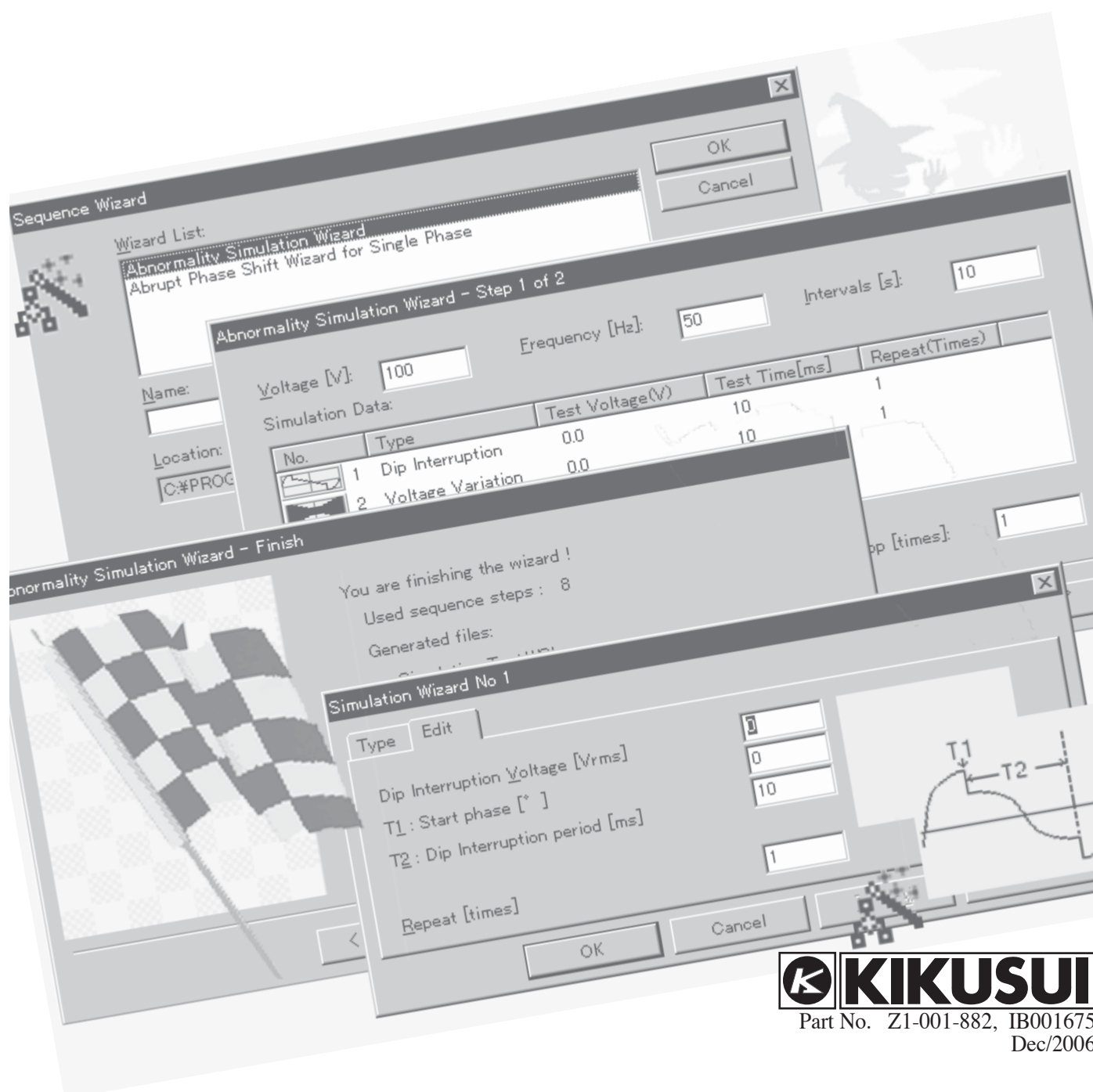




Software for AC Power Supply

SD04-PCR-L(E) Ver. 1.0

Software Quick Wave Sequencer
User's Manual



Use of This User's Manual

Please read through and understand this User's Manual before operating the product. After reading, always keep the manual nearby so that you may refer to it as needed. When moving the product to another location, be sure to bring the manual as well.

If you find any incorrectly arranged or missing pages in this manual, they will be replaced. If the manual it gets lost or soiled, a new copy can be provided for a fee. In either case, please contact Kikusui distributor/agent, and provide the "Kikusui Part No." given on the cover.

This manual has been prepared with the utmost care; however, if you have any questions, or note any errors or omissions, please contact Kikusui distributor/agent.

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Chapter 1 Introduction

Overview

Software Quick Wave Sequencer SD04-PCR-L (E) (hereinafter referred to as "Quick Wave Sequencer") is application software that uses the sequence functions of our company's AC power-supply PCR-L series (hereinafter referred to as "PCR-L") to perform AC power-source simulation.

Quick Wave Sequencer consists of the following two pieces of software, which are activated and operated simultaneously:

1. Sequence Builder (SeqBuild.exe)
 - This software generates the sequence parameters of the PCR-L, such as output voltage, frequency, and time, for the waveform bank that was created and transferred from Wave Bank Server, and transfers those parameters to the PCR-L.
 - The software executes the transferred sequence and conducts voltage variation tests and Dip interruption tests.
 - The software contains wizard functions that automatically set the input of sequence parameters.
2. Wave Bank Server (WBanksvr.exe)
 - The software creates AC voltage waveforms from sine-wave harmonic composite waveforms, distortion waveforms, triangle waves, and square waves, as well as waveforms acquired from the oscilloscope.
 - The software transfers generated waveforms to the waveform bank of the PCR-L.
 - The software is activated by activating Sequence Builder.

For novice Windows operators

Quick Wave Sequence runs on Windows. The basic operations, such as windows, menus, and buttons, are the same as those of other Windows applications. Those who are unfamiliar with the basic operations of Windows should refer to the Microsoft Windows instruction manual.

Features

Quick Wave Sequence has the following features:

1. The software supports single-phase systems.
2. Using the PCR-L waveform bank and the sequence function, a highly flexible simulation test can be performed on the AC power source.
 - Dip interrupt test
 - Voltage variation test
 - Abrupt phase shift test (supporting single-phase systems only)
 - Output of harmonic composite waveform
 - Waveform obtained from the oscilloscope is output from the PCR-L.
3. The Wizard automatically creates sequence steps for Dip interruption, voltage variation, or abrupt phase shift tests, with no need for complex settings for the simple test.
4. The combination of the waveform bank of the PCR-L and the sequence function enables execution of tests of the composite combination of the sine, distortion, and harmonic composite waveforms.

System requirements

System requirements for the Quick Wave Sequencer:

Personal computer

IBM PC/AT compatible machine with:

Processor: i486/66 or faster

At least 16MB memory

CD-ROM drive

Hard disk (installation requires a minimum of 20 MB of free disk space)

Microsoft mouse or compatible pointing device

VGA (800x600) display adapter capable of 256-color depth and color monitor

Printer compatible with Microsoft Windows

Operating system

Microsoft Windows 95/NT*/2000 Professional/XP Professional
and Internet Explorer 4.01 or later

* Microsoft Windows NT Workstation 4.0 which Service pack3 is installed in.

GPIB card for personal computer

GPIB board compatible with NI-488.2M made by National Instruments Corp.

(AT-GPIB/TNT, PCMCIA-GPIB, or PCI-GPIB)

VISA 2.6 or later

GPIB cable

A 24-pin cable with connector, conforming to ANSI/IEEE std 488.1-1987

AC Power Supply

Single-phase system: PCR-L series

To use this application, the PCR-L the main unit must have ROM Ver2.04 or later.

IB11-PCR-L

GPIB interface board for PCR-L

Equipment under test(EUT)

EUT is able to operate with power that the PCR-L series supplies.

Install

Before using Quick Wave Sequencer, you must install the software on your PC hard disk. Installation is performed by the setup program (SETUP.EXE), found on the program diskette.

To install:

Setup

1. Launch Windows (close all other applications).
2. Insert program disk into a CD-ROM drive.
3. To install Quick Wave Sequencer, follow the instructions on the screen.

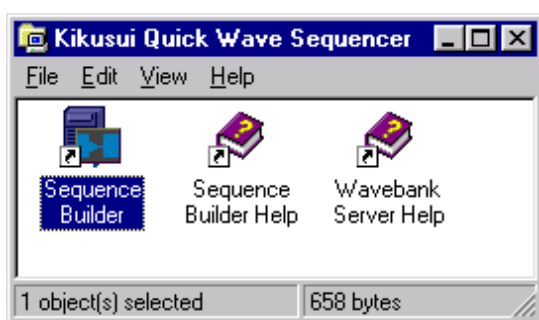
(Note: In the operating environment that Windows Installer is not installed in, a reboot may be required.)

The default location for the Quick Wave Sequencer files is C:\Program Files\Kikusui \Quick Wave Sequencer\. You can modify default setting to change the destination directory.

Program Folder specifies the folder name for the application. The default name is Kikusui Quick Wave Sequencer.

End of installation

When installation is completed, Windows creates the folder for Kikusui Quick Wave Sequencer that is accessible from the Windows Start menu.



Precautions

For correct and safe use of this software, read and make sure you understand the following descriptions.

Safety

<Warning>

Connecting the EUT to the PCR-L AC power supply:

The test involves high-voltages and large AC currents. Take extra care in connecting the EUT to the PCR-L power supply, since improper connections can damage equipment and lead to fire or explosion. For connection directions, refer to the PCR-L instruction manual.

<Warning>

For PCR-L AC power supply, always connect OUTPUT terminal N to terminal G. If OUTPUT terminals G and N at the rear of the PCR-L are not connected while an oscilloscope is used to observe PCR-L output, a potential difference is produced between the PC or PCR-L and oscilloscope cables, possibly resulting in electric shock or equipment damage. You also need to connect the oscilloscope GROUND to OUTPUT terminal G at the rear of the PCR-L.

<Caution>

Stopping the test

To stop the test, click the Stop button in the execute dialog. In an emergency in which the EUT is damaged, switch off power to the PCR-L. When a GPIB error occurs, click OK button to exit.

<Caution>

DC component

This application software is capable of outputting triangle and square waves. These waveforms are set so that the AC power source contains the DC component. When AC current containing a DC component is input, overcurrent may occur in some EUTs, setting off an alarm. Immediately stop testing when this occurs.

<Caution>

Bank14 is used with this software. After you used this software, do not output Bank14 by using a remote controller or GPIB. However, you can output Bank14 when you do not let this software run after having set Bank14 anew.

For trouble-free operation

- Close all other applications before running this software.
- If your PC hard disk has 5MB or less of free space, data may not be written properly to disk. Before running the software, check the remaining capacity of the hard disk.
- Before running the software, initialize PCR-L.
- Set the GPIB address for the PCR-L to "5" (the GPIB address for Quick Wave Sequencer is preset to 5).

<Description>

- To initialize the PCR-L, press the "SHIFT" + "6" (RESET) keys and "SHIFT" + "ENTER" keys in sequence from the PCR-L panel. Initialization takes several seconds.
- Set the GPIB address for the PCR-L by pressing the "SHIFT" + "F" (GPIB) keys from the PCR-L panel. In GPIB address setting mode, enter 5. Then restart the PCR-L. This validates the GPIB address just entered.

General Items for Software Use

- Voltage settings in the application are based on the effective value of the sine wave. Voltage set values for another waveform may have different meanings.
- For set voltage value V , voltage $(2 \cdot \sqrt{2} \cdot V)$ p-p is output.
- A phase angle set by the Simulation Wizard can be entered in 1° . Since the PCR-L sequence function needs to be specified in 1 ms, the value at a frequency of 50 Hz is set in $360^\circ / 20 \text{ ms}$ (18°).
- You can enter up to the 50th order for harmonic composite waveforms. The actual output waveform depends on frequency characteristics of the PCR-L.

Chapter 2 Introduction to Testing

This chapter describes a simple method for performing the abnormality simulation (Dip interruption and voltage Variations) test using the Sequence Wizard.

GPIB setting

Since Quick Wave Sequencer communicates with the PCR-L through GPIB, testing requires the setup described below.

- Install the PC GPIB card and the driver software. (For information on installing the GPIB card, refer to the instruction manual from National Instrument Corp.)
- Set the PCR-L GPIB address to "5." (The GPIB address for Quick Wave Sequencer is preset to "5.")

<Description>
Set the PCR-L GPIB address by pressing the "SHIFT" + "F" (GPIB) keys from the PCR-L panel. In GPIB address setting mode, enter 5. Then restart the PCR-L to validate the GPIB address just entered.

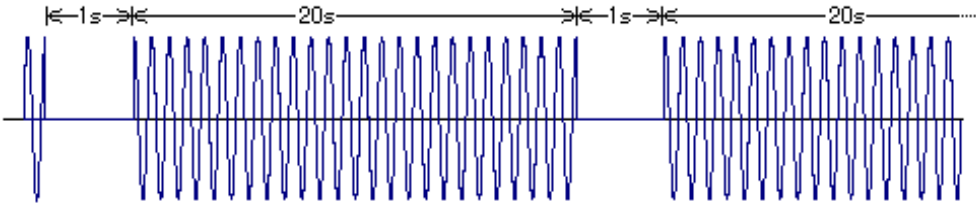
- Properly connect the designated GPIB cables.

The Dip interruption test

This section gives a step-by-step description of an Dip interruption test, using the Sequence Wizard.

1. Make a test plan.

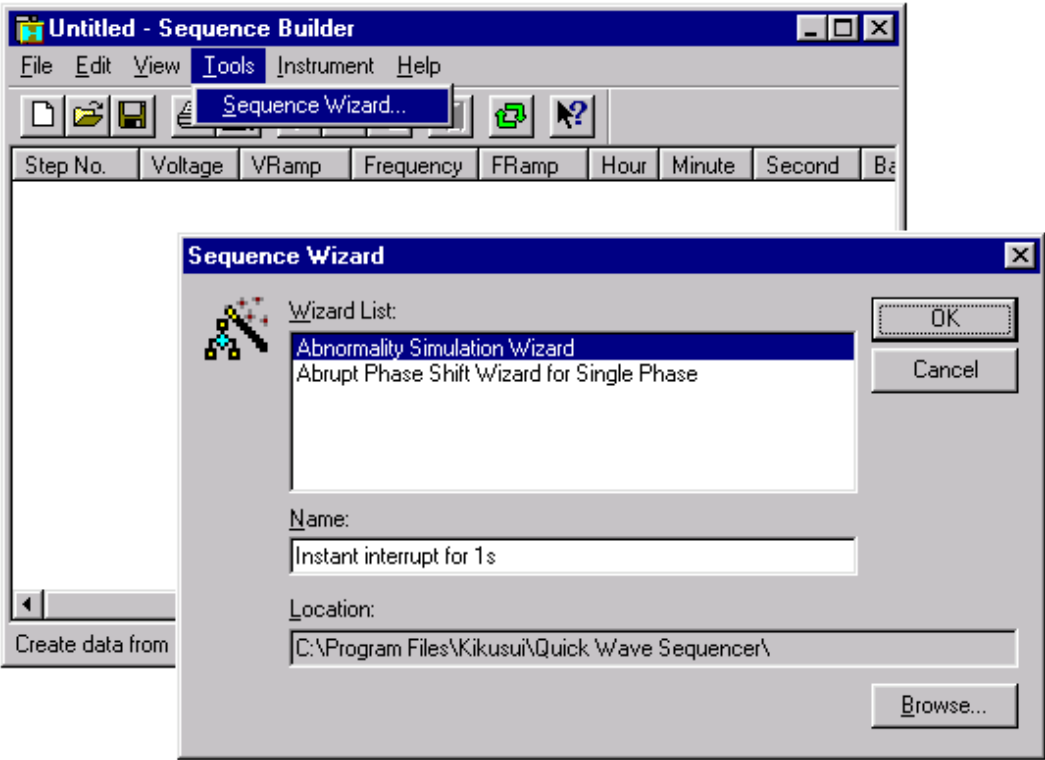
- Steady voltage Single phase: 100.0V
- Frequency: 50.00 Hz
- Instant interrupt voltage: 0.0 V
- Instant interrupt start phase angle: 90°
- Instant interrupt duration: 1000 ms(1s)
- Instant interrupt interval time: 20 s
- Number of repeats: 4 repeats



2. Open Sequence Builder and open Sequence Wizard.

When you open Sequence Builder, Wave Bank Server is opened automatically.

