle. Statistical processing is performed from the oldest measured data of the displayed waveform. Statistical processing of up to 48000 measured values of automated waveform parameters is possible. If statistical processing is performed on a single parameter, statistical processing of up to 48000 cycles is possible.

Example in which CH1 is selected as the waveform used to determine the cycle



Automated measurement parameters are measured in each range, a, b, and c, and statistical processing is performed on the automated measurement parameters in the order a, b, and c.
The automated measurement parameters of other channels are also measured using ranges a, b, and c.
Automated measurement can also be made using the cycle of each waveform as the range.

Statistical Processing of History Data

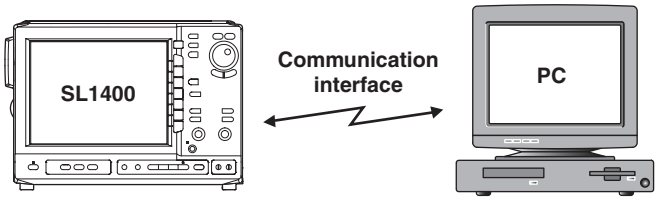
Performs automated measurement of waveform parameters on the waveform that is acquired using the history memory function and performs statistical processing. Statistical processing is performed from the oldest waveform.

2.8 Communications

Command Communications (GP-IB, Serial (RS-232), USB, and Ethernet) «For procedures, see the Communication Interface User's Manual on the CD-ROM.»

The SL1400 comes standard with GP-IB, serial (RS-232), and USB interfaces. The Ethernet interface is available as an option.

Through communication functions, you can output waveform data to a PC for data analysis or control the SL1400 using an external controller to carry out waveform measurements.

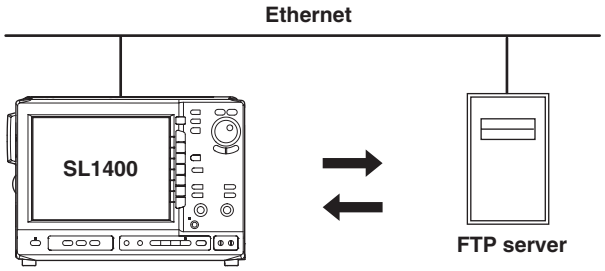


Saving/Loading Data to a Network Drive (FTP Client Function) «For procedures, see chapter 15.»

Waveform data,*1 screen image data, and setup data can be saved, deleted, or copied on an FTP server*2 on the network in the same way as the built-in PC card, internal hard disk (option), or external SCSI device.

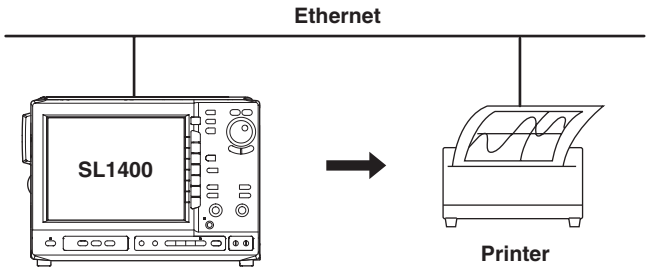
*1 The following types of waveform data cannot be loaded from a network drive.
- Waveform data that is 50 MB or more in size.
- Waveform data saved on the all waveform display (All) of the history memory function.

*2 PC or workstation on which the FTP server function is running.



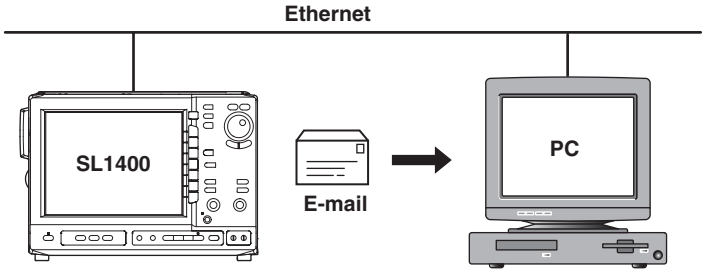
Printing on a Network Printer «For procedures, see section 15.4.»

The screen image data can be printed on a network printer in the same way as the built-in printer or USB printer.



Transmitting E-mail Messages (SMTP Client) «For procedures, see section 15.5.»

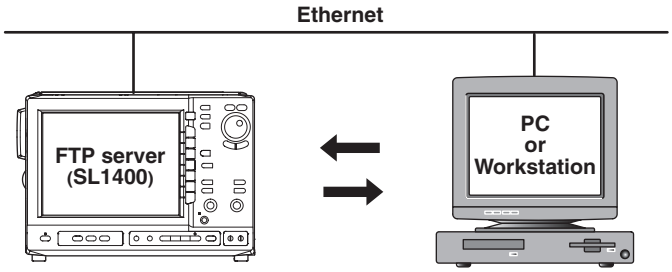
Information from the SL1400 can be transmitted periodically in an e-mail message to a specified mail address. You can also transmit information such as the trigger time in an e-mail message as an action for action-on-trigger.



Accessing the SL1400 from a PC or Workstation (FTP Server Function) «For procedures, see section 15.6.»

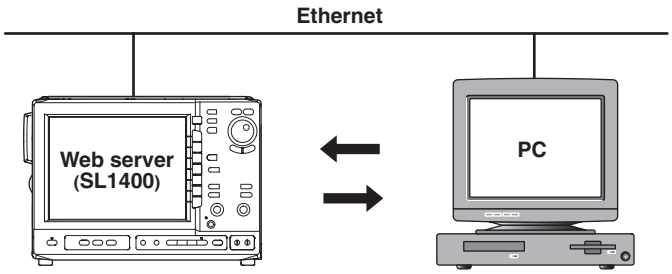
The files on the built-in PC card, internal hard disk (option), or external SCSI device on the SL1400 can be retrieved by accessing the SL1400 from an FTP client* on the network.

* PC or workstation on which the FTP client function is running.



Web Server Function «For procedures, see section 15.7.»

The SL1400 can function as a Web server. By using the Web page of the SL1400, file transfer, monitoring of displayed waveforms, basic SL1400 key control, and retrieval of waveform data are possible.



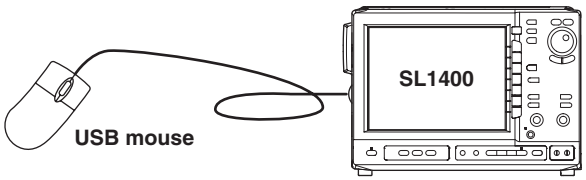
2.9 Other Useful Functions

Entering Values and Strings from a USB Keyboard «For procedures, see section 4.3.»

You can connect a USB keyboard for entering file names, comments, and other information. In addition, the functions of each key on the front panel of the SL1400 are assigned to the keys on the keyboard. Thus, the keyboard can be used to carry out operations that are the same as the key operations on the SL1400. For the key assignments, see appendix 7.

Operations Using a USB Mouse «For procedures, see section 4.3.»

You can use a USB mouse to operate the SL1400 as you would using the front panel keys. In addition, you can point to a desired item on a menu and click the item. This is analogous to pressing a soft key corresponding to a menu and pressing the SELECT key.



Initialization «For procedures, see section 4.4.»

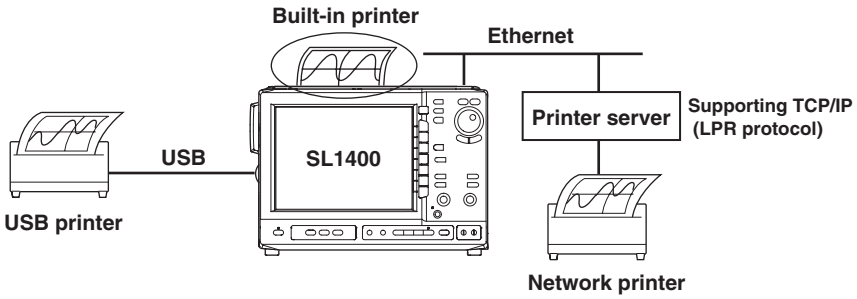
The settings of each key can be reset to their initial conditions. However, date and time settings, communication settings, and SCSI ID setting are not initialized. To reset the communication-related and SCSI ID settings to factory default, turn ON the power while holding down RESET. Release RESET after a beep sound is heard. (Date and time settings are not reset.)

Auto Setup «For procedures, see section 4.5.»

This function automatically sets the voltage axis, time axis, trigger settings, and other settings to suit the input signal. This is useful when the characteristics of the input signal are unknown. However, the auto setup function may not work depending on the input signal.

Printing the Screen Image «For procedures, see chapter 12.»

Screen images can be printed on the built-in printer (option), USB printer, or network printer (when the Ethernet interface option is installed).



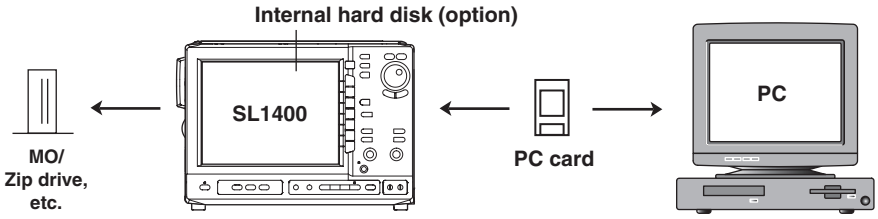
Note

There is a function that enables comments to be entered and displayed using a keyboard that appears on the screen or a USB keyboard. You can enter a comment describing the displayed waveform before printing the screen image. The comment is printed along with the waveform allowing the printed matter to be identified later on.

Saving and Loading Data on the Storage Medium «For procedures, see chapter 13.»

The SL1400 allows various data to be stored to and loaded from the following storage media.

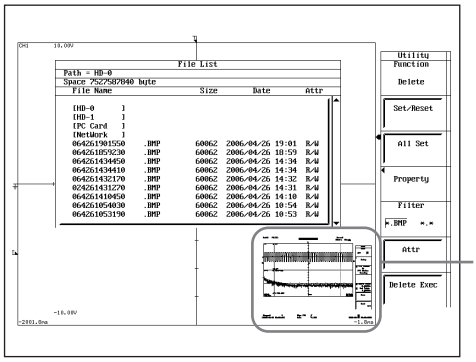
- PC card
- Internal hard disk (option)
- External USB storage (MO disk, hard disk, and flash memory)
- External SCSI device (MO disk, Zip disk, etc.)
- External SCSI device (MO disk, Zip disk, etc.)
- Network drive (when the Ethernet interface option is installed)



Saving the Screen Image Data and Displaying the Thumbnails of the Stored Screen Image Data

The screen image data can be stored to a specified storage medium. The data can be stored in PNG, JPEG, BMP, and PostScript formats allowing the screen image to be pasted on a document created with a DTP application.
In addition, the thumbnails (reduced and simplified image) of the screen image data saved to the storage medium can be displayed on the SL1400 screen. This feature is useful for checking the contents of the stored screen image data.

Thumbnail Display on the FILE Menu

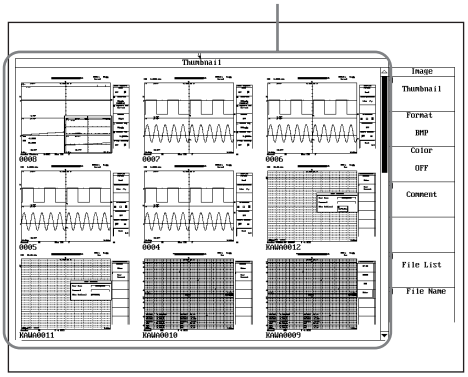


Selecting a file from the File List and pressing SELECT displays the thumbnail screen of the selected screen image data

Thumbnail screen

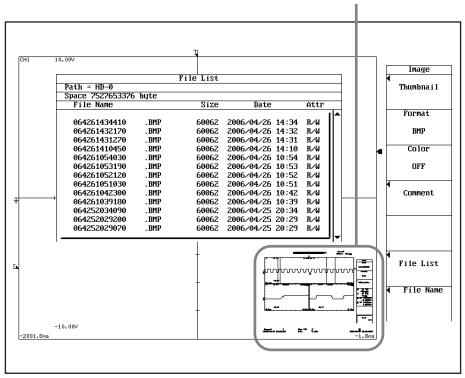
Thumbnail Display on the IMAGE Menu

Thumbnail screen



Pressing the Thumbnail soft key displays a thumbnail screen of the screen image data saved to the specified format.

Thumbnail screen



Selecting a file from the File List and pressing SELECT displays the thumbnail screen of the selected screen image data

Saving and Loading Setup Data, Waveform Data, and Snapshot Waveform Data

The setup data, waveform data, and snapshot waveform data can be saved to or loaded from a specified storage medium.

Saving the Results of the Automated Measurement of Waveform Parameters

The automated measured values of waveform parameters can be stored to a specified storage medium.

Creating a PDF File of the Print Image «For procedures, see section 13.14.»

By setting the output destination in the PRINT menu to “PDF,” a PDF file of the print image (image similar to fine print (see section 12.1)) can be created. A print image of the specified range and magnification is created to the specified file name on the specified storage medium simply by pressing the PRINT key.

Operating the SL1400 Using a Free Software Program

The SL1400 can be controlled from a PC using Wirepuller, a free software program, when connected via the GP-IB, USB, or Ethernet interface. The software program can be downloaded from the following Web pages.

- English version http://www.yokogawa.com/tm/tm-softdownload.htm
- Japanese version http://www.yokogawa.co.jp/tm/F-SOFT/

Connecting the SL1400 and the PC via the SCSI «For procedures, see section 13.19.»

You can connect a PC to the SCSI of the SL1400 and download the files on the internal hard disk (option) to the PC.
You cannot upload or delete files on the internal hard disk. If you do, the internal hard disk may become unusable.

The following limitations exist.
While connected to the PC, the File List window of the SL1400 may not be displayed properly. If the connected PC enters sleep, standby, or rest mode, the SL1400 will not be able to access its internal hard disk. Before connecting the PC to the SL1400, disable such modes on the PC.

3.1 Handling Precautions

Safety Precautions

If you are using this instrument for the first time, make sure to thoroughly read “Safety Precautions” on pages vi to viii.

Do Not Remove the Case

Do not remove the case from the instrument. Some parts of the instrument use high voltages, which are extremely dangerous. For internal inspection and adjustment, contact your nearest YOKOGAWA dealer.

Unplug If Abnormal Behavior Occurs

If you notice any symptoms of trouble such as unusual odors or smoke coming from the instrument, immediately turn OFF the power switch and unplug the power cord. If these symptoms occur, contact your nearest YOKOGAWA dealer.

Handle the Power Cord with Care

Do not place objects on top of the power cord and keep it away from any heat sources. When unplugging the power cord from the outlet, never pull by the cord itself. Be sure to pull by the plug. If the power cord is damaged, contact your dealer for replacement. Refer to page iii for the part number when placing an order.

General Handling Precautions

Do Not Place Objects on Top of the Instrument

Never place other instruments or objects containing water on top of the instrument, otherwise a breakdown may occur.

Do Not Apply Shock to the Input Section

Applying shock to the input connectors or probes may turn into electrical noise and enter the instrument via the signal lines.

Do Not Damage the LCD

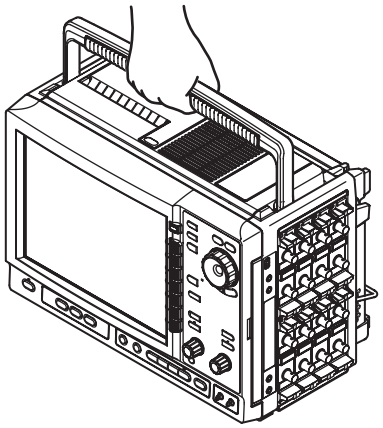
Since the LCD screen is very vulnerable and can be easily scratched, do not allow any sharp objects near it. Also, it should not be exposed to vibrations and shocks.

Unplug during Extended Non-Use

Unplug the power cord from the outlet.

Carry the Instrument Properly

First, remove the power cord and connection cables. Always carry the instrument by the handles as shown below or carry it with both hands.



Clean the Instrument Properly

When cleaning the case or the operation panel, first remove the power cord from the outlet. Then, wipe with a dry, soft, clean cloth. Do not use volatile chemicals such as benzene or thinner for cleaning, as this may lead to discoloration or deformation.

3.2 Installing the Instrument

Installation Conditions

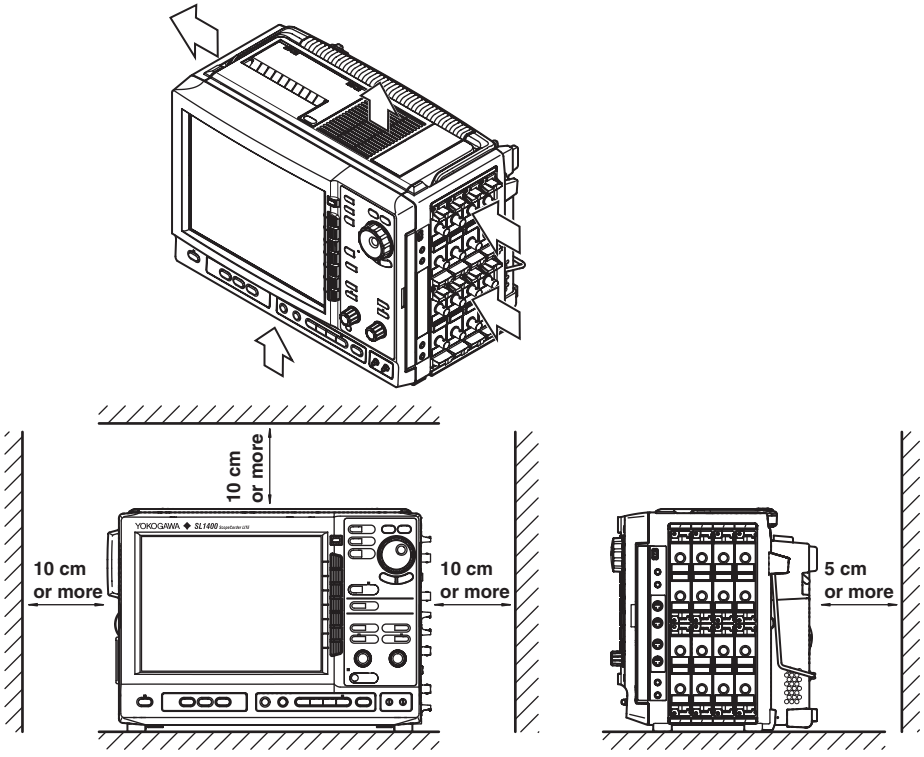
Install the instrument in a place that meets the following conditions:

Flat, Even Surface

Set the instrument in the proper direction (see page 3-4) and in a level and stable place. Note that the instrument can be tilted on the stand if the instrument is set with the rear panel facing down. If placed in an uneven or unstable place, printing quality may deteriorate.

Well-Ventilated Location

There are vent holes on the bottom side of the instrument. In addition, there are vent holes for the cooling fans in the left side and top panels. To prevent internal overheating, allow for enough space around the instrument (see the figure below) and do not block the vent and inlet holes.



When connecting various cables or when opening or closing the built-in printer cover, provide extra space for operation in addition to the space indicated above.

Ambient Temperature and Ambient Humidity

Ambient temperature: 5 to 40°C
Ambient humidity: 20 to 85%RH (when the printer is not used) } No condensation
35 to 85% RH (when using the printer)

Note

- To ensure high measurement accuracy, operate the instrument in the 23 ± 5°C temperature range and 55 ± 10% RH.
- Condensation may occur, if the instrument is moved to another place where the ambient temperature is higher or if the temperature changes rapidly. In such cases, allow the instrument adjust to the new environment for at least an hour before using the instrument.

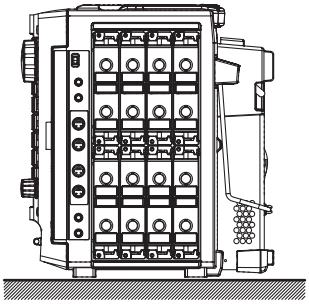
Do Not Install the Instrument in the Following Places.

- In direct sunlight or near heat sources.
- Where an excessive amount of soot, steam, dust, or corrosive gas is present.
- Near strong magnetic field sources.
- Near high voltage equipment or power lines.
- Where the level of mechanical vibration is high.
- On an unstable surface.

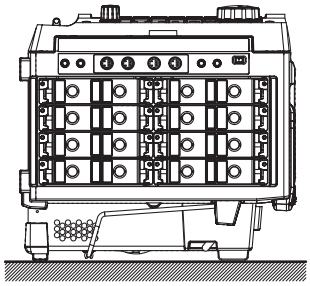
Installation Position

Place the instrument in a horizontal position or with the rear panel facing down. When using the stand, pull it until it locks (see the right figure below). To retract it, press the stand backward while pressing it inward.

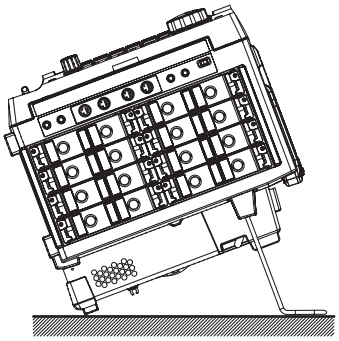
Installed horizontally



Installed with the rear panel facing down



Installed using the stand



Rubber Feet

If the instrument is installed in a horizontal position as shown in the figure above, rubber stoppers can be attached to the feet to prevent the instrument from sliding. One set (four pieces) of rubber feet are included in the package.

3.3 Installing Input Modules

WARNING

- To prevent electric shock and damage to the instrument, make sure to turn OFF the power before installing or removing the input module.
- Check that the input cable is not connected to the input terminals before installing or removing the input module.
- To prevent electric shock and to satisfy the specifications, make sure to put the accessory cover plate on the slots that are not being used.
  Using the instrument without the cover plate allows the dust to enter the instrument and may cause malfunction due to the rise in temperature inside the instrument.
- If the input module happens to come out of the slot while it is in use, it may cause electric shock or cause damage to the instrument as well as the input module. Make sure to screw the input module in place at the two locations (top and bottom).
- Do not put your hand inside the slot, because there are protrusions along the module guide that may injure your fingers.
- **Precautions to Be Taken When Using the Modules**
  - Do not apply input voltage exceeding the maximum input voltage, withstand voltage, or allowable surge voltage.
  - To prevent electric shock, be sure to furnish protective earth grounding of the SL1400.
  - To prevent electric shock, be sure to fasten the module screws. Otherwise, the electrical protection function and the mechanical protection function will not be activated.
  - Avoid continuous connection under an environment in which the allowable surge voltage may occur.
  - When measuring high voltages using the 701250 (HS10M12) or the 701251 (HS1M16), use the isolated probe (700929), 1:1 safety cable (combination of 701901 and 701954), or differential probe (700924).
  - Be sure to connect the GND lead of the differential probe (700924) to the functional ground terminal of the SL1400. High voltage may appear at the BNC connector of the differential probe. Be sure to connect the GND lead to the SL1400 before connecting the probe to the parameter to be measured.
  - When using the 701255 (NONISO_10M12), be sure to fasten the module screws. Fastening the module screws activates the protection function and the non-isolation function. It is extremely dangerous if you do not fasten the screws. In addition, when measuring high voltage above 42 V, be sure to use the passive probe (701940).
  - The BNC part of the passive probe (701940) is made of metal. Therefore, use the probe at 42 V or less for isolated inputs (701250 (HS10M12), 701251 (HS1M16), 701260 (HV (with RMS)), 701275 (ACCL, VOLT), and 701280 (FREQ)) for safety reasons. (Do not connect voltage above 42 V to both the High and Low sides.) For non-isolated inputs (701255 (NONISO_10M12), etc.), fasten the module screws as described before.
  - When applying high voltage using the 701260 (HV (with RMS)), use the 1:1 safety cable (combination of 701901 and 701954) or the isolated probe (700929).
  - The measurement category of the 701260 (HV (with RMS)) is 400V-CAT II for the low side and 700V-CAT II for the high side. Use caution because the overvoltage tolerance differs between the low and high sides.
  - When applying high voltage to the 701280 (FREQ), use the isolated probe (700929).

Types of Input Modules

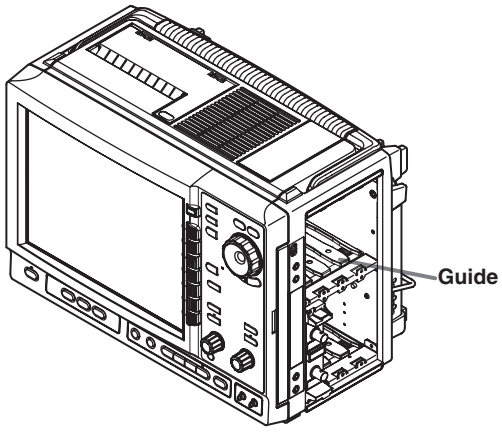
There are 11 types of input modules. See page iii. For detailed specifications, see section 18.12.

Precautions to Be Taken When Installing or Removing Input Modules

Switching the installed input module with a different module and turning ON the power initializes the settings on that channel. To save the settings, specify the destination media (see sections 13.1 or 13.9).

Installation Procedure of Modules

1. Check that the power switch on the left side panel is OFF.
2. Check the channel number indicated above the slots for installing the input modules on the right side panel of the instrument. Then, install the module along the guide.
   Holding the handles on the top and bottom of the input module, press firmly until it clicks in place.
   If there is a cover plate on the slot in which to install the module, remove the cover plate, first.
3. Make sure to screw the two locations, top and bottom, of the input module firmly into place.
4. Turn ON the power switch.
5. Check to see that the correct input module name is displayed at the corresponding channel number in the overview screen. If it is not correct, remove the module according to the steps in “Removal” shown below, and reinstall the module according to steps 1 to 3 shown above. For the procedure to display the overview display, see section 17.4.

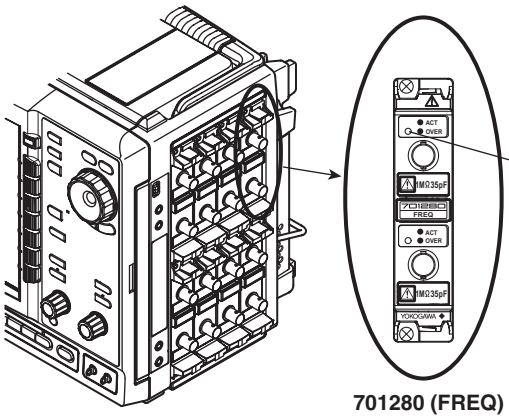


Removal Procedure

1. Check that the power switch is OFF.
2. Loosen the two screws holding the input module in place.
3. Holding the handles on the top and bottom of the input module, pull out the module.

LEDs on the Frequency Module

On the front panel of the frequency module (701280 (FREQ)) are LEDs for each channel. These LEDs allow you to check the input condition of the pulse.



701280 (FREQ)

LED

Illuminated in green:	**When pulse is applied**
Illuminated in red:	**When the input voltage level is over range.**
Off:	**When pulse is not applied**

Note

- The LEDs on the frequency module illuminates in green when pulse is applied and red when the input voltage level is over range. It is independent of the start/stop condition of waveform acquisition of the SL1400.
- If the frequency module preset (see section 5.17) is set to “EM Pickup (electromagnetic pickup),” the LED does not illuminate in red even when the input voltage level is over range.

3.4 Connecting the Power Supply and Turning the Power Switch ON/OFF

Before Connecting the Power Supply

Make sure that you observe the following points before connecting the power. Failure to do so may cause electric shock or damage to the instrument.

WARNING

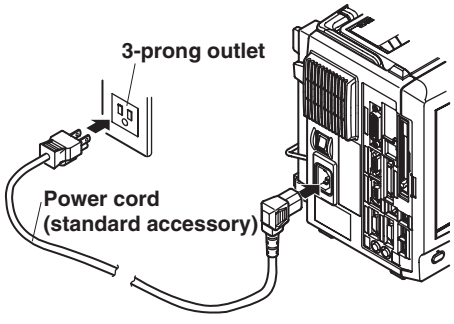
- Before connecting the power cord, ensure that the source voltage matches the rated supply voltage of the instrument and that it is within the maximum rated voltage of the provided power cord.
- Connect the power cord after checking that the power switch of the instrument is turned OFF.
- To prevent electric shock or fire, be sure to use the power cord for the instrument that is supplied by YOKOGAWA.
- Make sure to provide protective earth grounding to prevent electric shock. Connect the power cord to a three-prong power outlet with a protective earth terminal.
- Do not use an extension cord without protective earth ground. Otherwise, the protection function will be compromised.
- If an AC outlet that matches the power cord provided is unavailable and protective grounding cannot be furnished, do not use the instrument.

Connecting the Power Cord

1. Check that the power switch is turned OFF.
2. Connect the power cord plug to the power connector on the left side panel.
3. Connect the plug on the other end of the power cord to the outlet that meets the conditions below. The AC outlet must be of a three-prong type with a protective earth ground terminal.

Item	
Rated supply voltage*	100 to 120 VAC/200 to 240 VAC
Permitted supply voltage range	90 to 132 VAC/180 to 264 VAC
Rated power supply frequency	50/60 Hz
Permitted power supply frequency range	48 to 63 Hz
Maximum power consumption	Approx. 200 VA Max. (Reference value: 135 VA when the built-in printer is not used and 16 channels are running)

* The instrument can use a 100-V or a 200-V system for the power supply. The maximum rated voltage of the power cord varies depending on its type. Check that the voltage supplied to the instrument is less than or equal to the maximum rated voltage of the provided power cord (see page ii) before using it.



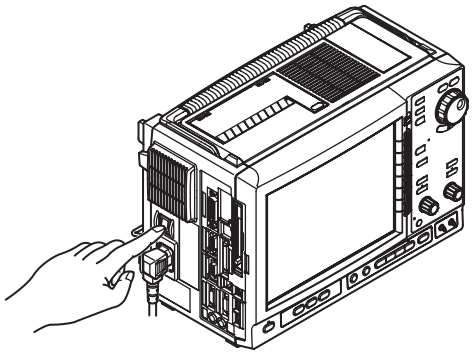
Turning ON/OFF the Power Switch

Items to Be Checked before Turning ON the Power

- Check that the instrument is properly installed. See section 3.2.
- Check that the power cord is properly connected. See the previous page.

Turning ON/OFF the Power Switch

Pressing the power switch located on the left side panel to the “ON (|)” side, turns the power ON. Pressing it to the “OFF (O)” side turns the power OFF.



Power Up Operation

Self-test and calibration start automatically when the power switch is turned ON. The operation takes approximately 30 seconds; if the check results are satisfactory, the normal waveform display screen will appear.

Note

- Allow at least 10 s when turning ON the power switch after turning it OFF.
- If self-test and calibration do not start when the power is turned ON or if the normal waveform display screen does not appear, turn OFF the power switch and check the following items.
  - Check that the power cord is securely connected.
  - Check that the correct voltage is being supplied from the AC outlet. (See the previous page.)
  - If you turn ON the power switch while holding down RESET, the settings are initialized to their factory default values. For details on the initialization of the settings, see section 4.4.

  If the instrument still fails to power up when the power switch is turned ON after checking these items, contact your nearest YOKOGAWA dealer for repairs.
- It may take a few seconds for the startup screen to appear.

To Make Accurate Measurements

- Allow the instrument to warm up for at least 30 minutes after turning ON the power switch.
- After warm-up is complete, perform calibration (see section 4.6). If auto calibration is turned ON, the calibration is automatically executed when the measurement range is changed or when the waveform acquisition is started.

Power Down Operation

Settings existing immediately before the power is turned OFF (also if the power cord is removed) are retained. This allows measurements to be performed using those saved settings the next time the power is turned ON.

Note

The settings are stored using an internal lithium battery. The battery lasts for approximately 5 years, if it is used at an ambient temperature of 23°C. When the lithium battery voltage falls below a specified level, a message is displayed on the screen (error 907) when the power switch is turned ON. If this message appears frequently, the battery must be replaced quickly. The user cannot replace the battery. Contact your nearest YOKOGAWA dealer to have the battery replaced.

3.5 Loading the Roll Paper for the Built-in Printer

Printer Roll Paper

Use a dedicated roll paper that is provided by YOKOGAWA. Do not use other types of roll paper. When you are using the printer for the first time, use the roll paper that came with the package. Order extra rolls from your nearest YOKOGAWA dealer.

Part number: 701966
Specifications: Thermal paper, 20 m
Minimum Q'ty: 6 rolls

Roll Paper Handling

The paper is a thermal paper that changes color with the application of heat. Note the following:

Storage Precautions

The paper starts changing color at around 70°C. It is affected by heat, humidity, light, and chemicals regardless of whether the paper has been used.

- Store the paper rolls in a cool, dry, and dark place.
- After opening the package, use it quickly.
- If the paper is left in contact with plastic film containing plasticizers (such as a vinyl chloride film or Scotch tape) for an extended time, the paper will lose some of its ability to reproduce color. If you are going to store the paper in a folder, for example, use a folder made of paper stock or polypropylene.
- When using glue on the paper, do not use glue containing organic solvents such as alcohol or ether, as they will change the color of the paper.
- For prolonged storage, we suggest you make copies of results printed on the roll paper. Due to the characteristics of the thermal paper, the recording section may lose color over time.

Handling Precautions

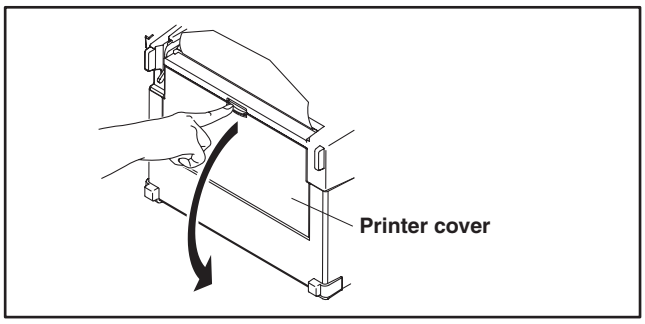
- Be sure to use only genuine paper rolls provided by YOKOGAWA.
- Touching the paper with sweaty hands can leave finger prints or blur the printing.
- Rubbing the surface with a hard object can cause the paper to change color due to the heat caused by friction.
- If chemicals, oil, or other liquids come in contact with the paper, the paper may change color or the printing may fade.

Precautions to Be Taken When Using the Built-in Printer

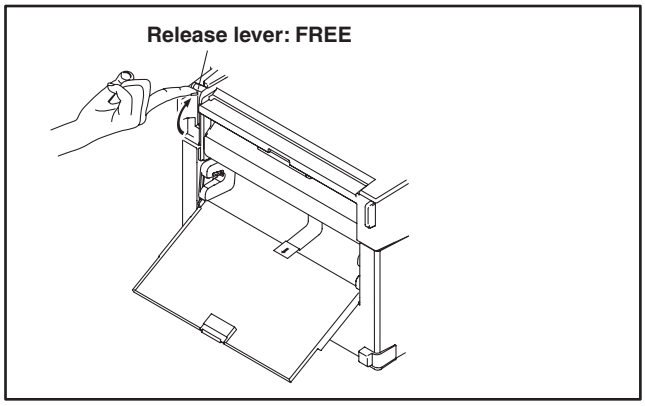
Allow enough space around the output area of the printer. If the roll paper is continuously fed out when the output area is close to a wall, for example, the roll paper that has been delivered may reenter the output area and get entangled.

Procedure

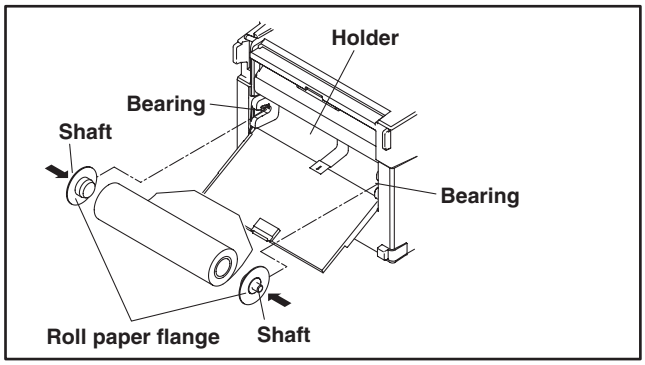
Loading the Roll Paper



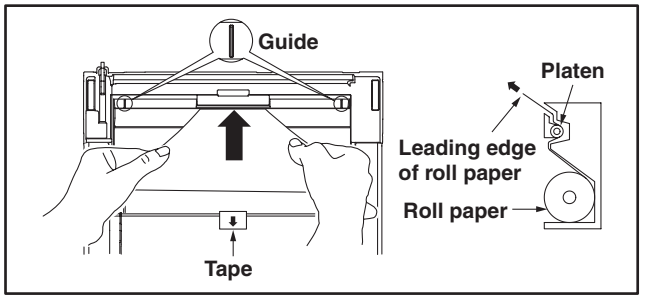
1. While pressing the knob down on the top side of the printer cover, open the printer cover.



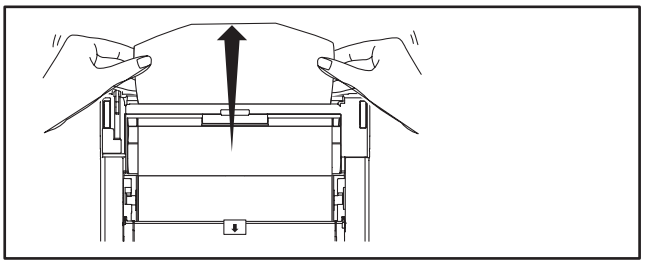
2. Move the release lever at the top left side to the FREE position (up direction).



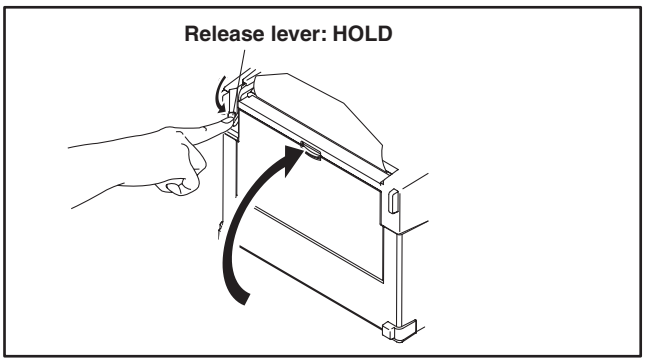
3. Fit the roll paper flange to the left and right edges of the roll paper core.
4. With the leading edge of the roll paper in the back, load the roll paper in the holder by pressing the shaft of the roll paper flange in the holder bearing.
   Set the direction of the roll paper as shown in the left figure. If the direction is reversed, the printer head does not make contact with the thermal surface. If this happens, nothing may be printed, or the paper may not feed properly.



5. Insert the leading edge of the roll paper evenly from the bottom side of the platen, and pass it through so that approximately 2 cm is showing from the top side. Align the roll paper with the left and right guides.
   To remove a roll paper that is already loaded, pull the tape in the direction of the arrow.



6. Pull the roll paper out further to straighten out the paper.



7. Move the release lever to the HOLD position (down direction). The printing will fail with an error message, if the release arm is in the FREE position during operation.
8. Close the printer cover. Push the printer cover down firmly until it clicks into place.

Note

- If you are reusing an old roll paper that had been taken out, the roll paper can be inserted easily by cutting the leading edge at an angle.
- Before closing the printer cover, be sure to set the release arm position to HOLD.
- After loading the roll paper, make sure that the paper is feeding properly according to the steps given below. If the paper is not being fed evenly, continue to feed the paper for approximately 30 cm. The paper will straighten out.

Feeding the Paper

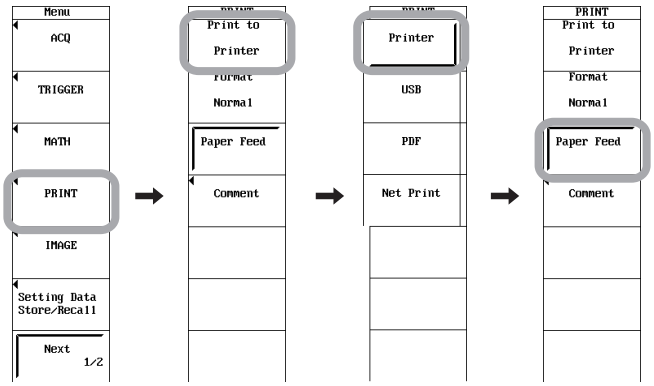
You can feed the paper to check whether the roll paper has been loaded properly or to skip dirty sections.

Feeding the Paper with the FEED Key

Press **FEED**. Each time you press the key, the paper is fed out by 15 mm.

Feeding Paper from the PRINT Menu

1. Press **MENU**.
2. Press the **PRINT** soft key.
3. Press the **Print to** soft key. The printer selection menu appears. (Net Print appears only when the Ethernet interface option is installed.)
4. Press the **Printer** soft key.
5. Press the **Paper Feed** soft key. Each time you press the key, the paper is fed out by 15 mm.



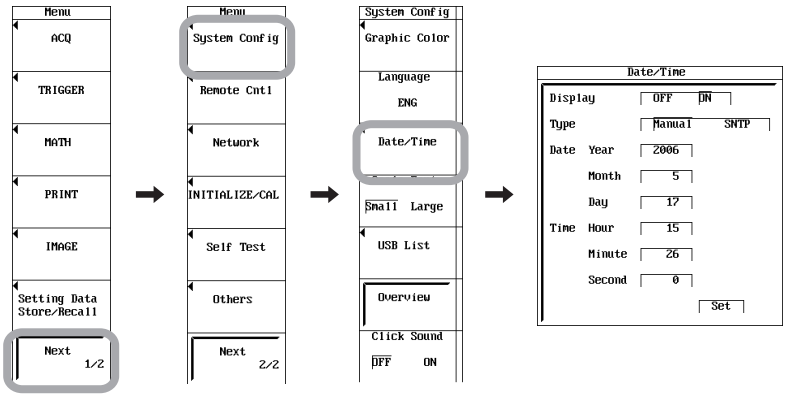
3.6 Setting the Date and Time

Procedure

1. Press **MENU**.
2. Press the **Next 1/2** soft key.
3. Press the **System Config** soft key.
4. Press the **Date/Time** soft key. The Date/Time dialog box opens.

Turning ON/OFF the Date/Time display

5. Use **jog shuttle+SELECT** to set Display to ON or OFF.



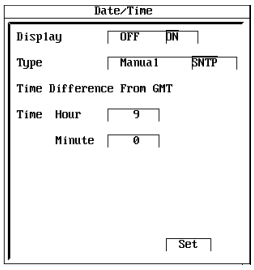
Setting the Time and Date Manually (Manual)

6. Use **jog shuttle+SELECT** to set Type to Manual.
7. Use **jog shuttle+SELECT** to set Date Year.
8. Likewise, set the Month, Day, Time Hour, Minute, and Second.
9. Use the **jog shuttle** to move the cursor to Set and press **SELECT**. The date and time specified in steps 6 to 8 are applied.

Setting the Date and Time Using the SNTP Server (Option)

To obtain the time from the SNTP server, you must first connect to the network and then to the SNTP server. For details, see sections 15.2 and 15.8.

10. After step 5, use **jog shuttle+SELECT** to set Type to SNTP.



11. Use **jog shuttle+SELECT** to set Time Hour under Time Difference from GMT.
12. Likewise, set Minute.
13. Use the **jog shuttle** to move the cursor to Set and press **SELECT**. The time is obtained from the SNTP server, and the date and time calculated from the specified GMT time difference are set.

Explanation

Date (Year/Month/Day)

Set the year, month and day.

Time (Hour/Minute/Second)

Set the time using a 24-hour clock.

Setting the Time Using the SNTP Server

You can use the SNTP server time to set the date and time on the instrument.
This function is available on models with the Ethernet interface installed.
For details on SNTP and GMT, see section 15.8.
The time difference from GMT specified here is linked to the setting of 15.8.

Note

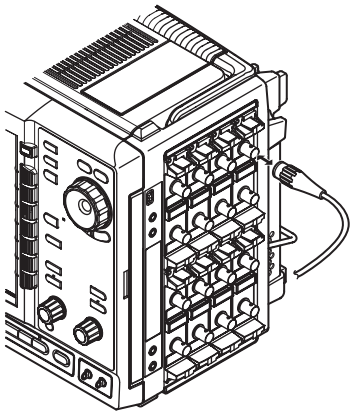
- The date and time information is backed up with the internal lithium battery, even if the power is turned OFF.
- Leap year information is retained.
- If you are using the Web server function (when the Ethernet interface option is installed), you must set the time offset from GMT (Greenwich Mean Time) in addition to the date and time. For the setup procedure, see section 15.8.

3.7 Connecting Probes

Connecting Probes

Connect the probes (or other input cables such as BNC cables) to any of the input terminals of the modules below. The input impedance is 1 MΩ ± 1% and approximately 35 pF in parallel.

- High-Speed 10 MS/s, 12-Bit Isolation Module: 701250 (HS10M12)
- High-Speed High-Resolution 1 MS/s, 16-Bit Isolation Module: 701251 (HS1M16)
- High-Speed 10 MS/s, 12-Bit Non-Isolation Module: 701255 (NONISO_10M12)
- High-Voltage 100 kS/s, 16-Bit Isolation Module (with RMS): 701260 (HV(with RMS))
- Acceleration/Voltage Module (with AAF): 701275 (ACCL/VOLT)
- Frequency Module: 701280 (FREQ)



WARNING

- When connecting the item to be measured, be sure to turn OFF the power to the item. Connecting or disconnecting the measurement lead while the item being measured is turned ON is very dangerous.
- **Precautions to Be Taken When Using the Modules**
  - Do not apply input voltage exceeding the maximum input voltage, withstand voltage, or allowable surge voltage.
  - To prevent electric shock, be sure to furnish protective earth grounding of the SL1400.
  - To prevent electric shock, be sure to fasten the module screws. Otherwise, the electrical protection function and the mechanical protection function will not be activated.
  - Avoid continuous connection under an environment in which the allowable surge voltage may occur.
  - Use only specified cables. Using cables that do not meet the safety specifications is extremely dangerous (especially when using high voltages (42 V or higher).
  - When measuring high voltages using the 701250 (HS10M12) or the 701251 (HS1M16), use the isolated probe (700929), 1:1 safety cable (combination of 701901 and 701954), or differential probe (700924).
  - When applying high voltage using the 701260 (HV (with RMS)), use the 1:1 safety cable (combination of 701901 and 701954) or the isolated probe (700929).

- The BNC part of the passive probe (701940) is made of metal. Therefore, use the probe at 42 V or less for isolated inputs (701250 (HS10M12), 701251 (HS1M16), 701260 (HV (with RMS)), 701275 (ACCL, VOLT), and 701280 (FREQ)) for safety reasons. (Do not connect voltage above 42 V to both the High and Low sides.) For non-isolated inputs (701255 (NONISO_10M12), etc.), fasten the module screws.
- The measurement category of the 701260 (HV (with RMS)) is 400V-CAT II for the low side and 700V-CAT II for the high side. Use caution because the overvoltage tolerance differs between the low and high sides.
- When applying high voltage to the 701280 (FREQ), use the isolated probe (700929).

- **Precautions When Using the High Voltage Differential Probes**
  Be sure to connect the GND lead of the differential probe (700924/700925) to the functional ground terminal on the right side panel of the SL1400. Otherwise, high voltage may appear at the BNC connector making it dangerous.

- Applying a voltage exceeding the value indicated below may damage the input section. If the frequency is above 1 kHz, damage may occur even when the voltage is below this value.
- **701250 (HS10M12)**
  Maximum input voltage (at a frequency of 1 kHz or less):
  - Combined with the isolated probe 700929 (10:1)[1]
    600 V (DC+ACpeak)
  - Safety cable (1:1) (combined with 701901+701954)[5] or direct input[9]
    250 V (DC+ACpeak)

  Maximum allowable common mode voltage (at a frequency of 1 kHz or less)
  - Combined with the isolated probe 700929 (10:1)[2] or safety cable (1:1) (combined with 701901+701954)[8]
    400 Vrms (CAT I), 300 Vrms (CAT II)
  - Direct input[10]
    42 V (DC+ACpeak) (CAT I and CAT II, 30 Vrms)

- **701251 (HS1M16)**
  Maximum input voltage (at a frequency of 1 kHz or less)
  - Combined with the isolated probe 700929 (10:1)[1]
    600 V (DC+ACpeak)
  - Safety cable (1:1) (combined with 701901+701954)[5] or direct input[9]
    140 V (DC+ACpeak)

  Maximum allowable common mode voltage (at a frequency of 1 kHz or less)
  - Combined with the isolated probe 700929 (10:1)[2] or safety cable (1:1) (combined with 701901+701954)[8]
    400 Vrms (CAT I), 300 Vrms (CAT II)
  - Direct input[10]
    42 V (DC+ACpeak) (CAT I and CAT II, 30 Vrms)

- **701255 (NONISO_10M12)**
  This module is non-isolated. Be sure to fasten the module screws when measuring a voltage above 42 V on this module. In addition, use the dedicated 701940 non-isolated passive probe (10:1).
  Maximum input voltage (at a frequency of 1 kHz or less)
  - Combined with the 701940 passive probe (10:1)
    600 V (DC+ACpeak)
  - Direct input[9]
    250 V (DC+ACpeak)

- **701260 (HV (with RMS))**
  Maximum input voltage (at a frequency of 1 kHz or less)
  - Combined with the isolated probe 700929 (10:1)[1]
    1000 V (DC+ACpeak)
  - Safety cable (1:1) (combined with 701901+701954)[5] or direct input[9]
    850 V (DC+ACpeak)

  Maximum allowable common mode voltage (at a frequency of 1 kHz or less)
  - Combined with the 700929 isolated probe (10:1)
    1000 Vrms (CAT II) on the H side[3], 400 Vrms (CAT II) on the L side[4]
  - Safety cable (1:1) (combined with 701901+701954)
    700 Vrms (CAT II) on the H side[6], 400 Vrms (CAT II) on the L side[7]
  - Direct input[10]
    30 Vrms (42 VDC + ACpeak) (CAT I or CAT II)

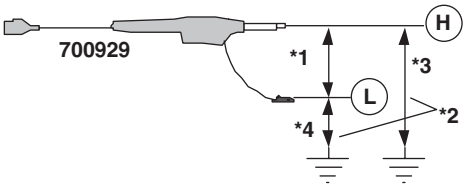
- **701275 (ACCL/VOLT)**
  Maximum input voltage (at a frequency of 1 kHz or less)
  - Combined with the 701940 passive probe (10:1)[11] or direct input[9]
    42 V (DC+ACpeak)

  Maximum allowable common mode voltage (at a frequency of 1 kHz or less)
  - Combined with the 701940 passive probe (10:1)[12] or direct input[10]
    30 Vrms (CAT I and CAT II)

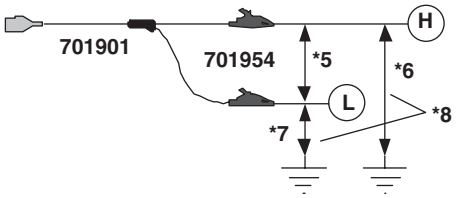
- **701280 (FREQ)**
  Maximum input voltage (at a frequency of 1 kHz or less)
  - Combined with the isolated probe 700929 (10:1)[1]
    420 V (DC+ACpeak)
  - Safety cable (1:1) (combined with 701901+701954)[5] or direct input[9]
    42 V (DC+ACpeak)

  Maximum allowable common mode voltage (at a frequency of 1 kHz or less)
  - Combined with the isolated probe 700929 (10:1)[2]
    300 Vrms (CAT I and CAT II)
  - Safety cable (1:1) (combined with 701901+701954)[8] or direct input[10]
    30 Vrms (CAT I and CAT II)

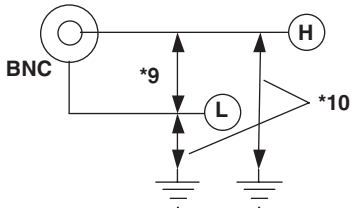
Combined with the 700929



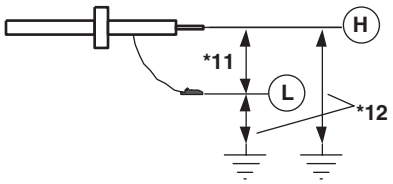
Combined with the 701901 + 701954



Direct input (cable not complying with the safety standard)



Combined with the 10:1 passive probe (701940)



Precautions to Be Taken When Connecting Probes

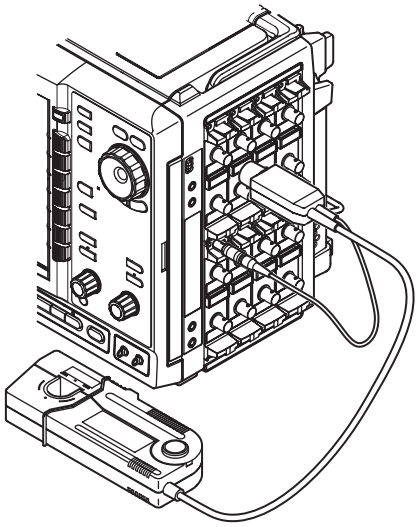
- When connecting the probe for the first time, perform phase correction of the probe as described in section 3.8. If you do not, frequency characteristics will not be flat, and measurements will not be correct. Make the phase correction on each channel to which the probe is to be connected.
- You cannot perform phase correction of the probe on the frequency module (701280 (FREQ)). Perform phase correction of the probe on another module before connecting the probe to the 701280 (FREQ).
- If the object to be measured is connected to the instrument directly, without using a probe, correct measurement cannot be performed due to the input impedance.
- When using a voltage probe other than the isolated probe (700929), correct measured values cannot be displayed if the probe's attenuation is not 1:1, 10:1, 100:1, or 1000:1.
- Follow the instructions given in section 5.6 to set the probe attenuation to match the actual value using the soft key menu. If they do not match, measured values cannot be read correctly.

Connecting Current Probes

When using current probes* made by YOKOGAWA, use the probe power supply (option) on the right side panel of the SL1400.

* Current probes made by YOKOGAWA: 701930, 701931, and 701933

For details on the connection procedure, see the manual that comes with the current probe.

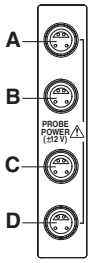


CAUTION

Do not use the probe power supply terminals (option) on the right side panel of the SL1400 for purposes other than supplying power to the current probes. Also, be sure to use only the number of probes allowed. Otherwise, the device connected to the probe power supply terminal may break.

Precautions to Be Taken When Using Current Probes

When connecting the current probe to the probe power supply terminal on the right side panel, make sure that the current does not exceed the range shown below. Otherwise, the SL1400 operation may become unstable due to the activation of the excessive current protection circuit of the power supply.



When each terminal is assigned names A through D

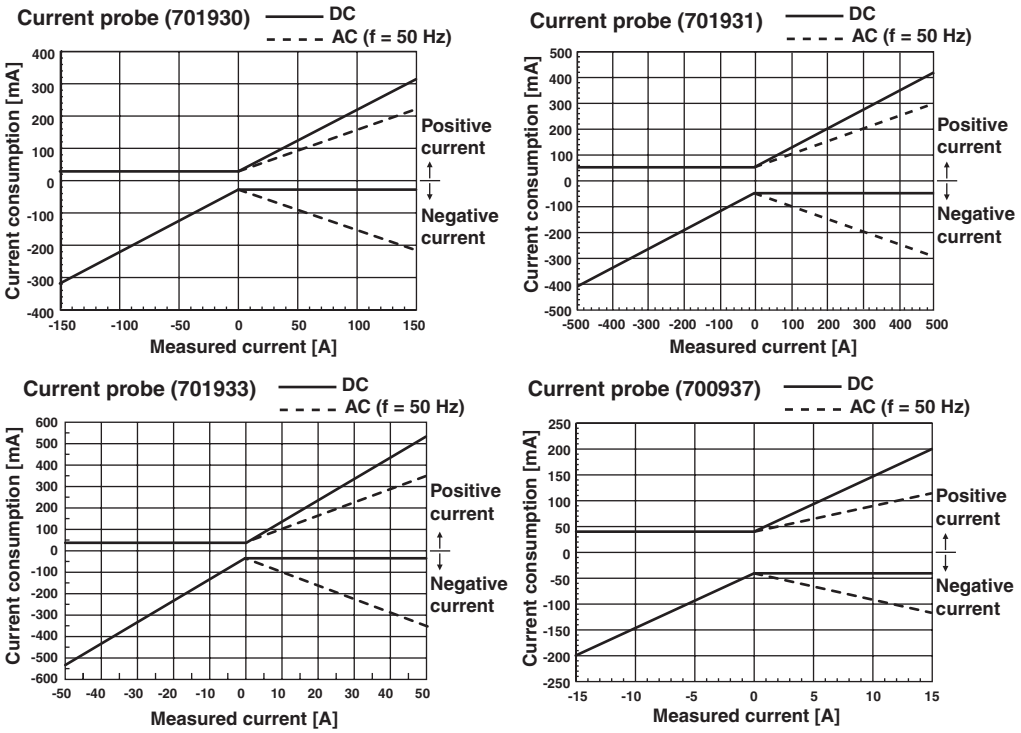
(Total current consumption of A through D) ≤ 800 mA

Specifications of the Probe Power Supply Terminals (Option)

Item		
Number of probes that can be used	4	
Compatible probes*	Current probe (701930, 701931, and 701933)	
Number of current probes that can be used	701930 (150 A):	2
	701931 (500 A):	1
	701933 (30 A):	2
Supply voltage	±12 V	2 outputs (up to a total of 800 mA)

* Up to four 700937 current probes can be used, but the 700937 is a discontinued product.

When using the current probe, the number of probes that can be used is limited by the current generated by the device under measurement (current measured by the current probe). The characteristics of the measured current versus the current consumption of a current probe that can be connected to the SL1400 are shown below.

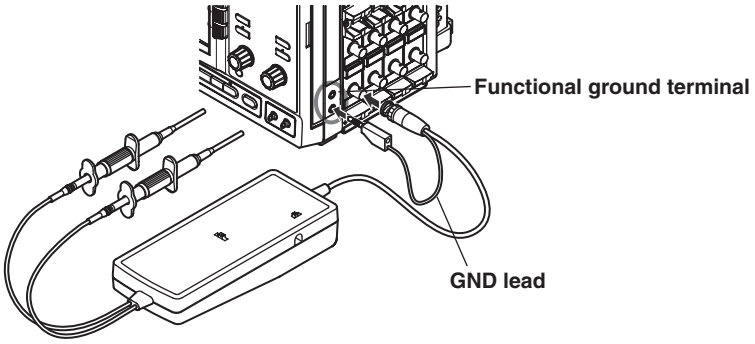


For details on the usage conditions of each probe, see “Relationship between the current being measured and probe’s current consumption” on the following Web page.
http://www.yokogawa.com/tm/probe/

Connecting Differential Probes (700924)

When using differential probes (700924) made by YOKOGAWA, connect the BNC output connector to the input terminal of the oscilloscope. In addition, be sure to connect the GND lead to the functional ground terminal of the SL1400. If necessary, use the auxiliary grounding lead extension. A measurement of 1400 Vpeak is possible by connecting the GND lead to the SL1400.

For details on the connection procedure, see the manual that comes with the differential probe.



WARNING

Precautions to Be Taken When Using High Voltage Differential Probes

Be sure to connect the GND lead of the differential probe (700924/700925) to the functional ground terminal on the right side panel of the SL1400. Otherwise, high voltage may appear at the BNC connector making it dangerous. Be sure to connect the GND lead to the SL1400 before connecting the probe to the parameter to be measured.

3.8 Compensating the Probe (Phase Correction)

When making measurements using a probe on the following modules, be sure to perform phase correction of the probe first.

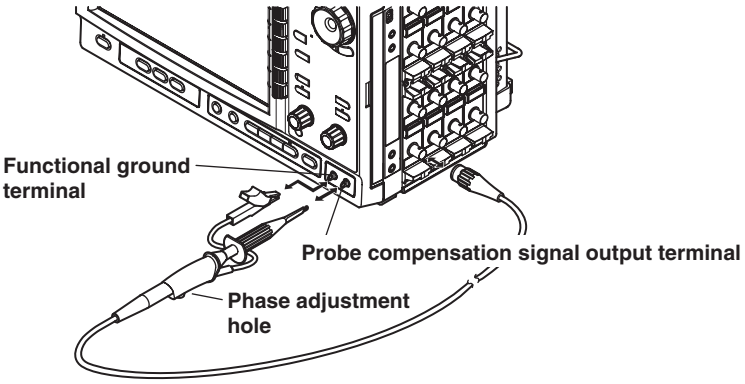
- High-Speed 10 MS/s, 12-Bit Isolation Module: 701250 (HS10M12)
- High-Speed High-Resolution 1 MS/s, 16-Bit Isolation Module: 701251 (HS1M16)
- High-Speed 10 MS/s, 12-Bit Non-Isolation Module: 701255 (NONISO_10M12)
- High-Voltage 100 kS/s, 16-Bit Isolation Module (with RMS): 701260 (HV (with RMS))
- Acceleration/Voltage Module (with AAF): 701275 (ACCL/VOLT)
- Frequency Module: 701280 (FREQ)

CAUTION

Do not apply external voltage to the probe compensation signal output terminal, as it may damage the internal circuit.

Procedure

1. Turn ON the power switch.
2. Connect the probe to the input terminal to which the signal is to be applied.
3. Connect the probe's tip to the probe compensation signal output terminal on the front panel and connect the earth wire to the functional earth terminal.
4. Perform auto setup according to the procedure described in section 4.5.
5. Insert a flat-head screwdriver to the phase correction hole and turn the variable capacitor to make the displayed waveform a correct rectangular wave.



Explanation

Necessity of Phase Correction of the Probe

The probe comes with its phase corrected approximately to match the input capacitance of the relevant oscilloscope. However, there is variance in the input resistance and input capacitance of each input channel of individual oscilloscopes. This results in a mismatch in the voltage divider ratio between low and high frequency signals and causes uneven frequency characteristics.

There is a variable capacitor for adjusting the voltage divider ratio (trimmer) for high frequency signals on the probe. The phase is corrected by adjusting this trimmer so that even frequency characteristics are obtained.

When using the probe for the first time, make sure to perform phase correction.

Because the input capacitance varies on each channel, probe compensation is also required when the probe is switched from one channel to another.

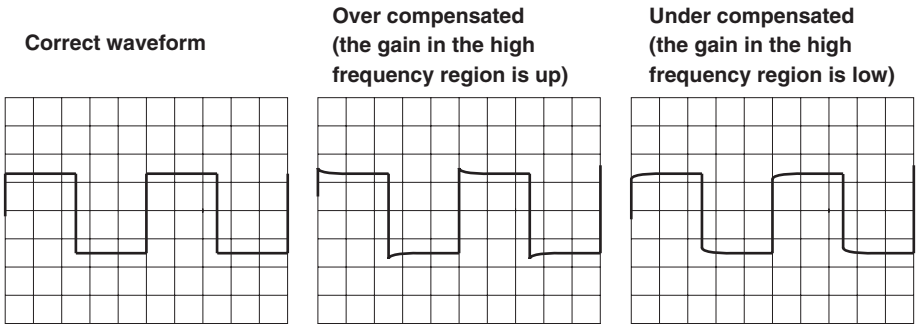
Phase Compensation Signal

The probe compensation signal output terminal (COMP terminal) delivers the following rectangular wave signal.

Frequency: 1 kHz ± 1%

Amplitude: 1 V ± 10%

Differences in the Waveform Caused by the Phase Correction of the Probe



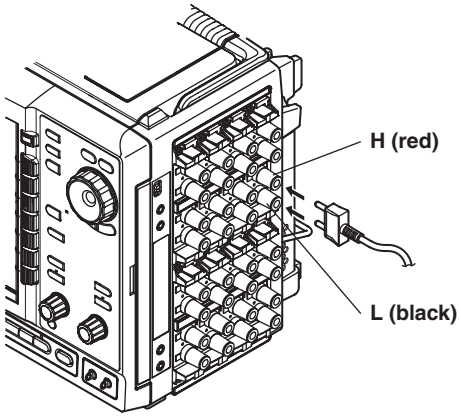
Precautions to Be Taken When Using the Probe on the Frequency Module (701280 (FREQ))

You cannot perform phase correction of the probe on the frequency module. When connecting a probe to the frequency module, perform phase correction of the probe on another module beforehand.

3.9 Connecting Measurement Leads

Connecting Measurement Leads

Connect measurement leads of bipolar banana plug terminal to the input terminal (binding post terminal) when measuring the voltage on the 701261 (UNIVERSAL), 701262 (UNIVERSAL (AAF)), or 701265 (TEMP/HPV) as shown below.



WARNING

- When connecting the item to be measured, be sure to turn OFF the power to the item. Connecting or disconnecting the measurement lead while the item being measured is turned ON is very dangerous.
- To prevent electric shock, make sure to use the measurement lead suitable for the voltage range being measured on the input terminals of the 701261 (UNIVERSAL), 701262 (UNIVERSAL (AAF)), or 701265 (TEMP/HPV).
- Applying a voltage exceeding the value indicated below may damage the input section. If the frequency is above 1 kHz, damage may occur even when the voltage is below this value.

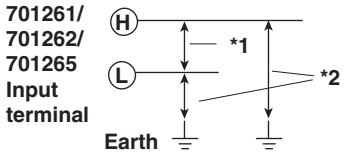
  701261, 701262, and 701265

  Maximum input voltage (across the input terminals, H and L[1], at a frequency of 1 kHz or less)

  42 V (DC+ACpeak)

  Maximum allowable common mode voltage (across the input terminals, H or L, and earth[2], at a frequency of 1 kHz or less)

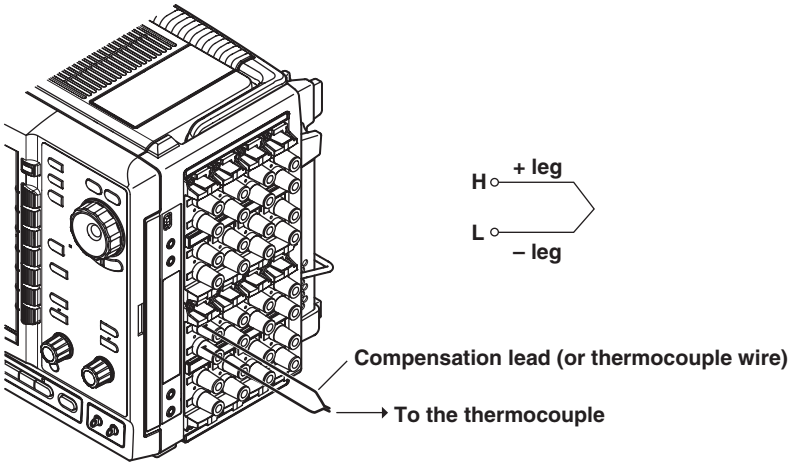
  42 V (DC+ACpeak) (CAT I and CAT II, 30 Vrms)
- Do not connect a plug-in type terminal with exposed conducting parts to the input terminal to be used as a measurement lead. It is very dangerous, if the connector comes loose.



3.10 Connecting Thermocouples

Connecting Thermocouples

If you are connecting the compensation lead of the thermocouple to the input terminal (binding post terminal) of the 701261 (UNIVERSAL), 701262 (UNIVERSAL (AAF)), or 701265 (TEMP/HPV), loosen the terminal knob, pass the lead through the terminal, and tighten the knob.



CAUTION

- The 701261 (UNIVERSAL), 701262 (UNIVERSAL (AAF)), or 701265 (TEMP/HPV) is isolated from the SL1400. However, applying a voltage exceeding the value below may damage the input section. If the frequency is above 1 kHz, damage may occur even when the voltage is below this value.
  Maximum input voltage (across the input terminals, H and L, at a frequency of 1 kHz or less)
  42 V (DC+ACpeak)
  Maximum allowable common mode voltage (across the input terminal L and earth at a frequency of 1 kHz or less)
  42 V (DC+ACpeak) (CAT I and CAT II, 30 Vrms)
- Correct measurements cannot be made, if the positive and negative legs of the thermocouple are reversed.
- Immediately after connecting the thermocouple, the heat balance may be disturbed at the input terminal section and may cause measurement errors. Therefore, wait about 10 minutes before making a measurement.
- In an environment where the air from the air conditioning is directly applied to the input terminals or where there are effects from a heat source, the heat balance may be disturbed at the input terminal section and cause measurement errors.
  When making measurements in this type of environment, take preventive measures such as changing the position.

3.11 Connecting the Bridge Head

Strain is measured by connecting a strain gauge bridge (bridge head) or a strain gauge transducer to the strain module (701270 (STRAIN_NDIS) or 701271 (STRAIN_DSUB)). This section will mainly describe the procedures and precautions related to the connection of the bridge head (Model 701955/701956/701957/701958). For the connection of other strain gauge bridges or strain gauge transducers, see the respective manuals.

CAUTION

Only connect a strain gauge bridge (bridge head) or a strain gauge transducer to the strain module. Connecting other devices or applying a voltage that exceeds the values indicated below to the strain module may damage the input section.

- Maximum input voltage (between Input+ and Input–)
  10 V (DC+ACpeak)
- Maximum allowable common mode voltage (between each terminal and earth ground)
  42 V (DC+ACpeak) (CAT I and CAT II, 30 Vrms)

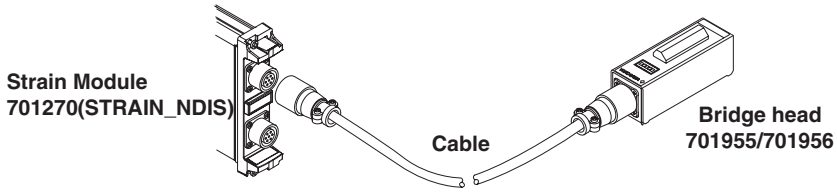
Connecting the Strain Gauge

The bridge head (701955/701956/701957/701958) supports six types of connection methods: single-gauge method, single-gauge three-wire method, adjacent-side two-gauge method, opposite-side two-gauge method, opposite-side two-gauge three-wire method, and four-gauge method. For details, see the manual that comes with the bridge head (701955/701956/701957/701958).
If you are using a strain gauge bridge or a strain gauge transducer other than the bridge head (701955/701956/701957/701958), see the respective manuals.

Connecting the Strain Module and the Bridge Head

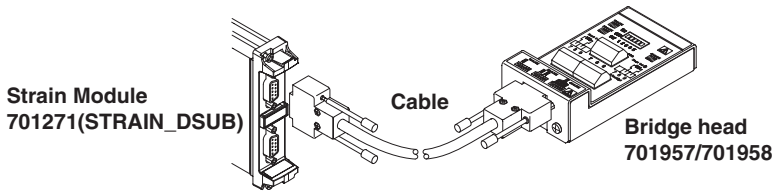
When Using the Strain Module (701270) and the Bridge Head (701955/701956)

Using the cable that comes with the bridge head (701955/701956), connect the bridge head to the 701270 (STRAIN_NDIS).



When Using the Strain Module (701271) and the Bridge Head (701957/701958)

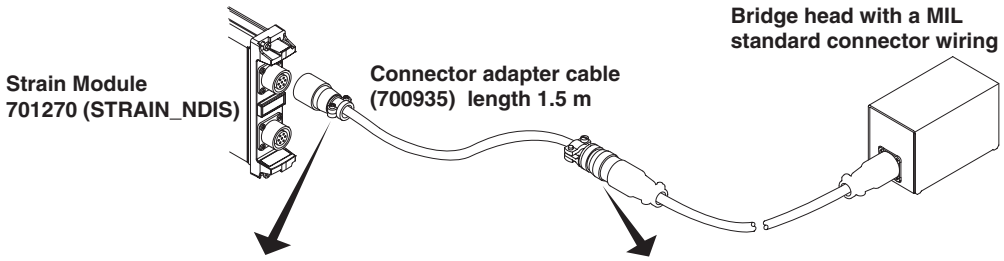
Using the cable that comes with the bridge head (701957/701958), connect the bridge head to the 701271 (STRAIN_DSUB).



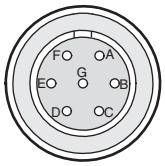
When Using a Bridge Head with a MIL Standard (MIL-C-26482) Connector Wiring

The connector on the 701270 (STRAIN_NDIS) is a NDIS connector. Use a connector adapter cable (700935) by YOKOGAWA to make a MIL-NDIS conversion and connect the bridge head to the Strain Module (701270).

* A connector recommended by JSNDI (The Japanese Society for Non-destructive Inspection)

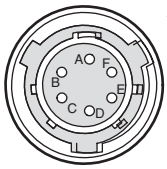


Pin arrangement of an NDIS connector



A: Bridge+ **(positive bridge voltage)**
B: Input– **(negative measurement signal)**
C: Bridge– **(negative bridge voltage)**
D: Input+ **(positive measurement signal)**
E: Floating common
F: Sense+
(positive bridge voltage sensing)
G: Sense–
(negative bridge voltage sensing)

Pin arrangement of a MIL standard connector



A: Signal+
B: Signal–
C: Excitation+
D: Excitation–
E: NC (no connection)
F: NC (no connection)

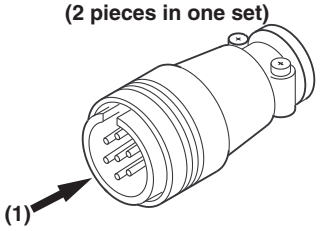
Terminal relationship

NDIS		MIL
A	——	C
B	——	B
C	——	D
D	——	A

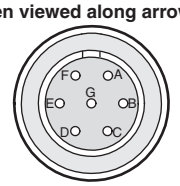
When Using the A1002JC Connector by YOKOGAWA

You can create your own cable by using the YOKOGAWA A1002JC connector that is compatible with the strain module and use the cable to connect a strain gauge bridge or a strain gauge transducer to the strain module.

A1002JC NDIS connector (2 pieces in one set)



Pin arrangement
When viewed along arrow (1)



A: Bridge+ **(positive bridge voltage)**
B: Input– **(negative measurement signal)**
C: Bridge– **(negative bridge voltage)**
D: Input+ **(positive measurement signal)**
E: Floating common
F: Sense+ **(positive bridge voltage sensing)**
G :Sense– **(negative bridge voltage sensing)**

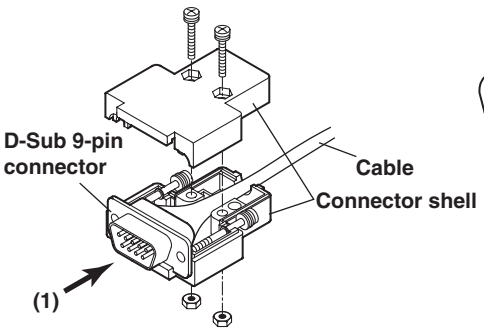
Note

- The connector shell is connected to the case potential (earth) of the SL1400.
- Signals A through G are isolated inside the module.
- When creating your own cable, we recommend that you use a shielded cable in order to shut out external noise.

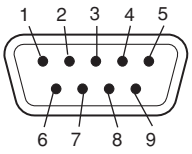
CAUTION

Take extra care when wiring the connectors. If the wiring is shorted or incorrect, it can damage the SL1400 or other instruments that are connected it.

Pin Arrangement of the D-Sub Connector



When viewed along arrow (1)



1: Floating common
2: Sense– **(negative bridge voltage sensing)**
3: Shuntcal– **(negative shunt signal)**
4: Shuntcal+ **(positive shunt signal)**
5: Sense+ **(positive bridge voltage sensing)**
6: Bridge– **(negative bridge voltage)**
7: Input– **(negative measurement signal)**
8: Input+ **(positive measurement signal)**
9: Bridge+ **(positive bridge voltage)**

3.12 Connecting Logic Probes

CAUTION

- Applying a voltage exceeding the value indicated below may damage the logic probe or the SL1400. If the frequency is above 1 kHz, damage may occur even when the voltage is below this value.
  Maximum input voltage (at a frequency of 1 kHz or less)
  - 702911/702912 logic probe: 35 V
  - 700986 High-Speed Logic Probe: 42 V (DC+ACpeak)
  - 700987 Isolated Logic Probe: 250 Vrms (except ACpeak is less than or equal to 350 V and DC is less than 250 V)
- On the 702911, 702912, or 700986 logic probe, the 8 input lines on each POD have a common earth. In addition, the earth for the instrument and the earth for each POD are also common. Do not connect inputs which have different common voltages, as it may cause damage to the SL1400, logic probe, or other connected instruments.
- Each input terminal of the isolated logic probe is isolated from all other input terminals and the isolated logic probe is isolated from the SL1400.
- Make sure to turn OFF the instrument before connecting or disconnecting the 26-pin connector from the logic input connector.
- Do not stack the isolated logic probes during use. Also, allow enough space around the probes to prevent the temperature inside the probes from increasing.
- Do not use the 700985 logic probe by YOKOGAWA on the SL1400. The structure of the 700985 allows it to be connected to the logic signal input connector of the SL1400. However, because it is not electrically compatible, connecting the 700985 may cause damage to the SL1400 or the 700985.

Logic Input Connector

Connect the 702911, 702912, 700986, or 700987 logic probe to either of the logic signal input connectors (two connectors marked Logic A and Logic B).

About the Logic Probe

Types of Logic Probes

The following logic probes are available for connecting to the logic input connector of the SL1400.

- 702911 (1 m) and 702912 (3 m) logic probes
- 700986 High-Speed Logic Probe
- 700987 Isolated Logic Probe
  * Do not use the 700985 on the SL1400. Read the caution above.

Types of Connection Leads That Can Be Used

Use the following leads to connect to the point of measurement.

- **Types of Connection Leads That Can Be Used on the 702911, 702912, and 700986 Probes**
  The following two types are available.
  - Connection lead (alligator clip, parts No. B9879PX)
    This lead is mainly used to connect to contact circuits. The lead consists of 8 signal lines (red) and 8 earth lines (black).
  - Connection lead (IC clip, parts No. B9879KX)
    This lead is mainly used to connect to electronic circuits. The lead consists of 8 signal lines (red) and 2 earth lines (black).

- **Types of Measurement Leads That Can Be Used on the 700987 Isolated Logic Probe**

  Use the following measurement lead.

  For measuring voltages of 42 V or more: Measurement lead for isolation logic (758917)

  An alligator adapter (758922), alligator adapter (758929), or alligator clip (dolphin type, 701954) is needed to make measurements.

Note

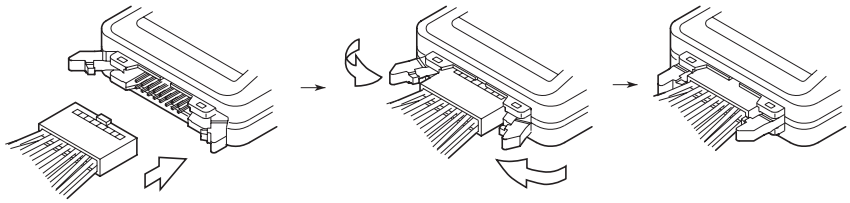
Do not alter the connection leads, as it may cause the leads from satisfying the specifications.

Connecting Logic Probes

702911, 702912, and 700986 Logic Probes

1. Attach the accessory connection lead (IC clip or alligator clip) to the logic probe, and lock the connector by clamping the lever inwards. To release the connection lead from the logic probe, pull both levers outwards.
2. On the 702911 or 702912, use the input switch on the probe to set the input format to TTL level* or contact.*

   * TTL level: Set to 1 at a voltage greater than or equal to approximately 1.4 V. Contact: Set to 1 when the input is shorted to the earth line.

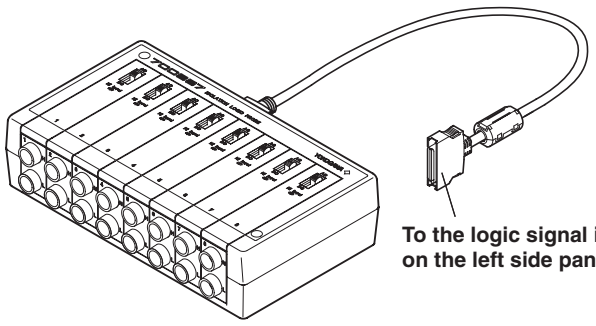


700987 Isolated Logic Probe

1. Connect the measurement lead to the input terminal of the logic probe.
2. Set the input switch. The threshold level is set to 50 VAC ± 50% (Hi: 80 to 250 VAC, Lo: 0 to 20 VAC) and 6 V ± 50% (Hi: 10 to 250 VDC, Lo: 0 to 3 VDC) when set to “AC” and “DC,” respectively.

Connecting the Logic Probe to the Logic Signal Input Connector

3. Turn OFF the SL1400.
4. Connect the end with the 26-pin connector (clamp filter with ferrite core, parts No. A1190MN) of the logic probe to the logic signal input connector of the SL1400.
5. Turn ON the SL1400.



Note

- Each bit is displayed as “L level” when the logic probe is not connected to the instrument.
- For logic probe specifications, see section 18.13.
- The logic input display is turned OFF by default. For the procedure to turn ON/OFF the display, see section 5.1.

3.13 Connecting Acceleration Sensors

An acceleration sensor is connected when measuring acceleration on the 701275 (ACCL/VOLT). For a details on acceleration sensors, see the respective manuals.

CAUTION

- Applying a voltage that exceeds the values indicated below to the 701275 (ACCL/VOLT) may damage the input section.
  Maximum input voltage: 42 V (DC+ACpeak)
- Connect acceleration sensors without supplying bias current to the sensor. Otherwise, damage to the internal circuitry of the acceleration sensors may result.
- The SL1400 only supports acceleration sensors that are driven by constant current with driving current of 4 mA and driving voltage of 22 V.

Connecting Acceleration Sensors

When Connecting Built-in Amplifier Type Acceleration Sensors

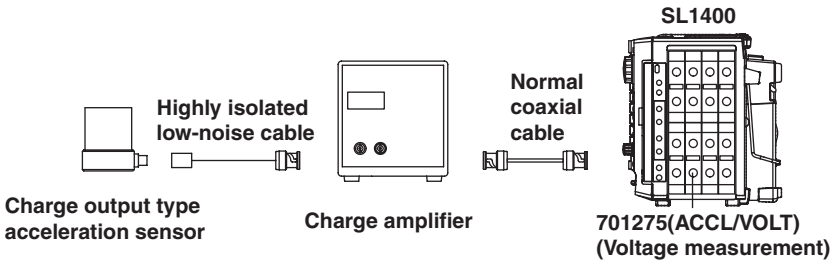
The SL1400 allows built-in amplifier type (low impedance) acceleration sensors to be directly connected. To connect built-in amplifier type acceleration sensors, use BNC cables. Use cables that are appropriate for the acceleration sensors being used. Connect the acceleration sensors with the bias current turned OFF. After connection, turn ON the supply current to the acceleration sensors to make measurements.

When Connecting Charge Output Type Acceleration Sensors

Since the charge output type (high impedance) acceleration sensors do not have a built-in amplifier circuit, they cannot be directly connected to the SL1400. Use either of the following two methods to connect the sensors.

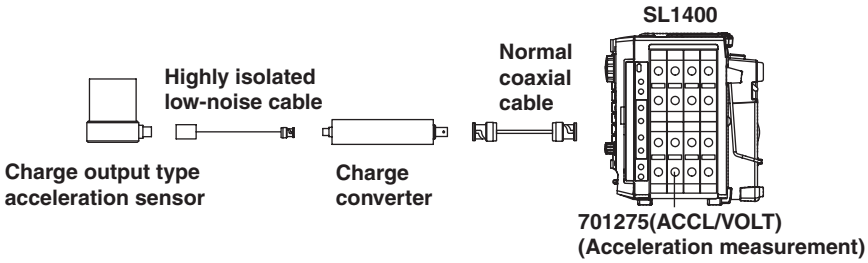
Using the Charge Amplifier

Connect the charge output type acceleration sensor to a charge amplifier using a highly isolated low-noise cable. The acceleration signal (charge signal) that has been converted to a voltage signal by the charge amplifier is applied to the SL1400 using a normal coaxial cable. The SL1400 measures the signal in the voltage measurement mode. The measured data can be converted to acceleration values using the scale conversion function of the SL1400.



Using the Charge Converter

Connect the charge output type acceleration sensor to a charge converter using a highly isolated low-noise cable. By driving the charge converter using a constant current from the SL1400, voltage signals similar to those of the built-in amplifier type acceleration sensor can be obtained. The SL1400 measures the signals in the acceleration measurement mode and supplies bias current to the charge converter. Set the input sensitivity of the SL1400 according to the charge converter gain and the sensitivity of the charge output type acceleration sensor.
The SL1400 only supports charge converters that are driven by constant current with driving current of 4 mA and driving voltage of 22 V.



Note

The unit of measurement of acceleration on the SL1400 is m/s^2. The sensitivity is sometimes expressed in units of mV/G depending on the acceleration sensor. In such cases, convert the unit. (1 G = 9.81 m/s^2)

Precautions

- Do not apply shock outside the specifications (see the manual for the acceleration sensor) to the acceleration sensors. Doing so can damage the sensors.
- Do not impose drastic temperature changes on the acceleration sensors. Temperature changes may affect the output value of the acceleration sensors.
- By default, the bias current on the acceleration sensors is turned OFF. Be sure to turn it ON before using the acceleration sensors. Bias current is valid only when measuring acceleration. When measuring other parameters, it is automatically turned OFF. The ON/OFF setting of the bias current is retained even when you turn OFF the SL1400.

3.14 Connecting Sensors to the Frequency Module

Sensors and Signal Output Sources That Can Be Connected

The table below shows the sensor and signal output source that can be connected. Appropriate input presets are provided for each sensor and signal output source. For the procedure of presets, see section 5.17.

Sensor and Signal Output Source	Preset Name
5-V logic signal, 5-V output sensor, and sensor with TTL output	Logic 5V
3-V logic signal and 3-V output sensor	Logic 3V
12-V driven relay/sequence circuit and 12-V driven sensor	Logic 12V
24-V driven relay/sequence circuit and 24-V driven sensor	Logic 24V
Sensor/Encoder that outputs positive and negative voltages and sensor that outputs sine waves	ZeroCross
100-VAC power supply (connected via the 700929 isolated probe)	AC100V
200-VAC power supply (connected via the 700929 isolated probe)	AC200V
Power-generating electromagnetic pickup	EM Pickup
Open collector output (0 to 5 V output) and contact output	Pull-up 5V*

* For the internal equivalent circuit for “Pull-up 5V,” see page 5-40.

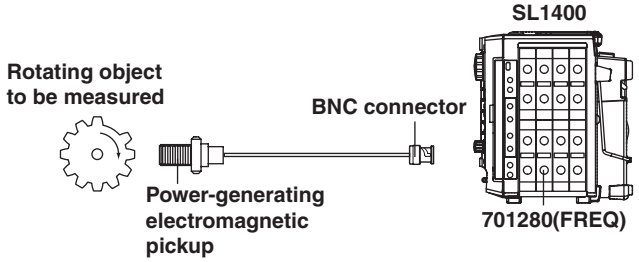
Precautions to Be Taken When Connecting to Sensors or Signal Output Sources

CAUTION

- The maximum input voltage for direct input is indicated below. Applying a voltage exceeding this value can damage the input section. If you are applying high voltage that exceeds 42 V, be sure to use the isolated probe (700929).
  Maximum input voltage: 42 V (DC+ACpeak) (CAT I and CAT II)
- The minimum input voltage is 0.2 V_{P-P}. At voltage amplitude less than 0.2 V_{P-P}, the measured values may be unstable.
- Attach/Remove the sensors after confirming that the rotating object to be measured is stopped.
- Set the preset to electromagnetic pickup (EM Pickup) only when using the electromagnetic pickup.

Connecting the Electromagnetic Pickup

- The SL1400 allows power-generating electromagnetic pickup to be connected directly. The SL1400 does not support electromagnetic pickups that require external power supply or those that require a terminator at the output.
- To connect electromagnetic pickups, use BNC cables. Use cables that are appropriate for the electromagnetic pickups being used.
- When the input is set to EM Pickup (electromagnetic pickup), determination is not made on whether the input voltage level exceeds the specified input voltage range. The LEDs (see page 3-7) do not illuminate even when the voltage level is over range.



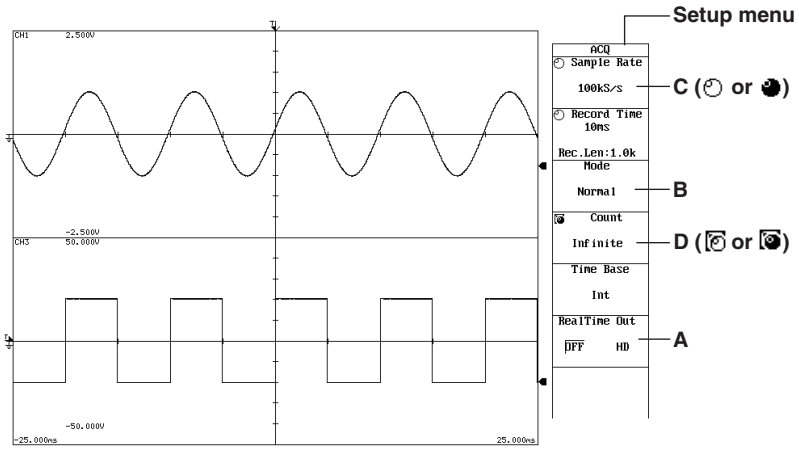
4.1 Operations and Functions of Keys and the Jog Shuttle

This section describes the basic operations of the keys and jog shuttle on the SL1400.

Basic Key Operations

Displaying the Setup Menu of the Panel Keys

1. Press a key. The menu corresponding to the key appears.
2. Press the soft key corresponding to each item.



A: Press the corresponding soft key to switch the selected item.

B: Press the corresponding soft key to display the selection menu.
Press the soft key corresponding to a selection to make the selection.

C: Press the corresponding soft key to set the item under jog shuttle control.
Turn the **jog shuttle** to change the setting.

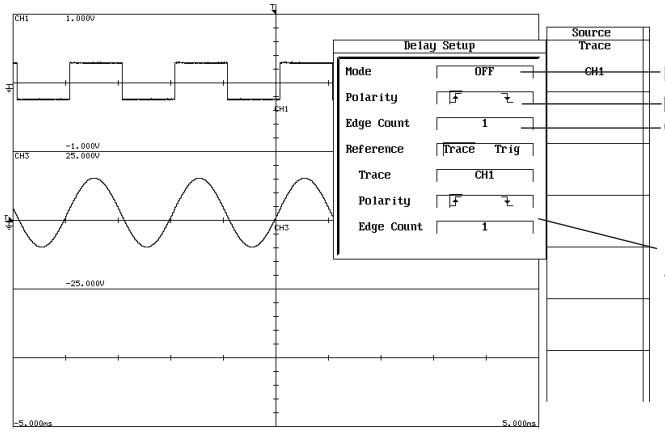
D: Press the corresponding soft key to set the item under jog shuttle control.
Turn the **jog shuttle** to set the value.
Press the **arrow keys** to change the selected digit.
You can directly enter the value from a USB keyboard.

Note

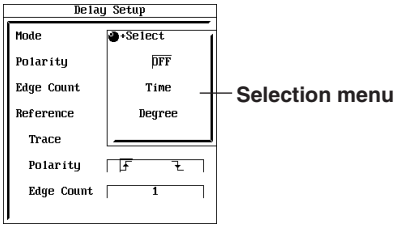
If the setup menu shows Next 1/2, you can press the soft key corresponding to Next 1/2 to show the 2/2 menu. To show the 1/2 menu again, press the soft key corresponding to Next 2/2. If Next 1/3 is shown, the soft key switches in the following order: Next 1/3, Next 2/3, Next 3/3, Next 1/3, and so on.

Operations on the Setup Dialog Box

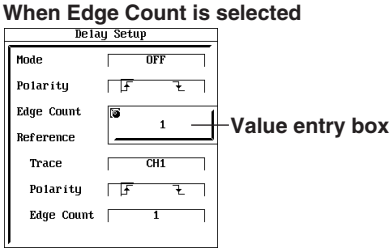
1. Show the setup dialog box using basic key operations or other similar means.
2. Turn the **jog shuttle** to move the cursor to the desired item.
3. Press **SELECT**. The behavior that results when you press **SELECT** varies depending on the item as described below. This manual refers to the above operation as "**jog shuttle** + **SELECT**."



When Mode is selected



When Edge Count is selected



E: Press **SELECT** to display the selection menu.
Turn the **jog shuttle** to move the cursor to the item you wish to set.
Press **SELECT** to apply the selected item.

F: Press **SELECT** to switch the selected item.

G: Press **SELECT** to display the value entry box.
Turn the **jog shuttle** to set the value.
Press the **arrow keys** to change the selected digit.
You can directly enter the value from a USB keyboard.

Clearing the Setup Menu and Setup Dialog Box

Press **ESC**. The setup menu or setup dialog box shown on top is cleared from the screen.

Note

- In the operating procedures in this manual, the step for clearing the setup menu and setup dialog box is not indicated.
- When the setup menu is cleared, the main information on the displayed channels is shown. For details, see section 8.13.

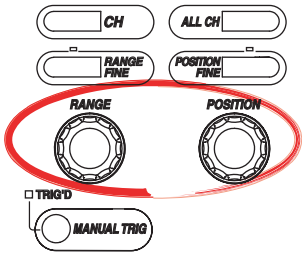
4.2 Entering Values and Strings

Entering Values

Entering Values Directly Using the Dedicated Knob

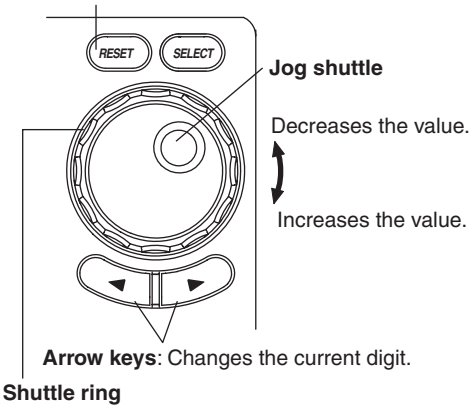
The dedicated knobs indicated below can be turned to directly enter values.

- Range knob
- Position knob



Entering Values Using the Jog Shuttle

After selecting the setup item using the soft key, use the jog shuttle to change the value. The outer shuttle ring can be used to step through the values in large increments. On some items, the arrow keys below the jog shuttle can be used to move among the digits.



Note

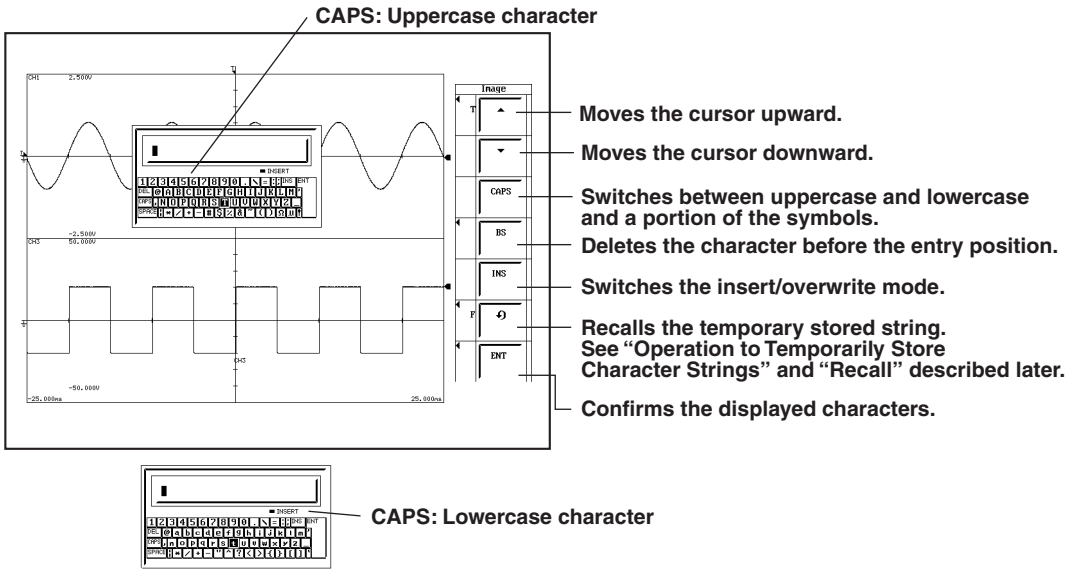
The items that can be changed using the jog shuttle are reset to their initial values when you press RESET.

Entering Strings

The keyboard displayed on the screen is used to enter character strings such as file names and comments. The jog shuttle, SELECT, and arrow keys are used to operate the keyboard to enter the character strings.

Operating the Keyboard

1. Turn the **jog shuttle** to move the cursor to the character to be entered. You can also press the soft keys corresponding to ▲ and ▼ to move the cursor vertically.
2. Press **SELECT**. The character is confirmed. If a character string is already been entered, move the cursor to the position in the string at which you want to enter a character.
3. Repeat steps 1 and 2 to enter all the characters in the string.
4. Selecting ENT on the keyboard and pressing **SELECT** confirms the string and the keyboard disappears. You can also press the ENT soft key to confirm the string and clear the keyboard. At the same time, the confirmed string is temporarily stored. If you wish to clear the entire string that you have entered, press **RESET** before confirming the string.



- **Operation of Temporarily Storing the Character Strings**

  The strings that are previously confirmed are sequentially sent to the subsequent memories. When the number of confirmed strings exceeds eight, the strings are deleted in order starting from the oldest string. Symbols ↺0 to ↺7 are used in the explanation as a matter of convenience, but numbers 0 to 7 do not appear on the actual screen.

Symbol indicating the memory storing the string	↺0	↺1	↺2	.....	↺7
When string "AA" is confirmed first	Stores AA				
When string "BB" is confirmed next	Stores BB	Moves and stores AA			
When string "CC" is confirmed next	Stores CC	Moves and stores BB	Moves and stores AA		
.....					
When string "HH" is confirmed next	Stores HH	Moves and stores GG	Moves and stores FF	.....	Moves and stores AA
When string "JJ" is confirmed next	Stores JJ	Moves and stores HH	Moves and stores GG	.....	Moves and stores BB Deletes AA

- **Recalling Strings**

  Note that the string that is displayed in the entry box of the keyboard is overwritten when a string is recalled using the procedure in step 1 below.

  1. Every time the ↶ soft key is pressed, strings that are temporary stored (strings that have been entered previously) appear in order in the input box of the keyboard. When the eight strings that are temporarily stored are displayed, the most recent string is displayed again.
  2. Make appropriate corrections to the recalled string and confirm it according to steps 1 to 4 that were described in "Operating the Keyboard" on the previous page. At this point, the confirmed string is temporarily stored.

- **Keys Other Than the Character Keys**

  DEL: Deletes the character at the cursor.
  INS: Switches the insert/overwrite mode. When in insert mode, the INSERT indicator on the keyboard illuminates.
  SPACE: Enters a space.
  ENT: Confirms the displayed characters.
  CAPS: Switches between uppercase and lowercase.

Number of Characters and Types That Can Be Used in the Settings

Setup Item	Number of Characters	Characters That Can Be Used	Reference Section
Date/Time	Specified number	0 to 9	3.6
Waveform labels	1 to 8	All characters (including spaces)	8.10
Unit of linear scaling	0 to 4	All characters (including spaces)	5.11
File name	1 to 16	A to Z, %, _, (,)	13.8 to 13.12, 7.5
Comments for files	0 to 160	All characters (including spaces)	13.8 to 13.11, 7.5
Comments for screen images	0 to 20	All characters (including spaces)	13.12
Comments for printing	0 to 20	All characters (including spaces)	12.1
Message of annotation	0 to 80	All characters (including spaces)	9.3, 12.1
Comments for PDF files	0 to 20	All characters (including spaces)	13.14
Title, author, and sub title of PDF files	0 to 30	All characters (including spaces)	9.8, 13.14
Keyword of PDF files	0 to 90	All characters (including spaces)	9.8, 13.14
E-mail address	0 to 40	ASCII characters (including spaces)	15.5
Comments for e-mail	0 to 30	All characters (including spaces)	15.5
User name, login name, and password	0 to 15	ASCII characters (including spaces)	15.3, 15.6, 15.7

Note

- The multiple @ characters cannot be entered consecutively.
- File names are not case-sensitive. Uppercase and lowercase are distinguished in comments. In addition, the following five file names cannot be used due to limitations of MS-DOS.
  AUX, CON, PRN, NUL, CLOCK, COM1 to COM9, LPT1 to LPT9

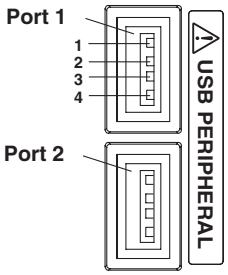
4.3 Operating the SL14000 Using a USB Keyboard or a USB Mouse

Entering Values from a USB Keyboard

You can connect a USB keyboard for entering file names, comments, and other information. In addition, the functions of each key on the front panel of the SL1400 are assigned to the keys on the keyboard (see appendix 7). Thus, the keyboard can be used to carry out operations that are the same as the key operations on the SL1400.

USB PERIPHERAL connector

To connect a USB keyboard to the SL1400, connect a USB cable to the USB PERIPHERAL connector on the left side panel. There are two USB PERIPHERAL connectors (ports).



Pin No.	Signal Name	
1	VBUS:	+5 V
2	D–:	–Data
3	D+:	+Data
4	GND:	Ground

Compatible Keyboards

Keyboards that can be used are determined by the language selected in section 16.1. The following keyboards conforming to USB Human Interface Devices (HID) Class Ver1.1 can be used.

- When the language is not Japanese: 104 or 89 English Keyboard
- When the language is Japanese: 109 or 89 Japanese Keyboard

Note

For USB keyboards that have been tested for compatibility, contact your nearest YOKOGAWA dealer.

Connection Procedure

When connecting a USB keyboard, directly connect the keyboard to the SL1500 using a USB cable as shown below. You can connect/disconnect a USB cable at any time regardless of the power ON/OFF state of the SL1400 (supports hot-plugging). Connect the type A connector of the USB cable to the SL1400; connect the type B connector to the keyboard. When the power switch is ON, the keyboard is detected and enabled approximately six seconds after it is connected.

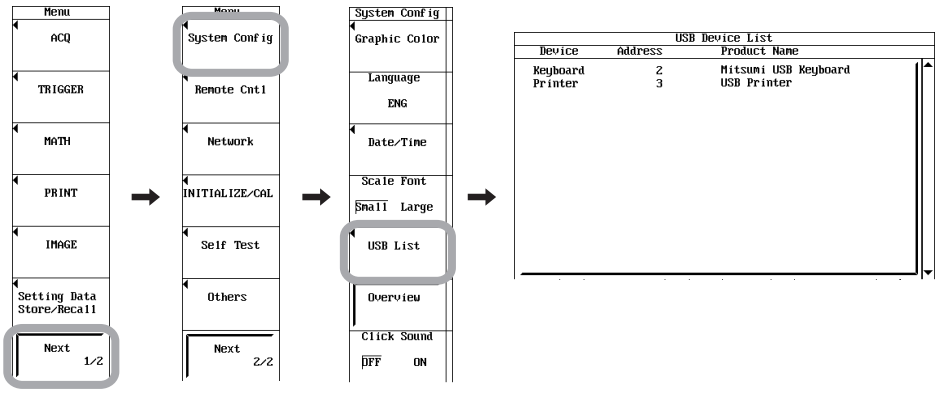
Note

- Connect the keyboard directly without going through a USB hub.
- Do not connect USB devices other than a USB keyboard, USB mouse, USB printer, or USB storage device to the USB PERIPHERAL connector.
- Do not connect multiple keyboards.
- Holding down a key on the keyboard does not enter the character or value repetitively.
- Do not connect and disconnect multiple USB devices repetitively. To do so, allow at least 10 s between connection and disconnection.
- Do not connect or disconnect the USB cable after the power is turned ON until key operation is ready (approximately 20 to 30 s).

Checking the Keyboard That Is Connected

To check the keyboard that is connected to the SL1400, carry out the procedure below.

1. Press **MENU**.
2. Press the **Next 1/2** soft key.
3. Press the **System Config** soft key.
4. Press the **USB List** soft key to display the USB Device List. Check the USB keyboard that is connected.



Entering File Names, Comments, and Other Items

When a keyboard is displayed on the screen, you can enter the file name, comment, and other items using a USB keyboard. The character that is entered through each key of the USB keyboard varies depending on the keyboard type. For details, see appendix 7.

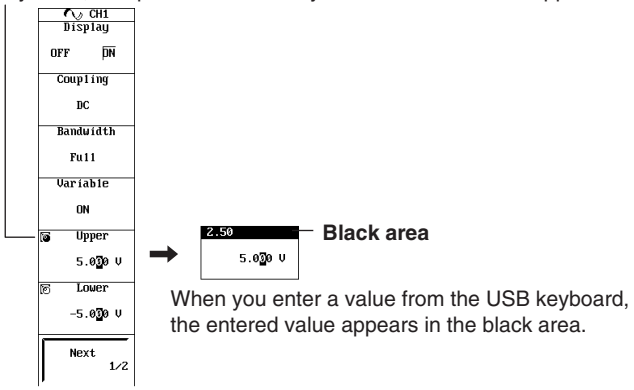
Executing Functions Corresponding to the Front Panel Keys of the SL1400

The functions corresponding to the front panel keys of the SL1400 are assigned to the keys on the USB keyboard. Therefore, you can press the key on the keyboard to carry out the corresponding function. The assignment of functions varies depending on the keyboard type. For details, see appendix 7.

Entering Values Directly from a USB Keyboard

You can directly enter values from a USB keyboard for items with the or icon on the SL1400 setup menu.

Press the soft key corresponding to the item, enter the value from the USB keyboard, and press the Enter key. The entered value is applied.



When you enter a value from the USB keyboard, the entered value appears in the black area.

When a Prefix Unit Is Displayed

For voltage (V) and time (s) items, you can also enter the prefix unit from the USB keyboard.

Example

Selecting “Upper” in the above menu and entering “1”, “0”, and “m” from the USB keyboard is equivalent to entering “10 mV”. Thus, the Upper box shows “0.010V” when the voltage range is 5.00 V. If you enter the prefix unit from a USB keyboard, you do not have to press Enter.

Below are the prefix units that can be entered.

Input Key	Prefix Unit
K or k	10^{3} (kilo)
m	10^{-3} (milli)
U or u	10^{-6} (micro)
N or n	10^{-9} (nano)
P or p	10^{-12} (pico)

When Displayed in Exponential Notation

You can also enter the menu items displayed in exponential notation from the USB keyboard.

Example

Entering “2”, “.”, “3”, “E”, “1”, “Enter” for the menu item displaying “0.0000E+00” causes the value to be displayed as “2.3000E+01”.

Operations Using a USB Mouse

You can use a USB mouse to operate the SL1400 as you would using the front panel keys. In addition, you can click a desired item on a menu. This is analogous to pressing a soft key corresponding to a menu and pressing SELECT.

USB PERIPHERAL Connector

The USB mouse is connected to the USB PERIPHERAL connector on the left side panel of the SL1400. For details on the USB PERIPHERAL connector, see page 4-6.

Compatible USB Mouse

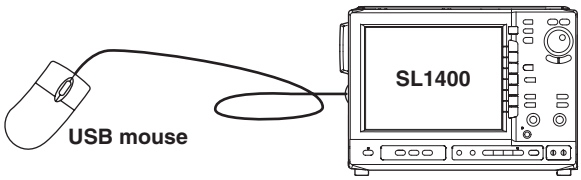
A wheel USB mouse conforming to USB HID Class Version 1.1 can be used.

Note

- For USB mouse devices that have been tested for compatibility, contact your nearest YOKOGAWA dealer.
- Some items cannot be specified when using a mouse without a wheel.

Connection Procedure

Connect the USB mouse to the USB PERIPHERIAL connector as shown below. You can connect/disconnect the USB mouse connector regardless of the power ON/OFF state of the SL1400 (supports hot-plugging). When the power switch is ON, the mouse is detected, and a pointer (↖) is displayed approximately 6 seconds after it is connected.



Note

- Do not connect USB devices other than a USB keyboard, USB mouse, or USB printer to the USB PERIPHERAL connector.
- There are two USB PERIPHERAL connectors. However, do not connect mouse devices to both connectors at the same time.
- Do not connect and disconnect multiple USB devices repetitively. To do so, allow at least 10 s between connection and disconnection.
- Do not connect or disconnect the USB cable after the power is turned ON until key operation is ready (approximately 20 to 30 s).

Checking the USB Mouse That Is Connected

The procedure to check the type of USB mouse that is connected to the SL1400 is the same as the procedure used to check the type of USB keyboard. See page 4-7.

USB Mouse Operation

Operations Similar to the Front Panel Keys on the SL1400 (Top Menu)

- **Displaying the Top Menu**

  Right-click on the screen. The front panel keys on the SL1400 are displayed as the top menu.

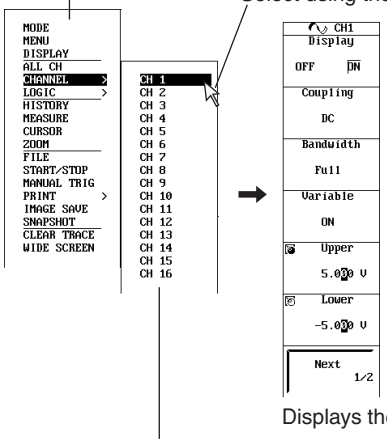
- **Selecting Items on the Top Menu**

  Left-click the item you want to select. The setup menu corresponding to the selected item is displayed on the right side of the screen. The top menu is cleared from the screen.

  Pointing to an item with a sub menu (items with a > mark displayed to the right) displays the sub menu. As with the top menu, left-click the item you want to select.

Top menu: Right-click to display the top menu.

Select using the **pointer** and left-click.



Displays the setup menu that you select with the pointer.

Sub menu: Sub menus are displayed for items that have lower layers.

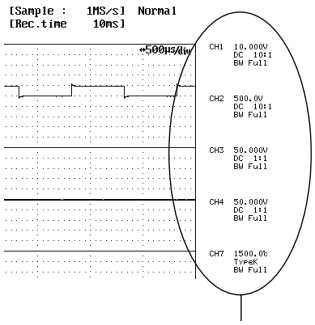
Note

- The following keys do not appear on the top menu.
  ESC, RESET, SELECT, and arrow keys
- There is no WIDE SCREEN key on the front panel.

- **Clearing the Top Menu**

  Displaying the Main Setup Information of Each Channel on the Right Side of the Screen after Clearing the Top Menu

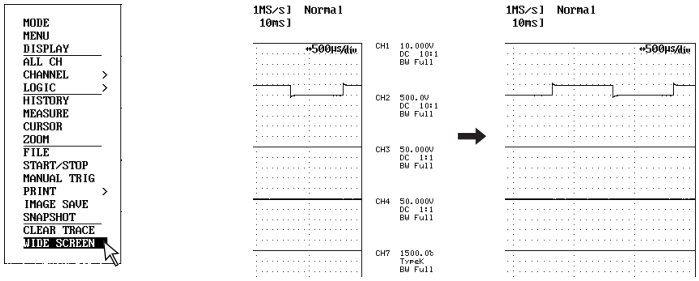
  Left-click on an area outside the top menu. The top menu is cleared, and the main setup information of the channel that is currently displayed is shown on the right side of the screen.



Main setup information of each channel

Expanding the Waveform Display Area after Clearing the Top Menu

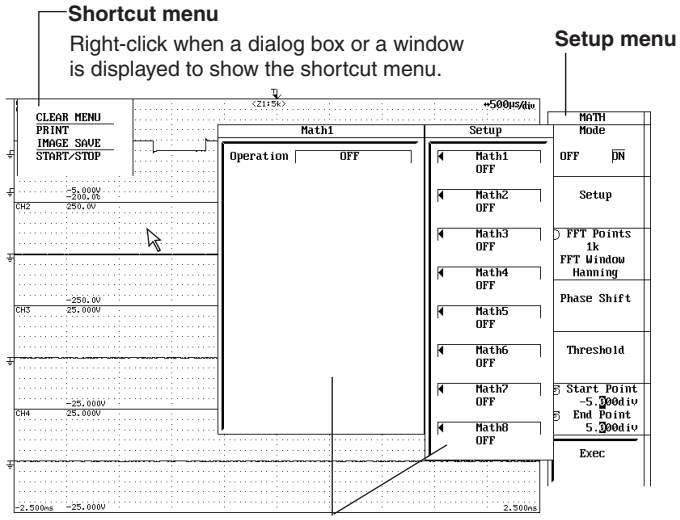
Left-click WIDE SCREEN on the top menu. The top menu is cleared, and the waveform display area is displayed expanded.



Select WIDE SCREEN using the **pointer** and left-click to expand the waveform display area.

- **Displaying the Shortcut Dialog Box**

  As shown in the following figure, a shortcut menu is provided in addition to the setup menu so that certain items can be executed even while a dialog box or a window is open. The shortcut menu appears when you right-click on the screen while a dialog box or a window is open. In this case, the top menu is not displayed.



Setup Menu Operation (Similar to the Soft Key Operation)

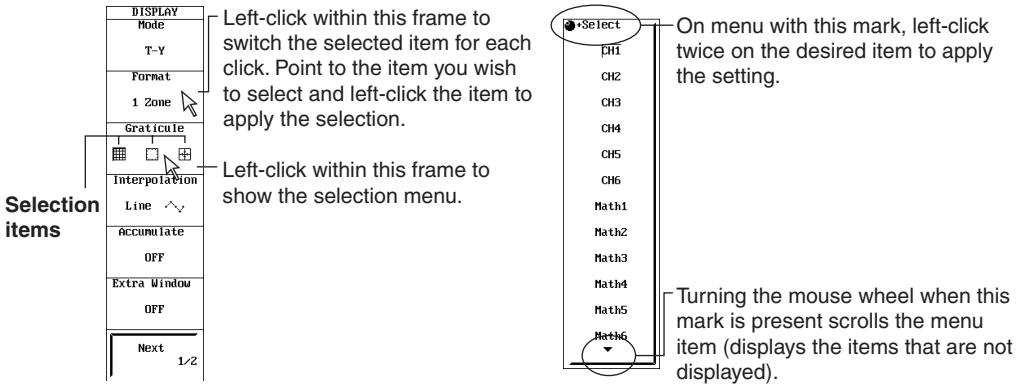
- **Selecting an Item on the Setup Menu**

  Left-click the item you want to select on the setup menu.

  If another menu appears when you select an item, move the pointer to the new menu displaying the item you want to select and left-click the item.

  If an item such as ON or OFF appears when you select an item, move the pointer to the new frame and left-click within the frame to switch the selected item.

  For menus in which items are selected using jog shuttle+SELECT, left-click the desired item. Left-click again to confirm the new setting and close the selection dialog box. For scrollable items, turn the mouse wheel to scroll.



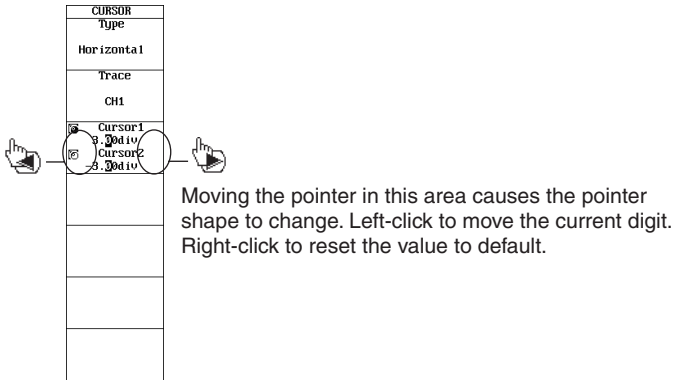
- **Clearing the Menu Screen**

  Left-click an area outside the menu.

Setting Values

For menu items with a or icon, the numeric value can be entered as follows:

- To select a menu item with a or icon, left-click the center of the menu item. If there are two setup items in a single menu item, you can repetitively left-click to select either item.
- Turn the mouse wheel downward to increase the value.
- Turn the mouse wheel upward to decrease the value.
- To change the selected digit, move the pointer to the left or right of the value. The pointer shape changes to or . If you point to the left of the value and left-click, the current digit moves to the left; if you point to the right of the value and left-click, the current digit moves to the right. The current digit moves one digit at a time for each left-click.
- To reset the value to default, right-click on the desired menu item.



Selecting Toggle Box Items on the Dialog Box

- Left-click the item you want to select. The item is selected. Click the selected item again to deselect it.
- To close the dialog box, left-click an area outside the dialog box.

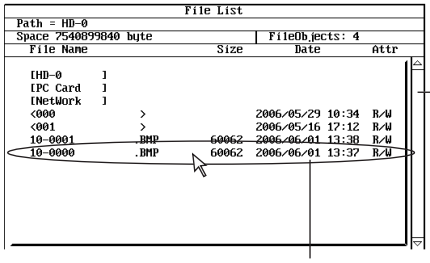
Left-click the item you wish to select.

Note

To close an error dialog box also, left-click an area outside the error dialog box.

Selecting a File, Directory, or Medium Drive on the File List Window

- Left-click a file, directory, or medium drive name to select it.
- If a scroll bar is shown on the file list window, you can turn the mouse wheel to scroll the file list.
- To cancel the selection, left-click an area outside the file list window. The selection is cancelled, and the file list window closes.



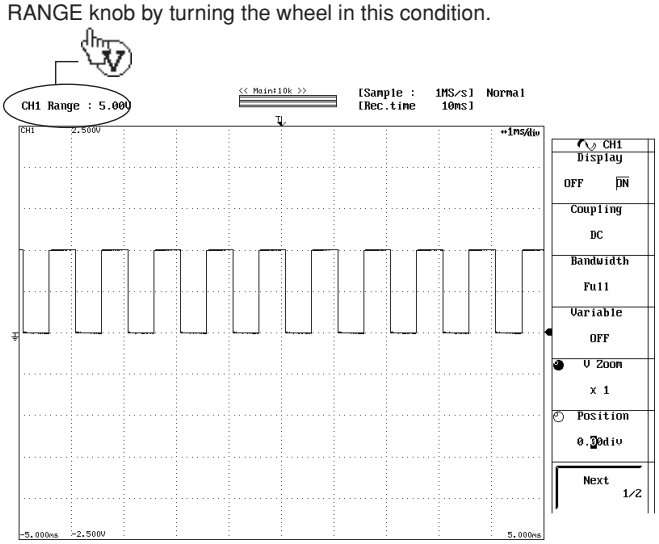
Scroll bar

Move the pointer to the file, directory, or storage drive you want to select and left-click.

Setting the Measurement Range

When the waveform of a channel measuring a voltage is displayed, point near the measurement range value displayed at the upper left of the screen. The pointer shape changes to . Turning the mouse wheel upward increases the measurement range value; turning it downward decreases it.

Moving the pointer to the position indicated below changes the pointer shape. You can change the setting of the items that are set with the RANGE knob by turning the wheel in this condition.



4.4 Initializing Settings

<For a description of this function, refer to page 2-49.>

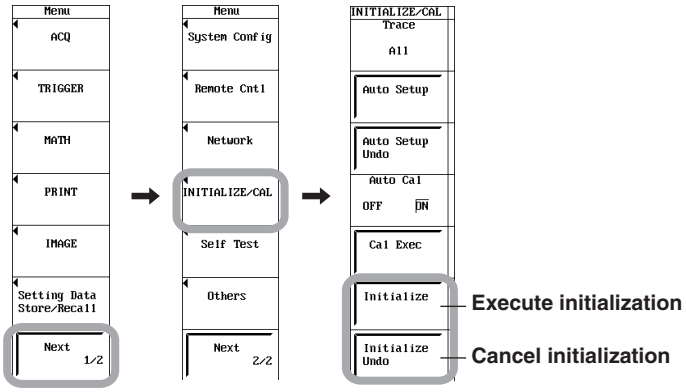
Procedure

Executing Initialization

1. Press **MENU**.
2. Press the **Next 1/2** soft key.
3. Press the **INITIALIZE/CAL** soft key.
4. Press the **Initialize** soft key to execute initialization.

Canceling Initialization

4. Press the **Initialize Undo** soft key. The settings return to the conditions that existed immediately before initialization.



Note

If you turn OFF the power switch, the settings that existed immediately before initialization are cleared. Therefore, the “Undo” operation is not possible in this case.

Explanation

The values specified by the keys can be reset to the factory default values. This is useful when you want to clear previous settings or start the measurement from scratch.

Initialization

Initialization refers to the act of restoring the factory default condition.
For a list of the factory default settings, see appendix 6.

Settings That Cannot Be Initialized

- Date and time settings
- Settings related to communications and Ethernet interface
- SCSI ID number setting
- Menu/message language setting
- Setting of the time difference from GMT
- ON/OFF setting of the internal hard disk motor

Canceling Initialization

If you initialize the settings by mistake, you can press the Initialize Undo soft key to revert to the condition that existed before initialization.

Initializing All the Settings

Turning ON the power switch while holding down RESET also initializes settings related to communications and Ethernet interface and SCSI ID settings. The stored setup data (see section 13.1) is cleared. If you initialize the SL1400 in this fashion, the settings cannot be set back to their original condition.

4.5 Performing Auto Setup

<For a description of this function, refer to page 2-49.>

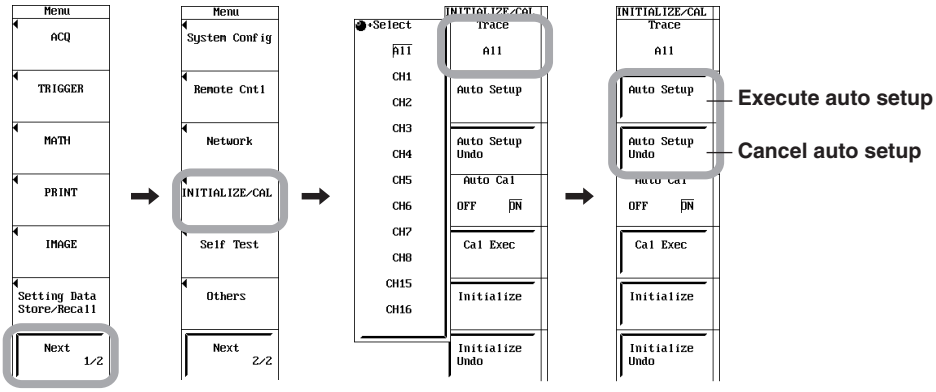
Procedure

Executing Auto Setup

1. Apply the signal to be measured.
2. Press **MENU**.
3. Press the **Next 1/2** soft key.
4. Press the **INITIALIZE/CAL** soft key.
5. Press the **Trace** soft key. The channel selection menu appears. The menu does not appear for channels without modules.
6. Turn the **jog shuttle+SELECT** to select the target channel.
7. Press the **Auto Setup** soft key. Auto setup is executed.
   When auto setup is executed, waveform acquisition starts automatically.

Canceling Auto Setup

8. Press the **Auto Setup Undo** soft key. The settings are set back to the original condition.



Explanation

Auto setup automatically sets the settings such as voltage range, record time, and trigger level that are appropriate for the input signal.

Center Position after Auto Setup

The center position is always 0 V.

Target Channels

Auto setup is performed on all channels or on the specified channel.

Applicable Modules

701250 (HS10M12), 701251 (HS1M16), 701255 (NONISO_10M12), 701260 (HV (with RMS)), 701261 (UNIVERSAL), 701262 (UNIVERSAL (AAF)), and 701275 (ACCL/VOLT)

Canceling Auto Setup

Pressing the Auto Setup Undo soft key sets the SL1400 back to the condition that existed immediately before auto setup. However, if you turn OFF the power switch, the settings that existed immediately before auto setup are cleared. Therefore, the “Undo” operation is not possible in this case. The settings that existed immediately before auto setup are cleared, if you execute initialization after auto setup.

Applicable Waveforms for Auto Setup

Frequency:	Approx. 10 kHz
Absolute value of the input voltage:	Maximum value is between approximately 20 mV (1:1) and ((maximum range)×10)
Type:	Repetitive waveform (that is not complex) When the input coupling is set to DC

Note

The auto setup function may not work properly, if the waveform includes DC components or high-frequency components.

Settings after Auto Setup

Waveform acquisition and display conditions	
START/STOP	START
Acquisition mode	Normal
Number of acquisitions	Infinite
Time base	Int
Accumulate mode	OFF
Zoom target	Channels whose display is turned ON
Vertical-axis settings	
Voltage range	Value that causes the absolute value of the input waveform to be 1.6 to 4.5 divisions
Offset voltage	0 V or the center value between the maximum and minimum values of the input signal
Coupling	DC
Bandwidth limit	FULL
Display ON/OFF	Turns ON channels whose absolute value of the input voltage is greater than or equal to 20 mV (1:1)
Position	0 division
Variable mode	OFF
V Zoom	×1
Scaling	OFF
Horizontal-axis settings	
Record time	Value that the displays 1.6 to 4 periods of the waveform with the shortest period of the auto setup target waveforms
Trigger settings	
Trigger mode	Auto
Trigger type	SIMPLE
Trigger source	Channel whose waveform amplitude is greater than or equal to 1 division with the longest period
Trigger level/slope	Center level between the maximum and minimum values/ rising
Trigger coupling	DC
Hysteresis	 (high sensitivity)
Hold off time	0.0 ns
Trigger position	50.0%
Trigger delay	0.0 μs
Computation settings	
Math	OFF
Other settings	
Realtime output	OFF
Accumulation	OFF
Logic A and Logic B display	OFF

Items other than those listed above are not applicable for auto setup.

Note

If none of the input waveforms are detected on the target module, the waveform acquisition is not started.

4.6 Performing Calibration

Calibrate the SL1400 when observing voltages.

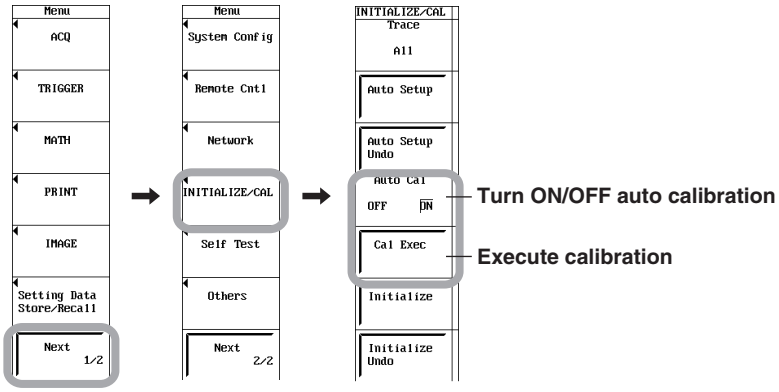
Procedure

Executing Calibration

1. Press **MENU**.
2. Press the **Next 1/2** soft key.
3. Press the **INITIALIZE/CAL** soft key.
4. Press the **Cal Exec** soft key to execute calibration.

Performing Auto Calibration

5. Press the **Auto Cal** soft key to select ON.



Explanation

Calibration

The following parameters are calibrated. Perform calibration when you want to measure waveforms with high accuracy.

- Ground level offset
- A/D converter gain

Precautions to Be Taken When Performing Calibration

- Allow the instrument to warm up for at least 30 minutes after the power is turned ON before performing calibration. If calibration is performed immediately after the power is turned ON, the calibration may be inaccurate due to drift caused by fluctuation in the temperature of the instrument.
- Perform calibration when the temperature of the instrument is stable and is between 5°C and 40°C (preferably at 23°C±5°C).

Note

The calibration described above is performed automatically when power is turned ON or when the Cal Exec soft key is pressed.

Auto Calibration

If Auto Cal is set to ON, auto calibration is performed the first time the record time is changed or the first time measurement is started after the time shown below passes. After turning ON the power

- 3 minutes pass.
- 10 minutes pass.
- 30 minutes pass, and every 30 minutes from here on after.

5.1 Turning Channels ON/OFF

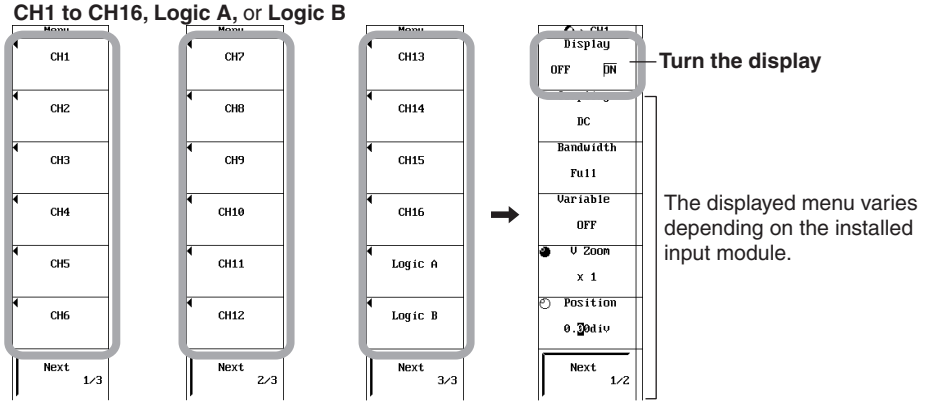
Procedure

1. Press **CH**.
2. Press one of the soft keys from **CH1 to CH16**, **Logic A**, and **Logic B**.

Turning the Display ON/OFF

3. Press the **Display** soft key to select ON or OFF.

CH1 to CH16, Logic A, or **Logic B**



Press the **Next** soft key to display the next menu.

Explanation

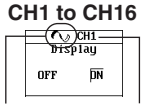
Select a channel from CH1 to CH16, Logic A, and Logic B, and turn ON/OFF the input waveform display.

- CH1 to CH16, Logic A, and Logic B waveforms can be displayed simultaneously.
- When you are entering the settings of a selected channel, the channel name and the specified measurement range are displayed at the upper left of the screen.

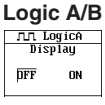
Note

- The screen can be split into up to 16 display areas using the DISPLAY menu (section 8.1). Scale values (section 8.9) and waveform labels (section 8.10) can also be displayed.
- When displaying history waveforms or waveforms recalled from the PC card, the waveforms applied to the channels cannot be displayed. To compare waveforms, use the snapshot function.
- Channels that do not have input modules installed cannot be turned ON.
- A waveform icon is displayed to the left of the channel name at the top of the CH1 to CH16 or Logic A/B setup menu. The icon color is the same as the color of the displayed waveform (see section 16.3). The icon shape varies depending on the channel setup menu as follows:

CH1 to CH16



Logic A/B



Waveform icon **Channel name**

5.2 Setting the Record Time and Sample Rate

<For a description of this function, refer to page 2-3.>

Procedure

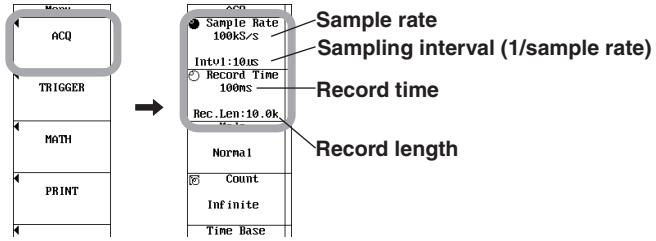
1. Press **MENU**.
2. Press the **ACQ** soft key.

Setting the Record Time

3. Select the **Record Time** soft key to select Record Time.
4. Turn the **jog shuttle** to set the record time.

Setting the Sample Rate

5. Select the **Sample Rate** soft key to select Sample Rate.
6. Turn the **jog shuttle** to set the sample rate.
   - If you set a small sample rate, the record time can be set long.
   - If you change the record time and sample rate, the record length for storing the sampled data varies.



Explanation

Record Time

The record time specifies the length of time of the input waveform to be displayed on a single screen.

Selectable range: 100µs to 30 days

The selectable record time varies depending on the maximum record length installed in the SL1400, the number of channels whose display is turned ON, and the specified sample rate.

Sample Rate

Sample rate refers to the number of times the measured waveform is sampled per second.

- The maximum sample rate varies depending on the input module. To effectively use the record length provided by the SL1400, we recommend that the sample rate be set less than the maximum sample rate of the input module.
- For the maximum sample rate (or data update rate) of each input module, see the specifications of the respective module in chapter 18.

Record Time and Roll Mode

The display switches to roll mode if you set the record time to 1 s to 30 days under the following conditions.

- Acquisition mode is set to a mode other than averaging.
- The trigger mode is set to auto, auto level, single, or log.
- The time base is set to the internal clock signal.

Sampling Interval

Sampling interval is the inverse of the sample rate. It indicates the interval at which the measured waveform is sampled.

Record Length

The term *record length* normally refers to the number of data points acquired per channel in the acquisition memory. The record length changes when you change the record time or sample rate (see appendix 1). The following equation holds: record length = record time × sample rate. The maximum record length of the SL1400 is 50 MW. The measured waveform signal of a single channel can be acquired up to the maximum record length of 50 MW when only a single channel is displayed.
The time over which the signal of the measured waveform of a single channel that can be recorded with a record length of 50 MW is shown below.

Sample Rate	In Seconds	In Minutes	In Hours	In Days
10 MS/s	5	–	–	–
1 MS/s	50	–	–	–
100 kS/s	300	5	–	–
10 kS/s	3600	60	1	–
1 kS/s	36000	600	10	–
200 S/s	180000	3000	50	208

The record length that is stored in the acquisition memory and the record length of the displayed waveform are the same.

Note

- The record time and sample rate are displayed at the upper right of the screen. If you change the record time while waveform acquisition is stopped, the new record time is displayed in parentheses at the upper right of the screen. The new value takes effect the next time acquisition is started.
- For the relationship between the record time, sample rate, and record length, see appendix 1.

5.3 Setting the Voltage Range

<For a description of this function, refer to page 2-6.>

Procedure

Selecting the Channel

1. Press **CH**.
2. Press one of the soft keys from **CH1** to **CH16**.
   For the displayed menus when this operation is executed, see section 5.1.

Setting the Voltage Range

3. Turn the **RANGE** knob to set the voltage range.

Explanation

Voltage Range (When Variable Is OFF)

The voltage range adjusts the displayed amplitude of the waveform. Set the voltage that corresponds to the area between the top and bottom edges of the waveform display area (10 divisions) for each channel. Set the voltage in 1-2-5 steps as in 1 V → 2 V → 5V. When Variable is set to OFF, the Position and V Zoom settings are valid.

Note

- The specified range is displayed at the upper left of the screen. If you change the range while waveform acquisition is stopped, the new range is displayed in parentheses at the upper left of the screen. The new value takes effect the next time acquisition is started.
- Changing the range while acquisition is stopped has no affect on cursor measurement and automated measurement of waveform parameters. The displayed values are for the range setting that were used when the measurement was made.

Selectable Range

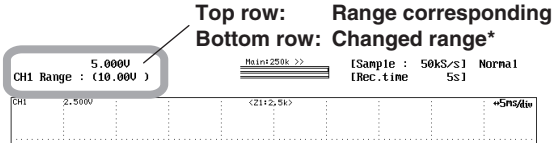
The selectable range varies depending on the input module as follows:

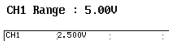
Input Module	Selectable Range
701250 (HS10M12)	50 mV to 200 V
701251 (HS1M16)	10 mV to 200 V
701255 (NONISO_10M12)	50 mV to 200 V
701260 (HV (with RMS))	200 mV to 2 kV
701261 (UNIVERSAL)	50 mV to 200 V
701262 (UNIVERSAL(AAF))	50 mV to 200 V
701265 (TEMP/HPV)	1 mV to 100 V
701275 (ACCL/VOLT)	50 mV to 100 V

The values are those when the probe attenuation is set to 1:1. Multiply the above values by 10, 100, and 100 for probe attenuation of 10:1, 100:1, and 1000:1, respectively.

Display Position of Range

If you turn the RANGE knob while waveform acquisition is stopped, the top row of the range display shows the range for the displayed waveform, and the bottom row shows the new range. The new range takes effect the next time acquisition is started.





* If the range corresponding to the displayed waveform and the changed range are the same, only the bottom row is displayed.

