

**SONY**  
**Tektronix**

**User Manual**

**WaveWriter**

(AWE) Arbitrary Waveform Editor



# User Manual



## WaveWriter (AWE) Arbitrary Waveform Editor

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# Preface

The purpose of this manual is to explain the Sony/Tektronix software package *WaveWriter* (AWE). Using *WaveWriter*, engineers may create, edit and display various waveforms with ease and accuracy. They may also retrieve and store data to and from external devices, allowing the exchange of waveforms among different platforms.

*WaveWriter* is a Microsoft Windows based application, and as such, provides a friendly user interface. The Sony/Tektronix and Tektronix instruments currently supported by *WaveWriter* are described on page 1-3.

---

## About this Manual

This manual contains the following sections and appendices:

- *Section 1, Getting Started* — Provides general information about system requirements.
- *Section 2, Operating Basics* — Describes the installation procedures and user interface and includes a tutorial.
- *Section 3, Reference* — Provides menu-specific details in the following sub-sections: *File Operations, Creating Waveforms, Processing Waveforms, Transferring Waveforms, Modifying and Listing Waveforms.*
- *Section 4, Appendices* — Provides waveform formats and instrument-specific information, including error messages.
- *Glossary* — Provides a list of terms, with explanations, that are specific to *WaveWriter*.
- *Index*

# Preface

The authors of this book are pleased to announce the publication of this second edition. The book is intended for use as a text in a course in the theory of computation. It is also suitable for self-study by those who are interested in the subject. The book is written in a clear and concise style, and it contains many examples and exercises. The authors hope that this book will be useful to many students and teachers.

The book is divided into two parts. The first part, Chapters 1 through 5, deals with the theory of computation. The second part, Chapters 6 through 8, deals with the theory of automata. The book is written in a clear and concise style, and it contains many examples and exercises. The authors hope that this book will be useful to many students and teachers.





# Getting Started

Getting started

# Overview

WaveWriter is an application program used to create waveforms for advanced signal generating and processing instruments. Many Tektronix instruments, such as arbitrary waveform generators and oscilloscopes with the "save-on-delta" feature, are enhanced by this program. WaveWriter helps users configure waveforms with a minimum of effort.

---

## What This Program Does

With the WaveWriter package, you can create new waveforms or edit waveforms acquired from various instrument sources. WaveWriter gives you interactive control of the waveform generating process.

WaveWriter operates within the Microsoft *Windows*<sup>TM</sup> environment. Its functions are divided among the following menus:

- File
  - Start a new waveform
  - Open and save waveforms
  - Print a hardcopy of the current display
  - Exit WaveWriter
- Edit
  - Modify an existing waveform
  - Flip waveforms horizontally and vertically
  - Change horizontal and vertical resolution
- Display
  - Set waveform and screen display characteristics
- Draw
  - Modify an existing waveform or envelope
- Create
  - Generate a waveform from an equation
  - Generate a sine, triangle, square, and pulse
  - Create an envelope
- SigProc (Signal Processing)
  - Add, subtract, multiply, divide waveforms
  - Perform scalar operations on waveforms

- Transfer
  - Setup and configure communication parameters
  - Move data from instruments to WaveWriter
  - Move data from WaveWriter to instruments
- Waveforms
  - Change amplitude, offset, and clock rate
  - Associate waveform with different instruments
  - Set additional waveform information
  - Display waveform information
  - Clear or rename waveforms
  - Select new current waveform
- Help
  - WaveWriter provides help screens to aid in using the program.

---

## What You Get With This Program

You should receive the following items with this product:

- One 3½ inch diskette
- The WaveWriter User manual
- A registration card that entitles you to future updates. Be sure to send it in.

---

## What You Need to Run This Software

WaveWriter runs in a Microsoft *Windows* environment. Microsoft *Windows*, Version 3.1 or later, must be installed on your system before running WaveWriter. See the Microsoft *Windows* User's Guide for installation instructions.

### The Computer

The recommended **Minimum** configuration for your system is:

- 386 Class personal computer
- 4 MB memory (However, refer to the table in page 1-3, for further memory size information)
- 40 MB hard disk

- A graphics monitor interface, preferably an EGA or VGA adapter. A CGA adapter will run in high resolution mode but it displays in monochrome. A monochrome graphics adapter (Hercules or compatible) will run with *Windows*, but a color adapter is recommended for the sake of clearly separating screen information.
- For use with GPIB instruments, you will need a National Instruments GPIB interface card and interface library.
- When using NI-VXI, NI-MXI or GPIB-VXI, you will need the VISA Library.
- Microsoft *Windows*, Version 3.1

The amount of memory recommended for the minimum configuration is insufficient for waveforms longer than 64K points. You should match your system's memory with the length of the waveforms that you intend to manipulate according the table below.

Number of Points	Minimum Memory	Recommended Memory
64K	4MB	8MB
1M	8MB	12MB
2M	12MB	24MB
4M	24MB	32MB

### Optional Equipment

Adding a math coprocessor to your PC will enhance the performance of WaveWriter. Although WaveWriter (and *Windows*) may be run from the keyboard, a mouse is highly recommended.

### Supported Instruments

Currently, the following Tektronix instruments are supported by WaveWriter, Version 4.0:

- AFG 2020 Arbitrary Function Generator
- AFG 300 Series Arbitrary Function Generator
- AFG 5102 Arbitrary Function Generator
- AWG 2005/2020/2021/2040/2041 Arbitrary Waveform Generator
- AWG 5101 Arbitrary Waveform Generator
- AWG 5102 Arbitrary Waveform Generator
- AWG 5105 Arbitrary Waveform Generator
- TDS Series Oscilloscopes (see *Appendix J* for instruments supported)
- 2230 Series Oscilloscopes (see *Appendix M* for instruments supported)

- 2400 Series Oscilloscopes
- 11000 Series Oscilloscopes
- TVS 600 Series VXI Waveform Analyzer
- VX4790A VXI Arbitrary Waveform Generator
- VX4792 VXI Arbitrary Waveform Generator



# Operating Basics

Operating Basis



# Installation

This section explains how to install WaveWriter on your personal computer and configure its internal option cards to allow GPIB communications.

---

## Software Installation

WaveWriter is supplied on a 3½ inch diskette (1.44 Mbyte).

### Making a Backup Copy

Magnetic diskettes are subject to physical damage and the data contained on them is easily destroyed by inadvertent stray magnetic fields. A backup copy is inexpensive insurance against loss of data.

Before proceeding, make a copy of each of the diskettes in the WaveWriter package. Use the copies for installing programs and files and store the original diskettes in a safe place.

Consult your DOS manual for instructions for using the **diskcopy** command.

### Installing Files on a Hard Disk

Insert the *WaveWriter* diskette into drive A:.

#### NOTE

*In these instructions, we are assuming that diskette drive A: is your input device. If you are using a drive with a different designation, substitute the correct drive letter in each of the examples.*

If you are already running windows, you can select the **Run** item from the 'File' menu of the program manager, enter the file name 'a:\install' and click on the **OK** button.

Alternatively, and more simply, you can open the File Manager window by double clicking on the File Manager icon. Then in that window, select the disk drive **a:** and execute the installation program by double clicking on the name **install.exe**.

You will be prompted for any additional data changes required by the installation program.

**Aborting the Installation** — If, at any time, you need to terminate the installation procedure, press **ESCAPE**.

The diskette includes a file called README.TXT. Read that file now; it contains various information including some instructions that may need to be done in addition to the automatic installation procedure.

---

## Configuring GPIB

To avoid conflicts between PC option cards when installing a GPIB card, you need to ensure that the Direct Memory Access (DMA) and interrupt channels are unique for each device within your PC. Consult the GPIB interface card user's guide for correct hardware installation and setup. For example, if another interface card uses DMA channel 1, you need to set your GPIB card to a different DMA channel. Seldom, if ever, can two or more devices share the same DMA channel. If you continue to have difficulty communicating with instruments even though neither the DMA nor interrupt channels are conflicting, try turning off both. In your GPIB.INI file, set *irq = none* and *DMA = none*.

### NOTE

*To use WaveWriter with GPIB instruments, a National Instruments GPIB interface card must be installed.*

*For use with VXI instruments you must have NI-VXI, NI-MXI or VXI-GPIB hardware.*

# Using WaveWriter

This section discusses basic WaveWriter concepts and provides instruction on how to use the product.

---

## Using Windows

Microsoft *Windows* is a control program that provides a common interface between the Disk Operating System (DOS), resident application programs, and the user. If you are not an experienced *Windows* user, become familiar with the interface before accessing WaveWriter.

---

## WaveWriter Concepts

WaveWriter creates a unique environment for each waveform it displays. Each waveform is identified with a target instrument having a specified clock rate, amplitude, offset, and markers position setting.

### The Waveform Environment

The selected waveform is always the current waveform; all portions of the display refer to this waveform. Additional waveforms (if any) are called background waveforms. Background waveforms may be displayed within the current waveform environment, subject to the current display parameters. To avoid reflected clock rate differences when displaying background waveforms, the X-axis is displayed as if the waveforms were in point mode.

If the current waveform is altered with the Waveforms menu, the display changes to reflect the new environment.

### The Target Instrument

Fundamental to WaveWriter is the concept of the "target" instrument. The target instrument is the instrument for which you are creating waveforms. The instrument defines specific parameters and limits, such as the clock rate and vertical display ranges. When acquiring a waveform from an instrument other than the target instrument, or recalling one from a file, you are automatically informed of any parameter discrepancies. You can then alter the waveform to conform to the target instrument limits.

Each time you create a new waveform, you must identify a target instrument. This process ensures that all waveforms are compatible with the target instrument.

## Clock Rate

Each waveform has a unique clock rate and there are two methods for altering the clock rate. First, to reassign the time/point for the waveform without waveform expansion or compression, use the Change Clock Rate selection in the Waveforms menu. Second, to alter the clock rate while maintaining the timing relationship, use the Horizontal Resolution selection in the Edit menu.

When a waveform is acquired from an instrument or read in from a file, select either the current clock rate, the clock rate of the waveform, or massage the data from the acquired rate to the current rate.

## Offset

Some instruments represent offset as a value external to the data. WaveWriter represents offset in only one way, as part of the data. If data is acquired from an instrument that represents offset separately, WaveWriter appends the data for closest approximation to the instrument.

## Display Amplitude and Bit range

The horizontal axis represents time displayed in either points or seconds. Its maximum peak-to-peak display amplitude should not exceed the maximum peak-to-peak amplitude of the target instrument. (Although the waveform amplitude may exceed this limit.) If the data is clipped on the display, it will be clipped when sent to a target instrument or saved to an instrument-specific file.

The vertical axis amplitude represents the full bit range of the target instrument. That is, if the vertical axis range is set from +5 to -5 Volts and the target instrument has 12-bit resolution, 5 Volts would represent level 2047 and -5 Volts would represent -2047.

## Delimiting Waveforms

Markers delimit segments of the waveform. For many menu selections, you have the option of using the entire waveform or a portion that is between and includes the markers. The distance between the markers may never exceed the maximum record length for the target instrument. If the *Start* or *Stop* marker is dragged past this length, the other marker moves with it. (See *Markers* later in this section for more information.)

## Adjusting Amplitude

To position the waveform for the desired amplitude at the instrument, use Autoscale Current Waveform and Set Axis Range. Note that the greater the display amplitude (the more the waveform fills the display), the finer the resolution at the instrument.

In the case of digital oscilloscopes, the waveform sent to the instrument is identical to that displayed, up to its volts-per-division setting.

## The WaveWriter Window

The WaveWriter environment is accessed through menus operated by the *Windows* interface. The WaveWriter window is discussed here, WaveWriter menus are discussed and demonstrated in the *Tutorial* and *Reference* sections to follow.

### Waveform Display Area

The area of the screen displaying acquired, created, or modified waveforms is the Waveform Display Area (Figure 2-1). When a waveform is created or acquired, the displayable range is 0 to 1 Mbyte points, even if a longer length is valid for an instrument. The waveform display area scrolls through-out its range.

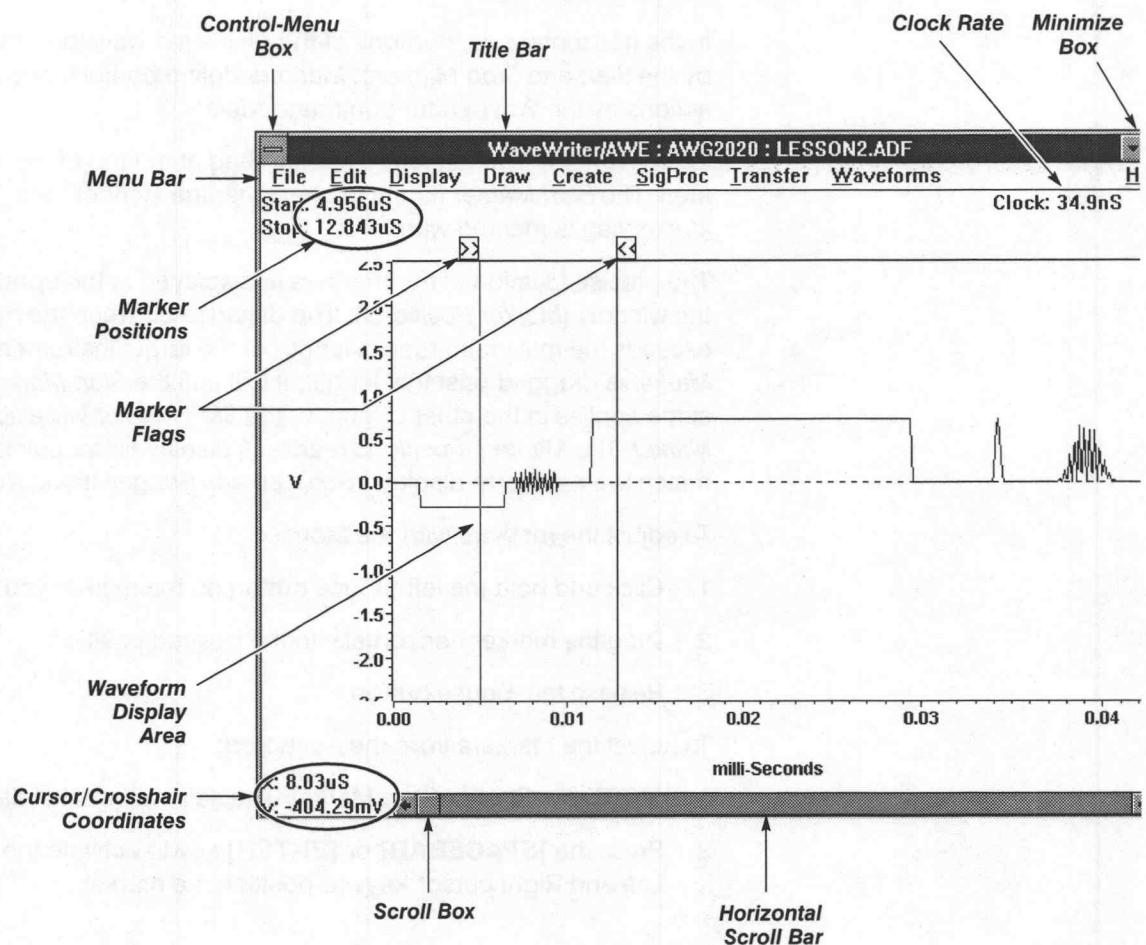


Figure 2-1: WaveWriter Window Elements

### Title Bar

The Title Bar lists three items separated by colons: the name WaveWriter, the target instrument, the name of the current waveform.

## Menu Bar

The Menu Bar is located just below the Title Bar. It displays the available menus. To select a menu, either point and click the mouse or press and hold **[ALT]**, press and release the underlined letter.

## Clock Rate

The readout in the upper right corner of the window displays the clock rates of the waveforms in the *Waveform List*. All waveforms in memory have the same clock rate. Clock rates are used in frequency and equation calculations and are set for each target instrument as described in the *Appendices*.

## Marker Positions

In the horizontal axis, portions of the displayed waveform may be bounded by the *Start* and *Stop Markers*. Markers define portions of waveforms for actions by the WaveWriter command tools.

Each marker has an attached Marker Flag at the top of the waveform display area. The *Start Marker* flag is marked with the symbol “> >” and the *Stop Marker* flag is marked with “< <”.

The precise location of the markers is displayed in the upper left corner of the window (*Marker Positions*). The distance between the markers never exceeds the maximum record length of the target instrument. If the *Stop Marker* is dragged past this length, it will pull the *Start Marker* with it. The same applies in the other direction; the *Start Marker* will also pull the *Stop Marker*. The *Markers Positions* readouts display either points or seconds, to match the waveform display. (See Set Axis Ranges in the Display menu.)

To adjust the markers with the Mouse:

1. Click and hold the left mouse button on the marker you wish to move.
2. Drag the marker horizontally to the desired position.
3. Release the mouse button.

To adjust the markers from the Keyboard:

1. **[TAB]** to a Start or Stop Marker. The selected marker flashes once.
2. Press the **[SPACEBAR]** or **[ENTER]** key to activate the marker. Use the Left and Right cursor keys to position the marker.

3. Press the [SPACEBAR] or [ENTER] key to set the marker.

You can also set markers to absolute coordinates with the **Display → Set Markers** menu.

### Cursor and Crosshair Coordinates

The precise location of the pointer or crossbar cursors (whichever is selected) is displayed in the lower-left corner of the window. The X readout displays either points or seconds to match the waveform display. The Y readout always displays Volts. If you move the mouse within the Waveform Display Area, the Coordinates update.

### Help

The menu item at the far right of the *Menu Bar* is the Help command. When you select **Help** (with no dialog box on the screen), the index page of the help information is displayed using Windows Help utility. The usage of the utility is not described in this manual. Refer to the Windows User Manual.

---

## Setting Characteristics

You define waveform characteristics by entering or modifying parameters within the dialog boxes associated with some menus.

### Units of Measure

Wherever appropriate, units of measure are appended to an edit box at its right side. Modifiers to those units are included as part of the data within the edit box. For example, a value of 230 milliseconds is displayed as:

230m S

The modifiers recognized by WaveWriter are the following *Systeme Internationale* (SI) characters. Case is significant.

E = exa	u = micro
P = pecta	n = nano
T = tera	p = pico
G = giga	f = femto
M = mega	a = atto
k = kilo	
m = milli	

Noninteger numeric values are expressed in *scientific* or *exponential notation*. Scientific notation uses a *mantissa* (a decimal number) followed by an *exponent*. The form for this type of number is:

$$-n.nnE-n$$

The signs can be omitted for positive values.

The earlier 230 millisecond example could also be entered as any of the following:

0.23 S

0.23E0 S

2.3E-1 S

230,000u S

### Choice of Units

Some parameters may be expressed in different units of measure. For example, horizontal units may either be seconds or points; phase angle may be degrees or radians. (Vertical units are always Volts.)

Use the option buttons to set units of measure. When you choose a different unit of measure, the current edit box value converts to the new units.



# Tutorial

This section covers the essentials of using WaveWriter, including the user interface commands, controls, and displays. The tutorial is divided into four lessons:

- System Fundamentals
- Creating and Modifying Waveforms
- Working with an AWG 2020 Arbitrary Waveform Generator
- Working with a TDS 500 Series Digitizing Oscilloscope and Envelope Waveforms

You may complete each lesson independently of the others. However, we recommend completing lesson one first, then the lesson involving the instrument you will be using. Each lesson uses waveforms and files included with WaveWriter and loaded when you installed the software. The last two lessons require the instrument “specified” to be available for some portion of the lesson.

In each lesson you are asked to clear waveforms from memory before proceeding. If there are waveforms existing in memory from a previous session, you will be prompted. If you wish to save prior data select **Yes**. Otherwise, select **No**.

In some lessons the files you create are saved. If you wish to perform the same tutorial a second time and are about to create a file that already exists, you will be warned. If you wish to overwrite the existing file select **Yes**.

When the software returns a phrase like “Enter 1.24u in the *Start* edit box,” place the cursor in the *Start* edit box and type in the characters “1.24u”. Do not press the **[ENTER]** key following your entry. For dialog boxes, the **[ENTER]** key is usually the equivalent of selecting **OK**.

The most effective way to use WaveWriter is with a mouse. If you are not using a mouse, refer to your Microsoft *Windows* manuals for information on how the interface works without a mouse.

## NOTE

*The user must be familiar with Microsoft Windows to perform the following tutorials. If not, please refer to the appropriate Microsoft Windows manual or their tutorial on learning Windows.*

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## Lesson 1 System Fundamentals

This lesson will familiarize you with the following WaveWriter concepts:

- Help screens
- Clearing waveforms
- The target instrument
- Clock rate
- Horizontal and vertical axis scaling
- Autoscaling
- Zooming
- Offset
- Moving markers
- Cursor coordinates.

### Step 1: Starting WaveWriter

If you have not installed WaveWriter please do so before continuing. See page 2-1, *Installation*.

To begin you should be in the *Windows* environment and have located the WaveWriter icon **WaveWriter 4.0** in the program group named **AWE 4.0**. From this point on, the terms WaveWriter and AWE are used interchangeably.

1. Open the **AWE 4.0** program group by double-clicking it.
2. Start WaveWriter by double-clicking the **WaveWriter 4.0** icon.

After WaveWriter loads, take a moment to become familiar with the WaveWriter window. The WaveWriter Window is discussed in detail on Page 2-5. Note that the WaveWriter title bar includes the name WaveWriter/AWE and the default target instrument name.

#### **NOTE**

*If you are using a monochrome monitor, consider setting the **Display** → **Set Colors and Line Styles** menu to black and white only. Either set the Current Waveform, Background Waveform, and Labels & Units color to black and the Background and Graph Background to white or vice versa. Failure to make this adjustment may result in default colors that are not visible.*

## Step 2: Using the Help Function

Help information is available whenever you use WaveWriter.

- The Help selection in the Menu Bar displays a list of all available topics.
- Each WaveWriter dialog box has a Help command button. If you select this button, you get information pertinent to the current dialog box.

To use Help in the Menu Bar:

1. Select **Help** in the menu bar (click and release).

The Help Topics dialog box is displayed listing all available Help topics.

2. Double-click on any topic.

An overview Help screen appears. This screen discusses WaveWriter-specific issues.

3. To close the Help window, double-click on the **Control-menu** box at the upper left corner of the window. You return to the Help Topics dialog box.
4. To exit the Help function, select **Cancel**.

## Step 3: Clear All Waveforms from WaveWriter Memory

To avoid confusing current waveforms with waveforms from previous sessions, clear all waveforms from memory before proceeding. If there are waveforms existing in memory from a previous session, you will be prompted. If you wish to save prior data select **Yes**. Otherwise, select **No**.

