



CONTROL SOFTWARE FOR WF198x SERIES

INSTRUCTION MANUAL

DA00102232-003

CONTROL SOFTWARE FOR WF198x SERIES

INSTRUCTION MANUAL

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Preface

Thank you for purchasing our Multifunction Generator WF198x Series.

For safe and correct use of the electrical product, please first read "Safety Precautions" on the next page.

- This manual consists of the following chapters.

If it is the first time for you to use this product, start with "1. Outline."

1. **Outline:** Provides an overview of the functions of the Control Software.
2. **Installation:** Explains the environment required for Control Software to operate and the installation method.
3. **Control Software Operation:** Explains the basic operations of Control Software, such as starting/exiting, the window configuration, the system setting, and so on.
4. **Basic Controller:** Explains how to operate the "Basic controller" function, one of the primary functions of the Control Software.
5. **Sequence:** Explains how to operate the "Sequence" function, one of the primary functions of the Control Software.
6. **Arbitrary Waveform Editing:** Explains how to operate the Arbitrary waveform editing tool (WAVE DESIGNER for WF198x Series).
7. **Sequence View:** Explains how to operate the "Sequence View".
8. **Maintenance:** Explains how to check the version.

- Coverage of the mentioning contents.

The version of the Control Software for WF198x series is indicated on these instructions about a product after 1.0.0.0.

———— Safety Precautions ————

For safe use, ensure to obey the following warnings and cautions.

We are not responsible for damage resulting from failure to obey these warnings and cautions.

- Ensure you obey the instructions in this instruction manual.

This instruction manual contains instructions for safe operation and use of this product.

Before using the product, please read this manual first.

All the warning items contained in this instruction manual are intended for preventing risks that may lead to serious accidents. Ensure to obey them.

- If you notice anything strange

If the power system controlled by this product produces smoke, unusual odor, or strange sound, immediately stop using it.

Should you encounter any anomaly like above, make sure the system cannot be used until the repair is completed, and immediately contact us or our agent.

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Should you find any fault or any questions, please contact us or our agent from whom you purchased the product.

When you contact us or our agent, tell us the model name (or product name), version number, and more detailed symptom/condition of use.

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1. Outline

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1.1 Overview

Control Software for WF198x Series is a program to support the Remote control, Arbitrary waveform creation, Sequence functions of Multifunction Generator WF198x Series (hereinafter abbreviated as "WF198x"). This software works on Windows (10 or 11) running on a personal computer (PC), and can transfer the output control data, arbitrary waveform data, sequence data to the WF198x through USB or LAN, or perform various functions on the WF198x.

The major functions of Control Software for WF198x Series are listed below. For detailed operations of the Sequence refer to the instruction manual of WF198x.

- Basic operation function
 - Remote control
 - Status monitor

- Arbitrary waveform function
 - Creating, editing, and saving the Arbitrary waveform data
 - Transferring the Arbitrary waveform data to the WF198x

- Sequence function
 - Creating, editing, and saving the Sequence data
 - Transferring the Sequence data to the WF198x
 - Execution control of Sequence function on the WF198x
 - Monitor display during sequence execution
 - Graphical representation of the sequence

1.2 Software Configuration

Control Software for WF198x Series consists of two major functions displayed on the same screen, and one tools.

- Major functions
 - Basic controller
 - Sequence function
- Tool functions
 - Arbitrary waveform creation function
 - Sequence view function

1.3 Conventions Used in This Manual

This manual uses the following conventions to describe the functions of Control Software for WF198x Series.

- Menu names displayed on the screen, and user-input text: block letters enclosed by square brackets ([,]).
- Example: [Wave], [s=2*pi;]
- Button names displayed on the screen, and keys that user should press: block letters enclosed by a box (□).
- Example: Cancel, OK, Alt
- String that represents each function or item of this software: block letters enclosed by " ".
- Example: "Basic controller", "Arbitrary waveform editing tool"
- Press one key while holding down another key: Two keys are connected by "+".
- Example: Ctrl + O
- Press one key, release it and press another key: Two keys are connected by ", ".
- Example: Alt, F

2. Installation

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2.1 System Requirements

Make sure that your system satisfies the requirements described in Table 2-1, before installing Control Software for WF198x Series.

Table 2-1 System Requirements

Item	Description
OS	Windows 10 (64-bit) / 11 (64-bit) English
Display	1920 x 1080 pixel or higher, 256 colors or more
Free hard disk drive space	64 MB or more
Communication interface	USB / LAN
Software component	Microsoft .NET Framework 4.8 and later VISA environment See "2.2.1 Installation of USB Driver Software"

Notes

- This software might not operate properly depending on the conditions of your operating system.

■ About software component

In most cases, .NET Framework 4.8 and later component is already installed in Windows 10/11.

If it is not installed, you can download it from the Microsoft website. For installation details, please see the Microsoft website.

2.2 Installation Procedure

To install/uninstall Control Software for WF198x, log on to Windows with Administrator permissions.

To establish the communication connection between Control Software for WF198x Series and the WF198x, the USB driver software or the VISA environment must be installed.

2.2.1 Installation of USB Driver Software

If the VISA environment is set up in your computer, the USB and LAN driver software is already installed. VISA (Virtual Instrument Software Architecture) is a standard recommended by the IVI Foundation to promote the standardization of instrument software architecture.

If the VISA environment is not set up on your computer, you will need to set it up.

This software is confirmed to work on NI-VISA Version 2023 Q4 (NI-VISA.NET) provided by National Instruments Corporation. Please be aware that we do not provide support for problems that occur in the VISA environment provided by other vendor products.

If you want to use this software in the NI-VISA environment, you must obtain the license yourself from National Instruments Corporation. For details of NI-VISA, contact National Instruments Corporation or visit the National Instruments Website.

2.2.2 Installation of Control Software for WF198x Series

■ Installation procedure

1. Execute setup.exe The installer starts up.
2. Follow the instructions shown in the dialog box to click the **Next** and install the software.
3. After installation, you can perform this software (☞ 3.1).

■ Uninstallation procedure

In Windows, open Programs and Features from Control Panel. From the list of currently installed programs, select "Control Software for WF198x Series" and delete it.

The folder where Control Software for WF198x Series is installed is not always removed. The folder still contains the operation setting file of Control Software for WF198x Series, and deleting this folder and its files after uninstallation does not cause any problem.

3. Control Software Operation

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3.1 Start and Exit

This section explains how to start and exit the software.

3.1.1 Start

Following two methods are available. The desktop shortcut is automatically created when the software is installed.

- Double-click the shortcut icon on the desktop (Figure 3-1).
- From the Start menu, select [Start] - [All Programs] - [NF Corporation] - [WF198x] - [Control Software for WF198x Series].



Figure 3-1 Shortcut Icon on Desktop

3.1.2 Exit

Following three methods are available. When you perform the exit operation, the dialog opens as shown in Figure 3-2. To exit, select **Yes**. To cancel exiting, select **No**.

- Click the **X** button in the upper right corner of the window.
- With the window selected, press **Alt + F4** on the keyboard.
- From the Menu Bar, select **[File] - [Exit]**.

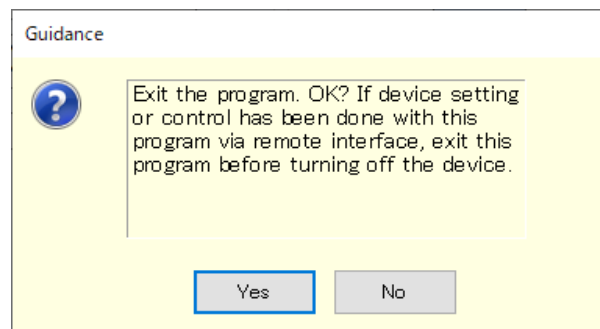


Figure 3-2 Exit Confirmation Dialog

3.2 Communication with WF198x

This software can set and control the WF198x connected via USB or LAN, by communicating with it. To distinguish from the state in which the computer and WF198x are just connected physically using a USB cable or LAN cable, "communication online state" is used to describe that the communication is established between the software and a WF198x. The state in which the communication is not established between them is called "communication offline state".

■ Communication with WF198x at Software Startup

The software checks the communication connection with the WF198x when it is started.

When the communication connection with the WF198x is established, the software retrieves the parameter settings of Basic controller from the WF198x, and displays them on the PC screen. If the communication connection with the WF198x cannot be established, the default settings of the software are used for the parameters of Basic controller.

■ Restrictions in the Communication Offline State

When you perform an operation that needs communication, the software attempts to communicate with the WF198x. If the communication connection cannot be established, the software goes into the communication offline state. In this case, a dialog opens as shown in Figure 3-3.

In the communication offline state, the WF198x cannot be controlled from the computer. The setting data and sequence data can still be created and saved to file. However, even when the software is used in the communication offline state, the system setting should be adjusted in advance for the WF198x to which this is to be connected (☞ 3.6).

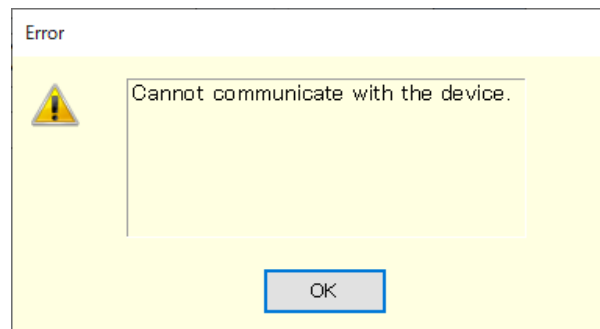


Figure 3-3 Dialog that Opens when the Communication Connection cannot be established

■ Setting the communication interface of the WF198x

To communicate with the WF198x, you must set the communication interface of the WF198x to "USBTMC" or "LAN" in advance. For details of the communication interface setting, set the instruction manual of the WF198x.

3.3 Composition of Main Window

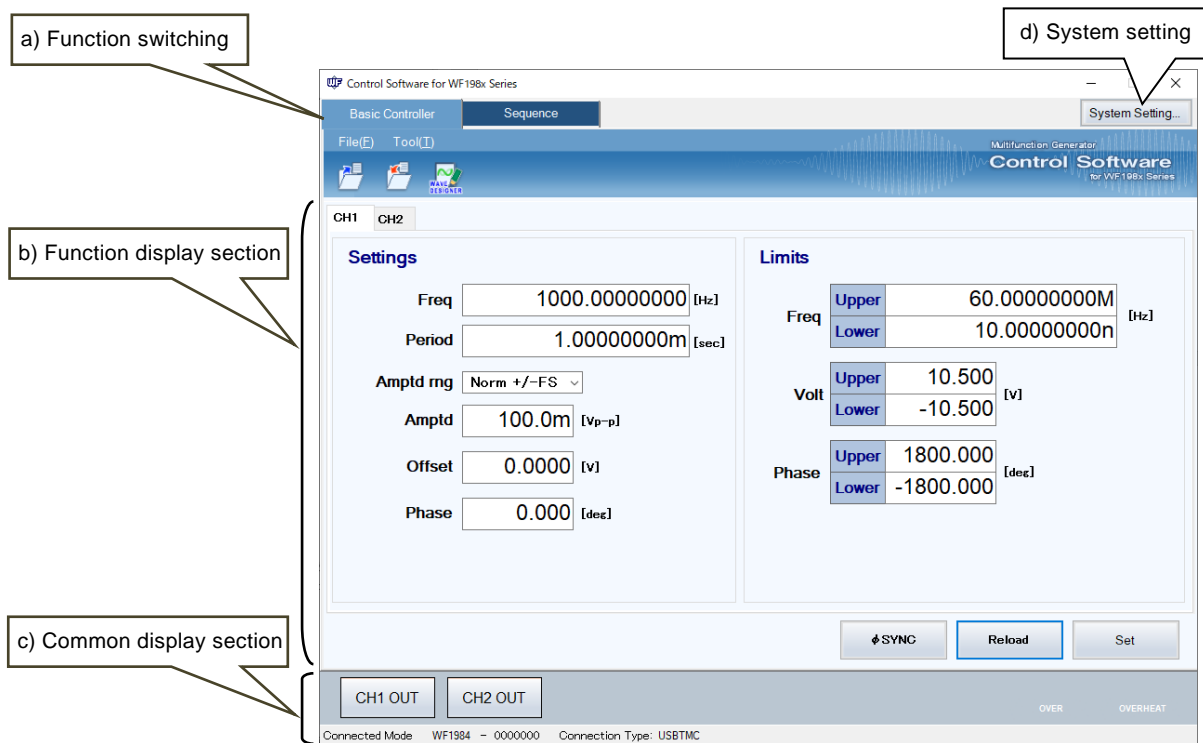








Figure 3-4 Composition of Main Window

- | | |
|-----------------------------|--|
| a) Function switching |  3.4 |
| b) Function display section |  3.4 |
| c) Common display section |  3.5 |
| d) System Setting |  3.6 |

3.4 Function Switching and Function Display Section

With this software, you can use two types of functions by switching among them.

When you click a function switching tab, items corresponding to that function are displayed in the function display section.

- Basic controller ( 4)
- Sequence ( 5)

3.5 Common Display Section

The common display section is shown commonly to all functions.

3.5.1 Operation Bar

The Operation Bar has the output ON/OFF switching button and other buttons for various function operations.



Figure 3-5 Operation Bar

3.5.2 Status Monitor

The status monitor indicates the status of the currently connected WF198x.



Figure 3-6 Status monitor

3.5.3 Status Bar

The status bar indicates the states of the WF198x connection and the software.

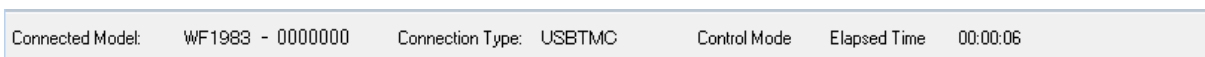


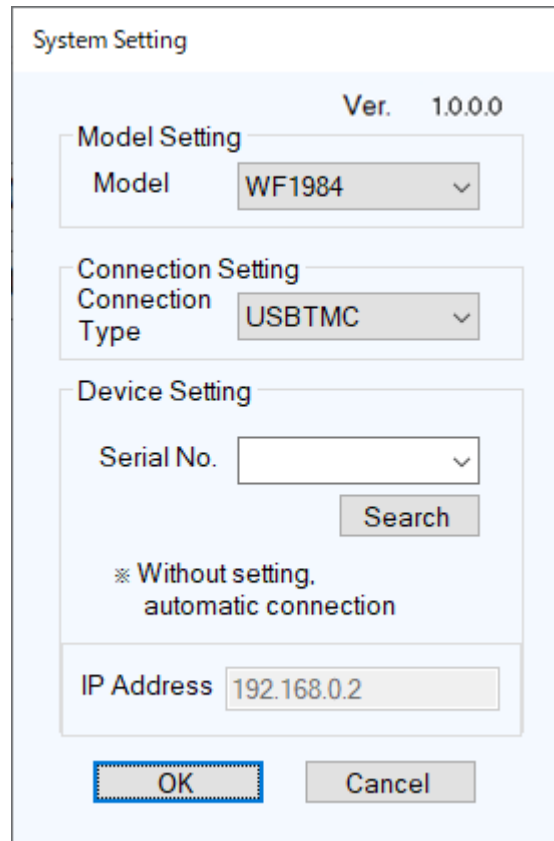
Figure 3-7 Status Bar

- Connected Model
 - Shows the model name of the WF198x set in the System Settings.
 - When connected to the WF198x, shows the Serial No. of the connected WF198x.
- Connection Type
 - Shows the connection mode with the WF198x set in the System Settings.
- Edit Mode/Control Mode
 - Shows the execution mode for the sequence (☞ 5.4.7).
- Elapsed Time
 - Shows the time elapsed after the sequence was started.

3.6 System Setting

When you first use this software, system setting is needed. Click the **System Setting** button in the upper right corner of the window to open the System Setting dialog as shown in Figure 3-8.

You can change the system setting whenever the software is up and running. However, changing the system setting clears parameters and other settings that are being edited.



The image shows a 'System Setting' dialog box with a light blue background. At the top right, it says 'Ver. 1.0.0.0'. The dialog is divided into three sections: 'Model Setting', 'Connection Setting', and 'Device Setting'. In the 'Model Setting' section, there is a 'Model' dropdown menu with 'WF1984' selected. In the 'Connection Setting' section, there is a 'Connection Type' dropdown menu with 'USBTMC' selected. In the 'Device Setting' section, there is a 'Serial No.' dropdown menu, a 'Search' button, and a note: '※ Without setting, automatic connection'. At the bottom, there is an 'IP Address' text box containing '192.168.0.2'. At the very bottom, there are 'OK' and 'Cancel' buttons. The 'OK' button is highlighted with a blue dashed border.

Figure 3-8 System Setting Dialog

3.6.1 Connection Type

Specify the type of communication with the WF198x to connect. Select the driver software to use (USBTMC/LAN). The set communication type is shown in the status bar (☞ 3.5.3).

3.6.2 Serial No.

When the communication type is USBTMC, specify the Serial No. with the WF198x to connect. If the Serial No. is blank, it will search the connected WF198x with the PC and communicate with the first searched WF198x. You enter the Serial No. by selecting manually or by selecting it from the list of the Serial No.

When you click on the **Search** button, the list of the Serial No. display the Serial No. of the connected WF198x up to 8 devices.

When 9 or more the WF198x connected, when communicating with a WF198x that does not display the Serial No., communication can be performed by manually entering the Serial No.

3.6.3 IP address

When the communication type is LAN, specify the IP address. Specify the IP address to be displayed in the LAN settings of the WF98x's Remote Settings window. Refer to the instruction manual of the WF198x for how to display the Remote Settings window.

3.7 Error Message

You might see some error message in the dialog while using the software. In that case, handle the error according to the instruction described in the message.