Voltage Range (When Variable Is ON)

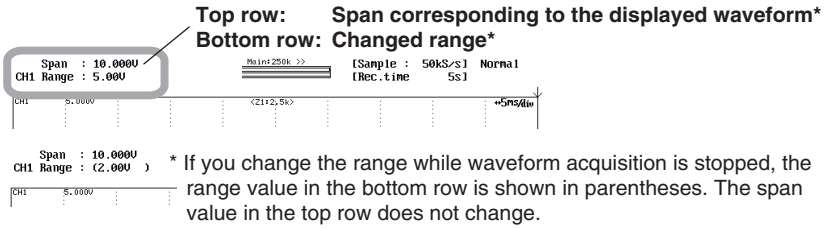
When Variable is ON, you can adjust the displayed amplitude of the waveform by changing the Upper and Lower values. For the operating procedure, see section 5.9. Even if you change the range using the RANGE knob when Variable is ON, the new range is not applied to the waveform amplitude. This is because the Upper and Lower values are not changed. The new range takes effect when Variable is turned OFF.

Note

If you turn the jog shuttle while waveform acquisition is stopped and change the Upper and Lower values, the displayed waveforms also change.

Display Position of Range

If you turn the RANGE knob while waveform acquisition is stopped, the top row of the range display shows the span (range that can be displayed between the top and bottom edges of the waveform display area (10 divisions), see section 5.9) for the displayed waveform, and the bottom row shows the new range. The new range takes effect the next time acquisition is started.



* If you change the range while waveform acquisition is stopped, the range value in the bottom row is shown in parentheses. The span value in the top row does not change.

5.4 Setting the Vertical Position of the Waveform

<For a description of this function, refer to page 2-7.>

Procedure

Selecting the Channel

1. Press **CH**.
2. Press one of the soft keys from **CH1** to **CH16**, **Logic A**, and **Logic B**.
   For the displayed menus when this operation is executed, see section 5.1.

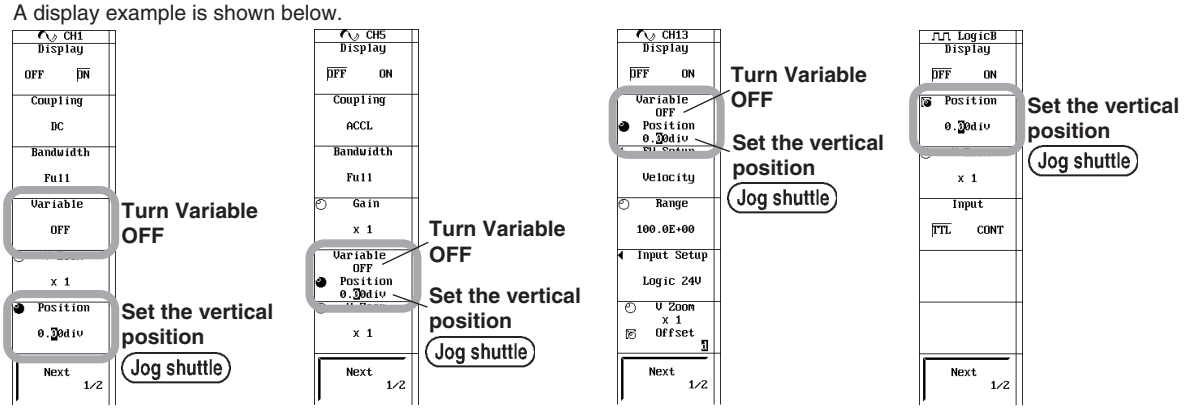
Selecting Variable OFF

3. Press the **Variable** soft key to select OFF.

Setting the Vertical Position

4. Press the **Position** soft key to select Position.
5. Turn the **jog shuttle** to set the vertical position.

The displayed menu varies depending on the installed input module.
A display example is shown below.



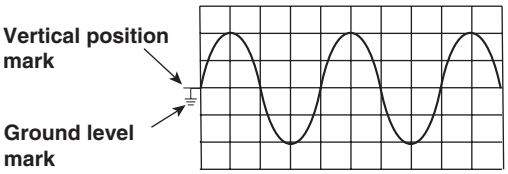
Explanation

Selectable Range

Set the vertical display position of the waveform for each channel.
Selectable range: ±5 divisions from the center position of the waveform display area
Resolution: 0.01 division

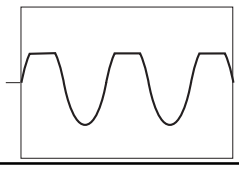
Checking the Vertical Position

For input waveforms and computed waveforms, the ground level and vertical position are marked to the left of the waveform display area.



Note

Data exceeding the measurement range (see section 2.2) is cut when the vertical position or upper and lower limits (when Variable is ON) are changed, and the waveform appears clipped as shown below.



5.5 Selecting the Input Coupling

<For a description of this function, refer to page 2-8.>

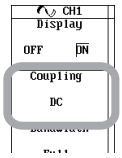
Procedure

Selecting the Channel

1. Press **CH**.
2. Press one of the soft keys from **CH1 to CH16**.
   For the displayed menus when this operation is executed, see section 5.1.

Selecting the Input Coupling

3. Press the **Coupling** soft key.
4. Press the soft key corresponding to the desired input coupling.
   - To measure RMS values using the 701260 (HV (with RMS)), select AC-RMS or DC-RMS. For the setup procedure of RMS measurements, see section 5.13.
   - To measure the temperature using the 701261 (UNIVERSAL), 701262 (UNIVERSAL (AAF)), or 701265 (TEMP/HPV), select TC. For the setup procedure of temperature measurements, see section 5.14.
   - To measure acceleration on the 701275 (ACCL/VOLT), select ACCL. For the setup procedure of acceleration measurements, see section 5.16.



Select the input coupling

Explanation

Input Coupling

Select how the input signal is coupled to the vertical control circuit from the list below. The selectable settings vary depending on the module.

AC
Acquires and displays only the AC component of the input signal.

DC
Acquires and displays all the components (DC and AC) of the input signal (selectable only when measuring voltage).

GND
Checks the ground level.

TC
Select this type to measure temperature.

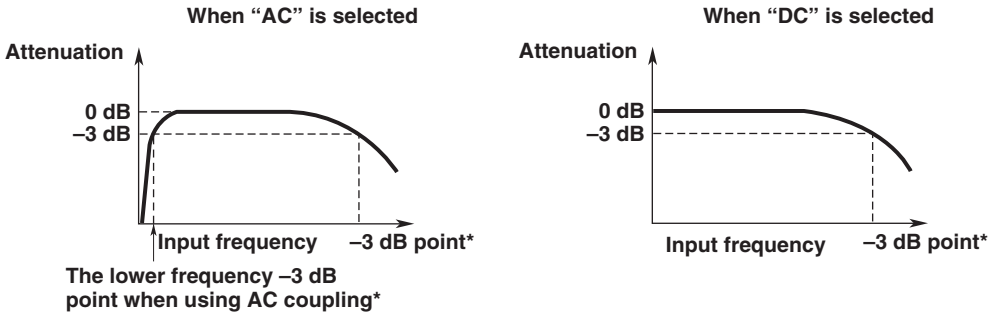
AC-RMS
Converts and displays only the AC component of the input signal.

DC-RMS
Converts and displays both DC and AC components of the input signal.

ACCL
Select this type to measure acceleration.

Input Coupling and Frequency Characteristics

The frequency characteristics when AC or DC is specified are shown below.
Note that low-frequency signals and signal components are not acquired if AC is selected as indicated in the figure below.



*** The value varies for each input module. For details, see section 18.12.**

Notes for 701261, 701262, 701265, 701275, and 701280

- If the input coupling is changed from TC to DC or DC to TC while waveform acquisition is stopped on the 701261 (UNIVERSAL), 701262 (UNIVERSAL (AAF)), or 701265 (TEMP/HPV), the waveforms are no longer drawn. If you set the input coupling to the original setting, the waveforms are redrawn.
- If the input coupling is changed from ACCL to some other setting or some other setting to ACCL while waveform acquisition is stopped on the 701275 (ACCL/VOLT), the waveforms are no longer drawn. If you set the input coupling to the original setting, the waveforms are redrawn.
- If you change the contents of the function of the FV setting while the waveform acquisition is stopped on the 701280 (FREQ), the waveforms are no longer drawn. If you set the contents of the function to the setting that was present during measurement, the waveforms are redrawn.

CAUTION

- If the input coupling is AC and the frequency of the input signal is less than 1 Hz, the signal at the input terminal of the module is not attenuated to 1/10 even if the probe with 10:1 attenuation and input resistance of 10 MΩ is used. Make sure not to apply a voltage that has a signal component less than 1 Hz that exceeds the maximum input voltage of each module.
- Do not apply a voltage exceeding the maximum input voltage or maximum allowable common mode voltage of the input modules. This may cause damage to the input section.

5.6 Selecting the Probe Attenuation or Current-to-Voltage Conversion Ratio

<For a description of this function, refer to page 2-9.>

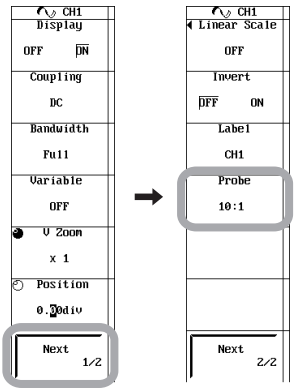
Procedure

Selecting the Channel

1. Press **CH**.
2. Press one of the soft keys from **CH1** to **CH16**.
   For the displayed menus when this operation is executed, see section 5.1.

Selecting the Probe Attenuation or Current-to-Voltage Conversion Ratio

3. Press the **Next 1/2** soft key.
4. Press the **Probe** soft key.
5. Press the soft key corresponding to the desired attenuation ratio or current-to-voltage conversion ratio according to the probe that you are using.



Select the probe attenuation or current-to-voltage conversion ratio

Explanation

Select the desired setting for each channel from the following:

1:1, 10:1, 100:1, 1000:1, 10A:1V, or 100A:1V

- 1:1 to 1000:1 represent the probe attenuation for voltage probes.
- 10A:1V and 100:1V represent the output voltage rate of current probes.

Set the probe attenuation for the accessory probes (sold separately) as follows:

- Isolated probe (700929): 10:1
- Current probe (701933): 10A:1V
- Current probe (701930 and 701931): 100A:1V
- Differential Probe (700924): 1000:1 or 100:1
- 10:1 passive probe (701940): 10:1

Note

If the attenuation or current-to-voltage conversion ratio is not set correctly according to the probe that you are using, the voltage and scale values of the input signals will not be displayed correctly. For example, if you set the attenuation to 1:1 when you are actually using a 10:1 probe, the displayed value for the waveform amplitude will be 1/10th the actual value.

5.7 Selecting the Bandwidth Limit

Procedure

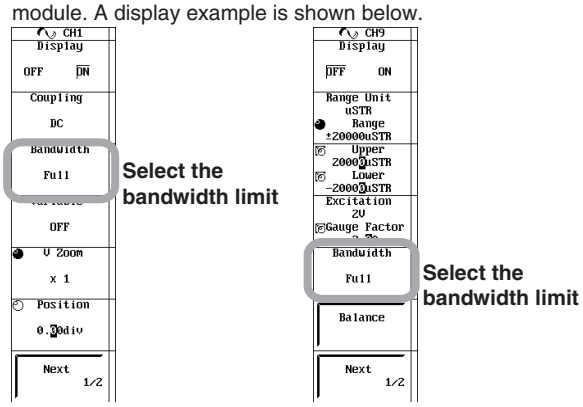
Selecting the Channel

1. Press **CH**.
2. Press one of the soft keys from **CH1** to **CH16**.
   For the displayed menus when this operation is executed, see section 5.1.

Selecting the Bandwidth Limit

3. Press the **Bandwidth** soft key.
4. Press the soft key corresponding to the desired bandwidth limit value.

The displayed position of the menu varies depending on the installed input module. A display example is shown below.



Explanation

Bandwidth Limit

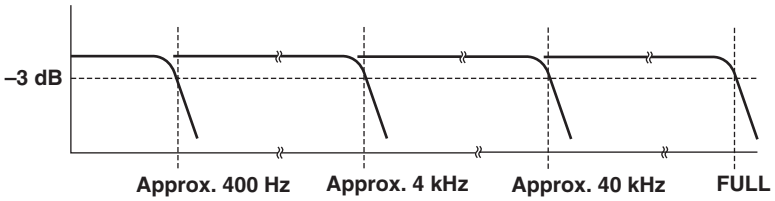
High frequency components can be eliminated from the input signal.

- Select the bandwidth limit (cutoff frequency) for each channel.
- The selectable bandwidth limits vary depending on the input module as follows:
- For the bandwidth limit of the 701280 (FREQ), see page 5-40.

Input Module	Selectable Bandwidth Limits
701250 (HS10M12)/ 701255 (NONISO_10M12)	500 Hz, 5 kHz, 50 kHz, 500 kHz, or Full
701251 (HS1M16)	400 Hz, 4 kHz, 40 kHz, or Full
701260 (HV(with RMS))	100 Hz, 1 kHz, 10 kHz, or Full
701261 (UNIVERSAL)[1] 701262 (UNIVERSAL(AAF))[1] 701265 (TEMP/HPV)	2 Hz, 8 Hz, 30 Hz, or Full
701270 (STRAIN_NDIS)/ 701271 (STRAIN_DSUB)	10 Hz, 100 Hz, 1 kHz, or Full
701261 (UNIVERSAL)[2] 701262 (UNIVERSAL (AAF))[2] 701275(ACCL/VOLT)	40 Hz, 400 Hz, 4 kHz, Auto, or Full

1 When measuring temperature
2 Auto is not available on the 701261 when measuring voltage.

For example, bandwidth limits of 400 Hz, 4 kHz, and 40 kHz are available on the 701251 (HS1M16). The frequency characteristics when the bandwidth is limited are shown below. When Full is selected, the maximum bandwidth of the input module is used.



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

If voltage is being measured on the 701262 (UNIVERSAL (AAF)) or if you set the bandwidth limit on the 701275 (ACCL/VOLT) to Auto, the anti-aliasing filter and low-pass filter settings are set to values shown below according to the sample rate.

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

For example, for sample rates between 100 kS/s to 50 kS/s, the cutoff frequency of the anti-aliasing filter is set to 40% of the sample rate.

5.8 Zooming Vertically by Setting the Zoom Rate

<For a description of this function, refer to page 2-7.>

Procedure

Selecting the Channel

1. Press **CH**.
2. Press one of the soft keys from **CH1 to CH16**, **Logic A**, and **Logic B**.
   For the displayed menus when this operation is executed, see section 5.1.

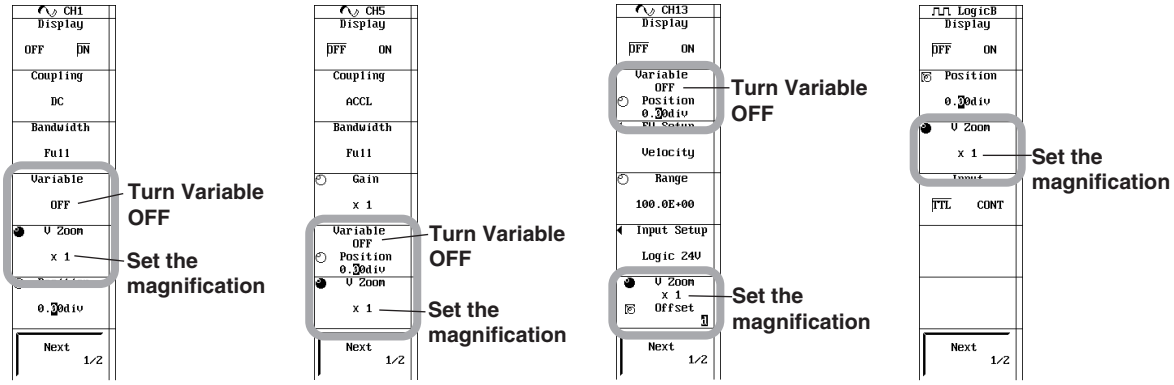
Selecting Variable OFF

3. Press the **Variable** soft key to select OFF.

Setting the Zoom Rate

4. Press **RANGE FINE**. The indicator above the RANGE FINE key illuminates.
   Press the key again to clear the indicator. You can set the zoom rate only when the indicator is illuminated.
5. Turn the **RANGE** knob to set the zoom rate of the vertical display.
   You can also select V Zoom in the menu and turn the jog shuttle.

The displayed menu varies depending on the installed input module. A display example is shown below.



Note

Pressing RESET while the jog shuttle control is set to V Zoom sets the zoom rate to ×1.

Explanation

The displayed waveform can be expanded/reduced vertically. This function is useful when you want to change the vertical axis setting after displaying waveforms. You can use this function when the Variable setting is OFF.

Waveform to Be Zoomed

Select a waveform from CH1 to CH16, Logic A, and Logic B.
However, zooming is not possible if the display of the selected waveform is turned OFF.

Zoom rate: V Zoom

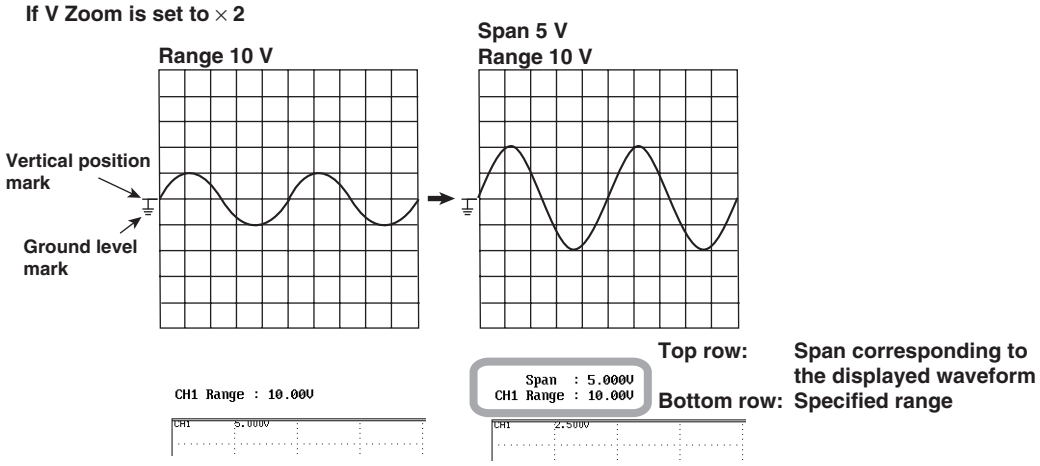
The following zoom rates are available.
×0.1, ×0.111, ×0.125, ×0.143, ×0.167, ×0.2, ×0.25, ×0.33, ×0.4,
×0.5, ×0.556, ×0.625, ×0.667, ×0.714, ×0.8, ×0.833, ×1, ×1.11,
×1.25, ×1.33, ×1.43, ×1.67, ×2, ×2.22, ×2.5, ×3.33, ×4, ×5,
×6.67, ×8, ×10, ×12.5, ×16.7, ×20, ×25, ×40, ×50, and ×100

However, the selectable range of zoom rates may be limited as follows:

- **701260 (HV (with RMS))**
  500 V range: ×0.25 to ×100
  1 kV range: ×0.5 to ×100
  2 kV range: ×1 to ×100
- **When Measuring Acceleration on the 701275 (ACCL/VOLT)**
  ×0.5 to ×50
- **701280 (FREQ)**
  ×0.33 to ×100

Zoom Position

The waveform is zoomed around the vertical position. If the waveform is zoomed vertically using V Zoom, the top row displays the span corresponding to the displayed waveform (display range), and the bottom row displays the specified range.



5.9 Zooming Vertically by Setting the Upper and Lower Limits of the Display Range

<For a description of this function, refer to page 2-7.>

Procedure

Selecting the Channel

1. Press **CH**.
2. Press one of the soft keys from **CH1** to **CH16**.
   For the displayed menus when this operation is executed, see section 5.1.

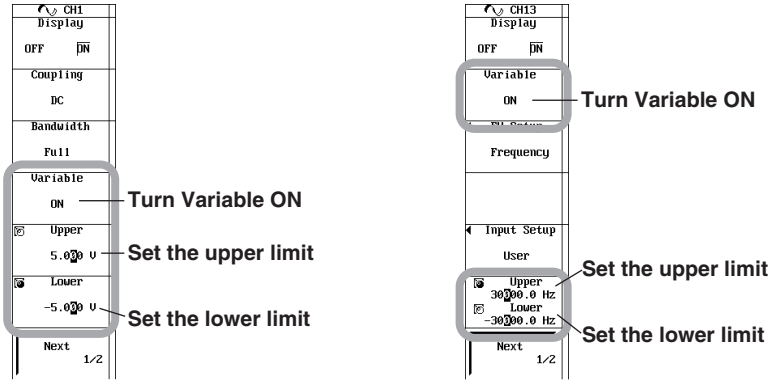
Selecting Variable ON

3. Press the **Variable** soft key to select ON.

Setting the Upper and Lower Limits

4. Press the **Upper** or **Lower** soft key.
   - The upper and lower limits can be set separately using the jog shuttle.
   - If both Upper and Lower are selected simultaneously, the upper and lower limits can be set simultaneously without changing the spacing between the two. If Upper and Lower are assigned to separate soft keys, the values cannot be set simultaneously, because you cannot select Upper and Lower simultaneously.
5. Turn the **jog shuttle** to set the upper or lower limit.

The displayed menu varies depending on the installed input module.
A display example is shown below.



Note

Pressing RESET sets the maximum and minimum values of the measurement range to the upper and lower limits.

- When measuring voltage — Upper: +Voltage range; Lower: –Voltage range
- When measuring strain — Upper: +Fs; Lower: –Fs
- When measuring acceleration — Upper: 5000/(gain × sensitivity); Lower: –5000/(gain × sensitivity)
- When measuring frequency and other parameters on the frequency module — Upper: (Offset) + (measurement range×3); Lower: (Offset) – (measurement range×3)

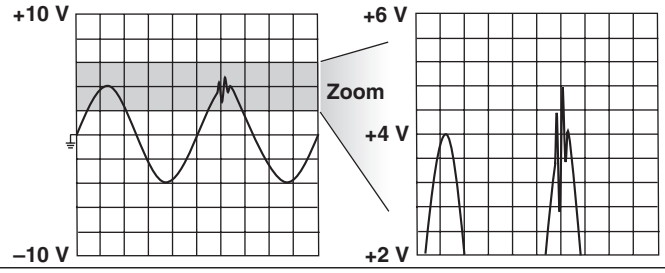
Explanation

Zooming Vertically According to the Upper and Lower Limitsof the Display Range (Variable)

If you turn Variable ON, you can vertically zoom in or out the displayed waveform by setting the upper and lower limits of the display range.

ON

You can zoom in on the desired section of the observed waveform by specifying the upper and lower limits of the vertical axis according to the displayed waveform. In addition, you can widen the display range to view waveforms outside the display range. The A/D conversion resolution and accuracy remain the same as those for the original waveform, when the waveform is expanded/reduced with Variable turned ON.



OFF

The waveform is not zoomed in or out vertically using the upper and lower limit settings. In this setting, the vertical position (section 5.4), vertical zoom by setting the zoom rate (section 5.8), and offset (section 5.10) can be changed.

Upper and Lower Limits

You can set the upper and lower limits to the smaller of the two values, ±(10 times the specified measurement range) or ±2000 V. Make sure the upper limit value (Upper) is greater than the lower limit value (Lower).

- Below are the ranges on the 701270 (STRAIN_NDIS) and 701271 (STRAIN_DSUB) according to the range unit.
  When the range unit is μSTR: ±30000 μSTR
  When the range unit is mV/V: ±15 mV/V
- Up to ±2000000 unit on the 701275 (ACCL/VOLT).
- Up to (offset) ± (measurement range × 3) on the 701280 (FREQ).
  - When measuring the frequency: –1500 kHz to 1700 kHz
  - When measuring RPMs: –300 krpm to 350 krpm
  - When measuring RPSs: –5000 rps to 7000 rps
  - When measuring the period: –150 s to 200 s
  - When measuring the duty cycle: –500% to 700%
  - When measuring the pulse width: –150 s to 200 s
  - When measuring the pulse integration: –2.5E+22 to 2.5E+22
  - When measuring the velocity: –2.5E+22 to 2.5E+22

Note

If you change the range using the RANGE knob after you set the upper and lower limits, the measurable range changes even though the range on the screen does not change. If you set the measurable range smaller than the specified upper and lower limits and start the waveform acquisition, the section of the waveform exceeding the measurable range may not be displayed. The measurable range is up to approximately ±10 divisions (around 0) when Variable is OFF.

5.10 Setting the Offset

Procedure

Selecting the Channel

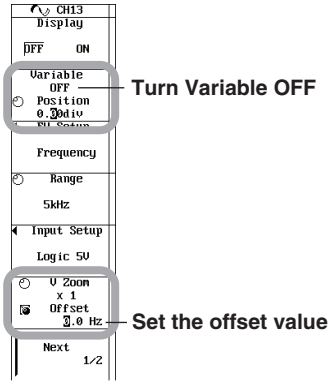
1. Press **CH**.
2. Press one of the soft keys from **CH1** to **CH16** in which the 701280 (FREQ) is installed.
   For the displayed menus when this operation is executed, see section 5.1.

Selecting Variable OFF

3. Press the **Variable** soft key to select OFF.

Setting the Offset

4. Press the **Offset** soft key.
5. Turn the **jog shuttle** to set the offset.



Note

Pressing RESET while the jog shuttle control is set to Offset sets the offset to 0.

Explanation

The 701280 (FREQ) allows you to set the center of observation (offset value) and expand the area around the offset value for close observation. This feature allows you to measure the fluctuation around a certain frequency.

Selectable Range of Offset

The selectable range of offset varies depending on the measurement item.

- When measuring the frequency: ±(100 times the measurement range or 200 kHz)
- When measuring RPMs: ±(100 times the measurement range or 50 krpm)
- When measuring RPSs: ±(100 times the measurement range or 1000 rps)
- When measuring the period: ±(100 times the measurement range or 50 s)
- When measuring the duty cycle: ±(100 times the measurement range or 100%)
- When measuring the pulse width: ±(100 times the measurement range or 50 s)
- When measuring the pulse integration: ±(100 times the measurement range or 1.0000E+22)
- When measuring the velocity: ±(100 times the measurement range or 1.0000E+22)

Note

- You can change the waveform position with respect to the vertical position (the center when zooming the waveform vertically) by changing the offset.
- If you change the offset while waveform acquisition is stopped, the change does not take effect. The new value takes effect the next time acquisition is started.

5.11 Using the Linear Scaling Function (AX+B or P1-P2)

<For a description of this function, refer to page 2-9.>

The linear scaling function is applied when measuring voltage on the voltage module or strain on the strain module.

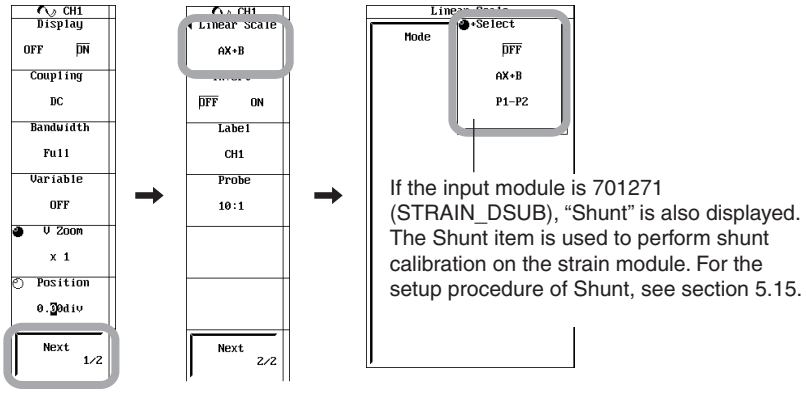
Procedure

Selecting the Channel

1. Press **CH**.
2. Press one of the soft keys from **CH1** to **CH16**.
   For the displayed menus when this operation is executed, see section 5.1.

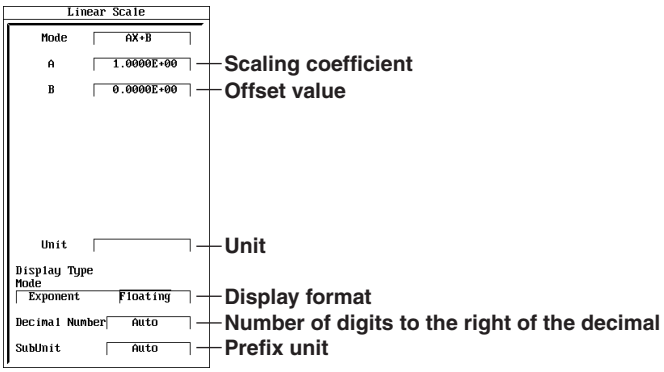
Selecting the Linear Scaling Method

3. Press the **Next 1/2** soft key.
4. Press the **Linear Scale** soft key. A Linear Scale setup dialog box appears.
5. Use **jog shuttle+SELECT** to set Mode to AX+B or P1-P2.
   - If you select AX+B, proceed to step 6 on this page.
   - If you select P1-P2, proceed to step 6 on the next page.



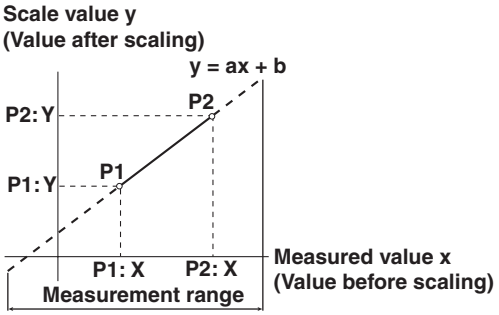
If AX+B Is Selected

6. Use **jog shuttle+SELECT** to set the scaling coefficient, offset, unit, and display type.
   - Set the unit as necessary. For the procedure to set the character string of the unit, see section 4.2.
   - If the display format is set to Floating, set the Decimal Number and SubUnit values.

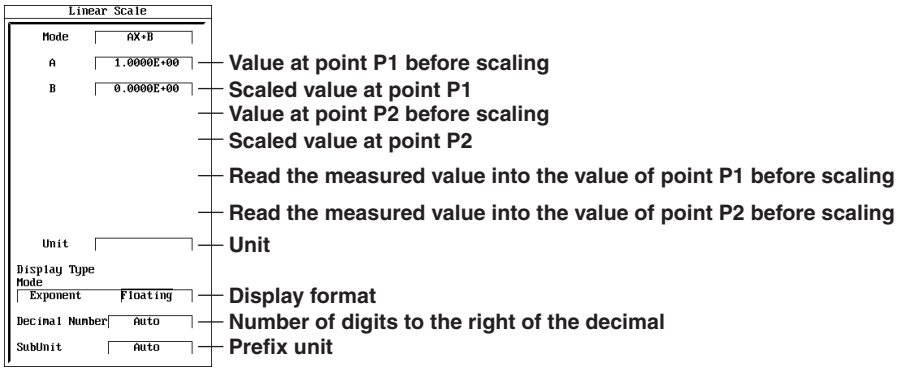


If P1-P2 Is Selected

6. Use **jog shuttle+SELECT** to set the values before scaling, P1:X and P2:X.
   - You can also read the measured value into P1:X by selecting Get Measure P1:X and pressing Exec.
   - You can also read the measured value into P2:X by selecting Get Measure P2:X and pressing Exec.
7. Use **jog shuttle+SELECT** to set the scaled values (values after scaling), P1:Y and P2:Y.
   Set the value corresponding to P1:X in P1:Y and the value corresponding to P2:X in P2:Y.



8. As necessary, use **jog shuttle+SELECT** to enter the unit.
   For the procedure to set the character string of the unit, see section 4.2.
9. If the display format is set to Floating, use **jog shuttle+SELECT** to set the Decimal Number and SubUnit values.



Explanation

Selecting the Linear Scaling Method

Select the linear scaling method from the following:

OFF
Disables linear scaling.

AX+B
Scaling is performed using the specified scaling coefficient A and offset B according to the equation shown below. Cursor measurement values and automated measurement values of waveform parameters are displayed using scaled values. You can also assign a unit to the scaled value.

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

P1-P2
Specify arbitrary scale values (P1:Y and P2:Y) for the values of two arbitrary points (P1:X and P2:X). The conversion equation (y = ax + b) is derived from these four values.

- Range of values of the two arbitrary points (P1:X and P2:X)
  Same as the measurement range. You can also read in the measured values.
- Range of scale values (P1:Y, P2:Y)
  –9.9999E+25 to +9.9999E+25
- Initial scale values
  P1:X +0.0000E+00, P1:Y +0.0000E+00
  P2:X +1.0000E+00, P2:Y +1.0000E+00

Setting AX+B

The selectable range of scaling coefficient A and offset B is as follows:
Selectable range of A and B: –9.9999E+30 to +9.9999E+30
Initial value of A: +1.0000E+00, initial value of B: +0.0000E+00

Reading in the Measured Values When the Linear Scaling Method is P1-P2 (Get Measure)

Regardless of whether waveform acquisition is started or stopped, the current value (value indicated by the level indicator) can be read into P1:X or P2:X.

Unit

Number of characters that can be entered: Up to 4 characters

Display Type

When measuring voltage on the voltage module or strain on the strain module, select the display type for the linear scaled values from the two types below.

Exponent
Exponential display.

Floating
Floating point display.
Use Decimal Number to select the number of digits to the right of the decimal from Auto, 0 to 3.
Use SubUnit to select the sub unit from Auto, p, n, μ, m, None, k, M, G, and T.

- Decimal Number
  If a setting between 0 and 3 is selected, the selected number of digits is displayed to the right of the decimal point. If Auto is selected, the value is displayed using 5 digits total (example: 1.0000 and 250.00). The initial setting is Auto.
- SubUnit
  If a setting other than Auto is selected, the value is displayed using the specified sub unit. If Auto is selected, the most suitable unit for the value is automatically set. The initial setting is Auto. If the value cannot be displayed using a decimal value, exponential display is enabled.

Displaying the Scaled Values

The linearly scaled values of the upper and lower limits of the vertical axis of each channel can be displayed. For details, see section 8.9.

Note

- Linear scaling cannot be performed when measuring temperature, acceleration, or frequency.
- Linear scaling is not available for the following waveforms.
  Snapshot waveforms
  Accumulated waveforms (excluding the most recent waveform)
- Linear scaling is set for each channel.
- The scaling coefficient A and offset B that you entered are held even if you turn OFF the linear scaling function.
- Computation is performed using the linearly scaled values.

5.12 Inverting the Waveforms

<For a description of this function, refer to page 2-10.>

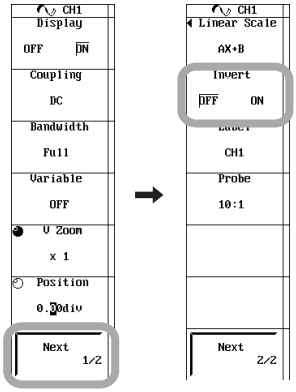
Procedure

Selecting the Channel

1. Press **CH**.
2. Press one of the soft keys from **CH1** to **CH16**.
   For the displayed menus when this operation is executed, see section 5.1.

Turning Waveform Inversion ON/OFF

3. Press the **Next 1/2** soft key.
4. Press the **Invert** soft key to select ON.



Explanation

The input signals to CH1 to CH16 can be inverted independently.
The waveform is inverted around the vertical position.

Note

- Cursor measurements, automated measurement of waveform parameters, and computation are performed on the inverted waveform.
- The trigger function is executed on the original waveform even if the waveform is inverted.
- When measuring strain, inversion is not possible on waveforms after measurements. The invert ON/OFF change takes effect in the next measurement.

5.13 Setting the RMS Measurement

<For a description of this function, refer to page 2-11.>

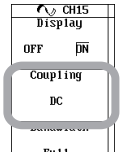
Procedure

Selecting the Channel

1. Press **CH**.
2. Press one of the soft keys from **CH1** to **CH16** in which the 701260 (HV (with RMS)) is installed.
   For the displayed menus when this operation is executed, see section 5.1.

Selecting the Input Coupling of the RMS Measurement

3. Press the **Coupling** soft key followed by the DC-RMS or AC-RMS soft key.



Select the input coupling

Explanation

Input Coupling of the RMS Measurement

On the 701260 (HV (with RMS)) input module, you can select the RMS measurement mode (AC-RMS or DC-RMS coupling) that displays the RMS value of the input signal in addition to the waveform measurement mode (AC, DC, or GND coupling) that displays the RMS value of the input signal.
For details on the RMS measurement, see page 2-11. For details on the input coupling circuit of AC-RMS/DC-RMS, see page 2-8.

Notes When Measuring RMS Values

If an AC component that is less than 40 Hz is acquired in the RMS measurement mode, ripples are produced as a result of the RMS conversion circuit characteristics, and correct RMS values cannot be displayed. DC signals are correctly measured.

5.14 Setting the Temperature Measurement

<For a description of this function, refer to page 2-12.>

Procedure

Selecting the Channel

1. Press **CH**.
2. Press one of the soft keys from **CH1** to **CH16** in which the 701261 (UNIVERSAL), 701262 (UNIVERSAL(AAF)), or 701265(TEMP/HPV)) is installed.
   For the displayed menus when this operation is executed, see section 5.1.

Selecting the Input Coupling of the Thermocouple

3. Press the **Coupling** soft key to select TC.

Selecting the Thermocouple Type

4. Press the **Type** soft key to select the thermocouple from K to Au7Fe.

Setting the Display Range

5. Press the **Upper** soft key.
6. Turn the **jog shuttle** to set the upper limit.
7. Likewise, set Lower.

Selecting the Temperature Unit

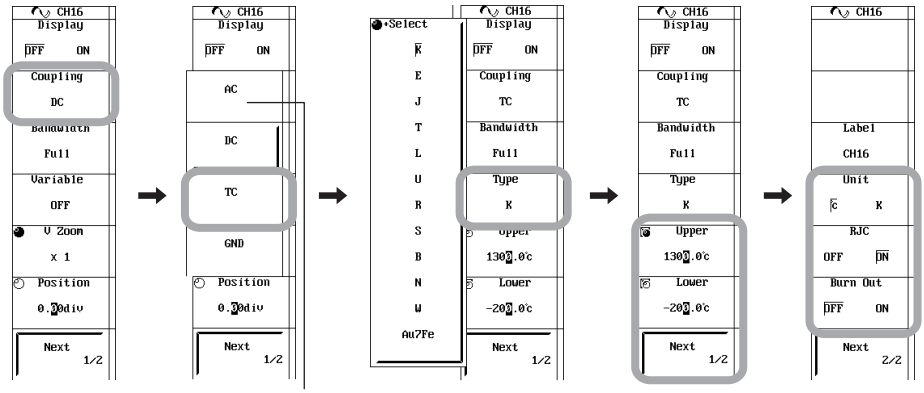
8. Press the **Next 1/2** soft key.
9. Press the **Unit** soft key to select °C or K.

Setting the RJC

10. Press the **RJC** soft key to select OFF or ON.

Setting the Burnout

11. Press the **Burn Out** soft key to select OFF or ON.



AC is not available on the 701265.

Explanation

Thermocouple Type

Select the type to match the thermocouple that you are using.
Select the thermocouple type from the list below.
When the input terminal is open, the displayed value is set to a value less than or equal to the lower limit of the measurement range.

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

Temperature Unit

Select the temperature unit from °C and K. The default setting is °C.

Displayed Range

To display the measured waveform, the upper and lower limits need to be set according to the input.

Selectable Range

–5432 to 5432°C (resolution: 0.1°C)

–5432 to 5432 K (resolution: 0.1 K)

The minimum span is 2°C (or 2 K).

Reference Junction Compensation (RJC)

The SL1400 normally performs reference junction compensation with the built-in RJC circuit when measuring temperature with the thermocouple. The SL1400 allows you to turn ON or OFF the internal reference junction compensation.
Normally, turn it ON.

ON
Select this setting to enable the reference junction compensation by the internal RJC circuit.

OFF
Select this setting when checking the temperature measurement value or when using an external reference junction (0 °C).

Note

If a voltage corresponding to a certain temperature t is applied at the input with the RJC turned OFF and the measured temperature does not match temperature t, the instrument may be damaged. In this happens, contact your nearest YOKOGAWA dealer.

Burnout

Specify the behavior when the thermocouple input detects a burnout. By default, this is set to OFF.

ON
Fix the measured value to the upper limit of the measurement range of each thermocouple if a burnout is detected.

OFF
Not detect burnouts.

5.15 Setting the Strain Measurement

<For a description of this function, refer to page 2-12.>

Procedure

Selecting the Channel

1. Press **CH**.
2. Press one of the soft keys from **CH1** to **CH16** in which the 701270 (STRAIN_NDIS) or 701271 (STRAIN_DSUB) is installed.
   For the displayed menus when this operation is executed, see section 5.1.

Selecting the Measurement Range

3. Press the **Range Unit** soft key, and then press the **μSTR** (the unit of strain) or **mV/V** (the unit of the output value of the strain gauge transducer) soft key.

Note

Be sure to execute balancing when you change the measurement range.

If μSTR Is Selected

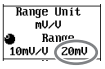
4. Turn the **jog shuttle** to select the Range from 500μSTR to 20000μSTR.

If mV/V Is Selected

4. Turn the **jog shuttle** to select the Range from 0.25 mV/V to 10 mV/V.

Note

If the range unit is set to mV/V, a numeric value is displayed at the right side of the range display. This value is the maximum input at the current bridge voltage converted to volts. It indicates the maximum input voltage at the selected range.

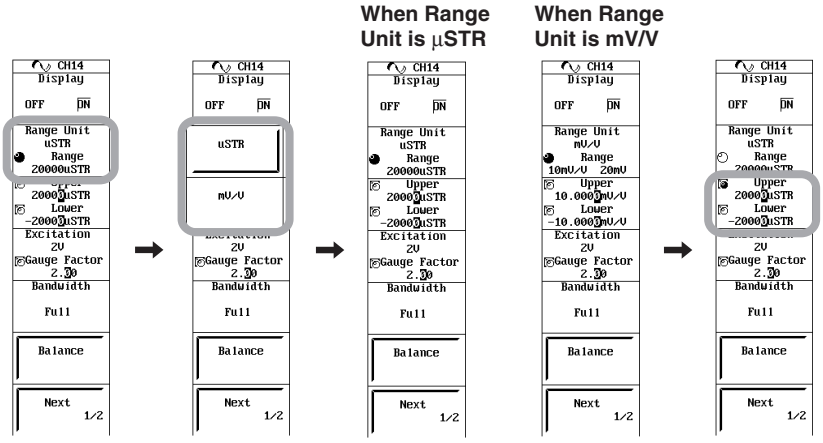


Setting the Display Range

5. Press the **Upper/Lower** soft key to set the jog shuttle control to Upper.
6. Turn the **jog shuttle** to set the upper limit.
7. Likewise, set Lower.

Note

Pressing RESET sets the maximum and minimum values of the measurement range to the upper and lower limits.



Setting the Gauge Factor

8. Press the **Excitation/Gauge Factor** soft key to set the jog shuttle control to Gauge Factor.
9. Turn the **jog shuttle** to set the gauge factor in the range of 1.90 to 2.20.

Selecting the Bridge Voltage

10. Press the **Excitation/Gauge Factor** soft key.
11. Press the **2V**, **5V**, or **10V** soft key to select the Excitation (bridge voltage).

Note

- The bridge voltage can be set to 5 V or 10 V only when the following conditions are met.
  - When the bridge resistance is 350 Ω or more.
  - When the strain gauge transducer supports the bridge voltage of 5 V or 10 V.
- Be sure to execute balancing when you change the bridge voltage.

Executing Balancing

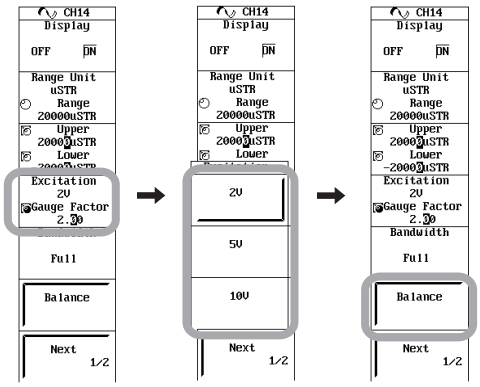
12. Press the **Balance** soft key. Balancing is executed.

Note

Perform balancing by connecting a bridge box or strain gauge transducer and without applying a load to the strain gauge.

Setting the Bandwidth, Linear Scaling, and Waveform Label

For the setup procedure of bandwidth, linear scale, and waveform label, see section 5.7, 5.11, and 8.10, respectively.



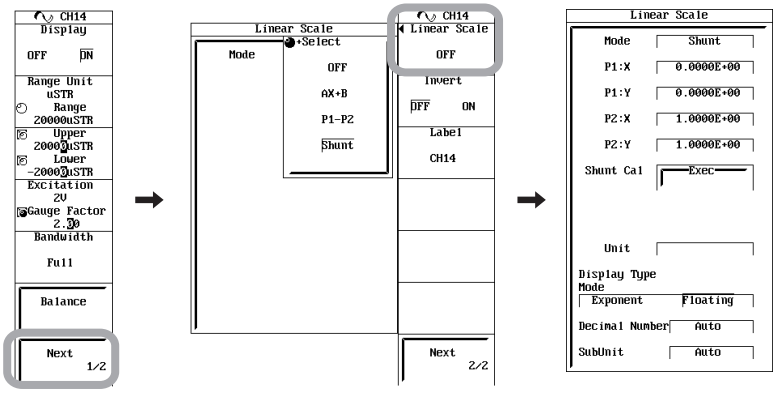
Executing Shunt Calibration (only on the 701271 (STRAIN_DSUB))

To execute shunt calibration, the strain corresponding to the shunt resistor to be used must be calculated in advance. For the calculation procedure, see appendices 9 and 10. Be sure to execute balancing before executing shunt calibration.

13. Press the **Next 1/2** soft key.
14. Press the **Linear Scale** soft key. A Linear Scale setup dialog box appears.
15. Use **jog shuttle+SELECT** to set the Mode to Shunt.

Reading the Connected Shunt Resistance and Calibrating

16. Use **jog shuttle+SELECT** to set a strain corresponding to the calculated shunt resistance in P2:Y.
17. Use **jog shuttle+SELECT** to select Shunt Cal. Then, press Exec to read the current input value into P2:X.
18. Enter the Unit as necessary.
    For the procedure to set the character string of the unit, see section 4.2.
19. If the Display Type is set to Floating, set the Decimal Number and SubUnit values.



Note

- In a normal shunt calibration, set only P2:Y (P1:Y is 0).
- Scale the strain value using a shunt resistor. P1:X is the input value when a shunt resistor is not connected. P1:Y is the strain value corresponding to P1:X. P2:X is the input value when a shunt resistor is connected. P2:Y is the strain value corresponding to the shunt resistance. The line connecting points P1 and P2 is used to perform scaling.
- When Shunt Cal Exec is executed, the relay circuit for shunt calibration built into the strain module is turned ON/OFF to automatically set P1:X and P2:X to the input value when the shunt resistor is connected and the input value when the shunt resistor is not connected, respectively.
- If you change P1:X, P1:Y, P2:X, or P2:Y, the linear scaling setting is also changed.
- Executing Shunt Cal changes P1:X and P2:X to the current input values.

Inverting the Waveforms

For details on the inverted display, see section 5.12.

Explanation

Range Unit

The unit can be changed between “the strain unit (×10–6 strain): μSTR” and “the output unit of the strain gauge transducer: mV/V.” The default value is μSTR. The following equation is used to derive the mV/V range.

mV/V = 0.5×(μSTR/1000)

Range

Select from the following:

If μSTR Is Selected

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

For the measurement range, see section 18.12.

If mV/V Is Selected

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

For the measurement range, see section 18.12.

The value that is indicated at the right side of the range display is the maximum input at the current bridge voltage converted to volts. It indicates the maximum input voltage at the selected range.

Display Range (Upper/Lower)

You can change the upper and lower limits of the display range according to the input for easier viewing of the measured waveforms.

Selectable range: –3.0000E+04 to +3.0000E+04 (when set to μSTR)
–1.5000E+01 to +1.5000E+01 (when set to mV/V)

Be sure the upper limit value (Upper) is greater than the lower limit value (Lower).

Bridge Voltage (Excitation)

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

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

The bridge voltage cannot be changed while waveform acquisition is in progress.

* The bridge voltage can be set to 5 V or 10 V only when the following conditions are met.
- The bridge resistance is greater than or equal to 350 Ω.
- Strain gauge transducer that supports the bridge voltage of 5 V or 10 V.

Gauge Factor

You can set the gauge factor of the strain gauge.

Selectable range: 1.90 to 2.20 (the resolution is 0.01)

The gauge factor is a unique constant defined for the strain gauge. It is usually described in the manual for the strain gauge. The gauge factor cannot be changed while waveform acquisition is in progress.

Gauge Factor (K) If mV/V Is Selected

You can set the gauge factor to an arbitrary value on the SL1400. However, if there are no specifications on the strain gauge transducer, set the gauge factor to 2.00. If the gauge factor is not 2.00, e is derived within the SL1400 using the following equation.

e = (4/K)×(V/E)

e: Measured value of the strain gauge transducer [mV/V]
V: Voltage measured on the bridge [V]
E: Voltage applied to the bridge [V]
K: Gauge factor

Bandwidth Limit

See section 5.7.

Executing Balancing

Balancing automatically compensates the unbalanced portion of the bridge resistance.
The execution of balancing takes a few seconds.
Executable range of balancing: ±10000 μSTR (when set to μSTR)
±5 mV/V (when set to mV/V)

Inverting the Waveforms

See section 5.12.

Precautions to Be Taken When Making Strain Measurements

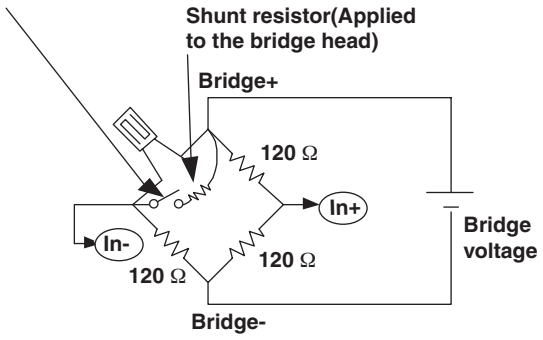
- Be sure to execute balancing when measuring the strain.
- Select a bridge voltage of 5 V or 10 V when the bridge resistance is greater than or equal to 350 Ω. If a bridge voltage of 5 V or 10 V is applied when the bridge resistance is less than 350 Ω, correct measurements will not be made.
- If using a strain gauge transducer, use a bridge voltage in the recommended voltage range of the transducer.
- Correction cannot be executed if a strain gauge bridge (bridge head) or a strain gauge transducer is not connected to the channel on which balancing is to be executed.
- If balancing fails on any of the specified channels, an error message and information on the failed channel is displayed.
- If the power is turned ON, a new strain gauge is connected, or the measurement range, bridge voltage, or gauge factor is changed, balancing must be performed again before making measurements.
  The scale value indicates “imbalance” immediately after power-up or when the range is changed. If this indication is showing, execute balancing.
- If you switch the unit, the unit of all related parameters of the channel is switched accordingly (upper and lower limits, trigger level, measured values of automated measurement parameters, cursor measurement values, etc.).

Shunt Calibration (Only on the 701271(STRAIN_DSUB))

Shunt calibration is used to correct the gain of strain measurements by inserting a known resistance (shunt calibration resistance (shunt resistance)) in parallel with the strain gauge. It is a type of scaling. The Strain Module (701271(STRAIN_DSUB) supports shunt calibration and has a built-in relay circuit for shunt calibration. To execute shunt calibration, a bridge head that supports shunt calibration (701957/701958) is needed.

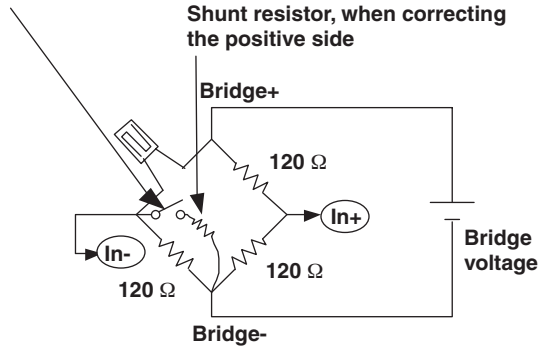
- **When correcting the gain on the negative side (normal)**

Shunt calibration relay circuit (Turns ON/OFF automatically when shunt calibration that is built into the strain module is executed.)



- **When correcting the gain on the positive side (normal)**

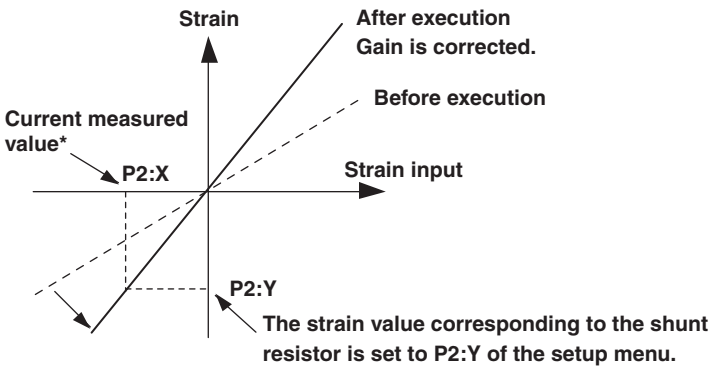
Shunt calibration relay circuit (Turns ON/OFF automatically when shunt calibration that is built into the strain module is executed.)



In addition to the normal shunt calibration (when the shunt calibration relay circuit is ON), the SL1400 allows the setting of a zero point when the relay circuit is OFF. This function is effective when the strain value is not 0 after the execution of balancing.

P1:X	If (Shunt Cal) Exec is executed, the input value when the relay circuit is OFF is applied.
P1:Y	Sets the value (usually 0) when the relay circuit is OFF.
P2:X	If (Shunt Cal) Exec is executed when the relay circuit is ON, the input value when the relay circuit is ON is applied.
P2:Y	Set the strain value corresponding to the shunt resistance when the relay circuit is ON.

- **Shunt calibration**



*** Automatically obtained when shunt calibration is executed.**

For details on shunt calibration, see appendix 10.

Note

- When executing shunt calibration, select an appropriate range so that the measured values do not exceed the range when the shunt calibration relay circuit is ON. The SL1400 attempts shunt calibration within the current specified range.
- If shunt calibration fails (the measured value exceeds the range, for example), an error message is displayed. If this happens, change the range and execute shunt calibration again.

5.16 Setting the Acceleration Measurement

<For a description of this function, refer to page 2-13.>

CAUTION

Before connecting the acceleration sensor, check that the bias current to the sensor is OFF (see step 9 below). If you connect the acceleration sensor with the bias current turned ON, damage may occur to the internal circuitry of the acceleration sensor.

Procedure

Selecting the Channel

1. Press **CH**.
2. Press one of the soft keys from **CH1** to **CH16** in which the 701275 (ACCL/VOLT) is installed.
   For the displayed menus when this operation is executed, see section 5.1.

Selecting the Input Coupling of the Acceleration

3. Press the **Coupling** soft key followed by the **ACCL** soft key.

Setting the Gain

4. Press the **Gain** soft key and select a value in the range of ×0.1 to ×100.

Setting the Sensitivity

5. Press the **Next 1/2** soft key.
6. Press the **Sensitivity** soft key.
7. Turn the **jog shuttle** to set the sensitivity of the acceleration sensor in the range of 0.10 mV/Unit to 2000.00 mV/Unit.

Setting the Unit

The default unit is m/s^2. Change it as necessary.

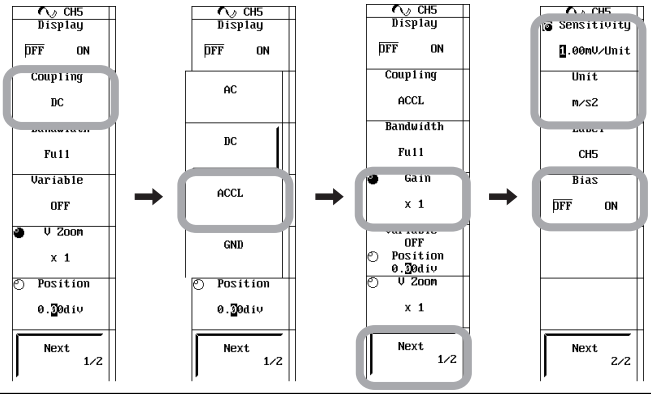
8. Press the **Unit** soft key to display a software keyboard, and enter the unit according to the procedure given in section 4.2.

Connecting Acceleration Sensors

9. Press the **Bias** soft key to select OFF.
10. Connect the acceleration sensor according to the explanation given in section 3.13.

Setting the Bias Current Supply

11. Press the **Bias** soft key to select ON.



Setting the Bandwidth Limit and Waveform Label

For the setup procedure of the bandwidth limit, see section 5.7. For the setup procedure of the waveform label, see section 8.10.

Explanation

Gain

Set the ratio of the output signal with respect to the input signal in the range of ×0.1 to ×100.
The default value is ×1.

Sensitivity

Set the sensitivity of the acceleration sensor in the range of 0.10 mV/Unit to 2000.00 mV/Unit.

Unit

Set the unit of the acceleration to be displayed on the screen using up to 4 characters. The default setting is m/s^2. Change the unit as necessary.
Up to 8 character strings assigned to the unit are stored. The stored strings can be recalled using the soft key. In addition, the stored strings can be used on the acceleration modules of other channels. This function is useful when you are assigning the same unit to multiple channels. The stored strings held even when the power is turned OFF.

Bias Current Supply to the Acceleration Sensor

When Bias is turned ON, a 4-mA bias current is supplied to the acceleration sensor. Do not connect the acceleration sensor with Bias turned ON.

Bandwidth Limit

See section 5.7.

5.17 Setting the Frequency (Number of Rotations, Period, Duty Cycle, Power Supply Frequency, Pulse Width, Pulse Integration, and Velocity) Measurement

<For a description of this function, refer to page 2-13.>

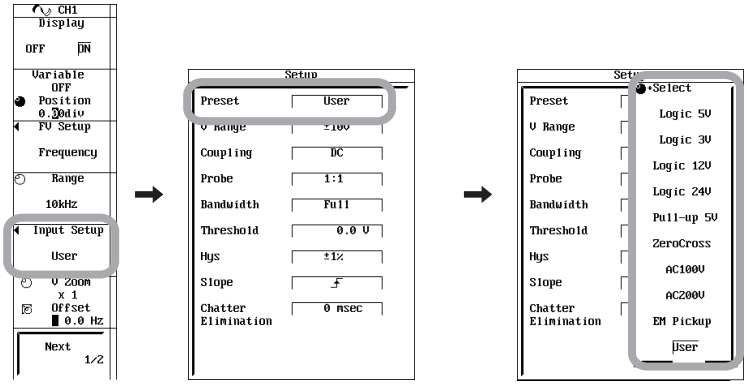
Procedure

Selecting the Channel

1. Press **CH**.
2. Press one of the soft keys from **CH1** to **CH16** in which the 701280 (FREQ) is installed.
   For the displayed menus when this operation is executed, see section 5.1.

Selecting the Preset

3. Press the **Input Setup** soft key. A setup dialog box opens.
4. Use **jog shuttle+SELECT** to select a preset according to the type of signal applied to the frequency module.
   - If you select a preset (Logic 5V to EM Pickup), the input is set to a value appropriate for the signal. (You need to set a portion of the items.)
   - If you select User (user-defined), all the setup items can be set arbitrarily. For a description of the setup items, see the next page.

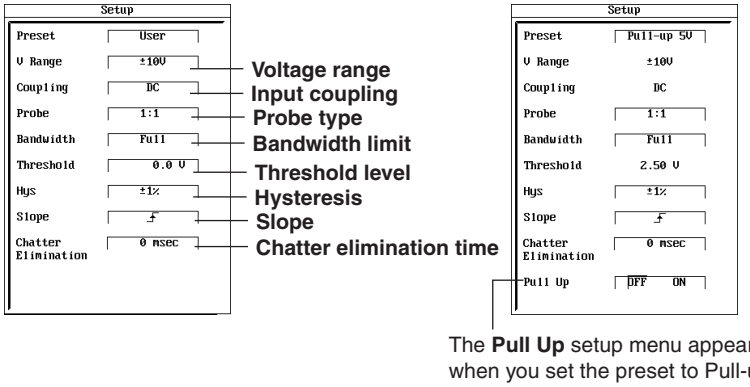


Typical Applications and Signal Examples of the Presets

Preset	Application and Signal Example
Logic 5V	5-V logic signal, 5-V output sensor, and sensor with TTL output
Logic 3V	3-V logic signal and 3-V output sensor
Logic 12V	12-V driven relay/sequence circuit and 12-V driven sensor
Logic 24V	24-V driven relay/sequence circuit and 24-V driven sensor
Pull-up 5V	Open-collector output sensor and contact circuit
ZeroCross	Sensor/Encoder that outputs positive and negative voltages and sensor that outputs sine waves
AC100V	When measuring a supply voltage of 100 VAC using the isolated probe (700929)
AC200V	When measuring a supply voltage of 200 VAC using the isolated probe (700929)
EM Pickup	Power-generating electromagnetic pickup

Setting the Input Conditions

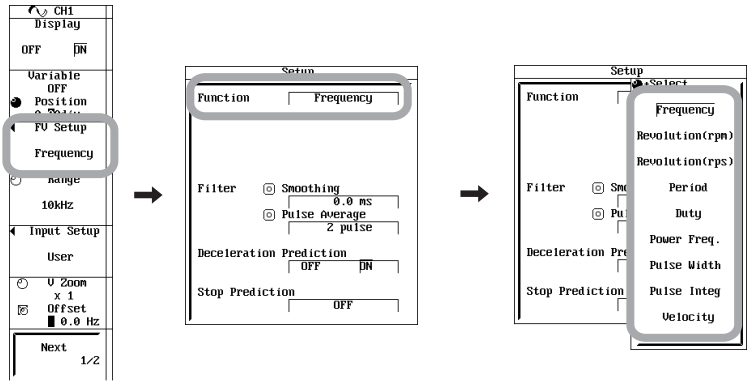
5. As necessary, use **jog shuttle+SELECT** to set the items of the preset (Logic 5V to EM Pickup) that you selected in step 4. If you select User (user-defined), all the setup items can be set arbitrarily.



The **Pull Up** setup menu appears only when you set the preset to Pull-up 5 V.

Selecting the Measurement Item

6. Press the **FV Setup** soft key. A setup dialog box opens.
7. Use **jog shuttle+SELECT** to select Function.
8. Use **jog shuttle+SELECT** to select the measurement item.



For the setup procedure of the selected measurement item, see the pages indicated below.

- Frequency → Page 5-35
- Revolution (rpm) → Page 5-35
- Revolution (rps) → Page 5-35
- Period → Page 5-36
- Duty cycle → Page 5-36
- Power frequency → Page 5-37
- Pulse width → Page 5-37
- Pulse integration → Page 5-38
- Velocity → Page 5-38

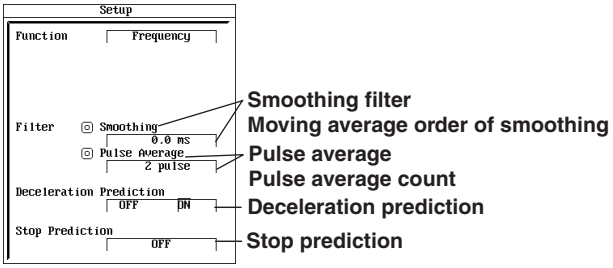
Note

The Range unit and Offset unit are linked to the unit of the measurement item selected in step 8. For the procedure to set the offset, see section 5.10.

Frequency

The procedure after selecting Frequency in step 8 on page 5-34 is explained below.

9. As necessary, use **jog shuttle+SELECT** to enter the smoothing filter, pulse average, deceleration prediction, and stop prediction.



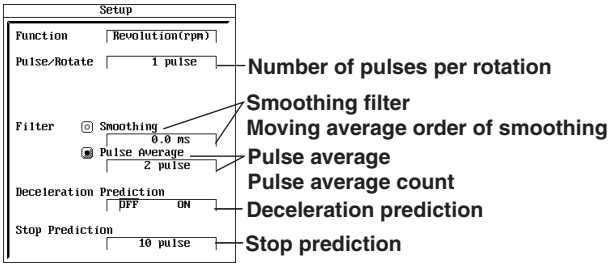
Setting the Measurement Range

10. Turn the **RANGE** knob to set the measurement range.
    You can also set the measurement range by pressing the Range soft key and turning the jog shuttle.

RPMs/RPSs

The procedure after selecting Revolution (rpm) or Revolution (rps) in step 8 on page 5-34 is explained below.

9. Use **jog shuttle+SELECT** to set the number of pulse per rotation (Pulse/Rotate).
10. As necessary, use **jog shuttle+SELECT** to enter the smoothing filter, pulse average, deceleration prediction, and stop prediction.



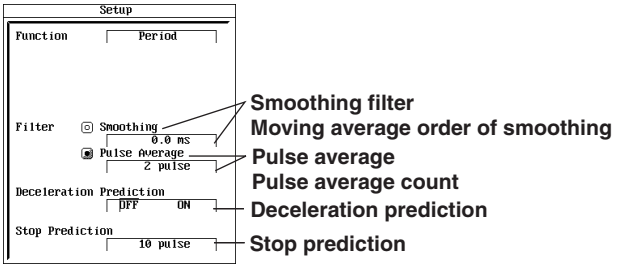
Setting the Measurement Range

11. Turn the **RANGE** knob to set the measurement range.
    You can also set the measurement range by pressing the Range soft key and turning the jog shuttle.

Period

The procedure after selecting Period in step 8 on page 5-34 is explained below.

9. As necessary, use **jog shuttle+SELECT** to enter the smoothing filter, pulse average, deceleration prediction, and stop prediction.



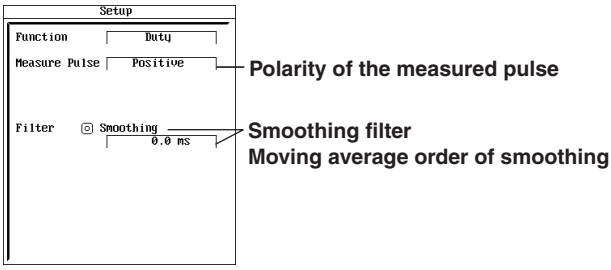
Setting the Measurement Range

10. Turn the **RANGE** knob to set the measurement range.
    You can also set the measurement range by pressing the Range soft key and turning the jog shuttle.

Duty Cycle

The procedure after selecting Duty in step 8 on page 5-34 is explained below.

9. Use **jog shuttle+SELECT** to select the polarity of the pulse to be measured (Measure Pulse).
10. As necessary, use **jog shuttle+SELECT** to set the smoothing filter.



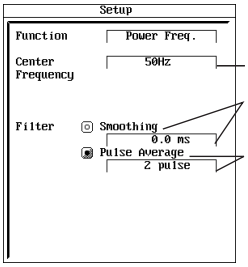
Setting the Measurement Range

11. Turn the **RANGE** knob to set the measurement range.
    You can also set the measurement range by pressing the Range soft key and turning the jog shuttle.

Power Supply Frequency

The procedure after selecting Power Freq. in step 8 on page 5-34 is explained below.

9. Use **jog shuttle+SELECT** to select the center frequency of the power supply.
10. As necessary, use **jog shuttle+SELECT** to set the smoothing filter and pulse average.



Center value of the power frequency
Smoothing filter
Moving average order of smoothing
Pulse average
Pulse average count

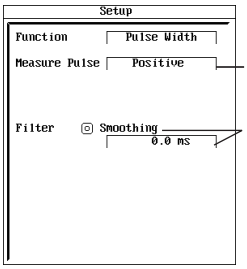
Setting the Measurement Range

11. Turn the **RANGE** knob to set the measurement range.
    You can also set the measurement range by pressing the Range soft key and turning the jog shuttle.

Pulse Width

The procedure after selecting Pulse Width in step 5 on page 5-32 is explained below.

9. Use **jog shuttle+SELECT** to select the polarity of the pulse to be measured (Measure Pulse).
10. As necessary, use **jog shuttle+SELECT** to set the smoothing filter.



Polarity of the measured pulse
Smoothing filter
Moving average order of smoothing

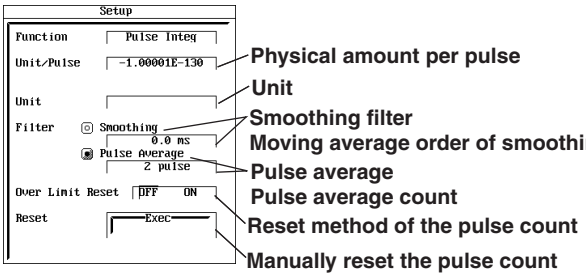
Setting the Measurement Range

11. Turn the **RANGE** knob to set the measurement range.
    You can also set the measurement range by pressing the Range soft key and turning the jog shuttle.

Pulse Integration

The procedure after selecting Pulse Integ in step 8 on page 5-34 is explained below.

9. Use **jog shuttle+SELECT** to set the physical amount per pulse (Unit/Pulse).
10. Use **jog shuttle+SELECT** to select the method for resetting the integrated value of the pulse count.
    - Over Limit Reset: ON
      Automatically resets the pulse count when the range is exceeded.
    - Over Limit Reset: OFF
      You can manually reset the pulse count.
11. As necessary, use **jog shuttle+SELECT** to set the unit, smoothing filter, and pulse average.
    For the procedure to set the character string of the unit, see section 4.2.



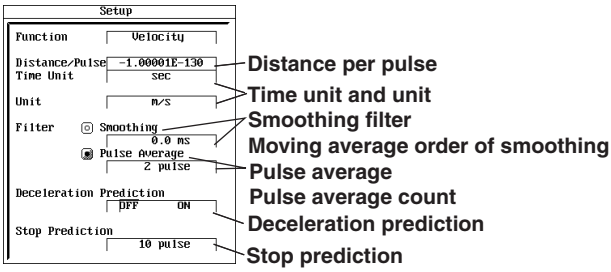
Setting the Measurement Range

12. Turn the **RANGE** knob to set the measurement range.
    You can also set the measurement range by pressing the Range soft key and turning the jog shuttle.

Velocity

The procedure after selecting Velocity in step 8 on page 5-34 is explained below.

9. Use **jog shuttle+SELECT** to set the distance per pulse.
10. Use **jog shuttle+SELECT** to select the time unit for calculating the velocity.
11. As necessary, use **jog shuttle+SELECT** to set the unit, smoothing filter, pulse average, deceleration prediction, and stop prediction.
    For the procedure to set the character string of the unit, see section 4.2.



Setting the Measurement Range

12. Turn the **RANGE** knob to set the measurement range.
    You can also set the measurement range by pressing the Range soft key and turning the jog shuttle.

Explanation

Preset

- When you select a preset, settings appropriate for each signal are set automatically. (You need to set a portion of the items.)
- The 10 presets below are available. For details on the settings of each preset, see appendix 12.

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

Pull-up 5V
Use this preset when the sensor output is open collector or contact output. The pull-up setting on the next page can be specified only when this preset is selected. The pull-up voltage is approximately 5 V, and the pull-up resistor is 4.7 kΩ. If you turn pull-up ON, set the input voltage in the range of 0 V to 5 V. If the input voltage exceeds this range, the protection circuit is tripped and the pull-up resistor is automatically cut off.

ZeroCross
Use this preset when the input voltage changes around 0 V. The input coupling is automatically set to AC, and the threshold level is automatically set to 0 V. Select the voltage range so that the maximum amplitude of the input voltage is within the voltage range.

AC100V and AC200V
Use this preset when measuring the supply voltage of 100-V or 200-V power supply systems. The probe type is automatically set to 10:1; the voltage range is automatically set to a value suitable for the input voltage and probe factor; and the coupling is automatically set to AC. Be sure to use the isolated probe (700929) when measuring the power supply voltage.

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

User (User-Defined)
Use this preset when entering the input conditions arbitrarily. Pull-up cannot be specified.

Note

- When measuring high voltage exceeding 42 V (AC+DCpeak) on the 701280 (FREQ), be sure to use the isolated probe (700929).
- Use EM Pickup only when connecting the electromagnetic pickup.
- When set to EM Pickup, the LEDs of the frequency module do not illuminate in red even when the range is exceeded.
- The SL1400 does not support electromagnetic pickups that require power supply or those that require terminators at the output. For these types of electromagnetic pickup, furnish appropriate measures on the sensor end.
- The output from the electromagnetic pickup must be within 42 V_{P-P}. The minimum sensitivity is 0.2 V_{P-P}. If the output is less than the minimum sensitivity, the measured values may be unstable.
- When using the pull-up function, do not let the voltage exceed the 0 to 5 V range. If the voltage exceeds the range, the protection circuit will be tripped, and the pull-up circuit will be cut off.

Input Conditions

The following nine input conditions are available.

Voltage Range (V Range)
- Select the voltage range (±FS) from the following:
  - When the probe attenuation is set to 1:1
    ±1 V, ±2 V, ±5 V, ±10 V, ±20 V, or ±50 V (±FS)
  - When the probe attenuation is set to 10:1
    ±10 V, ±20 V, ±50 V, ±100 V, ±200 V, or ±500 V (±FS)
- You can change the setting only when you select the ZeroCross or User preset.

Coupling
- Set the input coupling to DC or AC.
- The setting is the same as with the input coupling of other modules. See the functional explanation given in “Input Coupling” on page 2-8 and the explanation given in section 5.5.
- You can change the setting only when you select the User preset.

Probe Type
- Set the probe attenuation to 1:1 or 10:1.
- The setting is the same as with the probe of other modules. See the functional explanation given in “Probe attenuation or current-to-voltage conversion ratio” on page 2-9 and the explanation given in section 5.6.
- You can change the setting only when you select the Logic 5V (3V/12V/24V), Pull-up 5V, ZeroCross, or User preset.

Bandwidth Limit
- Select the bandwidth limit from 100 Hz, 1 kHz, 10 kHz, 100 kHz, and Full.
- You cannot select Full if you select the AC100V or AC200V preset.
- You can change the setting on all presets.

Threshold Level
- Set the threshold level within the voltage range. The resolution is a value corresponding to 1% of FS.
- You can change the setting only when you select the User preset.

Hys (Hysteresis)
- Select the hysteresis from ±1%, ±2.5%, and ±5% of the voltage range.
- You can change the setting on all presets.

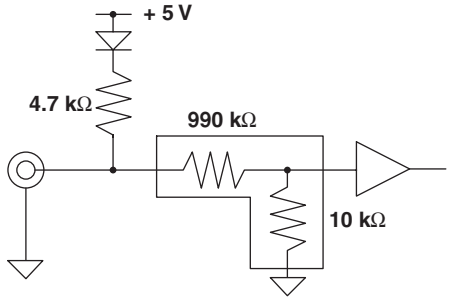
Slope
- Set the slope to ⎍ (rising) or ⎎ (falling).
- You can change the setting only when you select the Logic 5V (3V/12V/24V), Pull-up 5V, or User preset.

Chatter Elimination

Eliminates the chatter that occurs such when the contact is turned ON/OFF. The changes in the signal (chattering) over the specified time can be discarded.
- Set the chatter elimination time in the range of 0 to 1000 ms (1-ms resolution). If 0 ms is selected, the chatter elimination function is turned OFF.
- Chatter elimination is effective against both the rising and falling signals.
- You can change the setting on all presets.

Pull Up
- You can turn ON/OFF pull-up only when you select the Pull-up 5V preset. Pull-up is not possible in other presets.
- When using pull-up, set the input voltage in the range of 0 to 5 V. If a voltage exceeding this range is applied, the internal protection circuit will cut off the pull-up circuit.

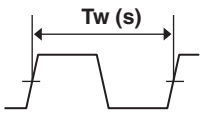
Internal equivalent circuit when using pull-up



Measurement Items (Functions)

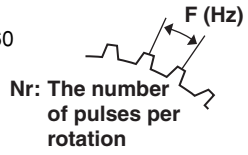
The following nine measurement items are available.

Frequency
Frequency (Hz) = 1/Tw (s)
Measurable range: 0.01 Hz to 200 kHz

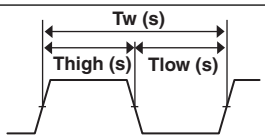


Period
Period (s) = Tw (s)
Measurable range: 5 μs to 50 s

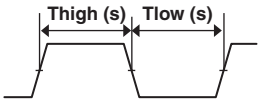
RPMs/RPSs
- RPMs = Frequency (Hz)/the number of pulses per rotation (Nr) × 60
  Measurable range: 0.01 to 100000 rpm
- RPSs = Frequency (Hz)/the number of pulses per rotation (Nr)
  Measurable range: 0.001 to 2000 rps



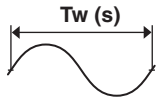
Duty
Duty cycle (%) = Thigh (s)/Tw (s)
Or, duty cycle (%) = Tlow (s)/Tw (s)
Measuring range: 0 to 100%



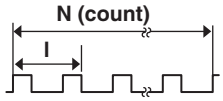
Pulse Width
Pulse width (s) = Thigh (s)
or pulse width (s) = Tlow (s)
Measurable range: 2 μs to 50 s



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



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



Velocity
Velocity (km/h) = Distance per pulse l (km)/Tw (s) × 3600
Velocity (m/s) = Distance per pulse l (m)/Tw (s)
The distance and unit can be user defined (angular velocity, etc.).
Measurable range: F (=1/Tw) = 0.01 Hz to 200 kHz

Setup Items for Each Measurement Item

Number of Rotations

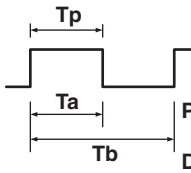
Pulse/Rotation (Pulse/Rotate)
Set the number of pulses per rotation in the range of 1 to 99999 pulses.

Duty Cycle or Pulse Width

Measure Pulse
Set the polarity of the pulse to be measured to positive or negative.

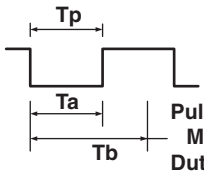
- **Duty**
  Positive: Measures the ratio of the positive pulses.
  Negative: Measures the ratio of the negative pulses.
- **Pulse Width**
  Positive: Measures the width of the positive pulse.
  Negative: Measures the width of the negative pulse.

• When Positive is selected



Pulse width:
Measures the width of Tp
Duty:
Measures Ta/Tb

• When Negative is selected

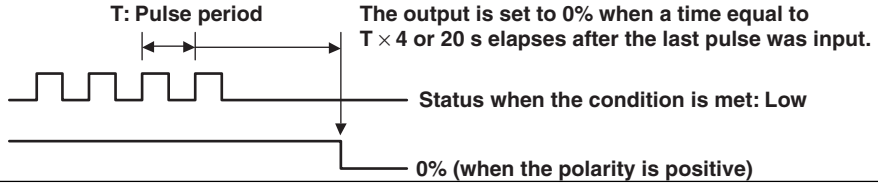


Pulse width:
Measures the width of Tp
Duty:
Measures Ta/Tb

Precautions to Be Taken When Measuring the Duty Cycle
The output is set to 0% or 100% when either of the conditions below is met when measuring the duty cycle.

- When there is no pulse input after a time equal to 4 times the period (T) of the pulse that was input immediately before.
- When there is no pulse input for 20 s.

When the polarity is set to Positive, the output is set to 0% when the pulse input is low when the condition is met and 100% when the pulse input is high. When the polarity is set to Negative, the output is set to 0% when the pulse input is high when the condition is met and 100% when the pulse input is low.



Power Supply Frequency

Center Frequency
Set the center value of the power supply frequency to 50 Hz, 60 Hz, or 400 Hz.

Pulse Integration

Unit/Pulse
Set the physical amount per pulse in the range of –9.9999E+30 to 9.9999E+30.

Over Limit Reset
Select ON to reset the pulse count automatically when the range is exceeded. Select OFF to not reset the pulse count. The default setting is OFF.

Executing Manual Reset
To reset the pulse count manually, select Exec.

Unit
As necessary, enter the unit of pulse integration to be displayed on the screen using up to 4 characters.

Velocity

Distance/Pulse
Set the distance per pulse in the range of –9.9999E+30 to 9.9999E+30.

Time Unit
Set the time unit to hour, min, or sec.
The output is automatically converted to a velocity with respect to the specified time.

Unit
Set the unit of the velocity to be displayed on the screen using up to 4 characters. The default setting is m/s.

Filter

Computation such as smoothing filter and pulse average can be performed depending on the measurement item.

Smoothing
Set the moving average order of smoothing in the range of 0.0 to 1000.0 ms.

Pulse Average
Set the number of times to perform pulse average in the range of 1 to 4096.

Deceleration Prediction

ON
Automatically computes and predicts the deceleration curve from the time elapsed since the stopping of the pulse.

OFF
Disables deceleration prediction.

Stop Prediction

Set the time from the point when the pulse input stops to the point when the function determines that the object has stopped.
The time can be set to ×1.5, ×2, ×3, ... , ×9, and ×10 (10 settings) of the pulse period (T) of the pulse one period before the pulse input stopped. If you select OFF, stop prediction is not performed.

5.18 Setting Logic Waveforms

<For a description of this function, refer to page 2-16.>

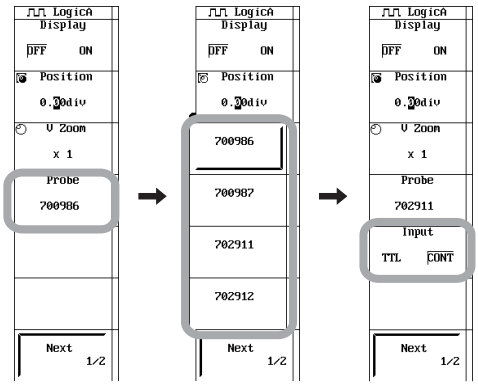
Procedure

Selecting the Channel

1. Press **CH**.
2. Press the **Logic A** or **Logic B** soft key.
   For the displayed menus when this operation is executed, see section 5.1.

Selecting the Input Signal Type

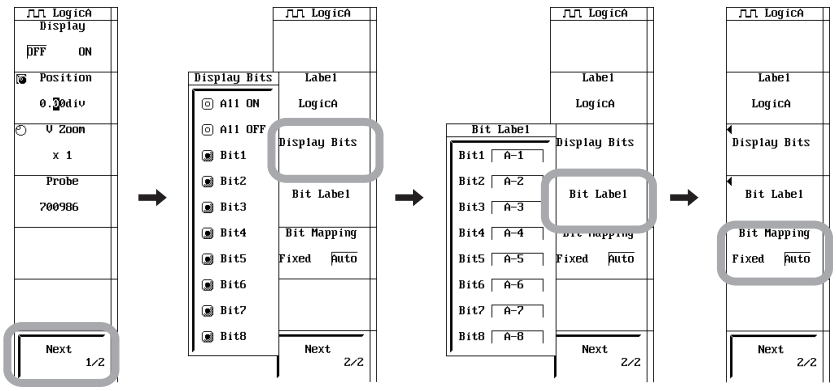
3. Press the **Probe** soft key. The logic probe selection menu appears.
4. Press one of the soft keys from **700986** to **702912** to select the type of logic probe that is connected.
5. If you select 702911 or 702912 for the logic probe, select the input signal type.



Only when the logic probe is set to 702911 or 702912

Setting the Bit Display

6. Press the **Next 1/2** soft key.
7. Press the **Display Bits** soft key. The bit display ON/OFF dialog box appears.
8. Use **jog shuttle+SELECT** to turn the bit display ON/OFF.
   You can turn ON all items at once by selecting All ON.
   You can turn OFF all items at once by selecting All OFF.
9. Press the **Bit Label** soft key. The bit label setting dialog box appears.
10. Use **jog shuttle+SELECT** to set the bit label according to the procedure given in section 4.2.
11. Press the **Bit Mapping** soft key to select how to assign the bit display. Select Fixed or Auto.



Explanation

Types of Logic Probes

Select the logic probe from 700986, 700987, 702911, and 702912.

Input Signal Type

If the logic probe is 702911 or 702912, select the input signal type.

TTL
TTL level voltage signal: Indicates 1 at a voltage greater than equal to approximately 1.4 V.

CONT
Voltage-free contact signal: Indicates 1 when signal is shorted to the earth line.

Bit Display ON/OFF (Display Bits)

You can specify whether to display the waveform for each bit.

Bit Label

Alphanumeric characters that can be entered: Up to 8 characters

Bit Mapping

Fixed
A space is allocated for bits that are turned OFF.

Auto
A space is not allocated for bits that are turned OFF.
Only the bits that are turned ON are displayed in order from the top.

Example When Bit 7 of Logic A is OFF

Fixed
A1
A2
A3
A4
A5
A6
A8

Auto
A1
A2
A3
A4
A5
A6
A8

Note

If you are observing the logic channel waveforms measured on the SL1400 using a software application such as XViewer or if you are reading the logic channel data using the WAVeform communication command, set the logic probe type of both LogicA and LogicB the same. If they are not the same, correct waveforms may not be displayed or correct data may not be output.

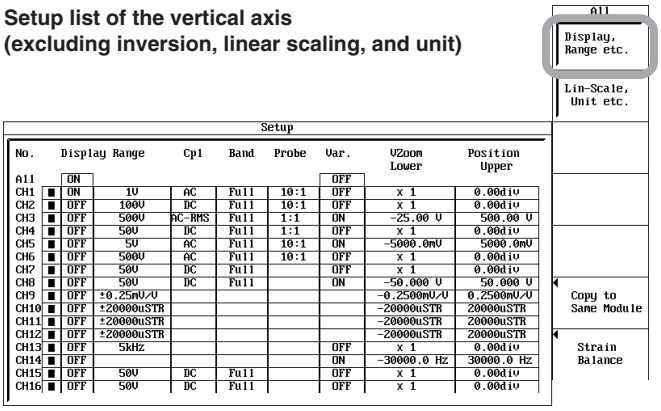
5.19 Entering Settings on the All Channel Menu

Procedure

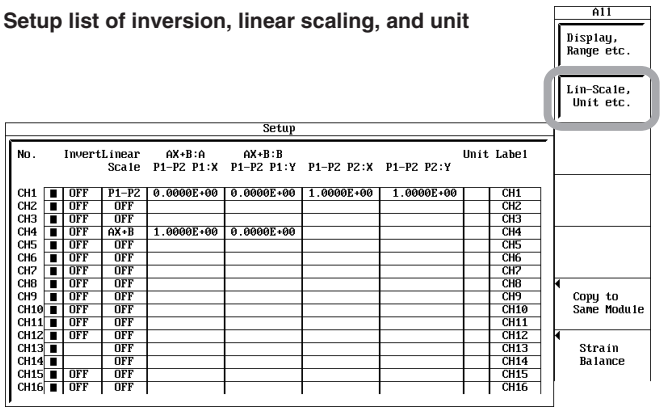
Displaying the All Channel Menu

1. Press **ALL CH**.
2. Press the **Display, Range etc.** or **Lin-Scale, Unit etc.** soft key. A setup list of the vertical axis (excluding inversion, linear scale, and unit) or a setup list of inversion, linear scaling, and unit is displayed.
3. Set each item.
   - Use **jog shuttle+arrow keys** to move the cursor.
   - Use **jog shuttle+SELECT** to set each item.

Setup list of the vertical axis (excluding inversion, linear scaling, and unit)

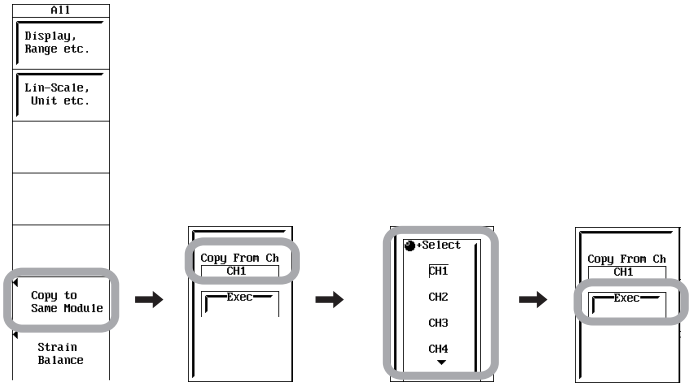


Setup list of inversion, linear scaling, and unit



Copying All the Settings of the Vertical Axis (Only to the Same Type of Modules)

2. Press the **Copy to Same Module** soft key.
3. Use **jog shuttle+SELECT** to select the copy source.
4. Turn the **jog shuttle** to move the cursor to Exec and press **SELECT**. All the settings of the vertical axis are copied only to the same type of modules.



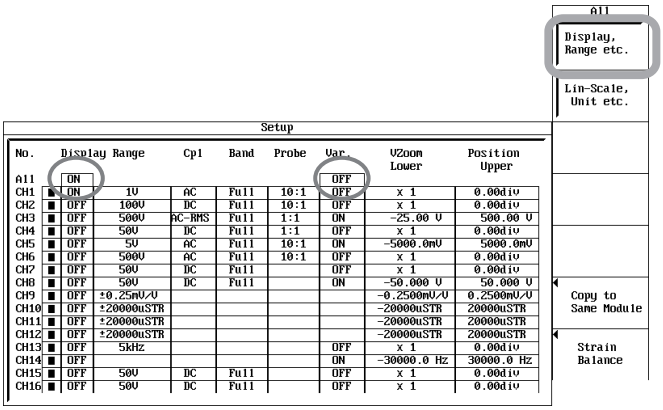
Note

The waveform color and label are not copied.

Turning the Display of All Channels ON/OFF and Variable ON/OFF

2. Select Display or Var. in the All line to select ON or OFF.
   - Use **jog shuttle+arrow keys** to move the cursor.
   - Use **jog shuttle+SELECT** to set each item.

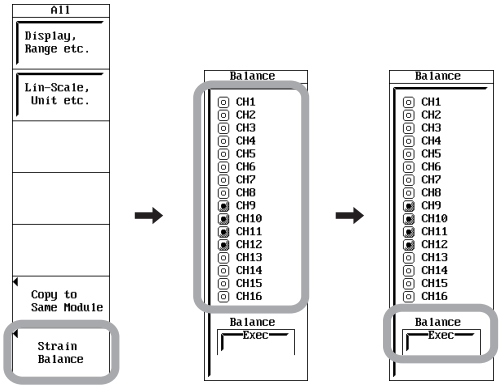
   * Corresponds to the setting of the vertical zoom according to the upper and lower limits of the display range for channels other than those in which a strain module is installed.



No.	Display	Range	Cpl	Band	Probe	Var.	VZoom Lower	Position Upper
All	ON					OFF		
CH1	ON	1V	AC	Full	10:1	OFF	x 1	0.00div
CH2	OFF	100V	DC	Full	10:1	OFF	x 1	0.00div
CH3	OFF	500V	AC-RMS	Full	1:1	ON	-25.00 V	500.00 V
CH4	OFF	50V	DC	Full	1:1	OFF	x 1	0.00div
CH5	OFF	5V	AC	Full	10:1	ON	-5000.0mV	5000.0mV
CH6	OFF	500V	AC	Full	10:1	OFF	x 1	0.00div
CH7	OFF	50V	DC	Full		OFF	x 1	0.00div
CH8	OFF	50V	DC	Full		ON	-50.000 V	50.000 V
CH9	OFF	±0.25mV/V					-0.2500mV/V	0.2500mV/V
CH10	OFF	±20000uSTR					-20000uSTR	20000uSTR
CH11	OFF	±20000uSTR					-20000uSTR	20000uSTR
CH12	OFF	±20000uSTR					-20000uSTR	20000uSTR
CH13	OFF	5kHz				OFF	x 1	0.00div
CH14	OFF					ON	-30000.0 Hz	30000.0 Hz
CH15	OFF	50V	DC	Full		OFF	x 1	0.00div
CH16	OFF	50V	DC	Full		OFF	x 1	0.00div

Executing Balancing When Measuring Strain

2. Press the **Strain Balance** soft key.
3. Use **jog shuttle+SELECT** to select the channel on which to execute balancing.
   Select a channel in which a strain module is installed.
4. Turn the **jog shuttle** to move the cursor to Exec and press **SELECT**. Balancing is executed.



Explanation

You can display the setup menu of all the channels (excluding logic input) over the entire screen to set the channels. The following items can be specified.

- Waveform color
- Display ON/OFF
- Measurement range
- Input coupling
- Bandwidth limit
- Probe attenuation or current-to-voltage conversion ratio
- Variable ON/OFF
- Zoom rate and vertical position (when Variable is OFF)
- Upper and lower limits of the display range (when Variable is ON)
- Linear scale

5.20 Selecting the Time Base (Internal Clock or External Clock)

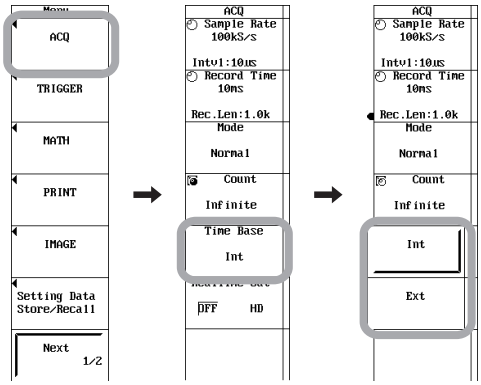
<For a description of this function, refer to page 2-3.>

Procedure

1. Press **MENU**.
2. Press the **ACQ** soft key.

Selecting the Time Base

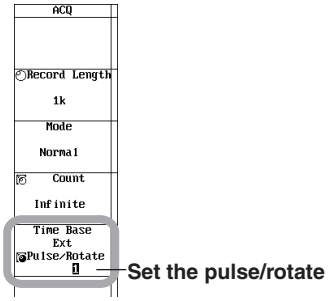
3. Press the **Time Base** soft key.
4. Press the **Int** or **Ext** soft key.
   If you select Ext, the Pulse/Rotate menu appears.



If Time Base Is Set to Ext

Setting Pulse/Rotate

5. Press the **Pulse/Rotate** soft key.
6. Turn the **jog shuttle** to set the number of pulses of the external clock signal that corresponds to one rotation (or one period).



Note

Pressing RESET while the jog shuttle control is set to Pulse/Rotate sets the number of pulses to 1.

Explanation

Time Base

Select from the following:

Int
Internal clock signal (the specified record time and sample rate are valid)

Ext
Clock signal applied to the external clock input terminal (the specified record time and sample rate are valid)

If Ext Is Selected

Apply a clock signal of the following specifications to the TRIG OUT/EXT CLK IN terminal (shared with the trigger output terminal) on the left side panel.

Item	Specifications
Connector type	RCA jack
Frequency range	See Note below
Input level	TTL (0 to 5 V)
Valid edge	Rising
Minimum pulse width	400 ns or more for high and low
External clock frequency range	1 MHz maximum
Rise/Fall time of the clock	2 μs or less

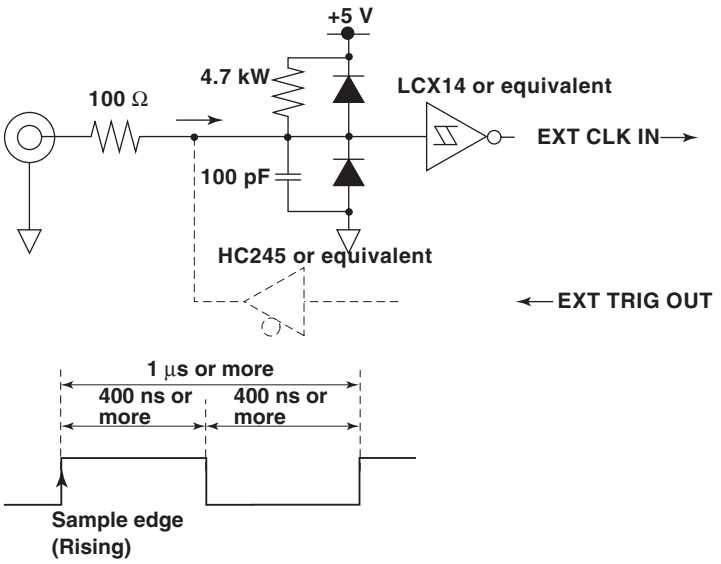
Note

- The upper limit frequency of the external clock is as follows:

Input Module	Upper Limit Frequency
701250/701251/701255	1 MHz
701260/701270/701271/701275	100 kHz
701280	25 kHz
701261/701262	100 kHz when measuring voltage, 500 Hz when measuring temperature
701265	500 Hz

- If the external clock frequency exceeds the upper limit frequency of the module, sampling is executed at the upper limit frequency.

Circuit Diagram and Timing Chart of the External Clock Input



CAUTION

Applying a voltage exceeding the maximum allowable input voltage to the TRIG OUT/EXT CLK IN terminal may damage the input section.

Pulse/Rotate

You can specify the number of pulses of the external signal that is to correspond to one mechanical rotation (one cycle).
Range of the number of pulses: 1 to 24000

Notes When Sampling Using the External Clock Signal

- You cannot set the acquisition mode to envelope or box average.
- You cannot display waveforms in roll mode.
- No function is provided for frequency-dividing the clock signal.
- Since the time axis setting cannot be changed, change the record length setting or zoom in on the time axis if you want to change the display range of the time axis.
- The time measured by the cursor measurement or automated measurement of waveform parameters is expressed in the number of pulses of the clock signal. No unit is displayed.
- Realtime recording to the internal hard disk cannot be selected.
- The following trigger settings are invalid.
  - Trigger delay
  - Hold off
  - B > Time, B < Time, and B Timeout trigger
  - Period trigger

Maximum Sample Rate of Each Input Module

If the sample rate of the SL1400 is set higher than the maximum sample rate of the input module, the data is updated only at the maximum sample rate of the input module. Consequently, all of the data within the data update interval of the module are the same data. The maximum sample rate of each input module is as follows:

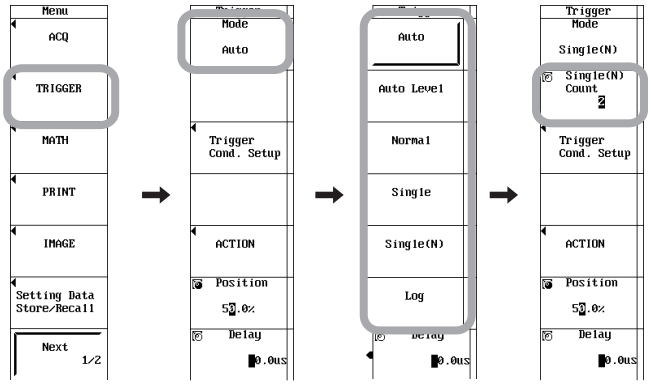
Input Module	During Internal Clock	During External Clock
701250/701255:	10 MHz	1 MHz
701251:	1 MHz	1 MHz
701260/701270/701271/701275:	100 kHz	100 kHz
701261/701262 (when measuring voltage):	100 kHz	100 kHz
(when measuring temperature):	500 Hz	500 Hz
701280:	25 kHz	25 kHz
701265:	500 Hz	500 Hz

6.1 Setting the Trigger Mode

<For a description of this function, refer to page 2-24.>

Procedure

1. Press **MENU**.
2. Press the **TRIGGER** soft key.
3. Press the **Mode** soft key.
4. Press the soft key corresponding to the desired mode to set the trigger mode.
5. If you select Single(N), turn the **jog shuttle** to set the Single(N) Count.



Explanation

Auto Mode

If the trigger condition is met within the 50-ms timeout period, the waveform is updated on each trigger occurrence. If the trigger condition is not met after the timeout period elapses, the waveform is automatically updated. If the time axis setting is in the range in which the display mode is set to roll mode, the display is set to roll mode. However, triggering operates in normal mode when using simple trigger with the trigger source set to Time, even if auto mode is specified.

Auto Level Mode

Within the timeout period (approximately 1 s), the waveforms are displayed in the same fashion as in the auto mode. If a trigger does not occur within the timeout period (approximately 1 s), the center value of the amplitude of the trigger source is detected, the trigger level is automatically changed to the center value, and the trigger is generated to update the displayed waveform. The auto-level mode is valid only if the trigger is a simple trigger and the trigger source is between CH1 and CH16. For all other cases, the operation is the same as for auto mode.
If the time axis setting is in the range in which the display mode is set to roll mode, the display is set to roll mode.

Normal Mode

The display is updated only when the trigger conditions are met. The display is not updated if the trigger does not occur. Therefore, to check the waveform or ground level when no trigger is detected, use auto mode.

Single Mode

When the trigger condition is met, the displayed waveforms are updated only once, and acquisition stops. In the time axis setting range in which the display mode is set to roll mode, the display is set to roll mode. When a trigger occurs, the specified record length of data is acquired and the displayed waveform stops.

Single(N) Mode

When the trigger condition is met, the waveform is acquired the specified number of times and stops. After waveform acquisition is finished, all the waveforms are displayed. This mode is used when acquiring a waveform using the sequential store function.

Log Mode

In this mode, the trigger settings are disabled. The specified record length of data is acquired once when acquisition is started, and the displayed waveforms are updated. If the time axis setting is in the range in which the display mode is set to roll mode, the display is set to roll mode.

Note

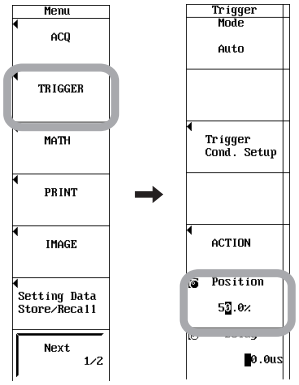
- The trigger mode setting applies to both simple and enhanced triggers.
- In Recorder mode (see chapter 9), select the trigger mode from Auto, Repeat, Single, and Log. For details on the Repeat mode, see section 9.2.

6.2 Setting the Trigger Position

<For a description of this function, refer to page 2-25.>

Procedure

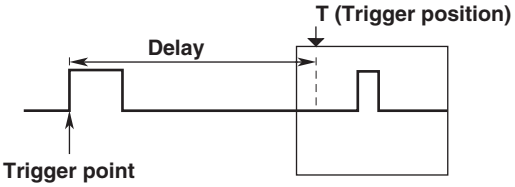
1. Press **MENU**.
2. Press the **TRIGGER** soft key.
3. Press the **Position** soft key.
4. Turn the **jog shuttle** to set the trigger position. Pressing **RESET** resets the value to 50%.



Explanation

Trigger Position

Trigger position = Trigger point + trigger delay
You can select the location of the trigger position on the screen.
If the trigger delay is 0 s, the trigger position and the trigger point match.



Selectable Range of the Trigger Position

With the display record length taken to be 100%, set in the range of 0 to 100% (in 0.1% steps).

Displaying the Trigger Position

A position marker (▼) appears at the top of the screen. The marker indicates the trigger position with respect to the display record length.

Time Reference Mark

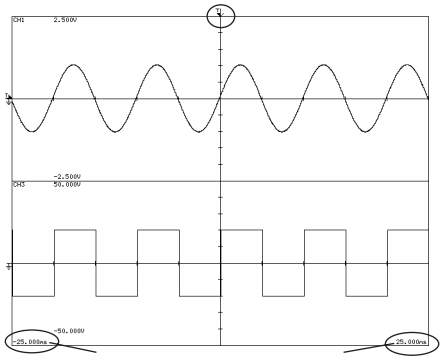
A ↓ mark is displayed at the time reference position of the acquisition data separately from the trigger position.

- **When Set to a Mode Other Than Roll Mode**

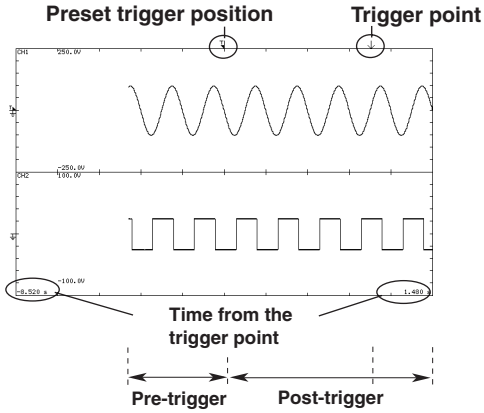
  Normally, the time reference point and the trigger position are displayed at the same position, because they match.

  If the waveform acquisition is stopped in the middle of the operation, the preset trigger position and the actual trigger position (trigger point) are offset, because not all the data of the pre-trigger section and post-trigger section have been acquired. In this case, the time reference mark is offset from the trigger position mark, because it indicates the actual trigger point.

When the time reference mark is displayed overlapped with the trigger position mark (↓)



When the time reference mark is displayed offset from the trigger position mark

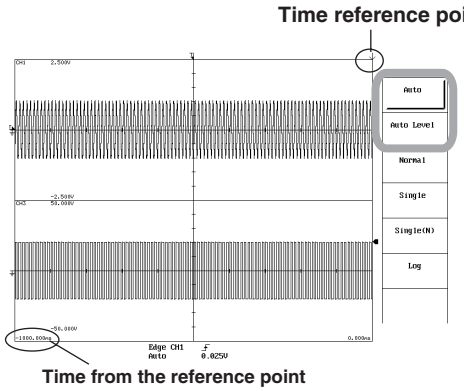


- **When Set to Roll Mode Display**

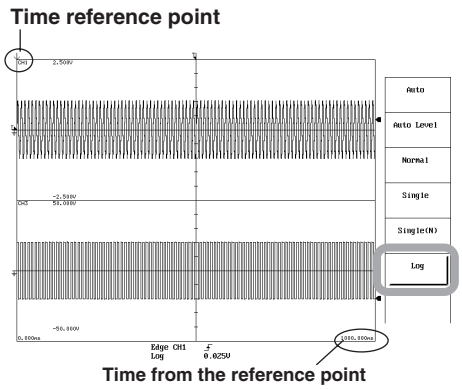
  If the trigger mode is set to Auto or Auto Level, the reference point is the point when the waveform acquisition was stopped.

  If the trigger mode is set to Log, the reference point is the point when the waveform acquisition was started.

When trigger mode is set to Auto/Auto Level



When trigger mode is set to Log



Notes for Setting the Trigger Position

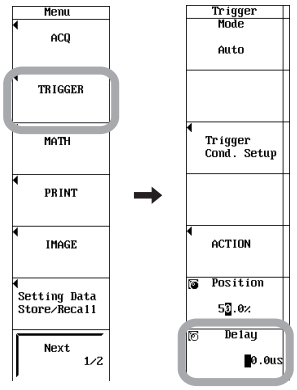
- If you change the trigger position while waveform acquisition is stopped, the new setting will not become effective until acquisition is started, and the waveform is updated.
- Note that cursor time measurements are with respect to the trigger position. Changing the trigger position therefore changes the measurement values (except when in roll mode display).
- If you change the record time, the time axis setting is rescaled with respect to the trigger position.

6.3 Setting the Trigger Delay

<For a description of this function, refer to page 2-25.>

Procedure

1. Press **MENU**.
2. Press the **TRIGGER** soft key.
3. Press the **Delay** soft key.
4. Turn the **jog shuttle** to set the trigger delay. Pressing **RESET** resets the value to 0.0 μs.

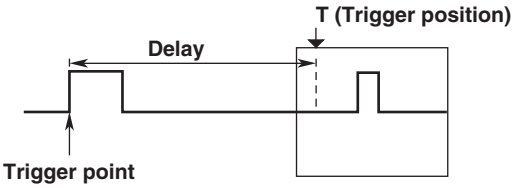


Explanation

Although the display usually shows the waveform before and after the trigger point, it is possible to display the acquired waveform after a fixed time period elapses using the delay function.

Selectable Range of the Trigger Delay

0 to 10 s (resolution: 0.1 μs)



Notes for Setting the Trigger Delay

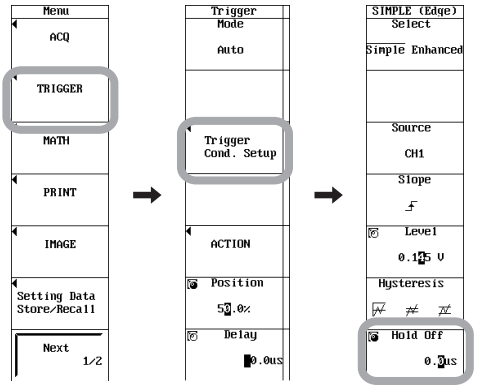
When record time is changed, the trigger delay remains unchanged.

6.4 Setting the Hold Off Time

<For a description of this function, refer to page 2-26.>

Procedure

1. Press **MENU**.
2. Press the **TRIGGER** soft key.
3. Press the **Trigger Cond. Setup** soft key.
4. Press the **Hold Off** soft key.
5. Turn the **jog shuttle** to set the hold off time. Pressing **RESET** resets the value to 0.0 μs.

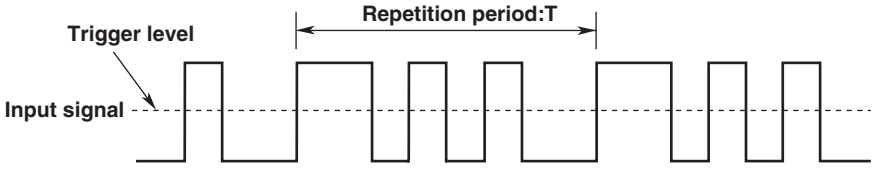


Note

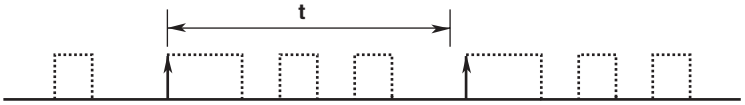
The hold off time setting applies to both simple and enhanced triggers.

Explanation

This function prevents a trigger from being activated for a specified time, even if the trigger conditions are met during this time. This is effective when you want to activate the trigger in sync with a periodic signal as shown in the figure below.



Trigger signal limited by hold off time t (when the trigger slope is set to rising edge)



Selectable Range of the Hold Off Time

0 to 10 s (resolution: 0.1 μs)

Notes for Setting the Hold Off Time

- If you are setting the hold off time to 50 ms or greater, set the trigger mode to normal.
- When used with A->B(N) or A Delay B trigger, the hold off time applies only to condition B.
- The hold off time is set to 0 ns for Period trigger, and this function is invalid.

6.5 Setting the Edge Trigger (SIMPLE)

<For a description of this function, refer to page 2-17.>

Procedure

1. Press **MENU**.
2. Press the **TRIGGER** soft key.
3. Press the **Trigger Cond. Setup** soft key.
4. Press the **Select** soft key to select Simple.

Setting the Trigger Source

5. Press the **Source** soft key. The trigger source selection menu appears.
6. Use **jog shuttle+SELECT** to select the channel to be used as the trigger source from **CH1** to **CH16**.

Note

The menu does not appear for channels without modules.

Setting the Trigger Level

7. Press the **Level** soft key.
8. Turn the **jog shuttle** to set the trigger level. Pressing **RESET** sets the trigger level to 0.

Note

The trigger level setting applies to both simple and enhanced triggers.

Setting the Trigger Slope

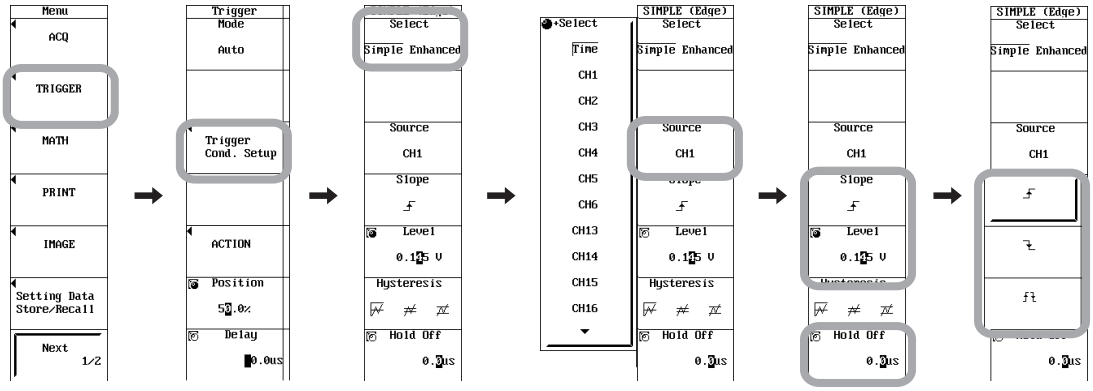
9. Press the **Slope** soft key to select ⨍, ⨏, or ⨍⨏.

Setting the Hysteresis

10. Press the **Hysteresis** soft key to select ⩘, ≠, or ⩛.

Setting the Hold Off

11. Set the hold off time according to the procedures given in section 6.4.



Explanation

This function activates a trigger when the trigger source signal crosses a specified level.

Trigger Source

Select the trigger source from CH1 to CH16.

Note

If you set the trigger source to a value other than CH1 to CH16, see the sections below.

- Time: Section 6.8, “Setting the Timer Trigger (SIMPLE)”
- LogicA or Logic B: Section 6.9, “Setting the Logic Trigger (SIMPLE)”
- Ext (TRIG IN terminal of the side panel): Section 6.6, “Setting the External Trigger (SIMPLE)”
- Line (commercial power supply signal): Section 6.7, “Generating Triggers on the Power Signal (SIMPLE)”

Trigger Level

When Measuring Voltage

Selectable range: Within voltage range
Resolution: Varies depending on the input module (see the table below).

When Measuring Temperature

Selectable range: Measurement range of each thermocouple
Resolution: 0.1°C or 0.1 K (set within the measurement range (varies depending on the thermocouple type)
For a description of the measurement range of thermocouples, see section 5.14.

When Measuring Strain

Selectable range: ±(Measurable range)
Resolution: 1 μSTR or 0.0005 mV/V

Trigger Level Resolution

The selectable resolution varies depending on the input module.

When Measuring Voltage (When Probe Attenuation Is 1:1)

	Input Module				
Voltage Range	701250/701255/ 701261/701262	701251	701265	701260	701275
1 mV	–	–	0.001 mV	–	–
2mV	–	–	0.002 mV	–	–
5 mV	–	–	0.005 mV	–	–
10 mV	–	0.01 mV	0.01 mV	–	–
20 mV	–	0.02 mV	0.02 mV	–	–
50 mV	0.05 mV	0.05 mV	0.05 mV	–	0.05 mV
100 mV	0.1 mV	0.1 mV	0.1 mV	–	0.1 mV
200 mV	0.2 mV	0.2 mV	0.2 mV	0.2 mV	0.2 mV
500 mV	0.5 mV	0.5 mV	0.5 mV	0.5 mV	0.5 mV
1 V	0.001 V	0.001 V	0.001 V	0.001 V	0.001 V
2 V	0.002 V	0.002 V	0.002 V	0.002 V	0.002 V
5 V	0.005 V	0.005 V	0.005 V	0.005 V	0.005 V
10 V	0.01 V	0.01 V	0.01 V	0.01 V	0.01 V
20 V	0.02 V	0.02 V	0.02 V	0.02 V	0.02 V
50 V	0.05 V	0.05 V	0.05 V	0.05 V	0.05 V
100 V	0.1 V	0.1 V	0.1 V	0.1 V	0.1 V
200 V	0.2 V	0.2 V	–	0.2 V	–
500 V	–	–	–	0.5 V	–
1 kV	–	–	–	0.001 kV	–
2 kV	–	–	–	0.002 kV	–

The resolution is 0.01 division on all modules.

When Measuring Temperature

Range	Resolution
K, E, J, T, L, U, N, R, S, B, W	0.1°C
Au7Fe	0.1 K

Trigger Slope

Select how the trigger source is to cross the specified level for activating the trigger from the following three choices.

- ⎍ : Activated when the trigger source changes from below the trigger level to above the trigger level (rising).
- ⎎ : Activated when the trigger source changes from above the trigger level to below the trigger level (falling).
- ⎍⎎ : Activated on either a rising edge or falling edge.

Trigger Hysteresis

Sets a width to the trigger level so that triggers are not activated by small changes in the trigger signal. Select the trigger hysteresis from the following three types.

When Measuring Voltage

- : Approximately ±0.1 division of hysteresis around the trigger level.
- : Approximately ±0.5 division of hysteresis around the trigger level.
- : Approximately ±1 division of hysteresis around the trigger level.

When Measuring Temperature

- : Approximately ±0.5°C (K)
- : Approximately ±1°C (K)
- : Approximately ±2°C (K)

When Measuring Strain

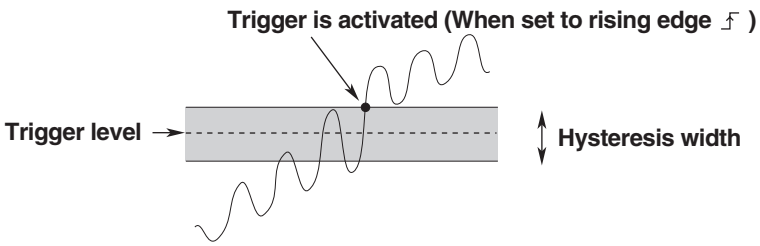
- : Hysteresis of approximately ±2.5% of the range around the trigger level.
- : Hysteresis of approximately ±12.5% of the range around the trigger level.
- : Hysteresis of approximately ±25% of the range around the trigger level.

When Measuring Acceleration

- : Hysteresis of approximately ±0.1 divisions of the range around the trigger level.
- : Hysteresis of approximately ±0.5 divisions of the range around the trigger level.
- : Hysteresis of approximately ±1 divisions of the range around the trigger level.

When Measuring Frequency and Other Parameters on the Frequency Module

- : Hysteresis of approximately ±0.01 divisions of the range around the trigger level.
- : Hysteresis of approximately ±0.5 divisions of the range around the trigger level.
- : Hysteresis of approximately ±1 divisions of the range around the trigger level.



Hold Off

See section 6.4.

6.6 Setting the External Trigger (SIMPLE)

<For a description of this function, refer to page 2-17.>

Procedure

1. Press **MENU**.
2. Press the **TRIGGER** soft key.
3. Press the **Trigger Cond. Setup** soft key.
4. Press the **Select** soft key to select Simple.

Setting the Trigger Source

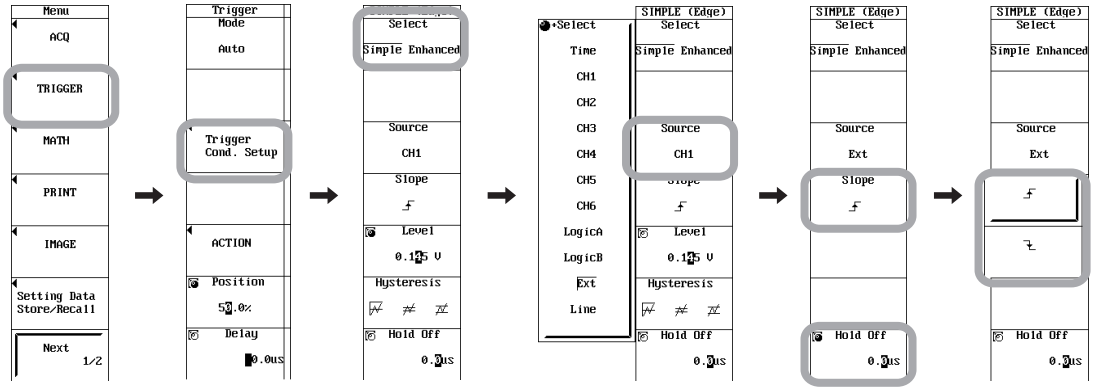
5. Press the **Source** soft key. The trigger source selection menu appears.
6. Use **jog shuttle+SELECT** to select Ext.

Setting the Trigger Slope

7. Press the **Slope** soft key to select ⨍ or ⨏.

Setting the Hold Off

8. Set the hold off time according to the procedures given in section 6.4.



Explanation

The external signal that is input through the TRIG IN terminal on the left side panel of the SL1400 can be used to generate triggers.

Note

For details on the TRIG IN terminal, see section 14.1.

Trigger Source

Select Ext.

Trigger Slope

Select how the trigger source is to cross the specified level for activating the trigger from the following two choices.

⨍ : Activated when the trigger source changes from below the trigger level to above the trigger level (rising).

⨏ : Activated when the trigger source changes from above the trigger level to below the trigger level (falling).

Hold Off

See section 6.4.

6.7 Activating Triggers on the Power Signal (SIMPLE)

<For a description of this function, refer to page 2-17.>

Procedure

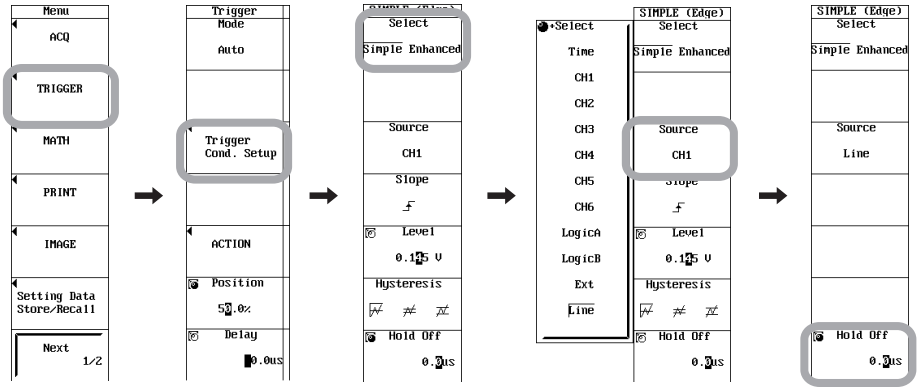
1. Press **MENU**.
2. Press the **TRIGGER** soft key.
3. Press the **Trigger Cond. Setup** soft key.
4. Press the **Select** soft key to select Simple.

Setting the Trigger Source

5. Press the **Source** soft key. The trigger source selection menu appears.
6. Use **jog shuttle+SELECT** to select Line.

Setting the Hold Off

7. Set the hold off time according to the procedures given in section 6.4.



Explanation

A triggers can be activated on the rising edge of the power signal that is being supplied to the SL1400. Waveforms synchronized to the commercial power supply frequency (50 Hz or 60 Hz) can be observed.

Trigger Source

Select Line. The power signal that is being supplied to the SL1400 becomes the trigger source.

Hold Off

See section 6.4.

6.8 Setting the Timer Trigger (SIMPLE)

<For a description of this function, refer to page 2-17.>

Procedure

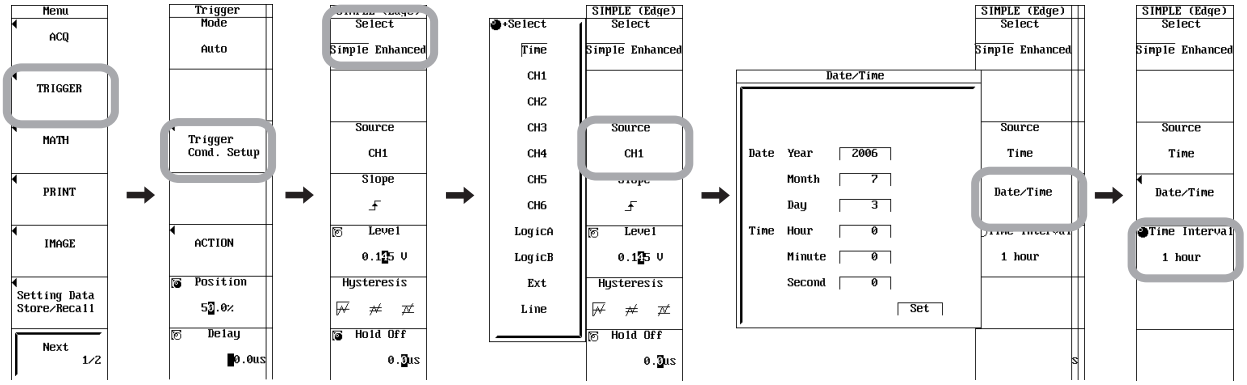
1. Press **MENU**.
2. Press the **TRIGGER** soft key.
3. Press the **Trigger Cond. Setup** soft key.
4. Press the **Select** soft key to select Simple.

Setting the Trigger Source

5. Press the **Source** soft key. The trigger source selection menu appears.
6. Use **jog shuttle+SELECT** to select Time.

Setting the Date/Time and the Interval for Activating Triggers

7. Press the **Date/Time** soft key. A setup dialog box opens.
8. Use **jog shuttle+SELECT** to set the Date and Time.
9. When you are done, Use **jog shuttle+SELECT** to select Set.
10. Press the **Time Interval** soft key.
11. Turn the **jog shuttle** to set the ß for activating triggers in the range of 1 min to 24 hours.



Explanation

The trigger is activated at specified time intervals from the specified time.

Trigger Source

Select Time.

Reference Date and Time for Activating Triggers

Set the date and time for activating the trigger.

Time Interval for Activating Triggers

The following intervals can be specified.
1 min, 2 min, 3 min, 4 min, 5 min, 6 min, 7 min, 8 min, 9 min, 10 min, 15 min, 20 min, 25 min, 30 min, 40 min, 45 min, 50 min, 1 hour, 2 hour, 3 hour, 4 hour, 5 hour, 6 hour, 7 hour, 8 hour, 9 hour, 10 hour, 11 hour, 12 hour, 18 hour, and 24 hour

Trigger Position

Like the normal trigger, you can set the trigger position to observe the phenomenon occurring around the specified time. Initially, the trigger position is set to 50% and positioned at the center of the screen. To observe only the waveform after the trigger set the trigger position to 0%. To observe only the waveform before the trigger set it to 100%.

Notes on the Timer Trigger

- Depending on the time interval setting, a trigger may occur while the waveform is being acquired or during the pre-trigger period (a preparation period for observing the waveform before the trigger time). In such cases, the trigger is ignored.
- If the trigger time is set to a time in the past, the trigger is activated when the current time becomes
  Specified time + time interval × N (where N is an integer).
- If you specify the acquisition count, the waveforms are acquired the specified number of times. If it is set to infinite, the waveforms are acquired until you press START/STOP to stop the waveform acquisition. For the procedure to set the acquisition count, see section 7.2.
- You can save the waveform to a PC card or internal hard disk (optional), output the waveform on the built-in printer, and do other operations by using the action-on-trigger function.

6.9 Setting the Logic Trigger (SIMPLE)

<For a description of this function, refer to page 2-17.>

Procedure

1. Press **MENU**.
2. Press the **TRIGGER** soft key.
3. Press the **Trigger Cond. Setup** soft key.
4. Press the **Select** soft key to select Simple.

Setting the Trigger Source

5. Press the **Source** soft key. The trigger source selection menu appears.
6. Use **jog shuttle+SELECT** to select Logic A or Logic B.

Specifying the Bit for Assigning the Trigger Slope

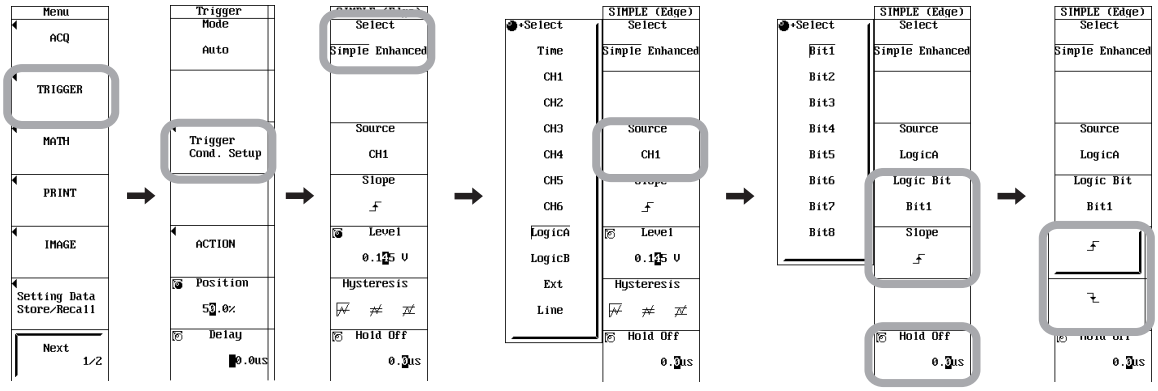
7. Press the **Logic Bit** soft key. The bit selection menu appears.
8. Use **jog shuttle+SELECT** to set the bit to assign the trigger slope.

Setting the Trigger Slope

9. Press the **Slope** soft key to select ↑ or ↓.

Setting the Hold Off

10. Set the hold off time according to the procedures given in section 6.4.



Explanation

This is the edge trigger when the trigger source is set to a logic waveform.

Trigger Source

Select Logic A or Logic B.

Bit to Assign the Trigger Slope (Logic Bit)

Select the trigger source from Bit 1 to Bit 8.

Trigger Slope

Select how the trigger source is to cross the specified level for activating the trigger from the following two choices.

- ⎍ : Activated when the trigger source changes from below the trigger level to above the trigger level (rising).
- ⎎ : Activated when the trigger source changes from above the trigger level to below the trigger level (falling).

Hold Off

See section 6.4.

6.10 Setting the A->B(N) Trigger (ENHANCED)

<For a description of this function, refer to page 2-18.>

Procedure

1. Press **MENU**.
2. Press the **TRIGGER** soft key.
3. Press the **Trigger Cond. Setup** soft key.
4. Press the **Select** soft key to select Enhanced.

Setting the Trigger Type

5. Press the **Type** soft key. The trigger type selection menu appears.
6. Use **jog shuttle+SELECT** to select A->B(N).

Setting Condition A

7. Press the **Set Pattern** soft key. The A->B(N) trigger setup menu appears.

- **Setting the Condition A Pattern**

8. Use **jog shuttle+SELECT** to select the pattern of each channel (CH1 to CH16) from H, L, and X. For logic input channels, select Disable or Enable.

- **Setting the Condition A Condition**

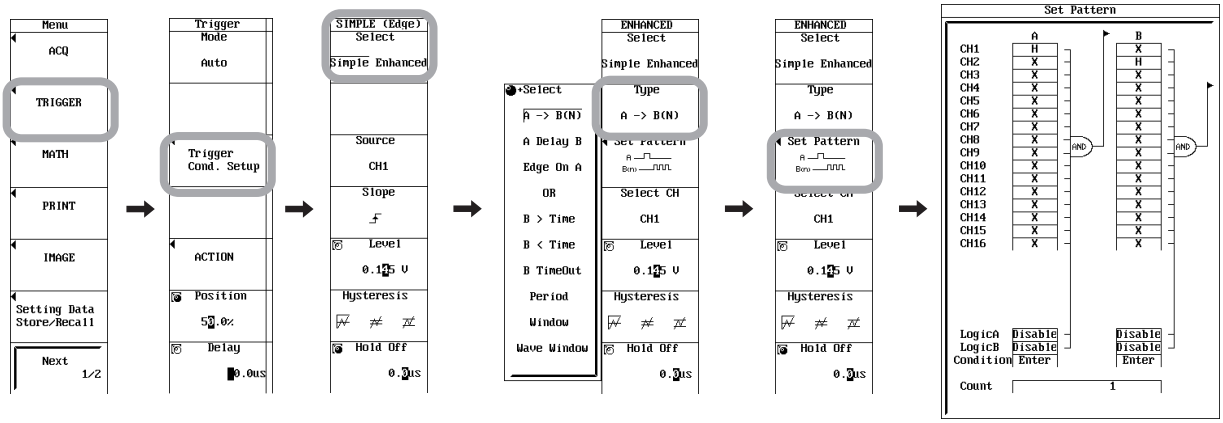
9. Use **jog shuttle+SELECT** to set Condition to Enter or Exit.

Setting Condition B

10. Set the pattern and condition of condition B in a similar fashion as in steps 8 and 9.

- **Setting the Number of Times Condition B Is to Be Met**

11. Use **jog shuttle+SELECT** to set Count (the number of times condition B is to be met). Pressing **RESET** resets the value to 1.



Setting the Bit Patterns of Logic A and Logic B

(Only when using logic input channels)

12. Press the **Logic Pattern** soft key. The Logic Pattern setup dialog box appears.
13. Use **jog shuttle+SELECT** to select the pattern of each bit (Bit A1 to Bit A8 and Bit B1 to Bit B8) from H, L, and X.

Setting the Trigger Level

14. Press the **Select CH** soft key. The channel selection menu appears.
15. Use **jog shuttle+SELECT** to set the channel to assign the trigger level.
16. Press the **Level** soft key.
17. Use **jog shuttle+SELECT** to set the trigger level.
18. Likewise, set the trigger level for all channels on which patterns were assigned in steps 8 to 10.

Note

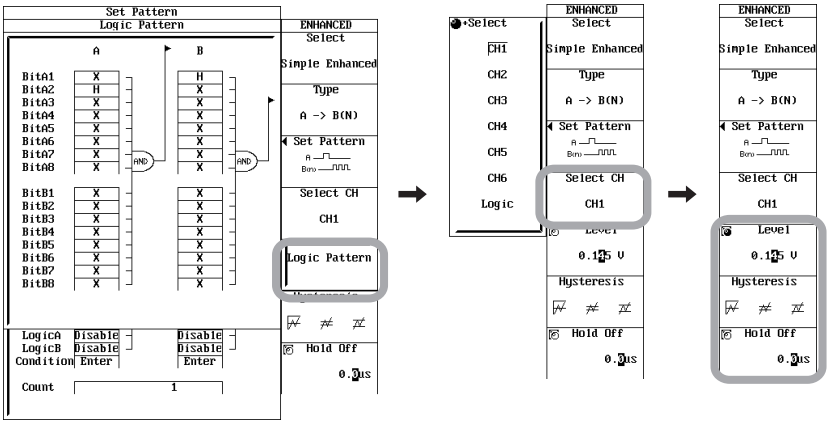
The trigger level setting applies to both simple and enhanced triggers.

Setting the Hysteresis

19. Press the **Hysteresis** soft key to select , , or .

Setting the Hold Off

20. Set the hold off time according to the procedures given in section 6.4.



Note

The pattern settings of conditions A and B apply to all trigger types.

Explanation

This function activates a trigger when the N^{th} time condition B becomes true after condition A has become true.

Condition A and Condition B (Set Pattern)

Pattern of each channel: CH1 to CH16, Logic A, or Logic B

Select from the following:

- **CH1 to CH16 (Other Than Logic Inputs)**
  H: Above the preset trigger level
  L: Below the preset trigger level
  X: Don't Care
- **Logic Input**
  Enable: Make the combination of the pattern[1] of each bit the trigger condition
  Disable: Don't Care

1 Select the pattern of each pattern from the following:
  H: Above a certain level[2]
  L: Below a certain level[2]
  X: Don't Care
2 Varies depending on the logic probe being used as follows:
  702911/702912/700986: Approx. 1.4 V
  700987: 6 V ± 50% (for DC input)
  700987: 50 V ± 50% (for AC input)

Condition

Select from the following:

Enter: A trigger is activated when all channels match the specified pattern.

Exit: A trigger is activated when any of the channels no longer match the specified pattern.

Number of Times Condition B Is to Be Met (Count)

1 to 255 times

Trigger Level

The trigger level setting applies to both simple and enhanced triggers.
See "Trigger Level" in section 6.5.

Trigger Hysteresis

Sets a width to the trigger level so that triggers are not activated by small changes in the trigger signal. Select the trigger hysteresis from  , , and .
See "Trigger Hysteresis" in section 6.5.

Hold Off

See section 6.4.

Note

- If you want to use a simple pattern trigger (only one pattern condition for activating the trigger), set all of the status of condition B to Xs (Don't care) and set a pattern for condition A.
- If you want to set the trigger only on the condition of the pattern of each bit of the logic input (trigger on the AND of each bit), then specify the following settings.
  - Condition A pattern
    Set the logic input channels to be used to Enable and all other channels to X (Don't care)
  - Condition B pattern
    All Xs (Don't care)
  - Bit pattern of logic input
    Set arbitrarily.

6.11 Setting the A Delay B Trigger (ENHANCED)

<For a description of this function, refer to page 2-18.>

Procedure

1. Press **MENU**.
2. Press the **TRIGGER** soft key.
3. Press the **Trigger Cond. Setup** soft key.
4. Press the **Select** soft key to select Enhanced.

Setting the Trigger Type

5. Press the **Type** soft key. The trigger type selection menu appears.
6. Use **jog shuttle+SELECT** to select A Delay B.

Setting Condition A

7. Press the **Set Pattern** soft key. The A Delay B trigger setup menu appears.

Setting the Condition A Pattern

8. Use **jog shuttle+SELECT** to select the pattern of each channel (CH1 to CH16) from H, L, and X. For logic input channels, select Disable or Enable.

