



# WAVE DESIGNER FOR WF1947/WF1948

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## Instruction Manual



DA00037638-004

# WAVE DESIGNER FOR WF1947/WF1948

## Instruction Manual

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## ———— Preface ————

Thank you very much for purchasing our "Multifunction Generator WF1947/WF1948".

To ensure safe and proper use of this product, please read first "Safety Precautions" on the next page.

● This manual has the following chapter organization.

If using this product for the first time, start with "1. Outline."

1. **Outline:** This chapter describes the overview of the functions of WAVE DESIGNER FOR WF1947/WF1948.
2. **Installation:** This chapter describes the environment required for WAVE DESIGNER FOR WF1947/WF1948 to operate and the installation method.
3. **Descriptions of Operations:** This chapter describes the operations, such as starting/exiting, the window configuration, and the utility setting, and the arbitrary waveform editing function.
4. **Maintenance:** This chapter describes the management of the CD-ROM, and what to do when it is damaged.

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To ensure safe use, be sure to observe the following warnings and cautions.

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- **Be sure to observe the contents of instruction manual.**

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

Be sure to read this manual first before using this product.

All the warnings in this instruction manual are intended to prevent hazards that may lead to serious accidents. Be sure to observe them.

- **In case of suspected anomaly**

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If such an abnormal occurs, prevent anyone from using this product until it has been repaired, and immediately report the problem to NF Corporation or one of our representatives.

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## ———— Contact Us ————

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

This software is an application to support the arbitrary waveform editing function of Multifunction Generator WF1947/WF1948 (hereinafter, abbreviated as "equipment"). It works on Windows (7, 8.1, or 10 or later) running on a personal computer (PC), and can transfer arbitrary waveform data by directly connecting the equipment to the PC via USB.

This software can create and edit arbitrary waveforms as shown in Figure 1-1.

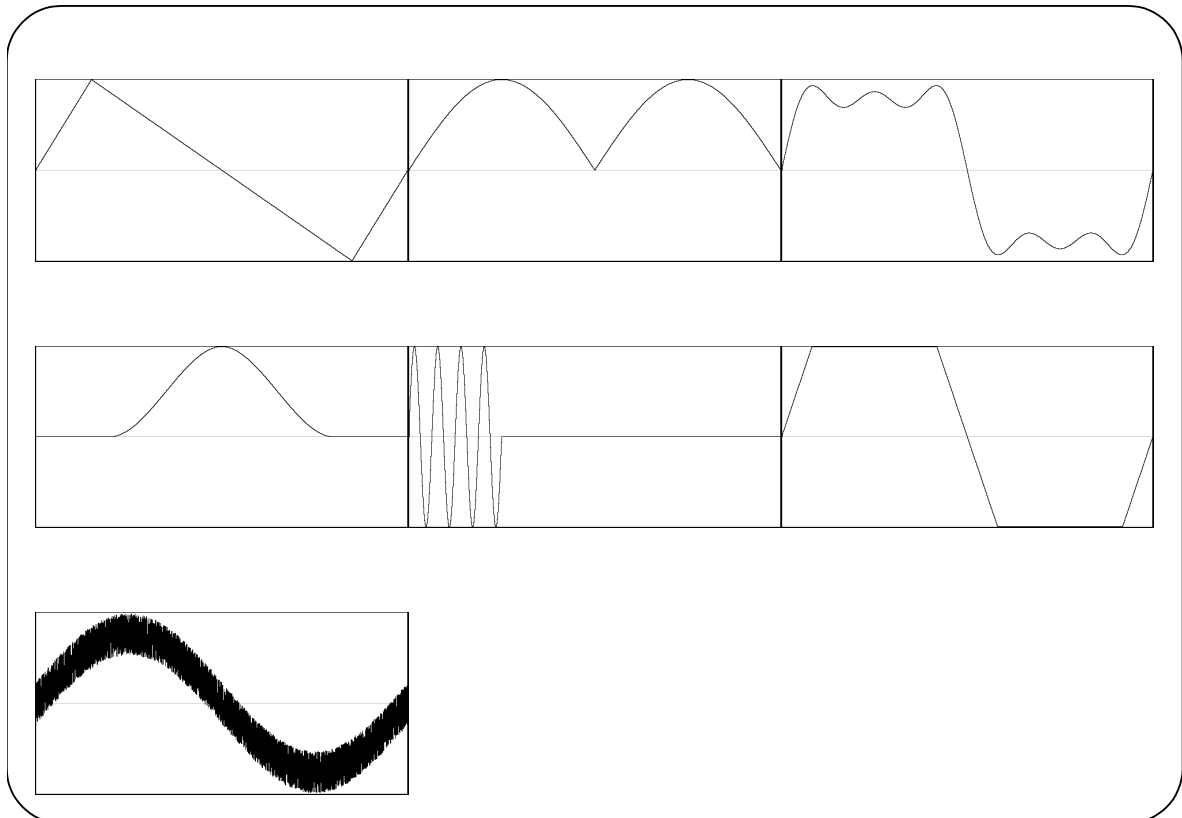


Figure 1-1 Arbitrary Waveform Creation Examples

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### Comments

In this software the waveform data is handled as 16-bit (-32768 to +32767).

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## 1.2 Communication with Equipment

This software establishes communications only when transferring the arbitrary waveform data to the equipment's memory or performing the clear operation. During this, the front panel operations of the equipment are disabled.

When the transfer or clear operation is completed, the communication with the equipment is disconnected, and you can operate the equipment again.

## 1.3 Conventions Used in This Manual

This manual uses the following conventions to describe the functions of this software.

- Menu names displayed on the screen, and user-input text: **block letters**, surrounded with [ ].  
Example: [Waveform], [s=2\*pi;]
- Button names displayed on the screen, and keys that user should press: **block letters**, surrounded with .  
Example: , ,
- String that represents each function or item of this software: **block letters**, surrounded with " ".  
Example: "Operate", "Memory Transfer"
- Press one key while holding down another key: Two keys are connected by "+".  
Example:  +
- Press one key, release it and press another key: Two keys are connected by ", ".  
Example: ,



## 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 this software.

Table 2-1 System Requirements

Item	Contents
Free Hard Disk Drive Space	64 MB or more
Display	1024 x 768 pixel or higher, 256 colors or more
OS	Windows 7 (32-bit, 64-bit) Windows 8.1 (32-bit, 64-bit) Windows 10 or later English Edition
Disk drive	CD-ROM drive
Communication interface	USB
Software component	Microsoft .NET Framework 4.0

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### Comments

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- Even when the CPU and memory satisfy the above specifications, this software might not operate properly depending on the conditions of your operating system.
  - A CD-ROM drive is required only when installing this software.
- 

### ■ About software component

To run this software, .NET Framework (version 4.0 or later) is required.

.NET Framework 4.0 is available from website of Microsoft Corporation (<http://www.microsoft.com>).

When setup.exe is invoked on a PC without .NET Framework 4.0 installed, a message which prompts for installing .NET Framework 4.0 is shown.



## 2.2 Installation Procedure

To install/uninstall this software, log on to Windows with Administrator permissions.

To establish the communication connection between this software and the equipment, the USB driver software must be installed. If the VISA environment is set up in your computer, the USB 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.

### 2.2.1 Installation of the USB driver software

This software is confirmed to work on NI-VISA Version 2023Q3 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.

For details of NI-VISA, contact National Instruments Corporation or visit the National Instruments Website.

### 2.2.2 Installation of WAVE DESIGNER FOR WF1947/WF1948

#### ■ Installation procedure

1. Insert the CD-ROM into the CD-ROM drive of your computer.
2. Execute English¥Application¥setup.exe in CD-ROM. The installer starts up.
3. Follow the instructions shown in the dialog box to click the **Next** and install the software.
4. When the installation is finished, remove the CD-ROM from the CD-ROM drive.

After installation, you can operate this software (☞ 3.1).

#### ■ Uninstallation procedure

In Windows, select [Control Panel], and then [Programs and Features]. From the list of currently installed programs, select "WAVE DESIGNER FOR WF1947/WF1948" and delete it.

However, the folder where this software is installed is not removed. The folder still contains the files related to this software, and deleting this folder and its files after uninstallation does not cause any problem.



## 3. Descriptions of Operations

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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] - [WAVE DESIGNER for WF1947\_WF1948].