- Click the Sequence Builder **Tools** |**Sequence Wizard** and select "**Abnormality Simulation Wizard**" from the **Wizards List** .
- Type a new file name at **Name**. In this example, the file name is "Instant interrupt for 1s".



<Note>

- The application supports the Windows 95 long file-name format. Since the report print output truncates any file names longer than 80 characters, use 80 or fewer characters .
- Enter numbers in half-size characters.

- Click **OK**. Enter test conditions.

3. Enter test conditions.

Abnormality Simulation Wizard - Step 1 of 2

Voltage [V]: Frequency [Hz]: Intervals [s]:

Simulation Data:

No.	Type	Test Voltage[V]	Test Time[ms]	Repe. ▲
1	Not Used			
2	Not Used			
3	Not Used			
4	Not Used			

Loop [times]:

- Set **Voltage, Frequency, Interval, and Loop**. Input the steady voltage (effective value) of the test plan 100 for **Voltage**, frequency 50 for **Frequency**, time of instantaneous interruption interval 20 for **Interval**, and 4 for **Loop**.
- Double-click Number 1. (You can perform the same action by positioning the cursor at Number 1 and clicking the Edit button.) The Data Input screen appears.
- Select **Dip interruption** from the **Type** page **Abnormality Simulation mode**.

Simulation Wizard No 1

Type Edit

Abnormality Simulation mode:

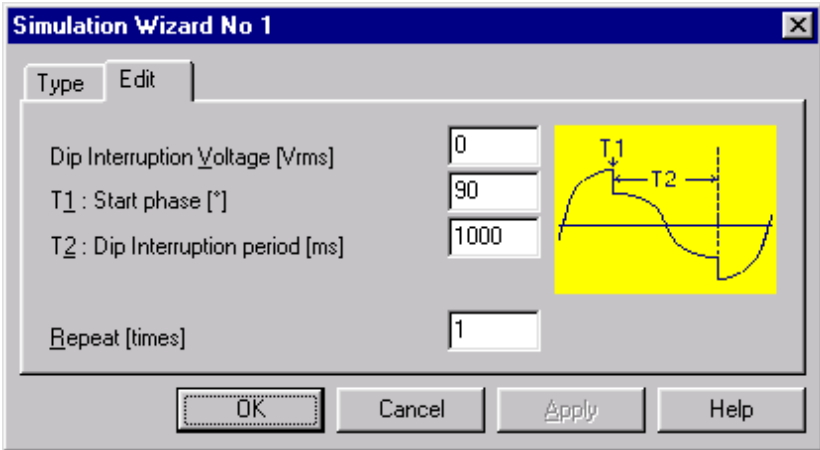
Not Used

Dip Interruption

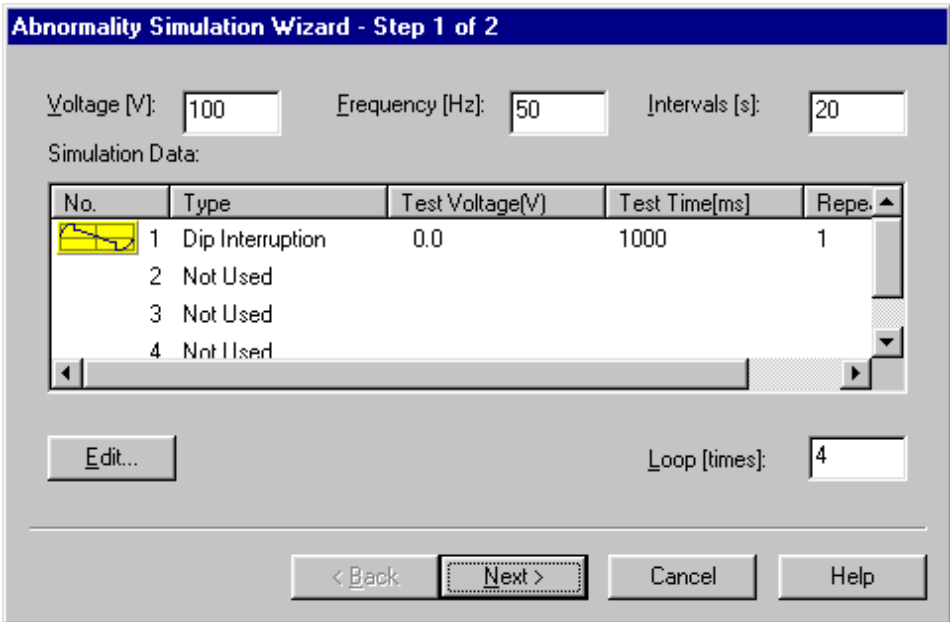
Voltage Variation

- Enter the simulation data for Dip interrupt in the **Edit** page. Input the test plan **Dip Interrupt voltage** 0V for Dip instant voltage, an Dip interruption start phase angle of 90° for **T1: Start phase**, and a **Dip interruption period** 1000 ms for the instant interruption period. The **Repeat** should be one.

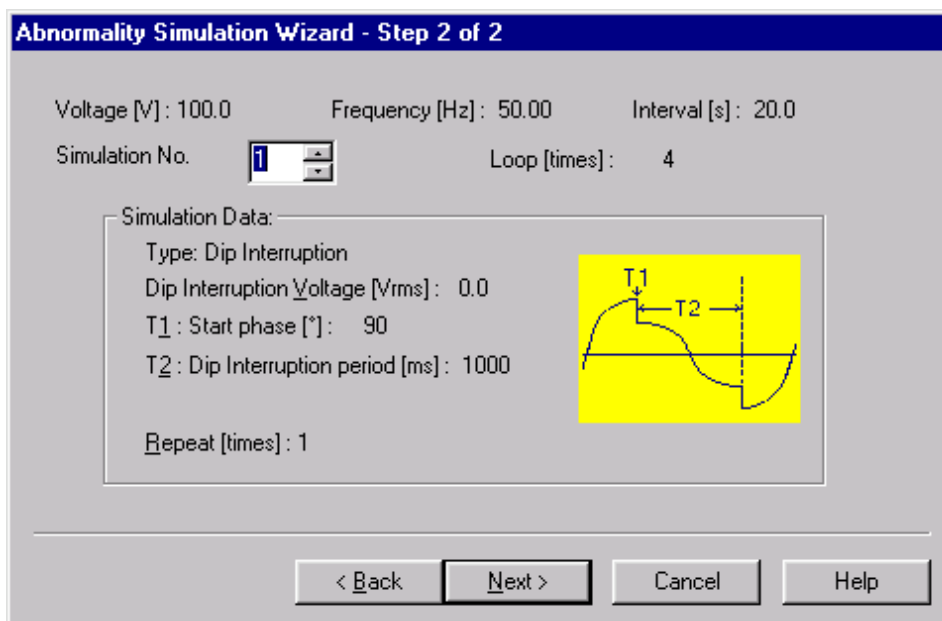
<Note>
When Dip interruption end phase angle exceeds approximately 280°, Dip interruption occurs at an interval of 1 cycle. For details, see page 40.



- After entering the test data, click **OK**,



- Click the **Next** button.

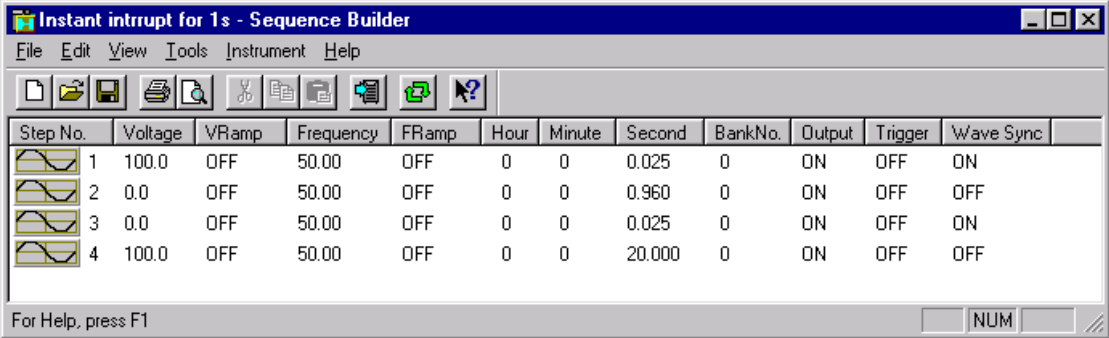
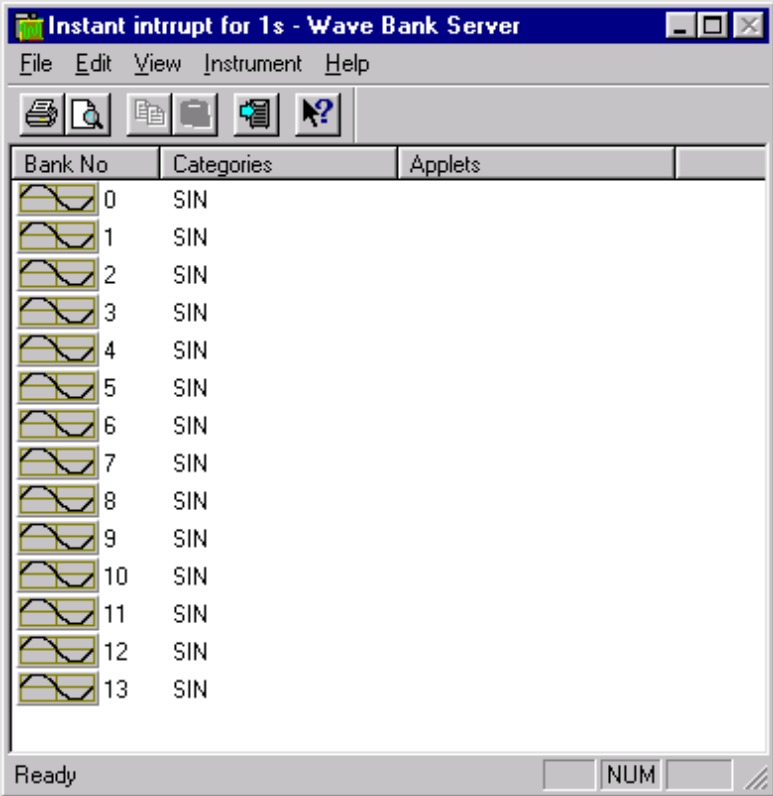


- After confirming the current test conditions, click the **Next** button.



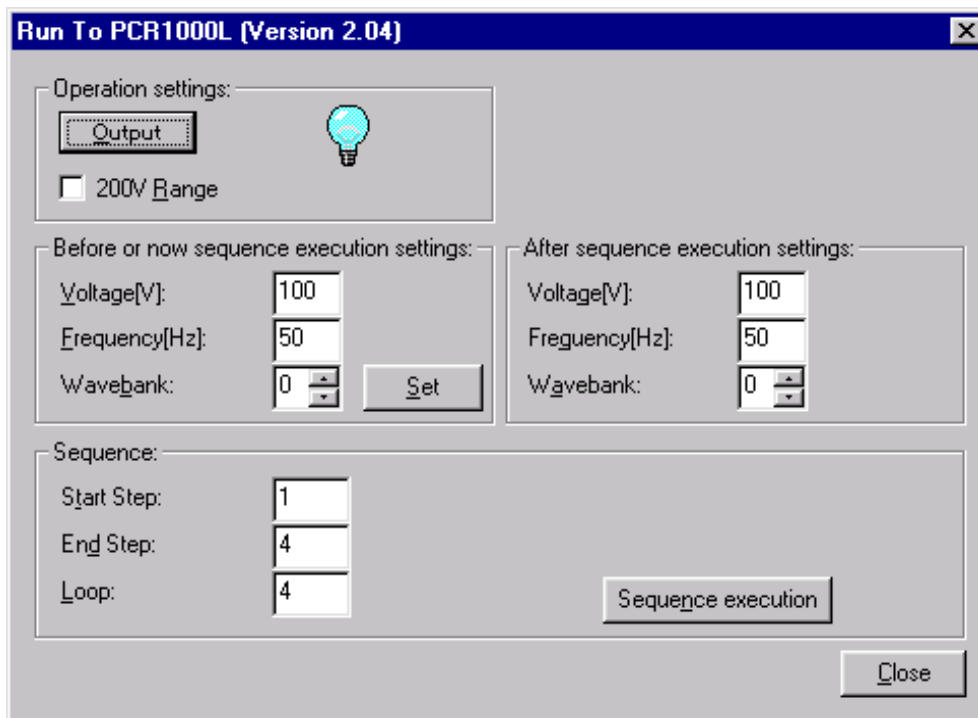
<Description>
 Used sequence steps: Number of steps created in Sequence Builder
 Files to be created:
 Instant interrupt for one second WSL: Data file for Sequence Builder
 Instant interrupt for one second WBL: Data file for Wave Bank Server

- Click on the **Finish** button to finish setting of the test conditions using Wizard. When you exist from Wizard, the bank waveform and sequence steps are created in Wave Bank Server and Sequence Builder.

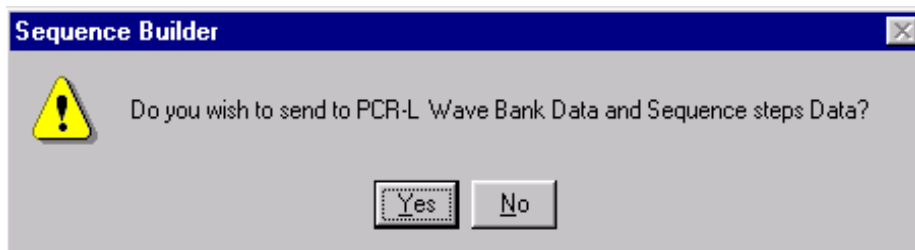


4. Executing the test

- Switch on power for the PCR-L and open the test execute screen on the Sequence Builder **Instrument |Run...** menu .

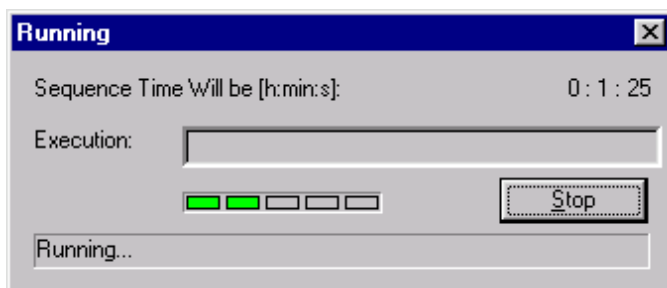


- Click the **Sequence execution** button. The following confirmation dialog appears.