Perform the following steps to clear the memory:

1. From the **Waveforms** menu select **Clear Waveform(s)**.

The Clear Waveform(s) dialog box appears.

2. Select the **All Waveforms** button.

### NOTE

*Clear Waveform(s) is grayed and unavailable if there are no waveforms in memory. If there are altered waveforms in memory not previously saved, you are given the option to save them before deleting them.*

## Step 4: Configuring a Target Instrument

The selected target instrument defines instrument specific parameters and limits such as clock rate, start and stop marker limits, and vertical resolution and display range. The target instrument is the only instrument you can send waveform data to until you select a different target instrument.

Each waveform is associated with its own target instrument. You will be asked which instrument to use each time you open or create a new waveform.

Lesson 1 begins by configuring a new instrument to be used in Lesson 3 of this tutorial. Even if the designated instrument is not available, WaveWriter can be configured for demonstration purposes.

Perform the following steps to configure the target instrument:

1. From the WaveWriter **Transfer** menu select **Configure Instruments**.

Figure 2-2 shows the Configure Instrument dialog box.

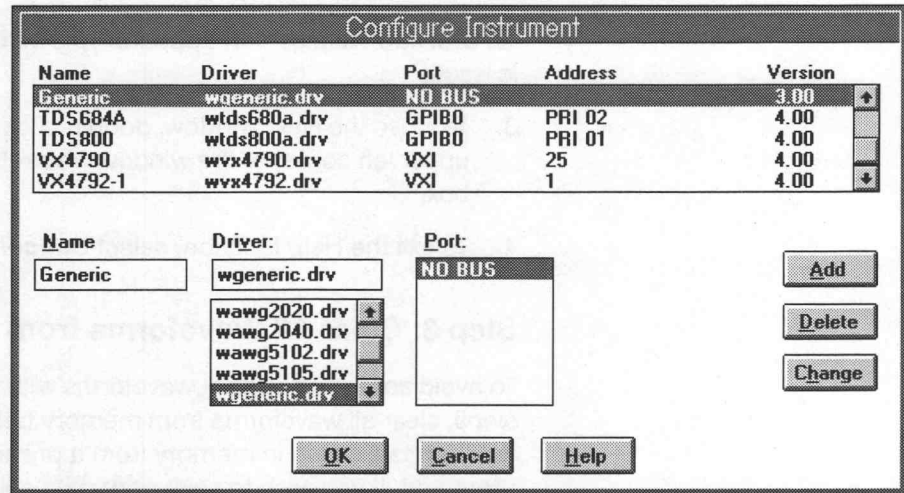


Figure 2-2: Configure Instrument Dialog Box

Use the Configure Instrument dialog box to add, change, or delete instruments with which waveforms are associated.

2. In the bottom list box under *Name* type in "AWG2020".
3. In the bottom list box under *Driver*, scroll and select the driver "wawg2020.drv".
4. Under *Port* in the bottom list box, scroll and select the Port as applicable to your local PC GPIB configuration. This example uses "GPIB0". Instrument addresses may be entered directly to the *Address* group in the *Primary* and *Secondary* edit boxes. See Pages 2-2 and 3-84 for Port and Address configuration instructions. Enter "1" in the *Primary Address* box for this example.
5. Select the **Add** button to append the new instrument to the list.
6. Select **OK** to accept the changes and close the dialog box.
7. From the **Waveforms** menu select **Associate Waveform**.

8. From the Associate Waveform with Instrument dialog box, select the instrument you just added (AWG2020) from the *Instrument List* and click **OK**.

Note the instrument name is now in the title bar because you changed the default target instrument to the AWG2020. If the clock rate or display amplitude is out of range for the new instrument, WaveWriter issues an error message and provides instructions on how to correct the incompatibilities.

### Step 5: Setting the Clock Rate

Each waveform in memory has its own environment, including the clock rate. Changing the clock rate affects only the frequency of the current waveform and has no effect on other waveforms. The waveform shape or size (number of points) is not affected, only the time per point.

Perform the following steps to set the clock rate:

1. From the **Waveforms** menu select **Change Clock Rate**.

Figure 2-3 shows the AWG2020 Clock Rate dialog box. Note that you can enter the clock rate in either Time per Point or Frequency.

2. Enter "2u" in the *Time per Point* edit box.

#### NOTE

*The Time per Point entry nomenclature might be 2E-6, 2u, or 0.000002; frequency nomenclature might be 500K, 500000, or 5E5.*

3. To see the equivalent *Frequency* entry, press the **[TAB]** key.

The Frequency edit box is updated to 500k as shown in Figure 2-3.

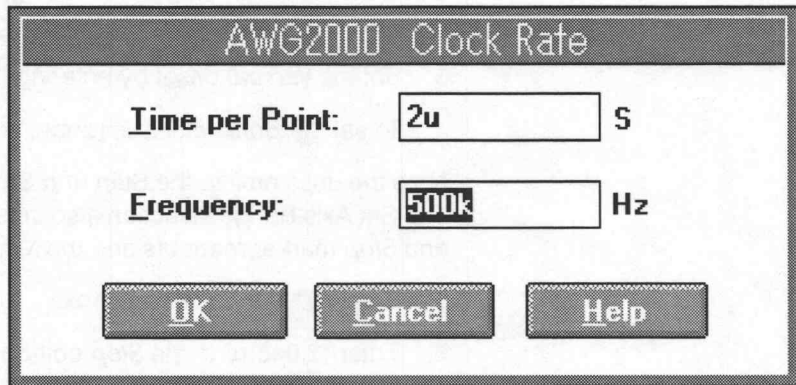


Figure 2-3: AWG 2000 Clock Rate Dialog Box

4. Select **OK** to confirm the clock rate selection.

The Clock readout (just below Help in the Menu Bar) indicates the new clock rate. The horizontal axis units also update to reflect any changes.

### NOTE

*The appearance of the AWG 2000 Clock Rate dialog is the same for all instruments in the AWG 2000 series. Do not be confused by this; provided you carried out Step 4 in this tutorial correctly, WaveWriter knows that your waveform is associated with an AWG2020. If you think that you have made a mistake, check that the driver 'wawg2020.drv' is displayed against the name 'AWG2020' in the Configure Instrument dialog box, and correct as necessary. Also, check that the name 'AWG2020' is displayed in the title bar of the WaveWriter main window, and use the **Waveforms**→**Associate Waveform** selection to associate the waveform with the instrument named 'AWG2020' if necessary.*

## Step 6: Setting the Axis Ranges

The Set Axis Ranges menu adjusts the vertical and horizontal display scales controlling which portion of the overall waveform is displayed. If a portion of the waveform extends outside the axis range, it is clipped. Clipped waveforms can be restored by setting a wider range with the Set Axis Ranges dialog box.

Perform the following steps to change the axis ranges:

1. From the **Display** menu select **Set Axis Ranges**.

Figure 2-4 shows the Set Axis Ranges dialog box.

2. Set the *Vertical* range by entering "2.5" in the *Amplitude: (Pk-Pk)* edit box. The vertical axis range setting is +1.25 to -1.25 volts.
3. Set the *Vertical* offset by entering "0" in the *Offset* edit box.
4. To set the *Horizontal* axis range, select the *Seconds* radio button.

Note the units next to the Start and Stop edit boxes reflects the entry (Sec). The Set Axis Range selection also sets the horizontal axis units for the *Start* and *Stop* marker readouts and the X-coordinate readout.

5. Enter "0" in the *Start* edit box.
6. Enter "2.046m" in the *Stop* edit box.

Figure 2-4 show the new dialog box.

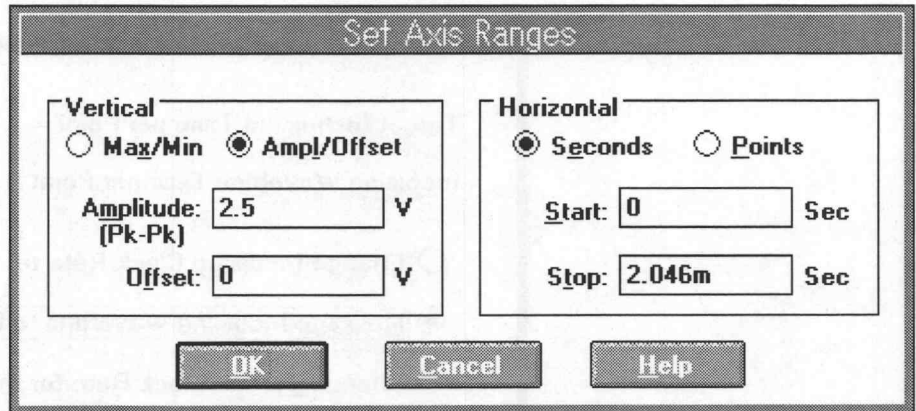


Figure 2-4: Set Axis Ranges Dialog Box

7. Select **OK**.

The Waveform Display Area now reflects the new Axis selection. The horizontal axis, Start and Stop markers, and X-coordinate are displayed in seconds.

### Step 7: Load a Waveform and Manipulate the Clock Rate

Not all loaded or acquired waveforms have the appropriate clock rate. WaveWriter can manipulate waveforms to conform to the required clock rate. The following procedure illustrates this capability.

Perform the following steps to read a waveform from disk, associate the waveform, and set the clock rate by several methods:

1. From the **File** menu select **Open**.
2. In the *Directories* list box double-click **awe4\sample**. From the left list box under *File Name*, scroll and select "ultrason.adf".
3. Select **OK**.

The dialog box Associate Waveform with Instrument appears. Notice the default instrument is the AWG 2020 that was designated earlier.

4. Select **OK** to associate ultrason.adf with the AWG 2020.

A dialog box appears (Figure 2-5) warning you that the clock rate of the waveform does not match that of the target instrument.

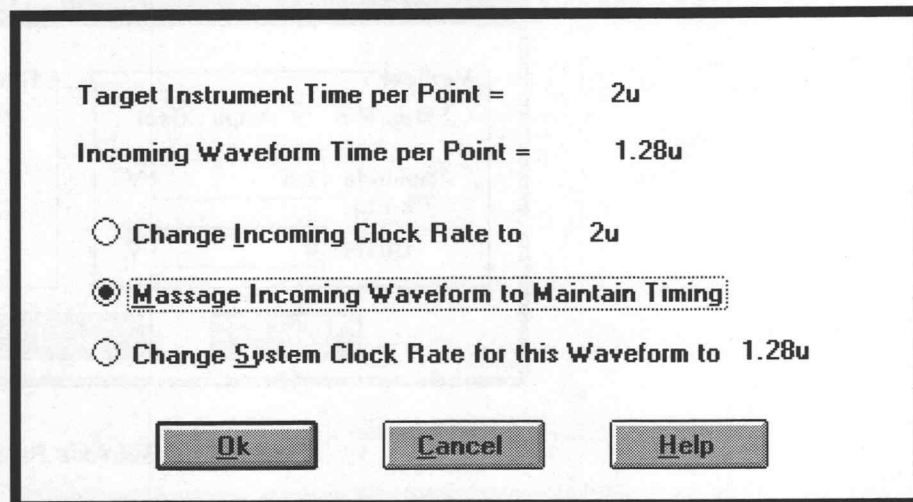


Figure 2-5: Different Clock Rate Dialog Box

You are offered three choices to resolve the inconsistency:

- The first choice changes the clock rate of the waveform to match the clock rate identified in WaveWriter.
  - The second choice either lengthens or shortens the waveform to maintain the timing relationship; one second in the incoming waveform equals one second at the current clock rate.
  - The third choice changes the WaveWriter clock rate to the rate of the incoming waveform (without changing the clock rate of other waveforms in memory).
5. Select the *Message Incoming Waveform to Maintain Timing* radio button.
  6. Select **OK** to confirm the selection.
  7. From the *Message Incoming Waveform Parameters* dialog box select *Nearest Related Point*, then select **OK**.

The waveform ULTRASON.ADF becomes the current waveform as noted in the title bar.

Next, load the file again, but this time choose the second option to maintain timing so you can compare results.

8. From the **File** menu select **Save**. The Save As dialog appears.
9. In the File Name edit box, change the name to "ultra2.adf".
10. Select **OK** to save the current waveform (ultra2.adf).



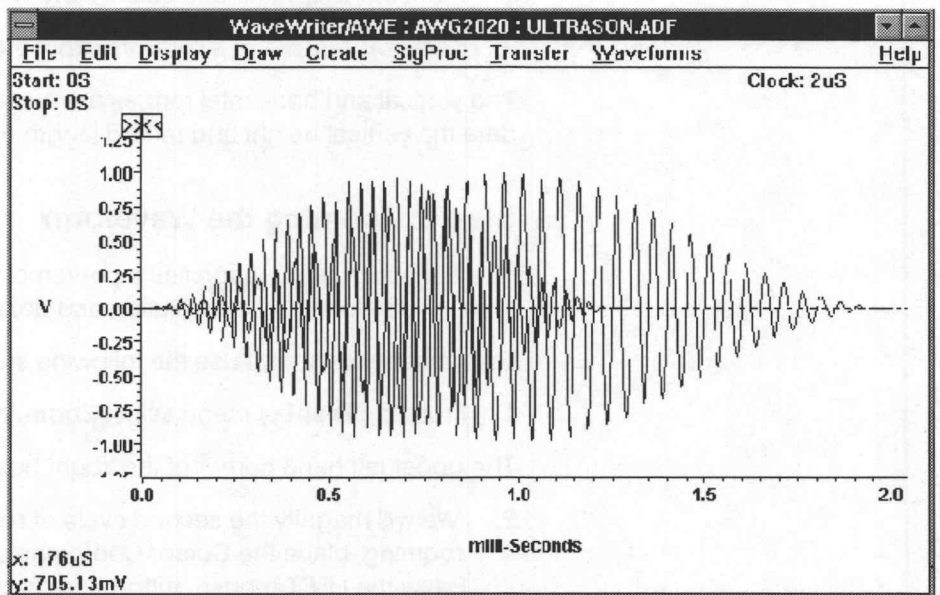
11. From the **File** menu select **Open**. Scroll the left list box and select `ultra2.adf` Click **OK** to confirm your selection.

The Associate Waveform with Instrument dialog box appears. Select the `AWG2020` and *Use Current default Amp/Offset* as before.

12. Select **OK**.
13. From the **Edit** menu select **Horizontal Resolution**.
14. The Horizontal Resolution dialog box appears.
15. Enter "2ms" in the *New Interval* edit box.
16. Select **OK**.

The waveform is then altered to conform to the new clock rate. Notice the differences in the two waveforms. The new waveform becomes the current waveform as noted by the change in the title bar and the change of waveform colors.

The waveform appears as shown in Figure 2-6.



**Figure 2-6: Waveform Display Area**

17. From the **File** menu select **Save**. Change the filename from `ultra2.adf` to "`ultrason.adf`".
18. Select **OK**.
19. In the Warning box, select **YES** to overwrite the existing file with the new waveform.

Load two more waveforms from disk using the following steps:

20. From the **File** menu select **Open**.

- From the *File Name* list box scroll and select the "sample.adf" file then select **OK**. Associate it with the AWG 2020 (click AWG2020) on the Associate Waveform with Instrument menu to follow. Select **OK**.

This time, since the clock rate conforms to the default clock rate, the waveform loads automatically and becomes the current waveform.

- From the **File** menu select **Open**.

Select the "decay.adf" file and associate it with the AWG 2020.

Again, the waveform loads successfully and becomes the current waveform.

### Step 8: Autoscaling the Current Waveform

Loading the last two waveforms exceeded the vertical axis scale established previously in Set Axis Ranges. Use the Autoscale Current Waveform function to automatically alter the vertical and horizontal scales for optimum display of the current waveform.

Perform the following steps to autoscale these waveforms:

- From the **Display** menu select **Autoscale Current Waveform**.
- Select **At Middle of Waveform** from the sub-menu.

The vertical and horizontal ranges are automatically rescaled to accommodate the vertical height and record length of the current waveform.

### Step 9: Zooming the Waveform

The Zoom In feature magnifies a portion of the Waveform Display Area. Use this function to improve resolution and detail for drawing.

To zoom the waveform use the following steps:

- From the **Display** menu select **Zoom In**.

The upper left hand corner of the zoom box becomes the cursor.

- We will magnify the second cycle of decay.adf. To identify the region for zooming, place the Cursor Coordinates readout at x: 378  $\mu$ s, y: 3.53 V. Press the LEFT mouse button and drag the lower right hand corner to approximately x: 766  $\mu$ s, y: 300 mV. Release the mouse button.

The region within the box is now magnified.

- To return to the original display, select **Zoom Out** from the **Display** menu.

### Step 10: Changing the Current Waveform

Most WaveWriter functions operate on the current waveform. When you load a new waveform from disk it automatically become the current waveform. To designate another waveform as the current waveform, use one of the following methods:

1. From the **Waveforms** menu select a new waveform from the bottom of the list (waveforms must be loaded to be listed). Note that the checked waveform is the current waveform.

When you select a new waveform, the display color and title bar reflect its status as the current waveform.

2. From the **Waveforms** menu select **Waveforms Summary**.

The Waveform Summary lists each waveform currently in memory. The associated instrument, record length, and waveform type are displayed. The waveform *Type* is either waveform (Norm) or envelope (Env). The current waveform is highlighted as shown in Figure 2-7.

Waveforms Summary			
Double Click to Change Current Waveform			
Waveform Name	Instrument Name	Length	Type
ULTRASON.ADF	AWG2020	1005	Norm
ULTRA2.ADF	AWG2020	643	Norm
SAMPLE.ADF	AWG2020	1024	Norm
DECAY.ADF	AWG2020	1000	Norm

Figure 2-7: Waveform Summary List Box

3. Double-click on SAMPLE.ADF to identify it as the current waveform.

Note that the WaveWriter title bar changes to reflect your selection and SAMPLE.ADF assumes the current waveform color.

4. Select **OK** to close the Waveforms Summary window.

### Step 11: Changing Offset

This step briefly discusses the offset adjustment. In Lesson 2 you will enter offsets and construct more complex waveforms.

Some instruments incorporate offset into the waveform data or retain an offset external to the data. WaveWriter always incorporates the offset with the data. As a result, what you see on the screen is always what is sent to the instrument.

Use the **Waveforms** → **Change Amplitude/Offset** menu to alter the offset incorporated into a waveform data set. In the Change Amplitude/Offset dialog box, enter the desired offset in the *Amplitude* edit box and select **OK**.

## Step 12: Using Markers

Markers delimit segments of the waveform in the horizontal axis. For many menu selections you have the option of using the entire waveform or only the portion between and including the markers. The distance between the markers can never exceed the maximum record length for the target instrument. If the Start or Stop marker is dragged past this length, the corresponding marker will be moved with it.

Each marker has a flag attached to it at the top of the Waveform Display Area. The Start marker flag is marked with the symbol "> >" and the Stop marker flag with "< <".

The location of the markers is indicated by the *Start* and *Stop* readouts in the upper left corner of the window.

Perform the following steps to move the markers:

1. To move the *Start* marker, click and drag on the flag with the "> >". As you drag the marker to the right, the *Stop* marker automatically moves with it. If you move the *Start* marker back to the left, the *Stop* marker no longer moves. Note that as you move the markers, the marker readouts update.
2. To move the *Stop* marker, click and drag on the box with the "< <".

### NOTE

*If it becomes difficult to position a marker to a specific point, use the **Display** → **Set Markers** function. The **Set Markers** function allows direct entry of point values for the markers.*

## Summary

You have just completed Lesson 1. In this lesson you learned how to:

- Start up WaveWriter
- Use the Help function
- Configure the target instrument
- Set the horizontal and vertical axis ranges
- Read waveforms from disk
- Autoscale the current waveform
- Zoom a portion of the current waveform
- Set and change waveform offsets
- Move markers and enter marker coordinates

## Lesson 2 Creating and Saving a TV Signal Waveform

This lesson steps you through the creation of a television signal waveform using various WaveWriter menu selections. In Lesson 2 we will learn to use:

- Create functions: Equation, Sine, and Pulse
- Draw functions: Autoline and Horizontal
- Edit functions: Copy Between Markers and Replace Between Markers
- SigProc functions: Add Scalar, Multiply by Scalar, and Multiply Waveforms

The waveform you will create is a NTC-7 composite test signal consisting of the following five parts:

- Horizontal Blanking pulse
- Line Bar
- 2T Pulse
- Modulated Sine-Squared Pulse
- Modulated 5-Riser Staircase

Figure 2-8 shows the waveform you will create.

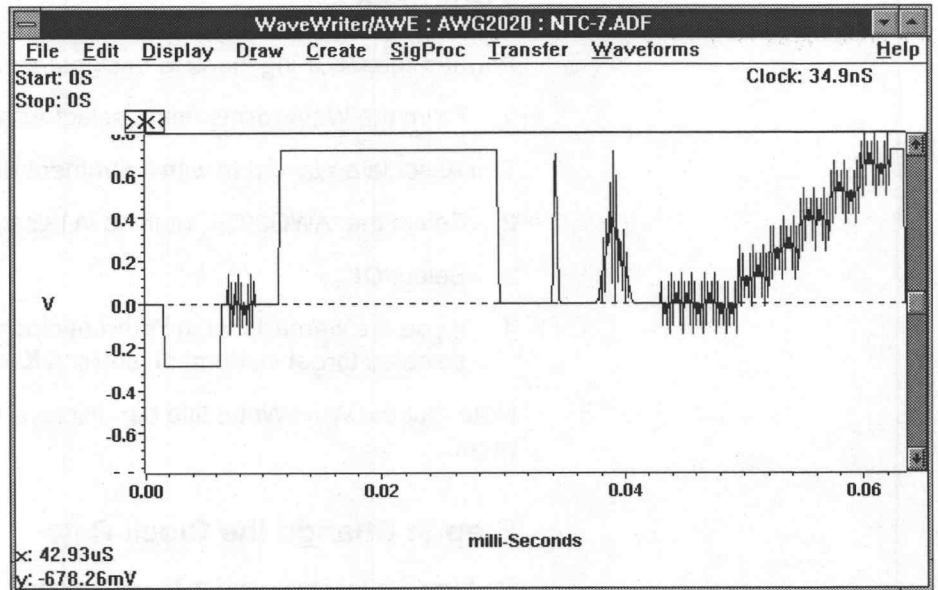


Figure 2-8: NTC-7 Composite Test Signal

### Step 1: Clear All Waveforms from WaveWriter Memory

To avoid confusing current waveforms with waveforms from previous sessions, clear all waveforms from memory before proceeding. If there are waveforms existing in memory from a previous session, you will be prompted. If you wish to save prior data select **Yes**. Otherwise, select **No**.