Setting the Condition A Condition

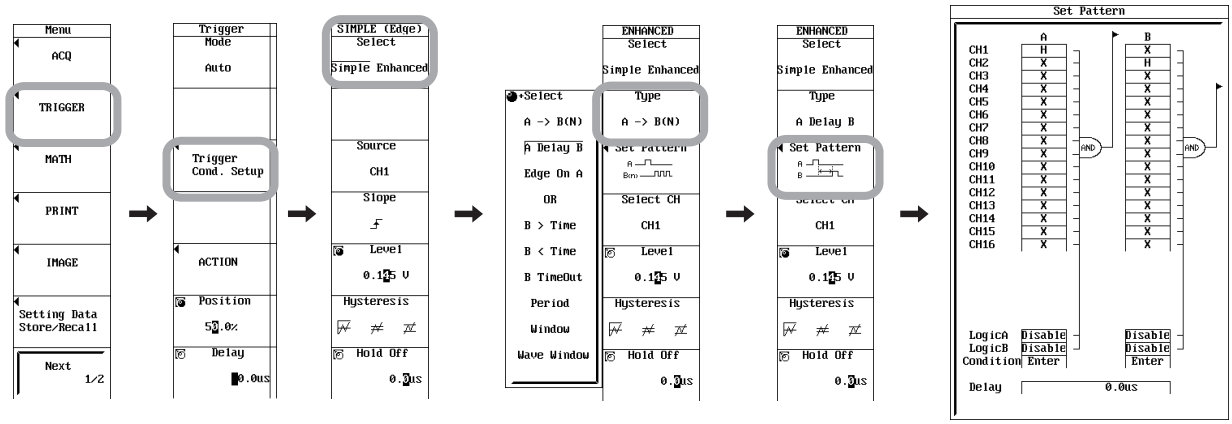
9. Use **jog shuttle+SELECT** to set Condition to Enter or Exit.

Setting Condition B

10. Set the pattern and condition of condition B in a similar fashion as in steps 8 and 9.

Setting the Delay Time

11. Use **jog shuttle+SELECT** to set Delay. Pressing **RESET** resets the value to 0.0 μs.



Setting the Bit Patterns of Logic A and Logic B

(Only when using logic input channels)

12. Press the **Logic Pattern** soft key. The Logic Pattern setup dialog box appears.
13. Use **jog shuttle+SELECT** to select the pattern of each bit (Bit A1 to Bit A8 and Bit B1 to Bit B8) from H, L, and X.

Setting the Trigger Level

14. Press the **Select CH** soft key. The channel selection menu appears.
15. Use **jog shuttle+SELECT** to set the channel to assign the trigger level.
16. Press the **Level** soft key.
17. Use **jog shuttle+SELECT** to set the trigger level.
18. Likewise, set the trigger level for all channels on which patterns were assigned in steps 8 to 10.

Note

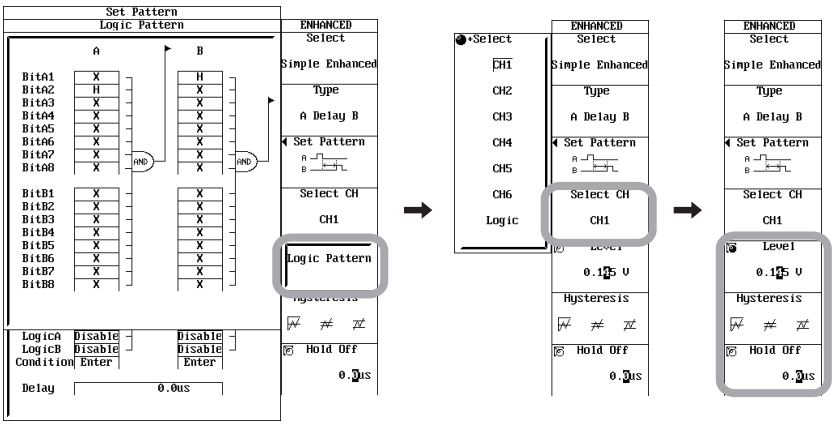
The trigger level setting applies to both simple and enhanced triggers.

Setting the Hysteresis

19. Press the **Hysteresis** soft key to select ⩘, ⩙, or ⩗.

Setting the Hold Off

20. Set the hold off time according to the procedures given in section 6.4.



Note

The pattern settings of conditions A and B apply to all trigger types.

Explanation

This function activates a trigger the first time condition B becomes true after condition A has become true and a preset time has elapsed.

Condition A and Condition B (Set Pattern)

Pattern of each channel: CH1 to CH16, Logic A, and Logic B

Select from the following:

- **CH1 to CH16 (Other Than Logic Inputs)**

  H: Above the preset trigger level

  L: Below the preset trigger level

  X: Don't Care

- **Logic Input**

  Enable: Make the combination of the pattern[1] of each bit the trigger condition

  Disable: Don't Care

  *1 Select the pattern of each pattern from the following:

  H: Above a certain level[2]

  L: Below a certain level[2]

  X: Don't Care

  2 Varies depending on the logic probe being used as follows:

702911/702912/700986:	Approx. 1.4 V
700987:	6 V ± 50% (for DC input)
700987:	50 V ± 50% (for AC input)

Condition

Select from the following:

Enter: A trigger is activated when all channels match the specified pattern.

Exit: A trigger is activated when any of the channels no longer match the specified pattern.

Delay Time

0 to 10 s (resolution is 100 ns)

Trigger Level

The trigger level setting applies to both simple and enhanced triggers.
See "Trigger Level" in section 6.5.

Trigger Hysteresis

Sets a width to the trigger level so that triggers are not activated by small changes in the trigger signal. Select the trigger hysteresis from , , and .
See "Trigger Hysteresis" in section 6.5.

Hold Off

See section 6.4.

Note

If you want to activate only one pattern trigger, use the A->B(n) trigger function (see section 6.10).

6.12 Setting the Edge on A Trigger (ENHANCED)

<For a description of this function, refer to page 2-19.>

Procedure

1. Press **MENU**.
2. Press the **TRIGGER** soft key.
3. Press the **Trigger Cond. Setup** soft key.
4. Press the **Select** soft key to select Enhanced.

Setting the Trigger Type

5. Press the **Type** soft key. The trigger type selection menu appears.
6. Use **jog shuttle+SELECT** to select Edge on A.

Setting Condition A

7. Press the **Set Pattern** soft key. The Edge on A trigger setup menu appears.

Setting the Condition A Pattern

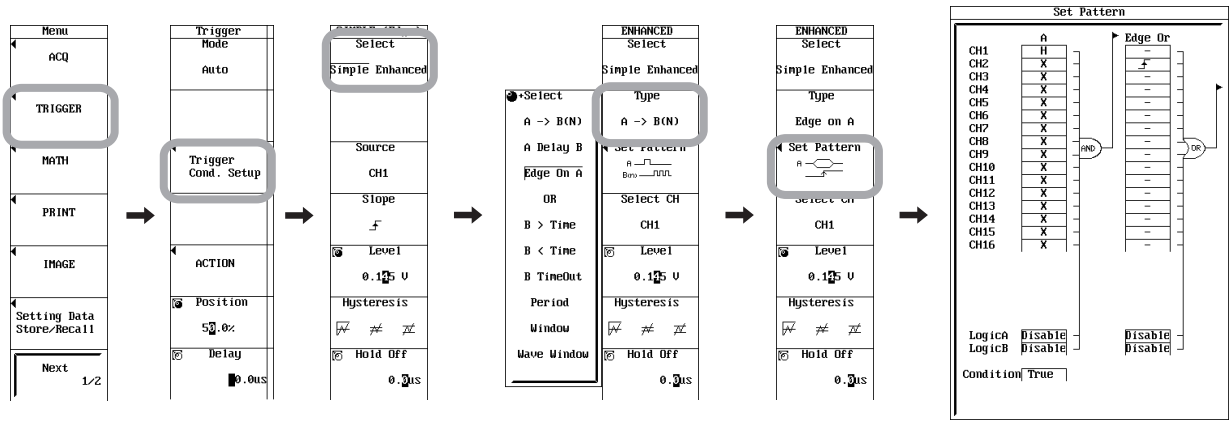
8. Use **jog shuttle+SELECT** to select the pattern of each channel (CH1 to CH16) from H, L, and X. For logic input channels, select Disable or Enable.

Setting the Condition A Condition

9. Use **jog shuttle+SELECT** to set Condition to True or False.

Setting the Edge Trigger OR

10. Use **jog shuttle+SELECT** to select the edge trigger OR status of each channel (CH1 to CH16) from ⨍, ⨏, and –. For logic input channels, select Disable or Enable.



Setting the Bit Pattern/Status of Logic A and Logic B

(Only when using logic input channels)

11. Press the **Logic Pattern** soft key. The Logic Pattern setup dialog box appears.
12. Use **jog shuttle+SELECT** to select the pattern of each bit (Bit A1 to Bit A8 and Bit B1 to Bit B8) of condition A from H, L, and X.
13. Like wise, use **jog shuttle+SELECT** to select the edge trigger OR status from ⎍ , ⎎ , and –.

Setting the Trigger Level

14. Press the **Select CH** soft key. The channel selection menu appears.
15. Use **jog shuttle+SELECT** to set the channel to assign the trigger level.
16. Press the **Level** soft key.
17. Use **jog shuttle+SELECT** to set the trigger level.
18. Likewise, set the trigger level for all channels on which patterns were assigned in steps 7 to 8.

Note

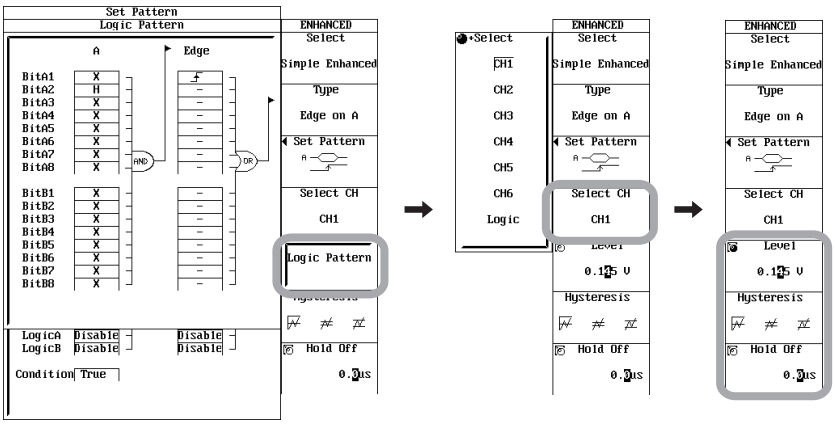
The trigger level setting applies to both simple and enhanced triggers.

Setting the Hysteresis

19. Press the **Hysteresis** soft key to select ⩘, ⩘, or ⩘.

Setting the Hold Off

20. Set the hold off time according to the procedures given in section 6.4.



Note

The pattern settings of conditions A apply to all trigger types.

Explanation

This function activates a trigger on the OR logic of the edge trigger of each channel while condition A is true.

Conditions A/Edge Or (Set Pattern)

Pattern of Each Channel of Condition A: CH1 to CH16, Logic A, and Logic B

Select from the following:

- **CH1 to CH16 (Other Than Logic Inputs)**
  - H: Above the preset trigger level
  - L: Below the preset trigger level
  - X: Don't Care
- **Logic Input**
  - Enable: Make the combination of the pattern[1] of each bit the trigger condition
  - Disable: Don't Care

1 Select the pattern of each pattern from the following:
- H: Above a certain level[2]
- L: Below a certain level[2]
- X: Don't Care

2 Varies depending on the logic probe being used as follows:

702911/702912/700986:	Approx. 1.4 V
700987:	6 V ± 50% (for DC input)
700987:	50 V ± 50% (for AC input)

Condition

Select from the following:

True: A trigger is activated while all channels match the specified pattern.

False: A trigger is activated while any of the channels do not match the specified pattern.

Edge Trigger of Each Channel (Edge Or)

This setting is possible only if the channel's condition A pattern is set to X (Don't Care). If you set all condition A patterns to X (Don't Care), the trigger will operate as an OR trigger.

- **CH1 to CH16 (Other Than Logic Inputs)**
  - ⎍ : Rising edge
  - ⎎ : Falling edge
  - – : Don't Care
- **Logic Input**
  - Enable: Make the combination of the pattern[1] of each bit the trigger condition
  - Disable: Don't Care

1 Select the pattern of each pattern from the following:
- ⎍ : When the signal goes above a certain level[2]
- ⎎ : When the signal goes below a certain level[2]
- – : Don't Care

2 Varies depending on the logic probe being used as follows:
- 700986: Approx. 1.4 V
- 700987: 6 V ± 50% (for DC input)
- 700987: 50 V ± 50% (for AC input)

Trigger Level

The trigger level setting applies to both simple and enhanced triggers.
See “Trigger Level” in section 6.5.

Trigger Hysteresis

Sets a width to the trigger level so that triggers are not activated by small changes in the trigger signal. Select the trigger hysteresis from , , and .
See “Trigger Hysteresis” in section 6.5.

Hold Off

See section 6.4.

6.13 Setting the OR Trigger (ENHANCED)

<For a description of this function, refer to page 2-19.>

Procedure

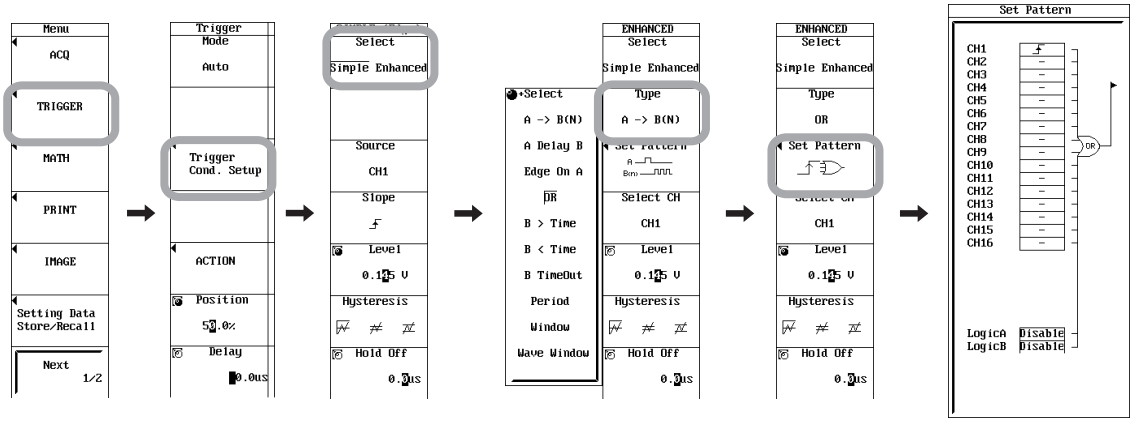
1. Press **MENU**.
2. Press the **TRIGGER** soft key.
3. Press the **Trigger Cond. Setup** soft key.
4. Press the **Select** soft key to select Enhanced.

Setting the Trigger Type

5. Press the **Type** soft key. The trigger type selection menu appears.
6. Use **jog shuttle+SELECT** to select OR.

Setting the Edge Trigger OR

7. Press the **Set Pattern** soft key. The OR trigger setup menu appears.
8. Use **jog shuttle+SELECT** to select the edge trigger OR status of each channel (CH1 to CH16) from ⎍, ⎎, and –. For logic input channels, select Disable or Enable.



Setting the Status of Each Bit of Logic A and Logic B (Only when using logic input channels)

9. Press the **Logic Pattern** soft key. The Logic Pattern setup dialog box appears.
10. Use **jog shuttle+SELECT** to select edge trigger OR status of each bit (Bit A1 to Bit A8 and Bit B1 to Bit B8) from ⎍, ⎎, and –.

Setting the Trigger Level

11. Press the **Select CH** soft key. The channel selection menu appears.
12. Use **jog shuttle+SELECT** to set the channel to assign the trigger level.
13. Press the **Level** soft key.
14. Use **jog shuttle+SELECT** to set the trigger level.
15. Likewise, set the trigger level for all channels on which patterns were assigned in step 8.

Note

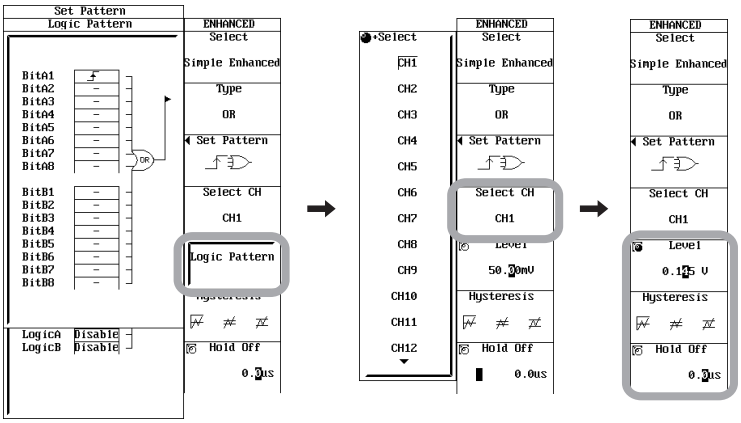
The trigger level setting applies to both simple and enhanced triggers.

Setting the Hysteresis

16. Press the **Hysteresis** soft key to select ⩘, ⩘, or ⩘.

Setting the Hold Off

17. Set the hold off time according to the procedures given in section 6.4.



Explanation

This function activates a trigger on the OR logic of edge triggers. You can set trigger conditions on all channels (CH1 to CH16). For example, a trigger can be activated on the rising edge of CH1 or CH2.

Edge Trigger of Each Channel (Set Pattern)

Select from the following:

- **CH1 to CH16 (Other Than Logic Inputs)**
  - ⎍ : Rising edge
  - ⎎ : Falling edge
  - – : Don't Care
- **Logic Input**

  Enable: Make the combination of the status[1] of each bit the trigger condition

  Disable: Don't Care

  1 Select the status of each bit from the following:
  - ⎍ : When the signal goes above a certain level[2]
  - ⎎ : When the signal goes below a certain level[2]
  - – : Don't Care

  2 Varies depending on the logic probe being used as follows:

702911/702912/700986:	Approx. 1.4 V
700987:	6 V ± 50% (for DC input)
700987:	50 V ± 50% (for AC input)

Trigger Level

The trigger level setting applies to both simple and enhanced triggers.
See "Trigger Level" in section 6.5.

Trigger Hysteresis

Sets a width to the trigger level so that triggers are not activated by small changes in the trigger signal. Select the trigger hysteresis from  ,  , and  .
See "Trigger Hysteresis" in section 6.5.

Hold Off

See section 6.4.

Note

The OR trigger is equivalent to setting the pattern of condition A of Edge on A trigger to all Xs (Don't Care).

6.14 Setting the B > Time, B < Time, or B Timeout (Pulse Width) Trigger (ENHANCED)

<For a description of this function, refer to page 2-20.>

Procedure

1. Press **MENU**.
2. Press the **TRIGGER** soft key.
3. Press the **Trigger Cond. Setup** soft key.
4. Press the **Select** soft key to select Enhanced.

Setting the Trigger Type

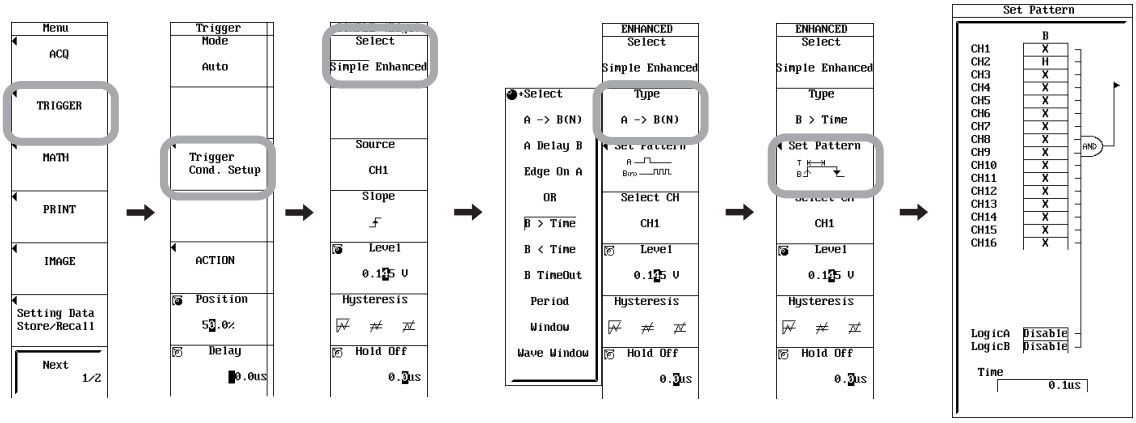
5. Press the **Type** soft key. The trigger type selection menu appears.
6. Use the **jog shuttle+SELECT** to select B > Time, B < Time, or B TimeOut.

Setting the Condition B Pattern

7. Press the **Set Pattern** soft key. The B > Time trigger, B < Time trigger, and B TimeOut trigger setup menu appears.
8. Use **jog shuttle+SELECT** to select the pattern of each channel (CH1 to CH16) from H, L, and X. For logic input channels, select Disable or Enable.

Setting the Pulse Width

9. Use **jog shuttle+SELECT** to set Time. Pressing **RESET** resets the value to 0.1 µs.



Setting the Bit Patterns of Logic A and Logic B

(Only when using logic input channels)

10. Press the **Logic Pattern** soft key. The Logic Pattern setup dialog box appears.
11. Use **jog shuttle+SELECT** to select the pattern of each bit (Bit A1 to Bit A8 and Bit B1 to Bit B8) from H, L, and X.

Setting the Trigger Level

12. Press the **Select CH** soft key. The channel selection menu appears.
13. Use **jog shuttle+SELECT** to set the channel to assign the trigger level.
14. Press the **Level** soft key.
15. Use **jog shuttle+SELECT** to set the trigger level.
16. Likewise, set the trigger level for all channels on which patterns were assigned in step 8.

Note

The trigger level setting applies to both simple and enhanced triggers.

Setting the Hysteresis

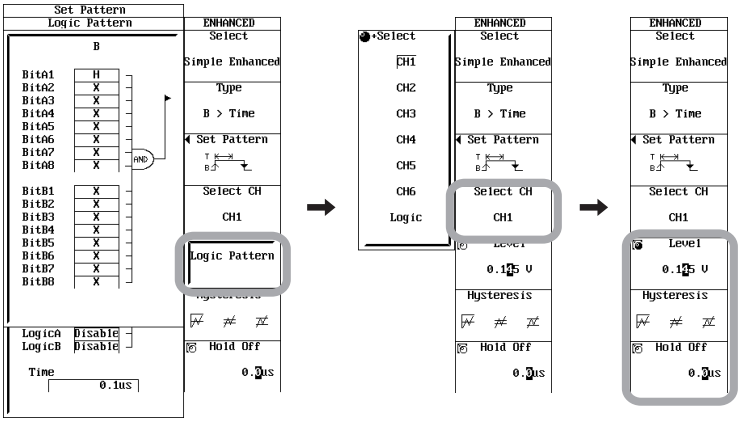
17. Press the **Hysteresis** soft key to select , , or .

Setting the Hold Off

18. Set the hold off time according to the procedures given in section 6.4.

Note

The pattern settings of conditions B apply to all trigger types.



Explanation

The following three pulse width triggers are available.

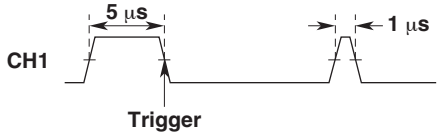
B > Time: A trigger is activated when condition B goes false after holding true for the preset pulse width.

B < Time: A trigger is activated when condition B goes false after holding true for less than the preset pulse width.

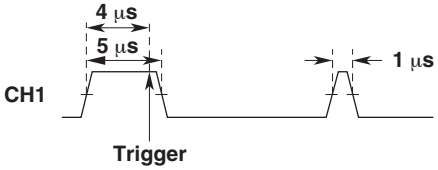
B Time Out: A trigger is activated when condition B has held true for the preset pulse width.

The point where the trigger is activated differs between B > Time and B Time Out as shown in the figure below.

When B > Time, CH1 = H, and Time = 4 μs

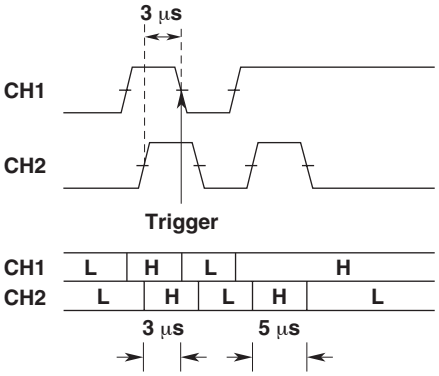


When B Time Out, CH1 = H, and Time = 4 μs



B<Time Setup Example

When B < Time, condition B: CH1 = H, CH2 = H, and Time = 4 μs



Condition B (Set Pattern)

Pattern of each channel: CH1 to CH16, Logic A, and Logic B

Select from the following:

- **CH1 to CH16 (Other Than Logic Inputs)**

  H: Above the preset trigger level

  L: Below the preset trigger level

  X: Don't Care

- **Logic Input**

  Enable: Make the combination of the pattern[1] of each bit the trigger condition

  Disable: Don't Care

  1 Select the pattern of each pattern from the following:
  H: Above a certain level[2]
  L: Below a certain level[2]
  X: Don't Care

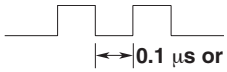
  2 Varies depending on the logic probe being used as follows:
  702911/702912/700986: Approx. 1.4 V
  700987: 6 V ± 50% (for DC input)
  700987: 50 V ± 50% (for AC input)

Pulse Width (Time)

0.1 μs to 10 s (resolution : 0.1 μs)

Notes for Setting the B>Time, B<Time, or B Time Out Trigger

Correct operation is not guaranteed if adjacent pulses are less than 0.1 μs apart or if the pulse width is less than 0.1 μs (typical).



Trigger Level

The trigger level setting applies to both simple and enhanced triggers.
See "Trigger Level" in section 6.5.

Trigger Hysteresis

Sets a width to the trigger level so that triggers are not activated by small changes in the trigger signal. Select the trigger hysteresis from  , , and .
See "Trigger Hysteresis" in section 6.5.

Hold Off

See section 6.4.

6.15 Setting the Period Trigger (ENHANCED)

<For a description of this function, refer to page 2-21.>

Procedure

1. Press **MENU**.
2. Press the **TRIGGER** soft key.
3. Press the **Trigger Cond. Setup** soft key.
4. Press the **Select** soft key to select Enhanced.

Setting the Trigger Type

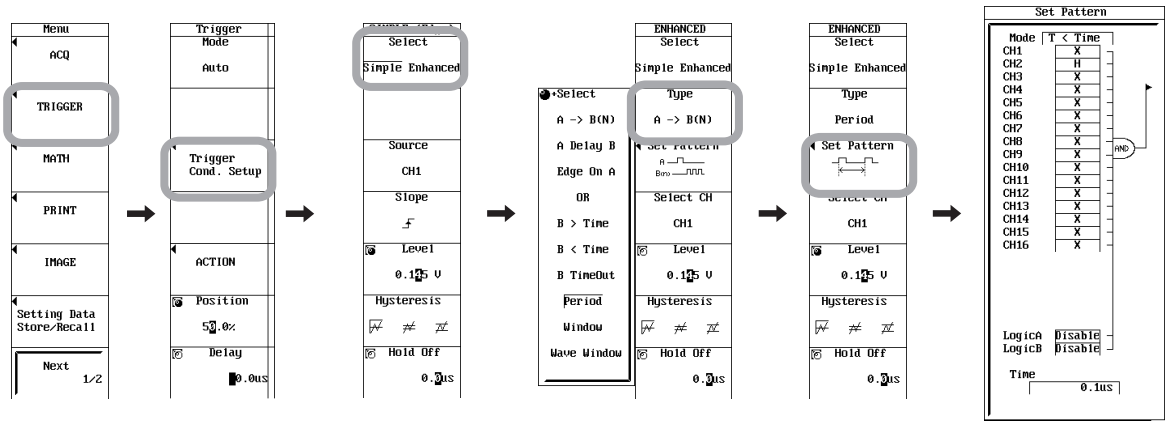
5. Press the **Type** soft key. The trigger type selection menu appears.
6. Use **jog shuttle+SELECT** to select Period.

Setting the Condition B Status

7. Press the **Set Pattern** soft key. The Period trigger setup menu appears.
8. Use **jog shuttle+SELECT** to select Mode and use **jog shuttle+SELECT** to select T > Time, T < Time, T1 < T < T2, or T < T1, T2 < T.
9. Use **jog shuttle+SELECT** to select the pattern of each channel (CH1 to CH16) from H, L, and X. For logic input channels, select Disable or Enable.

Setting the Time of Satisfaction

- **For T > Time or T < Time**
  10. Use **jog shuttle+SELECT** to set Time. Pressing **RESET** resets the value to 0.1 μs.
- **For T1 < T < T2 or T < T1, T2 < T**
  10. Use **jog shuttle+SELECT** to set Time1 and Time2. Press **RESET** resets Time1 to 0.1 μs and Time2 to 0.2 μs.



Setting the Bit Patterns of Logic A and Logic B

(Only when using logic input channels)

11. Press the **Logic Pattern** soft key. The Logic Pattern setup dialog box appears.
12. Use **jog shuttle+SELECT** to select the pattern of each bit (Bit A1 to Bit A8 and Bit B1 to Bit B8) from H, L, and X.

Setting the Trigger Level

13. Press the **Select CH** soft key. The channel selection menu appears.
14. Use **jog shuttle+SELECT** to set the channel to assign the trigger level.
15. Press the **Level** soft key.
16. Use **jog shuttle+SELECT** to set the trigger level.
17. Likewise, set the trigger level for all channels on which patterns were assigned in step 9.

Note

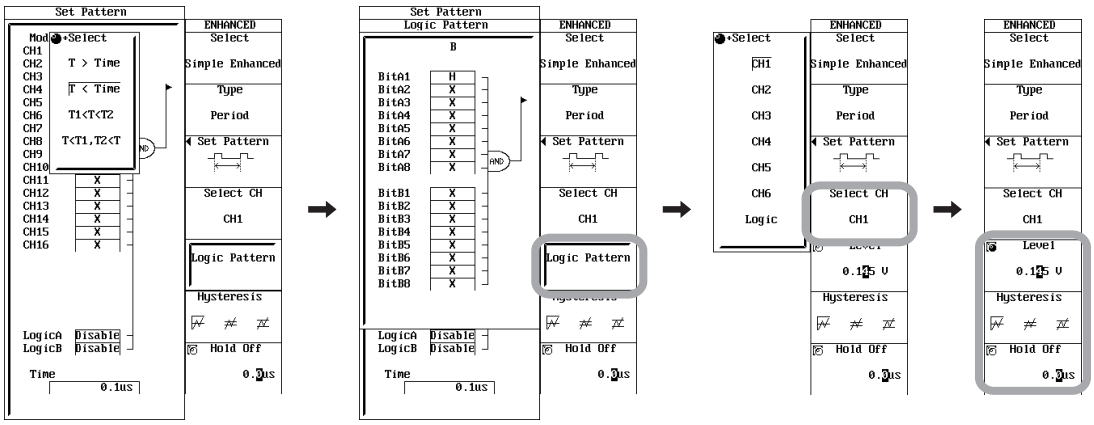
The trigger level setting applies to both simple and enhanced triggers.

Setting the Hysteresis

18. Press the **Hysteresis** soft key to select ⩘, ≠, or ⩛.

Note

The pattern settings of conditions B apply to all trigger types.



Explanation

The following four period triggers are available.

T > Time: A trigger is activated when condition B is met the second time if the time when condition B is met the second time is longer than a specified time.

T < Time: A trigger is activated when condition B is met the second time if the time when condition B is met the second time is shorter than a specified time.

T1 < T < T2: A trigger is activated when condition B is met the second time if the time when condition B is met the second time is within a specified time range.

T < T1, T2 < T: A trigger is activated when condition B is met the second time if the time when condition B is met the second time is outside a specified time range.

Condition B (Set Pattern)

Pattern of each channel: CH1 to CH16, Logic A, and Logic B

Select from the following:

- **CH1 to CH16 (Other Than Logic Inputs)**

  H: Above the preset trigger level

  L: Below the preset trigger level

  X: Don't Care

- **Logic Input**

  Enable: Make the combination of the pattern[1] of each bit the trigger condition

  Disable: Don't Care

  1 Select the pattern of each pattern from the following:

  H: Above a certain level[2]

  L: Below a certain level[2]

  X: Don't Care

  *2 Varies depending on the logic probe being used as follows:

702911/702912/700986:	Approx. 1.4 V
700987:	6 V ± 50% (for DC input)
700987:	50 V ± 50% (for AC input)

Time of Satisfaction

- **For T > Time or T < Time**

  Time: 0.1 μs to 9999999.9 μs

- **For T1 < T < T2 or T < T1, T2 < T**

  Time1: 0.1 μs to 9999999.9 μs

  Time2: 0.2 μs to 10000000.0 μs

Trigger Level

The trigger level setting applies to both simple and enhanced triggers.

See "Trigger Level" in section 6.5.

Trigger Hysteresis

Sets a width to the trigger level so that triggers are not activated by small changes in the trigger signal. Select the trigger hysteresis from  ,  , and  .

See "Trigger Hysteresis" in section 6.5.

Hold Off

The hold function is invalid for the period trigger.

6.16 Setting the Window Trigger (ENHANCED)

<For a description of this function, refer to page 2-22.>

Procedure

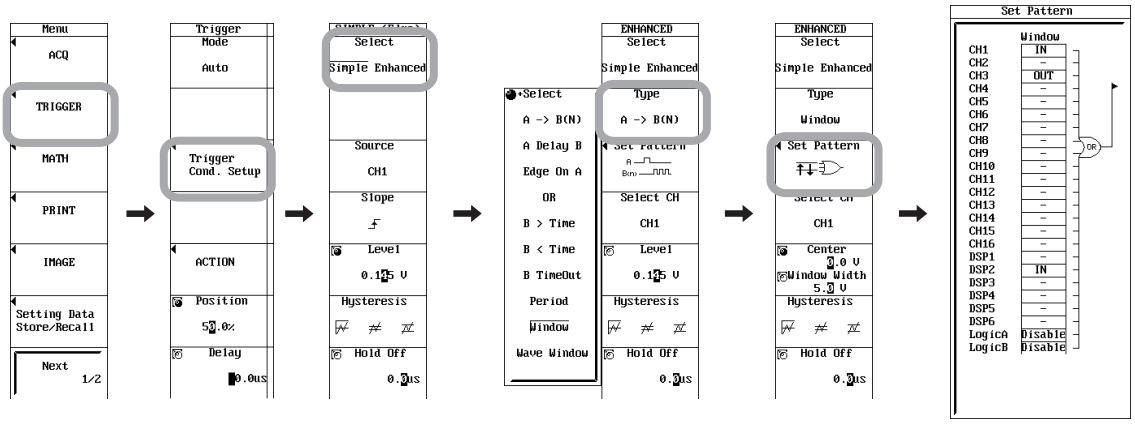
1. Press **MENU**.
2. Press the **TRIGGER** soft key.
3. Press the **Trigger Cond. Setup** soft key.
4. Press the **Select** soft key to select Enhanced.

Setting the Trigger Type

5. Press the **Type** soft key. The trigger type selection menu appears.
6. Use **jog shuttle+SELECT** to select Window.

Setting the Trigger Conditions

7. Press the **Set Pattern** soft key. The Window trigger setup menu appears.
8. Use **jog shuttle+SELECT** to select the pattern of each channel (CH1 to CH16) from IN, OUT, and –. For logic input channels, select Disable or Enable.



Setting the Status of Each Bit of Logic A and Logic B (Only when using logic input channels)

9. Press the **Logic Pattern** soft key. The Logic Pattern setup dialog box appears.
10. Use **jog shuttle+SELECT** to select the status of each bit (Bit A1 to Bit A8 and Bit B1 to Bit B8) from ⎍, ⎎, and –.

Selecting the Target Waveform

11. Press the **Select CH** soft key. The channel selection menu appears.
12. Use **jog shuttle+SELECT** to select the target channel.

Setting the Window (When the Target Waveform Is Not Logic)

Setting the Center Level

13. Press the **Center/Width** soft key to set the jog shuttle control to Center.
14. Turn the **jog shuttle** to set the center level.

Setting the Window Width

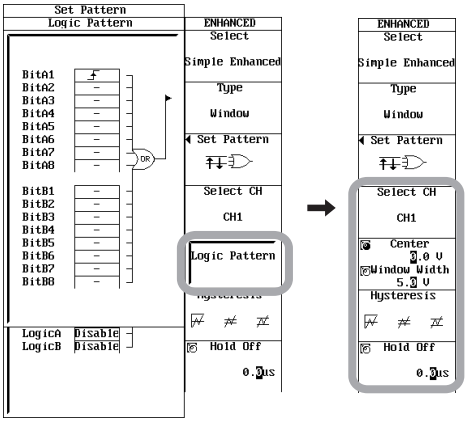
15. Press the **Center/Width** soft key to set the jog shuttle control to Width.
16. Turn the **jog shuttle** to set the window width.

Setting the Hysteresis

17. Press the **Hysteresis** soft key to select ⩘, ⩘, or ⩘.

Setting the Hold Off

18. Set the hold off time according to the procedures given in section 6.4.



Explanation

Window Trigger Target

You can set trigger conditions on all channels (CH1 to CH16) other than logic waveforms. A trigger occurs if any of the specified trigger conditions (OR condition) is met.

Trigger Condition (Set Pattern)

- **CH1 to CH16 (Other Than Logic Inputs)**
  - IN: A trigger is activated when the trigger source enters the area between two preset levels.
  - OUT: A trigger is activated when the trigger source exits the area between two preset levels.
- **Logic Input**
  - Enable: Make the combination of the status[1] of each bit the trigger condition
  - Disable: Don't Care

1 Select the status of each bit from the following:
- ⤴ : When the signal goes above a certain level[2]
- ⤵ : When the signal goes below a certain level[2]
- – : Don't Care

*2 Varies depending on the logic probe being used as follows:

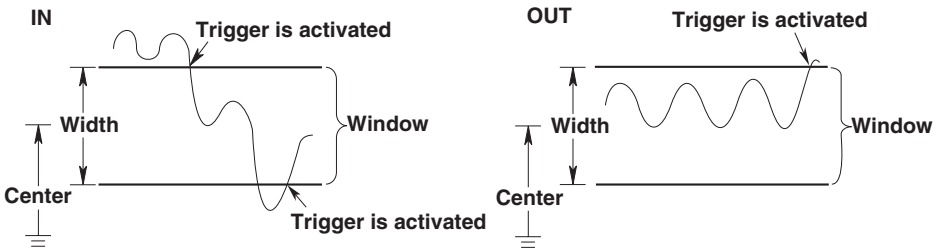
702911/702912/700986:	Approx. 1.4 V
700987:	6 V ± 50% (for DC input)
700987:	50 V ± 50% (for AC input)

Window (Center/Width)

A window is specified by a center level and width around the center level.

Selectable range of Center: ±(Voltage range) when measuring voltage, measurement range of the thermocouple when measuring temperature. (Resolution: Same as the resolution of the trigger level. See section 6.5.)

Selectable range of Width: ±(Voltage range) when measuring voltage, measurement range of the thermocouple when measuring temperature around the center level. (Resolution: Same as the resolution of the trigger level. See section 6.5.)



Trigger Hysteresis

Sets a width to the trigger level so that triggers are not activated by small changes in the trigger signal. Select the trigger hysteresis from ⩘, ⩛, and ⩙.
See "Trigger Hysteresis" in section 6.5.

Hold Off

See section 6.4.

Notes for Activating Window Triggers

The operation is the same as the OR trigger for logic input.

6.17 Setting the Wave Window Trigger (ENHANCED)

<For a description of this function, refer to page 2-23.>

Procedure

1. Press **MENU**.
2. Press the **TRIGGER** soft key.
3. Press the **Trigger Cond. Setup** soft key.
4. Press the **Select** soft key to select Enhanced.

Setting the Trigger Type

5. Press the **Type** soft key. The trigger type selection menu appears.
6. Use **jog shuttle+SELECT** to select Wave Window.

Setting the Trigger Conditions

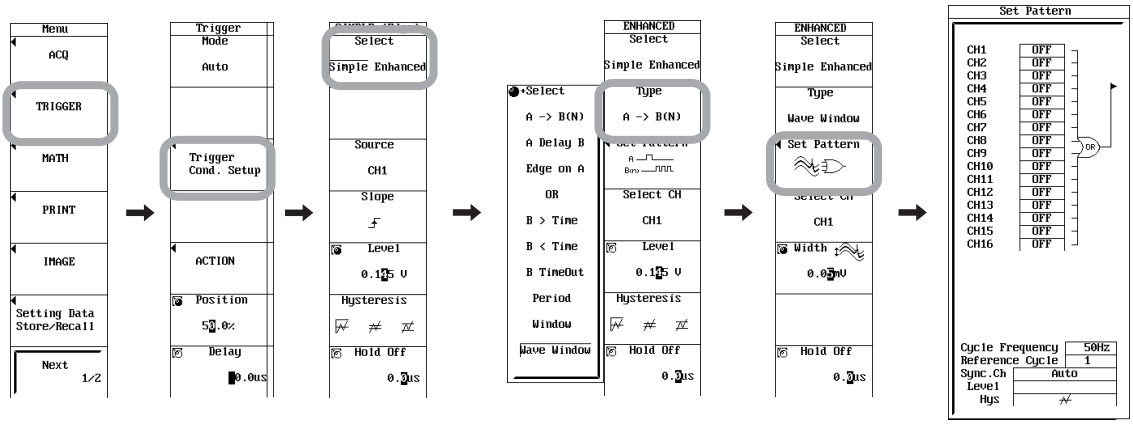
7. Press the **Set Pattern** soft key. The Wave Window trigger setup menu appears.
8. Use **jog shuttle+SELECT** to select the pattern of each channel (CH1 to CH16) from ON and OFF.

Note

- The wave window trigger does not apply to the 701265 (TEMP/HPV) and the 701280 (FREQ).
- Wave window trigger is not applicable when measuring temperature on the 701261 (UNIVERSAL) or 701262 (UNIVERSAL (AAF)).
- Wave window trigger cannot be used in Recorder mode.

Setting the Cycle Frequency, Reference Cycle, Synchronization Channel, Level, and Hysteresis

8. Use **jog shuttle+SELECT** to set Cycle Frequency. Pressing **RESET** resets the value to 50 Hz.
10. Likewise, set the Reference Cycle to 1, 2, or 4.
11. Likewise, set Sync. Ch to Auto or CH1 to CH16.
12. If you select a setting other than Auto in step 11, set the Level of the synchronization channel.
13. Likewise, set Hys to  ,  , or  .



Selecting the Target Waveform

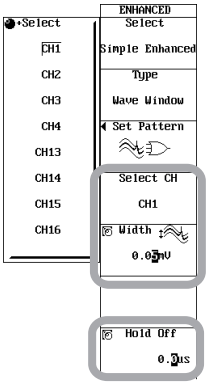
14. Press the **Select CH** soft key. The channel selection menu appears.
15. Use **jog shuttle+SELECT** to select the target channel.

Setting the Window Width

16. Press the **Width** soft key.
17. Turn the **jog shuttle** to set the window width.

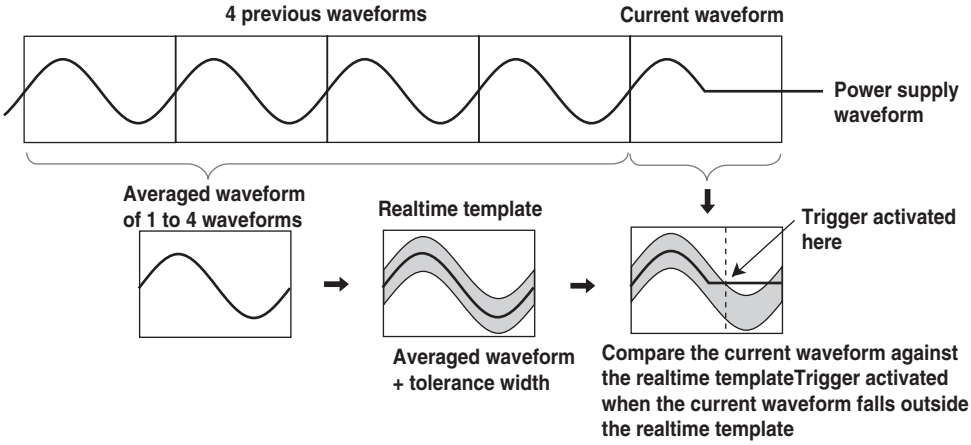
Setting the Hold Off

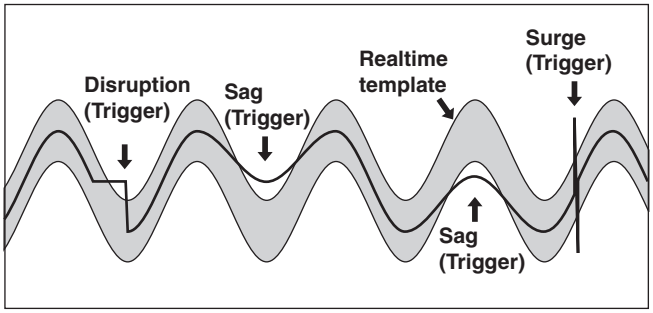
18. Set the hold off time according to the procedures given in section 6.4.



Explanation

This trigger is used to detect abnormalities in the power waveform (disruption, sag, surge, frequency fluctuation, voltage drop, etc.). A realtime template is created automatically using 1 to 4 waveforms before the current waveform, and comparison is made between the current waveform and the realtime template. A trigger occurs if the current waveform falls outside the realtime template.





Operating Conditions of the Wave Window Trigger

Target waveform: AC waveform or triangular waveform between 40 and 1 kHz. (Rectangular waveforms such as inverter waveforms and waveforms with a fast rising edge are excluded)
Sample rate: 10 kS/s to 500 kS/s
Acquisition mode: Normal
Trigger mode: Normal, Single, or Single(N)

Applicable Modules

- 701250 (HS10M12)
- 701251 (HS1M16)
- 701255 (NONISO_10M12)
- 701260 (HV(with RMS))
- 701261 (UNIVERSAL) (only when measuring voltage)
- 701262 (UNIVERSAL (AAF)) (only when measuring voltage)
- 701270 (STRAIN_NDIS)
- 701271 (STRAIN_DSUB)
- 701275 (ACCL/VOLT)

A trigger is activated if any of the specified trigger conditions (OR condition) is met.

Notes When Using the Wave Window Trigger

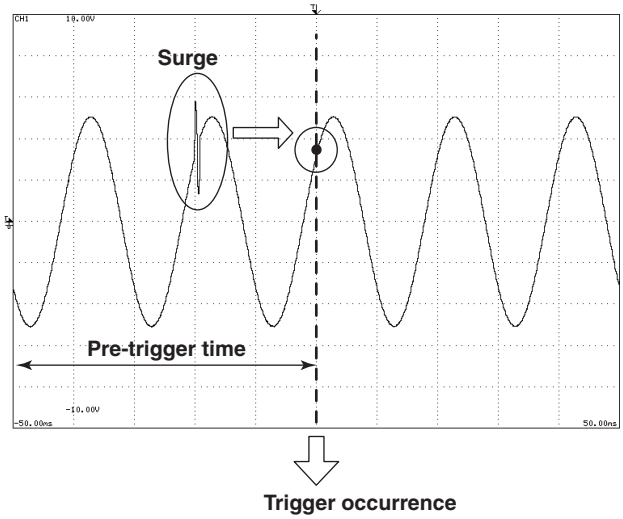
The wave window trigger cannot be used in the following cases:

- When the acquisition mode is set to Average or Envelope
- When the record time is less than or equal to 25 KW and T/div is less than 100 ms.

Normally, set the trigger mode to Normal, Single, or Single(N). Wave window triggers are not easily triggered when the trigger mode is set to Auto or Auto Level.

The wave window trigger is used to detect rapid changes in the waveform. If a difference is observed after comparing 1 to 4 cycles (reference cycles) of the previous waveform and the current waveform, a trigger is activated. Therefore, if an abnormal waveform such as surge is contained in the 1 to 4 cycles of the previous waveform immediately after waveform acquisition is started (during which measured data of size equal to the pretrigger section is acquired), a trigger is activated on the normal waveform. If this happens, the trigger point may appear as though it is delayed by several cycles as shown in the figure below. This phenomenon is unavoidable due to the principles of the wave window trigger.

Trigger appears as though it is delayed by 1 cycle.



The time difference from the abnormal waveform to the trigger point varies depending on the reference cycle as shown below. (When the frequency of the trigger is low the time difference will be 0 cycles in most cases.)

Reference Cycle	Time Difference
1 cycle	0 or 1 cycle
2 cycles	0, 1, or 2 cycles
4 cycles	0, 1, 2, 3, or 4 cycles

When using the wave window trigger, it is recommended that a pretrigger equal to the reference cycle be specified. This allows abnormal waveforms to be observed on the screen even when the above phenomenon occurs.

Trigger Condition (Set Pattern)

ON: Use the channel as a target channel for the wave window trigger.
OFF: Do not use the channel as a target channel for the wave window trigger.

Cycle Frequency

Set the frequency of the measured power supply in the range of 40 to 1000 Hz. The resolution is 1 Hz. The default value is 50 Hz.
If the actually frequency is within ±10% of the specified value, it is automatically tracked.

Reference Cycle

Select how many waveforms before the current waveform are used to create the realtime template (wave window).
1 (1 waveform), 2 (2 waveforms), or 4 (4 waveforms)
The waveforms of the specified number of reference cycles are used to create the realtime template.

Sync. Ch, Level, and Hys

Select the channel used to detect the waveform determination start point of the wave window trigger. Select the synchronization channel from Auto or CH1 to CH16.

If you select Auto, the synchronization channel is automatically set using the following conditions.
Target channel: Channel with the smallest channel number among the target channels of the wave window trigger.
Level: 1/2 the peak-to-peak value over 0.5 s after starting the waveform acquisition.
Hysteresis: Same as the hysteresis of an edge trigger (see section 6.5)
If you select a setting other than Auto, set the level and hysteresis of the synchronization channel.

Setting the Level

The selectable range of the level is the same as that of the simple trigger.

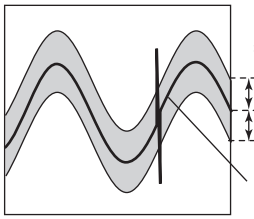
Setting the Hysteresis

Sets a width to the trigger level so that triggers are not activated by small changes in the trigger signal. Select the trigger hysteresis from  , , and .
See “Trigger Hysteresis” in section 6.5.

Window Width

The realtime template is created by applying a tolerance width (window width) to the averaged waveform. The selectable range of the window width varies depending on the measured item as follows:

When measuring voltage: (Voltage range)/1000 to voltage range
When measuring strain: 11 μSTR to (measurement range)×2
Or, 0.0005 mV/V to (measurement range)×2
When measuring acceleration: 0.01 Unit to (Unit/div)×10
(The resolution is the same as the resolution of the trigger level. See section 6.5.)



For example, if Width is set to 2 V, a window width of ±1 V is created with respect to the reference waveform.

Hold Off

See section 6.4.

Note

If a trigger waveform such as a surge is input immediately before the completion of the pre-trigger, the trigger point may be delayed by up to 4 cycles.

6.18 Setting the Action-on-Trigger

<For a description of this function, refer to page 2-26.>

Procedure

1. Press **MENU**.
2. Press the **TRIGGER** soft key.
3. Press the **ACTION** soft key.

Setting the Action

4. Press the **Mode** soft key. The Mode setup menu appears.
5. Press the **On Trigger** soft key.
6. Press the **Action** soft key. The Action setup menu appears.
7. Use **jog shuttle+SELECT** to select the action to be enabled. (You can select multiple actions.)
8. If you select Save to File in step 7, use the **jog shuttle+SELECT** to set the file save format to Binary, ASCII, or Float. If you select Send Mail, use **jog shuttle+SELECT** to set Mail Count.

Setting the Number of Actions

9. Press the **Sequence** soft key to select Single or Continue.
10. If you select Continue, turn the **jog shuttle** to set the number of actions. Pressing RESET resets the count to Infinite.

Setting the Execution Mode of the Action-on-Trigger at Power ON

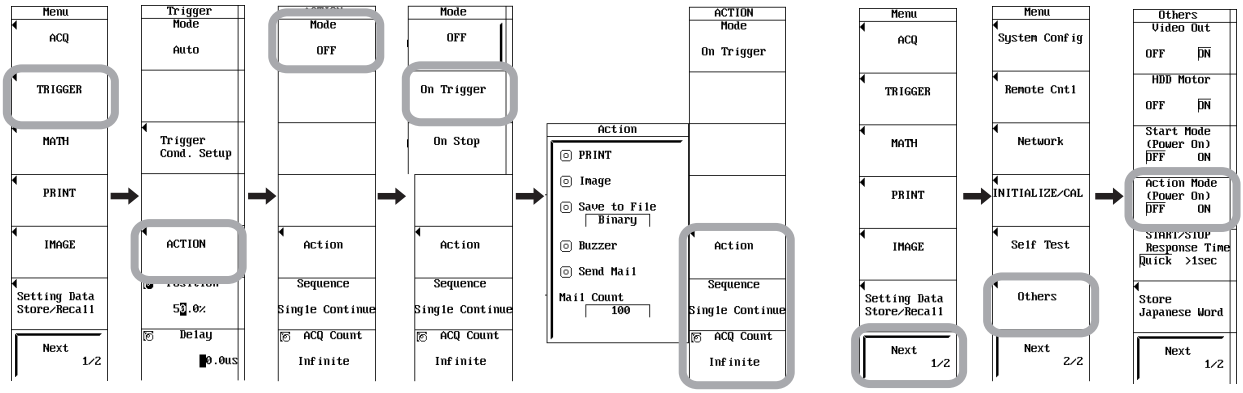
11. Press **MENU**.
12. Press the **Next 1/2** soft key.
13. Press the **Others** soft key.
14. Press the **Action Mode (Power ON)** soft key to select ON or OFF.

Executing Action-on-Trigger

15. Press **START/STOP**. Waveform acquisition is started, and action-on-trigger is executed. While action-on-trigger is in execution, ACT is displayed at the upper left of the screen. In addition, if the following action is specified, the following icon is displayed at the upper left of the screen while the action is being executed.

    Image/Save to File: Save destination medium (PC card, SCSI device, internal HD, network drive, or USB storage device)

    Send Mail: ✉≈



Aborting Action-on-Trigger

16. Press **START/STOP**. Waveform acquisition is stopped, and action-on-trigger is aborted.

Explanation

Mode

A specified action is executed each time a trigger is activated. When action-on-trigger is enabled, the trigger mode is set to Single.

Action

The following five types of actions are available.

Print the Screen Image Data (PRINT)

Prints the screen image on the printer (Printer (built-in printer), USB (USB printer), or Net Print (network printer)) specified by Print to in the PRINT menu.

Save the Screen Image Data (Image)

Saves the screen image data to the destination (PC card, internal HD (optional), SCSI device, or USB storage device) specified in the IMAGE SAVE menu.

Save Waveform Data (Save to File)

Saves the waveform data in binary, ASCII, or floating format to the destination (PC card, internal HD (optional), SCSI device, or USB storage device) specified in the FILE menu. The save format is synchronized to data type (see section 13.8) on the FILE menu.

Buzzer

Sounds a buzzer.

Send Mail

Sends an e-mail message to a specified address (when Ethernet interface option is installed). Set the number of mail transmissions in the range of 1 to 1000.
For the procedure to set the address, see section 15.5.

Note

If action-on-trigger is started, the data is acquired using single mode trigger regardless of the trigger mode setting, and the specified action is carried out.

Sequence and ACQ Count

Sequence

Single: Performs the action once.
Continue: Performs the action the number of times specified by ACQ Count.

ACQ Count

2 to 65536: Repeats the action the specified number of counts.
Infinite: Repeats the action until waveform acquisition is stopped.

PRINT, Image, and Save to File Operations

Operates according to the settings in the PRINT, IMAGE, and FILE menus.

File Name When Action Is Set to Image or Save to File

If the Auto Naming of the IMAGE menu or the FILE menu is OFF, numbers are automatically assigned to the file names. Otherwise, the file is saved using the specified method.
For details, see section 13.8 or 13.12.

Send Mail Operation

Sends e-mail messages to the address specified by pressing MENU and selecting Next 1/2 > Network > Mail Setup > Mail Address.

Setting the Execution Mode of the Action-on-Trigger at Power ON (Action Mode(Power On))

You can select whether to enable action-on-trigger at power-on. Turn this ON if you want to continue the action-on-trigger operation after a power failure.

ON: At power ON, the action-on-trigger is set to the mode that was used when the power was turned OFF.

OFF: Action Mode is turned OFF at power ON.

The default setting is OFF.

Notes When Using the Action-on-Trigger

- Action-on-trigger cannot be used if the acquisition mode is Average.
- You cannot change the settings while the action-on-trigger is in progress.
- The action-on-trigger operation may slow down if there is access from the network while the following action is in progress.
  Printing/saving of the screen image data and saving of the waveform data
- You cannot use action-on-trigger or action-on-stop when the realtime recording to the internal hard disk is ON.

Notes When Action Is Set to Image or Save to File

- Do not specify the root directory of the medium as the save destination directory. (Only up to 512 files can be saved to the root directory of a medium that has been formatted using the SL1400.)
- The maximum number of files that can be created in a single directory is 5000. Do not place files in the save destination folder before starting the action-on-trigger operation.
- If you select Image and Save to File simultaneously, separate the folders specified by the IMAGE menu and the FILE menu.
- If you select Numbering for the file name assignment method (Auto Naming) in the IMAGE menu and the FILE menu, the creation of files takes an extended period when the number of saved files becomes large. When creating more than 2000 files, select Date for Auto Naming.
- When 5000 files are saved, the action-on-trigger operation ends.

6.19 Activating Manual Triggers

<For a description of this function, refer to page 2-27.>

Procedure

1. Press **START/STOP**. The waveform acquisition starts.
2. Press **MANUAL TRIG** to manually activate the trigger.

Explanation

You can manually activate the trigger by pressing the MANUAL TRIG key on the front panel.

7.1 Starting/Stopping Waveform Acquisition

Procedure

Starting/Stopping Waveform Acquisition

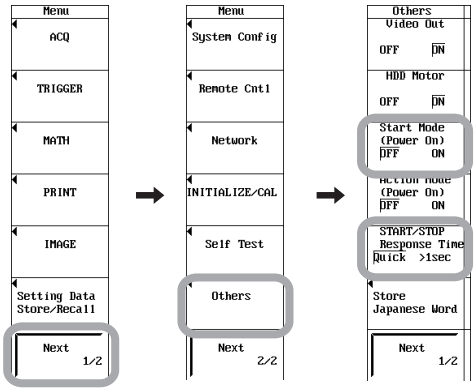
Press **START/STOP**. Waveform acquisition starts or stops.
Waveform acquisition is in progress when the RECORD indicator above the START/STOP key is illuminated.

Setting the Waveform Acquisition Mode at Power ON

1. Press **MENU**.
2. Press the **Next 1/2** soft key.
3. Press the **Others** soft key.
4. Press the **Start Mode(Power On)** soft key to select ON or OFF.

Setting the Start/Stop Response Time

5. Press the **START/STOP Response Time** soft key to select Quick or >1sec.



Explanation

Waveform Acquisition and Indicator Display

- Waveform acquisition is in progress when the RECORD indicator above the START/STOP key is illuminated. The word “Running” is displayed at the lower left of the screen.
- If the RECORD indicator above START/STOP is not illuminated, waveform acquisition is stopped. The word “Stopped” is displayed at the lower left of the screen.

Operation When the Acquisition Mode Is Set to Averaging Mode

- Averaging is stopped when waveform acquisition is stopped.
- Averaging starts again when waveform acquisition is restarted.

START/STOP Operation during Accumulation

- Accumulation is suspended when acquisition is stopped.
- It is resumed when waveform acquisition is restarted.

Conditions When Waveform Acquisition Cannot Be Started or Stopped

- When the SL1400 is being controlled remotely via communications.
- While printing is in progress or during auto setup.

Waveform Acquisition Mode at Power ON

You can select whether to start the waveform acquisition at power on. For example, select ON if you want to start the waveform acquisition when power supply recovers after a power failure. The default setting is OFF.

ON: Starts waveform acquisition at power on.

OFF: Does not start the waveform acquisition at power on.

Response Time of the START/STOP Key

You can set whether the SL1400 responds immediately when START/STOP is pressed or when the key is held down for at least 1 second.

Quick: Immediate response.

>1sec: Responds when the key is held down for at least 1 second.

Note

- If you start the waveform acquisition after changing the waveform acquisition conditions indicated below, the past data that is stored in the acquisition memory is cleared.
  - Setup conditions on the ACQ menu
  - Setup conditions of the module
  - Input coupling of the 701261 (UNIVERSAL), 701262 (UNIVERSAL (AAF)), or 701265 (TEMP/HPV) (when a change is made between TC and some other setting) and the thermocouple type setting (when measuring temperature)
  - Input coupling of the 701275 (ACCL/VOLT) (when a change is made between ACCL and some other setting) and the sensitivity setting (when measuring acceleration)
  - FV and offset settings of the 701280 (FREQ)
  - Trigger setup conditions
- A snapshot function that keeps the current displayed waveform on the screen is also available. You can update the display without stopping waveform acquisition (see section 8.7).
- For a description of the behavior when the Start Mode (Power On) is ON or OFF, see appendix 8.

7.2 Setting the Acquisition Mode

<For a description of this function, refer to page 2-28.>

Procedure

1. Press **MENU**.
2. Press the **ACQ** soft key.

Setting the Acquisition Mode

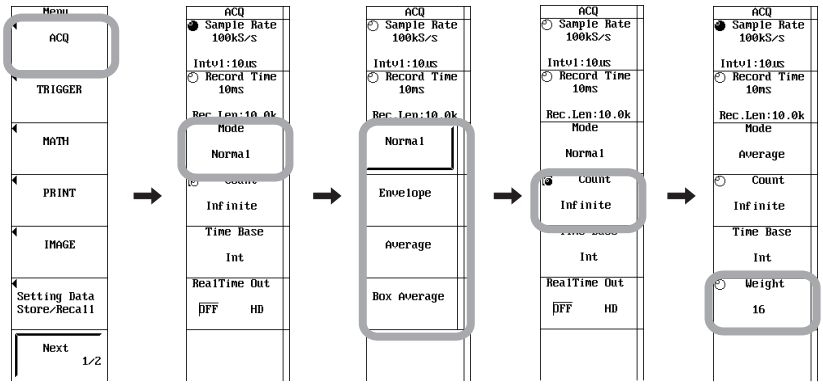
3. Press the **Mode** soft key.
4. Press the **Normal**, **Envelope**, **Average**, or **Box Average** soft key.
   You may not be able to select some modes depending on the trigger mode setting.

Setting the Acquisition Count

5. Press the **Count** soft key.
   You cannot set the acquisition count when the trigger mode is Single, Single (N), or Log.
6. Turn the **jog shuttle** to set the acquisition count. Pressing **RESET** resets the count to Infinite.
   If the acquisition mode is Average and you set Count to Infinite, proceed to step 7.

Setting the Attenuation (When the acquisition mode is Average and Count is Infinite)

7. Press the **Weight** soft key.
8. Turn the **jog shuttle** to set the attenuation.



Explanation

Acquisition Mode

The acquisition modes below are available. The default setting is Normal.

- **Normal Mode**
  Sampled data is stored in the acquisition memory without special processing.
- **Envelope Mode**
  The maximum and minimum values are determined every acquisition interval from the data sampled at 10 MS/s. The maximum and minimum values are stored to the acquisition memory and an envelope waveform is displayed.
- **Average Mode**
  Sampled data is averaged and stored to the acquisition memory. The averaging method varies depending on the acquisition count setting.
  If the acquisition count is set to Infinite, exponential averaging is performed. You are required to set the attenuation (Weight).
  If the acquisition count is set to a value in the range of 2 to 65536, simple averaging is performed. The specified value is the average count.

  • Exponential average (when set to Infinite)

  $$An = \frac{1}{N}\{(N-1)A_{n-1} + X_n\}$$

  An: n^{th} averaged value
  Xn: n^{th} measured value
  N : Attenuation (2 to 256, 2^n steps)

  • Simple average (when set to a value from 2 to 65536)

  $$A_N = \frac{\sum_{n=1}^{N} X_n}{N}$$

  Xn: n^{th} measured value
  N : Average count (acquisition count, 2^n steps)

  You cannot use averaging mode when the trigger mode is Single, Single (N), or Log. In addition, you cannot use averaging mode when realtime recording is in progress.
- **Box Average Mode**
  For details, see section 7.3.

Note

For the procedure to switch the acquisition mode in Chart Recorder mode, see section 9.2.

Acquisition Count

Set the values in the range indicated below. If you set the value to Infinite, acquisition will continue until you press START/STOP. The default value is Infinite. You cannot change the acquisition count during measurement. The new value is activated when the measurement is stopped.

Normal, Envelope, and Box Average: 2 to 65536 (in 1 step) and Infinite
Average: 2 to 65536 (in 2^n steps) and Infinite

Notes on Averaging

- Averaging is effective only for repetitive waveforms.
- Correct averaging is not possible if the waveform has imperfect triggering (incomplete synchronization). Thus, the displayed waveform will be distorted. When working with this type of signal, set the trigger mode to Normal, so that the waveform display is updated only when the trigger is activated (see section 6.1).
- Roll mode display is disabled during averaging.
- Averaging is not possible when the trigger mode is Single, Single (N), or Log.
- If you stop the waveform acquisition by pressing START/STOP, the averaging process also stops. Averaging restarts from the beginning when acquisition resumes.
- If you are using simple averaging, the SL1400 terminates acquisition automatically when the specified number of acquisitions (acquisition count) is completed.
- Averaging is not possible when realtime recording is in progress.
- When acquiring waveforms in averaging mode, the data that is retained in the history memory is 1 record.

7.3 Acquiring Data Using Box Average

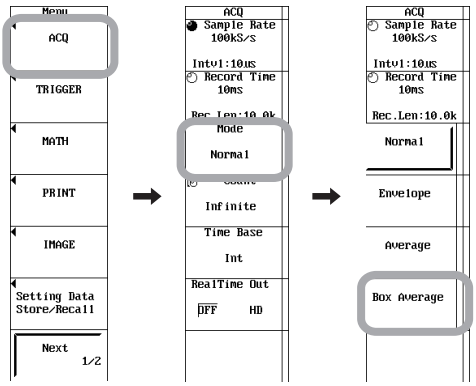
<For a description of this function, refer to page 2-29.>

Procedure

1. Press **MENU**.
2. Press the **ACQ** soft key.

Selecting Box Average Mode

3. Press the **Mode** soft key.
4. Press the **Box Average** soft key.

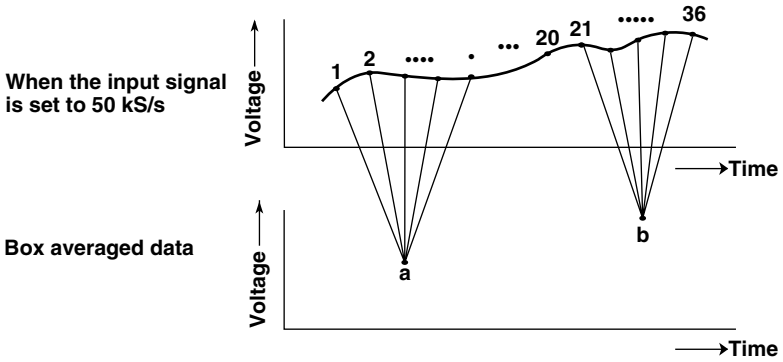


Explanation

This function is valid only on the 701250 (HS10M12) and 701255 (NONISO_10M12) input modules.

At sample rates that allow box averaging, data is normally sampled at 10 MS/s and the sampled data is decimated according to the record time and stored to the acquisition memory. The internal sample rate is the same as the envelope mode.

When you use the box averaging function, moving average is computed on a given number of data points (not simply decimating the sampled data), and the result is sampled and stored to the acquisition memory.



Number of Data Points on Which Moving Average Is Computed

Sample Rate (S/s)	Number of Data Points
10 M*	1 point
5 M	2 points
2 M	4 points out of 5 points
1 M	8 points out of 10 points
500 k	16 points out of 20 points
200 k	32 points out of 50 points
100 k	64 points out of 100 points
50 k	128 points out of 200 points
20 k	256 points out of 500 points
10 k or less	256 points out of (10 M ÷ sample rate)

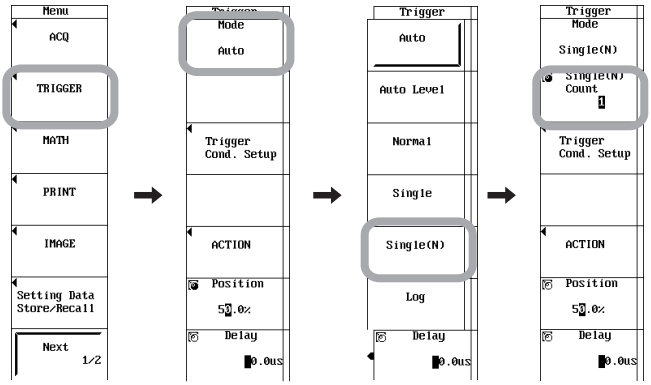
* Same operation as the normal mode.

7.4 Acquiring Data Using the Sequential Store Function (Single (N) Mode)

<For a description of this function, refer to page 2-29.>

Procedure

1. Press **MENU**.
2. Press the **TRIGGER** soft key.
3. Press the **Mode** soft key.
4. Press the **Single(N)** soft key to set the trigger mode to Single (N).
5. Press the **Single(N) Count** soft key.
6. Turn the **jog shuttle** to set Single(N) Count.



Explanation

You can use the sequential store function by setting the trigger mode to Single(N).

Acquisition Count (Single(N) Count)

Set a value between 1 and 2000.
However, the selectable acquisition count varies depending on the selected record length and acquisition mode. For details, see appendix 3.

Displaying Waveforms

You can recall waveforms from memory in the same fashion as with the history memory function. For details, see section 11.1.

Notes on When Using Sequential Store

If you stop the waveform acquisition by pressing START/STOP, sequential store also stops. Sequential store restarts from the beginning when acquisition resumes.

7.5 Realtime Recording to the Internal Hard Disk (Option)

<For a description of this function, refer to page 2-31.>

CAUTION

- If the power is cut off when realtime recording is in progress, a disk area that cannot be freed may result in the realtime recording area or damage may occur to the internal hard disk.
  If a disk area that cannot be freed results, the disk performance in the realtime area may deteriorate. Consequently, realtime recording may not operate properly. If this happens, back up the required data on the internal hard disk and format the internal hard disk.
- Do not apply shock to the SL1400 when realtime recording is in progress. Damage may occur to the internal hard disk, or the realtime recording may not operate properly.
- The Real Time drive is a working area on the SL1400 internal hard disk for realtime recording. Never delete files from the drive or add files to the drive from an external PC such as by using the FTP server function. If you do, the realtime recording may not operate properly.

Procedure

1. Press **MENU**.
2. Press the **ACQ** soft key.
3. Press the **RealTime Out** soft key to select HD.

Note

The RealTime Out menu does not appear if Time Base is set to Ext.

Setting the Realtime Recording

4. Press the **RealTime Out Setup** soft key. A setup dialog box opens.
5. Use the **jog shuttle+SELECT** to set Sequence to Single or Continue.
6. If you select Continue in step 5, use the **jog shuttle+SELECT** to set Count to a value in the range of 2 to 128.
7. Use **jog shuttle+SELECT** to select the auto naming method from OFF, Numbering, and Date.
8. As necessary, enter the File Name and Comment according to the procedures given in section 4.2.

Executing the Realtime Recording

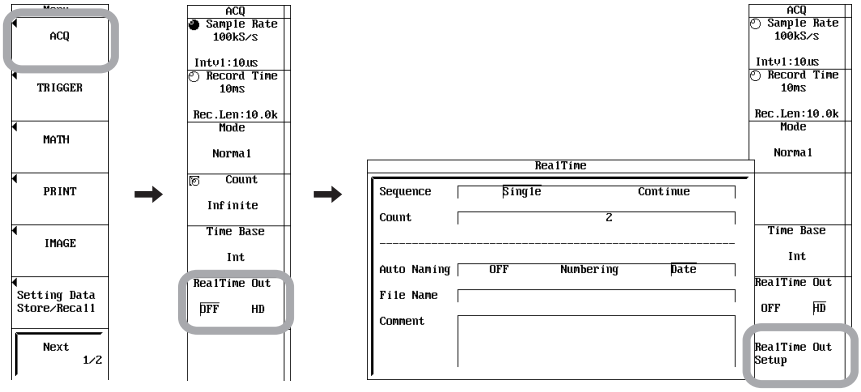
9. Press **START/STOP** to start the waveform acquisition. Realtime recording is executed.
   While realtime recording is executing,  is displayed in the upper left of the screen.

Aborting the Realtime Recording

10. Press **START/STOP** to stop the waveform acquisition. Realtime recording is aborted.

Note

If you stop the waveform acquisition by pressing START/STOP, realtime recording is aborted even if it is within the specified recording time.



Explanation

The data can be recorded in realtime to the internal hard disk (option).
The internal hard disk consists of the following drives.

RealTime: A drive for realtime recording. You can set the capacity of this drive in the range of 30% to 70% of the entire capacity of the internal hard disk (see section 13.6).

HD-0, HD-1:* A drive for saving various data.

* HD-0 only if the internal hard disk is partitioned to 2; HD-0 and HD-1 if the internal hard disk is partitioned to 3.

Waveforms That Are Realtime Recorded

All normal waveforms displayed on the screen are realtime recorded.

Possible Time Axis Range and Maximum Sample Rate for Realtime Recording

Varies depending on the number of channels that are to be realtime recorded as follows:

Number of Channels Used	Time Axis Range	Maximum Sample Rate
12 or more	200 s to 30 days	5 kS/s
6 to 11	1 min to 30 days	10 kS/s
4 or 5	30 s to 30 days	20 kS/s
3	20 s to 30 days	50 kS/s
1 or 2	10 s to 30 days	100 kS/s

Sequence/Count

Single: Acquisition is started by pressing START. When the specified record length is reached, acquisition stops.

Continue: Acquisition is started by pressing START. When the specified record length is reached, acquisition stops. This sequence is repeated the specified number of times (count).

Trigger Mode for Realtime Recording

If you select Single, Auto or Log trigger modes are available. If you select Continue, only Log is valid.

Auto: Acquisition is started by pressing START. If the specified record length is exceeded, old data is overwritten. Acquisition continues until you press STOP.

Log: Acquisition is started by pressing START. When the specified record length is reached, acquisition stops.

Auto Naming

File names are automatically created during realtime recording. You can also enter comments. The following three auto naming modes are available.

OFF

The file is assigned the name specified by File Name (up to 16 characters).

Numbering

Automatically creates files by attaching a four-digit number, 0000 to 4999, to the file name. You can specify a common name (up to 4 characters, specified through File Name) that is placed before the number.

Date

Automatically creates files using the date and time for the file names. (The file name specified by File Name is void.)

Selecting Date is convenient for file management, because the file names do not overlap.

Executing the Realtime Recording

Press START/STOP to start the realtime recording. If the trigger mode is set to Auto, acquisition continues until the next time you press START/STOP. If the trigger mode is set to Log, the operation stops after recording the specified time.

Aborting the Realtime Recording

If you stop the waveform acquisition by pressing START/STOP, realtime recording is aborted even if it is within the specified recording time.

Saving and Loading the Waveform Data That Has Been Realtime Recorded

See section 13.15.

Notes on Realtime Recording

- Realtime recording is not possible when the acquisition mode is set to Average.
- During realtime recording, only the executing/aborting of the realtime recording, zoom display setting, and protection function are valid.
- Cursor measurements and automated measurement of waveform parameters are suspended while realtime recording is in progress.
- History memory waveforms, loaded waveforms, and computed waveforms cannot be displayed while realtime recording is in progress.
- The following operations are possible on the data that is realtime recorded to the hard disk (history memory function cannot be used).
  - Cursor measurement and automated measurement of waveform parameters (up to 10 MW)
  - Zooming on the Waveform
  - Various computations
  - X-Y waveform display (uses compressed data)
  - Saving/Loading of waveform data
  - Printer output
- When realtime recording to the internal hard disk, do not connect a PC to the SCSI connector.
- Realtime recording is not possible when action-on-trigger is ON.
- Realtime recording is not possible if the record length is less than 1 MW.
- Key response slows down while realtime recording is in progress.

- The maximum number of files that can be created in the realtime recording area of the internal hard disk is 128. If the number of files reaches 128, delete unneeded files by operating the SL1400. You can also copy the files to an area outside the realtime recording area of the internal hard disk or to other storage media.
- If you specify a setting that exceeds the number of files that can be created in the realtime recording area (for example, if Sequence is set to Continue and Count is set to 30 when there are already 100 files in the realtime recording area), realtime recording is not possible. In addition, realtime recording is not possible if there is not enough free space in the realtime recording area.
- Zoom waveforms can be displayed using the ZOOM menu while realtime recording is in progress. However, there is a limitation on the number of display points that can be expanded depending on the record length.

Record Length	Number of Display Points That Can Expanded
1 MW to 10 MW	Record time in which the number of displayed points is 250 k or more
25 MW	Record time in which the number of displayed points is 500 k or more
50 MW	Record time in which the number of displayed points is 1 M or more

7.6 Setting the Action When Waveform Display Is Updated (Action-on-Stop)

<For a description of this function, refer to page 2-32.>

Procedure

1. Press **MENU**.
2. Press the **TRIGGER** soft key.
3. Press the **ACTION** soft key.

Setting the Action

4. Press the **Mode** soft key. The Mode setup menu appears.
5. Press the **On Stop** soft key.
6. Press the **Action** soft key. The Action setup menu appears.
7. Use **jog shuttle+SELECT** to select the action to be enabled. (You can select multiple actions.)
8. If you select Save to File in step 7, use the **jog shuttle+SELECT** to set the file save format to Binary, ASCII, or Float. If you select Send Mail, use **jog shuttle+SELECT** to set Mail Count.

Setting the Number of Actions

9. Press the **Sequence** soft key to select Single or Continue.
10. Press the **ACQ Count** soft key.
11. Turn the **jog shuttle** to set the number of actions. Pressing RESET resets the count to Infinite.

Setting the Execution Mode of the Action-on-Stop at Power ON

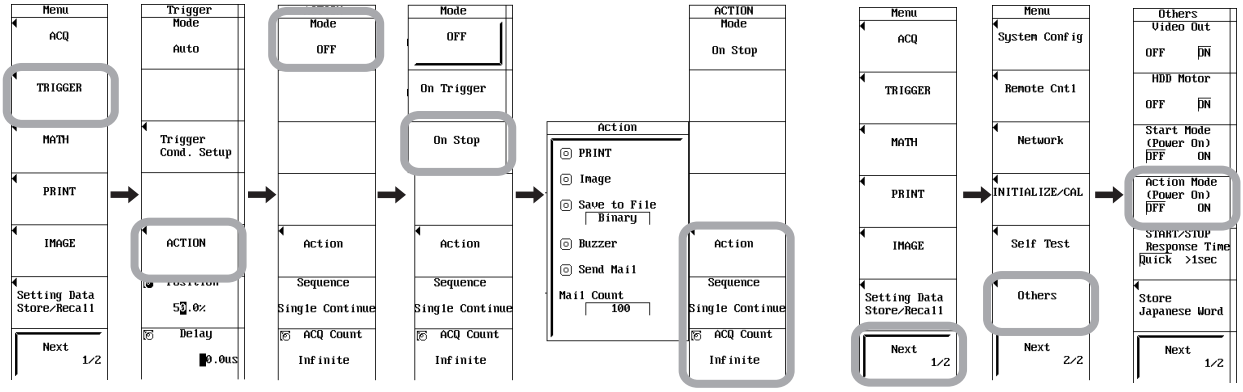
12. Press **MENU**.
13. Press the **Next 1/2** soft key.
14. Press the **Others** soft key.
15. Press the **Action Mode (Power ON)** soft key to select ON or OFF.

Executing Action-on-Stop

16. Press **START/STOP**. Waveform acquisition is started, and action-on-stop is executed. While action-on-stop is in execution,  is displayed in the upper left of the screen. In addition, if the following action is specified, the following icon is displayed at the upper left of the screen while the action is being executed.

    Image/Save to File: Save destination medium (PC card, SCSI device, internal HD, network drive, or USB storage device)

    Send Mail: ✉≈



Aborting Action-on-Stop

17. Press **START/STOP**. Waveform acquisition is stopped, and action-on-stop is aborted.

Explanation

Mode

The specified record length of data is acquired when measurement is started, and the waveform is displayed. Then, the specified action is executed. In addition, the specified action is also executed when measurement is stopped. When action-on-stop is enabled, the trigger mode is set to Log.

Action

The following five types of actions are available.

Print the Screen Image Data (PRINT)

Prints the screen image on the printer (Printer (built-in printer), USB (USB printer), or Net Print (network printer)) specified by Print to in the PRINT menu.

Save the Screen Image Data (Image)

Saves the screen image data to the destination (PC card, internal HD (optional), SCSI device, or USB storage device) specified in the IMAGE SAVE menu.

Save Waveform Data (Save to File)

Saves the waveform data in binary, ASCII, or floating format to the destination (PC card, internal HD (optional), SCSI device, or USB storage device) specified in the FILE menu. The save format is synchronized to data type (see section 13.8) on the FILE menu.

Buzzer

Sounds a buzzer.

Send Mail

Sends an e-mail message to a specified address (when Ethernet interface option is installed). Set the number of mail transmissions in the range of 1 to 1000.
For the procedure to set the address, see section 15.5.

Note

If action-on-stop is executed, the data is acquired in Log mode regardless of the trigger mode setting, and the specified action is carried out. The specified action is also carried out when the measurement is stopped in the middle of the measurement.

Sequence and ACQ Count

Sequence

Single: Performs the action once.
Continue: Performs the action the number of times specified by ACQ Count.

ACQ Count

2 to 65536: Repeats the action the specified number of counts.
Infinite: Repeats the action until waveform acquisition is stopped.

PRINT, Image, and Save to File Operations

Operates according to the settings in the PRINT, IMAGE, and FILE menus.

File Name When Action Is Set to Image or Save to File

If the Auto Naming of the IMAGE menu or the FILE menu is OFF, numbers are automatically assigned to the file names. Otherwise, the file is saved using the specified method.
For details, see section 13.8 or 13.12.

Send Mail Operation

Sends e-mail messages to the address specified by pressing MENU and selecting Next 1/2 > Network > Mail Setup > Mail Address.

Setting the Execution Mode of the Action-on-Stop at Power ON (Action Mode(Power On))

You can select whether to enable action-on-stop at power-on. Turn this ON if you want to continue the action-on-stop operation after a power failure.

ON: At power ON, the action-on-stop is set to the mode that was used when the power was turned OFF.

OFF: Action Mode is turned OFF at power ON.

The default setting is OFF.

Notes When Using the Action-on-Stop

- Action-on-stop cannot be used if the acquisition mode is Average.
- You cannot change the settings while the action-on-stop is in progress.
- The action-on-stop operation may slow down if there is access from the network while the following action is in progress.
  Printing/saving of the screen image data and saving of the waveform data
- You cannot use action-on-stop when the realtime recording to the internal hard disk is ON.

Notes When Action Is Set to Image or Save to File

- Do not specify the root directory of the medium as the save destination directory. (Only up to 512 files can be saved to the root directory of a medium that has been formatted using the SL1400.)
- The maximum number of files that can be created in a single directory is 5000. Do not place files in the save destination folder before starting the action-on-stop operation.
- If you select Image and Save to File simultaneously, separate the folders specified by the IMAGE menu and the FILE menu.
- If you select Numbering for the file name assignment method (Auto Naming) in the IMAGE menu and the FILE menu, the creation of files takes an extended period when the number of saved files becomes large. When creating more than 2000 files, select Date for Auto Naming.
- When 5000 files are saved, the action-on-stop operation ends.

7.7 Backing Up the Acquisition Memory

<For a description of this function, refer to page 2-32.>

The data held in the acquisition memory can be backed up immediately before the power is shut down even if the power supply is cut off due to reasons such as a sudden power failure.

Data That Is Backed Up

- Waveform data
- History memory data

Backup Batteries

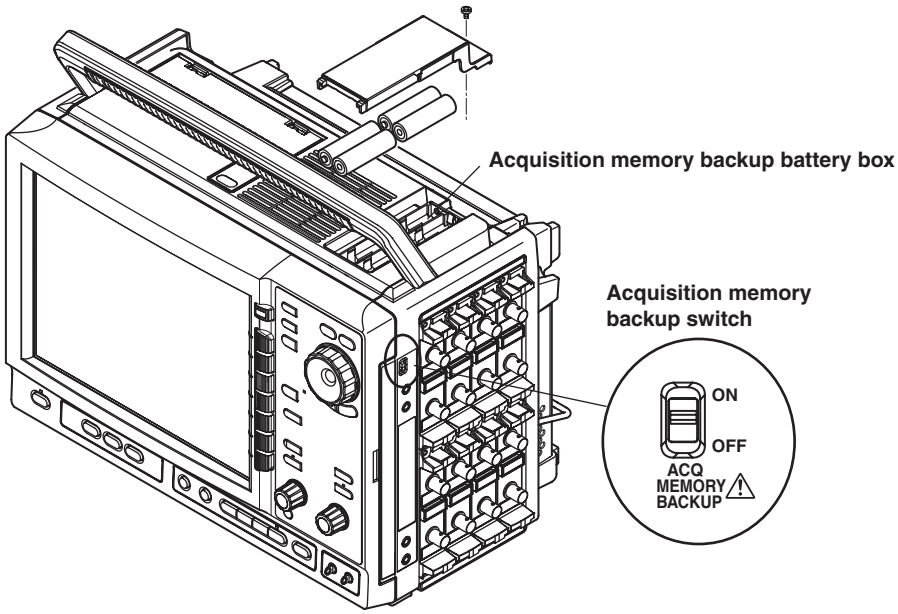
Types of Batteries That Can Be Used

- AAA alkaline dry cells (AA/R6) (JIS, IEC model: LR6): 4 cells
- Nickel hydride rechargeable batteries: 4 cells

Loading the Batteries

The battery storage box is located on the right side of the top panel.

1. Lift the handle and remove the screws from the battery storage box using a screwdriver.
2. Remove the storage box cover, and insert four batteries while paying attention to their direction.
3. Set the storage box cover back to the original place and fasten the screws.



Backup Procedure

1. Turn ON the ACQ MEMORY BACKUP switch on the right side panel of the SL1400. The acquisition memory backup starts.
2. To stop the acquisition memory backup, turn OFF the ACQ MEMORY BACKUP switch.

The time needed to back up the acquisition memory varies depending on the operating environment. See section 18.5.

Note

- When using the nickel hydride rechargeable batteries, be sure to charge them before use. (The SL1400 does not have a charge function.)
- You cannot check the battery level on the SL1400. Use a commercially sold battery level checker or the like.
- For a description of the backup operation, see appendix 8.

8.1 Changing the Display Format

<For a description of this function, refer to page 2-32.>

Procedure

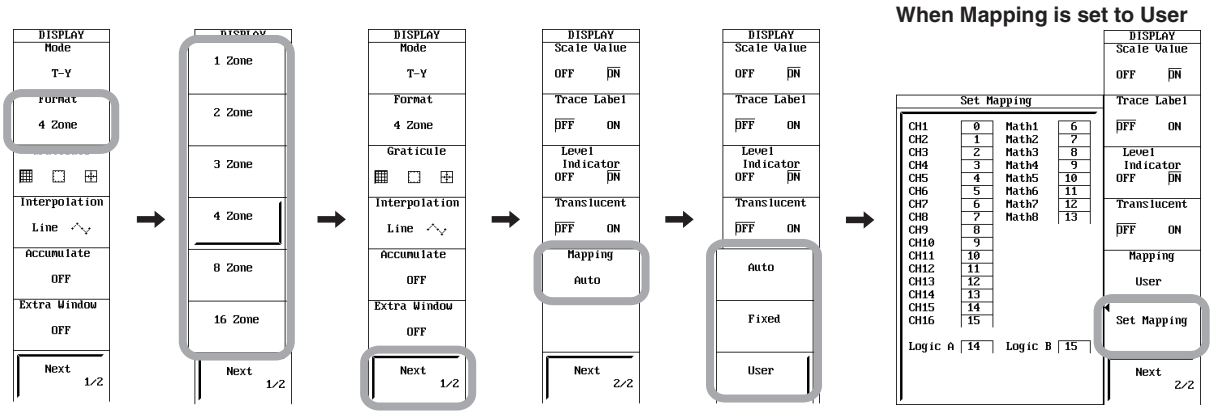
1. Press **DISPLAY**.

Setting the Display Format

2. Press the **Format** soft key.
3. Press one of the soft key from **1 Zone** to **16 Zone** to select the format.

Setting the Waveform Mapping

4. Press the **Next 1/2** soft key.
5. Press the **Mapping** soft key to select Auto, Fixed, or User. If you select User, proceed to step 6.
6. Press the **Set Mapping** soft key. The waveform mapping setup menu appears.
7. Use **jog shuttle+SELECT** to set the mapping number of each channel.



Explanation

You can select the number of zones into which the analog waveform display window is divided. The position of the waveform of each channel varies depending on the display format.

Display Format

1 Zone 2 Zone
3 Zone 4 Zone
8 Zone 16 Zone

Waveform Mapping

- **Auto**
  Zones are arranged from top to bottom in order: CH1, CH2, ... , CH16, Math1 to Math8. But no zones are shown for channels whose display is set to OFF.
- **Fixed**
  Channels are that are set to OFF are also mapped.
- **User**
  Assign numbers from 0 to 7 to CH1, CH2, ... , CH16, Math1 to Math8. The display position varies depending on the assigned number.

Mapping Example When Display Format Is 2 Zone

Fixed (When CH6 to CH16 = OFF) **Auto (When CH3, CH5 to CH16 = OFF)** **User (When CH3, CH5 to CH16 = OFF)**

The number of points that can be displayed in the waveform display area varies depending on the display format as shown below. The vertical resolution remains unchanged.

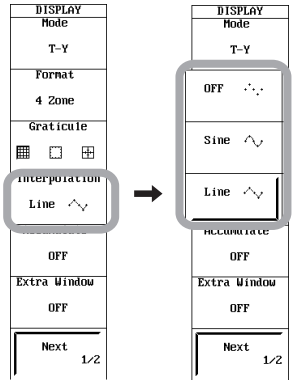
1 Zone (□): 512 points 2 Zone (▤): 256 points
3 Zone (▤): 170 points 4 Zone (▤): 128 points
8 Zone (▤): 64 points 16 Zone (▤): 32 points

8.2 Setting the Display Interpolation Method

<For a description of this function, refer to page 2-33.>

Procedure

1. Press **DISPLAY**.
2. Press the **Interpolation** soft key. The interpolation selection menu appears.
3. Press one of the soft keys from **OFF**, **Sine**, or **Line**.
   If the display mode is X-Y or T-Y&X-Y, press the Next 1/2 soft key to display the Interpolation menu.



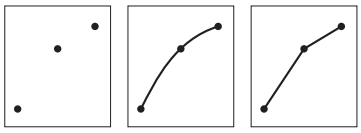
Explanation

Interpolation

Any area along the time axis having less than 1000 points in 10 divisions (less than 500 points in the Z1 and Z2 window when displaying Main&Z1&Z2) is recognized as an interpolation area. If you leave interpolation off, these points will appear as discrete dots (so that the display will show gaps between dots or vertical lines).
If you set interpolation on, the SL1400 will connect the points. Three following interpolation methods are available.

Sine ( ): Interpolates between two points using the sin(x)/x function.
Line ( ): Linearly interpolates between two points.
OFF ( ): No interpolation.

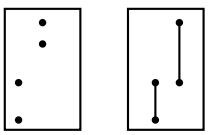
- **When the Area Is an Interpolation Area**



Interpolate: OFF Sine Line

- **When the Area Is Not an Interpolation Area**

  If interpolation is set to Sine or Line, the instrument draws lines between points that are aligned vertically. If the number of data points is greater than or equal to 2002, P-P compression is performed (maximum and minimum values are determined at certain intervals), and two points are displayed on a single vertical line (1 raster).



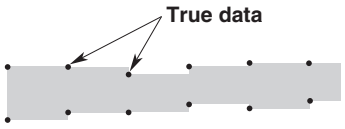
Interpolate: OFF Sine/Line

Number of Data Points Used for Waveform Display

When the area is not an interpolation area on the T-Y waveform display and Interpolation is set to Sine or Line, the aforementioned P-P compressed values are displayed. However, if Interpolation is set to OFF or if X-Y waveforms are being displayed, the acquisition data is decimated, and data that has been picked up at certain intervals are displayed. The number of data points used to display the waveform is 100 k.
If the record length is greater than or equal to 100 kW, the data is decimated to 100 kW, and 100 points are displayed on a vertical line. Otherwise, all points are displayed.
If the number of data points per division is greater than or equal to 100 for a realtime recorded waveform or when in roll mode, the maximum and minimum values at certain number of data points of acquisition data are displayed using linear interpolation.

Data Interpolation and Envelope Mode

When the acquisition mode is envelope, the data is interpolated using an area regardless of the specified interpolation method (see the following figure). This is because in envelope mode the maximum and minimum values are determined over a certain interval, and the data time position cannot be pinpointed.

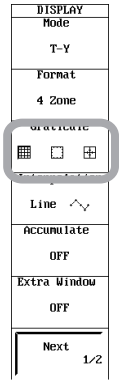


8.3 Changing the Graticule

<For a description of this function, refer to page 2-33.>

Procedure

1. Press **DISPLAY**.
2. Press the **Graticule** soft key to select the graticule.
   If the display mode is X-Y or T-Y&X-Y, press the Next 1/2 soft key to display the Graticule menu.

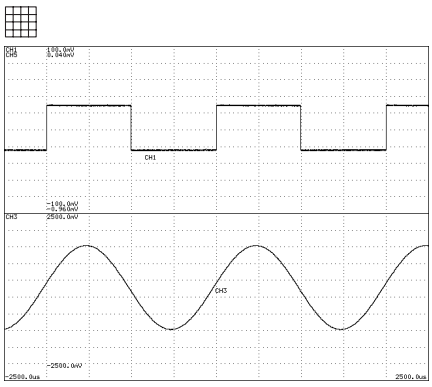


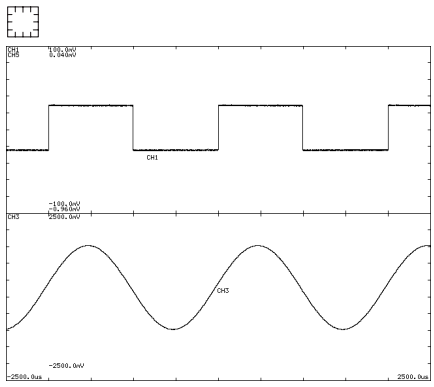
Note

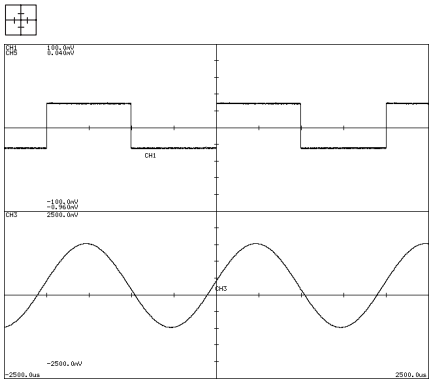
The graticule setting is linked to the RECORD COND menu > Print Setup > Graticule Type setting. However, if ⬚ is selected, OFF is selected in the RECORD COND menu.

Explanation

Select the graticule from the following three types.







8.4 Accumulated Waveform Display

<For a description of this function, refer to page 2-33.>

Procedure

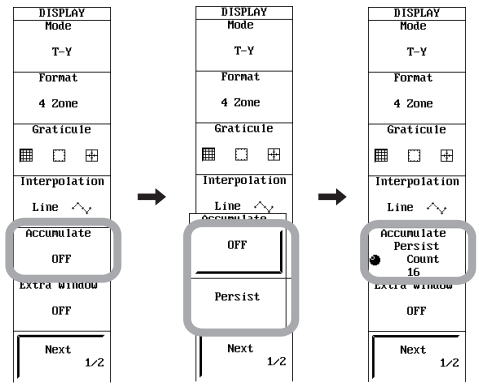
1. Press **DISPLAY**.

Setting the Accumulate Mode

2. Press the **Accumulate** soft key. The accumulate mode selection menu appears.
3. Press the **OFF** or **Persist** soft key to select the accumulate mode.
   If you select Persist, proceed to step 4.

Setting the Accumulate Time

4. Turn the **jog shuttle** to set the Count in the range of 2 to 128 (2^n steps).



Explanation

Normally, the display is updated every time a trigger is activated making it difficult to capture transient conditions such as sudden distortion of waveforms. By using the accumulate function, the waveform display of the acquired data remains on the screen for the specified time.

Accumulate Mode

Persist: Persistence mode. Waveforms are accumulated in red. Waveforms are displayed for the specified time period by gradually lowering the brightness.

Accumulate Time (Count)

When using persistence mode, set the number of times to accumulate the waveforms in the range of 2 to 128 (in 2^n steps). If you select Infinite, the accumulation is carried out infinitely. The default value is 16.

Notes on Accumulation

- Automated measurement of waveform parameters is performed on the most recent waveform.
- When printing accumulated waveforms using the built-in printer, they are printed using two tones.
- If the waveform acquisition is forcibly stopped by pressing START/STOP, the accumulation is temporarily suspended. When the acquisition is restarted, the display is cleared and accumulation continues.
- You cannot change the parameters on the HISTORY menu when accumulating waveforms on the display.
- Accumulated display is not possible in roll mode display.
- When you turn OFF the accumulate mode, accumulated waveforms are cleared. To display the acquired waveforms again, specify the record number on the HISTORY menu.
- If you display the waveforms again by setting the accumulate mode to Persist, the accumulated waveforms are not cleared. To clear them, execute clear trace.
- Even if you change the display format during accumulated display, the waveforms that are already displayed accumulated are not cleared. To clear them, execute clear trace.

Clearing Accumulated Waveforms

You can clear accumulated waveforms by pressing CLEAR TRACE.

8.5 Zooming and Auto Scrolling the Waveform

<For a description of this function, refer to page 2-34.>

Procedure

1. Press **ZOOM**.

Zooming on the Waveform

Selecting the Display Mode

2. Press the **Mode** soft key. The display mode selection menu appears.
3. Press the soft key corresponding to the desired mode.
   If you select Main, you cannot carry out the following operations.

Selecting the Display Format of Zoomed Waveforms

4. Press the **Format** soft key. The format selection menu appears.
   If you set Mode to Main in step 3, the format selection menu is not displayed.
5. Press the soft key corresponding to the desired format.

Setting the Waveform to Be Zoomed

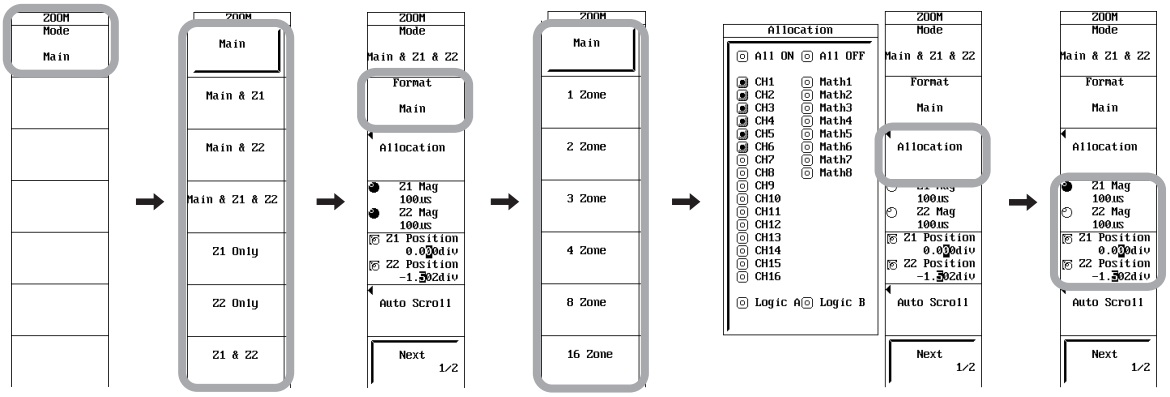
6. Press the **Allocation** soft key. The menu for setting the waveform to be zoomed appears.
7. Use **jog shuttle+SELECT** to select the waveform to be zoomed.
   Select All ON to select all waveforms that are currently displayed.

Setting the Zoom Rate

8. Press the **Z1 Mag/Z2 Mag** soft key to set the jog shuttle control to Z1 Mag.
   If you set Mode to Z1, Z1 Mag is displayed. If you select Z2, Z2 Mag is displayed. If you select Z1 and Z2, the Z1 Mag and Z2 Mag menu is displayed.
9. Turn the **jog shuttle** to set the zoom ratio of the Z1 zoom box.
10. Likewise, set the zoom rate of the Z2 zoom box with Z2 Mag.
    By setting the jog shuttle control to both Z1 Mag and Z2 Mag, the zoom rate of both Z1 and Z2 can be set simultaneously.

Setting the Zoom Position

11. Press the **Z1 Position/Z2 Position** soft key to set the jog shuttle control to Z1 Position.
    If you set Mode to Z1, Z1 Position is displayed. If you select Z2, Z2 Position is displayed. If you select Z1 and Z2, the Z1 Position and Z2 Position menu is displayed.
12. Turn the **jog shuttle** to set the zoom position of the Z1 zoom box.
13. Likewise, set the zoom position of the Z2 zoom box with Z2 Position.
    By setting the jog shuttle control to both Z1 Position and Z2 Position, the zoom positions of both Z1 and Z2 can be moved simultaneously.



When Mode Is Set to Main&Z1, Main&Z2, Z1 Only, and Z2 Only in Step 3

Change the Range of the Automated Measurement of Waveform Parameters

14. Press the **Next 1/2** soft key.
15. Press the **Fit Meas Range to Z1** or **Fit Meas Range to Z2** soft key.
    The range of the automated measurement of waveform parameters is set to the zoom range of Z1 or Z2.

Moving the Zoom Box to the Most Recent Position of the Waveform

16. Press the **Move Z1 to Front** or **Move Z2 to Front** soft key.
    The zoom box moves to the most recent position of the waveform.

When Mode Is Set to Main&Z1&Z2 or Z1&Z2 in Step 3

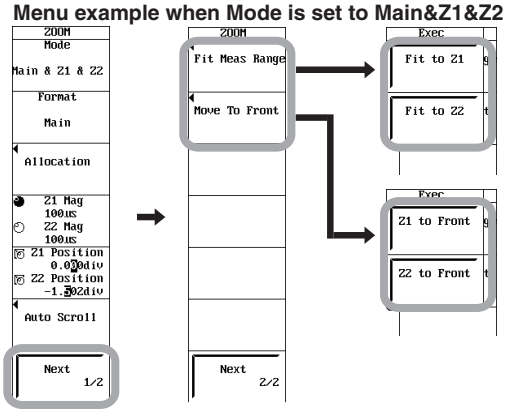
Change the Range of the Automated Measurement of Waveform Parameters

14. Press the **Next 1/2** soft key.
15. Press the **Fit Meas Range** soft key.
16. Press the **Fit to Z1** or **Fit to Z2** soft key.
    The range of the automated measurement of waveform parameters is set to the zoom range of Z1 or Z2.

Moving the Zoom Box to the Most Recent Position of the Waveform

17. Press the **Move to Front** soft key.
18. Press the **Z1 to Front** or **Z2 to Front** soft key.
    The zoom box moves to the most recent position of the waveform.

Menu example when Mode is set to Main&Z1&Z2 or Z1&Z2



Auto Scroll

8. Press the **Auto Scroll** soft key.

Selecting the Scroll Direction

9. Press the **Direction** soft key to set the scroll direction.

Setting the Display Position of the Search Result Window

(When Mode Is Set to Main&Z1&Z2 or Z1&Z2 in Step 3)

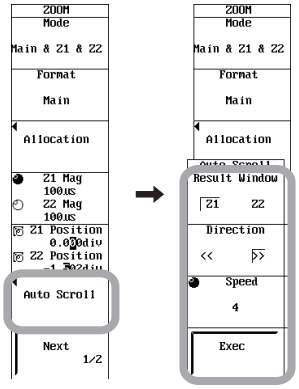
10. Press the **Result Window** soft key to select Z1 or Z2.

Setting the Scroll Speed

11. Press the **Speed** soft key and turn the **jog shuttle** to set the scroll speed in the range of 1 to 10.

Executing the Scroll Operation

12. Press the **Exec** soft key. The zoom box automatically moves, and the zoom position changes. While the scroll operation is in progress, the **Exec** soft key changes to the **Abort** soft key. Press the **Abort soft** key to abort the scroll operation.



Explanation

Zooming on the Waveform

Zoomed waveforms of two locations can be displayed simultaneously (dual zoom). You can also specify which channels to zoom. Zooming is not possible if the number of displayed points on the screen is less than or equal to 10 (less than or equal to 50 for FFT waveforms).

Display Mode of Zoomed Waveforms

Main: Displays only the main (unzoomed) waveform.
Z1 Only: Displays only the zoomed waveform of zoom box Z1.
Z2 Only: Displays only the zoomed waveform of zoom box Z2.
Main&Z1: Displays the main waveform in the top window and zoomed waveform of zoom box Z1 in the bottom window.
Main&Z2: Displays the main waveform in the top window and zoomed waveform of zoom box Z2 in the bottom window.
Z1&Z2: Displays the zoomed waveform of zoom box Z1 in the top window and the zoomed waveform of zoom box Z2 in the bottom window.
Main&Z1&Z2: Displays the main waveform in the top window, the zoomed waveform of zoom box Z1 in the lower left window and the zoomed waveform of zoom box Z2 in the lower right window.

Zoomed Trace (Allocation)

The traces whose Allocation is turned ON are zoomed. If the allocation is OFF, the trace is not zoomed. You cannot allocate channels whose display is turned OFF.

Display Format of Zoomed Waveforms

As with the normal waveform, six display formats (Main*, 1 Zone, 2 Zone, 3 Zone, 4 Zone, 8 Zone, and 16 Zone) are available. You cannot set different formats for Z1 and Z2.

* Selecting Main results in the same format as Main Format in the DISPLAY menu.

Zoom Rate (Z1 Mag/Z2 Mag)

- Sets the record time that is displayed in the zoom box.
- If the time base is set to an external clock signal, select the magnification from the following:
  ×2, ×2.5, ×5, ×10, ×25, ×50, ×100, ×250, ×500, ×1000, ×2500..., ten-fold multiples of1, 2.5, 5, up to ×1000000
- The maximum zoom rate varies depending on the display record length.
  Maximum zoom rate: Display record length ÷ 10
- The maximum magnification during realtime recording with respect to the record length of the main waveform is as follows:

Main Waveform Record Length	Record Length of the Zoom Window
1 M or 10 MW	250 kW
25 MW	500 kW
50 MW	1 MW
1000 MW or more	2.5 MW

- For details on the record length, see appendix 1.
- You can set different zoom rates for Z1 and Z2 (zoomed waveform of two locations).

Zoom Position (Z1Position and Z2Position)

- The zoom position can be set by specifying the zoom center position (center of the zoom box) in the range of –5 to +5 divisions with the center of the waveform display area set to 0 division. The resolution is as follows:
  Selectable steps of zoom position: Record time × 10 ÷ display record length
- The zoom box enclosed by solid lines is Z1, and the one enclosed by dashed lines is Z2. Since each box is independent, you can set the position separately.

Changing the Range of the Automated Measurement of Waveform Parameters (Fit Meas Range to Z1/Fit Meas Range to Z2)

Set the range of the automated measurement of waveform parameters to the zoom range of Z1 or Z2. This setting is effective even when the automated measurement of waveform parameters is turned OFF.

Moving the Zoom Box to the Most Recent Position of the Waveform (Z1 to Front/Z2 to Front)

Moves the zoom box of Z1 or Z2 to the most recent position (right end) of the main waveform.

Auto Scroll

The zoom box automatically moves (scrolls) in the specified direction. You can scroll while viewing the expanded waveform.

Scroll Direction

Set the scroll direction to << (left) or >> (right).

Display Position of the Search Result Window

When the zoom mode is Main&Z1&Z2 or Z1&Z2, you can select the window, Z1 or Z2, that will display the searched waveform.

Scroll Speed

Set the scroll speed using 10 levels from 1 to 10. The speed increases as the number gets larger.

Note

- Auto scroll is not possible while the data acquisition is in progress.
- You can only change the Direction and Speed while auto scroll is in progress.

8.6 Displaying X-Y Waveforms

<For a description of this function, refer to page 2-35.>

Procedure

1. Press **DISPLAY**.

Selecting the Display Mode

2. Press the **Mode** soft key. The mode selection menu appears.
3. Press one of the soft keys from **T-Y**, **X-Y**, and **T-Y&X-Y** to set the mode.

Selecting the X Axis Mode (When Mode Is Set to X-Y or T-Y&X-Y)

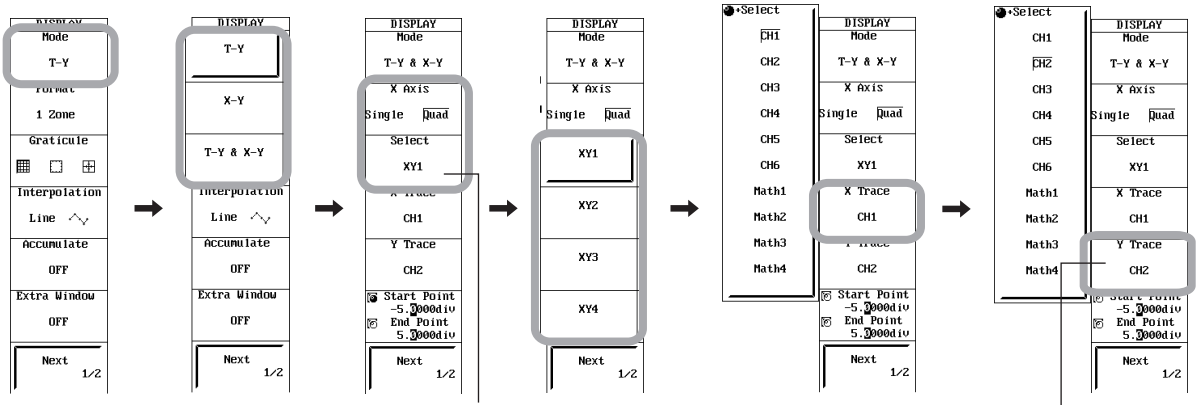
4. Press the **X Axis** soft key to select Single or Quad.
   If you select Single proceed to step 7; if you select Quad proceed to step 5.
5. Press the **Select** soft key. The X-Y waveform selection menu appears.
6. Press the soft key corresponding to the desired X-Y waveform from **XY1** to **XY4**.

Setting the X-Axis

7. Press the **X Trace** soft key. The channel selection menu appears.
8. Use **jog shuttle+SELECT** to set the channel to assign to the X-axis. If you set X Axis to Quad, proceed to step 10.

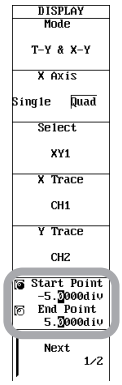
Setting the Y-Axis (When X Axis Is Set to Quad)

9. As with the X axis, press the **Y Trace** soft key to set the Y axis.



Setting the Display Range

10. Press the **Start Point/End Point** soft key to set the jog shuttle control to Start Point.
11. Turn the **jog shuttle** to set the start point of the X-Y waveform display.
12. Likewise, press the **Start Point/End Point** soft key to set the jog shuttle control to End Point and set the end point of the X-Y waveform display.



Explanation

X-Axis Mode

Single: The X-axis is set to a common trace, and the Y-axis displays all the waveforms whose display is turned ON.

Quad: The X-axis trace and Y-axis trace are set individually for XY1 to XY4.

Assigning X (Horizontal) and Y (Vertical) Axes (When X Axis Is Set to Quad)

The channels that are assigned to the X and Y axes depending on the X-axis mode are as follows:

X-Axis Mode	X-Y Waveform	X-Axis	Y-Axis
Single		CH1 to CH16 and Math1 to Math8	All channels that are turned ON
Quad	XY1	CH1 to CH8, Math1 to Math4	CH1 to CH8, Math1 to Math4
	XY2	CH1 to CH8, Math1 to Math4	CH9 to CH16, Math5 to Math8
	XY3	CH9 to CH16, Math5 to Math8	CH1 to CH8, Math1 to Math4
	XY4	CH9 to CH16, Math5 to Math8	CH9 to CH16, Math5 to Math8

Number of X-Y Waveforms That Can Be Displayed

The number of X-Y waveforms that can be displayed is 16 for Single and 4 for Quad. The display of each X-Y waveform is turned ON/OFF by turning the Y-axis trace display ON/OFF.

Display Mode

You can select from the following three display modes.

T-Y&X-Y: The top window displays T-Y (normal) waveforms. The bottom window displays X-Y waveforms.

X-Y: Displays only X-Y waveforms.

T-Y: Displays only T-Y waveforms.

Number of Data Points to Be Used for Waveform Display

Same as “Number of Data Points to Be Used for Waveform Display” described in section 8.2.
See section 8.2.

X-Y Waveform Display Range (Start Point/End Point)

The X-Y display shows the range selected on the T-Y waveform.
You can set the start (fine dashed line) and end (coarse dashed line) positions in the range of –5 to +5 divisions from the center of the waveform display frame. The start and end points are not displayed if only X-Y waveforms are displayed.
The resolution is as follows:
Resolution: Record time ÷ record length

Notes on Displaying X-Y Waveforms

- The divided windows of the T-Y waveform display when using the T-Y & X-Y mode are displayed according to Format in the DISPLAY menu.
- The zoom function applies only to T-Y waveforms. In addition, Main, Z1, or Z2 can be selected for the T-Y waveform.
- To expand the X-Y waveform, change Upper and Lower settings or V Zoom of each channel. The displayed waveform can be expanded/reduced.
- To change the display position of the X-Y waveform, change the position of each channel. (For voltage input)
- X-Y waveform is not displayed when the horizontal axis of a waveform trace is in units of time and the horizontal axis of another waveform trace is in units of frequency.
- Logic waveforms are not applicable to X-Y waveform display.

8.7 Taking Snapshots and Clearing Traces

<For a description of this function, refer to page 2-35.>

Procedure

Snapshot

Press **SNAPSHOT** to take a snapshot of the screen.

Clear Trace

Press **CLEAR TRACE** while the waveform acquisition is stopped. The waveform is cleared.

Explanation

Snapshot

The snapshot function leaves the current displayed waveform on the screen. This function allows the current displayed waveform to remain temporarily on the screen (snapshot waveform) without requiring waveform acquisition to stop. It is useful when you want to compare waveforms.

You cannot perform the following operations on snapshot waveforms.

- Cursor measurements and automated measurement of waveform parameters
- Zoom and computation
- Position movement
- X-Y waveform display

You can save and load snapshot waveforms. See section 13.10.

Clear Trace

Clears all the waveforms that are currently displayed on the screen. However, this does not apply in X-Y Recorder mode (see section 9.1).
Loaded waveforms are also cleared.
When you restart the waveform acquisition, the waveforms in the acquisition memory are cleared.

Note

The data corresponding to the waveforms that have been cleared by executing clear trace remains in the history memory. You can display the waveform again by selecting the desired waveform record using Select Record on the HISTORY menu.

Conditions When SNAP SHOT and CLEAR TRACE Cannot Be Used

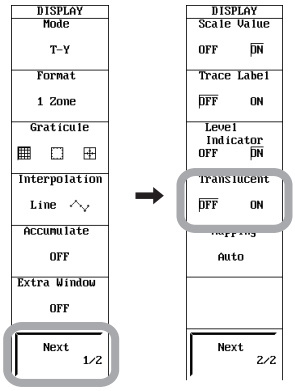
- When engaging remote mode using the communication interface.
- When printing
- During auto setup

8.8 Turning ON/OFF the Translucent Display

<For a description of this function, refer to page 2-35.>

Procedure

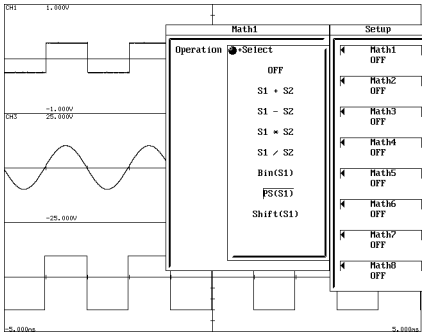
1. Press **DISPLAY**.
2. Press the **Next1/2** soft key.
3. Press the **Translucent** soft key to select ON or OFF.



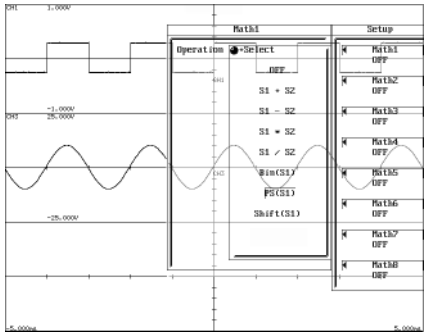
Explanation

When this is turned to ON, the popup menu becomes translucent. The contents underneath the popup menu can be seen.

Translucent: OFF



Translucent: ON

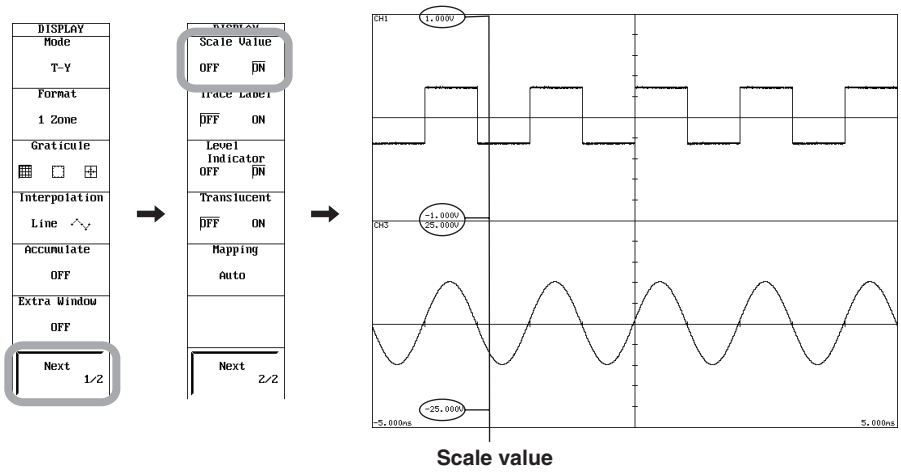


8.9 Turning the Scale Value Display ON/OFF

<For a description of this function, refer to page 2-36.>

Procedure

1. Press **DISPLAY**.
2. Press the **Next 1/2** soft key.
3. Press the **Scale Value** soft key to select ON or OFF.



Explanation

You can turn ON/OFF the upper and lower limits of the vertical and horizontal axes of each channel and the scale value display corresponding to the upper and lower limits.

Note

The scale values are displayed to the left of the waveform display area. If the scale values do not fit in the section left of the waveform display area, they are displayed on the right side of the waveform display area.

8.10 Setting Waveform Labels

<For a description of this function, refer to page 2-36.>

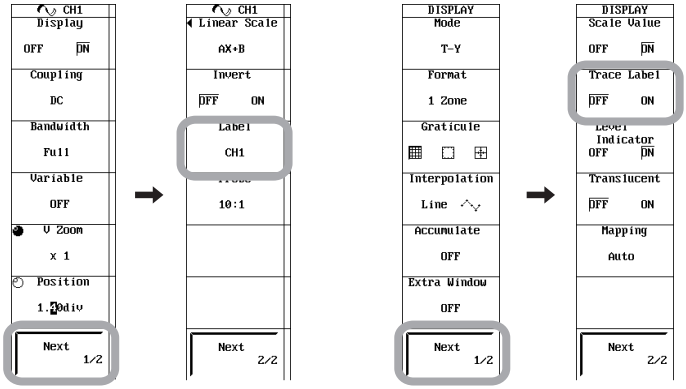
Procedure

Setting the Waveform Label

1. Press **CH**.
2. Press one of the soft keys from **CH1** to **CH16**, **Logic A**, and **Logic B**.
   For the displayed menus when this operation is executed, see section 5.1.
3. Press the **Next 1/2** soft key.
4. Press the **Label** soft key to display a keyboard, and enter the waveform label according to the procedure given in section 4.2.

Turning the Waveform Labels ON/OFF

5. Press **DISPLAY**.
6. Press the **Next 1/2** soft key.
7. Press the **Trace Label** soft key to select ON or OFF.



Explanation

Waveform Label

- You can arbitrary set the waveform label of each channel using up to eight characters.
- The labels are applied to waveform labels, scale values, and cursor measurement values. However, only the first 5 characters are displayed when displaying the cursor measurement values.
- In Recorder mode, a function called “Channel Label” is available for printing the waveform label specified here. See section 9.3.

Turning ON/OFF the Waveform Labels (Trace Label)

You can select whether to display labels corresponding to the displayed waveforms.

Note

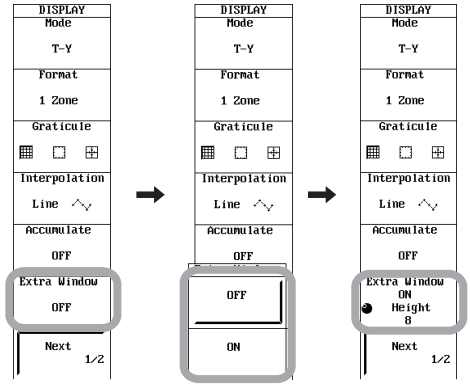
If the waveform display area is small due to the display format setting or zoom format, waveform labels may not be displayed.

8.11 Turning the Extra Window ON/OFF

<For a description of this function, refer to page 2-36.>

Procedure

1. Press **DISPLAY**.
2. Press the **Extra Window** soft key. The extra window selection menu appears.
3. Press the **ON** or **OFF** soft key.
4. If you select ON, use the jog shuttle to set the height of the extra window in the range of 0 to 8.
   If the display mode is X-Y or T-Y&X-Y, press the Next 1/2 soft key to display the Extra Window menu.

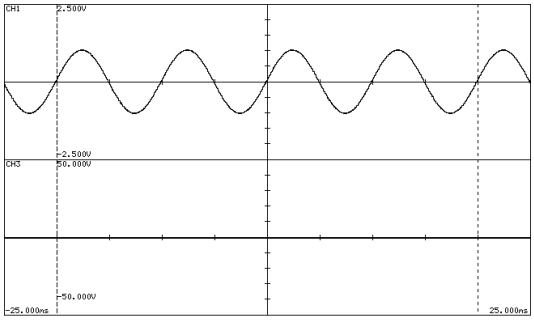


Explanation

An extra window is provided to display information other than waveforms when waveforms obscure the information in the display area. The following two types of information can be displayed in the extra window.

- Cursor measurement values
- Automated measured value of waveform parameters

Example of Cursor Measurement Values



X1	-20.000ms	Y1(CH1)	0.072V
X2	20.000ms	Y2(CH1)	0.068V
ΔX	40.000ms	ΔY	-0.003V
1/ΔX	25.00000Hz		

Extra window
(Displays cursor measurement values)

Number of Points Displayed Vertically When Extra Window Is ON

When the extra window is turned ON, the vertical axis size of the waveform display window is reduced according to the Height setting. The vertical resolution does not change, but the number of displayed points varies as follows.

Height setting = 8:	384 points	Height setting = 7:	400 points
Height setting = 6:	416 points	Height setting = 5:	432 points
Height setting = 4:	448 points	Height setting = 3:	464 points
Height setting = 2:	480 points	Height setting = 1:	496 points
Height setting = 0:	512 points		

(When display format is set to Single)

Note

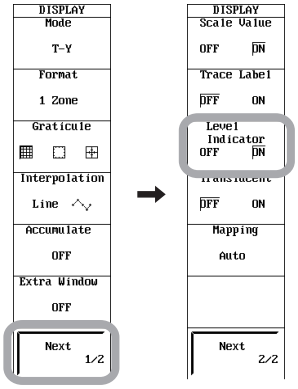
Use of the extra window together with certain zoom formats may cause scale values to overlap making them difficult to be read.

8.12 Turning the Level Indicator Display ON/OFF

<For a description of this function, refer to page 2-36.>

Procedure

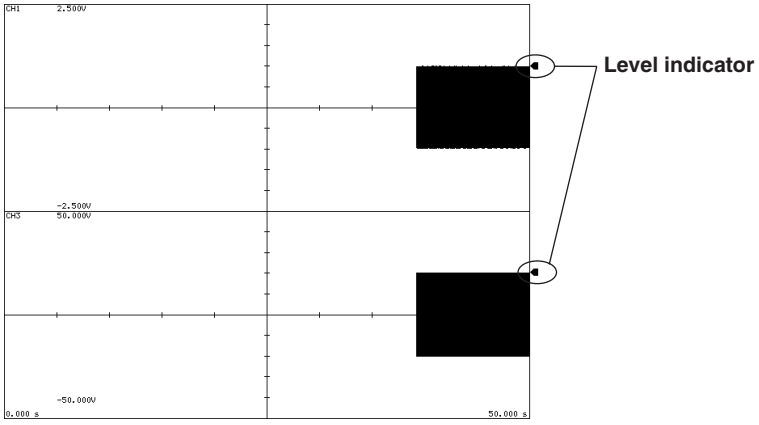
1. Press **DISPLAY**.
2. Press the **Next 1/2** soft key.
3. Press the **Level Indicator** soft key to select ON or OFF.



Explanation

Level Indicator

The level of each waveform is displayed using an indicator to the right of the waveform display area.



8.13 Displaying Channel Information/Displaying Waveforms on a Full Screen (Expanding the Waveform Display Area)

<For a description of this function, refer to page 2-36.>

Procedure

Displaying the Channel Information

1. Press **ESC** while the setup menu is displayed. The setup menu displayed on the right side of the screen disappears, and the key information about the channel (CH1 to CH16) whose display is turned ON is displayed.

Displaying the Numeric Monitor

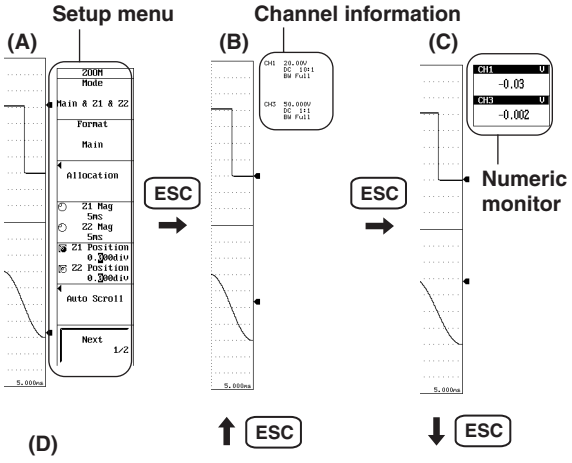
2. Press **ESC** on the screen showing the channel information. The channel information disappears, and the numeric monitor of the channels (CH1 to CH16, Logic A, and Logic B) whose display is turned ON is displayed.

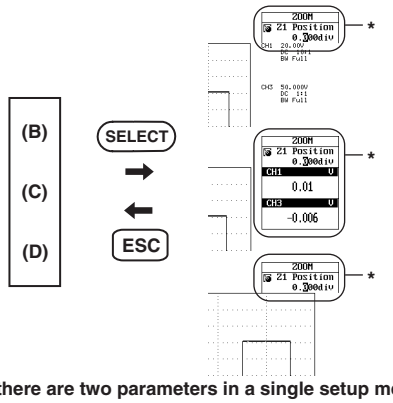
Expanding the Waveform Display Area

3. Press **ESC** on the screen showing the numeric monitor. The numeric monitor disappears, and the waveform display area is expanded horizontally.
   If you press **ESC** again, the channel information is displayed.

Displaying the Parameter That Was Controlled by the Jog Shuttle Immediately Before Pressing the ESC Key

4. Press **SELECT** in step 1, 2, or 3. If there is a parameter under jog shuttle control in the setup menu that was cleared immediately before you pressed the ESC key, the parameter is displayed at the upper right of the screen and can be set using the jog shuttle.
5. Press **ESC** to clear the parameter display.





* If there are two parameters in a single setup menu such as the Z1 Position and Z2 Position settings of the zoom rate (see section 8.5), the parameter controlled by the jog shuttle switches each time you press SELECT.
The jog shuttle icon (or) is usually white, but it sometimes turns yellow. Yellow indicates that two parameters are selected simultaneously (controlled by the jog shuttle).
Taking Z1 Position and Z2 Position as an example, pressing SELECT once selects Z1 Position. Pressing SELECT again selects Z2 Position. Pressing SELECT once more turns the icon yellow and Z1 Position and Z2 Position are controlled by the jog shuttle. If you press SELECT yet again, the icon returns to a white color, and the jog shuttle controls only Z1 Position.

Note

- Each time you press the ESC key, the display switches cyclically as follows: channel information display → numeric monitor display → full screen display of waveforms full → channel information display.
- When the SL1400 receives communication commands, the screen switches to channel information display.

Explanation

Displaying the Channel Information

Pressing ESC once when the setup menu is displayed clears the channel information of the channel (CH1 to CH16) whose display is turned ON. The parameters displayed in the channel information are as follows: However, not all parameters may be displayed when the number of displayed channels increases.

- When measuring voltage: Voltage range setting, input coupling, probe attenuation (type), and bandwidth limit.
- When measuring temperature: Temperature setting, thermocouple type, and bandwidth limit.
- When measuring strain: μSTR (or [mV/V]) setting, measurement range, and bandwidth limit
- When measuring acceleration:* Acceleration setting, gain, input coupling, and bias setting.
- When measuring the frequency:* Value/div setting, measurement mode setting, and preset setting.

* Some parameters may not be displayed depending on the amount of information present.

Displaying the Numeric Monitor

The channel information clears when you press ESC once when the channel information is displayed, and the numeric monitor of the channels (CH1 to CH16, Logic A, and Logic B) whose display is turned ON is displayed. The update interval of the numeric monitor is approximately 1 s.

Note

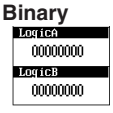
Notation of the Numeric Monitor of Logic Waveforms

The numeric monitor of logic waveforms (Logic A or Logic B) is displayed in binary or hexadecimal notation.

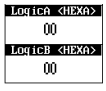
Select the notation by carrying out the following procedure.

Press CURSOR > Type soft key > Vertical soft key, press the Logic Setup soft key that appears when Trace is set to All, LogicA, LogicB, or LogicA & LogicB, and set Format to Binary or Hexa. See section 11.4.

• **Binary**



• **Hexadecimal**



Expanding the Waveform Display Area

Pressing the ESC key once when the numeric monitor is displayed clears the numeric monitor and expands the waveform display area horizontally to cover the entire screen. The waveform display area is expanded at power up.

Displaying the Parameter That Was Controlled by the Jog Shuttle Immediately Before Pressing the ESC Key

If the channel information is displayed or the waveform display area is expanded and there is a parameter under jog shuttle control in the setup menu* that was cleared immediately before you pressed the ESC key, the parameter is displayed at the upper right of the screen and can be set using the jog shuttle. To clear the display of the parameter, press the ESC key.

* ZOOM, CURSOR, MEASURE, and HISTORY menus as well as the X-Y mode menu under DISPLAY

9.1 Selecting the Recorder Mode

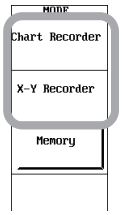
<For a description of this function, refer to page 2-37.>

Procedure

Note

If you change the recorder mode by carrying out the procedure in this section, the acquired waveform data is cleared. Be sure to save data that you need before changing the recorder mode. For the procedure to save the data, see chapter 13.

1. Press **MODE** to display the mode selection menu.
2. Press the **Chart Recorder** or **X-Y Recorder** soft key.
   If you change the recorder mode to a different mode, the acquired waveform data is cleared. Be sure to save data that you need before changing the recorder mode. For the procedure to save the data, see chapter 13.



Then, configure the respective recorder mode.

If Chart Recorder Is Selected

Continue with the procedures described in sections 9.2 to 9.5.

If X-Y Recorder Is Selected

Continue with the procedures described in section 9.6.

Explanation

Recorder Mode

You must select the recorder mode to record in recorder mode. There are two recorder modes, Chart Recorder and X-Y Recorder.

Functions That Cannot Be Used in Chart Recorder Mode

The following functions (keys) cannot be used during recorder mode.

- Waveform acquisition conditions (MENU key > ACQ menu)
- History memory (History key)
- Waveform computation (MENU key > MATH menu)
- Display mode (DISPLAY key > Mode menu)

Functions That Cannot Be Used during X-Y Recorder Mode

The following functions (keys) cannot be used during recorder mode.

- Waveform acquisition conditions (MENU key > ACQ menu)
- History memory function (History key)
- Waveform computation (MENU key > MATH menu)
- Trigger (MENU key > Trigger menu)
- Display (DISPLAY key)
- Zoom (ZOOM key)

SL1400 Settings in Chart Recorder Mode

If you select Chart Recorder mode, the SL1400 settings change as follows:

Menu	Soft key	Setting
ACQ	Record Length	Fixed to 2.5 MW
	Mode	Envelope*
	Time Base	Int
	RealTime Out	OFF
DISPLAY	Accumulate	OFF
	Mode	T-Y
MATH	Mode	OFF
MEASURE	Mode	Statistics and History Statistics set to OFF

* The acquisition mode can be changed to Normal. For details, see section 9.2.

If the recorder mode is switched from Memory to Chart Recorder mode back to Memory, Items under MENU key > ACQ menu and the record time setting return to the settings that existed before switching to Chart Recorder mode.

SL1400 Settings in X-Y Recorder Mode

If you select X-Y Recorder mode, the SL1400 settings change as follows:

Menu	Soft key	Setting
ACQ	Record Length	Fixed to 1 MW
Trigger	Mode	Auto

If the recorder mode is switched from Memory to X-Y Recorder mode back to Memory, Items under MENU key > ACQ menu and the trigger mode setting return to the settings that existed before switching to X-Y Recorder mode.

9.2 Setting the Record Conditions of T-Y Waveform Recording

<For a description of this function, refer to page 2-37.>

Procedure

Before carrying out the procedure below, select Chart Recorder mode according to the procedures in section 9.1.

Selecting the Chart Speed

1. Press **CHART SPEED**.
2. Turn the **jog shuttle** to select the chart speed.

Setting the Record Conditions

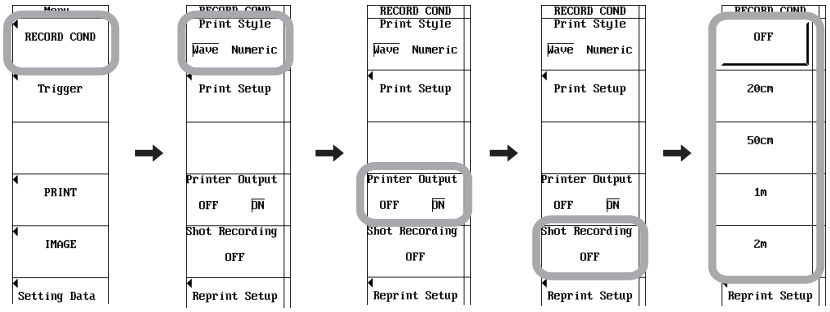
1. Press **MENU**.
2. Press the **RECORD COND** soft key.
3. Press the **Print Style** soft key to select Wave.