4. Basic Controller

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4.6	Reset.....	23

4.1 Name of Each Component in the Window

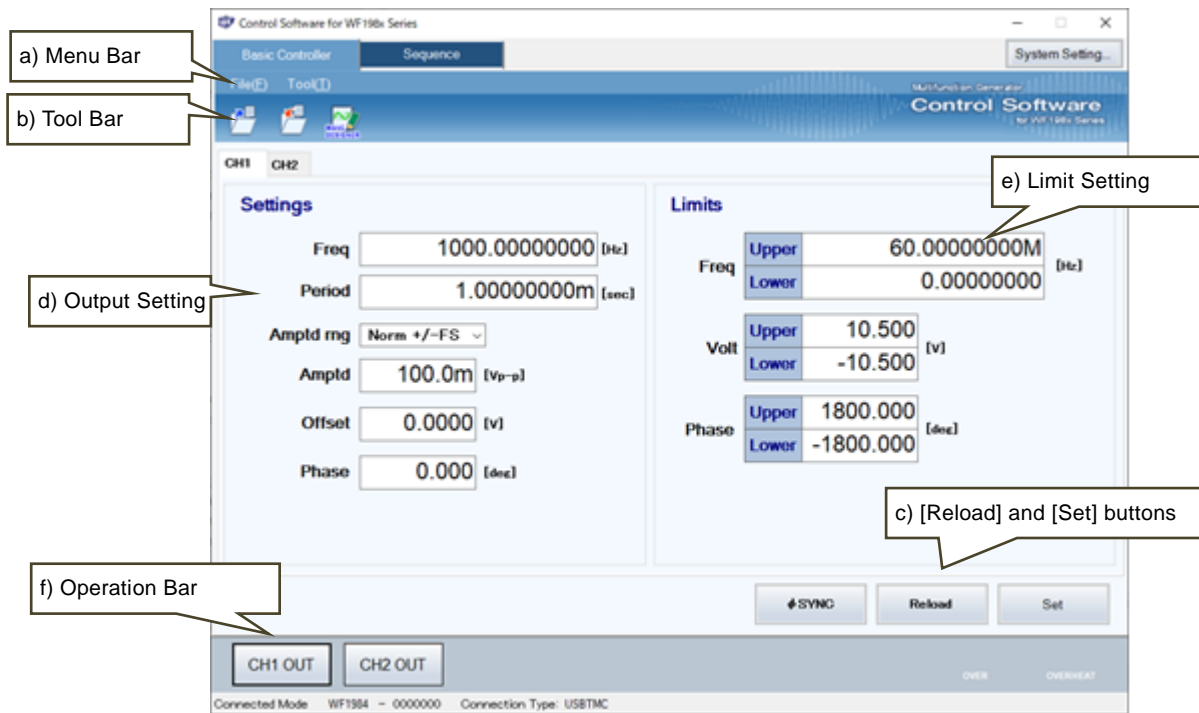


Figure 4-1 Basic Controller Window

- | | |
|-------------------------------|-------|
| a) Menu Bar | 4.2.1 |
| b) Tool Bar | 4.2.2 |
| c) [Reload] and [Set] buttons | 4.2.3 |
| d) Output setting | 4.2.4 |
| e) Limit setting | 4.2.5 |
| f) Operation Bar | 4.2.6 |

4.2 Operations on Each Section

This section explains how to operate each section assuming that the operation is performed in the communication online state. In the communication offline state, some functions are restricted.

Based on the WF198x status, you may encounter an error message when setting an item. In that case, handle the error according to the message content.

4.2.1 Menu Bar

The menu of [Basic Controller] appears in Figure 4-2.

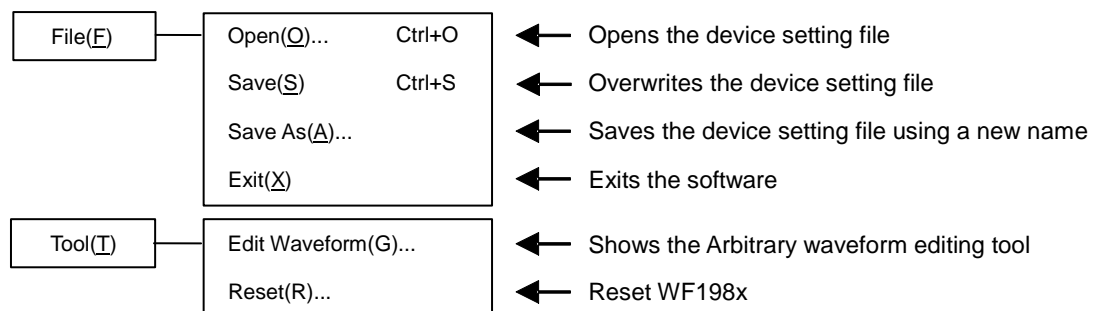


Figure 4-2 Basic Controller Window Menus

4.2.2 Tool Bar

On the [Basic Controller] Tool Bar, you just click each icon shown in Figure 4-3 to execute the corresponding function.

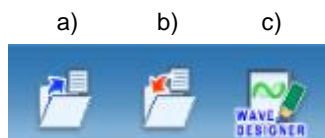


Figure 4-3 Basic Controller Tool Bar

- | | |
|----------------------------|---|
| a) Open | Opens the device setting file. |
| b) Save | Overwrites and saves the device setting file. |
| c) Arbitrary Edit Waveform | Shows the Arbitrary waveform editing tool. |

4.2.3 Reload and Set Buttons

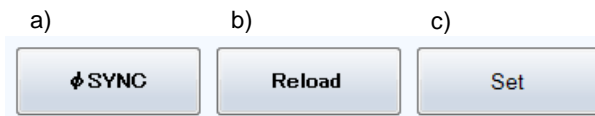


Figure 4-4 Reload and Set Buttons

- a) [Φ SYNC] button Phase synchronization operation between devices when multiple units are synchronously connected, and phase synchronization operation between multiple channels.
- b) [Reload] button Obtains the basic, output, and limiter settings from the connected WF198x, and updates the setting values for the windows of the software.
- c) [Set] button Sets the basic, output, and limiter settings entered in the windows of the software to the connected WF198x.

4.2.4 Output Setting

Set the output-related items.

Figure 4-5 Output Setting

In a numerical entry box, if the entered value is out of the setting range, the error dialog opens as shown in Figure 4-6. Enter a value within the setting range shown in the dialog. The setting range differs by models. For details of the setting range, see the instruction manual of the WF198x.

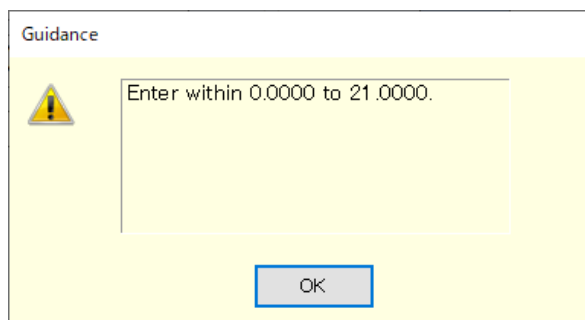


Figure 4-6 Example of Setting Range Error Dialog

4.2.5 Limit Setting

In the limit setting, you set the restriction on the setting ranges.

Limits			
Freq	Upper	60.00000000M	[Hz]
	Lower	0.00000000	
Volt	Upper	10.500	[V]
	Lower	-10.500	
Phase	Upper	1800.000	[deg]
	Lower	-1800.000	

Figure 4-7 Limit Setting

In a numerical entry box of the limiter setting, if the entered value is out of the setting range, the error dialog opens as shown in Figure 4-6. For details of the setting range, see the instruction manual of the WF198x.

4.2.6 Operation Bar

In the Operation Bar, clicking **CH1 OUT** toggles between output on and off of the connected WF198x. The indication of the **CH1 OUT** button changes as shown in Figure 4-8.

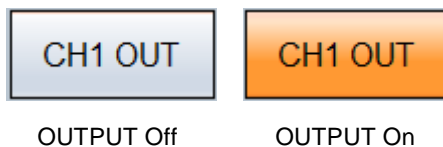


Figure 4-8 The Indication of OUTPUT Button

4.3 WF198x Setting File

Control Software for WF198x Series handles the following one type of file format as the Basic controller setting file.

■ WF198x setting file (extension is .rmt)

This file stores the Basic controller settings except the output ON/OFF setting. This file can be read and saved by Control Software for WF198x Series.


4.3.1 Save As

Saves the WF198x setting file as a new file. The [Save As] dialog can be opened by any of the following two methods. For newly created data, the Save operation works as "Save As."

- From the Menu Bar, select [File] - [Save As].
- On the keyboard, press **Alt**, **F**, **A**.


4.3.2 Save

Overwrites and saves to the existing WF198x setting file. Following four methods are available. For newly created data, the Save operation works as "Save As."

- From the Menu Bar, select [File] - [Save].
- On the keyboard, press **Alt**, **F**, **S**.
- On the keyboard, press **Ctrl** + **S**.
- On the Tool Bar, click the [Save] icon ( 4.2.2).

4.3.3 File Reading

Opens the WF198x setting file. The Open File dialog can be opened by any of the following four methods.

- From the Menu Bar, select [File] - [Open].
- On the keyboard, press **Alt**, **F**, **O**.
- On the keyboard, press **Ctrl** + **O**.
- On the Tool Bar, click the [Open] icon ( 4.2.2).

4.4 Status

The software inquires the connected WF198x for the statuses with the interval of about two seconds, and refreshes the display of the status monitor. Table 4-1 shows the list of statuses to be monitored. After the WF198x status inquiry, the applicable status (i.e., the status is ON) illuminates in red. Figure 4-9 shows the example of status display.

Table 4-1 Status Display List

Notation	Description	Display color when it is ON
OVER	Overload detection	Red
OVERHEAT	Overheat detection	Red



Figure 4-9 Status Display Example (OVER)

4.5 Arbitrary Waveform Editing

Show the Arbitrary waveform editing tool (☞ 6). Following two methods are available.

- From the Menu Bar, click [Tool(T)] - [Edit Waveform(G)].
- On the Tool Bar, click the [Arbitrary Waveform Editing] icon (☞ 4.2.2).

4.6 Reset

From the Menu Bar, click [Tool(T)] - [Reset(R)]. The connected WF198x is reset to the factory defaults.

5. Sequence

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5.1 Name of Each Component in the Window

a) Menu Bar

b) Tool Bar

c) Step arrangement

d) Step-transition parameter setting

e) Step-execution parameter setting

f) Operation Bar

Step	Time	AutoHold	Stop Phase [deg]	Event Branch	State Branch	JumpTo	JumpCount	StepTerm	StepCode
0	0.10000								LLLL
1	0.20000	Off	0.000					CONTINUE	LLHL
2	0.10000	Off						CONTINUE	LLHL
3	0.20000	Off						CONTINUE	LLHH
4	0.20000	Off				2	1	CONTINUE	LHLL

Step	Waveform	ARB	Freq[Hz]	Ampld [Vp-p]	ScaleRange	DC Ofc [V]	Phase [deg]	Symm [%]	Duty [%]	Duty Extend
0	Sine		1000.000000000	0.1000	Norm +/-FS	0.0000	0.000			
1	Sine		1000.000000000	0.1000	Norm +/-FS	0.0000	0.000			
2	Sine		2000.000000000	3.0000	Norm +/-FS	2.0000	0.000			
3	Sine		1000.000000000	3.0000	Norm +/-FS	2.0000	0.000			
4	Sine		1000.000000000	4.0000	Norm +/-FS	0.0000	0.000			

Figure 5-1 Sequence Window

- | | | |
|--------------------------------------|--|-------|
| a) Menu Bar | | 5.2.1 |
| b) Tool Bar | | 5.2.2 |
| c) Step arrangement | | 5.2.3 |
| d) Step-transition parameter setting | | 5.2.4 |
| e) Step-execution parameter setting | | 5.2.5 |
| f) Operation Bar | | 5.2.6 |

5.2 Operations on Each Section

5.2.1 Menu Bar

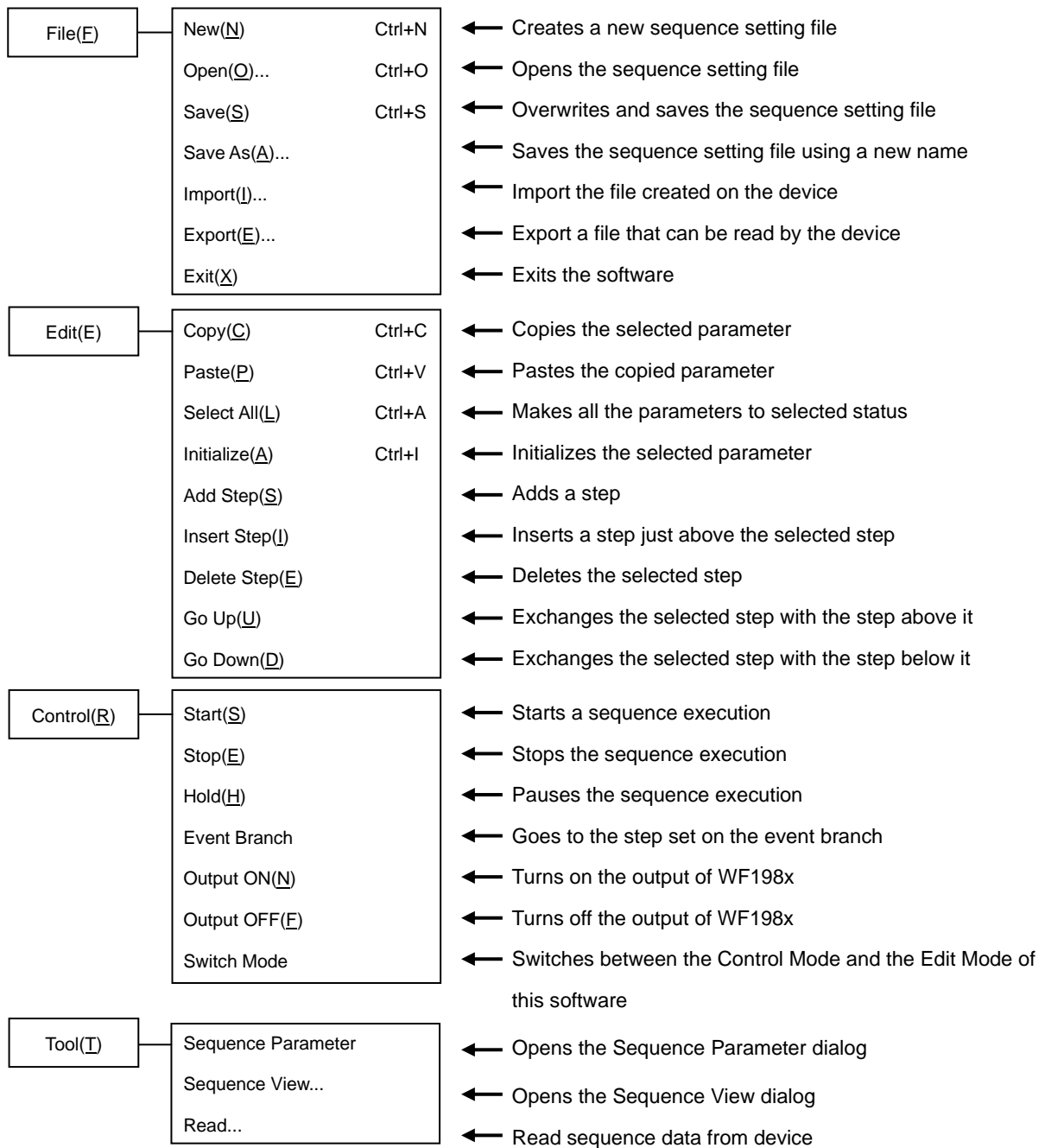


Figure 5-2 Sequence Window Menus

5.2.2 Tool Bar

On the Sequence Tool Bar, you just click each icon shown in Figure 5-3 to execute the corresponding function.

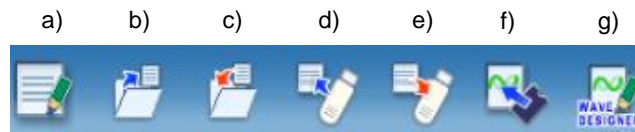


Figure 5-3 Sequence Tool Bar

- | | |
|-------------------------------|--|
| a) New | Creates a new sequence setting. |
| b) Open | Opens the sequence setting file. |
| c) Save | Overwrites and saves the sequence setting file. |
| d) Import | Reads a sequence data file for the USB memory from the USB memory. |
| e) Export | Writes a sequence data file for the USB memory to the USB memory. |
| f) Read | Reads the sequence data from the device. |
| g) Arbitrary Waveform Editing | Shows the Arbitrary waveform editing tool. |

5.2.3 Step Arrangement

This section describes how to add, insert, delete, move, and copy a step (line).



Figure 5-4 Step Arrangement Buttons

Notes

- When the step number is changed for a step that is set as a jump-to step or branch step, the step number is automatically changed on the calling side of the jump or branching also, preserving the dependency between steps.
- When a step that is set as the destination of any jump-to step or branch step is deleted, the dialog as shown in Figure 5-5 appears. When you select **Yes**, the step is deleted and then the step number of the jump-to or branch step is automatically updated to disable. If you select **No**, deletion of the step is canceled.

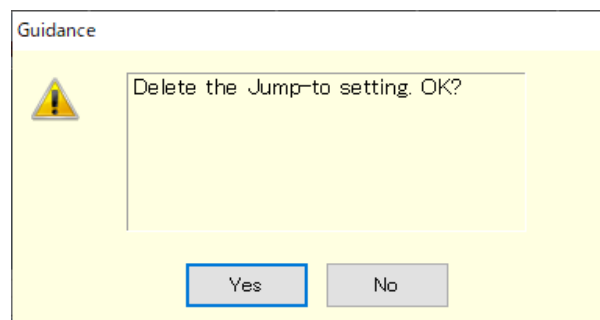


Figure 5-5 Confirmation Dialog for Deleting a Step

■ Add Step

Adds a new step after the last step (line). Following three methods are available.

- From the Menu Bar, select [Edit] - [Add Step].
- On the keyboard, press **Alt**, **E**, **S**.
- Click [Add Step] button of the step arrangement.

■ Insert Step

Adds a new step just above the current cursor step (line). Following three methods are available.

- From the Menu Bar, select [Edit] - [Insert Step].
- On the keyboard, press **Alt**, **E**, **I**.
- Click [Insert Step] button of the step arrangement.

■ Delete Step

Deletes the current cursor step (line). Following three methods are available.

- From the Menu Bar, select [Edit] - [Delete Step].
- On the keyboard, press **Alt**, **E**, **D**.
- Click [Delete Step] button of the step arrangement.

■ Go Up

Exchanges the current cursor step (line) with the step above it. Following three methods are available.

- From the Menu Bar, select [Edit] - [Go Up].
- On the keyboard, press **Alt**, **E**, **U**.
- Click [**▲**] button of the step arrangement.