Perform the following steps to clear the memory:

1. From the **Waveforms** menu select **Clear Waveform(s)**.

The Clear Waveform(s) dialog box appears.

2. Select the **All Waveforms** button.

#### NOTE

*Clear Waveform(s) is grayed and unavailable if there are no waveforms in memory. If there are altered waveforms in memory not previously saved, you are given the option to save them before deleting them.*

### Step 2: Change the Default Target Instrument to the AWG 2020

Perform the following steps to designate the target instrument:

1. From the **Waveforms** menu select **Associate Waveform**.

The Associate Waveform with Instrument dialog box appears.

2. Select the "AWG2020" defined in Lesson 1 from the *Instrument List*.
3. Select **OK**.
4. If you are warned that the current clock rate is invalid for the newly selected target instrument, select **OK** to accept the clock rate offered.

Note that the WaveWriter title bar displays AWG2020 as the target instrument.

### Step 3: Change the Clock Rate

Perform the following steps to change the clock rate:

1. From the **Waveforms** menu select **Change Clock Rate**.

The AWG2020 Clock Rate dialog box appears.

2. Enter "34.9n" in the *Time per Point* edit box.
3. Select **OK**.

The Clock readout (just below Help in the Menu Bar) indicates the new clock rate: 34.9nS.

### Step 4: Create a New Waveform

Perform the following steps to create a new waveform:

1. From the **File** menu select **New**.

The Associate New Waveform with Instrument dialog box appears.

2. Select **OK** to associate the new waveform with the AWG 2020.

The associate waveform dialog box is replaced by the *New* dialog box.

3. Enter "Lesson2" in the *New Waveform Name* edit box. This is the name of our new waveform.
4. Select the *Seconds* option button.
5. Enter "63.6576u" in the *Record Length* edit box.
6. Select **OK**.

The waveform "Lesson2" is created at 0 Volts. This waveform becomes the current waveform as noted in the title bar.

### Step 5: Set Up the Axis to Display the Desired Amplitude and Record Length

Perform the following steps to configure the axis ranges for the new waveform:

1. From the **Display** menu select **Set Axis Ranges**.

The Set Axis Ranges dialog box appears.

2. In the *Vertical* group, select the *Ampl/Offset* option button.
3. In the *Amplitude: (Pk-Pk)* edit box enter "2".
4. In the *Offset* edit box enter "0".
5. In the *Horizontal* group, select the *Seconds* option button.
6. In the *Start* edit box enter "0".
7. In the *Stop* edit box enter "63.6227u".
8. Select **OK**.

The vertical and horizontal axis ranges are now set to display the new waveform.

### Step 6: Create the Horizontal Blanking Pulse

The first portion of the NTC waveform we are creating is the Blanking pulse. Perform the following steps to create the pulse:

1. From the **Display** menu select **Zoom In**.

The left-hand corner of the zoom box becomes the cursor.

- Using the Cursor/Crosshair Coordinate readouts, place the corner at approximately x: 0 s, y: 350 mV. Press the LEFT mouse button and drag the cursor to approximately x: 6.9  $\mu$ s, y: -720 mV. Release the mouse button.

The region within the box is magnified.

- From the **Draw** menu select **Horizontal**.
- Position the cursor at approximately x: 1.54  $\mu$ s, y: -287.5 mV ( $\pm 10$  mV). Click the LEFT mouse button and drag to x: 6.42  $\mu$ s. (Note that as you drag the mouse, the horizontal line always stays at the original voltage selected.) Release the LEFT mouse button to end the line segment. Press the RIGHT mouse button to redraw the display.

### NOTE

*If you experience difficulty in positioning the cursor to an exact location, use the mouse for coarse adjustment and the arrow keys for fine the adjustment. If an error is created, use the **Edit** → **Undo** function to delete the operation, then start over.*

- From the **Display** menu select **Zoom Out**.

- From the **Create** menu select **Sine**.

The Sine dialog box appears as shown in Figure 2-9.

- In the *Vertical* group, select the *Ampl/Offset* option button.
- In the *Amplitude: (Pk-Pk)* edit box enter "287.5m".
- In the *Offset* edit box enter "0".
- In the *Horizontal* group, select the *Seconds* option button.
- Select the *Cycles* check box if it is not empty

Note that the Calculate button changes to Calculate Cycles. This parameter will be calculated based on the *Start Point*, *Stop Point*, *Frequency*, and current clock rate.

- In the *Start Point* edit box enter "6.98u".
- In the *Stop Point* edit box enter "9.42u".
- In the *Frequency* edit box enter "3.586M".
- Select the **Calculate Cycles** button.

*Cycles* is updated based on the parameters entered. The value should be 8.89.

- In the *Phase* edit box enter "0".
- In the *Action* group, select the *Replace* option button.



The Sine dialog box appears as shown in Figure 2-9.

Figure 2-9: Sine Dialog Box

18. Select **OK** to create the Blanking Pulse.
19. From the **Display** menu select **Zoom In**, to magnify the waveform created so far.

The waveform should be similar to that shown in Figure 2-10.

- From the **Display** menu select **Zoom Out** to return to the original display.

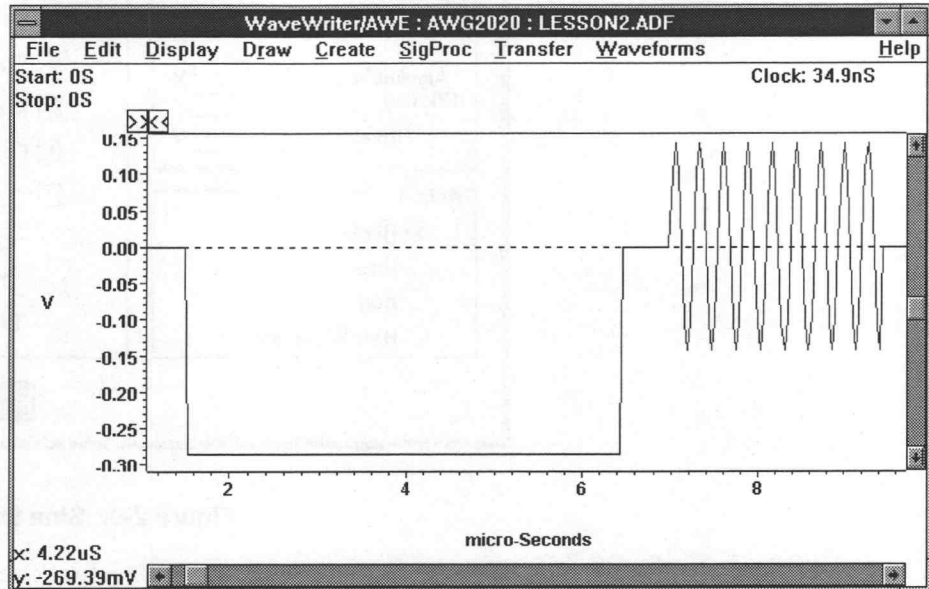


Figure 2-10: Horizontal Blanking Pulse

### Step 7: Create the Line Bar

The second portion of the NTC waveform we are creating is the Line Bar. Perform the following steps to add the Line Bar to the existing waveform:

- From the **Create** menu select **Pulse**.

The Pulse Wave dialog box appears.

- In the *Vertical* group: enter "714.3m" in the *Maximum* edit box, "0" in the *Minimum* edit box.
- In the *Action* group, select the *Replace* option button.
- In the *Horizontal* group, select the *Seconds* option button.
- Select the *Period* check box if it is not empty
- In the *Start Point* edit box enter "11.31u".
- In the *Stop Point* edit box enter "29.73u".
- In the *Cycles* edit box enter "1".
- In the *Delay* edit box enter "0".
- In the *Pulse Width (50%)* edit box enter "18.15u".

11. In the *Transitions (10% – 90%)* group, select the *Pulse Direction: Pos* option button.
12. In the *Risetime* edit box enter “104.7n”
13. In the *Falltime* edit box enter “104.7n”
14. Select both *Ramp* option buttons.

The completed Pulse Wave dialog box should appear as shown in Figure 2-11.

Figure 2-11: Pulse Wave Dialog Box

15. Select **OK** to add the Line Bar to the waveform.

The Line Bar should be identical to the positive-going 700 mV pulse beginning at approximately .01 ms and ending at .03 ms, as shown in Figure 2-8.

### Step 8: Create a 2T Pulse

The third portion of the NTC waveform is the 2T pulse. Perform the following steps to add the pulse to the existing waveform:

1. From the **Create** menu select **Equation**.

The Equation dialog box appears.

2. Select the **Library** button at the bottom of the dialog box.

The equation library dialog box appears.

3. Scroll and select the "2T" pulse entry by double-clicking on it.

The Equation dialog box is redisplayed with the selected 2T pulse equation entered in the *Equation* edit box.

4. Select the *Seconds* option button.
5. In the *Horizontal* group, enter "33.923u" in the *Start Point* edit box.
6. Enter "34.551u" in the *Stop Point* edit box.
7. In the *Action* group, select the *Replace* option button.

The Equation dialog box should be identical to Figure 2-12.

Figure 2-12: Equation for 2T Pulse

8. Select **OK** to add the 2T pulse to the waveform.
9. From the **Display** menu, select **Zoom In** to magnify the region just created.

The 2T Pulse should be identical to Figure 2-13.

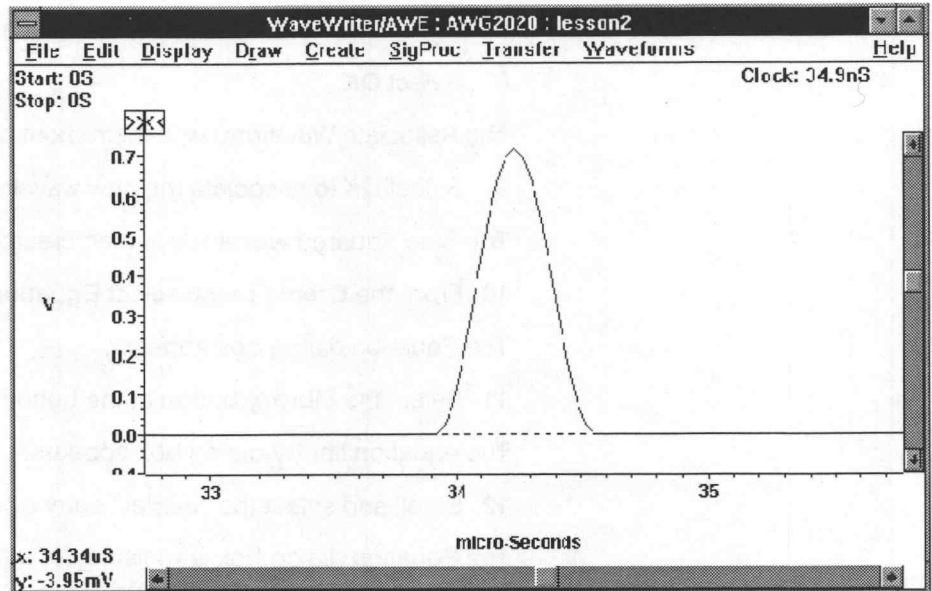


Figure 2-13: 2T Pulse Display

10. Select the **Display** menu function **Zoom Out** to return to the original display.

### Step 9: Create the Modulate Sine Squared Pulse

The fourth portion of the NTC waveform is the Sine Squared pulse. We will build the modulated sine squared pulse by creating two individual waveforms, multiply them together, then copy the result into the Lesson2 waveform.

Steps 1 through 5 below can be accomplished in a single step with the Modsin2 equation. However, to demonstrate the SigProc and Edit functions, we will forgo the most direct method.

Perform the following steps to add the Sine Squared pulse to our waveform:

1. From the **Create** menu select **Equation**.

The Equation dialog box appears.

2. Select the **Library** button at the bottom of the dialog box.

The equation library dialog box appears.

3. Scroll and select the "sin2" entry by double-clicking on it.

The Equation dialog box is redisplayed with the selected Sin2 equation entered in the *Equation* edit box.

4. In the *Horizontal* group, enter "0" in the *Start Point* edit box.

5. Enter "3.385u" in the *Stop Point* edit box.
6. In the *Action* group, select the *New Waveform* option button.
7. Enter "Sin2" in the *Waveform Name* edit box.
8. Select **OK**.

The Associate Waveform with Instrument dialog box appears.

9. Select **OK** to associate the new waveform with the AWG 2020.  
The Sine Squared waveform is then created starting at time zero.
10. From the **Create** menu select **Equation**.

The Equation dialog box appears.

11. Select the **Library** button at the bottom of the dialog box.

The equation library dialog box appears.

12. Scroll and select the "carrier" entry by double-clicking on it.

The Equation dialog box is redisplayed with the selected carrier equation entered in the *Equation* edit box.

13. In the *Action* group, select the *New Waveform* option button.
14. Enter "Carrier" in the *Waveform Name* edit box.

Notice that the *Start* and *Stop* points remain the same as the previous step.

15. Select **OK**.

The Associate Waveform with Instrument dialog box appears.

16. Select **OK** to associate the new waveform with the AWG 2020.  
The Carrier waveform is then created starting at time 0.

We will now offset the carrier and scale it back to 1 V.

17. From the **SigProc** menu **Add Scalar**.

The Add Scalar dialog box appears.

18. Enter "1" in the *Add Scalar* edit box.
19. In the *Processing Region* group, select the *Entire Waveform* option button.
20. Select **OK**.

21. From the **SigProc** menu select **Multiply by Scalar**.

The Multiply Current Waveform by Scalar dialog box appears.

22. Enter ".5" in the *Multiply by Scalar* edit box.
23. In the *Processing Region* group, select the *Entire Waveform* option button.
24. Select **OK**.

25. From the **SigProc** menu select **Multiply Waveforms**.

The Multiply Waveforms dialog box appears.

26. Double-click on the "Carrier" entry in the *Displayed Waveforms* list box.

The *Wfm 1* edit box reflects the entry: *Carrier*.

27. Double-click on the "Sin2" entry in the *Displayed Waveforms* list box.

The *Wfm 2* edit box reflects the entry: *Sin2*.

28. Click on the *Wfm 3* edit box and enter "Modsin2". The product of the two waveforms will be called Modsin2.

29. Select **OK**.

The Associate Waveform with Instrument dialog box appears.

30. Select **OK** to associate the new waveform with the AWG 2020. Modsin2 is now the current waveform.

31. From the **SigProc** menu select **Multiply by Scalar**.

The Multiply Current Waveform by Scalar dialog box appears.

32. Enter ".7143" in the *Multiply by Scalar* edit box.

33. Select **OK**.

34. From the **Display** menu select **Zoom In**. Magnify the region between approximately x: 0 s, y: 700 mV and x:4.26  $\mu$ s, y: -100 mV.

35. Move the *Start Marker* to 0 s.

36. Move the *Stop Marker* to 3.385  $\mu$ s (the end of the Modsin2 waveform).

37. From the **Edit** menu select **Copy Between Markers**.

This copies the current waveform data from Modsin2 into the edit buffer.

38. Remove the three waveforms we just created from memory: from the **Waveforms** menu select **Clear Waveform(s)**.

The Clear Waveform(s) list box appears.

39. Select the *Sin2* entry.

40. Press and hold the **[CTRL]** key.

41. Select the *Carrier* entry.

42. Select the *Modsin2* entry.

43. Release the **[CTRL]** key and select **OK**.

For each selection, you are warned that you have not saved the waveform and given the opportunity to save it. Select **No** for each option. We no longer need these waveforms.

44. From the **Display** menu select **Zoom In**. Magnify the region between approximately x: 36  $\mu$ s, y: 750 mV and x: 42  $\mu$ s, y: -100 mV.

45. Move the *Start Marker* to 37.413  $\mu\text{s}$ .
46. Move the *Stop Marker* to 40.833  $\mu\text{s}$ .
47. From the **Edit** menu select **Replace Between Markers**.

The contents of the edit buffer, containing the Modulated Sine Squared Pulse, are inserted into the current waveform between the markers.

The displayed waveform appears as shown in Figure 2-14.

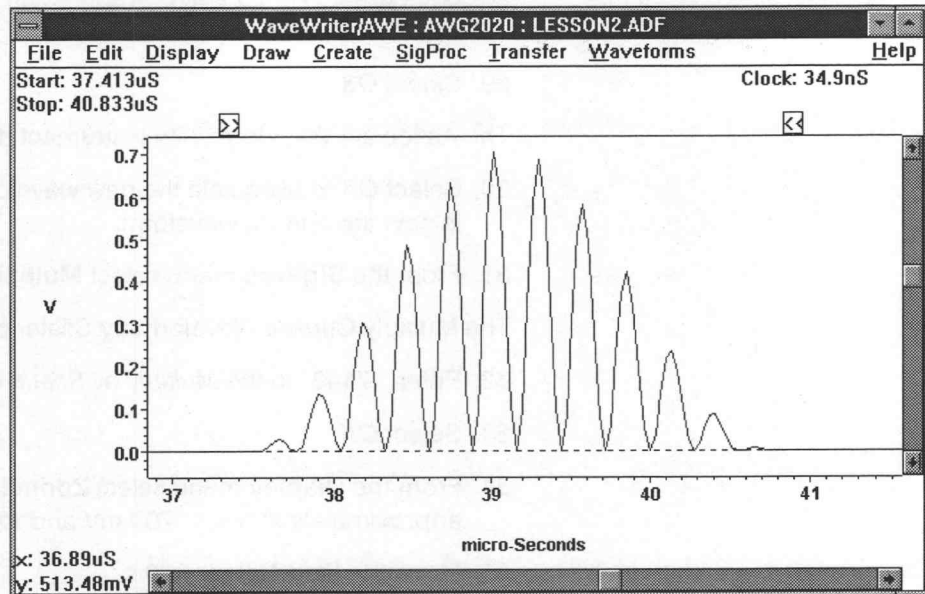


Figure 2-14: Modulated Sine Squared Pulse

48. To return to the original display, select **Zoom Out** from the **Display** menu.

### Step 10: Create the Modulated 5-Riser Staircase Test Signal

The last portion of the NTC waveform we are creating is the Staircase.

Perform the following steps to add the staircase to the existing waveform:

1. From the **Create** menu select **Sine**.

The Sine dialog box appears. Some values entered previously are retained.

- In the *Horizontal* group, enter "42.9968u" in the *Start Point* edit box.
- In the *Stop Point* edit box enter "49.4886u".
- In the *Frequency* edit box enter "3.581662M".
- Select *Calculate Cycles*.



When completed, the dialog box should be identical to that shown in Figure 2-15. If not, correct any discrepant items.

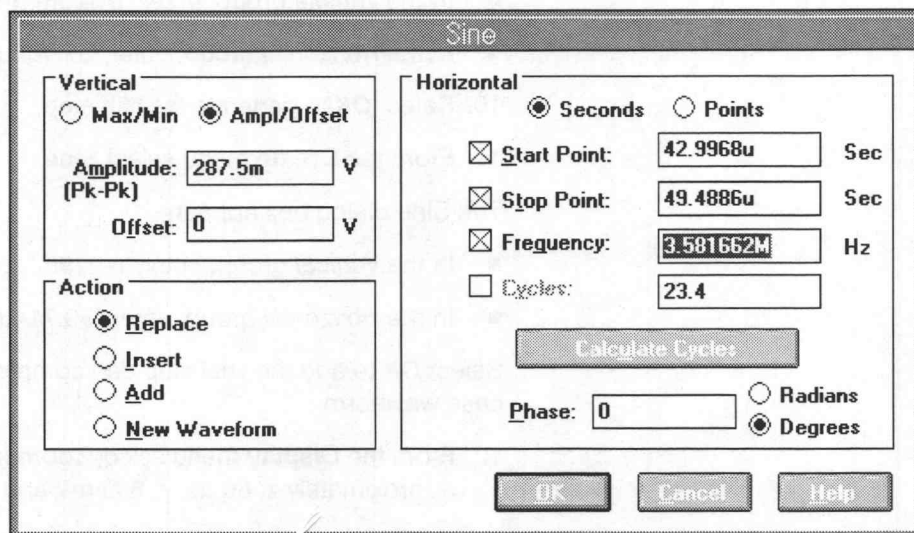


Figure 2-15: Sine Dialog Box

2. Select **OK** to generate the first step.
3. From the **Create** menu select **Sine**.

The Sine dialog box appears.

- In the *Vertical* group, enter “128.6m” in the *Offset* edit box.
- In the *Horizontal* group, enter “49.523u” in the *Start Point* edit box
- Enter “9.125” in the *Cycles* edit box.
- Select the **Calculate Stop Point** button to see the resulting *Stop Point*.

4. Select **OK** to generate the second step.
5. From the **Create** menu select **Sine**.

The Sine dialog box appears.

- In the *Vertical* group, enter “257.1m” in the *Offset* edit box.
- In the *Horizontal* group, enter “52.07u” in the *Start Point* edit box

6. Select **OK** to create the third step.
7. From the **Create** menu select **Sine**.

The Sine dialog box appears.

- In the *Vertical* group, enter “385.7m” in the *Offset* edit box.
- In the *Horizontal* group, enter “54.617u” in the *Start Point* edit box.

8. Select **OK** to generate the fourth step.

9. From the **Create** menu select **Sine**.

The Sine dialog box appears.

- In the *Vertical* group, enter "514.3m" in the *Offset* edit box.
- In the *Horizontal* group, enter "57.164u" in the *Start Point* edit box.

10. Select **OK** to generate the fifth step.

11. From the **Create** menu select **Sine**.

The Sine dialog box appears.

- In the *Vertical* group, enter "642.9m" in the *Offset* edit box.
- In the *Horizontal* group, enter "59.714u" in the *Start Point* edit box.

Select **OK** to add the final step and complete the Modulated 5-Riser Staircase waveform.

12. From the **Display** menu select **Zoom In** to magnify the region between approximately x: 60  $\mu$ s, y: 800 mV and x: 63.65  $\mu$ s, y: -100 mV.

13. From the **Draw** menu select **Autoline** to draw the final line of the waveform.

14. Position the cursor at x: 62.26  $\mu$ s, y: 714.3 mV ( $\pm 10$  mV).

15. Click the LEFT mouse button and let up.

16. Move the cursor to x: 63.45  $\mu$ s, y: 714.3 mV.

17. Click the LEFT mouse button and let up to end the line segment.

18. Press the RIGHT mouse button to redraw the screen.

19. Select the **Display** menu function **Zoom Out**.

20. Select the **Display** menu function **Zoom In** to magnify the 5-Riser staircase region just created (from approximately x: 42  $\mu$ s, y: 800 mV to x: 63  $\mu$ s, y: -200 mV).

The staircase portion of the NTC waveform should appear as shown in Figure 2-16.