Enabling/Disabling T-Y Recording to the Built-in Printer

4. Press the **Printer Output** soft key to select ON or OFF.

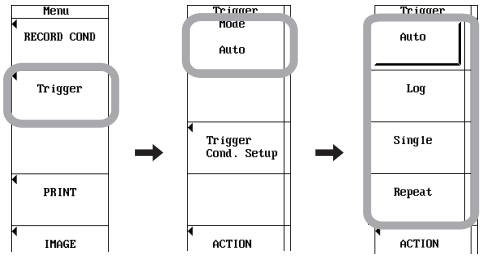
Setting the Shot Recording

5. Press the **Shot Recording** soft key. A menu used to select the length of the shot recording is displayed.
6. Press the soft key corresponding to the desired length of the short recording.



Setting the Trigger Mode

1. Press **MENU**.
2. Press the **Trigger** soft key.
3. Press the **Mode** soft key.
4. Press the soft key corresponding to the desired mode to select the trigger mode.

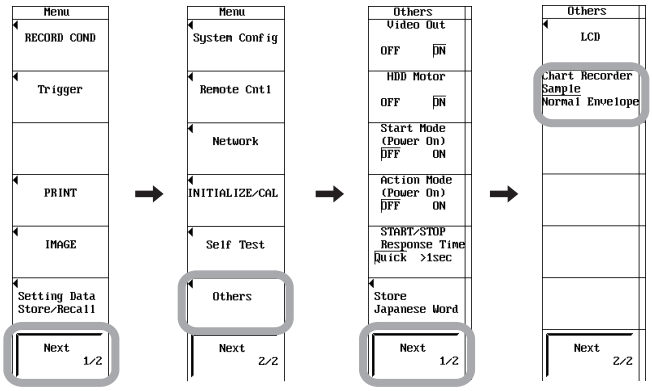


For a description of other trigger condition settings, see chapter 6.

Setting the Acquisition Mode

By default, the acquisition mode in Chart Recorder mode is set to envelope. If you want to select the acquisition mode between normal and envelope, carry out the steps below.

1. Press **MENU**.
2. Press the **Next 1/2** soft key.
3. Press the **Others** soft key.
4. Press the **Next 1/2** soft key.
5. Press the **Chart Recorder Sample** soft key to select the acquisition mode.



Explanation

Chart Speed

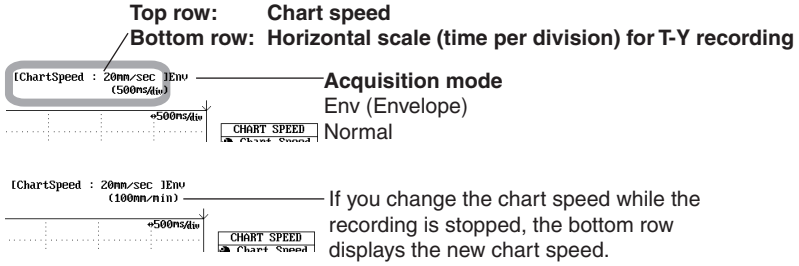
You can select the chart speed from below.
10 mm/h, 20 mm/h, 25 mm/h, 50 mm/h, 100 mm/h, 1 mm/min, 2 mm/min, 5 mm/min, 10 mm/min, 20 mm/min, 25 mm/min, 50 mm/min, 100 mm/min, 1 mm/s, 2 mm/s, 5 mm/s, 10 mm/s, or 20 mm/s

You can change the chart speed even while the recording is in progress. However, the waveform acquired in the internal memory up to that point is cleared.

Display Position of the Chart Speed and Acquisition Mode

The specified chart speed and acquisition mode are displayed at the upper right of the screen.

- While the recording is in progress, the horizontal scale (time per division) for T-Y waveform recording is displayed below the chart speed (bottom row).
- If you change the chart speed when the recording is stopped, the bottom row displays the new chart speed. The new chart speed takes effect the next time you start the recording.



T-Y Recording to the Built-in Printer (Printer Output)

Set whether to carry out T-Y recording to the built-in printer. If set to ON, the waveform is recorded on the built-in printer and acquired to the internal memory. If set to OFF, the waveform is acquired only to the internal memory and not recorded on the built-in printer.

Shot Recording

When the specified length of waveform is recorded, the waveform acquisition and recording stop.
You can select the length of the shot recording from OFF (no shot recording), 20 cm, 50 cm, 1 m, and 2 m.

Trigger Mode

In Chart Recorder mode, you can select the trigger mode from Auto, Log, Single, or Repeat. For details on the trigger mode in Chart Recorder mode, see page 2-37.

Auto

Starts recording to the built-in printer simultaneously with the start of the waveform acquisition. Recording continues until the waveform acquisition is stopped.

Log

Starts recording to the built-in printer simultaneously with the start of the waveform acquisition. Waveform acquisition and recording stop when the maximum number of divisions (see page 2-39) of the waveform data that can be saved is recorded.

Single

Starts recording when the trigger conditions are met after starting the waveform acquisition. Waveform acquisition and recording stop when the maximum number of divisions (see page 2-39) of the waveform data that can be saved is recorded.

Repeat

Starts recording when the trigger conditions are met after starting the waveform acquisition. Recording stops when the shot record length of waveform data is recorded. Then, the SL1400 enters the trigger-wait state. This operation is repeated until the waveform acquisition is stopped.

Acquisition Mode

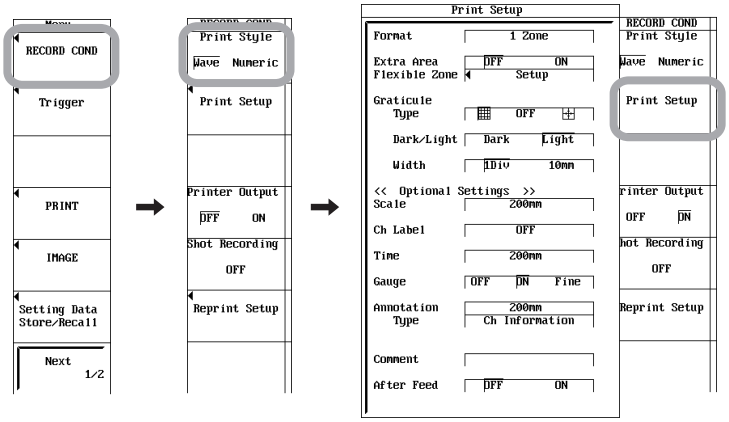
By default, the acquisition mode in Chart Recorder mode is set to envelope. You can select the acquisition mode from normal and envelope. The operation of envelope and normal modes is the same as that when recorder mode is disabled. For details, see page 2-28.

9.3 Setting the Recording Format of T-Y Waveform Recording

Procedure

Before carrying out the procedure below, select Chart Recorder mode according to the procedures in section 9.1.
The settings specified here are not applied to the print settings of the A4 print in Memory Mode (see page 12-3). However, if you turn OFF the power switch in Recorder Mode, the settings immediately before the power is turned OFF is stored (see section 3.4). Therefore, when the power switch is turned ON the next time, the settings in Recorder Mode that existed immediately before the power was turned OFF are also applied to the print settings in Memory Mode.

1. Press **MENU**.
2. Press the **RECORD COND** soft key.
3. Press the **Print Style** soft key to select Wave.
4. Press the **Print Setup** soft key. The print setup dialog box opens.



Selecting the Display (Recording) Format

5. Use **jog shuttle+SELECT** to select the format.

Setting the Extra Area

6. Use **jog shuttle+SELECT** to turn the extra area ON or OFF.

Setting the Flexible Zone

7. Use **jog shuttle+SELECT** to select Setup in Flexible Zone. The flexible zone setup dialog box appears.
8. Use **jog shuttle+SELECT** to turn the mode ON or OFF.
9. Use **jog shuttle+SELECT** to set Upper and Lower of the waveform to be recorded.
10. Press **ESC**.

Setting the Graticule

Selecting the Grid

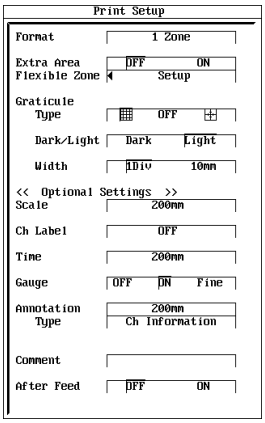
11. Use **jog shuttle+SELECT** to select the type.

Setting Dark/Light

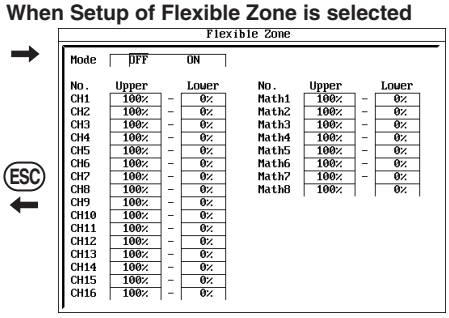
12. Use **jog shuttle+SELECT** to select dark or light.

Selecting the Width of the Vertical Scale

13. Use **jog shuttle+SELECT** to select the width.



When Setup of Flexible Zone is selected



Setting the Details

Setting the Print Interval of Scale Values

14. Use **jog shuttle+SELECT** to select the print interval of the scale.

Setting the Print Interval of Channel Label

15. Use **jog shuttle+SELECT** to select the print interval of the channel label (Ch Label).

Setting the Print Interval of the Time

16. Use **jog shuttle+SELECT** to select print interval of the time.

Selecting the Gauge Printing

17. Use **jog shuttle+SELECT** to select the print interval of the gauge.

Setting the Annotation

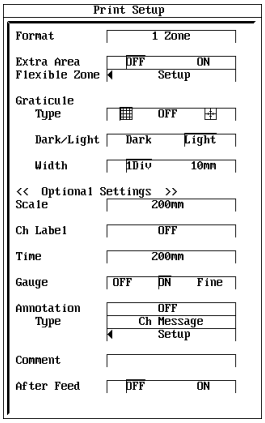
18. Use **jog shuttle+SELECT** to select the print interval of the annotation.
19. Use **jog shuttle+SELECT** to select the type of annotation to be printed.
    - If you select Ch Message, proceed to step 20.
    - If you select Ch Information or Ch Data, proceed to step 21.
20. Use **jog shuttle+SELECT** to select Setup. Then, enter the message you want to print using up to 80 characters according to the procedure in section 4.2. You can enter a message for each channel.

Setting a Comment

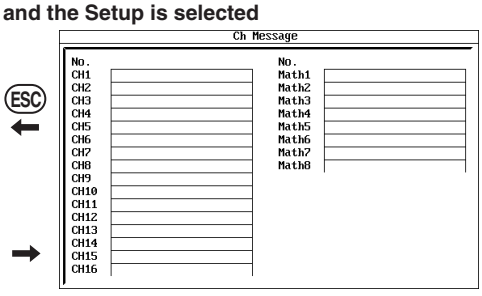
21. Use **jog shuttle+SELECT** to select Comment. Then, enter the comment you want to print using up to 20 characters according to the procedure in section 4.2.

Setting the Paper Feed after Stopping the Recording

22. Use **jog shuttle+SELECT** to turn After Feed ON or OFF.



When Annotation Type is set to Ch Message and the Setup is selected



Explanation

Set the recording format for printing the T-Y waveform to the built-in printer. For a T-Y waveform recording print example on the built-in printer, see the next section.

Selecting the Display (Recording) Format

Select the number of divisions of the recording area for recording to the built-in printer. This setting is linked with the DISPLAY menu > Format setting.

1 Zone 2 Zone
3 Zone 4 Zone
8 Zone 16 Zone

Extra Area

You can set the extra area only when the format is set to 1 Zone, 2 Zone, 3 Zone, or 4 Zone.

When the Format Is 1 Zone

If the extra area is turned ON, the top 16 cm of the recording area (20 cm) is used to record waveforms, and the remaining 4 cm is used to record waveform information (extra area). Annotations (see page 9-10) and logic waveforms are recorded in the extra area. The default setting is OFF.

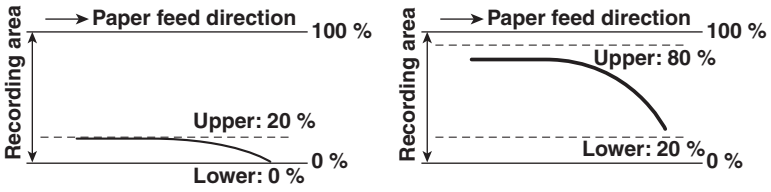
When the Format Is 2 Zone, 3 Zone, or 4 Zone

If the extra area is turned ON, the area below each of the divided waveform recording area is used to record waveform information (extra area). If the extra area is turned OFF, the extra area between each waveform recording area disappears. The vertical axis of each waveform recording area is adjusted automatically according to the paper size and recorded. The default setting is ON.

Flexible Zone

The flexible zone can be set only when the display (recording) format is 1 Zone and the extra area is OFF. The position in the recording area (20 cm) where each waveform is to be recorded is set with Upper and Lower (%). The Upper value can be set in the range of 2% to 100%. The Lower value can be set in the range of 0% to 98%. The resolution of each value is 1%. The minimum zone width (the difference between the Upper and Lower values) is 2%.

[Example] • When Flexible Zone on CH1 is set to Upper = 20% and Lower = 0%
The CH1 waveform is recorded in the area from the bottom to 4 cm of the recording area.
• When Flexible Zone on CH2 is set to Upper = 80% and Lower = 20%
The CH2 waveform is recorded in the area from 4 cm to 16 cm from the bottom of the recording area.



Graticule

Grid (Type)

Select the grid type from ▦, OFF, or ⊞. This setting is linked with the DISPLAY menu > Graticule setting. However, if OFF is selected, the DISPLAY menu is set to ⬚.

Dark/Light

Set the graticule dark/light setting to Light or Dark.

Width of the Vertical Graticule (Width)

Select how to set the vertical graticule width.

1Div: Grid that divides the recording area into 10 areas

10mm: mm graticule type

Graticule lines that are printed

The format of the scale lines that are printed depending on the selected graticule type and width is given in the table below.

Graticule Width	Grid Type		
		OFF	
1 Div		No graticule lines	
10 mm		No graticule lines	

Details

Print Interval of Scale Values (Scale)

Select the interval for the scale values (see section 8.9) printed at the top and bottom edges of the recording area from OFF, 200 mm, 400 mm, or 800 mm. If OFF is selected, the scale values are not printed.

Print Interval of Channel Labels (Ch Label)

Select the interval for printing waveform channel labels (see section 8.10) from OFF, 200 mm, 400 mm, or 800 mm. The channel label is printed near each waveform. If OFF is selected, the channel labels are not printed.

Time Print

Select the interval for printing the time from OFF, 200 mm, 400 mm, or 800 mm. The time is printed at the top row of the recording area. If OFF is selected, the times are not printed.

Gauge Print

Select whether to not print (OFF), print (ON), or print in detail (Fine) on the right (or left) side of the recording area. If ON is selected a gauge that equally divides the vertical axis of the waveform display area into two is displayed. If Fine is selected, a gauge that equally divides the vertical axis of the waveform display area into 10 is displayed. In realtime recording, the gauge is printed on the right side of the recording area when the recording is completed. When reprinting waveforms saved to the internal memory (see section 9.7), the gauge is printed on the left side of the recording area when the recording is started. The gauge, scale values, an arrow indicating the ground position, and measurement range* are printed.

* The measurement range may not be printed depending on the setting of T-Y Recording.

Paper Feed after Stopping the Recording

You can select whether the paper is fed automatically after stopping the T-Y waveform recording. This function can be used on products with firmware version 6.52 or higher. Check the firmware version under Soft Version described in section 17.4.

ON: Automatically feeds the paper approximately 40 mm so that the gauge information that is printed after the waveform recording can be seen.

OFF: Disables the auto feed function. To feed the paper, do it manually according to the procedure given on page 3-12.

Annotation

Channel information, channel messages, or measured values (Ch Data) is printed. Use Annotation to select the print interval from OFF, 200 mm, 400 mm, and 800 mm. Use Type to set the type of annotation to be printed from below.

- **Ch Information**
  Prints settings such as the measurement range, filter, and module.

- **Ch Message**
  Prints the character string (up to 80 characters) that is assigned to each channel.

- **Ch Data**
  Records the measured values at a given interval using numeric values.

The position where annotations are printed varies depending on the display (recording) format and extra area settings as follows:

- When Format Is 1 Zone, 2 Zone, 3 Zone, or 4 Zone and Extra Area Is ON
  The annotations are printed in the extra area. They are not printed in the waveform recording area.
- When Format Is 1 Zone, 2 Zone, 3 Zone, or 4 Zone and Extra Area Is OFF
  The annotations are printed at the bottom row of the waveform recording area.
- When Format Is 8 Zone or 16 Zone
  The annotations are printed between the divided waveform recording areas (between the grids).

Note

If all of the conditions below are met, only up to 67 characters of channel message are printed.
When Format is 1 Zone, 2 Zone, 3 Zone, or 4 Zone, Extra Area is OFF, and Scale is not OFF

Comment

A comment string of up to 20 characters can be printed at the lower right section. This setting is linked with the PRINT menu > Comment setting.

9.4 Recording T-Y Waveforms

Procedure

Before carrying out the procedure below, set the recording conditions and recording format of T-Y waveform recording according to the procedures in sections 9.2 and 9.3.

Starting the T-Y Waveform Recording

Press **START/STOP**. Waveform acquisition starts, and T-Y waveform recording starts.

Stopping the T-Y Waveform Recording

Press **START/STOP** when T-Y waveform recording is in progress. Waveform acquisition and T-Y waveform recording stop.

Explanation

Starting/Stopping the T-Y Waveform Recording

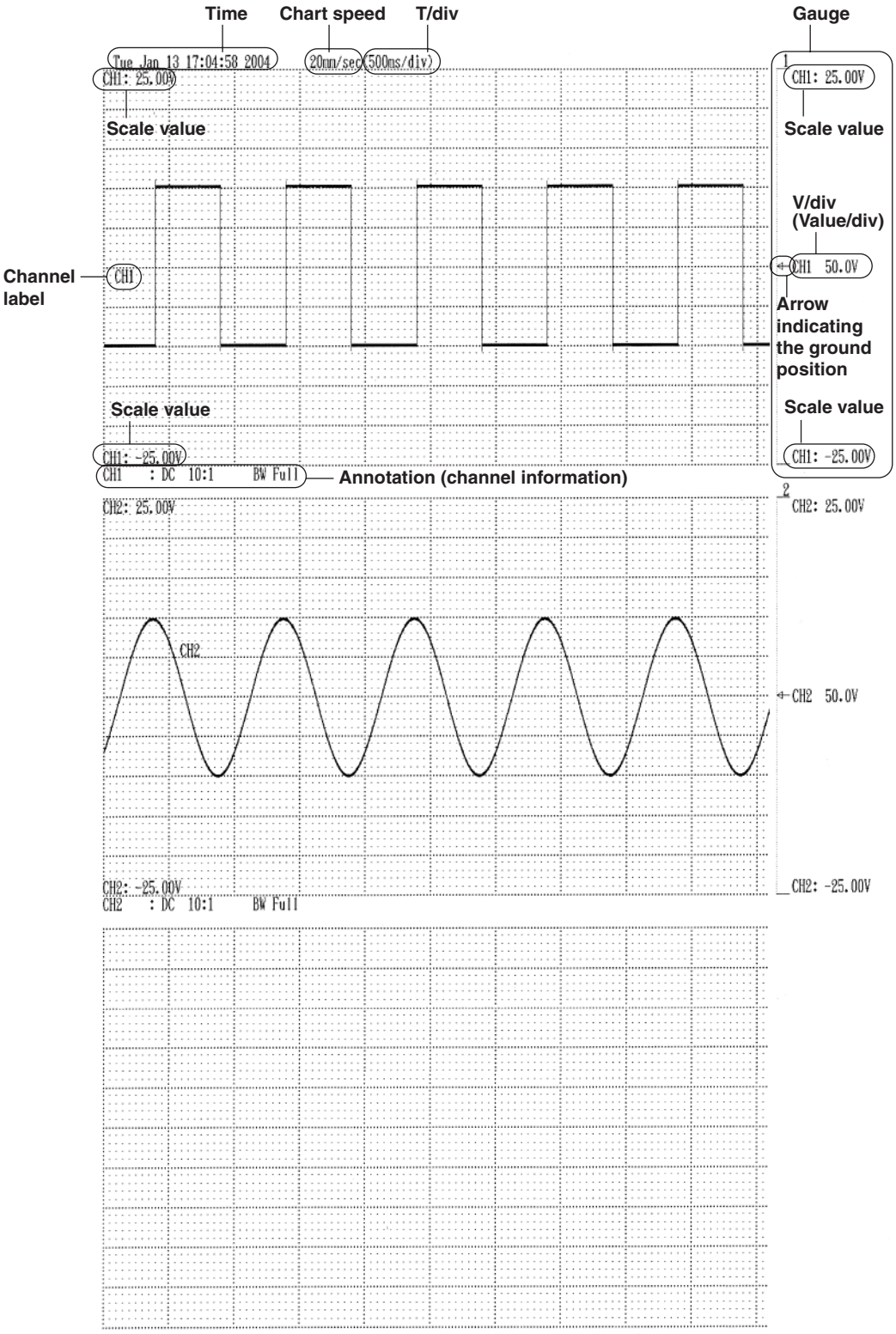
If you press START/STOP and start the waveform acquisition, T-Y waveform recording to the built-in printer also starts. To abort the T-Y waveform recording, press START/STOP to stop the waveform acquisition. However, if the T-Y waveform recording to the built-in printer was set to OFF in section 9.2, the waveform is acquired only to the internal memory. T-Y waveform recording to the built-in printer is not performed.

Changing the Settings during T-Y Waveform Recording

- You can change the input conditions even while T-Y waveform recording is in progress. The recording does not stop.
- Calibration is not executed while the T-Y waveform recording is in progress.
- You cannot change the recording format while the T-Y waveform recording is in progress.
- You can change the chart speed while the T-Y waveform recording is in progress. However, the waveform acquired in the internal memory up to that point is cleared. The waveform after the chart speed change is acquired in the internal memory.

Print Example of the T-Y Waveform Recording

Format: Triad
Graticule Type:
Width: 10 mm



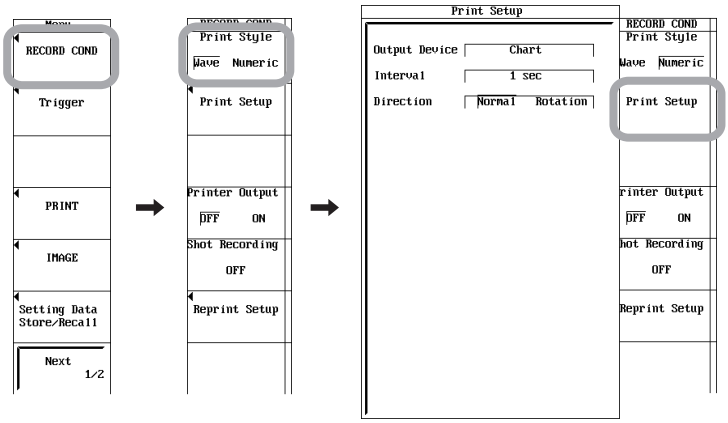
9.5 Recording Numeric Values

<For a description of this function, refer to page 2-37.>

Procedure

Before carrying out the procedure below, select Chart Recorder mode according to the procedures in section 9.1.

1. Press **MENU**.
2. Press the **RECORD COND** soft key.
3. Press the **Print Style** soft key to select Numeric.
4. Press the **Print Setup** soft key. The print setup dialog box opens.



Setting the Output Destination

5. Use **jog shuttle+SELECT** to select the output device.

Setting the Output Interval

6. Use **jog shuttle+SELECT** to select the interval.

If you select Chart in step 5, proceed to step 7.
If you select File in step 5, proceed to step 8.

Setting the Print Direction (If Chart Is Selected in Step 5)

7. Use **jog shuttle+SELECT** to select the direction.
   Proceed to step 11.

Setting the Output File (If Chart Is Selected in Step 5)

Setting the Auto Naming Function

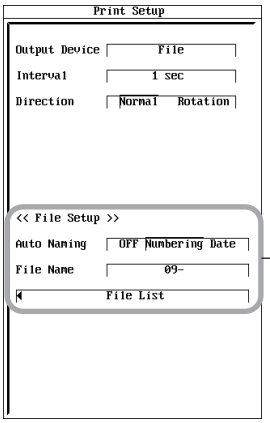
8. Use **jog shuttle+SELECT** to select the auto naming method of the file name.

Setting the File Name

9. Use **jog shuttle+SELECT** to select File Name. Then, enter the file name using up to 16 characters according to the procedure in section 4.2.

Selecting the File Output Destination

10. Use **jog shuttle+SELECT** to select File List. Then, select the file output destination according to steps 14 to 17 in section 13.8. Proceed to step 11.



Displayed only when Output Device is set to File

Note

Up to 10000 lines are output to the file. When 10000 lines are exceeded, writing stops. However, the waveform acquisition continues.

Setting the Trigger Mode

11. Carry out the procedure in “Setting the Trigger Mode” on page 9-3.

Setting the Acquisition Mode

12. Carry out the procedure in “Setting the Acquisition Mode” on page 9-4.

Starting the Numeric Value Recording

13. Press **START/STOP**. Waveform acquisition starts, and the numeric value recording starts.

Stopping the Numeric Value Recording

14. Press **START/STOP** when numeric value recording is in progress. Waveform acquisition and numeric value recording stop.

Explanation

Output Device

To record numeric values on the built-in printer, select Chart. To save numeric values to a file on a specified storage medium, select File.

Interval

Select 1 s, 2 s, 5 s, 10 s, 15 s, 20 s, 30 s, 1 min, 2 min, 5 min, 10 min, 15 min, 20 min, 30 min, or 60 min.

Direction

If the output destination is set to Chart, set the print direction to Normal (the newest data is at the top of the paper) or Rotation (the oldest data is at the top of the paper).

Output File (File Setup)

If the output destination is set to File, set the output file (auto naming, file name, and file output destination). These settings are the same as those of normal files. For details, see section 13.8.

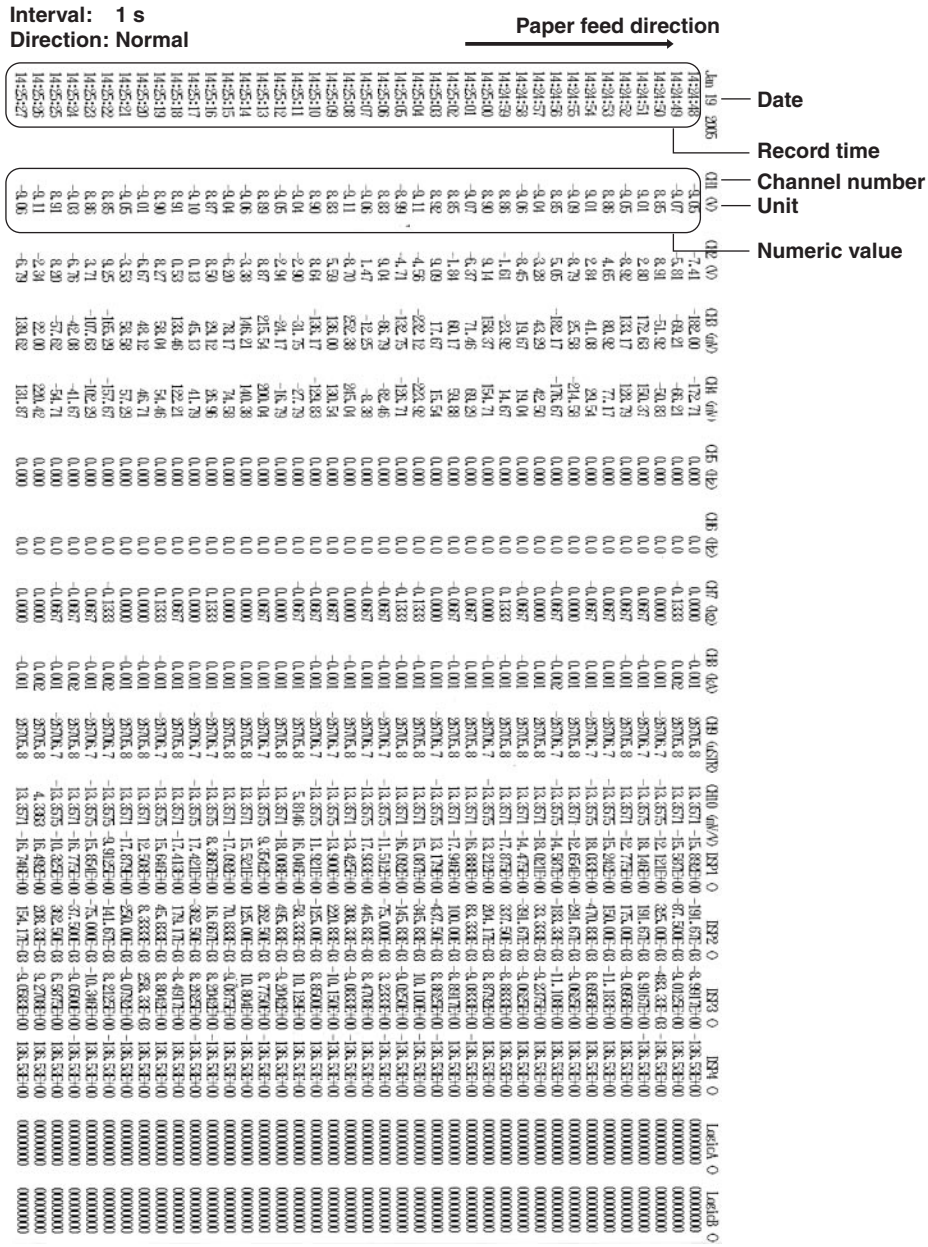
Trigger Mode

You can select Auto or Log in numeric value recording. Each trigger mode operation is the same as with the T-Y waveform recording. For details, see page 2-37 and section 9.2.

Acquisition Mode

The acquisition mode is the same as with the T-Y waveform recording. For details, see page 2-28 and section 9.2.

Print Example of the Numeric Value Recording



Note

- If the output destination is set to File, the waveform acquisition does not start when the power is turned ON even if the waveform acquisition start mode at power ON (see section 7.1) is turned ON.
- The print timing may deviate from the specified output interval.

9.6 Recording X-Y Waveforms

<For a description of this function, refer to page 2-40.>

Procedure

Before carrying out the procedure below, select X-Y Recorder mode according to the procedures in section 9.1.

1. Press **MENU**.
2. Press the **RECORD COND** soft key.

Setting the Sample Rate

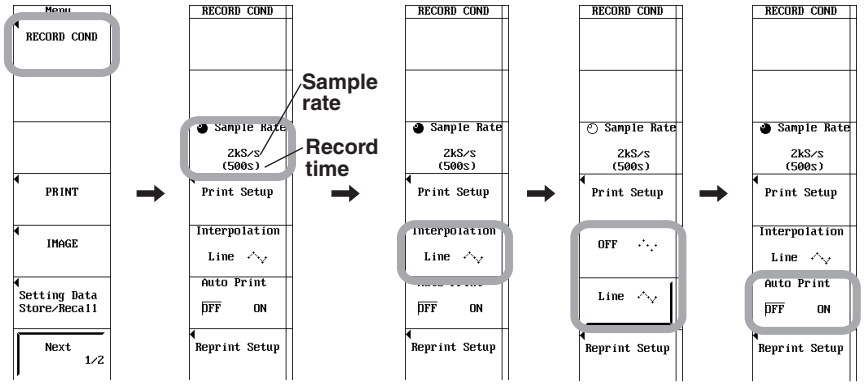
3. Press the **Sample Rate** soft key.
4. Turn the **jog shuttle** to select the sample rate.

Setting the Interpolation Method

5. Press the **Interpolation** soft key. The interpolation selection menu appears.
6. Press the soft key corresponding to the desired interpolation method.

Setting the Auto Print Function

7. Press the **Auto Print** soft key to select ON or OFF. If you select ON, the X-Y waveform recording on the built-in printer starts automatically when the waveform acquisition stops.



Selecting the X-Y Waveform to Be Displayed (Recorded)

8. Press the **Print Setup** soft key. The print setup dialog box opens.
9. Use **jog shuttle+SELECT** to select XY1 to XY4, turn the display ON/OFF of each X-Y waveform, and set the X trace and Y trace channels.

Setting the Graticule

Setting the Grid

10. Use **jog shuttle+SELECT** to select the type.

Setting Dark/Light

11. Use **jog shuttle+SELECT** to select dark or light.

Setting the Grid Width of the X- and Y-Axes

12. Use **jog shuttle+SELECT** to select the width.

Setting Whether to Print the Scale

13. Use **jog shuttle+SELECT** to turn the scale ON or OFF.

Setting Whether to Display the Pointer

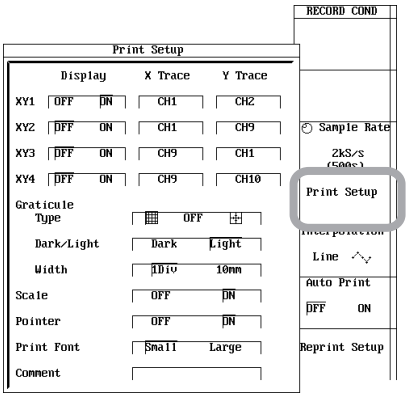
14. Use **jog shuttle+SELECT** to turn the pointer ON or OFF.
    If you select ON, a pointer indicating the most recent recording position appears on the screen. It is not printed on the printer.

Selecting the Print Font Size

15. Use **jog shuttle+SELECT** to select the print font size.

Setting a Comment

16. Use **jog shuttle+SELECT** to select Comment. Then, enter the comment you want to print using up to 20 characters according to the procedure in section 4.2.



Starting the X-Y Waveform Recording

17. Press **START/STOP**. The waveform acquisitions starts, and the screen shows the X-Y waveform.

Stopping the X-Y Waveform Recording

18. Press **START/STOP** while the waveform acquisition is in progress. The waveform acquisition stops. If auto print is turned ON in step 7, the X-Y waveform recording starts when the data acquisition stops.

Note

If auto print turned OFF, the X-Y waveform is not automatically printed. You can use the reprint function to print the X-Y waveform (see section 9.7).

Explanation

Sample Rate

Select the sample rate from the following:
5 S/s, 10 S/s, 20 S/s, 50 S/s, 100 S/s, 200 S/s, 500 S/s, 1 kS/s, 2 kS/s, or 5 kS/s

Interpolation

Set the interpolation method to OFF or Line. For details on the interpolation method, see section 8.2.

Auto Print

Select whether to automatically perform the X-Y waveform recording (printing) on the built-in printer when the waveform acquisition is stopped.

Selecting the X-Y Waveform to Be Displayed (Recorded)

- Select the X-Y waveform to be recorded (displayed) from XY1 to XY4.
- Assign channels to the X- and Y-axes for each item between XY1 and XY4. For the channels that can be assigned, see the explanation in section 8.6. You cannot select Math1 to Math8 in the table in section 8.6.

Graticule

Grid (Type)

The grid type is the same as with the T-Y waveform recording. For details, see page 9-8.

Dark/Light

Set the graticule dark/light setting to Light or Dark.

Setting the Grid Width of the X- and Y-Axes

Select how to set the grid of the X- and Y-axes. For details on the format of the grid lines that are printed, see page 9-9.

1Div: Grid that divides the recording area into 10 areas
10mm: mm graticule type

Scale

Select whether to print the scale.

Pointer

Select whether to display the pointer that indicates the most recent recording position on the screen.
The pointer is only displayed on the screen and not printed on the printer.

Print Font

Select the print font size to small or large. The setting applies to all printed characters.

Comment

A comment string of up to 20 characters can be printed at the lower right section. This setting is linked with the PRINT menu > Comment setting.

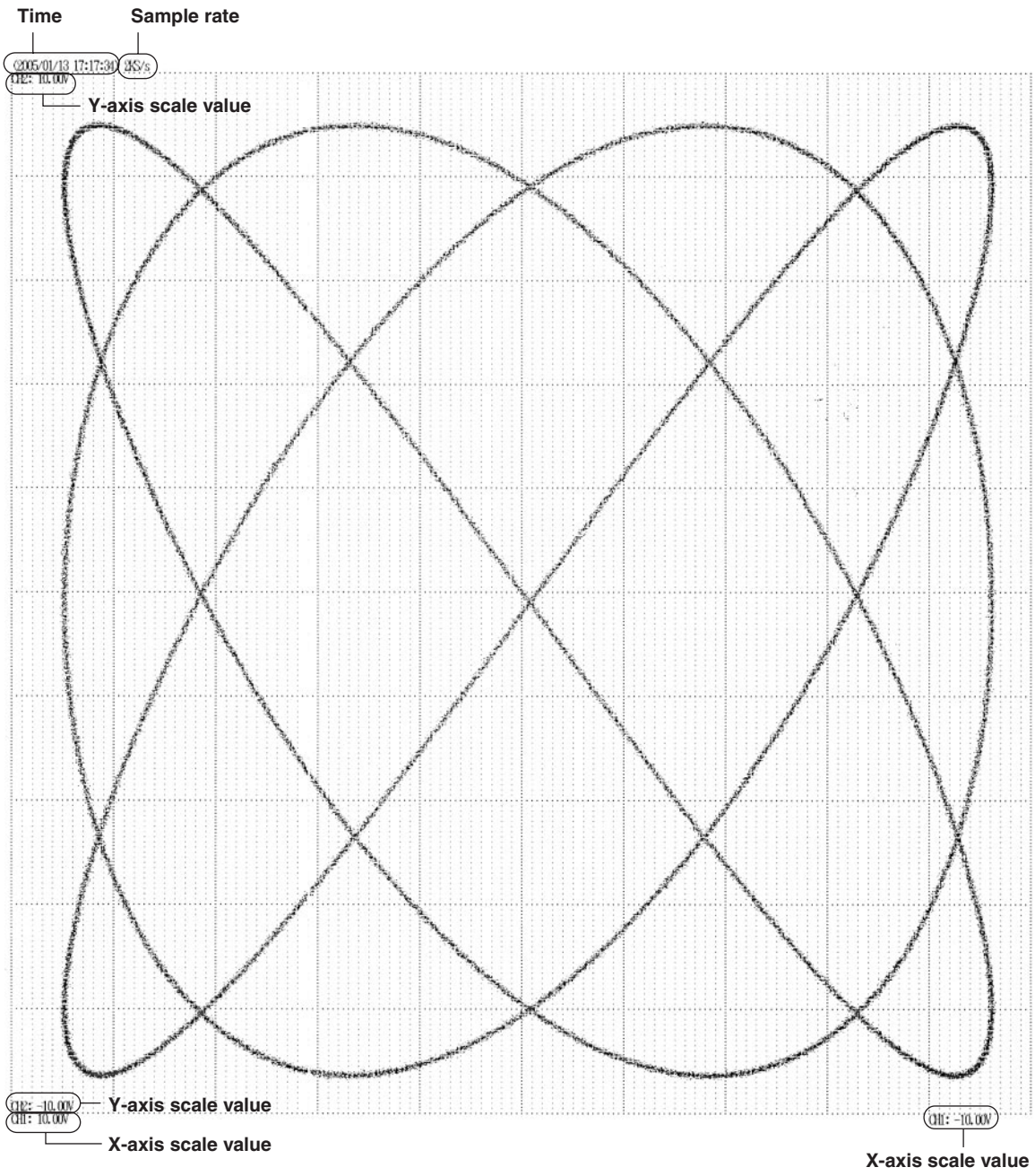
Starting/Stopping the X-Y Waveform Recording

When you press START/STOP, the waveform acquisitions starts, and the screen shows the X-Y waveform. Pressing START/STOP again stops the waveform acquisition.
If auto print is turned ON, the X-Y waveform recording on the built-in printer starts when the data acquisition stops. The waveform that is acquired between start and stop is recorded.
The reprint function (see section 9.7) can be used to execute the X-Y waveform recording on the built-in printer when auto print is turned OFF.
The most recent 1 MW of data that are acquired during the X-Y waveform recording are saved to the internal memory of the SL1400. The data can be used in the automated measurement of waveform parameters* (see section 11.5) and cursor measurements (excluding the marker cursor. See section 11.4). The data can also be saved to a storage medium.

* Area computation on the X-Y waveform is performed only on XY1.

Print Example of the X-Y Waveform Recording

Graticule Type:
Width: 10 mm



9.7 Reprinting on the Built-in Printer

<For a description of this function, refer to page 2-40.>

Procedure

Reprinting the Waveform Recorded in Chart Recorder Mode (T-Y Recording)

Before carrying out the procedure below, record the T-Y waveform in Chart Recorder mode according to the procedures in sections 9.1 to 9.4. This section explains the procedure from the point when the RECORD COND menu is displayed.

1. Press the **Reprint Setup** soft key.

Setting the Print Destination

2. Press the **Print to** soft key. The print destination selection menu appears.
3. Press the **Printer** soft key.

Selecting the Print Length

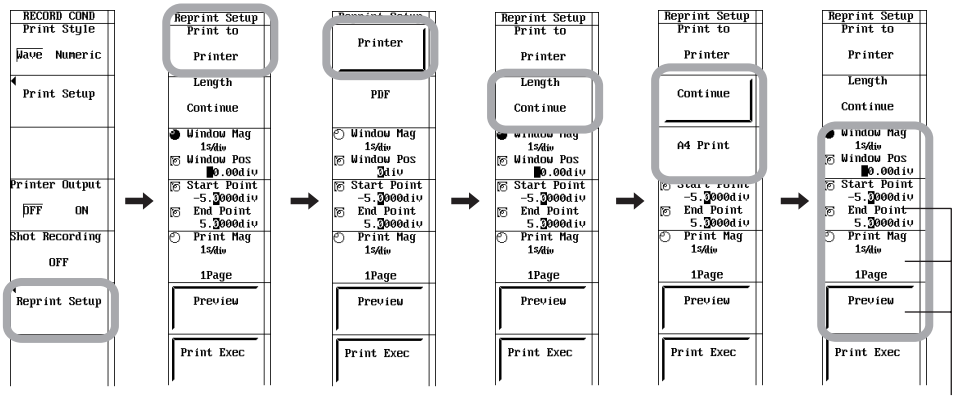
4. Press the **Length** soft key. The print length selection menu appears.
5. Press the **Continue** or **A4 Print** soft key.

Selecting the Section to Be Reprinted

6. Press the **Window Mag/Window Pos** soft key to select Window Mag.
7. Use the **jog shuttle** to set the zoom rate. You can reduce the zoom rate to redisplay the waveform that had been cleared from the screen.
8. Press the **Window Mag/Window Pos** soft key to select Window Pos.
9. Use the **jog shuttle** to set the zoom position. You can move the zoom position to redisplay the waveform that had been cleared from the screen.
10. If you select Continue in step 5, press the **Start Point/End Point** soft key.
11. Use the **jog shuttle** to set the start and end points of the section to be reprinted.

Setting the Print Magnification (Only If Continue Is Selected in Step 5)

12. Press the **Print Mag** soft key.
13. Use the **jog shuttle** to set the magnification of the section to be reprinted that you selected in steps 6 to 11. The top row of the menu shows the magnification; the bottom row shows the number of pages when the waveform is recorded using the magnification indicated in the top row.



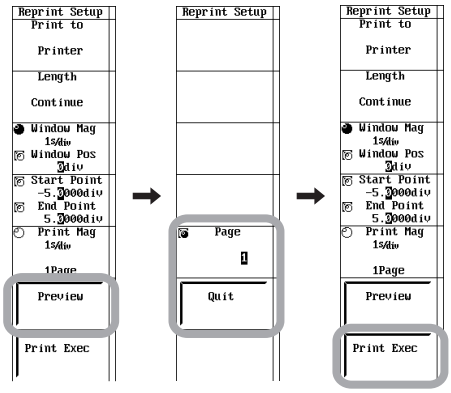
Start Point/End Point, Print Mag, and Preview are displayed only when Length is set to Continue.

Displaying the Preview (Only If Continue Is Selected in Step 5)

14. Press the **Preview** soft key.
15. Turn the **jog shuttle** to select the page you want to preview.
16. Press the **Quit** soft key to close the preview display.

Executing the Reprint Operation

17. Press the **Print Exec** soft key. Reprint is executed using the conditions set in steps 6 to 13.



Reprinting the Waveform Recorded in X-Y Recorder Mode

Before carrying out the procedure below, record the X-Y waveform in X-Y Recorder mode according to the procedures in sections 9.1 to 9.6. This section explains the procedure from the point when the RECORD COND menu is displayed.

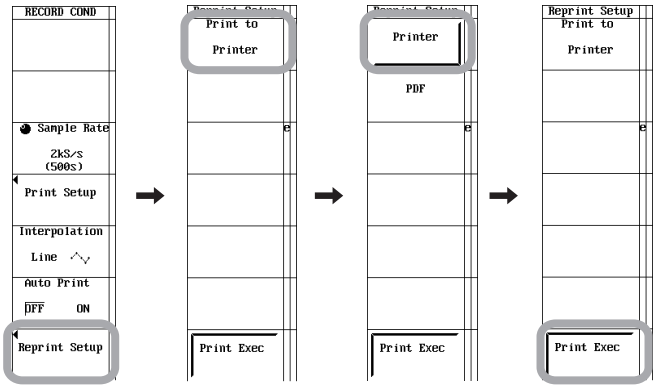
1. Press the **Reprint Setup** soft key.

Setting the Print Destination

2. Press the **Print to** soft key. The print destination selection menu appears.
3. Press the **Printer** soft key.

Executing the Reprint Operation

4. Press the **Print Exec** soft key to execute the reprint operation.



Explanation

The waveform data of the T-Y waveform recorded in Chart Recorder mode or the measured data of the X-Y waveform recorded in X-Y Recorder mode is stored in the internal memory.

Reprinting the Waveform Recorded in Chart Recorder Mode (T-Y Waveform Recording)

Print to

To reprint the waveform recorded in Chart Recorder mode (T-Y waveform recording), set the print destination to Printer (built-in printer).

Length

Continue: Prints the range specified by Window Mag/Window Pos and Start Point/End Point using the magnification specified by Print Mag.

A4 Print: Prints the range specified by Window Mag/Window Pos to A4 size. The magnification changes automatically so that the display range fits on an A4 size paper.

Selecting the Section to Be Reprinted

Zoom Rate/Zoom Position (Window Mag/Window Pos)

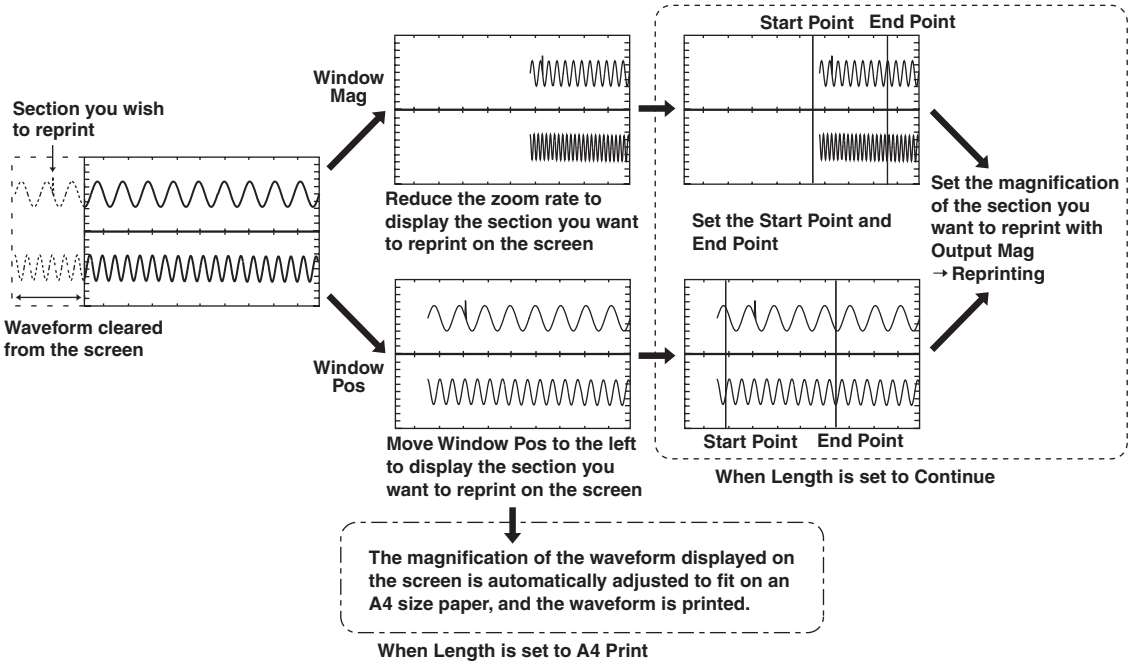
When selecting the section to be reprinted, Window Mag is used to reduce the zoom rate in order to redisplay the waveform that has been cleared from the screen. You can also move Window Pos to redisplay the waveform that had been cleared from the screen.

Start Point/End Point

If Length is set to Continue, display the section to be reprinted on screen, and then use Start Point and End Point to set the start and end points.

Print Mag

Set Print Mag only when Length is set to Continue. Set the waveform magnification for reprinting. The top row of the menu shows the magnification; the bottom row shows the number of pages when the waveform is recorded using the magnification indicated in the top row.



Preview

Displays a preview of the section that you want to reprint. Press the Quit soft key to close the preview display.

Executing the Reprint Operation (Print Exec)

Reprint is executed using the specified conditions.

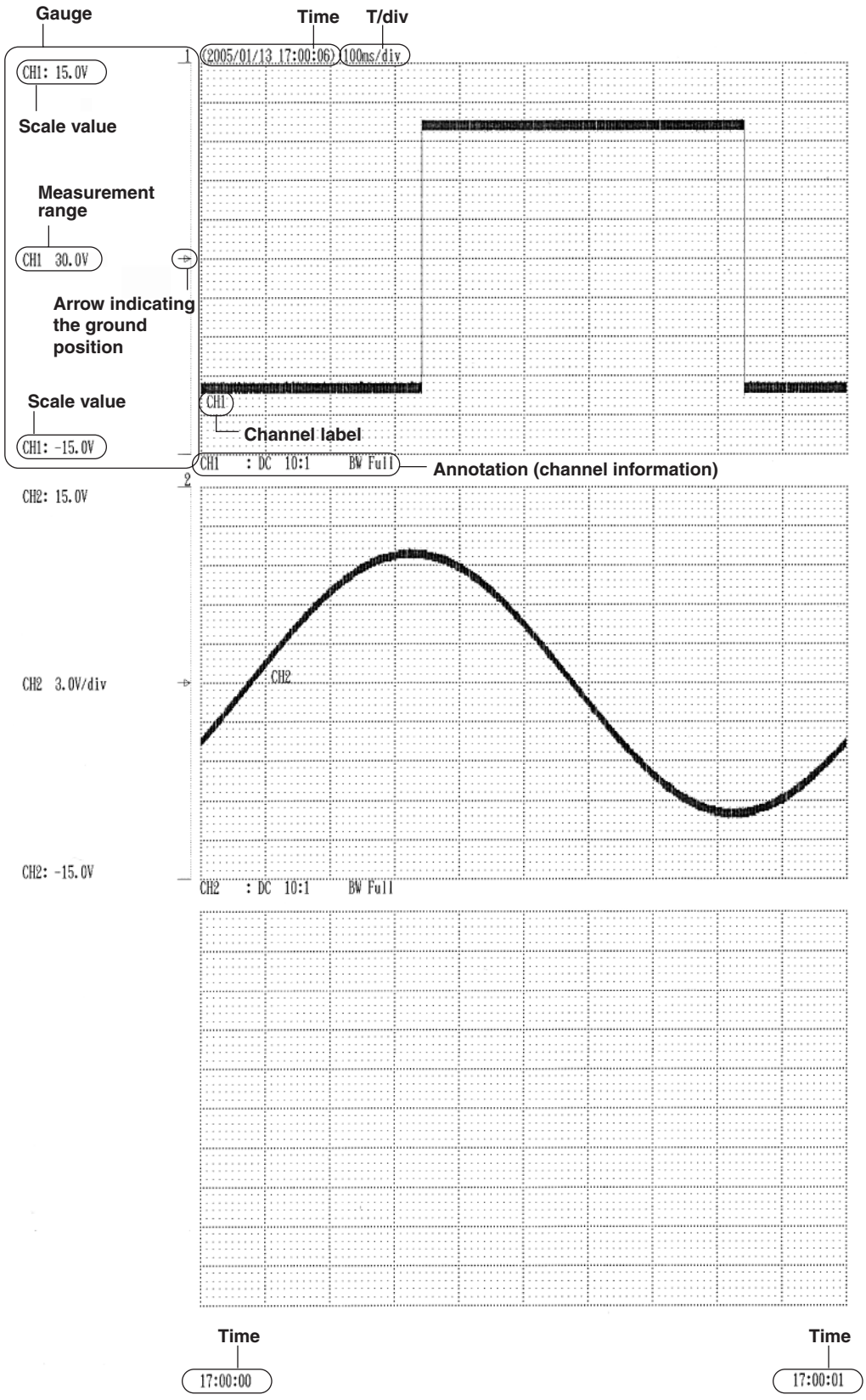
Reprinting the Waveform Recorded in X-Y Recorder Mode (X-Y Waveform Recording)

Executing the Reprint Operation (Print Exec)

The waveform data recorded to the internal memory immediately before in X-Y Recorder mode is reprinted as a waveform.

Reprint Example of the T-Y Waveform Recording

Format: Triad
Graticule Type:
Width: 10 mm



9.8 Creating a PDF File of the Reprint Image

<For a description of this function, refer to page 2-40.>

Procedure

Before carrying out the procedure below, record the T-Y waveform in Chart Recorder mode according to the procedures in sections 9.1 to 9.4 or record the X-Y waveform in X-Y Recorder mode according to the procedures in section 9.6. This section explains the procedure from the point when the RECORD COND menu is displayed.

1. Press the **Reprint Setup** soft key.

Setting the Print Destination

2. Press the **Print to** soft key. The print destination selection menu appears.
3. Press the **PDF** soft key.
   For Chart Recorder mode, proceed to step 4.
   For X-Y Recorder mode, proceed to step 12.

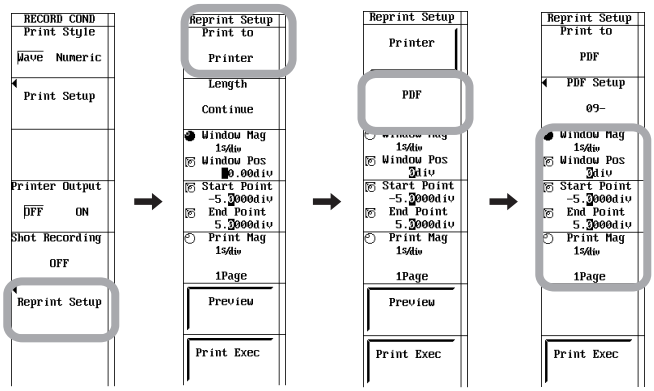
Selecting the Section to Be Output to the PDF File (Only for Chart Recorder Mode)

4. Press the **Window Mag/Window Pos** soft key to select Window Mag.
5. Use **jog shuttle+SELECT** to set the zoom rate. You can reduce the zoom rate to redisplay the waveform that had been cleared from the screen.
6. Press the **Window Mag/Window Pos** soft key to select Window Pos.
7. Use **jog shuttle+SELECT** to set the zoom position. You can move the zoom position to redisplay the waveform that had been cleared from the screen.
8. Press the **Start Point/End Point** soft key.
9. Use **jog shuttle+SELECT** to set the start and end points of the section to be output to the PDF file.

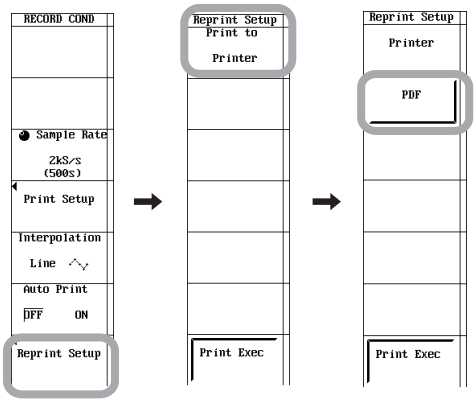
Setting the Print Magnification (Only for Chart Recorder Mode)

10. Press the **Print Mag** soft key.
11. Use the **jog shuttle** to set the magnification of the section that you selected in steps 4 to 9 to be output to the PDF file. The top row of the menu shows the magnification; the bottom row shows the number of pages when the waveform is recorded using the magnification indicated in the top row.

Chart Recorder mode



X-Y Recorder mode



Setting the PDF File

12. Press the **PDF Setup** soft key. The PDF setup dialog box appears.

Setting the Paper Size

13. Use **jog shuttle+SELECT** to select the paper size.

Setting the Orientation (If You Select A3, A4, or A5 in Step 13)

14. Use **jog shuttle+SELECT** to select the orientation.

Setting the Number of Divisions per Page (If You Select A3, A4, or A5 in Step 13 (Only for Chart Recorder Mode))

15. Use **jog shuttle+SELECT** to select Div/Page and set the number of divisions per page.

Setting the Document Information

16. Use **jog shuttle+SELECT** to select Title, Author, Sub Title, or KeyWord. Then, enter the title, author, or sub title using up to 30 characters or the keyword using up to 90 characters of the PDF file according to the procedures in section 4.2.

Selecting the Color

17. Use **jog shuttle+SELECT** to turn the color ON or OFF.

Enabling/Disabling Compression

18. Use **jog shuttle+SELECT** to turn the compression ON or OFF.

Setting the Auto Naming Function

19. Use **jog shuttle+SELECT** to select the auto naming method of the file name.

Setting the PDF File Name

20. Use **jog shuttle+SELECT** to select File Name. Then, enter the file name using up to 16 characters according to the procedure in section 4.2.

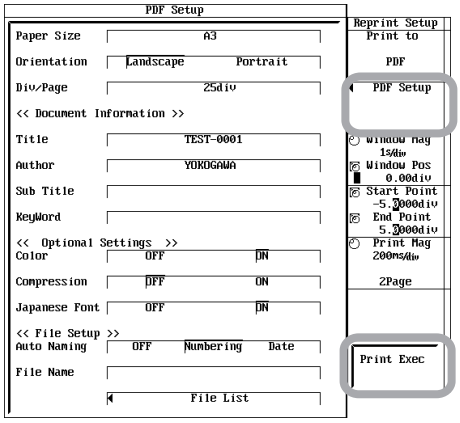
Selecting the PDF File Output Destination

21. Use **jog shuttle+SELECT** to select File List. Then, select the file output destination according to steps 14 to 17 in section 13.8.

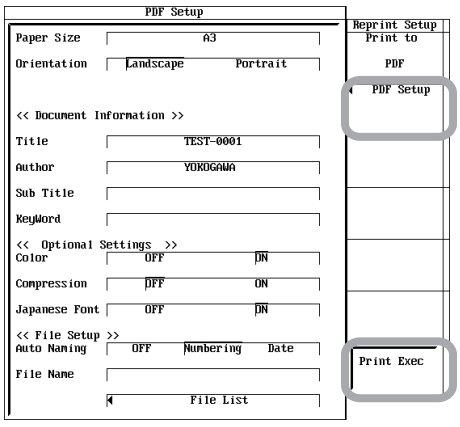
Executing the PDF File Generation

22. Press the **Print Exec** soft key. A PDF file is created using the conditions set in steps 4 to 21.

Chart Recorder mode



X-Y Recorder mode



Explanation

Print to

When creating a PDF file of the waveform recorded in Chart Recorder mode (T-Y recording) or X-Y Recorder mode (X-Y recording), set the print destination to PDF.

Selecting the Section to Be Output to the PDF File (Window Mag/Window Pos and Start Point/End Point)

Can be specified only in Chart Recorder mode. These are the same as Window Mag/ Window Pos and Start Point/End Point when reprinting on the built-in printer. See page 9-22.

Print Mag

Can be specified only in Chart Recorder mode. This is the same as Print Mag when reprinting on the built-in printer. See page 9-22.

Setting the PDF File

Paper Size

Select the paper size from built-in printer size, A3, A4, and A5. If the built-in printer size is selected, a PDF file is created of an image similar to the printed output on the built-in printer.

Orientation

If the paper size is set to A3, A4, or A5, set the PDF orientation to Landscape or Portrait.

Div/Page

Can be specified only in Chart Recorder mode. If the paper size is set to A3, A4, or A5, set the number of divisions per PDF page. The image data of the specified number of divisions is saved. The selectable range of Div/Page varies depending on the paper size, orientation, and gauge (see section 9-9) as follows:

Paper Size	Orientation	Selectable Range of Div/Page	
		Gauge: OFF	Gauge: ON
Built-in printer	-	20 (fixed)	20 (fixed)
A3	Portrait	1 to 25	1 to 20
A3	Landscape	1 to 40	1 to 35
A4	Portrait	1 to 20	1 to 15
A4	Landscape	1 to 25	1 to 20
A5	Portrait	1 to 10	1 to 10
A5	Landscape	1 to 20	1 to 15

Document Information (Title, Author, Sub Title, and Keyword

As necessary, enter the title, author, sub title, and keyword of the PDF file to be created.

Color

The PDF file is created in color if ON is selected and monochrome if OFF is selected.

Compression

Select whether to compress the file. If you select ON, the file is compressed. However, the generation of the PDF file takes longer than when you select OFF.

File Setup

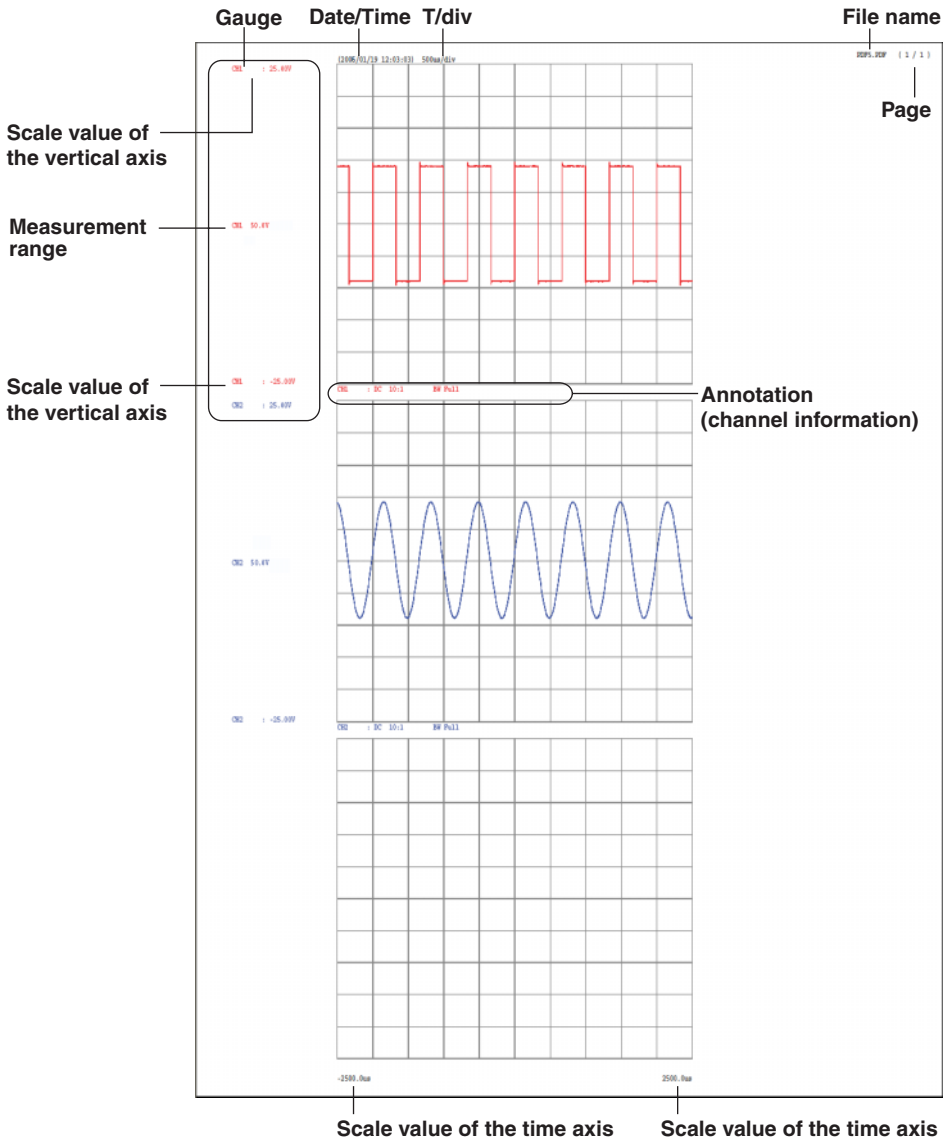
Set the auto naming, file name, and file output destination of the PDF file. These settings are the same as those of normal files. For details, see section 13.8.

Executing the PDF File Generation

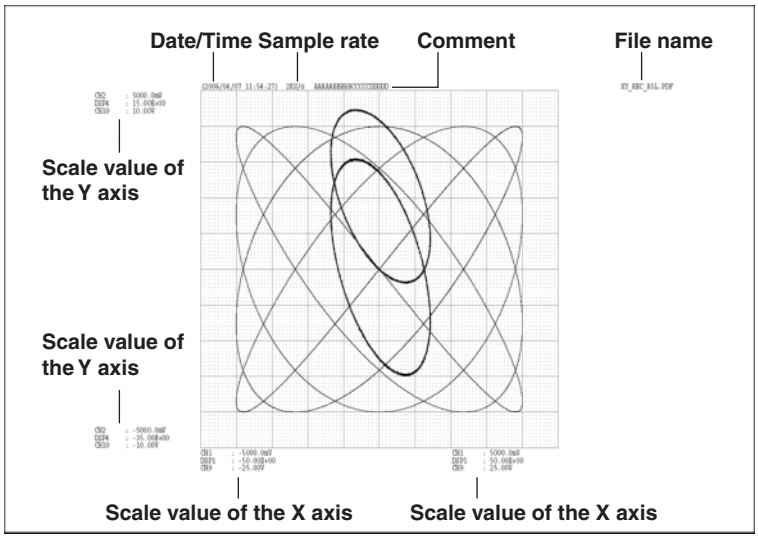
The PDF file is created using the specified conditions. The extension to the PDF file is .pdf.

PDF File Example

Chart Recorder mode (Paper Size: A4)



X-Y Recorder mode (Paper Size: A5)



10.1 Adding, Subtracting, Multiplying, and Dividing Waveforms

<For a description of this function, refer to page 2-41.>

Procedure

1. Press **MENU**.
2. Press the **MATH** soft key.
3. Press the **Mode** soft key to select ON.

Setting the Computation Start and End Points

4. Press the **Start Point/End Point** soft key to set the jog shuttle control to Start Point.
5. Turn the **jog shuttle** to set the start point.
6. Likewise, set the End Point.

Setting the Computation

7. Press the **Setup** soft key. The Math1 to Math8 setup dialog boxes appear.
8. Use **jog shuttle+SELECT** to select the desired Math waveform. The corresponding Math waveform setup dialog box appears.

Setting the Computing Operation

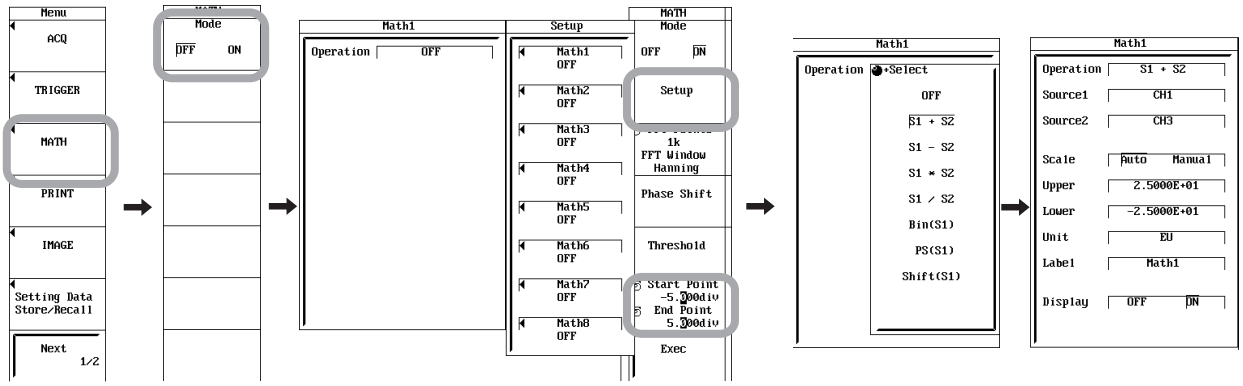
9. Use **jog shuttle+SELECT** to set Operation to S1+S2, S1–S2, S1*S2, or S1/S2.

Selecting the Channel on Which to Perform Computation

10. Use **jog shuttle+SELECT** to select Source1.
11. Likewise, select Source2.

Setting the Scaling

12. Use **jog shuttle+SELECT** to set Scale to Auto or Manual.
    If you select Manual, proceed to step 13; if you select Auto, proceed to step 15.



Setting the Upper and Lower Limits of Waveform Display (When Scale Is Set to Manual)

13. Use **jog shuttle+SELECT** to set the upper limit.
14. Likewise, set the lower limit.

Note

If you select Auto, you cannot set Upper and Lower.

Setting the Unit

15. Use **jog shuttle+SELECT** to set the Unit using up to four characters according to the procedure given in section 4.2.

Setting the Label

16. Use **jog shuttle+SELECT** to set the Label according to the procedure given in section 4.2. For a description of the label display, see section 8.10.

Turning ON/OFF the Math Waveform Display

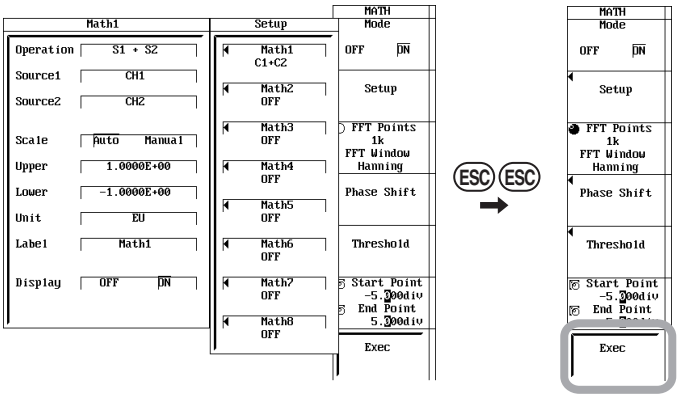
17. Use **jog shuttle+SELECT** to turn the display ON or OFF.

As necessary, set Math2 to Math8 in a similar fashion.

18. Press **ESC** twice.

Executing the Computation

19. Press the **Exec** soft key.



Explanation

Addition, subtraction, multiplication, and division can be performed between channels.

Computation Target Channels

CH1 to CH16, Math1 to Math7

Computation range: Start Point/End Point

By default, the measurement range is ±5 divisions of the display frame on the time axis. You can limit this range.
The concept of the computation range is analogous to the concept of the selectable range of cursor display position in cursor measurement.
For details, see “Selectable Range of Cursor Position” in section 11.4.

Scaling

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

Auto: The upper and lower limits are set according to the computed result.

Manual: The upper and lower limits can be set arbitrarily. The selectable range is –9.9999E+30 to 9.9999E+30.

Unit

Unit can be set arbitrarily using up to four characters. The specified characters are applied to the scale values.

Linear Scaling

When performing computation on a channel that has linear scaling set, the computation is performed on the scaled value.

Notes on Computation

Computation is not executed when you change Start Point or End Point while the computation is stopped. Be sure to press Exec to perform the computation again. If you do not, the waveform will not be displayed correctly when the screen is redrawn.

Note

While computation is in progress,  is displayed at the upper left of the screen.

10.2 Performing Binary Computation

<For a description of this function, refer to page 2-41.>

Procedure

1. Press **MENU**.
2. Press the **MATH** soft key.
3. Press the **Mode** soft key to select ON.

Setting the Computation Start and End Points

4. Press the **Start Point/End Point** soft key to set the jog shuttle control to Start Point.
5. Turn the **jog shuttle** to set the start point.
6. Likewise, set the End Point.

Setting the Computation

7. Press the **Setup** soft key. The Math1 to Math8 setup dialog boxes appear.
8. Use **jog shuttle+SELECT** to select the desired Math waveform. The corresponding Math waveform setup dialog box appears.

Setting the Computing Operation

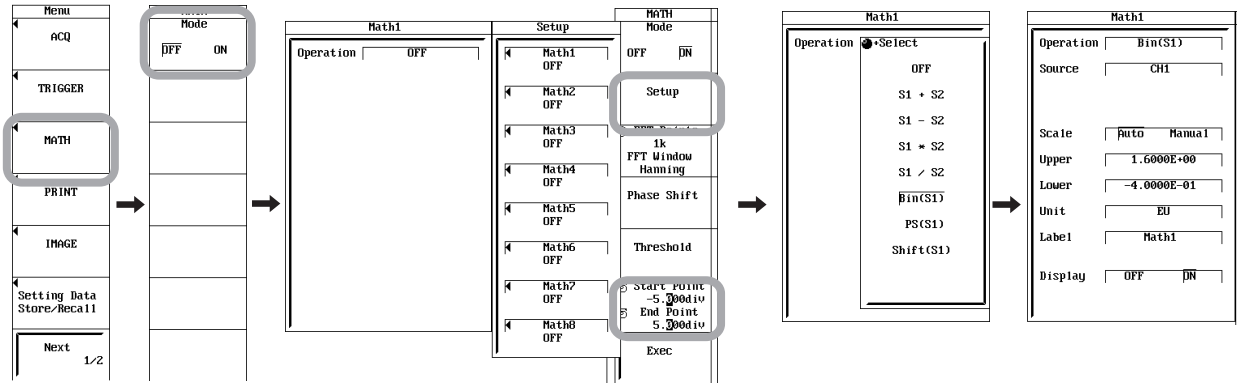
9. Use **jog shuttle+SELECT** to set Operation to Bin(S1).

Selecting the Channel on Which to Perform Computation

10. Use **jog shuttle+SELECT** to select Source.

Setting the Scaling

11. Use **jog shuttle+SELECT** to set Scale to Auto or Manual.
    If you select Manual, proceed to step 12; if you select Auto, proceed to step 14.



Setting the Upper and Lower Limits of Waveform Display (When Scale Is Set to Manual)

12. Use **jog shuttle+SELECT** to set Upper.
13. Likewise, set Lower.

Note

If you select Auto, you cannot set Upper and Lower.

Setting the Unit

14. Use **jog shuttle+SELECT** to set the Unit using up to four characters according to the procedure given in section 4.2.

Setting the Label

15. Use **jog shuttle+SELECT** to set the Label according to the procedure given in section 4.2. For a description of the label display, see section 8.10.

Turning ON/OFF the Math Waveform Display

16. Use **jog shuttle+SELECT** to set Display to ON or OFF.
17. Press **ESC** twice.

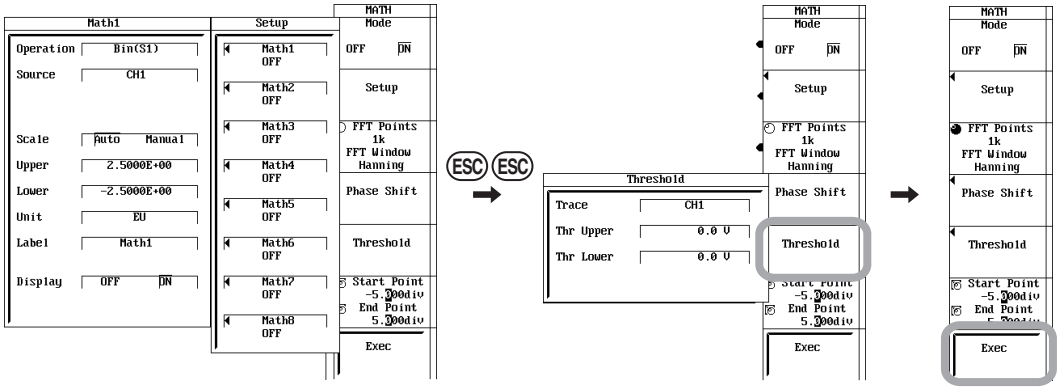
Setting the Threshold Level

18. Press the **Threshold** soft key.
19. Use **jog shuttle+SELECT** to set the Trace (channel on which to assign the threshold level).
20. Use **jog shuttle+SELECT** to set Thr Upper.
21. Likewise, set Thr Lower.

As necessary, set Math2 to Math8 in a similar fashion.

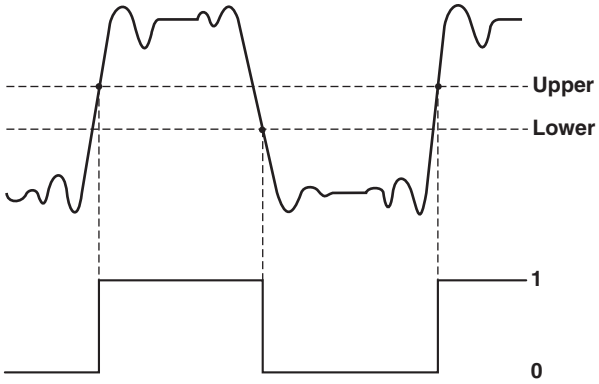
Executing the Computation

22. Press the **Exec** soft key.



Explanation

This function converts CH1 to CH16 or Math1 to Math7 waveform to a digital signal (1s and 0s) according to the specified threshold level.



Computation range: Start Point/End Point

By default, the measurement range is ±5 divisions of the display frame on the time axis. You can limit this range.
The concept of the computation range is analogous to the concept of the selectable range of cursor display position in cursor measurement.
For details, see “Selectable Range of Cursor Position” in section 11.4.

Scaling

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

Auto: The upper and lower limits are set according to the computed result.

Manual: The upper and lower limits can be set arbitrarily. The selectable range is –9.9999E+30 to 9.9999E+30.

Unit

Unit can be set arbitrarily using up to four characters. The specified characters are applied to the scale values.

Linear Scaling

When performing computation on a channel that has linear scaling set, the computation is performed on the scaled value.

Notes on Computation

Computation is not executed when you change Start Point or End Point while the computation is stopped. Be sure to press Exec to perform the computation again. If you do not, the waveform will not be displayed correctly when the screen is redrawn.

Note

While binary computation is in progress, is displayed at the upper left of the screen.

10.3 Performing Power Spectrum Computation (FFT)

<For a description of this function, refer to page 2-41.>

Procedure

1. Press **MENU**.
2. Press the **MATH** soft key.
3. Press the **Mode** soft key to select ON.

Setting the Computation Start and End Points

4. Press the **Start Point/End Point** soft key to set the jog shuttle control to Start Point.
5. Turn the **jog shuttle** to set the start point.
6. Likewise, set the End Point.

Setting the Computation

7. Press the **Setup** soft key. The Math1 to Math8 setup dialog boxes appear.
8. Use **jog shuttle+SELECT** to select the desired Math waveform. The corresponding Math waveform setup dialog box appears.

Setting the Computing Operation

9. Use **jog shuttle+SELECT** to set Operation to PS(S1).

Selecting the Channel on Which to Perform Computation

10. Use **jog shuttle+SELECT** to select Source.

Setting the Scaling

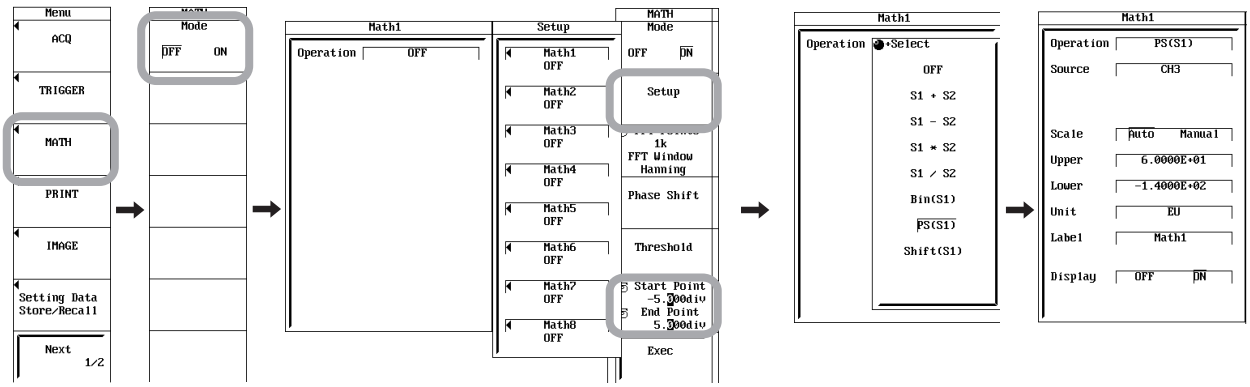
11. Use **jog shuttle+SELECT** to set Scale to Auto or Manual.
    If you select Manual, proceed to step 12; if you select Auto, proceed to step 14.

Setting the Upper and Lower Limits of Waveform Display (When Scale Is Set to Manual)

12. Use **jog shuttle+SELECT** to set Upper.
13. Likewise, set Lower.

Note

If you select Auto, you cannot set Upper and Lower.



Setting the Unit

14. Use **jog shuttle+SELECT** to set the Unit using up to four characters according to the procedure given in section 4.2.

Setting the Label

15. Use **jog shuttle+SELECT** to set the Label according to the procedure given in section 4.2. For a description of the Label display, see section 8.10.

Turning ON/OFF the Math Waveform Display

16. Use **jog shuttle+SELECT** to set Display to ON or OFF.
17. Press **ESC** twice.

Setting the Number of FFT Points

18. Press the **FFT Points/FFT Window** soft key to set the jog shuttle control to FFT Points.
19. Turn the **jog shuttle** to select 1k, 2k, 5k, 10k, 20k, 50k, or 100k.

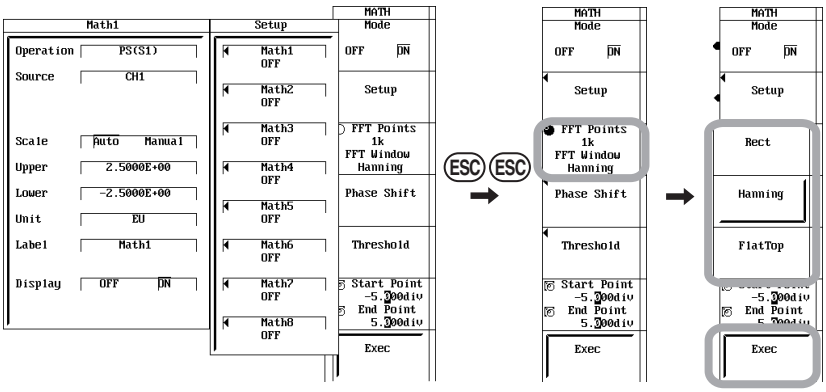
Selecting the Time Window

20. While the jog shuttle control is set to FFT Points, press the **FFT Points/FFT Window** soft key again. The FFT Window selection menu appears.
21. Select the time window from **Rect**, **Hanning**, and **FlatTop**.

As necessary, set Math2 to Math8 in a similar fashion.

Executing the Computation

22. Press the **Exec** soft key.



Explanation

This function displays the power spectrum of CH1 to CH16 and Math1 to Math7 waveforms.

Computation range: Start Point/End Point

By default, the measurement range is ±5 divisions of the display frame on the time axis. You can limit this range.
The concept of the computation range is analogous to the concept of the selectable range of cursor display position in cursor measurement.
For details, see “Selectable Range of Cursor Position” in section 11.4.

Scaling

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

Auto: The upper and lower limits are set according to the computed result.

Manual: The upper and lower limits can be set arbitrarily. The selectable range is –9.9999E+30 to 9.9999E+30.

Unit

Unit can be set arbitrarily using up to four characters. The specified characters are applied to the scale values.

Number of FFT Points

Select from 1000(1k), 2000(2k), 5000(5k), 10000(10k), 20000(20k), 50000(50k), and 100000(100k). Using the number of FFT points from the specified Start point, FFT is performed and the power spectrum is displayed.

Note

If you set the number of FFT points to 50k or greater, only Math1 and Math2 can be used. In this case, Math3 to Math8 cannot be used even in computations other than FFT.

Example 1) Math1 = C1×C2, Math2 = PS-LOGMAG(M1), Math3 = C3×C4.
If the number of FFT points of Math1 to Math3 is 50 k, only Math1 and Math2 are computed.

Example 2) Math1 = C1, Math2 = C2, Math3: The number of FFT points is 50k
→ Computes only Math1 and Math2.

Time Window

Select from the three types listed below. For details on the time window, see page 2-42.

Rect (Rectangular): Best suited for transient signals that attenuate completely within the time window.

Hanning: Best suited for continuous and non-periodic signals.

FlatTop: Best suited for improve the accuracy of the level even if the frequency resolution is to be compromised.

Displaying the Overall Value (Only When Measure Is Set to ON)

If the channels (Math1 to Math8) on which power spectrum computation (PS) is selected are in the middle of the automated measurement of waveform parameters (MEASURE: ON) and Rms is ON, the screen shows “Rms = overall value.” For details on the automated measurement of waveform parameters, see section 11.5.
The overall value is the total RMS value determined from the frequency spectrum included in the signal. The overall value is determined by summing the power spectrum of all frequencies and then taking the square root.

$$\text{Overall Value} = \sqrt{\frac{2 \times PS_0 + \Sigma PS_i}{k}} \quad \text{(Vrms)}$$

The k value varies depending on the selected time window as follows:

Time Window Type	k
Rect (Rectangular)	1
Hanning	1.5
Flattop	3.19693

Linear Scaling

When performing computation on a channel that has linear scaling set, the computation is performed on the scaled value.

Notes on Power Spectrum Display

- The power spectrum cannot be computed, if the displayed record length is less than number of computed points.
- The number of computed points, time window, Start Point, and End Point are common to all computation channels.
- You cannot expand the FFT waveforms horizontally that would cause the number of points to be 50 or less.

Notes on Computation

- Computation is not executed when you change Start Point or End Point while the computation is stopped. Be sure to press Exec to perform the computation again. If you do not, the waveform will not be displayed correctly when the screen is redrawn.
- Normally, computation is performed on the sampled data stored in the acquisition memory. However, for waveforms that have been acquired in envelope mode, computation is performed on the maximum/minimum values per acquisition interval.

Note

While computation is in progress,  is indicated at the upper left of the screen.

10.4 Shifting the Phase

<For a description of this function, refer to page 2-42.>

Procedure

1. Press **MENU**.
2. Press the **MATH** soft key.
3. Press the **Mode** soft key to select ON.

Setting the Computation Start and End Points

4. Press the **Start Point/End Point** soft key to set the jog shuttle control to Start Point.
5. Turn the **jog shuttle** to set the start point.
6. Likewise, set the End Point.

Setting the Computation

7. Press the **Setup** soft key. The Math1 to Math8 setup dialog boxes appear.
8. Use **jog shuttle+SELECT** to select the desired Math waveform. The corresponding Math waveform setup dialog box appears.

Setting the Computing Operation

9. Use **jog shuttle+SELECT** to set Operation to Shift(S1).

Selecting the Channel on Which to Shift the Phase

10. Use **jog shuttle+SELECT** to select Source.

Setting the Scaling

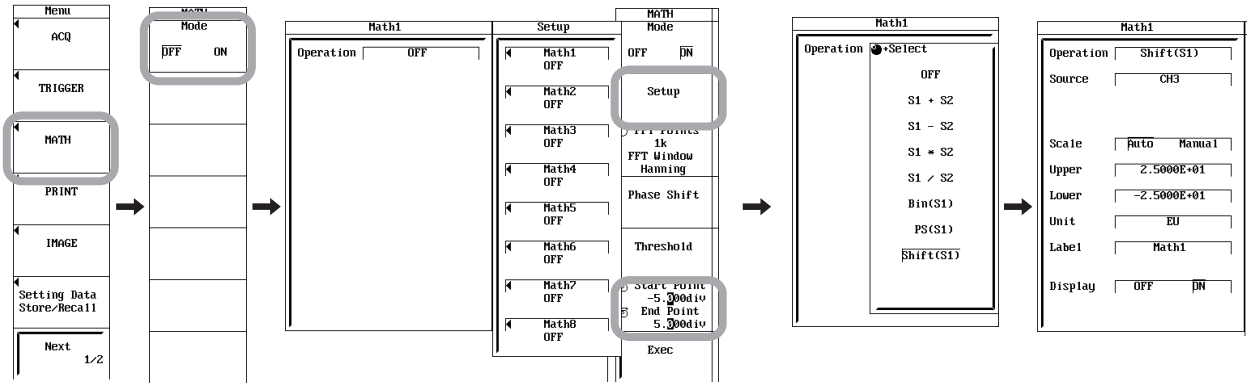
11. Use **jog shuttle+SELECT** to set Scale to Auto or Manual.
    If you select Manual, proceed to step 12; if you select Auto, proceed to step 14.

Setting the Upper and Lower Limits of Waveform Display (When Scale Is Set to Manual)

12. Use **jog shuttle+SELECT** to set Upper.
13. Likewise, set Lower.

Note

If you select Auto, you cannot set Upper and Lower.



Setting the Unit

14. Use **jog shuttle+SELECT** to set the Unit using up to four characters according to the procedure given in section 4.2.

Setting the Label

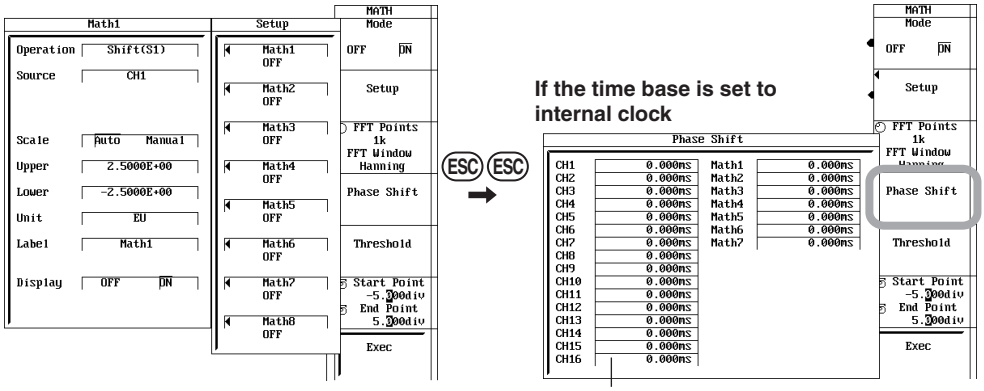
15. Use **jog shuttle+SELECT** to set the Label according to the procedure given in section 4.2. For a description of the Label display, see section 8.10, “Setting Waveform Labels.”

Turning ON/OFF the Math Waveform Display

16. Use **jog shuttle+SELECT** to set Display to ON or OFF.
17. Press **ESC** twice.

Selecting the Time (or the Number of Data Points) for Shifting the Phase

18. Press the **Phase Shift** soft key. The phase dialog box opens.
19. Use **jog shuttle+SELECT** to set the time (or number of data points) for shifting the phase of each waveform. If the time base is set to internal clock (Int), set the time for shifting the phase. If the time base is set to external clock (Ext), set the number of data points for shifting the phase.

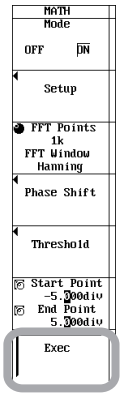


If the time base is set to external clock, the setup menu used to set the number of data points for shifting the phase appears.

As necessary, set Math2 to Math8 in a similar fashion.

Executing the Computation

20. Press the **Exec** soft key.



Explanation

The phase of CH1 to CH16 and Math1 to Math7 waveforms can be displayed with the phase shifted. Computation can also be performed on phase-shifted waveforms.

Computation range: Start Point/End Point

By default, the measurement range is ±5 divisions of the display frame on the time axis. You can limit this range.
The concept of the computation range is analogous to the concept of the selectable range of cursor display position in cursor measurement.
For details, see “Selectable Range of Cursor Position” in section 11.4.

Scaling

Set the upper and lower limits of the math waveform display.
Auto: The upper and lower limits are set according to the computed result.
Manual: The upper and lower limits can be set arbitrarily. The selectable range is –9.9999E+30 to 9.9999E+30.

Unit

Unit can be set arbitrarily using up to four characters. The specified characters are applied to the scale values.

Allowable Phase Shift Range

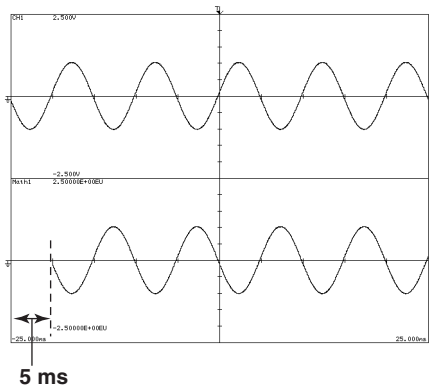
The phase can be shifted in the following range.

- **When the time base is set to internal clock**
  Selectable range: Time value of –(record length/2) to (record length/2)
  Resolution: 1/sample rate

- **When the Time Base Is Set to External Clock**
  Selectable range: –(record length/2) to (record length/2)
  Resolution: 1

When a Waveform That Results by Offsetting the CH1 Waveform by 5 ms Is Set to Math1

- Phase Shift CH1: 5 ms
- Math1 Operation: Shift (S1)
  Source1: CH1



Linear Scaling

When performing computation on a channel that has linear scaling set, the computation is performed on the scaled value.

Notes on Computation

Computation is not executed when you change Start Point or End Point while the computation is stopped. Be sure to press Exec to perform the computation again. If you do not, the waveform will not be displayed correctly when the screen is redrawn.

Note

When the waveform is displayed with the phase shifted,  is displayed at the upper left of the screen.

11.1 Displaying History Waveforms

<For a description of this function, refer to pages 2-30 and 2-43.>

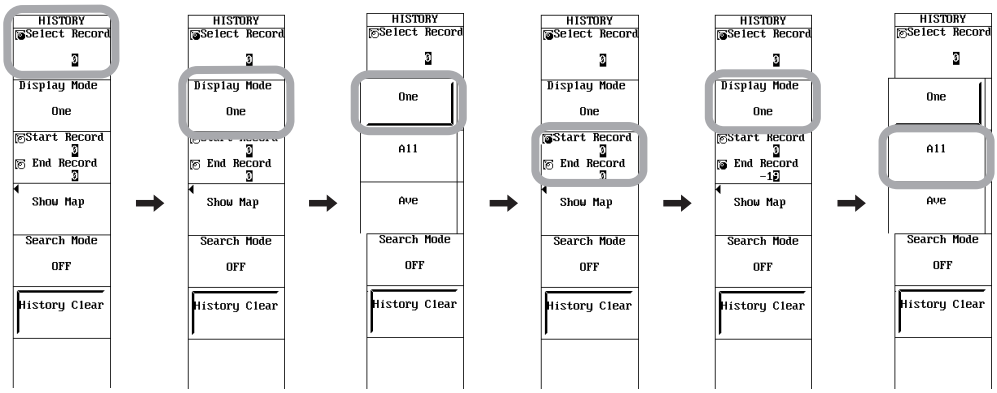
Procedure

Displaying the Waveform Data of a Selected Record

1. Press **HISTORY**.
2. Press the **Select Record** soft key.
3. Turn the **jog shuttle** to set the record No. you want to recall. Set the record No. in the range of Start Record to End Record.
4. Press the **Display Mode** soft key to select One.

Displaying All of the Selected Waveform Data

5. Press the **Start Record/End Record** soft key to set the jog shuttle control to Start Record.
6. Turn the **jog shuttle** to set the first record No. to be accumulated.
7. Likewise, set the last record No. (End Record) to be accumulated.
8. Press the **Display Mode** soft key to select All.
   The waveform data of record numbers specified in steps 5 to 7 are displayed accumulated.
   To abort the accumulated display, press the **Display Mode** soft key to select One.



Average Display of Selected Waveform Data

9. Press the **Start Record/End Record** soft key to set the jog shuttle control to Start Record.
10. Turn the **jog shuttle** to set the first record No. to be averaged.
11. Likewise, set the last record No. (End Record) to be averaged.
12. Press the **Display Mode** soft key to select Ave.
    The waveform data of record numbers specified in steps 9 and 10 are displayed averaged.
    To abort the average display, press the **Display Mode** soft key to select One.

Displaying a List of Time Stamps

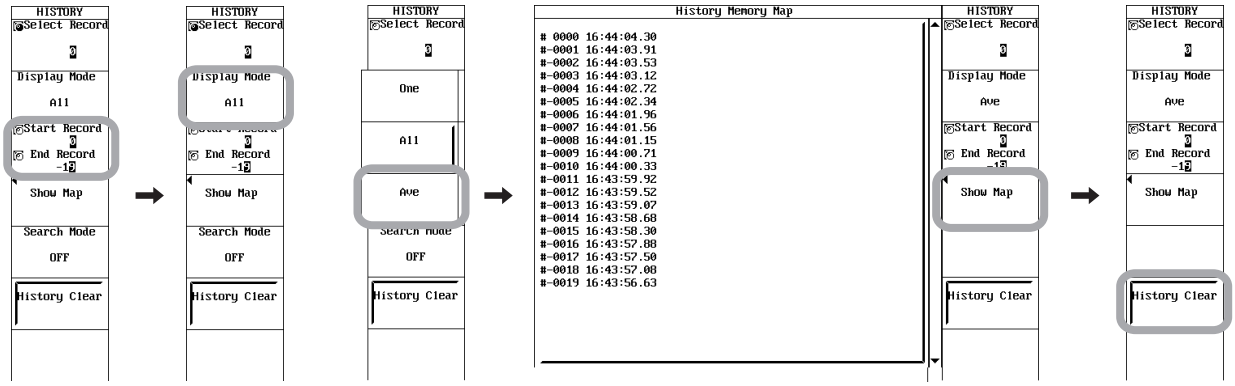
13. Press the **Show Map** soft key. A list of acquired data numbers and the time at acquisition end are displayed.
14. Turn the **jog shuttle** to select the history waveform you want to display and press **SELECT**.

Clearing the History Memory

15. Press the **History Clear** soft key. All the waveforms in the acquisition memory are cleared.

Note

Waveform acquisition cannot be started when the HISTORY menu is displayed.



Explanation

The acquisition memory retains waveform data of the last specified number of triggers. If a trigger is activated beyond the number of triggers that can be held, the oldest waveform data is cleared.

Selected Record No.

The selectable range is 0 to –(the number of retained waveforms – 1). The default value is 0. The most recent (current) waveform is 0, the waveform previous to that is –1, and so on.
The number of triggers that can be held varies depending on the selected record length. For details, see appendix 2.
If the trigger count is 1, only the displayed waveform is held in the acquisition memory; waveform data in the past are not held.

Display Mode

- **Display Waveform Data of a Single Record: One**
  Select the waveform to be displayed using Select Record in the range specified by Start Record and End Record.
- **Display All of the Selected Waveform Data: All**
  The waveform data specified by Start Record and End Record are displayed accumulated. The waveform data selected by Select Record is displayed brightly.
- **Average Display of the Selected Waveform Data: Ave**
  The waveform data specified by Start Record and End Record are displayed averaged.

Show Map (A List of History Maps)

You can list the number of the waveform data stored in the acquisition memory and the time at acquisition end. One screen displays 75 data points of information. You can scroll through the data by using the jog shuttle.

Clearing the Waveform Data

- Clears all the waveforms in the acquisition memory.
- Cleared waveforms cannot be recovered.

Notes When Setting the History Memory Function

- You cannot use the history memory function when realtime recording is in progress.
- You cannot use the history memory function, if the acquisition mode is Average.
- If you abort the waveform acquisition, the triggered waveform is displayed as a valid waveform.
- History records are not lost when waveform acquisition is stopped and then restarted, provided that acquisition conditions remain unchanged.
- If you change the acquisition settings, history memory is cleared when you restart acquisition using the new settings.
  For details on the waveform acquisition conditions, see section 7.1.
- Average display is not possible on the following waveforms.
  - Waveforms of a record length greater than equal to 1 MW.

Notes When Recalling Data Using the History Memory Function

- You cannot use the history memory function while waveform acquisition is in progress.
- You cannot restart the waveform acquisition when the HISTORY menu is displayed.
- Settings are restricted by the following condition: End Record ≤ Select Record ≤ Start Record.
- If you load a waveform record from the external storage medium, the loaded waveform becomes Record 0. In the case of multiple records (sequential store), the records will be loaded sequentially, with the most recent record as 0.
- Computation and automated measurement of waveform parameters are performed on the record No. specified by Select Record. Analysis of old data is possible as long as the history memory content remains unchanged after acquisition is restarted. However, for average display, computation is not performed again when you specify a different record.
- The time displayed in Show Map is the waveform trigger time. The information varies depending on the trigger mode as follows:

Trigger Mode	Condition	Time Displayed in Show Map
Auto/Auto Level	Roll mode	Stop time
Single	Roll mode, trigger not activated	Stop time
Log		Start time

- When displaying all waveforms, if the selected number of records is large, it may take an extended period for the display to complete. In this case,  is indicated at the upper left corner of the screen. To abort the operation, set Display Mode to One.
- Turning OFF the power clears the waveform data (history waveform) in the acquisition memory. However, if the acquisition memory backup is enabled, the data is backed up.
  For details on the acquisition memory backup function, see section 7.7.

11.2 Searching History Memory Data Using Zones (History Search Function)

<For a description of this function, refer to page 2-43.>

Procedure

1. Press **HISTORY**.
2. Press the **Search Mode** soft key. The search mode menu appears.
3. Press the **Zone** soft key.

Setting the Search Zone

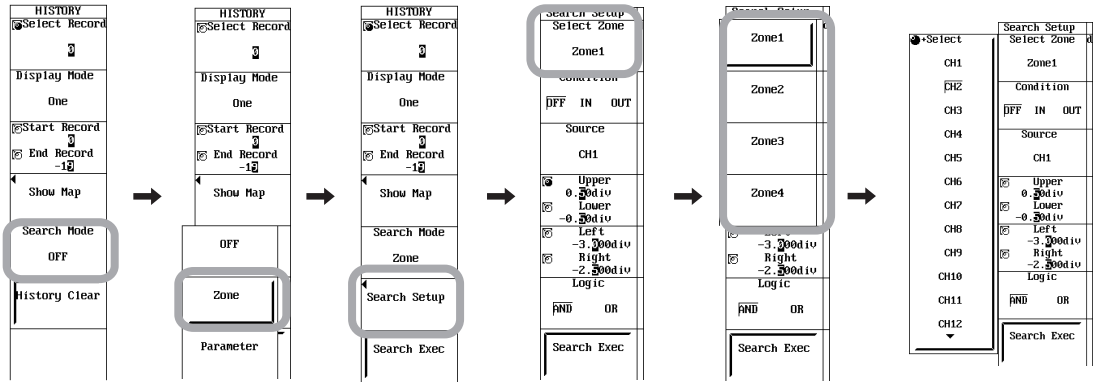
4. Press the **Search Setup** soft key. The search setup menu appears.
5. Press the **Select Zone** soft key. The search condition selection menu appears.
6. Press any of the **Zone1** to **Zone4** soft keys to select the zone to which to set the search condition.

Setting the Search Condition

7. Press the **Condition** soft key to select OFF, IN, or OUT.
   If you select IN or OUT, a search window appears in the area where the Source channel is displayed.

Setting the Source Channel

8. Press the **Source** soft key. The source channel selection menu appears.
9. Press the soft key corresponding to the desired channel to select the source channel.



Setting the Search Window

10. Press the **Upper/Lower** soft key to set the jog shuttle control to Upper.
11. Turn the **jog shuttle** to set the top of the search range. Pressing **RESET** resets the value to default.
12. Press the **Upper/Lower** soft key to set the jog shuttle control to Lower.
13. Turn the **jog shuttle** to set the bottom of the search range. Pressing **RESET** resets the value to default.
    By controlling both Upper and Lower using the **jog shuttle**, you can move the search window up and down without changing the vertical width.
14. Likewise, use the **Left/Right** soft key to set the horizontal range of the search window.
15. Repeat steps 5 to 13 to set Zone1 to Zone4.

Setting the Search Logic

16. Press the **Logic** soft key to select AND or OR.

Executing the Search

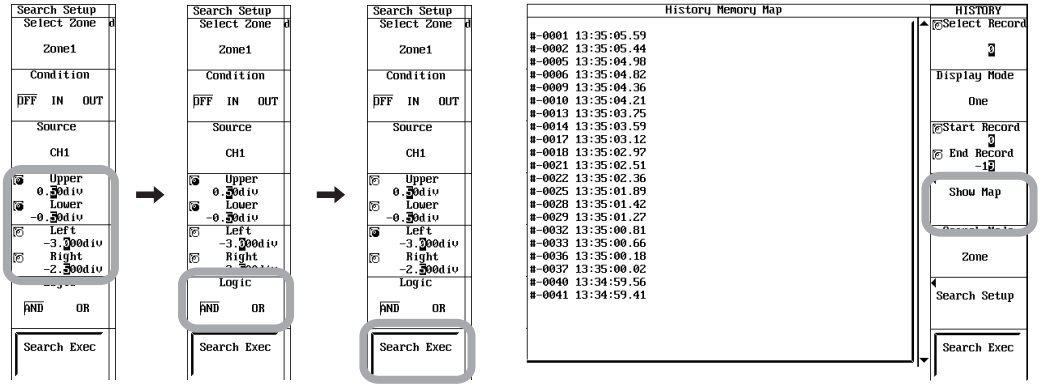
17. Pressing the **Search Exec** soft key to execute the search.
    While search is in execution,  is displayed at the upper left corner of the screen.

Displaying the Waveform That Are Found

18. Press the **ESC** to return to the HISTORY menu.
19. Press the **Show Map** soft key. A list of detected data numbers and the time at acquisition end are displayed.
20. Turn the **jog shuttle** to select the data you want to display and press **SELECT**. The waveform is displayed.

Resetting the Search Results

21. Turn OFF the Search Mode in the HISTORY menu or turn OFF Zone1 to Zone4 and execute the search to reset the search results.



Explanation

You can search for a waveform that matches the specified conditions from the past waveforms in the acquisition memory and display it.

Select Zone

Four types of search zones can be registered in Zone1 to Zone4. You can set the channel that is to be searched, the search condition, and the search range for each search zone.

Condition

IN: Searches for waveforms that pass through the specified search window.
OUT: Searches for waveforms that do not pass through the specified window.
OFF: Does not search for waveforms.

Source

Search is carried out on the channel that is specified as the Source. The channels that can be specified are CH1 to CH16. Waveforms of other channels are also displayed.

Vertical Range of Search Window (Upper/Lower)

The selectable range is ±5 divisions. The resolution is 0.01 divisions.
Upper must always be greater than or equal to Lower.

Horizontal Range of Search Window (Left/Right)

The selectable range is ±5 divisions. The resolution is (10 division/record length).
Right must always be greater than or equal to Left.

Logic

AND: Searches for waveforms that meet all search conditions from Zone1 to Zone4.
OR: Searches for waveforms that meet any one of the search conditions from Zone1 to Zone4.

Search Range

The search range is between the Start Record and the End Record.

Search Order

The search is carried out from the most recent waveform to the oldest waveform.

Show Map (A List of Time Stamps)

Only the waveforms that are found are listed in Show Map. If the Search Mode is turned OFF, all waveforms from Start Record to End Record are displayed.

11.3 Searching History Memory Data Using Parameters (History Search Function)

<For a description of this function, refer to page 2-43.>

Procedure

1. Press **HISTORY**.
2. Press the **Search Mode** soft key. The search mode menu appears.
3. Press the **Parameter** soft key.

Setting the Search Zone

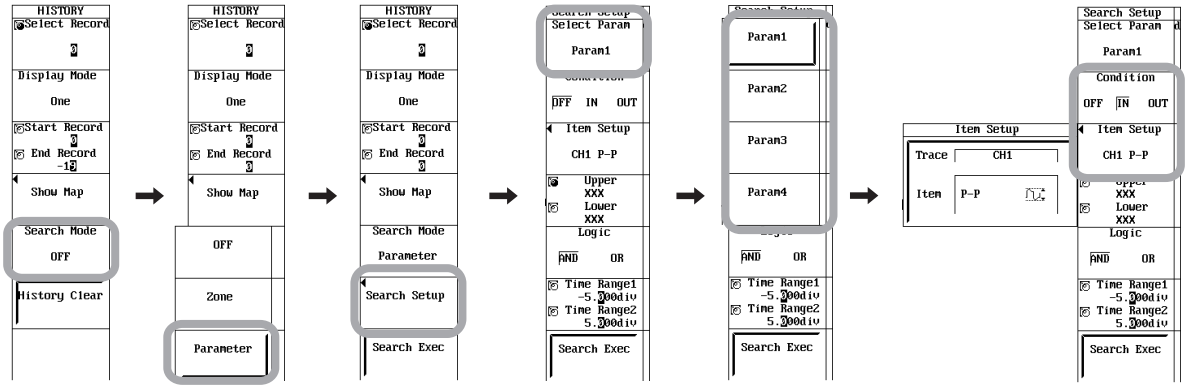
4. Press the **Search Setup** soft key. The search setup menu appears.
5. Press the **Select Param** soft key. The search condition selection menu appears.
6. Press any of the **Param1** to **Param4** soft keys to select the parameter to which to set the search condition.

Setting the Search Condition

7. Press the **Condition** soft key to select OFF, IN, or OUT.

Setting the Source Channel

8. Press the **Item Setup** soft key. The parameter selection menu appears.
9. Use **jog shuttle**+**SELECT** to select the trace channel.
10. Use **jog shuttle**+**SELECT** to select the parameter.



Setting the Range for Judging the Measured Values of Waveform Parameters

11. Press the **Upper/Lower** soft key to set the jog shuttle control to Upper.
12. Turn the **jog shuttle** to set the top of the search range. Pressing **RESET** resets the value to default.
13. Press the **Upper/Lower** soft key to set the jog shuttle control to Lower.
14. Turn the **jog shuttle** to set the bottom of the search range. Pressing **RESET** resets the value to default.
15. Repeat steps 5 to 14 to set Param1 to Param4.

Setting the Search Logic

16. Press the **Logic** soft key to select AND or OR.

Setting the Search Range of the Measured Values of Waveform Parameters

17. Press the **Time Range1/Time Range2** soft key to set the jog shuttle control to Time Range1.
18. Turn the **jog shuttle** to set the left edge of the measuring range. Pressing **RESET** resets the value to default.
19. Press the **Time Range1/Time Range2** soft key to set the jog shuttle control to Time Range2.
20. Turn the **jog shuttle** to set the right edge of the measuring range. Pressing **RESET** resets the value to default.

Executing the Search

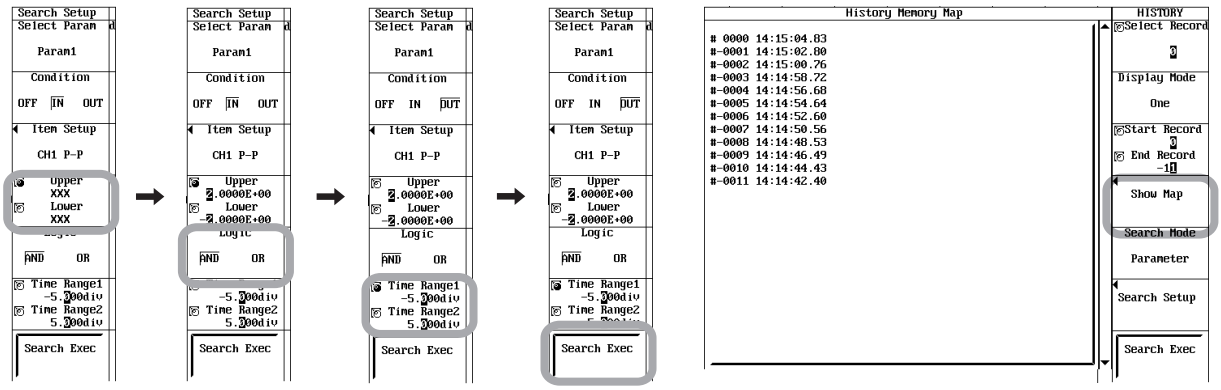
21. Pressing the **Search Exec** soft key to execute the search.
    While search is in execution,  is displayed at the upper left corner of the screen.

Displaying the Waveform That Are Found

22. Press the **ESC** to return to the HISTORY menu.
23. Press the **Show Map** soft key. A list of acquired data numbers and the time at acquisition end are displayed.
24. Turn the **jog shuttle** to select the data you want to display and press **SELECT**.

Resetting the Search Results

25. Turn OFF the Search Mode in the HISTORY menu or turn OFF Param1 to Param4 and execute the search to reset the search results.



Explanation

You can search for a waveform that matches the specified conditions from the past waveforms in the acquisition memory and display it.

Search Parameter (Select Param)

Four types of search parameters can be registered in Parameter1 to Parameter4. You can set the channel that is to be searched, the search condition, and the search range for each search parameter.

Condition

IN: Searches for waveforms entering the specified range of the specified parameter.
OUT: Searches for waveforms extending the specified range of the specified parameter.
OFF: Does not search for waveforms.

Waveform Parameter (Item Setup)

Assign search parameters to each trace channel. Choose one of the automated waveform measurement parameter.

Range for Judging the Measured Values of Waveform Parameters (Upper/Lower)

The selectable range is –9.9999E+30 to 9.9999E+30.

Logic

AND: Searches for waveforms that meet all search conditions from Param1 to Param4.
OR: Searches for waveforms that meet any one of the search conditions from Param1 to Param4.

Search Range of the Measured Values of Waveform Parameters (Time Range1/ Time Range2)

The selectable range is ±5 divisions. The resolution is 10 divisions/record length.
Time Range2 must be greater than or equal to Time Range2.

Search Range

The search range is between the Start Rec and the End Rec.

Search Order

The search is carried out from the most recent waveform to the oldest waveform.

Show Map (A List of Time Stamps)

Only the waveforms that are found are listed in Show Map. If the Search Mode is turned OFF, all waveforms from Start Record to End Record are displayed.

11.4 Measuring Waveforms Using Cursors

<For a description of this function, refer to page 2-44.>

Procedure

For H (Horizontal) Cursors (When Not Displaying the X-Y Waveform)

1. Press **CURSOR**.

Selecting the Cursor Type

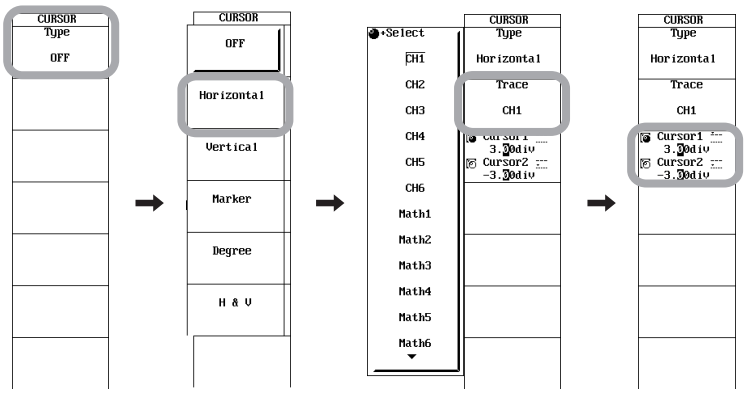
2. Press the **Type** soft key. The cursor type selection menu appears.
3. Press the **Horizontal** soft key.

Selecting the Waveform to Be Measured

4. Press the **Trace** soft key. The trace selection menu appears.
5. Use **jog shuttle+SELECT** to select the waveform to be measured.

Moving the Cursor

6. Press the **Cursor1/Cursor2** soft key to set the jog shuttle control to Cursor1.
7. Turn the **jog shuttle** to move Cursor1.
8. Likewise, move Cursor2. If the jog shuttle control is set to both Cursor1 and Cursor2, both cursors are moved.



For V (Vertical) Cursors (When Not Displaying the X-Y Waveform)

1. Press **CURSOR**.

Selecting the Cursor Type

2. Press the **Type** soft key. The cursor type selection menu appears.
3. Press the **Vertical** soft key.

Selecting the Waveform to Be Measured

4. Press the **Trace** soft key. The trace selection menu appears.
5. Use **jog shuttle+SELECT** to select the waveform to be measured.
   If you set the waveform to be measured to All, LogicA, LogicB, or LogicA & LogicB, proceed to step 6. If not, proceed to step 9.

Setting the Logic (When Trace Is Set to All, LogicA, LogicB, or LogicA & LogicB)

6. Press the **Logic Setup** soft key. The logic setup menu appears.

Selecting the Notation of Cursor Measurement Values

7. Use **jog shuttle**+**SELECT** to set Format to Binary or Hexa.

Note

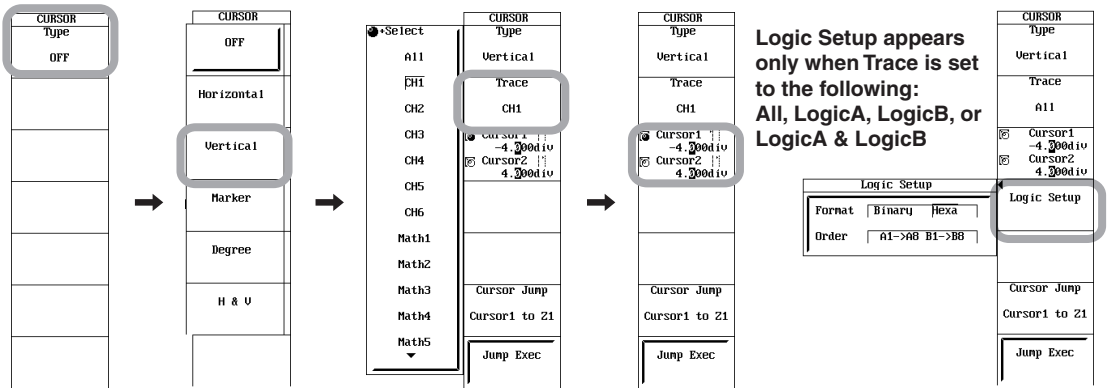
The notation selected in step 7 applies to the notation of the numeric monitor display that is shown on the right side of the screen. For the procedure of displaying the numeric monitor, see section 8.13.

Selecting the Read Direction of Bit Data

8. Use **jog shuttle**+**SELECT** to set Order to A1->A8 or B1->B8.

Moving the Cursor

9. Press the **Cursor1/Cursor2** soft key to set the jog shuttle control to Cursor1.
10. Turn the **jog shuttle** to move Cursor1.
11. Likewise, move Cursor2. If the jog shuttle control is set to both Cursor1 and Cursor2, both cursors are moved.



For Marker Cursors (When Not Displaying the X-Y Waveform)

1. Press **CURSOR**.

Selecting the Cursor Type

2. Press the **Type** soft key. The cursor type selection menu appears.
3. Press the **Marker** soft key.

Selecting the Marker

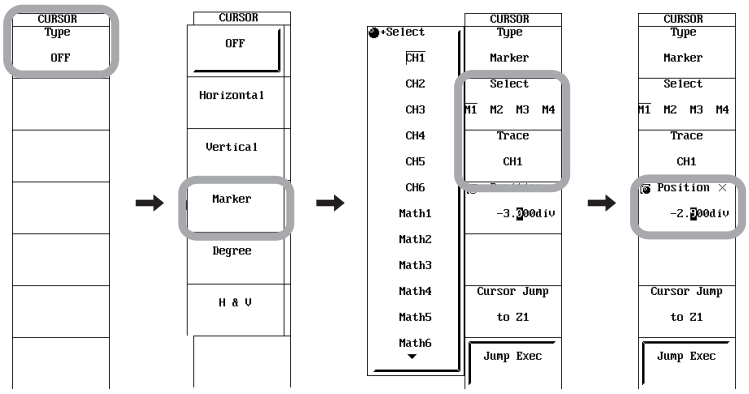
4. Press the **Select** soft key to select the desired marker from M1 to M4.

Selecting the Waveform to Be Measured

5. Press the **Trace** soft key. The trace selection menu appears.
6. Use **jog shuttle+SELECT** to select the waveform to be measured.

Moving the Cursor

7. Press the **Position** soft key and turn the **jog shuttle** to move the cursor As the cursor is moved, the displayed value of Position changes.



For Angle (Degree) Cursors (When Not Displaying the X-Y Waveform)

1. Press **CURSOR**.

Selecting the Cursor Type

2. Press the **Type** soft key. The cursor type selection menu appears.
3. Press the **Degree** soft key.

Selecting the Waveform to Be Measured

4. Press the **Trace** soft key. The trace selection menu appears.
5. Use **jog shuttle+SELECT** to select the waveform to be measured.

Moving the Cursor

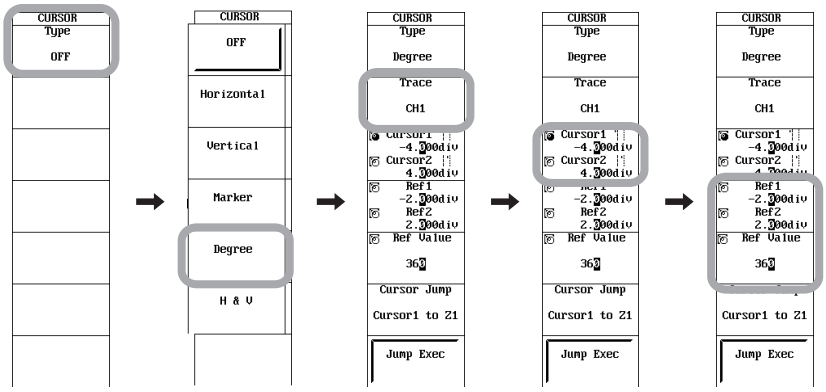
6. Press the **Cursor1/Cursor2** soft key to set the jog shuttle control to Cursor1.
7. Turn the **jog shuttle** to move Cursor1.
8. Likewise, move Cursor2. If the jog shuttle control is set to both Cursor1 and Cursor2, both cursors are moved.

Moving the Reference Cursor

9. Press the **Ref1/Ref2** soft key to set the jog shuttle control to Ref1.
10. Turn the **jog shuttle** to move Ref1.
11. Likewise, move Ref2. If the jog shuttle control is set to both Ref1 and Ref2, both cursors are moved.

Setting the Reference Angle

12. Press the **Ref Value** soft key.
13. Turn the **jog shuttle** to set the reference angle in the range of 1 to 720.



For H&V Cursors (When Not Displaying the X-Y Waveform)

1. Press **CURSOR**.

Selecting the Cursor Type

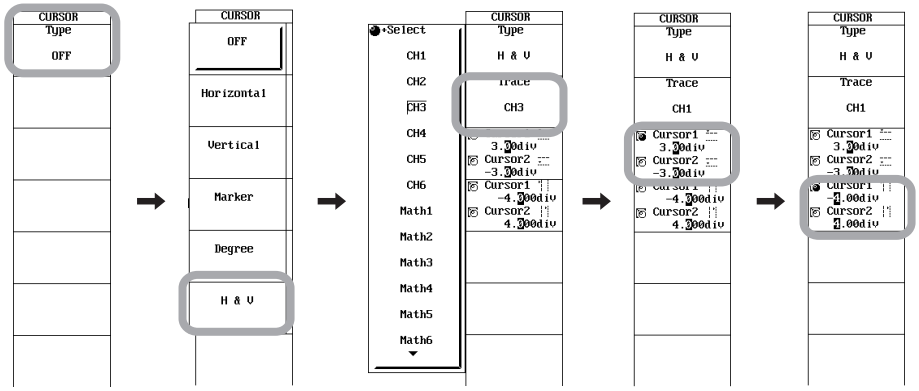
2. Press the **Type** soft key. The cursor type selection menu appears.
3. Press the **H&V** soft key.

Selecting the Waveform to Be Measured

4. Press the **Trace** soft key.
5. Use **jog shuttle+SELECT** to select the waveform to be measured.

Moving the Cursor

6. Press the **Cursor1** /**Cursor2** soft key to set the jog shuttle control to Cursor1.
7. Turn the **jog shuttle** to move Cursor1.
8. Likewise, move Cursor2. If the jog shuttle control is set to both Cursor1 and Cursor2, both cursors are moved.
9. Move Cursor1 and Cursor2 by carrying out steps similar to steps 6 to 8.



Cursor Jump (When the Cursor is Vertical, Marker, or Angle and When Not Displaying the X-Y Waveform)

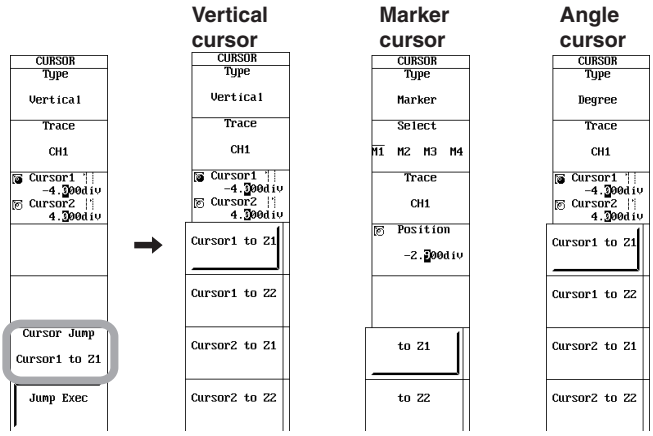
1. Follow steps 1-3 on the previous pages to set the Type to Vertical, Marker, or Degree.

Setting Jumps

2. Press the **Cursor Jump** soft key. A menu for selecting the cursor to be jumped and the jump destination appears.
3. Press the soft key corresponding to the type of jump to select the desired cursor and the destination.

Executing the Jump

4. Press the **Jump Exec** soft key. The cursor moves to the jump destination screen.



For Horizontal (H) Cursors (When Displaying the X-Y Waveform)

1. Press **CURSOR**.

Selecting the Cursor Type

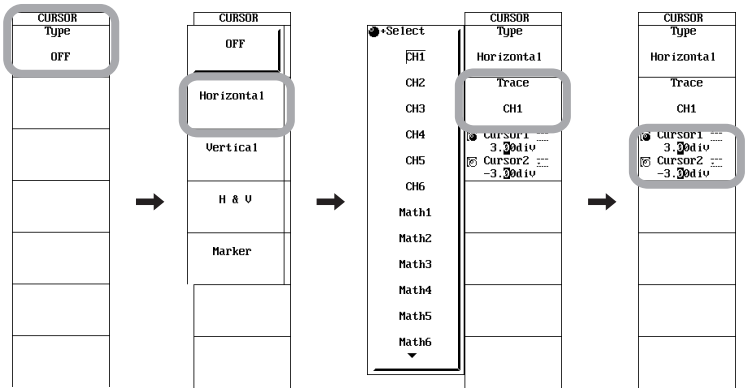
2. Press the **Type** soft key. The cursor type selection menu appears.
3. Press the **Horizontal** soft key.

Selecting the Waveform to Be Measured

4. Press the **Trace** soft key.
5. If X Axis of the DISPLAY menu is set to Single, use **jog shuttle**+**SELECT** to select the trace. If X Axis is set to Quad, press the soft key corresponding to the X-Y waveform (XY1 to XY4) to select the waveform to be measured.

Moving the Cursor

6. Press the **H Cursor1/H Cursor2** soft key to set the jog shuttle control to Cursor1.
7. Turn the **jog shuttle** to move Cursor1.
8. Likewise, move Cursor2. If the jog shuttle control is set to both H Cursor1 and H Cursor2, both cursors are moved.



For Vertical (V) Cursors (When Displaying the X-Y Waveform)

1. Press **CURSOR**.

Selecting the Cursor Type

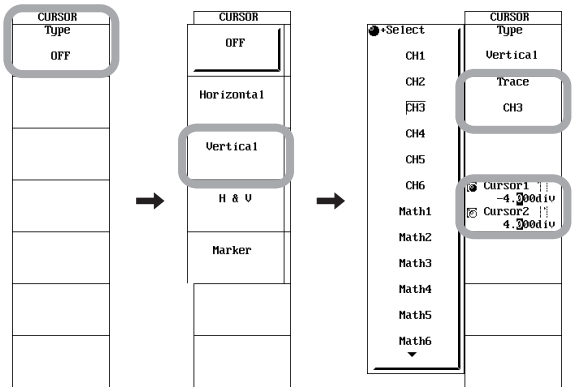
2. Press the **Type** soft key. The cursor type selection menu appears.
3. Press the **Vertical** soft key.

Selecting the Waveform to Be Measured

4. Press the **Trace** soft key.
5. If X Axis of the DISPLAY menu is set to Single, the channel specified by X trace of the DISPLAY menu is displayed. Since this setting is for viewing purpose only, you cannot change it.
   If X Axis is set to Quad, press the soft key corresponding to the X-Y waveform (XY1 to XY4) to select the waveform to be measured.

Moving the Cursor

6. Press the **V Cursor1/V Cursor2** soft key to set the jog shuttle control to V Cursor1.
7. Turn the **jog shuttle** to move V Cursor1.
8. Likewise, move V Cursor2. If the jog shuttle control is set to both V Cursor1 and V Cursor2, both cursors are moved.



For H&V Cursors (When Displaying the X-Y Waveform)

1. Press **CURSOR**.

Selecting the Cursor Type

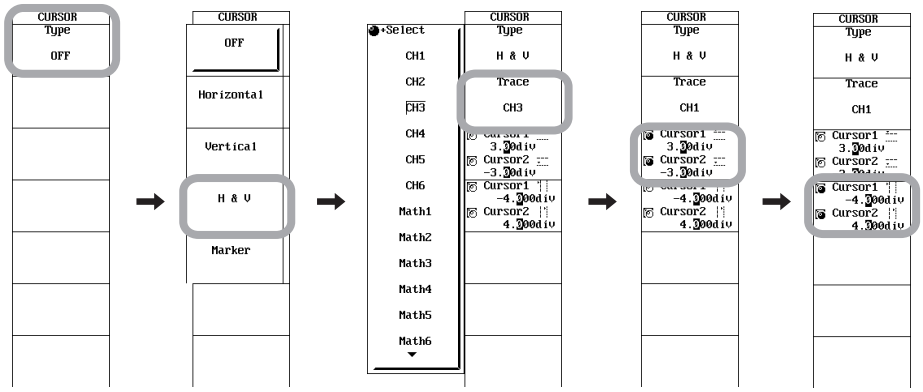
2. Press the **Type** soft key. The cursor type selection menu appears.
3. Press the **H&V** soft key.

Selecting the Waveform to Be Measured

4. Press the **Trace** soft key.
5. If X Axis of the DISPLAY menu is set to Single, use **jog shuttle**+**SELECT** to select the trace. If X Axis is set to Quad, press the soft key corresponding to the X-Y waveform (XY1 to XY4) to select the waveform to be measured.

Moving the Cursor

6. Press the **Cursor1** /**Cursor2** soft key to set the jog shuttle control to Cursor1.
7. Turn the **jog shuttle** to move Cursor1.
8. Likewise, move Cursor2. If the jog shuttle control is set to both H Cursor1 and H Cursor2, both cursors are moved.
9. Move Cursor1 and Cursor2 by carrying out steps similar to steps 6 to 8.



For Marker Cursors (When Displaying the X-Y Waveform)

1. Press **CURSOR**.

Selecting the Cursor Type

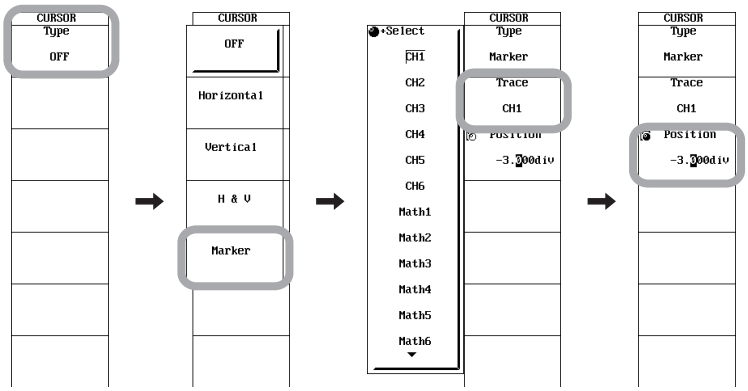
2. Press the **Type** soft key. The cursor type selection menu appears.
3. Press the **Marker** soft key.

Selecting the Waveform to Be Measured

4. Press the **Trace** soft key.
5. If X Axis of the DISPLAY menu is set to Single, use **jog shuttle**+**SELECT** to select the trace. If X Axis is set to Quad, press the soft key corresponding to the X-Y waveform (XY1 to XY4) to select the waveform to be measured.

Moving the Cursor

6. Press the **Position** soft key.
7. Turn the **jog shuttle** to move Position.
   As the cursor is moved, the displayed value of Position changes.



Note

The marker is displayed for the Y Trace (target Y-axis waveform) specified in the DISPLAY menu.

Explanation

Limitations

Cursor measurements cannot be made on the following waveforms.

- Snapshot waveforms
- Accumulated waveforms other than the most recent waveform.

Cursor Types and Measurement Items: Type (When Not Displaying the X-Y Waveform)

- **H (Horizontal) Cursor**
  Measures the Y-axis value at the cursor position.

Y1	The Y-axis value at Cursor1
Y2	The Y-axis value at Cursor2
ΔY	The difference between the Y-axis values at Cursor1 and Cursor2

- **V (Vertical) Cursor**

  Measures the X-axis value at the cursor position.

X1	The X-axis value at Cursor1
X2	The X-axis value at Cursor2
ΔX	The difference between the X-axis values at Cursor1 and Cursor2
1/ΔX	The inverse or the difference between the X-axis values at Cursor1 and Cursor2
Y1	The Y-axis value at Cursor1
Y2	The Y-axis value at Cursor2
ΔY	The difference between the Y-axis values at Cursor1 and Cursor2

- **Marker Cursors**

  Move the cursor on the waveform data and measure the value of each point on the waveform. M1 (Marker 1) to M4 (Marker 4) can be set on different waveforms.

Y1 to Y4	The Y-axis values of M1 to M4
ΔY2	The difference between the Y-axis values of M1 and M2
ΔY3	The difference between the Y-axis values of M1 and M3
ΔY4	The difference between the Y-axis values of M1 and M4
X1 to X4	The X-axis values of M1 to M4
ΔX2	The difference between the X-axis values of M1 and M2
ΔX3	The difference between the X-axis values of M1 and M3
ΔX4	The difference between the X-axis values of M1 and M4

- **Angle Cursor (Degree)**

  Set the measurement zero point (position of reference cursor Ref1) and the end point (position of the reference cursor Ref2) on the X-axis within the screen and assign an angle corresponding to the width of Ref1 and Ref2. Using this angle as a reference, this function measures the angle of the two angle cursors (Cursor1 and Cursor2).

X1	The angle of Cursor1 from Ref1
X2	The angle of Cursor2 from Ref1
ΔX	The angle difference between Cursor1 and Cursor2
Y1	The Y-axis value at Cursor1
Y2	The Y-axis value at Cursor2
ΔY	The difference between the Y-axis values at Cursor1 and Cursor2
Range of reference width	1 to 720°

- **H&V Cursor**

  Measures the Y-axis and X-axis values at the cursor position.

Y1	The Y-axis value at horizontal Cursor1
Y2	The Y-axis value at horizontal Cursor2
ΔY	The difference between the Y-axis values at horizontal Cursor1 and horizontal Cursor2
X1	The X-axis value at vertical Cursor1
X2	The X-axis value at vertical Cursor2
ΔX	The difference between the X-axis values at vertical Cursor1 and vertical Cursor2

Cursor Types and Measurement Items: Type (When Displaying the X-Y Waveform)

- **H (Horizontal) Cursor**

  Measures the Y-axis value at the cursor position.

Y1	The Y-axis value at H Cursor1
Y2	The Y-axis value at H Cursor2
ΔY	The difference between the Y-axis values at H Cursor1 and H Cursor2

- **V (Vertical) Cursor**
  Measures the X-axis value at the cursor position.