■ Go Down

Exchanges the current cursor step (line) with the step below it. Following three methods are available.

- From the Menu Bar, select [Edit] - [Go Down].
- On the keyboard, press **Alt**, **E**, **D**.
- Click [**▼**] button of the step arrangement.

■ Copy

Copies the setting data in the selected line range or cell range to the Clip Board. Following three methods are available.

- From the Menu Bar, select [Edit] - [Copy].
- On the keyboard, press **Alt**, **E**, **C**.
- On the keyboard, press **Ctrl** + **C**.

■ Paste

Pastes the setting data on the clip board to the selected line range or cell range. Following three methods are available.

- From the Menu Bar, select [Edit] - [Paste].
- On the keyboard, press **Alt**, **E**, **P**.
- On the keyboard, press **Ctrl** + **V**.

----- **Notes** -----

- Row numbers and column items should be matched between the destination data range to be pasted and the source data range that was copied to the clip board. If the data ranges do not match, the error dialog shown in Figure 5-6 appears.

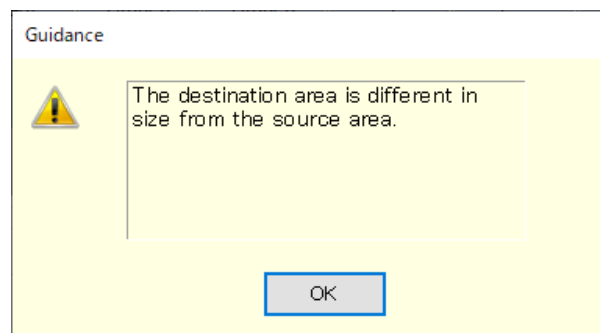


Figure 5-6 Error Dialog for Copying Data

5.2.4 Step- transition Parameter Setting

■ Enter a setting value

Select a cell and then enter a value. If the entered value is out of the setting range, the error dialog appears. Enter a value according to the dialog.

Select [Termination] from the combo box opened by clicking a cell.

■ Enter a enable / disable setting value

When a cell of [Stop Phase], [Jump-to] or [Branch] is selected, enable and disable radio buttons become enabled. If you select the [Enable] radio button, you can set a phase as shown in Figure 5-7.

For WF198x Series, when a cell of [Stop Phase] is enabled, its setting value is fixed to 0.0 degree.

■ Enter a [Jump Count] Parameter

When [Jump to] is enabled and the [Jump Count] cel is selected, the radio buttons for Enable/Infinity can be set. When Enable is selected, the [Jump Count] can be set. When Infinity is selected, the [Jump Count] becomes infinite.

■ Clear setting values

Restores a setting value to the default value. Following two methods are available.

- From the Menu Bar, select [Edit] - [Initialize].
- On the keyboard, press **Ctrl** + **I**.

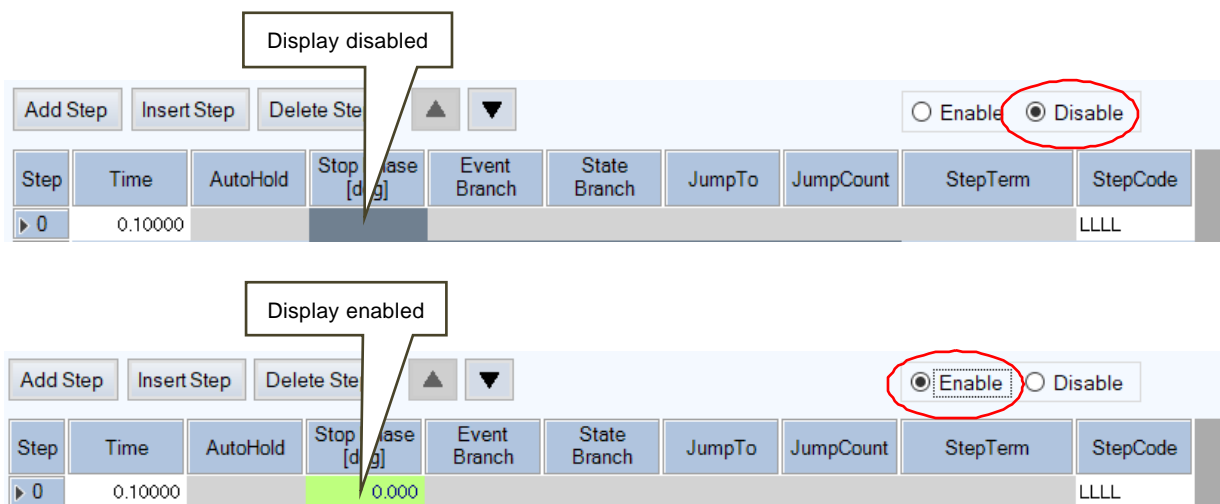


Figure 5-7 Enabling or Disabling Start Phase and Stop Phase

5.2.5 Step-execution Parameter Setting

- Enter a setting value

Select a cell and then enter a value. If the entered value is out of the setting range, the error dialog appears. Enter a value according to the dialog.

- Enter operation type

When a cell of the setting value in which you can set an operation type is selected, radio buttons for the operation type (Const, Keep, and Sweep) are enabled. An operation type can be set by selecting the radio buttons (Figure 5-8). In the cell, the icon corresponding to the setting operation type is displayed.

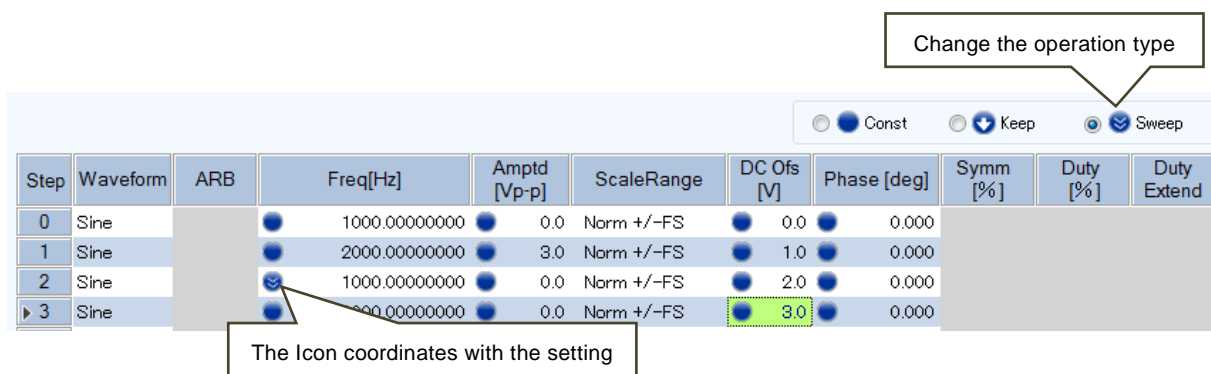


Figure 5-8 Set Behavior Type

5.2.6 Operation Bar



Figure 5-9 Operation Bar of Sequence

In the Operation Bar of the sequence, you can perform Start, Stop, Hold, and Event Branch of the sequence in addition to switching the on/off of the output.

5.3 Sequence Setting File

There is the following type of file format for the sequence data used by the Control Software for WF198x Series:

- Sequence setting file (extension is .sqd)

This file can be read and saved by Control Software for WF198x Series.

- Sequence data file for the USB memory (extension is .WFseq)

It can be written (exported) by this software. After writing it to the dedicated folder for the USB memory, it can be read by the device. It cannot be read by this software.


5.3.1 Save As

Saves the sequence setting file as a new file. The [Save As] dialog can be opened by any of the following two methods. For newly created data, the Save operation works as "Save As."

- From the Menu Bar, select [File] - [Save As].
- On the keyboard, press **Alt**, **F**, **A**.


5.3.2 Save

Overwrites and saves to the existing sequence setting file. Following four methods are available. For newly created data, the Save operation works as "Save As."

- From the Menu Bar, select [File] - [Save].
- On the keyboard, press **Alt**, **F**, **S**.
- On the keyboard, press **Ctrl** + **S**.
- On the Tool Bar, click the [Save] icon ( 5.2.2).

5.3.3 File Reading

Opens the sequence setting file. The Open File dialog can be opened by any of the following four methods.

- From the Menu Bar, select [File] - [Open].
- On the keyboard, press **Alt**, **F**, **O**.
- On the keyboard, press **Ctrl** + **O**.
- On the Tool Bar, click the [Open] icon ( 5.2.2).


----- Notes -----

About compatibility with “Sequence Edit software” accompanying with WF1973/WF1974 or WF1967/WF1968:

- Sequence data file (*.dat) created with the “Sequence Edit software” can be used with this software.
 - Sequence setting file created with this software cannot be used with the “Sequence Edit software”.
-


5.3.4 Read from USB Memory (Import)

Reads a sequence data file for the USB memory. The Open File dialog can be opened by any of the following three methods.

- From the Menu Bar, select [File] - [Import].
- On the keyboard, press **Alt, F, I**.
- On the Tool Bar, click the [Import] icon ( 5.2.2).

5.3.5 Write to USB Memory (Export)

Writes a sequence data file for the USB memory. The [Save As] dialog can be opened by any of the following three methods.

- From the Menu Bar, select [File] - [Export].
- On the keyboard, press **Alt, F, E**.
- On the Tool Bar, click the [Export] icon ( 5.2.2).

5.4 Control

This section describes how to control a start, stop, etc. of the sequence.

5.4.1 Start

Enabled only in the execution mode and with the output on. Following three methods are available.

- From the Menu Bar, select [Control] - [Start].
- On the keyboard, press **Alt**, **R**, **S**.
- In the Operation Bar, click [Start] button (☞ 5.2.6).

5.4.2 Stop

Following three methods are available.

- From the Menu Bar, select [Control] - [Stop].
- On the keyboard, press **Alt**, **R**, **E**.
- In the Operation Bar, click [Stop] button (☞ 5.2.6).

5.4.3 Hold

Following three methods are available.

- From the Menu Bar, select [Control] - [Hold].
- On the keyboard, press **Alt**, **R**, **H**.
- In the Operation Bar, click [Hold] button (☞ 5.2.6).

5.4.4 Event Branch

Describes the Event Branch. Following two methods are available.

- From the Menu Bar, select [Control] - [Event Branch].
- In the Operation Bar, click [Event Branch] button (☞ 5.2.6).

5.4.5 Output On

Following three methods are available.

- From the Menu Bar, select [Control] - [Output ON].
- On the keyboard, press **Alt**, **R**, **N**.
- In the Operation Bar, click **OUTPUT** (☞ 5.2.6).

5.4.6 Output Off

Following three methods are available.

- From the Menu Bar, select [Control] - [Output OFF].
- On the keyboard, press **Alt**, **R**, **F**.
- In the Operation Bar, click **OUTPUT** (☞ 5.2.6).

5.4.7 Switch Execution Mode

Switches between the Edit mode and Execution mode. Following two methods are available.

- From the Menu Bar, select [Control] - [Switch Mode].
- In the Operation Bar, click **Control/Edit** (☞ 5.2.6).

5.4.8 Sequence Data Reading

Reads the sequence data from the device. At this time, the data currently being edited is discarded and the data read from the device is displayed.

Following two methods are available.

- From the Menu Bar, select [Tool] - [Read].
- On the Tool Bar, click [Read] button (☞ 5.2.2).

5.5 Sequence View

Select [Tool] - [Sequence View] from the menu bar to display the sequence view window (☞ 7).

6.Arbitrary Waveform Editing

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6.1 Overview

This chapter uses some examples of creating arbitrary waveforms shown in the Figure 6-1 to help you understand the basic operations and functions of the "Arbitrary waveform editing tool."

We recommend you to operate the tool while reading this chapter to understand how it works more easily.

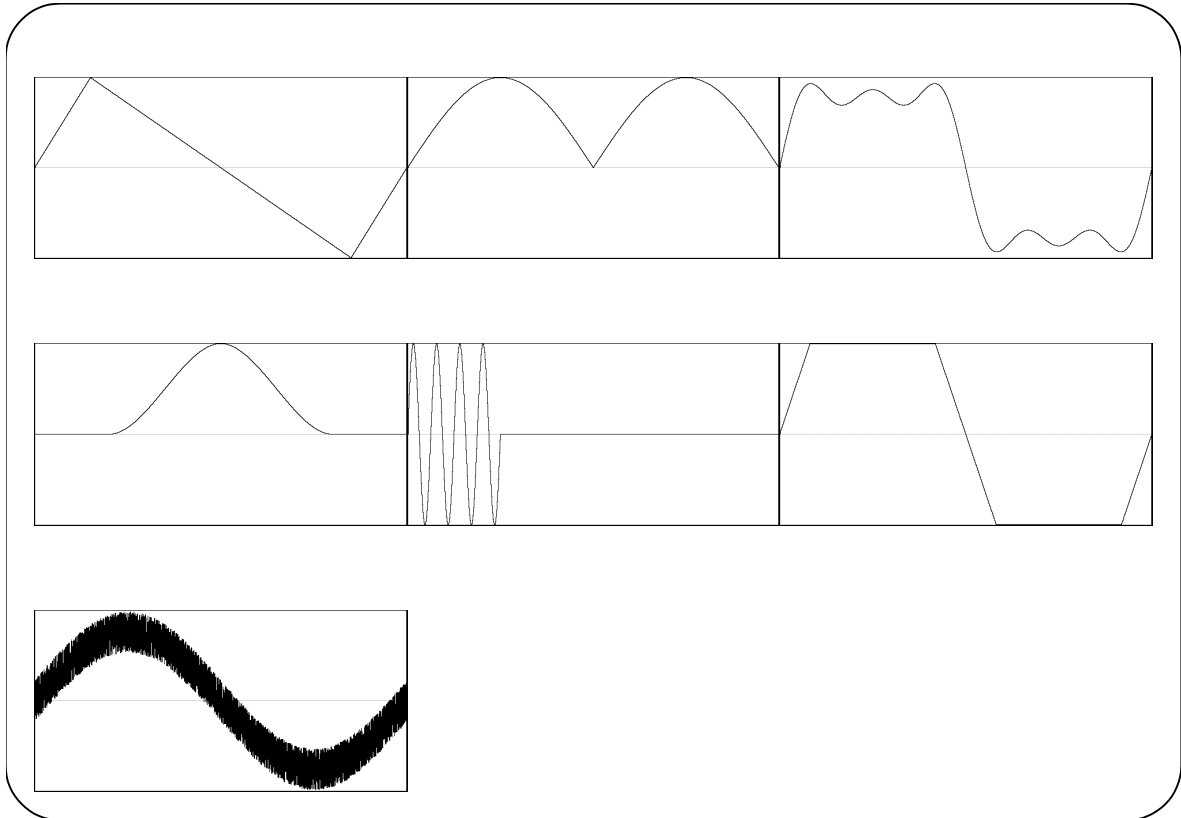


Figure 6-1 Created Arbitrary Waveforms Examples

6.2 Open or Close the Arbitrary Waveform Editing Window

6.2.1 Open the Arbitrary Waveform Editing Window

Following three methods are available.

- In the [Basic Controller] Menu Bar, select [Tool] - [Edit Waveform] (☞ 4.2.1).
- Click the [Arbitrary Waveform Editing] icon (☞ 4.2.2) on the [Basic Controller] Tool Bar.
- Click the [Arbitrary Waveform Editing] icon (☞ 5.2.2) on the [Sequence] Tool Bar.

6.2.2 Close the Arbitrary Waveform Editing Window

Following two methods are available to finish editing arbitrary waveforms. When you perform the exit operation, the confirmation dialog opens as shown in Figure 6-2. Select **Yes** to close the [Arbitrary Waveform Editing] window.

- From the Menu Bar, select [File] - [Exit].
- Click the **X** in the upper right corner of the [Arbitrary Waveform Editing] window.

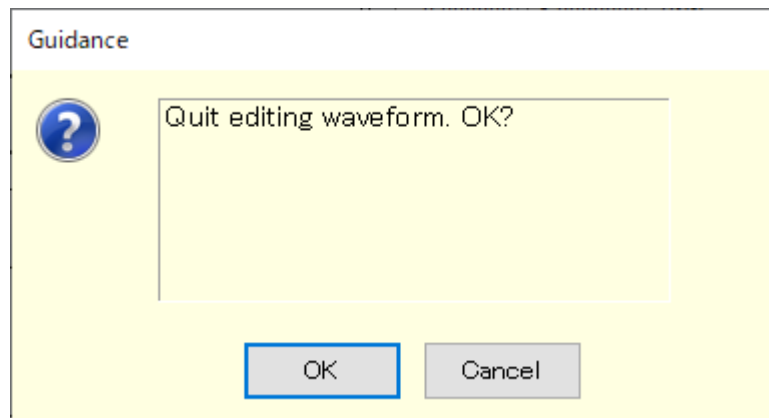


Figure 6-2 The Confirmation Dialog When Finishing Editing Arbitrary Waveforms

6.3 Name of Each Component in the Window

The name of the file used to read/write the waveform data is shown in the title bar. If no file has been read/written, [<Untitled>] is shown in the bar.

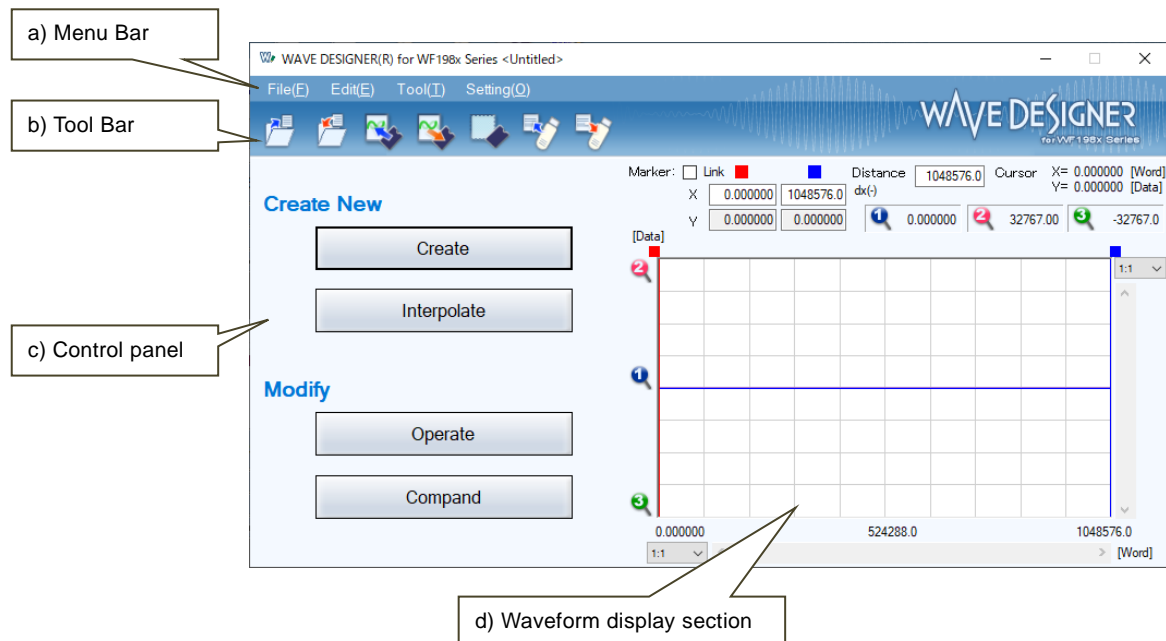


Figure 6-3 The Arbitrary Waveform Editing Window

- | | |
|-----------------------------|-------|
| a) Menu Bar | 6.4.1 |
| b) Tool Bar | 6.4.2 |
| c) Control panel | 6.4.3 |
| d) Waveform display section | 6.4.4 |

6.4 Operations on Each Section

This section provides how to operate each section.