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 **OK**. To cancel exiting, select **Cancel**.

- Click the **X** button at the top right corner of the window.
- With the window selected, press **Alt + F4** on the keyboard.
- From the menu bar, select [File] - [Exit].

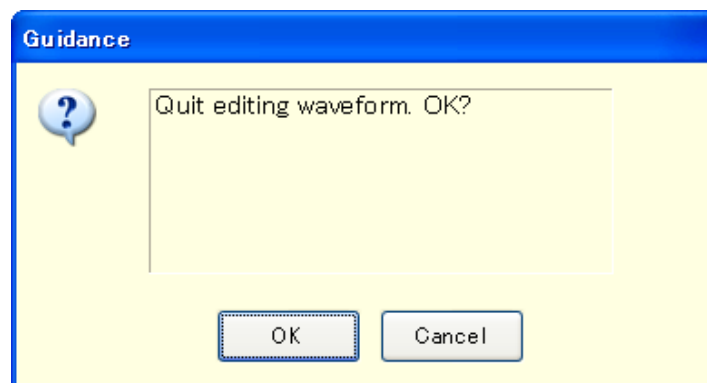


Figure 3-2 Exit Confirmation Dialog

## 3.2 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.

### 3.3 Window Component Names

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.

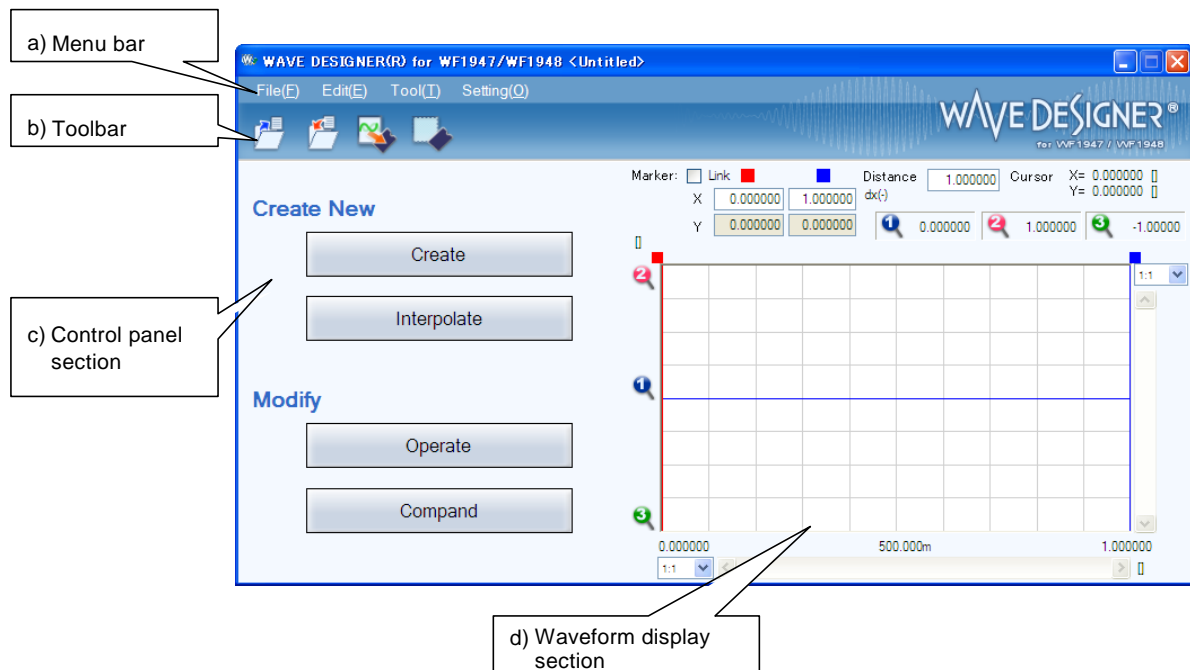






Figure 3-3 Edit Arbitrary Waveform Window

- |                             |   |
|-----------------------------|---|
| a) Menu bar                 |  3.4.1 |
| b) Toolbar                  |  3.4.2 |
| c) Control panel section    |  3.4.3 |
| d) Waveform display section |  3.4.4 |

### 3.4 Operations on Each Section

This section provides how to operate each section assuming that the operation is performed in the communication online state.

In the communication offline state, you cannot perform any action requiring communication because the communication with the equipment is disabled.

Based on the state of the equipment, you may encounter an error message when setting an item.

Handle the error according to the message content.

#### 3.4.1 Menu Bar

The menu composition of the Edit arbitrary waveform window is shown in Figure 3-4.

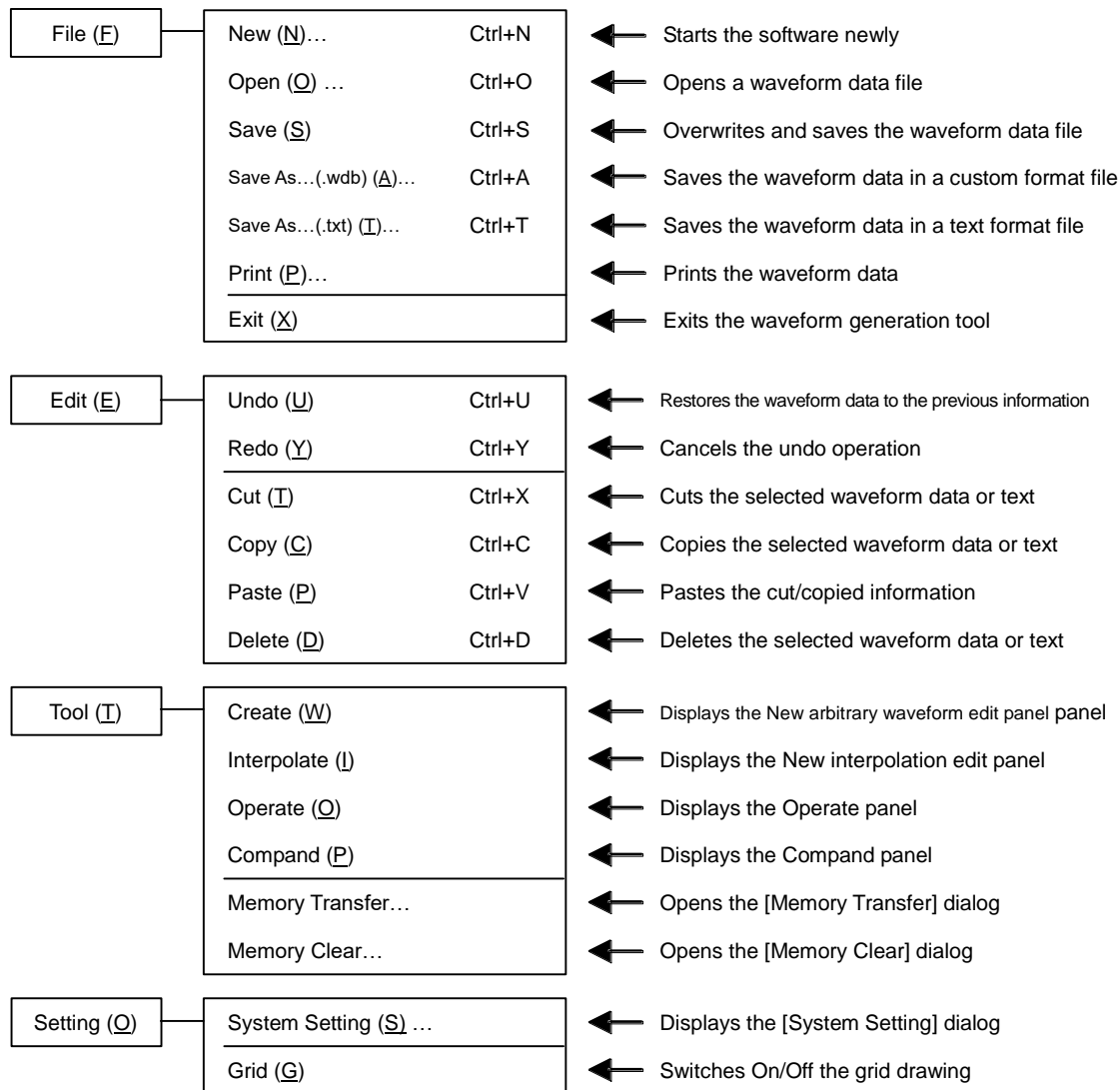


Figure 3-4 Menu Composition of the Edit Arbitrary Waveform Window

### 3.4.2 Toolbar

On the toolbar of the Edit arbitrary waveform window, you just click each icon shown in Figure 3-5 to execute the corresponding function.