X1	The X-axis value at V Cursor1
X2	The X-axis value at V Cursor2
ΔX	The difference between the X-axis values at V Cursor1 and V Cursor2

- **H&V Cursor**
  Measures the Y-axis and X-axis value at the cursor position.

Y1	The Y-axis value at H Cursor1
Y2	The Y-axis value at H Cursor2
ΔY	The difference between the Y-axis values at H Cursor1 and H Cursor2
X1	The X-axis value at V Cursor1
X2	The X-axis value at V Cursor2
ΔX	The difference between the X-axis values at V Cursor1 and V Cursor2

- **Marker Cursors**
  Move the cursor on the waveform data and measure the value of each point on the waveform.

T	Display the time difference from the trigger point at the cursor
X	The X-axis value at Cursor
Y	The Y-axis value at Cursor

Movement Range of the Cursors (When Not Displaying the X-Y Waveform)

- **H Cursor**
  Can be set in the range of ±5 divisions. The resolution is 0.01 division.
- **V Cursor, Marker Cursor, and Angle Cursor**
  Can be set in the range of ±5 divisions. The resolution is 10 divisions/record length.

Movement Range of the Cursors (When Displaying the X-Y Waveform)

- **H Cursor, V Cursor, and H&V Cursor**
  Can be set in the range of ±5 divisions. The resolution is 0.01 division.
- **Marker Cursors**
  Can be set in the range of ±5 divisions. The resolution is 10 divisions/record length.

Display Format of Logic Waveforms (When Not Displaying the X-Y Waveform)

You can set the following items when measuring logic waveforms using V cursors.

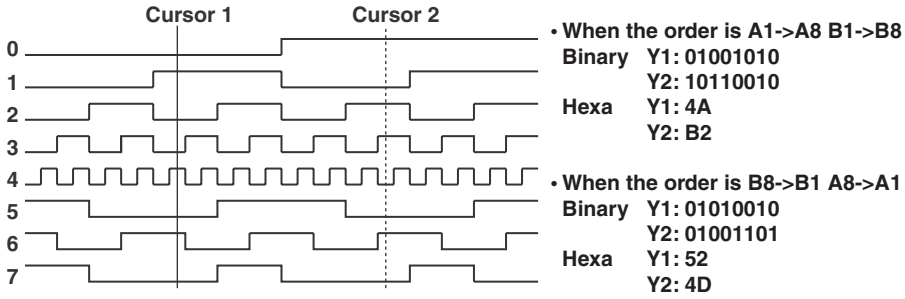
- **Selecting the Notation of Cursor Measurement Values: Format**
  Select the notation system used to display cursor measurement values.
  Binary: Displays values in binary notation.
  Hexa: Displays values in hexadecimal notation.
- **Read Direction of Bit Data: Order**
  Select the direction of reading the bit data of the logic input.
  A1->A8 B1->B8: Bit 1 to bit 8 of LogicA, bit 1 to bit 8 of LogicB
  B8->B1 A8->A1: Bit 8 to bit 1 of LogicB, bit 8 to bit 1 of LogicA

- **Combining of the Bit Data**
  The data of LogicA and LogicB can be combined and handled as 16-bit data.
- **Handling of the OFF Bit**
  - In binary notation, a dash is displayed at the bit.
  - In hexadecimal notation, value is displayed as though the bit does not exist.

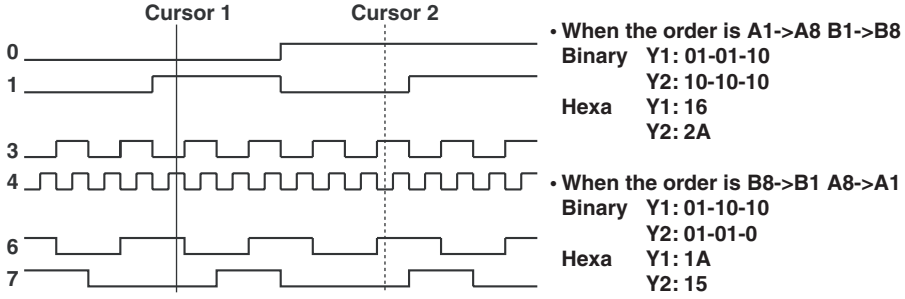
Measurement Example of Logic Waveforms

The values of measurement parameters Y1 and Y2 when the logic waveform is measured using vertical cursors are as follows.

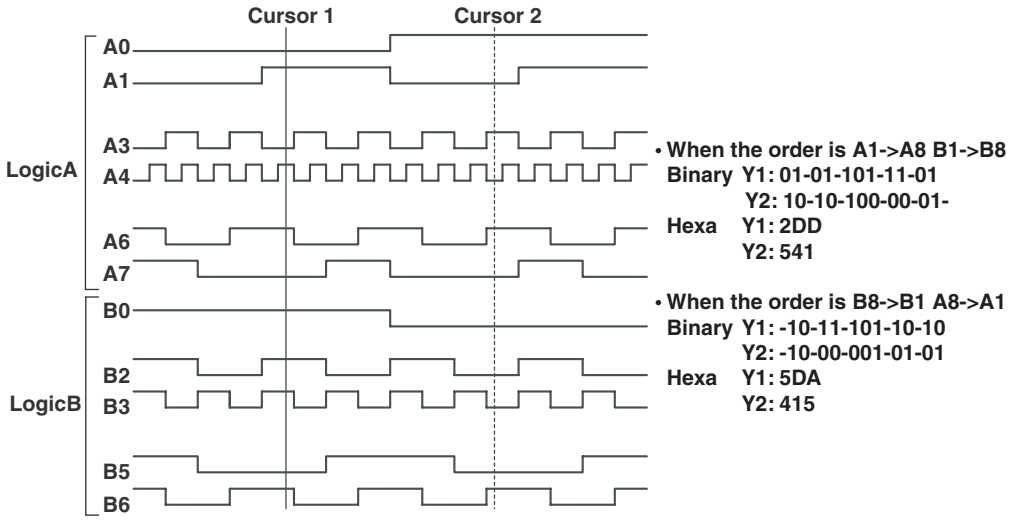
- **When LogicA or LogicB is measured by itself and OFF bits do not exist**



- **When LogicA or LogicB is measured by itself and OFF bits exist**



- **When LogicA & LogicB (combined data of LogicA and LogicB) is measured and OFF bits exist**



Cursor Jump (When Not Displaying the X-Y Waveform)

For V cursors, marker cursors, and angle cursors, you can move M1 to M4, Cursor1, and Cursor2 to the center of the zoom window. The cursors can be jumped in the following manner.

- **Marker Cursors**

to Z1	Make the selected marker jump to the Z1 window.
to Z2	Make the selected marker jump to the Z2 window.

- **V Cursor and Angle Cursor**

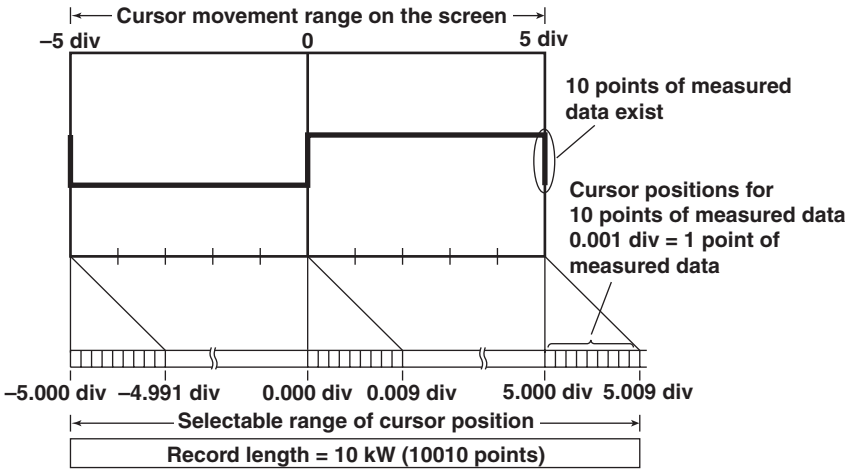
C1 to Z1	Make Cursor1 jump to the Z1 window
C1 to Z2	Make Cursor1 jump to the Z2 window
C2 to Z1	Make Cursor2 jump to the Z1 window
C2 to Z2	Make Cursor2 jump to the Z2 window

Notes When Making Cursor Measurements

- The time axis values are measured from the trigger position.
- The measured value will display "***," if the measurement is not possible.
- The pulse/rotate setting (see section 5.20) is applied to the X-axis (horizontal) measurement values in cursor measurements.

Selectable Range of Cursor Position

In cursor measurements, measurement is performed on the data stored in the acquisition memory not on the displayed data. Since 1001 points along the time axis are used to displayed the waveform, the number of acquired data points is equal to "record length × 1.001." If the record length is set to 10 kW, the number of acquired data points is 10010. Therefore, 10 points of measured data will exist at the same position on the screen. The movement range of the cursor position is normally within ±5 divisions around the center position of the waveform display frame. In this case, if the cursor display position is set to +5 div, only 1 point out of 10 points can be measured even if there are 10 points of measured data at the same time axis position. In such case, the cursor position can be set in the range of –5 divisions to +5.009 divisions (if the record length is set to 10 kW). In other words, the data at the right end of the waveform display frame can be measured by setting the cursor position in the range of 5.000 to 5.009 divisions. Because the number of points at the same time axis position increases as the record length gets larger, the range varies depending on the record length (5.000 to 5.0099 divisions for 100 kW).



11.5 Automated Measurement of Waveform Parameters

<For a description of this function, refer to page 2-45.>

Procedure

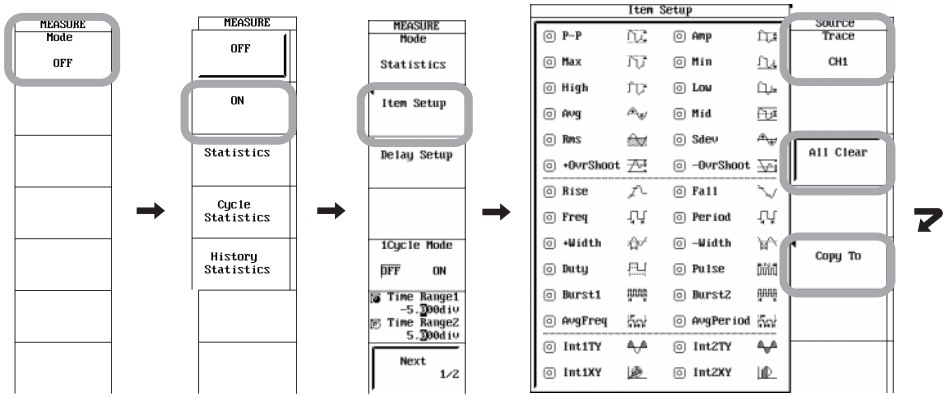
1. Press **MEASURE**.
2. Press the **Mode** soft key , and press the ON soft key.

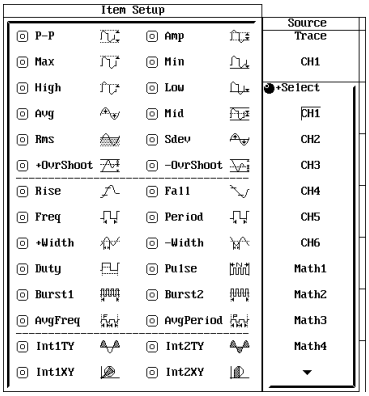
Selecting the Measurement Parameter

3. Press the **Item Setup** soft key. The measurement parameter setup dialog box appears.

- **Selecting the Waveform to Be Measured**
  4. Press the **Trace** soft key. The trace selection menu appears.
  5. Use **jog shuttle**+**SELECT** to select waveform to be measured from CH1 to CH6 or Math1 to Math8.

- **Selecting the Measurement Parameter**
  6. Use **jog shuttle**+**SELECT** to turn ON/OFF each item on the measurement parameter dialog box.
     You can turn OFF all parameters at once by pressing the **All Clear**.
     You can copy the current parameter settings to all traces by pressing the **Copy to All Trace** soft key.
  7. Repeat steps 4 to 6 as many times as necessary.





Setting the Delay

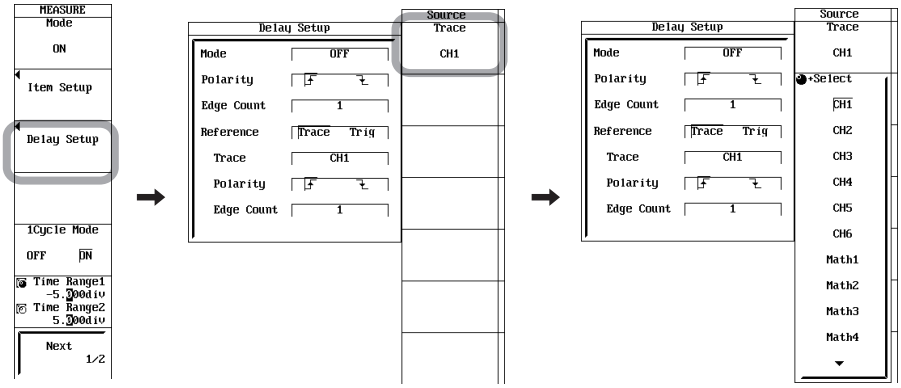
8. Press the **Delay Setup** soft key. The Delay Setup dialog box appears.

- **Selecting the Waveform to Be Measured**

9. Press the **Trace** soft key. The trace selection menu appears.
10. Use **jog shuttle**+**SELECT** to select waveform to be measured.

- **Setting the Delay**

11. Use **jog shuttle**+**SELECT** to set Mode of the Delay Setup dialog box to Time, Degree, or OFF.
12. Use **jog shuttle**+**SELECT** to set Polarity under Measure to ⎍ (rising edge) or ⎎ (falling edge).
13. Use **jog shuttle**+**SELECT** to set Edge Count under Measure.
14. Use **jog shuttle**+**SELECT** to select whether the trace or the trigger is to be the reference. If you select Trace, proceed to step 15.
15. Use **jog shuttle**+**SELECT** to set Trace under Reference.
16. Use **jog shuttle**+**SELECT** to set Polarity under Reference to ⎍ (rising edge) or ⎎ (falling edge).
17. Use **jog shuttle**+**SELECT** to set Edge Count under Reference.



Setting the 1 Cycle Mode

18. Press the **1Cycle Mode** soft key to select ON or OFF.

Setting the Measurement Range

19. Press the **Time Range1/Time Range2** soft key to set the jog shuttle control to Time Range1.
20. Turn the **jog shuttle** to set the measurement start point.
21. Likewise, set Time Range2 (measurement end point).

Note

Up to 10 MW from the measurement start point (Time Range1) are measured.

Selecting the Target Waveform for Distal, Mesial, and Proximal Points

22. Press the **Next 1/2** soft key
23. Press the **Trace** soft key. The trace selection menu appears.
24. Press the soft key corresponding to the desired waveform to select the target waveform.

Setting the Distal, Mesial, and Proximal Unit

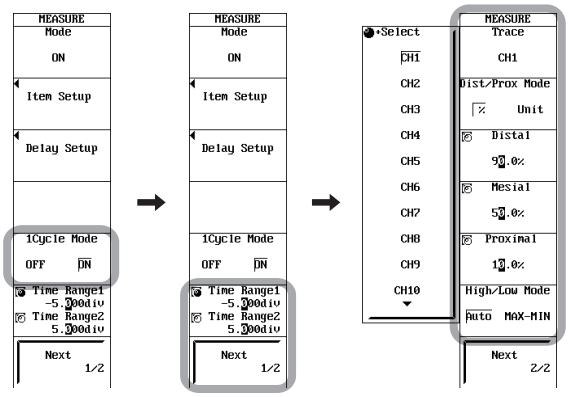
25. Press the **Dist/Prox Mode** soft key to set the unit for distal, mesial, and proximal points to % or Unit.

Setting Distal, Mesial, and Proximal

26. Press the **Distal**, **Mesial**, or **Proximal** soft key.
27. Turn the **jog shuttle** to set the distal, mesial, or proximal point.

Selecting the High and Low Setting

28. Press the **High/Low Mode** soft key to select Auto or MAX-MIN.



Explanation

Limitations

Automated measurement of waveform parameters cannot be performed on the following waveforms.

- Snapshot waveforms
- Accumulated waveforms other than the most recent waveform.

Measurement Parameters (Item Setup)

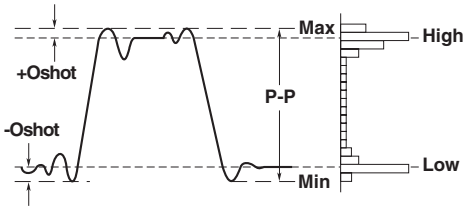
You can select among the 28 types of measurement parameters shown below and delay between channels. Up to 48000 combinations of parameters of all traces (CH1 to CH16 and Math1 to Math8) can be saved.

- **Voltage-axis Parameters**

P-P : Peak to Peak Value (MAX - MIN) [V]
Max : Maximum Voltage [V]
Min : Minimum Voltage [V]
Rms[1]: Root Mean Square Value $(1/\sqrt{n})(\Sigma(xi)^2)^{1/2}$ [V]
Avg : Average Voltage (1/n)Σxi [V]
Sdev: Standard Deviation (SDv)[2] $(1/n(\Sigma xi^2 - (\Sigma xi)^2/n))^{1/2}$ [V]

–Ovr shoot (–Ovr)[1] : Undershoot Value (LOW - MIN)/(HIGH - LOW) x 100 [%]
+Ovr shoot (+Ovr)[1] : Overshoot Value (MAX - HIGH)/(HIGH - LOW) x 100[%]
High : High Level Voltage [V]
Low : Low Level Voltage [V]
Amp : Amplitude (High-Low) [V]
Mid : (MAX+MIN)/2

1. If Rms is ON on the channels (Math1 to Math8) on which power spectrum computation (PS) is selected, the screen shows "Rms = overall value." For details on the power spectrum computation and overall value, see section 10.3.
2. ( ) shows the corresponding name at the measurement item setting screen.

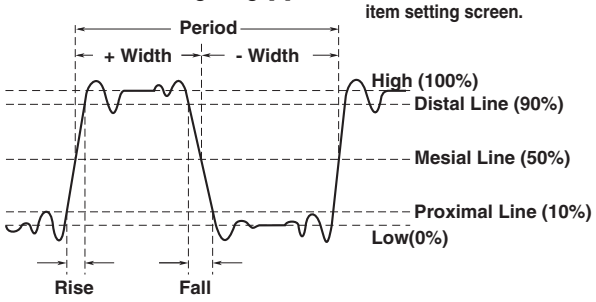


- **Time-axis Parameters**

Rise : Rise Time [s]
Fall : Fall Time [s]
Freq : Frequency [Hz],1/PERIOD
Period (Prod)[1] : Period [s]
Avg Freq (FR-A)[1] : Mean Frequency in Measuring Range[Hz]
Avg Period (PR-A)[1]: Mean Period in Measuring Range[s]

+Width (+Wd)[1] : Width (s) Greater than the Mesial Value
–Width (–Wd)[1] : Width (s) Smaller than the Mesial Value
Duty : Duty Ratio + Width/Period x 100[%]

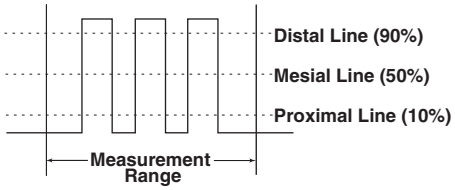
1. ( ) shows the corresponding name at the measurement item setting screen.



Pulse (PlsN) : Pulse Count

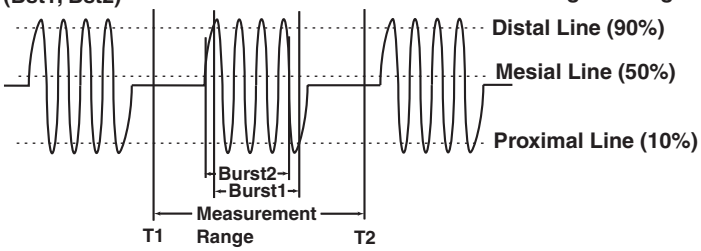
When Pulse=3

Set the measurement range (T-Range) to match the pulse width of the signal being measured.



Automated measurement of various waveform parameters are performed on the data stored to the acquisition memory. Up to 48000 data points among the parameters that are automatically measured can also be saved to a file. For details, see section 13.11.

Burst1, Burst2: Burst Width [S] (Bst1, Bst2) **Set the measurement range (T-Range) to match the burst width of the signal being measured.**

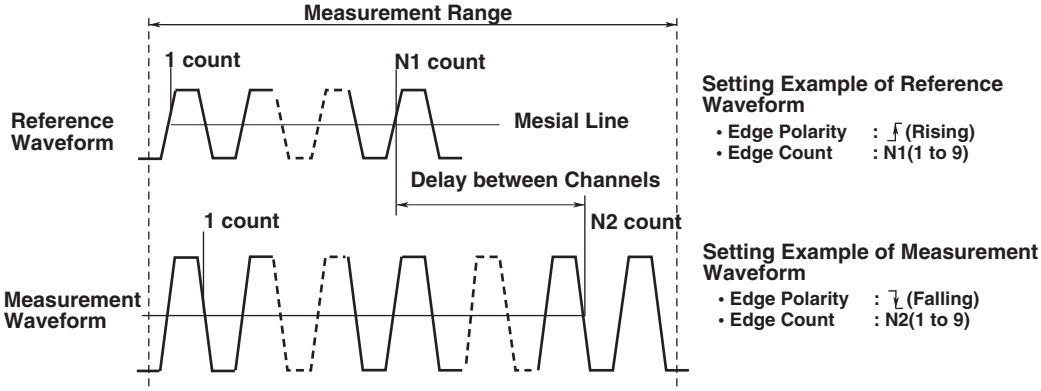


- **Other Measurement Parameters**
  - Int1TY: The area under the positive amplitude
  - Int2TY: The area under the positive amplitude – the area under the negative amplitude
  - Int1XY: The summation of the triangular area of the X-Y waveform
  - Int2XY: The summation of the trapezoidal area of the X-Y waveform

  For details regarding the area calculations, see Appendix 4.

Setting the Delay

The time difference between the rising or falling edges of trace waveforms or trigger points is called the delay between channels.



- If Mode is set to Time or Degree, the delay is measured. The default setting is OFF.
  - Time: Display the delay between channels as a time
  - Degree: Display the delay between channels as an angle
    Degree = Delay (s)/Period (s) × 360 (deg). The period is that of a reference waveform.
- Select ⎍ (rising edge) or ⎎ (falling) for the slope of the edge to be detected using Edge Polarity. The default setting is rising.
- Set the number of edges to detect before actually considering it a detection point in Edge Count. The range is an integer from 1 to 9. The default value is 1.
- The voltage level at the detection point is the mesial point.
- The parameter name when the measured value is displayed is (Dly).

Note

If the Mode is set to Degree and the reference waveform is Trig, the measured value shows "****."

1 Cycle Mode

This mode is used to compute items related to the voltage axis or the area over one cycle after determining the cycle. This mode is suited to items such as Rms and Avg that produce errors depending on the measurement range.
This mode does not affect the items related to the time axis or the area of the X-Y waveforms.

Setting the Measurement Range (Time Range1/Time Range2)

By default, the ±5 divisions of the time axis display frame is the measurement range. However, this range can be shortened. The measurement range is specified using two vertical cursors. The measurement start point is the position where the fine dotted line is located, and the measurement end point is the position where the coarse dotted line is located. Up to 10 MW from the measurement start point (Time Range1) are measured. The concept of the measurement range is analogous to the concept of the selectable range of cursor display position in cursor measurement.
For details, see section 11.4, “Selectable Range of Cursor Position.”

Setting the Distal, Mesial, and Proximal Unit (Dist/Prox Mode)

Select the method of assigning the three levels that are used as references in measurements such as the rise and fall times.

- **%**
  The distal, mesial, and proximal values are set in terms of percentages when High of any trace (CH1 to CH16, Math1 to Math8) and Low are taken to be 100.0% and 0.0%, respectively.
- **Unit**
  Set the distal, mesial, and proximal values of any trace (CH1 to CH16, Math1 to Math8) to arbitrary voltage or temperature values.

Setting Distal, Mesial, and Proximal

Unit:	Dist/Prox Mode
Proximal range:	0.0 to 99.8 (resolution: 0.1%) or voltage or temperature corresponding to ±10 divisions (resolution: varies depending on the module).
Mesial range:	0.0 to 99.9 (resolution: 0.1%) or voltage or temperature corresponding to ±10 divisions (resolution: varies depending on the module).
Distal range:	0.0 to 100.0 (resolution: 0.1%) or voltage or temperature corresponding to ±10 divisions (resolution: varies depending on the module).

Selecting the High and Low Setting (High/Low Mode)

High indicates the 100% level in measurements such as the rise or fall time. And, Low indicates the 0% level. Select the assignment method of High and Low from the following two methods.

- **Auto**
  Sets the higher amplitude level to High and lower level to Low within the measurement range based on the voltage level frequency of the waveform by taking the effects of ringing, spikes, etc. into consideration. This method is best-suited when measuring rectangular waveforms and pulse waveforms.
- **MAX-MIN**
  Sets the maximum value to High and lowest value to Low in the measurement range. This method is best-suited when measuring sine waveforms, ramp waveforms, etc. It is not suited for measurement of waveforms with ringing and spikes.

Notes When Performing Automated Measurement of Waveform Parameters

- The measurement value displays "***" if the measurement is not possible (such as when the measurement range is greater than or equal to 10 MW).
- For waveforms of small amplitude, correct measurements may not be possible.
- If there are two or more cycles of a waveform in the measurement range, the measurement is made on the first waveform.
- Automated measurement is not possible on logic waveforms.
- If automated measurement is made on waveforms that are measured using the realtime recording function, the execution of the automated measurement takes a long period due to the hard disk access.
- Depending on the conditions such as the memory length, the number of measured items, and the input waveform, the execution of the automated measurement may take an extended period. While automated measurement is in progress,  is indicated at the upper left corner of the screen.
- To abort the automated measurement, set Mode to OFF. The process is aborted at that point.
- If X Axis is set to Quad in the DISPLAY menu, Int1XY and Int2XY cannot be measured.
- For FFT waveforms, only Max and Min can be measured.

11.6 Performing Statistical Processing

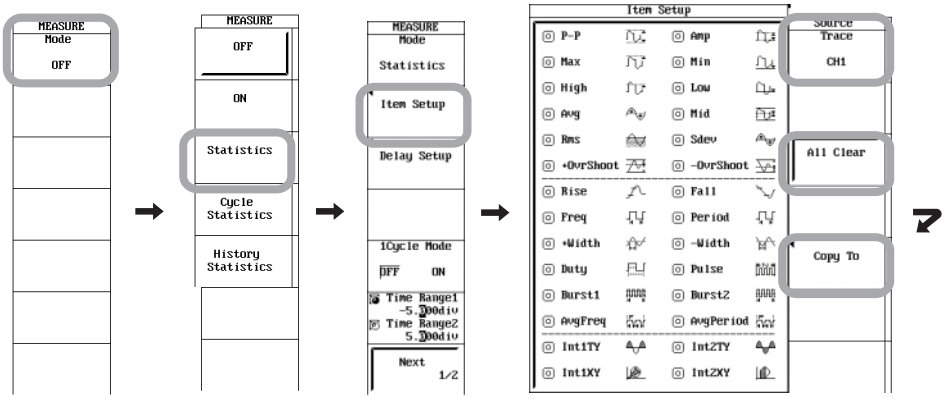
<For a description of this function, refer to page 2-45.>

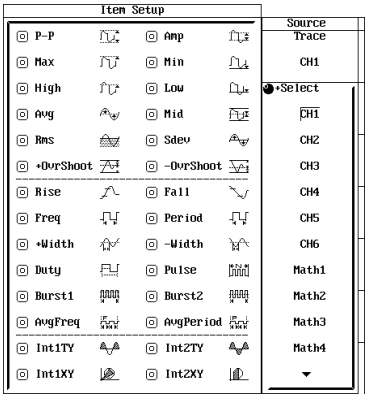
Procedure

Setting Normal Statistical Processing

1. Press **MEASURE**.
2. Press the **Mode** soft key to select **Statistics**.
3. Press the **Item Setup** soft key. The measurement parameter dialog box and the measurement channel menu appear.
4. Press the **Trace** soft key and use **jog shuttle**+**SELECT** to select the measurement channel.
5. Turn the **jog shuttle** to move the cursor to the parameter you want to turn ON.
6. Press **SELECT** to turn on the parameter selected in step 5.
   You can turn OFF all parameters at once by pressing the **All Clear**. You can copy the current parameter settings to all traces by selecting "**Copy to All Trace**."
7. Repeat steps 4 to 6 as many times as necessary. Press **ESC**.

   The setting of other parameters is the same as the automated measurement of waveform parameters (see step 8 and following steps in section 11.5).





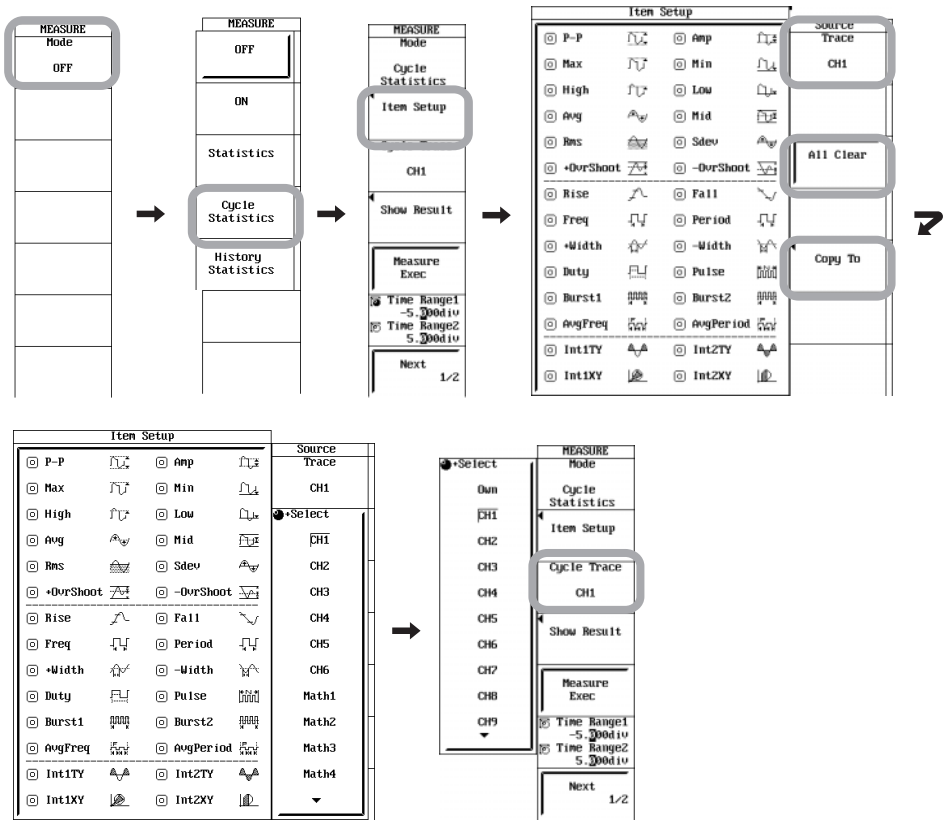
Setting Cyclic Statistical Processing

1. Press **MEASURE**.
2. Press the **Mode** soft key to select **Cycle Statistics**.
3. Press the **Item Setup** soft key. The measurement parameter dialog box and the measurement channel menu appear.
4. Press the **Trace** soft key and use **jog shuttle**+**SELECT** to select the measurement channel.
5. Turn the **jog shuttle** to move the cursor to the parameter you want to turn ON.
6. Press **SELECT** to turn on the parameter selected in step 5.
   You can turn OFF all parameters at once by pressing the **All Clear**. You can copy the current parameter settings to all traces by selecting "**Copy to All Trace**."
7. Repeat steps 4 to 6 as many times as necessary. Press **ESC**.
8. Press the **Cycle Trace** soft key. The cycle trace menu appears.
9. Press the soft key corresponding to the channel to be used to determine the cycle. If Own is specified, the cycle is determined on each waveform for statistical processing.

   The setting of other parameters is the same as the automated measurement of waveform parameters (see step 19 and following steps in section 11.5).

Executing Statistical Processing

10. Press the **Measure Exec** soft key. Statistical processing is executed. Press the same key again to abort.
    Proceed to step 11.



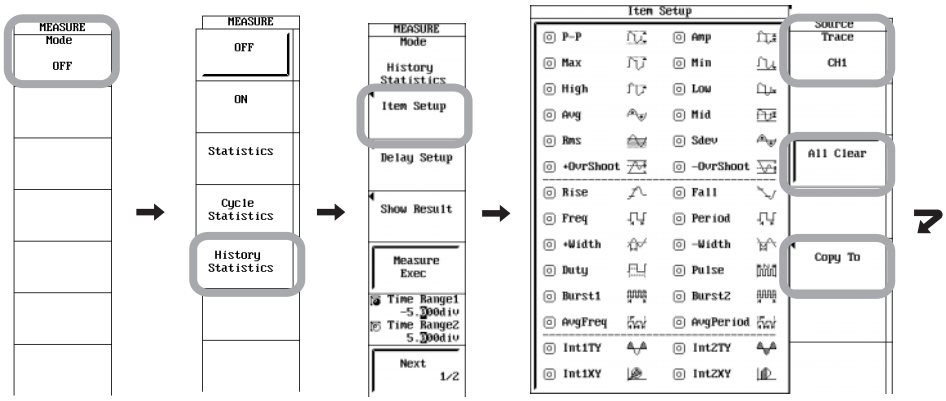
Setting Statistical Processing of History Data

1. Press **MEASURE**.
2. Press the **Mode** soft key to select History Statistics.
3. Press the **Item Setup** soft key. The measurement parameter dialog box and the measurement channel menu appear.
4. Press the **Trace** soft key and use **jog shuttle**+**SELECT** to select the measurement channel.
5. Turn the **jog shuttle** to move the cursor to the parameter you want to turn ON.
6. Press **SELECT** to turn on the parameter selected in step 5.
   You can turn OFF all parameters at once by pressing the **All Clear**. You can copy the current parameter settings to all traces by selecting "**Copy to All Trace**."
7. Repeat steps 4 to 6 as many times as necessary. Press **ESC**.

   The setting of other parameters is the same as the automated measurement of waveform parameters (see step 8 and following steps in section 11.5).

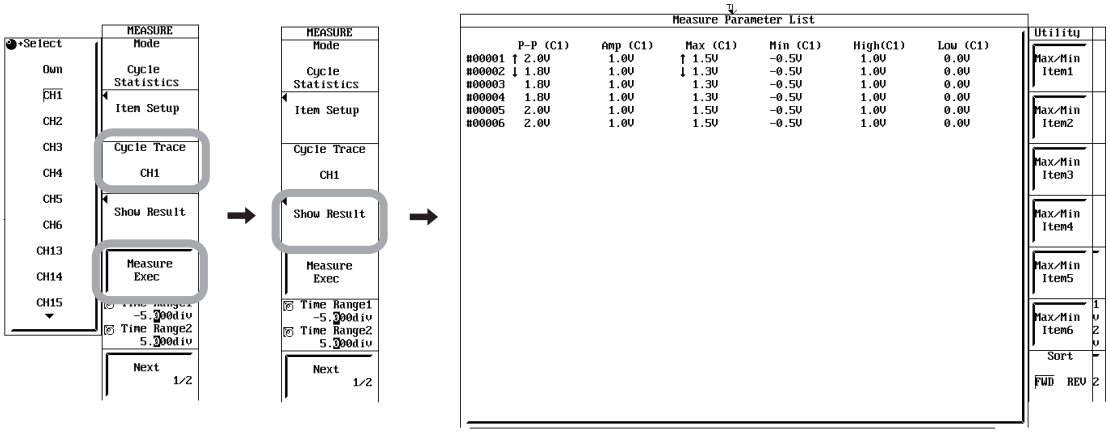
Executing Statistical Processing

8. Press the **Measure Exec** soft key. Statistical processing is executed. Press the same key again to abort.
   Proceed to step 11.



Displaying the Results of Statistical Processing

11. Press the **Show Result** soft key to display a list of the results of statistical processing. Press the arrow key to scroll the list horizontally. Turn the jog shuttle to scroll the list vertically.
    Press the Max/Min Item1 to Max/Min Item6 soft keys to move the cursor to the maximum and minimum values of each waveform parameter. The displayed parameters from the left end correspond to Item1, Item2, Item3, Item4, Item5, and Item6.
    You can press the Sort soft key to sort the list in ascending (FWD) or descending (REV) order.



Explanation

Statistical processing is performed on the same measurement parameters as those of the automated measurement of waveform parameters. The following five statistics are determined on the three measured values of automated measurement parameters.

- Max: Maximum value
- Min: Minimum value
- Avg: Average value
- Sdv: Standard deviation
- Cnt: Number of measured values used in the statistical processing

For example, if you selected P-P of CH1 as an automated measurement parameter, the maximum, minimum, average, standard deviation, and the number of measured values used in the statistical processing are displayed at the bottom section of the screen.
The result of statistical processing that can be displayed is three parameters of automated measurement. If you selected four or more parameters for automated measurement, the first three parameters in the automated measurement parameter selection menu (P-P, Amp, Max, Min, *, Init1XY, and Init2XY) of Item Setup are displayed in order from the smallest channel.

Example 1: When CH1: P-P, Amp; CH2: Min; and CH3: Max, Min are selected
CH1: P-P, CH2: Min, and CH3: Max are displayed.

Example 2: If CH1: Max, Min and CH2: P-P and Amp are selected
CH1: Max, Mix, and CH2: P-P are displayed.

The results of statistical processing that are not displayed can be loaded in the following manner.

- Load the results into your PC using the communication function.
- Save the results of statistical processing as measured values of automated measurement parameters (see section 13.11) and load the values into your PC.
- Scroll the list of statistical processing results using the arrow keys.

Statistical processing includes three types: normal statistical processing, cyclic statistical processing, and statistical processing of history data.

Normal Statistical Processing (Statistics)

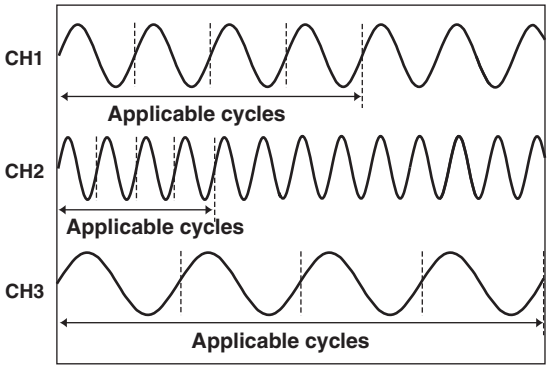
Statistical processing is performed on all acquired waveforms while acquiring waveforms. If you stop the waveform acquisition and start it again, statistical processing continues from the statistical processing result obtained up to the previous stop.
Statistical processing is performed on the selected parameters for automated measurement that are not displayed. Therefore, if you disable the statistical processing of a displayed automated measurement parameter while waveform acquisition is in progress, the statistical processing results of the next selected automated measurement parameter in line to be displayed are displayed. The number of measured values used in the statistical processing (Cnt) is the number of waveforms that have been acquired up to that point.
If you add statistical processing on a new automated measurement parameter while waveform acquisition is in progress or when it is stopped, the number of measured values used in the statistical processing (Cnt) is the number of waveforms that have been acquired since the parameter was added.

Cyclic Statistical Processing

The cycle of the displayed waveform is determined in order from the oldest data, the selected parameters for automated measurement are measured on the data within the cycle, and statistical processing is performed. The cycle is determined in the same fashion as the Period for the waveform parameter. You can select whether to apply the cycle of the specified waveform to all waveforms or determine the cycle for each waveform.

- CH, Math: Performs automated measurement of waveform parameters on all target waveforms per cycle of the specified channel, and performs statistical processing.
- Own: Determines the cycle for each target waveform, performs automated measurement of waveform parameters for each cycle, and performs statistical processing. However, if signals of different cycles are applied to multiple channels, automated measurement of waveform parameters and statistical processing are performed for the number of cycles of the channel whose cycle is the slowest on all other channels.

When Own is selected as the waveform used to determine the cycle



In the left figure, the number of cycles of the channel whose cycle is the slowest (CH3) is 4. Therefore, statistical processing is performed on the 4 oldest cycles of data for CH1 and CH2, also. The rest of the data is not used in statistical processing.

Statistical processing is performed from the oldest data of the displayed waveform in blocks of cycles.
It can not be used with the 1 cycle mode at the same time.

In addition, the following waveform parameters are not measured:

- For waveforms on which the cycle is measured: Avg Freq (average frequency), Avg Period (average period), PlsN (pulse count), Int1XY (area), Int2XY (area), and Delay.
- For other waveforms: Int1XY (area), Int2XY (area), and Delay.

Statistical Processing of History Data

Performs automated measurement of waveform parameters on the waveform that is acquired using the history memory function and performs statistical processing. Statistical processing is performed from the oldest waveform. The range on which the statistics are measured is the waveform that is displayed on Show Map. It can be used with Delay and 1 cycle mode.

Target Waveforms

CH1 to CH16, and Math1 to Math8
However, Math1 to Math8 are not applicable for statistical processing of history data.

Automated Measurement Parameters for Statistical Processing

The parameters on which statistical processing is performed are the parameters of automated measurement of waveform parameters in section 11.5. The result of statistical processing that can be displayed is only three parameters of automated measurement.

Measurement Range for Statistical Processing

The measurement range is the same as that specified for automated measurement of waveform parameters (see section 11.5).

Show Results

If you perform cyclic statistical processing or statistical processing of history data, a list of measured results can be displayed for the selected automated measurement parameters. The waveforms are numbered from the oldest cycle data or history data, and the corresponding results of automated measurement are displayed. The maximum and minimum values of each waveform parameter are displayed using ↑ (maximum) and ↓ (minimum). If there are multiple points that are of the same value, the maximum and minimum values are marked on the oldest data. The number of data points that can be listed is 48000. If this value is exceeded, the most recent 48000 points of automated measurement parameters of history waveforms or data are displayed. In this case, the maximum and minimum values may exist outside the displayed list. In such case, ↑ (maximum) and ↓ (minimum) that are outside the range are not displayed.
In statistical processing of history data, you can select a waveform using the jog shuttle and press SELECT to display the selected historical waveform.
In cyclic statistical processing, you can select a number using the jog shuttle and press SELECT to zoom in on the waveform (1 cycle) of the selected number. Statistical processing is performed only on the data that can be listed.

Notes When Performing Statistical Processing

- While statistical processing is in progress,  is indicated at the upper left corner of the screen. All soft keys except the Measure Abort soft key are disabled.
- Statistical processing is not possible in the following cases.
  - Realtime recorded waveforms
  - FFT waveforms
  - The number of data points in the measurement range (see section 11.5) is greater than or equal to 10 Mpoints.
- Depending on the conditions such as the record length, the number of parameters on which statistical processing is performed, and the input waveform, the execution or termination (aborting) may take an extended time.

12.1 Printing on the Built-in Printer

<For a description of this function, refer to page 2-49.>

Procedure

1. Press **MENU**.
2. Press the **PRINT** soft key.

Selecting the Printer

3. Press the **Print to** soft key. The printer selection menu appears. (Net Print appears only when the Ethernet interface option is installed.)
4. Press the **Printer** soft key.

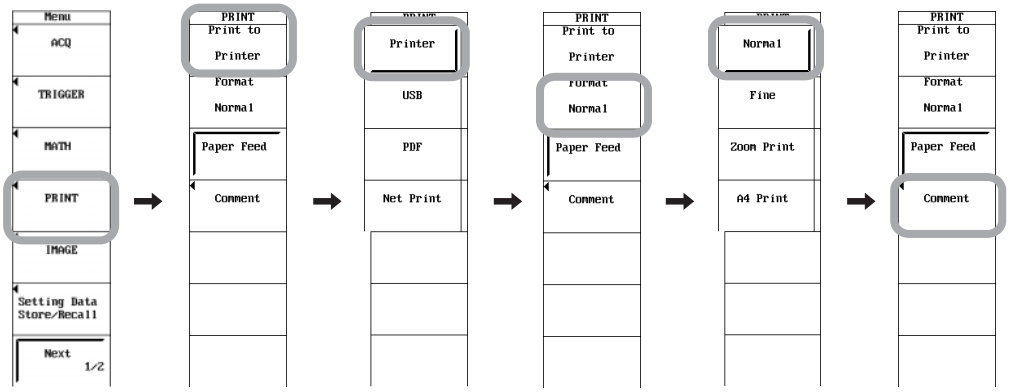
Setting the Output Format

5. Press the **Format** soft key. The output format selection menu appears.
6. Press the **Normal**, **Fine**, **Zoom Print**, or **A4 Print** soft key.

Printing in Normal Output Format (When Normal Is Selected in Step 6)

Setting a Comment

7. Press the **Comment** soft key.
8. Enter the comment string according to the procedure given in section 4.2. Proceed to step 30 on page 12-5.



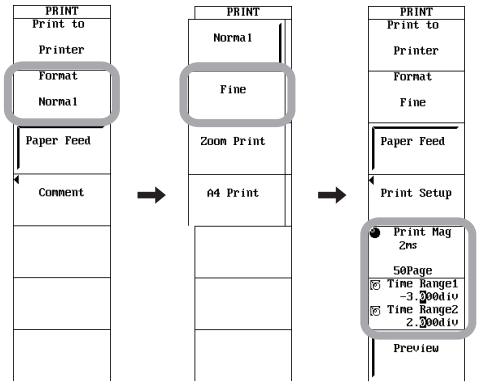
Fine Print (When Fine Is Selected in Step 6)

Setting the Magnified Print

7. Press the **Print Mag** soft key, and use the **jog shuttle** to set the magnification along the time axis for the printing. The top section of the menu shows the record time corresponding to 10 divisions. The bottom section shows the number of pages when printing using the record time shown in the top section.

Setting the Print Range

8. Press the **Time Range1/Time Range2** soft key to set the jog shuttle control to Time Range1.
9. Use **jog shuttle**+**SELECT** to set the print start point.
10. Likewise, set Time Range2 (print end point).
    Proceed to step 11 on page 12-3.



Zoom Print (When Zoom Print Is Selected in Step 6)

Setting Zoom Box Z2

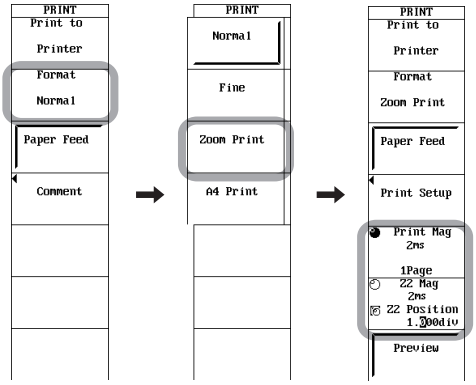
7. Press the **Z2 Mag/Z2 Position** soft key to set the jog shuttle control to Time Z2 Mag.
8. Turn the **jog shuttle** to set the record time of the Z2 zoom box.
9. Likewise, set the zoom position of the Z2 zoom box with Z2 Position.

Setting the Print Magnification

10. Press the **Print Mag** soft key, and use the **jog shuttle** to set the magnification along the time axis for the printing. The top section of the menu shows the record time corresponding to 10 divisions. The bottom section shows the number of pages when printing using the record time shown in the top section.

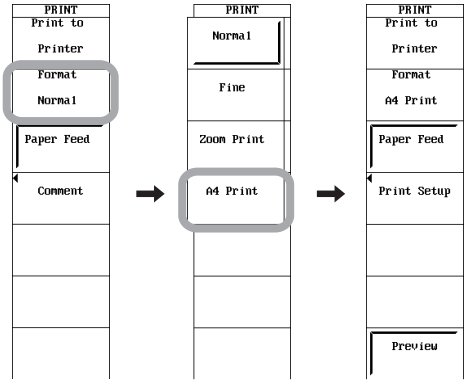
Note

- In zoom print, the range of zoom box Z2 (10 divisions) is printed.
- The Z2 Mag/Z2 Position setting is linked with the ZOOM menu (see section 8.5) setting.



A4 Print (When A4 Print Is Selected in Step 6)

Proceed to step 11.



Specifying the Print Settings

Setting the Print Format

11. Press the **Print Setup** soft key.
12. Use **jog shuttle**+**SELECT** to select the format from 1 Zone to 16 Zone.

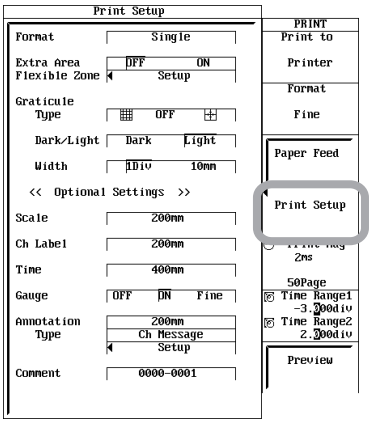
Note

The print format setting is linked with the DISPLAY menu > Format setting.

Setting the Extra Area

The settings specified in steps 13 to 27 are applied to the recording format settings in Recorder Mode (see section 9.3).

13. Use **jog shuttle**+**SELECT** to turn the extra area ON or OFF.



Setting the Flexible Zone

(Can be set when you select 1 Zone in step 12 on page 12-3)

14. Use **jog shuttle**+**SELECT** to select Setup in Flexible Zone.
15. Use **jog shuttle**+**SELECT** to set Mode to OFF or ON.
16. Use **jog shuttle**+**SELECT** to set Upper/Lower of the waveform to be recorded.

Setting the Graticule

- **Setting the Grid**

17. Use **jog shuttle**+**SELECT** to set the type to , OFF, or .

- **Setting Dark/Light**

18. Use **jog shuttle**+**SELECT** to set dark/light to light or dark.

- **Setting the Width of the Vertical Scale**

19. Use **jog shuttle**+**SELECT** to set the width to 1div or 10mm.

    Proceed to step 19.

Note

The grid setting is linked with the DISPLAY menu > Graticule setting. However, if OFF is selected, the DISPLAY menu is set to  .

Setting Details

Setting the Print Interval of Scale Values

20. Use **jog shuttle**+**SELECT** to set the scale to OFF, 200mm, 400mm, or 800mm.

Setting the Print Interval of Channel Labels

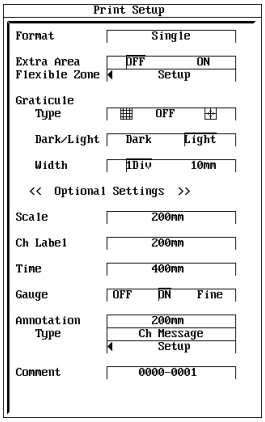
21. Use **jog shuttle**+**SELECT** to set Ch Label to OFF, 200mm, 400mm, or 800mm.

Setting Whether to Print the Time

23. Use **jog shuttle**+**SELECT** to set the time to OFF, 200mm, 400mm, or 800mm.

Setting the Gauge Print

23. Use **jog shuttle**+**SELECT** to set the gauge to OFF, ON, or Fine.

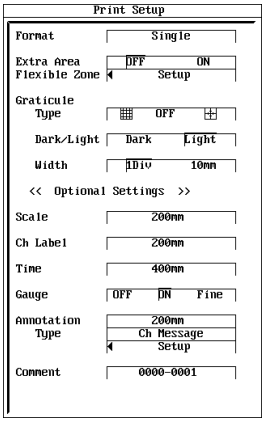


Setting the Annotation

24. Use **jog shuttle**+**SELECT** to set the print interval of annotations in the right column of Annotation to OFF, 200mm, 400mm, or 800mm.
25. Use **jog shuttle**+**SELECT** to set the type of annotation to be printed in the right column of Type to Ch Information, Ch Message, or Ch Data.
    If Ch Message is selected, proceed to step 26.
    If Ch Information or Ch Data is selected, proceed to step 27.
26. Use **jog shuttle**+**SELECT** to select Setup. Then, enter the message you wish to print for the channel using up to 80 characters according to the procedure in section 4.2.

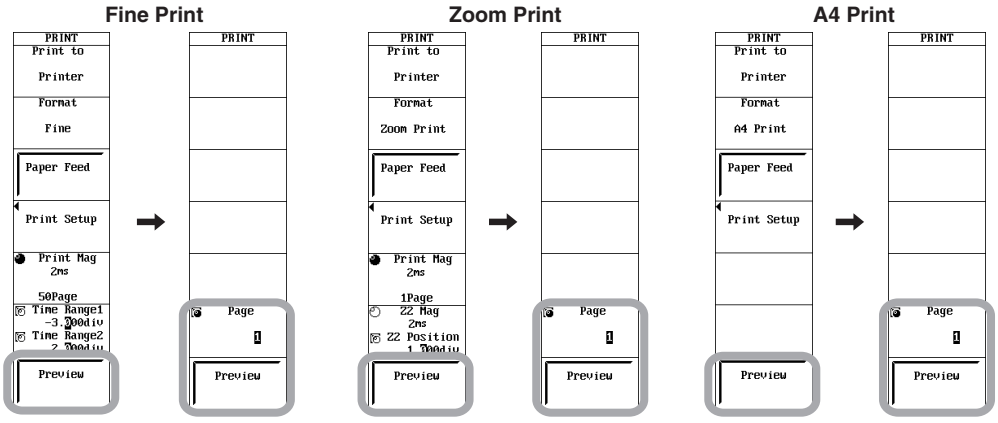
Setting a Comment

27. Use **jog shuttle**+**SELECT** to select Comment. Then, enter the comment text you wish to print using up to 20 characters according to the procedure in section 4.2.



Previewing the Print Image

28. Press the **Preview** soft key. The print image is displayed on the screen.
    Turn the **jog shuttle** to change the displayed page.
29. Press the **Quit** soft key. The original display appears.



Executing the Printing

30. Press **PRINT**. The screen image data is printed on the built-in printer.
    To abort printing, press **PRINT** while printing is in progress.
    While printing is in progress, is indicated at the upper left of the screen.

Explanation

Output Format: Format

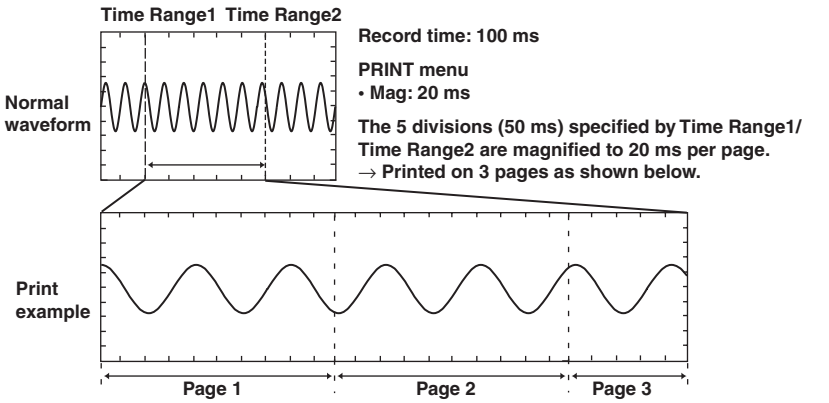
Select from four types: Normal, Fine, Zoom Print, and A4 Print.

Normal

Prints using normal size.

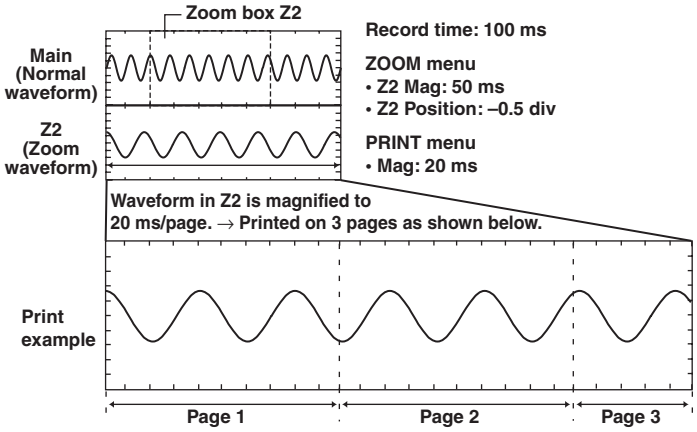
Fine

The print range on the waveform displayed on the screen (Time Range1 and Time Range2) is specified, and the print range is printed magnified.



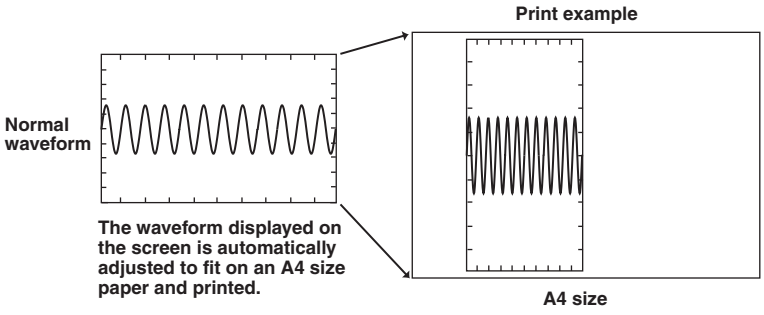
Zoom Print

The range of zoom box Z2 of the zoom function (see section 8.5) is magnified and printed.



A4 Print

Prints the waveform displayed on the screen to an A4 size paper.



Printing Using Normal Output Format

Comment

A comment string of up to 20 characters can be printed at the top section of the print area.

Fine Print, Zoom Print, and A4 Print

Print Magnification (Print Mag)

Set the print magnification only during fine print and zoom print. The selectable range varies depending on the record time setting and record length.

Print Range (Time Range1/Time Range2)

Set the print range only during fine print. Set the print range in the range of –5 divisions to 5 divisions.

Zoom Box Z2 (Z2 Mag/Z2 Position)

Set zoom box Z2 only during zoom printing. The zoom box Z2 setting is linked to the ZOOM menu setting. For details such as the selectable range, see section 8.5.

Print Setup

Format

Select the number of zones of the print area when printing on the built-in printer.

1 Zone	4 Zone
2 Zone	8 Zone
3 Zone	16 Zone

The format setting is linked with the DISPLAY menu > Format setting.

Extra Area

The extra area can be set only when the format is set to 1 Zone, 2 Zone, 3 Zone, or 4 Zone.

- **When the Format Is 1 Zone**
  If extra area is turned ON, the top 16 cm of the print area (20 cm) is used to print waveforms, and the remaining 4 cm is used to print waveform information (extra area). Annotations (see page 12-9) and logic waveforms are printed in the extra area. The default setting is OFF.
- **When the Format is 2 Zone, 3 Zone, or 4 Zone**
  If extra area is turned ON, the area below each of the divided waveform recording area is used to print the waveform information (extra area). If extra area is turned OFF, the extra area between each waveform recording area disappears. The magnification of the vertical axis of each waveform recording area is adjusted automatically according to the paper size and printed. The default setting is ON.

Flexible Zone

The flexible zone can be set only when the format is 1 Zone and the extra area is OFF.

The position in the print area (20 cm) where each waveform is to be recorded is set with Upper and Lower (%). The Upper value can be set in the range of 2% to 100%. The Lower value can be set in the range of 0% to 98%. Each value can be set in 1% steps. The minimum width is 2%.

[Example]

- When Flexible Zone on CH1 is set to Upper = 20% and Lower = 0%
  The CH1 waveform is printed in the area from the bottom to 4 cm of the print area.
- When Flexible Zone on CH2 is set to Upper = 80% and Lower = 20%
  The CH2 waveform is printed in the area from 4 cm to 16 cm from the bottom of the print area.

Graticule

- **Type**
  Select the graticule type from  , OFF, or  .
  The grid setting is linked with the DISPLAY menu > Graticule setting. However, if OFF is selected, the DISPLAY menu is set to  .

- **Dark/Light**
  Set the graticule Dark/Light setting to Light or Dark.

- **Width of the Vertical Graticule: Width**
  Select how to set the vertical graticule width. For details on the format of the graticule lines that are printed, see section 9.3.
  1Div: Graticule obtained by dividing the print zone into 10 areas
  10mm: mm graticule type

Details

- **Print Interval of Scale Values: Scale**
  Select the interval for the scale printed at the top and bottom edges of the print area from OFF, 200 mm, 400 mm, or 800 mm. If OFF is selected, the scale is not printed.

- **Print Interval of Channel Labels: CH Label**
  Select the interval for printing waveform channel labels from OFF, 200 mm, 400 mm, or 800 mm. The channel label is printed near each waveform. If OFF is selected, the channel labels are not printed.

- **Time Print: Time**
  Select the interval for printing the time from OFF, 200 mm, 400 mm, or 800 mm. The time is printed at the top section of the print area. If OFF is selected, the times are not printed.

- **Gauge Print**
  Select whether to not print (OFF), print (ON), or print in detail (Fine) on the left side of the print area. If ON is selected a gauge that equally divides the waveform display area into two is displayed. If Fine is selected, a gauge that equally divides the waveform display area into 10 is displayed. The gauge, scale values, an arrow indicating the ground position, and V/div (Value/div)* are printed.

  * Depending on the setting, V/div (Value/div) may not be printed.

- **Annotation**
  Channel information, channel messages, or measured values are printed. Use Annotation to select the print interval from OFF, 200 mm, 400 mm, and 800 mm. Use Type to select the type of annotation to be printed from Ch Information, Ch Message, and Ch Data.

  Ch Information
  Prints settings such as V/div, filter, and module.
  Ch Message
  Prints the character string (up to 80 characters) that is assigned to each channel.
  Ch Data
  Prints the measured values at a given interval using numeric values.

  The position where annotations are printed varies depending on the display (recording) format and extra area settings as follows:

  - When Format is 1 Zone, 2 Zone, 3 Zone, or 4 Zone, and Extra Area is ON
    The annotations are printed in the extra area. The annotations do not overlap the waveform print area.
  - When Format is 1 Zone, 2 Zone, 3 Zone, or 4 Zone, and Extra Area is OFF
    The annotations are printed at the bottom section of the waveform print area.
  - When Format is 8 Zone or 16 Zone
    The annotations are printed between the divided waveform print areas (between the grids).

Note

If all of the conditions below are met, only up to 67 characters of CH Message are printed.
Format: 1 Zone/2 Zone/3 Zone/4 Zone, Extra Area: OFF, Scale: Other than OFF

- **Comment**
  A comment string of up to 20 characters can be printed at the top section of the print area.

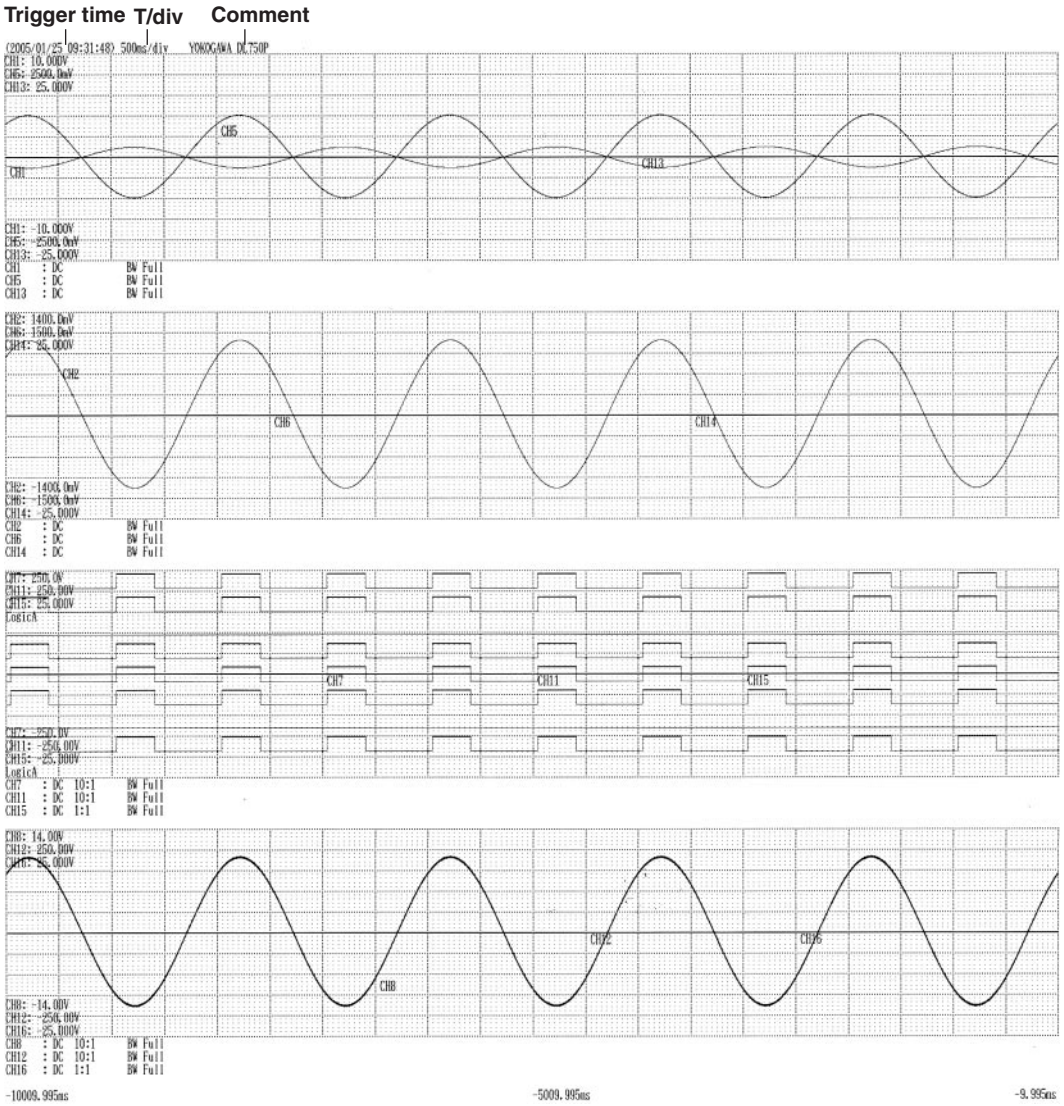
Preview

A preview of the print image data can be displayed in the specified output format.

Notes on Fine Print, Zoom Print, and A4 Print

- Fine print, zoom print, and A4 print cannot be carried out while waveform acquisition is in progress.
- Only Main waveforms are applicable for fine print and A4 print.
- If waveforms are being displayed using the history memory function, only the waveforms specified by Selected Record No. are applicable for fine print, zoom print, and A4 print.
- Fine print, zoom print, and A4 print cannot be carried out when X-Y waveforms are being displayed.
- Fine print, zoom print, and A4 print cannot be carried out on the snapshot and accumulated waveforms.
- If the number of printed pages exceeds 100, fine print cannot be carried out. (The number of printed pages is determined by the Print Mag and Time Range settings.)

Examples of Fine Print and Zoom Print



12.2 Printing on a USB Printer

<For a description of this function, refer to page 2-49.>

Procedure

1. Connect the SL1400 and a USB printer using a USB cable. For details, see the explanation on page 12-13.

Selecting the Printer

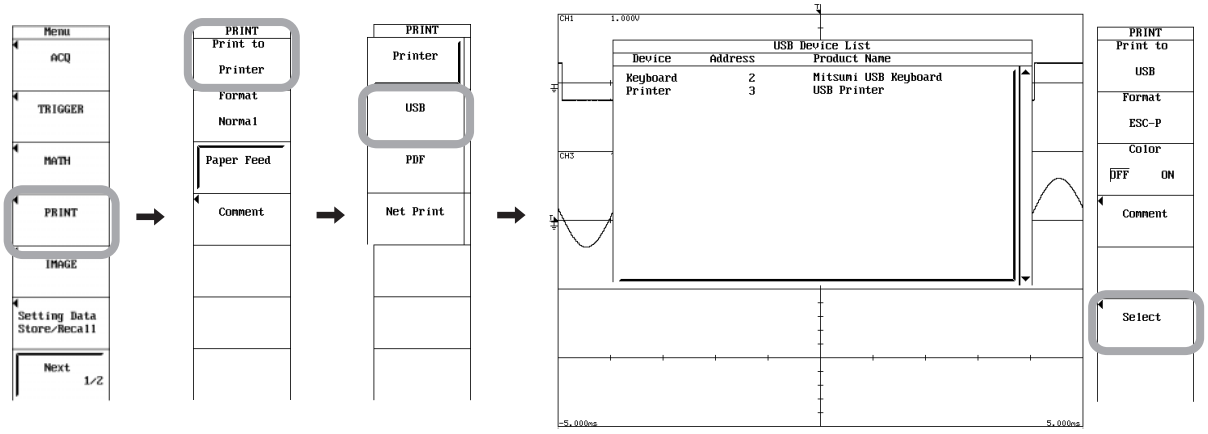
2. Press **MENU**.
3. Press the **PRINT** soft key.
4. Press the **Print to** soft key. The printer selection menu appears. (Net Print appears only when the Ethernet interface option is installed.)
5. Press the **USB** soft key.

Confirming the Printer That Is Connected

6. Press the **Select** soft key. The USB Device List appears. Check the printer that is connected.

Note

You can also check the printer that is connected by pressing the MENU key > Next 1/2 > System Config > USB List soft keys.



Setting the Output Format

7. Press the **Format** soft key. The output format selection menu appears.
8. Select the soft key corresponding to the output format from ESC-P to BJ.

Setting the Color

9. Press the **Color** soft key to select ON or OFF.

Setting a Comment

10. Press the **Comment** soft key.
11. Enter the comment string according to the procedure given in section 4.2.

Setting the Print Size (When Format Is ESC-PR)

(ESC-PR is a format for the Seiko Epson printers.)

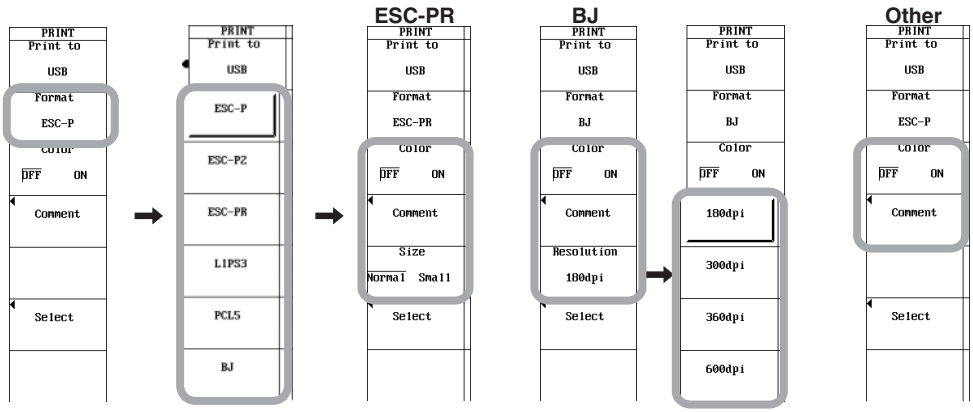
12. Press the **Size** soft key to select Normal or Small.
    - Normal: A4 size printer
    - Small: Postcard size printer

Setting the Print Resolution (When Format Is BJ)

13. Press the **Resolution** soft key. The print resolution setup menu appears.
14. Press any of the soft keys corresponding to 180 dpi, 300 dpi, 360 dpi, and 600 dpi.

Executing the Print Operation

15. Press **PRINT**. The screen image data is printed on the USB printer.
    To abort printing, press **PRINT** while printing is in progress.
    While printing is in progress,  is indicated at the upper left corner of the screen.

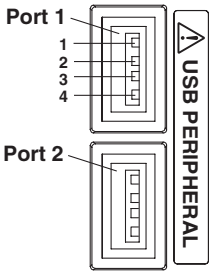


Explanation

You can print the screen image to a USB printer via the USB PERIPHERAL interface.

USB PERIPHERAL Connector

To connect a USB printer to the SL1400, connect a USB cable to the USB PERIPHERAL connector. There are two USB PERIPHERAL connectors (ports).



Pin No.	Signal Name	
1	VBUS:	+5 V
2	D–:	–Data
3	D+:	+Data
4	GND:	Ground

Printers That Can Be Used

USB printers conforming to USB Printer Class Ver. 1.1 that support the following print formats can be used.

Note

- Connect only the printers that are allowed.
- For details on USB printers that have been tested for compatibility, contact your nearest YOKOGAWA dealer.

Connection Procedure

When connecting a USB printer, directly connect the keyboard to the SL1400 using a USB cable as shown below. You can connect the USB cable regardless of the power ON/OFF state of the SL1400 (supports hot-plug). Connect the type A connector of the USB cable to the SL1400; connect the type B connector to the printer. When the power switch is ON, the printer is detected and enabled approximately 6 s after it is connected.

Note

- Connect the printer directly without going through a hub.
- Do not connect USB devices other than USB keyboard, USB mouse, USB printer, and USB storage device that can be used to the USB PERIPHERAL connector.
- Do not connect multiple printers to the USB PERIPHERAL connector.
- Never turn OFF the printer or remove the USB cable while the printer is printing.
- Do not connect or disconnect the USB cable after the power is turned ON until key operation is ready (approximately 20 to 30 s).

Output Format

You can select the output format that is sent to the USB printer from the following five types.

- ESC-P
- ESC-P2
- ESC-PR (a format for Seiko Epson printers)
- LIPS3
- PCL5
- BJ (can be used on models that support the BJC-35V native commands)

Print Size When Printing in ESC-PR Format (Size)

Select the print size when printing to a Seiko Epson printer that supports the USB.

- Normal: A4 size printer
- Small: Postcard size printer

Output Resolution When Printing Using the BJ Format

When printing the screen image to a USB BJ printer, select the output resolution from 180 dpi, 300 dpi, 360 dpi, and 600 dpi.

Comment

A comment string of up to 0 characters can be printed at the bottom right section. The comment setting is linked with the PRINT menu > Comment setting.

Color

Select from the following:

ON: Print the data using colors similar to the screen. (No background color and grid printed in black)

OFF: Prints the image using the same colors as the image printed using the built-in printer.

Notes When Printing on the USB Printer

- Images may not print properly on some printers. Use USB printers that have been tested for compatibility.
- You can also print to a USB printer that is connected to your PC. To do so, save the screen image data to a PC card (see section 13.12). Then, load and print the data on the PC.

Note

The SL1400 does not detect “out of paper” and printer errors on the USB printer. If an error occurs, press PRINT again to stop the printing.

12.3 Printing on a Network Printer (Option)

<For a description of this function, refer to page 2-49.>

Procedure

Configuring the Network

1. Configure the TCP/IP and network printer according to the procedures given in section 16.2 and 16.4.

Selecting the Printer

2. Press **MENU**.
3. Press the **PRINT** soft key.
4. Press the **Print to** soft key. The printer selection menu appears. (Net Print appears only when the Ethernet interface option is installed.)
5. Press the **Net Print** soft key.

Selecting the Output Format

6. Press the **Format** soft key.
7. Select the soft key corresponding to the output format from ESC-P to PostScript.

Setting the Color (When Format Is ESC-P, ESC-P2, PCL5, or BJ)

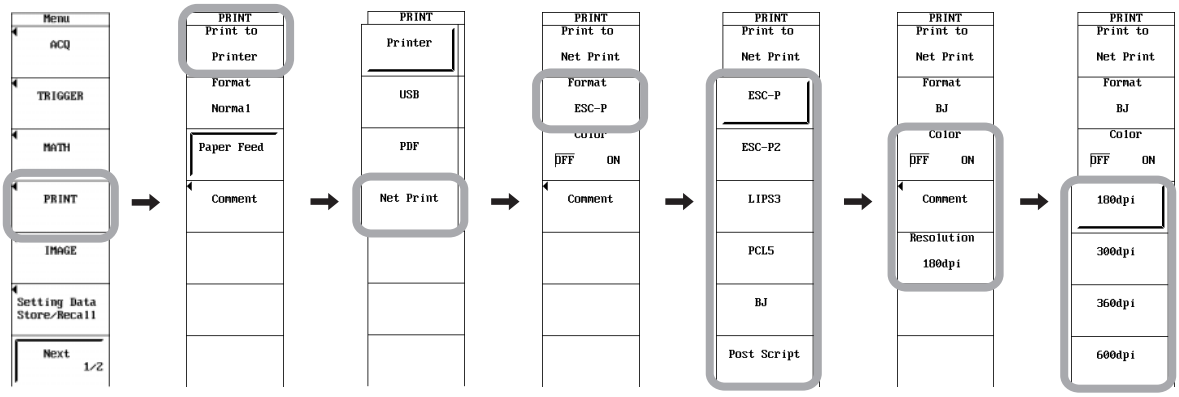
8. Press the **Color** soft key to select ON or OFF.

Setting a Comment

9. Press the **Comment** soft key.
10. Enter the comment according to the procedure given in section 4.2.

Setting the Print Resolution (When Format Is BJ)

11. Press the **Resolution** soft key. The print resolution setup menu appears.
12. Press any of the soft keys corresponding to 180 dpi, 300 dpi, 360 dpi, and 600 dpi.



Executing the Print Operation

13. Press **PRINT**. The screen image data is printed on the network printer. To abort printing, press **PRINT** while printing is in progress.
    While printing is in progress,  is indicated at the upper left corner of the screen.

Explanation

Like the built-in printer, you can print the screen image data on a network printer[1] via the Ethernet network.

1. Printing is possible on a printer or printer server supporting the TCP/IP protocol.

Selecting the Output Format

The following six printer formats are supported.

- ESC-P
- ESC-P2
- LIPS3
- PCL5
- BJ
- PostScript

Output Resolution When Printing Using the BJ Format

When printing the screen image data to a BJ printer, select the output resolution from 180 dpi, 300 dpi, 360 dpi, and 600 dpi.

Comment

A comment string of up to 20 characters can be printed at the bottom right section.

Color

Select from the following:

ON: Print the data using colors similar to the screen. (No background color and grid printed in black)

OFF: Prints the image using the same colors as the image printed using the built-in printer.

Note

Printing is possible on printers that support the TCP/IP protocol.

13.1 Storing and Recalling the Setup Data

CAUTION

Do not remove the storage medium (disk) or turn OFF the power when the access indicator or the PC card or internal hard disk (option) icon is blinking. Doing so can damage the storage medium or destroy the data on the medium.

Procedure

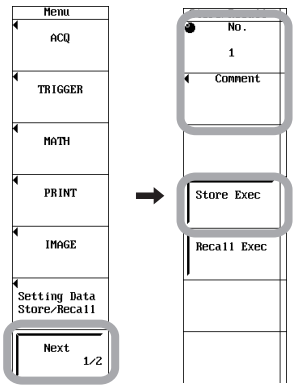
1. Press **MENU**.
2. Press the **Setting Data Store/Recall** soft key. The store/recall menu appears.

Storing the Setup Data

3. Turn the **jog shuttle** to select the memory number (No.) of the storage destination.
4. As necessary, press the **Comment** soft key and enter the comment according to the procedure given in section 4.2.

Executing the Storage Operation

5. Press the **Store Exec** soft key to execute the storage operation.



Recalling the Data

3. Turn the **jog shuttle** to select the memory number (No.) of the storage destination.

Note

Select a memory number in which setup data was stored by the procedure described in “Storing the Setup Data” on the previous page. An error will occur if you select a memory number in which no setup data is stored and execute the recall operation.

Executing the Recall Operation

4. Press the **Recall Exec** soft key to execute the recall operation.

Explanation

Data That Is Stored

The setup data of each key existing at the time of the storage operation can be saved. However, setup data such as the date/time, communications, and SCSI ID numbers is not saved.

Number of Memories

Three sets of setup data can be stored in memories numbered 1 to 3.
If the setup data is already stored at the selected number, the previous data is overwritten.

Comment

A comment of up to 160 characters can be added and saved. Comments are optional. All characters (including spaces) can be used.

Data That Is Recalled

Select a memory number 1 to 3 in which setup data is stored. You can only recall data from a memory in which setup data is stored.

Note

- If you execute the recall operation, the settings cannot be set back to those that existed before the recall operation.
- The stored setup data is not cleared even if you initialize the settings. The stored setup data is cleared if you turn ON the power switch while holding down the RESET key.

13.2 PC Cards

A PC card interface (selected at the time of purchase) can be installed as a built-in storage device.

PC Cards That Can Be Used

The SL1400 supports flash ATA cards (PC card TYPE II) and compact flash (using the PC card TYPE II adapter). In addition, some of the Flash ATA HDD cards can be used. For details, contact your nearest YOKOGAWA dealer.

Note

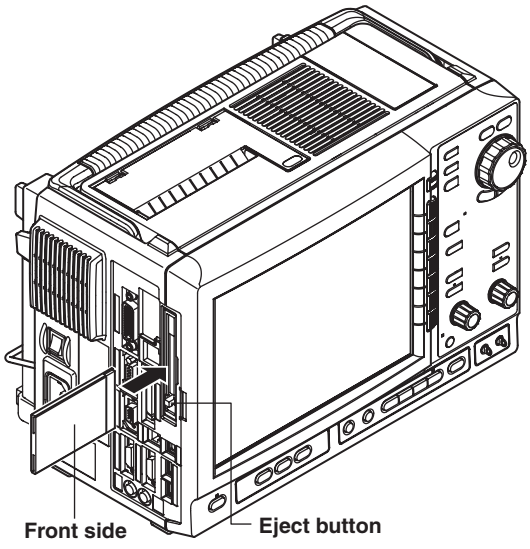
To use the PC card on the PC, use a PC that supports the PC card. Depending on the PC that you are using, the PC cards indicated above may not operate properly. Check it beforehand.

Inserting the PC Card

With the label side of the PC card facing toward you, insert the PC card into the drive. The PC card drive is located on the left side panel of the SL1400.

Ejecting the PC Card

Check that the PC card is not being accessed, and press the PC card ejection button to the right of the drive.



CAUTION

- The SL1400 may malfunction if the PC card is frequently inserted and ejected (inserted and ejected within a 1-s time period).
- Removing the PC card while it is being accessed may destroy the data on the PC card.

General Handling Precautions of PC Cards

For the general handling precautions of the PC card, read the instruction manual that came with the PC card.

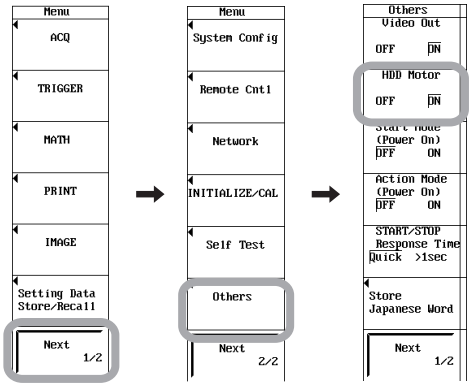
13.3 Internal Hard Disk (Option)

CAUTION

- When using the SL1400 in a vibrating environment, turn OFF the motor rotation of the internal hard disk.
- Do not place more than 512 files in the root directory of the internal hard disk. If the number of files exceeds 512, all file access operations slows down. In addition, the operation of realtime recording cannot be guaranteed.
- If an external SCSI device is connected, do not change the HDD Motor setting.

Procedure

1. Press **MENU**.
2. Press the **Next 1/2** soft key.
3. Press the **Others** soft key.
4. Press the **HDD Motor** soft key to select ON or OFF.



Explanation

You can turn ON/OFF the motor rotation of the internal hard disk on the SL1400.
If you turn OFF the internal hard disk motor, the internal hard disk cannot be accessed.
To save various data to the internal hard disk, turn the HDD Motor ON.
Turning OFF the HDD Motor protects the internal hard disk from vibrations.

Note

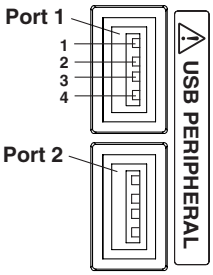
Even if the motor rotation is turned OFF, the motor rotation is turned ON for approximately 1 minute after the power is turned ON.

13.4 Connecting a USB Storage Device (MO Disk Drive, Hard Disk, or Flash Memory) to the USB PERIPHERAL Interface

USB PERIPHERAL Interface Specifications

Item	Specifications
Connector type	USB type A connector (receptacle)
Electrical and mechanical specifications	Conforms to USB Rev.1.1
Data rate	12 Mbps maximum
Power Supply	5 V, 500 mA* (per port)
Number of ports	2

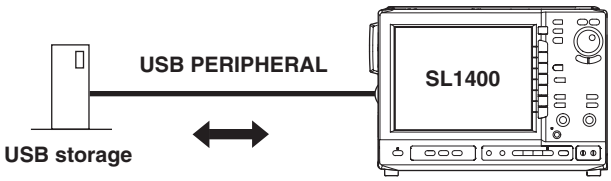
* Devices whose maximum current consumption exceeds 100 mA cannot be connected simultaneously to the two ports.



Pin No.	Signal Name
1 VBUS:	+5 V
2 D–:	–Data
3 D+:	+Data
4 GND:	Ground

Connecting the USB Storage Device

When connecting a USB storage device, directly connect the printer to the SL1400 using a USB cable as shown below. You can connect the USB cable regardless of whether the power switch on the SL1400 is ON or OFF (supports hot-plugging). When the power switch is ON, the USB storage device is detected and enabled approximately six seconds after it is connected.



Compatible USB Storage Devices

The SL1400 can use HD drives, MO drives, and flash memories that support USB (USB Mass Storage Class).

Note

- Do not connect USB devices other than a USB keyboard, USB mouse, USB printer, or USB storage device to the USB PERIPHERAL connector.
- The SL1400 has two USB PERIPHERAL ports. However, USB devices whose maximum consumption current exceeds 100 mA cannot be connected simultaneously to the two ports.

CAUTION

- Do not remove the USB storage device or turn OFF the power when the USB storage device is being accessed. If you do, the data on the USB storage device may be destroyed.
- An access icon is displayed at the upper left corner of the screen while the USB storage device is being accessed.

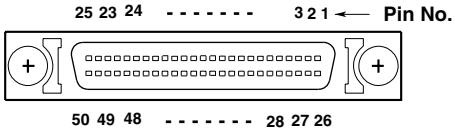
General Handling Precautions of USB Storage Devices

For the general handling precautions of the USB storage device, read the instruction manual that came with the device.

13.5 Connecting a SCSI Device

SCSI Specifications

Item	Specifications
Interface standard	SCSI (Small Computer System Interface), ANSI X3.131-1986
Connector type	Half pitch 50 pins (pin type)
Connector pin assignment	Unbalanced (single-ended), see table below.



Pin No.	Signal Name	Pin No.	Signal Name
1 to 12	GND	38	TERMPWR
13	NC	39, 40	GND
14 to 25	GND	41	-ATN
26	-DB0	42	GND
27	-DB1	43	-BSY
28	-DB2	44	-ACK
29	-DB3	45	-RST
30	-DB4	46	-MSG
31	-DB5	47	-SEL
32	-DB6	48	-C/D
33	-DB7	49	-REQ
34	-DBP	50	-I/O
35 to 37	GND		

Items Necessary for Connection

Cable

Use a commercially sold cable that is 3 m or less in length that has a characteristic impedance between 90 and 132 Ω.

Connection Procedure

1. Connect the SCSI cable to the SCSI connector on the left side panel of the SL1400.
2. Turn ON the SCSI device and the SL1400 (in that order).
   To format the disk, follow the procedure described in the section 13.6.

Connectable SCSI Devices

SCSI devices that can be connected to the SL1400 are MO disk drives and Zip drives. For details on which devices can be connected, contact your nearest YOKOGAWA dealer.

For general handling precautions for the connected SCSI device, see the instruction manual that is provided with the device.

Note

- If the SL1400 fails to detect the external SCSI device that is connected, initialize the SCSI ID by press the MENU key > Next 1/2 > Self Test > Test Item to SCSI > Initialize SCSI.
- The SL1400 has a built-in SCSI terminator. When using multiple SCSI devices, connect the SL1400 to the end of the chain. The terminator is always ON when the power is ON.
- Do not connect an external SCSI device with the same ID as that specified by pressing the MENU key > Next 1/2 > Self Test > Test Item (SCSI) > Internal ID.

13.6 Formatting the Storage Medium

CAUTION

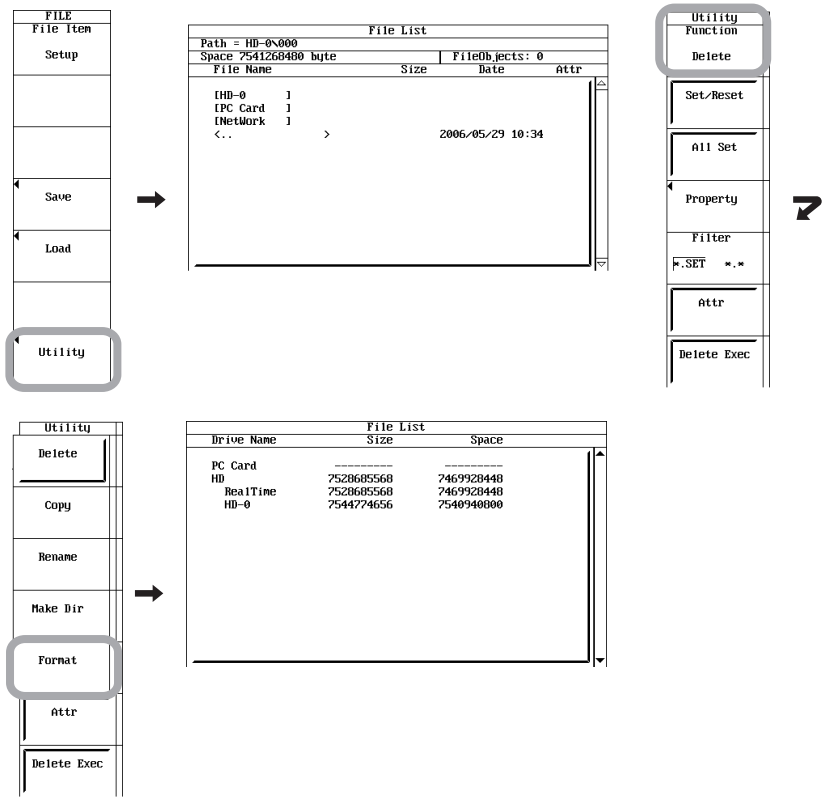
- Never remove the storage medium (disk) or turn OFF the power while the access indicator or the PC card or hard disk icon is blinking. Such acts can damage the storage medium or destroy the data on the medium.
- If the SL1400 cannot recognize a formatted medium, format the disk again on the SL1400. Note that all the data on the disk are cleared when the disk is formatted. Make sure to back up important data beforehand.

Procedure

1. Press **FILE**.
2. Press the **Utility** soft key. The Utility setup menu and the File List window appear.

Selecting the Storage Medium to Be Formatted

3. Press the **Function** soft key. The file function selection menu is displayed.
4. Press the **Format** soft key. A media list is displayed in the File List window. (Net Drive cannot be formatted.)
5. Turn the **jog shuttle** to select the storage medium to be formatted.
   If no external SCSI devices (option) or USB storage devices are detected, the internal hard disk option is not installed and only the PC card is inserted in the drive, only [PC card] is displayed.



Selecting the PC Card, or USB Storage Device Format

6. Press the **Format** soft key. The format selection menu appears.
   No setting is necessary in formatting the PC card, or USB storage device.
   Proceed to step 11.

Selecting the Number of Partitions of the SCSI Device

6. Press the **Format** soft key. The format selection menu appears.
7. Press the **Partition** soft key.
8. Turn the **jog shuttle** to set the number of partitions.
   Proceed to step 9.

Note

The number of partitions is 1 for removable disks (such as SCSI and Zip disks).

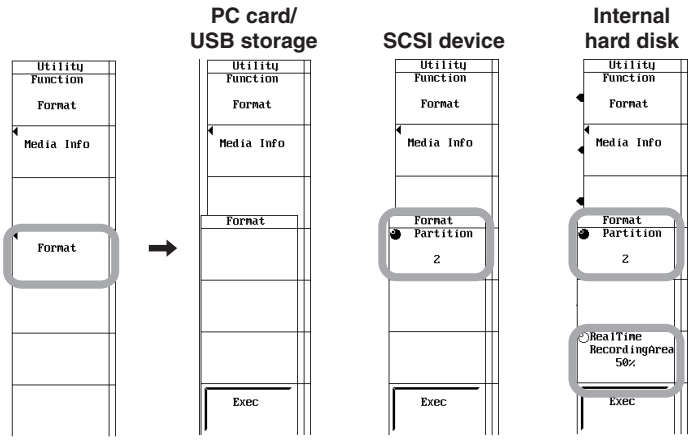
Selecting the Number of Partitions of the Internal Hard Disk (Option)

- **Selecting the Number of Partitions**
  6. Press the **Format** soft key. The format selection menu appears.
  7. Press the **Partition** soft key.
  8. Turn the **jog shuttle** to set the number of partitions to 2 or 3.

- **Setting the Realtime Recording Area**
  9. Press the **RealTime Recording Area** soft key.
  10. Turn the **jog shuttle** to set the realtime recording area in the range of 30 to 70% of the entire capacity of the internal hard disk. Proceed to step 11.

Note

Do not place files other than those created by realtime recording in the Real Time area of the internal hard disk. Otherwise, the realtime recording may not operate properly.

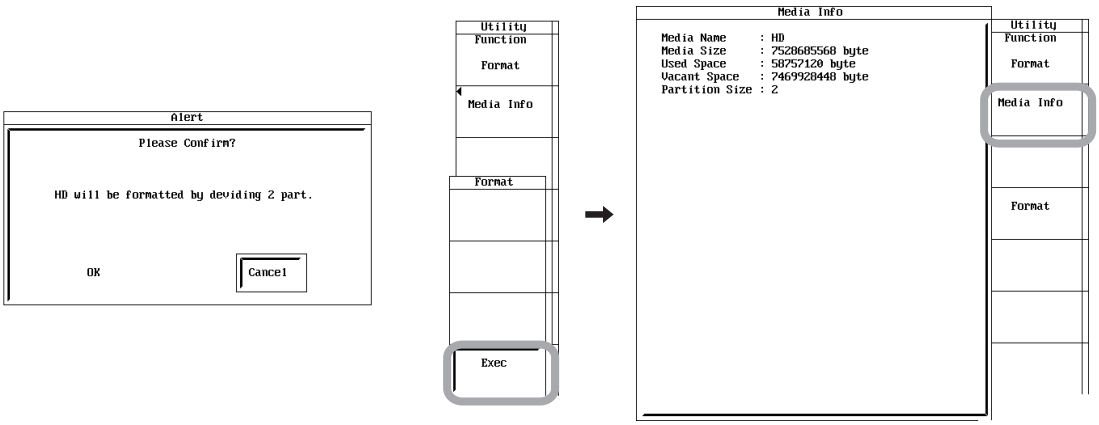


Executing/Aborting the Format Operation

11. Press the **Exec** soft key. An Alert dialog box appears.
12. Turn the **jog shuttle** to select OK or cancel.
13. Select OK and press **SELECT** to execute the format operation.
    Select Cancel and press **SELECT** to cancel the format operation.
    While the medium is being formatted, an icon corresponding the medium (PC card, external SCSI device, internal HD, or USB storage device) being formatted is displayed at the upper left corner of the screen.
    Select Cancel and press **SELECT** to cancel the format operation.

Viewing the Media Information

Select the storage medium according to steps 1 to 5.
Press the **Media Info** soft key. The information about the storage medium that was selected in step 5 is displayed.



Explanation

Formatting a PC Card or USB Storage Device

Flash ATA cards are formatted to IBM-compatible format.

2GB or more: FAT32
Less than 2GB: FAT16

Formatting an External SCSI Device

The formats of the disk that are connected via the SCSI (option) are as follows:

- **MO**
  Semi-IBM format. Handled as a removable disk.
- **Zip**
  FDISK 1 partition. Handled as a fixed disk.

Formatting the Internal Hard Disk (Option)

- **Selecting the Number of Partitions**
  You can set the number of partitions to 2 or 3.
- **Setting the Realtime Recording Area**
  You can set the realtime recording area to 30%, 40%, 50%, 60%, or 70% of the entire capacity of the internal hard disk. The default value is 50%.

Selecting the Number of Partitions

You can set partitions on the internal hard disk (option) and some of the external SCSI devices. However, partitions cannot be specified on removable disks. You can select the number of partitions from 1 to 3 (2 or 3 on the internal hard disk).

Media Info

Lists the information about the selected medium. The following information is displayed.

- Media Name: Name of the medium.
- Media Size: Total size.
- Used Space: Size of the used area.
- Vacant Space: Size of the free area.
- Partition Size: Number of partitions.

Note

- If you format a medium that has data stored on it, all the data are cleared when the medium is formatted.
- It takes a few seconds to format a PC card.
- It takes approximately 30 s to 1 minute to format the internal hard disk (option).
- Do not format a disk while the SL1400 and a PC is connected via a SCSI cable.
- If an error message is displayed after the format operation, the target medium may be damaged.
- This function cannot be used when using the FTP server function, the FTP client function, network printer function, or the Web server function.

13.7 Changing the SCSI ID Number

Procedure

1. Press **MENU**.
2. Press the **Next 1/2** soft key.
3. Press the **Self Test** soft key.
4. Press the **Test Item** soft key.
5. Use **jog shuttle+SELECT** to select SCSI.

Changing the ID Number of the SL1400

6. Press the **Own ID** soft key.
7. Turn the **jog shuttle** to select a value in the range of 0 to 7.

Changing the ID Number of the Internal Hard Disk

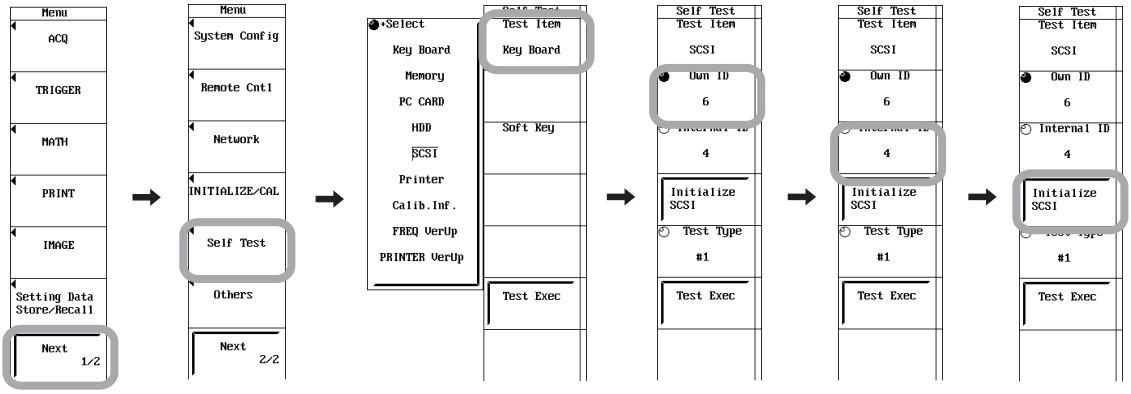
8. Press the **Internal ID** soft key.
9. Turn the **jog shuttle** to select a value in the range of 0 to 7.

Executing the ID Number Change

10. Press the **Initialize SCSI** soft key. The SCSI ID is changed to the selected ID number. The SCSI icon (SCSI) at the upper left corner of the screen blinks while the change is in progress. When the change is complete, the icon disappears.

Note

- If you do not execute Initialize SCSI after changing Own ID or Internal ID, the new ID is not activated until the SL1400 is powered up the next time.
- To save the data after executing Initialize SCSI, select the destination medium and directory.



Explanation

The SCSI ID number is used to distinguish between the various devices connected to the SCSI chain. Make sure not to use duplicate ID numbers on any of the connected devices.

Selectable Range of Own ID Number

Own ID (the ID number of the SL1400) can be set in the range of 0 to 7. The default value is 6.

Selectable Range of Internal ID Number

Internal ID (ID number of the internal hard disk (option) can be set in the range of 0 to 7. The default value is 4.

Notes When Setting the ID Number

- If you change the ID number, make sure to press the Initialize SCSI soft key.
- Do not set the same SCSI ID number for the external SCSI device and the internal hard disk of the SL1400.
- The SCSI ID numbers of external SCSI devices are automatically detected when the SL1400 is turned ON.
- If you change the ID number of the external SCSI device, make sure to execute Initialize SCSI to detect the new SCSI ID.
- Own ID and Internal ID cannot be set to the same value.

13.8 Saving and Loading Waveform Data

CAUTION

Do not remove the storage medium (disk) or turn OFF the power when the access indicator or the PC card or internal hard disk (option) icon is blinking. Doing so can damage the storage medium or destroy the data on the medium.

Procedure

Saving the Waveform Data

1. Press **FILE**.
2. Press the **File Item** soft key. The File Item setup menu appears.
3. Press the **Waveform** soft key.

Selecting the Data Type

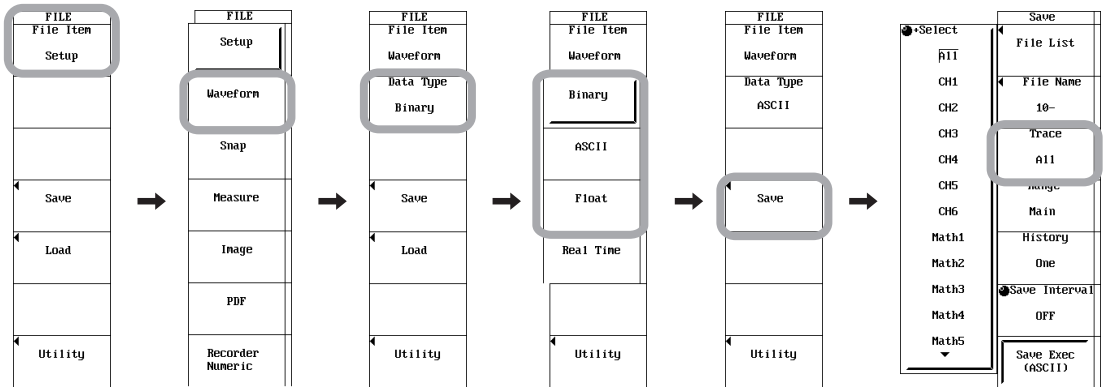
4. Press the **Data Type** soft key. The data type selection menu appears.
5. Press the **Binary**, **ASCII**, or **Float** soft key to select the data type.

Note

- Binary files can be saved and loaded. ASCII and Float files can only be saved.
- Select Real Time when loading or converting the waveform that has been realtime recorded. For details, see section 13.15.
- The data type is linked to the data type specified when Save to File is selected for the action-on-trigger action (see section 6.18).

Selecting the Waveform to Be Saved

6. Press the **Save** soft key. The save setup menu appears.
7. Press the **Trace** soft key. The waveform selection menu appears.
8. Press the soft key corresponding to the desired channel to select the waveform.



Selecting the Range of the Waveform to Be Saved

9. Press the **Range** soft key. A menu used to select the range of the waveform to be saved appears.
10. Press the **Main**, **Z1**, or **Z2** soft key to select the range of the waveform to be saved.
11. Press the **History** soft key to save all the data in the history memory (All), save only the selected waveform (One), or save the average data in the history memory (Ave).
    If you select All after performing a search on the history memory data, only the searched waveforms are saved.

Compressing or Decimating the Data and Saving the Data

Decimating the Data and Saving (When Data Type Is Set to ASCII)

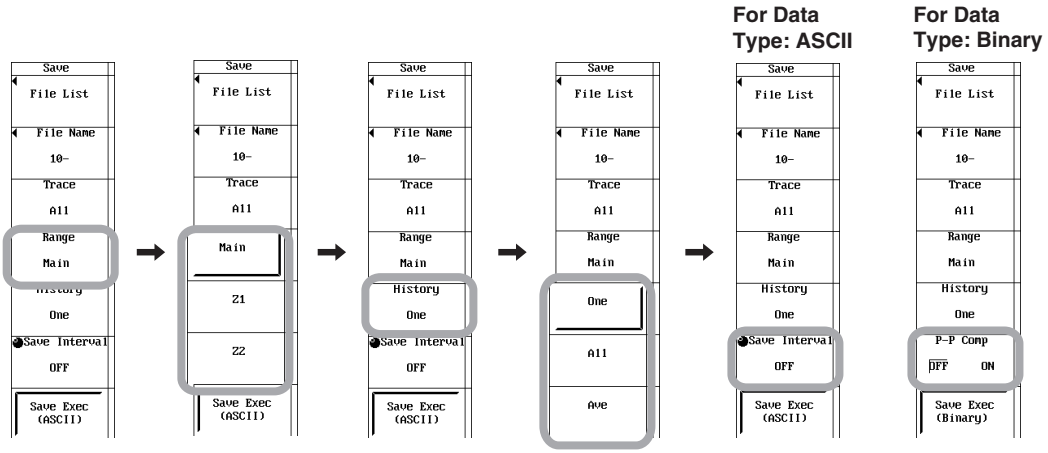
12. Press the **Save Interval** soft key.
    Turn the **jog shuttle** to set the save interval from OFF, Per5 to Per5000.

Compressing the Data and Saving (When Data Type Is Set to Binary)

12. Press the **P-P Comp** soft key to select ON (compress and save) or OFF (do not compress and save).
    If P-P Comp is turned ON when saving waveform data, only the maximum and minimum values of the multiple data points existing at the same time position are saved. Consequently, the file size is reduced. However, the SL1400 cannot load the saved data.

Note

If P-P Comp is set to ON, you cannot set the save range using Range.



Selecting Save Destination Medium

13. Press the **File List** soft key. The File List window appears.
14. Turn the **jog shuttle** to select the save destination medium (indicated by [ ]).
15. Press **SELECT** to confirm the new medium.

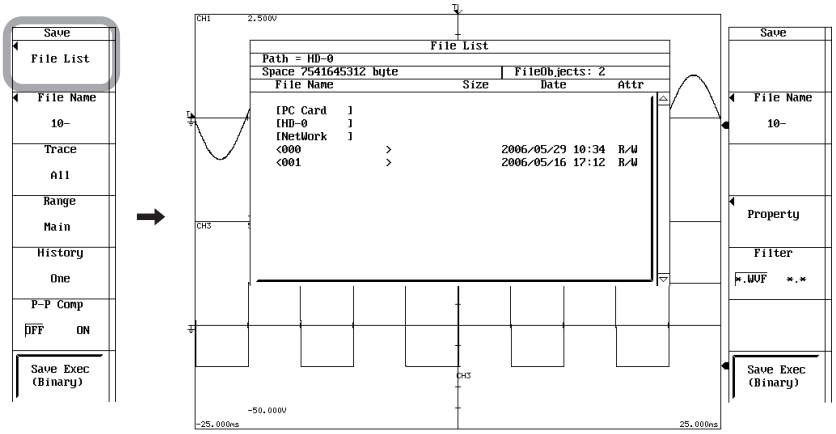
Select the Save Destination Directory

(Perform this operation when directories are present on the medium.)

16. Turn the **jog shuttle** to select the save destination directory (indicated by < >).
17. Press **SELECT** to confirm the directory. The selected medium/directory is displayed in “Path=.....” located at the upper left of the File List window. Select <..> to move to the parent directory.

Note

If History is set to All, MATH channels are not saved. If you want to save the data of the MATH channels, set History to One.



Setting the Name of the File to Be Saved and Comment

18. Press the **File Name** soft key. The file name setup menu appears.
19. Turn the **jog shuttle** to set Auto Naming.
20. Press **SELECT** to select OFF, Numbering, or Date.
21. Turn the **jog shuttle** to select File Name.
22. Enter the file name using up to 16 characters according to the procedure given in section 4.2.
23. Turn the **jog shuttle** to select Comment.
24. Enter the comment using up to 160 characters according to the procedure given in section 4.2.

Executing the Save Operation

25. Press the **Save Exec** soft key. The data is saved to the directory indicated by Path=..... At the same time, the Save Exec soft key changes to the Abort soft key.
    While the data is being saved, an icon corresponding the save destination medium (PC card, external SCSI device, internal HD, or USB storage device) is displayed at the upper left of the screen.

Aborting the Save Operation

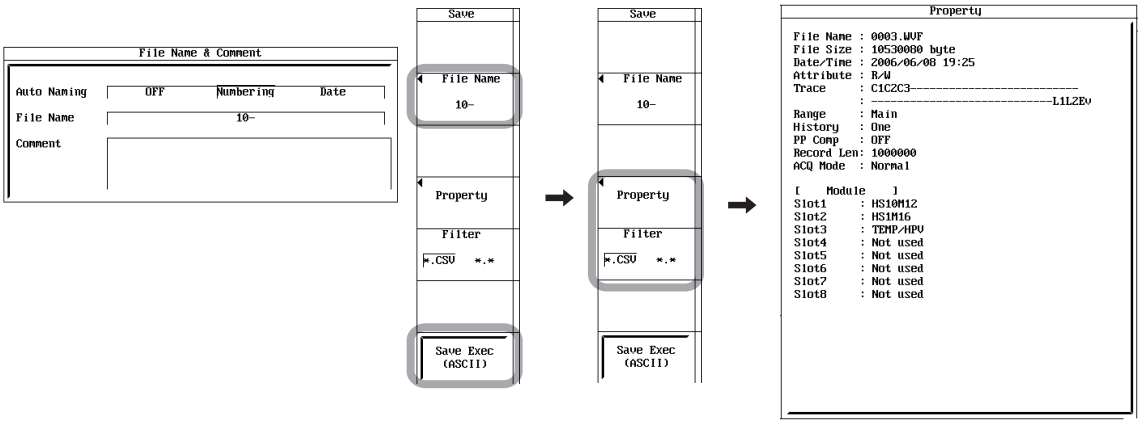
26. Press the **Abort** soft key to abort the save operation. At the same time, the Abort soft key changes to the Save Exec soft key.

Specifying the File to Be Displayed in the File List Dialog Box

27. On the screen showing the File List dialog box, press the **Filter** soft key to select *.extension or *.*.
28. Turn the **jog shuttle** to select the files in the File List dialog box.

Displaying Properties

29. Press the **Property** soft key. Information about the selected file is displayed.



Loading the Waveform Data

1. Press **FILE**.
2. Press the **File Item** soft key. The File Item setup menu appears.
3. Press the **Waveform** soft key.

Selecting the Data Type

4. Press the **Data Type** soft key. The data type selection menu appears.
5. Press the **Binary** soft key.

Selecting the Load Source Medium/Directory

6. Press the **Load** soft key. The load setup menu and File List window appear.
7. Select the load source directory according to steps 13 to 17 in “Saving the Waveform Data.”

Selecting the File to Be Loaded

8. Turn the **jog shuttle** to select the file.

Executing the Load Operation

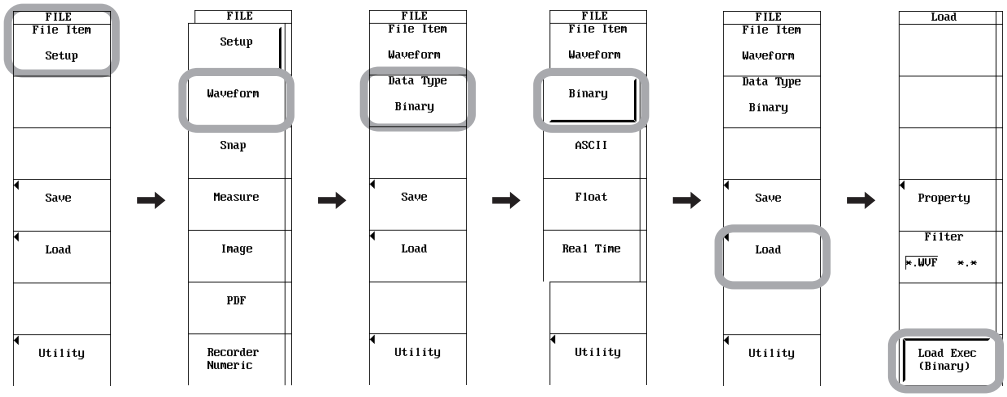
9. Press the **Load Exec** soft key. A dialog box appears showing the module information of the selected waveform data and the current module information of the SL1400.
10. Press the **Load Exec** soft key again. The selected file is read from the directory indicated in Path=..... At the same time, the Load Exec soft key changes to the Abort soft key.

Note

- Waveform data on modules whose information differs from the current module information of the SL1400 cannot be loaded.
- Realtime recorded waveform data (.WDF extension)) can also be loaded.

Aborting the Load Operation

11. Press the **Abort** soft key to abort the load operation. At the same time, the Abort soft key changes to the Load Exec soft key.



Specifying the Files to Be Displayed in the File List Dialog Box and Displaying Properties

12. Carry out steps 27 to 29 in “Saving the Waveform Data.”

Note

When a file saved by specifying Z1 (or Z2) is loaded, the data of the record length of Z1 (or Z2) is displayed right justified.

Explanation

Selecting the Data Type

The following three data types are available.

Binary

- The sampled data in the acquisition memory is saved in binary format.
- The data that is saved (excluding the data has been P-P compressed and saved) can be loaded and used to display waveforms and compute numeric data.
  If the saved data is loaded, the accumulate setting is always turned OFF.
- A header file that is used when analyzing the waveform on a PC is automatically created. The header file cannot be opened on the SL1400. For details on the header file format, see appendix 5.
- The extension is .WVF. The extension of the header file name is .HDR.
- When saving waveform data in binary format, a header file is automatically created with the .HDR extension. When the SL1400 is used to copy, delete, change filenames, or change file attribute of waveform data files (files with .WVF extension), the header files are automatically updated to reflect the changes. Do not delete only the header file or only the waveform data file, as this may cause a system malfunction.

ASCII

- The sampled data in the acquisition memory is saved in ASCII format in the unit converted by the specified range. The data can be used to analyze the waveform on a PC.
- The file cannot be loaded into the SL1400.
- The extension is .CSV.
- If the file size exceeds 2 GB depending on the combination of the record length and the number of channels, the files cannot be created.

Float

- The sampled data in the acquisition memory is saved in 32-bit floating format (IEEE) in the unit converted by the specified range. The data can be used to analyze the waveform on a PC.
- The data is in Little Endian (Intel format).
- The file cannot be loaded into the SL1400.
- The extension is .FLD.
- If the file size exceeds 2 GB depending on the combination of the record length and the number of channels, the files cannot be created.

Data Size

The following table shows the data size when the record length is set to 100 kW, waveform data of CH1 to CH4 are saved, all Math channels are turned OFF, and using history waveform 1 condition.

Data Type	Extension	Data Size (Bytes)
Binary	.WVF	Approx. 800 K ((100 kW + 32) × 4 channels × the number of history waveforms × 2)
	.HDR	Approx. 2 K (approx. 3 K when Math1 and Math2 are ON)
ASCII	.CSV	4 to 5 MW
Float	.FLD	Approx. 1.6 M ((100 kW + 32) × 4) ¥ the number of history waveforms × 4)

Waveform to Be Saved (Trace)

- You can save all the waveforms or the specified waveforms from CH1 to CH16, Math waveforms, and logic waveforms.
- The setup data including vertical axis, horizontal axis, and trigger of the waveform to be saved are also saved.
- For waveforms that are loaded using the history memory function, you can select whether to save all of the history data, save the average of the history data, or save just the current displayed waveform on the screen. If History is set to All, MATH channels are not saved. If you want to save the data of the MATH channels, set History to One. You can also save only the results obtained by searching the history memory data. For a description of searching the history memory data, see section 11.2 and 11.3.
- For a description of snapshot waveforms, see section 13.10.

Selecting the Range of the Waveform to Be Saved

Select the range (region) of the waveform from the choices below. Only the data that has been saved by selecting Binary in the aforementioned section “Selecting the Data Type” can be loaded in the SL1400.

- **Main**
  The range of the normal (Main) waveform. It is the range defined by the displayed record length (range displayed on the screen).
- **Z1**
  The range of zoom waveform Z1.
- **Z2**
  The range of zoom waveform Z2.

Compressing the Data and Saving: P-P Comp (When Data Type Is Set to Binary)

You can select whether to P-P compress the waveform data before saving.
Power spectrum computation data cannot be saved using P-P compression.

Decimating the Data and Saving (When Data Type Is Set to ASCII)

When saving to ASCII format, data is decimated and converted to ASCII format before the data is saved.
Save interval: OFF (no decimation), Per 5, Per 10, Per 20, Per 50, Per 100, Per 200, Per 500, Per 1000, Per 2000, or Per 5000
For example, if you select Per 5, the data is decimated as follows:
“First data point” “+5” “+10” “+15” ...

Selecting the Storage Medium and Directory

Storage media on which saving and loading are possible are displayed on the File List window.

- **Display Examples of Storage Media**

  [PC Card]: PC card
  [HD]: Hard disk
  [SCSI5]: SCSI device with the ID number set to 5*
  [SCSI5-1]: Partition 1 of a SCSI device whose ID number is 5*
  [NetWork]: Network drive (when the Ethernet interface option is installed)
  [USB]: USB storage device

  * When a SCSI device whose ID number is 5 is connected

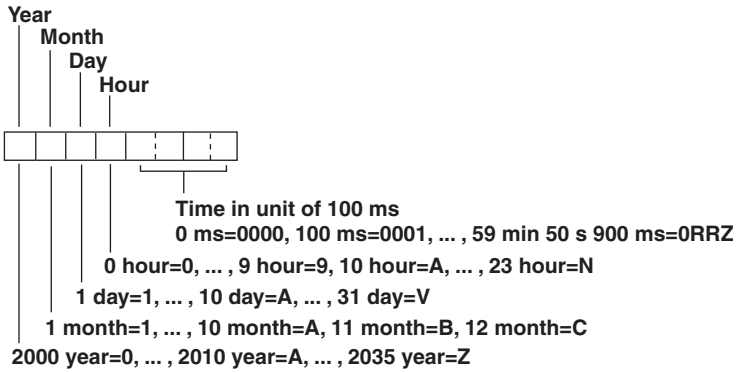
Setting the File Name

You can specify the file name using up to 16 characters. The characters that can be used are 0-9, A-Z, %, _, (, and).

Auto Naming

Select from the following three types.

- OFF: The name specified by File Name is assigned.
- Numbering: Files are automatically named with four digit numbers from 0000 to 4999. You can specify a common name (up to 4 characters, specified through File Name) that is placed before the number.
- Date: Files are automatically named using eight characters (base 36 consisting of 0 to 9 and A to Z) based on the date and time. (The file name specified by File Name is void.)



Note

Up to 16 characters can be entered for the common name. Characters exceeding 16 characters are void.

Setting a Comment

A comment of up to 160 characters can be added and saved. Comments are optional. All characters (including spaces) can be used.

Specifying the File to Be Displayed in the File List Dialog Box

You can specify the type of files to be displayed.

- *.WVF/*.CSV/*.FLD: Displays only the files that have the same file format as the file being saved.
- *.*: Displays all the files in the storage medium/directory.

Property

Displays the following information about the selected file: filename.extension, the file size, the date/time the file was saved, the attribute, the comment, the module configuration when the file was saved, the conditions for saving, etc.

Note

- An error occurs if a key other than the Abort key is pressed while saving or loading a file.
- Saving and Loading is not possible while the data acquisition is in progress.
  If waveform data is loaded, the accumulate setting is always turned OFF.
- If you change the extension of the saved data such as on a PC, the file can no longer be loaded.
- Up to 36 characters can be displayed in Path.
- File names are not case-sensitive. Comments are case-sensitive. In addition, the following names cannot be used due to limitations of MS-DOS.
  AUX, CON, PRN, NUL, CLOCK, COM1 to COM9, and LPT1 to LPT9
- The waveform data loaded from a file overwrites the data in the acquisition memory. Once the memory is overwritten, the old data cannot be recovered. It is recommended that the current waveform data be saved before loading data from a file.
- If the total number of files and directories exceed 5000 in a single directory, the file list is no longer displayed.
- This function cannot be used when using the FTP server function, network printer function or the Web server function.
- Waveform (.wvf) and header (.hdr) files are saved as file pairs. If you specify "*.*" for the files to be displayed (Filter) on the File List and manipulate individual files (Delete, Rename, or Copy), the file can no longer be loaded.
- Files that do not have an archive attribute are not displayed in the File List dialog box.

Data Format When Storing Multiple Records

When multiple records are stored (history memory, for example), the following data format is used.

ASCII Format: CR+LF is inserted between records.

<Header>
Measured data 1-1 of CH1, Measured data 1-1 of CH2, Measured data 1-1 of CH3, ... , [CR+LF]
Measured data 1-2 of CH1, Measured data 1-2 of CH2, Measured data 1-2 of CH3, ... , [CR+LF]
⋮
Measured data 1-m of CH1, Measured data 1-m of CH2, Measured data 1-m of CH3, ... , [CR+LF] — **Record 1**
[CR+LF]
Measured data 2-1 of CH1, Measured data 2-1 of CH2, Measured data 2-1 of CH3, ... , [CR+LF]
Measured data 2-2 of CH1, Measured data 2-2 of CH2, Measured data 2-2 of CH3, ... , [CR+LF]
⋮
Measured data 2-n of CH1, Measured data 2-n of CH2, Measured data 2-n of CH3, [CR+LF] — **Record 2**
[CR+LF]
⋮

Float Format: Stored in blocks of channels.

Measured data of record 1 of CH1
Measured data of record 2 of CH1
⋮
Measured data of record N of CH1
Measured data of record 1 of CH2
Measured data of record 2 of CH2
⋮
Measured data of record N of CH2
⋮

13.9 Saving/Loading the Setup Data

CAUTION

Never remove the storage medium (disk) or turn OFF the power while the access indicator or the PC card or internal hard disk (option) icon is blinking. Such acts can damage the storage medium or destroy the data on the medium.

Procedure

Saving the Setup Data

1. Press **FILE**.
2. Press the **File Item** soft key. The File Item setup menu appears.
3. Press the **Setup** soft key.

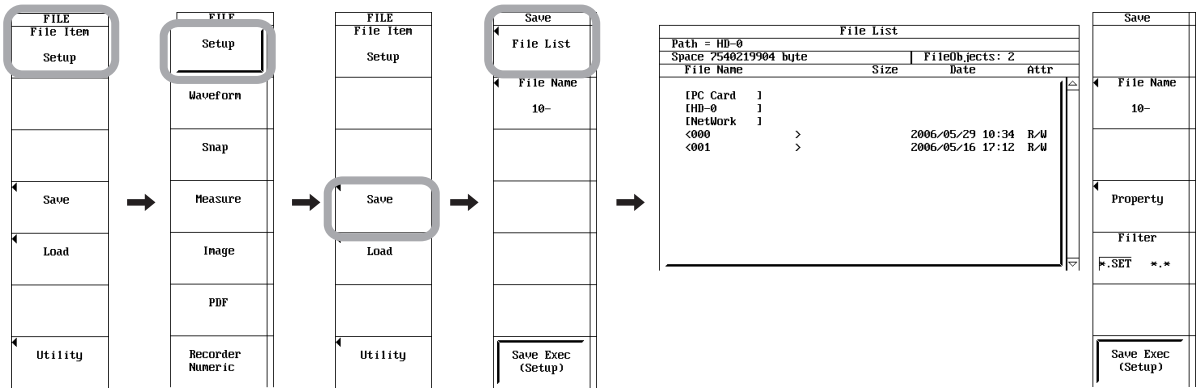
Selecting Save Destination Medium

4. Press the **Save** soft key. The save setup menu appears.
5. Press the **File List** soft key. The File List window appears.
6. Turn the **jog shuttle** to select the save destination medium (indicated by brackets).
7. Press **SELECT** to confirm the storage medium.

Selecting the Destination Directory

(Perform this operation when directories are present on the medium.)

8. Turn the **jog shuttle** to select the save destination directory (indicated by < >).
9. Press **SELECT** to confirm the directory. The selected medium/directory is displayed in “Path=.....” located above and to the left of the File List window. Select <..> to move to the parent directory.



Setting the File Name and Comment

10. Press the **File Name** soft key. The file name setup menu appears.
11. Turn the **jog shuttle** to select Auto Naming.
12. Press **SELECT** to select OFF, Numbering, or Date.
13. Turn the **jog shuttle** to select File Name.
14. Enter the file name using up to 16 characters according to the procedure given in section 4.2.
15. Turn the **jog shuttle** to select Comment.
16. Enter the comment using up to 160 characters according to the procedure given in section 4.2.

Note

You can set up to 16 characters for the file name, but only 15 characters are displayed on the setup menu.

Executing the Save Operation

17. Press the **Save Exec** soft key. The data is saved to the directory indicated by Path=..... At the same time, the **Save Exec** soft key changes to an **Abort** soft key.
    While the data is being saved, an icon corresponding the save destination medium (PC card, external SCSI device, internal HD, or USB storage device) is displayed at the upper left corner of the screen.

Aborting the Save Operation

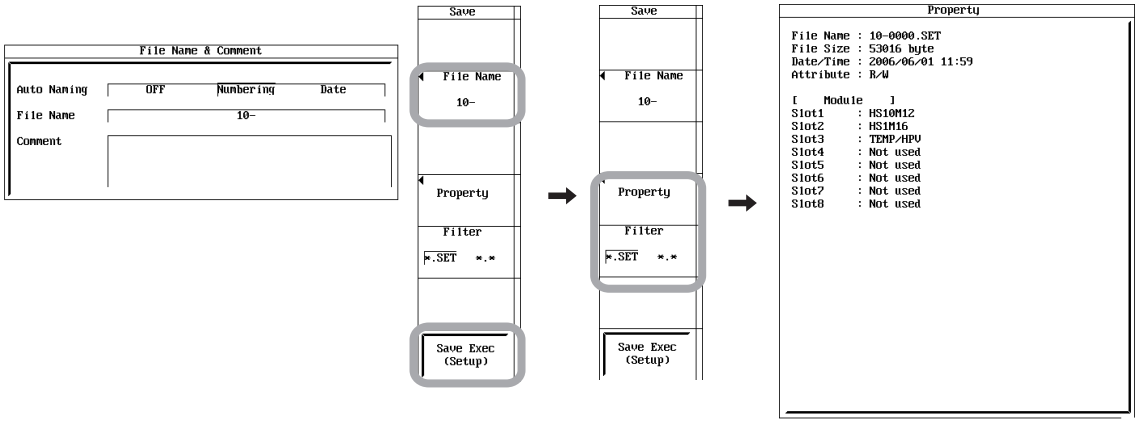
18. Press the **Abort** soft key. The save operation is aborted. At the same time, the **Abort** soft key changes to a **Save Exec** soft key.

Specifying the File to Be Displayed on the File List window

19. On the screen showing the File List window, press the **Filter** soft key to select *.SET or *.*.
20. Turn the **jog shuttle** to select the files in the File List window.

Displaying Properties

21. Press the **Property** soft key. Information about the selected file is displayed.



Loading the Setup Data

1. Press **FILE**.
2. Press the **File Item** soft key. The File Item setup menu appears.
3. Press the **Setup** soft key.

Selecting the Load Source Medium/Directory

4. Press the **Load** soft key. The load setup menu and File List window appear.
5. Select the load source directory according to steps 4 to 9 in “Saving the Setup Data.”

Selecting the File to Be Loaded

6. Turn the **jog shuttle** to select the file.

Executing the Load Operation

7. Press the **Load Exec** soft key. A dialog box appears showing the module information of the selected setup data and the current module information of the SL1400.
8. Press the **Load Exec** soft key again. The selected file is read from the directory indicated in Path=..... At the same time, the **Load Exec** soft key changes to an **Abort** soft key.

Note

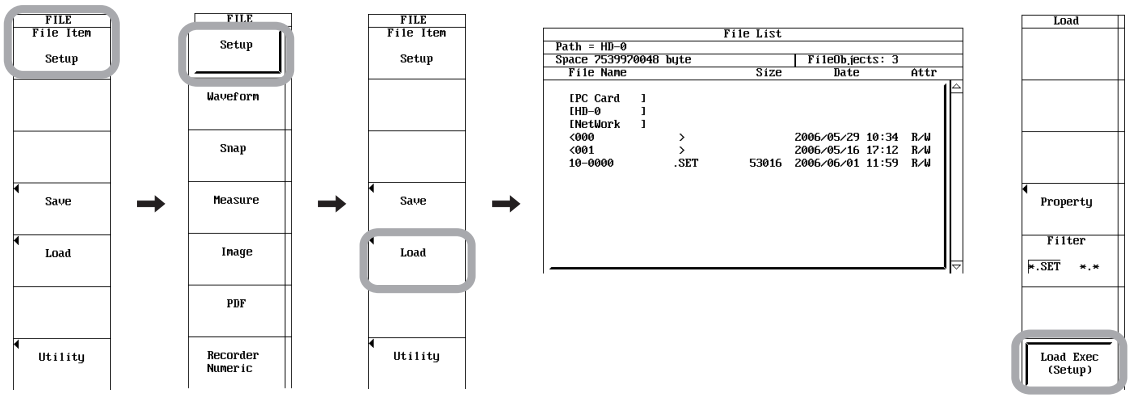
If the module information of the setup data and the current module information of the SL1400 differ, the setup data cannot be loaded.

Aborting the Load Operation

9. Press the **Abort** soft key. The load operation is aborted. At the same time, the **Abort** soft key changes to a **Load Exec** soft key.

Specifying the Files to Be Displayed in the File List Window and Displaying Properties

10. Carry out steps 19 to 21 in “Saving the Setup Data.”



Explanation

Setup Parameters That Are Saved

The setup parameter of each key existing at the time of the save operation can be saved. However, setup parameters such as the date and time, communications, and SCSI ID numbers are not saved.

Data Size

Approx. 64 KB

Selecting the Storage Medium and Directory: File List

Media on which saving and loading are possible are displayed on the File List window.

- **Display Examples of Storage Media**

  [PC Card]: PC card
  [HD]: Internal hard disk
  [SCSI5]: SCSI device with the ID number set to 5[1]
  [SCSI5-1]: Partition 1 of a SCSI device whose ID number is 5[1]
  [NetWork]: Network drive (when the Ethernet interface option is installed)
  [USB]: USB storage device

  1. When a SCSI device whose ID number is 5 is connected

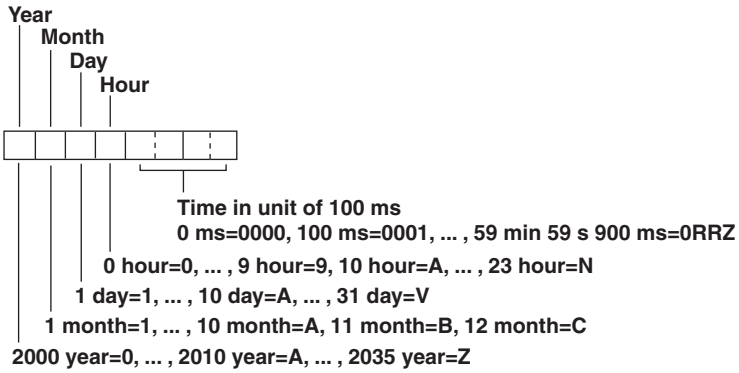
Setting the File Name

You can specify the file name using up to 16 characters. The characters that can be used are 0-9, A-Z, %, _, (, and).

- **Auto Naming**

  Select from the following three types.

  - OFF: The name specified by File Name is attached.
  - Numbering: Files are automatically named with four digit numbers from 0000 to 4999. You can specify a common name (up to four characters, specified by File Name) that is placed before the number.
  - Date: Files are automatically named using 8 characters (base 36 consisting of 0 to 9 and A to Z) based on the date and time. (The file name specified by File Name is void.)



Note

Up to 16 characters can be entered for the common name. Characters exceeding 16 characters are void.

- **Setting a Comment**

  A comment of up to 160 characters can be added and saved. Comments are optional. All characters (including spaces) can be used.

Notes When Saving Setup Data

- You cannot save setup data while waveform acquisition is in progress. Press START/STOP to stop the acquisition first.
- The number of directories and files that is displayed in the file list is up to 5000. If the number of directories and files in a directory exceeds 5000, the file list displays 5000 directories and files, but the ones that are displayed cannot determined.

Extension of Setup Data

A .set extension is automatically attached to the file name.

Specifying the File to Be Displayed on the File List Window: Filter

Specify the type of files to be displayed.

- *.SET: Displays only setup data files.
- *.*: Displays all the files in the medium/directory.

Property

Displays the following information about the selected file: filename.extension, the file size, the date the file was saved, the attribute, the comment, and the module configuration when the file was saved, etc.

Note

- An error occurs, if a key other than the Abort key is pressed while saving or loading a file.
- Saving and Loading is not possible while data acquisition is in progress.
- If you change the extension of the file such as on a PC, the file can no longer be loaded.
- Up to 36 characters can be displayed in “Path.”
- File names are not case-sensitive. Comments are case-sensitive. In addition, the following five file names cannot be used due to limitations of MS-DOS.
  AUX, CON, PRN, NUL, CLOCK, COM1 to COM9, and LPT1 to LPT9
- If the setup parameters that are saved to a file are loaded, the key settings are changed to the loaded information and cannot be undone. It is recommended that you first save the current setup parameters and then load the setup parameters from a file.
- Setup parameters such as the date and time, communications, SCSI ID numbers, menu language, message language, and USB keyboard language are not saved. Therefore, loading setup parameters from a file will not change the these settings.
- This function cannot be used when using the FTP server function, network printer function or the Web server function.
- Files that do not have an archive attribute are not displayed in the File List window. Do not remove the archive attribute of the files saved by the SL1400 using your PC.

13.10 Saving/Loading Snapshot Waveforms

CAUTION

Never remove the storage medium (disk) or turn OFF the power while the access indicator or the PC card or internal hard disk (option) icon is blinking. Such acts can damage the storage medium or destroy the data on the medium.

Procedure

Saving Snapshot Waveforms

1. Press **FILE**.
2. Press the **File Item** soft key. The File Item setup menu appears.
3. Press the **Snap** soft key.

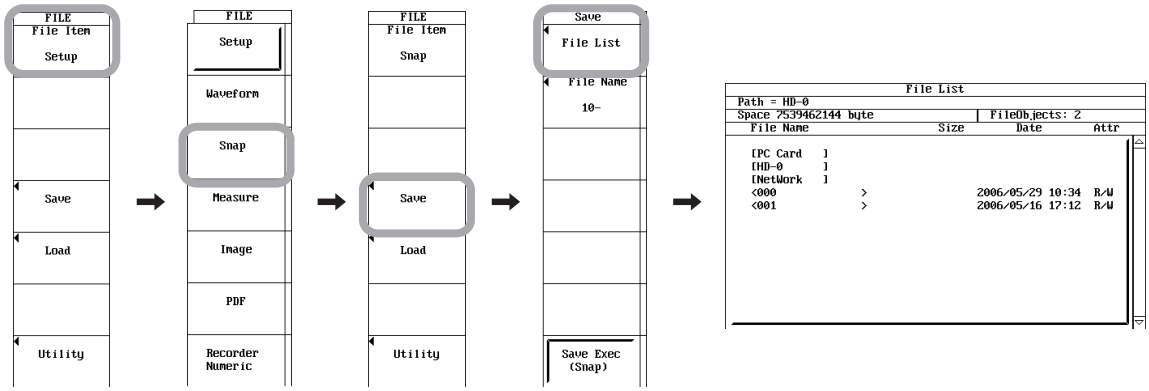
Selecting Save Destination Medium

4. Press the **Save** soft key. The save setup menu appears.
5. Press the **File List** soft key. The File List window appears.
6. Turn the **jog shuttle** to select the save destination medium (indicated by brackets).
7. Press **SELECT** to confirm the storage medium.

Selecting the Destination Directory

(Perform this operation when directories are present on the medium.)

8. Turn the **jog shuttle** to select the save destination directory (indicated by < >).
9. Press **SELECT** to confirm the directory. The selected medium/directory is displayed in “Path=.....” located above and to the left of the File List window. Select <..> to move to the parent directory.



Setting the File Name and Comment

10. Press the **File Name** soft key. The file name setup menu appears.
11. Turn the **jog shuttle** to select Auto Naming.
12. Press **SELECT** to select OFF, Numbering, or Date.
13. Turn the **jog shuttle** to select File Name.
14. Enter the file name using up to 16 characters according to the procedure given in section 4.2.
15. Turn the **jog shuttle** to select Comment.
16. Enter the comment using up to 160 characters according to the procedure given in section 4.2.

Note

You can set up to 16 characters for the file name, but only 15 characters are displayed on the setup menu.