Based on the WF198x side status, you may encounter an error message when setting an item. Handle the error according to the message content.

6.4.1 Menu Bar

The menu of [Arbitrary Waveform Editing] appears in Figure 6-4.

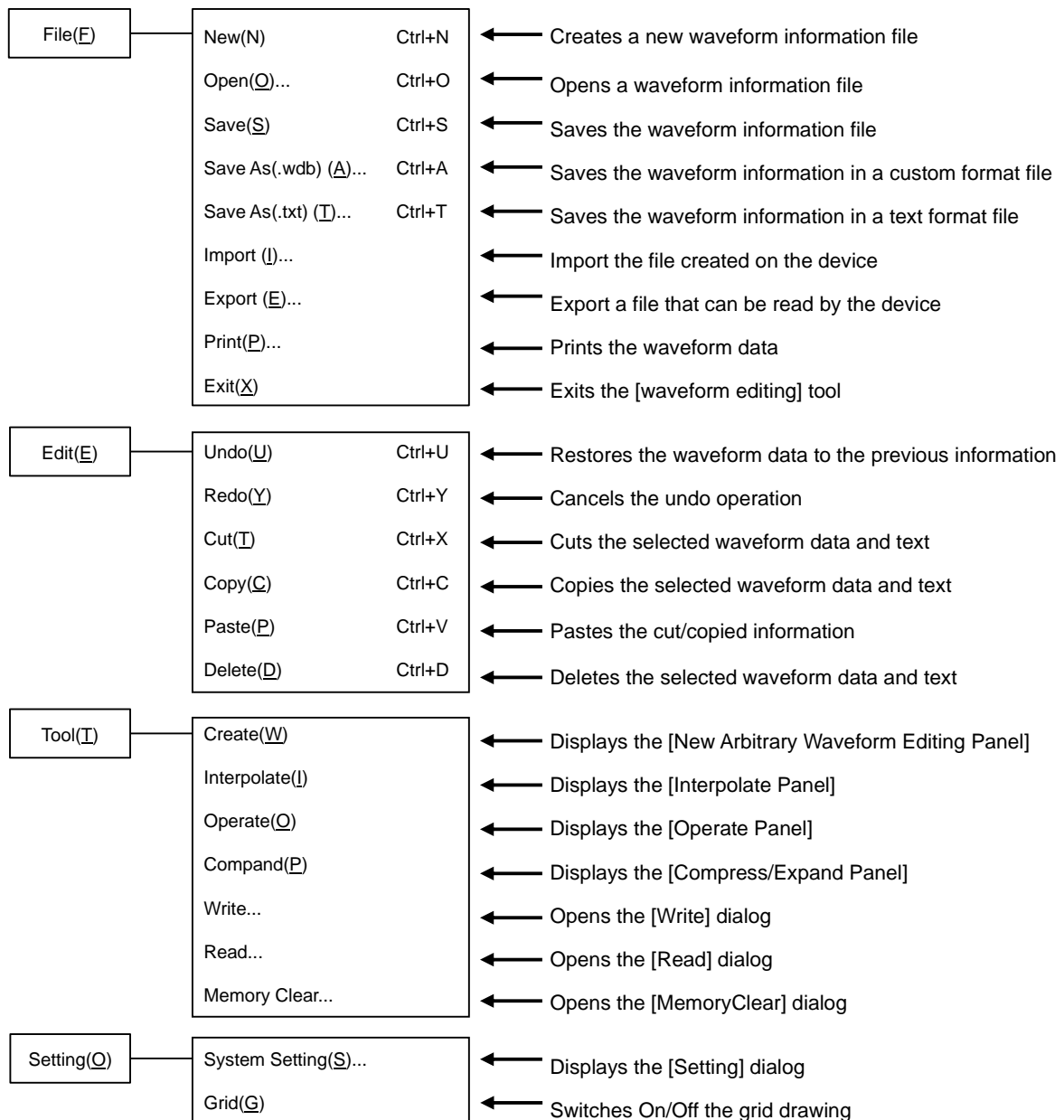


Figure 6-4 Arbitrary Waveform Editing Window Menus

6.4.2 Tool Bar

On the [Arbitrary Waveform Editing] Tool Bar, you just click each icon shown in Figure 6-5 to execute the corresponding function.



Figure 6-5 Tool Bar in the Arbitrary Waveform Editing Window

a) Open	Opens a waveform information file.
b) Save	Saves the waveform information file.
c) Read	Opens the [Read] dialog.
d) Write	Opens the [Write] dialog.
e) Memory Clear	Opens the [MemoryClear] dialog.
f) Import	Import files created on the device.
g) Export	Export a file that can be read by the device.

6.4.3 Control Panel Section

In the Control Panel section, the control panel that is currently selected is displayed.

Immediately after the Arbitrary waveform editing tool is started or after each operation, the Select Item Panel is displayed instead.

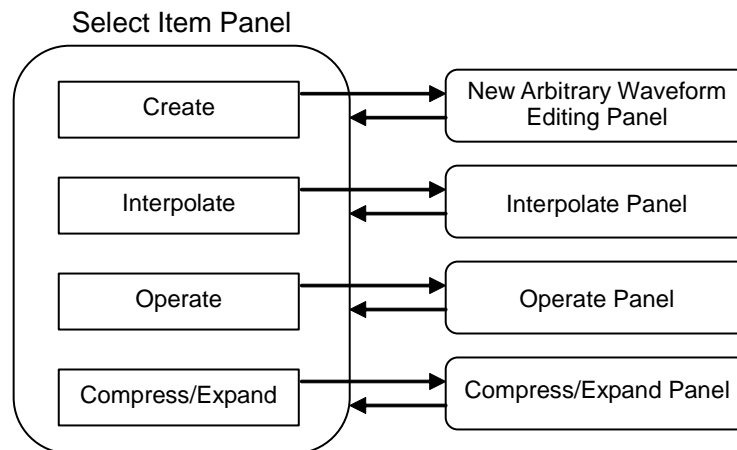


Figure 6-6 Transitions for Control Panels

6.4.4 Waveform Display Section

In the waveform display section, the image of the created waveform or each type of the coordinates data is displayed.

6.5 Waveform Display Section

6.5.1 Waveform Display Area

The waveform data currently being created is always displayed in the waveform display area.






In the waveform display area, coordinate values indicating the display area size, markers used for each operation (see 6.5.3), and the grid for checking the waveform rate (see 6.5.6) are drawn in addition to the waveform data.

6.5.2 Display Magnification

In the waveform display area, you can expand the displayed waveform by changing the display magnification horizontally and vertically.






■ Display magnification of vertical axis

The vertical magnification can be set to [1:1] (displays the complete waveform), [1:2] (expands half of the waveform to be displayed in the entire screen), [1:4], or up to [1:512].

To set the display magnification, click the  button located in the upper part of the vertical scroll bar and select the desired magnification from the displayed list. Pressing the  or  key while the magnification list is displayed increases the magnification, and pressing the  or  key decreases the magnification. Pressing the **Home** key shows the waveform in its original size, and pressing the **End** key displays the waveform in the maximum magnification.

■ Display magnification of horizontal axis

The horizontal magnification can be set to [1:1] (displays the complete waveform), [1:2] (expands half of the waveform to be displayed in the entire screen), [1:4], or up to [1: 1048576].

To set the display magnification, click the  button located on the right of the horizontal scroll bar and select the desired magnification from the displayed list. Pressing the  or  key while the magnification list is displayed increases the magnification, and pressing the  or  key decreases the magnification. Pressing the **Home** key shows the waveform in its original size, and pressing the **End** key displays the waveform in the maximum magnification.

■ Scrolling

When the vertical/horizontal magnification is set to [1:2] or more, you can slide the scroll bar.

The coordinate values of the waveform display area changes as you slide the scroll bar. You can drag the scroll bar to the desired coordinates to observe other parts of the waveform.

6.5.3 Markers

Markers are used to select the waveform range in the horizontal direction when editing or creating any type of the waveform. They are also used to specify the horizontal position in order to read the vertical value of the waveform.

Markers are displayed with red and blue vertical lines in the waveform display area.



■ Markers operation

Two types of markers are used in the Arbitrary waveform editing tool: A marker (red) and B marker (blue).

A marker cannot be located on the right side of B marker. A marker is always located on the left side or same position of B marker. The position of each marker is displayed in the [X] field corresponding to the [Marker:] field of each color. The value of the waveform corresponding to the marker position is displayed in the [Y] field.

■ Moving markers (mouse dragging)

Two methods are provided in order to move markers: dragging a mouse and specifying values.

When the mouse cursor is hovered over a marker, the shape of the cursor is turned into  from . To move the marker, drag the mouse while the cursor is in this shape. Although the markers on any end of the line can be difficult to identify, they can also be moved by using the marker flag located in the upper part of the waveform display area.

When moving markers by dragging a mouse, the address of the waveform data is moved as a unit of movement. Under the display magnification in which multiple addresses are mapped to one dot, the movement occurs by a step of that number of addresses corresponding to one dot.

■ Moving markers (specifying values)

To specify the marker location with higher resolution, enter values for the marker location directly.

The location display section for A marker is selected by clicking the [X] item corresponding to it or pressing the **Alt** key and **A** key. Enter values and press the **Tab** key to move A marker to the specified location.

To specify the marker location with higher resolution, enter values for the marker location directly.

B marker is also moved to the specified location by clicking the [X] item corresponding to B marker or pressing the **Alt** key and **B** key, entering values for B marker in the location display section, and pressing the **Tab** key.

The marker can be located in any location within the range of the settings/display resolution regardless of addresses of the waveform data by specifying values.

■ Coordinate marker mode

A and B markers can be moved independently or together depending on the Link check box.

When the Link check box is selected, A and B markers are moved together. The gap in the horizontal direction between A and B markers (distance between markers) is displayed on the right of [dX(-)].

When moving one of these markers, the other one is also moved keeping the distance.

When you click the right side of the [dX(-)] or press the **Alt** key and the **]** key, enter values, and press the **Tab** key, B marker is moved so that the gap between markers is set to the specified value.

■ Range of impact by markers

Selecting the range by using markers affects the operations below.

- Range to copy/cut/paste of waveforms (☞ 6.5.4)
- Range of arbitrary waveforms editing (☞ 6.8)
- Range to generate waveforms by interpolation (☞ 6.9)
- Range of performing compression/expansion (☞ 6.11)
- Range to perform operation among waveforms (☞ 6.10)

Technically, markers are located "immediately before" the specified/displayed location on the horizontal axes (value displayed on the right of the [X] field).

For example, when the horizontal location is 5 for A marker and 10 for B marker, the selected range is $5 \leq X < 10$. A marker is located immediately before 5, therefore 5 falls between A marker and B marker. B marker is located immediately before 10, therefore 10 does not fall between A marker and B marker.

6.5.4 Waveform Manipulation

■ Undo and redo

With the Arbitrary waveform editing tool, the waveform data can be restored to the previous status after editing arbitrary waveforms (Undo). To do so, click [Edit] - [Undo] (**Alt**, **E**, **U**) or press the **Ctrl** and **U**.

To cancel the previous Undo operation (Redo), click [Edit] - [Redo] (**Alt**, **E**, **Y**) or press the **Ctrl** and **Y**.

■ Cut/copy/paste/delete

With the Arbitrary waveform editing tool, you can cut/copy/paste/delete the waveform data or edit waveforms as needed.

● Cut

[Edit] - [Cut] (**Alt**, **E**, **T** or **Ctrl** and **X**)

● Copy

[Edit] - [Copy] (**Alt**, **E**, **C** or **Ctrl** and **C**)

● Paste

[Edit] - [Paste] (**Alt**, **E**, **P** or **Ctrl** and **V**)

● Delete

[Edit] - [Delete] (**Alt**, **E**, **D** or **Ctrl** and **D**)

When performing the cut or copy operation, the waveform data of the selected part is sent to the clip board.

In this case, the waveform data of the selected part which is 16-bit data (0 to 65535), is sent to the clip board as a number string with one data per one row. If a data value is originally negative, 65536 is added to it to convert into a positive value.

These contents can be pasted to any text editor or spreadsheet software, or can be pasted to itself or any other "Arbitrary waveform editing tools" which are currently active.

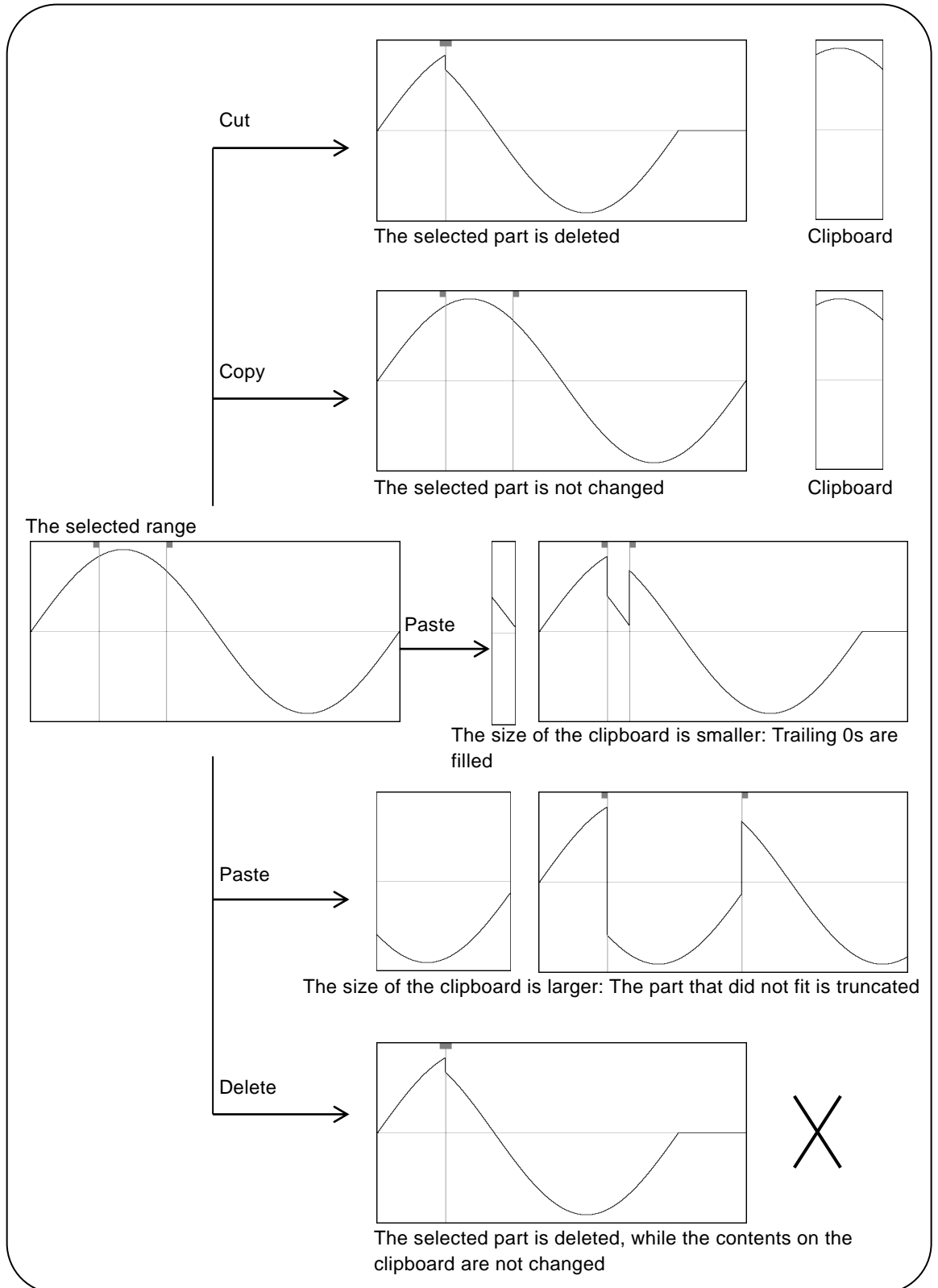


Figure 6-7 Operations with the Clipboard

6.5.5 Example of Arbitrary Waveform Editing

We will create a full-wave rectification waveform to demonstrate copy and paste functions of a waveform.

- Step 1: Click the button on the upper left corner of the screen. You can also click [Tool] - [Create] to obtain the same result.
- Step 2: A sine wave is selected in the initial state. Click the **All-Page OK** button to return to the waveform display screen.
- Step 3: Move B marker to the center of the waveform.
[1048576.000] is displayed at the lower right corner of the screen.
Enter [524288] (half of 1048576) in the numeric area of [X] corresponding to B marker and press the **Tab** key.
- Step 4: Hold down the **Ctrl** key and press the **C** key. You can also click [Edit] - [Copy] to obtain the same result. This operation copies the data between A marker and B marker, which is the first half of the waveform, to the clip board.
- Step 5: Select the check box to the left of the Link to enter the coordinate marker mode.
Enter [2048] in the numeric area of [X] corresponding to the marker A and press the **Tab** key.
- Step 6: Hold down the **Ctrl** key and press the **V** key. You can also click [Edit] - [Paste] to obtain the same result.
This operation pastes the waveform data from the clip board to the last half of the waveform.