<Note>
 This dialog is displayed only if the sequence or waveform data is not transferred. It does not appear if the data is already transferred.

- Click the **Yes** button. The Dip interruption test executes the data transfer.



- When the test is completed, the displayed message "Running" changes to "Sequence End " and the **Stop** button becomes a **Close** button. Click **Close** to close the Running dialog.

<Description>

The forecast sequence running time is the total of all sequence running times. When sequence wave sync is on, actual running time is longer than the forecast sequence running time.

<Note>

To halt sequence execution, click the **Stop** button in the Running dialog. In an emergency in which the unit being tested is damaged, switch off power to the PCR-L. This will produce an GPIB error. Click **OK** button to exit.

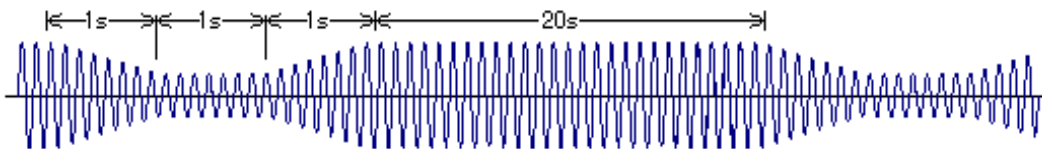
- The same test can be repeated using the **Sequence execution** button in the Run dialog.

Executing the voltage variation test

This section describes the steps required to conduct a voltage variation test using the Sequence Wizard.

1. Make the test plan.

- Steady voltage: : Single phase 100.0V
- Frequency : 50.00 Hz
- Front slope time : 1000 ms(1s)
- Fluctuating voltage : 40.0 V
- Fluctuation sustain time : 1000 ms(1s)
- Post slope time : 1000 ms(1s)
- Fluctuation interval : 20 s
- Number of repeats : 4 repeats



2. Open Sequence Builder and select Sequence Wizard.

When you open Sequence Builder, Wave Bank Server is opened automatically.

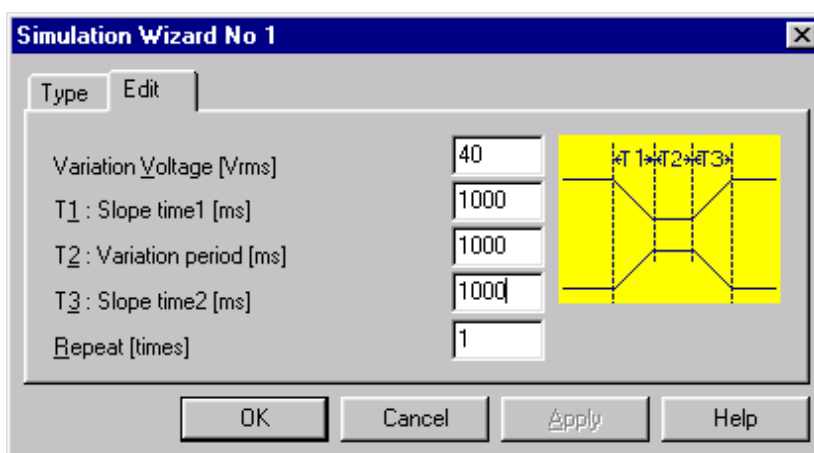
- In Sequence Builder, click **Tools |Sequence Wizard...** and select the "**Abnormality Simulation Wizard**" from the **Wizards List**. Type at file name

at **Name**.

- Click **OK**.

3. Enter test conditions.

- Set **Voltage, Frequency, Interval, and Loop**. Enter test plan steady voltage (effective value) 100 for **Voltage**, frequency 50 for **Frequency**, time of fluctuating interval 20 for **Interval**, and 4 for **Loop**.
- Double-click Number 1. (This performs the same action as positioning the cursor at Number 1 and clicking Edit.) The Data Input screen appears.
- Select **Voltage Variation** from **Type** page **Abnormality Simulation mode**.
- Set the simulation data for voltage variation in the **Edit** page. Input fluctuating voltage 40V for **Voltage Variation**, front slope time 1000 ms for **Slope Time 1**, fluctuation sustained time 1000 ms for **Variation period**, and post-slope time 1000 ms for **Slope Time 2**. The **Repeat** should be one.



- Enter test data and click **OK**.
- Inspect the test data and click the **Next** button. Click the **Finish** button to complete entry of test conditions. When you close the Wizard, a bank waveform and the sequence steps are created in Wave Bank Server and Sequence Builder.

4. Execution of test

- In Sequence Builder, open the **Instrument |Run...** menu.
- Click the **Sequence execution** button to transfer the set data. The fluctuating voltage test is executed.

Chapter 3 Wave Bank Server (waveform generation)

In previous chapters, we performed tests by transmitting the sine waveform in Wave Bank Server to the PCR-L. Wave Bank Server creates the sine, harmonic composite, and distortion waveforms, triangle and square waves, and artificial waveforms obtained from the oscilloscope. It transmits the created waveforms to the PCR-L waveform bank, enabling use as the waveform setting for Sequence Builder.

In Wave Bank Server, waveform generation creates the waveform without the attributes of voltage, time, or frequency.

Waveform generation categories

Waveform generation has four categories

- Sine waveform

A combination of sine waves is used to achieve instant interrupt and voltage fluctuations.

- Peak clipped waveform

The distorted sine waveform is created by specifying the crest factor.

- Harmonic composite waveform

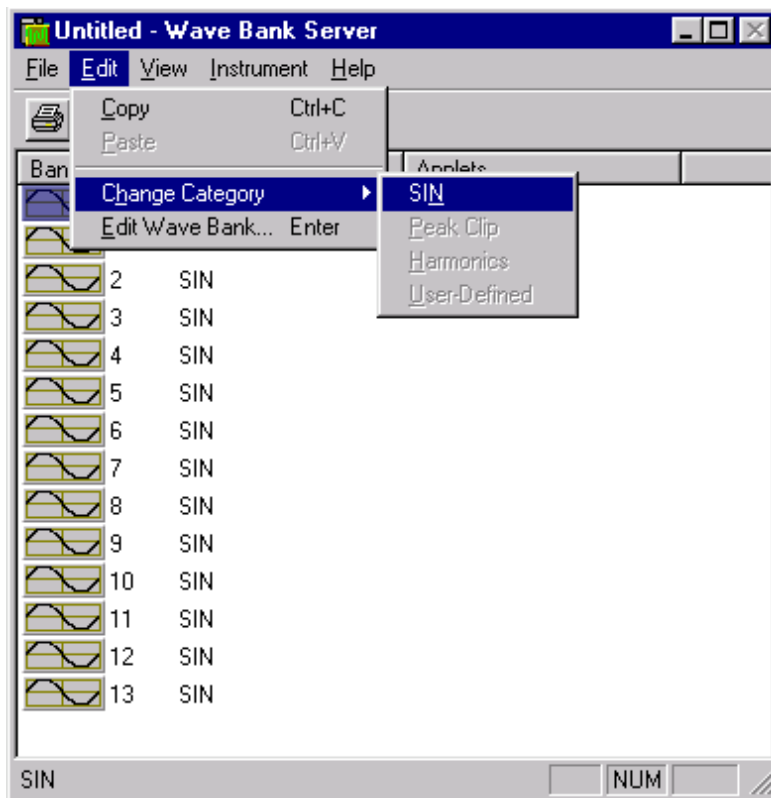
This category creates a waveform that includes harmonic components. Harmonic components can be set from primary to 50th order. You can also set the level and phase of each order.

- User-defined waveform

This category covers triangle and square waves and artificial waveforms obtained from the oscilloscope.

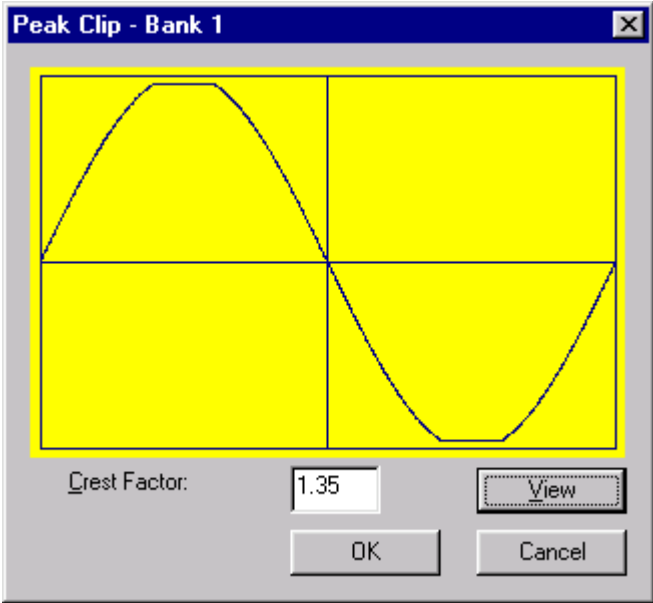
Sine waveform

This is the default Wave Bank Server category. In New Creation, waveform bank numbers from 0 to 13 are all sine waveforms. Bank No. 0 of the waveform may not be changed to any category other than sine waveforms. To select sine waveforms in Category, position the cursor at a waveform number and select **Edit |Change Category |SIN** menu. You can also select "SIN" from the right-click popup menu. In Sin, you can select Category, but may not set any other data.



Peak-clipped waveforms

In creating a sine waveform with distorted peak, you can specify the degree of waveform distortion. To select a peak-clipped waveform, select a waveform bank number from No. 1 - No. 13 and select **Edit |Change Category ...|Peak Clip** menu. You can also position the cursor at the appropriate waveform bank number and right-click to select **Peak Clip** from the popup menu. Peak-clipped Waveform sets data after categories are changed. Double-click the waveform at which the category has now been changed, or select **Edit |Edit Wave Bank** .



<Peak-clipped waveform in single-phase systems>

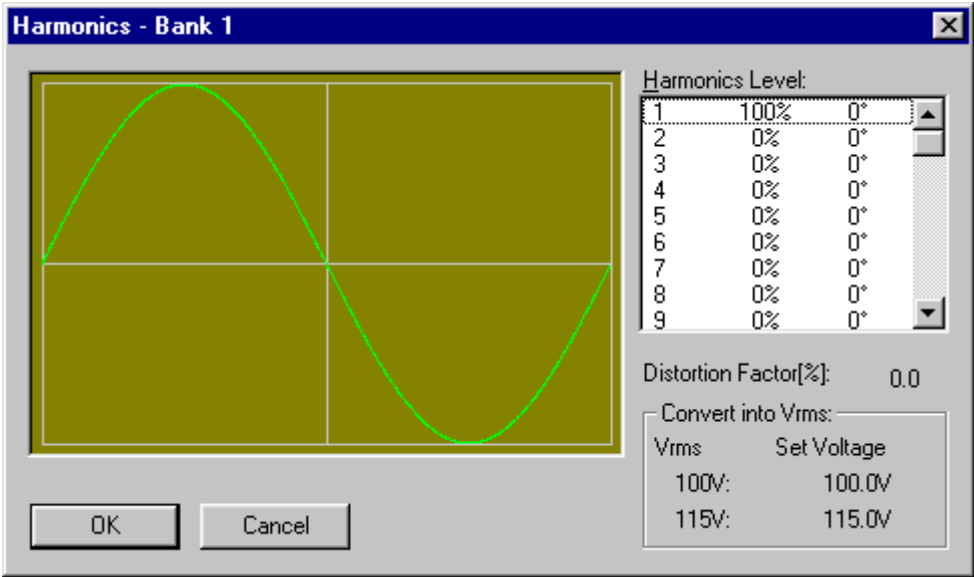
Crest factor :

The **Crest factor** is used to specify the degree of waveform distortion, 1.10 - 1.40 for single-phase systems.

To display a preview of the waveform, click the View button. Clicking **OK** completes entry.

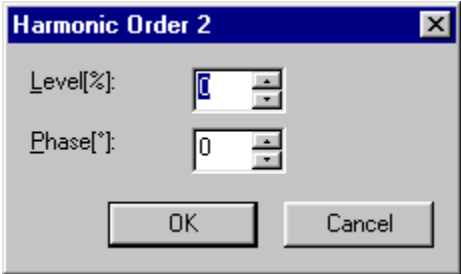
Harmonic composite waveform

This category creates waveforms containing harmonic components. For the harmonic component, you can set the phase and any level from primary to 50th order. To select a harmonic composite waveform, select the waveform bank number, from No. 1 to No. 13, and select **Edit |Change Category...|Harmonics** menu. You can also position the cursor at a waveform bank number and right-click to select **Harmonics** from the popup menu. Harmonics sets data after the category is changed. Double-click the waveform bank number or select **Edit |Edit Wave Bank...**



Harmonic level :

Set level and phase for the harmonic component of each order. The default level is 100% for the primary order and 0% for all other orders. The default phase is 0° for all orders. To edit harmonic component data, double-click an order number in the **Harmonics Level** list box.



Level :

Set the level of an order number. Possible settings range from 0% to 100%.

Phase :

Set the phase for an order number. Possible settings range from 0 to

359°

When you've finished setting level and phase, click **OK**.

Distortion Factor[%]:

The following indicates a theoretical distortion factor of the waveform with a composed higher harmonic:

Equation

$$DF = \frac{\sqrt{L_2^2 + L_3^2 + \dots + L_{50}^2}}{L_1} * 100(\%)$$

DF : Distortion Factor

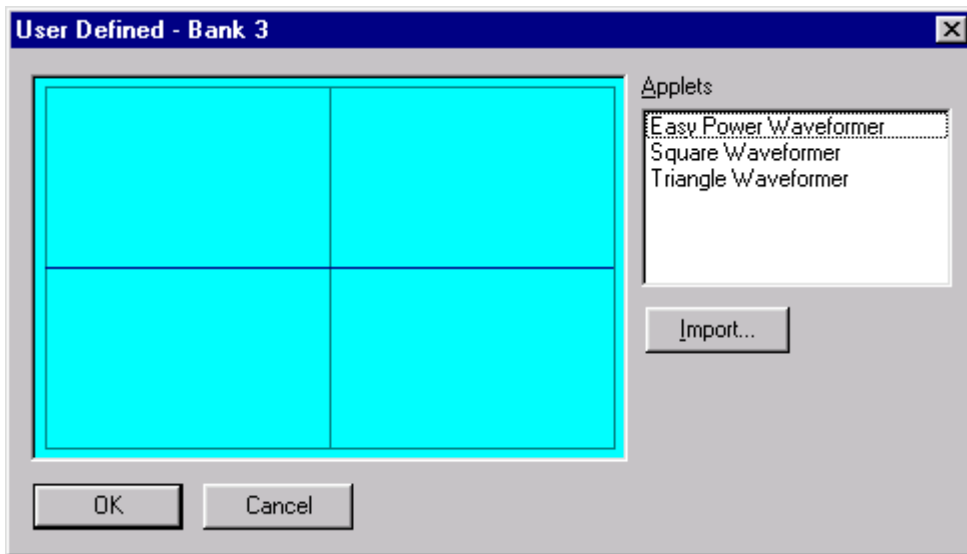
 L_n : level value at the nth order**Convert into Vrms:**

This indicates the set value for the voltage used to output the generated harmonic composite waveform at the effective value. When this set value for voltage is input as voltage during sequence execution, the harmonic composite waveform can be output at the designated effective value. The set values for voltage for the 200V and 230V effective values are the doubled set values for voltage of the 100V and 115V effective values.