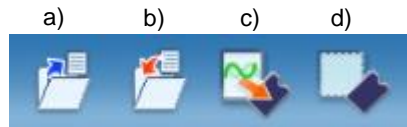


Figure 3-5 Toolbar of the Edit Arbitrary Waveform Window

- |                    |                                      |
|--------------------|--------------------------------------|
| a) Open            | Opens a waveform information file.   |
| b) Save            | Saves the waveform information file. |
| c) Memory Transfer | Opens the [Memory Transfer] dialog.  |
| d) Memory Clear    | Opens the [Memory Clear] dialog.     |

### 3.4.3 Control Panel Section

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

Immediately after the Edit arbitrary waveform tool is started or after each operation is completed, the Item selection panel is displayed.

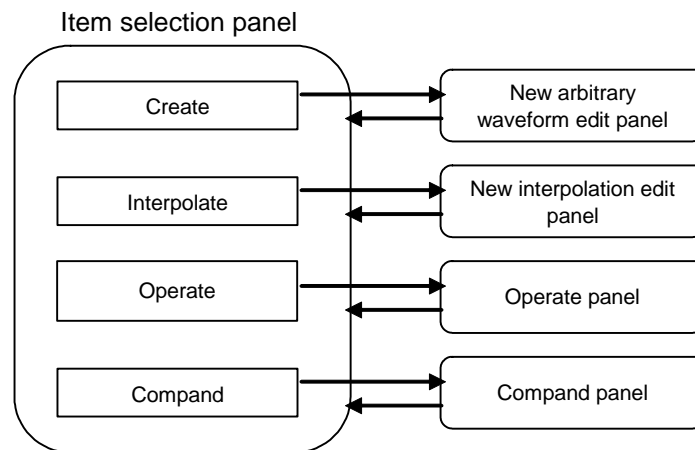


Figure 3-6 Transitions of Control Panels

### 3.4.4 Waveform Display Section

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

For details on how to generate or operate waveforms, see "Waveform Display Section" (3.5).

## 3.5 Waveform Display Section

### 3.5.1 Waveform Display Area

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






In addition to the waveform data, the Waveform display area shows the coordinate values indicating the display area size, the markers used for each operation (see 3.5.3), and the grid for checking the waveform rate (see 3.5.6).

### 3.5.2 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 [1:256].

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 [1:8192].

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.



### 3.5.3 Marker

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 Edit arbitrary waveform tool: marker A (red) and marker B (blue).

Marker A cannot be located on the right side of marker B. Marker A is always located on the left side or same position of marker B. 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 maker 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. If you click the [X] item corresponding to marker A or press **Alt** + **A**, the location display section for marker A is selected. If you then enter values and press the **Tab** key, marker A is moved to the specified location.

Similarly, if you click the [X] item corresponding to marker B or press **Alt** + **B**, then enter values for marker B in the location display section, and press the **Tab** key, marker B is moved to the specified location.

The markers can be located in any location within the range of the settings/display resolution by specifying values.

#### ■Coordinate marker mode

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

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

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

When you click the right side of the [Distance dX(-)] or press **Alt** + **B**, enter values, and press the

**Tab** key, marker B 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 (3.5.4)
- Range of arbitrary waveforms editing (3.8)
- Range to generate waveforms by interpolation (3.9)
- Range of performing compression/expansion (3.11)
- Range to perform operation among waveforms (3.10)

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 marker A and 10 for marker B, the selected range is  $5 \leq X < 10$ . Marker A is located immediately before 5, therefore 5 falls between markers A and B.

Marker B is located immediately before 10, therefore 10 does not fall between markers A and B.

### 3.5.4 Waveform Manipulation

#### ■ Undo and redo

You can restore the waveform data to the previous state after editing waveforms (Undo). To undo the edit, select [Edit] - [Undo] (**Alt**, **E**, **U**), or press **Ctrl** + **U**.

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

#### ■ Cut/copy/paste/delete

You can cut/copy/paste/delete the waveform data to edit waveforms as needed.

- Cut  
[Edit] - [Cut] (**Alt**, **E**, **T** or **Ctrl** + **X**)
- Copy  
[Edit] - [Copy] (**Alt**, **E**, **C**, or **Ctrl** + **C**)
- Paste  
[Edit] - [Paste] (**Alt**, **E**, **P**, or **Ctrl** + **V**)
- Delete  
[Edit] - [Delete] (**Alt**, **E**, **D**, or **Ctrl** + **D**)

When you perform the cut or copy operation, the waveform data of the selected part is sent to the clipboard.

In this operation, the waveform data of the selected part which is 16 bit data (0 to +65535), is sent to the clipboard as a number string with one data per one row. If the original value is negative, it is converted to a positive value by adding 65536.

The content of the clipboard can be pasted to any text editor or spreadsheet software, or can be pasted to the current Edit waveform screen or the Edit waveform screen of any other "WAVE DESIGNER for WF1947/WF1948" which is currently active.