Description 1: The operation such as clicking the **C** key with the **Ctrl** key held down is described by "**Ctrl** + **C**" in the following sections. When **Ctrl** + **C** (Copy) is performed, the waveform from the copied area remains without changes. When **Ctrl** + **X** (Cut) is performed, the data from the selected area is copied to the clip board too, but the waveform from this area is deleted. When **Ctrl** + **D** (Delete) is performed, the waveform from the selected area is deleted, but the contents in the clip board are not changed.

Description 2: A marker and B marker are used to select the range. For example, if the range specified with the markers is 0 - 1024, the actual selected range is $0 \leq X < 1048576$.

6.5.6 Grid

When you select or deselect [Set] - [Grid] (**Alt**, **S**, **G**), a check mark appears or disappears to the left of [Grid]. When the check mark is shown, the grid is shown in the waveform display area. When the check mark is hidden, the grid is hidden.

The grid is not printed when printing waveforms. (6.7)

6.6 File Operation

You can read/write the following types of files by using the Arbitrary waveform editing tool. Texts in parentheses indicate file extensions to be added to that type of file.

- Custom format file including the waveform data and the display unit setting (.wdb) (☞ 6.6.1)
- Text format file including only the waveform data (.txt) (☞ 6.6.2)
- Text format file including parameters used for editing arbitrary waveforms (.wfn / .pwf) (☞ 6.8.7)
- Text format file including the control point information (.prn/.tsv/.csv) (☞ 6.9.4)
- Arbitrary waveform file for USB memory (.WFwfm) (☞ 6.6.4)

Notes

About compatibility with "WF1967/WF1968 Arbitrary Waveform Editor" and "WF1973/WF1974 Arbitrary Waveform Editor", "WF1947/WF1948 WAVE DESIGNER":

- Various kinds of files (*.wdb / *.wfn / *.prn / *.tsv / *.csv / *.pwf) created with the "Arbitrary Waveform Editor" or "WF1947/WF1948 WAVE DESIGNER" can be used with this software.
- Some kinds of settings like those of signal generator cannot be used.
- "Arbitrary Waveform Editor" proprietary format (*.ocb) files cannot be used.
- Files created with this software cannot be used with the "Arbitrary Waveform Editor" and "WF1947/WF1948 WAVE DESIGNER".

6.6.1 Custom Format File

You can save the waveform data created with the Arbitrary waveform editing tool and the display unit setting in one file.

When you click [File] - [Save As...(wdb)] (Alt, F, A, or Ctrl + A), the window titled [Save As] will be displayed.

Select the location where the file will be saved, enter the file name, and click the [Save] button. The file extension is ".wdb," which can be omitted when entering a file name.

After you read/write a file, when you click [File] - [Save] (Alt, F, S or Ctrl + S) or the corresponding button on the Tool Bar, the file is overwritten to the current file whose title is shown in the title bar. If you have not performed any file operation, clicking [Save] performs the same action as [Save As] for the custom file.

6.6.2 Text Format File

The waveform data created with the Arbitrary waveform editing tool can be saved as a text file so that the data can be used in other applications easily.

When you click [File] - [Save As...(txt)] (**Alt**, **F**, **T** or **Ctrl** + **T**), the window titled [Save As] will be displayed.

Select the location where the file will be saved, enter the file name, and click the **Save** button. The file extension is ".txt," which can be omitted when entering a file name.

In a text file, 16-bit data (0 to +65535) is saved as the number string with one data per one row. If a data value is originally negative, 65536 is added to it to convert into a positive value.

This file can be read with any text editor or spreadsheet software.

Also, a text file created with any text editor or spreadsheet software can be read with the "Arbitrary waveform editing tool." When creating a text file, include one data per one row. The data must be 16-bit signed integers (−32768 to +32767). Note that the numeric data format is different from that of the created text file.

As a standard, include 4194304 data in a data file. If a file includes more than 4194304 data, the excess data is skipped during the read process. On the other hand, if a file includes less than 4194304 data, they are read into the first part of the waveform and the rest of the waveform will not be changed.


6.6.3 File Reading

Display the Open File dialog by clicking [File] - [Open] (**Alt**, **F**, **O** or **Ctrl** + **O**) or the corresponding button on the Tool Bar. Enter the file name and click **OK** button. The waveform information will be read from the specified waveform data file.

6.6.4 Arbitrary waveform file for USB memory


By exporting the waveform data created with the arbitrary waveform editing tool to a USB memory, the device can read the arbitrary waveform file in the USB memory.

Following three methods are available.

- From the Menu Bar, select [File] - [Export].
- On the keyboard, press **Alt**, **F**, **E**.
- On the Tool Bar, click the [Export] icon ( 6.4.2).

Conversely, you can also import arbitrary waveform files exported from the device to a USB memory into an arbitrary waveform editing tool.

Following three methods are available.

- From the Menu Bar, select [File] - [Import].
- On the keyboard, press **Alt**, **F**, **I**.
- On the Tool Bar, click the [Import] icon ( 6.4.2).

6.7 Printing Waveforms

You can print the waveform data created with the "Arbitrary waveform editing tool" as a waveform image. However, the grid is not printed regardless of the display mode.

When you click [File] - [Print] (**Alt**, **F**, **P** or **Ctrl** + **P**), the Print dialog is displayed. For details of the print setup, see the instruction manual of your printer.

6.8 Editing a New Arbitrary Waveform

[New Arbitrary Waveform Editing Panel] is used to create a standard waveform or a formula waveform.

By clicking **Create** button on Select Item Panel or performing [Tool] - [Create] (**Alt**, **T**, **W**), [New Arbitrary Waveform Editing Panel] is displayed. Operations on waveform display sections disabled during [New Arbitrary Waveform Editing Panel] is displayed.

Just after editing an arbitrary waveform on [New Arbitrary Waveform Editing Panel] and returning to waveform display screen, the generated waveform can be restored to the state before the edited contents were reflected by selecting [Edit] - [Undo] (**Alt**, **E**, **U**), or **Ctrl** + **U**.

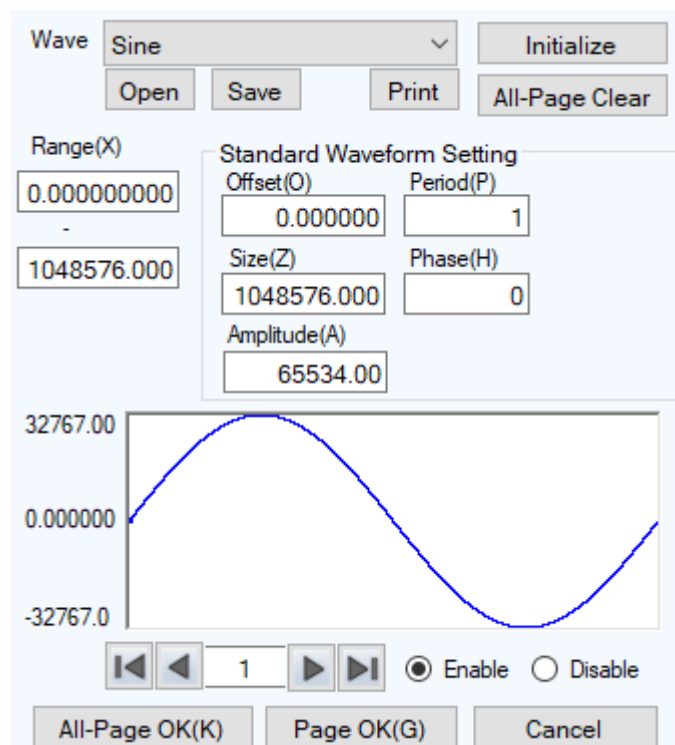


Figure 6-8 Editing a New Arbitrary Waveform





6.8.1 Range/Page



In Edit new arbitrary waveform, a waveform is generated by applying a "range" and a "definition of waveform" that are independent for each page. When [New Arbitrary Waveform Editing Panel] is displayed for the first time, the present range for marker specification is applied as the range for New arbitrary waveform editing.

The range for each page is set on the two numeric input areas under [Range].

If the ranges of two or more pages overlap together, the waveform definition of the page with larger number (the later page) is effective. By utilizing this feature, some parts of waveforms defined on the previous pages can be changed all at once.

Each page can be enabled/disabled independently. Click either [Enable] or [Disable] radio button to make it selected status.

Move between pages by using  button and  button on the left bottom of the Arbitrary waveform editing screen.  button moves to the previous page, and  button moves to the next page.

Clicking  button moves you to the first active page. Clicking  button moves you to the last active page.

By entering numbers directly into the value input area between buttons and pressing **Enter** key, you can jump to the specified page. Available page number is from 1 to 200.

By clicking the **Initialize** button on the top of [New Arbitrary Waveform Editing Panel], you can initialize the setting values for the displayed page to the default values.

To initialize setting values for all pages to the default values at once, click **All-Page Clear** button. Then [Range] of each page is set to zero.

To generate the waveform on the displayed page, click **Page OK** button on the bottom of the page.

To generate the waveforms on all pages at once, click **All-Page OK** button on the bottom of the page.

To return to the waveform display screen without generating a waveform, click **Cancel** button on the bottom of the page.

6.8.2 Select a Waveform


Click  button on the right of [Wave] on [New Arbitrary Waveform Editing Panel] to display the list of available waveforms. Select a waveform by clicking it.

Table 6-1 shows the types of waveform that can be generated.

Table 6-1 Waveform Selection

Waveform	Description
Sine	Generate a sine wave by setting appropriate parameters.
Triangle	Generate a triangle wave by setting appropriate parameters.
Square	Generate a square wave by setting appropriate parameters.
Noise	Generate a noise waveform that is different every time. It is generated based on the random number calculation. The generated noise waveform is white noise with the uniform distribution in amplitude.
DC	Generate a waveform assuming the data within the specified range as same.
Function	Define a waveform by combining various formulas.
PWF	Generate a PWF wave by setting appropriate parameters.

See 6.8.3 for the setting of each parameter.

See 6.8.4 for the setting of waveform function formula.

See 6.8.5 for the setting of PWF.

6.8.3 Parameter Setting

If the setting of [Wave] is sine wave, triangle wave, square wave, noise, or DC, you must set appropriate parameters to generate the wave. The following shows the available parameters to set.

Table 6-2 Parameters of the Standard Waveform

	Sine	Triangle	Square	Noise	DC
Offset	✓	✓	✓	✓	✓
Size	✓	✓	✓	✓	✓
Amplitude	✓	✓	✓	✓	—
Period	✓	✓	✓	—	—
Phase	✓	✓	✓	—	—
Symmetry	—	✓	—	—	—
Duty	—	—	✓	—	—
Transition	—	—	✓	—	—

■ Type of parameter

The size is the width of [Range] of the page. When the size is changed, the upper limit of range specification is changed.

Amplitude is peak to peak value.

Period specifies how many cycles (waves) of the waveform should be generated within the range.

The unit of phase is deg.

For a triangle waveform, slope (symmetry) can be set. The unit of slope is %.

For a square wave, duty ratio and transition can be set. The unit of duty ratio is [%]. Transition sets the time needed for the wave height to reach from 0% to 100% using the ratio (%) against the cycle.

If [Offset] or [Amplitude] that exceeds +/- full scale value is set, the waveform is clipped at +/- full scale.

----- Notes -----

- Values entered in [Range (X)], [Offset (O)], [Size (Z)], and [Amplitude (A)] are rounded to the internal processing resolution.

Therefore, you may get a value different from the input value.

For example, if [Amplitude] in the Y-axis unit setting is 2Vp-p and [Amplitude (A)] is set to 500m, the value will be rounded to 500.015m.

6.8.4 Waveform Function Setting

When [Function] is selected in Select a Waveform (6.8.2), constant input section [Constant] and formula input section [Y=] are displayed.

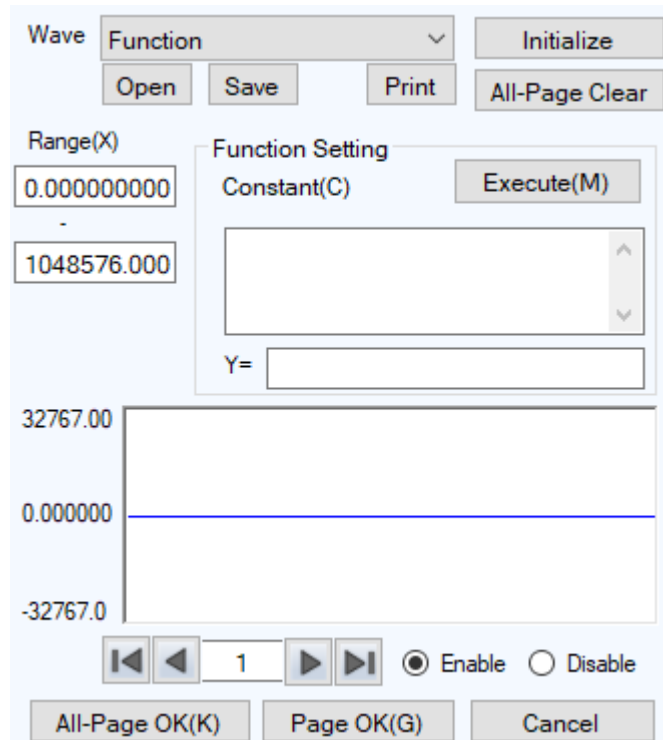


Figure 6-9 When "Waveform Function" is Selected

By entering constant and formula and clicking the **Execute** button, you can check the calculated waveform in waveform display area of [New Arbitrary Waveform Editing Panel].

■ Constant

Constant is described as [constant = value or formula] format, for example, [fs=32767;], [s=2*pi/1048576;]. Always add semicolon [;] at the end of a constant definition or formula.

A constant or formula is described in single-byte. Alphabetical characters are case-independent.

Any constant should start with an alphabetical character and consist of alphanumeric characters.

Name of a constant should not be same as any of the embedded functions (6.5). It is also recommended to avoid using the same string as one of the embedded constants (6.3).

With the **All-Page OK** button, constant is effective for all pages on and after the defined page.

For example, constants defined on page 1 are effective for all the pages. Constants defined on page 3 are not effective for page 1 and 2, but effective for page 3 and after.

When creating only the waveforms that are displayed by the **Page OK** button, constants are effective only for pages being displayed. For example, constants defined on page 2 are not effective for page 1 or pages on and after 3.

In this case, to make the constant given on other page effective, click the **Execute** button on the page where the constant is defined to perform a calculation beforehand.

■ Embedded constant

Constants shown in Table 6-3 are embedded into the Arbitrary waveform editing tool.

If you use the above stated method to define a constant with the same name as one of the embedded constants, the definition of that embedded constant is disabled and your definition of values and formulas become effective.

Table 6-3 Embedded Constant

Expression	Meaning	Value
pi	Pi	3.1415926535898
c	Speed of light	2.99792458e8
h	Planck's constant	6.6260755e-34
k	Boltzmann's constant	1.380658e-23
r	Euler's constant	0.57721566490153

■ Function

In formula input section [Y=], provide a formula in $Y=f(X)$ format.

[X] is a value to be changed within the range of the page. For example, if the range in a page is 1000 to 2000, [X] in the formula changes between 1000 to 2000.

The value of [X] in the formula is affected by the unit of horizontal axis (☞ 6.12.2) which is set on the unit setting screen.

For example, consider the following cases that a sine wave is provided by a formula like [Y=] [sin(X)]. Radian expression is used for the arguments of the sin() function.

Assume that the unit of horizontal axis is [Address] and the range is from 0 to 1024. Since $1024=2*\pi*162.9746\dots$, the result of this formula is a sine wave with about 163 waves.

In the case that the unit of horizontal axis is [Time] and the frequency is 500 Hz, the cycle is 2 ms and $2e-3=2*\pi*0.0003183\dots$. Then the result of this formula is a value that changes just little around 0° of the sine wave.

In the case that the unit of the vertical axis is [User] and the range is from 0 to 1, $1=2*\pi*0.1591\dots$. Then, the result of this formula is a waveform of about 1/6 first half of a sine wave.

To obtain 1 wave of sine wave from the simplest formula, set the unit of the horizontal axis to [User] and [Min-Max] to 0 to 6.283185.

The value of [Y=] in the formula is affected by the unit of vertical axis (☞ 6.12.3) which is set on the system setting screen.

Consider the following cases that a sine wave is provided by a formula like [Y=] [sin(X)]. The value of sin() function is ± 1 .

In the case that the unit of a vertical axis is [Data], its range is -32768 to $+32767$. Therefore, the result of this formula is a waveform around 0 with very small amplitude.

In the case that the unit of a vertical axis is [Voltage] and the amplitude is 20 Vp-p, its range is ± 10 . Therefore, the result of this formula is a sine wave of 1/10 of full scale.

In the case that the unit of a vertical axis is [User] and its range is -1 to $+1$, the result of this formula is a full scale sine wave.

If the result of calculation exceeds \pm full scale, the waveform clips at \pm full scale.

■ Operator

In constant input section [Constant] and formula input section [Y=], combination of Table 6-4 operators can be used.

The operators in the following table are shown in the descending order of the priority.

Logical operator returns 1 when the given condition is true, and returns 0 when false.

Table 6-4 Operators

Operator	Coupling rule	Remarks
(), Function, Constant, User-defined variable, Number string	→	
+, -, !	←	Unary operator. ! is a logical operator.
^	→	Binary operator, Power
*, /	→	Binary operator, Multiplying/Dividing calculation
+, -	→	Binary operator, Adding/Subtracting calculation
<, <=, >, >=	→	Logical operator, Bigger/Smaller comparison
==, !=	→	Logical operator, Equivalent comparison
&&	→	Logical operator, Logical multiply
	→	Logical operator, Logical add

■ Embedded function

In the constant input section [Constant] and the formula input section [Y=], combination of Table 6-5 functions can be used.