After confirming settings and display data, click **OK**.

User-defined waveform

This item uses a subcategory called Applet for simple settings for creating triangle and square waves and the artificial waveform obtained from the oscilloscope. To select user-defined waveform by category, select a waveform bank number from No. 1 to No. 13 and select **Edit |Change Category ...|User Defined** menu. You can also position the cursor at a waveform bank number and right-click to select **User Defined** from the popup menu. User-define waveform sets data after the category is changed. Double-click the waveform bank number or select the **Edit |Edit Wave Bank...** menu.



Applets :

This is a subclassification for creating user-defined waveforms. Selecting Applet enables the generation of each waveform.

- Easy Power Waveformer

Creates artificial waveforms obtained from the oscilloscope.

- Square Waveformer

Creates square waves.

- Triangle Waveformer

Creates triangle waves.

After confirming setting and display data, click **OK**.

Obtaining data from the oscilloscope:

Selecting **Easy Power Waveformer** from the Applets of the user-defined waveform enables generation of artificial waveforms obtained from the

oscilloscope. Below is a procedure for creating artificial waveforms.

- Obtain waveform.
- Shadow the unused area.
- Enlarge the waveform.
- Change the 1-point data.

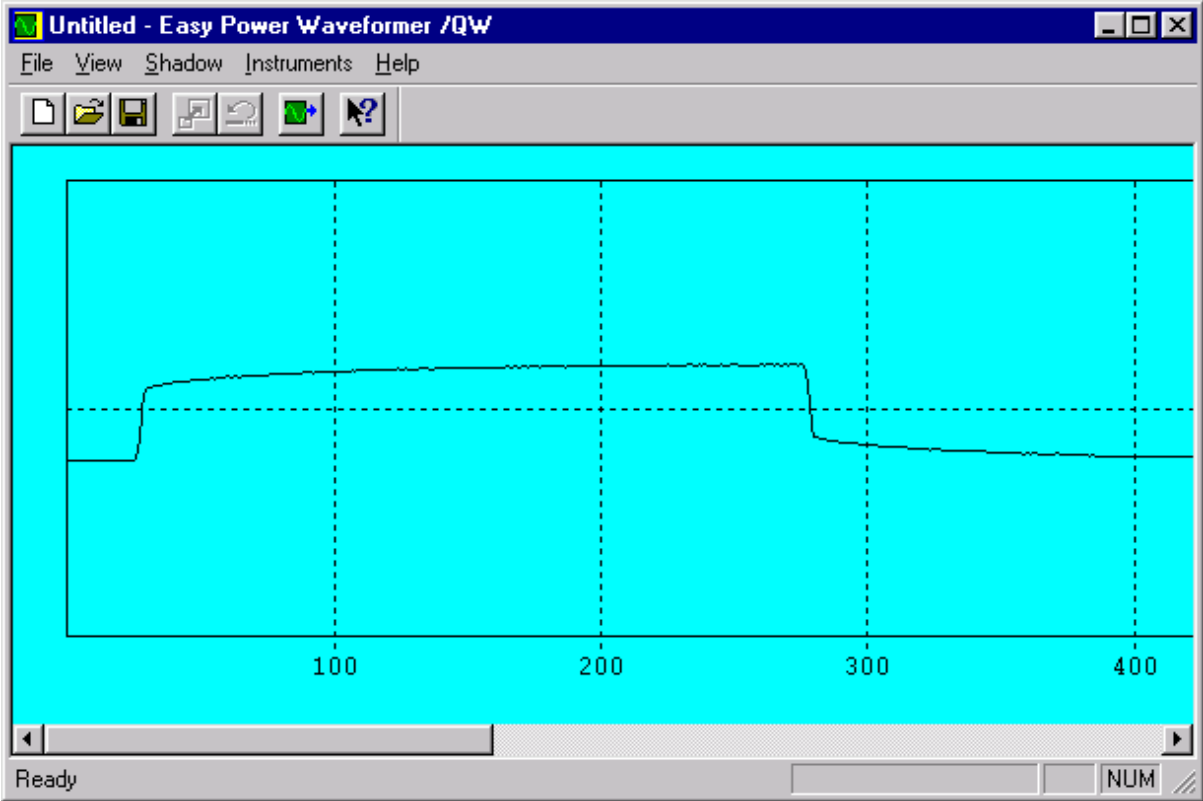
Obtaining a waveform:

The user-defined waveform created by Easy Power Waveformer is digitized. Obtaining the waveform is the first step toward creating a user-defined waveform. We use a digital oscilloscope connected to the GPIB interface. The following oscilloscopes are compatible with this application.

- Kikusui COM3000 series
- Kikusui COM7000A series
- Kikusui COR5500 series
- LeCroy 9350A series
- Tektronix TDS320 series

((For the names of specific models in the series, refer to Appendix "Application Specifications" at the end of this volume.)

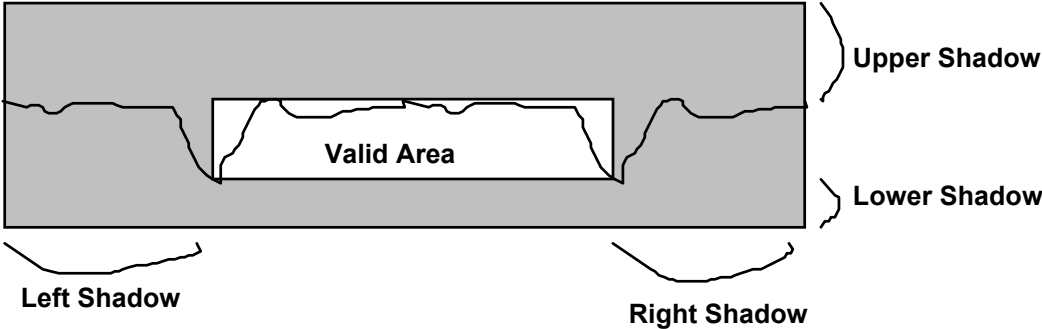
With any of these oscilloscopes, you can read waveforms through the GPIB interface. Select **Instrument |Read from the Digital Scope** menu, select the CH1 (or other channel), and click **Go**. The waveform appears in the main window.



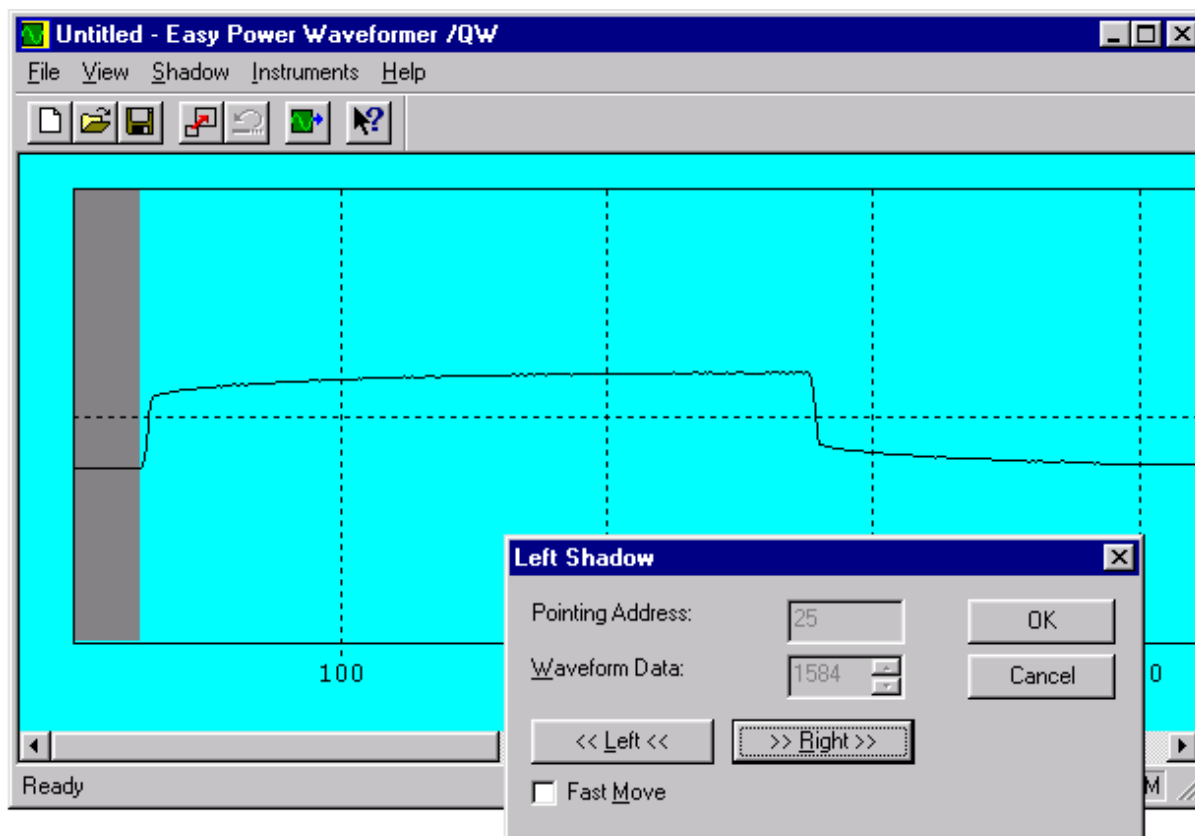
Shadowing the unused area:

Easy Power Waveformer converts waveform data into a user-defined waveform acceptable to the PCR-L. The format of user-defined waveform data is 12 bits x 1024 words. This is the only acceptable size and format.

Generally speaking, not all 1024 words captured from the oscilloscope will fit in the full-scale rectangle. In many cases, the 1024-word buffer contains data longer than the 1 period to be repeated, and the signal level of the captured waveform does not fit. You must shadow the unused area using **left**, **right**, **upper**, and **lower** shadows. The effective area left unshadowed is accepted as one waveform cycle.

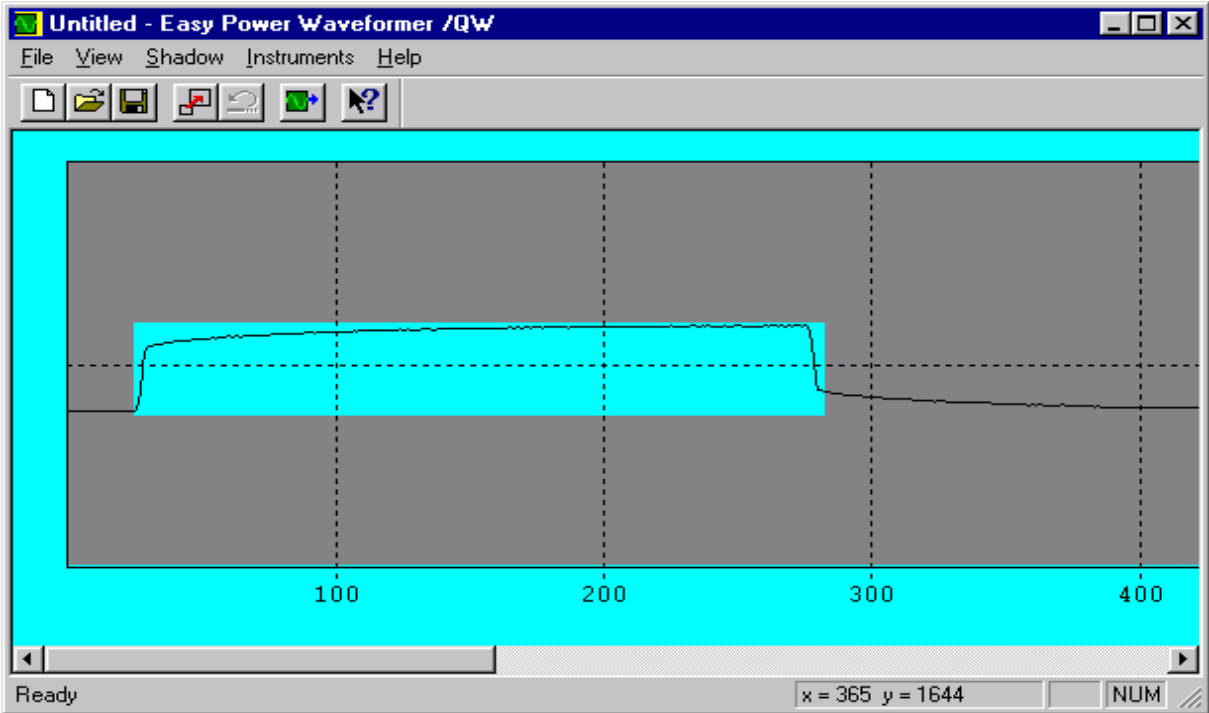


To shadow the waveform, point and click the right mouse button at the boundary of the area to be shadowed. A popup menu prompts you to select a shadow type. Selecting left displays a dialog box.

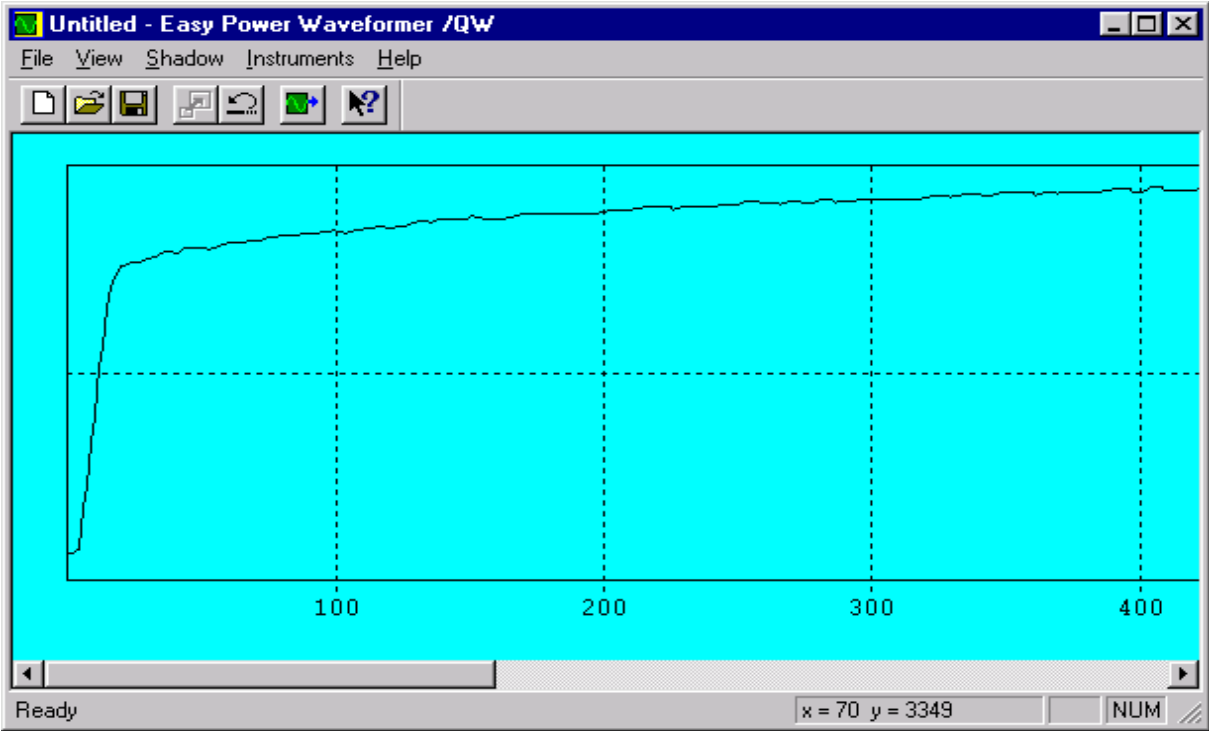


In the above dialog, "Point Address 25" indicates that the current position of the left shadow boundary is 25. Similarly, "Waveform Data 1584" indicates that the data value of that position is currently 1584. As a general rule, bottom data is assigned zero and top data is assigned 4095. Set other shadows on the waveform in the same way. Clicking on the left or right button enables you to move between the boundary positions of the left and right shadows. Similarly, clicking on the **Up** or **Down** button enables you to move between the boundary positions of the upper and lower shadows. These actions move a shadow position by one digit. To move the shadow quickly, check the **Fast Move** check box before performing.