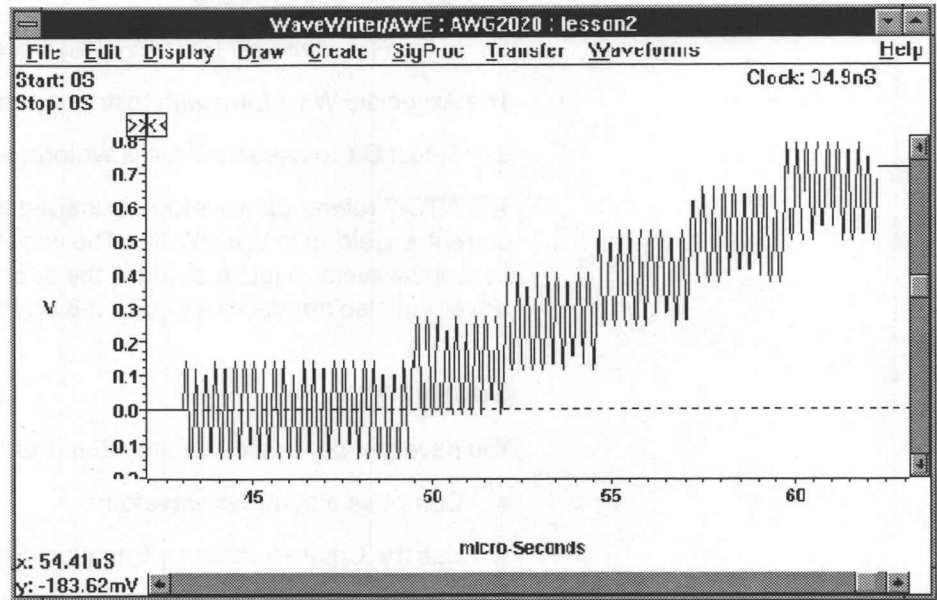


Figure 2-16: 5-Riser Staircase

21. Select the **Display** menu function **Zoom Out** to return to the original display.

The NTC-7 composite test signal is now complete.

### Step 11: Save the Waveform as an ADIF file

To save the NTC-7 composite waveform, complete the following steps:

1. From the **File** menu select **Save**.

The Save As dialog box appears.

The name you entered previously, Lesson 2, appears as the default name in the *File Name* edit box.

2. Scroll and select "ADIF 1.0" from the *Save File as Type* list box at the bottom left.
3. Select **OK**.

The file LESSON2.ADF is now saved.

### Step 12: Load File NTC-7.ADF and Compare Results

To check the accuracy of the composite waveform created in Lesson 2, compare it to the reference waveform (NTC-7.ADF) stored in memory.

To recall the reference waveform from memory:

1. From the **File** menu select **Open**.

The Open list box appears.

2. In the *File Name* list box, scroll and double-click on the "ntc-7.adf" entry.

The Associate Waveform with Instrument dialog box appears.

3. Select **OK** to associate the waveform with the AWG 2020.

The NTC-7 reference waveform is loaded from memory and displayed as the current waveform in WaveWriter. The waveform should closely match the Lesson2 waveform just created, if the tutorial was followed correctly. The waveform also appears as Figure 2-8 on Page 2-21.

## Summary

You have just completed Lesson 2. In this lesson you learned how to:

- Compose a complex waveform
- Use the Create functions: Equation, Sine, Pulse
- Select and incorporate waveforms from the library
- Use the Autoline and Horizontal Draw functions
- Copy between and replace between markers
- Use the Auto-calculate functions
- Add and multiply a waveform by Scalar
- Multiply a waveform
- Save a waveform
- Load a waveform from memory

---

## Lesson 3

### Working with an AWG 2020 Arbitrary Waveform Generator

Lesson 3 demonstrates the Acquire and Send functions for the AWG 2020. In this lesson you will load a waveform from disk, change the clock rate, and send the waveform to the Arbitrary Waveform Generator (AWG). You will then reacquire the waveform from the instrument to verify its accuracy.

#### Step 1: Clear All Waveforms from WaveWriter Memory

To avoid confusing current waveforms with waveforms from previous sessions, clear all waveforms from memory before proceeding. If there are waveforms existing in memory from a previous session, you will be prompted. If you wish to save prior data select **Yes**. Otherwise, select **No**.

Perform the following steps to clear the memory:

1. From the **Waveforms** menu select **Clear Waveform(s)**.

The Clear Waveform(s) dialog box appears.

2. Select the **All Waveforms** button.

#### NOTE

*Clear Waveform(s) is grayed and unavailable if there are no waveforms in memory. If there are altered waveforms in memory not previously saved, you are given the option to save them before deleting them.*

#### Step 2: Change the Target Instrument

Perform the following steps to designate the target instrument:

1. From the **Waveforms** menu select **Associate Waveform**.

The Associate Waveform with Instrument dialog box appears.

2. From the *Instrument list* select "AWG2020". (The name you select must identify the device driver "wawg2020.drv" in the **Transfer** → **Configure Instrument** list box).
3. Select **OK**.
4. If you are warned that the current clock rate is invalid for the newly selected target instrument, select **Yes** to accept the clock rate offered.

The WaveWriter title bar denotes the AWG 2020 as the target instrument.

#### Step 3: Change the Clock Rate

Perform the following steps to set the clock rate:

1. From the **Waveforms** menu select **Change Clock Rate**.

The AWG2020 Clock Rate dialog box appears.

2. Enter "2u" in the *Time per Point* edit box.
3. To see the corresponding *Frequency* value, press the [TAB] or [ENTER] key. The edit box will update with the equivalent value.
4. Select **OK**.

The Clock readout indicates the new clock rate.

#### Step 4: Open a New File

To open a new file perform the following steps:

1. From the **File** menu select **Open**.

The Open dialog box appears.

2. In the *Directories* list box double-click **awe4\sample**. In the *File Name* list box scroll and select the "sample.adf" file.
3. Select **OK**.

The Associate Waveform with Instrument dialog box appears.

4. Select **OK** to associate the new waveform with the AWG 2020.

The waveform is loaded from disk into WaveWriter memory and becomes the current waveform, as noted in the title bar.

### Step 5: Scale the Waveform

To maximize bit resolution when transferring the waveform to the AWG 2020, scale the waveform as outline:

1. From the **Display** menu select **Autoscale Current Waveform**. From the sub-menu select **At Zero Volts**.

Note the change in the vertical and horizontal axis scales. The waveform appears as shown in Figure 2-17.

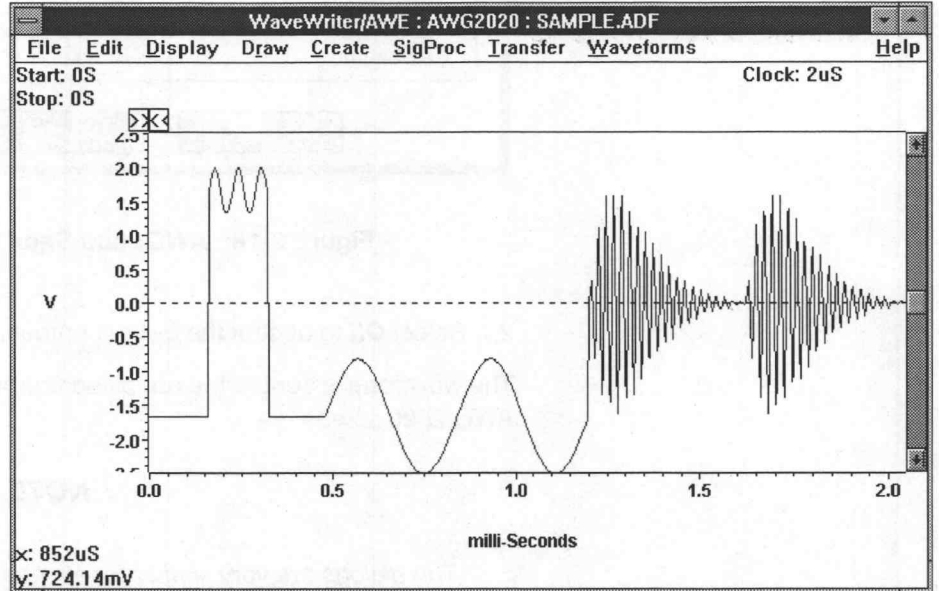


Figure 2-17: SAMPLE.ADF Display

### Step 6: Send the Waveform to the AWG 2020

To transfer the waveform to the AWG 2020 Arbitrary Waveform Generator:

1. From the **Transfer** menu select **Send**.

The Send AWG 2020 dialog box appears as shown in Figure 2-18.

**NOTE**

*If the AWG 2020 is not at the GPIB address shown in the **Transfer** → **Configure Instrument** dialog box, a warning stating “No AWG 2020 found on the bus” is displayed. Change the address in the **Configure Instrument** dialog box, and then try again. Alternatively, change the AWG’s GPIB address (using the instrument’s **UTILITY** menu) and then try again.*

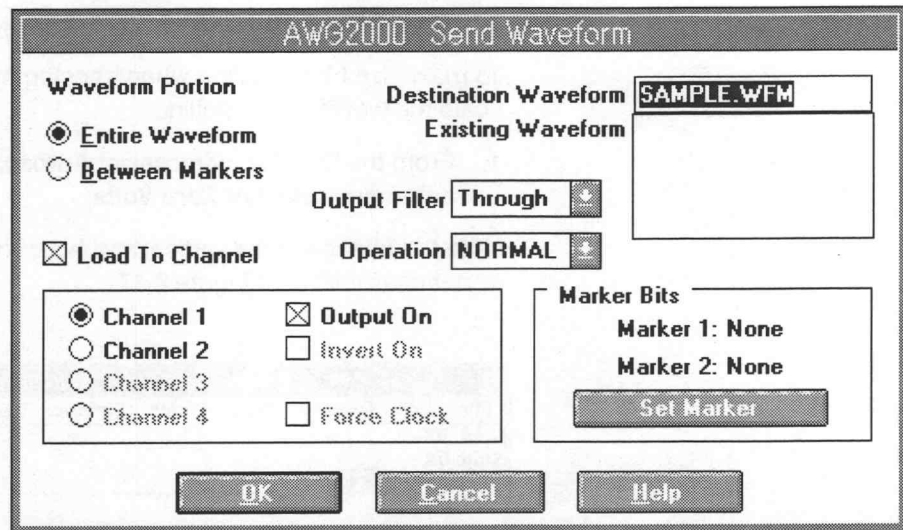


Figure 2-18: AWG2000 Send Waveform Dialog Box

2. Select **OK** to accept the default entries.

The waveform is sent to the specified channel and displayed on the AWG 2020 screen.

#### NOTE

*The dialogs are very similar for all instruments in the AWG 2000 series. Do not be confused by this; if you configured the wrong type of instrument in the Configure Instrument dialog box, WaveWriter will not be able to find the instrument. If the AWG2000 Send Waveform dialog successfully displays, you can be confident that the correct instrument type has been configured.*

### Step 7: Acquire the Waveform Back

To reacquire the waveform from the instrument and verify its accuracy:

1. From the **Transfer** menu select **Acquire**.

The Acquire Waveform dialog box appears listing all instruments previously configured.

2. Double-click on the "AWG2020".

The Acquire AWG 2020 dialog box appears.

3. In the *Source* group, *Waveform Name* edit box, enter "CH1".
4. In the *Destination* group select the *Create New Waveform* option button.
5. Enter "Lesson3" in the *Waveform Name* edit box.



The dialog box appears as shown in Figure 2-19.

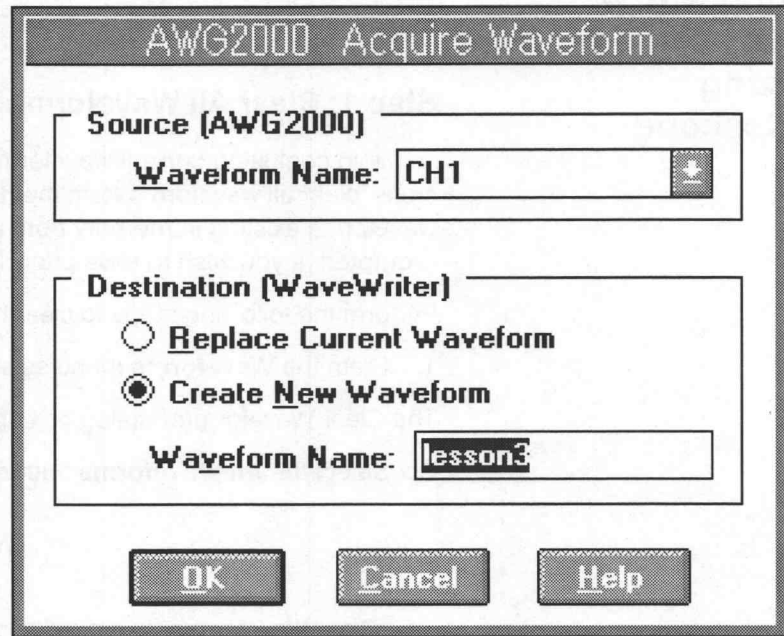


Figure 2-19: AWG2000 Acquire Waveform Dialog Box

6. Select **OK**.

The waveform is reacquired from the selected source and becomes the current waveform. The two waveforms appearing in the *Waveform Display Area* should be identical.

### Summary

You have just completed Lesson 3. In this lesson you learned how to:

- Associate a waveform
- Set the clock rate
- Load a waveform from disk
- Scale the waveform
- Transfer a waveform to the AWG 2020 with the Send command
- Acquire a waveform from the AWG 2020 with the Acquire command

---

## Lesson 4

### Working with a TDS 500 Series Digitizing Oscilloscope

In Lesson 4 you will modify the envelope of a nonenveloped waveform. You will then send the newly created (enveloped) waveform, along with the original normal waveform, to the oscilloscope reference memory.

#### Step 1: Clear All Waveforms from WaveWriter Memory

To avoid confusing current waveforms with waveforms from previous sessions, clear all waveforms from memory before proceeding. If there are waveforms existing in memory from a previous session, you will be prompted. If you wish to save prior data select **Yes**. Otherwise, select **No**.

Perform the following steps to clear the memory:

1. From the **Waveforms** menu select **Clear Waveform(s)**.

The Clear Waveform(s) dialog box appears.

2. Select the **All Waveforms** button.

#### NOTE

*Clear Waveform(s) is grayed and unavailable if there are no waveforms in memory. If there are altered waveforms in memory not previously saved, you are given the option to save them before deleting them.*

#### Step 2: Change the Target Instrument

Perform the following steps to designate the target instrument:

1. From the **Waveforms** menu select **Associate Waveform**.

The Associate Waveform with Instrument dialog box appears.

2. From the *Instrument List* select "TDS500". (The name you select must identify the device driver "wt ds500a.dr v" in the **Transfer** → **Configure Instrument** list box.)

#### NOTE

*If you have not configured the TDS 500 Series oscilloscope from within WaveWriter, see Lesson 1. Use the instructions for configuring the AWG 2020, using **wt ds500a.dr v** as the device driver.*

3. Select **OK**.
4. If you are warned that the current clock rate is invalid for the newly selected target instrument, select **Yes** to accept the clock rate offered.

The WaveWriter title bar denotes the TDS 500 as the target instrument.

### Step 3: Change the Clock Rate

Perform the following steps to set the clock rate:

1. From the **Waveforms** menu select **Change Clock Rate**.

The TDS Series Clock Rate dialog box appears.

2. Enter "2m" in the *Time per Division* edit box.
3. To see the corresponding *Time per Point* and *Frequency* values, press the **[TAB]** or **[ENTER]** key. The edit boxes will update with the equivalent values.

The dialog box appears as shown in Figure 2-20.

**TDS Series Clock Rate**

Enter ONE of the following:

**Time Per Division:**  S

**Time per Point:**  S

**Frequency:**  Points / Second

Figure 2-20: TDS Series Clock Rate Dialog Box

4. Select **OK**.

The Clock readout indicates the new clock rate.

#### NOTE

*The appearance of the TDS Series Clock Rate dialog is the same for all TDS series scopes. Do not be confused by this; provided you carried out Step 2 in this tutorial correctly, WaveWriter knows that your waveform is associated with a TDS 500 type of scope. If you think that you have made a mistake, check that the driver 'wtds500a.drv' is displayed against the name 'TDS500' in the Configure Instrument dialog box, and correct as necessary. Also, check that the name 'TDS500' is displayed in the title bar of the WaveWriter main window, and use the **Waveforms** → **Associate Waveform** selection to associate the waveform with the instrument named 'TDS500' if necessary.*

### Step 4: Open a New File

To open a new file perform the following steps:

1. From the **File** menu select **Open**.

The Open dialog box appears.

2. In the *Directories* list box double-click **awe4\sample**. In the *File Name* list box, scroll and select the "square.adf" file.
3. Select **OK**.

The Associate Waveform with Instrument dialog box appears.

4. From the *Display* group, select the *Autoscale at middle of Wfm* option button.
5. Select **OK** to associate the new waveform with the TDS 500.

The waveform is loaded from disk into WaveWriter memory and becomes the current waveform, as noted in the title bar.

The Waveform appears as shown in Figure 2-21.

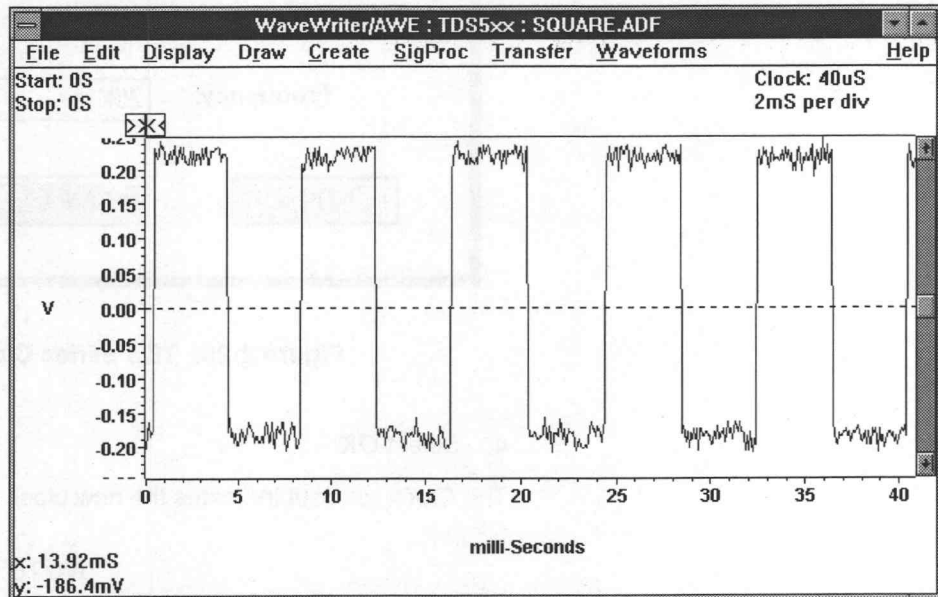


Figure 2-21: SQUARE.ADF Display

## Step 6: Create an Envelope Waveform

To create an enveloped waveform perform the following steps:

1. From the **Create** menu select **Envelope Tolerance**.

The Envelope Tolerance dialog box appears.

2. In the *Output Envelope* edit box enter "ENVELOPE".
3. In the *Vertical Tolerance* group, select the *Percentage [Peak to Peak]* option button.
4. In the *Maximum Tolerance* edit box enter "10".
5. In the *Minimum Tolerance* edit box enter "15".
6. In the *Horizontal Tolerance* group edit box enter "5".

The dialog box appears as shown in Figure 2-22.

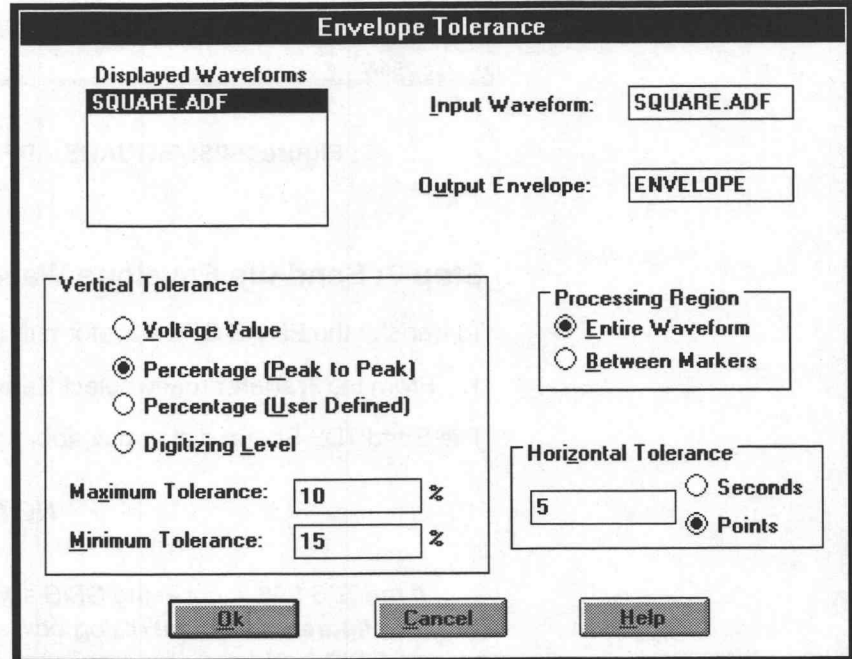


Figure 2-22: Envelope Tolerance Dialog Box

7. Select **OK**.

WaveWriter computes the waveform maximum and minimum values and creates the upper limit of the waveform using a 10% vertical tolerance and the lower limit using a 15% vertical tolerance. For the horizontal tolerance, each waveform point will be shifted left and right by 5 points, creating a band 10 points wide. ENVELOPE becomes the current waveform.

8. From the **Display** menu select **Autoscale Current Waveform**. From the sub-menu select **At Zero Volts**.

The Waveform appears as shown in Figure 2-23.