Table 6-5 Embedded Function

Function	Description
sin(arg), cos(arg), tan(arg)	Triangle functions. Arguments are in radians.
atn(arg)	Arctangent function. Returns the angle in radians whose tangent is the argument.
sqr(arg)	Returns the positive square root of the argument.
exp(arg)	Exponential whose base is e (base of natural logarithm)
log(arg)	Returns natural logarithm.
log10(arg)	Returns common logarithm.
power(arg1, arg2)	Returns the magnitude of the complex vector whose real part is the 1st argument and imaginary part is the 2nd.
phase(arg1, arg2)	Returns the angle of the complex vector whose real part is the 1st argument and the imaginary part is the 2nd.
tri(arg1, arg2)	Triangle wave whose angle is the 1st argument and slope (symmetry) is the 2nd. The 2nd argument is optional. When omitted, it is regarded as 50%.
sqw(arg1, arg2, arg3)	Square wave whose angle is the 1st argument, duty ratio is the 2nd, transition is the 3rd. The 2nd and the 3rd arguments are optional. When omitted, the 2nd is regarded as 50% and the 3rd regarded as 0%. The 2nd argument cannot be omitted when the 3rd is specified.
rnd()	White noise whose magnitude is uniformly distributed within ± 1 . No argument is specified.

■ Examples of waveform function formulas

This section shows several examples of waveform function formulas.

In the example consisting of only page 1, the range is whole range of the horizontal axis, and descriptions are omitted.

- One cycle of a sine wave (unit of the horizontal axis: address 0 to 1048576, unit of the vertical axis: data ± 32767)

Page 1	[Constant]	[fs=32767; s=2*pi/1048576;]	← Address 1048576 corresponds to 2π
	[Y=]	[fs*sin(x*s)]	

- One cycle of a sine wave (unit of horizontal axis: time 0ms to 1ms, unit of vertical axis: voltage $\pm 10V$)

Page 1	[Constant]	[fs=10; s=2*pi/1e-3;]	← 1ms is 2π
	[Y=]	[fs*sin(x*s)]	

- One cycle of a sine wave (unit of horizontal axis: user-defined unit 0 to 1, unit of vertical axis: user-defined unit -1 to $+1$)

Page 1	[Constant]	[s=2*pi;]
	[Y=]	[sin(x*s)]

- One cycle of a sine wave (unit of horizontal axis: user-defined unit 0 to 6.283185, unit of vertical axis: user-defined unit -1 to $+1$)

Page 1	[Constant]	(None)
	[Y=]	[sin(x)]

- One cycle of a square wave (unit of horizontal axis: user-defined unit 0 to 6.283185, unit of vertical axis: user-defined unit -1 to $+1$)

Page 1	[Constant]	(None)	
	[Y=]	[((sin(x)>=0) - 0.5)*2]	← Obtain a square wave of 0/+1 using the logical operator ">=" to convert into ± 1 .

- DC sweep waveform (unit of horizontal axis: user-defined unit 0 to 1, unit of vertical axis: user-defined unit -1 to $+1$)

Page 1	[Constant]	(None)
	[Y=]	[(x-0.5)+sin(2*pi*x*32)/2]

- Damped wave (unit of horizontal axis: user-defined unit 0 to 6.283185, unit of vertical axis: user-defined unit -1 to $+1$)

Page 1	[Constant]	(None)
	[Y=]	[exp(-x)*sin(x*64)]

- DSB waveform (unit of horizontal axis: user-defined unit 0 to 6.283185, unit of vertical axis: user-defined unit -1 to $+1$)

Page 1	[Constant]	[a=19.5; b=20.5;]
	[Y=]	[(sin(a*x)+sin(b*x))/2]

6.8.5 PWF

When [PWF] is selected in Select a Waveform (see 6.8.2), waveform data can easily be generated using 26 types of waveforms and setting up to 6 parameters.

For details on PWF waveforms, see “WF1983/WF1984 Instruction Manual (Operations)”.

The waveform data that can be generated from the PWF window includes single-polarity waveforms. On the PWF window, waveform data can be generated in the \pm full-scale range even for such waveforms. Change the settings of the amplitude range of the oscillator as necessary.

■ PWF parameters

The 26 types of waveforms that can be used on the PWF window, their parameters, and their setting ranges and resolutions are listed below.

Table 6-6 Steady Sine Group

Waveform	Parameter	Minimum Value	Maximum Value	Resolution
Unbalanced Sine	Amptd1	-100.00	100.00	0.01
	Amptd2	-100.00	100.00	0.01
Clipped Sine	Clip	0.00	99.99	0.01
CF Ctrl Sine	CF	1.41	10.00	0.01
Angle Ctrl Sine	Angle	-180.00	180.00	0.01
Staircase Sine	X Steps	2	1024 (Inf)	1
	Y Steps	2	256 (Inf)	1
Multi-Cycle Sine	Cycles	0.01	50.00	0.01
	SPhase	-360.00	360.00	0.01

Table 6-7 Transient Sine Group

Waveform	Parameter	Minimum Value	Maximum Value	Resolution
On-Ph Ctrl Sine	OnPhase	0.00	360.00	0.01
	SlopeT	0.00	50.00	0.01
Off-Ph Ctrl Sine	OffPhase	0.00	360.00	0.01
	SlopeT	0.00	50.00	0.01
Chattering-On Sine	OnPhase	0.00	360.00	0.01
	ChatterN	0	20	1
	Ton	0.00	20.00	0.01
Chattering-Off Sine	OffPhase	0.00	360.00	0.01
	ChatterN	0	20	1
	Ton	0.00	20.00	0.01
	Toff	0.00	20.00	0.01

Table 6-8 Pulse Group

Waveform	Parameter	Minimum Value	Maximum Value	Resolution
Gaussian Pulse	Sigma	0.01	100.00	0.01
Lorentz Pulse	Halfwidth	0.01	100.00	0.01
Haversine	Width	0.01	100.00	0.01
Half-Sine Pulse	Width	0.01	100.00	0.01
Trapezoid Pulse	RiseFall	0.01	50.00	0.01
	UpperBase	0.01	100.00	0.01
Sin(x)/x	ZeroCross	1	50	1

Table 6-9 Transient Response Group

Waveform	Parameter	Minimum Value	Maximum Value	Resolution
Exponential Rise	TC	0.01	100.00	0.01
Exponential Fall	TC	0.01	100.00	0.01
2nd Ord LPF Step	Fn	1.00	50.00	0.01
	Q	0.50	50.00	0.01
Damped Oscillation	OscFreq	0.01	50.00	0.01
	DampTC	-100.00	100.00	0.01

Table 6-10 Surge Group

Waveform	Parameter	Minimum Value	Maximum Value	Resolution
Oscillation Surge	OscFreq	0.01	50.00	0.01
	DampTC	0.01	100.00	0.01
	TrailTC	0.01	100.00	0.01
Pulse Surge	Tr	0.01	100.00	0.01
	Td	0.01	100.00	0.01


Table 6-11 Others Group

Waveform	Parameter	Minimum Value	Maximum Value	Resolution
Trapezoid with Offset	Delay	0.00	100.00	0.01
	Rise	0.00	100.00	0.01
	UpperBase	0.00	100.00	0.01
	Fall	0.00	100.00	0.01
	Offset	0.00	100.00	0.01
Half-Sine Edge Pulse	LE	0.00	100.00	0.01
	TE	0.00	100.00	0.01
	Duty	0.00	100.00	0.01
Double Pulse	LwrBase1	0.00	100.00	0.01
	LE	0.00	100.00	0.01
	UprBase1	0.00	100.00	0.01
	TE	0.00	100.00	0.01
	LwrBase2	0.00	100.00	0.01
	UprBase2	0.00	100.00	0.01
Bottom Referenced Ramp	Symm	0.00	100.00	0.01

6.8.6 Example of Creating an Arbitrary Waveform

■ Standard waveform

As an example of standard waveform, we will create a triangle wave of 30% symmetry.

Step 1:	Click the Create button on Select Item Panel. You can also click [Tool] - [Create] to obtain the same result. Select Item Panel is changed to [New Arbitrary Waveform Editing Panel].
Step 2:	Click  button on the right side of [Wave], and then click [Triangle] in the list.
Step 3:	In value input section on the right side of [Symmetry], change the value from [50] to [30], and then press Enter key. This specifies a triangle wave of 30% symmetry.
Step 4:	Click the All-Page OK to close [New Arbitrary Waveform Editing Panel] and display the generated waveform in the waveform display section.

Description 1: In this example, a waveform is generated over entire horizontal axis (X). In the "Arbitrary waveform editing tool", a waveform can be divided into two or more pages, for example, the first 1/4 of a waveform to page 1, the last 1/2 to page 2, and others. In this case, specified effective waveforms on multiple pages can be executed all at once by clicking the **All-Page OK** button. If you want to execute only the waveforms displayed on the current page, click the **Page OK** button. In the example above, since page 1 is the only page specified, the result is same for clicking either button.

Description 2: You can select sine wave, square wave (variable duty ratio), noise, DC, and waveform definition by a formula (waveform function), as well as triangle wave.

■ Formula waveform

As an example of editing an arbitrary waveform by formula, we will create a waveform of a fundamental wave with the 3rd and 5th harmonics waves superimposed.

Step 1:	Select [Set] - [System Setting]. A dialog titled [Unit Setting] appears.
Step 2:	In the [Unit (X)] combo box of [X-axis Unit Setting], click [User]. Leave Min-Max as the initial value of [0.000000 to 1.000000].
Step 3:	In the [Unit (Y)] combo box of [Y-axis Unit Setting], click [User]. Leave Min-Max as the initial value of [0.000000 to 1.000000].
Step 4:	Click the OK button to return to waveform display screen.
Step 5:	Click the Create button on Select Item Panel. You can also click [Tool] - [Create] to obtain the same result. Select Item Panel is changed to [New Arbitrary Waveform Editing Panel].
Step 6:	Click <input type="checkbox"/> button on the right side of [Wave], and then click [Function] in the displayed list.
Step 7:	Enter [s=2*pi;] in the input area on the right side of [Constant]. Enter [sin(x*s)+sin(x*s*3)/3+sin(x*s*5)/5] in the input area on the right side of [Y=].
Step 8:	Clicking the Execute button displays a waveform as a calculation result in the Arbitrary waveform editing screen.
Step 9:	Click the All-Page OK button to return to waveform display section.

Description 1: Here, entire horizontal axis (X) is processed as the range of 0 to 1 by using the user-defined unit. Also, entire vertical axis (Y) is processed as the range of ± 1 . One cycle of a sine wave is easily expressed by defining $s=2\pi$ as a constant and specifying [x*s] in the formula.

Description 2: In step 2, if the range of X is set as 0 to 6.283185 (2π) using the user-defined unit, the formula becomes more simple as $[\sin(x)+\sin(x*3)/3+\sin(x*5)/5]$.


6.8.7 Operation of Parameter File for Arbitrary Waveform Editing

Parameter setting of [New Arbitrary Waveform Editing Panel] can be saved as a text file.

Click **Save** button on the top of [New Arbitrary Waveform Editing Panel] to display a screen titled [Save As].

Select the location where the file will be saved, enter the file name, and click the **Save** button. The file extension is ".wfn,"(".pwf" if [PWF] is selected for waveform selection) which can be omitted when entering a file name.

To load a parameter setting file, click **Open** button on the top of [New Arbitrary Waveform Editing Panel]. The screen titled Open File is displayed. Select the location to save the file and enter the file name, and then click **Open** button.

Because the setting file for the Arbitrary waveform editing screen is a text file, it can be edited using any text editor. However, we do not recommend to do so. It may result in the situations where "Arbitrary waveform editing tool" is changed to a format that cannot be read. Or if a formula is changed to become too long exceeding the limit, edited file may not be readable. For the information of files that can be processed by "Arbitrary waveform editing tool", see  6.6.

6.8.8 Print

Parameter settings of [New Arbitrary Waveform Editing Panel] can be printed.

Click **Print** button on the top of [New Arbitrary Waveform Editing Panel] to display the Print dialog. For details of the print setup, see the instruction manual of your printer.

6.9 Interpolate

[Interpolate Panel] is used to create a waveform by using various interpolation. A "point" that is set to interpolate is called a "control point."

When you click the **Interpolate** button on Select Item Panel or select [Tool] - [Interpolate] (**Alt**, **I**), [Interpolate Panel] is displayed.

Just after editing an arbitrary waveform on [Interpolate Panel] and returning to waveform display screen, the generated waveform can be restored to the state before the edited contents were reflected by selecting [Edit] - [Undo] (**Alt**, **E**, **U**), or **Ctrl** + **U**.

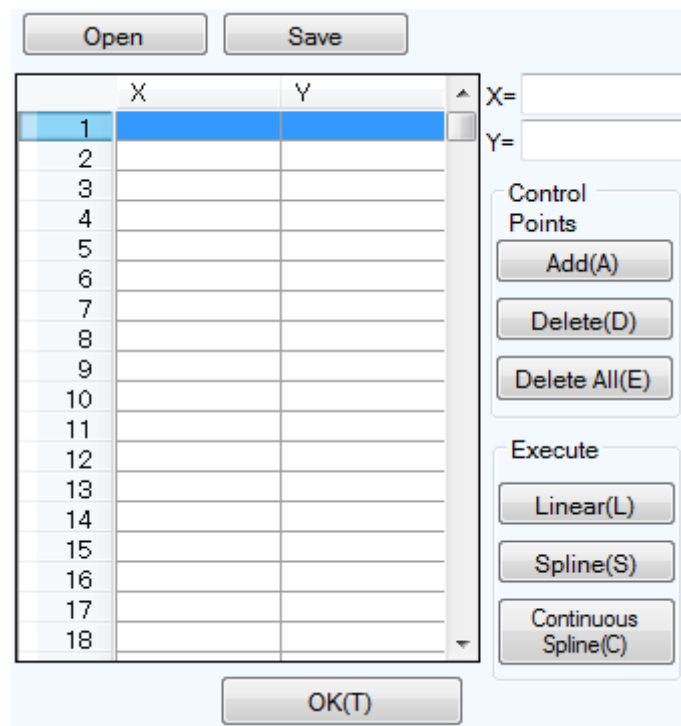


Figure 6-10 Interpolate

Operations to edit interpolation are executed for the selected range. First select the range by using A marker and B marker on waveform display screen.

6.9.1 Control Point Setting

Interpolation is executed for a range that is selected by markers in waveform display screen.

A control point can be set outside the selected range. However, control points outside the range are ignored when interpolation is executed.

A control point may be set on any location. However, two or more control points cannot be set on one X coordinate.

■ Specify a control point by values

Enter coordinate values in the input area on the right side of [X=] and [Y=] of [Interpolate Panel].

To activate the right side of [X=], click the input area, or press **Alt** + **X**.

To activate the right side of [Y=], click the input area, or press **Alt** + **Y**.

Click **Add** button to display the **[+]** mark at the specified position of the Waveform display section. The positions of the control points are displayed also in the list of control points of [Interpolate Panel] using their values. In the list of the control points, control points are displayed after sorted by the ascending order of their X values.

■ Specify a control point by mouse

If any **[+]** mark of control points is shown if red (selected), first click in the waveform display area where there is no mark displayed to change all marks to light blue (not selected).

Move the mouse cursor to the position to which you want to add a control point, and then click it while pressing **Ctrl** key. A control point will be added. You can know approximate position of the mouse cursor in [Cursor] on the top left of the Waveform display section. The added control point is also added to the list of control points in the [Interpolate Panel]. Check the coordinate values.

■ Move a control point by values

When you select (click) any control point from the list of control points in the [Interpolate Panel], the point is selected and the following processes are performed:

- The specified part of the list is displayed inverted.
- In the input area of [X=] and [Y=], the coordinate values of the selected control point are displayed.
- In the Waveform display section, the corresponding coordinate point **[+]** mark turns to red.

The control point can also be selected by clicking **[+]** mark in the Waveform display section. However, if the magnification of the screen is lower, the mark may not be caught due to the screen resolution.

While a control point is selected, updating the value of [Y=] and clicking **Add** button moves the selected control point. Clicking **Add** button after updating the value of [X=] adds a new control point if the identical coordinate point does not exist, or updates the control point if exists.

■ Move a control point by mouse

A control point can also be moved by dragging **[+]** mark of the Waveform display section. However, if the magnification of the screen is lower, the mark may not be caught due to the screen resolution.

■ Delete control points

Click the **Delete** button to delete control points being selected at that time.

There is no way to restore control points after delete operation. Caution is required for this function.

■ Delete all control points

Click the **Delete All** button to delete all control points being set at that time.

There is no way to restore control points after all delete operation. Great caution is required for this function.

6.9.2 Execute Interpolation

After the range is selected and the control point is set, execute the interpolation. There are the following three types of interpolation:

- Linear interpolation: interpolates using straight line between control points
- Spline interpolation: interpolates using smoothed curve between control points
- Continuous spline interpolation: interpolates with curved line so that the line forms an unified shape also with the waveforms outside the selected range

To execute linear interpolation, click the **Linear** button, or press **Alt + L**.

To execute spline interpolation, click the **Spline** button, or press **Alt + S**.

To execute continuous spline interpolation, click the **Continuous Spline** button.

When a part of the waveform is selected as the range, interpolation is performed by interpolating the both ends of the range and the control points within the range.

When entire waveform is selected, continuous spline interpolation interpolates so that the waveforms would be concatenated smoothly when repeated. In linear or spline interpolation, the first and last value are different resulting in the waveform discontinuous when repeated.

If that exceeds +/- full scale is set as the result of interpolation, the waveform is clipped at +/- full scale.

After executing interpolation, click the **OK** button to return to the waveform display screen.

6.9.3 Example of Creating an Arbitrary Waveform

As an example of editing an arbitrary waveform by interpolation, we will create a smoothed pulse waveform.

Step 1:	Select [Setting] - [System Setting] to display a dialog titled [System Setting].
Step 2:	Click [User] from the combo box on the right side of [Unit(X)]. Leave [Min-Max] as the initial value of [0.000000 to 1.000000].
Step 3:	Click [User] from the combo box on the right side of [Unit(Y)]. Leave [Min-Max] as the initial value of [-1.000000 to 1.000000]. Click the OK button to return to waveform display screen.
Step 4:	Set the coordinate value of A marker (read) as [0.2], and then press Tab key. Set the coordinate value of B marker (blue) as [0.8], and then press Tab key.
Step 5:	Click Interpolate button on Select Item Panel. You can also click [Tool] - [Interpolate] to obtain the same result. Select Item Panel is changed to [Interpolate Panel].
Step 6:	Enter [0.5] as the coordinate value of [X=], and [1] as the coordinate value of [Y=], and then click the Add button.
Step 7:	Click the Continuous Spline button. The interpolated waveform is displayed in the Waveform display section.
Step 8:	Click the OK button to return to waveform display section.

Description 1: In the interpolation editing, a point that is set in step 6 is called "control point."