Enlarging the waveform:

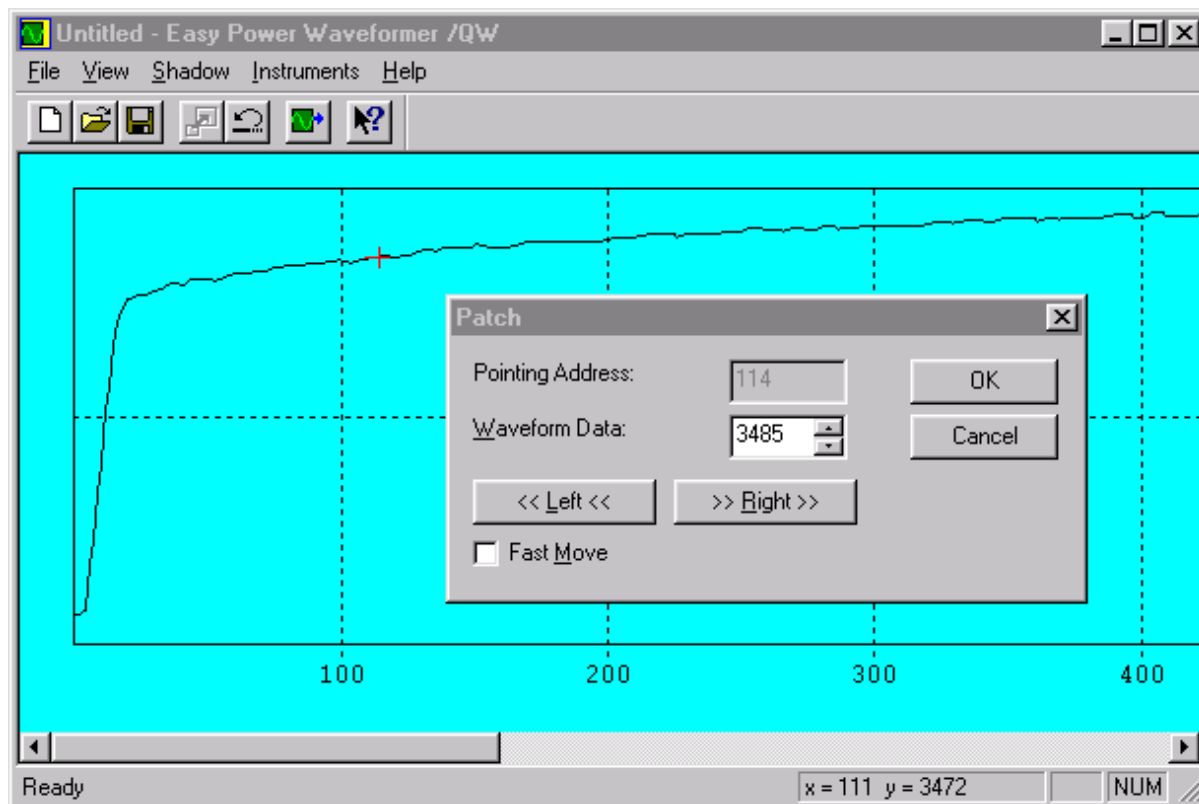


Assume shadow setting is complete and that the illustrated waveform has been obtained. Since a PCR-L user-defined waveform must be 12 bits x 1024 words, the above waveform must be enlarged to fit the size requested by the PCR-L. Select **Shadow|Expand waveform** from the menu bar. The waveform data is enlarged to the full size.



Changing the 1-point data:

The waveform pattern is complete. To patch the waveform, click the right mouse button at the appropriate waveform point. A popup menu appears, enabling selection of Patch, and a + mark at the waveform and a dialog box are displayed.



In the dialog box above, "Point Address 114" indicates that the current waveform position is 114. Similarly, "Waveform Data 3485" indicates that the current data value at that position is 3485. Make the appropriate changes to the waveform data. As a general rule, settings range from 0 to 4095, with bottom data assigned zero and top data assigned 4095.

Saving waveform data:

You can save created waveforms to disk in the 12 bits x 1024 word format. Select the **File |Save As...** menu to display a dialog box for selecting a file name. Name the file; the default extension is .EPW.

Reading existing data:

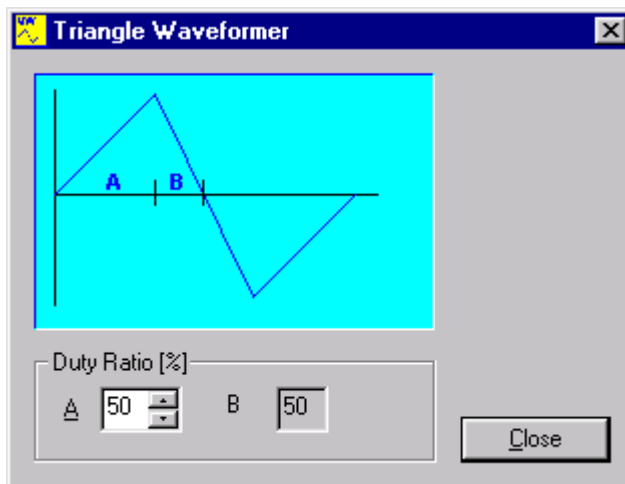
A saved waveform data file can be opened and read. Select the **File |Open...** menu to display a dialog box. Double-click on the desired file.

Generating user-defined waveforms

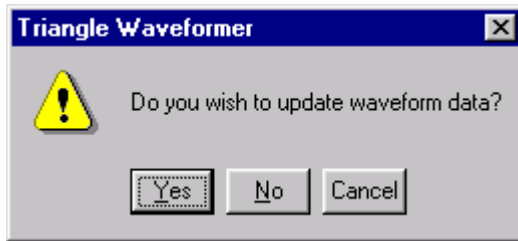
Since the waveform pattern that can be used as the user-defined waveform was created, exit from Easy Power Waveformer on the **File |Exit** menu. Closing the application displays a message box "Do you wish to update waveform data ?" No waveform is created when you click **No**. To generate the waveform created by Easy Power Waveformer as a user-defined waveform, click **Yes**. Clicking Cancel returns you to the original screen.

Generating triangle waves

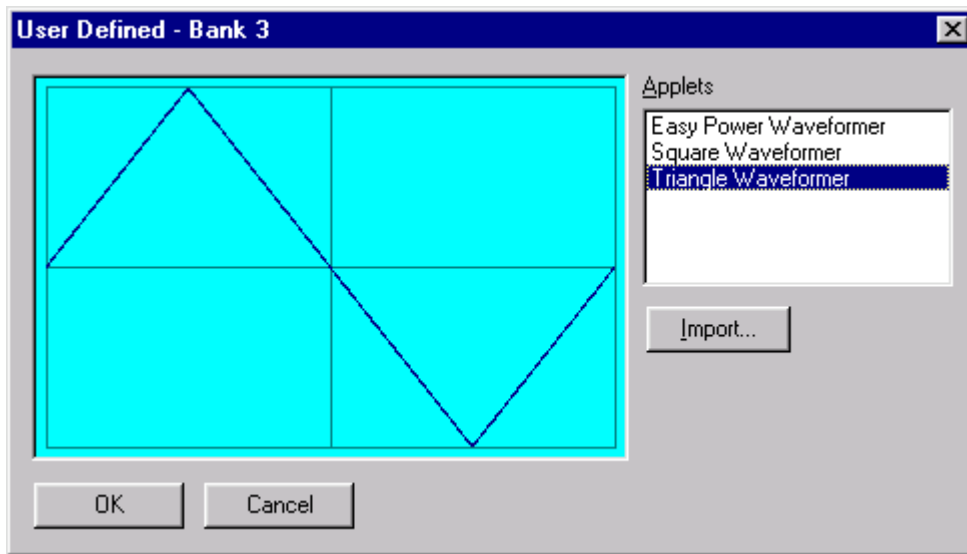
Generate triangle waves by selecting **Triangle Waveformer** from the Applets of the user-defined waveform. In the Applets, double-click **Triangle Waveformer**, or select **Triangle Waveformer** with the cursor and click the **Import...** button. The system displays a screen for creating triangle waves.



To generate, enter a setting in the range 0 - 100% for **A**. This automatically calculates the factor for **B**. Once you've entered a setting for **A**, click the **Close** button. The "Do you wish to update waveform data?" message box appears.



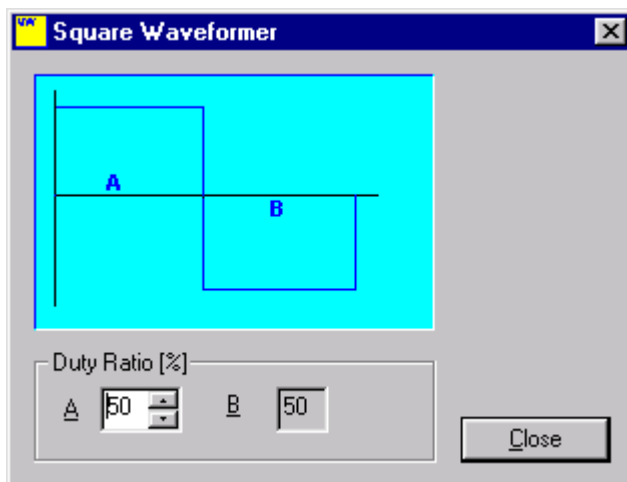
No waveform is created when you click **No**. To go back and set a different value for **A**, click **Cancel**. Clicking **Yes** generates a triangle wave in the user-defined waveform.



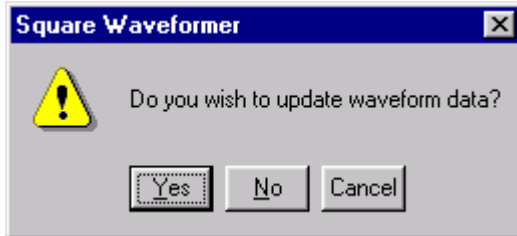
Inspect the created waveform and click **OK**.

Generating square waveforms

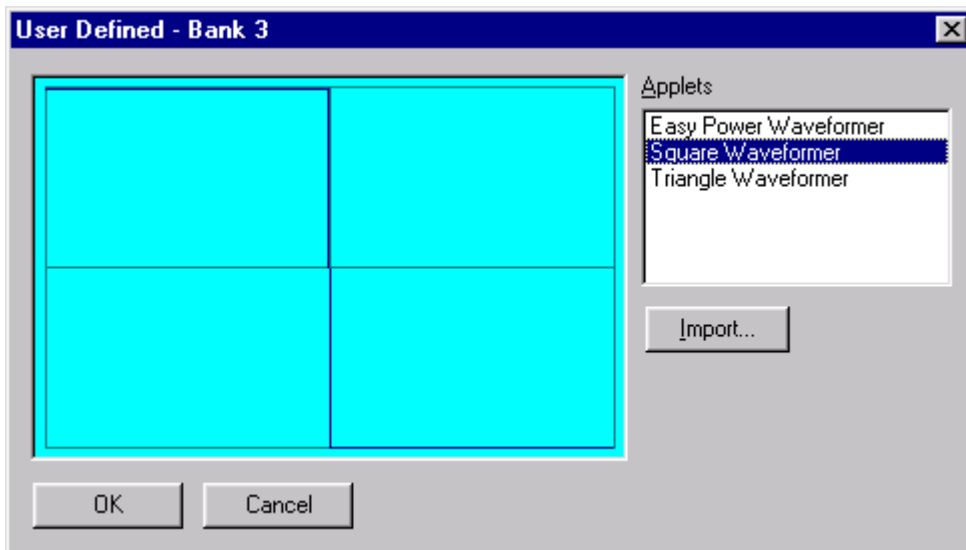
Square waves are generated by selecting **Square Waveformer** from the Applets of the user-defined waveform. Double-click **Square Waveformer** in the Applets , or select **Square Waveformer** with the cursor and click the **Import...** button. The system displays a screen for creating square waves.



To generate, enter a setting in the range 0 - 100% for **A**. This automatically calculates the factor for **B**. Once you've entered a setting for **A**, click the **Close** button. The "Do you wish to update waveform data?" message box appears.



No waveform is created when you click **No**. To go back and set a different value for **A**, click **Cancel**. Clicking **Yes** generates a triangle wave in the user-defined waveform.



Inspect the created waveform and click **OK**.

Simple printing

The system can print a waveform category (waveform bank No.0 - No.13) created by Wave Bank Server in a simple waveform image format. To print, select **File |Print** . To preview the printed image, select **File |Print Preview** menu.

Chapter 4 Sequence Builder

In addition to sequence execution and PCR-L output control, Sequence Builder can edit, create, and transfer sequence data.

Creating new data

To create new data, select **File |New...** The sequence step is cleared, with file name "untitled."

Reading existing data

A saved data file can be reopened for test execution. To read data, select the **File |Open...** menu to display the file name selection dialog box. Choose an existing file that was previously saved (with extension WSL). When the Sequence Builder file is read, a Wave Bank Server: waveform generation application file (with extension WBL) is read simultaneously.

Data storage

Sequence Builder can store set data on a disk, including set data for executing sequences and waveform generation application files. To save data, select **File |Save** menu or **File |Save As...** menu. Either displays the dialog box for file name selection. Name the file appropriately. The Sequence Builder extension is WSL. A Wave Bank Server file is saved under the same name at the same time, but with an WBL extension.

<Note>

The Sequence Builder and Wave Bank Server files are the only paired files that have different extensions. Changing the file name for one changes the file name for both.

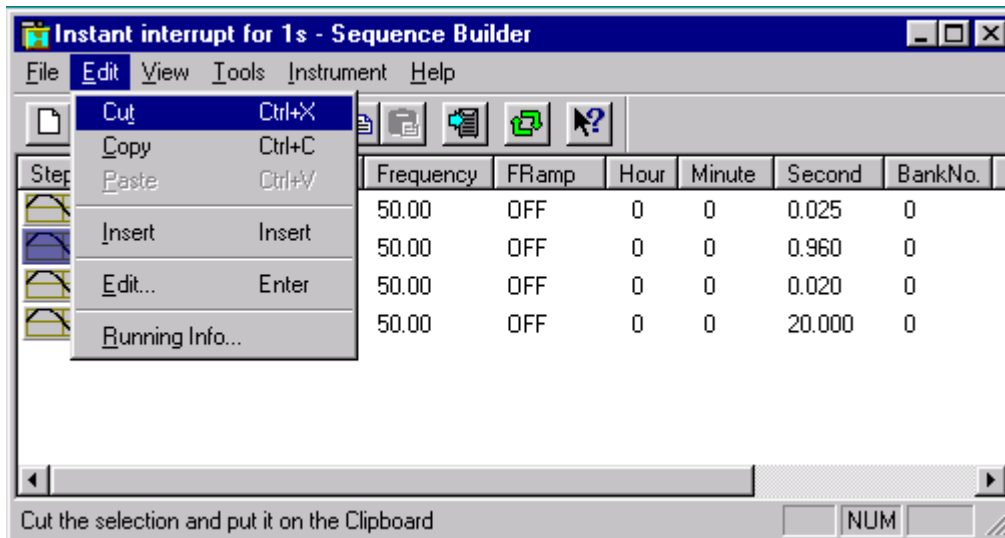
When moved or copied, the two files must reside in the same directory.