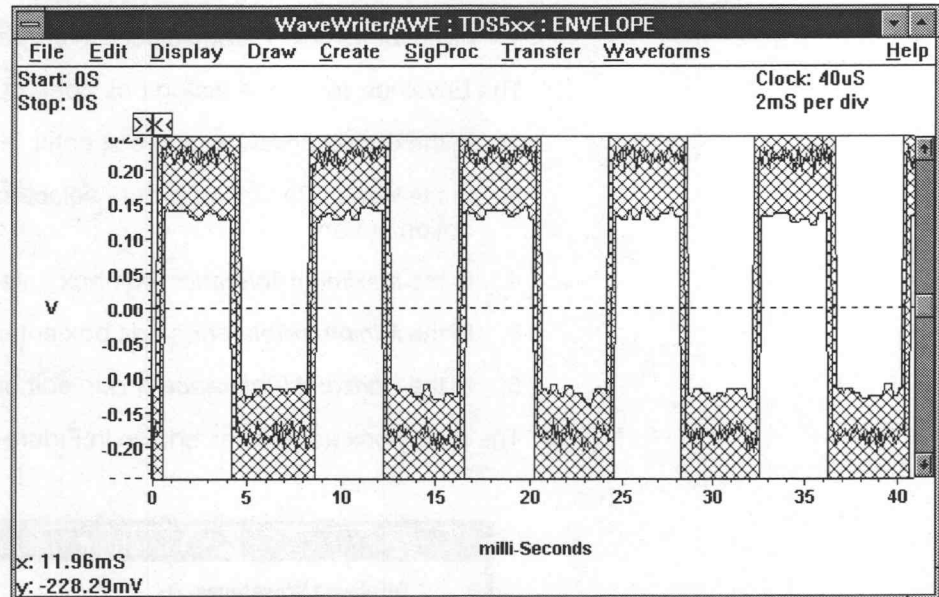


Figure 2-23: SQUARE.ADF and ENVELOPE Display

### Step 7: Send the Envelope Waveform to the TDS 500

To transfer the ENVELOPE waveform to the TDS 500 oscilloscope:

1. From the **Transfer** menu select **Send**.

The Send TDS Scope dialog box appears.

#### NOTE

*If the TDS 500 is not at the GPIB address shown in the **Transfer** → **Configure Instrument** dialog box, a warning stating "No TDS 500 on GPIB 0 address..." is displayed. Select "Search all addresses" to have WaveWriter search all addresses for the instrument.*

2. Select the *Send Waveform* option button.
3. In the *Location* group, select the *REF1* option button.
4. In the *Partial Envelope* group, click the *Allocate Reference Memory* check box and set the memory allocation to 2500.

The dialog box appears as shown in Figure 2-24.

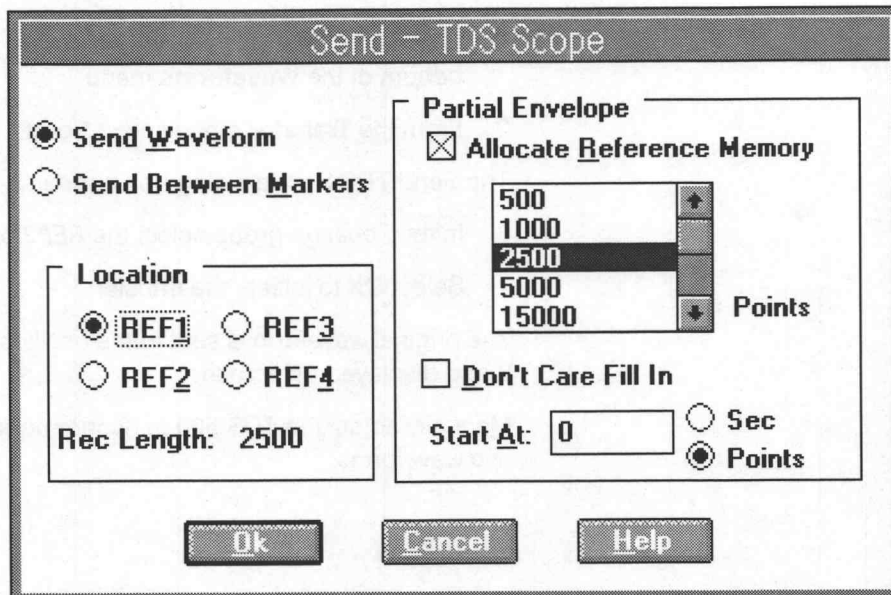


Figure 2-24: Send – TDS Scope Dialog Box

5. Select **OK** to initiate the transfer.

The envelope waveform is sent to the oscilloscope reference memory location 1 and displayed on screen.

#### NOTE

*The dialogs are very similar for all instruments in the TDS series. Do not be confused by this; if you configured the wrong type of instrument in the Configure Instrument dialog box, WaveWriter will not be able to find the instrument. If the Send – TDS Scope successfully displays, you can be confident that the correct instrument type has been configured.*

## Step 8: Send the Original Waveform to the Instrument

To transfer the SQUARE.ADF waveform to the TDS 500 oscilloscope:

1. Identify the new "current waveform" by selecting SQUARE.ADF from the bottom of the **Waveforms** menu.
2. From the **Transfer** menu select **Send**.

The Send TDS Scope dialog box appears.

3. In the *Location* group select the *REF2* option button.
4. Select **OK** to initiate the transfer.

The original waveform is sent to the oscilloscope reference memory location 2 and displayed on screen.

Manually adjust the TDS 500 to accommodate the on-screen display of the two waveforms.

## Summary

You have just completed Lesson 4. In this lesson you learned how to:

- Associate a waveform
- Set the clock rate
- Load a waveform from disk
- Associate the waveform
- Scale the waveform
- Envelope a waveform
- Transfer two waveforms to the TDS 500 with the Send command. Each waveform was sent to a different memory location.





# Reference

Reference

# Menu Map

The Menu Map lists the WaveWriter menu selections. Use the map as a reference to the WaveWriter functions. Menus are listed as they appear in the Menu Bar across the top of the Waveform Display Area. The Reference sections to follow discuss each WaveWriter menu in detail.

## **File**

---

- New...
- Open...
- Save...
- Import...
- Export...
- Hardcopy...
- Exit
- About...

## **Edit**

---

- Undo
- Disable Undo
- Cut Between Markers
- Copy Between Markers
- Delete Between Markers
- Insert at Start Marker
- Replace Between Markers
- Append to End of Waveform
- Flip Horizontal Between Markers
- Flip Vertical Between Markers
- Horizontal Resolution...
- Vertical Resolution...

---

**Display**

- Redraw Dot
- Redraw Vector
- Zoom In
- Zoom Out
- Zoom Between Markers
- Set Axis Ranges...
- Set Markers
- Autoscale Current Waveform
  - At Zero Volts
  - At Given Volts...
  - At Middle of Wfm
  - Horizontal Axis
- Show Crosshairs
- Show Multiple Waveforms
- Set Colors and Line Styles...

---

**Draw**

- Nodraw
- Freehand
- Horizontal
- Vertical
- Autoline
- Envelope Max Don't Care
- Envelope Min Don't Care
- Envelope Max
- Envelope Min

---

**Create**

- Equation...
- Sine...
- Triangle...
- Pulse...
- Square...
- Envelope Tolerance...
- Envelope Couple...
- Envelope Decouple...

---

**SigProc**

- Add Scalar...
- Multiply by Scalar...
- Add Waveforms...
- Subtract Waveforms...
- Multiply Waveforms...
- Divide Waveforms...

## **Transfer**

---

Configure Instruments...

Acquire...

Send...

---

## **Waveforms**

---

Change Clock Rate...

Change Amplitude/Offset...

Associate Waveform...

Rename Waveform...

Clear Waveform(s)...

Waveform Summary...

Waveform Detail

---

## **Help**

---

# Menu Map

File	1
Edit	2
View	3
Window	4
Help	5
Tools	6
Settings	7
Advanced Settings	8
System	9
Help	10

# File Operations

Use the following **File** menu selections to create, open, store, or print waveforms or to end a *WaveWriter* session:

- **New** — Creates a new waveform file
- **Open** — Opens an existing native format waveform file
- **Save** — Stores a waveform native format file
- **Import** — Opens an existing foreign format waveform file
- **Export** — Stores a waveform in a foreign format waveform file
- **Hardcopy** — Outputs the current waveform display to a printing device
- **Exit** — Ends the *WaveWriter* session
- **About** — Identifies the installed version of *WaveWriter*

## New

Use the **New** menu selection to create a new or envelope waveform. When you select **New** from the **File** menu, the dialog box in Figure 3-1 appears.

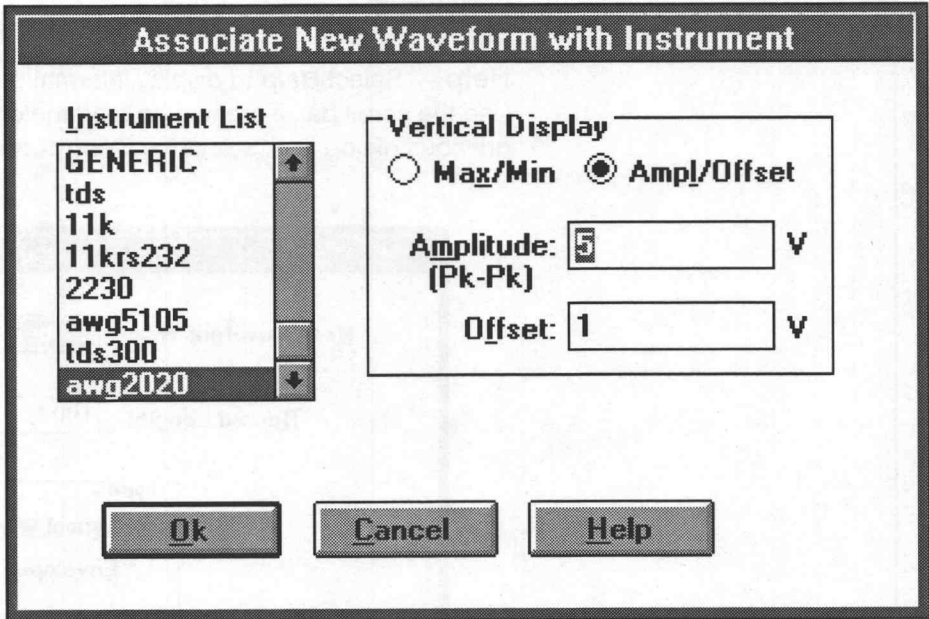


Figure 3-1: Associate New Waveform with Instrument Dialog Box

Use the Associate New Waveform with Instrument dialog box to associate an instrument with the new waveform and to define the amplitude and offset used in the display area.

**Instrument List** — Associate the new waveform with a target instrument by making a selection from the list.

**Max/Min** — Enter the desired highest and lowest voltage levels for the vertical display. Values should not be greater than those allowed by the target instrument.

**Amplitude (Pk-Pk)** — Enter the peak-to-peak vertical display voltage in the *Amplitude* edit box. Values should not exceed those allowed by the target instrument.

**Offset** — Enter the vertical external offset voltage in the *Offset* edit box. Values should not exceed those allowed by the target instrument.

**OK** — Associate the specified instrument with the new waveform. When the New dialog box (Figure 3-2) is completed in the next step, the display is adjusted to the parameters specified in the dialog box.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

**Help** — Select **Help** to display information relating to this menu selection. Use the scroll bar, if present, to read the entire Help text. To return to the previous dialog box, select the **Control-menu** box, then select *Close*.

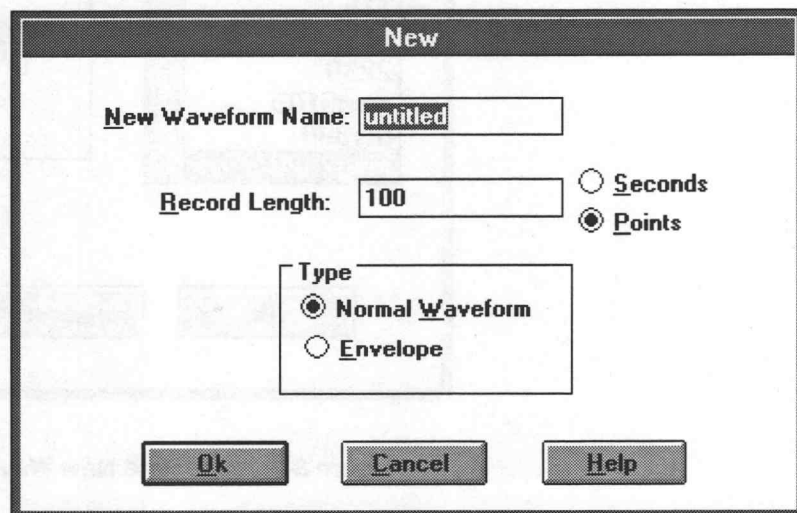


Figure 3-2: New Dialog Box



**New Waveform Name** — Enter the name of the waveform you are creating in this edit box. The eight character file name and three character extension can be a combination of characters acceptable to the DOS system. Certain reserved words are not permitted: aux, con, prn, nul, com1, com2, com3, com4, lpt1, lpt2, lpt3. A file name extension is not necessary since it is appended automatically when the waveform is saved to a disk file. If you choose to add an extension, use any three DOS-acceptable characters. The **Save** menu description (to follow) discusses recommended file extension nomenclature.

**Record Length** — In this edit box, enter the length of the waveform. Specify either *Points* or *Seconds*. The minimum length is two points and the maximum length depends on memory availability, with an upper limit of 4 M points for display. If you select *Seconds*, the number of points is based on the current clock rate.

**Type** — Select the basic file type you wish to create. You can create a normal or an envelope waveform.

- **Normal Waveform** — A “normal” waveform is any nonenvelope waveform.
- **Envelope** — An envelope waveform is a waveform that simultaneously defines upper and lower limits horizontally and vertically.

**OK** — Select **OK** to create the new waveform. (The new waveform becomes the current waveform.) For normal waveforms, all points are initialized at the external offset given in the Associate New Waveform with Instrument dialog box. For envelope waveforms, the maximum (upper limit) waveform is set to the maximum value of the Waveform Display Area; the minimum (lower limit) waveform is set to the minimum value of the work area. Envelopes are filled with a crosshatch pattern.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

**Help** — Select **Help** to display information relating to this menu selection. Use the scroll bar, if present, to read the entire Help text. To return to the previous dialog box, select the **Control-menu** box, then select *Close*.

## Open

The **Open** command retrieves an existing waveform file from disk and loads it as the current waveform. You can open a file created by *WaveWriter* in ADIF, ISF, or CSV format. You can also open files created by other systems using a compatible version of the ADIF format (.99 or 1.0 SCPI 1992). Selecting Open from the File menu displays the dialog box in Figure 3-3.

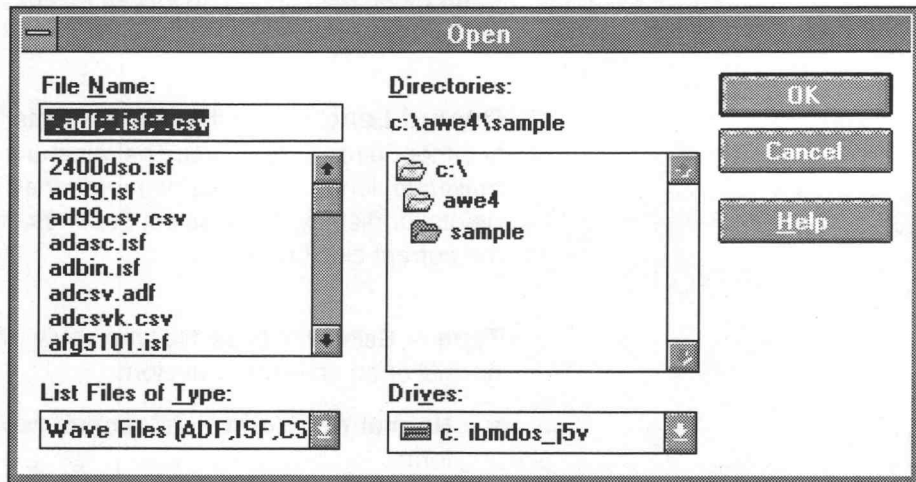


Figure 3-3: Open Dialog Box

**File Name** — Enter the name of the waveform to be loaded in the *File Name* edit box or click on one of the names in the list box. To change directories or drives, use the *Directories* and or *Drives* list boxes. You can choose the kind of files listed in the *File Name* list box by selecting entries from the *List Files of Type* list box or by specifying a particular file group with a “wild card”. For example, to list only files having a “.WFM” extension, enter “\*.WFM”.

**List Files of Types** — Lists the extensions *WaveWriter* uses for readable files. Also included is the default “All Files”, for looking at all files in the directory. ADF files are *WaveWriter* files written in the ADIF format (either .99 or 1.0), ISF files are Instrument Specific Format files, and CSV files are Comma Separated Values files. Compatible files written by other programs may have different extensions. *WaveWriter* can read files of both CSV and CSV (K3) format, automatically distinguishing between the two. See Appendix B for waveform file formats.

**Directories** — Lists the resident hierarchical directory structure including parallel directories. (Used in conjunction with the *Drives* list box below.) Use the *Directories* list box to find the directory that contains the file you want to read in. To switch directories, double-click on the folder for the desired

directory. To move to the root of a drive, double-click on the folder next to the drive name. The associated list boxes will update to reflect the new directory structure.

**Drives** — Use the *Drives* list box to switch drives. Scroll and select the drive you wish to use. The associated list boxes will update to reflect the new directory structure.

**OK** — Loads the selected waveform file as the current waveform or updates the list box if the entry was a wild card. If you specified a nonexistent file in the *File Name* edit box, a warning is issued and you are returned to the edit box. If the specified file name is the same as a file name already in *WaveWriter* memory, you are given the option of replacing the file in memory or creating a file with a different name.

After you select **OK**, *WaveWriter* will attempt to read the file first as an ADIF file, then as a CSV file, and finally as an ISF file.

After *WaveWriter* successfully reads the file as an ADIF or CSV format file, the Associate Waveform with Instrument dialog appears (Figure 3-5).

If *WaveWriter* attempts to read the file as an ISF file, the Choose ISF Source Instrument dialog box will appear (Figure 3-4). If you know the file is not an ISF file, select **Cancel**.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

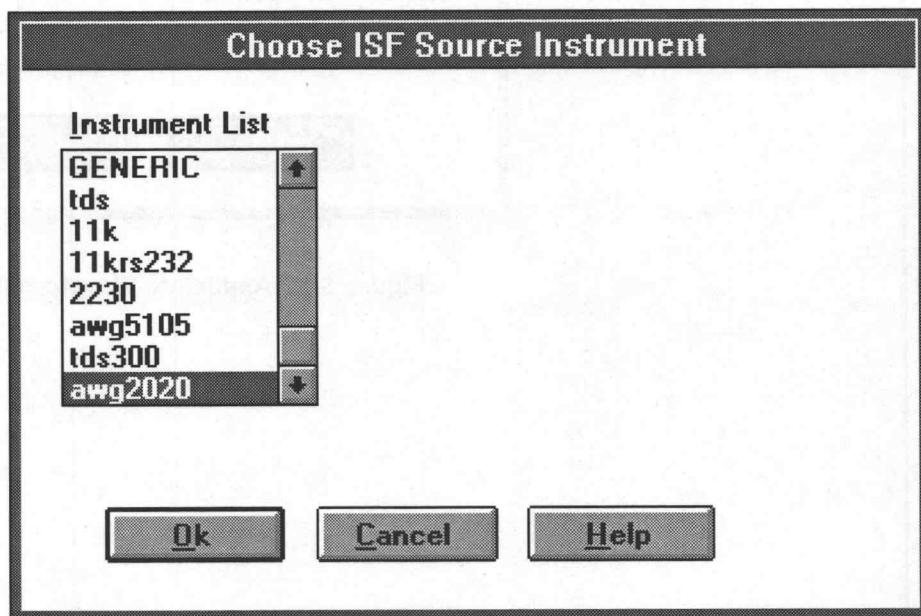


Figure 3-4: Choose ISF Source Instrument Dialog Box

## Choose ISF Source Instrument Dialog Box

**Instrument List** — Associate the ISF file with a source instrument by making a selection from the list.

**OK** — The driver for the selected instrument reads the file in the ISF format.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

**Help** — Select **Help** to display information relating to this menu selection. Use the scroll bar, if present, to read the entire Help text. To return to the previous dialog box, select the **Control-menu** box, then select **Close**.

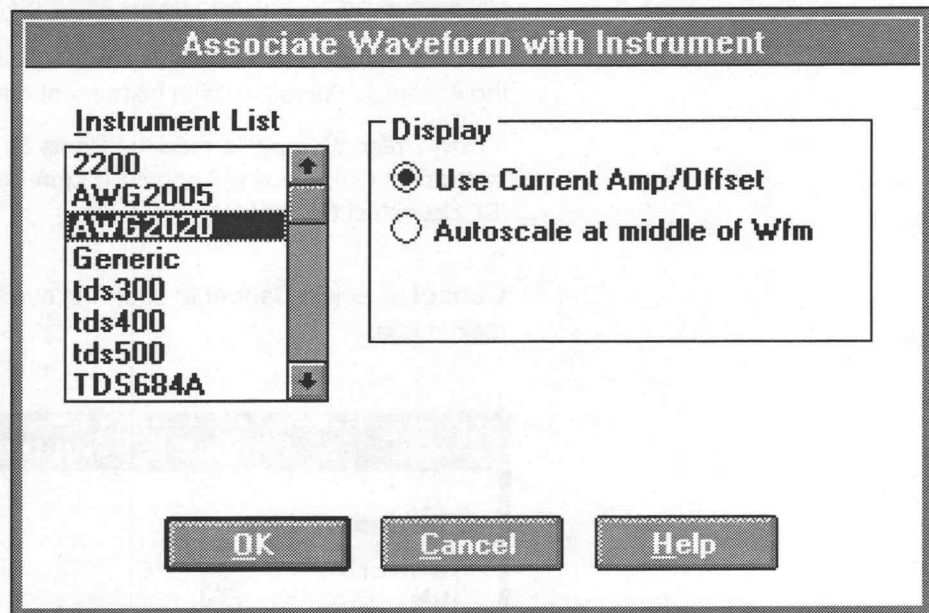


Figure 3-5: Associate Waveform with Instrument Dialog Box

## Associate Waveform with Instrument

**Instrument List** — Associate the waveform with a target instrument by making a selection from the list.

**Display** — Select either of two options: *Use Current Amp/Offset* or *Autoscale at middle of Wfm*.

- **Use Current Amp/Offset** — The Axis Ranges for the new waveform will be identical to those of the current (selected) waveform.
- **Autoscale at middle of Wfm** — The waveform is displayed as if the **Display** → **Autoscale at middle of Wfm** menu were selected.

**OK** — Associates the new waveform with the designated target instrument and adjusts the amplitude offset as specified in the Display group.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

## Data Nonconformance

If the parameters of the waveform you are attempting to load do not match those of the target instrument, several things may occur.

**Vertical** — If the waveform amplitude exceeds the current axis range, the display will be clipped. Use the **Display** → **Autoscale Current Waveform** menu to rescale the display, no data is lost. If the waveform amplitude exceeds the maximum range of the target instrument, Autoscale Current Waveform sets the vertical axis range to the maximum instrument range. That portion of the waveform beyond the instrument range will be shown clipped.