Description 2: In linear interpolation, a waveform is created by interpolating between control points with a straight line.

In spline interpolation, control points are interpolated smoothly with a spline curve.

Description 3: In continuous spline interpolation, interpolation is performed so that the waveform can concatenate also with the vicinity of the selected range smoothly. When all the range is selected, the waveform is interpolated so that the first and last waveform is concatenated smoothly when it is repeated.

6.9.4 Control Point File Operation

Control point setting of [Interpolate Panel] can be saved as a text file.

Click **Save** button on the top of [Interpolate Panel] to display a screen titled [Save As].


Select the location where the file will be saved, enter the file name, and click the **Save** button.

Select a file extension from ".prn", ".tsv", or ".csv." It can be omitted when entering a file name.

- Extension .prn Control point information file delimited by space
- Extension .tsv Control point information file delimited by tab
- Extension .csv Control point information file delimited by comma

To load a control point setting file, click **Open** button on the top of [Interpolate Panel]. The screen titled Open File is displayed. Select the location to save the file and enter the file name, and then click **Open** button.

This file can be read with any text editor or spreadsheet software. Also, a text file created with any text editor or spreadsheet software can be read with the "Arbitrary waveform editing tool." When creating a text file, one line must consist of 2 data elements of X and Y, and be saved in the format same as the file with the above extension.

For the information of files that can be processed by "Arbitrary waveform editing tool", see  6.6.

6.10 Operation

[Operate Panel] has a waveform in selected ranges, and the standard waveform, formula waveform, or the function to execute arithmetical operation on a waveform in clip board to create a waveform. When clicking the **Operate** button on Select Item Panel, or select [Tool] - [Operate] (**Alt**, **T**, **O**), [Operate Panel] is displayed. Operations on waveform display sections disabled during [Operate Panel] is displayed.

Just after editing an arbitrary waveform on [Operate Panel] and returning to waveform display section, the generated waveform can be restored to the state before the edited contents were reflected by selecting [Edit] - [Undo] (**Alt**, **E**, **U**), or **Ctrl** + **U**.

Operation is executed for a range selected by markers. First select the range to edit by using A marker and B marker on waveform display section.

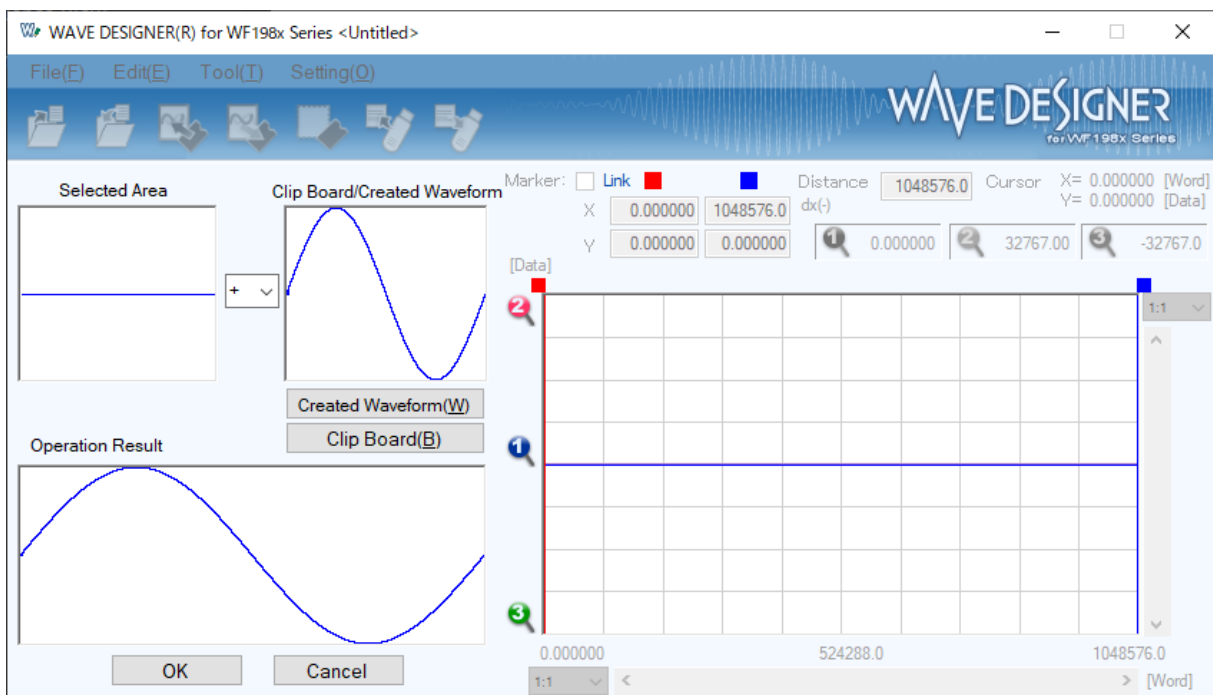







Figure 6-11 Operation

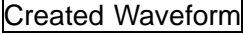



6.10.1 Types of Operation

When clicking  button between [Selected Area] and [Clip Board/Created Waveform], a list of arithmetical operation is displayed. Select an operator by clicking in the list, or pressing , , ,  key.


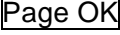
[*] represents multiplication, and [/] represents division.

6.10.2 Set an Operation Target





■ Generated waveform

When clicking the  button, or pressing  + , the Arbitrary waveform editing screen appears. Operations can be executed according to "Edit a New Arbitrary Waveform" ( 6.8). However, there are the following limitations for an arbitrary waveform editing in operations.

- [Range] or [Size] cannot be changed.
- A range cannot be divided over two or more pages.

After you create a waveform according to "Edit a New Arbitrary Waveform" ( 6.8) and click the , the created waveform is displayed in [Clip Board/Created Waveform] area.

■ Clip Board

Click the  button or pressing  +  to display a waveform stored in clip board in [Clip Board/Created Waveform] area. For operation with the clip board, see  6.5.4.



If the selected range is longer than the data in the clip board, the remained portion is processed as 0. If the selected range is longer than the data in clip board, the data is used beginning with its front part.

Though the data in the clip board is 16-bit integer, it is converted using the unit of vertical axis before the operations. For example, in the case that the unit of vertical axis is a user-defined unit: -1 to +1, data in the clip board is converted and processed after adjusted to the range of ± 1 .

6.10.3 Operation Execution

Operation is executed automatically every time the operation type is changed or data in [Clip Board/Created Waveform] is changed.

The result of operation is displayed as a waveform in [Operation Result] area.

To reflect the operation result to the Waveform display section, click  button. Or, click  button to discard the result of calculation and return to the Waveform display section.

6.10.4 Example of Creating an Arbitrary Waveform

As an example of operations, we will create a waveform of sine wave with noise superimposed.

- Step 1: Display [New Arbitrary Waveform Editing Panel].
In its initial state, a sine wave is selected.
Change the value on the right side of [Amplitude] from [65534] to [50000] to make the amplitude smaller.
Click the **All-Page OK** button to return to waveform display screen.
- Step 2: Click the **Operate** button on Select Item Panel.
You can also click [Tool] - [Operate] to obtain the same result.
Select Item Panel is changed to [Operate Panel].
- Step 3: Click the **Created Waveform** button.
- Step 4: Select [Waveform] combo box, and then click [Noise] in the list displayed.
Change the value on the right side of [Amplitude] from [65534] to [15000].
Return to [Operate Panel] by clicking the **Page OK** button.
In this stage, the result of the addition is displayed in the [Operation Result] field.
- Step 5: Click the **OK** button to return to waveform display section.
This produces a waveform of a sine wave with noise superimposed.

- Description 1: Subtraction, multiplication, and division are also available as well as addition which was shown in this example.
- Description 2: You can operate for only a part of a waveform by selecting that part of the waveform using A and B markers in the waveform display screen beforehand.
- Description 3: In this example, the waveform created on the [Arbitrary Waveform Editing Panel] is used for operation.
In step 3, the contents in "clipboard" can be used for operation by clicking the **Clip Board** button.
- Description 4: When executing multiplication, it is convenient to set the unit of the vertical axis as ± 1 of the user-defined unit.
This makes the result of the multiplication between full scale values to a full scale value also.

6.11 Compress/Expand

[Compress/Expand Panel] generates a waveform by compressing or expanding the waveform in the selection vertically/horizontally.

When you click the **Compan**d button on Select Item Panel or perform [Tool] - [Compan]d (**Alt**, **T**, **P**), [Compress/Expand Panel] is displayed. Operations on waveform display sections disabled during [Compress/Expand Panel] is displayed.

Just after editing an arbitrary waveform on [Compress/Expand Panel] and returning to waveform display section, the generated waveform can be restored to the state before the edited contents were reflected by selecting [Edit] - [Undo] (**Alt**, **E**, **U**), or **Ctrl** + **U**.

Figure 6-12 Compression/Expansion

6.11.1 Compression/Expansion along Horizontal Axis

Because the compression/expansion operation affects only the selected range by markers, you must set the selection by using markers in the waveform display section (6.5.3) before you compress/expand along the horizontal axis.

To set the compression/expansion along the horizontal axis, you use the items in the [X-axis] on the Compression/Expansion screen.

■ Compress/expand selection to start/end point

Enter the numeric values in the input areas of the [Start X=] and [End X=] and click **OK** button.

The waveform in the selection that is already selected by the markers can be compressed/expanded or moved to the selection specified by the start and end points.

The area with no data as the result of the compression/expansion is filled with the data immediately before or after it.

- Expand selection to fit

Click the **Expand All** button to expand the selection that is already selected by the markers to the entire waveform data. For example, the actual data collected by the digital oscilloscope usually does not represent an exact one cycle. In this case, you can use this feature to clip one cycle.

- Notes

Note that when the expansion rate is too high, the distortion may occur in the waveform.

6.11.2 Compression/Expansion along Vertical Axis

Because the compression/expansion operation affects only the selected range by markers, you must set the selection by using markers in the waveform display section (see 6.5.3) before you compress/expand along the vertical axis.

To set the compression/expansion along the vertical axis, you use the items in the [Y-axis] on the Compression/Expansion screen.

- Compression/expansion using maximum/minimum value

When [Max/Min] (option button) is selected () , the maximum value and the minimum value in the selected range specified by the markers are displayed on the right of [Max] and [Min], respectively. When you enter the maximum/minimum value for the target in the respective display section after compression/expansion and press **Enter** key, the waveform in the display waveform section will be changed.

You can also flip the waveform by setting the maximum value smaller than the minimum value.

When you are satisfied with the generated waveform, click **OK** button.

To return to the waveform display screen without performing compression/expansion, click **Cancel** button.

- Compression/expansion using amplitude/offset

When [Amplitude/Offset] (option button) is selected () , amplitude value and offset value in the selection selected by the markers is displayed on the right of [Amplitude] and [Offset], respectively.

The following shows the relationship between amplitude/offset and maximum/minimum value.

amplitude = (width from maximum value to minimum value), offset = (center of maximum value and minimum value)

maximum value = offset + (amplitude / 2), minimum value = offset - (amplitude / 2)

You can also flip the waveform by setting amplitude to a negative value.

When you are satisfied with the generated waveform, click **OK** button.

To return to the waveform display screen without performing compression/expansion, click **Cancel** button.

- Expand selection to max amplitude

Click the **Expand with Offset Clear** button to expand the selection that is already selected by the markers to the maximum amplitude. If the offset in the selection before expansion is not 0, it will be changed to 0 after the expansion.

By clicking the **Expand with Fixed Offset** button, you can expand the waveform so that the positive or negative peak matches the maximum value without changing the offset.

- Notes

If the result of expansion exceeds +/- full scale, the waveform is clipped at +/- full scale.

Note that when the expansion rate is too high, the distortion may occur in the waveform.

6.11.3 Example of Creating an Arbitrary Waveform

- Horizontal Compression/Expansion

As an example of horizontal compression/expansion of the waveform, we will generate the burst waveform by compressing a sine wave to the first quarter of the waveform display screen.

Step 1:	Display [New Arbitrary Waveform Editing Panel]. In its initial state, a sine wave is selected. Change [1] on the right of [Period] to [4] to make it a sine wave with 4 cycles. Click the All-Page OK button to return to waveform display screen.
Step 2:	Click the Compad button on Select Item Panel. You can also click [Tool] - [Compad] to obtain the same result. Select Item Panel is changed to [Compress/Expand Panel].
Step 3:	[1048576.000] is displayed in the lower right of the waveform display screen. Leave the numeric area on the right of [Start X=] as [0]. Enter the quarter of 1048576, which is [262144], in the numeric area on the right of [End X=] and press Enter key. In the waveform display screen, you can see that the sine wave with 4 waveforms which had been displayed in the entire screen is now compressed to the first quarter of the screen.
Step 4:	Click the OK button to return to waveform display screen.

Description 1: In this example, because you left [Start X=] as [0], the original waveform was compressed to the first quarter of the waveform in the waveform display screen.
For example, if [Start X=] is set to [262144] and [End X=] is set to [524288], the original waveform is compressed to the second quarter of the waveform display screen instead of the first quarter.

Description 2: You can also expand the selection of the waveform to the entire waveform.
You must select the portion of the waveform using marker A and B in the waveform display screen in advance.
Then click the **Expand All** button in the [Compress/Expand] screen to expand the selection to the entire waveform.

■ Vertical compression/expansion

As an example of vertical compression/expansion of the waveform, we will generate a trapezoidal waveform by expanding and clipping the triangle waveform.

Step 1:	<p>Display [New Arbitrary Waveform Editing Panel]. In its initial state, a sine wave is selected. Select [Triangle] from [Wave] combo box. Click the All-Page OK button to return to waveform display screen.</p>
Step 2:	<p>Click the Compan button on Select Item Panel. You can also click [Tool] - [Compress/Expand] to obtain the same result. Select Item Panel is changed to [Compress/Expand Panel].</p>
Step 3:	<p>In the numeric area on the right of [Max], change [32767] to [100000], then press Enter key. In the numeric area on the right of [Min], change [-32767] to [-100000], then press Enter key. In the waveform display section, you can see that the triangle waveform is expanded vertically and clipped, transforming to a trapezoidal waveform.</p>
Step 4:	<p>Click the OK button to return to waveform display screen.</p>

- Description 1: You can also use the maximum/minimum numeric values specified in the step 3 to compress the waveform vertically or move the waveform up or down. If the result of the expansion or movement exceeds the +/- full scale, the waveform will be clipped at the +/- full scale point.
- Description 2: You can compress/expand only a part of a waveform by selecting that part of the waveform using A marker (red) and B marker (blue) in the waveform display screen beforehand.
- Description 3: If the +/- full scale is not reached by the waveform, you can expand the waveform to maximum amplitude by clicking the **Expand with Fixed Offset** button or the **Expand with Offset Clear** button.
- Description 4: If the maximum is set to [-100000] and the minimum is set to [100000] in the step 3, the waveform will be flipped.
- Description 5: While you used [Max/Min] to specify the compression/expansion rate in this example, you can also use [Amplitude/Offset] to do so. Click (option button) on the left of [Amplitude/Offset] to turn it to (selected). Next, set [Amplitude] to [200000] and [Offset] to [0] to obtain the same result as this example.
- Description 6: In this example, you generated the trapezoidal waveform by clipping the triangle waveform. You can generate it more easily by setting [Transition] against the square waveform.

6.12 System Setting

6.12.1 Data Count Settings

In the "Arbitrary waveform editing tool", you can set the number of arbitrary waveform data to be edited.

Since the maximum sampling frequency is 240 MHz, the maximum frequency at which all data can be played back is 240 MHz divided by the number of data. No higher frequency can be set.

6.12.2 X Axis Unit Settings






In "Arbitrary waveform editing tool," you can use time and user-defined unit in addition to the address of waveform data as a unit for displaying/setting horizontal axis.

Time coordinates with [Freq].

For a user-defined unit, you can arbitrarily specify the start point and end point of the waveform data and name of the unit.

Some examples of user-defined units for the horizontal axis are listed in Table 6-12.

When you use mathematical expressions to generate the waveform, it is useful to use values from 0 to 6.283185 because the unit of the trigonometric function such as $\sin()$ is radian.

Click the  button on the right of [Unit] to display a list of available units for the horizontal axis. Select a unit of horizontal axis by clicking in the list, or pressing , , ,  key.

Selecting a user-defined unit as the unit of X axis allows you to specify [Name] and [Min-Max].

In the area on the right of the [Name], enter a string of up to 4 characters (2 two-byte characters) as the name of the unit of horizontal axis.

In the areas on the right of the [Min-Max], enter the minimum value (the value at the left end of the waveform) and maximum value (the value at the right end of the waveform) of the user-defined unit.

Table 6-12 Example of User-defined Unit of Horizontal Axis

Range	Name (Description)
0~1	Period
-1~1	(vertical axis user-defined unit: used to adjust to vertical axis range of \pm)
0~360	deg (degree, °)
0~400	grad
0~6.283185	rad






6.12.3 Y Axis Unit Settings

In "Arbitrary waveform editing tool," you can use voltage and user-defined unit in addition to waveform data (16 bit: -32768 to $+32767$) as a unit for displaying/setting vertical axis.

Voltage coordinates with [Amplitude] and [Offset].

For a user-defined unit, you can arbitrarily specify the bottom and top of the waveform data and name of the unit.

When you use mathematical expressions to generate the waveform, it is useful to use values from -1 to $+1$ because the result of the function such as $\sin()$ is within ± 1 .

Click the  button on the right of [Unit] to display a list of available units for the vertical axis. Select a unit of vertical axis by clicking in the list, or pressing , , ,  key.

Selecting a user-defined unit as the unit of vertical axis allows you to specify [Name] and [Min-Max].

In the area on the right of the [Name], enter a string of up to 4 characters (2 two-byte characters) as the name of the unit of vertical axis.

In the areas on the right of the [Min-Max], enter the minimum value (the value at the bottom end of the waveform) and maximum value (the value at the top end of the waveform) of the user-defined unit.

6.13 Memory

"Arbitrary waveform editing tool" allows you to read and write the generated waveform data to the WF198x.

6.13.1 Memory Write

Select [Tool] - [Write] or click the [Write] icon on the Tool Bar to display the [Write] dialog.

Specify the memory number and transfer method on the WF198x you want to set. Click the button to start the waveform data transmission to the WF198x.