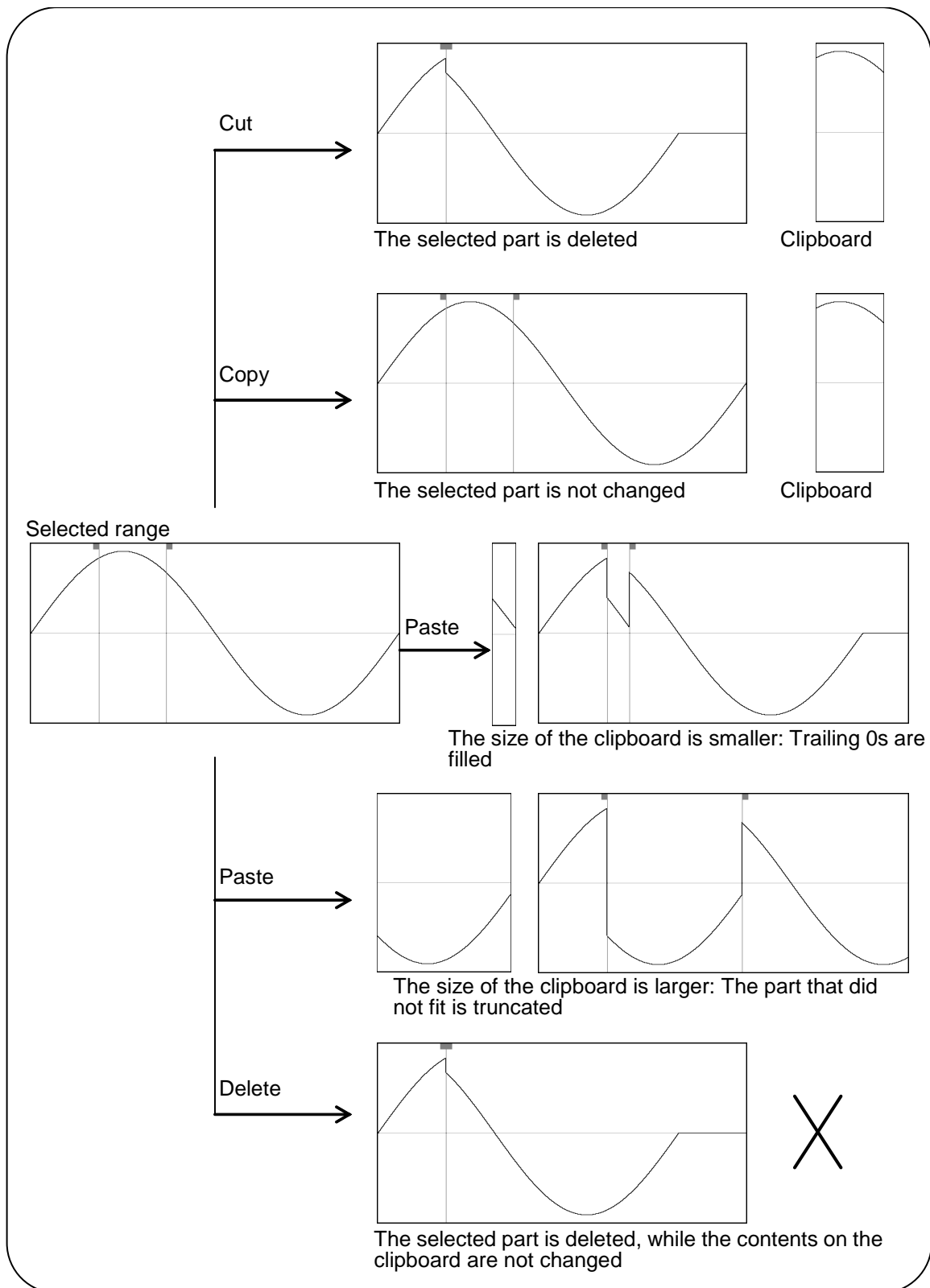


Figure 3-7 Operations with the Clipboard

### 3.5.5 Arbitrary Waveform Edit Example

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

Step 1:	Click the button on the top left corner of the screen. You can also select [Tool] - [Create] to obtain the same result.
Step 2:	A sine wave is selected in the initial state. Click the <b>All-pages OK</b> button to return to the Waveform display screen.
Step 3:	Move marker B to the center of the waveform. [524288.000] is displayed at the bottom right corner of the screen. Enter [262144] (half of 524,288) in the numeric area of [X] corresponding to marker B, and press the <b>Tab</b> key.
Step 4:	Press the <b>C</b> key while holding down the <b>Ctrl</b> key. You can also select [Edit] - [Copy] to obtain the same result. This operation copies the data between markers A and B, which is the first half of the waveform, to the clipboard.
Step 5:	Select the check box to the left of the [Link] to enter the coordinate marker mode. Enter [262144] in the numeric area of [X] corresponding to marker A, and press the <b>Tab</b> key.
Step 6:	Press the <b>V</b> key while holding down the <b>Ctrl</b> key. You can also select [Edit] - [Paste] to obtain the same result. This operation pastes the waveform data from the clipboard to the last half of the waveform.

Description 1: The operation such as pressing 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 of the copy source area remains without changes. When **Ctrl** + **X** (Cut) is performed, the data from the selected area is copied to the clipboard 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 clipboard are not changed.

Description 2: Markers A and B are used to select the range. For example, if the range specified with the markers is 0 - 524,288, the actual selected range is  $0 \leq X < 524,288$ .

### 3.5.6 Grid Drawing

When you select or deselect [Setting] - [Grid] (**Alt**, **O**, **G**), a check mark appears or disappears to the left of [Grid]. When the check mark is shown, the grid drawing function is enabled in the Waveform display area. When the check mark is hidden, the function is disabled in this area.

The grid is not printed when printing waveforms. (3.7)

## 3.6 File Operation

You can read/write the following types of files by using the Edit arbitrary waveform 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) (3.6.1)
- Text format file including only the waveform data (.txt) (3.6.2)
- Text format file including parameters used for editing arbitrary waveforms (.wfn) (3.8.6)
- Text format file including the control point information (.prn/.tsv/.csv) (3.9.4)

---

### Comments

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Compatibility with ARB Edit provided with WF1973/WF1974

- ".txt" format file:  
This format file can be read out and utilized.
  - ".wdb" format file and ".prn / .tsv / .csv" format file:  
You can read these files if you save the file by the following axis settings in System Setting dialog of ARB Edit and you read the file on the same setting in [System Setting] dialog of this software.
    1. [X-Axis Unit] parameter in "X-Axis Unit" setting frame : [Address]
    2. [Y-Axis Unit] parameter in "Y-Axis Unit" setting frame : [Data]
- 

### 3.6.1 Custom Format File

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

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

Select the location to save the file, 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 select [File] - [Save] (Alt, F, S, or Ctrl + S) or the corresponding button on the toolbar, 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.

### 3.6.2 Text Format File

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

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

Select the location to save the file, 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 the original value is negative, it is converted to a positive value by adding 65536.

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. When creating a text file, include one data per one row. The data must be 16-bit signed integers (-32768 to +32767). Note that this numeric format is different from that of the saved file.

As a standard, include 524,288 data in a data file. If the number of the data item is more than this standard number, the excess data is skipped during the read process. On the other hand, if the number of the data item is less than the standard number, they are read into the first part of the waveform and the rest of the waveform will not be changed.

### 3.6.3 Reading File

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

## 3.7 Printing Waveforms

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

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

### 3.8 New Arbitrary Waveform Editing

The New arbitrary waveform edit panel is used to create a standard waveform or a formula waveform. When you click the **Create** button on the Item selection panel or select [Tool] - [Create] (**Alt**, **T**, **W**), the New arbitrary waveform edit panel is displayed. Operations on the Waveform display section are disabled during the New arbitrary waveform edit panel is displayed.

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

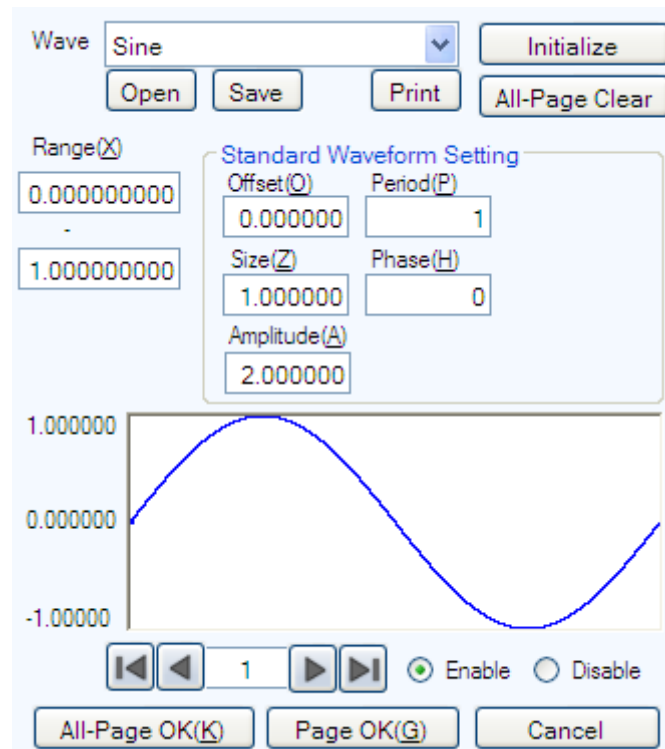


Figure 3-8 New Arbitrary Waveform Edit Panel

#### 3.8.1 Range/Page

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



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.

To move between pages, use the **◀** and **▶** buttons at the bottom left of the Edit arbitrary waveform screen. The **◀** button moves you to the previous page, and the **▶** button moves you to

the next page.

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

By entering numbers directly into the value input area between buttons and pushing **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 the New arbitrary waveform edit 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 the **Clear All Pages** button. This will initialize the range for each page to zero.

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

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

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

### 3.8.2 Waveform Selection


Click the  button on the right of [Waveform] on the New arbitrary waveform edit panel to display the list of available waveforms and select a waveform by clicking it.

Table 3-1 shows the types of waveform that can be generated.

Table 3-1 Waveform Selection

Waveform	Description
Sine	Set appropriate parameters to generate a sine wave.
Triangle	Set appropriate parameters to generate a triangle wave.
Square	Set appropriate parameters to generate a square wave.
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 same amplitude distribution.
DC	Generate a waveform assuming the data within the specified range as same.
Function	Define a waveform by combining various formulas.

See 3.8.3 for the setting of each parameter.

See 3.8.4 for the setting of waveform function formula.



### 3.8.3 Parameter Setting

If the setting of [Waveform] 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 3-2 Parameters of the Standard Waveform

	Sine	Triangle	Square	Noise	DC
Offset	○	○	○	○	○
Size	○	○	○	○	○
Amplitude	○	○	○	○	-
Period	○	○	○	-	-
Phase	○	○	○	-	-
Slope	-	○	-	-	-
Duty	-	-	○	-	-
Transition	-	-	○	-	-

#### ■Type of parameter

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

Amplitude is peak to peak value.

Cycle specifies which waveform with how many cycles (waves) 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.