**Horizontal** — If the time per point of the incoming waveform does not match the system clock rate, *WaveWriter* warns you of the mismatch. Choose one of the following actions:

- Change the clock rate of the incoming waveform to the system clock rate.
- Massage (expand or compress) the incoming waveform to maintain a timing match. (See *Horizontal Resolution*, Page 3-26).
- Change the clock rate to match that of the incoming waveform. If the incoming clock rate is not valid for the selected target instrument, the option is grayed and unavailable.
- Cancel the **Open** command.

## Save

The **Save** command stores the current waveform file to disk. The file format, directory path, and resident drive must be specified.

Selecting Save from the File menu displays the dialog box in Figure 3-6.

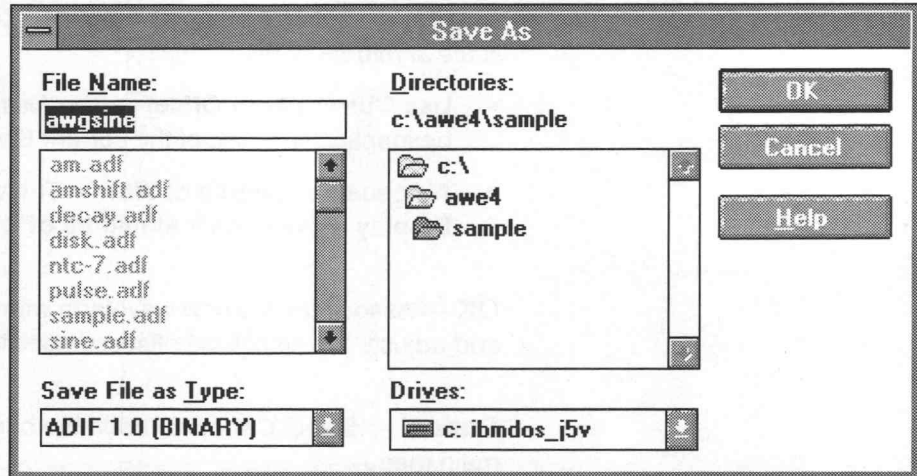


Figure 3-6: Save As Dialog Box

**File Name** — Enter the new or existing name for the waveform to be saved. The eight-character file name and three character extension can be any combination of characters acceptable to the DOS system. If no extension is given, a default extension identifying the file format type will be automatically appended. If an extension **is** included, it will be used instead of the default extension without verification of the selected Save File as Type (file format). To set the write path of the file to be saved, modify the **Directories** and or **Drives** list boxes.

**Save File as Type** — Determines the file format used by *WaveWriter* to store data, regardless of the extension given in the *File Name*.

### File Formats

You can choose from three file formats when saving waveforms: ADIF, ISF, or CSV.

- **ADIF** — The Analog Data Interchange Format saves files in a signal definition format developed at Tektronix and adopted by the Standard Commands for Programmable Instruments (SCPI) Consortium. It is intended to provide a common signal storage format that can be read and used by various instruments and software, both from Tektronix and other vendors. *WaveWriter* writes ADIF .99 (the preliminary version), or ADIF 1.0 ASCII or BINARY (compatible with SCPI 1992.0), depending on your program needs. Use ADIF 1.0 unless other programs using ADIF require Version .99.

- **ISF** — The Instrument Specific File selection saves data in a form read directly by individual target instruments. The actual file format varies according to the instrument. ISF files from other programs may not be compatible with this format.
- **CSV** — The Comma Separated Values selection saves data in an ASCII file where the values are separated by commas. Files can then be read by a spreadsheet or other data manipulation software. Two different CSV formats are selectable. The standard CSV format contains just value information; the CSV (K3) format contains a small amount of additional textual information.

See the *Waveform Formats* Appendix for file format descriptions.

### Extensions

Default extensions for the possible file types are:

- .ADF is appended to files written in the Analog Data Interchange Format.
- .ISF is appended to files written in Instrument Specific Format.
- .CSV is appended to files written in Comma Separated Values Format.

**Directories** — Lists the resident hierarchical directory structure including parallel directories. (Used in conjunction with the *Drives* list box below.) Use the *Directories* list box to find the directory into which you wish to write the file. To switch directories, double-click on the desired folder for that directory. To move to the root of a drive, double-click on the folder next to the drive name. The associated list boxes will update to reflect the new directory structure.

**Drives** — Use the *Drives* list box to switch drives. Scroll and select the drive you wish to use. The associated list boxes will update to reflect the new directory structure.

**OK** — Stores the current waveform file to the specified location using the selected file format. If the specified file name already exists, you are prompted requesting if you want to overwrite the existing file.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

## Import

The **Import** menu selection can be used to retrieve a waveform from a file written by another software system or instrument. You can import from a file written in any of the formats TDS WFM, AWG WFM, TDS ASCII and IQSIM ASCII. Waveforms in Files in general ASCII and binary formats can also be imported.

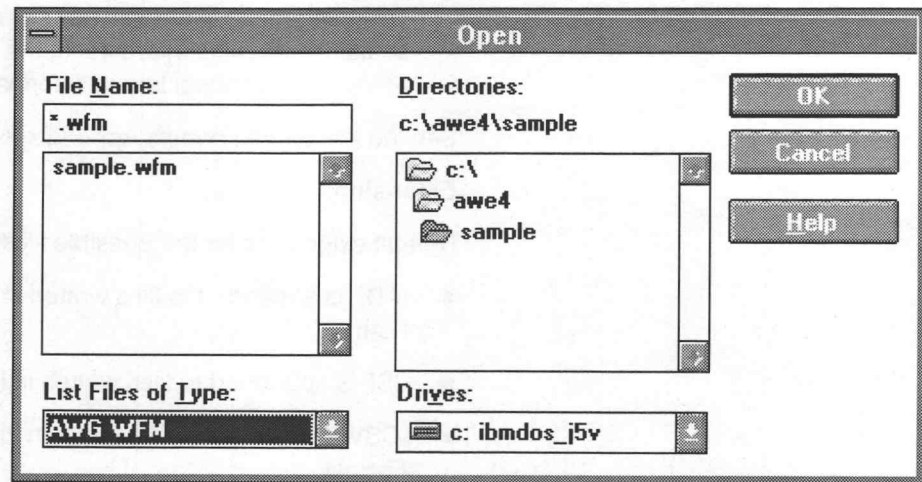


Figure 3-7: The Import Dialog Box

**File Name** — Enter the name of the waveform to be loaded in the *File Name* edit box or click on one of the names in the list box. To change directories or drives, use the *Directories* and/or *Drives* list boxes. You can choose the kind of files listed in the *File Name* list box by selecting entries from the *List Files of Type* list box or by specifying a particular file group with a “wild card” in the *File Name* edit box. For example, to list only files having a “.BIN” extension, enter “\*.BIN”.

**List Files of Type** — Lists the types of files from which *WaveWriter* can import waveforms. The possible types with their customary extension are as follows.

- **TDS WFM (\*.WFM)** — A format used by Tektronix TDS series digital scopes.
- **TDS ASCII (\*.DAT)** — Another format used by Tektronix TDS series digital scopes, but the contents of these files are written in ASCII characters. Certain waveform parameters placed at the top of the files are recognized by *WaveWriter*.
- **AWG WFM (\*.WFM)** — The format used by Sony/Tektronix AWG2000 series Arbitrary Waveform Generators. The format of these files is different from that of TDS WFM files; only the customary extension is the same.



- **IQSIM ASCII (\*.I, \*.Q)** — A format written in ASCII characters produced by signal processing applications such as IQSIM by R&S.
- **BINARY (\*.BIN)** — These files can have a variety of formats which are only similar in that the waveform data they contain is in a binary format. When this format is selected and **OK** is clicked, the user will be prompted for additional parameters to define the exact format. (See the Binary Import Option dialog box in Figure 3-8.)
- **ASCII (\*.ASC)** — These files can have a variety of formats which are only similar in that the waveform data they contain is written in ASCII characters. When this format is selected and **OK** is clicked, the user will be prompted for additional parameters to define the exact format. (See the ASCII Import Option dialog box in Figure 3-9.)

**Directories** — Lists the resident hierarchical directory structure including parallel directories. (Used in conjunction with the *Drives* list box below.) Use the *Directories* list box to find directory that contains the file you want to read in. To switch directories, double-click on the folder for the desired directory. To move to the root of a drive, double-click on the folder next to the drive name. The associated list boxes will update to reflect the new directory structure.

**Drives** — Use the *Drives* list box to switch drives. Scroll and select the drive you wish to use. The associated list boxes will update to reflect the new directory structure.

**OK** — Loads the selected waveform file as the current waveform or updates the list box if the entry was a wild card. If you specified a nonexistent file in the *File Name* edit box, a warning is issued and you are returned to the edit box. If the specified file name is the same as a file name already in *WaveWriter* memory, you are given the option of replacing the file in memory or creating a file with a different name.

For TDS WFM, TDS ASCII, AWG WFM and IQSIM ASCII, directly after you select **OK** *WaveWriter* does some file format checking, and the Associate Waveform with Instrument dialog appears. Refer to Figure 3-5 for the details of this dialog. For BINARY and ASCII files another dialog will appear prompting the user for details of the format of the file to be read.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

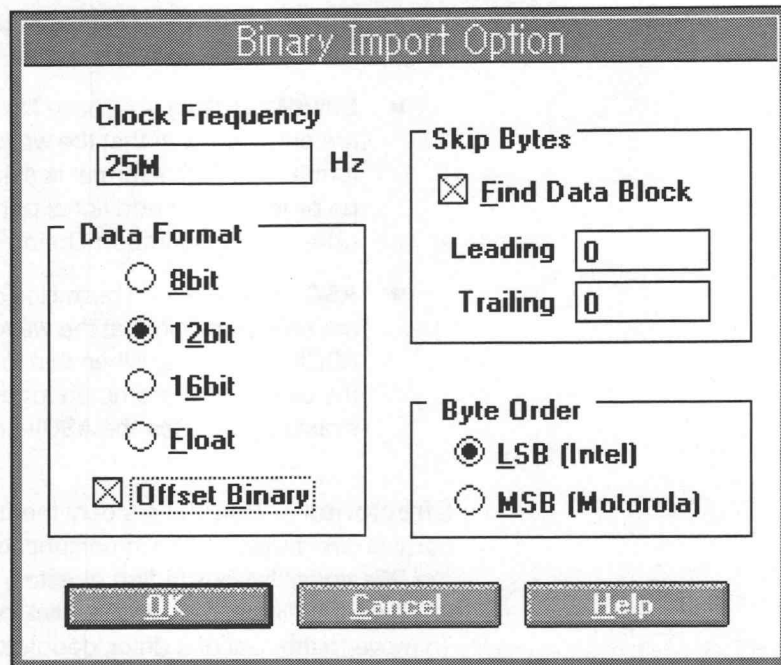


Figure 3-8: Binary Import Option Dialog Box

### Binary Import Option Dialog Box

This dialog is used to define how a binary waveform file is read into *WaveWriter*. Such files can take a wide variety of formats in which waveform points are represented by binary data. By setting the parameters of the read appropriately, *WaveWriter* can be made to extract just the waveform data part of a file, ignoring data that is of no interest or is of unknown format.

The following parameters are available to handle various data formats.

**Clock Frequency** — The default clock rate is initially displayed. You can edit it to set the desired clock frequency.

**Data Size** — This specifies the size of each point; 8, 12 or 16 bits may be selected (for files containing integer point values), or Float (for files containing floating point values). When Float is selected each point value is read in 32-bit floating point format.

**Offset Binary** — Only applicable to integer formats. When this box is checked, the point value data is assumed to be positive (offset) binary. Otherwise, the data is assumed to be signed integer.

**Skip Bytes** — What data you want to be read in is specified by choosing either of the following methods.

- **Find Data Block** — When this box is checked, the input file is assumed to contain an arbitrary data block with a block header of the form #41024... (for example) which specifies the length of the data block. The preceding part of the file is ignored, and the data block is located automatically. GPIB commands often use this method for representing waveform data in a binary format, so this option can be used for reading files containing GPIB commands.
- **Leading, Trailing** — Instead of automatically finding the data, you can specify a number of bytes starting at the top of the input file which will be ignored. You can also specify a number of bytes to be ignored at the end of the input file. The number of data points is determined from the leading and trailing values, and the length of the file.

**Byte Order** — You can specify either LSB or MSB byte ordering for the point values. LSB has the least significant byte first, as produced by Intel x86 processors. MSB has the most significant byte first, as produced by Motorola 680x0 processors.

**OK** — Proceed to the Associate Waveform with Instrument dialog, and after that, read in the waveform data.

**Cancel** — Cancel the Import command.

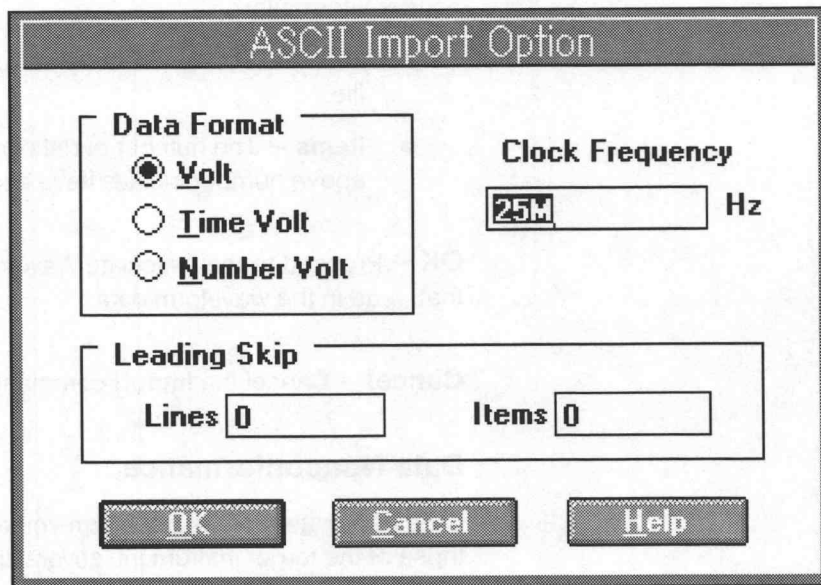


Figure 3-9: ASCII Import Option Dialog Box

## ASCII Import Option Dialog Box

This dialog is used to define how an ASCII waveform file is read into *WaveWriter*. In the file point data is written as floating point numbers. Fractional parts and exponents may be omitted when they are not needed to express the value (e.g. 12.3,  $-4.56e-3$  and 7 will all be accepted).

Spaces, TABs, commas and newlines may be used to separate data items. Using all of these separators in the same file is permitted. A group of separators is equivalent to a single separator.

The following parameters are available to handle various file formats.

**Data Format** – The sort of data that each point is assumed to be represented by can be selected. When Volt is selected, data is read assuming each point is represented by a single voltage value. When Time Volt is selected, data is read assuming each point is represented by a time followed by a voltage. When Number Volt is selected, a point number followed by a voltage is assumed.

**Clock Frequency** – The default clock rate is initially displayed. You can edit it to show the desired clock frequency. If the "Time Volt" data format is selected, the clock rate is derived from the time values in the file, and the Clock Frequency edit box is grayed.

**Leading Skip** – These parameters are useful for ignoring unwanted file header information.

- **Lines** – The number of lines to be ignored from the top of the input file.
- **Items** – The number of data items (tokens) to be ignored after the above number of lines have been skipped.

**OK** – Proceed to the Associate Waveform with Instrument dialog, and after that, read in the waveform data.

**Cancel** – Cancel the **Import** command.

## Data Nonconformance

If the parameters of the waveform you are attempting to load do not match those of the target instrument, several things may occur.

**Vertical** — If the waveform amplitude exceeds the current axis range, the display will be clipped. Use the **Display** → **Autoscale Current Waveform** menu to rescale the display; no data is lost. If the waveform amplitude exceeds the maximum range of the target instrument, Autoscale Current

Waveform sets the vertical axis range to the maximum instrument range. That portion of the waveform beyond the instrument range will be shown clipped.

**Horizontal** — If the time per point of the incoming waveform does not match the system clock rate, *WaveWriter* warns you of the mismatch. Choose one of the following actions:

- Change the clock rate of the incoming waveform to the system clock rate.
- Massage (expand or compress) the incoming waveform to maintain a timing match. (See *Horizontal Resolution*, Page 3-26).
- Change the clock rate to match that of the incoming waveform. If the incoming clock rate is not valid for the selected target instrument, the option is grayed and unavailable.
- Cancel the **Import** command.

## Export

The Export command stores the current waveform to a disk file in a format that is compatible with other application programs or instruments. The file format, directory path, and resident drive must be specified.

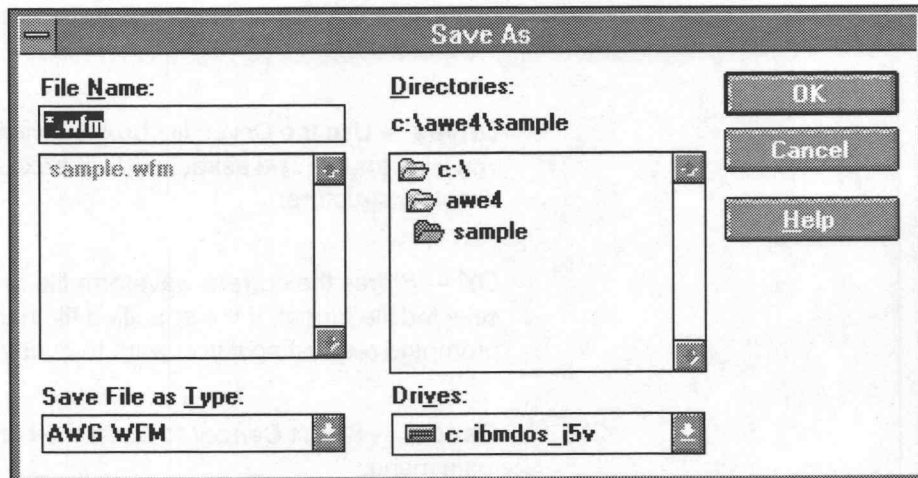


Figure 3-10: The Export Dialog Box

**File Name** — Enter the new or existing name for the waveform to be exported. The eight-character file name and three-character extension can be any combination of characters acceptable to the DOS system. If no extension is given, a default extension identifying the file format type will be automatically appended. If an extension is included, it will be used instead of the

default extension without verification of the selected Save File as Type (file format). To set the write path of the file to be exported, modify the **Directories** and or **Drives** list boxes.

**Save File of Type** — Lists the types of files to which *WaveWriter* can export waveforms. The possible types which the user can select with their customary extensions are as follows.

- **AWG WFM (\*.WFM)** — The native format used by Sony/Tektronix AWG2000 series Arbitrary Waveform Generators.
- **ASCII (Volts) (\*.ASC)** — Each point is represented by a voltage written in ASCII characters.
- **ASCII (Time Volts) (\*.ASC)** — Each point is represented by a time and a voltage written in ASCII characters.
- **ASCII (Time Volts) (\*.ASC)** — Each point is represented by a point number and a voltage written in ASCII characters.

Refer to Appendix B for details of file formats.

**Directories** — Lists the resident hierarchical directory structure including parallel directories. (Used in conjunction with the *Drives* list box below.) Use the *Directories* list box to find directory that contains the file you want to read in. To switch directories, double-click on the folder for the desired directory. To move to the root of a drive, double-click on the folder next to the drive name. The associated list boxes will update to reflect the new directory structure.

**Drives** — Use the *Drives* list box to switch drives. Scroll and select the drive you wish to use. The associated list boxes will update to reflect the new directory structure.

**OK** — Stores the current waveform file to the specified location using the selected file format. If the specified file name already exists, you are prompted requesting if you want to overwrite the existing file.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

## Hardcopy

The **Hardcopy** command sends the current *Waveform Display Area* to the selected printer or plotter. Selecting Hardcopy from the File menu displays the dialog box in Figure 3-11.

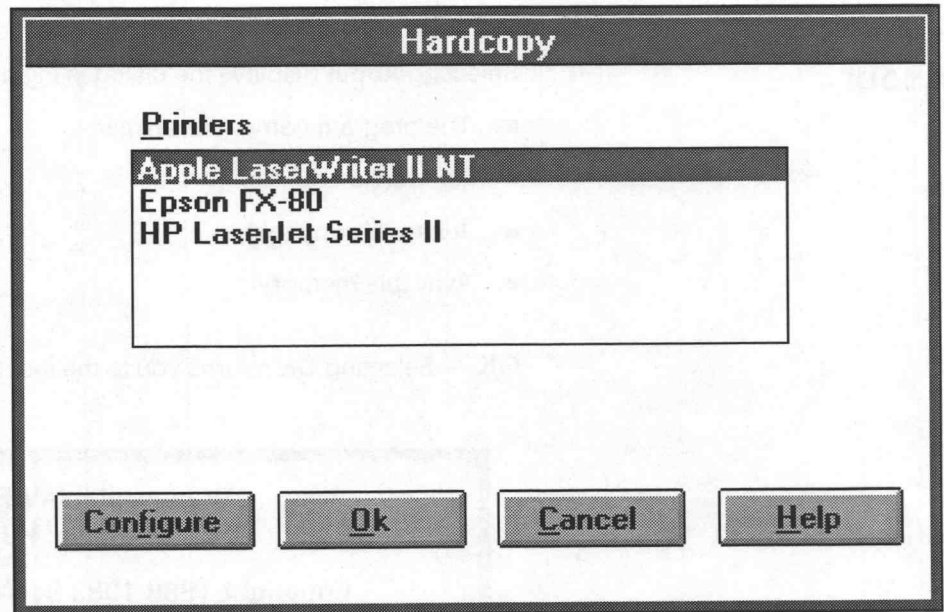


Figure 3-11: Hardcopy Dialog Box

**Printers** — Lists the installed output device drivers; select an output device from the list. To install additional printers, see the *Windows User Guide*.

**Configure** — Displays the *Windows Control Panel*. The panel contains a setup menu for printer selection and configuration. See your *Microsoft Windows Users* manual for more detailed information.

**OK** — Sends the current *Waveform Display Area* to the selected printer or plotter. During data transfer, a *Cancel Print* dialog box appears allowing termination of the print or plot prior to completion.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

**Help** — Select **Help** to display information relating to this menu selection. Use the scroll bar, if present, to read the entire Help text. To return to the Hardcopy dialog box, select the **Control-menu** box, then select *Close*.

---

## Exit

The **Exit** selection ends the *WaveWriter* session and returns you to the Windows Program Manager. If any data has been altered, you are prompted to save it before exiting. The current *WaveWriter* configuration is saved.