Executing the Save Operation

17. Press the **Save Exec** soft key. The data is saved to the directory indicated by Path=..... At the same time, the **Save Exec** soft key changes to an **Abort** soft key.

Aborting the Save Operation

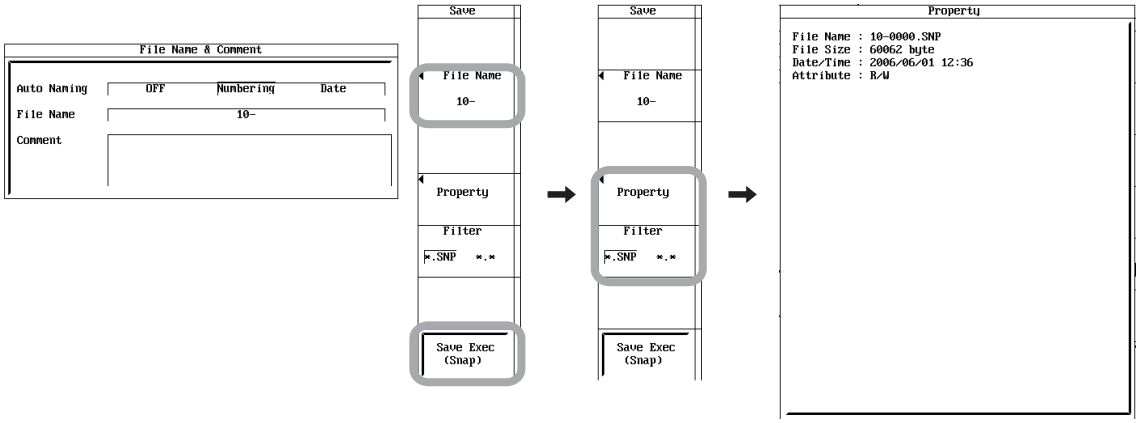
18. Press the **Abort** soft key. The save operation is aborted. At the same time, the **Abort** soft key changes to a **Save Exec** soft key.
    While the data is being saved, an icon corresponding the save destination medium (PC card, external SCSI device, internal HD, or USB storage device) is displayed at the upper left corner of the screen.

Specifying the File to Be Displayed on the File List Window

19. On the screen showing the File List window, press the **Filter** soft key to select *.SNP or *.*.
20. Turn the **jog shuttle** to select the files in the File List window.

Displaying Properties

21. Press the **Property** soft key. Information about the selected file is displayed.



Loading Snapshot Waveforms

1. Press **FILE**.
2. Press the **File Item** soft key. The File Item setup menu appears.
3. Press the **Snap** soft key.

Selecting the Load Source Medium/Directory

4. Press the **Load** soft key. The load setup menu and File List window appear.
5. Select the load source directory according to steps 4 to 9 in “Saving Snapshot Waveforms.”

Selecting the File to Be Loaded

6. Turn the **jog shuttle** to select the file.

Executing the Load Operation

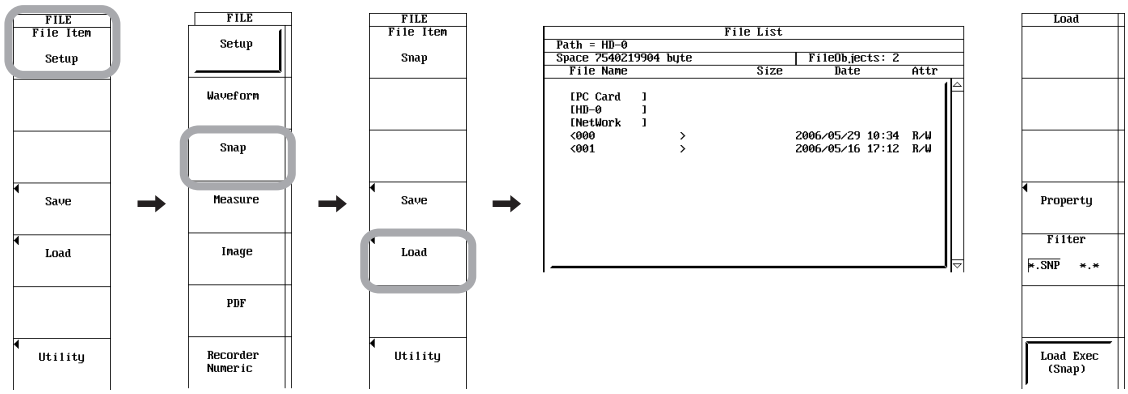
7. Press the **Load Exec** soft key. The selected file is read from the directory indicated in Path=..... At the same time, the **Load Exec** soft key changes to an **Abort** soft key.

Aborting the Load Operation

8. Press the **Abort** soft key. The load operation is aborted. At the same time, the **Abort** soft key changes to a **Load Exec** soft key.

Specifying the Files to Be Displayed in the File List Window and Displaying Properties

9. Carry out steps 19 to 21 in “Saving Snapshot Waveforms.”



Explanation

You can take snap shots of the waveform and save the image to the file. You can also load the snapshot waveform.

Data Size

Approx. 60 KB

Data Extension

The extension is .SNP.

The selection of the medium and directory, file name, auto naming function, comments, specification of the files to be displayed in the File List window, and properties are the same as those for saving/loading normal waveform data.
For details, see section 13.8.

Clearing the Waveform

The loaded snapshot waveform is cleared when CLEAR TRACE or initialization is performed.

Note

- An error occurs, if a key other than the Abort key is pressed while saving or loading a file.
- This function cannot be used when using the FTP server function, network printer function, or the Web server function.

13.11 Saving the Results of the Automated Measurement of Waveform Parameters

CAUTION

Never remove the storage medium (disk) or turn OFF the power while the access indicator or the PC card, internal hard disk (option), or USB storage device icon is blinking. Such acts can damage the storage medium or destroy the data on the medium.

Procedure

1. Press **FILE**.
2. Press the **File Item** soft key. The File Item setup menu appears.
3. Press the **Measure** soft key.

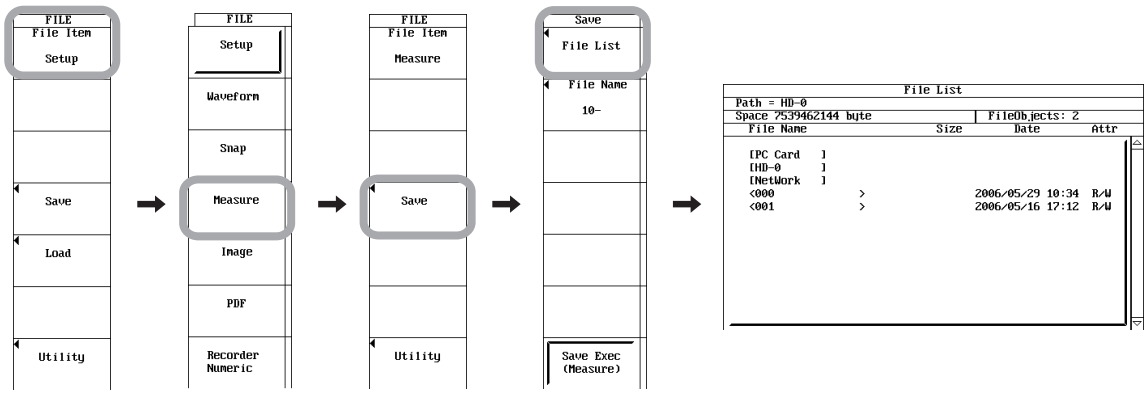
Selecting Save Destination Medium

4. Press the **Save** soft key. The save setup menu appears.
5. Press the **File List** soft key. The File List window appears.
6. Turn the **jog shuttle** to select the save destination medium (indicated by brackets).
7. Press **SELECT** to confirm the storage medium.

Selecting the Destination Directory

(Perform this operation when directories are present on the medium.)

8. Turn the **jog shuttle** to select the save destination directory (indicated by < >).
9. Press **SELECT** to confirm the directory. The selected medium/directory is displayed in “Path=.....” located above and to the left of the File List window. Select <..> to move to the parent directory.



Setting the File Name and Comment

10. Press the **File Name** soft key. The file name setup menu appears.
11. Turn the **jog shuttle** to select Auto Naming.
12. Press **SELECT** to select OFF, Numbering, or Date.
13. Turn the **jog shuttle** to select File Name.
14. Enter the file name using up to 16 characters according to the procedure given in section 4.2.
15. Turn the **jog shuttle** to select Comment.
16. Enter the comment using up to 160 characters according to the procedure given in section 4.2.

Executing the Save Operation

17. Press the **Save Exec** soft key. The data is saved to the directory indicated by Path=..... At the same time, the **Save Exec** soft key changes to an **Abort** soft key.
    While the data is being saved, an icon corresponding the save destination medium (PC card, SCSI external SCSI device, internal HD, or USB storage device) is displayed at the upper left corner of the screen.

Aborting the Save Operation

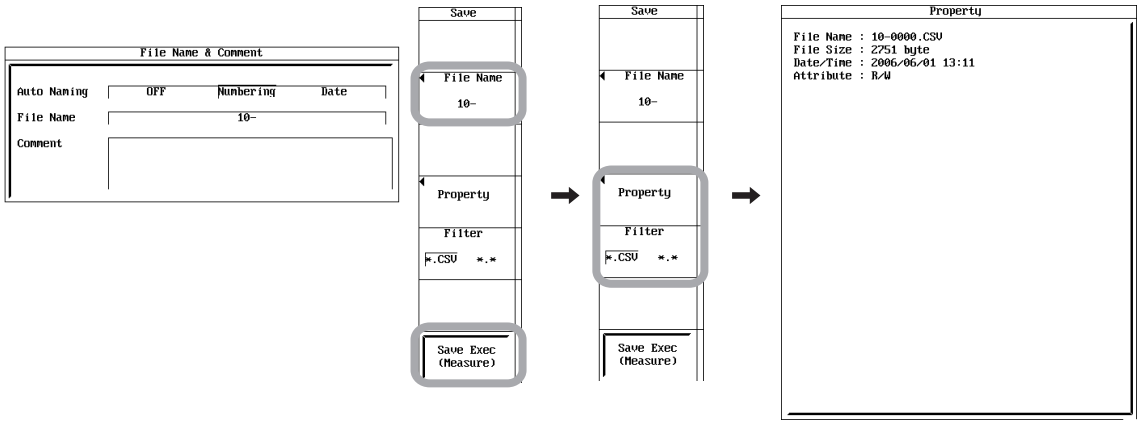
18. Press the **Abort** soft key. The save operation is aborted. At the same time, the **Abort** soft key changes to a **Save Exec** soft key.

Specifying the File to Be Displayed on the File List Window

19. On the screen showing the File List window, press the **Filter** soft key to select *.CSV or *.*.
20. Turn the **jog shuttle** to select the files in the File List window.

Displaying Properties

21. Press the **Property** soft key. Information about the selected file is displayed.



Explanation

The results of the automated measurement of waveform parameters can be saved in CSV format (.CSV extension) to a PC card, an external SCSI device, the internal hard disk (option), or the USB storage device.
A CSV file is a comma-separated format file. The CSV file is one of the common file formats used to exchange data between spreadsheet and database applications.
The data that are saved are the measured results of the parameters that are specified in the automated measurement of waveform parameters.

Notes When Saving the Results of the Automated Measurement of Waveform Parameters

The restrictions are as follows.

- Up to (48000/the number of items that are turned ON) data points before the point at which the save operation is executed are saved. However, the data points that are saved are limited to those that are acquired after fixing the record time, record length, and Measure settings.

  Output Example

“CH1 P-P”,	“CH1 Max”,	“CH1 Min”,	“CH2 P-P”	
“V”,	“V”,	“V”,	“V”,	
0.500E+00,	0.500E+00,	0.000E+00,	0.02E-06	Oldest data
0.375E+00,	0.375E+00,	0.000E+00,	0.02E-06	
0.313E+00,	0.188E+00,	-0.125E+00,	0.02E-06	
•	•	•	•	↓
•	•	•	•	
•	•	•	•	
•	•	•	•	Most recent data

  For a description of the automated measurement of waveform parameters, see section 11.5.

Data Size

The data size can be derived from the following equation.
Data size = the number of items × 15 × the number of history waveforms (bytes)

Data Extension

The extension is .CSV.

The selection of the medium and directory, file name, comments, auto naming function, specification of the files to be displayed in the File List window, and properties are the same as those for saving/loading normal waveform data.
For details, see section 13.8.

Note

- An error occurs, if a key other than the Abort key is pressed while saving a file.
- This function cannot be used when using the FTP server function, network printer function, or the Web server function.
- If you change the measurement conditions after performing automated measurement of waveform parameters, the measured results are cleared. At this point, the measured results after the change are displayed on the screen, but they cannot be saved to a file.

13.12 Saving Screen Image Data

<For a description of this function, refer to page 2-50.>

Procedure

1. Press **MENU**.
2. Press **IMAGE** soft key.

Selecting the Output Format

3. Press the **Format** soft key.
4. Press the soft key corresponding to the desired output format from PNG, JPEG, BMP, and Post Script.

Setting the Color (When Format Is PNG, JPEG, or BMP)

5. Press the **Color** soft key to select ON, ON(Revers), ON(Gray), or OFF.

Setting the Compression Format (When Format Is BMP and Color Is Not OFF)

6. Press the **Compression** soft key to select ON or OFF.

Setting a Comment

7. Press the **Comment** soft key.
8. Enter the comment using up to 20 characters according to the procedure given in section 4.2.

Selecting Save Destination Medium

9. Press the **File List** soft key. The save destination File List window appears.
10. Turn the **jog shuttle** to select the save destination storage medium.

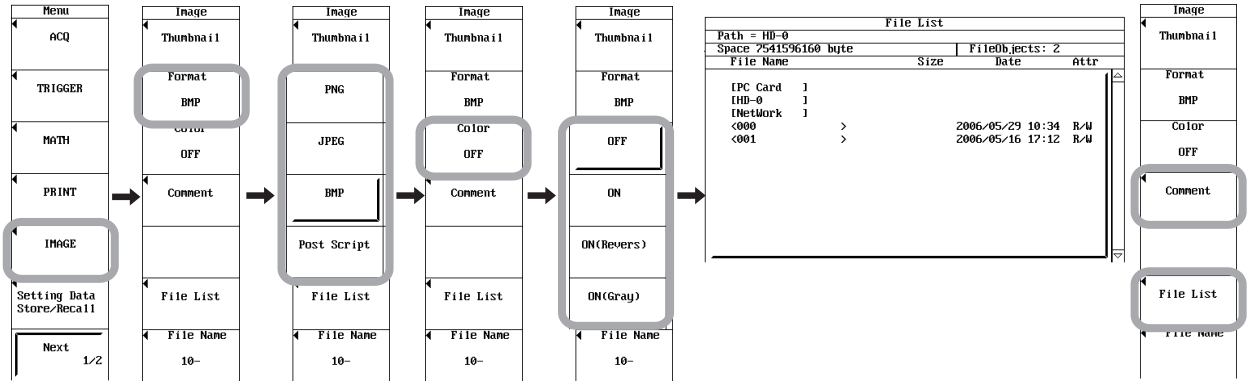
Note

Storage media such as the built-in PC card, internal HD (option), external SCSI device, and USB storage device are displayed in brackets.

- PC card [PC Card]
- External SCSI device [SCSI]
- Internal hard disk [HD]
- USB storage device [USB]

Directories are displayed using < >.

11. Press **SELECT**. The contents of the selected storage medium or directory are displayed.



Selecting the Destination Directory

(Perform this operation when directories are present on the medium.)

12. Turn the **jog shuttle** to select the save destination directory (indicated by < >).
13. Press **SELECT** to confirm the new directory. The selected medium/directory is displayed in “Path=.....” located above and to the left of the File List window. Select <..> to move to the parent directory.

Setting the Name of the File to Be Saved

14. Press the **File Name** soft key. The file name setup menu appears.
15. Turn the **jog shuttle** to select Auto Naming.
16. Press **SELECT** to select OFF, Numbering, or Date.
17. Turn the **jog shuttle** to select File Name.
18. Enter the file name using up to 16 characters according to the procedure given in section 4.2.

Note

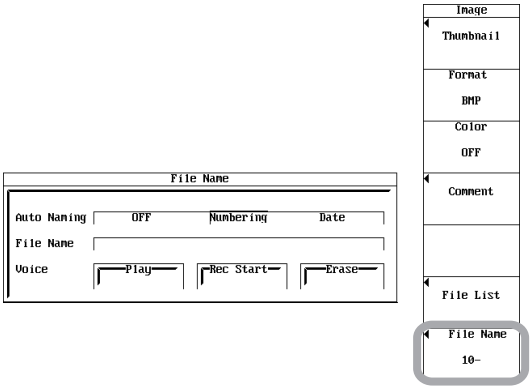
- If Auto Naming is set to Numbering, the first four characters are valid. If Auto Naming is set to Date, the file name is invalid.
- You can set up to 16 characters for the file name, but only 15 characters are displayed on the setup menu.

Executing the Save Operation

19. Press **IMAGE SAVE**. The screen image data is saved to the storage medium. Pressing **IMAGE SAVE** again aborts the save operation.
    While the data is being saved, an icon corresponding the save destination medium (PC card, SCSI external SCSI device, internal HD, or USB storage device) is displayed at the upper left corner of the screen.

Note

Thumbnails of the saved screen image data can be displayed. For details, see section 13.13.



Explanation

The screen image data can be stored to a specified storage medium.
You can select the storage medium from the PC card, external SCSI device, internal hard disk (option), and network drive (when the Ethernet interface option is installed). For details on saving data to the network drive, see section 15.3.

Setting the Output Format

Data in the following formats can be saved to a specified storage medium. The extension that is automatically attached and the data size (reference value) are indicated below.

Output Data Format	Extension	Data Size[1]
PNG	*.PNG	Approx. 6 kbytes (Approx. 14 kbytes)[2]
JPEG	*.JPG	Approx. 400k bytes (Approx. 400 kbytes)[2]
BMP	*.BMP	Approx. 60 kbytes (Approx. 480 kbytes)[2]
Post Script	*.PS	Approx. 123 kbytes

1. When color is OFF
2. The data size inside the parentheses is for the case when color is ON

Setting the Color (When Format Is BMP)

Select ON, ON(Revers), ON(Gray), or OFF.

ON: Output using 256 colors.
ON(Revers): Do not output the background of the screen in color.
ON(GRAY): Output the data using a tint of 16 gray levels.
OFF: Output in black and white.

Setting the Compression Format (When Format Is BMP and Color Is Not OFF)

When the output format is set to BMP, the data can be output by compressing using RLE. However, data compression is not possible if the color is OFF.

Setting a Comment

A comment of up to 20 characters can be added to the lower section of the screen and saved. Comments are optional. All characters (including spaces) can be used.

Setting the Save Destination: File List

The available storage medium is displayed in the File List window.

- **Display Examples of Storage Media**

  [PC Card]: PC card
  [HD]: Hard disk
  [SCSI5]: SCSI device with the ID number set to 5[1]
  [SCSI5-1]: Partition 1 of a SCSI device whose ID number is 5[1]
  [NetWork]: Network drive (when the Ethernet interface option is installed)
  [USB]: USB storage device

  1. When a SCSI device whose ID number is 5 is connected

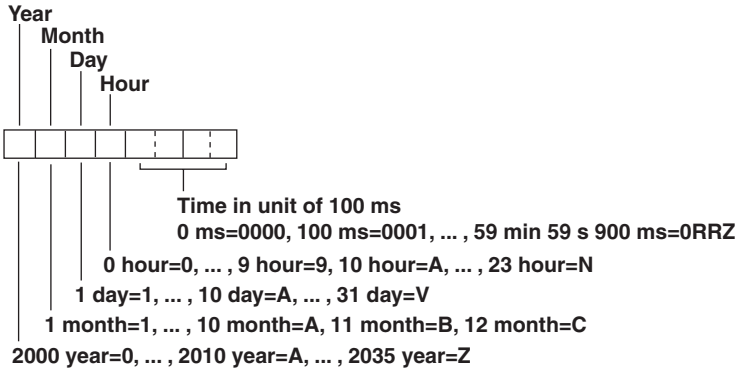
PC Card, Internal Hard Disk, External SCSI Device, and USB Storage Device

PC card, internal hard disk, external SCSI device, and USB storage device are described in sections 13.2 to 13.5. For the formatting procedure, see section 13.6.

Setting the File Name

You can specify the file name using up to 16 characters. (However, the setup menu displays only up to 15 characters.) The characters that can be used are 0-9, A-Z, %, _, (, and).

- **Auto Naming**
  Select from the following three types.
  - OFF: The name specified by File Name is attached.
  - Numbering: Files are automatically named with four digit numbers from 0000 to 4999. You can specify a common name (up to four characters, specified by File Name) that is placed before the number.
  - Date: Files are automatically named using 8 characters (base 36 consisting of 0 to 9 and A to Z) based on the date and time. (The file name specified by File Name is void.)



Note

Up to 16 characters can be entered for the common name. Characters exceeding 16 characters are void.

Notes When Saving Screen Image Data

- The maximum number of files that can be saved when auto naming is enabled is 5000.
- If the total number of files and directories exceed 5000 in a single directory, the file list is no longer displayed.

13.13 Displaying Thumbnails of the Saved Screen Image Data

<For a description of this function, refer to page 2-50.>

Procedure

Thumbnail Display from the IMAGE Menu

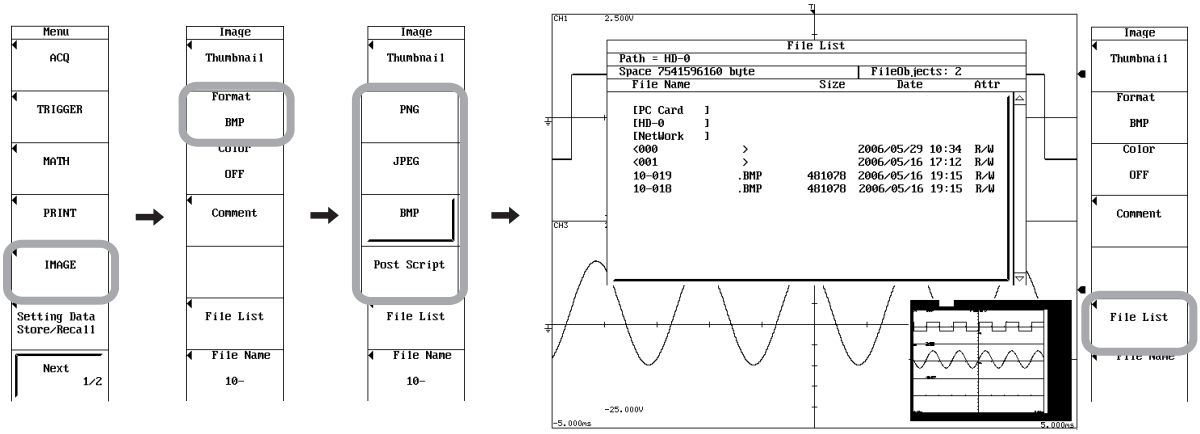
1. Press **MENU**.
2. Press **IMAGE** soft key.
3. Press the **Format** soft key. The save format selection menu appears.
4. Press the soft key corresponding to the save format of the screen image data of which you want to display the thumbnails from PNG to PostScript.

- **Displaying the Thumbnails of the Specified Screen Image Data**

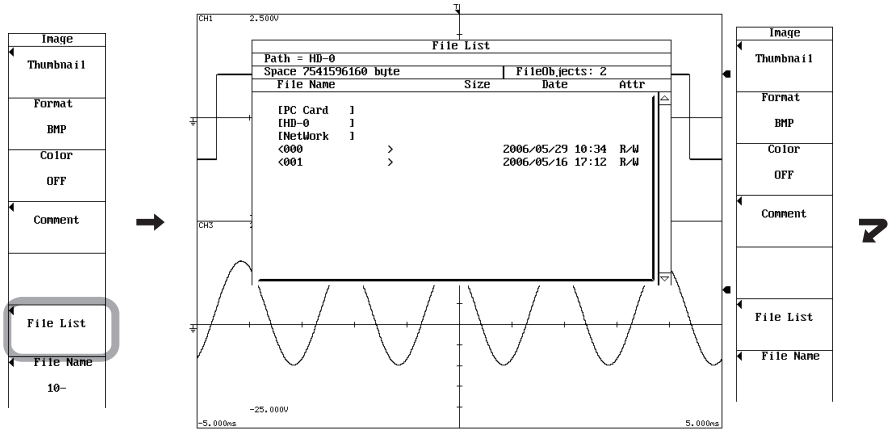
5. Press the **File List** soft key. The File List window appears.
6. Turn the **jog shuttle** to select the screen image data file in the File List window.
7. Press **SELECT**. The thumbnail of the selected screen image data file is displayed at the lower right section of the File List window.
   To clear the thumbnail, turn the **jog shuttle**.

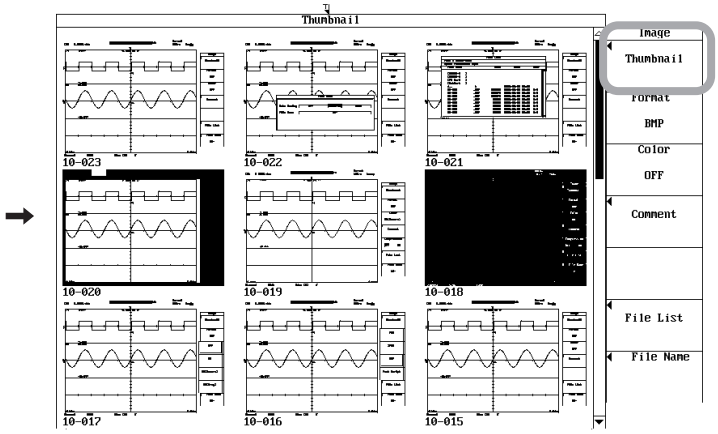
Note

- If the selected screen image data file does not have data (file) for thumbnail display, an error message screen appears.
- You can press ESC to clear the thumbnail, but in this case, the File List window is also cleared. To clear only the thumbnail display, turn the jog shuttle.



- **Listing the Thumbnails of the Specified Format**
  5. Press the **File List** soft key. The File List window appears.
  6. Turn the **jog shuttle** to select the directory that you want to display the thumbnails.
  7. Press the **Thumbnail** soft key. The thumbnails of the screen image data of the format specified in step 4 are displayed (9 thumbnails (3 × 3) in the waveform display area).
  8. If there are more than 9 thumbnails, you can scroll the screen using the **jog shuttle**. To scroll the files upward, turn the **jog shuttle** counter-clockwise. To scroll the files downward, turn the **jog shuttle** clockwise. The files scroll three files at a time.
  9. To clear the list of thumbnails, press **ESC**.



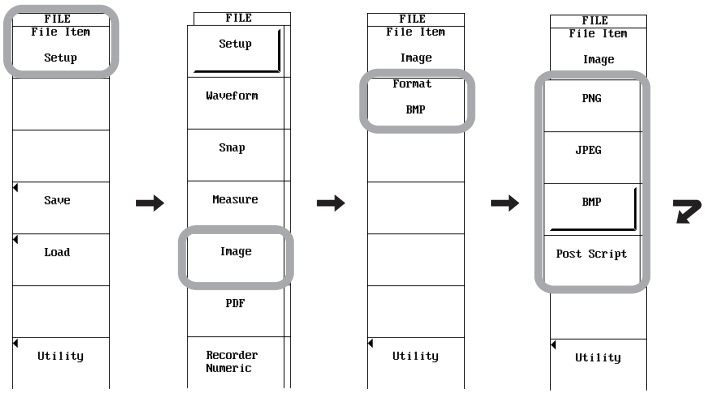


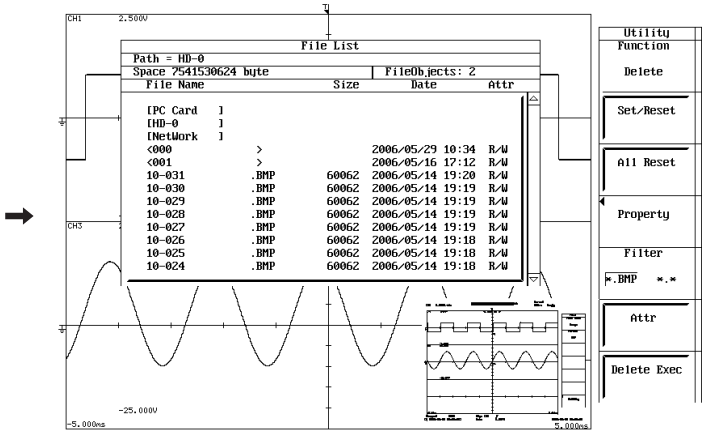
Thumbnail Display from the FILE Menu

1. Press **FILE**.
2. Press the **File Item** soft key.
3. Press the **Image** soft key.
4. Press the **Format** soft key.
5. Select the format you want to display thumbnails from PNG to PostScript.
6. Press the **Utility** soft key. The File List window appears.
7. Turn the **jog shuttle** to select the screen image data file (file with .png, .jpg, .bmp, and .ps extensions) on the File List window.
8. Press **SELECT**. The thumbnail of the selected screen image data file is displayed at the lower right section of the File List window.
   To clear the thumbnail, turn the **jog shuttle**.

Note

- If the selected screen image data file does not have data (file) for thumbnail display, an error message screen appears.
- You can press ESC to clear the thumbnail, but in this case, the File List window is also cleared. To clear only the thumbnail display, turn the jog shuttle.





Explanation

Thumbnails of the screen image data that are saved on a storage medium can be displayed.

Thumbnail Display from the IMAGE Menu

- **Thumbnail Screen**
  Thumbnails are displayed for the screen image data files (files with .png, .jpg, .bmp, and .ps extensions) in the directory selected by File List of the IMAGE menu.
  The data used to display thumbnails are separate from the screen image data and are created simultaneously when the screen image data is created. The extension of thumbnail data varies depending on the output format of the original screen image data as follows:
  - PNG file: .NTD
  - JPEG file: .JTD
  - BMP file: .BTD
  - PS file: .PTD

  The data size is approximately 2 to 6 KB for all formats.

- **Thumbnail Items**
  The following two items are displayed.
  - Thumbnail of the waveform area
  - File name

- **Thumbnail Display Format**
  The number of files displayed on the thumbnail screen (the number of thumbnails displayed in the waveform area) is 9. The display order is the same as the order for displaying files in the File List window. In addition, the files are displayed from left to right and top to bottom.

- **Scrolling the Thumbnail Screen**
  If the number of thumbnails exceeds the maximum number of thumbnails that can be displayed (9), the thumbnail screen can be scrolled one row (three thumbnails) at a time. To scroll the files upward, turn the jog shuttle counter-clockwise. To scroll the files downward, turn the jog shuttle clockwise.

- **Thumbnails on the File List**
  When you select a screen image data file on the File List, the thumbnail of the screen image data is displayed at the lower right section of the File List. The file name is not displayed on the thumbnail screen on the File List.

Thumbnail Display from the FILE Menu

When you select a screen image data file on the File List, the thumbnail of the screen image data is displayed at the lower right section of the File List. The file name is not displayed on the thumbnail screen on the File List.

Note

The screen image data and thumbnail data are saved in file pairs. For example, if you set the output format to BMP, the following two types of files are saved.
- 0000.BMP (screen image data)
- 0000.BTD (thumbnail data)

If you specify "*.*" for the files to be displayed (Filter) on the File List and manipulate individual files (Delete, Rename, or Copy), the thumbnail display function can no longer be used.

13.14 Creating PDF Files of the Printed Image

Procedure

1. Press **MENU**.
2. Press the **PRINT** soft key.

Selecting the Print Destination

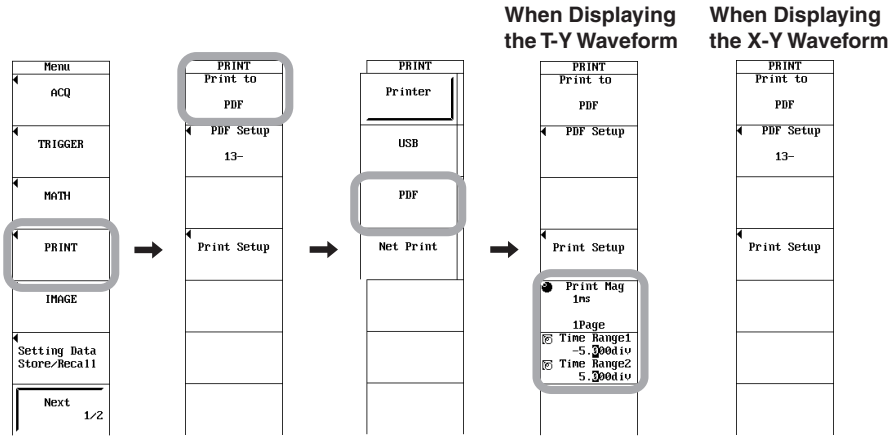
3. Press the **Print to** soft key. The print destination selection menu appears. (Net Print appears only when the Ethernet interface option is installed.)
4. Press the **PDF** soft key.
   When displaying T-Y waveforms, proceed to step 5.
   When displaying X-Y waveforms, proceed to step 9.

Selecting the Section to Be Output to the PDF File (Only When Displaying the T-Y Waveform)

5. Press the **Time Range1/Time Range2** soft key.
6. Use **jog shuttle**+**SELECT** to set the output start point and output end point of the section to be output to the PDF file.

Setting the Print Magnification (Only When Displaying the T-Y Waveform)

7. Press the **Print Mag** soft key.
8. Use the **jog shuttle** to set the magnification along the time axis when creating the PDF file. The top section of the menu shows the record time corresponding to 10 divisions when creating the PDF file; the bottom section shows the number of pages when the PDF file is created using the record time indicated in the top section.



Specifying the Print Settings

9. Press the **Print Setup** soft key. The print setup dialog box opens.
   When displaying T-Y waveforms, proceed to step 10.
   When displaying X-Y waveforms, proceed to steps 15 to 18 and then 24.

Setting the Print Format

10. Use **jog shuttle**+**SELECT** to select the format from 1 Zone to 16 Zone.

Note

The print format setting is linked with the DISPLAY menu > Format setting.

Setting the Extra Area (Only When Displaying the T-Y Waveform)

11. Use **jog shuttle**+**SELECT** to turn the extra area ON or OFF.

Setting the Flexible Zone (Only When Displaying the T-Y Waveform)

12. Use **jog shuttle**+**SELECT** to select Setup in Flexible Zone.
13. Use **jog shuttle**+**SELECT** to set the mode to OFF or ON.
14. Use **jog shuttle**+**SELECT** to set the upper and lower limits of the waveform to be recorded.

Setting the Graticule

- **Setting the Grid**

15. Use **jog shuttle**+**SELECT** to set the type to , OFF, or .

- **Setting Dark/Light**

16. Use **jog shuttle**+**SELECT** to set dark/light to light or dark.

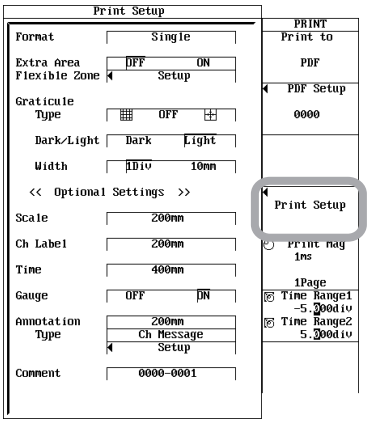
- **Setting the Width of the Vertical Scale**

17. Use **jog shuttle**+**SELECT** to set the width to 1div or 10mm.

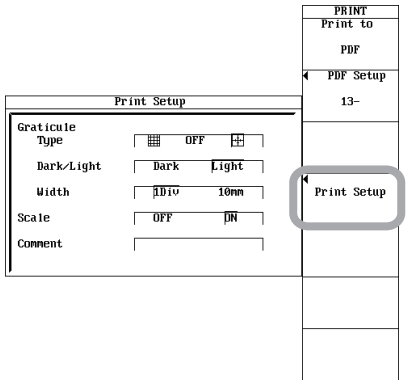
Note

The grid setting is linked with the DISPLAY menu > Graticule setting. However, if OFF is selected, the DISPLAY menu is set to  .

When Displaying the T-Y Waveform



When Displaying the X-Y Waveform



Setting Details

- **Setting the Scale Value (Only When Displaying the X-Y Waveform)**

18. Use **jog shuttle**+**SELECT** to turn the scale OFF or ON.

- **Setting Whether to Print the Time (Only When Displaying the T-Y Waveform)**

19. Use **jog shuttle**+**SELECT** to set the time to OFF, 200mm, 400mm, or 800mm.

- **Setting Whether to Print the Gauge (Only When Displaying the T-Y Waveform)**

20. Use **jog shuttle**+**SELECT** to set the gauge to OFF or ON.

- **Setting the Annotation (Only When Displaying the T-Y Waveform)**

21. Use **jog shuttle**+**SELECT** to set the print interval of annotations in the right column of Annotation to OFF, 200mm, 400mm, or 800mm.
22. Use **jog shuttle**+**SELECT** to set the type of annotation to be printed in the right column of Type to Ch Information, Ch Message, or Ch Data.
    If Ch Message is selected, proceed to step 23.
    If Ch Information or Ch Data is selected, proceed to step 24.
23. Use **jog shuttle**+**SELECT** to select Setup. Then, enter the message you want to print for the channel using up to 80 characters according to the procedure in section 4.2.

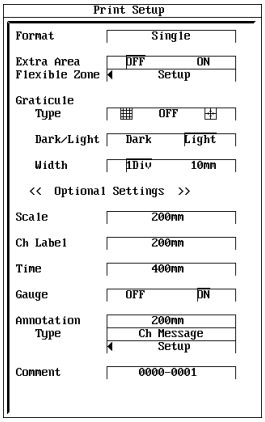
- **Setting Comments**

24. Use **jog shuttle**+**SELECT** to select Comment. Then, enter the comment text you want to print using up to 20 characters according to the procedure in section 4.2.

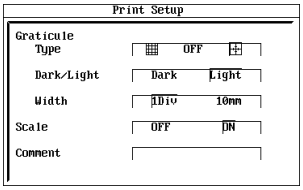
Note

- The comment setting is linked with the PRINT menu > Comment setting.
- When creating a PDF file of the print image while displaying T-Y waveforms, Scale and Ch Label settings are void.

When Displaying the T-Y Waveform



When Displaying the X-Y Waveform



Setting the PDF File

25. Press the **PDF Setup** soft key to display the PDF setup dialog box.

Setting the Paper Size

26. Use **jog shuttle**+**SELECT** to set the paper size to Built-in Printer, A3, A4, or A5.

Setting the Orientation (If A3, A4, or A5 was selected in step 25 (Only When Displaying the T-Y Waveform))

27. Use **jog shuttle**+**SELECT** to set the orientation to Landscape or Portrait.

Setting the Number of Divisions per Page (If A3, A4, or A5 was selected in step 26)

28. Use **jog shuttle**+**SELECT** to set div/page.

Setting Document Information

29. Use **jog shuttle**+**SELECT** to select Title, Author, Sub Title, or KeyWord. Enter the title, author, sub title of the PDF file using up to 30 characters and the keyword using up to 90 characters according to the procedure given in section 4.2.

Setting the Color

30. Use **jog shuttle**+**SELECT** to turn the color OFF or ON.

Enabling/Disabling Compression

31. Use **jog shuttle**+**SELECT** to turn the compression ON or OFF.

Setting Auto Naming

32. Use **jog shuttle**+**SELECT** to select the auto naming mode from OFF, Numbering, and Date.

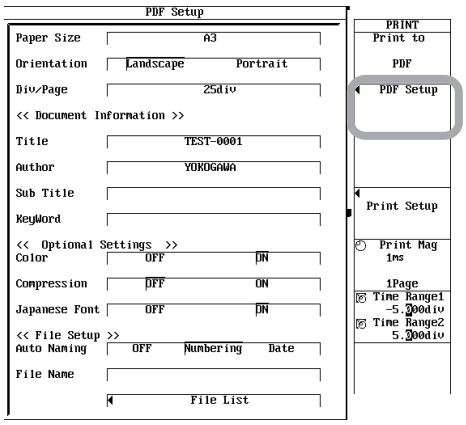
Setting the PDF File Name

33. Use **jog shuttle**+**SELECT** to select File Name. Then, enter the file name using up to 16 characters according to the procedure in section 4.2.

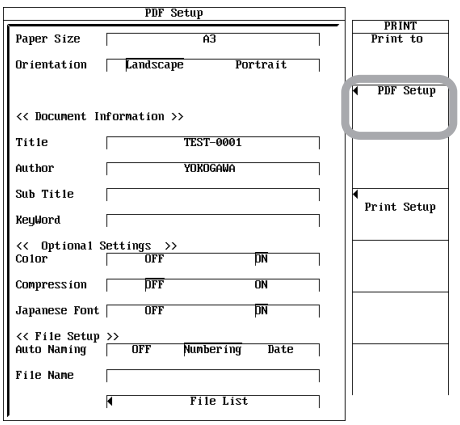
Selecting the Save Destination of the PDF File

34. Use **jog shuttle**+**SELECT** to select File List. Then, select the file save destination according to steps 14 to 17 in section 13.8.

When Displaying the T-Y Waveform



When Displaying the X-Y Waveform



Executing the PDF File Generation

35. Press **PRINT**. A PDF file is created using the conditions set in steps 5 to 34. Pressing **PRINT** again aborts the save operation. While the data is being saved, an icon corresponding the save destination medium (PC card, external SCSI device, internal HD, or USB storage device) is displayed at the upper left of the screen.

Explanation

Print to

When creating a PDF file of the print image (image similar to the printed output of fine print), set the print destination to PDF.

Selecting the Section to Be Output to the PDF File (Time Range1/Time Range2)

Can be specified only when displaying T-Y waveforms. Set the output start point and output end point of the section to be output to the PDF file.

Magnified Print (Print Mag)

Can be specified only when displaying T-Y waveforms. Set the magnification along the time axis for creating the PDF file. The top section of the menu shows the record time corresponding to 10 divisions when creating the PDF file; the bottom section shows the number of pages when the PDF file is created using the record time indicated in the top section.

Print Setup

Format, Extra Area, Flexible Zone, and Graticule (Scale)

The items other than graticule can be specified only when displaying T-Y waveforms. The format, extra area, flexible zone, and graticule (scale) settings are the same as the settings when performing fine print or zoom print on the built-in printer. For details, see page 12-7.

Details

- **Time Print/Gauge Print**
  Can be specified only when displaying T-Y waveforms. The time print and gauge print settings are the same as the settings when performing fine print or zoom print on the built-in printer. For details, see page 12-8.
  The scale value and channel label are not printed when creating a PDF file.
- **Annotation**
  Can be specified only when displaying T-Y waveforms. The annotation setting is the same as the setting when performing fine print or zoom print on the built-in printer. For details, see page 12-9. When creating a PDF file, annotations are not printed if the print interval is set to OFF. However, if the print interval is set to value other than OFF, annotations are printed on each page of the PDF file.
- **Scale**
  Can be specified only when displaying X-Y waveforms. Select whether to print the scale.
- **Comment**
  The comment setting is the same as the setting when performing fine print or zoom print on the built-in printer. For details, see page 12-9.

Setting the PDF File

Paper Size

Select the paper size from built-in printer size, A3, A4, and A5. If the built-in printer size is selected, a PDF file is created of an image similar to the printed output on the built-in printer (A4 size).

Orientation

If the paper size is set to A3, A4, or A5, set the orientation of the PDF file to Landscape or Portrait.

Number of Divisions per Page: Div/Page

Can be specified only when displaying T-Y waveforms. If the paper size is set to A3, A4, or A5, set the number of divisions to be printed per page in the PDF file. The specified number of divisions is printed per page in the PDF file. The selectable range varies depending on the paper size, orientation, and gauge (see the previous page) as follows:

Paper Size	Orientation	Selectable Range of Div/Page	
		Gauge: OFF	Gauge: ON
Built-In Printer	–	20 (fixed)	20 (fixed)
A3	Portrait	1 to 25	1 to 20
A3	Landscape	1 to 40	1 to 35
A4	Portrait	1 to 20	1 to 15
A4	Landscape	1 to 25	1 to 20
A5	Portrait	1 to 10	1 to 10
A5	Landscape	1 to 20	1 to 15

Document Information (Title, Author, Sub Title, and KeyWord)

As necessary, enter the title, author, sub title, and keyword of the PDF file to be created.

Color

The PDF file is created in color if ON is selected and monochrome if OFF is selected.

Compression

Select whether to compress the file. If ON is selected, the file is compressed. However, the generation of the PDF file takes longer than when OFF is selected.

File Setup

Set the auto naming, file name, and file output destination of the PDF file. These settings are the same as those of normal files. For details, see section 13.8.

Executing the PDF File Generation

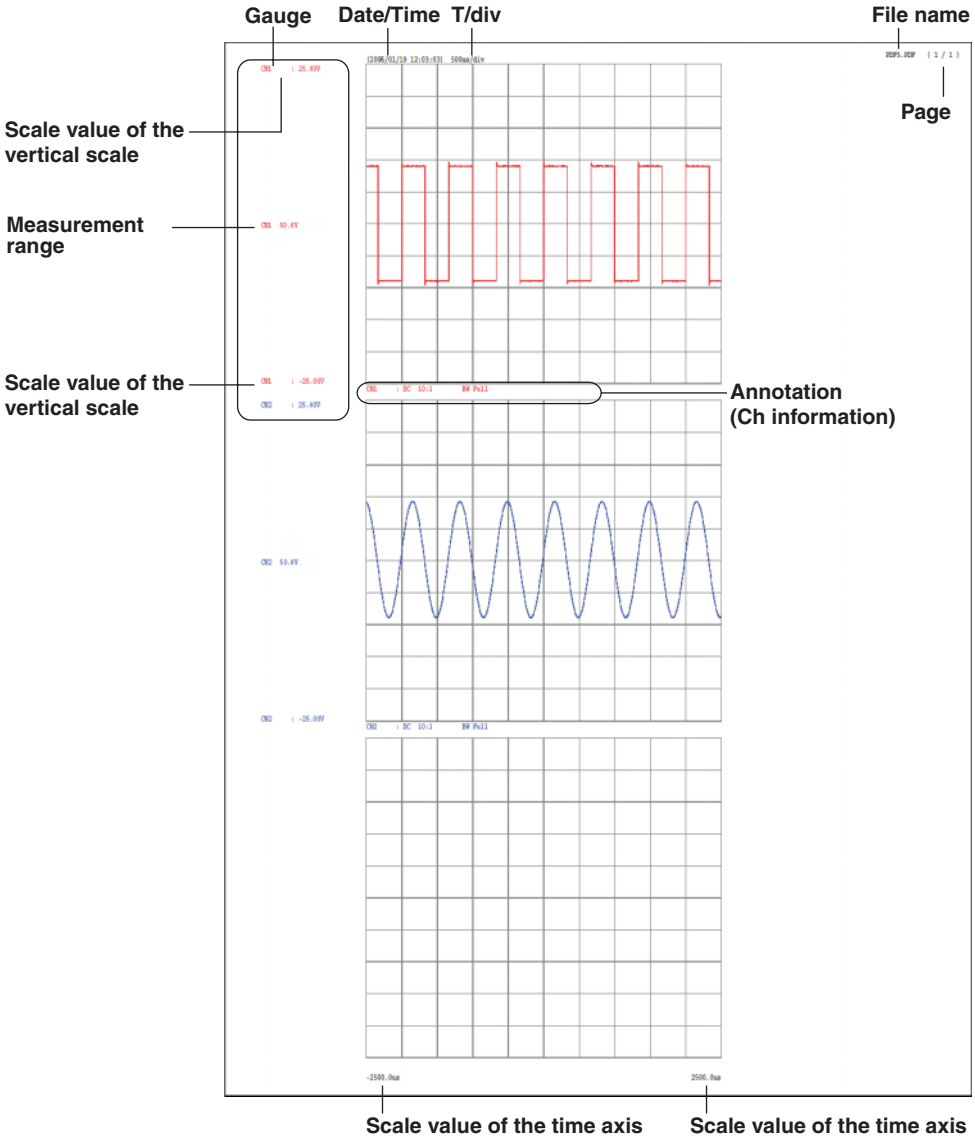
The PDF file is created using the specified conditions. The extension to the PDF file is .pdf.

Note

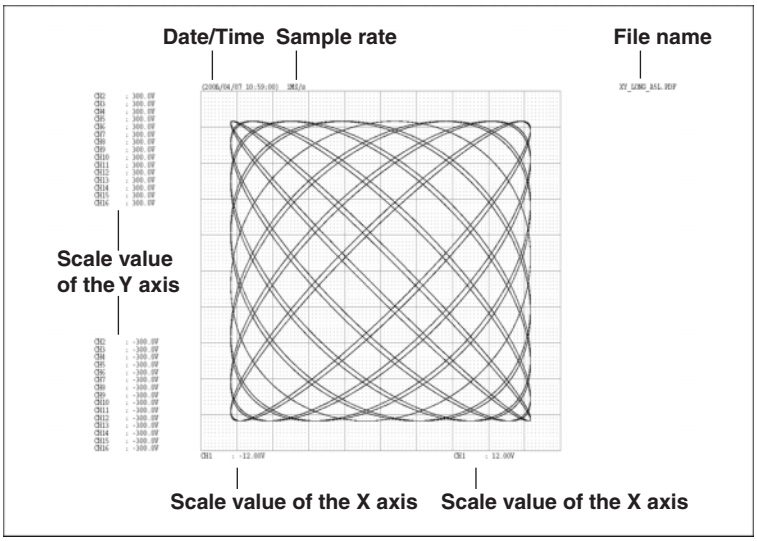
- A PDF file of a print image can be created even when all waveform display (Display Mode: All) is selected in the history memory function.
- A PDF file whose size exceeds 2GB cannot be created. Adjust the number of channels, pages, and history memory pages, so that only the required sections are saved to the PDF file.

PDF File Example

When Displaying the T-Y Waveform (Paper Size: A4)



When Displaying the X-Y Waveform (Paper Size: A5)



13.15 Loading/Converting Realtime Recorded Waveforms

<For a description of this function, refer to page 2-31.>

Procedure

Loading the Realtime Recorded Waveform Data

1. Press **FILE**.
2. Press the **File Item** soft key. The File Item setup menu appears.
3. Press the **Waveform** soft key.

Selecting the Data Type

4. Press the **Data Type** soft key. The data type selection menu appears.
5. Press the **Real Time** soft key.

Selecting the Load Source Medium/Directory

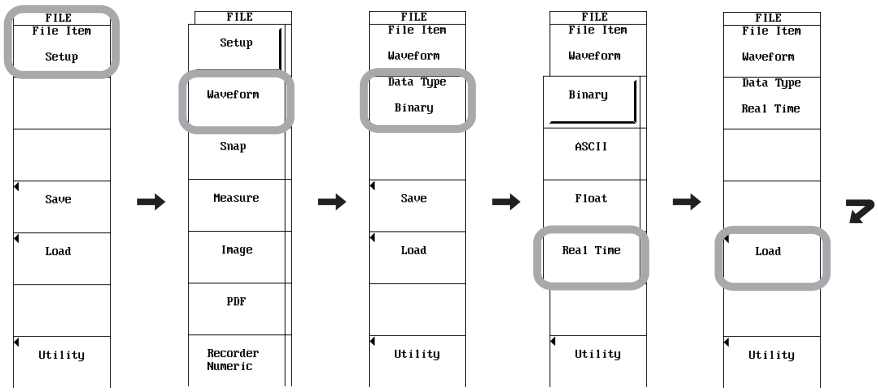
6. Press the **Load** soft key. The load setup menu and File List window appear.
7. Select the load source directory according to steps 14 to 17 in “Saving the Waveform Data” in section 13.8.

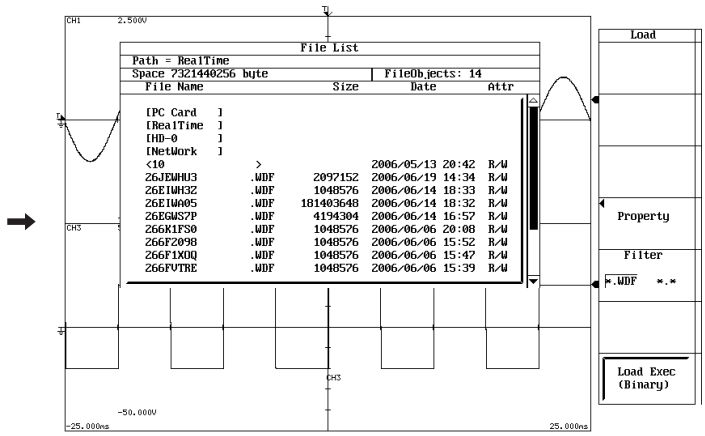
Note

The files that have been realtime recorded are saved in the [RealTime] drive. WDF data that is copied from the [RealTime] drive to another drive can also be loaded.

Selecting the File to Be Loaded

8. Turn the **jog shuttle** to select the file.





Executing the Load Operation

9. Press the **Load Exec** soft key. A dialog box appears showing the module information of the selected realtime recorded waveform data and the current module information of the SL1400.
10. Press the **Load Exec** soft key again. The selected file is read from the directory indicated in Path=..... At the same time, the **Load Exec** soft key changes to an **Abort** soft key.

Note

If the module information of the realtime recorded waveform data and the current module information of the SL1400 differ, the realtime recorded waveform data cannot be loaded.

Aborting the Load Operation

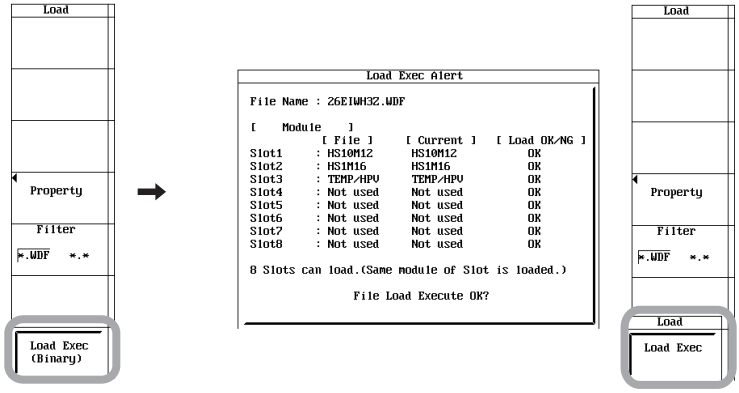
11. Press the **Abort** soft key. The load operation is aborted. At the same time, the **Abort** soft key changes to a **Load Exec** soft key.

Specifying the Files to Be Displayed in the File List Window and Displaying Properties

12. Carry out steps 27 to 29 in “Saving the Waveform Data” in section 13.8.

Note

Files with .WDF extension in the RealTime area and User area of the internal hard disk (option) can be loaded.



Converting the Realtime Recorded Waveform Data to Binary, ASCII, or Float Format and Saving

1. Load the realtime recorded waveform data according to the procedure described in “Loading the Realtime Recorded Waveform Data.”
2. Convert the realtime recorded waveform data to Binary, ASCII, or Float format and save the data according to the procedure described in “Saving the Waveform Data” in section 13.8.

Note

Files containing realtime recorded waveform data that has been converted into Binary cannot be loaded into the SL1400.

Explanation

Selecting the Data Type

Real Time

- Data saved using realtime recording.
- The data that is realtime recorded can be loaded to display the waveform and compute numeric data.
- The extension is .WDF.

Data Size

The maximum data size is as follows: The unit of the record length is word.
(Record length × 2 × (the number of channels + 1) × (1.05 to 1.15)) bytes

[RealTime] Drive

- The WDF data that is created by the realtime recording is saved to the [RealTime] drive.
- The [RealTime] drive appears only when Data Type is set to Real Time. If you want to manage the files on the [RealTime] drive, set Data Type to Real Time.
- You can set the size of the RealTime drive in the range of 30% to 70% of the entire capacity of the internal hard disk. This setting is entered when the internal hard disk is formatted. For details, see section 13.6.

13.16 Changing the File Attributes and Deleting Files

CAUTION

Never remove the storage medium (disk) or turn OFF the power while the access indicator or the PC card or internal hard disk (option) icon is blinking. Such acts can damage the storage medium or destroy the data on the medium.

Procedure

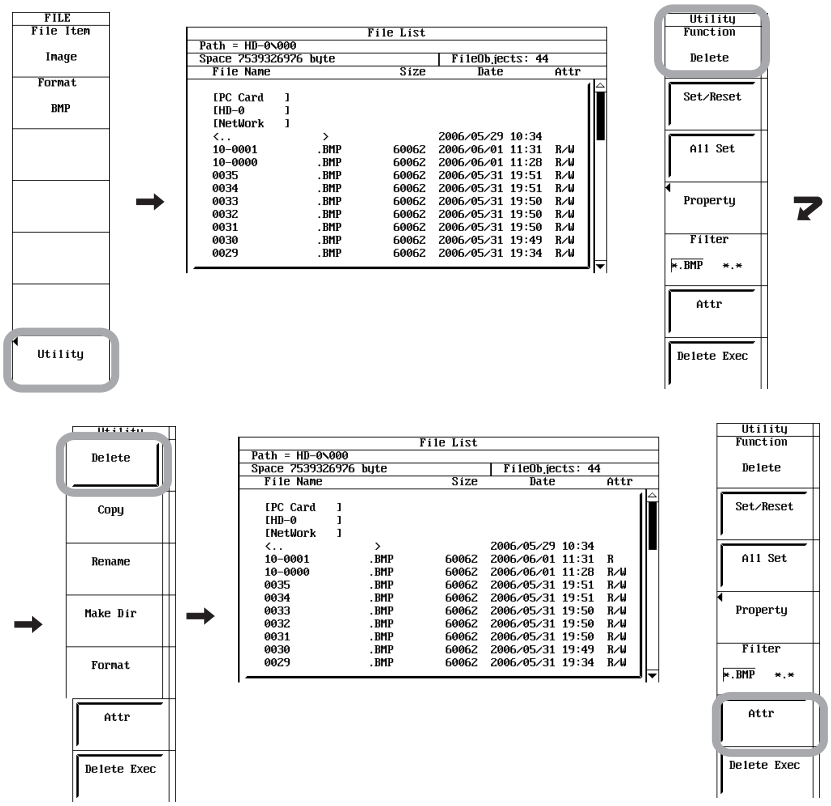
1. Press **FILE**.
2. Press the **Utility** soft key. The Utility setup menu and the File List window appear.

Selecting Media and Directories

3. Select the medium and directory according to steps 6 to 9 in section 13.9.

Changing the File Attributes

4. Press the **Function** soft key. The file function selection menu is displayed.
5. Press the **Delete** soft key.
6. Turn the **jog shuttle** to select the file.
7. Press the **Attr** soft key. The attribute of the selected file changes.



Selecting the File to Be Deleted One at a Time

8. Turn the **jog shuttle** to select the file.
9. Press the **Set/Reset** soft key. An asterisk (*) is displayed to the left of the selected file to indicate that it will be deleted. Pressing the **Set/Reset** soft key again removes the asterisk (*) to the left of the selected file. The file will not be deleted.
   Proceed to step 13.

Selecting the Files to Be Deleted at Once

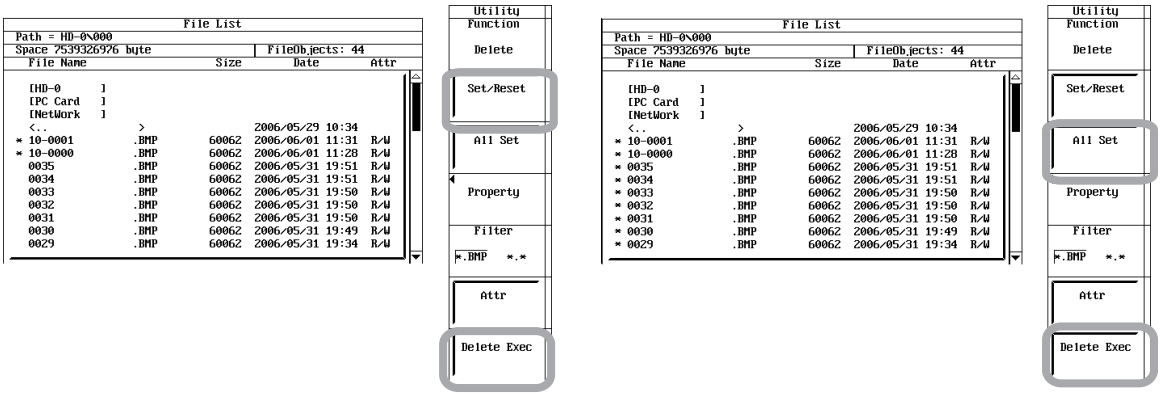
10. Turn the **jog shuttle** to select the file, directory, or medium.
11. Press the **All Set** soft key. Asterisks (*) are displayed to the left of every file in the directory containing the selected file or directory to indicate that they will be deleted. At the same time, the **All Set** soft key changes to an **All Reset** soft key.
12. Press the **All Reset** soft key. Asterisks (*) are removed from the left of every file in the directory containing the selected file or directory to indicate that they will not be deleted. At the same time, the **All Reset** soft key changes to an **All Set** soft key.

Executing the Delete Operation

13. Press the **Delete Exec** soft key. All files with asterisk marks are deleted.

Specifying the Files to Be Displayed in the File List Window and Displaying Properties

14. Carry out steps 19 to 21 in section 13.9.



Explanation

Selecting the Storage Medium and Directory (File List)

Media on which saving and loading are possible are displayed on the File List window.

- **Display Example of Storage Media**
  [PC Card]: PC card
  [HD]: Hard disk
  [SCSI5]: SCSI device with the ID number set to 5[1]
  [SCSI5-1]: Partition 1 of a SCSI device whose ID number is 5[1]
  [NetWork]: Network drive (when the Ethernet interface option is installed)
  [USB]: USB storage device

1. When a SCSI device whose ID number is 5 is connected

Selecting the File Attribute: Attr (excluding Net Drive)

Select the file attribute of each file from the following list of choices.

- **R/W**
  Read and write possible.
- **R**
  Read only. Cannot write to the file or delete the file.

Selecting the Files to Be Deleted

You can delete all files that have an asterisk to the left of the file name. There are two methods in selecting the files to be deleted.

- **Selecting the Files One at a Time: Set/Reset**
  Place an asterisk to the left of the file names one at a time, using the Set/Reset soft key.
- **Selecting All the Files at Once: All Set**
  Places an asterisk to the left of all the file names selected collectively using the All Set soft key.
  Selecting a file or directory and pressing the All Set soft key places an asterisk on every file in the directory containing the selected file or directory.

Specifying the File to Be Displayed on the File List Window: Filter

Specify the type of files to be displayed.

- ***.Extension**
  Displays only the data file that was selected in the File Item setup menu and the data type menu.
- ***.***
  Displays all the files in the medium.

Property

Displays the following information about the selected file: filename.extension, the file size, the date the file was saved, the attribute, etc.

Note

- Files cannot be deleted while the data acquisition is in progress.
- Data that is deleted cannot be recovered. Make sure you erase the correct files.
- You can not delete directories if there are files in them.
- If an error occurs while deleting multiple files, the files after the error occurrence are not deleted.
- You cannot change a directory attribute.
- This function cannot be used when using the FTP server function, network printer function, or the Web server function.
- The screen image data and thumbnail data are saved in pairs of files. If you specify "*.*" for the files to be displayed (Filter) on the File List and manipulate individual files (Delete, Rename, or Copy), the thumbnail display function can no longer be used.
- If the realtime recorded waveform is being displayed, the file cannot be deleted.
- If you want to delete the files on the [RealTime] drive, set Data Type to Real Time.

13.17 Copying Files

CAUTION

Never remove the storage medium (disk) or turn OFF the power while the access indicator or the PC card, internal hard disk (option), or USB storage device icon is blinking. Such acts can damage the storage medium or destroy the data on the medium.

Procedure

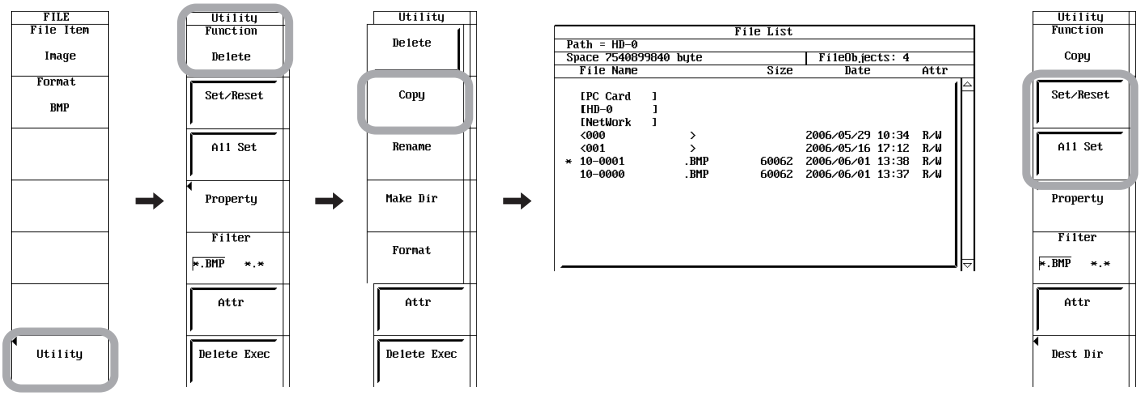
1. Press **FILE**.
2. Press the **Utility** soft key. The Utility setup menu and the File List window appear.
3. Press the **Function** soft key. The file function selection menu is displayed.
4. Press the **Copy** soft key.

Selecting Media and Directories

5. Select the medium and directory according to steps 6 to 9 in section 13.9, “Saving/Loading the Setup Data.”

Selecting the Copy Source Files One at a Time

6. Turn the **jog shuttle** to select the file.
7. Press the **Set/Reset** soft key. An asterisk (*) to the left of the selected file to indicate that it will be copied. Pressing the **Set/Reset** soft key again removes the asterisk (*) to the left of the selected file. The file will not be copied. Proceed to step 11.



Selecting the Copy Source Files at Once

8. Turn the **jog shuttle** to select the file, directory, or medium.
9. Press the **All set** soft key. Asterisks (*) are displayed to the left of every file in the directory containing the selected file or directory to indicate that they will be copied. At the same time, the **All Set** soft key changes to an **All Reset** soft key.

Resetting the Selected Copy Source Files at Once

10. Press the **All Reset** soft key. Asterisks (*) are removed from the left of every file in the directory containing the selected file or directory to indicate that they will not be copied. At the same time, the **All Reset** soft key changes to an **All Set** soft key.

Selecting the Copy Destination

11. Press the **Dest Dir** soft key. The copy execution menu and the copy destination File List window appears.

Selecting Copy Destination Medium and Directory

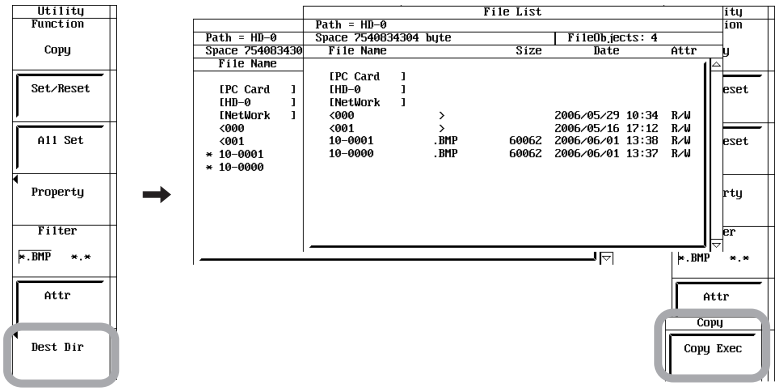
12. Select the copy destination medium and directory according to steps 6 to 9 in section 13.9.

Executing the Copy Operation

13. Press the **Copy Exec** soft key. All the copy source files with asterisk marks are copied.

Specifying the File to Be Displayed in the File List Window and Viewing File Properties

14. Carry out steps 19 to 21 in section 13.9.



Explanation

Selecting the Copy Source Files

You can copy all files that have an asterisk to the left of the file name. There are two methods in selecting the files to be copied.

- **Selecting the Files One at a Time: Set/Reset**
  Place an asterisk to the left of the file names one at a time, using the Set/Reset soft key.
- **Selecting All the Files at Once: All Set**
  Places an asterisk to the left of all the file names selected collectively using the All Set soft key.
  If you select a file and press the All Set soft key, asterisk marks are placed on all the files in the directory containing the selected file.

Specifying the File to Be Displayed on the File List Window: Filter

Specify the type of files to be displayed.

- ***.Extension**
  Displays only the data file that was selected in the File Item setup menu and the data type menu.
- ***.***
  Displays all the files in the medium.

Property

Displays the following information about the selected file: filename.extension, the file size, the date the file was saved, the attribute, the comment, etc.

Note

- Files cannot be copied while the data acquisition is in progress.
- If an error occurs while copying multiple files, the files after the error occurrence are not copied.
- You cannot change a directory attribute.
- You cannot copy files if files with the same file name exist at the copy destination, .
- You cannot copy the same files to another directory after copying the files. Select the files to be copied again and copy them.
- The date/time information of the copied file retains the date/time information of the copy source file. However, if the copy destination is a network drive, the date/time is set to the date/time when the file is copied.
- This function cannot be used when using the FTP server function, network printer function, or the Web server function.
- The screen image data and thumbnail data are saved in pairs of files. If you specify “*.*” for the files to be displayed (Filter) on the File List and manipulate individual files (Delete, Rename, or Copy), the thumbnail display function can no longer be used.
- Copying to the [RealTime] drive is not possible. (Copying from the [RealTime] drive to other drives is possible.)

13.18 Changing the Directory/File Name of the Storage Medium and Creating Directories

CAUTION

Never remove the storage medium (disk) or turn OFF the power while the access indicator or the PC card, internal hard disk (option), USB storage device icon is blinking. Such acts can damage the storage medium or destroy the data on the medium.

Procedure

Changing the Directory/File Name of the Storage Medium

1. Press **FILE**.
2. Press the **Utility** soft key. The Utility setup menu and the File List window appear.
3. Press the **Function** soft key. The file function selection menu is displayed.
4. Press the **Rename** soft key.

Selecting Media and Directories

5. Select the medium and directory according to steps 6 to 9 in section 13.9.

Changing the File Attributes

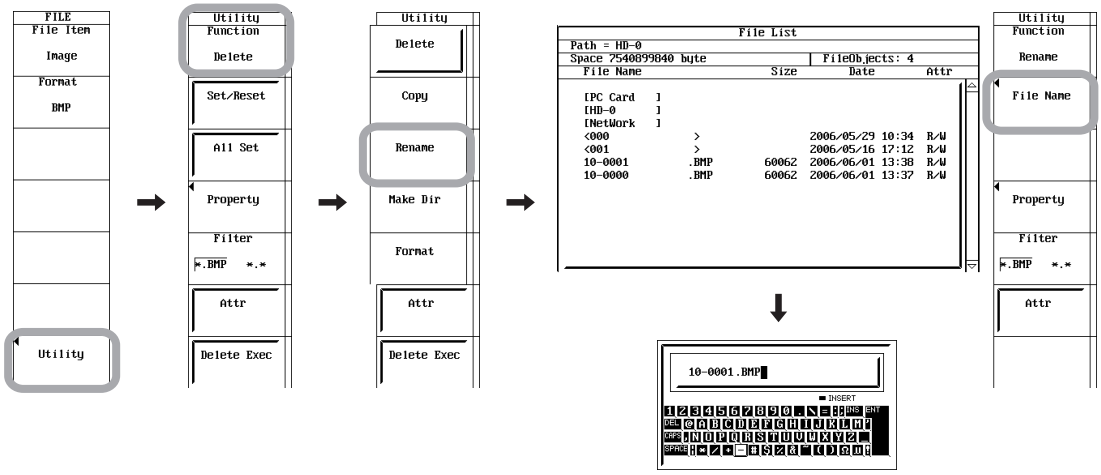
6. Change the file attribute according to steps 6 and 7 in section 13.16.

Changing the Directory/File Name of the Storage Medium (Excluding Net Drive)

7. Turn the **jog shuttle** to select a directory name or file name.
8. Press the **File Name** soft key. A keyboard appears. The name of directory/file is displayed in the entry box of the keyboard.
9. Enter the directory name or file name according to the procedure given in section 4.2.

Specifying the Files to Be Displayed in the File List Window and Displaying Properties

10. Carry out steps 19 to 21 in section 13.9.



Creating a Directory

1. Press **FILE**.
2. Press the **Utility** soft key. The Utility setup menu and the File List window appear.
3. Press the **Function** soft key. The file function selection menu is displayed.
4. Press the **Make Dir** soft key.

Selecting Media and Directories

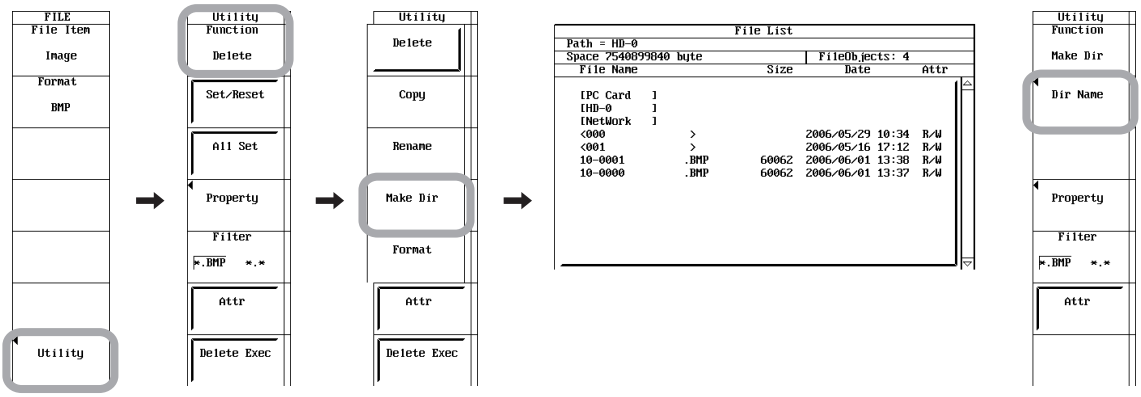
5. Select the medium and directory according to steps 6 to 9 in section 13.9.

Creating Directories

6. Turn the **jog shuttle** to select a medium or directory.
7. Press the **Dir Name** soft key. A keyboard appears.
8. Enter the directory name or file name according to the procedure given in section 4.2.

Specifying the Files to Be Displayed in the File List Window and Displaying Properties

9. Carry out steps 19 to 21 in section 13.9.



Explanation

Selecting the Storage Medium and Directory: File List

Media on which saving and loading are possible are displayed on the File List window.

- **Display Examples of Storage Media**

  [PC Card]: PC card
  [HD]: Hard disk
  [SCSI5]: SCSI device with the ID number set to 5[1]
  [SCSI5-1]: Partition 1 of a CSI device whose ID number is 5[1]
  [NetWork]: Network drive when the Ethernet interface option is installed)
  [USB]: USB storage device

  1. When a SCSI device whose ID number is 5 is connected

Selecting the File Attribute: Attr (Excluding Net Drive)

Select the file attribute of each file from the following list of choices.

- **R/W**
  Read and write possible.
- **R**
  Read only. Cannot write to the file or delete the file.

Changing the Directory/File Name of the Storage Medium: Rename

Number of characters and types that can be used

Item	Number of Characters	Characters That Can Be Used
Directory name	1 to 16 characters	0 to 9, A to Z, %, _, (,), -
File name	1 to 16 characters	0 to 9, A to Z, %, _, (,), -

* However, a directory name that starts with “ND” (ND000 for example) is not allowed.

Creating a Directory: Make Dir

You can create a new directory in the medium. See above for the assignment of the directory name when creating a new directory.

Specifying the File to Be Displayed on the File List Window: Filter

Specify the type of files to be displayed.

- ***.Extension**
  Displays only the data file that was selected in the File Item setup menu and the data type menu.
- ***.***
  Displays all the files in the medium.

Property

Displays the following information about the selected file: filename.extension, the file size, the date the file was saved, the attribute, the comment, etc.

Note

- You cannot rename a directory/file or create a new directory while the data acquisition is in progress (START/STOP indicator is ON).
- You cannot change a directory attribute.
- If a file with the same name already exists in the same directory, the file cannot be renamed.
- If a directory with the same name already exists in the same directory, the directory cannot be created.
- This function cannot be used when using the FTP server function, network printer function, or the Web server function.
- The screen image data and thumbnail data are saved in pairs of files. If you specify “*.*” for the files to be displayed (Filter) on the File List and manipulate individual files (Delete, Rename, or Copy), the thumbnail display function can no longer be used.
- Directories cannot be created on the [RealTime] drive.

13.19 Connecting a PC to the SL1400 via SCSI

You can connect a PC to the SCSI of the SL1400 and access the internal hard disk (option) from the PC.

Supported PC OSs

Windows 2000 and Windows XP (updating of the files on the SL1400 cannot be detected due to the limitation on the OS.)

Items Necessary for Connection

Cable (SCSI cable: half pitch 50 pins, pin type)
Use a commercially sold cable that is 3 m or less in length that has a characteristic impedance between 90 and 132 Ω.

Connection Procedure

Changing the ID Number of the SL1400

Before connecting the SL1400 to a PC, you may need to change the SCSI ID of the SL1400 so that it does not conflict with the PC's ID. For the procedure in changing the ID, see section 13.7.

Changing the ID Number of the Internal Hard Disk Drive

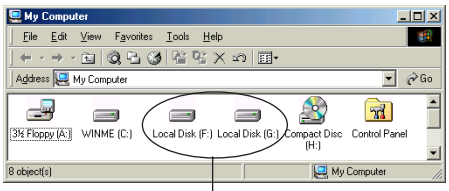
Set the ID number of the internal hard disk drive so that it does not overlap with the IDs of other SCSI devices. For the procedure in changing the ID, see section 13.7.

CAUTION

- Make sure to follow the procedures exactly as written in "Connecting the instrument to the PC" described below. Otherwise, drives of other SCSI devices connected to the PC may get damaged.
- Never change the contents on the SL1400 disk from the PC (read only). Writing to the disk may destroy files.
- Never perform the following operations. The internal hard disk of the SL1400 will become inaccessible.
  - Delete files on the internal hard disk of the SL1400 from the PC.
  - Add files to the internal hard disk of the SL1400 from the PC.
- While connected to the PC, the File List window of the SL1400 may not be displayed properly.
- If the connected PC enters sleep, standby, or rest mode, the SL1400 will not be able to access its internal hard disk. Before connecting the PC to the SL1400, disable such modes on the PC.

Connecting the SL1400 and the PC

1. Turn OFF the SL1400 and the PC.
2. Connect the SL1400 and the PC with the SCSI cable.
3. Turn ON the SL1400 first.
4. After the SL1400 boots up completely, check that the connected SCSI device operates on the SL1400.
5. Turn ON the PC.



SL1400

Precautions to Be Taken When Connecting

- **Drive**

  When formatting the internal hard disk on the SL1400, the hard disk can be partitioned into two or three drives. For example, your PC will identify the two partitions on the SL1400 internal hard disk as drives F and G on the PC. The drive with the smaller drive letter (drive F: in the above example) is the area dedicated to the realtime recording. Other drives are used to store setup data, waveform data, screen image data, etc.

  The drive for realtime recording is used as a working area for the realtime recording within the SL1400. Never delete files, copy and paste files, and add new files on this drive from the PC. Otherwise, the realtime recording may not operate properly.

  Other drives are used to save other types of data such as waveforms that can be recalled later. The waveforms that can be used on the PC are saved on this drive.

  Newly Created File During Connection

  If a file is created with the SL1400 while it is connected to the PC, the new file is not recognized by the PC.

- **Drive Letter**
  If the PC to which the SL1400 is connected has multiple hard disks or if the hard disk is partitioned, connecting the SL1400 will cause the internal hard disk of the SL1400 to be assigned drive letters after the hard disks on the PC.
  For details, see the instruction manual for the PC or the drive.
  The drive letter for the SL1400 cannot be changed.

  Example
  - The PC uses one hard disk as a single drive
    Before connection C: (HDD)
    After connection C: (HDD)
    D: (SL1400)
  - The PC uses one hard disk as two drives
    Before connection C: (HDD)
    D: (HDD)
    After connection C: (HDD)
    D: (HDD)
    E: (SL1400)

  Actually, this may vary depending on how the hard disk is partitioned and the type of interface (IDE, SCSI, etc) and drive.

Note

- The internal hard disk of the SL1400 has a built-in terminator. When the SL1400 is connected to a PC, it is recommended that the SL1400 be connected to the end of the SCSI chain.
- Note that the driver letter assignments are different from the DL708, DL708E, and DL716.
- Do not access the internal hard disk of the SL1400 from the PC when the internal hard disk is being accessed from the SL1400. Likewise, do not access the internal hard disk from the SL1400 when the internal hard disk is being accessed from the PC.

14.1 External Trigger Input (TRIG IN)

CAUTION

Only input signals that meet the specifications below. Otherwise, undesirable signal such as excessive voltage may damage the SL1400.

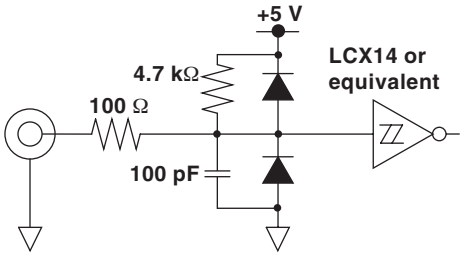
External Trigger Input Terminal

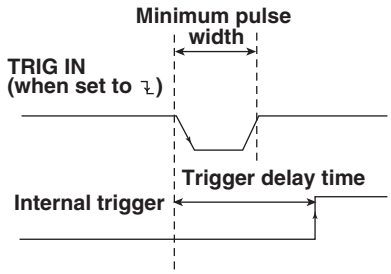
This terminal is used when an external signal is used as a trigger source (see section 6.6).

Specifications

Connector type:	RCA jack
Input Level:	TTL (0 to 5 V)
Minimum pulse width:	500 ns
Logic:	Rising edge or falling edge
Trigger delay time:	Within (200 ns + 1 sample period)
Externally synchronized operation:	Possible (by connecting TRIG IN and TRIG OUT on two SL1400s)

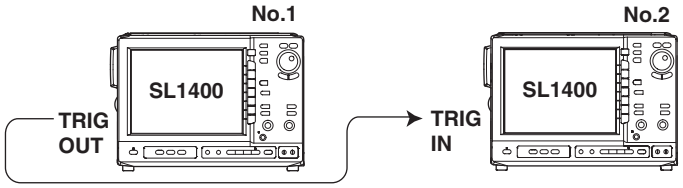
External Trigger Input Circuit Diagram and Timing Chart





Note

By using the trigger output function, the operation of two SL1400s can be synchronized.



14.2 Trigger Output (TRIG OUT)

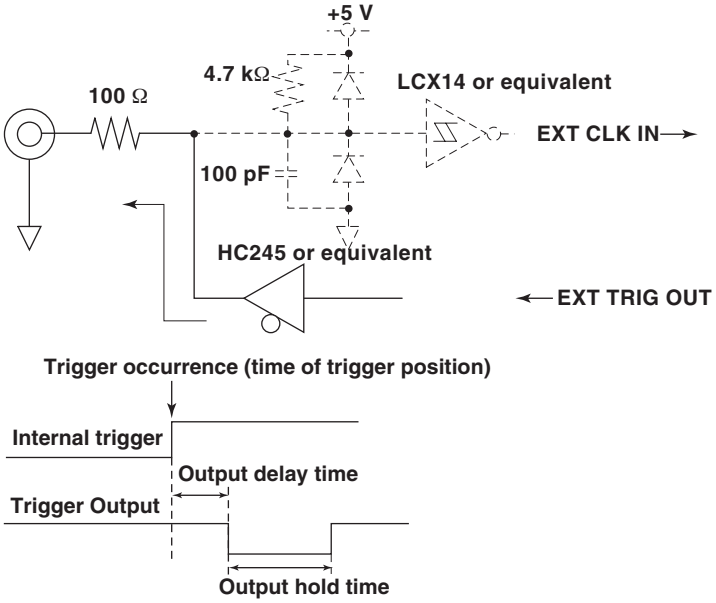
External Trigger Output Terminal

A TTL level signal is output when a trigger is activated. The signal level is normally high and goes low when a trigger is activated.

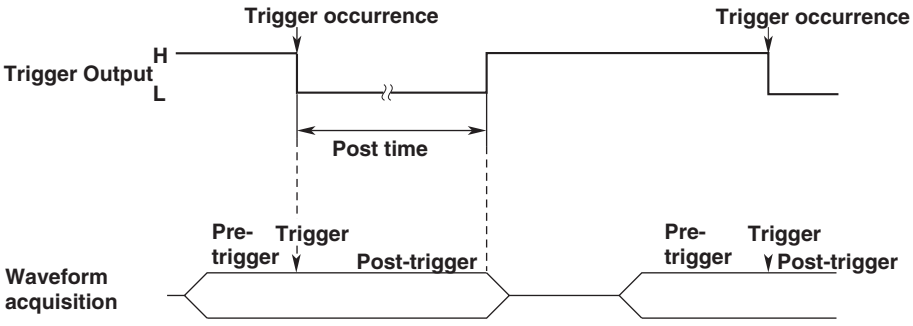
Specifications

Connector type:	RCA jack
Output level:	CMOS level (0 to 5 V)
Logic:	Falls when the trigger is activated, rises after completing acquisition
Output delay time:	Within (1 μs + 1 sample period)
Output hold time:	200 ns or more

Trigger Output Circuit Diagram and Timing Chart



Low Level/High Level Hold Time



14.3 External Clock Input (EXT CLK IN)

CAUTION

Only input signals that meet the specifications below. Otherwise, undesirable signal such as excessive voltage may damage the SL1400.

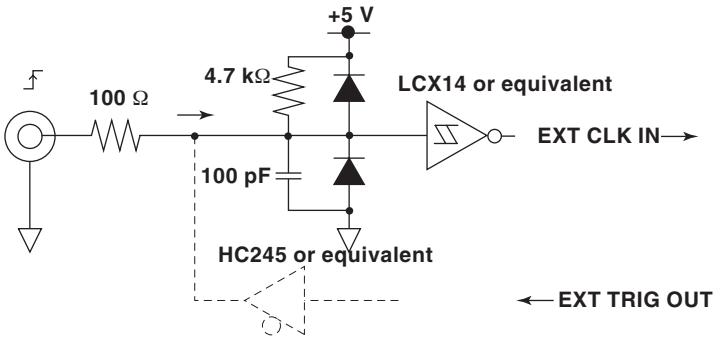
External Clock Input Terminal

Use this terminal if you want to operate the SL1400 using an external clock signal. This terminal is shared with the trigger output terminal (TRIG OUT).

Specifications

Connector type:	RCA jack
Input Level:	TTL (0 to 5 V)
Valid edge:	Rising edge
Minimum pulse width:	400 ns or more for high and low
External clock frequency range:	1 MHz maximum.

External Clock Input Circuit Diagram



14.4 Video Signal Output (VIDEO OUT (SVGA))

CAUTION

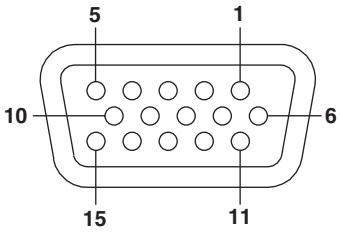
- Connect the cable after turning OFF the SL1400 and the monitor.
- Do not short the VIDEO OUT terminal or apply external voltage to it. This may cause damage to the SL1400.

Video Signal Output Terminal

The SL1400 display can be output to a monitor through the video signal output. Connectable monitors are multi-sync monitors capable of displaying SVGA.

Specifications

Connector type: 15-pin D-SUB
Output type: Analog RGB output
Output resolution: SVGA output 800 × 600 dots/60 Hz Vsync

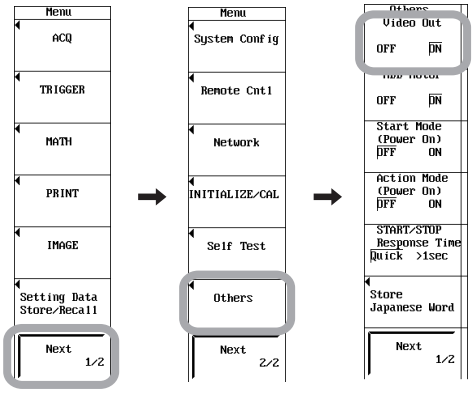


D-Sub 15-pin receptacle

Pin No.	Signal Name	Specifications
1	Red	0.7 V_{P-P}
2	Green	0.7 V_{P-P}
3	Blue	0.7 V_{P-P}
4	–	
5	–	
6	GND	
7	GND	
8	GND	
9	–	
10	GND	
11	–	
12	–	
13	Horizontal sync signal	Approx. 36.4 kHz, TTL positive logic
14	Vertical sync signal	Approx. 60 Hz, TTL positive logic
15	–	

Connecting to the Monitor

1. Turn OFF the SL1400 and the monitor.
2. Connect the SL1400 and the monitor using an analog RGB cable.
3. Turn ON the SL1400 and the monitor.
4. Press the **MENU** soft key.
5. Press the **Next 1/2** soft key.
6. Press the **Others** soft key.
7. Press the **Video Out** soft key to select ON. The screen of the SL1400 is displayed on the monitor.
   Select OFF to stop the display on the monitor.



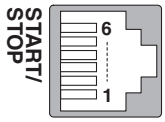
14.5 External Start/Stop Input

The SL1400 start/stop can be controlled externally.

External Start/Stop Input Terminal

Specifications

Modular jack (RJ-11). Use the optional accessory 366973 (sold separately) for the cable.

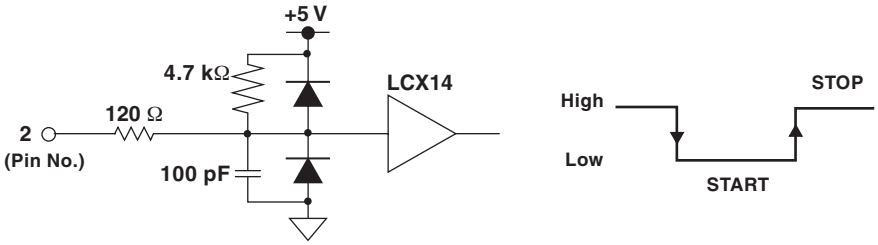


Connector on the SL1400

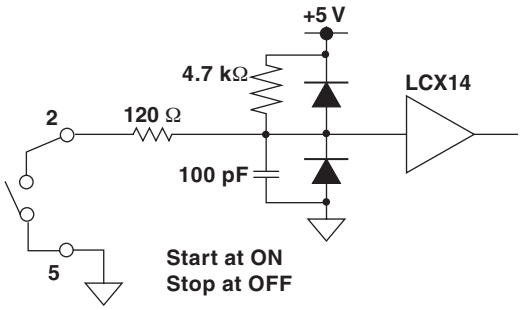
Pin No.	Signal Name	
1	NC (no connection)	
2	START IN	Start on the low edge Stop on the high edge
3	NC (no connection)	
4	NC (no connection)	
5	GND	
6	NC (no connection)	

Input level: TTL (0 to 5 V)

External Start/Stop Input Circuit Diagram



• Switch input is possible



Note

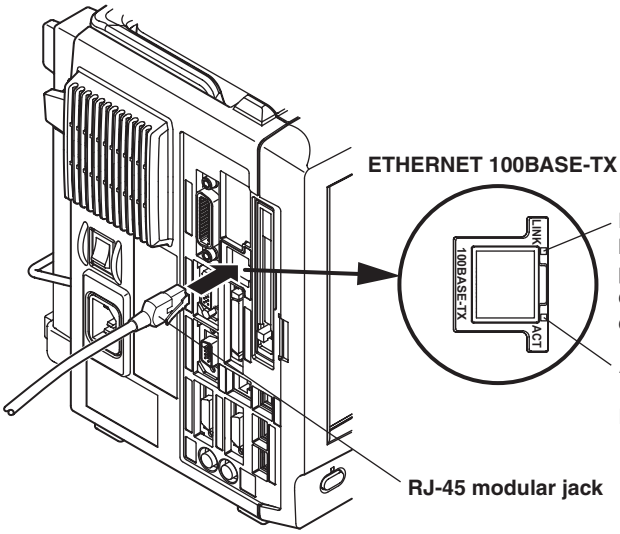
Low and High edges are used to detect start/stop.

15.1 Connecting the SL1400 to the Network

Ethernet Interface Specifications

A 100BASE-TX port is provided on the left side panel of the SL1400.

Item	Specifications
Number of communication ports	1
Electrical and mechanical specifications	Conforms to IEEE802.3
Transmission system	Ethernet (100BASE-TX/10BASE-T)
Transmission rate	100 Mbps max.
Communication protocol	TCP/IP
Supported services	FTP server, FTP client (network drive), LPR client (network printer), SMTP client (mail transmission), DHCP, DNS, and Web server
Connector type	RJ-45 connector



Items Necessary for Connection

Cable

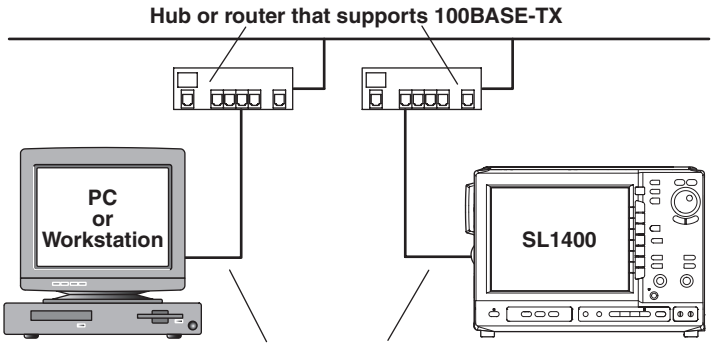
Be sure to use one the following cables for connection.

- UTP (Unshielded Twisted-Pair) cable (category 5 or better)
- STP (Shielded Twisted-Pair) cable (category 5 or better)

Connection Procedure

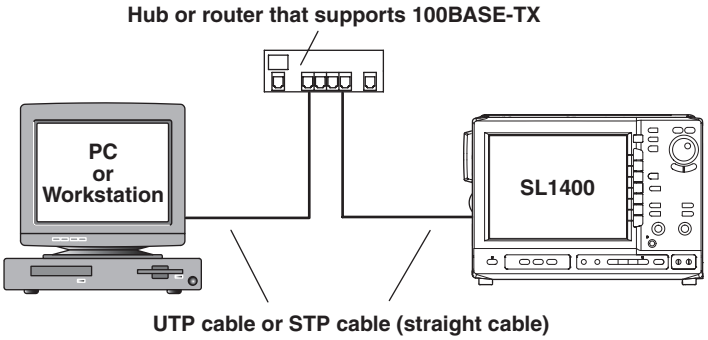
When Connecting to a Network PC or Workstation

1. Turn OFF the SL1400.
2. Connect one end of the UTP (or STP) cable to the ETHERNET 100BASE-TX terminal on the left side panel.
3. Connect the other end of the UTP (or STP) cable to a hub or router.
4. Turn ON the SL1400.



When Making a One-to-One Connection to the PC or Workstation

1. Turn OFF the SL1400 and the PC or workstation.
2. Connect one end of the UTP (or STP) cable to the ETHERNET 100BASE-TX terminal on the left side panel.
3. Connect the other end of the UTP (or STP) cable to a hub or router.
4. Likewise, connect the PC or workstation to a hub or router.
5. Turn ON the SL1400.



Note

- When connecting the PC or workstation one-to-one, a NIC (a 10BASE-T/100BASE-TX autoswitching card) is required for the PC or workstation.
- When using a UTP cable or STP cable (straight cable), be sure to use only a category 5 cable.
- Avoid connecting the PC or workstation directly to the SL1400 without going through the hub or router. Operations are not guaranteed for communications using direct connection.

15.2 Setting up the TCP/IP

Procedure

1. Press **MENU**.
2. Press the **Next 1/2** soft key.
3. Press the **Network** soft key.
4. Press the **TCP/IP Setup** soft key. The TCP/IP setup menu appears.

Turning DHCP ON/OFF

5. Use **jog shuttle**+**SELECT** to set DHCP to ON or OFF.

   If you DHCP to OFF, proceed to step 5.
   If the DHCP is set to ON, you do not have to set the IP address, subnet mask, and default gateway.
   - To set up the DNS, proceed to step 12.
   - If you do not want to set up the DNS, check the network cable connection and restart the SL1400. The IP address, subnet mask, and default gateway are automatically configured.

Setting the IP Address

Set the IP address if you turned DHCP OFF.

6. Use **jog shuttle**+**SELECT** to set the IP Address. Enter using values in the range of 0 to 255.

Setting the Subnet Mask

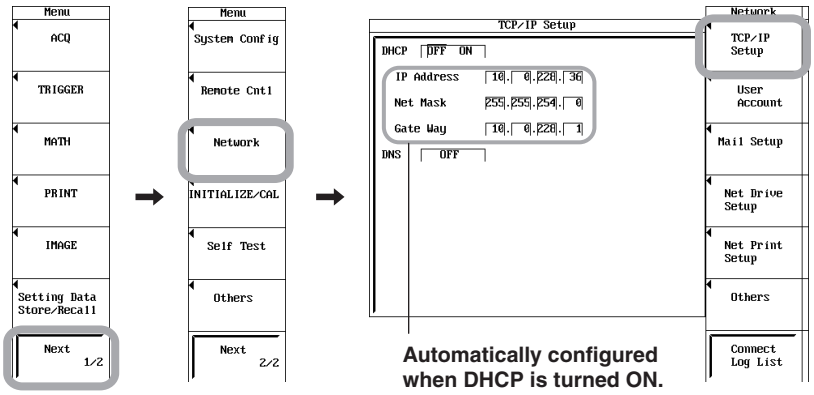
Set the subnet mask if you turned DHCP OFF.

7. Use **jog shuttle**+**SELECT** to set the Net Mask. Enter using values in the range of 0 to 255.

Setting the Default Gateway

Set the default gateway if you turned DHCP OFF.

8. Use **jog shuttle**+**SELECT** to set the Gate Way. Enter using values in the range of 0 to 255.



Setting the DNS

9. Use **jog shuttle**+**SELECT** to set DNS to ON, OFF, or AUTO. (AUTO can be specified when DHCP is ON.)
   When DNS is set to AUTO, the domain name and DNS server name are automatically configured by power-cycling the SL1400.
   If DNS is set to ON, the domain name, DNS server name, and domain suffix are displayed.
   If DNS is set to OFF, check the network cable connection and power cycle the SL1400.

Setting the Domain Name

10. Use **jog shuttle**+**SELECT** to select Domain Name.
11. Enter the domain name according to the procedure given in section 4.2.

Setting the DNS Server

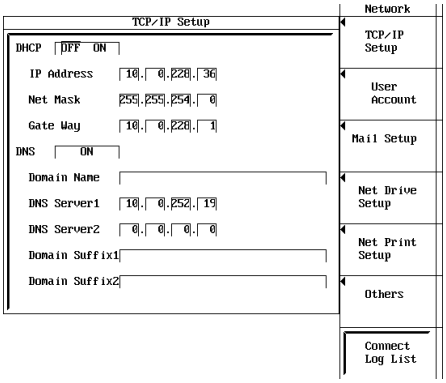
12. Use **jog shuttle**+**SELECT** to select DNS Server1 (primary DNS server) and set the primary DNS server address in the range of 0 to 255.
13. Likewise, set the secondary DNS server address in DNS Server2.

Setting the Domain Suffix

14. Use **jog shuttle**+**SELECT** to select Domain Suffix1 and set the primary domain suffix.
15. Likewise, set the secondary domain suffix in Domain Suffix2.

Turning ON/OFF the Power

16. To apply the new settings, the SL1400 must be power cycled.
    After all the settings are complete, turn the power to the SL1400 OFF, then back ON again.



Explanation

The following TCP/IP settings must be entered to use the Ethernet communications functions on the SL1400.

- IP address
- Subnet mask
- Default gateway

IP Address (Internet Protocol Address)

Set the IP address to assign to the SL1400. The default setting is “0.0.0.0.”
The IP address is an ID that is assigned to each PC on an IP network such as the internet or an intranet. The address is a 32-bit value expressed using four octets (each 0 to 255), each separated by a period as in [192.168.111.24].
Obtain an IP address from your network administrator. The setting is automatically configured in environments using DHCP.

Subnet Mask (Net Mask)

Set the mask value used when determining the subnet network address from the IP address. The default setting is “255.255.255.0.”
Huge TCP/IP networks such as the Internet are often divided up into smaller networks called sub networks. The subnet mask is a 32 bit value that specifies the number of bits of the IP address used to identify the network address. The portion other than the network address is the host address that identifies individual PCs on the network.
Consult your network administrator for the subnet mask value. You may not need to set the value. The setting is automatically configured in environments using DHCP.

Default Gateway

Set the IP address of the gateway (default gateway) used to communicate with other networks. The default setting is “0.0.0.0.”
The default gateway has control functions that handle protocol exchanges when communicating with multiple networks, so that data transmission is carried out smoothly..
Consult your network administrator for the default gateway value. You may not need to set the value. The setting is automatically configured in environments using DHCP.

DHCP (Dynamic Host Configuration Protocol)

DHCP is a protocol that allocates setup information that are needed temporarily to the PCs connecting to the network. When DHCP is turned ON, the following settings are automatically assigned.

- IP address
- Subnet mask
- Default gateway
- DNS

To use DHCP, the network must have a DHCP server. Consult your network administrator to see if DHCP can be used.
When DHCP is turned ON, different settings may be assigned each time the power is turned ON. When using the FTP server function (see section 15.6), be sure to check the IP address and other settings of the SL1400 using a PC or workstation each time you turn ON the SL1400.

DNS (Domain Name System)

DNS is a system used to associate names used on the Internet called host names and domain names to IP addresses. (Given AAA.BBBBB.com, AAA is the host name and BBBBB.com is the domain name.) Instead of using the IP address, which is a sequence of numbers, host name and domain name can be used to access the network.
On the SL1400, you can specify the host by name instead of by IP address when using the FTP client function (see section 15.3) or network printer function (see sections 15.4 and 12.3).
Set the domain name, the DNS server address (“0.0.0.0” by default), and the domain suffix. In networks that support DHCP, these settings can be configured automatically. For details, consult your network administrator.

DNS Server: DNS Server1/DNS Server2

Up to two DNS server addresses can be specified (primary and secondary). If the primary DNS server is down, the secondary DNS server is automatically looked up for the mapping of the host name/domain name and IP address.

Domain Suffix: Domain Suffix1/Domain Suffix2

When the IP address corresponding to the server name with the aforementioned domain name is not found, the system may be set up to search using a different domain name. Enter this alternate domain name as the domain suffix. Up to two domain suffixes can be specified, Domain Suffix1 (primary), and Domain Suffix2 (secondary).

Note

- If you changed settings related to the Ethernet network, the SL1400 must be power cycled.
- If the SL1400 is turned ON with the DHCP function enabled without an Ethernet cable connected, communications and file functions may not operate properly. In this case, turn DHCP OFF and power cycle the SL1400.

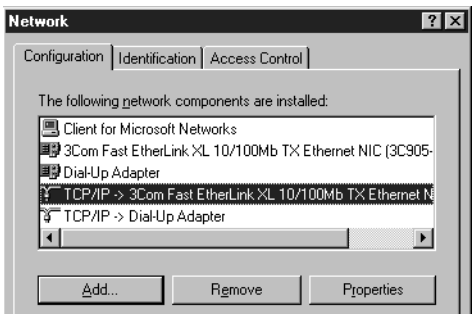
Configuring the TCP/IP Settings of the PC

Communication parameters such as the IP address must also be specified on the PC. Communication parameters are specified for each Ethernet NIC that is installed in the PC. Here, the settings of the NIC required to connect your PC to the SL1400 are explained.
To automatically obtain the IP address and other parameters from a DHCP server, select **Obtain an IP address automatically** under the **IP Address** tab of the **TCP/IP Properties** dialog box.
For example, if you are connecting the PC to the SL1400 in a one-to-one relationship via the Ethernet interface, specify the parameters as indicated in the next table.
For parameter details, consult your system or network administrator.

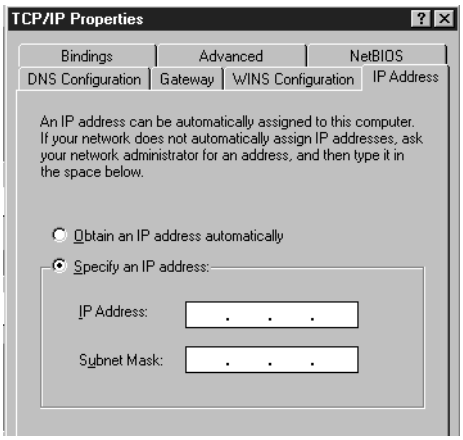
Parameter	Value	Note
IP address	Example: 192.168.211.28	IP address for the PC
Subnet mask	Example: 255.255.255.0	Set the same value as the subnet mask specified for the SL1400.
Gateway	0.0.0.0 (default value)	
DNS	Disable	
WINS	Disable	

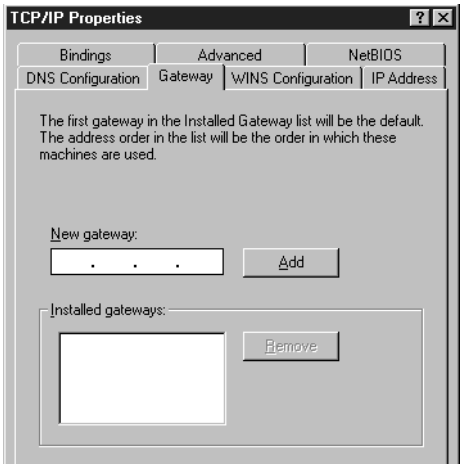
The following procedure describes the steps for Windows 2000. For other versions of Windows, carry out equivalent steps.

1. On the taskbar, click **Start**, point to **Settings**, and click **Control Panel**. Control Panel opens.
2. Double-click the **Network and Dial-up Connections** icon.
3. Right-click **Local Area Connection** and select Properties.
4. Select **Internet Protocol (TCP/IP)** and click **Properties** to open the TCP/IP Properties dialog box.



5. Set the parameters such as the IP address according to the table on the previous page and click **OK**.





15.3 Saving/Loading Data to a Network Drive (FTP Client Function)

<For a description of this function, refer to page 2-47.>

Procedure

1. Press **MENU**.
2. Press the **Next 1/2** soft key.
3. Press the **Network** soft key.
4. Press the **Net Drive Setup** soft key. The Net Drive setup menu appears.

Setting the FTP Server

5. Use **jog shuttle**+**SELECT** to select FTP Server.
6. Enter the IP address of the FTP server according to the procedure given in section 4.2. When using DNS (section 15.2), you can specify the address by name.

Setting the Login Name and Password

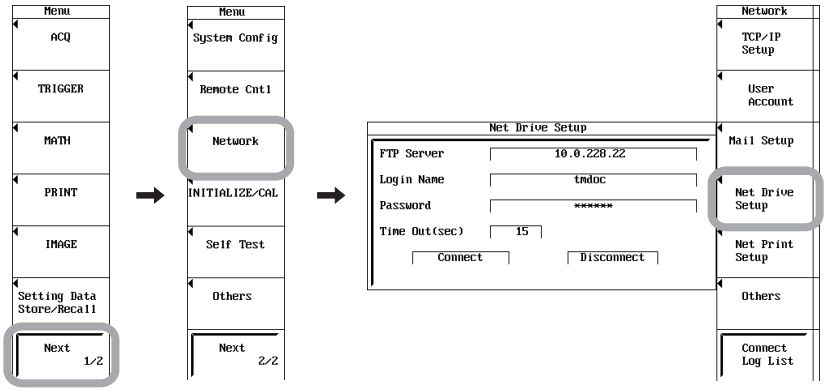
7. Use **jog shuttle**+**SELECT** to select Login Name.
8. Enter the login name using up to 15 characters according to the procedure given in section 4.2.
9. Use **jog shuttle**+**SELECT** to select Password.
10. Enter the password corresponding to the login name using up to 15 characters according to the procedure given in section 4.2.

Setting the Timeout Time

11. Use **jog shuttle**+**SELECT** to set Time Out. The selectable range is 0 to 3600 (s).

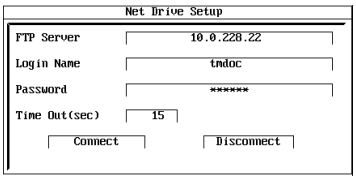
Note

If Login Name is set to anonymous, you do not have to enter the password.



Connecting/Disconnecting to a Network Drive

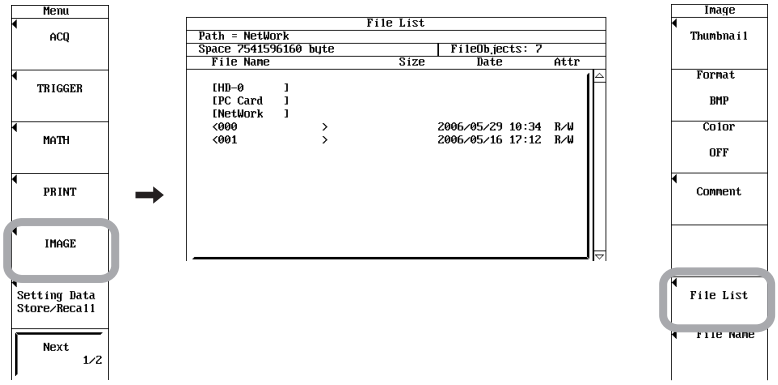
12. Use **jog shuttle**+**SELECT** to select Connect. Connection is made to the network drive. When the connection is established, is displayed at the upper right corner of the screen.
    Use the **jog shuttle** to move the cursor to Disconnect, then press **SELECT** to close the connection. The displayed at the upper right corner of the screen disappears.



Saving/Loading the Screen Image, Waveform, and Setup Data

Saving/Loading the screen image data

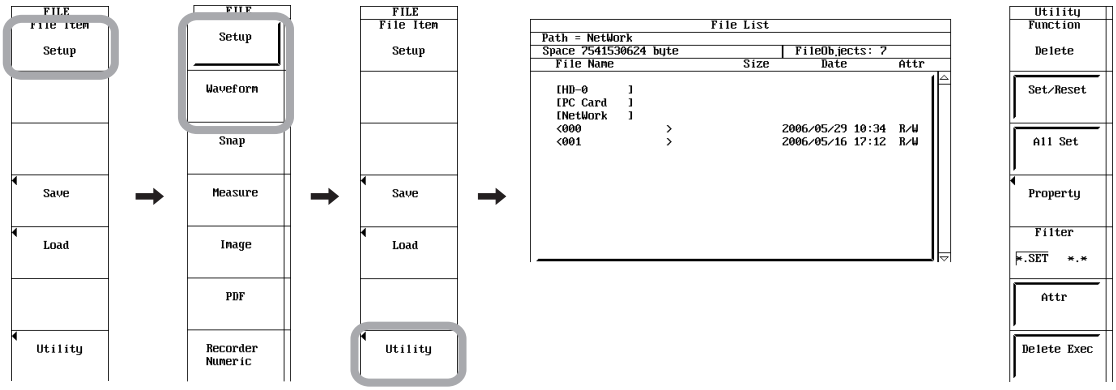
13. Press **MENU**.
14. Press the **IMAGE** soft key.
15. Press the **File List** soft key. The File List window appears.
16. Use the **jog shuttle** to select [Network] in the File List window.



17. The succeeding procedure is the same as the procedure described in section 13.12 and 13.13.

Saving/Loading Waveform Data and Setup Data

13. Press **FILE**.
14. Press the **File Item** soft key.
15. Select **Setup** or **Waveform**.
16. Press the **Utility** soft key. The File List window appears.
17. Use the **jog shuttle** to select [Network] in the File List window.



18. The succeeding procedure is the same as the procedure described in section 13.8 and 13.9.

Note

- An FTP server software must be running on the PC or workstation to which the SL1400 is to be connected. In addition, the following points need attention regarding the server program settings.
- Set the list output (string returned by the dir command) to UNIX format.
- Set the home directory and its subdirectories to allow writing.
- The client cannot move above the home directory.
- The newest file is not necessarily displayed at the top of the file list.
- Files and directories that are longer than 17 characters cannot be accessed.
- Depending on the server, “<..>” that indicates a higher directory may not be displayed.
- The time information in the file list will not be displayed correctly for the following cases.
  - On Windows NT when the time stamp is displayed using am and pm.
  - Servers that return characters other than ASCII characters in the list
- The following operations are not possible.
  - Turning file protect ON and OFF on saved files.
  - Formatting a network drive.
  - Copying between network drives.
  - Renaming a file on the network.
- This function cannot be used when using the FTP server function or the Web server function.
- To use this function, you must configure TCP/IP according to the procedure given in section 15.2.
- To apply new settings that are made while connected to a network drive, drop the connection using Disconnect and reconnect.
- If you are disconnected by the server when using the FTP client, you will be automatically reconnected if you perform a file operation. This also hold true, if the network drive is selected for Save to File when using an action trigger.

Explanation

You can save the screen image data, waveform data, and setup data to network drives via the Ethernet network in the same fashion as with the PC card interface.
If you want to make the SL1400 the FTP server and access the SL1400 from an FTP client on the network, see section 15.6.

FTP Server

Enter the IP address of the FTP server (the PC or workstation running the FTP server) on the network to which waveform and setup data will be saved. On networks supporting DNS, you can specify the host and domain by name instead of the IP address.

Login Name

Enter the login name using up to 15 characters. The default setting is “anonymous.”
The characters that can be used are all the ASCII characters on the keyboard.

Password

Enter the password corresponding to the login name using up to 15 characters.
The characters that can be used are all the ASCII characters on the keyboard.

Time Out

When an FTP server is accessed from the SL1400 and data is not transmitted for a certain period of time (timeout time), the SL1400 decides that the transmission to the FTP server is not possible and closes the connection. You can set the timeout value in the range of 0 to 3600 s. The default setting is 15 s.

15.4 Setting up the Network Printer (LPR Client Function)

<For a description of this function, refer to page 2-47.>

Procedure

1. Press **MENU**.
2. Press the **Next 1/2** soft key.
3. Press the **Network** soft key.
4. Press the **Net Print Setup** soft key. The Net Print setup menu appears.

Setting the LPR Server

5. Use **jog shuttle**+**SELECT** to select LPR Server.
6. Enter the IP address of the printer server according to the procedure given in section 4.2. If you are using DNS, you can specify the printer server by name.

Setting the Printer Name

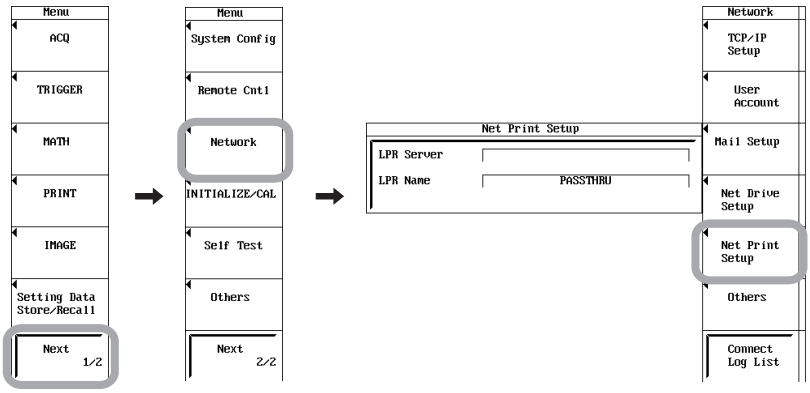
7. Use **jog shuttle**+**SELECT** to select LPR Name.
8. Enter the printer name according to the procedure given in section 4.2.

Printing the Screen Image Data

9. Print the screen image data according to the procedure given in section 12.3.

Note

- To use this function, configure the TCP/IP settings beforehand according to section 15.2.
- Output is possible to printers or printer servers that support the TCP/IP protocol.
- This function cannot be used when using the FTP server function or the Web server function, or when performing file operations.



Explanation

As with the built-in printer, you can print the screen image on a network printer via the Ethernet network.

Net Print Setup

LPR Server

Specify the IP address of the network printer server. On networks supporting DNS, you can specify the host and domain by name instead of the IP address.

Printer Name: LPR Name

Specify the name of the printer on which screen image data will be printed.

Output Format

The following six printer formats are supported.

- ESC-P
- ESC-P2
- LIPS3
- PCL5
- BJ
- PostScript

15.5 Sending Periodic Mail or Action Mail (SMTP Client Function)

<For a description of this function, refer to page 2-48.>

Procedure

Sending Periodic E-mail Messages

1. Press **MENU**.
2. Press the **Next 1/2** soft key.
3. Press the **Network** soft key.
4. Press the **Mail Setup** soft key. The Mail setup menu appears.

Setting the Mail Server

5. Use **jog shuttle**+**SELECT** to select Mail Server.
6. Enter the IP address of the mail server according to the procedure given in section 4.2. If you are using DNS, you can specify the mail server by name.

Setting the Recipient Mail Address

7. Use **jog shuttle**+**SELECT** to select Mail Address.
8. Enter the recipient mail address using up to 40 characters according to the procedure given in section 4.2.

Setting a Comment

9. Use **jog shuttle**+**SELECT** to select Comment.
10. As necessary, enter the comment using up to 30 characters according to the procedure given in section 4.2.

Setting the Time When the Mail Is to Be Sent

11. Use **jog shuttle**+**SELECT** to select the hour, minute, or second of MailBaseTime
12. Enter the time when mail is to be sent according to the procedure given in section 4.2.

Setting the Attached Image File

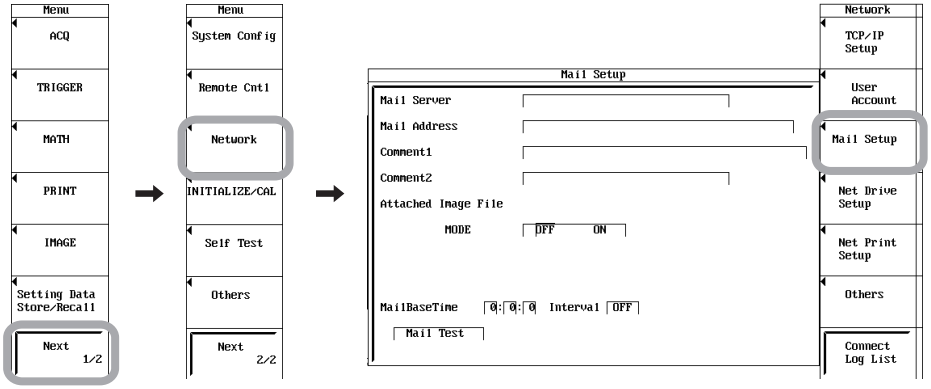
13. Use **jog shuttle**+**SELECT** to select ON (attach image file) or OFF (do not attach image file).

Setting the Interval for Sending Mail

14. Use **jog shuttle**+**SELECT** to select Interval.
15. Select the interval for sending mail in the range of 1 h to 24 h according to the procedure given in section 4.2.

Sending a Test Mail

16. Turn the **jog shuttle** to move the cursor to Mail Test.
    To send a test mail to the specified recipient, press **SELECT**.
    While mail transmission is in progress, ✉≈ is indicated at the upper left corner of the screen.



Note

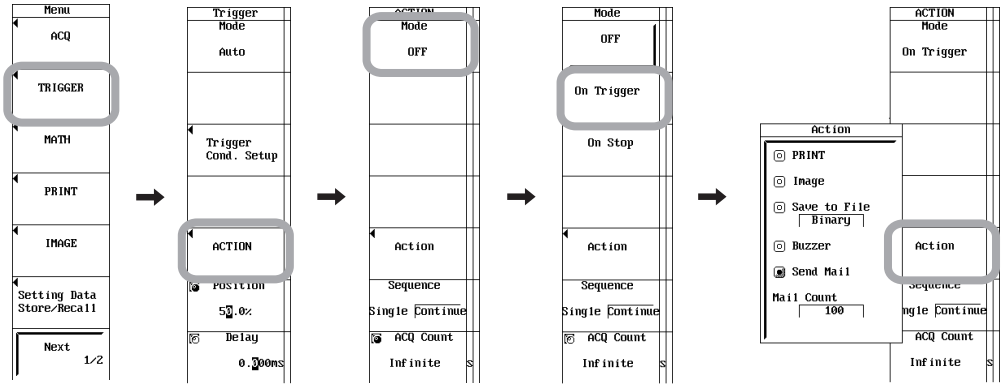
- The sender (From) address of the e-mail messages sent by the SL1400 is the same as the specified recipient address.
- If the transmitted contents indicate error logs, the most recent error is at the top of the error log.
- To use this function, configure the TCP/IP settings beforehand according to section 15.2.
- If you set Interval to OFF, periodic mail is not sent.

Sending Action E-mail Messages

1. Set items according to steps 1 to 10 in “Sending Periodic E-mail Messages” on the previous page.
   You do not have to set MailBaseTime and Interval for action mail. If you want to use only action mail, set Interval to OFF.

Setting the Action

2. Press **MENU**.
3. Press the **TRIGGER** soft key.
4. Press the **ACTION** soft key.
5. Press the **Mode** soft key and then the **On Trigger** soft key.
6. Press the **Action** soft key. The action setup menu appears.
7. Use **jog shuttle**+**SELECT** to set Send Mail to ON.
8. Use **jog shuttle**+**SELECT** to set Mail Count (the number of mail messages).
9. Press **START/STOP** to start the waveform acquisition. A mail is sent to the specified address each time a trigger occurs.
   While mail transmission is in progress, ✉≈ is indicated at the upper left corner of the screen.



Note

- The mail recipient is the address specified by pressing the Menu key > Next 1/2 > Network > Mail Setup > Mail Address.
- The sender (From) address of the e-mail messages sent by the SL1400 is the same as the specified recipient address.
- Periodic mail and action mail can be used together. To use only action mail, set Interval to OFF.
- To use this function, configure the TCP/IP settings beforehand according to section 15.2.

Explanation

Mail Server

Specify the IP address of the network mail server. On networks supporting DNS, you can specify the host and domain by name instead of the IP address.

Mail Address

Enter the recipient address using up to 40 characters.

Comment

The comment is written on the first line of the transmitted mail. Enter it as necessary. Enter comment using up to 30 characters.

Transmission Time (MailBaseTime)

The time when mail transmission is to start can be set in units of hour, minute, and second, in the following range.
0:0:0 to 23:59:59

Attaching Image Data (Attached Image File, Version 4.01 or Later)

The screen image data at the time of mail transmission can be attached to the mail. The data format of the screen image data is the format specified in section 13.12.
The file name differs between periodic mail and action mail.
File name of periodic mail: DL_image.png
File name of action mail: DL_nnnn.png (where nnnn is an automatically assigned number in the range of 0001 to 1000)

Transmission Interval

The following mail transmission intervals are available.
OFF, 1 H, 2 H, 3 H, 4 H, 6 H, 8 H, 12 H, and 24 H
However, if you select OFF, periodic mails cannot be transmitted.

Sending a Test Mail: Mail Test

A test mail is sent to the address specified by Mail Address.

Periodic Mail

The SL1400 status can be sent periodically to a specified mail address on the network.

SL1400 Information That Is Transmitted

- **Acquisition Condition**
  Start/Stop, trigger condition, and acquisition counter
- **Error Log Information**
  Error number and corrective action in English (up to 16 errors)
- **Results of Waveform Parameter Measurement**
  Only when automated measurement of waveform parameters (see section 11.5) is executed.
  The maximum number of measurement results of waveform parameters that are sent is the same as the maximum number (24) of measurement results displayed on the SL1400.

Sample Periodic Mail

[Comment] aaaaaa

[ACQ Status] Stopped 162

ErrNo 602 No SCSI device or no media inserted.
Check the SCSI device connection and
the SCSI ID, and make sure that the storage
medium is inserted (if applicable).

Action Mail

Information such as the trigger time can be sent to a specified mail address on the network as an action of action-on-trigger.

SL1400 Information That Is Transmitted

- **Acquisition Condition**
  Start/Stop, acquisition counter
- **Trigger Time**
- **Results of Waveform Parameter Measurement**
  Only when automated measurement of waveform parameters (see section 11.5) is executed.

Sample Action Mail

[Comment] aaaaaa

[ACQ Status] Stopped 1

[Trigger Date and Time] 2002/06/17 17:28:59.38

Max (C1) 4.16667V
SDv (C2) 697.941mV
Freq(C3) 500.0000kHz
+Wd (C4) 1.00us>

15.6 Accessing the SL1400 from a PC or Workstation (FTP Server Function)

<For a description of this function, refer to page 2-48.>

Procedure

This section describes the FTP server function when a general FTP client software (such as WS_FTP or FFFTP) is used. To use FTP through the Web browser, see section 15.7.

1. Press **MENU**.
2. Press the **Next 1/2** soft key.
3. Press the **Network** soft key.
4. Press the **User Account** soft key. The User Account setup menu appears.

Setting the User Name

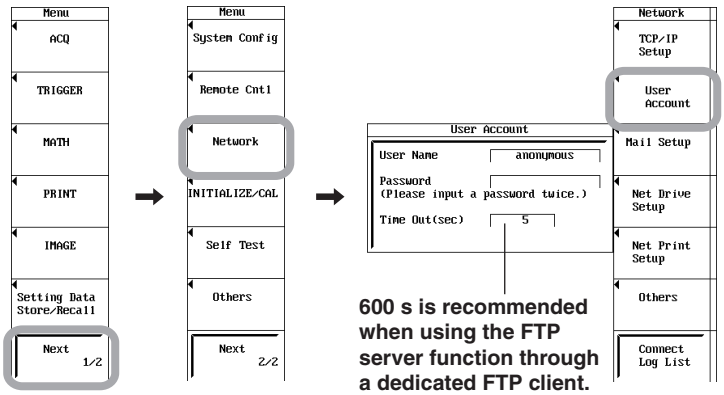
5. Use **jog shuttle**+**SELECT** to select User Name.
6. Enter the user name according to the procedure given in section 4.2. Specify anonymous if you want to allow access to all users. To restrict access, enter the user name using up to 15 characters.

Setting the Password

7. Use **jog shuttle**+**SELECT** to select Password.
8. Enter the password using up to 15 characters according to the procedure given in section 4.2.
   If you select the ENT key on the soft keyboard or press the ENT soft key, the entered password (appears as *****) is cleared from the soft keyboard screen. Enter the password again for confirmation. The password (appears as *****) is confirmed and displayed in the Password column of the User Account setup menu. If the password entered the second time is different from the first, the entered password is cleared from the soft keyboard screen.
   If the user name is set to anonymous, you do not have to enter the password.

Setting the Timeout Time

9. Use **jog shuttle**+**SELECT** to set Time Out.
   The connection to the network is automatically closed if there is no access to the SL1400 for the specified time.



Executing the FTP Client Software

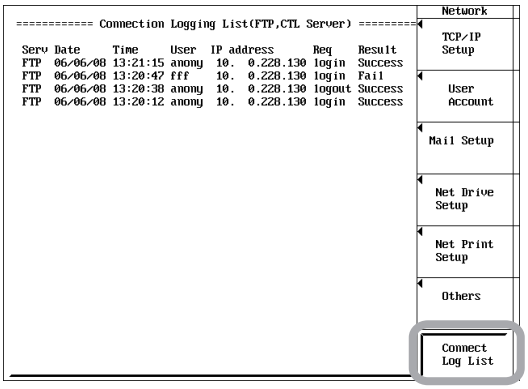
10. Execute an FTP client software on the PC or workstation. Perform file operations using the user name specified in steps 5 and 6.

Displaying the Connection Log List

11. Press the **Connect Log List** soft key. The data and time, user name, and IP address of the 25 recent accesses are displayed.

Note

- The log list is cleared when the power is turned OFF.
- The SL1400 supports up to two clients, but file operations cannot be performed simultaneously.
- When the SL1400 is being accessed from a PC or workstation (logged in), is displayed in the lower right part of the screen.
- This function cannot be used when using the FTP client function, network printer function, or the Web server function, or when performing file operations.
- To use this function, configure the TCP/IP settings beforehand according to section 15.2.
- To apply new settings, the SL1400 must be power cycled.
- The files that can be uploaded to the SL1400 are those with the following extensions.
  .WVF, .HDR, and .SET
  However, do not upload files to the realtime recording area.



Explanation

You can access the SL1400's PC card drive, internal hard disk (option), SCSI device, or USB storage device from a PC or workstation via the Ethernet network.
To access the SL1400, an FTP client software is needed on the PC or workstation.
For a description of the FTP using the Web browser (Web server function), see section 15.7.

User Name

Enter the user name using up to 15 characters. The default setting is "anonymous." The characters that can be used are all the ASCII characters on the keyboard.

Password

Enter the password using up to 15 characters. The characters that can be used are all the ASCII characters on the keyboard.

Time Out

The connection to the network is automatically closed if there is no access to the SL1400 for the specified time. The default value is 5 s. Set the timeout to a long value when using an FTP client (such as FFFTP).

Note

- It is recommended that the timeout be set to 600 s when using the FTP server function through an FTP client.
- When using the FTP server function on a Web browser (see section 15.7), it is recommended that the timeout be set to 5 s (default value).

Connect Log List

The data and time, user name, IP address, access result of the 25 recent accesses from the PC or workstation to the SL1400 are displayed.

15.7 Using the Web Server Function

<For a description of this function, refer to page 2-48.>

You can use the Web server function on the SL1400 to display the screen image of the SL1400 on the Web browser window on your PC and perform file operations on the SL1400 using the keys displayed on the Web browser window.

This section contains the following information.

Overview of the Web Server Function

- **FTP Server Function (On the Web Browser)**
  View the list of files stored on the storage media of the SL1400 (internal hard disk or built-in storage medium) and transfer files to the PC.
- **Data Capture**
  The following operations can be carried out.
  - Change the display format of the SL1400 and display data that is acquired in the history memory.
  - Display the screen image of the SL1400.
  - Save the waveform data and setup data to the PC.
  - Load the setup data stored on the PC into the SL1400.
- **Measurement Trend of the Waveform Parameter Values**
  Using the Excel function, display the trend of the selected waveform parameter values. The statistics of the measured values can also be computed.
- **Control Script**
  Control the SL1400 using communication commands (see the *Communication Interface User's Manual IM701240-17E* .
- **Log**
  Displays the past log of errors that occurred on the SL1400, and action-on-trigger. Up to the 30 most recent incidents are logged.
- **Instrument Information**
  Display the model of the SL1400, the module configuration, the presence/absence of options, the ROM version (firmware version), etc.
- **Link**
  View the Web page for the SL1400.

System Requirements

PC Environment

PC

PC running Microsoft Windows 2000 Professional or Microsoft Windows XP Professional.

OS

Microsoft Windows 2000 Professional or Microsoft Windows XP Professional.

Internal Memory

64 MB or more recommended.

Communication Port

Ethernet communication port that supports 10BASE-T or 100BASE-TX. Use this communication port to connect the PC to the network.

Display

Display supported by the OS indicated above with a resolution of 1024 × 768 dots or higher.

Mouse or Pointing Device

Mouse or pointing device supported by the OS indicated above.

Files Required for the Web Browser

Of the Web server functions, the following files are required when using the data capture, measurement trend, or command script function. For the installation procedure on the PC, see “Installing Files Required for the Web Browser” (page 15-25).

`Msvbvm60.dll`
`cmdlgjp.dll`
`comdlg32.ocx`

Combinations of OS and Application Software That Have Been Tested

OS	Web Browser	Spreadsheet Software[1]
Windows 2000 Professional	Internet Explorer 5.0/5.5/6.0	Microsoft Excel 97
Windows XP Professional	Internet Explorer 6.0	Microsoft Excel 2002

1. The spreadsheet software is required when displaying the trend of waveform parameters of the Web server function.

SL1400 Environment

Connection to the Network

Connect the SL1400 to the network using the Ethernet. For the connection procedure, see section 15.1.

TCP/IP

Configure the network environment and IP address for communication using the Ethernet interface. For the procedure, see section 15.2.

Communication Interface

Set the communication interface to Network. For the procedure, see “Setting the Communication Interface to the Network” (page 15-23).

User Account

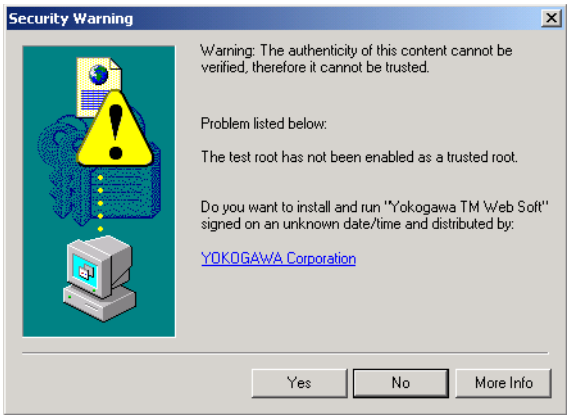
Set the user account used to access the SL1400 from the PC. For the procedure, see section 15.6.

Time Difference from the Greenwich Mean Time

When using the Web server function, set the time difference from the GMT. Normally, the time difference is also set on the PC. Setting the time difference correctly allows the SL1400 and the PC to detect the local time correctly. Consequently, the PC will be able to detect whether a file is new when transferring or saving the file. For the procedure, see section 15.8.

Note

- Use Internet Explorer version 5.0 or later for the Web browser.
- The Web server function contains software programs that have not been authenticated. Therefore, the following dialog box may appear. In such case, click Yes and install the software.



- You cannot open multiple Internet Explorer windows on the same PC and use the same function of the Web server function simultaneously.
- When using the storage function of the FTP server function (on the Web browser), data capture function, or the log display on the same PC, other Web server functions cannot be used.
- When using the storage function of the FTP server function (on the Web browser), data capture function, or the log display on a PC, other PCs cannot use the Web server function.
- The Web server functions use the Ethernet interface for communication. If the Ethernet interface is configured for controlling the SL1400 using a communication command (see the *Communication Interface User’s Manual IM701240-17E*), the Ethernet interface cannot be used simultaneously.
- The Web server function cannot be used while the SL1400 is printing, operating files (file operation from the front panel key or file transfer using the FTP server function), realtime recording, or while the Windows network drive is being used.
- When the SL1400 is registered as a network drive (see section 15.3), the Web server function cannot be used.

Preparations for Using the Web Server Function

Connecting the PC and the SL1400 to the Network

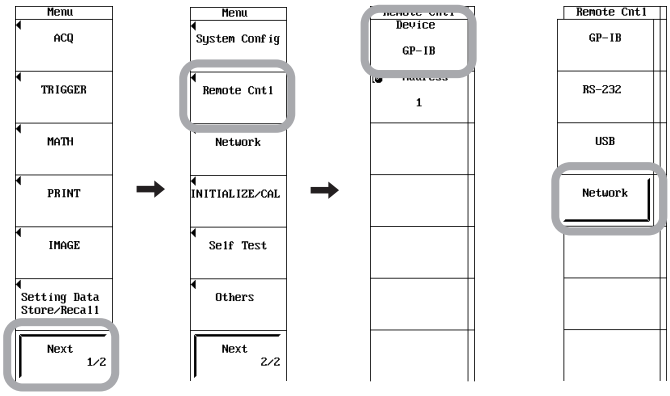
Connect the PC and the SL1400 to the network. For the connection procedure, see section 15.1.

Preparations on the SL1400

Setting the Communication Interface to Network

Turn ON the power to the SL1400. After the SL1400 boots up normally, carry out the following procedure.

1. Press **MENU**.
2. Press **Next 1/2** soft key.
3. Press the **Remote Cntl** soft key. The Remote Cntl menu appears.
4. Press the **Device** soft key. The Device menu appears.
5. Press the **Network** soft key. The Ethernet interface is selected for the communication means.