Sequence step insertion (generation)

Click the specified step number and select the **Edit |Insert** menu (or the **INSERT** key). A new step is inserted just before the specified step number, and step numbers following this step are added one by one. The maximum step number is 100.

Sequence step cut

Click the cursor on any sequence step number [m], then click **SHIFT** + sequence step number [n]. This selects all sequence step numbers from m to n. Select the **Edit |Cut** menu or enter **CTRL + X** from the keyboard to delete these sequence step numbers from m to n. The sequence step data is moved to the clipboard. To restore this data, move the cursor to the desired insertion point of sequence number and select **Edit |Paste** menu, or enter **CTRL + V** from the keyboard. The clipboard contains only the most recent copying or cutting data; if any material was copied or cut in other work, the contents of the clipboard are cleared.

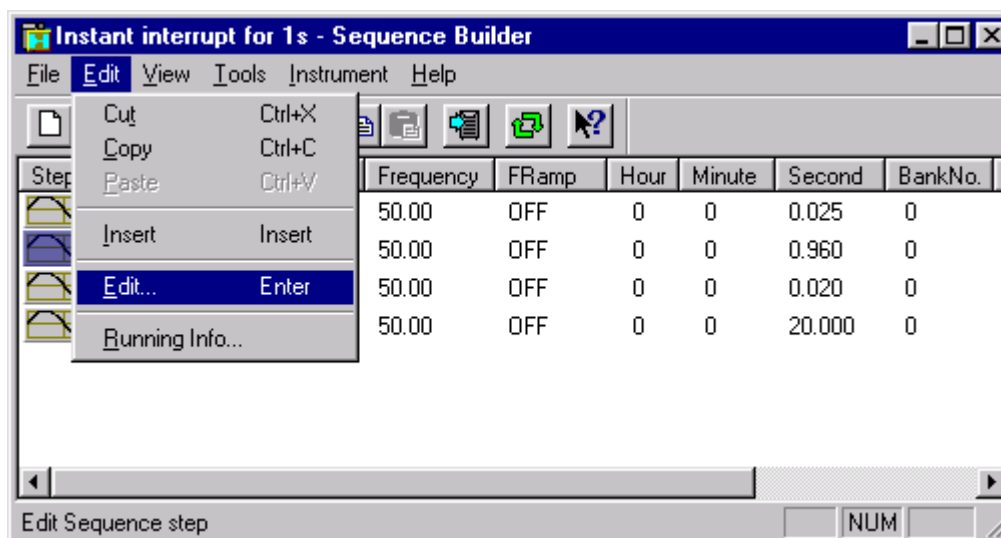


Sequence step copy

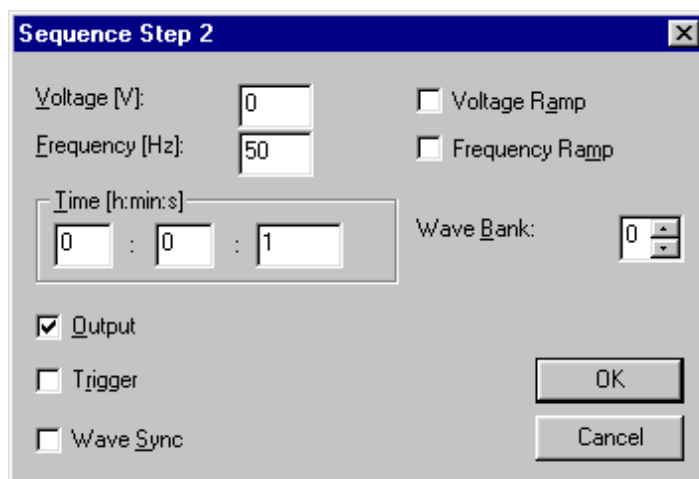
As with sequence step cut, select any sequence step number and select **Edit |Copy** menu, or enter **CTRL + C** from the keyboard. This moves the selected data to the clipboard. Position the cursor at the sequence step number you want to copy, and select **Edit |Paste** or enter **CTRL + V** from the keyboard.

Sequence step editing

To edit sequence steps, position the cursor over the sequence step number and select (or double-click) **Edit |Edit...** You can also position the cursor over the step number and right-click to select **Edit...** from the popup menu. Sequence parameters that are required for a sequence are modified in the edit dialog box.



Description of sequence parameters



Sequence parameter items

Voltage:

Set a value for output voltage in the range 0.0 - 305.0 V.

Voltage Ramp:

It takes the time set in this step to changes from the voltage set in one step before to that set in this step. If this item is not checked, the voltage is immediately changed to that set in this step. In this case, first ramp value is disabled.

Frequency:

Set a value for frequency output in the range 1.00 - 999.9 Hz.

Frequency Ramp:

It takes the time set in this step to changes from the frequency set in one step before to that set in this step. If this item is not checked, the frequency is immediately changed to that set in this step. In this case, first ramp value is disabled.

Time:

Set the step duration. Enter values for hours, minutes, and seconds, in the range 0.001 s - 999h59m59.999s.

<Note>

Depending on PCR-L function specifications, this value may differ by about 1 ms from the actual output time. To operate the system in cycles, set a value several ms shorter than cycle time and click the checkbox enabling "**Wave Sync**" for the next sequence step.

Wave Bank:

Enter a waveform bank number from 0 to 13. The waveform set by Wave Bank Server appears in this step. Bank 0 indicates sine waveform fixing.

Output:

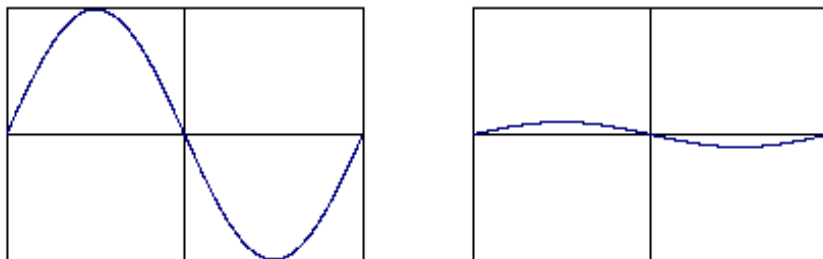
Set output in this step. To enable output, check this item.

Trigger:

Check this item to output a trigger signal (the "SEQ TRIG OUT" terminal on the back panel) from the PCR-L at the start of this step.

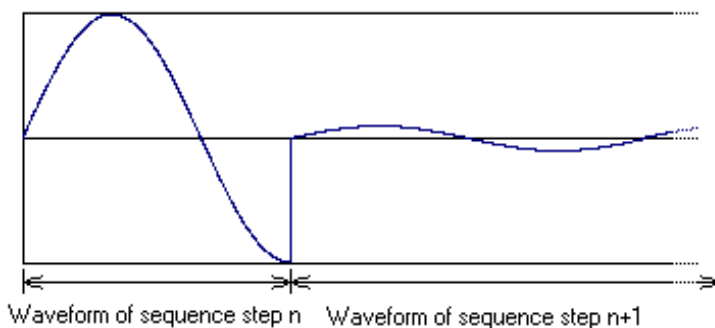
Wave Sync:

In the PCR-L sequence, the set time is not synchronized with the output waveform. Depending on the time set for the step, discontinuous waveforms may be output when steps switched. Checking Waveform Synchronization starts this step operation after waveform banks are switched in the previous step. Check this item for phase control. Otherwise, leave unchecked.

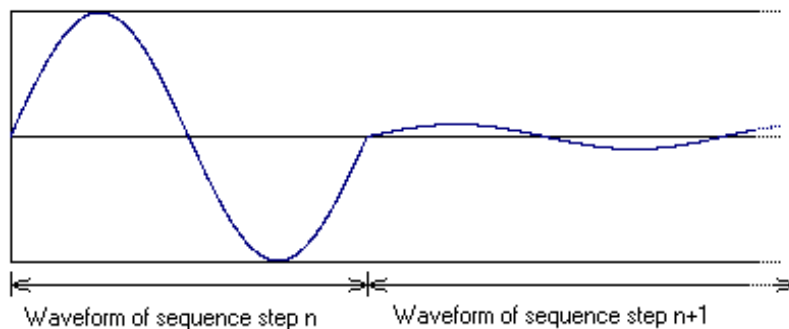


Waveform of sequence step n	Waveform of sequence step n+1
Voltage: 100.0 V	Voltage: 10.0 V
Frequency: 50.00 Hz	Frequency: 50.00 Hz
Time: 15ms	Time: 1s
Wave Bank: 0	Wave Bank: 1

When wave Sync for sequence step n+1 is disabled (unchecked):



When wave Sync for sequence step n+1 is enabled (checked)



When settings are complete, click **OK**.

<Note>

The time of waveform of sequence step n gets longer than the actual set time when wave Sync is enabled. Sequence Builder adjusts synchronization by using this time difference, however, 3-5 ms are required to adjust it. When the time is set to 18 ms, for example, waveform of sequence step n come to 2 cycles (40 ms). If it becomes an issue, contact your Kikusui agent.

Simple printing

Sequence Builder can print created sequence step data. Data is sent to the printer entered in the **File |Print...** menu. Select the **File |Print Preview** menu to see a preview of the output.

Chapter 5 Performing the Test

You can perform various tests by operating the PCR-L according to waveform bank or sequence step information. But before performing the test, you must set GPIB .

GPIB setting

This application communicates with external equipment through the GPIB by device name. Set the GPIB environment before using the GPIB function.

To inspect and change GPIB settings, specify a device name by selecting **Instrument |Options...** in Sequence Builder. Note that the GPIB address is not specified but the GPIB device name is. The GPIB device name is set by the GPIB board device driver. At installation, the device name is set to DEV5. By default, the National Instrument GPIB driver provides device numbers from DEV1 to DEV16. GPIB addresses for corresponding devices are set from 1 to 16; thus, a GPIB address of PCR-L must be set to "5" to connect to the DEV5 device. However, this does not necessarily hold if GPIB driver environment settings are modified.

<Caution>

- After changing the GPIB device name, restart the application to reflect the changed GPIB device name to Wave Bank Server.
- Set "I/O Time Out" for the National Instruments GPIB driver software to 10s (initial value). Setting it to 1s or less can produce an GPIB error.

<Note>

- To check for errors, run the diagnostic program attached to the GPIB board.
- This application supports only "GPIB 0" board control. Take the necessary precautions when using more than one GPIB board.



For more information on the National Instruments GPIB, refer to the instruction manual.

<Description>

Set the PCR-L GPIB address from the PCR-L panel with the SHIFT + F (GPIB) keys. Enter "5" in GPIB address setting mode, then restart the PCR-L to validate the new GPIB address.

Procedure for performing the test

Use one of the following procedures, depending on the specific test.

For a test to output a steady AC waveform:

The test continuously outputs sine, harmonic composite, and user-defined

1. **Creating bank waveforms**

Set the waveform to output to any bank number in Wave Bank Server. The sine waveform is set to bank number 0.

2. **Creation and transfer of bank waveforms**

Transmit waveform bank data to the PCR-L by selecting **Instrument |Send...** menu in Wave Bank Server.

3. **Performing the Test**

Open the Sequence Builder **Instrument |Run...** menu and set **Voltage**, **Frequency**, and **Wave Bank** that were set **Before or now sequence execution settings**. Click the **set** button, then the **Output** button for the **operation settings**. PCR-L output is enabled or disabled.

For a test to output AC waveforms that change over time

The test outputs AC waveforms for which output voltage, frequency, and waveform change as a function of time. Sequence Wizard automatically performs steps 1 to 3 below.

1. **Creating bank waveforms**

Set the waveform to be tested at any bank number in the Wave Bank Server. A simple sine waveform is set to bank number 0.

2. **Creating sequence steps**

Create a sequence step in Sequence Builder.

3. **Setting output voltage and frequency**

Open **Edit |Running Info...** menu in Sequence Builder and set all items.

4. **Transfer bank waveform and sequence data**

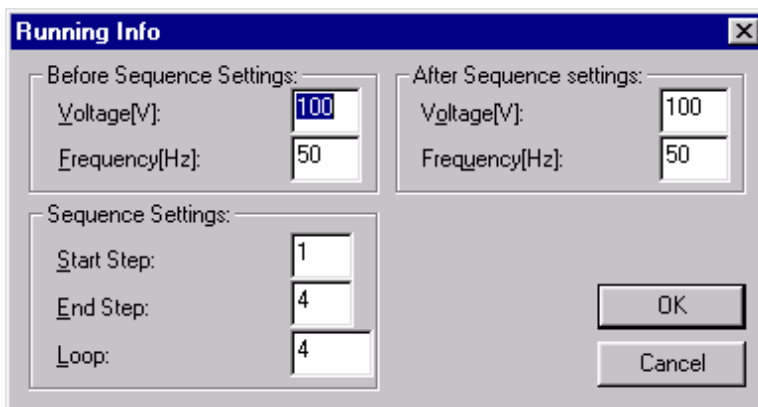
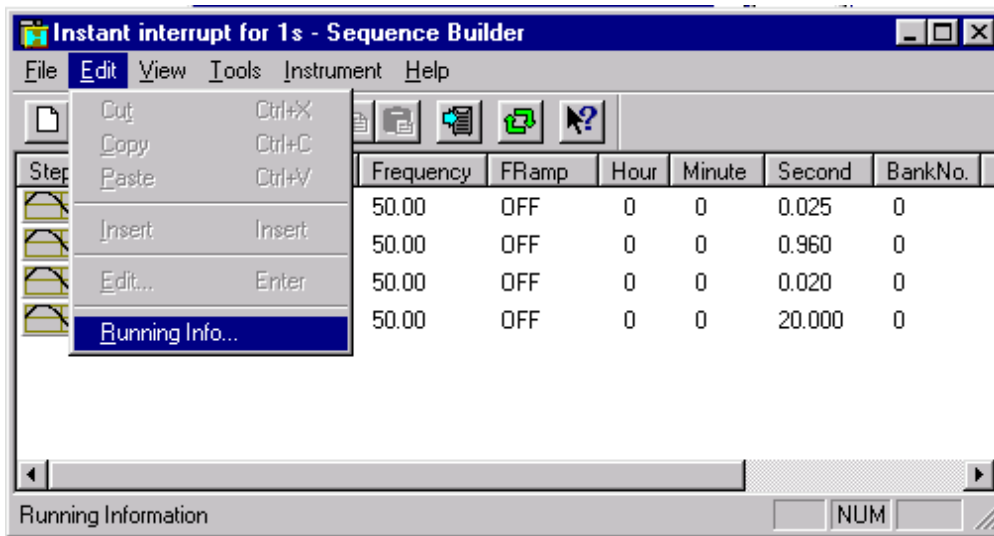
Transfer the waveform bank data to the PCR-L by selecting **Instrument |Send...** menu in Wave Bank Server. Transfer sequence data to the PCR-L by selecting **Instrument |Send...** menu in Sequence Builder.