### 3.8.4 Waveform Function Setting

When selecting a waveform (☞ 3.8.2), if you select [Function], the constant input section [Constant] and the formula input section [Y=] are displayed.

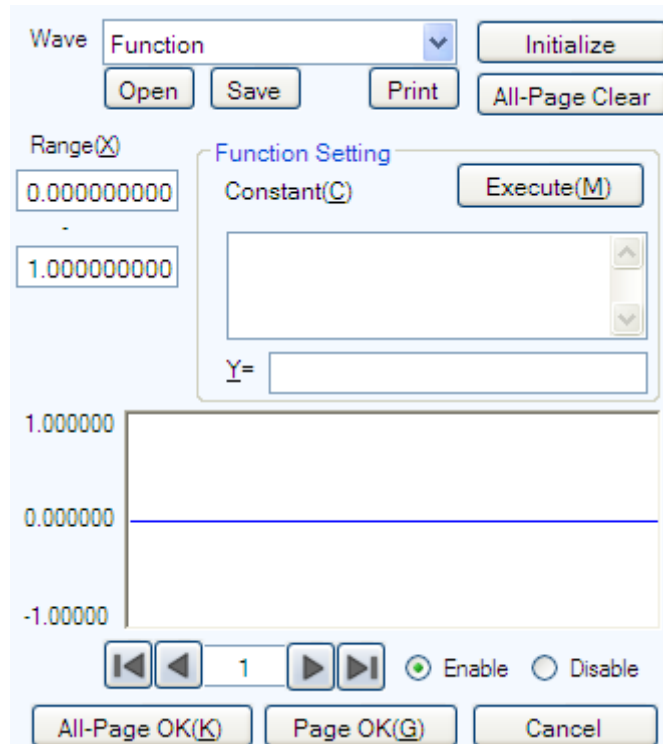


Figure 3-9 When "Function" is Selected

By entering constant and formula and clicking the **Execute** button, you can check the calculated waveform in the Waveform display area of the New arbitrary waveform edit panel.

#### ■ Constant

Constant should be entered in the format [constant = value or formula], for example, [fs=32767;], [s=2\*pi/524288;]. Always add semicolon [;] at the end of a constant definition or formula.

User-defined constants or formulas should be entered in single-byte. Alphabetical characters are not case sensitive. Any constant should start with an alphabetical character and consist of alphanumeric characters. You can also enter embedded constants (☞ Table 3-3) or embedded functions (☞ Table 3-5) for constants. In this case, alphabetical characters are case sensitive. If you define a constant with the same string as one of the embedded constants, the embedded constant will be replaced with the user-defined constant.

When defining a constant, it is recommended to use a different string from one of the embedded constants or functions, because mixture may cause mess in constant.

When you use the **All-pages OK** button, the constant is effective for all pages on and after the defined page. For example, the constant defined on page 1 are effective for all the pages. The constant defined on page 3 are not effective for page 1 and 2, but effective for page 3 and after.

When you create only the waveform in the displayed page by using the **Page OK** button, constants are effective only for the displayed page. 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

The constants shown in Table 3-3 are embedded in advance.

If you define a constant with the same name as one of the embedded constants in the above mentioned [Constant] field, the definition of that embedded constant is disabled and your definition of values and formulas become effective.

Table 3-3 Embedded Constants

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

#### ■ Function

In the 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 (☞ 3.12.1) 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 524288. Since  $524288 = 2 * \pi * 83443.0268\dots$ , the result of this formula is a sine wave with about 83443 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  $0^\circ$  of the sine wave.

In the case that the unit of the vertical axis is [User-defined Unit] 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-defined Unit] and set [Min] and [Max] to 0 and 6.283185, respectively.

The value of the formula [Y=] is affected by the unit of vertical axis (☞ 3.12.2) 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  $\pm 1$ .

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  $\pm 10$ . 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-defined Unit] and its range is -1 to +1, the result of

this formula is a full scale sine wave.

If the result of calculation exceeds +/- full scale, the waveform clips at +/- full scale.

#### ■Operator

In the constant input section [Constant] and the formula input section [Y=], the operators shown in Table 3-4 can be used in combination. 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 3-4 Operators

Operator	Coupling rule	Remarks
( ), Function, Constant, User-defined variable, Number string	→	
+, -, !	←	Unary operator. ! is a logical operator. (Only available in the constant input section)
^	→	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 functions

In the constant input section [Constant] and the formula input section [Y=], the functions shown in Table 3-5 can be used in combination.

Table 3-5 Embedded Functions

Function	Description
sin(formula), cos(formula), tan(formula)	Triangle function. Radian expression is used for the arguments.
atn(formula)	Arctangent function. Returns the angle, in radians, whose tangent is the argument.
sqr(formula)	Returns the positive root.
exp(formula)	Exponential function whose base is e (the base of natural logarithm).
log(formula)	Returns the natural logarithm.
power(formula 1, formula 2)	Returns the size of the complex vector in which formula 1 is its real part and formula 2 is its imaginary part.

phase(formula 1,formula 2)	Returns the declination of the complex vector in which formula 1 is its real part and formula 2 is its imaginary part.
tri(formula 1,formula 2)	This function provides an angle (in radians) to formula 1, and a slope with symmetry value ranged from 0 to 1 to formula 2, and defines a triangle wave.
sqw(formula 1,formula 2,formula 3)	This function provides an angle to formula 1, duty ratio (%) to formula 2, transition (%) to formula 3, and defines a square wave.
rnd()	Generates a same amplitude distribution (white noise) whose maximum amplitude is $\pm 1$ . There is no argument.

### ■ 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.

For details on how to set the unit of X/Y axis, see "3.12 System Setting."

- 1st wave of a sine wave (X axis unit: address 0 to 524288, Y axis unit: data  $\pm 32767$ )

Page 1      [Constant]      [fs=32767;]  
   [s=2\*pi/524288;]      ←Address 524288 corresponds to  $2\pi$   
   [Y=]      [fs\*sin(x\*s)]

- 1st wave of a sine wave (X axis unit: time 0 to 1 ms, Y axis unit: voltage  $\pm 10V$ )

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

- 1st wave of a sine wave (X axis unit: user-defined unit 0 to 1, Y axis unit: user-defined unit -1 to +1)

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

- 1st wave of a sine wave (X axis unit: user-defined unit 0 to 6.283185, Y axis unit: user-defined unit -1 to +1)

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

- 1st wave of a square wave (X axis unit: user-defined unit 0 to 6.283185, Y axis unit: 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  $\pm 1$ .

- DC sweep waveform (X axis unit: user-defined unit 0 to 1, Y axis unit: user-defined unit -1 to +1)

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

- Damped wave (X axis unit: user-defined unit 0 to 6.283185, Y axis unit: user-defined unit -1 to +1)

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

- DSB waveform (X axis unit: user-defined unit 0 to 6.283185, Y axis unit: user-defined unit -1 to +1)

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

- CR charge/discharge waveform (X axis unit: user-defined unit 0 to 1, Y axis unit: user-defined unit -1 to +1)

Page 1	[Range]	[0]~[0.5]
	[Constant]	[j=15;]
	[Y=]	[1-2*exp(-x*j)]
Page 2	[Range]	[0.5]~[1]
	[Constant]	[j=15;]
	[Y=]	[-1+2*exp(-(x-0.5)*j)]

- Differential waveform (X axis unit: user-defined unit 0 to 1, Y axis unit: user-defined unit -1 to +1)

Page 1	[Range]	[0]~[0.5]
	[Constant]	[j=15;]
	[Y=]	[exp(-x*j)]
Page 2	[Range]	[0.5]~[1]
	[Constant]	[j=15;]
	[Y=]	[-exp(-(x-0.5)*j)]

- Magnetic head waveform: Gaussian pulse

(X axis unit: user-defined unit -1 to 1, Y axis unit: user-defined unit -1 to +1))

Page 1	[Range]	[-1]~[0]
	[Constant]	[j=32;]
	[Y=]	[exp(-((x+0.5)^2)*j)]
Page 2	[Range]	[0]~[1]
	[Constant]	[j=32;]
	[Y=]	[-exp(-((x+0.5)^2)*j)]

- Magnetic head waveform: Lorentz waveform

(X axis unit: user-defined unit 0 to 6.283185, Y axis unit: user-defined unit -1 to +1))

Page 1	[Constant]	[None]
	[Y=]	[(sin(x)-sin(x*3)/3+sin(x*5)/5)/1.533333333]

- Waveform where surge is superimposed around  $180^\circ$

(X axis unit: user-defined unit 0 to 1, Y axis unit: user-defined unit -1 to +1))


Page 1	[Range]	[0]~[1]
	[Constant]	[s=2*pi;]
	[Y=]	[sin(s*x)]
Page 2	[Range]	[0.49]~[0.51]
	[Constant]	[j=50;s=2*pi;]
	[Y=]	[sin(s*x)+cos(s*j*x)/2+0.5]

Create a sine wave across page 1 and then overwrite the surge waveform on page 2.