---

## About

Selecting **About** displays the dialog in Figure 3-12. The Dialog box lists:

- The program name, *WaveWriter*
- The version number
- Tektronix copyright
- Available memory

**OK** — Selecting **OK** returns you to the main menu.



Figure 3-12: About Dialog Box



# Editing Waveforms

Many waveform modifications are possible without the Draw menu. Use the following **Edit** Menu selections to modify the Current Waveform without redrawing the waveform:

- **Undo** — Cancels the most recent change to the current waveform made by any menus.
- **Disable Undo** — Disables and enables the Undo feature.
- **Cut Between Markers** — Removes a portion of the current waveform; saves the segment in the edit buffer.
- **Copy Between Markers** — Copies a portion of the current waveform; saves the segment in the edit buffer.
- **Delete Between Markers** — Deletes a portion of the current waveform; *does not* save the segment.
- **Insert at Start Marker** — Inserts a copy of the edit buffer into the current waveform.
- **Replace Between Markers** — Deletes a portion of the current waveform and inserts a copy of the edit buffer into its place.
- **Append to End of Waveform** — Appends a copy of the edit buffer to the end of the current waveform.
- **Flip Horizontal Between Markers** — Reverses the current waveform time sequence.
- **Flip Vertical Between Markers** — Inverts the current waveform with instrument offset as the center.
- **Horizontal Resolution** — Expands or compresses the current waveform horizontally.
- **Vertical Resolution** — Modifies waveform data to simulate a lower vertical resolution.

---

## Undo

The **Undo** selection cancels the most recent change to the current waveform. If no modification has been made to the current waveform since it last became the current waveform, or since it was created, this selection is disabled. It can also be explicitly disabled with the **Disable Undo** selection.

## Disable Undo

Toggles the Undo feature between the disabled and enabled state. When a check mark appears to the left of the **Disable Undo** selection, **Undo** is disabled. **Undo** is a very useful feature, and the user is recommended to leave it in the enabled state most of the time. However, when very big waveforms are being edited, **Undo** may take an unacceptable amount of time and disk space. Selecting this menu item will avoid these problems.

---

## Cut Between Markers

Removes that portion of the current waveform between and including the *Start* and *Stop* markers and stores the information in the edit buffer. The *Stop Marker* and the data to its right is shifted to the left to align with the *Start Marker* position. Information stored in the buffer can be pasted to another waveform.

### The Edit Buffer

Information stored in the edit buffer can be pasted into other waveforms using the *Insert at Start Marker*, *Replace Between Markers*, or *Append to End of Waveform* commands. First, select a new current waveform from the Waveforms menu, then implement one of the commands as described below. Edit buffer data is available for multiple insert, replace, and append operations but is replaced when another cut or copy command is selected.

---

## Copy Between Markers

Copies that portion of the current waveform between and including the *Start* and *Stop* markers to the edit buffer. The current waveform does not change.

---

## Delete Between Markers

Removes that portion of the current waveform between and including the *Start* and *Stop* markers. The *Stop Marker*, and the data to its right, shifts left to align with the *Start Marker* position. The deleted waveform segment is not saved in the edit buffer.

---

## Insert at Start Marker

Inserts a copy of the waveform data from the edit buffer into the current waveform at the *Start Marker* location. Waveform data at the *Start Marker* and to the right is moved to align with the end of the inserted data. (This may extend the current waveform beyond its originally defined length.)

The distance between the markers cannot exceed the maximum record length of the target instrument. If insertion of data from the edit buffer causes the *Stop Marker* to go beyond this limit, the *Stop Marker* moves only to the maximum length allowed.

---

## Replace Between Markers

A copy of the waveform data stored in the edit buffer replaces the current waveform between and including the *Start* and *Stop* markers. If the edit buffer data is longer than the segment being replaced, the current waveform extends beyond its originally defined length. If the edit buffer data is shorter than the segment being replaced, the current waveform is shortened.

The distance between markers cannot exceed the maximum record length of the target instrument. If insertion of data from the edit buffer causes the *Stop Marker* to go beyond this limit, the *Stop Marker* moves only to the maximum length allowed.

---

## Append to End of Waveform

Appends a copy of the waveform data stored in the edit buffer to the end of the current waveform following the last data point. This extends the current waveform beyond its originally defined length.

---

## Flip Horizontal Between Markers

Reverses the timing of the current waveform between and including the *Start* and *Stop* markers. What was the the begging of the waveform segment is now the end, and conversely.

---

## Flip Vertical Between Markers

Inverts the polarity of the current waveform (between and including the *Start* and *Stop* markers) around the current external offset.

## Horizontal Resolution

A defined portion of the current waveform can be expanded or compressed along the horizontal axis. Select *Horizontal Resolution* from the Edit menu to specify the processing region; the dialog box shown in Figure 3-13 appears.

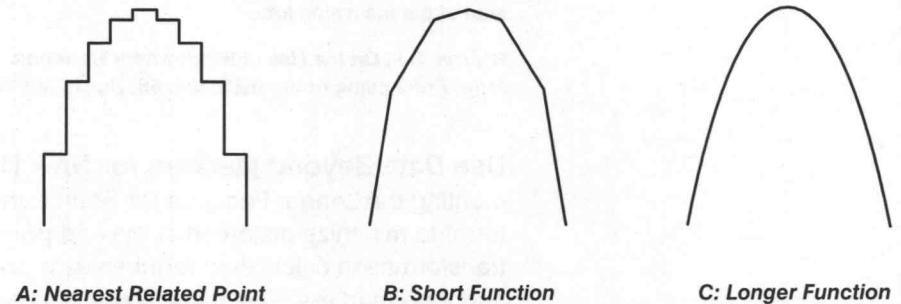
Figure 3-13: Horizontal Resolution Dialog Box

**Processing Region** — Define the length of the waveform affected by the horizontal resolution change:

- When **Entire Wfm** is selected, the *Waveform Interval: Stop – Start* line notes the total length of the waveform in points and seconds.
- When **Between Markers** is selected, the *Interval Between Markers: Stop – Start* line notes the length of the segment between and including the markers in points and seconds.

**New Interval** — Specify the desired length, either the entire waveform or the marked segment. Select either *Points* or *Seconds*.

**Transform Method** — There are three transform methods for redefining the horizontal interval: Nearest Related Point, Short Function, and Longer Function. Figure 3-14 depicts a sine wave transformed by each of these methods.



**Figure 3-14: Three Results of a Sine Wave Transformation**

**Nearest Related Point** — The fastest method of redefining the horizontal interval. Each newly assigned point is given the closest horizontal value to the original point. This method preserves steps in the original waveform.

**Short Function** — The general-purpose method of redefining the horizontal interval. Each new point is calculated using a weighted average of the original points to either side. The weighting function shape is triangular, linearly decreasing as you move away from the new point location. When a waveform interval is increased (more points), the Short Function translates to linear interpolation; the new point is located on a straight line between the two original points. When the new interval is decreased or decimated (fewer points), the triangular weighted average spans four or more original points to calculate each new point. Greater decimation ratios require wider averaging functions.

**Longer Function** — The slowest and most accurate method of redefining the horizontal interval. This method produces smooth band-limited signals (sine waves). Like the Short Function, this method calculates each new point with a weighted average of original points to either side. This weighting function is up to five times as wide as the triangular Short Function. When increasing intervals (interpolating), the weighted average spans ten points, five on each side. When decreasing intervals (decimating), the point span of the average is ten times the ratio of original to new interval lengths. The weighting function shape sinc function  $(\sin(x)/x)^a$  has been windowed<sup>b</sup> to limit its length. Sine waves with at least four points per cycle can be accu-

rately interpolated using the Longer Function (as shown in Figure 3-14C) with errors of less than 0.1%. Similarly, reducing a sine wave interval down to as few as four samples per cycle results in errors less than 0.1%.

<sup>a</sup>The sinc is the ideal interpolation function for sampled band-limited (nonaliased) signals.

<sup>b</sup>The 3-term (-67 dB) Blackman-Harris<sup>c</sup> window spanning the fifth zero crossing on either side of the main sinc lobe.

<sup>c</sup>Harris, F.J., *On the Use of Windows for Harmonic Analysis with the Discrete Fourier Transform*, Proceeding of the IEEE, Vol. 66, No. 1, Jan 1978.

**Use Data Beyond Markers for New Data Calculation** — When implementing the Longer Function (or Short Function when compressing a waveform) to minimize distortion at the end points of the waveform, the transformation calculation requires data points outside the limits of the *Start* and *Stop* markers. Select the **Yes** option button to acquire the data points. If the markers are at the ends of the waveform, extrapolated data points are calculated. If you do not wish to use external data points, select the **No** option button. This group box is grayed (not available for selection) when *Nearest Related Point* is selected.

**OK** — When **OK** is selected, the processing region is resized to the new length. The overall current waveform will lengthen or shorten accordingly.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

**Help** — Select **Help** to display information relating to this menu selection. Use the scroll bar, if present, to read the entire Help text. To return to the previous dialog box, select the **Control-menu** box, then select *Close*.

### NOTE

*Altering the Horizontal resolution does not change the clock rate.*

## Vertical Resolution

The current waveform can be modified to simulate a lower vertical resolution. When **Vertical Resolution** is selected, the dialog box in Figure 3-15 appears. Specify the lower-number bit level

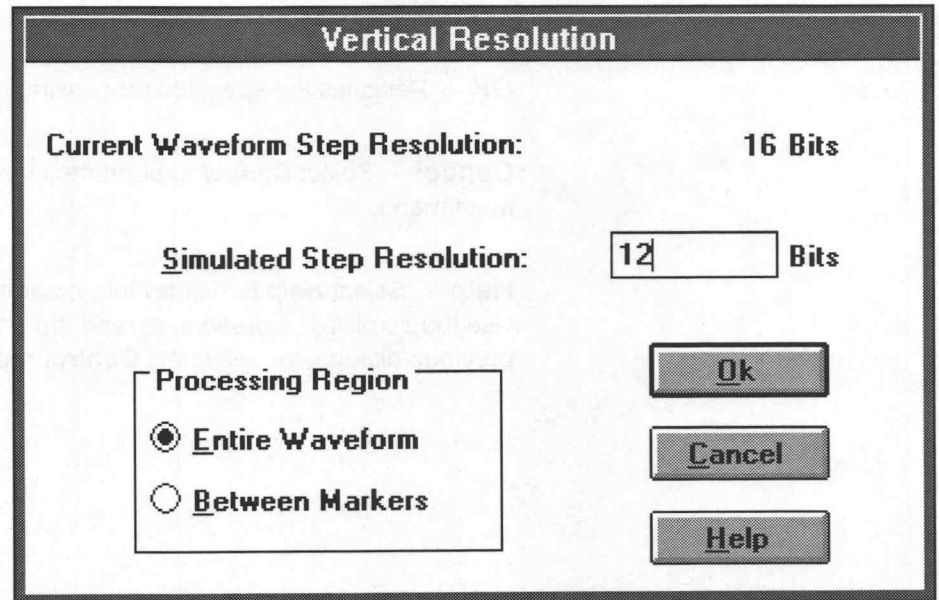


Figure 3-15: Vertical Resolution Dialog Box

**Current Waveform Step Resolution** — Lists the current waveform step resolution in bits.

**Simulated Step Resolution** — Specify the desired vertical resolution to simulate in bits. The number must be less than the *Current Waveform Step Resolution*.



*Once the bit level has been modified, it cannot be returned to a higher level resolution. **Previous waveform data cannot be recovered.** Always save the higher bit level waveform if the data needs to be retained.*

**Processing Region** — Specify the length of the waveform affected by the vertical resolution change:

- **Entire Waveform** — The entire waveform.
- **Between Markers** — That portion of the waveform between and including the markers.

**OK** — Rescales the specified processing region to the new bit levels.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

**Help** — Select **Help** to display information relating to this menu selection. Use the scroll bar, if present, to read the entire Help text. To return to the previous dialog box, select the **Control-menu** box, then select *Close*.



# Displaying Waveforms

Use the following **Display** menu selections to set screen presentation attributes:

- **Redraw Dot** — Displays waveforms in dot format.
- **Redraw Vector** — Displays waveforms in vector format.
- **Zoom In** — Magnifies a portion of the Waveform Display Area.
- **Zoom Out** — Returns the Waveform Display Area to its original size.
- **Set Axis Ranges** — Sets the horizontal and vertical display scale factors.
- **Set Markers** — Positions markers on the current waveform.
- **Autoscale Current Waveform** — Adjusts the display axis to fit the current waveform.
- **Show Crosshairs** — Configures the screen cursor as either a small cross or full-screen crossbars.
- **Show Multiple Waveforms** — Makes background waveforms visible or invisible.
- **Set Colors and Line Styles** — Configures display line styles, backgrounds, labels, and colors.

---

## Redraw Dot

Redraws all displayed waveforms in the dot format; each dot represents a data point of the waveform. Waveforms can also be displayed in Vector format (see below).

---

## Redraw Vector

Redraws all displayed waveforms in vector format; all points are connected with the current (selected) line style. Waveforms can also be displayed in Dot format (see above).

---

## Zoom In

The Zoom selection magnifies a designated portion of the Waveform Display Area to the full display size.

To zoom with the mouse, use the cursor to define the region to be enlarged:

1. Move the cursor to the upper left corner of the area to be magnified.
2. Press and hold the LEFT mouse button and drag the cursor to the lower right corner of the area to be magnified.

3. To set the dimensions and magnify the selected region, release the LEFT mouse button.
4. Zoom again to expand the region even further or *Zoom Out* to return to the standard view.

To zoom from the keyboard:

1. Use the direction keys to position the cursor at the upper-left corner of the area to be magnified.
2. When the cursor is at the correct starting point, press either **[SPACEBAR]** or **[ENTER]**.
3. With the direction keys, position the cursor at the lower-right corner of the area to be magnified.
4. To set the dimensions and magnify the selected portion of the display, press either **[SPACEBAR]** or **[ENTER]**.

---

## Zoom Out

Returns the Waveform Display Area to the *Set Axis Ranges* settings that existed prior to Zoom In.

---

## Set Axis Ranges

Sets the Waveform Display Area vertical and horizontal axis ranges. If the ranges are set to display a partial waveform, those portions of the waveform extending beyond the display area are clipped. The entire waveform can be restored by setting a wider range in the *Set Axis Ranges* dialog box.

Selecting *Set Axis Ranges* displays the dialog box in Figure 3-16.

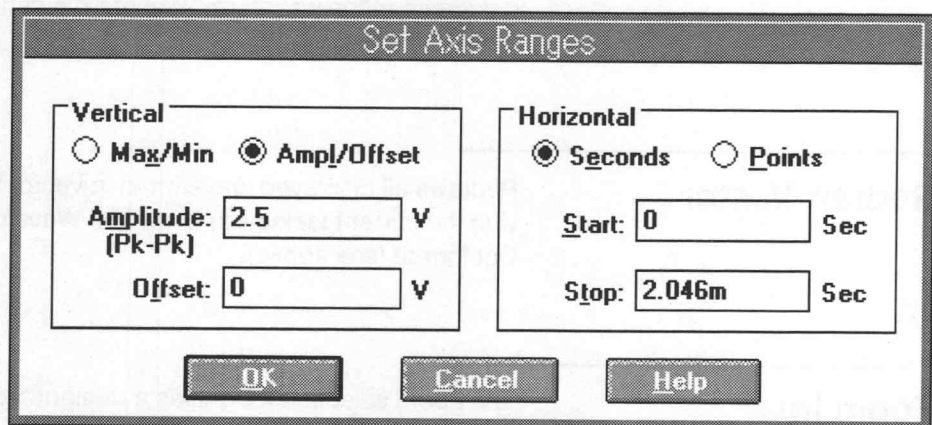


Figure 3-16: Set Axis Ranges Dialog Box

**Vertical** — To set the vertical scale, select either the Max/Min or Amp/Offset option button:

- If **Max/Min** is selected, enter the maximum and minimum peak values for the vertical axes in the *Max* and *Min* edit boxes. For example, 2.5 V<sub>max</sub> to -2.5 V<sub>min</sub> is 5 volts peak to peak.
- If **Amp/Offset** is selected, enter the peak-to-peak amplitude in the *Amplitude (Pk-Pk)* edit box. (A 5 V entry is +2.5 V peak to -2.5 V peak). Enter a positive or negative vertical offset in the *Offset* edit box if desired.

*WaveWriter* queries each target instrument for its valid range of Amplitude/Offset values. The display range is then mapped to the full vertical resolution of each instrument when sending or receiving files.

**Horizontal** — To set the horizontal scale, select either **Seconds** or **Points**. Figure 3-16 shows the Points option button selected.

The Start and Stop edit boxes define the horizontal limits of the Waveform Display Area. Since Points is selected in Figure 3-16, the units describing the edit boxes is "Pts". If Seconds were selected, "Sec" would be displayed.

Selection of Seconds or Points also affects the horizontal axis label, the Start and Stop marker readouts, and the X-coordinate readout in *WaveWriter*'s main window.

**OK** — Sets the vertical and horizontal axis scales to the specified ranges.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

**Help** — Select **Help** to display information relating to this menu selection. Use the scroll bar, if present, to read the entire Help text. To return to the previous dialog box, select the **Control-menu** box, then select *Close*.

### Set Markers

Sets the Markers to the display locations specified. Selecting **Set Markers** displays the dialog box shown in Figure 3-17. Enter the desired *Start* and *Stop* marker locations and select either *Points* or *Seconds*. Marker settings do not affect the Set Axis Ranges.

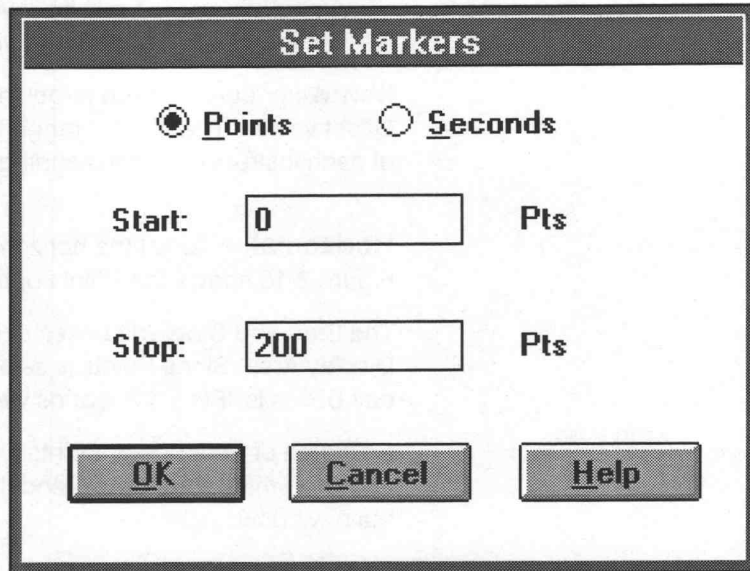


Figure 3-17: Set Markers Dialog Box

For lengthy waveforms, setting the markers manually may be more effective than placing the marker flags with the mouse or keyboard.

**NOTE**

*Selecting Point or Seconds in this window does not affect the units used for displaying horizontal ranges and positions in WaveWriter's main window. Use Set Axis Ranges to set these units.*

---

## Autoscale Current Waveform

The **Autoscale Current Waveform** selection is used to scale the horizontal display so that the entire length of the waveform is displayed within the range of the X-axis, while simultaneously adjusting the vertical scale in a number of user selectable ways.

### At Zero Volts

*At Zero Volts* centers the waveform at zero volts and uses the waveform absolute voltage to set the maximum and minimum vertical range.

### At Given Volts

*At Given Volts* recenters the display to a user-specified vertical offset and adjusts the vertical range to accommodate the waveform. Figure 3-18 shows the Offset dialog box.

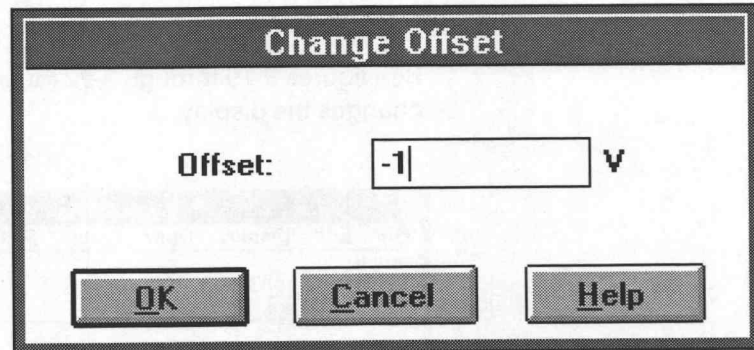


Figure 3-18: Change Offset Dialog Box

**Offset** — Enter the external offset in volts.

**OK** — Calculates the new display amplitude and verifies that the Amplitude/Offset is valid for the target instrument. If the new amplitude is greater than the maximum allowable amplitude, the range is adjusted to the maximum. If the new amplitude is smaller than the allowable minimum amplitude, the range is adjusted to the minimum. If the Offset is out of range, it is adjusted to zero.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

**Help** — Select **Help** to display information relating to this menu selection. Use the scroll bar, if present, to read the entire Help text. To return to the previous dialog box, select the **Control-menu** box, then select *Close*.

### At Middle of Wfm

*At Middle of Wfm* centers the display around the waveform. The center of the waveform is placed at the display offset and the maximum and minimum voltages become the max/min ranges of the display.

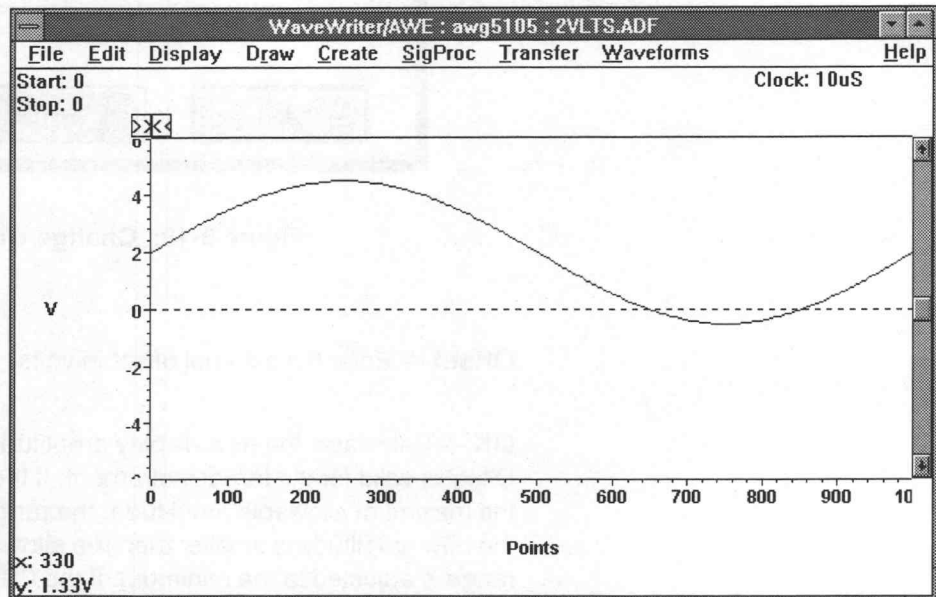
### Horizontal Axis

Simply automatically scales the horizontal axis without changing the vertical scale. Convenient for quickly setting the horizontal scale for the best overall view of the current waveform.