5. **Performing the Test**

Open the Execute screen by selecting **Instrument |Run...** menu in Sequence Builder, and execute the test. Click the **Sequence execution** button. When output must be turned on before performing the sequence test, click the **Output** button for the **operation settings**. PCR-L is enabled or disabled.

Setting Running Information

Running Information sets voltage and frequency in advance before and after sequence operation. Open the dialog box by selecting **Edit |Running Info...** menu in Sequence Builder.



Before Sequence settings:

Enter values for PCR-L output voltage and frequency before the test is performed.

- **Voltage**

When the Execute dialog opens, set PCR-L output voltage in the range

0.0 - 305.0V. When set in the 100V range, this setting automatically switches to the 200V range for a voltage 152.5V or greater. When the PCR-L current range differs from the range to be set, you must shut off PCR-L output to change the range. Otherwise, the Execute dialog box will not open.

- **Frequency**

When the Run dialog box is opened, set the frequency to be set in the PCR-L in the range 1.00 - 999.9Hz.

After Sequence settings:

Enter values for PCR-L output voltage and frequency following test execution.

- **Voltage**

Set the voltage to be set in PCR-L on test completion in the range 0.0 - 305.0V. When a voltage before test execution is set to 152.5V or greater, the set voltage following testing switches to 152.5V or greater.

- **Frequency**

Following testing, set the frequency in the PCR-L in the range 1.00 - 999.9 Hz.

Sequence settings:

A sequence test can be performed when sequence step data includes at least 2 steps.

- **Start step**

Set the step with which the sequence starts. When testing data created by the Wizard, this step is generally 1. The setting range from 1 to the end step.

- **End step**

Set the step with which sequence ends. When testing data created by the Wizard, the number of steps is the number that has already been set. The setting range is from the start step to the number of set steps.

- **Loop**

Set the number of operation repeats from start to end step. When testing data created by the Wizard, this value is already set. The setting range is from 1 to 99999.

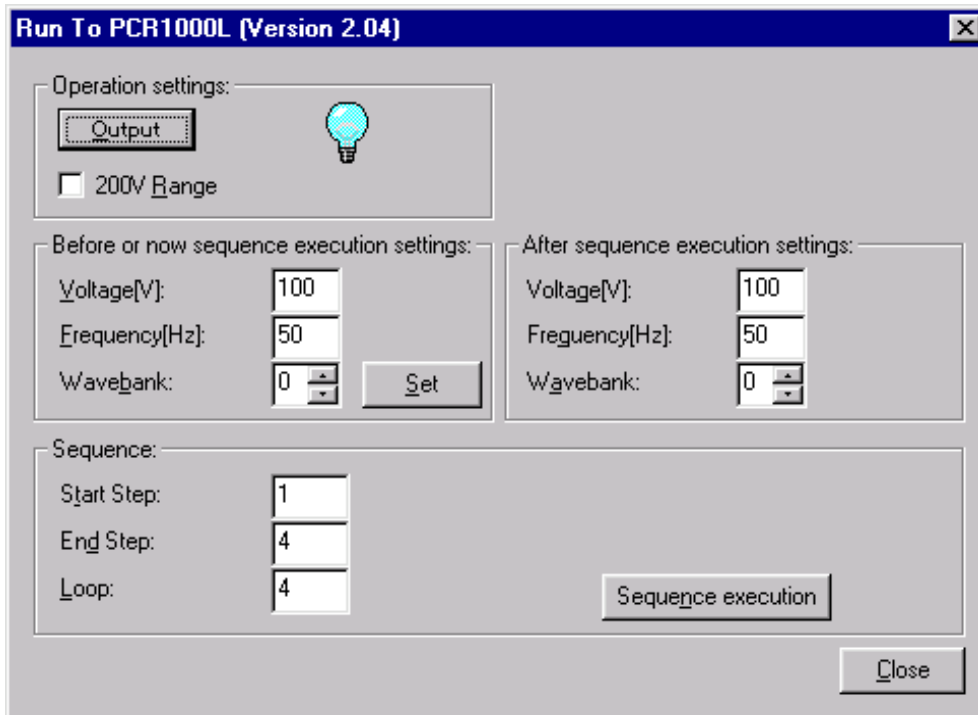
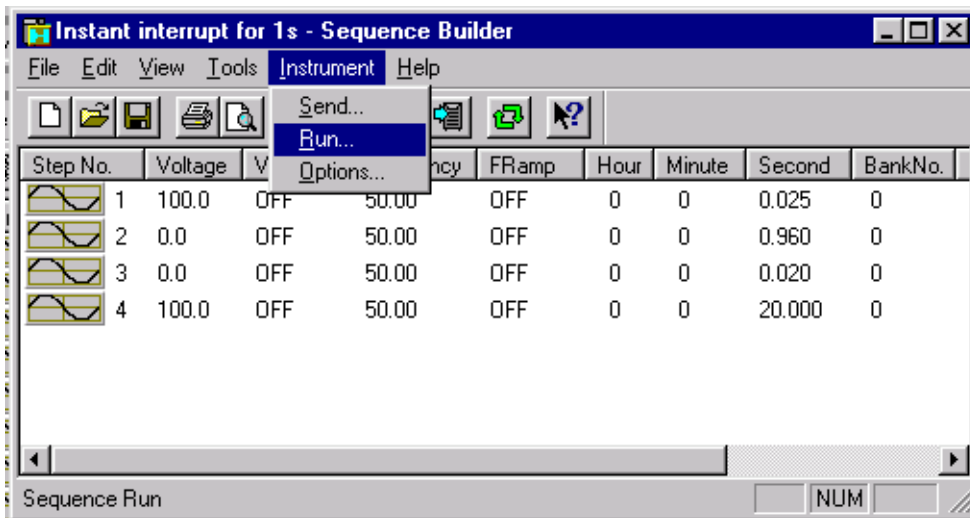
99999 sets for infinite repetitions.

<Note>

In the PCR which SUBCPU version 2.07 installed in, 99999 is not infinite repetitions but 99998 repetitions. The version number of SUBCPU is indicated at the upper right of the indicator (frequency indication section) when turning on the PCR. If you want to update SUBCPU in your PCR, contact your Kikusui agent.

Test execution

Run the test from the Sequence Builder **Instrument |Run...** menu. If sequence steps are edited but sequence data is not transmitted to the PCR-L before the Execute dialog box appears, transmit waveform bank and sequence data to the PCR-L. You can cancel transmission waveform bank and sequence data. Following the first test after power-on or modification of the last setting, perform the operation by transmitting data. Neither waveform bank or sequence data is saved to PCR-L nonvolatile memory. The waveform bank data cannot be transmitted unless PCR-L output is turned off.



Settings made in the Running Information are valid when the Run dialog box is opened. And waveform bank 0 are set as initial settings for the Run dialog in the PCR-L.

Even when the Run dialog box is opened, you can click the **set** button to enter **Before or now sequence execution settings, Operation settings** in the PCR-L.

Operation settings:



This output button turns PCR-L output on or off.

- **200V Range**

This button switches between 100V/200V for the PCR-L, a change that can be made only when PCR-L output is off. For a voltage less than 152.5V, select the 100V range by unchecking the box. For a voltage 152.5V or greater, select the 200V range by checking the box. When the Execute dialog box opens, confirm the PCR-L setting and check the voltage for "setting before test execution" in Running Information. The range is automatically switched to the 200V Range, if necessary.

Before or now sequence execution settings:

- **Voltage**

Set PCR-L output voltage in the range 0.0 - 305.0V. If the set value is 152.5V or greater, click the check box for the 200V Range, confirming that PCR-L output is off. Set the voltage value. Clicking the **set** button sets the value in the PCR-L, along with frequency and waveform bank number.

- **Frequency**

Set the PCR-L output frequency in the range 1.00 - 999.9Hz. Clicking the **Set** button sets the value in the PCR-L, along with voltage and waveform bank number.

- **Wavebank**

Set a value for output bank number in the PCR-L. When the dialog box is opened, the default value is 0. When the waveform bank is created by Wave Bank Server and transmitted to the PCR-L, you can output the bank stored in the PCR-L bank in the range 0 - 13. Clicking the **set** button sets the number in the PCR-L, along with voltage and frequency.

After sequence execution settings:

- **Voltage**

Set the voltage for the PCR-L on test completion in the range 0.0 - 305.0 V. When the set value is 152.5V or greater, click the check box for the 200V Range, confirming that PCR-L output is off. Then set voltage.

- **Frequency**

Set the frequency to be set in the PCR-L on test completion in the range 1.00 - 999.9Hz.

- **Wavebank**

Set an output bank number to be output to the PCR-L on test completion. When the dialog box is opened, the default is 0. When the waveform bank is created by Wave Bank Server and transmitted to the PCR-L, you can output the bank stored in the PCR-L bank in the range 0 - 13.

<Note>

It takes at least 10 ms for the PCR-L to execute **Voltage**, **Frequency**, and **Wavebank** of **After sequence execution settings** following sequence execution. When time management is required for the last sequence, create a sequence step to output **Voltage**, **Frequency**, and **Waveform bank** of **After sequence execution settings**, and add this step to the last step.

Sequence:

The sequence test can be executed for two or more steps of sequence step data.

- **Start step**

Set the step to start the sequence. To test data created by the Wizard, this value is usually set to 1, in the range from 1 to the end step.

- **End step**

Set the step to end the sequence. To test data created by the Wizard, this value has been set to the number of steps set, in the range from the start step to the number of steps set.

- **Loop**

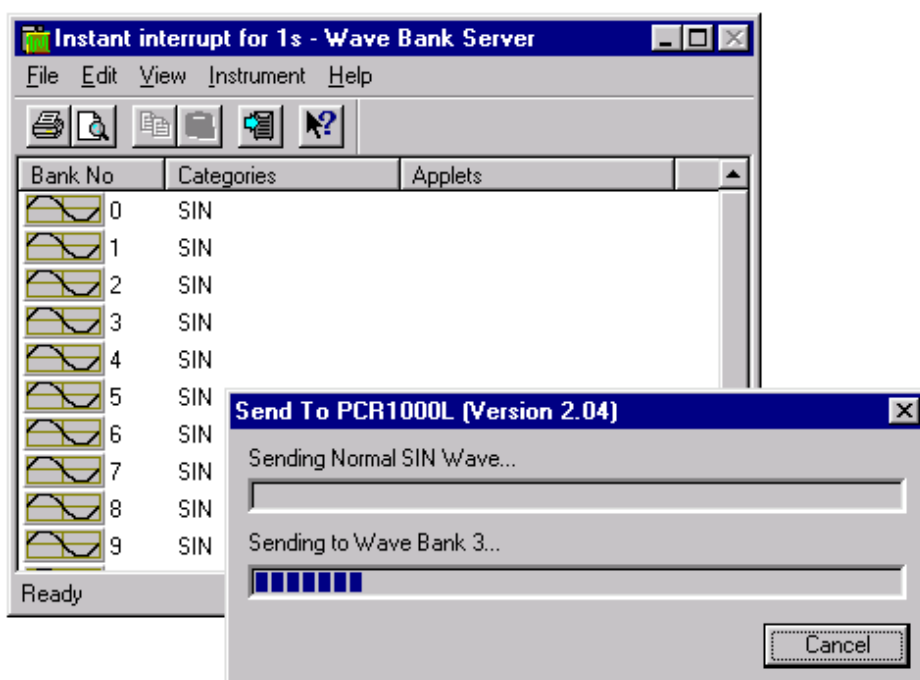
Set the number of repeats from start to end step. To test data created by the Wizard, this value has been set in the range from 1 to 99999 repeats. The value 99999 indicates an infinite number of repeats.

<Note>

In the PCR which SUBCPU version 2.07 installed in, 99999 is not infinite repetitions but 99998 repetitions. The version number of SUBCPU is indicated at the upper right of the indicator (frequency indication section) when turning on the PCR. If you want to update SUBCPU in your PCR, contact your Kikusui agent.

Transmission of waveform bank

Perform waveform transmission to the PCR-L on the Wave Bank Server **Instrument |Send...** menu. Wave Bank Server waveform bank data is required, since the waveform bank is used for sequence step data. Data is sent continuously from Bank 1 to Bank 13. Transmission of the waveform bank data can be cancelled, but if data has not been sent to the PCR-L, testing waveforms will be different from the set data. If waveform data is not transmitted to the PCR-L when the test is conducted from the menu of the Sequence Builder **Instrument |Run...**, waveform bank data is transmitted with sequence steps.



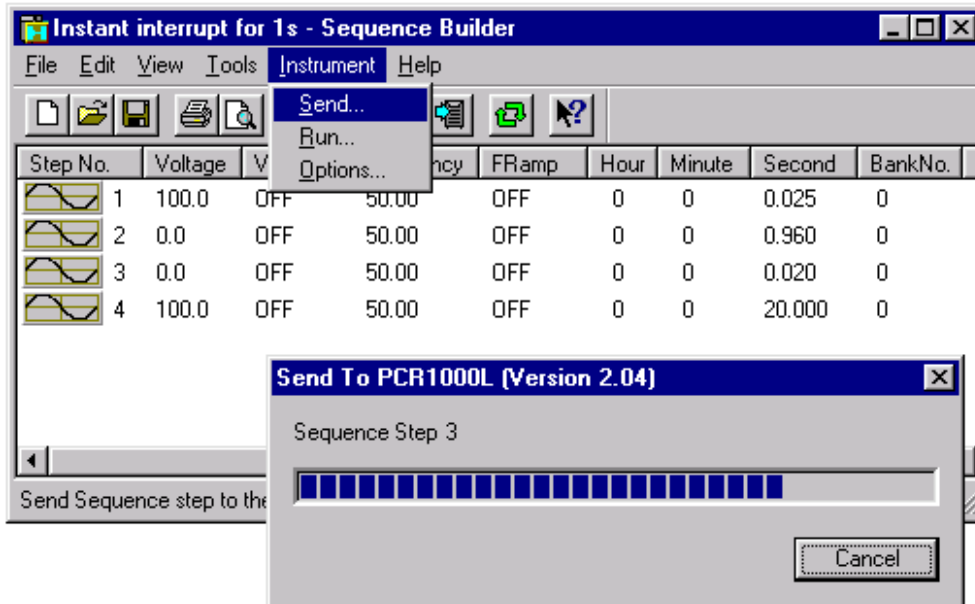
<Note>

The following are times for each bank at which a user-defined waveform is transferred. When the user-defined waveform has been transferred to PCR-L, data transfer of that bank is skipped at waveform transmission. Waveform data is cleared once power to the PCR-L is shut off. (PCR-L's ROM version 2.04.)

Single-phase system: Approximately 45 seconds

Transmission of sequence step

Perform transmission of sequence step data to the PCR-L from the Sequence Builder **Instrument | Send...** menu.



Chapter 6 Sequence Wizard

Within Quick Wave Sequencer, the Sequence Wizard function can be used to automatically create waveform bank and sequence steps for voltage tests (Dip interruption and voltage variation) and abrupt phase shift tests, which are general AC tests. Click the Sequence Builder **Tools | Sequence Wizard...** menu to open Sequence Wizard. Sequence Wizard consists of two subfunctions: Simulation Wizard, which executes voltage testing, and Abrupt Phase Shift Wizard, for single-phase systems.