Setting up the TCP/IP

6. Set the TCP/IP on the PC and the SL1400. For the procedure on the SL1400, see section 15.2.

Setting the User Account Used to Access the SL1400

7. Set the user account used to access the SL1400 from the PC. For the procedure, see steps 1 to 9 in section 15.6.

Note

The User Account in the menu that appears after step 5 is the user account that is used to control the SL1400 through communication commands via the Ethernet network. It is not the user account for using the Web server function.

Setting the Time Difference from GMT (Greenwich Mean Time)

8. Set the time difference between the location where the SL1400 is located and the GMT. For the procedure, see section 15.8.

Rebooting

9. To activate the TCP/IP, user account, and time difference settings, turn OFF the power switch. After a few seconds, turn ON the power switch and boot the SL1400.

Preparations on the PC

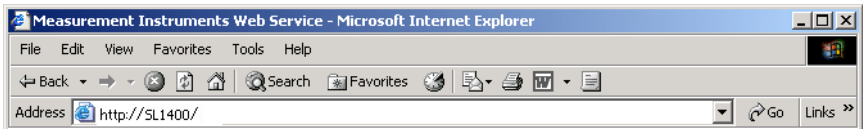
1. Power up the PC and log on.
   If the PC is running Windows 2000 or Windows XP, log on as an administrator. If you do not log on as an administrator, you may not be able to install files that are required for using the Web server function (described later).

Logging into the Web Server (SL1400)

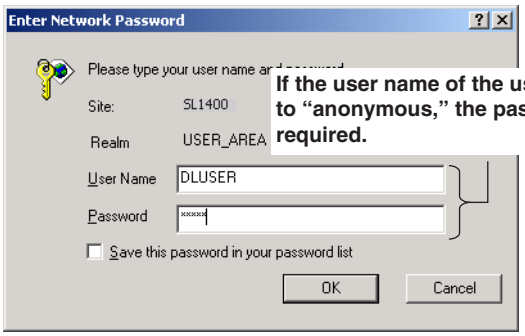
2. Start Internet Explorer.
3. Enter the IP address of the SL1400 (for example, 192.168.0.101) or the host name of the SL1400 (for example, SL1400) if a DNS server is available on the network.

   Enter the IP address **http://192.168.0.101/**

   Enter the host name **http://SL1400/**



4. Press the ENTER key on the PC keyboard. A network password entry dialog box opens.
5. Enter the user name and password.
   - Enter the user account (see section 15.6) used to access the SL1400. In the example below, “DLUSER” and “******” are entered for the user name and password, respectively.
   - If the user name of the user account is set to “anonymous” (default setting), the password is not required.
6. Click **OK**. If the login to the SL1400 Web server is successful, the Web server window appears.



If the user name of the user name is set to “anonymous,” the password is not required.

Web Server Window

Installing Files Required for the Web Server

- **Using the SL1400 and the PC While Connected to the Internet**

  When you use the Web server function for the first time, the files required for the Web browser are installed automatically from the Microsoft Web site.

  * If the three files (`Msvbvm60.dll`, `cmdlgjp.dll`, and `comdlg32.ocx`) are already installed in the PC when using the Web server function for the first time, step 7 is no required.

7. When the data capture, measurement trend, or command script function of the Web server function is used for the first time, three files, `Msvbvm60.dll`, `cmdlgjp.dll`, and `comdlg32.ocx`, are automatically downloaded from the Microsoft Web site and installed in the PC. At this point, a dialog box for confirming the installation appears. Click **Yes**.
   (You may need to restart the PC during the installation.)

   After the installation completes successfully, proceed to step 9 on the next page.

or

- **Using the SL1400 without Connecting to the Internet**

  If the three files, `Msvbvm60.dll`, `cmdlgjp.dll`, and `comdlg32.ocx`, are not installed in the PC when using the Web server function for the first time, install the files beforehand according to the following procedure.

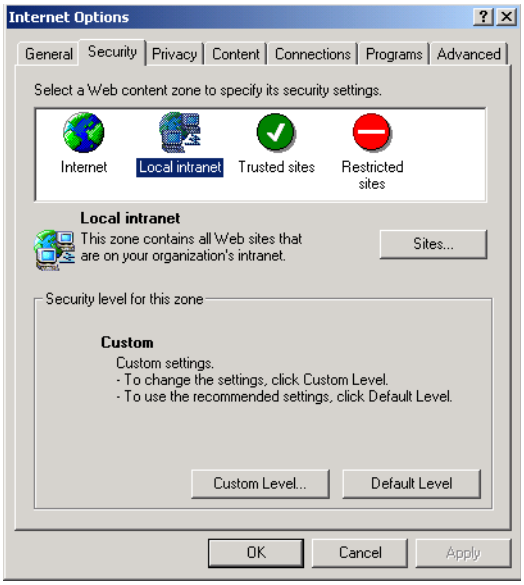
  7. Download the following file from the YOKOGAWA Web site (http://www.yokogawa.com/tm/Bu/DLsoft/web.htm).
     YOKOGAWA T&M Web Runtime: ytmwrun.exe
     Data size: Approx. 2.2 MB
  8. Double-click ytmwrun.exe that you have downloaded. The installation of the aforementioned three files starts. Follow the instructions to install the files.

  Checking the Web Browser (Internet Explorer) Security Settings

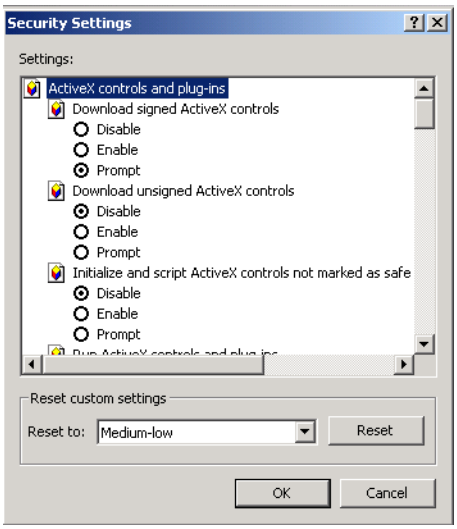
  Check the security settings on the Internet Explorer. The settings indicated in the table on the next page are defaults. If the settings on your browser do not match, set them back to the settings in the table on the next page. Otherwise, the Web server function cannot be used.

  The following explanation is for Internet Explorer 5.5. For other versions, carry out equivalent steps accordingly.

  9. Choose **Internet Options** from the **Tools** menu. The Internet Options dialog box opens.
  10. Click the **Security** tab.
  11. Select a Web content zone.
      The Web service zone varies depending on the network environment and browser settings. Check with your network administrator to select the zone.



12. Click **Custom Level**. The Security Settings dialog box opens.



13. Set the security settings as shown in the following table.

Item	Security Level
Run ActiveX controls and plug-ins	Enable
Script ActiveX controls marked safe for scripting	Enable
Download signed ActiveX controls	Prompt

14. Click **OK**.

Using the Web Server Function

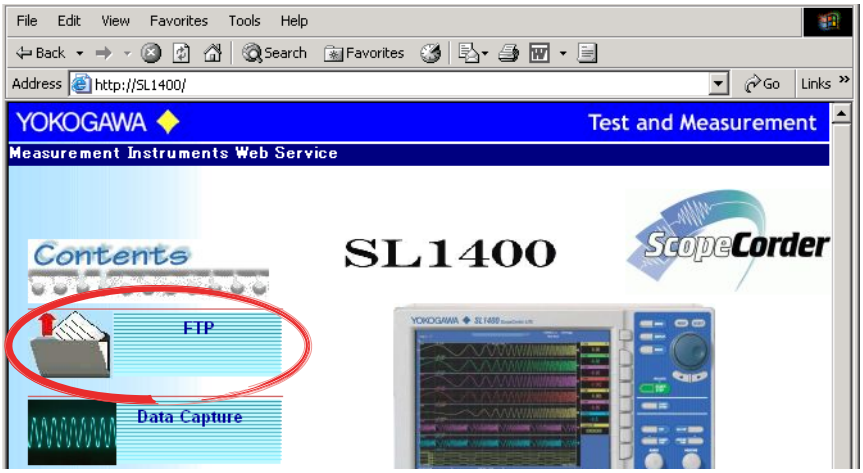
Using the FTP Server Function (On the Web Browser)

Before using this function, check that the communication interface of the SL1400 is set to Network (see page 15-23).

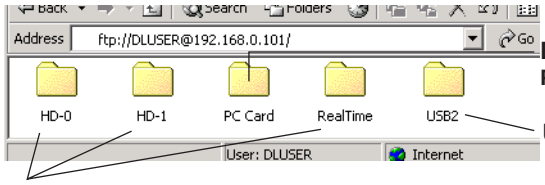
Click the **FTP** icon on the Web server window. A window for viewing the storage media of the SL1400 (storage media view window) appears.

The storage media view window may not appear. In this case, click the Refresh button on the Web browser. A login dialog box opens. Log in. The storage media view window appears.

Web Server Window



Storage Media View Window



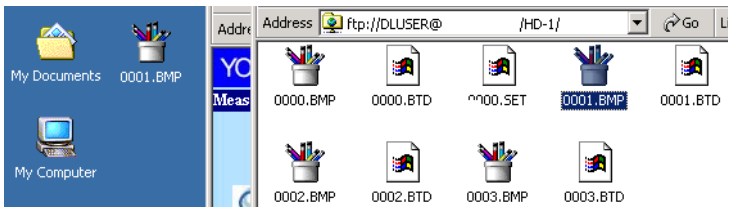
Built-in storage media
PC Card

USB storage device

Internal hard disk

- **Real Time: Area used by realtime recording**
- **HD0, HD1:**
  Storage area for waveform and setup data (the number of displayed items varies depending on the number of partitions)

- You can open folders on each storage medium and view the file list.
- You can select files displayed on the window and transfer files to the PC.



CAUTION

- Never change the contents on the SL1400 disk from the PC (read only). Writing to the disk may destroy files.
- Never perform the following operations. The internal hard disk of the SL1400 will become inaccessible.
  - Delete files on the internal hard disk of the SL1400 from the PC.
  - Add files to the internal hard disk of the SL1400 from the PC.

Note

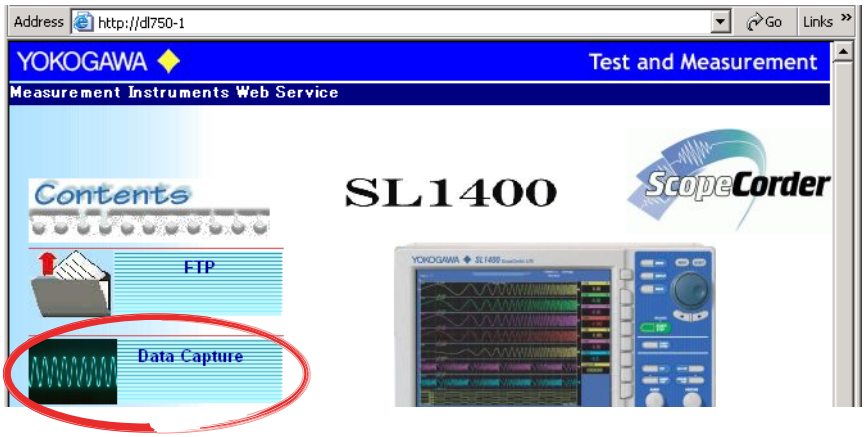
- Up to two PCs can log into the file transfer function simultaneously.
- You cannot operate the files simultaneously from two PCs.
- When the SL1400 is printing, operating files (file operation from the front panel key or file transfer using the FTP server function), or realtime recording, the Web server function cannot be used.
- To use the FTP server on a Web browser, a network user account on the SL1400 must be configured. For the procedure of setting user accounts, see steps 1 to 9 in section 15.6.
- An authentication login dialog box may appear on the Web browser, when the FTP icon on the Web server window is clicked. In such case, enter the user name and password that were entered in section 15.6.

Capturing Data

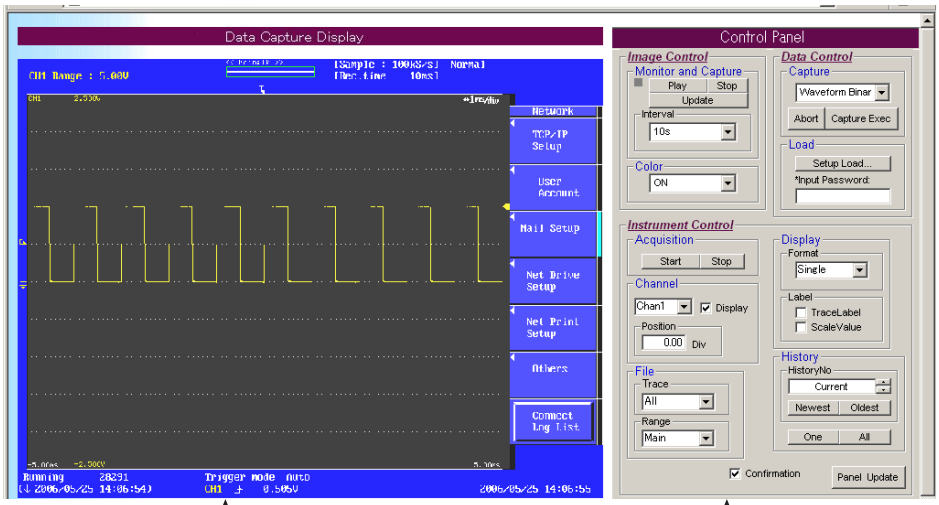
Before using this function, check that the communication interface of the SL1400 is set to Network (see page 15-23).

Click the **Data Capture** icon on the Web server window. The Data Capture window showing the screen image of the SL1400 and the control panel that allows data saving and loading appears

Web Server Window



Data Capture Window



Displaying and Saving the Screen Image (Image Control)

The screen image of the SL1400 can be displayed on the PC screen and saved.

- **Updating the Screen Image (Monitor & Capture)**

  Play

  Click **Play** to illuminate the update indicator in green and start the updating of the screen image at the specified display update interval (see below).

  Stop

  Click **Stop** to turn off the update indicator and stop the updating of the screen image.

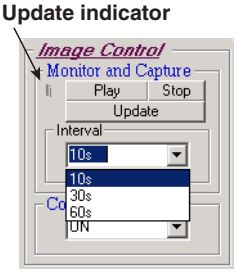
  Update

  The screen image is updated when you click Update.

  Interval

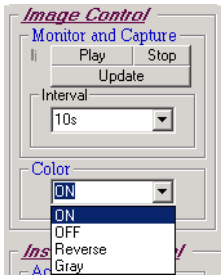
  Set the display update interval to 10 s, 30 s, or 60 s.

  Update indicator



- **Selecting the Display Color of the Screen Image (Color)**

  Select the display color from ON, OFF, Reverse, and Gray. For a description of the displayed information for each setting, see the explanation in section 13.12.

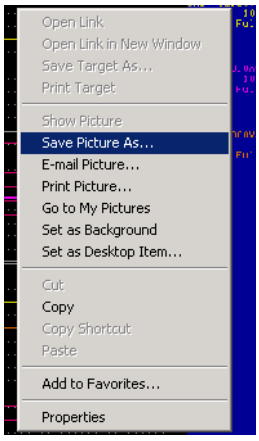


Note

The time it takes to display the screen image on the PC varies depending on the color setting. In decreasing order, the color settings are ON, Reverse, Gray, and OFF.

- **Saving the Screen Image in the PC**

  Right-click on the screen image that is displayed. A shortcut menu appears as shown in the following figure. Choose Save Picture As to save the current screen image.

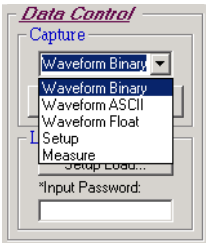


Saving Data in the PC and Loading Setup Data from the PC into the SL1400 (Data Control)

- **Saving Data in the PC (Capture)**

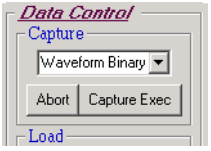
  Data Type

  Select the type of data to be saved from Waveform Binary, Waveform ASCII, Waveform Float, Setup, and Measure. For details on the settings, see the explanations in section 13.8, 13.9, and 13.11.



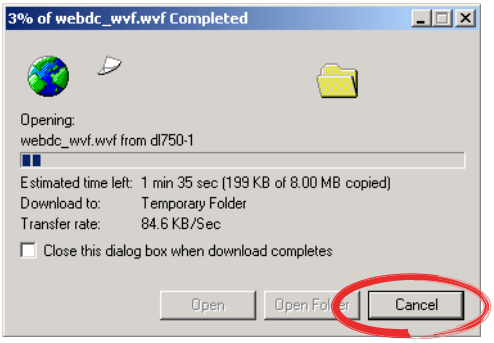
  Capture Exec

  Using the dialog box that appears when you click Capture Exec, set the save destination and file name and save the data.



  Abort

  To abort the save operation while data is being saved, click Cancel on the dialog box. Then, click Abort on the Control Panel.



You must enter a password to abort. For details, see "Input Password" in the next section.

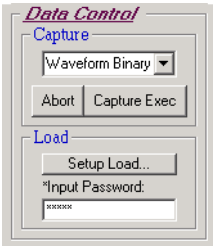
- **Loading the Setup Data from the PC into the SL1400 (Load)**

  Input Password

  Enter the password (see page 15-24) that you used to log into the Web server (SL1400). If the user name of the user account is set to "anonymous" (default setting), the password is not required.

  Setup Load

  Click Setup Load to display the Open dialog box. Select the setup data file you want to load and click OK to execute the load operation.



Note

- Depending on the operation condition of the SL1400 (such as when measurement is in progress), data save and setup data load operations may not be possible.
- When data is being saved or the setup data is being loaded, other Web server functions cannot be used.
- When loading the setup data or when aborting the save operation, a temporary file (zzzftpzzztmpzzz.bat) is created in the start directory of the Internet Explorer. After the operation is complete, the temporary file will be deleted.
- If you execute the data save operation when there is no waveform data or waveform parameter, an error is displayed on the SL1400 screen, and a 0-byte file is saved.

Controlling the SL1400 (Instrument Control)

You can use the PC to set the display format and the data save conditions of the SL1400. The settings entered here apply to the display format and save conditions used to save the data on the previous page

- **Starting/Stopping the Waveform Acquisition (Acquisition)**

  Start

  Click **Start** to start the waveform acquisition.

  Stop

  Click **Stop** to stop the waveform acquisition.

- **Turning ON/OFF the Waveform Display and Setting the Vertical Position (Channel)**

  Selecting the Target Waveform

  From the channel box, select the channel for turning ON/OFF the display and setting the vertical position from the following:

  Chan1 to Chan16 (channels 1 to 16)

  Display ON/OFF

  To display the waveform of the selected channel (turn it ON), select the Display check box. Clear the check box to not display the waveform of the selected channel (OFF).

  Vertical Position

  You can set the vertical position of the waveform of the selected channel. For a description of the selectable range of the vertical position, see section 5.4.

- **Setting the Display Format (Display)**

  Display Format

  Select the number of divided windows when displaying waveforms from the following:

  1 Zone, 2 Zone, 3 Zone, 4 Zone, 8 Zone, and 16 Zone

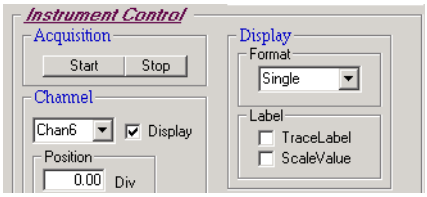
  For the meanings of the selections, see the explanation in section 8.1.

  Turning ON/OFF the Display of the Waveform Labels and Scale Values (Label)

  - Display Waveform Label (TraceLabel)

    To display the labels of the displayed waveforms, select the TraceLabel check box. Clear the check box to not display the labels.
  - Turning ON/OFF the Display of the Upper and Lower Limits of the Displayed Waveforms (ScaleValue)

    To display the upper and lower limits of the displayed waveforms, select the ScaleValue check box. Clear the check box to not display the upper and lower limits.

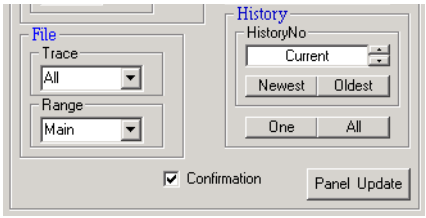


- **Selecting the Waveforms to Be Saved (File)**
  Selecting the Target Waveforms (Trace)
  From the Trace box, select the waveforms to be saved from the following:
  All (all waveforms), 1 to 16 (channels 1 to 16), Math 1 to Math 8 (computed waveforms), and PodA to PodB (logic waveforms).
  Selecting the Save Area (Range)
  Select the area in which the target waveform to be saved is displayed from the following:
  Main, Z1, and Z2
  For the meanings of the selections, see the explanation in section 13.8.

- **Setting the History Data Display**
  Selecting by History Data Number (History No.)
  You can specify the history number of the data to be displayed.
  Selecting the Most Recent or Oldest Data
  You can specify the most recent or the oldest data in the history data to be displayed.
  Selecting One or All
  - One
    Click **One** to display a single history data point that is selected by the data number or selected by most recent or oldest.
  - All
    Click **All** to display all the history data.

- **Updating the Setup Condition (Panel Update)**
  Click **Panel Update** to update the control panel settings on the Data Capture window (PC) to match the most recent setup condition on the SL1400.

- **Automatically Updating the Screen Image (Confirmation)**
  Select the Confirmation check box to automatically update the screen image using the same conditions as Color-OFF when you change the settings of the above items that would cause the screen image to change. Clear the check box to not update automatically.



Note

- You cannot set the history data display when the SL1400 is making measurements.
- Setting the history data display when there is no history data results in error.
- The timeout time on the PC when controlling the SL1400 is 30 s. Depending on the SL1400 condition, a timeout may occur preventing you from controlling the SL1400.

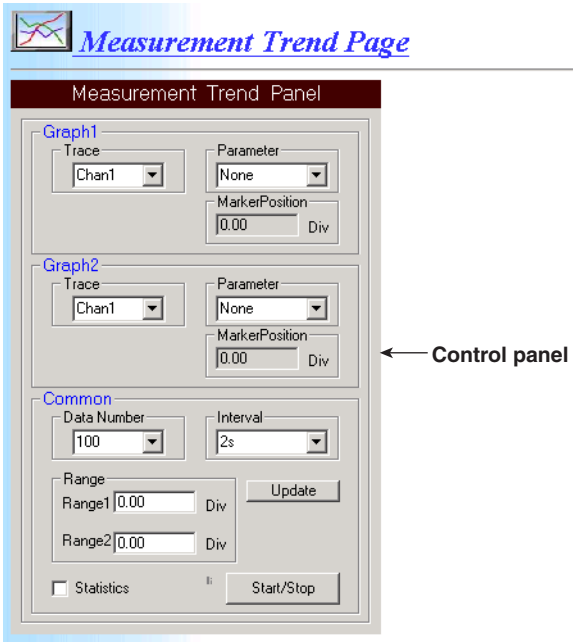
Displaying the Measurement Trend of the Waveform Parameter Values

Before using this function, check that the communication interface of the SL1400 is set to Network (see page 15-23).

Click the **Measurement Trend** icon on the Web server window. The Measurement Trend window in which the trend display of the waveform parameter values can be set appears.

Web Server Window

Measurement Trend Window



← Control panel

Note

- This function retrieves the selected waveform parameter values at the selected retrieve interval from the SL1400 into the PC and displays the trend. To display the retrieved measurement values and trend, Microsoft Excel 97 or later must be installed on the PC.
- Set the record time setting of the SL1400 to 1 s or less (shorter). This function cannot be used on record time settings that exceed 1 s.
- If the measured value of a waveform parameter is not a normal number (Not A Number), the cell displaying the measured value on Microsoft Excel is set to blank.
- The retrieve interval specified using this function and the measurement interval of the waveform parameters on the SL1400 are not synchronized.
- If the waveform parameter measurement is not complete within the specified retrieve interval, Not A Number is transmitted to the PC because there is no measured value. In this case, the cell displaying the measured value on Microsoft Excel is set to blank.

Setting the Trend Display Conditions

- **Selecting the Waveform Parameter to Be Displayed (Graph 1 and Graph 2)**
  You can display two trend graphs. For each graph, you can specify the trend target waveform and the waveform parameter. When the waveform parameter is "Marker," you can set the Marker Position.
  Selecting the Target Waveform (Trace)
  From the Trace box, select the target waveform for the trend display from the following:
  Chan1 to Chan16 (channels 1 to 16), Math1 to Math8 (computed waveforms)
  Selecting the Waveform Parameter
  From the Parameter box, select the target waveform parameter of the trend display (same expression as the communication command) from the following: For the meanings of the waveform parameters and the marker cursor, see the explanation in section 11.5 or 11.4.

Parameter	SL1400 Menu	Parameter	SL1400 Menu
None	Not selected	MINIMUM	Min
AMPLITUDE	Amp	NOVERSHOOT	-OShot
AVERAGE	Avg	NWIDTH	-Width
AVGFREQ	AvgFreq	PERIOD	Period
AVGPERIOD	AvgPriod	PNUMBER	Pulse
BWIDTH1	Burst1	POVERSHOOT	+OShot
BWIDTH2	Burst2	PTOPEAK	P-P
DELAY (For a detail setting, use Delay Setup on the SL1400)	Delay	–	–
DUTYCYCLE	Duty	PWIDTH	+Width
FALL	Fall	RISE	Rise
FREQUENCY	Freq	RMS	Rms
HIGH	High	SDEVIATION	Sdev
LOW	Low	TY1INTEG	Int1TY
MAXIMUM	Max	TY2INTEG	Int2TY
Marker(M1<2>) (marker cursor for cursor measurements)	M1<2>	XY1INTEG	Int1XY
MIDDLE	Mid	XY2INTEG	Int2XY

  Setting the Marker Position
  You can set the marker position if "Marker(M1)" or "Marker(M2)" is selected as the waveform parameter.

- **Setting the Conditions for Retrieving the Measured Values of Waveform Parameters (Common)**
  Number of Displayed Measured Values (Data Number)
  Select the number of measured values (measured values retrieved from the SL1400 into the PC) to be displayed in the cells of Excel from the following: If the number of measured values exceeds the selected number, the values are cleared from the oldest values to display the most recent measured values.
  10, 20, 50, 100, 200, and 500
  Retrieve Interval
  Select the retrieve interval from the following. However, of the selected waveform parameters, select the interval to match the longest parameter cycle measured on the SL1400.
  2 s, 5 s, 10 s, 30 s, and 60 s

Measurement Range

You can set the range on the time axis for measuring the waveform parameter.
Range1 and Range2 are the start and end points, respectively.
Selectable range: ±5 div
Resolution: Varies depending on the record length.
However, the measurement start point cannot be set to the same point as the measurement end point or to a value to the right of the measurement end point.

Turning ON/OFF the Statistics Display

- The statistics (Max, Min, and Average) of the waveform parameters retrieved into the PC can be displayed.
- To display the statistics, select the Statistics check box. Clear the check box to not display the statistics.
- The number of measurement values displayed in the cell of Excel is up to the number specified in “Number of Displayed Measured Values (Data Number)” on the previous page. The statistics are determined on all the measured data since the trend display was started, not on only the displayed measured values.

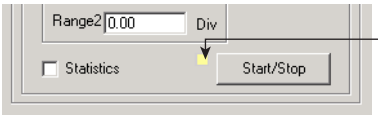
Updating the Setup Condition

Click **Update** to update the Marker Position and Range that are set on the control Panel of the measurement trend window to match the most recent setup conditions of the SL1400.

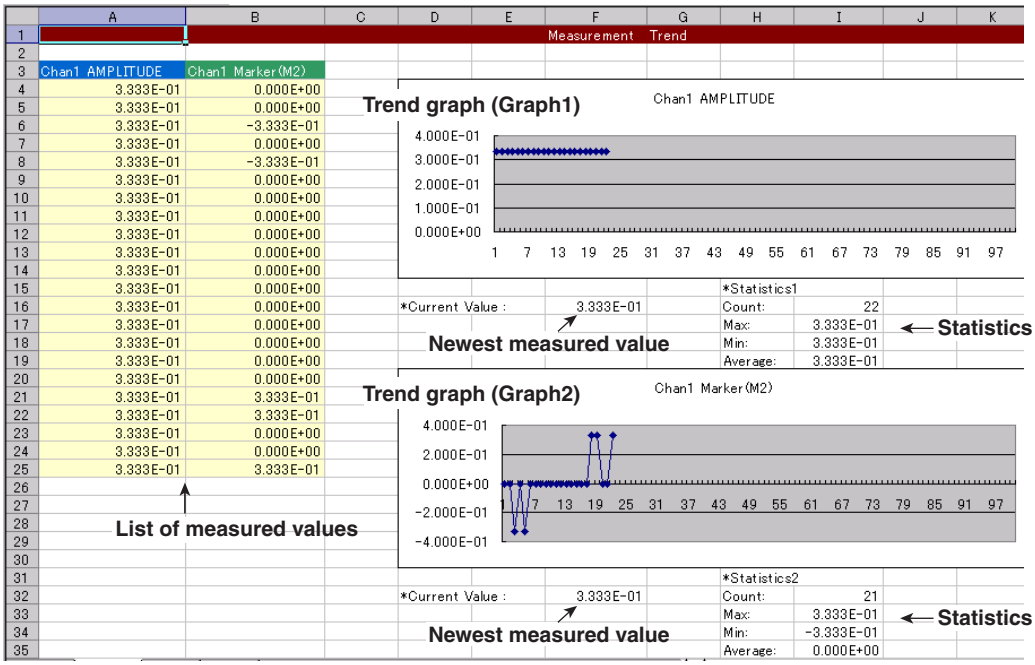
Starting/Stopping the Trend Display of the Measured Values of the Waveform Parameters

- **Start**

  Click **Start/Stop**. The indicator illuminates in yellow, and retrieval of the measured values of waveform parameters starts at the specified retrieve interval. At the same time, Microsoft Excel starts, and the measured values and trend graphs are displayed/drawn. If the statistical display is turned ON, the statistics are also displayed. The retrieval of the measured value of waveform parameter continues until the operation is stopped.
- **Stop**
  - Click **Start/Stop** while the trend display is in progress. The indicator turns OFF, and the display and drawing of the measured values and trend graph stop.
  - If you attempt to save the data to a file or close Excel while the trend display is in progress, a runtime error occurs. In this case, select **No** on the runtime error dialog box and close the dialog box. Then, click **Start/Stop** on the measurement trend window to stop the trend display. After stopping the trend display, save the file or close Excel.



Display Example of Measured Values, Trend Graphs, and Statistics



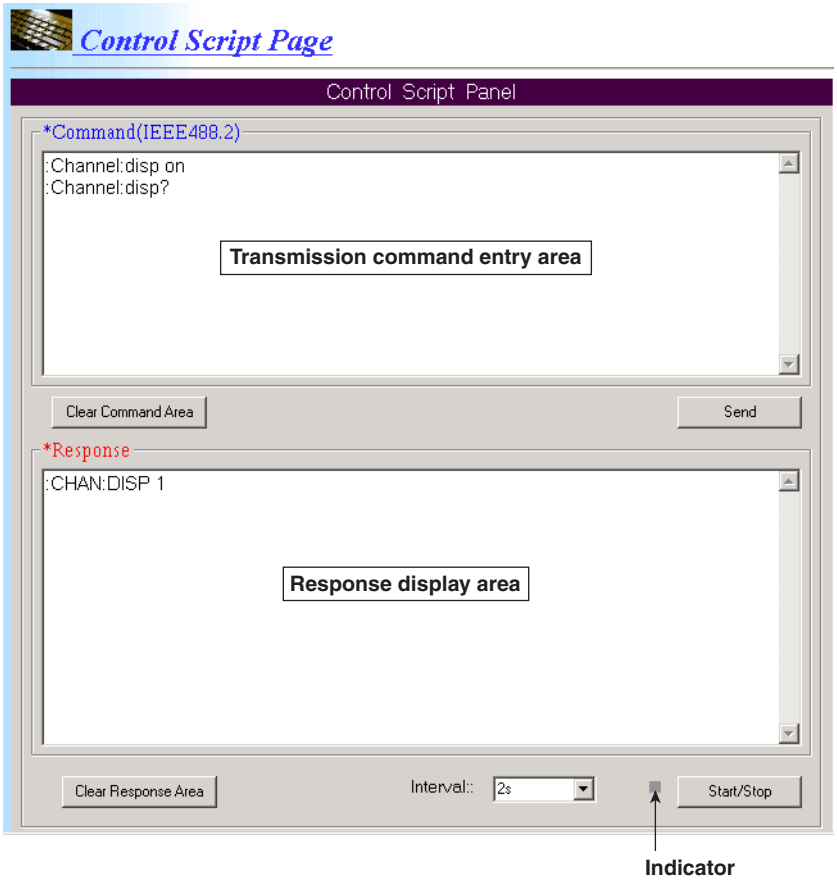
Using the Control Script

Before using this function, check that the communication interface of the SL1400 is set to Network (see page 15-23).

Click the **Control Script** icon on the Web server window. The Control Script window used to send communication commands (see the *Communication Interface User's Manual*) to the SL1400 and display the responses from the SL1400 appears.

Web Server Window

Control Script Window



Sending Commands (*Command IEEE 488.2)

- **Entering the Transmission Commands**
  Enter the commands in the transmission command entry area.
  Maximum number of input characters: Up to 50,000 (50 KB).
- **Sending Commands**
  Click **Send** to send the commands in the transmission command entry area collectively in the order displayed in the area.
- **Clearing the Entered Commands (Clear Command Area)**
  Click **Clear Command Area** to clear all the commands in the transmission command entry area.

Displaying the Responses from the SL1400 (*Response)

The responses from the SL1400 against the commands (queries) sent to the SL1400 using the control script function can be received and displayed.

- **Clearing the Responses (Clear Response Area)**
  Click **Clear Response Area** to clear all the responses received from the SL1400 that are displayed in the response display area.

Sending Commands Periodically and Displaying Responses

The commands in the transmission command entry area can be sent periodically. If commands (queries) that request responses from the SL1400 are sent, the responses from the SL1400 are displayed in the response display area.

- **Setting the Transmission Interval**
  Select the command transmission interval from the following:
  2 s, 5 s, 10 s, 30 s, and 60 s
- **Starting Periodic Transmission (Start)**
  Click **Start/Stop**. The indicator illuminates in yellow, and the command transmission and response display start at the specified transmission interval.
- **Stopping Periodic Transmission (Stop)**
  Click **Start/Stop** while the periodic transmission is in progress. The indicator turns OFF, and the command transmission and response reception/display stop. However, if the last command before stopping the periodic transmission was a query command, the response to that command is displayed in the response display area.

Note

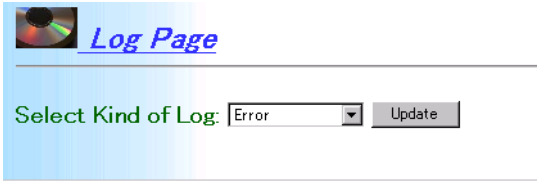
- If a wrong command is sent, the error message is not automatically displayed in the Control Script window. The error code and message are displayed by entering the "`:status:error?`" command in the transmission command entry area and sending the command. You can also confirm the error on the screen image displayed using the data capture function and also on the SL1400 screen.
- Binary data cannot be received or displayed.
- The transmission timeout is 30 s. Transmission and reception exceeding 30 s results in a timeout error. If all the commands specified in the transmission command entry area is sent, and the responses to the commands are not received within 30 s, a timeout error occurs.

Displaying the Log

Before using this function, check that the communication interface of the SL1400 is set to Network (see page 15-23).
Click the **Log** icon on the Web server window. The Log window that can display the past log of errors that occurred on the SL1400, and action-on-trigger appears. Up to the 30 most recent incidents are logged. Logs older than the past 30 are not displayed.

Web Server Window

Log Window



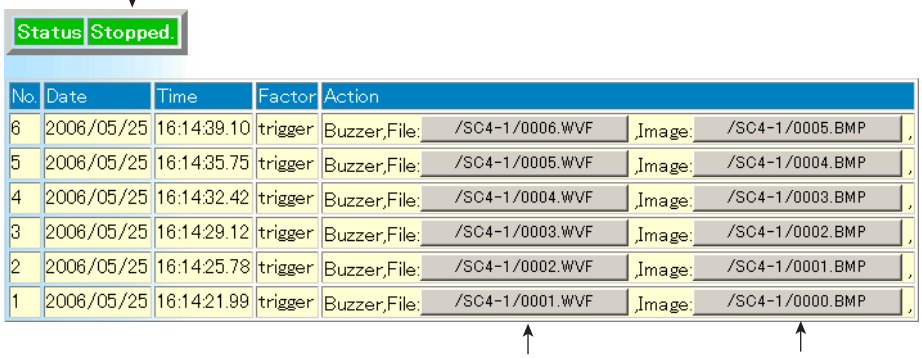
Displaying the Log

- **Selecting the Log Type (Select Kind of Log)**
  From the list box, select the item for displaying the log from the following:
  - Error (log of errors that occurred on the SL1400)
  - Action Trigger (log of action-on-triggers)
    For the setup procedure for the action-on-trigger, see section 6.18.
- **Updating the Log (Update)**
  Click **Update** to display the selected log. If the selected type of log is the same as that of the log being displayed, the log is updated.

Log Display Example

The following figure shows an example displaying the log of the action-on-trigger.

Displays "Executing..." when action-on-trigger is in execution.



If screen image data or waveform data files is being saved in the action-on-trigger, the files can be saved on the PC from the Log display window.

The log displays the save destination drive as follows.

CA0: PC card
SC4: SCSI device with the ID number set to 4*
SC4-1: Partition 1 of a SCSI device whose ID number is 4*
ND0: Network drive (when the Ethernet interface option is installed)
US□-□: USB storage device

Partition number (or LUN (logical unit number))
Address number

*** ID number 4 is the default value for the SL1400 internal hard disk (option).**

Note

- When the SL1400 is printing, operating files (file operation from the front panel key or file transfer using the FTP server function), or realtime recording, files cannot be saved on the PC. In addition, other Web server functions cannot be used while saving files.
- Files on the network drive (NetWork) cannot be saved to the PC.

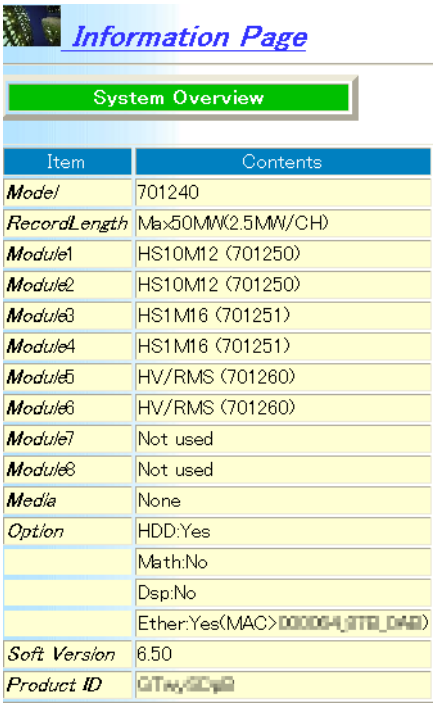
Displaying the Instrument Information

Before using this function, check that the communication interface of the SL1400 is set to Network (see page 15-23).

Click the **Information** icon on the Web server window. The Information window that displays the SL1400 model (Model), the maximum record length available (Record Length), the module configuration (Module), the storage media type (Media), the presence of options (Option), ROM version (firmware version, Soft Version), and other information appears.

Web Server Window

Information Window

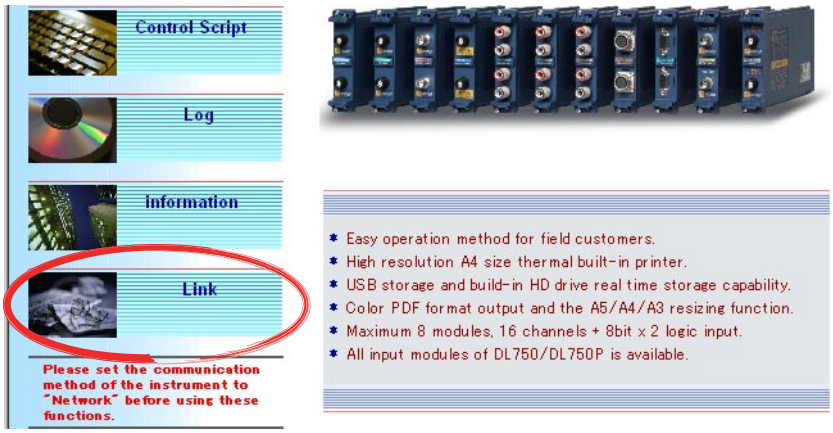


Item	Contents
Model	701240
RecordLength	Max50MW(2.5MW/CH)
Module1	HS10M12 (701250)
Module2	HS10M12 (701250)
Module3	HS1M16 (701251)
Module4	HS1M16 (701251)
Module5	HV/RMS (701260)
Module6	HV/RMS (701260)
Module7	Not used
Module8	Not used
Media	None
Option	HDD:Yes
	Math:No
	Dsp:No
	Ether:Yes(MAC>[illegible])
Soft Version	6.50
Product ID	[illegible]

Viewing the Link

Before using this function, check that the communication interface of the SL1400 is set to Network (see page 15-23).
Click the **Link** icon on the Web server window. You can view the Web page for the SL1400.

Web Server Window



Web Page Display

If the language of the SL1400 is set to English, the English Web page is displayed; if the message language is set to Japanese, the Japanese Web page is displayed; if the message language is set to Chinese, the Chinese Web page is displayed. For the setup procedure for the language, see section 16.1.

Note

To use the link function, the PC must be connected to the Internet.

15.8 Setting the Time Difference from GMT (Greenwich Mean Time)/SNTP

Procedure

1. Press **MENU**.
2. Press the **Next 1/2** soft key.
3. Press the **Network** soft key.
4. Press the **Others** soft key. The Others setup menu appears.

Setting the Time Difference from GMT

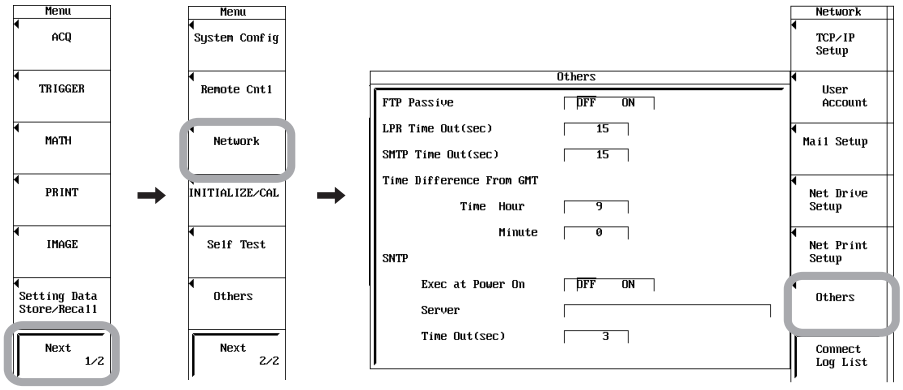
5. Use **jog shuttle**+**SELECT** to set the Time Hour of Time Difference From GMT in the range of –12 to 13.
6. Likewise, set the Minute of Time Difference From GMT in the range of 0 to 59.

Note

Minute can be specified only if Time Hour is set in the range of –11 to 12. (Minute cannot be specified if Time Hour is set to –12 or 13.)

Setting the SNTP (Simple Network Time Protocol)

7. Use **jog shuttle**+**SELECT** to set the Exec at Power On to ON or OFF.
8. Use **jog shuttle**+**SELECT** to select SNTP Server.
9. Enter the IP address of the SNTP server according to the procedure given in section 4.2.
10. Use **jog shuttle**+**SELECT** to select Time Out.
11. Enter the time out time in the range from 1-60 according to the procedure given in section 4.2.



Explanation

Set the time difference from GMT (Greenwich Mean Time). Make sure to set this value if you are using the Web server function.

Setting the Time Difference from GMT (Greenwich Mean Time)

Set the time difference in the range of –12 hour 00 minute to 13 hour 00 minute.
For example, Japan standard time is ahead of GMT by 9 hours. In this case, set Time Hour to 9 and Minute to 00.

Checking the Standard Time

Check the standard time for the region where the SL1400 is to be used using one of the following methods.

- Check the date and time settings on your PC.
- Check the site at the following
  URL:http://www.worldtimeserver.com/

Note

The SL1400 does not support daylight savings time. To set the daylight savings time, adjust the time difference from GMT.

Setting the SNTP

When turning ON the power to the instrument, the instrument's time is synchronized with that of the SNTP server connected to the network.

Note

- If a time difference from world standard time (Greenwich Mean Time) is specified, the time obtained from the SNTP server is adjusted accordingly, and that time is used.
- When setting the date and time on the instrument, you can synchronize the time with the SNTP server. For details, see section 3.6.
- When not synchronizing the time with the SNTP server, do not enter the SNTP server's IP address.

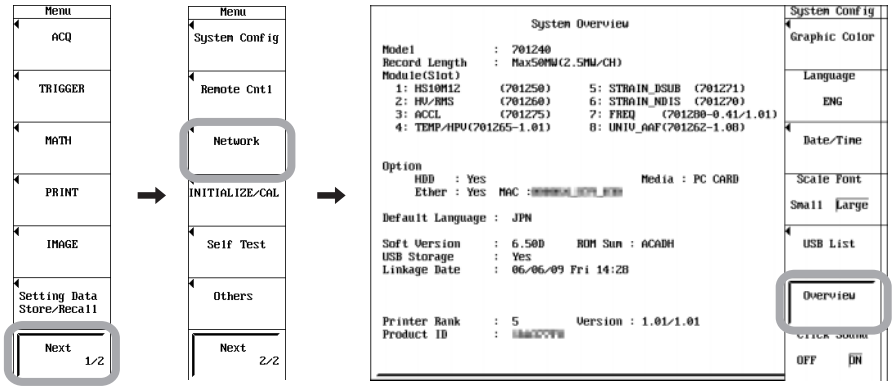
15.9 Checking the Presence of the Ethernet Interface and the MAC Address

Procedure

1. Press **MENU**.
2. Press **Next 1/2** soft key.
3. Press the **System Config** soft key.
4. Press the **Overview** soft key. The overview screen appears.
5. When Ether:Yes appears for the Option item in the overview screen, this indicates that the Ethernet interface is installed.
   The number indicated to the right is the MAC address.
   The MAC number is intentionally blurred in the example below.

Note

- Ether: Yes is displayed only if the Ethernet interface option is installed.
- If XXXXXX_XXX_XXX is displayed for the MAC address, contact your nearest YOKOGAWA dealer.



Explanation

You can check the presence of the Ethernet interface and the MAC address.
MAC address is a unique address that is pre-assigned to the SL1400.

The Presence of the Ethernet Interface

The presence of the Ethernet interface is displayed under “Ether” on the overview screen.

- Ether:Yes: The Ethernet interface is installed.
- Ether:No: The Ethernet interface is not installed.

MAC Address

MAC address is a unique address that is pre-assigned to the SL1400. It is necessary for transmitting data between nodes.

15.10 Setting the FTP Passive Mode and LPR/SMTP Timeout

Procedure

1. Press **MENU**.
2. Press **Next 1/2** soft key.
3. Press the **Network** soft key.
4. Press the **Others** soft key. The Others setup menu appears.

Selecting the FTP Passive Mode

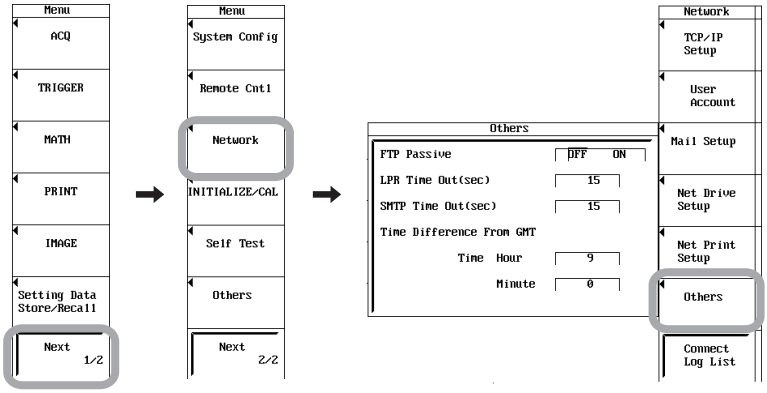
5. Use **jog shuttle**+**SELECT** to set FTP Passive to ON or OFF.

Setting the LPR Timeout Time

5. Use **jog shuttle**+**SELECT** to set LPR Time Out.

Setting the SMTP Timeout Time

5. Use **jog shuttle**+**SELECT** to set SMTP Time Out.



Explanation

Special settings related to the FTP client, LPR, and SMTP are entered. Normally, these parameters do not need to be specified.

Turning ON/OFF FTP Passive Mode

Turn this function ON when using the SL1400 behind a firewall that requires the passive mode. The default setting is OFF. (A firewall is furnished on a system that has security features. It prevents intrusion from the outside into the network system.)

Setting the LPR Time Out

The SL1400 closes the connection to the printer if there is no response from the printer for a certain period of time (timeout time) when it accesses the printer. You can set the timeout value in the range of 0 to 3600 s. The default setting is 15 s.

Setting the SMTP Time Out

When a mail server is accessed from the SL1400 and connection cannot be established after a certain period of time (timeout time), the SL1400 decides that the connection to the mail server is not possible and closes the connection. You can set the timeout value in the range of 0 to 3600 s. The default setting is 15 s.

15.11 Using the Instrument as a Windows Network Drive

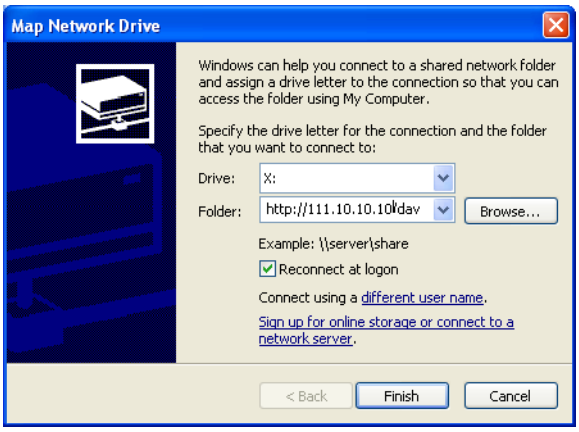
Procedure

Setting the SL1400

Follow the procedures in section 15.2 and section 15.6 to enter TCP/IP and user account settings, then connect to the network.

Setting the PC

1. Open Entire Network Places.
2. Choose Map Network Drive under Tools on the menu bar. The Map Network Drive dialog box appears.



3. Select the drive to assign in the drive selection area.
4. Enter the instrument's IP address in the folder input area using the format, http://instrument's IP address/dav/.
5. Click Finish. The enter user name and password input dialog box appears.
6. Enter the user name and password specified under user account (see section 15.6.
7. Click OK. The instrument is registered as a network drive.
8. To cancel the registration as a network drive, select Disconnect Network Drive under Tools on the menu bar. The disconnect network drive dialog box opens.
9. Select the network drive you want to disconnect, and click OK.

Explanation

The external storage medium and the internal hard disk (including the realtime drive) on the SL1400 can be used as a network drive on a PC running Windows XP.

Network Drive

When the SL1400 is registered as a network drive, the files on the SL1400 drive can be view using a software application running on a PC.

Note

- The SL1400 can be mapped as a network drive only on Windows XP.
- When manipulating files using the network drive function, do not perform other network functions such as the FTP client/server function or Web server function. If you do, the SL1400 or the PC may become unstable.
- Do not change the contents of the SL1400 drive (including the contents of the drives connected via the SCSI) from the PC. Reading the contents of the drive is allowed.
- Never perform the following operations.
  - Delete files on the SL1400 drive from the PC.
  - Add files on the SL1400 drive from the PC.
  - Change the directory structure of the SL1400 drive from the PC.
- If you attempt to move a large file from the PC to the SL1400, the file may be lost due to the limitations of Windows.
- You cannot manipulate the files simultaneously from multiple PCs.
- You cannot view a directory containing 1000 or more files.
- You cannot use the WebDAV function simultaneously with the Web server function.

Available Characters

This function uses the Windows WebDAV client function and the instrument's WebDAV server function . The characters that can be used with the WebDAV server function on this instrument are as follows.

0 to 9
A to Z, a to z
%, (,) , _

Therefore, please make note of the following.

- Files and folders whose names contain characters other than the ones indicated above cannot be saved on the SL1400's drive. Also, these files cannot be copied or moved.
- Files in the instrument' drive containing characters other than those listed above are not displayed in the file list using WebDAV.
  Also, these files and folders are not taken into account in the calculation of used disk space. Therefore, the actual amount of used disk space is different from the calculated amount of space.

File Information

If you copy files or folders from the instrument's drive to a Windows local disk, the creation date and time of the file or folder changes to that of the date and time copied. Likewise if you copy files or folders from a Windows local disk to the instrument's drive, the creation and modified dates and times of the file or folder changes to that of the date and time when copied.

16.1 Changing the Message/Menu Language and Turning the Click Sound ON/OFF

Procedure

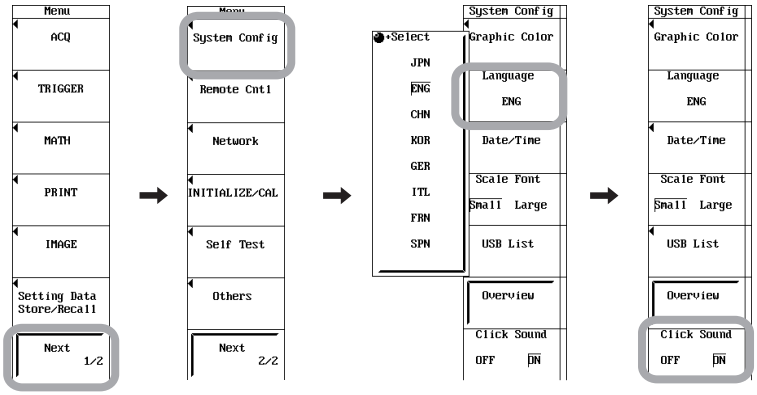
1. Press **MENU**.
2. Press the **Next 1/2** soft key.
3. Press the **System Config** soft key.

Setting the Message Language

4. Press the **Language** soft key and press the soft key corresponding to the language you want to display.

Setting the Click Sound

5. Press the **Click Sound** soft key to select ON or OFF.



Explanation

Message Language

A message appears when an error occurs or when prompting for confirmation on an operation. You can select the message language from ENG (English), JPN (Japan), CHN (Chinese), KOR (Korean), GER (German), ITL (Italian), FRN (French), and SPN (Spanish). The messages codes are common in all languages. For details on the message codes, see section 17.2.

Menu Language

- If the message language is set to ENG, JPN, CHN, or KOR, the menu is displayed in the respective language.
- If the message language is set to a language other than ENG, JPN, CHN, or KOR, the menu is displayed in English.

USB Keyboard Language

The language of the USB keyboard used to enter file names and comments (see section 4.2) varies depending on the message language setting as follows:

Message Language	Supported USB Keyboard Language
Language other than JPN (Japanese)	English
JPN (Japanese)	Japanese

Turning ON/OFF the Click Sound

You can enable or disable the click sound that is generated when you turn the jog shuttle. The default setting is ON.

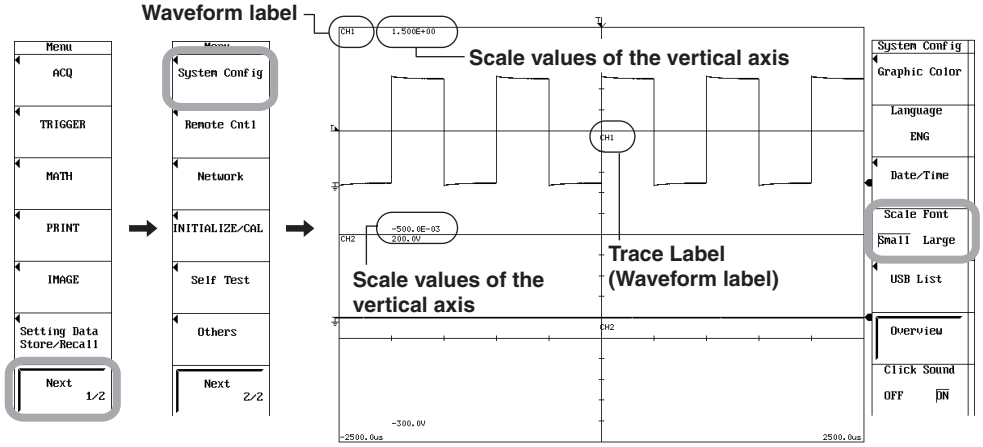
16.2 Switching the Screen Display Font Size

Procedure

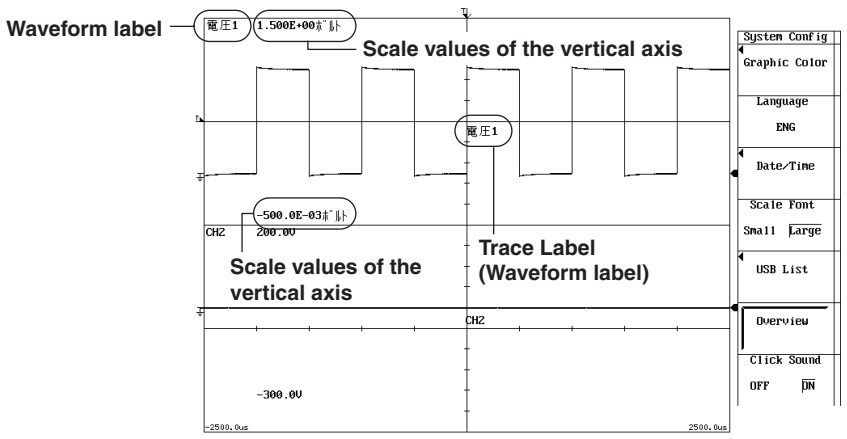
1. Press **MENU**.
2. Press **Next 1/2** soft key.
3. Press the **System Config** soft key.
4. Press the **Scale Font** soft key to select Small or Large.
   If Large is selected, the waveform labels displayed at the upper left of the waveform display area, the scale values of the vertical axis, and the trace labels (waveform labels) are shown using a large font.

The font size in the area enclosed by ⬭ changes.

When Scale Font is set to Small



When Scale Font is set to Large



Explanation

The screen display font size can be set to small or large. The default setting is Large. The font size changes for the waveform labels displayed at the upper left of the waveform display area, the scale values of the vertical axis, and the trace labels (waveform labels). If Large is selected and there are numerous waveforms displayed on the screen, the scale values of the vertical axis may overlap.

16.3 Setting the Screen Color and Brightness

Procedure

1. Press **MENU**.
2. Press **Next 1/2** soft key.
3. Press the **System Config** soft key.
4. Press the **Graphic Color** soft key. The Graphic setup menu appears.

Setting the Color

5. Use **jog shuttle**+**SELECT** to select the item you want to change the color. The color selection menu appears.
6. Use **jog shuttle**+**SELECT** to select the color.

Note

The items that you can change the color are listed below. The selectable colors are limited depending on the item.

- CH1 to CH16
- Math waveforms
- Logic A, Logic B
- Background
- Menu Base Color (menu screen)

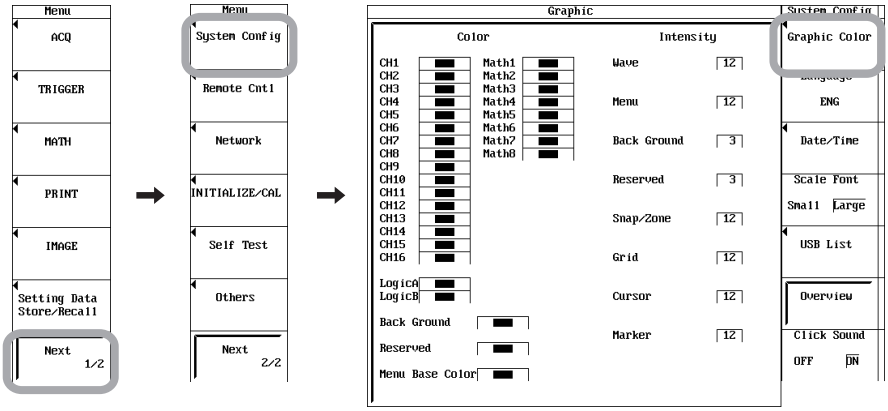
Setting the Brightness

7. Use **jog shuttle**+**SELECT** to select the item you want to change the brightness.
8. Turn the **jog shuttle** to set the brightness in the range of 1 to 15.

Note

The items that you can change the brightness are as follows:

- Wave (waveforms)
- Menu
- Back Ground
- Snap/Zone (snapshot waveforms/zones)
- Grid
- Cursor
- Marker



Explanation

Screen Color

You can set arbitrary colors for the following items.
The selectable colors vary depending on the item. See the color selection menu of each item.

CH1 to CH16:	Waveform color
Math1 to Math8:	Waveform color
Logic A, Logic B:	Waveform color
Back Ground:	Background color of the waveform display area
Menu Base Color:	Menu

Brightness: Intensity

You can set the brightness for the following items from 1 to 15 steps.

Wave (waveform)
Menu
Back Ground: Background
Snap/Zone (snapshot waveforms/zones)
Grid
Cursor
Marker

16.4 Turning OFF the Backlight and Setting the Brightness of the Backlight

Procedure

1. Press **MENU**.
2. Press the **Next 1/2** soft key.
3. Press the **Others** soft key.
4. Press the **Next 1/2** soft key.
5. Press the **LCD** soft key.

Setting Backlight Auto Off

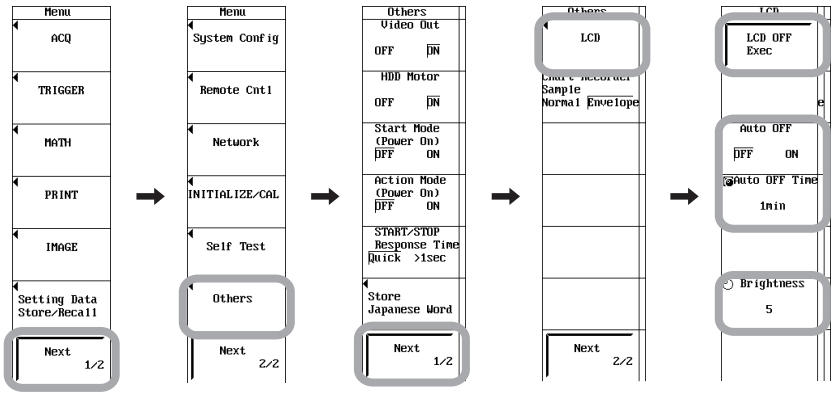
6. Press the **Auto OFF** soft key to select ON or OFF.
   If you set Auto OFF to ON, proceed to step 7.
7. Press the **Auto OFF Time** soft key.
8. Turn the **jog shuttle** to set the time when the backlight will automatically turn OFF.

Setting the Backlight Brightness

9. Press the **Brightness** soft key.
10. Turn the **jog shuttle** to set the backlight brightness.

Turning ON/OFF the Backlight

11. Press the **LCD OFF Exec** soft key. The backlight turns OFF.
    Press any key to return to the measurement screen.



Explanation

Turning ON/OFF the Backlight (LCD OFF Exec)

Turns ON/OFF the LCD backlight. If a key is pressed when the backlight is OFF, the screen returns to the measurement screen.

Setting the Backlight Auto OFF (Auto OFF, Auto OFF Time)

The backlight automatically turns OFF, if there is no key operation for the specified time.

Setting the Backlight Brightness

You can change the brightness of the backlight. Set the brightness in the range of 0 (darkest) to 7 (brightest).
The lifetime of the backlight can be prolonged by dimming the backlight or turning OFF the backlight when it is not necessary.

16.5 Locking the Keys

Procedure

Locking the Keys

Press **PROTECT**. The LED above the key illuminates, and the keys are locked.

Releasing the Lock

To release the lock, press **PROTECT** again.

Explanation

This function locks the operation keys so that the current SL1400 condition is not changed accidentally. When keys are locked, all keys other than the PROTECT key cannot be used.

Note

When keys are locked, operations using the USB mouse and USB keyboard are also disabled.

17.1 Troubleshooting

Troubleshooting

- If a message is displayed on the screen, read the next section.
- If servicing is necessary, or if the instrument is not operating correctly after performing the corrective actions, contact your nearest YOKOGAWA dealer.

Problem	Probable Cause	Corrective Action	Reference Section
The power cannot be turned ON.	Using a power supply outside the ratings.	Use a correct power supply.	3.4
Nothing is displayed.	The backlight is turned OFF.	Press any key.	16.4
	The screen colors are not appropriate.	Power cycle the SL1400 while holding down the **RESET** key.	16.3
The display is odd.	The system is abnormal.	Power-cycle the SL1400.	3.4
Keys do not work.	The SL1400 is in the remote mode.	Press **SHIFT + CLEAR TRACE** enable local mode.	–
	Other causes.	Perform a key test. If the test fails, servicing is required.	17.3
	Protected.	Press the **PROTECT** key.	16.5
Trigger does not activate.	The trigger settings are not appropriate.	Set the trigger conditions correctly.	Chapter 6
Measured values are not correct.	Insufficient warm-up.	Warm up the SL1400 for 30 minutes after turning on the power.	–
	Not calibrated.	Perform a calibration.	4.6
	The probe's phase has not been corrected.	Correct the phase properly.	3.8
	The probe attenuation is not correct.	Set an appropriate value.	5.6
	An offset voltage is added.	Set the offset voltage to 0 V.	5.10
	Other causes.	Perform a calibration. In addition, select Test Item: Carib.Inf. for the self test item and execute the self test. If the measured value is still odd, servicing is required.	4.6 17.3
Cannot output to built-in printer.	The printer head is damaged or worn out.	Servicing required.	–
Cannot save to the specified medium.	The medium is not formatted.	Format the medium.	13.6
	The medium is write-protected.	Release the medium's write-protect.	–
	No more free space on the medium.	Delete unneeded files or use a new medium.	13.16
Cannot change settings or control the operation of the SL1400 via the communication interface.	The address of the SL1400 used by the program is different from the specified address.	Match the address used in the program to the address of the SL1400.	Communication Interface User's Manual on the CD-ROM
	The interface is not used in a way that conforms to the electrical or mechanical specifications.	Use it in a way that conforms to the specifications.	

17.2 Messages and Corrective Actions

Error Messages

A message may appear on the screen during operation. This section describes the meanings of the messages and their corrective actions. The messages can be displayed either in English or Japanese (see section 16.1). If the corrective action requires servicing, contact your nearest YOKOGAWA dealer for repairs.
In addition to the error messages below, there are communication error messages. These messages are described in the *Communication Interface User's Manual* on the CD-ROM.

Status Messages

Code	Message and Corrective Action	Section
51	File access is aborted.	Chapter 13
55	Image printing was aborted.	Chapter 12
57	Write to the EEPROM complete. Wrote module-specific information to the module.	–
58	Calibrating the temperature module.	–
59	Temperature module calibration complete.	–
60	The instrument is set to remote mode by the communication control. Press the CLEAR TRACE key to change to local mode.	–
62	Terminating...	–
63	Turned on pressing the RESET key. Will initialize.	4.4
64	A strain module is installed. Carry out automatic balancing before use.	–
65	The setting of the excitation voltage or the gauge factor was changed. Carry out automatic balancing before use.	–
66	Automatic balancing is running...	–
67	Automatic balancing is complete.	–
68	Test: SUCCESS	–
69	Calibration is running...	4.6
70	Calibration is complete.	4.6
71	Completed action-on-trigger.	6.18
73	Release the Preview mode.	12.1
82	Aborted the statistical measurement.	–
84	Averaging is in progress.	11.1
85	Averaging has been completed.	11.1
86	Input module configuration was changed. Relevant settings have been initialized.	–
87	Parameter block has been set. Restart to update the instrument configuration information.	–
88	There is no dry cell. Insert batteries or turn the backup switch OFF.	7.7
89	All operation was aborted due to a power disruption. The data before the disruption is stored. No data was acquired during the disruption.	7.7
90	When history is set to "All," data of math channels is not saved. To store the data of math channels, set history to "One." * Data of channels other than math is saved.	11.1
92	This model does not have the HDD option installed.	–
93	Realtime recording is being prepared.	7.5
94	Media information is being read.	13.6
95	Failed to retrieve the data. Execute again.	Chapter 11
279	This command cannot be used in the current mode.	Chapter 9

Errors in Execution (700 to 799)

Code	Message and Corrective Action	Section
701	Fine copy is not possible when waveform acquisition is in progress. Press the START/STOP key to stop the waveform acquisition first.	7.1, 12.1
703	Undo is not possible since data that existed immediately before initialization and auto setup is not available.	4.4, 4.5
704	Can not be executed while running. Press START/STOP key to stop acquisition.	7.1
707	Can not Start while data out. Wait until output is completed.	7.1
708	Can not data out while running. Press START/STOP key to stop acquisition.	7.1
710	File not found. Check the file.	Chapter 13
711	Cannot manipulate files while image printing is in progress. Wait until image printing is complete.	Chapter 13
712	Can not compress this hardcopy image. Turn off compression switch.	13.12
713	Calibration failure. Disconnect the input and execute again. If it fails again, servicing is necessary.	4.6
714	Temperature module calibration failed. Calibration value is invalid. Check the input signal.	4.6
716	Realtime recording to the internal hard disk is valid when the sampling rate is slower than the values shown below. 1~2 CH : 100kS/s, 3CH : 50kS/s, 4~5CH : 20kS/s, 6~11CH : 10kS/s, 12~18CH : 5kS/s	7.5
717	Too many channels to realtime record at the current record time. Decrease the number of channels by turning them OFF.	7.5
718	Too many channels to realtime record at the current record length. Turn OFF channels to reduce the number of channels or shorten the record length.	–
721	Can not operate while data out. Wait until output is completed.	7.5
723	Cannot load the realtime record.	7.5,13.15
724	Balancing failed. Failed CH: * * indicates the channel number of the channel for which automatic balancing failed.	–
725	Cannot be executed. Acquisition not active.	7.1
727	Insufficient output data. Increase Mag or widen the Time Range interval.	12.1
728	Image is being printed. Abort or wait until printing is complete.	–
732	Cannot be executed while computation is in progress.	Chapter 10
733	Failed to measure statistics. Waveform data may be missing. If Cycle Statistics is specified, the instrument may be configured in a way that fails to detect the cycle.	11.6
735	Executing file Load, Save, or Format. Abort or wait until it is complete.	–
736	Image is being printed or saved. Abort the operation or wait until the execution of the command is complete.	–
737	A setup of an action trigger can't be carried out under the state of on.	6.18
739	Cannot be executed when realtime record or print setting is ON.	7.5
740	A time base can't be carried out under the state of the outside clock.	5.20
742	Because there are too many channels, it can't start in the length of the present record.	5.2, Appendix 1
743	The indication mode of the history can't be carried out except for "Average".	11.1
744	Average practice can't be done because the record length of the history exceeds the record length that it can be carried out.	11.1
745	Set the trigger mode to Auto or Log for realtime hard disk recording. If the number of actions is set to Continuous, the only valid trigger mode is Log.	6.1, 7.5
748	Cannot start at the current record length. Shorten the record length or meet the following condition. • Set the trigger mode to Auto and increase the record time to longer than 1 s to enable roll mode. • Set the trigger mode to Single or Log.	5.2, 6.1
749	Averaging mode is not possible when the trigger mode is Single, SingleN, or Log. Change the trigger mode.	6.1

Code	Message and Corrective Action	Section
753	Cannot start when the HISTORY menu is being displayed. Press the ESC key to clear the menu before starting.	11.2
755	Time base cannot be set to external clock when set to envelope or box average.	5.20, 7.2
756	Cannot set accumulate during roll mode display. Turn Off accumulate.	5.2, 8.4
757	Cannot be executed when the acquisition mode is set to average. Change the mode.	7.2
758	Cannot copy if 50 pages is exceeded. Change the multiplier or range.	12.1
759	Realtime recording to the internal hard disk is valid when the record length is longer than 501 k.	5.2, 7.5
760	Cannot set the current drive on a realtime partition using communication commands.	7.5
761	Cannot be executed on realtime recorded waveforms.	7.5
764	File recorded in realtime is currently being analyzed. Files being analyzed cannot be deleted.	7.5, 13.16
765	File recorded in realtime is currently being analyzed. The name of files being analyzed cannot be changed.	7.5, 13.18
766	File recorded in realtime is currently being analyzed. Partitions containing files that are being analyzed cannot be formatted.	7.5, 13.6
767	128 and more file can't be formed in the real-time area.	7.5
768	The file which failed in the real-time record can't be read.	–
769	Cannot start Single(N) when accumulate is On. Change the accumulate to Off.	6.1, 8.4
773	The measuring range is up to 10 MWords from measure start (TimeRange1).	11.5
774	Synchronizing signal not detected.	6.17
775	Set acquisition mode to Normal when using a wave window trigger.	6.17
776	The wave window trigger cannot be used if the sampling rate is faster than 500 kS/s or slower than 10 kS/s. If the record length is shorter than 25 k, set the record time longer than 100 ms.	6.17
777	Range over. Change to an appropriate range then retry shunt calibration.	5.15
778	Statistical processing cannot be performed on waveforms recorded in real time.	11.6
779	Cannot detect a effective input signal at a Sync. channel.	6.17
780	Firmware was not overwritten in the following slots, since the version of the firmware in the module and that of the replacement firmware were the same. Check the versions on the overview screen. SLOT: XX	–
781	Cannot start while the following setup menus are displayed. Press the ESC key to clear the menu, and then start. (ALL CH, ZOOM, MEASURE, CURSOR, and PrintSetup)	–
782	Firmware was not overwritten, since the version of the firmware in the printer and that of the replacement firmware were the same.	17.4
783	Checksum error in the printer control program. Recycle the power. If the error occurs again, maintenance service is required.	3.4
784	Failed to transmit the printer control program. Recycle the power. If the error occurs again, maintenance service is required.	3.4
785	Failed to write the printer control program. Recycle the power. If the error occurs again, maintenance service is required.	3.4
787	Cannot be carried out during recording. Press the START/STOP key to stop the waveform acquisition first.	7.1
788	Cannot start while the alert dialog box is open. Press the ESC key to clear the dialog box, and then start.	–
789	Cannot copy if 100 pages is exceeded. Change the multiplier or range.	9.7, 12.1
790	Fine Print or Zoom Print is not possible when X-Y display is present.	8.6, 12.1
791	Up to 30 items can be registered.	4.2
792	Not entered in "Yomi" or "Goku."	4.2
793	Cannot specify characters other than "Hiragana" for "Yomi."	4.2
794	Kanji registration error. Below are the possible causes. • More than 17 items are registered with the same "Yomi." • Exceeded the dictionary registration capacity.	4.2

Errors in Setting (800 to 899)

Code	Message and Corrective Action	Section
800	Illegal date-time. Set the correct date and time.	3.6
801	Illegal file name. The file name contains characters which are not allowed or the file name is not a valid MS-DOS file name. Enter another file name.	Chapter 13
803	Turn off accumulate mode to enter history menu. It is not possible to activate the history menu by pressing the HISTORY key during accumulation.	8.4
804	Cannot change this parameter while running. Press the START/STOP key to stop acquisition.	7.1
808	Can not be specified at the current record time setting.	5.2, Appendix 1
809	Cannot change edge for status other than X. Set the state of the channel corresponding to condition A to 'X'.	Chapter 6
811	Cannot change display points in roll mode.	5.2
813	Set Items in measure menu. Set appropriate measurement items.	11.5
814	Duplicated Name. Change the label string.	8.10
816	Cannot turn off with the current record length. Please Change record length.	5.2
817	Cannot change. Please change X Trace in the X-Y menu.	8.6
819	Cannot change when Channel Display is OFF or Math settings are invalid. Set the channel display ON or make appropriate Math settings.	5.1, Chapter 10
821	Cannot change when External Clock is active.	5.20
823	Cannot change while running. Set the acquisition mode to Normal.	7.1, 7.2
824	Cannot change with the current acq mode.	7.2
829	Cannot change when Logic Mode is OFF or all bits of Logic Display are OFF.	5.18
834	Duplicate SCSI ID. Set different ID numbers.	13.7
835	Cannot change settings while realtime printing or realtime recording. Stop printing or recording.	7.5
836	Cannot change settings during Action On Trigger. Stop the Action On Trigger.	6.18
837	Cannot set the channels which do not have modules installed.	–
838	Cannot set the channels which do not have the strain module installed.	–
839	Cannot Set or Execute.	–
840	If the trigger mode is set to Single, Single (N), or LOG, the acquisition mode cannot be set to Average.	6.1, 7.2
843	If the acquisition mode is Average, the trigger mode cannot be set to Single, Single (N), or Log.	6.1, 7.2
844	It can't be set at the time of the roll mode.	5.2
845	The trigger mode cannot be set to Single(N) during the roll mode.	5.2, 6.1
850	The acquisition mode cannot be set in the current record length.	5.2, Appendix 1
851	Computation cannot be carried out at the current record length.	5.2, 10.3
855	Cannot be configured or executed during the history search operation.	11.2, 11.3
856	The record cannot be selected.	11.1 to 11.3
857	History record does not exist.	11.1 to 11.3
858	Cannot be configured or executed while computation is in progress. Aborted when history display mode is set to One.	11.1 to 11.3
859	It can't be set up or be carried out in the Preview mode. Choose Quit, and cancel the Preview mode.	12.1
860	Cannot be configured or executed while updating the history all display. Aborted when history display mode is set to One.	11.1 to 11.3
861	This format cannot output with color.	12.2, 12.3
868	Processing statistics. To perform other operations, abort the statistical processing.	11.6
869	The channel which couldn't be set up was specified.	Chapter 11, 13.8
870	Cannot be set when the acquisition mode is set to average.	7.2
872	Cannot be set during realtime recording.	7.5

Code	Message and Corrective Action	Section
873	It is an unacceptable parameter to set up to the present module.	Chapter 5
875	Cannot be set to a range of 200 sec to 30 day during roll display.	–
876	Because a record length is too long, it can't be set up by the present number of indication channels.	5.2, Appendix 1
877	Cannot be set because there are too many display channels at the current record length. Shorten the record length.	5.2
878	Zooming is not available when the number of displayed points of the FFT waveform is less than 50 in the Zoom window.	10.3
880	Cannot change this setting during realtime recording.	7.5
881	The time base cannot be set to external clock when the acquisition mode is set to envelope or box average.	7.2, 5.20
882	Spaces are not allowed for trace labels.	8.10
883	Cannot set accumulate during roll mode display.	5.2, 8.4
884	Cannot change the History parameter when accumulate is ON. Turn OFF accumulate first.	8.4
885	P-P compression cannot be used to save when a record length is 1 K.	13.8
887	A sampling speed was too fast, and it could be folded, and a real-time queue was needed. Slow down a sampling speed.	7.5
888	A sampling speed was too fast, and it could be folded, and a real-time buffer was needed. Slow down a sampling speed.	7.5
889	Cannot set On this module.	6.17
890	Settings can not be entered for channels on which no strain module is mounted.	–
891	Cannot be changed when Variable is turned ON.	–
895	Cannot be set when the trace is set to a frequency module.	–

System Operation Errors (900 to 999)

Code	Message and Corrective Action	Section
901	Failed to backup setup data. Will initialize. Backup battery may be low.	7.7
902	System RAM failure. Maintenance service is required.	–
903	System ROM failure. Maintenance service is required.	–
906	Fan stopped. Power off immediately. Maintenance service is required.	–
907	Backup battery is flat. Maintenance service is required to replace the back-up battery.	3.4
908	Internal temperature is too high. Power off immediately. Maintenance service is required.	3.4
909	Illegal SUM value. Maintenance service is required.	–
910	RAM read/write error. Maintenance service is required.	–
911	Memory bus error. Maintenance service is required.	–
912	Communication driver error.	–
914	Time out occurs in Communication.	–
915	EEPROM read error. EEPROM may be damaged. Maintenance service is required.	–
916	EEPROM write error. EEPROM may be damaged. Maintenance service is required.	–
917	No module installed. Install the module.	3.3
918	Turn ON the internal hard disk motor.	13.3
919	The current module installation condition and the setup data are inconsistent. Will initialize.	–
922	Cannot back up the acquisition memory. Memory will be initialized. The battery for acquisition memory backup may be flat.	7.7
928	Battery for waveform memory is flat. Waveform memory was initialized.	7.7
929	MS bus error occurred.	–
930	Slot 1 EEPROM error.	–
931	Slot 2 EEPROM error.	–

Code	Message and Corrective Action	Section
932	Slot 3 EEPROM error.	–
933	Slot 4 EEPROM error.	–
934	Slot 5 EEPROM error.	–
935	Slot 6 EEPROM error.	–
936	Slot 7 EEPROM error.	–
937	Slot 8 EEPROM error.	–
938	Key protect is enabled. To release the protection, press the PROTECT key.	16.5
940	The USB device's power consumption exceeded the capacity of the USB hub.	18.8

File Operation Errors (1000 to 1199)

Code	Message and Corrective Action	Section
1001	Invalid file name. * Duplicate file name or incorrect SCSI ID.	Chapter 13
1002	Cannot detect the medium. * Check the presence of the medium or the SCSI device connection.	Chapter 13
1003	Cannot detect the medium. * Check the presence of the medium or the SCSI device connection.	Chapter 13
1004	Media failure. Check the storage medium.	Chapter 13
1005	File not found. Check the file name and the storage medium.	Chapter 13
1006	Invalid file name. * Duplicate file name or incorrect SCSI ID.	Chapter 13
1007	Media failure. Check the storage medium.	Chapter 13
1008	Invalid file name. * Duplicate file name or incorrect SCSI ID.	Chapter 13
1009	Invalid file name. * Duplicate file name or incorrect SCSI ID.	Chapter 13
1010	Invalid file name. * Duplicate file name or incorrect SCSI ID.	Chapter 13
1011	The maximum number of files that can be stored in a single directory was exceeded. Save the file to another directory or medium.	Chapter 13
1012	Media full. Delete unnecessary file(s) or use another disk.	Chapter 13
1013	Cannot delete a directory if there are files in the directory.	13.16
1014	File is protected.	13.16
1015	Physical format error. Reformat the medium. If the same error occurs, the instrument is probably unable to execute a format on this medium.	13.6
1016	File system failure.	Chapter 13
1017	File system failure. Check using another disk. If the same message still appears, maintenance service is required.	Chapter 13
1018	File system failure. Check using another disk. If the same message still appears, maintenance service is required.	Chapter 13
1019	File system failure. Check using another disk. If the same message still appears, maintenance service is required.	Chapter 13
1020	File system failure. Check using another disk. If the same message still appears, maintenance service is required.	Chapter 13
1021	File is damaged. Check the file.	Chapter 13
1022	File system failure. Check using another disk. If the same message still appears, maintenance service is required.	Chapter 13
1023	File system failure. Check using another disk. If the same message still appears, maintenance service is required.	Chapter 13

Code	Message and Corrective Action	Section
1024	File system failure. Check using another disk. If the same message still appears, maintenance service is required.	Chapter 13
1025	File system failure. Check using another disk. If the same message still appears, maintenance service is required.	Chapter 13
1026	File system failure. Check using another disk. If the same message still appears, maintenance service is required.	Chapter 13
1027	File system failure. Check using another disk. If the same message still appears, maintenance service is required.	Chapter 13
1028	File system failure. Check using another disk. If the same message still appears, maintenance service is required.	Chapter 13
1029	File system failure. Check using another disk. If the same message still appears, maintenance service is required.	Chapter 13
1030	File system failure. Check using another disk. If the same message still appears, maintenance service is required.	Chapter 13
1031	File system failure. Check using another disk. If the same message still appears, maintenance service is required.	Chapter 13
1032	File system failure. Check using another disk. If the same message still appears, maintenance service is required.	Chapter 13
1033	File system failure. Check using another disk. If the same message still appears, maintenance service is required.	Chapter 13
1034	File system failure. Check using another disk. If the same message still appears, maintenance service is required.	Chapter 13
1035	File system failure. Check using another disk. If the same message still appears, maintenance service is required.	Chapter 13
1036	File system failure. Check using another disk. If the same message still appears, maintenance service is required.	Chapter 13
1037	File system failure. Check using another disk. If the same message still appears, maintenance service is required.	Chapter 13
1038	File system failure. Check using another disk. If the same message still appears, maintenance service is required.	Chapter 13
1039	File system failure. Check using another disk. If the same message still appears, maintenance service is required.	Chapter 13
1040	File system failure. Check using another disk. If the same message still appears, maintenance service is required.	Chapter 13
1041	File system failure. Check using another disk. If the same message still appears, maintenance service is required.	Chapter 13
1042	No media exists in SCSI device. Check that the storage medium is correctly inserted in the SCSI device.	13.5
1046	Media failure. Check the medium.	Chapter 13
1047	Media failure. Check the medium.	Chapter 13
1048	Media failure. Check the medium.	Chapter 13
1049	Media failure. Check the medium.	Chapter 13
1050	Media failure. Check the medium.	Chapter 13
1051	Media failure. Check the medium.	Chapter 13
1052	Media failure. Check the medium.	Chapter 13
1053	Media failure. Check the medium.	Chapter 13
1055	Turn the HDD motor ON.	13.3
1100	Invalid record number.	Chapter 13
1101	File system failure.	Chapter 13
1102	File system failure.	Chapter 13
1103	File system failure.	Chapter 13
1104	File system failure.	Chapter 13
1105	File system failure.	Chapter 13

Code	Message and Corrective Action	Section
1106	File system failure.	Chapter 13
1107	File system failure.	Chapter 13
1108	File system failure.	Chapter 13
1109	Invalid media format.	Chapter 13
1110	Cannot load this file format. Files stored on other models (DL/AG series) cannot be loaded.	Chapter 13
1111	File is now being accessed. Execute after access is made.	Chapter 13
1112	Cannot be executed while running. Press the START/STOP key to stop acquisition.	7.1
1113	Cannot find '.HDR' file. Check the file.	13.8
1114	The specified file cannot be loaded on this ROM version or this model.	Chapter 13
1115	No ch is displayed. Turn ON the display of the appropriate channel.	5.1
1116	Save data not found. Check for presence of data.	Chapter 13
1118	SCSI controller failure. Maintenance service is required.	–
1119	HDD overrun error. Due to spare sectors, the recording could not be finished within assigned time. The operation is aborted.	–
1120	HDD error. An error occurred in the HDD. The operation is aborted.	–
1121	Unknown file format. Check the file.	Chapter 13
1124	Data that have been P-P compressed and saved cannot be loaded.	13.8
1126	Cannot save in this format at the current record length. Specify a range and save a section of the data. * Cannot create a file of size 2 GB or larger.	13.8
1127	Cannot load because the medium is selected. Select a setup file (SET).	13.9
1128	Cannot load because a directory is selected. Select a setup file (SET).	13.9
1129	Cannot load because the medium is selected. Select a binary file (.WVF).	13.8
1130	Cannot load because a directory is selected. Select a binary file (.WVF).	13.8
1131	Cannot load files larger than 50 MB on a network drive. Copy the file to the local drive before loading it.	2.8, 13.17, 15.3
1132	Cannot load a HistoryAll binary file on a network drive.	13.8
1133	Turn the HDD motor ON.	13.3
1134	If the realtime recorded file is converted to binary format, the converted file cannot be loaded.	13.15
1135	Cannot save the waveform by specifying Z1 (Z2) for the range to be saved, if the zoom rate is set to x1. Save the waveform by specifying Main for the range to be saved.	13.8
1137	Cannot make a directory or a file in the real-time area of the internal hard disk. Change the current directory.	7.5, 13.15, 13.17
1138	Cannot save at the current PDF setting. Change the settings. * A file of size exceeding 2 GB cannot be created.	9.8, 13.14
1139	Cannot create PDF files on the network drive when the history waveform display format is set to All. Create the file on the local drive, and then copy it to the network drive.	–
1140	Cannot save files with Japanese file names to the network drive.	4.2
1141	Cannot copy files with Japanese file names to the network drive.	4.2
1142	Cannot create a PDF file with a Japanese file name if the Japanese font is OFF.	9.8, 13.14
1143	The setup data is not saved.	13.1

Printer Errors (1200 to 1299)

Code	Message and Corrective Action	Section
1200	Move the release arm to the “HOLD” position.	3.5
1201	Paper empty. Load a roll chart.	3.5
1202	The printer head temperature is high. Printing will be aborted. Printing will not be possible until the printer head temperature comes down.	–
1203	Printer over heat. Power off immediately. Maintenance service is required.	–
1204	Printer power supply error. Maintenance service is required.	–
1205	Printer time out. Maintenance service is required.	–
1206	USB printer error. Turn the power of the printer from OFF to ON.	12.2
1207	USB printer off-line.	12.2
1208	No paper.	12.2
1209	USB printer is in use.	12.2
1210	Cannot detect printer. Turn ON the printer. Check connectors.	12.2
1211	Printer is out of order. Maintenance service is required.	12.3
1212	Printer error. Turn the power of the printer from OFF to ON.	12.3
1213	Printer offline.	12.3
1214	Out of paper.	12.3
1215	Printer is in use.	12.3
1216	Cannot detect printer. Turn ON the printer. Check connectors.	12.3
1217	No applicable files for showing thumbnails.	13.13
1218	Print head temperature detection thermister is broken.	–
1219	Print head temperature detection thermister is shorted.	–

Network Errors (1300 to 1399)

Code	Message and Corrective Action	Section
1300	Cannot connect with ftp server. Confirm the network settings and connection.	Chapter 15
1301	Has not connect with ftp server yet. Confirm the network settings and connection.	Chapter 15
1302	This ftp function in not supported.	Chapter 15
1303	FTP Error: Pwd Confirm the network settings and connection.	Chapter 15
1304	FTP Error: Cwd Confirm the network settings and connection.	Chapter 15
1305	FTP Error: Rm Confirm the network settings and connection.	Chapter 15
1306	FTP Error: List Confirm the network settings and connection.	Chapter 15
1307	FTP Error: Mkdir Confirm the network settings and connection.	Chapter 15
1308	FTP Error: Rmdir Confirm the network settings and connection.	Chapter 15
1309	FTP Error: Get Confirm the network settings and connection.	Chapter 15
1310	FTP Error: Put Confirm the network settings and connection.	Chapter 15
1311	FTP Error: GetData Confirm the network settings and connection.	Chapter 15
1312	FTP Error: PutData Confirm the network settings, connection, and disk capacity.	Chapter 15

Code	Message and Corrective Action	Section
1313	FTP Error: AppendData Confirm the network settings, connection, and disk capacity.	Chapter 15
1314	FTP Error: Client Handle Confirm the network settings and connection.	Chapter 15
1315	FTP Error: Others Confirm the network settings and connection.	Chapter 15
1335	Cannot send data to a network printer. Confirm the network settings and connection.	12.3, 15.4
1336	Cannot send a mail. Confirm the network settings and connection.	15.5
1345	Test Error.	Chapter 15
1346	Test Success.	Chapter 15
1348	Failed to initialize network. Confirm the network settings.	Chapter 15
1349	The password entered the first time is different from the password entered the second time. Reenter the password for the second time.	15.6
1350	Failed to acquire time from SNTP server. Confirm the network settings and connection.	15.8
1501	To apply the changes, power-cycle the SL1400.	Chapter 15
1502	Executed the firmware overwriting of the frequency module.	17.4
1503	Overwriting firmware of the frequency module...	17.4
1505	Executed the firmware overwriting of the built-in printer.	17.4
1506	Overwriting the printer firmware...	–
1600	This function can be used only when the recorder mode is Off.	Chapter 9
1601	Can be specified only when the recorder mode is Off.	Chapter 9
1602	Can be configured only when the recorder mode is Off. Print from the Reprint menu.	Chapter 9
1603	This function cannot be used when the recorder mode is set to X-Y.	9.6
1604	Cannot be configured or executed when the recorder mode is Off.	Chapter 9
1605	Repeat trigger cannot be specified. Repeat trigger is valid only during chart recorder mode when the print style is waveform and shot recording is not OFF.	Chapter 9
1606	Cannot be changed during X-Y recording.	–
1607	Cannot use wave window trigger when the recorder mode is set to chart or X-Y.	6.17
1608	Can not be specified when the print style is Numeric.	9.5
1611	Cannot be specified because characters in the JIS level-2 kanji set are included. Create the file on the local drive, and then copy it to the network drive.	4.2
1612	Can not be specified in the current mode.	–

Other Errors (9999)

Code	Message and Corrective Action	Section
9999	This error No. is not defined.	–

Note

If servicing is required, initialize the instrument once for confirmation.

17.3 Self Test

Procedure

Displaying the Self Test Menu

1. Press **MENU**.
2. Press the **Next 1/2** soft key.
3. Press the **Self Test** soft key.
4. Press the **Test Item** soft key. The test item selection menu appears. Use **jog shuttle+SELECT** to select the item to be tested.
   - Memory test: Proceed to step 5
   - Key test: Proceed to step 7
   - Printer test: Proceed to step 12
   - PC card interface, internal hard disk, and SCSI tests: Proceed to step 14.

Executing the Memory Test

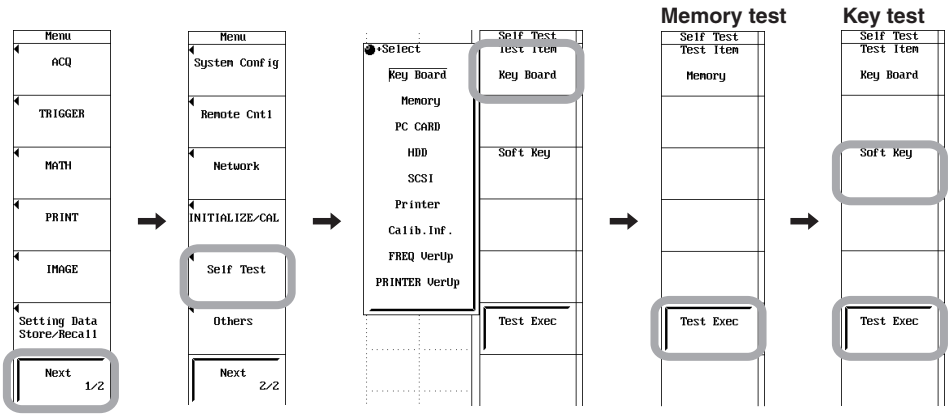
5. In step 4, select Memory.
6. Press the **Test Exec** soft key to execute the memory test.

Executing the Key Test

7. In step 4, select Key Board.
8. Press the **Test Exec** soft key to execute the key test.
9. Press all the keys or press **ESC** twice to end the key test.

- **Testing the Soft Keys**

10. Press the **Soft Key** soft key. A software keyboard appears.
11. Use **jog shuttle+SELECT** to check that all the characters on the keyboard can be entered correctly.



Note

"FREQ VerUp" and "PRINTRE VerUp" that are displayed with the Test Item soft key are used when updating the frequency module firmware and the built-in printer firmware. For details on updating the firmware, see the following Web page.
http://www.yokogawa.com/tm/SL1400/

Executing the Printer Test

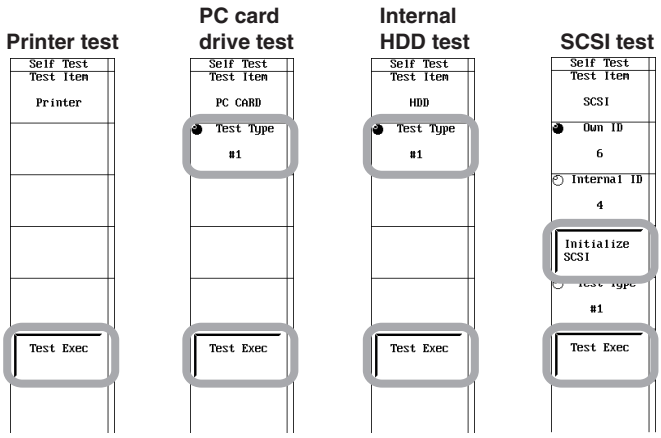
12. In step 4, select Printer.
13. Press the **Test Exec** soft key to execute the printer test.

Executing the PC Card Interface, Internal Hard Disk, and SCSI Tests

14. In step 4, select PC CARD, HDD, or SCSI.
15. Press the **Test Type** soft key.
16. Turn the **jog shuttle** to set the test type to #1.
17. Press the **Test Exec** soft key to execute the test selected in step 14.

Note

- To execute the PC card interface tests, install the PC card beforehand.
- Note the following points when performing a SCSI test.
  - Connect the SCSI device.
  - Only test unpartitioned SCSI devices.
  - Set the SCSI ID to 1.
- Test Item > Calib.Inf. is a menu for servicing (maintenance).



Explanation

Memory Test

Tests whether the RAM/ROM of the internal CPU board is operating correctly. If “Pass” is displayed, it is operating correctly.
If there is an error, “Failed” is displayed.

Key Test (Key Board)

Tests whether the front panel keys are operating properly. If the name of the key being pressed appears highlighted, the key is operating correctly. If there is an error, the name of the key will not appear highlighted. Press the ESC key twice to quit the key test.

PC Card Interface Test

Tests whether or not the PC card interface is operating properly. If there is an error, “Failed” is displayed after the test execution.

Internal Hard Disk Drive (Option) or SCSI Test (HDD, SCSI)

Tests whether the internal hard disk drive or SCSI is operating correctly. If there is an error, “Failed” is displayed after the test execution.

Printer Test

Tests whether the built-in printer is operating properly. If the tint is printed correctly, the operation is normal. If there is an error, the printing will not be correct.

If an Error Occurs during the Self Test

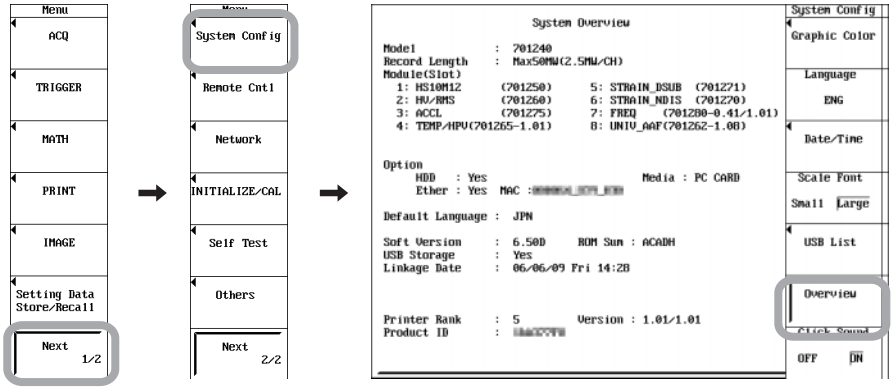
If an error still occurs after carrying out the following procedure, contact you nearest YOKOGAWA dealer.

- Perform the self test several more times.
- Check whether the medium to be tested is inserted.
- Check whether the internal hard disk (option) motor is turned ON (section 13.3).
- Check whether the paper is properly set in the built-in printer. Check for paper jams (section 3.5).
- Check whether the external SCSI device is connected properly (section 13.5).

17.4 Checking the System Conditions (Overview)

Procedure

1. Press **MENU**.
2. Press the **System Config** soft key.
3. Press the **Overview** soft key. The overview screen appears.
   Press any key to clear the overview screen.



Explanation

The following information can be confirmed on the Overview screen.

- Model: Model
- Record Length: Record length
- Module(Slot): Name of the Module in the slot
- Option: Presence of options (Yes/No)
- Default Language: Default language
- Soft Version: Software version number
- USB Storage: USB storage support (Yes: Supported, No: Not supported)
- Linkage Date: Software version date
- Printer Rank/Version: Printer firmware version
- Product ID: Unique number assigned to each instrument
  (Required when expanding the instrument with options sold separately.)

* The 701265 (TEMP/HPV) and the 701280 (FREQ) are equipped with a CPU and firmware inside the modules. On the channels in which these modules are inserted, the version of the firmware installed in the module is also displayed on the screen.

- **701265 (TEMP/HPV)**
  TEMP/HPV (model: 701265-X.XX)
  X.XX: Version of the firmware installed in the module.
  It is 1.01 in the screen above.

- **701280 (FREQ)**
  FREQ (701280-X.XX/Y.YY)
  X.XX: Version of the firmware installed in the module.
  It is 0.41 in the screen above.
  Y.YY: Version of the firmware in the SL1400 that can be installed into the 701280 (FREQ). It is 1.01 in the screen above.

When X.XX and Y.YY match, you do not have to upgrade the 701280 (FREQ). If they do not match, check the upgrading procedure on the following Web page.

http://www.yokogawa.com/tm/SL1400/

17.5 Recommended Replacement Parts

The three-year warranty applies only to the main unit of the instrument (starting from the day of delivery) and does not cover any other items or expendable items (items which wear out).
Contact your nearest YOKOGAWA dealer to have parts replaced.

Parts Name	Replacement Period
Built-in printer	Under normal usage, 1500 rolls of paper (part No.: 701966)
LCD backlight	Approx. 55000 hours under normal use

Parts Name	Warranty Period
Internal hard disk	One year after purchase (data is excluded).)

The following items are expendable items. It is recommended that the parts be replaced according to the period indicated below. Contact your nearest YOKOGAWA dealer to have parts replaced.

Parts Name	Recommended Replacement Period
Cooling fan	3 years
Backup battery (lithium battery)	5 years

18.1 Input Section

Item	Specifications
Number of input channels	16 channels + 16-bit log (8 bits × 2)
Type	Plug-in input unit (two 26-pin connectors (Logic A/Logic B) for the logic input)
Number of slots	8 (2 channels per slot)
Maximum record length	2.5 MW/CH (16 analog channels + 16-bit logic),50 MW/channel max.

18.2 Trigger Section

Item	Specifications
Trigger mode	Auto, auto-level, normal, single, single(N), log, repeat (only in Chart Recorder mode)
Trigger level range	±10 divisions around 0
Trigger hysteresis	When measuring voltage: Select ±0.1 div, ±0.5 div, or ±1 div of the trigger level When measuring temperature: Select ±0.5°C, ±1.0°C, and ±2.0°C. When measuring strain: Select ±2.5%, ±12.5%, or ±25% of the range
Trigger position	Can be set in 0.1% increments of the display record length.
Trigger delay range	0 to 10 s (resolution is 100 ns)
Hold off time range	0 to 10 s (resolution is 100 ns)
Manual trigger key	Dedicated manual trigger key is available
Simple trigger	
Trigger source	CH1 to CH16, EXT (signal input from the TRIG IN terminal), LINE (commercial power supply signal that is connected), Logic A, Logic B, and Time
Trigger slope	CH1 to CH16: Rising, falling, or rising/falling EXT, Logic A, Logic B: Rising or falling
Time trigger	Date (year/month/day), time (hour/minute), time interval (1 minute to 24 hours)
Enhanced trigger	
Trigger source	CH1 to CH16, Logic A, and Logic B (AND and OR possible on each logic bit)
Trigger type	A->B(N): Trigger occurs N^{th} time condition B becomes true after condition A becomes true. Count: 1 to 255 Condition A: Enter/Exit Condition B: Enter/Exit A Delay B: Trigger occurs the first time condition B becomes true after the specified delay elapses after condition A becomes true. Delay: 0 to 10 s (resolution is 100 ns) Condition A: Enter/Exit Condition B: Enter/Exit

Item	Specifications	
	Edge on A:	Trigger occurs on the OR condition of the edge while condition A is true. Condition A: True/False
	OR:	Trigger occurs on the OR of trigger conditions that are specified on multiple trigger sources. The OR condition can also be specified on each logic bit.
	B > Time:	Trigger occurs when time of satisfaction of (pulse width trigger) condition B (time during which the condition is satisfied) is greater than or equal to a specified time. Specified time: 100 ns to 10 s (resolution is 100 ns)
	B < Time:	Trigger occurs when time of satisfaction of (pulse width trigger) condition B is less than or equal to a specified time. Specified time: 100 ns to 10 s (resolution is 100 ns)
	B Time Out:	Trigger occurs when the satisfaction of (timeout trigger) condition B reaches a specified time. Specified time: 100 ns to 10 s (resolution is 100 ns)
	Period:	Periodic trigger. The following four types are available.
	T > Time:	Trigger occurs when the period of condition T is greater than or equal to a specified time. Specified time: 100 ns to 10 s (resolution is 100 ns)
	T < Time:	Trigger occurs when the period of condition T is less than or equal to a specified time. Specified time: 100 ns to 10 s (resolution is 100 ns)
	T1 < T < T2:	Trigger occurs when the period of condition T is within a specified time range. Specified time: Time1: 100 ns to 10 s Time2: 200 ns to 10 s (resolution is 100 ns)
	T < T1, T2 < T:	Trigger occurs when the period of condition T is outside a specified time range. Specified time: Time1: 100 ns to 10 s Time2: 200 ns to 10 s (resolution is 100 ns)
	Window:	Trigger occurs when the trigger source enters or exits the range specified by two points. Window OR of multiple channels is possible. Logic bits can also be included in the edge OR condition.
	Wave Window:	Trigger for monitoring the power supply. A realtime template is created by comparing 1, 2, or 4 cycles of waveforms before the current waveform and setting a tolerance (window width). The current waveform is compared against this template. If the current waveform falls outside the template, a trigger is activated.
	• Conditions A and B are parallel pattern conditions that are set separately to High, Low, or “Don’t Care” for each channel (CH1 to CH16), Logic A, and Logic B. • OR conditions can be set to ⨍, ⨏, or Don’t Care” for CH1 to CH16, Logic A, and Logic B. • Hold off time cannot be specified for period triggers.	

18.3 Time Axis

Item	Specifications	
Record time range	Can also be displayed in second, minute, hour, and day. 100 μs to 10 s(in 1-2-5 steps), 20 s, 30 s, 50 s, 1 min, 100 s, 200 s, 5 min, 10 min, 20 min, 30 min, 50 min, 1 hour, 100 min, 2 hour, 5 hour, 10 hour, 20 hour, 30 hour, 50 hour, 100 hour, 5 day, 10 day, 20 day, and 30 day	
Time axis accuracy*	±(0.005%)	
External clock input	Connector type:	RCA jack
	Input level:	TTL level (0 to 5 V)
	Valid edge:	Rising edge
	Frequency range:	1 MHz or less
	Minimum pulse width:	400 ns or more for high and low

* Under standard operating conditions (see section 18.11) after the warm-up

18.4 Display

Item	Specifications
Display	10.4-inch color TFT LCD monitor
Effective display screen size	211.2 × 158.4 mm
Display resolution*	SVGA 800 × 600 dots
Display resolution of the waveform display	650 × 512 (normal waveform display) or 750 × 512 (wide waveform display) selectable
Display format	Windows: Zoom: MAIN, MAIN&Z1, MAIN&Z2, MAIN&Z1&Z2, Z1only, Z2only, and Z1&Z2 X-Y: TY, XY, and TY&XY
Maximum display update rate	30 times/s when a single waveform is displayed

* Liquid crystal display may include few defective pixels. (Within 5 ppm (6 points) of the total number of pixels (including RGB) The LCD is a high technology device made up of more than 1.44 million pixels. There may be pixels that do not turn ON or those that remain ON at all times. However, these cases are not considered malfunctions.

18.5 Function

Acquisition and Display

Item	Specifications
Acquisition mode	Normal: Normal waveform acquisition Envelope: Maximum sample rate regardless of the record time, holds the peak value Averaging: Average count 2 to 65536 (2^n steps) Box average: Increase the A/D resolution up to 4 bits (16 bits max.)
Record length	1 kW, 2.5 kW, 5 kW, 10 kW, 25 kW, 50 kW, 100 kW, 250 kW, 500 kW, 1 MW, 2.5 MW, 5 MW, 10 MW, 25 MW, and 50 MW
Zoom	Expand the displayed waveform along the time axis (up two locations using separate zoom rates)
Display format	1, 2, 3, 4, 8, or 16 analog waveform windows
Display interpolation	Display samples using dot display, sine interpolation, or linear interpolation.
Graticule	Select from three graticule types.
Auxiliary display ON/OFF	Turn ON/OFF scale values, waveform labels, extra window, and level indicator display.
X-Y display	Select the X axis and Y axis from CH1 to CH16, MATH1 to MATH8 (up to 4)
Accumulation	Accumulates waveforms on the display (persistence mode)
Snapshot	Retains the current displayed waveform on the screen. Snapshot waveforms can be saved and loaded.
Clear trace	Clears the displayed waveform.
Realtime hard disk recording	Maximum sample rate: 100 kS/s (for 1 CH) max. Capacity: Up to 1 GW per operation. Action count: Select Single or Continue. If you select Continue, set the count in the range of 2 to 128. Features: Restore process not required. Saved to a format that can be loaded directly.

Vertical and Horizontal Axes Settings

Item	Specifications
Channel ON/OFF	Independently turn ON/OFF CH1 to CH16, Logic A, and Logic B.
ALL CH menu	Set all channels while displaying waveforms. Operation using the USB keyboard and USB mouse is possible.
Vertical axis expansion/ reduction	Expand or reduce the vertical axis for each channel.
Variable	Upper/Lower limit scaling when variable is ON.
Input filter	Set for each channel.
Vertical position setting	Waveforms can be moved vertically in the range of ±5 div from the center of the waveform display frame.
Linear scaling	Set AX+B mode or P1-P2 mode independently for CH1 to CH16.
Roll mode	The roll mode is enabled when the trigger mode is set to auto, auto-level, single, or log, and the record time is greater than or equal to 1 s.

Analysis

Item	Specifications
Auto scroll	Automatically scrolls the zoom position.
History search function	Search for and display waveforms from the history memory that satisfy specified conditions. Zone search: Set an area on the screen, then extract and display only those waveforms that pass through the area or do not pass through the area. Parameter search: Extract and display only the results of the automated measurement of waveform parameters that meet the specified condition.
Cursor measurement	The following cursors are selectable. Horizontal, Vertical, H&V, Degree (only for T-Y waveform display), and Marker
Automated measurement of waveform parameters	Capable of performing automated measurement of waveform parameters. Automated measurement of waveform parameters within one period (P-P through Int2XY). Up to 24 items can be displayed. P-P, Amp, Max, Min, High, Low, Avg, Mid, Rms, Sdev, +OvrShoot, –OvrShoot, Rise, Fall, Freq, Period, +Width, –Width, Duty, Pulse, Burst1, Burst2, AvgFreq, AvgPeriod, Int1TY, Int2TY, Int1XY, Int2XY, and Delay (between channels)
Statistical processing	Applicable items: Automated measured values of waveform parameters described above. Statistical items: Max, Min, Avg, Sdv, and Cnt Maximum number of cycles: 48000 cycles (when the number of parameters is 1) Maximum total number of parameters: 48000 (total number of results) Maximum measurement range: 10 MW
Normal statistical processing	Performs statistical processing on all acquired waveforms while acquiring waveforms.
Cyclic statistical processing	Performs statistical processing per cycle (cyclic statistical computation). Extracts a periodic waveform (cycle) from the acquisition memory and automatically calculates waveform parameters per cycle.
Statistical processing of history data	Performs automated measurement of waveform parameters on the waveform that is acquired using the history memory function and performs statistical processing. Statistical processing is performed from the oldest data.
Computation	Operators: +, –, ×, /, binary computation, phase shift, and power spectrum
Phase shift	Monitor waveforms by shifting the phase of CH1 to CH16. Computation is performed on the phase-shifted result.

* When the Ethernet interface option is installed

Recorder Mode

Item	Specifications
Realtime recording on the built-in printer	T-Y waveform recording/numeric value recording: Output to the chart in realtime. X-Y Waveform Recording: Starts the data acquisition with START and generates X-Y waveforms in realtime. Outputs X-Y waveforms to the chart with STOP.
Length of data saved to memory while realtime recording	T-Y waveform recording: Fixed to 2.5 MW. Automatically saves up to 1000 divisions of data (depending on the chart speed). X-Y waveform recording: Fixed to 1 MW.
Recording start trigger	Recording can be started using a trigger by setting the trigger mode. Auto: Trigger disabled. Continuous recording. Recording starts with measurement start. Log: Trigger disabled. Recording stops when the memory storage length of data is acquired. When short recording is specified, recording stops when shot recording ends. Single: Trigger enabled. Recording starts after a trigger detection. When short recording is specified, recording stops when shot recording ends. Repeat: Trigger enabled. Recording starts after a trigger detection. Selectable only when shot recording is specified. Reenters trigger-wait state after short recording.
Chart speed (T-Y waveform recording)	20 mm/s, 10 mm/s, 5 mm/s, 2 mm/s, 1 mm/s100 mm/min, 50 mm/min, 25 mm/min, 20 mm/min, 10 mm/min, 5 mm/min, 2 mm/min, 1 mm/min, 100 mm/h, 50 mm/h, 25 mm/h, 20 mm/h, 10 mm/h
Output interval (Numeric value recording)	1 s, 2 s, 5 s, 10 s, 15 s, 20 s, 30 s, 1 min, 2 min, 5 min, 10 min, 15 min, 20 min, 30 min, 60min
Sample rate during X-Y waveform recording	5 kS/s, 2 kS/s, 1 kS/s, 500 S/s, 200 S/s, 100 S/s, 50 S/s, 20 S/s, 10 S/s, 5S/s
Recording format	T-Y waveform recording: 1 division recording: 200 mm/zone or 160 mm/zone (flexible zone is selectable for 1 division recording) 2 zone recording: 80 mm/zone or 100 mm/zone 3 zone recording: 60 mm/zone or 65 mm/zone 4 zone recording: 40 mm/zone or 50 mm/zone 8 zone recording: 20 mm/zone 16 zone recording: 10 mm/zone Numeric value recording: Print direction selectable from standard and 180° rotation. X-Y waveform recording: Records up to 4 waveforms simultaneously. Assignment of X and Y channels on the 4 waveforms is arbitrary.
Grid	Width: Selectable from 1 div and 10 mm. Type: Selectable from two types and OFF. Density: Dark/Light selectable.
Recorded contents	Simultaneously prints, scale, channel label, graticule, timestamp, gauge, annotation, etc. During T-Y waveform recording Scale: Prints the scale value for each channel. Select the print interval from OFF, 200, 400, and 800 mm. Channel label: Prints channel labels near the waveforms. Select the print interval from OFF, 200, 400, and 800 mm. Time print: Prints the recording start time and timestamps. Select the print interval from OFF, 200, 400, and 800 mm. Gauge: Prints the scale value for each channel and the end of printing. Annotation: Select channel information, channel message, or Data to be printed. Channel information: Prints information such as measurement range, and filter. Message: Prints a preset message string. Data: Prints numeric measured values. Select the print interval from OFF, 200, 400, and 800 mm. During X-Y waveform recording Prints the scale value.
Shot recording	Automatically stops when the specified length is recorded after the start of measurement or after the trigger condition is met. Shot recording length: Continuous, 20 cm, 50 cm, 1m, or 2 m
External start/stop	Prints on a low signal. Stops printing on a high signal.
Reprint function	An arbitrary section of the recorded data saved to the memory simultaneously with realtime print can be reprinted in an arbitrary format.
Print image output	When performing reprint or fine print during T-Y waveform recording, the print image can be converted and output to a PDF file.

Screen Image Data Output

Item	Specifications
Built-in printer	Prints a hard copy of the screen
External printer	Outputs the screen image to an external printer via the USB PERIPHERAL terminal or the Ethernet network.* Supports ESC-P, ESC-P2, LIPS3, PCL5, BJ commands, and PostScript (only via the Ethernet network*)
PC card, SCSI, Built-in HDD (option), Network drive*	Output data format: PNG, JPEG, BMP, and PostScript

* When the Ethernet interface option is installed (to a printer server supporting TCP/IP).

Data Storage

Item	Specifications
History memory	Automatically holds up to 2000 pages of waveforms (depending on the memory length)
PC card, SCSI, Built-in HDD (option), Network drive*	Saves waveform data, setup data, and various data

* When the Ethernet interface option is installed.

Acquisition Memory Backup

Item	Specifications
Batteries	4 AAA alkaline dry cells (AA/R6) (JIS, IEC model: LR6) 4 nickel hydride rechargeable batteries
Backup time (reference value)	Reference value for A1070EB (LR6JE CPT alkaline battery by Toshiba) × 4 at an ambient temperature of 23 °C Approx. 150 hours
Backup function	Enable/Disable using the ON/OFF switch
Contents that are backed up	Acquisition memory waveform data (history memory data)

Other Functions

Item	Specifications
Initialization	Resets settings to the factory default (excluding date/time setting, communication interface settings, SCSI ID number setting, language setting, time difference from the GMT, and the ON/OFF setting of the internal hard disk motor)
Auto setup	Automatically sets the voltage axis, time axis, trigger level, etc.
Action-on-trigger	Outputs screen image data, saves waveform data (binary, ASCII, or floating), activates buzzer notification, or sends e-mail messages each time a trigger occurs.
Mail transmission function*	Sends the SL1400 status periodically to a specified mail address via the Ethernet network. Also sends information as an action of action-on-trigger.
Calibration	Auto calibration and manual calibration available
System settings	Set the screen color, date/time, menu/message language, and click sound ON/OFF
Probe compensation signal output	Outputs a signal (rectangular signal of approx. 1 V_{P-P} and approx. 1 kHz) from the probe compensation output terminal on the front panel
Overview	Shows system specifications
Self-test	Memory test, key test, printer test, PC card drive test, internal HDD (optional) test, and SCSI test
Thumbnail	Shows thumbnails of the screen images
PROTECT key	Disables keys to prevent inadvertent errors in operation.

* When the Ethernet interface option is installed.

18.6 Built-in printer

Item	Specifications
Print system	Thermal line dot system
Paper width	210 mm
Effective print width	204 mm (1632 dots)
Dot density	8 dots/mm
Feeding direction resolution	For normal print: 8 dots/mm. For fine (long) print: 10 dots/mm
Function	Normal print, fine print, zoom print, A4 print, and realtime recording
Maximum paper feeding speed	20 mm/s

18.7 Storage

Built-in Storage

• PC Card Interface

Item	Specifications
Number of drives	1
Maximum capacity	5 GB
Compatible cards*	Flash ATA memory card (PC card TYPE II), PC card type, CF card + adapter card, and HDD PC card.

* For details on compatible cards, contact your nearest YOKOGAWA dealer.

• Internal Hard Disk (Option)

Item	Specifications
Number of drives	1
Size	2.5 inch
HDD capacity used	40 GB, FAT32, 2 partitions by factory default
File name	Supports long file names (ANK16 characters)
Function	Mount the internal HDD via the SCSI port

External Storage Interface

• SCSI

Item	Specifications
Standard	SCSI (Small Computer System Interface).ANSIX3.131-1986
Connector	Half pitch 50 pins
Connector pin assignment	Unbalanced (single-ended)

• USB Storage Device*

Item	Specifications
Compatible USB mass storage devices	USB (USB Mass Storage Class) hard disk drive, MO disk drive, and flash memory

For specification details, see the next section, “USB PERIPHERAL Interface.”

18.8 USB PERIPHERAL Interface

Item	Specifications
Connector type	USB type A connector (receptacle)
Electrical and mechanical specifications	Conforms to USB Rev.1.1
Data rate	12 Mbps maximum
Compatible keyboards[1]	104 keyboard or 89 keyboard (US) and 109 keyboard or 89 keyboard (Japanese) conforming to USB HID Class Ver.1.1
Compatible printers[1]	ESC/P, ESC/P2, LIPS3, PCL5, and BJ (can be used on models that support the BJC-35V native commands) that support USB (USB Printer Class Version 1.0)
Compatible mouse[1]	Mouse (with wheel) that supports USB HID Class Ver.1.1
Compatible USB mass storage devices[1]	USB (USB Mass Storage Class) hard disk drive, MO disk drive, and flash memory
Power supply	5 V, 500 mA[2] (per port)
Number of ports	2

1 For details on compatible USB devices, contact your nearest YOKOGAWA dealer.
2 Devices whose maximum current consumption exceeds 100 mA cannot be connected simultaneously to the two ports.

18.9 Auxiliary I/O Section

Logic Input

Item	Specifications
Number of inputs	8 bits × 2
Connector type	26-pin half-pitch connector × 2
Maximum sample rate	10 MS/s Compatible probes Non-isolated (700986 (8 bits), 702911 (8 bits), 702912 (8 bits)), and isolated (700987 (8 bits)).

External Trigger Input

Item	Specifications
Connector type	RCA jack
Input level	TTL (0 to 5 V) input
Minimum pulse width	500 ns
Logic	Rising edge or falling edge selectable
Trigger delay	Within 200 ns + 1 sample
Externally synchronized operation	Possible (by connecting TRIG IN and TRIG OUT on two SL1400s)

Trigger Output (TRIG OUT)*

Item	Specifications
Connector type	RCA jack, shared with the external sampling clock
Output level	CMOS level (0 to 5 V) output
Logic	Falls when the trigger is activated, rises after completing acquisition.
Output delay	Within 1 μs + 1 sample
Output hold time	200 ns or longer

* This terminal is also used as an external clock input terminal.

Video Signal Output (VIDEO OUT (SVGA))

Item	Specifications
Connector type	15-pin D-Sub receptacle
Output format	Analog RGB output
Output resolution	SVGA output 800 × 600 dots/60 Hz Vsync

External Start/Stop

Item	Specifications
Connector type	Modular jack (RJ-11)
Input	TTL (0 to 5 V) or switch input Start on a low signal and stop on a high signal
Compatible cable	Four-wire modular cable for telephone lines (external start/stop cable (YOKOGAWA: 366973))

COMP Output (Rectangular Signal Output for Probe Compensation)

Item	Specifications
Output frequency	1 kHz ± 1%
Output amplitude	1 V ± 10%

Probe Power Output (Option)

Item	Specifications
Number of output terminals	4
Output voltage	±12 V 2 outputs (up to a total of 800 mA)
Compatible probes*	Current probe (701930 (150 A)) up to 2 probes Current probe (701931 (500 A)) 1 probe Current probe (701933 (30 A)) up to 2 probes * Up to four 700937 current probes can be used, but the 700937 is a discontinued product.

For details on the usage conditions of each probe, see “Relationship between the current being measured and probe’s current consumption” on the following Web page.
http://www.yokogawa.com/tm/probe/

18.10 Computer Interface

GP-IB[1]

Item	Specifications
Electrical and mechanical specifications	Conforms to IEEE St'd 488-1978 (JIS C 1901-1987)
Functional specifications	SH1, AH1, T5, L4, SR1, RL1, PP0, DC1, DT0, and C0
Protocol	Conforms to IEEE St'd 488.2-1992
Code	ISO (ASCII) code
Mode	Addressable mode
Address	Specify a talker/listener address between 0 and 30
Clear remote mode	Remote mode can be cleared using the CLEAR TRACE key (except during local lockout).

Serial (RS-232)[1]

Item	Specifications
Connector type	9-pin D-Sub plug
Electrical characteristics	Conforms to the EIA-574 standard (for the 9-pin interface of the EIA-232 (RS-232) standard)
Connection	Point-to-point
Transmission mode	Full-duplex
Synchronization	Start-stop synchronization
Baud rate	Select from the following rates. 1200, 2400, 4800, 9600, 19200, 38400, and 57600 If unstable, use 19200 or less.

USB-PC Connection[1]

Item	Specifications
Connector type	USB type B connector (receptacle)
Electrical and mechanical specifications	Conforms to USB Rev.1.1
Data rate	12 Mbps maximum
Number of ports	1
Supported service	Remote control[2]
PC system supported	PCs with standard USB ports running Windows 2000 or Windows XP.

Ethernet (Option)[1]

Item	Specifications
Number of communication ports	1
Electrical and mechanical specifications	Conforms to IEEE802.3
Transmission system	Ethernet (100BASE-TX/10BASE-T)
Data rate	100 Mbps maximum
Communication protocol	TCP/IP
Supported services	FTP server, FTP client (network drive), LPR client (network printer), SMTP client (mail transmission), DHCP, DNS, Web server, and remote control[2]
Connector type	RJ-45 connector

1 For details on the specifications, see the *Communication Interface User's Manual* on the CD-ROM.
2 The SL1400 can be controlled remotely from a host such as a PC. For details, see the *Communication Interface User's Manual* on the CD-ROM. A separate driver is needed to use this function. The driver can be downloaded from the following Web page.
http://www.yokogawa.com/tm/Bu/software.htm

18.11 General Specifications

Item	Specifications
Standard operating conditions	Ambient temperature: 23 ± 5°C Ambient humidity: 55 ± 10% RH Within 1% of the rated error of the power supply voltage and frequency After a 30-minute warm-up and after calibration
Recommended calibration period	1 year
Warm-up time	At least 30 minutes
Storage temperature	–20 to 60°C
Storage humidity	20 to 85% RH (no condensation)
Storage altitude	3000 m or less
Operating temperature range	5 to 40°C
Operating humidity range	20 to 85% RH (when not using the printer), 35 to 85% RH (when using the printer)
Operating altitude	2000 m or less
Rated supply voltage	100 to 120 VAC or 200 to 240 VAC (automatic switching)
Rated power supply frequency	50/60 Hz
Permitted supply voltage	90-132 VAC/180-264 VAC
Permitted power supply frequency range	48 to 63 Hz
Maximum power consumption	Approx. 200 VA max. (maximum power when the printer is OFF and 16 channels are running is 135 VA (reference value))
Withstand voltage	1500 VAC for 1 minute across the power supply and earth
Insulation resistance	10 MΩ or more at 500 VDC across the power supply and ground
External dimensions	355 mm (W) × 250 mm (H) × 180 mm(D) (excluding the handle and other projections)
Weight	Approx. 7.8 kg (only the SL1400 with all options (C8/C10/P4 options), without the chart paper) Approx. 11.8 kg (SL1400 + eight High-Speed 10 MS/s, 12-Bit Isolation Modules) Module: Approx. 300 g (High-Speed 10 MS/s, 12-Bit Isolation Module)
Instrument's cooling method	Forced air cooling. Exhaust on the left side panel and top.
Battery backup	Settings and clock are backed up with the internal lithium battery
Battery backup Battery life	Approx. 5 years (at ambient temperature of 25°C)
Fuse	Inside the power supply unit (cannot be replaced from the outside of the instrument)

Item	Specifications	
Safety standard	Complying standard	EN61010-1 • Overvoltage Category (Installation Category) II[1] • Measurement Category (Installation Category) II[5] • Pollution degree 2[2] Already certified (701240/701250/701251/701255/701260/701261/701262/701265/701270/701271/701275/701280/700986/700987/701955/701956/701957/701958)
Emission	Complying standard	EN61326 Already certified (701240/701250/701251/701255/701260/701261/701262/701265/701270/701271/701275/701280/700986/700987/701955/701956/701957/701958) • This product is a Class A (for commercial environment) product. Operation of this product in a residential area may cause radio interference in which case the user is required to correct the interference.
	Test item	1. Power supply terminal noise EN61326:ClassA 2. Electromagnetic radiation disturbance EN61326:ClassA 3. Power supply harmonics restriction EN61000-3-2 4. Supply voltage fluctuation & flicker EN61000-3-3
	Cable condition	• Shared external trigger/external clock input terminal Use the BNC-RCA adapter (YOKOGAWA: 366928) and a BNC cable[3] and attach a ferrite core (TDK: ZCAT2035-0930A, YOKOGAWA: A1190MN) on one end (SL1400 end). • Trigger output terminal Same as the external trigger input terminal above. • Video signal output (VIDEO OUT (SVGA)) terminal Use a 15-pin D-Sub VGA shielded cable[3]. • GP-IB interface connector Use shielded GP-IB cables[3]. • Serial (RS-232) interface connector Use a shielded RS-232 cable[3] and attach a ferrite core (TDK: ZCAT2035-0930A, YOKOGAWA: A1190MN) on one end (SL1400 end). • SCSI connector Use a shielded SCSI cable[3] and attach a ferrite core (TDK: ZCAT2035-0930A, YOKOGAWA: A1190MN) on one end (SL1400 end). • USB peripheral connector Use shielded USB cables.[3] • USB interface connector When connecting a USB keyboard or mouse using a shielded cable or when connecting to a USB printer, use shielded USB cables.[*3] • Ethernet connector Use category 5 Ethernet cables[4] or better cables. • Probes connected to modules and wiring Use twisted pair cables when connecting items other than probes to the module. Attach a ferrite core (TDK: ZCAT2035-0930A, YOKOGAWA: A1190MN) to the probes and cables that are connected to the modules. Wrap the cable around the ferrite core once. • Logic probe input Attach a ferrite core (TDK: ZCAT2035-0930A, YOKOGAWA: A1190MN) on one end (SL1400 end) of the cable to be connected to the logic probe input terminal. • Current probe (701930, 701931, and 701933) When connecting a current probe to the input terminal and probe power terminal of the module, attach a ferrite core (TDK: ZCAT2035-0930A, YOKOGAWA: A1190MN) on one end (SL1400 end) of the two cables together. • Bridge head for the strain module When using the 701270, use the 701955 or the 701956; when using the 701271, use the 701957 or the 701958.

Item	Specifications		
Immunity	Complying standard	EN61326	
		Already certified (701240/701250/701251/701255/701260/701261/701262/701265/701270/701271/701275/701280/700986/700987/701955/701956/701957/701958)	
		• Influence in the immunity environment (performance criterion A)	
		Noise increase 701250:	≤±3 mV (1:1 input, 50 mV range conversion)
		701251:	≤±3 mV (1:1 input, 10 mV range conversion)
		701255:	≤±25 mV (1:1 input, 50 mV range conversion)
		701260:	≤±30 mV (1:1 input, 200 mV range conversion)
		701261/701262:	≤±3 mV
		701265:	≤±0.05 mV
		701270:	≤±100 μSTR (when equivalent to ±100 mV, gauge factor = 2, and bridge voltage = 2 V)
		701271:	≤±100μSTR (when equivalent to ±100 mV, gauge factor = 2, and bridge voltage = 2 V)
		701275:	≤±3 mV (1:1 input, 50 mV range conversion)
		701280:	Within the specifications
	Test conditions	701250:	10 MS/s, envelope mode, 500 mV range, no input filter,with the tip of the probe (700929 (10:1)) shorted
		701251:	1 MS/s, envelope mode, 100 mV range, no input filter, with the tip of the probe (700929 (10:1)) shorted
		701255:	10 MS/s, envelope mode, 500 mV range, no input filter, with the tip of the probe (701940 (10:1)) shorted
		701260:	100 kS/s, envelope mode, 200 mV range, no input filter, with the tip of the probe (700929 (10:1)) shorted
		701261/701262:	100 kS/s, envelope mode, 50 mV range, no input filter, With the end of the 3-m twisted-pair cable shorted
		701265:	100 kS/s, envelope mode, 1 mV range, no input filter, With the end of the 3-m twisted-pair cable shorted
		701270:	100 kS/s, envelope mode, 500 μSTR, gauge factor: 2.0, no input filter, 701955 bridge voltage: 2 V, 701956 bridge voltage: 10 V
		701271:	100 kS/s, envelope mode, 500 μSTR, gauge factor: 2.0, no input filter, 701957 bridge voltage: 2 V, 701958 bridge voltage: 10 V
		701275:	100 kS/s, envelope mode, 500 mV range, no input filter, with the tip of the probe (700929 (10:1)) shorted
		701280:	25 kS/s, envelope mode, Frequency, 1 Hz range, no input filter, User (±1 V, threshold level: 0 V, hysteresis: ±1%), with the tip of the probe (700929 (10:1)) shorted
	Test item	1. Electrostatic discharge	EN61000-4-2, Air discharge: ±8 kV, contact discharge: ±4 kV, criteria B
		2. Radiated immunity	EN61000-4-3, 80 MHz to 1 GHz, 1.4 GHz to 2 GHz, 10 V/m, criteria A
		3. Conducted immunity	EN61000-4-6, 3 V, criteria A
		4. Electrical fast transient/burst	EN61000-4-4, Power line: ±2 kV, signal line: ±1 kV, criteria B
		5. Power frequency magnetic field	EN61000-4-8, 30 A/m, 50 Hz, criteria A
		6. Surge immunity	EN61000-4-5, Between lines: ±1 kV, common: ±2 kV, criteria B
		7. Voltage dip and interruption	EN61000-4-11, 0.5 cycle, both polarities, 100%, criteria A
	Definitions of criteria A and B	• Criteria A	Aforementioned “Influence in the immunity environment” is met during the test.
		• Criteria B	This apparatus continues to operate without hang-up or falling into uncontrollable conditions during the test. No change of actual operating state or stored data is allowed.

*1 The Overvoltage Category (Installation Category) is a value used to define the transient overvoltage condition and includes the impulse withstand voltage regulation. I applies to electrical equipment that is powered by a circuit with overvoltage control. II applies to electrical equipment that is powered by a fixed installation such as a distribution board.

*2 Pollution Degree applies to the degree of adhesion of a solid, liquid, or gas which deteriorates withstand voltage or surface resistivity. Pollution Degree 2 applies to normal indoor atmospheres (with only non-conductive pollution).

*3 Use cables of length 3 m or less.

*4 Use cables of length 30 m or less.

*5 Measurement Category (CAT II) applies to electrical equipment that is powered through a fixed installation such as a wall outlet wired to a distribution board and measurement performed on such wiring.

18.12 Module Specifications

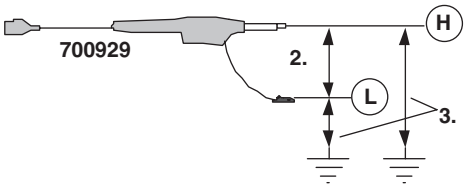
High-Speed 10 MS/s, 12-Bit Isolation Module (701250) Specifications

Item	Specifications
Standard operating conditions	Temperature: 23±5°C Humidity: 55±10% RH After a 30-minute warm-up and after calibration
Effective measurement range	Twice the measurement range
Number of input channels	2
Input coupling	AC, DC, and GND
Maximum sample rate	10 MS/s
Input format	Isolated unbalanced
Frequency characteristics[1]	(–3 dB point when a sine wave with an amplitude equivalent to 60% of the range is applied) DC to 3 MHz
Voltage-axis sensitivity range	10:1 ProbeFactor: 500 mV to 2 kV range (1-2-5 steps) 1:1 ProbeFactor: 50 mV to 200 V range (1-2-5 steps)
Maximum input voltage (at a frequency of 1 kHz or less)	Combined with the 700929 (10:1):[2] 600 V (DC+ACpeak) Combined with the 701901+701954 (1:1):[4] 250 V (DC+ACpeak) Direct input or cable not complying with the safety standard:[6] 250 V (DC+ACpeak)
Maximum allowable common mode voltage (at a frequency of 1 kHz or less)	Working voltage of safety standard Combined with the 700929 (10:1)[3] or combined with the 701901+701954 (1:1):[5] 400 Vrms (CAT I), 300 Vrms (CAT II) Direct input or cable not complying with the safety standard:[7] 42 V (DC+ACpeak) (CAT I and CAT II, 30 Vrms)
Vertical (voltage) axis accuracy DC accuracy[1]	50 mV to 200 V range: ±(0.5% of range)
Input connector	BNC connector (isolated type)
Input impedance	1 MΩ±1%, approx. 35 pF
Lower –3 dB point when AC coupled	10 Hz or less (1 Hz or less when using the 700929)
Common mode rejection ratio	80 dB (50/60 Hz) or more (typical[8])
Residual noise level (Input section shorted)	±400 μV or ±0.6% of the range, whichever is greater (typical[8])
Withstand voltage	1500 Vrms for 1 minute (across each terminal and earth) (60 Hz)
Allowable transient surge voltage (instantaneous)	±2100 Vpeak (across each input terminal and earth)
Insulation resistance	500 VDC, 10 MΩ or more (across each input terminal and earth)
A/D conversion resolution	12 bits (1500 LSB/range)
Temperature coefficient	Zero point: 50 mV to 200 V range: ±(0.05% of range)/°C (typical[8]) Gain: ±(0.02% of range)/°C (typical[8])
Bandwidth limit	Select from OFF, 500 kHz, 50 kHz, 5 kHz, and 500 Hz Cutoff characteristics: –18 dB/OCT (typical[8])
Probe attenuation setting	Voltage probe: 1:1, 10:1, 100:1, and 1000:1 Current probe: 10 A:1 V (for the 701933) and 100 A:1 V (for the 701930/701931)

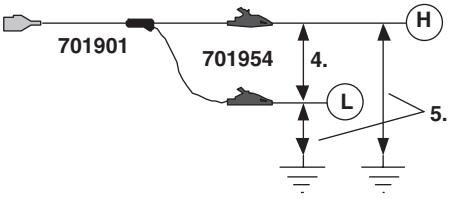
Item	Specifications
Compatible probes/cables	Voltage probe (10:1 safety probe): Recommended 700929 (10:1 safety probe) .20 to 45 pF: For measuring 600 Vpeak or less Current probe (power can be supplied from the SL1400) 701930 (150 A), 701931 (500 A), and 701933 (30 A) High voltage differential probe (connect the GND cable provided with the probe to the SL1400 case) 700924 (1000:1, 100:1/1400 Vpeak): For measuring 1400 Vpeak or less Connection cable (for high voltage 1:1) 701901 (isolated type BNC-safety alligator clip adapter × 2: For measuring 250 Vpeak or less), a separate alligator clip (701954) is required Connection cable (for low voltage 1:1) 366926 (non-isolated type BNC-alligator clip × 2: For measuring low voltage less than or equal to 42 Vpeak)

1 Value measured under standard operating conditions (section 18.11).

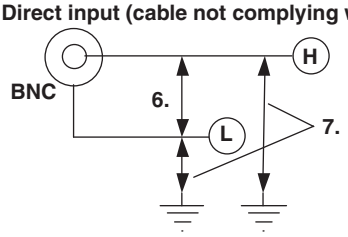
Combined with the 700929



Combined with the 701901+701954



Direct input (cable not complying with the safety standard)



Withstand voltage: 1500 Vrms for 1 minute
Allowable transient surge voltage: ±2100 Vpeak (between earth and input)

8 Typical value represents a typical or average value. It is not strictly warranted.

WARNING

- Do not apply input voltage exceeding the maximum input voltage, withstand voltage, or allowable surge voltage.
- To prevent electric shock, be sure to furnish protective earth grounding of the SL1400.
- To prevent electric shock, be sure to fasten the module screws. Otherwise, the electrical and mechanical protection functions will not be activated.
- Avoid continuous connection under an environment in which the allowable surge voltage or higher voltage may occur.
- To prevent electric shock, be sure to connect the GND lead of the differential probe (700924/700925) to the SL1400.