### 3.8.5 Arbitrary Waveform Creation Example

#### ■ Standard waveform

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


- Step 1: Click the **Create** button on the [Item selection panel].  
You can also select [Tool] - [Create] to obtain the same result.  
The [Item selection panel] is changed to the [New arbitrary waveform edit panel].
- Step 2: Click the  button on the right of [Waveform], and then click [Triangle] in the list.
- Step 3: In the value input section on the right of [Slope], change the value from [50] to [30], and then press the **Enter** key. This specifies a triangle wave of 30% symmetry.
- Step 4: When you click **All-pages OK**, the [New arbitrary waveform edit panel] is closed and the generated waveform is displayed in the Waveform display section.

- Description 1: In this example, a waveform is generated over entire horizontal axis. In the [Edit arbitrary waveform 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-pages 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 higher harmonics waves superimposed.

- Step 1: Select [Setting] - [System Setting].  
A dialog titled [Unit Setting] appears.
- Step 2: In the [Unit (X)] combo box of [X axis unit setting], click [User-defined Unit]. Leave [Min] and [Max] as the initial value of [0.000000] and [1.000000], respectively.
- Step 3: In the [Unit (Y)] combo box of [Y axis unit setting], click [User-defined Unit]. Leave [Min] and [Max] as the initial value of [-1.000000] and [1.000000], respectively.
- Step 4: Click the **OK** button to return to Waveform display screen.
- Step 5: Click the **Create** button on the [Item selection panel].  
You can also select [Tool] - [Create] to obtain the same result.  
The [Item selection panel] is changed to the [New arbitrary waveform edit panel].
- Step 6: Click the  button on the right of [Waveform], and then click [Function] in the displayed list.
- Step 7: Enter [s=2\*pi;] in the input area on the right of [Constant].  
Enter [sin(x\*s)+sin(x\*s\*3)/3+sin(x\*s\*5)/5] in the input area on the right of [Y=].
- Step 8: When you click the **Execute (M)** button, the calculated waveform is displayed in the Edit arbitrary waveform screen.
- Step 9: Click the **All-pages OK** button to return to the Waveform display section.

Description 1: Here, the entire horizontal axis (X) is processed as the range of 0 to 1 by using the user-defined unit. Also, the entire vertical axis (Y) is processed as the range of  $\pm 1$ . 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 ( $2\pi$ ) using the user-defined unit, the formula becomes more simple as  $[\sin(x)+\sin(x*3)/3+\sin(x*5)/5]$ .

### 3.8.6 Operation of Parameter File for Arbitrary Waveform Edit

Parameter setting on the New arbitrary waveform edit panel can be saved as a text file.

Click the **Save** button on the top of the New arbitrary waveform edit panel to display a screen titled **[Save As]**.

Select the location to save the file, enter the file name, and click the **Save** button. The file extension is ".wfn," which can be omitted when entering a file name.

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

As the setting file for the Edit arbitrary waveform screen is a text file, it can be edited using any text editor.

However, if the edited file has a different data format which is not supported by this software, the file cannot be loaded.

For the information of files that can be processed by this software, see 3.6.

### 3.8.7 Printing

The parameter setting on the New arbitrary waveform edit panel can be printed.

Click the **Print** button on the top of the New arbitrary waveform edit panel to display the **[Print Setup]** dialog. For details of the print setup, see the instruction manual of your printer.

### 3.9 New Interpolation Editing

The New interpolation edit panel is used to create a waveforms by using various interpolation. A "point" that is set to interpolate is called a "control point."

When you click the **Interpolate** button on the Item selection panel or select [Tool] - [Interpolate] (**Alt**, **T**, **I**), the New interpolation edit panel is displayed.

Just after editing an arbitrary waveform on the New interpolation edit panel and returning to the Waveform display screen, you can restore the generated waveform to the state before the edited contents were reflected, by selecting [Edit] - [Undo] (**Alt**, **E**, **U**), or pressing **Ctrl** + **U**.

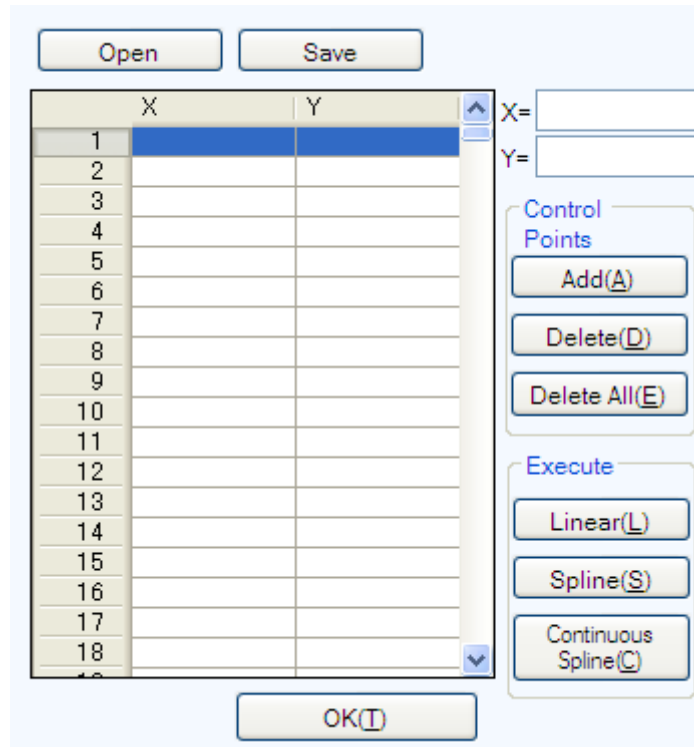


Figure 3-10 New Interpolation Edit panel

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

### 3.9.1 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 of [X=] and [Y=] on the New interpolation edit panel.

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

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

Click the **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 the New interpolation edit 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 in 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 holding down the **Ctrl** key. A control point will be added. You can know approximate position of the mouse cursor in **[Cursor]** at the top right of the Waveform display section. The added control point is also added to the list of control points in the New interpolation edit 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 New interpolation edit 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 the **[+]** 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.

When a control point is selected, if you update the value of [Y=] and click the **Add** button, the selected control point is moved. If you update the value of [X=] and then click the **Add** button, a new control point is added if the identical coordinate point does not exist, or if it exists the control point is updated.

**■ 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 point**

Click the **Delete** button to delete a control point being set at that time.

There is no way to restore a control point 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.

### 3.9.2 Interpolation Execution

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.

### 3.9.3 Arbitrary Waveform Creation Example

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 [Unit].
Step 2:	Click [User-defined Unit] from the combo box on the right of [Unit(X)]. Leave [Min] and [Max] as the initial value of [0.000000] and [1.000000], respectively.
Step 3:	Click [User-defined Unit] from the combo box on the right of [Unit(Y)]. Leave [Min] and [Max] as the initial value of [-1.000000] and [1.000000], respectively. Click the <b>OK</b> button to return to Waveform display screen.
Step 4:	Set the coordinate value of marker A (red) as [0.2], and then press the <b>Enter</b> key. Set the coordinate value of marker B (blue) as [0.8], and then press the <b>Enter</b> key.
Step 5:	Click the <b>Interpolate</b> button on the [Item selection panel]. You can also select [Tool] - [Interpolate] to obtain the same result. The [Item selection panel] is changed to the [New interpolation edit panel].
Step 6:	Enter [0.5] as the coordinate value of [X=], and [1] as the coordinate value of [Y=], and then click the <b>Add</b> button.
Step 7:	Click the <b>Continuous Spline</b> button. The interpolated waveform is displayed in the Waveform display section.
Step 8:	Click the <b>OK</b> 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.