On the Sequence Wizard screen, enter the file name to which waveform bank and sequence step information developed by the Wizard is saved.

Simulation Wizard

Select "**Abnormality Simulation Wizard**" in Sequence Wizard to start Simulation Wizard. Within one test, Simulation Wizard can create compositions for up to four types of voltage tests (Dip interruption and voltage variation). The simulation test is executed in the order No.1, No.2, No.3, and No.4. Selecting the Simulation Wizard opens the **Step 1 of 2** screen.

Abnormality Simulation Wizard - Step 1 of 2

Voltage [V]: Frequency [Hz]: Intervals [s]:

Simulation Data:

No.	Type	Test Voltage[V]	Test Time[ms]	Repe. ▲
1	Not Used			
2	Not Used			
3	Not Used			
4	Not Used			

Loop [times]:

< Back Next > Cancel Help

Set **Voltage**, **Frequency**, **Interval**, and **Loop** in this screen.

- **Voltage**

Set PCR-L output voltage before and after testing in the range 0.0 - 305.0V.

- **Frequency**

Set PCR-L output frequency before and after testing in the range 1.00 - 999.9Hz.

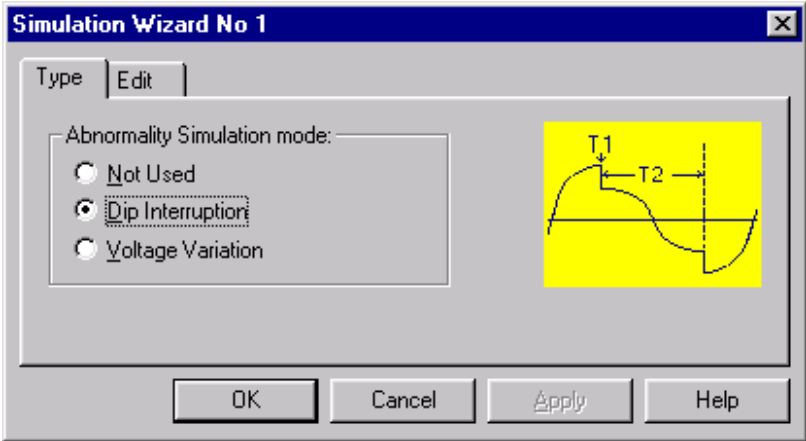
- **Interval**

Set the time interval between tests in the range 1.0 - 999.9s.

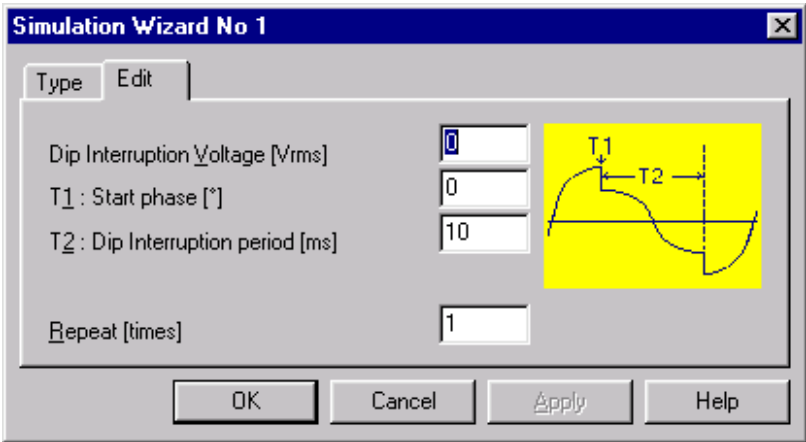
- **Loop**

Set the number of voltage test repeats (Dip interruption and voltage variation) for the whole system in the range 1 - 99999 repeats. The value 99999 sets for an infinite number of repeats.

Set the data. Double-click the specified number (or position the cursor at the Edit button and click) to display the Simulation Data Input screen. Select **Dip interruption** or **Voltage Variation** from abnormality simulation mode and click the Edit tab to enter data. **Not-Used** cancels data for that number.



Setting Dip Interruption Test Data



Select **Dip Interruption** from abnormality simulation mode and click the Edit tab. This sets Dip interruption test conditions.

- **Dip Interruption voltage [Vrms]**

Set the testing voltage for instantaneous interruption in the range 0.0 - 305.0V.

- **Start phase[°]**

Set the phase angle for the point at which instantaneous interruption starts. For example, enter 90 when instantaneous interruption takes place at the peak AC current (operating resolution is 18° (at 50Hz)).

- **Dip interruption period [ms]**

Set the time for which instantaneous interruption continues in the range 1 - 9999ms.

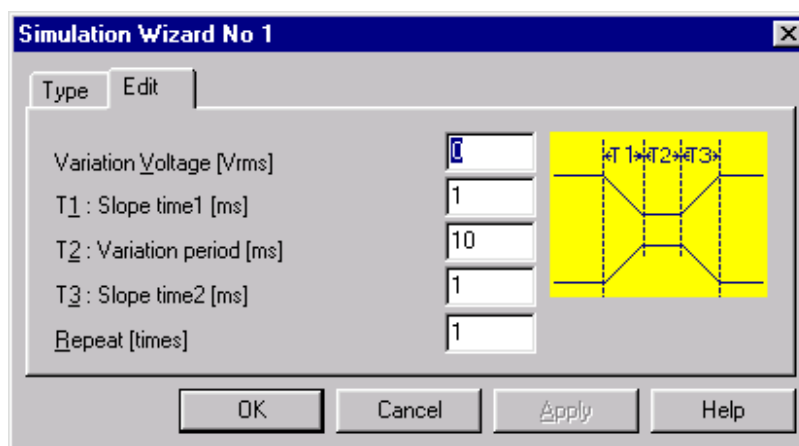
- **Repeat [times]**

Set number of test executions in the range 1 - 5 times.

<Note>

The Dip interruption test consumes up to four sequence steps. When **Repeat** is set to n, up to 4*n steps are consumed.

Setting voltage variation test data



To set test conditions for voltage fluctuations, select Voltage Variation from Abnormality Simulation mode and click the Edit tab.

- **Variation voltage[Vrms]**

Set the fluctuating test voltage in the range 0.0 - 305.0V.

- **Slope time 1[ms]**

Set the duration over which voltage rises or falls to the fluctuating voltage in

the range 1 - 99990ms.

- **Variation period [ms]**

Set the duration for which voltage fluctuates in the range 1 - 9999ms.

- **Slope time 2[ms]**

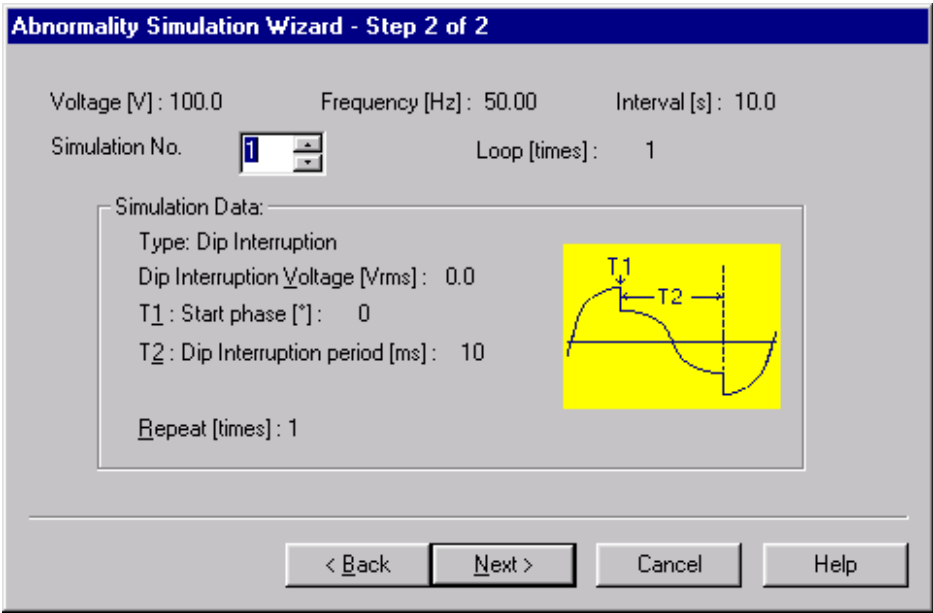
Set the duration over which voltage recovers in the range 1 - 99990ms.

- **Repeat [times]**

Set the number of test executions in the range 1 - 5.

<Note>
The voltage variation test consumes up to five sequence steps. When **Repeat** is set to n, up to 5*n steps are consumed.

Enter all test conditions and click **OK** to return to the **Step 1 of 2** screen. Then click the **Next** button to go to the **Step 2 of 2** screen. Here, you can confirm the test conditions just entered.



After confirming test conditions, click the **Next** button to display the Finish screen. Clicking the **Finish** button closes the Wizard, and waveform bank and sequence step information is developed to Wave Bank Server and Sequence Builder.

Abrupt phase shift wizard for single phase

Select "**Abrupt Phase Shift Wizard for Single Phase**" in the Sequence Wizard to activate the Abrupt Phase Shift Wizard for Single Phase. Abrupt Phase Shift Wizard for Single Phase can abruptly shift the phase and create a discontinuous sine waveform. The abrupt phase shift test is achieved by switching a waveform bank in which the phase-shifted waveform (using the applied waveform of the harmonic composite waveform) is set in advance. Select Abrupt Phase Shift Wizard for Single Phase. The **Step 1 of 1** screen appears.

<Note>

The abrupt phase shift test is imitatively conducted by the sequence function with PCR-L bank switching. The test involves the following actions, which can be considered the internal abrupt phase shift.

1. The output phase at the start of the test begins with the abrupt-shift phase.
2. When the test is finished, the phase switches to phase 0 since the waveform bank switches to waveform bank 0.
3. In a repeat phase test, the same phenomenon seen in 1 occurs.

Setting abrupt phase shift test data

Abrupt Phase Shift Wizard for Single Phase - Step 1 of 1

T1: Before Abrupt phase shift time [s]	1
P1: Abrupt phase shift phase [°]	0
P2: Abrupt phase shift phase [°]	90
T2: After Abrupt phase shift time [s]	1
Voltage [V]	100
Frequency [Hz]	50

< Back Next > Cancel Help

Set abrupt phase shift test data in this screen.

- **Before Abrupt phase shift time[s]**

Set the time before abrupt phase shift occurs in the range 0.001 - 9999s. Operating time is rounded up to an integer multiple of 1 cycle.

- **Abrupt phase shift phase[°]**

Set the waveform phase when abrupt shift occurs in the range 0 - 359° . In the displayed image graph, this is approximately 180° .

- **Abrupt phase shift phase[°]**

Set the waveform phase in which phase shifts abruptly in the range 0 - 359° . In the displayed image graph, this is approximately 0° .

- **After Abrupt phase shift time[s]**

Set the time after which the abrupt phase shift waveform is output in the range 0.001 - 9999s. Operating time is rounded up to an integer multiple of 1 cycle.

- **Voltage (V)**

Set output voltage in the range 0.0 - 305.0V.

- **Frequency (Hz)**

Set output frequency in the range 1.00 - 999.9Hz.

Enter all test conditions and click the **Next** button to go to the Finish screen. Click **Finish** to exit Wizard. Waveform bank and sequence step information is developed to Wave Bank Server and Sequence Builder.

Appendix 1 Error messages

Application error messages

- **You are using earlier version of PCR-L unit. ROM version 2.04 or later is required**

PCR-L ROM version is older than version 2.04. Contact us.

GPIB error messages

- **Unable to open instrument in device DEVx.**
- **Unable to close instrument in device DEVx.**

Access to GPIB failed in the initial stage. (The device name has a specific name, such as DEV1.) A problem has occurred. For example, the GPIB driver is not correctly installed, or the appropriate device name has not been defined in the GPIB driver environment setting.

- **Different model access in device DEVx.**

A wrong instrument has been connected through GPIB. An instrument other than the PCR-L may have been connected.

- **Error writing to instrument from file in device DEVx.**
- **Error reading from instrument to file in device DEVx.**

A communication error occurred while writing or reading data to and from the instrument through GPIB. Check that the GPIB cable is securely connected and that PCR-L power is on.

Confirm that the "I/O Time Out" of the GPIB driver software of National Instruments is set to 10s (initial value).

- **You are using earlier version of PCR-L unit. ROM version 2.04 or later is required**

The ROM version of the PCR-L is older than version 2.04.

Appendix 2 Application Specifications

Operating environment

Personal Computer

IBM PC/AT compatible with the following:

- Processor of i486/66 or better
- Memory of 16MB or greater
- CD-ROM drive
- Hard disk (at least 20MB of free space for installation)
- Microsoft mouse or compatible pointing device
- Display adapter of at least VGA (800x600) and 256-color depth, and color monitor
- Printer compatible with Microsoft Windows

Operating system

Microsoft Windows 95/NT*/2000 Professional/XP Professional and Internet Explorer 4.01 or later

* Microsoft Windows NT Workstation 4.0 which Service pack3 is installed in.

GPIB card for PCs

GPIB board compatible with NI-488.2M made by National Instruments Corp. (AT-GPIB/TNT, PCMCIA-GPIB, or PCI-GPIB)
VISA 2.6 or later

GPIB cable

Cable with a 24-pin connector conforming to ANSI/IEEE std 488.1-1987

Power supply (AC power)

Single-phase system: PCR-L series
(This application requires a PCR-L ROM version of 2.04 or later.)

IB11-PCR-L

PCR-L GPIB interface board

Equipment Under Test

The equipment being tested must operate with the PCR-L series.

Sequence Builder

Edit sequence steps in the following range.

Item	Numeric value/contents	Remarks
No. of sequence steps	Up to 100	
Voltage range setting	0.0V~305.0V	
Voltage ramp setting	Enabled	
Frequency setting range	1.00Hz~999.9Hz	
Frequency ramp setting	Enabled	
Sequence setting time	0.000s~999h59m59.999s	Whole sequence duration must be 0.001s or greater.
Waveform specification bank	0~13	For Bank 0, sine wave is fixed.
Output control	ON/OFF	
Sequence trigger setting	Enabled	
Waveform synchronizing function	Enabled	
Functions for data storage and reading	Yes	WSL: Sequence Builder file WBL: Wave Bank Server file The above two files are saved and read simultaneously.

*1.. Setting resolution and setting accuracy are shown in the following.

	Setting resolution	Setting accuracy
0 hour to 999 hours 59 minutes	1 min	$\pm (1 \times 10^{-3} + 0.5 \text{ min})$
0 minute to 59 minutes 59 seconds	1 sec	$\pm (1 \times 10^{-3} + 0.5 \text{ sec})$
0 second to 59.999 seconds	1 ms	$\pm (1 \times 10^{-3} + 0.5 \text{ ms})$

Wave Bank Server

Item	Numerical value/contents	Remarks
No. of waveform banks	14(0~13)	0: Sine wave is fixed
Selectable categories	Sine waveform Peak-clipped waveform Harmonic composite waveform User-defined waveform	
Aplet in user-defined waveform	Triangle waveform Square waveform Waveform obtained from oscilloscope	Data storage function is provided.
Compatible oscilloscopes	COM3101, 3051 COM7203/02A COR5502/01/61/41/21 9350A/9354A TDS310/320/350	Kikusui COM3000 series Kikusui COM7000 series Kikusui COR5500 series Lecroy 9350A series Tektronics TDS series