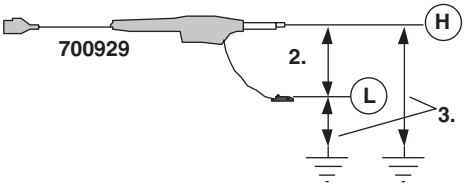
High-Speed High-Resolution 1 MS/s, 16-Bit Isolation Module (701251) Specifications

Item	Specifications
Standard operating conditions	Temperature: 23±5°C Humidity: 55±10% RH After a 30-minute warm-up and after calibration
Effective measurement range	Twice the measurement range
Number of input channels	2
Input coupling	AC, DC, and GND
Maximum sample rate	1 MS/s
Input format	Isolated unbalanced
Frequency characteristics[1]	(–3 dB point when a sine wave with an amplitude equivalent to 60% of the range is applied) 50 mV to 200 V range: DC to 300 kHz 20 mV to 10 mV range: DC to 200 kHz
Voltage-axis sensitivity range	10:1 ProbeFactor: 100 mV to 2 kV range (1-2-5 steps) 1:1 ProbeFactor: 10 mV to 200 V range (1-2-5 steps)
Maximum input voltage (at a frequency of 1 kHz or less)	Combined with the 700929 (10:1):[2] 600 V (DC+ACpeak) Combined with the 701901+701954 (1:1):[4] 140 V (DC+ACpeak) Direct input or cable not complying with the safety standard:[6] 140 V (DC+ACpeak)
Maximum allowable common mode voltage (at a frequency of 1 kHz or less)	Working voltage of safety standard Combined with the 700929 (10:1)[3] or combined with the 701901+701954 (1:1):[5] 400 Vrms (CAT I), 300 Vrms (CAT II) Direct input or cable not complying with the safety standard:[7] 42 V (DC+ACpeak) (CAT I and CAT II, 30 Vrms)
Vertical (voltage) axis accuracy DC accuracy[1]	50 mV to 200 V range: ±(0.25% of range) 20 mV range: ±(0.3% of range) 10 mV range: ±(0.5% of range)
Input connector	BNC connector (isolated type)
Input impedance	1 MΩ±1%, approx. 35 pF
Lower frequency –3 dB point when AC coupled	1 Hz or less (0.1 Hz or less when using the 700929)
Common mode rejection ratio	80 dB (50/60 Hz) or more (typical[8])
Residual noise level (Input section shorted)	±100 μV or ±0.1% of the range, whichever is greater (typical[8])
Withstand voltage	1500 Vrms for 1 minute (across each terminal and earth) (60 Hz)
Allowable transient surge voltage (instantaneous)	±2100 Vpeak (across each input terminal and earth)
Insulation resistance	500 VDC, 10 MΩ or more (across each input terminal and earth)
A/D conversion resolution	16 bits (24000 LSB/range)
Temperature coefficient	Zero point: 50 mV to 200 V range: ±(0.02% of range)/°C (typical[8]) 20 mV range: ±(0.05% of range)/°C (typical[8]) 10 mV range: ±(0.10% of range)/°C (typical[8]) Gain: 10 mV to 200 V range: ±(0.02% of range)/°C (typical[8])
Bandwidth limit	Select from OFF, 40 kHz, 4 kHz, and 400 Hz Cutoff characteristics: –12 dB/OCT (typical[8])
Probe attenuation setting	Voltage probe: 1:1, 10:1, 100:1, and 1000:1 Current probe: 10 A:1 V (for the 701933), 100 A:1 V (for the 701930/701931)

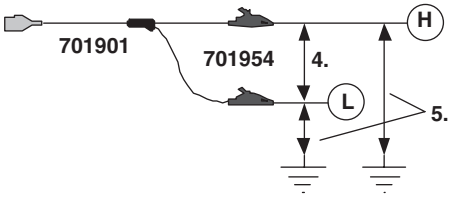
Item	Specifications
Compatible probes/cables	Voltage probe (10:1 safety probe): Recommended 700929 (10:1 safety probe) .20 to 45 pF: For measuring 600 Vpeak or less Current probe (power can be supplied from the SL1400) 701930 (150 A), 701931 (500 A), and 701933 (30 A) High voltage differential probe (connect the GND cable provided with the probe to the SL1400 case) 700924 (1000:1, 100:1/1400 Vpeak): For measuring 1400 Vpeak or less Connection cable (for high voltage 1:1) 701901 (isolated type BNC-safety alligator clip adapter × 2: For measuring 250 Vpeak or less), a separate alligator clip (701954) is required Connection cable (for low voltage 1:1) 366926 (non-isolated type BNC-alligator clip × 2: For measuring low voltage less than or equal to 42 Vpeak)

1 Value measured under standard operating conditions (section 18.11).

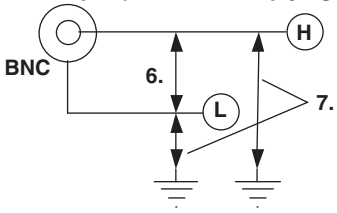
Combined with the 700929



Combined with the 701901+701954



Direct input (cable not complying with the safety standard)



Withstand voltage: 1500 Vrms for 1 minute
Allowable transient surge voltage: ±2100 Vpeak (between earth and input)

8 Typical value represents a typical or average value. It is not strictly warranted.

WARNING

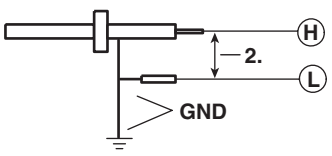
- Do not apply input voltage exceeding the maximum input voltage, withstand voltage, or allowable surge voltage.
- To prevent electric shock, be sure to furnish protective earth grounding of the SL1400.
- To prevent electric shock, be sure to fasten the module screws. Otherwise, the electrical and mechanical protection functions will not be activated.
- Avoid continuous connection under an environment in which the allowable surge voltage or higher voltage may occur.
- To prevent electric shock, be sure to connect the GND lead of the differential probe (700924/700925) to the SL1400.

High-Speed 10 MS/s, 12-Bit Non-Isolation Module (701255) Specifications

Item	Specifications
Standard operating conditions	Temperature: 23±5°C Humidity: 55±10% RH After a 30-minute warm-up and after calibration
Effective measurement range	Twice the measurement range
Number of input channels	2
Input coupling	AC, DC, and GND
Maximum sample rate	10 MS/s
Input format	Non-isolated, unbalanced
Frequency characteristics[1]	(–3 dB point when a sine wave with an amplitude equivalent to 60% of the range is applied) DC to 3 MHz
Voltage-axis sensitivity range	When using 10:1 probe attenuation: 500 mV to 2 kV (1-2-5 steps) 1:1 ProbeFactor: 50 mV to 200 V range (1-2-5 steps)
Maximum input voltage (at a frequency of 1 kHz or less)	Combined with the 701940 (10:1):[2] 600 V (DC+ACpeak) Direct input (1:1):[3] 250 V (DC+ACpeak)
Vertical (voltage) axis accuracy DC accuracy[1]	50 mV to 200 V range: ±(0.5% of range)
Input connector	BNC connector (metallic type)
Input impedance	1 MΩ±1%, approx. 35 pF
Lower –3 dB point when AC coupled	10 Hz or less (1 Hz or less when using the 701940)
Common mode rejection ratio	80 dB (50/60 Hz) or more (typical[4])
Residual noise level (Input section shorted)	±400 μV or ±0.6% of the range, whichever is greater (typical[4])
A/D conversion resolution	12 bits (1500 LSB/range)
Temperature coefficient	Zero point: 50 mV to 200 V range: ±(0.05% of range)/°C (typical[4]) Gain: ±(0.02% of range)/°C (typical[4])
Bandwidth limit	Select from OFF, 500 kHz, 50 kHz, 5 kHz, and 500 Hz Cutoff characteristics: –18 dB/OCT (typical[4])
Probe attenuation setting	Voltage probe: 1:1, 10:1, 100:1, and 1000:1 Current probe: 10 A:1 V (for the 701933) and 100 A:1 V (for the 701930/701931)
Compatible probes/cables	Voltage probe (10:1 passive probe): Recommended 701940, 17 to 46 pF: For measuring 600 V (DC+ACpeak) or less Current probe (power can be supplied from the SL1400) 701930 (150 A), 701931 (500 A), and 701933 (30 A) High voltage differential probe (connect the GND cable provided with the probe to the SL1400 case) 700924 (1000:1, 100:1/1400 Vpeak): For measuring 1400 Vpeak or less Connection cable (for low voltage 1:1) 366926 (non-isolated type BNC-alligator clip × 2: For measuring low voltage less than or equal to 42 Vpeak)

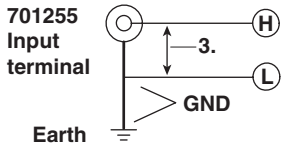
1 Value measured under standard operating conditions (section 18.11).

Recommended:
Combined with the 10:1 passive probe (701940)



GND is connected to the case potential.

Direct input
(When a cable that does not comply with the safety standard is connected)



GND is connected to the case potential.

4 Typical value represents a typical or average value. It is not strictly warranted.

WARNING

- Do not apply input voltage exceeding the maximum input voltage, withstand voltage, or allowable surge voltage.
- To prevent electric shock, be sure to furnish protective earth grounding of the SL1400.
- To prevent electric shock, be sure to fasten the module screws.
- The module screws must be fastened for the module to function as a non-isolation module. In addition, all electrical and mechanical protection functions are activated only when the screws are fastened.
- The maximum input voltage of the module is valid only when all the screws are fastened, and the protection path of the metal BNC is secured.

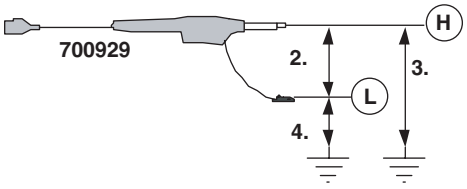
High-Voltage 100 kS/s, 16-Bit Isolation Module (with RMS) (701260) Specifications

Item	Specifications
Standard operating conditions	Temperature: 23±5°C Humidity: 55±10% RH After a 30-minute warm-up and after calibration
Effective measurement range	Twice the measurement range
Number of input channels	2
Input coupling	AC, DC, GND, AC-RMS, and DC-RMS
Maximum sample rate	100 kS/s
Input format	Isolated unbalanced
Frequency characteristics[1]	(–3 dB point when a sine wave with an amplitude equivalent to 60% of the range is applied) Waveform observation mode: DC to 40 kHz RMS observation mode: DC, 40 Hz to 10 kHz
Voltage-axis sensitivity range	When using 10:1 probe attenuation: 2 V to 20 kV range (1-2-5 steps) 1:1 ProbeFactor: 200 mV to 2 kV range (1-2-5 steps)
Maximum input voltage (at a frequency of 1 kHz or less)	Combined with the 700929 (10:1):[2] 1000 V (DC+ACpeak) Combined with the 701901 (1:1) and 701954:[5] 850 V (DC+ACpeak) Direct input or cable not complying with the safety standard:[8] 850 V (DC+ACpeak)
Maximum allowable common mode voltage (at a frequency of 1 kHz or less)	Working voltage of safety standard Combined with the 700929 (across probe tip H and earth[3]): 1000 Vrms (CAT II) (across probe tip L and earth[4]): 400 Vrms (CAT II) Combined with 701901(1:1)+701954 (across tip H and earth[6]): 700 Vrms (CAT II) (across tip L and earth[7]): 400 Vrms (CAT II) Direct input or cable not complying with the safety standard:[9] 30 Vrms (42 VDC+ACpeak) (across the input terminal, H or L, and earth)
Vertical (voltage) axis accuracy[1]	
Waveform observation mode	DC accuracy ±(0.25% of range)
RMS observation mode	DC accuracy ±(1.0% of range) AC accuracy (when a sine wave is input) ±(1.5% of range) AC accuracy (when the crest factor is 2 or less) ±(2.0% of range) } 40 Hz to 1 kHz range AC accuracy (when the crest factor is 3 or less) ±(3.0% of range)
Input connector	BNC connector (isolated type)
Input impedance	1 MΩ±1%, approx. 35 pF
Lower –3 dB point when AC coupled	1 Hz or less (0.1 Hz or less when using the 700929)
Common mode rejection ratio	80 dB (50/60 Hz) or more (typical[10])
Residual noise level (Input section shorted)	±1 mV or ±0.2% of range, whichever is greater (typical[10])
Withstand voltage	3700 Vrms for 1 minute (across each terminal and earth) (60 Hz)
Allowable transient surge voltage (instantaneous)	±5200 Vpeak (across each input terminal and earth)
Insulation resistance	500 VDC, 10 MΩ or more (across each input terminal and earth)
A/D conversion resolution	16 bits (24000 LSB/range)
Temperature coefficient (only when observing waveforms)	Zero point: ±(0.02% of range)/°C (typical[10]) Gain: ±(0.02% of range)/°C (typical[10])
Response time (only when observing RMS)	Rising (0 to 90% of 10 div): 100 ms (typical[10]) Falling (100 to 10% of 10 div): 250 ms (typical[10])
Bandwidth limit	Select from OFF, 10 kHz, 1 kHz, and 100 Hz Cutoff characteristics: –12 dB/OCT (typical[10])
Probe attenuation setting	Voltage probe: 1:1, 10:1, 100:1, and 1000:1 Current probe: 10 A:1 V (for the 701933) and 100 A:1 V (for the 701930/701931)

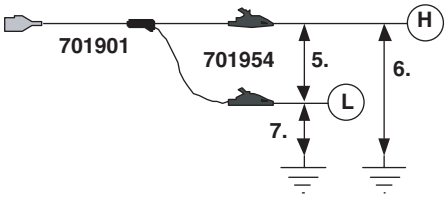
Item	Specifications
Compatible probes/cables	Connection cable (for high voltage 1:1): Recommended 1 701901 (isolated type BNC-safety alligator clip adapter × 2: For measuring 850 V (DC+ACpeak) or less), 701954 (alligator clip (dolphin type) red/black 2-piece set) is required separately Voltage probe (10:1 safety probe): Recommended 2 700929 (10:1 safety probe) .20 to 45 pF: For measuring 1000 V (DC+ACpeak) or less Current probe (power can be supplied from the SL1400) 701930 (150 A), 701931 (500 A), and 701933 (30 A)

1 Value measured under standard operating conditions (section 18.11).

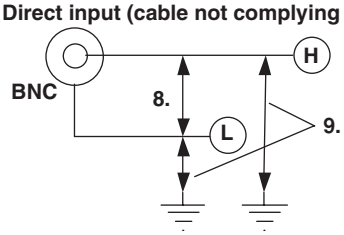
Combined with the 700929



Combined with the 701901+701954



Direct input (cable not complying with the safety standard)



Withstand voltage: 3700 Vrms for 1 minute

10 Typical value represents a typical or average value. It is not strictly warranted.

WARNING

- When applying high voltage using this module, use the 1:1 safety cable (combination of 701901 and 701954) or the isolated probe (700929).
- The measurement category of the direct input of this module is 400 Vrms-CAT II on the low side and 700 Vrms-CAT II on the high side. Use caution because the measurement category differs between the low and high sides.
- Do not apply input voltage exceeding the maximum input voltage, withstand voltage, or allowable surge voltage.
- To prevent electric shock, be sure to furnish protective earth grounding of the SL1400.
- To prevent electric shock, be sure to fasten the module screws. Otherwise, the electrical and mechanical protection functions will not be activated.
- Avoid continuous connection under an environment in which the allowable surge voltage or higher voltage may occur.

Universal (Voltage/Temp.) Module (701261) Specifications
Universal (Voltage/Temp.) Module (with AAF) (701262) Specifications

Item	Specifications
Standard operating conditions	Temperature: 23±5°C Humidity: 55±10% RH After a 30-minute warm-up and after calibration
Function	Temperature (thermocouple) or voltage measurement (switchable)
Effective measurement range	[Voltage measurement] Twice the measurement range
Number of input channels	2 Input coupling TC, DC, AC, and GND TC: Temperature (thermocouple) measurement DC: Voltage measurement (DC coupling) AC: Voltage measurement (AC coupling)
Maximum sample rate when measuring voltage	100 kHz
Data update rate when measuring temperature	500Hz
Input format	Isolated unbalanced
Measurement range	[Voltage measurement] Voltage sensitivity: 50 mV to 200 V range (1-2-5 steps) [Temperature measurement] Thermocouple: K, E, J, T, L, U, N, R, S, B, W, and Au7Fe
Measurement range/accuracy[1]	[Voltage measurement] Voltage sensitivity: 50 mV to 200 V range (1-2-5 steps) Voltage accuracy: ±(0.25% of range) [Temperature measurement][2]

Type	Measurement range	Accuracy
K E J T L U N	–200 to 1300°C –200 to 800°C 200°C to 0°C –200 to 1100°C –200 to 400°C –200 to 900°C –200 to 400°C 0 to 1300°C	±(0.1% of reading + 1.5°C) Except ±(0.2% of reading + 1.5°C) for –
R S	0 to 1700°C 0 to 1700°C	±(0.1% of reading + 3°C) Except ±8°C for 0 to 200°C ±5°C for 200 to 800°C
B	0 to 1800°C	±(0.1% of reading + 2°C) Except ±8°C for 400 to 700°C Effective range is 400 to 1800°C
W	0 to 2300°C	±(0.1% of reading + 3°C)
Au7Fe[3]	0 to 300K	0 to 50K: ±4K 50 to 300K: ±2.5K

Frequency characteristics[1] (–3 dB point when a sine wave with an amplitude equivalent to 60% of the range is applied)	[Voltage measurement] DC to 40 kHz [Temperature measurement] DC to 100 Hz
Maximum input voltage[4]	(at a frequency of 1 kHz or less) Both temperature and voltage input: 42 V (DC+ACpeak) (as a value that meets the safety standard) 150 V (DC+ACpeak) (maximum allowable voltage, as a value that does not damage the instrument when applied)
Maximum allowable common mode voltage[5] (at a frequency of 1 kHz or less)	42 V (DC+ACpeak) (CAT I and CAT II, 30 Vrms) for both temperature and voltage input
Vertical resolution	[Voltage measurement] During voltage input: 24000 LSB/range [Temperature measurement] When measuring temperature: 0.1°C
Lower frequency –3 dB point when AC coupled	[Voltage measurement] 0.5 Hz or less
Input connector	Binding post
Input impedance	Approx. 1 MΩ

Item	Specifications	
Common mode rejection ratio	[Voltage measurement]	80 dB or more (50/60 Hz) (typical[6])
	[Temperature measurement]	120 dB or more (50/60 Hz, with 2-Hz filter ON, signal source resistance of 500 Ω or less) (typical[6])
Residual noise level (Input section shorted)	[Voltage measurement]	±100 μV or ±0.1% of range, whichever is greater (typical[6])
A/D conversion resolution	[Voltage measurement]	16 bits (24000 LSB/range)
Temperature coefficient	[Voltage measurement]	Zero point: ±(0.01% of range)/°C (typical[6]) Gain: ±(0.02% of range)/°C (typical[6])
Reference junction compensation accuracy (when the input terminal temperature is balanced)	K, E, J, T, L, U, N: ±1°C R, S, B, W: ±1.5°C Au7Fe: ±1K	
Bandwidth limit	[Temperature measurement]	(digital filter + analog filter) Select from OFF, 30 Hz, 8 Hz, and 2 Hz + 150 Hz secondary analog filter
	[Voltage measurement]	Select from OFF, AUTO, 4 kHz, 400 Hz, and 40 Hz. Cutoff characteristics: –12 dB/OCT (typical[6], setting other than AUTO)

Cutoff frequency (fc) when set to AUTO (only on the 701262)

Sample Rate	Cutoff Frequency (fc)
100 kHz or higher	40 kHz
100 Hz to 50 kHz	40% of the sample rate
50 Hz or lower	20 Hz

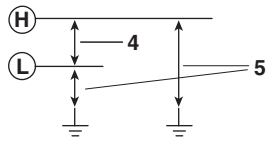
Cutoff characteristics during AUTO: –65 dB at 2×fc (typical[6])

Table of cutoff frequency characteristics of the anti-aliasing filter (AAF)

When the filter is set to Auto, the anti-aliasing filter and low-pass filter are automatically set according to the sample rate.

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

1 Value measured under standard operating conditions (section 18.11).
2 Does not include the reference junction temperature compensation accuracy.
3 This module supports Au7Fe with 0.07% metal content with respect to gold.



6 Typical value represents a typical or average value. It is not strictly warranted.

WARNING

- Do not apply input voltage exceeding the maximum input voltage or allowable common mode input voltage.
- To prevent electric shock, be sure to furnish protective earth grounding of the SL1400.
- To prevent electric shock, be sure to fasten the module screws. Otherwise, the electrical and mechanical protection functions will not be activated.

Temperature, High Precision Voltage Isolation Module (701265) Specifications

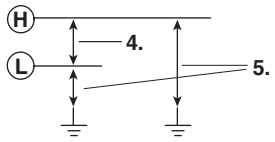
Item	Specifications
Standard operating conditions	Temperature: 23±5°C Humidity: 55±10% RH After a 30-minute warm-up and after calibration
Function	Temperature (thermocouple) or voltage measurement (switchable)
Number of input channels	2
Input coupling	TC, DC, and GND TC: Temperature (thermocouple) measurement DC: Voltage measurement (DC coupling)
Data update rate	500 Hz
Input format	Isolated unbalanced
Measurement range	[Voltage measurement] Voltage sensitivity: 1 mV to 100 V range (1-2-5 steps) [Temperature measurement] Thermocouple: K, E, J, T, L, U, N, R, S, B, W, and Au7Fe
Measurement range/accuracy[1]	[Voltage measurement] Voltage sensitivity: 1 mV to 100 V range (1-2-5 steps) Voltage accuracy: ±(0.08% of range + 2 μV) [Temperature measurement][2]

Type	Measurement Range	Accuracy
K E J T L U N	–200 to 1300°C –200 to 800°C –200 to 1100°C –200 to 400°C –200 to 900°C –200 to 400°C 0 to 1300°C	±(0.1% of reading + 1.5°C) Except ±(0.2% of reading + 1.5°C) for –200 to 0°C
R S	0 to 1700°C 0 to 1700°C	±(0.1% of reading + 3°C) Except ±8°C for 0 to 200°C ±5°C for 200 to 800°C
B	0 to 1800°C	±(0.1% of reading + 2°C) Except ±8°C for 400 to 700°C Effective range is 400 to 1800°C
W	0 to 2300°C	±(0.1% of reading + 3°C)
Au7Fe[3]	0 to 300K	0 to 50K: ±4K 50 to 300K: ±2.5K

Frequency characteristics[1] (–3 dB point when a sine wave with an amplitude equivalent to 60% of the range is applied)	[Voltage measurement]: DC-100 Hz [Temperature measurement]: DC-100 Hz
Maximum input voltage[4] (at a frequency of 1 kHz or less)	42 V (DC+ACpeak) for both temperature and voltage input
Maximum allowable common mode voltage[5] (at a frequency of 1 kHz or less)	42 V (DC+ACpeak) (CAT I and CAT II, 30 Vrms) for both temperature and voltage input
Vertical resolution	[Voltage measurement]: During voltage input: 24000 LSB/range [Temperature measurement]: When measuring temperature: 0.1°C
Input connector	Binding post
Input impedance	Approx. 1 MΩ
Common mode rejection ratio	[Voltage measurement]: 80 dB or more (50/60 Hz) (typical[6]) [Temperature measurement]: 120 dB or more (50/60 Hz, with 2-Hz filter ON, signal source resistance of 500 Ω or less) (typical[6])
Residual noise level (input section shorted)	[Voltage measurement] ±4 μV or ±0.1% of the range, whichever is greater (typical[6])
A/D conversion resolution	[Voltage measurement]: 16 bits (24000 LSB/range) Twice the measurement range
Temperature coefficient [Voltage measurement]	Zero point: ±(0.01% of range)/°C + 0.05 μV/C°C (typical[6]) Gain: ±(0.02% of range)/°C (typical[6])

Item	Specifications
Reference junction compensation accuracy (when the input terminal temperature is balanced)	
	K, E, J, T, L, U, N: ±1°C
	R, S, B, W: ±1.5°C
	Au7Fe: ±1K
Bandwidth limit (digital filter)	
	Select from OFF, 30 Hz, 8 Hz, and 2 Hz
Input bias current	20 nA or less The zero point appears to be offset when the input is open due to the effects of bias current on this module. However, this is not a malfunction. Connect the input to the object to be measured.

1 Value measured under standard operating conditions (section 18.11).
2 Does not include the reference junction temperature compensation accuracy.
3 This module supports Au7Fe with 0.07% metal content with respect to gold.



6 Typical value represents a typical or average value. It is not strictly warranted.

WARNING

- Do not apply input voltage exceeding the maximum input voltage or allowable common mode input voltage.
- To prevent electric shock, be sure to furnish protective earth grounding of the SL1400.
- To prevent electric shock, be sure to fasten the module screws. Otherwise, the electrical and mechanical protection functions will not be activated.

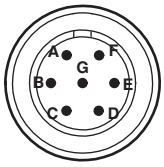
Strain Module (NDIS) (701270) Specifications

Item	Specifications
Standard operating conditions	Temperature: 23±5°C Humidity: 55±10% RH After a 30-minute warm-up and after calibration and auto balance
Effective measurement range	–FS to +FS (set using upper and lower limits)
Number of input channels	2
Maximum sample rate	100 kS/s
Input format	DC bridge (auto balancing), balanced differential input, and isolated
Auto balance type	Electronic auto balance
Auto balance range	±10000 μSTR (1 gauge method)
Bridge voltage	Select from 2 V, 5 V, and 10 V.
Gauge resistance	120 to 1000 Ω (bridge voltage: 2 V) 350 to 1000 Ω (bridge voltage: 2 V, 5 V, and 10 V)
Gauge factor	1.90 to 2.20 (set in 0.01 steps)
Frequency characteristics[1]	(–3 dB point when a sine wave with an amplitude equivalent to 60% of the range is applied) DC to 20 kHz
mV/V range support	Supports the strain gauge transducer unit system. mV/V range = 0.5×(μSTR range/1000)
Measurement range (FS) and measurement range	When using STR range Measurement Range (FS) — Measurement Range 500 μSTR — –500 to +500 μSTR 1000 μSTR — –1000 to +1000 μSTR 2000 μSTR — –2000 to +2000 μSTR 5000 μSTR — –5000 to +5000 μSTR 10000 μSTR — –10000 to +10000 μSTR 20000 μSTR — –20000 to +20000 μSTR
	When using mV/V range Measurement Range (FS) — Measurement Range 0.25 mV/V — –0.25 to +0.25 mV/V 0.5 mV/V — –0.5 to +0.5 mV/V 1 mV/V — –1 to +1 mV/V 2.5 mV/V — –2.5 to +2.5 mV/V 5 mV/V — –5 to +5 mV/V 10 mV/V — –10 to +10 mV/V
DC accuracy[1]	±(0.5% of FS + 5 μSTR)
Maximum input voltage (At 1 kHz or less)	Between Input+ and Input– 10 V (DC+ACpeak)
Maximum allowable common mode voltage (At 1 kHz or less)	Between each terminal and earth ground 42 V (DC+ACpeak) (CAT I and CAT II, 30 Vrms)
Input connector	NDIS connector (Recommended by JSNDI (The Japanese Society for Non-destructive Inspection)
Common mode rejection ratio	80 dB (50/60 Hz) or more (typical[2])
A/D conversion resolution	16 bit (48000 LSB/±FS: when Upper is +FS and Lower is –FS)
Temperature coefficient	Zero point: ±5 μSTR/°C (typical[2]) Gain: ±(0.02% of FS)/°C (typical[2])
Bandwidth limit	Select from OFF, 1 kHz, 100 Hz, and 10 Hz Cutoff characteristics: –12 dB/OCT (typical[2])
Function	mV/V support. Supports the strain gauge transducer unit system.
Standard accessories	NDIS connector (for external connection: PRC03-12A10-7M10.5 by Tajimi) A1002JC: 2 pieces
Compatible accessories (sold separately)	Recommended bridge head 701955 (NDIS 120 Ω, enhanced shield version, comes with a 5-m cable) Recommended bridge head 701956 (NDIS 350 Ω, enhanced shield version, comes with a 5-m cable)

Item	Specifications
Precautions	• Highly sensitive measurements are made in the μV level in strain measurements. Therefore, take measures against noise at the strain sensor perimeter, bridge head, and cable wiring. • Depending on the noise environment, an error may result in the balance. Check the influence before making measurements. • The bridge head specified by YOKOGAWA has high noise resistance. • Some of the strain gauge sensors and bridge heads made by other manufacturers do not have sensing wires connected. (No such problems with bridge heads made by YOKOGAWA.) If such products are used, an error may result in the bridge voltage leading to measurement errors, because sensing does not work effectively. If possible, it is desirable that sensing be done very close to the bridge. However, if this is not possible, use the NDIS conversion cable (DV450-001) that is sold separately by YOKOGAWA. Outline specifications of the DV450-001: Sensing cable, NDIS male-female, 30 cm in length, insert it as close to the bridge as possible. • The connector shell is connected to the case potential. • When a bridge head (701955 or 701956) is used, the connector shell, cable shield, and the bridge head case are all connected to the case potential of the SL1400. • When a bridge head (701955 or 701956) is used, the floating GND is connected to the bridge head case inside the bridge head. • Be sure to execute balancing again when you change the range or the bridge voltage.

1 Value measured under standard operating conditions (section 18.11).
2 Typical value represents a typical or average value. It is not strictly warranted.

Module front View



A: Bridge+ (positive bridge voltage)
B: Input- (negative measurement signal)
C: Bridge- (negative bridge voltage)
D: Input+ (positive measurement signal)
E: Floating common
F: Sense+ (positive bridge voltage sensing)
G: Sense- (positive bridge voltage sensing)

The connector shell is connected to the case potential.

WARNING

- Do not apply input voltage exceeding the maximum input voltage, withstand voltage, or allowable surge voltage.
- To prevent electric shock, be sure to furnish protective earth grounding of the SL1400.
- To prevent electric shock, be sure to fasten the module screws. Otherwise, the electrical and mechanical protection functions will not be activated.
- Avoid continuous connection under an environment in which the allowable surge voltage may occur.

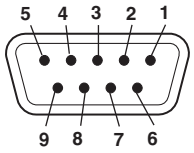
Strain Module (DSUB, Shunt-Cal) (701271) Specifications

Item	Specifications
Standard operating conditions	Temperature: 23±5°C Humidity: 55±10% RH After a 30-minute warm-up and after calibration and auto balance
Effective measurement range	–FS to +FS (set using upper and lower limits)
Number of input channels	2
Maximum sample rate	100 kS/s
Input format	DC bridge (auto balancing), balanced differential input, and isolated
Auto balance type	Electronic auto balance
Auto balance range	±10000 μSTR (1 gauge method)
Bridge voltage	Select from 2 V, 5 V, and 10 V.
Gauge resistance	120 to 1000 Ω (bridge voltage: 2 V) 350 to 1000 Ω (bridge voltage: 2 V, 5 V, and 10 V)
Gauge factor	1.90 to 2.20 (set in 0.01 steps)
Frequency characteristics[1]	(–3 dB point when a sine wave with an amplitude equivalent to 60% of the range is applied) DC to 20 kHz
mV/V range support	Supports the strain gauge transducer unit system. mV/V range = 0.5×(μSTR range/1000)
Measurement range (FS) and measurement range	When using STR range Measurement Range (FS) — Measurement Range 500 μSTR — –500 to +500 μSTR 1000 μSTR — –1000 to +1000 μSTR 2000 μSTR — –2000 to +2000 μSTR 5000 μSTR — –5000 to +5000 μSTR 10000 μSTR — –10000 to +10000 μSTR 20000 μSTR — –20000 to +20000 μSTR
	When using mV/V range Measurement Range (FS) — Measurement Range 0.25 mV/V — –0.25 to +0.25 mV/V 0.5 mV/V — –0.5 to +0.5 mV/V 1 mV/V — –1 to +1 mV/V 2.5 mV/V — –2.5 to +2.5 mV/V 5 mV/V — –5 to +5 mV/V 10 mV/V — –10 to +10 mV/V
DC accuracy[1]	±(0.5% of FS + 5 μSTR)
Maximum input voltage (At 1 kHz or less)	Between Input+ and Input– 10 V (DC+ACpeak)
Maximum allowable common mode voltage (At 1 kHz or less)	Between each terminal and earth ground 42 V (DC+ACpeak) (CAT I and CAT II, 30 Vrms)
Input connector	9-pin D-Sub connector (female)
Common mode rejection ratio	80 dB (50/60 Hz) or more (typical[2])
A/D conversion resolution	16 bit (48000 LSB/±FS: when Upper is +FS and Lower is –FS)
Temperature coefficient	Zero point: ±5 μSTR/°C (typical[2]) Gain: ±(0.02% of FS)/°C (typical[2])
Bandwidth limit	Select from OFF, 1 kHz, 100 Hz, and 10 Hz Cutoff characteristics: –12 dB/OCT (typical[2])
Function	mV/V support. Supports the strain gauge transducer unit system. Shunt calibration support. Built-in shunt calibration relay (1 gauge method).
Standard accessories	Connector shell set for soldering A1520JD (9-pin D-Sub): 2 pieces, A1618JD (connector shell): 2 pieces
Compatible accessories (sold separately)	Recommended bridge head 701957 (D-Sub 120 Ω, shunt-Cal, comes with a 5-m cable) Recommended bridge head 701958 (D-Sub 350 Ω, shunt-Cal, comes with a 5-m cable)

Item	Specifications
Precautions	• Highly sensitive measurements are made in the μV level in strain measurements. Therefore, take measures against noise at the strain sensor perimeter, bridge head, and cable wiring. • Depending on the noise environment, an error may result in the balance. Check the influence before making measurements. • The bridge head specified by YOKOGAWA has high noise resistance. • When executing shunt calibration, be sure to calculate the shunt resistance in advance, and execute it in a range so that the measured values do not exceed the range even when the shunt resistance is ON. • Some of the strain gauge sensors and bridge heads made by other manufacturers do not have sensing wires connected. (No such problems with bridge heads made by YOKOGAWA.) If such products are used, an error may result in the bridge voltage leading to measurement errors, because sensing does not work effectively. Perform sensing as close to the bridge head as possible. (There is no conversion cable for sensing on D-Sub connector types.) • The connector shell is connected to the case potential. • When a bridge head (701957 or 701958) is used, the connector shell, cable shield, and the bridge head case are all connected to the case potential of the SL1400. • When a bridge head (701957 or 701958) is used, the floating GND is connected to the bridge head case inside the bridge head. • Be sure to execute balancing again when you change the range or the bridge voltage.

1 Value measured under standard operating conditions (section 18.11).
2 Typical value represents a typical or average value. It is not strictly warranted.

Module front View



1: Floating common
2: Sense- (positive bridge voltage sensing)
3: Shuntcal- (negative shunt signal)
4: Shuntcal+ (positive shunt signal)
5: Sense+ (positive bridge voltage sensing)
6: Bridge- (negative bridge voltage)
7: Input- (negative measurement signal)
8: Input+ (positive measurement signal)
9: Bridge+ (positive bridge voltage)

WARNING

- Do not apply input voltage exceeding the maximum input voltage, withstand voltage, or allowable surge voltage.
- To prevent electric shock, be sure to furnish protective earth grounding of the SL1400.
- To prevent electric shock, be sure to fasten the module screws. Otherwise, the electrical and mechanical protection functions will not be activated.
- Avoid continuous connection under an environment in which the allowable surge voltage may occur.

Acceleration/Voltage Module (with AAF) (701275) Specifications

Item	Specifications
Standard operating conditions	Temperature: 23±5°C Humidity: 55±10% RH After a 30-minute warm-up and after calibration
Effective measurement range	Twice the measurement range
Number of input channels	2
Input coupling	AC, DC, ACCL (acceleration), and GND
Maximum sample rate	100 kS/s
Input format	Isolated unbalanced
Frequency characteristics[1]	(–3 dB point when a sine wave with an amplitude equivalent to 60% of the range is applied) Waveform measurement mode: DC to 40 kHz Acceleration measurement mode: 0.4 Hz to 40 kHz
Voltage-axis sensitivity range	1:1 ProbeFactor: 50 mV to 100 V range (1-2-5 steps) 10:1 ProbeFactor: 500 mV to 1 kV range (1-2-5 steps) (combined with the recommended probe 701940) Acceleration (±5 V = ×1 range: ×0.1 to ×1 to ×100 (1-2-5 steps))
Maximum input voltage	(At 1 kHz or less) 42 V (DC+ACpeak)[2]
Maximum allowable common mode voltage	(at a frequency of 1 kHz or less) Working voltage of safety standard 30 Vrms (CAT I and CAT II)[3]
Vertical (voltage) axis accuracy	Waveform measurement mode DC accuracy: ±(0.25% of range) Acceleration measurement mode: ±(0.5% of range) at 1 kHz
Input connector	Metal BNC connector
Input impedance	1 MΩ±1%, approx. 35 pF
Lower –3 dB point when AC coupled	0.4 Hz or less (0.04 Hz or less when using the 701940) (typical[4])
Common mode rejection ratio	80 dB (50/60 Hz) or more (typical[4])
Residual noise level (Input section shorted)	±100 μV or ±0.1% of the range, whichever is greater (typical[4])
A/D conversion resolution	16 bits (24000 LSB/range)
Temperature coefficient	When in waveform measurement mode (excluding AUTO filter) Zero point: ±(0.02% of range)/°C (typical[4]) Gain: ±(0.02% of range)/°C (typical[4])
Bandwidth limit	Select from OFF, Auto, 4 kHz, 400 Hz, and 40 Hz Cutoff characteristics: –12 dB/OCT (typical[4], excluding AUTO) Cutoff frequency (fc) when set to AUTO Sample rate of 100 kHz or higher: fc = 40 kHz Sample rate of 100 Hz to 50 kHz: fc = 40% of the sample rate Sample rate of 50 Hz or less: fc = 20 Hz Cutoff characteristics when set to AUTO: –65 dB at 2×fc (typical[4])
Probe attenuation setting	Voltage probe 1:1, 10:1, 100:1, and 1000:1 Current probe 10 A:1 V (for the 701933) and 100 A:1 V (for the 701930/701931)
Compatible probes/cables	Connection cable (for low voltage 1:1) 366926 (non-isolated type BNC-alligator clip × 2: For measuring low voltage less than or equal to 42 Vpeak) Voltage probe (10:1 passive probe) 701940 17 to 46 pF: For measuring 600 V (DC+ACpeak) or less Current probe (power can be supplied from the SL1400) 701930 (150 A), 701931 (500 A), and 701933 (30 A)
Sensor supply current (voltage)	OFF or 4 mA±10% (approx. 22 VDC)
Applicable acceleration sensor	Built-in amplifier type Kistler Instrument Corporation: Piezotron, PCB Piezotronics Incorporated: ICP, ENDEVCO Corporation: ISOTRON, etc.

Item	Specifications

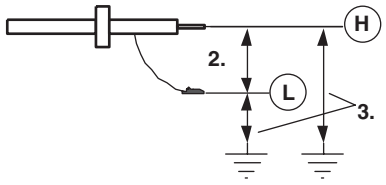
Table of cutoff frequency characteristics of the anti-aliasing filter (AAF)

When the filter is set to Auto, the anti-aliasing filter and low-pass filter are automatically set according to the sample rate.

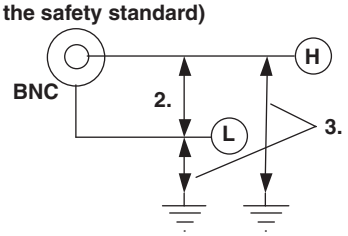
Sample rate	AAF	Low-Pass Filter
100 kS/s	40 kHz	OFF
50 kS/s	20 kHz	OFF
20 kS/s	8 kHz	OFF
10 kS/s	4 kHz	4 kHz
5 kS/s	2 kHz	4 kHz
2 kS/s	800 Hz	4 kHz
1 kS/s	400 Hz	400 Hz
500 S/s	200 Hz	400 Hz
200 S/s	80 Hz	400 Hz
100 S/s	40 Hz	40 Hz
50 S/s	20 Hz	40 Hz
20 to 5 S/s	20 Hz	40 Hz
2 S/s or less	20 Hz	40 Hz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

1 Value measured under standard operating conditions (section 18.11).

Combined with the 10:1 passive probe (701940)



Direct input (cable not complying with the safety standard)



4 Typical value represents a typical or average value. It is not strictly warranted.

WARNING

- Do not apply input voltage exceeding the maximum input voltage, withstand voltage, or allowable surge voltage.
- To prevent electric shock, be sure to furnish protective earth grounding of the SL1400.
- To prevent electric shock, be sure to fasten the module screws. Otherwise, the electrical and mechanical protection functions will not be activated.
- Avoid continuous connection under an environment in which the allowable surge voltage may occur.

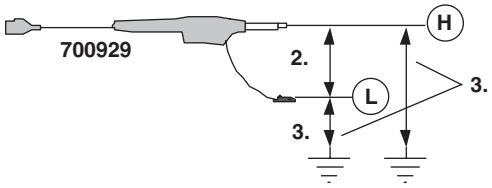
Frequency Module (701280) Specifications

Item	Specifications
Standard operating conditions	Temperature: 23±5°C Humidity: 55±10% RH After the warm-up time of 30 minutes has elapsed
Measurement function	Frequency, RPMs, RPSs, period, duty cycle, power supply frequency, pulse width, pulse integration, and velocity
Effective measurement range	Twice the measurement range
Number of input channels	2
Data update rate	25 kHz (40 μs)
Output delay	Up to 2 computation periods
Input format	Isolated unbalanced
Input connector	BNC connector (isolated type)
Maximum input voltage	Module only (when 1:1 cable is connected, across input terminals H and L): 42 V (DC+ACpeak)[4] Combined with the 700929 (10:1) (across the probe tips, H and L): 420 V (DC+ACpeak)[2]
Maximum allowable common mode voltage	Working voltage of safety standard Module only (when 1:1 cable is connected, across input terminal L and earth) 30 Vrms (CAT I and CAT II)[5] Combined with the 700929 (10:1) (across probe tip H or L and earth) 300 Vrms (CAT I and CAT II)[3]
Insulation resistance	500 VDC, 10 MΩ or more (across each input terminal and earth)
Minimum measurement resolution	50 ns
Measured data resolution	16 bits (24000 LSB/range)
Measurement accuracy[1]	• When in frequency, RPM, RPS, or velocity measurement mode[6] Measurement accuracy is specified according to the measurement range and input frequency [Definition of measurement accuracy] ±(0.05% of range + accuracy dependent on the input frequency) [Accuracy dependent on the input frequency] Input frequency of 2 or less: 0.05% of the input frequency + 0.001 Hz Input frequency of 2 to 10 kHz: 0.1% of the input frequency Input frequency of 10 to 20 kHz: 0.3% of the input frequency Input frequency of 20 or higher: 0.5% of the input frequency • **When in power supply frequency mode**[7] When the center frequency is 50/60 Hz ±0.03 Hz (0.01 Hz resolution) When the center frequency is 400 Hz: ±0.3 Hz (0.01 Hz resolution) (Input set to 100 VAC or 200 VAC with sine wave input) • **When in period measurement mode**[*6] Measurement accuracy is specified according to the measurement range and input period [Definition of measurement accuracy] ±(0.05% of range + accuracy dependent on the input period) [Accuracy dependent on the input period] Input period of 500 μs or greater: 0.05% of the input period Input period of 100 to 500 μs: 0.1% of the input period Input period of 50 to 100 μs: 0.3% of the input period Input period of 50 μs or less: 0.5% of the input period + 0.1 μs • **When in duty cycle measurement mode**[8] Dependent on the input frequency Input frequency of 1 kHz or less: ±0.1% Input frequency of 1 to 10 kHz: ±0.2% Input frequency of 10 to 50 kHz: ±1.0% Input frequency of 50 to 100 kHz: ±2.0% Input frequency of 100 to 200 kHz: ±4.0% • **When in pulse width measurement mode**[*8] Measurement accuracy is specified according to the measurement range and input pulse width [Definition of measurement accuracy] ±(0.05% of range + accuracy dependent on the input pulse width) [Accuracy dependent on the input pulse width] Input pulse width of 500 μs or greater: 0.05% of the input pulse width Input pulse width of 100 to 500 μs: 0.1% of the input pulse width Input pulse width of 50 to 100 μs: 0.3% of the input pulse width Input pulse width of 50 μs or greater: 0.5% of the input pulse width + 0.1 μs

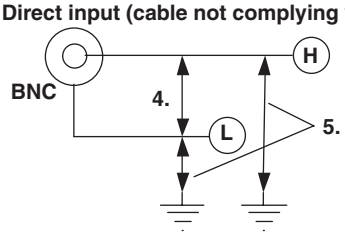
Item	Specifications
Input voltage range (±FS)	1:1 ProbeFactor: ±1 V, ±2 V, ±5 V, ±10 V, ±20 V, and ±50 V(±FS) 10:1 ProbeFactor: ±10 V, ±20 V, ±50 V, ±100 V, ±200 V, 500 V(±FS) (combined with the recommended probe 700929)
Input impedance	1 MΩ±1%, approx. 35 pF Pull-up function: 4.7 kΩ, approx. 5 V (pull-up can be turned ON only when the input is set to Pull-Up 5V)
Input coupling	AC and DC
Probe attenuation setting	10:1 and 1:1
Minimum voltage width for pulse detection	200 mV_{P-P}
Bandwidth limit	Select from Full, 100 kHz, 10 kHz, 1 kHz, and 100 Hz Cutoff characteristics: –12 dB/OCT (typical[9])
Threshold	Set within the FS of the voltage range. Set in units of 1% of the FS.
Hysteresis	Select ±1%, ±2.5%, or ±5% of the FS of the voltage range
Preset function	Logic (5V/3V/12V/24V), electromagnetic pickup, zero crossing, pull-up, AC100V, AC200V, and user-defined
Slope selection	Select rising or falling
Lower –3 dB point when AC coupled	0.5 Hz or less (0.05 Hz or less when using the 700929) (typical[9])
Chatter elimination function	OFF or 1 to 1000 ms (1 ms resolution) Eliminates the chatter that occurs such when the contact input is turned ON/OFF. Can discard the signal changes over the specified interval.
Input status indication function	Input status indication through the LEDs of each channel When in operation: Illuminates in green when pulse input is detected When overdriven: Illuminates in red when the input voltage exceeds the range
Compatible probes/cables	Connection cable (1:1): Recommended 1 366926 Voltage probe (10:1 safety probe): Recommended 2 700929 (10:1 safety probe) 20 to 45 pF: For measuring 1000 V (DC+ACpeak) or less

1 Value measured under standard operating conditions (section 18.11).

Combined with the 700929



Direct input (cable not complying with the safety standard)



Withstand voltage: 1500 Vrms for 1 minute
Allowable transient surge voltage (between earth and input): ±2100 Vpeak

6 Input waveform of 1 Vpp, rectangular wave, rise/fall time within 1 μs (input range: ±10 V, bandwidth limit: Full, and hysteresis: ±1%)
7 Input waveform of 90 Vrms, sine wave (input range: AC100V, bandwidth limit 100 kHz, and hysteresis: ±1%)
8 Input waveform of 1 Vpp, rectangular wave, rise/fall time within 5 ns (input range: ±10 V, bandwidth limit: Full, and hysteresis: ±1%)
9 Typical value represents a typical or average value. It is not strictly warranted.

WARNING

- Do not apply input voltage exceeding the maximum input voltage, withstand voltage, or allowable surge voltage.
- To prevent electric shock, be sure to furnish protective earth grounding of the SL1400.
- To prevent electric shock, be sure to fasten the module screws. Otherwise, the electrical and mechanical protection functions will not be activated.
- Avoid continuous connection under an environment in which the allowable surge voltage may occur.

Specifications by Measurement Modes

Item	Specifications
Frequency	
Measurable frequency range	0.01 Hz to 200 kHz
Selectable vertical axis sensitivity range	1 Hz to 500 kHz range (1-2-5 steps)
Minimum resolution	0.001 Hz
RPMs	
Measurable RPMs range	0.01 to 100000 rpm (where the input frequency is DC to 200 kHz).
Selectable vertical axis sensitivity range	1 to 100000 rpm range (1-2-5 steps)
Computing method	Computed from the frequency based on the number of pulses per rotation RPMs = Frequency/(pulse/rotate value) × 60
Selectable pulse/rotate range	1 to 99999
RPSs	
Measurable RPSs range	0.001 to 2000 rps (where the input frequency is DC to 200 kHz).
Selectable vertical axis sensitivity range	0.1 to 2000 rps range (1-2-5 steps)
Computing method	Computed from the frequency based on the number of pulses per rotation RPSs = Frequency/(pulse/rotate value)
Selectable pulse/rotate range	1 to 99999
Period	
Measurable period range	5 μs to 50 s (where the minimum pulse width is 2 μs
Selectable vertical axis sensitivity range	100 μs to 50 s range (1-2-5 steps)
Minimum resolution	0.1 μs
Duty cycle	
Measurable duty cycle range	0 to 100%
Selectable vertical axis sensitivity range	10 to 200% range (1-2-5 steps)
Measurable frequency range	0.1 Hz to 200 kHz
Measurement pulse selection	Select positive or negative pulse
Minimum resolution	0.01%
Power supply frequency	
Measurable frequency range	30 to 70 Hz (when the center frequency is 50 Hz), 40 to 80 Hz (when the center frequency is 60 Hz), 380 to 420 Hz (when the center frequency is 400 Hz)
Selectable vertical axis sensitivity range	1 to 20 Hz range (resolution: 0.01 Hz)
Center frequency setting	Select from 50 Hz, 60 Hz, and 400 Hz
Minimum resolution	0.0 1Hz
Pulse width	
Measurable pulse width	2 μs to 50 s (where the input frequency is up to 200 kHz)
Selectable vertical axis sensitivity range	100 μs to 50 s range (1-2-5 steps)
Measurement pulse selection	Select positive or negative pulse
Minimum resolution	0.1 μs
Pulse integration	
Maximum pulse count	2×10^9 pulses
Selectable vertical axis sensitivity range	5.000E+21 to 100.0E–21 range (1-2-5 steps: total of 123 steps)
Frequency measuring range	0.1 Hz to 200 kHz (where the minimum pulse width is 2 μs)
Computation function	Set the physical amount per pulse and display by converting the values into physical values such as distance and flow rate.
Selectable Unit/Pulse range	–9.9999E+30 to +9.9999E+30
Counter reset	Manual reset and over-limit reset
Speed	
Selectable vertical axis sensitivity range	5.000E+21 to 100.0E–21 range (1-2-5 steps: total of 123 steps)
Computing method	Set the amount of displacement per pulse and compute the velocity from the frequency Automatic unit time conversion of s, min, and hour.
Selectable Distance/Pulse range	–9.9999E+30 to +9.9999E+30

Functional Specifications

Item	Specifications
Deceleration prediction	Computes the deceleration condition in realtime when the pulse input is cut off. Can be specified when measuring the frequency, RPMs, RPSs, period, and velocity
Stop prediction	Sets the frequency to 0 after a certain time elapses after the pulse input is cut off. Stop interval setting: Set in the range of 1.5 to 10 times (10 settings) the period of the pulse measured last Can be specified when measuring the frequency, RPMs, RPSs, period, and velocity
Smoothing	Computes the moving average of the measured data using the specified time Specified time: 0.1 to 1000 ms (0.1 ms resolution) Can be specified on all measurement parameters
Pulse average	Performs frequency measurement per specified number of pulses. When fluctuation exists periodically in the pulse interval, the fluctuation can be eliminated. Specified number of pulses: 1 to 4096 Can be specified when measuring the frequency, RPMs, RPSs, power supply frequency, period, pulse integration, and velocity
Offset function	Observe fluctuation with respect to the offset frequency Offset range: Can be set up to 1000 times the maximum value/div value • Frequency: 0 Hz to 200 kHz • RPMs: 0 rpm to 50 krpm • RPSs: 0 to 1000 rps • Period: 0 to 50 s • Duty: 0 to 100% • Pulse width: 0 to 50 s • Pulse integration: -1.0000×10^{22} to 1.0000×10^{22} • Velocity: -1.0000×10^{22} to 1.0000×10^{22}

18.13 Logic Probe Specifications

High-Speed Logic Probe (700986) Specifications

Item	Specifications
Number of inputs	8
Input format	Non-isolated (earth of all bits is common, SL1400 earth and earth of all bits are common)
Maximum input voltage	42 V (DC+ACpeak) (CAT I and CAT II, 30 Vrms) across the probe tip and earth (At 1 kHz or less)
Response time	1 μs or less
Input impedance	100 kΩ or more
Threshold level	Approx. 1.4 V

Isolation Logic Probe (700987) Specifications

Item	Specifications
Number of inputs	8
Input format	Isolated (all bits are isolated)
Input connector	Safety terminal type (for banana plug) × 8
Input switching	Switchable between AC and DC for each bit
Input signal display	High and low indicated by an LED for each bit (illuminated when high)
Applicable input range	DC input: High/Low detection for 10 to 250 VDC AC input: High/Low detection for a 50/60-Hz AC system for 80 to 250 VAC
Threshold level	DC input: 6 V ± 50% (high level: 10 to 250 VDC, low level: 0 to 3 VDC) AC input: 50 VAC ± 50% (high level: 80 to 250 VAC, low level: 0 to 20 VAC)
Response time	DC input: Within 1 ms AC input: Within 20 ms
Input impedance	Approx. 100 kΩ
Maximum input voltage (across H and L of each bit)	250 Vrms[1] (CAT I and CAT II)
Maximum allowable common mode voltage (across the input terminal, H or L, and earth)	250 Vrms[1] (CAT I and CAT II)
Maximum allowable voltage between bits	250 Vrms[1] (CAT I and CAT II)
Withstand voltage (across input terminal and earth)	2000 VAC for 1 minute
Insulation resistance (across input terminal and earth)	500 VDC, 10 MΩ or more

Fuse[2]	Location	Max. Rated Voltage	Max. Rated Current	Type	Standard
	H side of input terminal	250 V	50 mA	Time lag	VDE/SEMKO certified

1 Make sure the ACpeak voltage does not exceed 350 V and the DC voltage does not exceed 250 V when the frequency is 1kHz or less.

2 Because all the fuses used by this instrument are inside the case, the user cannot exchange them. If you believe a fuse inside the case is blown, contact your nearest YOKOGAWA dealer.

Logic Probe (702911 and 702912) Specifications

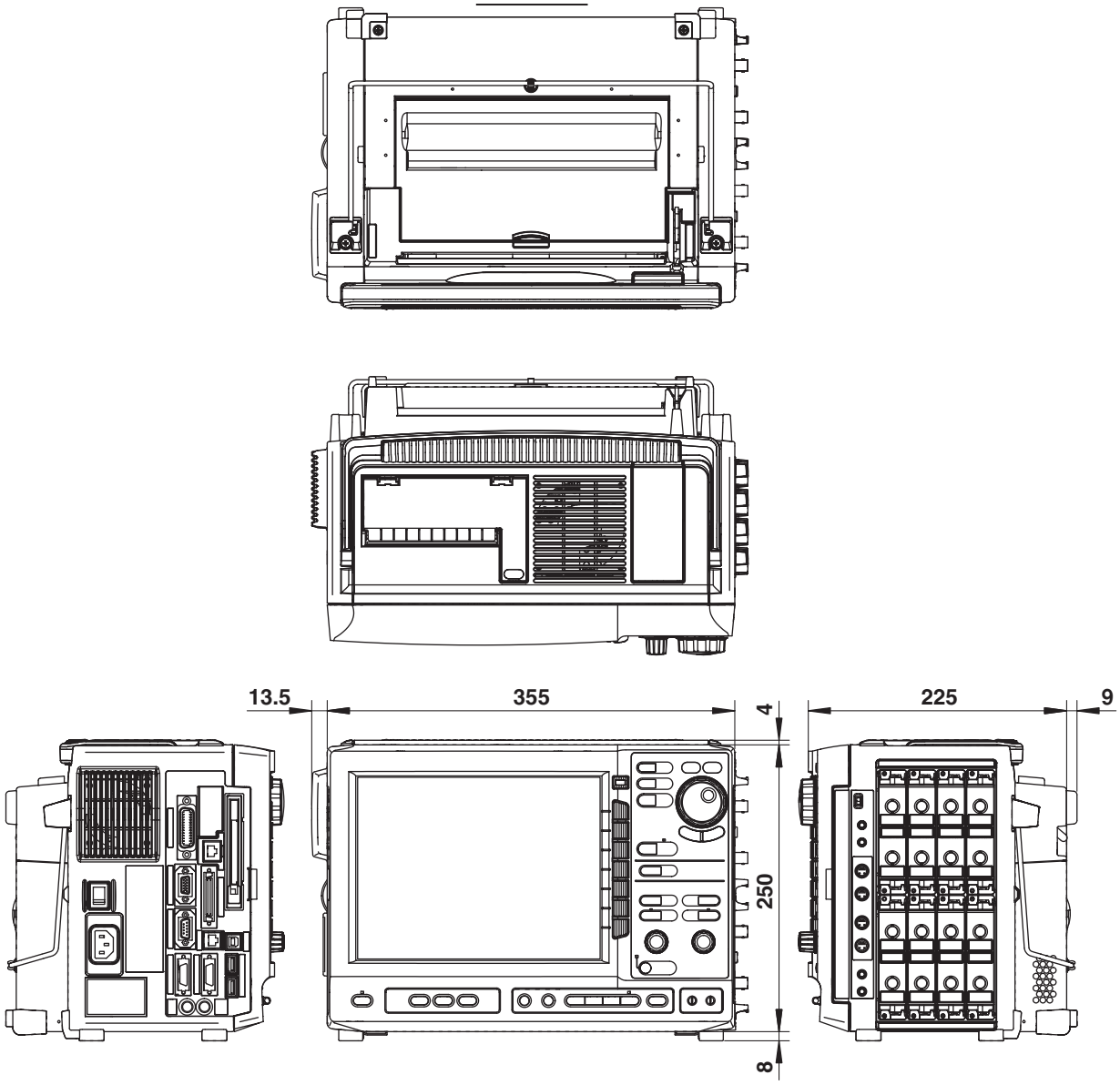
Item	Specifications
Number of inputs	8
Input format	Non-isolated (earth of all bits is common, SL1400 earth and earth of all bits are common)
Maximum input voltage	±35 V
Response time	3 μs or less
Input impedance	10 kΩ or greater
Threshold level	Approx. 1.4 V
Input type	TTL level or contact input (switching type)

18.14 External Dimensions

SL1400

Unit: mm

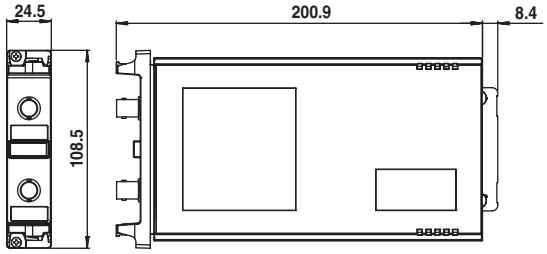
Rear View



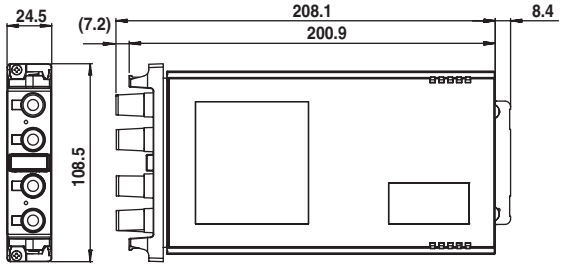
Unless otherwise specified, tolerance is ±3% (however, tolerance is ±0.3 mm when below 10 mm).

Module

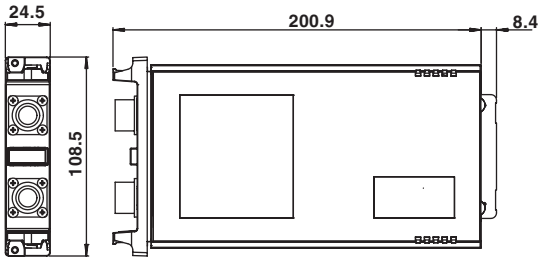
High-Speed 10 MS/s, 12-Bit Isolation Module (701250)
High-Speed High-Resolution 1 MS/s, 16-Bit Isolation Module (701251)
High-Speed 10 MS/s, 12-Bit Non-Isolation Module (701255)
High-Voltage 100 kS/s, 16-Bit Isolation Module (with RMS) (701260)



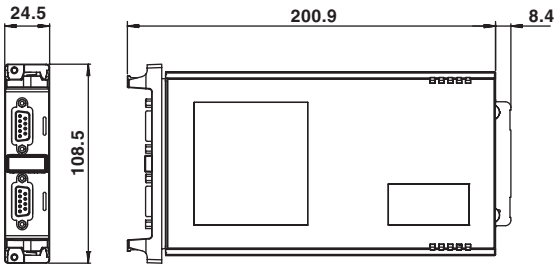
Universal (Voltage/Temp.) Module (701261)
Universal (Voltage/Temp.) Module (with AAF) (701262)
Temperature, High Precision Voltage Isolation Module (701265)



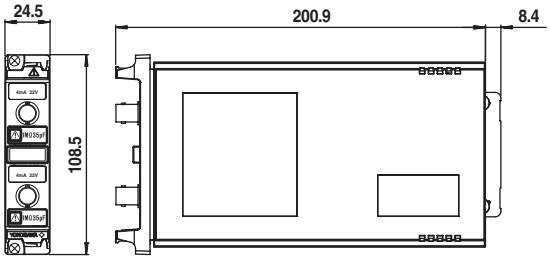
Strain Module (NDIS) (701270)



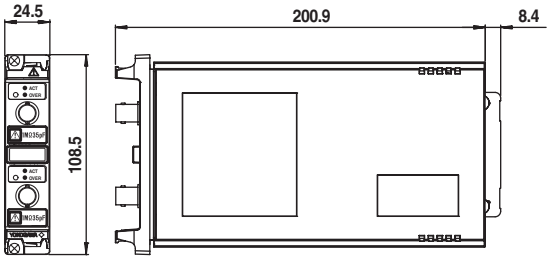
Strain Module (DSUB, Shunt-Cal) (701271)



Acceleration/Voltage Module (with AAF) (701275)



Frequency Module (701280)



Appendix 1 Relationship between the Record Time, Sample Rate and Record Length in Memory Mode

Rec. Time	Sample Rate (S/s)																			
	10 M	5 M	2 M	1 M	500 k	200 k	100 k	50 k	20 k	10 k	5 k	2 k	1 k	500	200	100	50	20	10	5
100 μs	1 k	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
200 μs	2 k	1 k	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Record length unit: Word			
500 μs	5 k	2.5 k	1 k	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1 ms	10 k	5 k	2 k	1 k	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2 ms	20 k	10 k	4 k	2 k	1 k	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5 ms	50 k	25 k	10 k	5 k	2.5 k	1 k	—	—	—	—	—	—	—	—	—	—	—	—	—	—
10 ms	100 k	50 k	20 k	10 k	5 k	2 k	1 k	—	—	—	—	—	—	—	—	—	—	—	—	—
20 ms	200 k	100 k	40 k	20 k	10 k	4 k	2 k	1 k	—	—	—	—	—	—	—	—	—	—	—	—
50 ms	500 k	250 k	100 k	50 k	25 k	10 k	5 k	2.5 k	1 k	—	—	—	—	—	—	—	—	—	—	—
100 ms	1 M	500 k	200 k	100 k	50 k	20 k	10 k	5 k	2 k	1 k	—	—	—	—	—	—	—	—	—	—
200 ms	2 M	1 M	400 k	200 k	100 k	40 k	20 k	10 k	4 k	2 k	1 k	—	—	—	—	—	—	—	—	—
500 ms	5 M	2.5 M	1 M	500 k	250 k	100 k	50 k	25 k	10 k	5 k	2.5 k	1 k	—	—	—	—	—	—	—	—
1 s	10 M	5 M	2 M	1 M	500 k	200 k	100 k	50 k	20 k	10 k	5 k	2 k	1 k	—	—	—	—	—	—	—
2 s	20 M	10 M	4 M	2 M	1 M	400 k	200 k	100 k	40 k	20 k	10 k	4 k	2 k	1 k	—	—	—	Roll mode display*		—
5 s	50 M	25 M	10 M	5 M	2.5 M	1 M	500 k	250 k	100 k	50 k	25 k	10 k	5 k	2.5 k	1 k	—	—			—
10 s	—	50 M	20 M	10 M	5 M	2 M	1 M	500 k	200 k	100 k	50 k	20 k	10 k	5 k	2 k	1 k	—	—	—	—
20 s	—	—	40 M	20 M	10 M	4 M	2 M	1 M	400 k	200 k	100 k	40 k	20 k	10 k	4 k	2 k	1 k	—	—	—
30 s	—	—	—	30 M	15 M	6 M	3 M	1.5 M	600 k	300 k	150 k	60 k	30 k	15 k	6 k	3 k	1.5 k	600	—	—
50 s	—	—	—	50 M	25 M	10 M	5 M	2.5 M	1 M	500 k	250 k	100 k	50 k	25 k	10 k	5 k	2.5 k	1 k	—	—
1 min	—	—	—	—	30 M	12 M	6 M	3 M	1.2 M	600 k	300 k	120 k	60 k	30 k	12 k	6 k	3 k	1.2 k	600	—
100 s	—	—	—	—	50 M	20 M	10 M	5 M	2 M	1 M	500 k	200 k	100 k	50 k	20 k	10 k	5 k	2 k	1 k	—
200 s	—	—	—	—	—	40 M	20 M	10 M	4 M	2 M	1 M	400 k	200 k	100 k	40 k	20 k	10 k	4 k	2 k	1 k
5 min	—	—	—	—	—	—	30 M	15 M	6 M	3 M	1.5 M	600 k	300 k	150 k	60 k	30 k	15 k	6 k	3 k	1.5 k
10 min	—	—	—	—	—	—	—	30 M	12 M	6 M	3 M	1.2 M	600 k	300 k	120 k	60 k	30 k	12 k	6 k	3 k
20 min	—	—	—	—	—	—	—	—	24 M	12 M	6 M	2.4 M	1.2 M	600 k	240 k	120 k	60 k	24 k	12 k	6 k
30 min	—	—	—	—	—	—	—	—	36 M	18 M	9 M	3.6 M	1.8 M	900 k	360 k	180 k	90 k	36 k	18 k	9 k
50 min	—	—	—	—	—	—	—	—	—	30 M	15 M	6 M	3 M	1.5 M	600 k	300 k	150 k	60 k	30 k	15 k
1 hour	—	—	—	—	–	—	—	—	—	36 M	18 M	7.2 M	3.6 M	1.8 M	720 k	360 k	180 k	72 k	36 k	18 k
100 min	—	—	—	—	—	—	—	—	—	—	30 M	12 M	6 M	3 M	1.2 M	600 k	300 k	120 k	60 k	30 k
2 hour	—	—	—	—	—	—	—	—	—	—	36 M	14.4 M	7.2 M	3.6 M	1.44 M	720 k	360 k	144 k	72 k	36 k
5 hour	—	—	—	—	—	—	—	—	—	—	—	36 M	18 M	9 M	3.6 M	1.8 M	900 k	360 k	180 k	90 k
10 hour	—	—	—	—	—	—	—	—	—	—	—	—	36 M	18 M	7.2 M	3.6 M	1.8 M	720 k	360 k	180 k
20 hour	—	—	—	—	—	—	—	—	—	—	—	—	—	36 M	14.4 M	7.2 M	3.6 M	1.44 M	720 k	360 k
30 hour	—	—	—	—	—	—	—	—	—	—	—	—	—	—	21.6 M	10.8 M	5.4 M	2.16 M	1.08 M	540 k
50 hour	—	—	—	—	—	—	—	—	—	—	—	—	—	—	36 M	18 M	9 M	3.6 M	1.8 M	900 k
100 hour	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	36 M	18 M	7.2 M	3.6 M	1.8 M
5 day	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	43.2 M	21.6 M	8.64 M	4.32 M	2.16 M
10 day	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	43.2 M	17.28 M	8.64 M	4.32 M
20 day	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	34.56 M	17.28 M	8.64 M
30 day	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	25.92 M	12.96 M

When the acquisition mode is not Average	When the acquisition mode is Average
All channels can be used	Record length 1 MW or less: All channels can be used
Record length 5 MW or less: Up to 11 channels can be used	
Record length 10 MW or less: Up to 5 channels can be used	
Record length 25 MW or less: Up to 3 channels can be used	
Record length 50 MW or less: Up to 1 channel can be used	
– Not selectable	

* For settings below the thick line (record length of 1 s or longer), roll mode display is enabled when the trigger mode is auto, auto level, single, or log.

Appendix 2 Relationship between the Chart Speed, Sample Rate and Record Length in Recorder Mode

The relationship between the chart speed, sample rate, and record length during Chart Recorder mode (see chapter 9) is as follows:

Chart Speed	Sample Rate (S/s)	Record Length (Word)	Maximum Number of Divisions That Can Be Saved	Record Time
20 mm/s	5 k	2.5 M	1000	8.33 min
10 mm/s	2 k	2 M	1000	16.66 min
5 mm/s	1 k	2 M	1000	33.3 min
2 mm/s	500	2.5 M	1000	1.38 h
1 mm/s	200	2 M	1000	2.76 h
100 mm/min	200	1.2 M	1000	1.66 h
50 mm/min	200	2.4 M	1000	3.33 h
25 mm/min	100	2.4 M	1000	6.66 h
20 mm/min	50	1.5 M	1000	8.33 h
10 mm/min	20	1.2 M	1000	16.6 h
5 mm/min	20	2.4 M	1000	1.38 day
2 mm/min	5	1.5 M	1000	3.47 day
1 mm/min	5	1.5 M	500	3.47 day
100 mm/h	5	1.8 M	1000	4.16 day
50 mm/h	5	1.8 M	500	4.16 day
25 mm/h	5	1.8 M	250	4.16 day
20 mm/h	5	1.8 M	200	4.16 day
10 mm/h	5	1.8 M	100	4.16 day

The sample rates in the table above are the data acquisition rate to the internal memory when the acquisition mode is set to normal.
If the acquisition mode is set to envelope, the data is acquired at the maximum sample rate of each input module. Then, the maximum and minimum values are determined over each interval defined by the sample rate in the table above and stored in the internal memory.

Appendix 3 Maximum Number of Acquisitions to the History Memory and Time Axis Range That Allows Realtime Recording

Maximum Number of Acquisitions to the History Memory

The maximum number of acquisitions is as follows:

Record Length	Maximum Number of Acquisitions
1 k	2000
2.5 k	483
5 k	324
10 k	241
25 k	121
50 k	60
100 k	29
250 k	11
500 k	4
1 M	3
2.5 M	1
5 M	1
10 M	1
25 M	1
50 M	1

Record length unit: Word

Time Axis Range That Allows Realtime Recording and Maximum Sample Rate

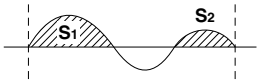
The time axis range and maximum sample rate vary depending on the number of channels as follows:

Channels Used	Time Axis Range	Maximum Sample Rate
12 or more	200 s to 30 day	5 kS/s
6 to 11 channels	1 min to 30 day	10 kS/s
4 to 5 channels	30 s to 30 day	20 kS/s
3 channels	20 s to 30 day	50 kS/s
1 to 2 channels	10 s to 30 day	100 kS/s

Appendix 4 How to Calculate the Area of a Waveform

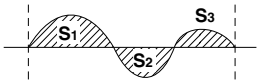
Integ1TY

Total Area for Positive Side Only: S_1+S_2



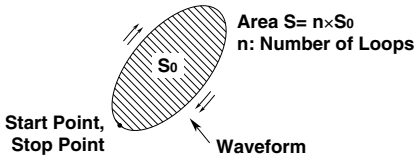
Integ2TY

Total Area for both Positive and Negative Sides: $S_1+S_3-S_2$

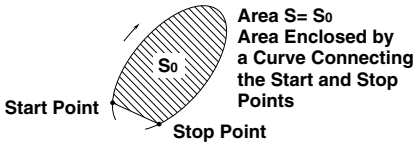


Integ1XY

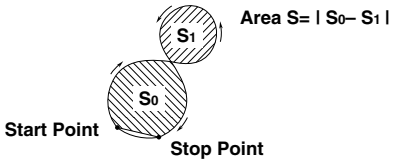
(1) Multiple Loops



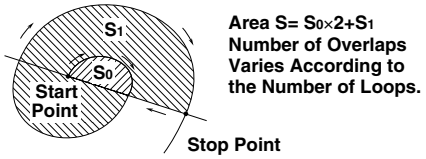
(2) Non-Closed Curve



(3) Loop Tracing a Figure-Eight



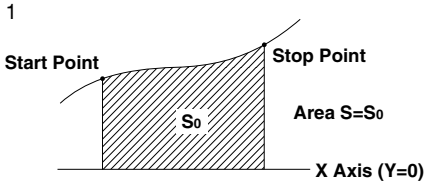
(4) Spiral Loop



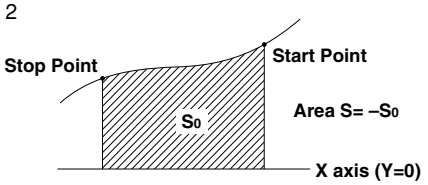
Integ2XY

(1) When Only One Y Data Corresponds to X Data

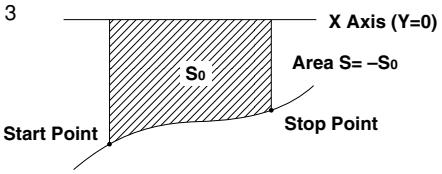
1



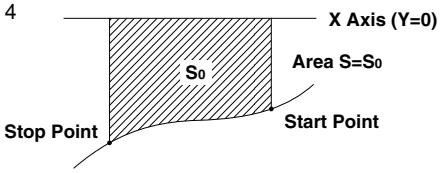
2



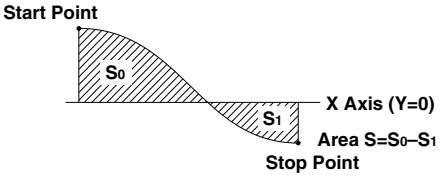
3



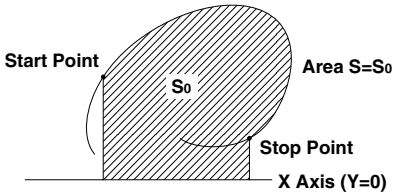
4

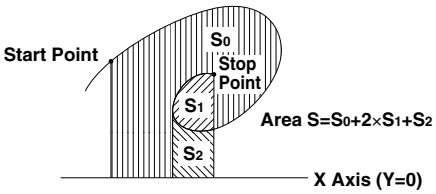


(2) When the Waveform Extends into the Negative Side



(2) When Two or more Y Data Correspond to X Data





Appendix 5 ASCII Header File Format

//YOKOGAWA ASCII		FILE FORMAT		
$PublicInfo				
FormatVersion	1.11			
Model	SL1400			
Endian	Big			
DataFormat	Trace			
GroupNumber	4			
TraceTotalNumber	13			
DataOffset	111548			
$Group1				
TraceNumber	4			
BlockNumber	1			
TraceName	CH1	CH2	CH3	CH4
BlockSize	10010	10010	10010	10010
VResolution	4.1666667E-04	2.0833333E-02	2.0833333E-02	2.0833333E-02
VOffset	1.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00
VDataType	IS2	IS2	IS2	IS2
VUnit	?	V	V	V
VPlusOverData	?	?	?	?
VMinusOverData	?	?	?	?
VIllegalData	-32768	-32768	-32768	-32768
VMaxData	32767	32767	32767	32767
VMinData	-32767	-32767	-32767	-32767
HResolution	2.0000000E-04	2.0000000E-04	2.0000000E-04	2.0000000E-04
HOffset	-2.0018000E+00	-2.0018000E+00	-2.0018000E+00	2.0018000E+00
HUnit	s	s	s	s
Date	2006/1/15	2006/1/15	2006/1/15	2006/1/15
Time	14:25:38.54	14:25:38.54	14:25:38.54	14:25:38.54
$Group2				
TraceNumber	4			
BlockNumber	1			
TraceName	CH5	CH6	CH7	CH8
BlockSize	10010	10010	10010	10010
VResolution	2.0833333E-03	2.0833333E-03	2.0833333E-03	2.0833333E-03
VOffset	0.0000000E+00	0.0000000E+00	0.0000000E+00	0.0000000E+00
VDataType	IS2	IS2	IS2	IS2
VUnit	V	V	V	V
VPlusOverData	?	?	?	?
VMinusOverData	?	?	?	?
VIllegalData	-32768	-32768	-32768	-32768
VMaxData	32767	32767	32767	32767
VMinData	-32767	-32767	-32767	-32767
HResolution	2.0000000E-04	2.0000000E-04	2.0000000E-04	2.0000000E-04

HOffset	-2.0018000E+00	-2.0018000E+00	-2.0018000E+00	2.0018000E+00
HUnit	s	s	s	s
Date	2006/1/15	2006/1/15	2006/1/15	2006/1/15
Time	14:25:38.54	14:25:38.54	14:25:38.54	14:25:38.54
$Group3				
TraceNumber	4			
BlockNumber	1			
TraceName	CH15	CH16	Math1	Math2
BlockSize	10010	10010	10010	10010
VResolution	4.1666667E-01	4.1666667E-01	2.0833333E-04	2.0833332E-05
VOffset	0.0000000E+00	0.0000000E+00	2.0000000E+00	0.0000000E+00
VDataType	IS2	IS2	IS2	IS2
VUnit	Hz	Hz	EU	EU
VPlusOverData	?	?	?	?
VMinusOverData	?	?	?	?
VIllegalData	-32768	-32768	-32768	-32768
VMaxData	32767	32767	32767	32767
VMinData	-32767	-32767	-32767	-32767
HResolution	2.0000000E-04	2.0000000E-04	2.0000000E-04	2.0000000E-04
HOffset	-2.0018000E+00	-2.0018000E+00	-2.0018000E+00	2.0018000E+00
HUnit	s	s	s	s
Date	2006/1/15	2006/1/15	2006/1/15	2006/1/15
Time	14:25:38.54	14:25:38.54	14:25:38.54	14:25:38.54
$PrivateInfo				
DisplayPointNo.	1	1	1	1
	1	1	1	1
	1	1	1	1
	1			
MathBlockNo.	1			
ModelVersion	3.1			
PTraceName	CH1	CH2	CH3	CH4
	CH5	CH6	CH7	CH8
	CH15	CH16	Math1	Math2
PUpperScaleData	6.00E+00	250.0V	250.00V	250.00V
	25.000V	25.000V	25.000V	25.000V
	5000.0Hz	5000.0Hz	4.50000E+00EU	250.000E-03EU
PLowerScaleData	-4.00E+00	-250.0V	-250.00V	-250.00V
	-25.000V	-25.000V	-25.000V	-25.000V
	-5000.0Hz	-5000.0Hz	-500.000E-03EU	250.000E-03EU
POffsetName	0.00000V	0.00000V	0.00000V	0.00000V
	0.00000V	0.00000V	0.00000V	0.00000V
	0.00000Hz	0.00000Hz		

Note

The header file is a common file used by YOKOGAWA's measuring instruments. Therefore, data that is not required by the SL1400 (0s) is also included.

$PublicInfo (Common Information)

FormatVersion:	Header file version number (common to YOKOGAWA's header files)
Model:	Model name
Endian:	Endian mode when saving data (Big/Ltl)[1]
DataFormat:	Storage format of the binary waveform data (Trace/Block)[2]
GroupNumber:	The number of "$Group"s indicated below
TraceTotalNumber:	Total number of selected waveforms
DataOffset:	Binary file start position[3]

$Group1 (Group Information)

TraceNumber:	Number of waveforms in this group
BlockNumber:	Number of blocks in this group[4]
TraceName:	Name of each waveform
BlockSize:	Number of data points in a single block of each waveform
VResolution:	Value of coefficient VResolution of the Y-axis conversion equation of each waveform[5]
VOffset:	Value of coefficient VOffset of the Y-axis conversion equation of each waveform[5]
VDataType:	Type of binary file waveform data for each waveform[6]
VUnit:	Unit used on the Y-axis of each waveform (no effect on the data)
VPlusOVerData:	Error data when the binary data of each waveform is greater than or equal to this value
VMinusOVerData:	Error data when the binary data of each waveform is less than or equal to this value
VMaxData:	Maximum value of binary data for each waveform
VMinData:	Minimum value of binary data for each waveform
HResolution:	Value of coefficient HResolution of the X-axis conversion equation of each waveform[7]
HOffset:	Value of coefficient HOffset of the X-axis conversion equation of each waveform[7]
HUnit:	Unit used on the X-axis of each waveform (no effect on the data)
Date:	Date when a trigger is activated
Time:	Time when a trigger is activated

For details on 1 to 7, see the next page.

$PrivateInfo (Model-Specific Information)

ModelVersion:	Version No. of the instrument
MathBlockNo.:	Block No. of block to be computed
DisplayPointNo.:	Value indicating the memory position (n^{th} point in the memory) corresponding the left end of the display record length.
PTraceName:	Label for each waveform
PUpperScaleData:	Scale value of the top edge of the screen
PLowerScaleData:	Scale value of the bottom edge of the screen
POffsetName:	Offset value

Creation of an ASCII Header File

If waveform data (waveform) is stored on a storage medium (such as a PC card), the following two files are automatically created.

- Waveform display data file (.wvf)
- ASCII header file (.hdr)

The waveform data file can be recalled to the instrument using the FILE menu. The ASCII header files explained here cannot be viewed on the SL1400. Use the data on a PC for analysis.

1 Endian mode when saving data

Big: Motorola 68000-family data
Ltl: Intel 86 family data

2 Storage format of the binary waveform data

Trace: Grouped into blocks for each waveform.
Block: Grouped into blocks by a given time interval.
Trace is used on the SL1400.

3 Binary file start position

Offset from the beginning of the file.

4 Maximum number of blocks in the group

Maximum number of blocks applies if the number of blocks varies between waveforms.

5 Y-axis conversion equation for each waveform

Y-axis value = VResolution × raw data + VOffset

6 Data type

ISn: n-byte signed integer
IUn: n-byte unsigned integer
FSn: n-byte signed real number
FUn: n-byte unsigned real number
Bm: m-bit data

7 X-axis conversion equation for each waveform

X-axis value = HResolution × (Data No. – 1) + HOffset

Appendix 6 List of Default Values

Key	Soft Key	Default Setting
CH1 to 16 (HS10M12(701250))		
	Range	500 V
	Variable	OFF
	Position	0.00 div
	Coupling	DC
	Probe	10:1
	BandWidth	Full
	V Zoom	×1
	Linear Scale	OFF
	InVert	OFF
	Label	Channel number
CH1 to 16 (HS1M16(701251))		
	Range	500.0 V
	Variable	OFF
	Position	0.00 div
	Coupling	DC
	Probe	10:1
	BandWidth	Full
	V Zoom	×1
	Linear Scale	OFF
	InVert	OFF
	Label	Channel number
CH1 to 16 (NONISO_10M12(701255))		
	Range	500 V
	Variable	OFF
	Position	0.00 div
	Coupling	DC
	Probe	10:1
	BandWidth	Full
	V Zoom	×1
	Linear Scale	OFF
	InVert	OFF
	Label	Channel number
CH1 to 16 (HV(with RMS)(701260))		
	Range	50.00 V
	Variable	OFF
	Position	0.00 div
	Coupling	DC
	Probe	1:1
	BandWidth	Full
	V Zoom	×1
	Linear Scale	OFF
	InVert	OFF
	Label	Channel number
CH1 to 16 (UNIVERSAL(701261)/UNIVERSAL(AAF)(701262))		
	Range	50.00 V
	Variable	OFF
	Position	0.00 div
	Coupling	DC
	BandWidth	Full
	V Zoom	×1
	Linear Scale	OFF
	InVert	OFF
	Label	Channel number

Key	Soft Key	Default Setting
CH1 to 16 (TEMP/HPV(701265))		
	Range	50.00 V
	Variable	OFF
	Position	0.00 div
	Coupling	DC
	BandWidth	Full
	V Zoom	×1
	Linear Scale	OFF
	InVert	OFF
	Label	Channel number
CH1 to 16 (STRAIN_NDIS(701270)/STRAIN_DSUB(701271))		
	Range Unit	μSTR
	Range	±20000 μSTR
	Upper	20000 μSTR
	Lower	–20000 μSTR
	Excitation	2 V
	Gauge Factor	2.00
	BandWidth	Full
	Linear Scale	OFF
	InVert	OFF
	Label	Channel number
CH1 to 16 (ACCL/VOLT(701275))		
	Range	500.0V
	Variable	OFF
	Position	0.00div
	Coupling	DC
	Probe	10:1
	BandWidth	Full
	V Zoom	×1
	Linear Scale	OFF
	InVert	OFF
	Label	Channel number
CH1 to 16 (FREQ(701280))		
	Range	10 kHz
	Variable	OFF
	Position	0.00 div
	FV Setup	Frequency
	Input Setup	User
	V Zoom	×1
	Offset	0.0 Hz
	Linear Scale	OFF
	Label	Channel number
Logic A, Logic B		
	Display	OFF
	Position	0 div
	VZoom	×1
	Label	LogicA or LogicB
	Display Bits	ON
	Bit Label	A–1 to A–8, B–1 to B–8
	Bit Mapping	Auto
	Probe	700986

Key	Soft Key	Default Setting
START/STOP		
		STOP
ACQ		
	Sample Rate	100 kS/s
	Record Time	100 ms
	Mode	Normal
	Count	Infinite
	RealTime Out	OFF
	Time Base	Int
SIMPLE/ENHANCED		
	Type	Simple
	Slope	Rising edge
	Source	CH1
	LeVel	0V
	Hysteresis	
	Hold Off	0.0 μs
MODE		
		Auto
HISTORY		
	Select Record	0
	Display Mode	One
	Start Record	0
	End Record	Oldest number
	Search Mode	OFF
MEASURE		
	Mode	OFF
	Item Setup:Trace	CH1
	Item Setup:Item	OFF
	Delay Setup:Trace	CH1
	Delay Setup:Mode	OFF
	1cycle Mode	OFF
	Time Range1	–5 div
	Time Range2	5 div
	Trace	CH1
	Dist/Prox Mode	%
	Distal	90%
	Mesial	50%
	Proximal	10%
	High/Low Mode	Auto
CURSOR		
	Type	OFF
DISPLAY		
	Format	4 Zone
	Interpolation	Line
	Graticle	Grid
	Mapping	Auto
	Trancelucent	OFF
	Extra Window	OFF
	Scale Value	ON
	Trace Label	OFF
	Accumulate	OFF
	Monitor	Both
X-Y		
	Mode	T-Y
	W1:XTrace	
	W1:YTrace	
	W2:XTrace	
	W2:YTrace	
	W3:XTrace	
	W3:YTrace	
	W4:XTrace	
	W4:YTrace	
	Start Point	–5 div
	End Point	5 div

Key	Soft Key	Default Setting
MATH		
	Mode	OFF
	Operation:Math1	OFF
	Operation:Math2	OFF
	Operation:Math3	OFF
	Operation:Math4	OFF
	Operation:Math5	OFF
	Operation:Math6	OFF
	Operation:Math7	OFF
	Operation:Math8	OFF
	Start Point	–5 div
	End Point	5 div
	Threshold:Trace	CH1
	Threshold:Upper	0.0 V
	Threshold:Lower	0.0 V
	AVerage:Mode	OFF
	Phase Shift	0.000 ms
	Filter:Select	FILT1
	Filter:Type	Gauss
	Filter:Band	Low-Pass
	Filter:CutOff	10.0%
	FFT Point	1 k
	FFT Window	Hanning
ZOOM		
	Mode	Main
	Format	Main
	Allocation	0 to 3 in order from 1CH
	Z1 Mag	500 μs/div
	Z2 Mag	500 μs/div
	Z1 Position	0 div
	Z2 Position	0 div
POSITION/DELAY		
	Position	50%
	Delay	0.0 μs
ACTION		
	Mode	OFF
	Buzzer	OFF
	Image	OFF
	PRINT	OFF
	SaVe to File	OFF
	Send Mail	OFF
	Mail Count	100
	Sequence	Cont
FILE		
	File Item	Setup
	Auto Naming	Numbering
PRINT		
	Print to	Printer
	Format	Normal
	Time Range1	–5 div
	Time Range2	5 div
	(Zoom Print) Mag	5 ms
SETUP		
	Auto Setup	0 V
	Trace	All
CAL		
	Auto Cal	ON

Key	Soft Key	Default Setting
MENU		
	System Config:Language(Menu)	Depends on the suffix code.
	System Config:Click Sound	ON
	Self Test:SCSI ID:Own ID	6
	Self Test:SCSI ID:Internal ID	4
	Others:Video Out	ON
	Others:HDD Motor	ON
	Others:Start Mode	OFF
	Others:Action Mode	OFF
	Others:START/STOP Response Time	Quick
	Others:LCD:Auto Off	OFF
	Others:LCD:Auto Off Time	1min
	Others:LCD:Brightness	5
	Remote Cntl:Device	GP-IB
	Remote Cntl:Address	1

Appendix 7 Key Assignments of the USB Keyboard

104 Keyboard (US)

Key	With the Ctrl Key Held Down on the USB Keyboard	When the Soft Keyboard Is Displayed on the SL1400		Other (Normal Condition)
		–	+Shift on the USB Keyboard	
A		*	*	
B	MENU menu	*	*	
C	Execute PRINT	*	*	
D	DISPLAY menu	*	*	
E		*	*	
F	FILE menu	*	*	
G		*	*	
H	HISTORY menu	*	*	
I	Execute IMAGE SAVE	*	*	
J		*	*	
K		*	*	
L	ALL CH menu	*	*	
M	MEASURE menu	*	*	
N	CH SEL menu	*	*	
O		*	*	
P	CHART SPEED menu	*	*	
Q	Execute CLEAR TRACE	*	*	
R	Execute RESET	*	*	
S		*	*	
T	RANGE FINE mode	*	*	
U	CURSOR menu	*	*	
V	Execute FEED	*	*	
W	POSITION FINE mode	*	*	
X	MODE menu	*	*	
Y		*	*	
Z	ZOOM menu	*	*	
1	CH1 menu	*	*	
2	CH2 menu	*	*	
3	CH3 menu	*	*	
4	CH4 menu	*	*	
5	CH5 menu	*	*	
6	CH6 menu	*	*	
7	CH7 menu	*	*	
8	CH8 menu	*	*	
9	CH9 menu	*	*	
0	CH10 menu	*	*	
Enter	Return (Enter), Select	*	*	
Esc	Escape	*	*	
Back Space		*	*	
Tab				
Space Bar		*	*	
-		*	*	
=		*	*	
[		*	*	
]		*	*	
\	INITIALIZE/CAL menu	*	*	
;		*	*	
'		*	*	
,		*	*	
.		*	*	
/	PRINT menu	*	*	
Caps Lock		*	*	

* Character or symbol similar to the normal PC keyboard is entered.
(Example) 1 key: 1 is entered if the USB keyboard is not +shift. ! is entered if the USB keyboard is +shift.

Appendix 7 Key Assignments of the USB Keyboard

Key	With the Ctrl Key Held Down on the USB Keyboard	When the Soft Keyboard Is Displayed on the SL1400		Other (Normal Condition)
		–	+Shift on the USB Keyboard	
F1	CH11 menu	Select soft key 1	Same as left	Select soft key 1
F2	CH12 menu	Select soft key 2	Same as left	Select soft key 2
F3	CH13 menu	Select soft key 3	Same as left	Select soft key 3
F4	CH14 menu	Select soft key 4	Same as left	Select soft key 4
F5	CH15 menu	Select soft key 5	Same as left	Select soft key 5
F6	CH16 menu	Select soft key 6	Same as left	Select soft key 6
F7		Select soft key 7	Same as left	Select soft key 7
F8	Escape	Escape	Same as left	Escape
F9				
F10				
F11		μ	Same as left	
F12	START/STOP	Ω	Same as left	START/STOP
Print Screen	Execute PRINT			
Scroll Lock	Execute IMAGE SAVE			
Pause	Execute SNAPSHOT			
Insert		Insert condition	Same as left	
Home	Decrease the RANGE value			Decrease the RANGE value
Page Up	Increase the POSITION value			Increase the POSITION value
Delete		*	*	
End	Increase the RANGE value			Increase the RANGE value
Page Down	Decrease the POSITION value			Decrease the POSITION value
→	Cursor to the right	Cursor to the right	Same as left	Cursor to the right
←	Cursor to the left	Cursor to the left	Same as left	Cursor to the left
↓	Jog shuttle down	Select soft key 4	Same as left	Jog shuttle down
↑	Jog shuttle up	Select soft key 6	Same as left	Jog shuttle up
(Numeric)				
Num Lock				
/		*	*	
*	START/STOP	*	*	START/STOP
-		*	*	
+		*	*	
Enter		*	*	Return(Enter), Select
1		*		Increase the RANGE value
2		*		Jog shuttle down
3		*		Decrease the POSITION value
4		*		Cursor to the left
5		*		
6		*		Cursor to the right
7		*		Decrease the RANGE value
8		*		Jog shuttle up
9		*		Increase the POSITION value
0		*	Insert condition	
.		*	Delete	

* Character or symbol similar to the normal PC keyboard is entered.
(Example) 1 key: 1 is entered if the USB keyboard is not +shift. ! is entered if the USB keyboard is +shift.

109 Keyboard (Japanese)

Key	With the Ctrl Key Held Down on the USB Keyboard	When the Soft Keyboard Is Displayed on the SL1400		Other (Normal Condition)
		–	+Shift on the USB Keyboard	
A		*	*	
B	MENU menu	*	*	
C	Execute PRINT	*	*	
D	DISPLAY menu	*	*	
E		*	*	
F	FILE menu	*	*	
G		*	*	
H	HISTORY menu	*	*	
I	Execute IMAGE SAVE	*	*	
J		*	*	
K		*	*	
L	ALL CH menu	*	*	
M	MEASURE menu	*	*	
N	CH SEL menu	*	*	
O		*	*	
P	CHART SPEED menu	*	*	
Q	Execute CLEAR TRACE	*	*	
R	Execute RESET	*	*	
S		*	*	
T	Execute RANGE FINE	*	*	
U	CURSOR menu	*	*	
V	Execute FEED	*	*	
W	POSITION FINE mode	*	*	
X	MODE menu	*	*	
Y		*	*	
Z	ZOOM menu	*	*	
1	CH1 menu	*	*	
2	CH2 menu	*	*	
3	CH3 menu	*	*	
4	CH4 menu	*	*	
5	CH5 menu	*	*	
6	CH6 menu	*	*	
7	CH7 menu	*	*	
8	CH8 menu	*	*	
9	CH9 menu	*	*	
0	CH10 menu	*	*	
Enter	Return (Enter), Select	*	*	
Esc	Escape	*	*	
Back Space		*	*	
Tab				
Space Bar		*	*	
-		*	*	
^		*	*	
@		*	*	
[		*	*	
;		*	*	
:		*	*	
]		*	*	
,		*	*	
.		*	*	
/	PRINT menu	*	*	
Caps Lock		*	*	

* Character or symbol similar to the normal PC keyboard is entered.
(Example) 1 key: 1 is entered if the USB keyboard is not +shift. ! is entered if the USB keyboard is +shift.

Appendix 7 Key Assignments of the USB Keyboard

Key	With the Ctrl Key Held Down on the USB Keyboard	When the Soft Keyboard Is Displayed on the SL1400		Other (Normal Condition)
		–	+Shift on the USB Keyboard	
F1	CH11 menu	Select soft key 1	Same as left	Select soft key 1
F2	CH12 menu	Select soft key 2	Same as left	Select soft key 2
F3	CH13 menu	Select soft key 3	Same as left	Select soft key 3
F4	CH14 menu	Select soft key 4	Same as left	Select soft key 4
F5	CH15 menu	Select soft key 5	Same as left	Select soft key 5
F6	CH16 menu	Select soft key 6	Same as left	Select soft key 6
F7		Select soft key 7	Same as left	Select soft key 7
F8	Escape	Escape	Same as left	Escape
F9				
F10				
F11		μ	Same as left	
F12	START/STOP	Ω	Same as left	START/STOP
Print Screen	Execute PRINT			
Scroll Lock	Execute IMAGE SAVE			
Pause	Execute SNAPSHOT			
Insert		Insert condition	Same as left	
Home	Decrease the RANGE value			Decrease the RANGE value
Page Up	Increase the POSITION value			Increase the POSITION value
Delete		*	*	
End	Increase the RANGE value			Increase the RANGE value
Page Down	Decrease the POSITION value			Decrease the POSITION value
→	Cursor to the right	Cursor to the right	Same as left	Cursor to the right
←	Cursor to the left	Cursor to the left	Same as left	Cursor to the left
↓	Jog shuttle down	Select soft key 4	Select soft key 4	Jog shuttle down
↑	Jog shuttle up	Select soft key 6	Same as left	Jog shuttle up
\	INITIALIZE/CAL menu	*	*	
\		*	*	
(Numeric)				
Num Lock				
/		*	*	
*	START/STOP	*	*	START/STOP
-		*	*	
+		*	*	
Enter		*	*	Return (Enter), Select
1		*		Increase the RANGE value
2		*		Jog shuttle down
3		*		Decrease the POSITION value
4		*		Cursor to the right
5		*		
6		*		Cursor to the right
7		*		Decrease the RANGE value
8		*		Jog shuttle up
9		*		Increase the POSITION value
0		*	Insert condition	
.		*	Delete	

* Character or symbol similar to the normal PC keyboard is entered.
(Example) 1 key: 1 is entered if the USB keyboard is not +shift. ! is entered if the USB keyboard is +shift.

Appendix 8 Waveform Acquisition Operation When the Power Supply Recovers after a Power Failure

The waveform acquisition operation when the power supply recovers after a power failure varies depending on the following two conditions.

- Start Mode (Power On)
  Whether to start the waveform acquisition at power on.
- Acquisition memory backup switch
  Whether to back up the acquisition memory

When Start Mode (Power On) is OFF

- **When the backup switch is OFF**
  The history memory is cleared.
  Waveform acquisition does not start regardless of whether measurement was in progress before the power failure.
- **When the Backup Switch Is ON**
  The history memory is held.
  If waveform acquisition was in progress before the power failure, the waveform acquisition is resumed.*
  Waveform acquisition does not start if measurement was stopped before the power failure.

Note

The behavior when the backup switch is ON but the batteries go flat while backing up the data is as follows:

- The history memory is cleared.
- Waveform acquisition does not start regardless of whether measurement was in progress before the power failure.

When Start Mode (Power On) is ON

- **When the Backup Switch Is OFF**
  The history memory is cleared.
  Waveform acquisition starts regardless of whether measurement was in progress before the power failure.
- **When the Backup Switch Is ON**
  The history memory is held.
  If waveform acquisition was in progress before the power failure, the waveform acquisition is resumed.* Waveform acquisition starts if measurement was stopped before the power failure.

Note

The behavior when the backup switch is ON but the batteries go flat while backing up the data is as follows:

- The history memory is cleared.
- Waveform acquisition starts regardless of whether measurement was in progress before the power failure.

* • If the acquisition mode is set to average or if realtime recording is in progress, the waveform acquisition is restarted. If a power failure occurs during realtime recording, the realtime recording file becomes an invalid file (this file cannot be loaded). Be sure that the power supply is not interrupted during realtime recording.
• Acquisition of waveforms continues during roll mode display. If the display is not in roll mode, pre-trigger data is acquired from the beginning for pre-triggered waveforms. The data of post-trigger waveform up to the power failure is considered valid, and the acquisition of waveforms continues from that point.

Appendix 9 Basic Defining Equation of Strain

Definition of Strain

$\Delta L/L = \varepsilon$ (1)

ε: Strain
L: Initial length of the material
ΔL: Amount of change due to external strain

Definition of the Gauge Factor

Gauge factor (K) refers to the ratio between the mechanical strain and the change in the resistance of the strain gauge resistor.

$$\varepsilon = \frac{\Delta L}{L} = \frac{\Delta R/R}{K} \quad (2)$$

$(\Delta R/R) = K \times \varepsilon$ (3)

R: Gauge resistance
ΔR: Amount of change in resistance when a strain is received

Normally, K=2.0. However, the value varies depending on the strain gauge material.

General Equation of the Measured Voltage (V) and Strain (ε) of the Wheatstone Bridge (1 Gauge Method)

If we assume V to be the voltage measured on the bridge and E to be the voltage applied to the bridge,

$V = (1/4) \times E \times (\Delta R/R)$ (4)

From equation (3),
$(\Delta R/R) = K \times \varepsilon$

Thus, $V = (1/4) \times E \times K \times \varepsilon$ (5)

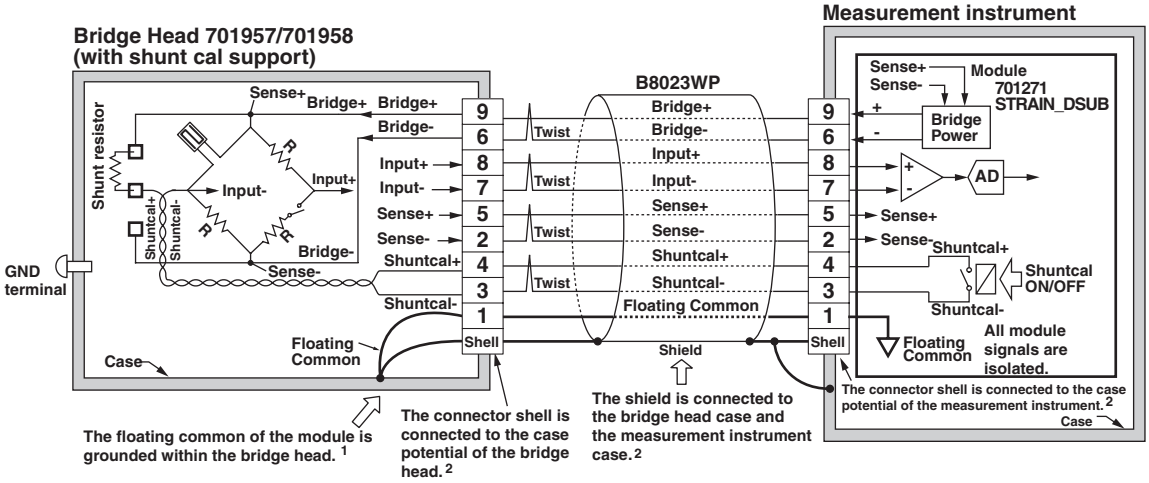
- **When Determining the Strain (ε) from the Measured Voltage (V) (Strain Gauge (1 Gauge Method))**
  If we derive ε from equation (5)
  $\varepsilon = (4/K) \times (V/E)$ (6)

- **When Determining the Measured Value of the Strain Gauge Sensor (e) from the Voltage Measured on the Bridge (V) (Strain Gauge Sensor)**
  Assuming e to be the measured value (measured value of the strain gauge sensor: mV/V unit) and substituting $\varepsilon = e$ in equation (6),
  $\varepsilon = (4/K) \times (V/E)$ (7)

  In the case of a strain gauge sensor, set the Gauge Factor (K) to 2 on the SL1400. If you change the value of K, conversion is made using the above equation.

Appendix 10 Shunt Calibration of the Strain Module

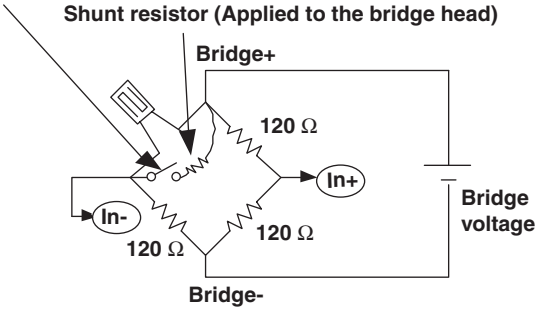
Shunt calibration is used to correct the gain of strain measurements by inserting a known resistance (shunt calibration resistance (shunt resistance)) in parallel with the strain gauge. The Strain Module (701271(STRAIN_DSUB) supports shunt calibration and contains a built-in relay circuit for shunt calibration.
To execute shunt calibration, a bridge head that supports shunt calibration (701957/701958) is needed.



1. The GND (floating common) of the module is connected to the case potential inside the bridge box.
2. The bridge head case, the cable shield, and the measurement instrument case are connected as measures against noise.

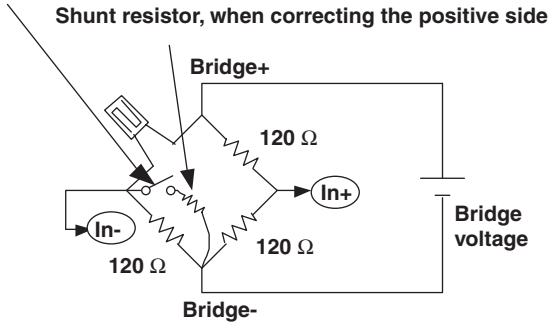
• When correcting the gain on the negative side (normal)

Shunt calibration relay circuit (Built into the strain module. Turns ON/OFF automatically when shunt calibration is executed.)



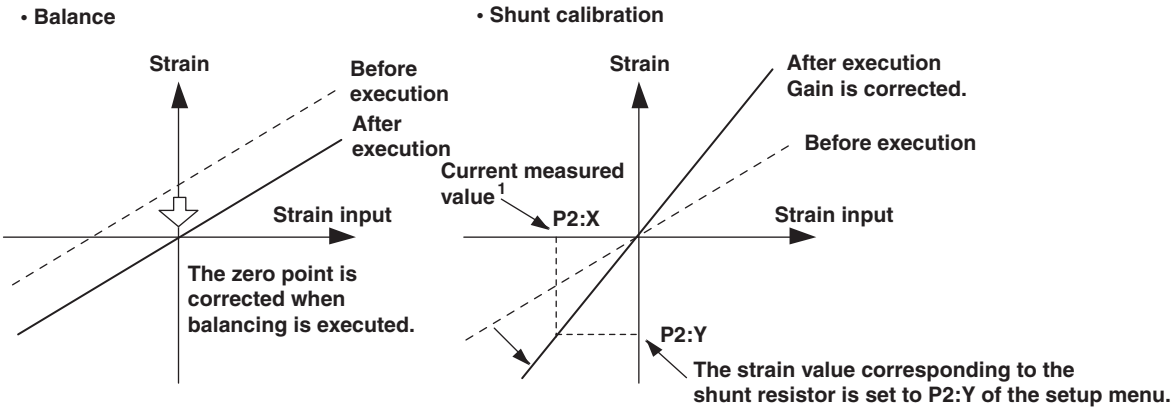
• When correcting the gain on the positive side

Shunt calibration relay circuit (Built into the strain module. Turns ON/OFF automatically when shunt calibration is executed.)



Shunt Calibration Procedure

1. Calculate the strain value (μSTR) corresponding to the shunt resistor to be used. For the calculation procedure, see “Calculating the Shunt Resistance” in the next section.
2. Execute balancing without applying a load to the strain gauge and correct the zero point.
3. Execute shunt calibration and correct the gain.
   Shunt calibration is executed using SL1400 channel menu > Linear Scale > Mode. Usually, the negative gain is corrected. However, if you are correcting the positive gain, change the position of the shunt resistor as shown in the upper right figure.



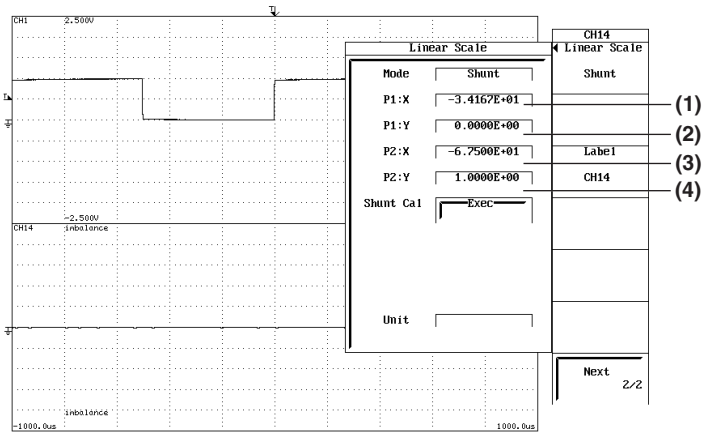
1. Automatically obtained when shunt calibration is executed.

Execution Menu of Shunt Calibration

The execution menu of shunt calibration is set using channel menu > Linear Scale > Mode. In normal shunt calibration, only P2:Y is set. In addition to the normal shunt calibration (when the shunt calibration relay circuit is ON), the SL1400 allows the setting of a zero point when the relay circuit is OFF. This function is useful when the strain value is not 0 after the execution of balancing.

Items in the Execution Menu

(1) P1:X: If (Shunt Cal) Exec is executed, the input value when the relay circuit is OFF is applied.
(2) P1:Y: Sets the value (usually 0) when the relay circuit is OFF.
(3) P2:X: If (Shunt Cal) Exec is executed when the relay circuit is ON, the input value when the relay circuit is ON is applied.
(4) P2:Y: Set the strain value corresponding to the shunt resistance when the relay circuit is ON.



Note

- When executing shunt calibration, select an appropriate range so that the measured values do not exceed the range when the shunt calibration relay circuit is ON. The SL1400 attempts shunt calibration within the current specified range.
- If shunt calibration fails (the measured value exceeds the range, for example), an error message is displayed. In such case, change the range and execute shunt calibration again.

Taking Measures against Noise

Because measurements are made at the μV level, the strain gauge is extremely susceptible to noise. If the execution of balancing or shunt calibration fails, it may be due to the effect of noise. Check the following points.

- Because the strain gauge is attached away from the bridge head, it is recommended that twisted wire be used for extension.
- Use a bridge head with high noise resistance. It is recommended that YOKOGAWA bridge head (701957/701958) with high noise resistance be used.

Calculation of the Shunt Resistance

To execute shunt calibration, the shunt resistance (Rs) and the expected strain (ε) need to be calculated in advance. Use ε as given in the equation below (normally a negative value). With the SL1400, enter the value into "P2-Y" under the shunt calibration execution menu. However, when using the general method given for shunt calibration (the easy method), an error of 1 to 2% can be introduced as the strain value (ε) increases. Therefore, calculate using the detailed method whenever possible. Also, you must select a setting range value that will not result in an overrange.

Equation for Rs and ε When Executing Shunt Calibration

- **General Equation**

  $\Delta R/R = K \times \varepsilon$ (1): Basic Equation of Strain

  $\Delta R = R - R//Rs$ (2): Equation of the change in resistance when the shunt resistance is ON

  In this manual, the parallel equation of resistors are expressed as follows:

  $$R//Rs = \frac{1}{\frac{1}{R} + \frac{1}{Rs}} = \frac{R \times Rs}{R + Rs}$$

  If ΔR is cancelled out from (1) and (2),

  $Rs = R \times (1 - K \times \varepsilon) / (K \times \varepsilon)$ (Equation A): General equation used to calculate the shunt resistance (includes error)

  ε: Strain (strain you wish to generate when the shunt resistance is turned ON)
  K: Gauge factor
  R: Bridge resistance
  ΔR: Resistance change
  Rs: Shunt resistance (shunt resistance you wish to derive)

- **Detailed Equation**

$V_0=E\times(R_1\times R_3-R_2\times R_4)/\{(R_1+R_2)\times(R_3+R_4)\}$

(1): Basic Equation of Wheatstone Bridge

When shunt calibration is ON,

$V_0=E\times(R_1\times R_3-R'\times R_4)/\{(R_1+R')\times(R_3+R_4)\}$

(2): Equation when turned ON

$R'=R_2//Rs$ (3): Equation of combined resistance R'

$R_1=R_2=R_3=R_4=R$ (4): Since R_1 to R_4 are equal, we represent them as R

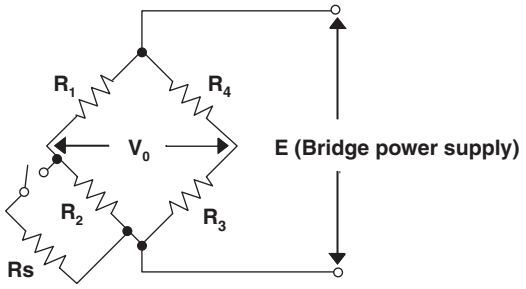
Also, from the basic equation of strain,

$V_0/E=K\times\varepsilon/4$ (5): Basic equation of strain

If V_0/E and R_1 to R_4 are cancelled out from (2), (3), (4), and (5),

$Rs=R\times(1-K\times\varepsilon/2)/(K\times\varepsilon)$ (Equation B): Detailed equation used to calculate the shunt resistance (no error)

E: Bridge voltage
V_0: Bridge output voltage
R_1 to R_4: Bridge resistance (except, $R_1=R_2=R_3=R_4$)
Rs: Shunt resistance (shunt resistance you wish to derive)
R': Combined resistance when the relay is turned ON (R'=R//Rs)



Calculation Example

- **When Determining the Corresponding Shunt Resistance (Rs) from the Strain (ε)**
  Given a gauge factor (K) of 2,
  Detailed equation (equation B) $Rs = R\times(1-\varepsilon)/(2\times\varepsilon)$ (6)
  General equation (equation A) $Rs = R\times(1-2\times\varepsilon)/(2\times\varepsilon)$ (7): Error of 1 to 2% present

Desired Strain ε (μSTR)	Derived by the Detailed Equation (6) Rs Value (Ω)		Rs value (Ω) Derived by the General Equation (7)	
	R=120 Ω	R=350 Ω	R=120 Ω	R=350 Ω
1,000	59,940	174,825	59,880	174,650
2,000	29,940	87,325	29,880	87,150
5,000	11,940	34,825	11,880	34,650
10,000	5,940	17,325	5,880	17,150

- **When Determining the Corresponding Strain (ε) from the Shunt Resistance (Rs)**
  If we derive e from equation (6) and (7),
  Detailed equation (equation B) $\varepsilon = 1/(1+2\times Rs/R)$ (8)
  General equation (equation A) $\varepsilon = 1/\{2\times(1+Rs/R)\}$ (9): Error of 1 to 2% present

When the Bridge Resistance R is 120 Ω

RS Value (Ω)	Strain ε (μSTR) Derived by the Detailed Equation (8)	Strain ε (μSTR) Derived by the General Equation (9)
60,000	999	998
30,000	1,996	1,992
12,000	4,975	4,950
6,000	9,901	9,804

When the Bridge Resistance R is 350 W

RS Value (Ω)	Strain ε (μSTR) Derived by the Detailed Equation (8)	Strain ε (μSTR) Derived by the General Equation (9)
180,000	971	970
90,000	1,941	1,937
36,000	4,838	4,814
18,000	9,629	9,537

Appendix 11 Measurement Principles (Measurement Method and Update Rate) of the Frequency Module

Measurement Principles of the Frequency Module

The measurement principles of period, frequency, pulse width, and duty cycle on the frequency module (701280 (FREQ)) are described below.

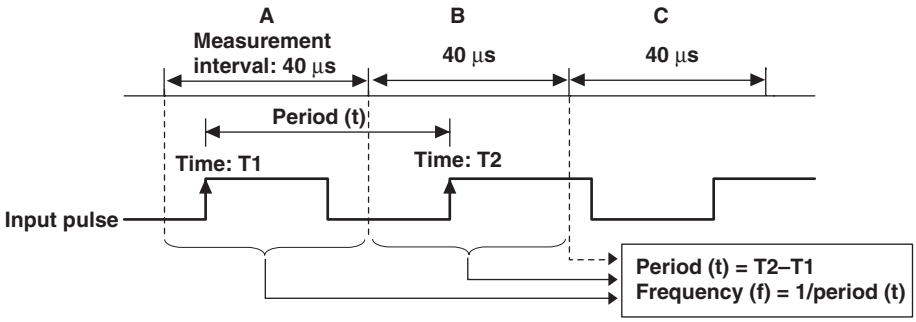
Period and Frequency Measurement

The frequency module updates the waveform at a rate of 25 kHz (40-μs interval). The measurement method differs for frequencies above 25 kHz and below 25 kHz.

- When the input signal is less than or equal to 25 kHz, measurement is made as described in (1).
- When the input signal is greater than or equal to 25 kHz, measurement is made as described in (2).
- The sequence of processing described below is performed simultaneously through pipeline processing. Thus, the period (t) and frequency (f) are updated every 40 μs.

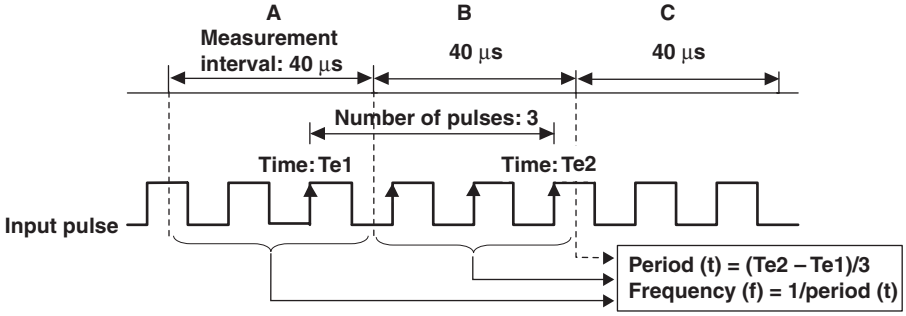
(1) When the input signal is less than or equal to 25 kHz

Measures the time of occurrence of the pulse edge (T1) in measurement interval A.
Measures the time of occurrence of the pulse edge (T2) in measurement interval B.
Calculates the period (t) = T2 – T1 in measurement interval C.
The frequency (f) is calculated as 1/period (t).
When the period of the input pulse spans over multiple measurement intervals, computation is performed at the measurement interval following the interval in which the edge is detected.



(2) When the input signal is greater than or equal to 25 kHz

Measures the time of occurrence of the last pulse edge (Te1) in measurement interval A.
Measures the time of occurrence of the last pulse edge (Te2) in measurement interval B.
Measures the number of pulses between the last pulse edge in measurement interval A and the last pulse edge of measurement interval B.
Calculates the period (t) = (Te2 – Te1)/the number of pulses in measurement interval C.
Period (t) is the average value of multiple pulses.
The frequency (f) is calculated as 1/period (t).
If the input pulse period is short, the SL1400 automatically takes the average of multiple pulses and calculates the period and frequency. Therefore, the resolution does not degrade even when the input pulse period is short, and highly accurate measurement is possible.



Pulse Width and Duty Cycle Measurement

- When the input signal is less than or equal to 25 kHz, measurement is made as described in (1).
- When the input signal is greater than or equal to 25 kHz, measurement is made from the last waveform in the measurement interval as described in (2).
- The sequence of processing described below is performed simultaneously through pipeline processing. Thus, the period (t) and frequency (f) are updated every 40 μs.

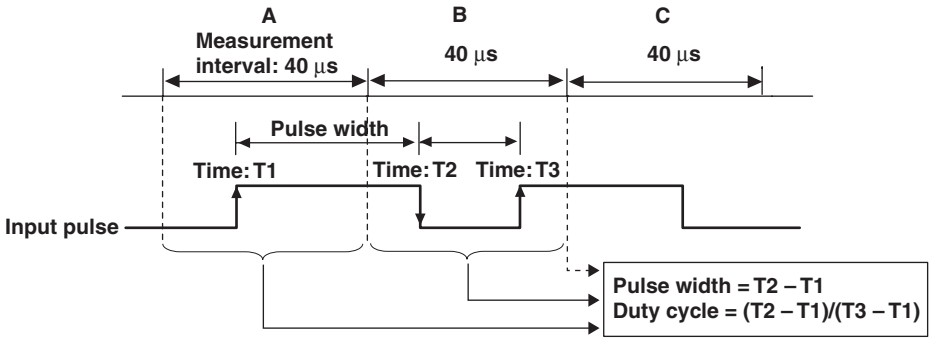
(1) When the input signal is less than or equal to 25 kHz

Measures the times of occurrences of pulse edges (T1, T2, and T3) in measurement intervals A and B.

In measurement interval C:

For pulse width: Calculates pulse width = T2 – T1.

For duty cycle: Calculates duty cycle = (T2 – T1)/(T3 – T1).



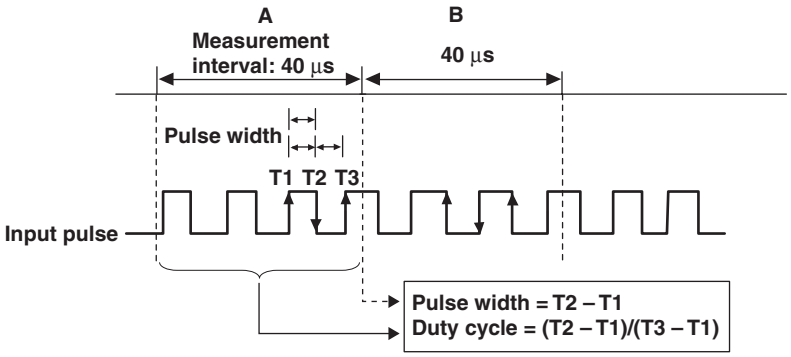
(2) When the input signal is greater than or equal to 25 kHz

Measures the times of occurrences of pulse edges (T1, T2, and T3) in measurement interval A.

In measurement interval B:

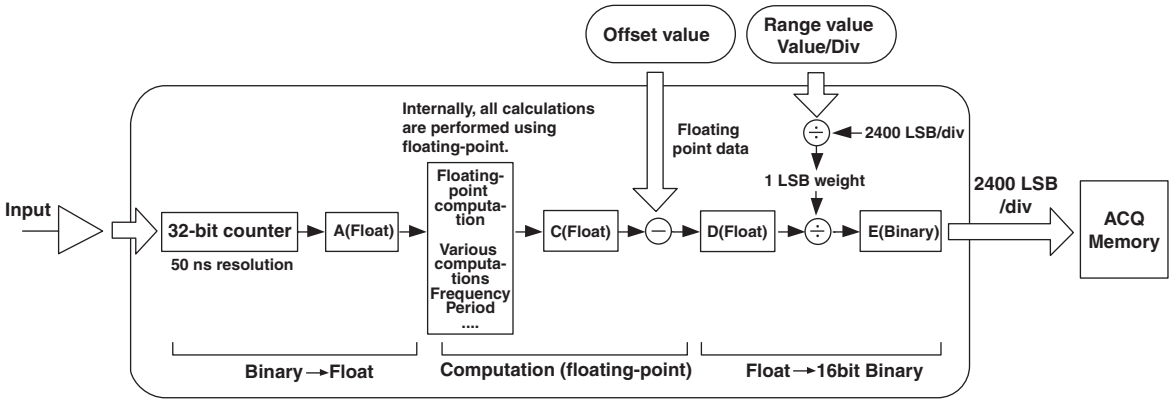
For pulse width: Calculates pulse width = T2 – T1.

For duty cycle: Calculates duty cycle = (T2 – T1)/(T3 – T1).



Computation Format (Resolution) of the Frequency Module

The computation flow on the frequency module is indicated below.



The frequency module measures the period of the input signal using a 32-bit counter of 50-ns resolution. Therefore, the minimum resolution of the counter values is 50 ns. Various computations are performed in floating point format. The data that is output from the frequency module and written to the acquisition memory (ACQ Memory) is 16-bit binary data. The data is converted using a weight of 1 LSB that is determined by Value/div. The data is normalized to 2400 LSB/div when displayed on the screen.

Input: Conversion from the 32-bit Counter Value to Floating Point

Converts the count value obtained using the 32-bit counter with 50-ns resolution to floating point format, and determines period A using the following equation.
Period: A (float) = (count value) × 50 ns

Computation

Various computations are performed in floating point format based on the settings.
Example) Frequency: C (float) = 1/A (float)

Calculation of the 1 LSB Weight of the Output

The 1 LSB weight of the output is determined from the range (Value/div).
Since 1 div = 2400 LSB,
1 LSB weight of the output = (Value/div)/2400

Computation Output: Conversion from Floating Point to 16-bit Binary (When Offset Is 0)

When the offset value is 0, offset calculation is not performed, and C (float) = D (float). The data is converted into 16-bit binary data and written to the acquisition memory (ACQ Memory).
16-bit binary data: E (binary) = D (float)/(1 LSB weight of the output)

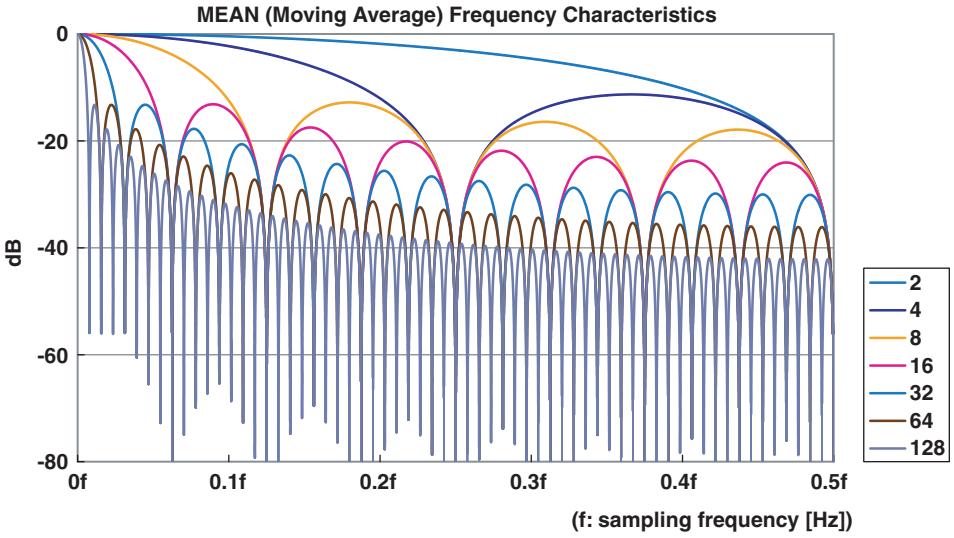
Offset Computation

When the offset value is not 0, the offset value is computed in floating point format using the following equation and converted to 16-bit binary data.
D (float) = C (float) – offset value (float)
In offset computation, if the computed result C is equal to the offset value, the output is 0. If the computed result C (float) is less than the offset value, E (binary) is negative.

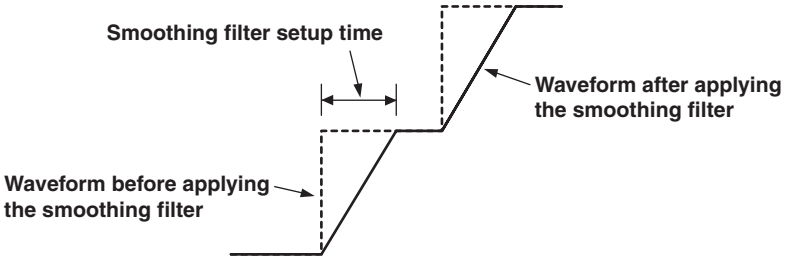
Filter Characteristics (Time Delay) of the Smoothing Filter

The smoothing filter is a moving average filter in which computation is performed in realtime. The computation interval of moving average is 40 μs (25 kHz). It is constant independent of the sampling rate of the SL1400.
The moving average order (the number of points of moving average) is specified in time. The maximum value is 25000 order (when set to 1000 ms).
The characteristics of the smoothing filter are as follows:

- The filter is a low-pass filter.
- Pass band is flat.
- Has linear phase characteristics and constant group delay by filter order.
  The group delay is derived using the following equation.
  Group delay = (the number of points of moving average – 1) × 40 μs/2
- Has comb-shaped bandwidth characteristics.



The figure below shows the result when the smoothing filter is applied to a waveform that changes in steps. The switching filter setup time follows the step change.



Appendix 12 List of Preset Settings of the Frequency Module

Logic 5V

Setup Item	Setting
V Range	±10 V
Coupling	DC
Probe	Yes[1]
Bandwidth	Yes[2]
Threshold	2.5 V
Hys	Yes[3]
Slope	Yes[4]
Chatter Elimination	Yes[5]
Pull Up	No

Logic 3V

Setup Item	Setting
V Range	±5 V (Probe = 1:1) ±10 V (Probe = 10:1)
Coupling	DC
Probe	Yes[1]
Bandwidth	Yes[2]
Threshold	1.5 V
Hys	Yes[3]
Slope	Yes[4]
Chatter Elimination	Yes[5]
Pull Up	No

Logic 12V

Setup Item	Setting
V Range	±20 V
Coupling	DC
Probe	Yes[1]
Bandwidth	Yes[2]
Threshold	6 V
Hys	Yes[3]
Slope	Yes[4]
Chatter Elimination	Yes[5]
Pull Up	No

Logic 24V

Setup Item	Setting
V Range	±50 V
Coupling	DC
Probe	Yes[1]
Bandwidth	Yes[2]
Threshold	12 V
Hys	Yes[3]
Slope	Yes[4]
Chatter Elimination	Yes[5]
Pull Up	No

Pull-up 5V

Setup Item	Setting
V Range	±10 V
Coupling	DC
Probe	1:1
Bandwidth	Yes[2]
Threshold	2.5 V
Hys	Yes[3]
Slope	Yes[4]
Chatter Elimination	Yes[5]
Pull Up	Yes[6]

ZeroCross

Setup Item	Setting
V Range	Yes[7]
Coupling	AC
Probe	Yes[1]
Bandwidth	Yes[2]
Threshold	0 V
Hys	Yes[3]
Slope	Rising edge
Chatter Elimination	Yes[5]
Pull Up	No

When you select a preset, the setup items are automatically set to the settings in the table. The meaning of Yes and No in the table is as follows:

Yes: Item that can be set to an arbitrary value
No: Item that cannot be set (not displayed on the menu)

1. Probe type: Select 1:1 or 10:1.
2. Bandwidth limit: Select 100 Hz, 1 kHz, 10 kHz, 100 kHz, or Full. Full is not selectable for AC100V and AC200V.
3. Hysteresis: Select ±1%, ±2.5%, or ±5%.
4. Slope: Select rising or falling.
5. Chatter elimination: Select from 0 ms to 1000 ms.
6. Pull-up: Select ON or OFF. Selectable only for Pull-up 5V.
7. Voltage range:
   (Probe = 1:1) Select ±1 V, ±2 V, ±5 V, ±10 V, ±20 V, or ±50 V.
   (Probe = 10:1) Select ±10 V, ±20 V, ±50 V, ±100 V, ±200 V, or ±500 V.

AC100V

Setup Item	Setting
V Range	±200 V
Coupling	AC
Probe	10:1
Bandwidth	Yes[2](Full is not allowed)
Threshold	0V
Hys	Yes[3]
Slope	Rising edge
Chatter Elimination	Yes[5]
Pull Up	No

AC200V

Setup Item	Setting
V Range	±500 V
Coupling	AC
Probe	10:1
Bandwidth	Yes[2](Full is not allowed)
Threshold	0 V
Hys	Yes[3]
Slope	Rising edge
Chatter Elimination	Yes[5]
Pull Up	No

EM Pickup

Setup Item	Setting
V Range	±1 V
Coupling	DC
Probe	1:1
Bandwidth	Yes[2]
Threshold	0 V
Hys	Yes[3]
Slope	Rising edge
Chatter Elimination	Yes[5]
Pull Up	No

User

Setup Item	Setting
V Range	Yes[7]
Coupling	Yes[8]
Probe	Yes[1]
Bandwidth	Yes[2]
Threshold	Yes[9]
Hys	Yes[3]
Slope	Yes[4]
Chatter Elimination	Yes[5]
Pull Up	No

When you select a preset, the setup items are automatically set to the settings in the table. The meaning of Yes and No in the table is as follows:
Yes: Item that can be set to an arbitrary value
No: Item that cannot be set (not displayed on the menu)

1. Probe type: Select 1:1 or 10:1.
2. Bandwidth limit: Select 100 Hz, 1 kHz, 10 kHz, 100 kHz, or Full. Full is not selectable for AC100V and AC200V.
3. Hysteresis: Select ±1%, ±2.5%, or ±5%.
4. Slope: Select rising or falling.
5. Chatter elimination: Select from 0 ms to 1000 ms.
6. Pull-up: Select ON or OFF. Selectable only for Pull-up 5V.
7. Voltage range:
   (Probe = 1:1) Select ±1 V, ±2 V, ±5 V, ±10 V, ±20 V, or ±50 V.
   (Probe = 10:1) Select ±10 V, ±20 V, ±50 V, ±100 V, ±200 V, or ±500 V.
8. Coupling: Select DC or AC.
9. Threshold level: Set within the specified voltage range.

Appendix 13 TCP and UDP Port Number Used in Ethernet Communications

The TCP and UDP port numbers that are used on the Ethernet interface of the SL1400 are as follows:

TCP Port Numbers

Port Number	Description	Function
20	File Transfer [Default Data]	FTP server, FTP client*, and a portion of the Web server
21	File Transfer [Control]	FTP server, FTP client, and a portion of the Web server
25	Simple Mail Transfer Protocol	SMTP client
80	World Wide Web HTTP	Web server and WebDAV server
515	-	LPR client
10001	-	Instrument control via the Ethernet interface

UDP Port Numbers

Port Number	Description	Function
67	Bootstrap Protocol Server	DHCP client
68	Bootstrap Protocol Client	(receive wait port)
123	Network Time Protocol	SNTP client

* The port number when FTP passive mode (see section 15.10) is turned OFF. If FTP passive mode is turned ON, the port number is arbitrary.
If FTP passive mode is OFF, connection is established from the server. If you are connecting the SL1400 behind a firewall, turn FTP passive mode ON.
For the procedure of changing the FTP passive mode, see section 15.10.

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