### 3.9.4 Control Point File Operation

Control point setting on the New interpolation edit panel can be saved as a text file.

Click the **Save** button on the top of the New interpolation edit panel to display a screen titled [Save As].

Select the location to save the file, 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 the **Open** button on the top of the New interpolation edit panel. The screen titled [Open File] is displayed. Select the location to save the file and enter the file name, and then click the **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. 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 this software, see 3.6.

### 3.10 Operate

The Operate panel has the function to execute arithmetical operation on a waveform in selected ranges, and the standard waveform, formula waveform, and a waveform in clipboard to create a waveform.

When you click the **Operate** button on the Item selection panel, or select [Tool] - [Operate] (**Alt**, **T**, **O**), the Operate panel is displayed. Operations on the Waveform display section are disabled while the Operate panel is displayed.

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

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

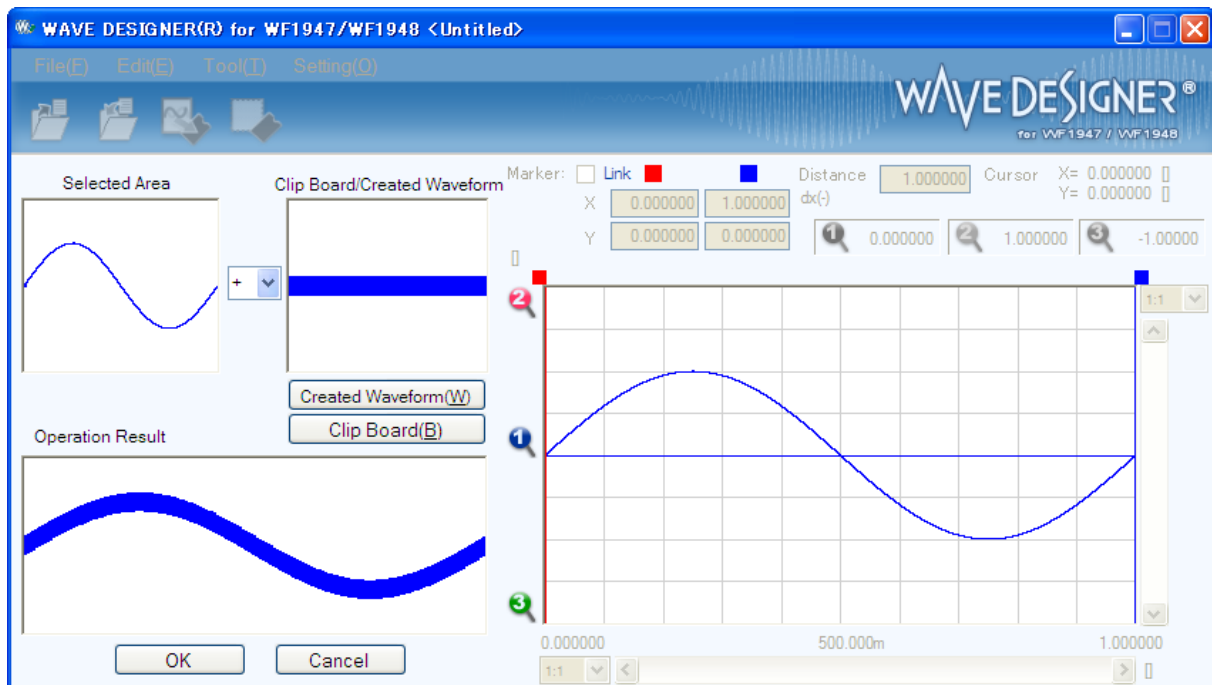







Figure 3-11 Operate Panel



### 3.10.1 Types of Calculation

When you click the  button between [Selected Area] and [Clipboard/Created Waveform], a list of arithmetical operation is displayed. Click in the list or press the , , , or  key to select an operator.

[\*] represents multiplication (x), and [/] represents division (/).

### 3.10.2 Calculation Target Setting

#### ■ Created waveform

When you click the **Created Waveform** button, or press **Alt + W**, the Edit arbitrary waveform screen appears. Operations can be executed according to "New Arbitrary Waveform Editing" (3.8).

However, there are the following limitations for editing an arbitrary waveform in calculation between waveforms.

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

After you create a waveform according to "New Arbitrary Waveform Editing" (3.8) and click the **Page OK**, the created waveform is displayed in the [Clipboard/Created Waveform] area.

#### ■ Clipboard

When you click the **Clipboard** button or press **Alt + B**, a waveform stored in the clipboard is displayed in the [Clipboard/Created Waveform] area. For operation with the clipboard, see 3.5.4. If the selected range is longer than the data in the clipboard, the remained portion is processed as 0. If the data in clipboard is longer than the selected range, the data is used beginning with its front part. Though the data in the clipboard is 16 bit integer, it is converted using the unit of vertical axis before the calculation between waveforms. For example, in the case that the unit of vertical axis is a user-defined unit: -1 to +1, data in the clipboard is converted and processed after adjusted to the range of  $\pm 1$ .

### 3.10.3 Calculation Execution

Calculation is executed automatically every time the calculation type is changed or the data in the [Clipboard/Created Waveform] area is changed.

The result of calculation is displayed as a waveform in the [Operation result] area.

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

### 3.10.4 Arbitrary Waveform Creation Example

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

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

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

## 3.11 Compand

The [Compand panel] generates a waveforms by compressing or expanding the waveforms in the selection vertically/horizontally.

When you click the **Compand** button in the Item selection panel or select [Tool] - [Compand] (**Alt**, **T**, **P**), the [Compand panel] is displayed. Operations on the Waveform display sections are disabled while the [Compand panel] is displayed.

Just after editing an arbitrary waveform on the [Compand panel] and returning to the Waveform display section, you can restore the generated waveform to the state before the edited contents were reflected, by selecting [Edit] - [Undo] (**Alt**, **E**, **U**), or pressing **Ctrl** + **U**.

The screenshot shows the 'Compand' panel with two main sections: 'X' and 'Y'. The 'X' section has input fields for 'Start(S)' (X= 0.000000000, Y= 0.000000) and 'End(E)' (X= 524288.0000, Y= 0.000000), with an 'Expand All' button below. The 'Y' section has two radio buttons: 'Max/Min(M)' (selected) and 'Amplitude/Offset(O)'. Under 'Max/Min(M)', there are fields for 'Max(X)' (16384.0000) and 'Min(N)' (-16383.000). Under 'Amplitude/Offset(O)', there are fields for 'Amplitude(I)' (32767.0000) and 'Offset(D)' (0.50000000). Below these are two buttons: 'Expand with Offset Clear' and 'Expand with Fixed Offset'. At the bottom are 'OK' and 'Cancel' buttons.

Figure 3-12 Compand panel

### 3.11.1 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 (3.5.3) 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 Compand screen.

#### ■ Compress/expand selection to start/end point

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

#### ■ Others

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

### 3.11.2 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 3.5.3) 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 Comband screen.

#### ■ Compression/expansion using maximum/minimum value

When [Max/Min] ☐ (option button) is selected (☒) , the maximum and minimum values 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 of the target after the compression/expansion operation in the respective display section and press the **Enter** key, the waveform in the Waveform display 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 the **OK** button.

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

#### ■ Compression/expansion using amplitude/offset

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

To return to the Waveform display screen without performing compression/expansion, click the **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.

#### ■ Others

If that exceeds +/- full scale is set as the result of extension, the waveform is clipped at +/- full scale. Note that when the expansion rate is too high, the distortion may occur in the waveform.

### 3.11.3 Arbitrary Waveform Creation Example

#### ■ 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 the [New arbitrary waveform edit 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 <b>All-pages OK</b> button to return to Waveform display screen.
Step 2:	Click the <b>Compond</b> button on the [Item selection panel]. You can also select [Tool] - [Compond] to obtain the same result. The [Item selection panel] is changed to the [Compond panel].
Step 3:	[524288.000] is displayed at the bottom right of the Waveform display screen. Leave the numeric area on the right of [Start Point X=] as [0]. Enter [131072] (quarter of 524288) in the numeric area on the right of [End Point X=] and press the <b>Enter</b> 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 <b>OK</b> button to return to Waveform display screen.