■ Transfer method

Depending on the waveform data, it may not be possible to transfer it in control point format. In this case, [Control point format] cannot be selected. Only [Array format] can be selected.

Control point format is waveform data for generating waveforms by linear interpolation inside the device. Create from the waveform data displayed on the waveform display screen. For example, waveform data with complex changes such as noise may not fit into the valid number of data points. In such cases, transfer in control point format is not possible.

Control point format allows the amount of data to be smaller than array format data and can be stored in the main unit's waveform memory. Therefore, when using arbitrary waveforms for sequence oscillation in equipment, more types of arbitrary waveforms can be used.

Please note that the control point data for this transfer method does not necessarily match the control points on the interpolation editing screen.

The array format is the data string itself corresponding to the waveform memory address. The control point format data described above will be created from this array format data.

6.13.2 Memory Read

Select [Tool] - [Read] or click the [Read] icon on the Tool Bar to display the [Read] dialog.

Specify the memory number on the WF198x you want to set. Click the button to start the waveform data read from the WF198x.

6.13.3 Memory Clear

Select [Tool] - [Memory Clear] or click the [Memory Clear] icon on the Tool Bar to display the [Clear] dialog.

Specify the memory number on the WF198x you want to clear. Click the **OK** button to clear the data for the selected memory number in the WF198x.

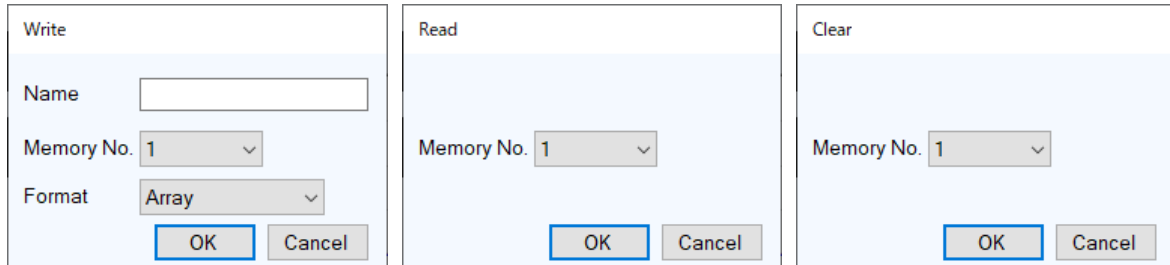


Figure 6-13 Write / Read / Clear Dialog

7. Sequence View


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7.1 Open or Close the Sequence View Window

7.1.1 Open the Sequence View Window

In the [Sequence] Menu Bar, select [Tool] - [Sequence View]

7.1.2 Close the Sequence View Window

Click the  in the upper right corner of the [Arbitrary Waveform Editing] window.

7.2 Name of Each Component in the Window

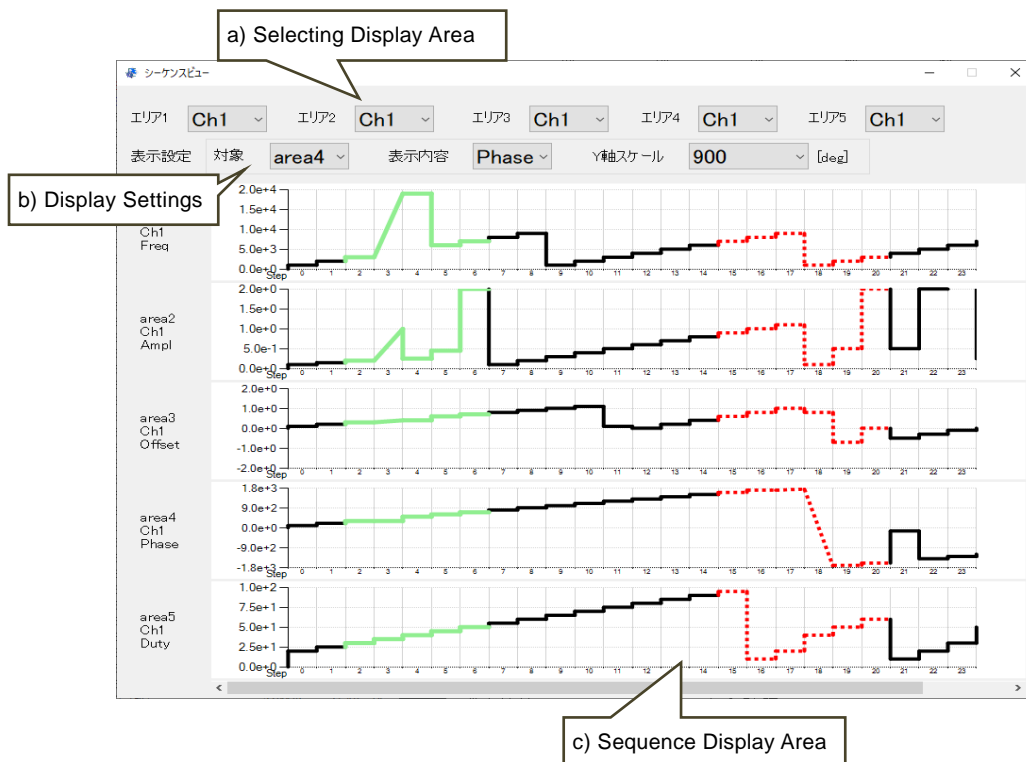





Figure 7-1 Sequence View Window

- | | |
|---------------------------|---|
| a) Selecting Display Area |  7.3.1 |
| b) Display Settings |  7.3.2 |
| c) Sequence Display Area |  7.3.3 |

7.3 Sequence Preview

7.3.1 Selecting Display Area

Select the channel to be displayed in the sequence view window from the combo box. Up to five sequence graphs can be displayed in the sequence display area.

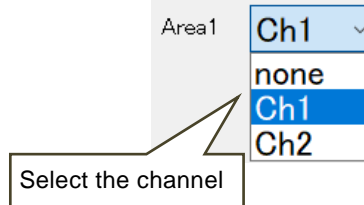


Figure 7-2 Select Display Area

If [none] is selected, the sequence graph will not be displayed in the display area.

7.3.2 Display Settings

For each display area, set the content to be displayed and the vertical axis scale. The settings of these parameters will be accepted only in the Edit mode.

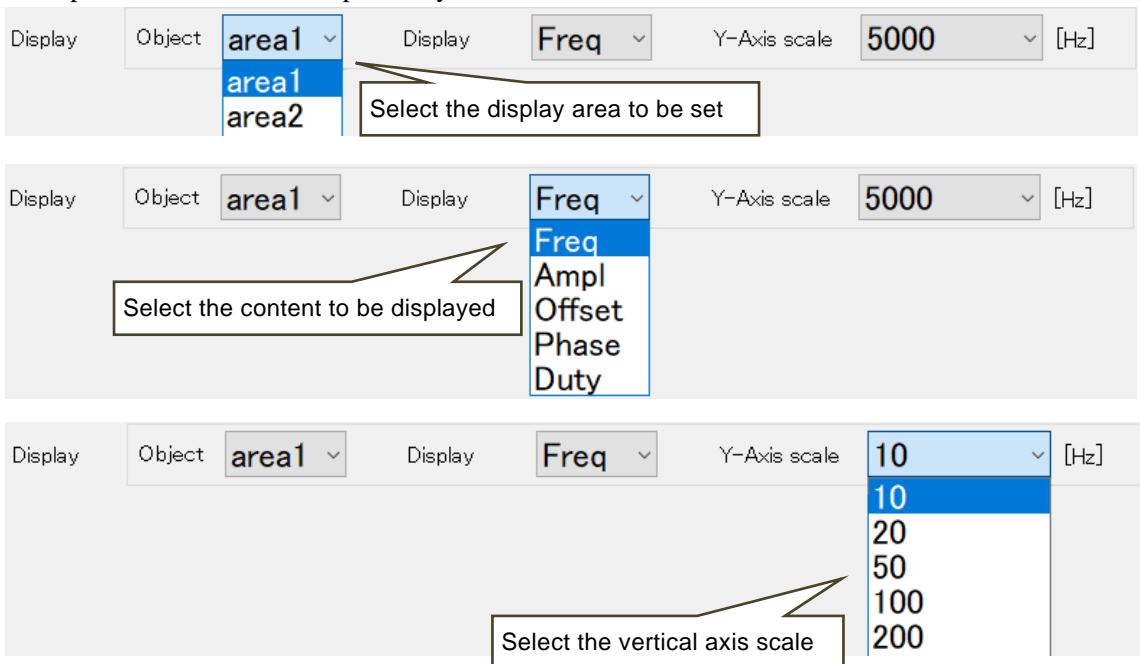


Figure 7-3 Display Settings

7.3.3 Sequence Display Area

The sequence graph is displayed as shown in Figure 7-4.

Use the horizontal scroll bar to scroll the display to see the portions that are not in the sequence display area. Any looping step is displayed only once by a green solid line. Any infinite looping step is displayed only once by a red dashed line.

If the number of steps is 24 or less, the sequence graph view will be enlarged according to the number of steps. If the number of steps is 25 or more, the width of displayed steps is fixed.

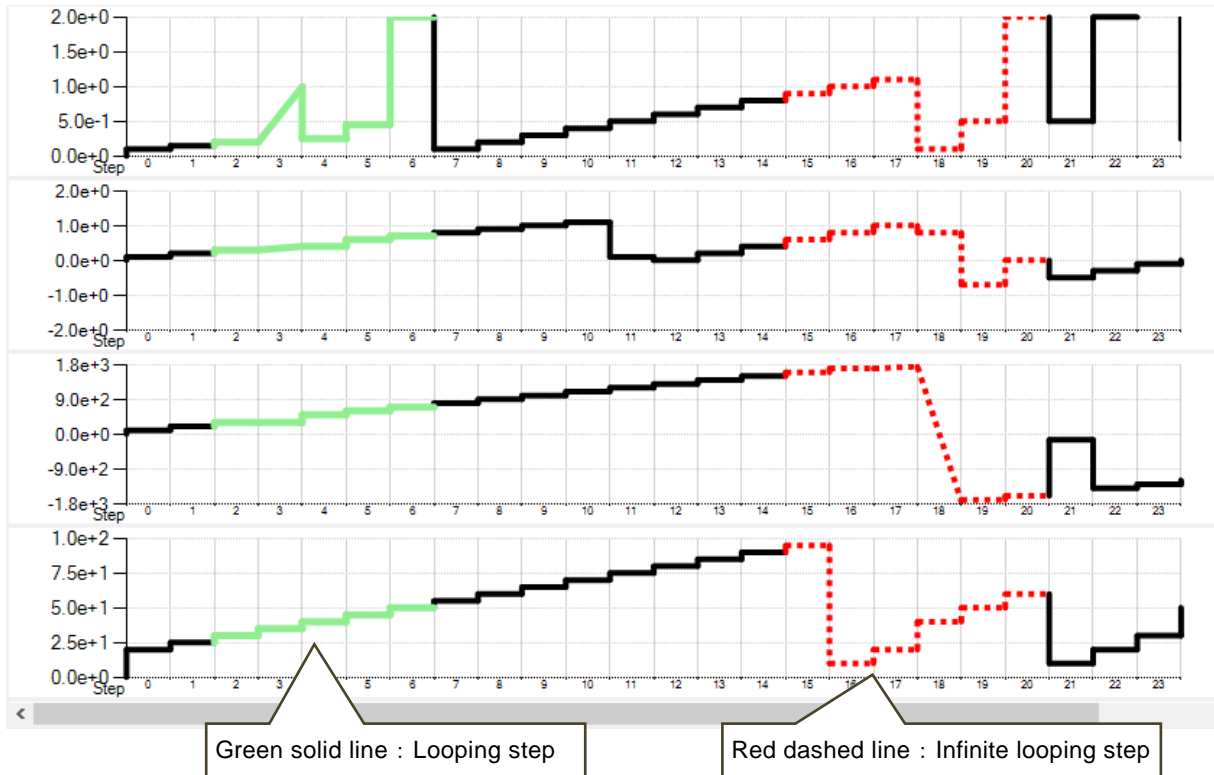


Figure 7-4 Sequence Display Area

7.4 Monitoring the Sequence Execution

When the sequence starts, sequence run monitoring starts as shown in Figure 7-5. While the sequence is being monitored, the window cannot be horizontally scrolled.

The current step area is displayed in a different color to indicate the progress of the sequence. The progress in each step is indicated by the sweep pointer.

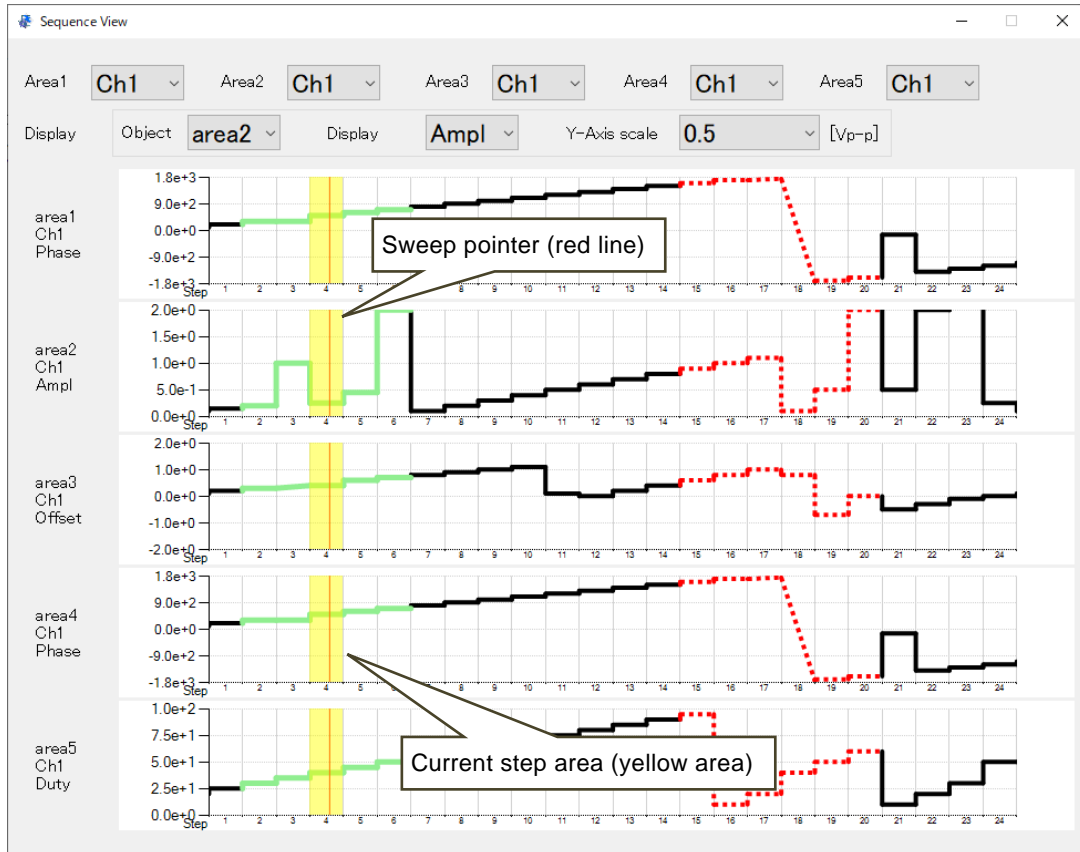


Figure 7-5 Display of the Sequence Progress

Notes

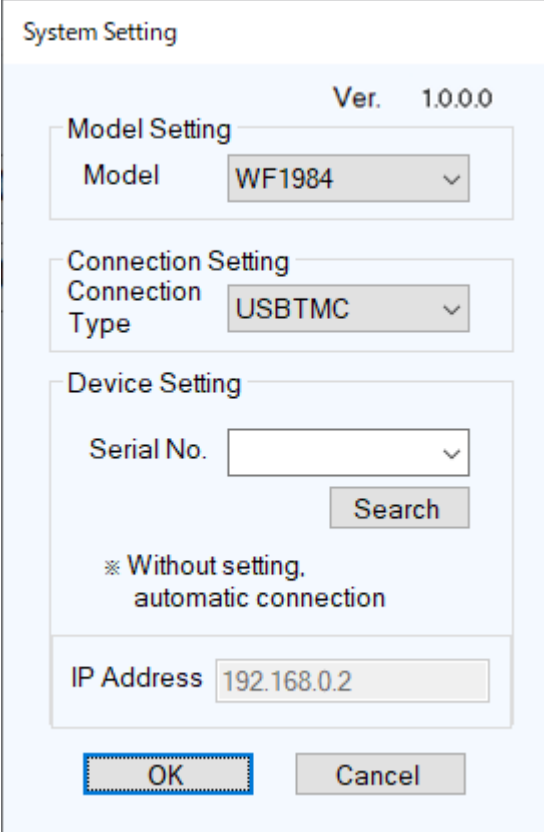
- The accuracy of sequence execution status is not guaranteed.
- In the sequence execution status, if the stop phase setting is enabled, there will be a time lag until the stop phase is reached after the step time has elapsed.
- When looping the same steps, the sweep pointer may appear to stop at the right edge of the current step area.
- If the operation type is hold/sweep setting, the display on the graph and the actual output value may differ.

8. Maintenance

8.1 Check Version	88
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8.1 Check Version

The version of this software is displayed in the upper right of the dialog which appears when you click the **System Setting** button.



The image shows a 'System Setting' dialog box. At the top right, it displays 'Ver. 1.0.0.0'. Below this, there are three main sections: 'Model Setting' with a 'Model' dropdown menu set to 'WF1984'; 'Connection Setting' with a 'Connection Type' dropdown menu set to 'USBTMC'; and 'Device Setting' which includes a 'Serial No.' dropdown menu, a 'Search' button, and a note: '※ Without setting, automatic connection'. At the bottom, there is an 'IP Address' text field containing '192.168.0.2'. At the very bottom are 'OK' and 'Cancel' buttons. The 'OK' button is highlighted with a blue dashed border.

Figure 8-1 System Setting Dialog

WABUN: (DA00102231-003)

If there are any misplaced or missing pages, we will replace the manual. Contact the sales representative.

NOTES

- Reproduction of the contents of this manual is forbidden by applicable laws.
- The contents of this manual may be revised without notice.
- Information provided in this manual is intended to be accurate and reliable. However, we assume no responsibility for any damage regarding the contents of this manual.
- We assume no responsibility for influences resulting from the operations in this manual.

Control Software for WF198x Series Instruction Manual

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