Description 1: In this example, because you left [Start Point X=] as [0], the original waveform was compressed to the first quarter of the waveform in the waveform display screen. For example, if [Start Point X=] is set to [131072] and [End Point X=] is set to [262144], the original waveform is compressed to adjust from the first quarter of the waveform display screen to the first half.

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 Compond panel 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:	Display the [New arbitrary waveform edit panel]. In its initial state, a sine wave is selected. Select [Triangle] from [Waveform] combo box. Click the <b>All-pages OK</b> button to return to Waveform display screen.
Step 2:	Click the <b>Compand</b> button on the [Item selection panel]. You can also select [Tool] - [Compand] to obtain the same result. The [Item selection panel] is changed to the [Compand panel].
Step 3:	In the numeric area on the right of [Max], change [32767] to [100000], then press the <b>Enter</b> key. In the numeric area on the right of [Min], change [-32767] to [-100000], then press the <b>Enter</b> key. In the waveform display section, you can see that the triangle waveform is expanded vertically and clipped, transforming to a trapezoidal waveform.
Step 4:	Click the <b>OK</b> button to return to Waveform display screen.

- 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 +/- full scale is exceeded as a result of the expansion or movement, 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 marker A (red) and marker B (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 **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 [DC 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.

## 3.12 System Setting

### 3.12.1 X Axis Unit Settings






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 [Frequency].

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 3-6.

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.

When you click the  button on the right of [Unit(X)], a list of available units for the horizontal axis is displayed. Click in the list or press the , , , or  key to select the unit for the horizontal axis.

Selecting a user-defined unit as the unit of X axis allows you to specify [Name], [Min], and [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 3-6 Example of User-defined Unit of Horizontal Axis

Range	Name (Description)
0~1	Period
-1~1	(Used to adjust to the vertical axis range when the vertical axis user-defined unit is $\pm 1$ )
0~360	deg (degree, °)
0~400	grad
0~6.283185	rad






### 3.12.2 Y Axis Unit Settings

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].

For a user-defined unit, you can arbitrarily specify the bottom and top of the waveform data and the 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  $\pm 1$ .

When you click the  button on the right of [Unit (Y)], a list of available units for the vertical axis is displayed. Click in the list or press the , , , or  key to select the unit for the vertical axis.

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

## 3.13 Memory






The created waveform data can be transferred to the equipment.






### 3.13.1 Memory Transfer

Select [Tool] - [Memory Transfer] or click the  button on the toolbar to display the [Memory Transfer] dialog.

Specify the Memory No. on the equipment you want to set. Click the  button to start the waveform data transmission to the equipment.

In the area on the right of [Name], you can enter a string of up to 20 characters (2-byte characters are not allowed) as the name of waveform memory.

When you click the  button on the right of [Memory No.], a list of available waveform Memory No. is displayed. Click in the list or press the , , , or  key to select the waveform Memory No..

When you click the  button on the right of [Memory Size], a list of available units for the vertical axis is displayed. Click in the list or press the , , , or  key to select the waveform Memory Size. If you select a large waveform Memory Size (up to 524288), the data may not be transferred due to the maximum space available in the equipment.



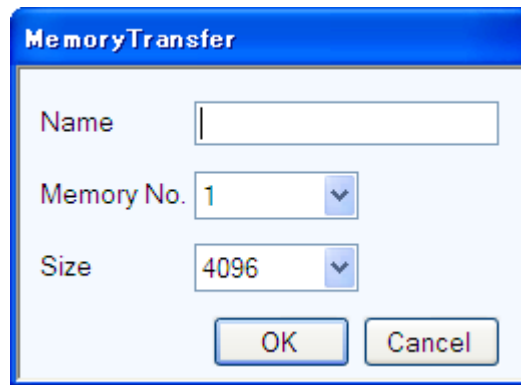


Figure 3-13 [Memory Transfer] Dialog

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**Comments**

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You can select a value of 1 to 128 for the Memory No..

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### 3.13.2 Memory Clear

Select [Tool] - [Memory Clear] or click the **Memory Clear** button on the toolbar to display the [Memory Clear] dialog.

Specify the Memory No. on the equipment you want to clear. Then click the **OK** button to clear the data for the selected Memory No. in the equipment.

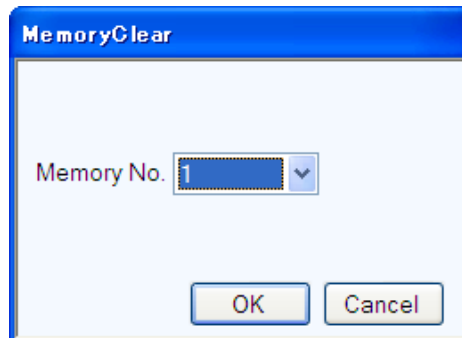


Figure 3-14 [Memory Clear] Dialog

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**Comments**

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You can select a value of 1 to 128 for the Memory No..

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## 4.Maintenance

4.1 CD-ROM Management.....	50
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## 4.1 CD-ROM Management

CD-ROM should be handled carefully paying attention to the followings.

- Do not store your CD-ROM under direct sunlight or in high temperature or humidity.
- Store and use the CD-ROM avoiding dusty environment.
- Do not touch the recording surface. It may cause damage or error.
- When the recording surface gets dirty, wipe the surface with dry soft cloth. Do not use solvent such as benzene.
- Store the CD-ROM horizontally and vertically to avoid twisting or curving.
- Use a felt pen when you write letters to the label surface of the CD-ROM (do not use a pen such as ball-point pen or pencil which tip is hard).

## 4.2 Replacement of Damaged CD-ROM

If your CD-ROM has is damaged, contact NF Corporation or our agent.

For a fee, we will replace it with a new CD-ROM.

## 4.3 Version Check

The version of this software is displayed in the top right of the dialog window which appears when you press [System Setting].

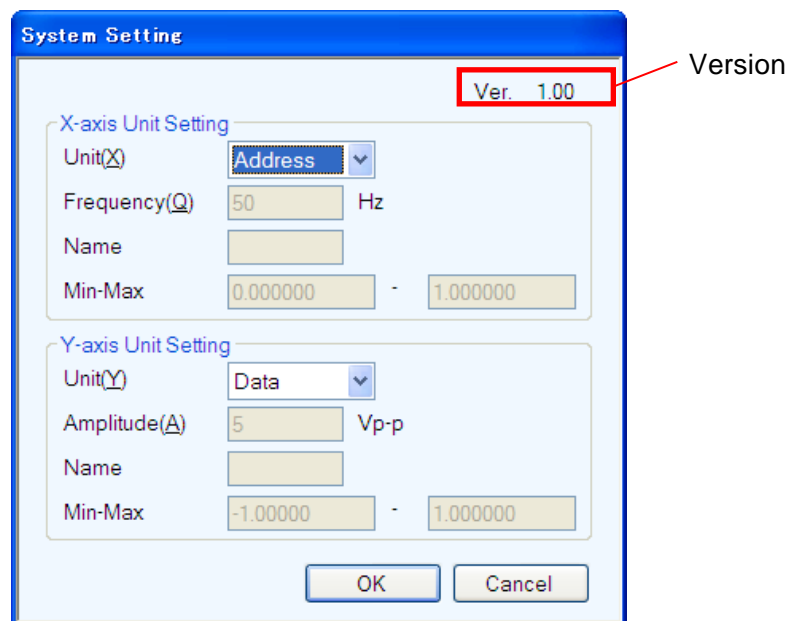


Figure 4-1 [System Setting] Dialog Window

WABUN:  
(DA00036699-005)

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## Notes

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1. No part of the contents of this instruction manual may be reprinted or reproduced without prior permission from us.
  2. The information in this instruction manual is subject to change without notice.
  3. We have taken enough care upon creating this instruction manual. However, should you notice any doubtful or wrong statement, or lack of description, please contact us or our agent.
  4. We are not responsible for any result of the operations in spite of the above Section 3.
- 

## WAVE DESIGNER FOR WF1947/WF1948 Instruction Manual

NF Corporation

6-3-20 Tsunashima Higashi, Kohoku-ku, Yokohama 223-8508, Japan

Phone: +81-45-545-8111 (Main)

<http://www.nfcorp.co.jp/>

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