**NOTE**

*In all cases, the number of points in the waveform is used to adjust the horizontal scale. If full display of the waveform cannot be accomplished (because of amplitude/offset limits), waveform data will be clipped on the display, but not lost.*

See figures 3-19 through 3-22 for examples of how each Autoscale menu changes the display.



**Figure 3-19: Before Autoscaling**

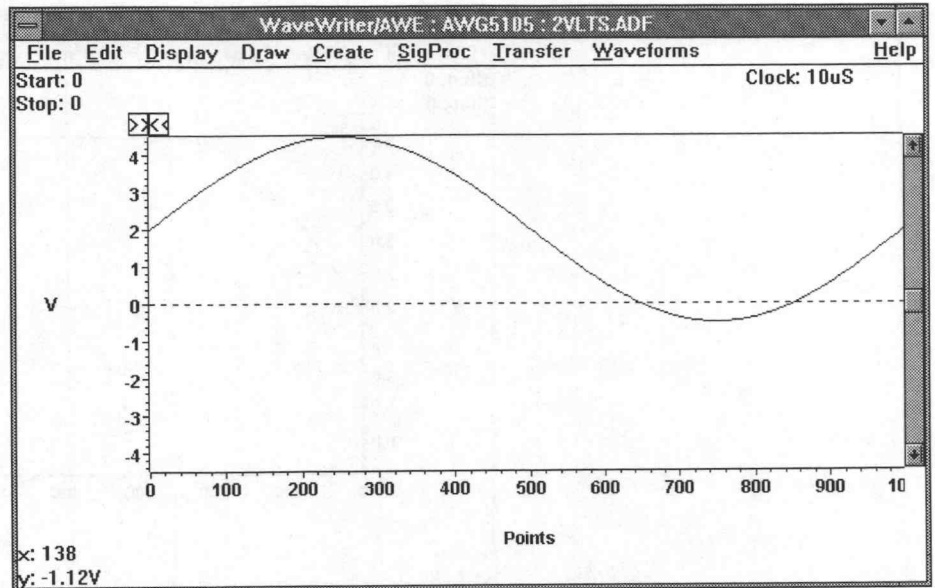


Figure 3-20: After Autoscale at Zero Volts

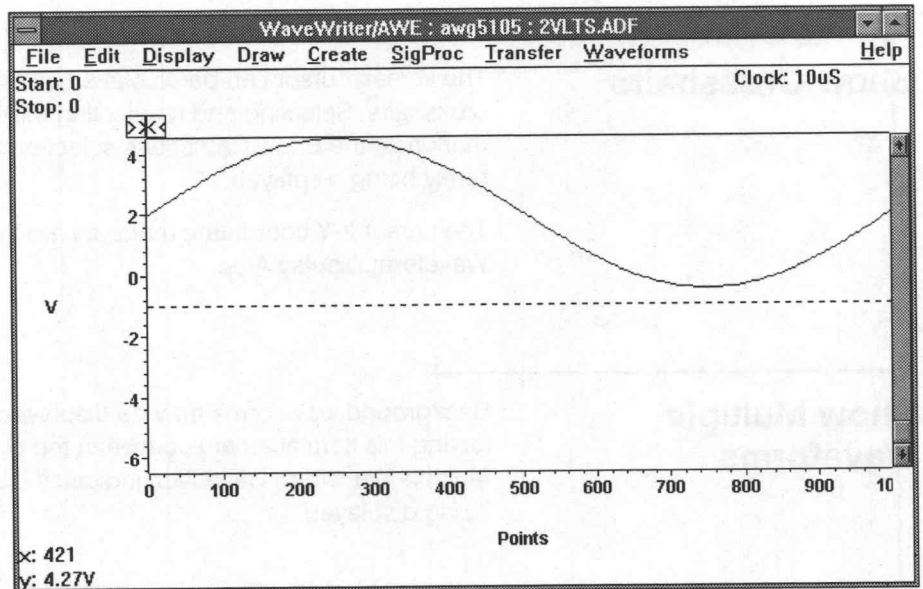


Figure 3-21: After Autoscale at Offset of -1 volt

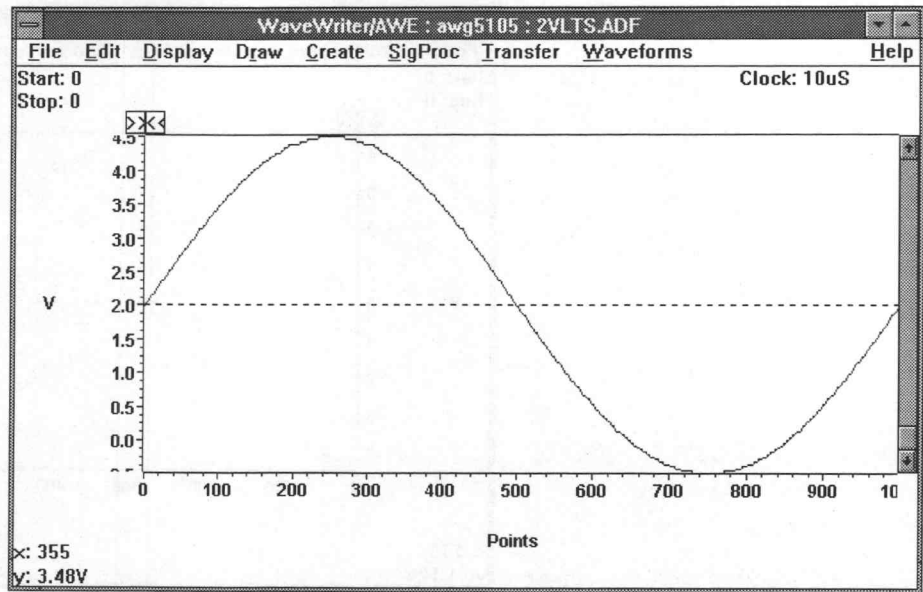


Figure 3-22: After Autoscale at Middle of Wfm

---

## Show Crosshairs

The screen cursor can be displayed as either a small cross or full-screen crosshairs. Selecting and reselecting this item alternates the two. A check mark next the Show Crosshairs selection indicates the crosshairs are currently being displayed.

The cursor X/Y coordinate readouts are located in the lower-left corner of the Waveform Display Area.

---

## Show Multiple Waveforms

Background waveforms may be displayed or invisible. Selecting and reselecting this item alternates between the two. A check mark next to the Show Multiple Waveforms selection indicates background waveforms are currently being displayed.

---

## Set Colors and Line Styles

If several waveforms are displayed on screen simultaneously, differentiating one waveform from another can be difficult. To minimize confusion, many display elements can be assigned separate attributes:

- Waveforms in memory can be assigned individual colors and line styles.
- A color and line style can be assigned to the current waveform. (Temporarily overriding any identical attribute assigned to another waveform in memory.)

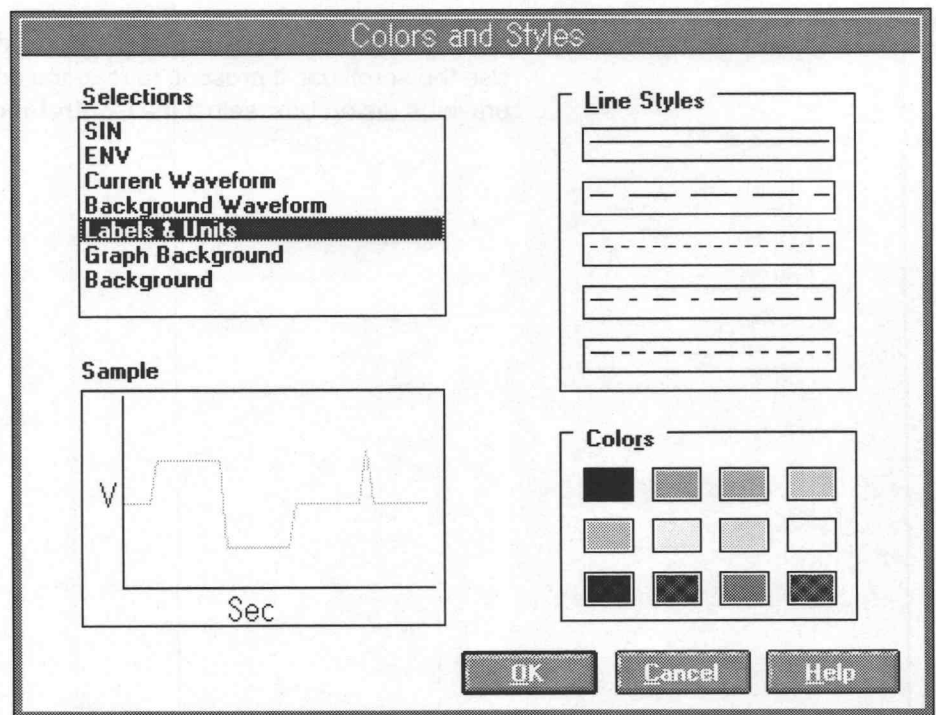


- A color and line style can be assigned to all background waveforms in general. (Default attributes are used until you specifically assign attributes to a waveform.)
- Labels and units in the Waveform Display Area can be assigned a color.
- The graph background can be assigned a color.
- The window background can be assigned a color.

**NOTE**

*Select colors with care. If the elements of a waveform and background are identical, the waveform will not be visible. If this occurs, reselect one or both colors.*

When you select *Set Colors and Line Styles* from the Display menu, the dialog box in Figure 3-23 appears.



**Figure 3-23: Colors and Styles Dialog Box**

**Selections** — In addition to the current waveform, an attribute can be assigned to each display element in the list box. Highlight the items to be assigned attributes.

**Sample** — Displays an example of the selected element with the attributes chosen from the *Line Styles* and *Colors* group boxes. Selecting elements and attributes and viewing examples, does not alter the selected item until **OK** is selected.

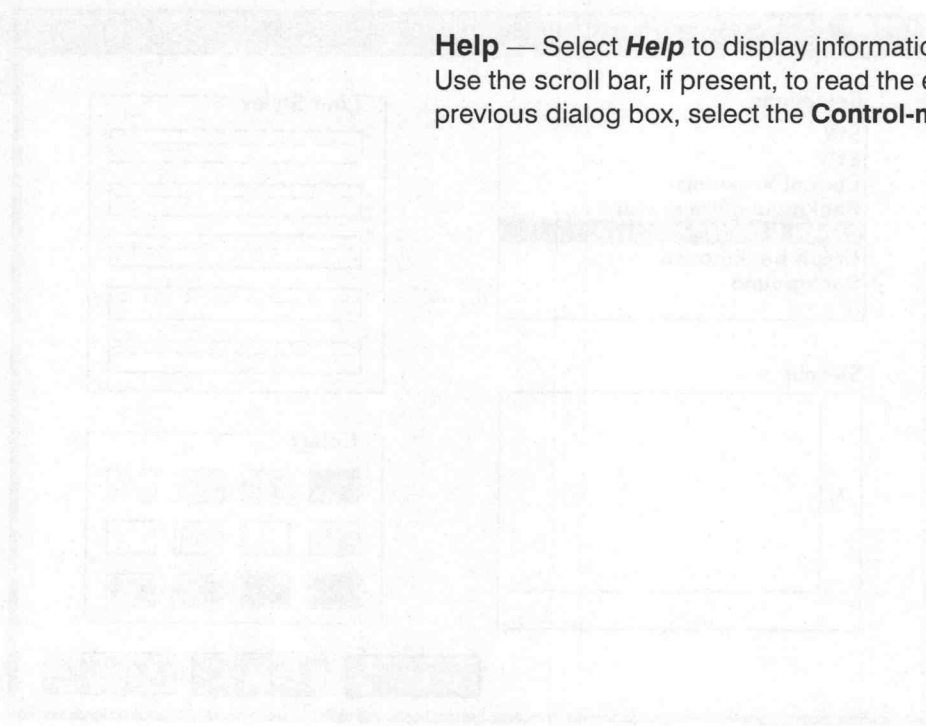
**Line Styles** — Select one of the available line styles. The specified style is identified by a heavy black border. Line styles may not be apparent without sufficient intervals between waveform data points. Line Style is visible in vector mode only.

**Colors** — Select one of the displayed colors. The specified color is identified by a heavier black border.

**OK** — After setting each attribute, select **OK** to affect the changes.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

**Help** — Select **Help** to display information relating to this menu selection. Use the scroll bar, if present, to read the entire Help text. To return to the previous dialog box, select the **Control-menu** box, then select *Close*.



# Drawing Waveforms

The **Draw** menu provides tools for modifying waveforms. Waveforms can be new, opened, acquired, or created. The tools are simple to use and can help you create precise and repeatable waveform segments. Selections in the **Draw** menu are:

- **Nodraw** — The initial and default state.
- **Freehand** — A waveform segment is defined by moving the cursor.
- **Horizontal** — Similar to Freehand, except a line segment can only be defined in a horizontal direction from its start point.
- **Vertical** — Similar to Freehand, except a line segment can only be defined in a vertical direction from its start point.
- **Autoline** — A waveform segment is defined by Start and Stop points.
- **Envelope Max Don't Care** — Similar to Horizontal; defines an upper limit "don't care" voltage acceptance range (envelope waveforms only).
- **Envelope Min Don't Care** — Similar to **Horizontal**; defines a lower limit "don't care" voltage acceptance range (envelope waveforms only).
- **Envelope Max** — Specifies the waveform envelope upper limit to be drawn (envelope waveforms only).
- **Envelope Min** — Specifies the waveform envelope lower limit to be drawn (envelope waveforms only).

You can use one Draw menu selection at a time, unless working with a waveform envelope. With waveform envelopes, identify the portion of the envelope to be modified with *Envelope Max* or *Envelope Min*.

## Drawing Segments

With the exception of Nodraw, the operation of each Draw menu selection is similar. With a waveform selected from memory, you can use either the keyboard or mouse to draw waveform segments. If the keyboard is used, make your selection from the Draw menu and press **[ENTER]**. Use the direction keys to position the cursor at the starting line segment location. Press **[ENTER]** or **[SPACEBAR]**. With the direction keys, move the cursor to mark the ending line segment location. Press **[ENTER]** or **[SPACEBAR]** to fill in the line.

### NOTE

*To access a waveform for drawing, the cursor must be within the limits of the Waveform Display Area. When moving the cursor with the direction keys, pressing **[CONTROL]** + **[DIRECTION]** moves the cursor faster.*

## Coordinates

The Cursor X/Y coordinate readouts are continually updated as the cursor moves, allowing accurate positioning of the cursor. Vertical changes in cursor position indicate a change in voltage, whereas horizontal changes in cursor position indicate a change in time or points (whichever is selected).

## Screen Redraw

In "draw" mode, pressing the RIGHT mouse button redraws the screen.

---

## Nodraw

**Nodraw** terminates the current drawing mode. Nodraw is automatically selected if you choose an operation from any other menu.

---

## Freehand

When **Freehand** is selected, moving the cursor in the horizontal and vertical directions defines the waveform.

To draw a waveform freehand with the Mouse:

1. Select *Freehand* from the Draw menu.
2. Move the cursor to the desired starting point for the line segment. Press and **hold** the LEFT mouse button to enable drawing.
3. Move the mouse in the desired direction and a line segment follows from the starting point to wherever the cursor moves.
4. When the cursor reaches the desired end point, release the LEFT mouse button to discontinue the line segment and disable drawing.

To draw a waveform freehand from the Keyboard:

1. Select *Freehand* from the Draw menu and press **[ENTER]**.
2. Use the direction keys to move the cursor to the desired starting point for the line segment. Press either **[ENTER]** or **[SPACEBAR]** to enable drawing.
3. Press the direction keys to extend the line segment in the desired direction.
4. Press either **[ENTER]** or **[SPACEBAR]** to end the line segment and disable drawing.

---

## Horizontal

When **Horizontal** is selected, movement of the cursor in the horizontal direction defines the waveform. Vertical movement of the mouse or direction keys is ignored.

To draw a horizontal line with the Mouse:

1. Select *Horizontal* from the Draw menu.
2. Move the cursor to the desired starting point for the line segment. Press and **hold** the LEFT mouse button to enable drawing.
3. Move the mouse in the horizontal direction, a line segment extends from the start point to the horizontal position of the cursor.
4. When the cursor reaches the desired end point, release the LEFT mouse button to discontinue the line segment and disable drawing.

To draw a horizontal line with the Keyboard:

1. Select *Horizontal* from the Draw menu and press **[ENTER]**.
2. Use the direction keys to move the cursor to the desired starting point for the line segment. Press either **[ENTER]** or **[SPACEBAR]** to enable drawing.
3. Press the direction keys to extend the line segment in the desired direction. The line extends horizontally originating from the start point.
4. Press either **[ENTER]** or **[SPACEBAR]** to end the line segment and disable drawing.

## Vertical

When **Vertical** is selected, movement of the cursor in the vertical direction defines the waveform. Horizontal movement of the mouse or direction keys is ignored.

To draw a vertical line with the Mouse:

1. Select *Vertical* from the Draw menu.
2. Move the cursor to the desired starting point for the line segment. Press and **hold** the LEFT mouse button to enable drawing.
3. Move the mouse in a vertical direction, a line segment extends from the start point to the vertical position of the cursor.
4. When the cursor reaches the desired end point, release the LEFT mouse button to discontinue the line segment and disable drawing.

To draw a vertical line with the Keyboard:

1. Select *Vertical* from the Draw menu and press **[ENTER]**.
2. Use the direction keys to move the cursor to the desired starting point for the line segment. Press either **[ENTER]** or **[SPACEBAR]** to enable drawing.
3. Press the direction keys to extend the line segment in the desired direction. The line extends vertically originating from the start point.
4. Press either **[ENTER]** or **[SPACEBAR]** to end the line segment and disable drawing.

---

## Autoline

Use the **Autoline** selection to draw a series of line segments where the end point of one line is the starting point of the next. You can draw line segments at any angle.

To use *Autoline* with the Mouse:

1. Select *Autoline* from the Draw menu.
2. Move the cursor to the desired starting point of a line segment. Click (but do not hold) the LEFT mouse button to enable drawing.
3. Use the mouse to extend the line segment in the desired direction (a line extends from the starting point to the cursor position).
4. When the cursor reaches the desired end point, click the LEFT mouse button to discontinue the line segment. The end point of this line is now the starting point for the next line. Move the mouse in a different direction and click the LEFT mouse button to add another line segment (if desired).
5. To complete an Autoline series, click the RIGHT mouse button to redraw the display and disable drawing.

To use *Autoline* from the Keyboard:

1. Select *Autoline* from the Draw menu and press **[ENTER]**.
2. With the direction keys, move the cursor to the desired starting point of a line segment. Press either **[ENTER]** or **[SPACEBAR]** to enable drawing.
3. Use the direction keys to extend the line segment in the desired direction (a line extends from the starting point to the cursor position).
4. When the cursor reaches the desired end point, press either **[ENTER]** or **[SPACEBAR]** to discontinue the line segment. The end point of this line is now the starting point for the next line. With the direction keys, move the mouse in a different direction and press either **[ENTER]** or **[SPACEBAR]** to add additional line segments (if desired).
5. To complete an Autoline series, press **[ESCAPE]** to redraw the display and disable drawing.

---

## Envelope Max Don't Care

The **Envelope Max Don't Care** selection is similar to the Horizontal menu selection. With this command, you can draw a "don't care" acceptance range for the upper limit of the waveform envelope. The "don't care" bit level is determined by the target instrument as the maximum bit level the instrument supports. When you select this option, the "don't care" level is used any time you draw outside the display axis range.

To use *Envelope Max Don't Care* with the Mouse:

1. Select *Envelope Max Don't Care* from the Draw menu.
2. Move the cursor to the desired starting point for the line segment. Press and **hold** the LEFT mouse button to enable drawing.
3. Move the mouse in the horizontal direction, a line segment extends from the start point to the horizontal position of the cursor.
4. When the cursor reaches the desired end point, release the LEFT mouse button to discontinue the line segment and disable drawing.
5. Repeat for additional line segments.

To use *Envelope Max Don't Care* from the Keyboard:

1. Select *Envelope Max Don't Care* from the Draw menu and press **[ENTER]**.
2. Use the direction keys to move the cursor to the desired starting point. Press either **[ENTER]** or **[SPACEBAR]** to enable drawing.
3. Press the direction keys to extend the line segment in the desired direction. The line extends in a horizontal direction originating from the start point.
4. Press either **[ENTER]** or **[SPACEBAR]** to end the line segment and disable drawing.
5. Repeat for additional line segments.



---

## Envelope Min Don't Care

The **Envelope Min Don't Care** selection is similar to the Horizontal menu selection. With this command you can draw a "don't care" acceptance range for the lower limit of the waveform envelope. The "don't care" bit level is determined by the target instrument as the minimum bit level the instrument supports. When you select this option, the "don't care" value is used anytime you draw outside the display axis range.

To use *Envelope Min Don't Care* with the Mouse:

1. Select *Envelope Min Don't Care* from the Draw menu.
2. Move the cursor to the desired starting point for the line segment. Press and **hold** the LEFT mouse button to enable drawing.
3. Move the mouse in the horizontal direction, a line segment extends from the start point to the horizontal position of the cursor.
4. When the cursor reaches the desired end point, release the LEFT mouse button to discontinue the line segment and disable drawing.
5. Repeat for additional line segments.

To use *Envelope Min Don't Care* from the Keyboard:

1. Select *Envelope Min Don't Care* from the Draw menu and press **[ENTER]**.
2. Use the direction keys to move the cursor to the desired starting point. Press either **[ENTER]** or **[SPACEBAR]** to enable drawing.
3. Press the direction keys to extend the line segment in the desired direction. The line extends in a horizontal direction originating from the start point.
4. Press either **[ENTER]** or **[SPACEBAR]** to end the line segment and disable drawing.
5. Repeat for additional line segments.

---

## Envelope Max

To modify the upper limit of the current envelope, select **Envelope Max** followed by a selection from the Draw menu.

---

## Envelope Min

To modify the lower limit of the current envelope, select **Envelope Min** followed by a selection from the Draw menu.

### **NOTE**

*When creating envelopes, Max values should be greater than Min values. Waveforms created with incorrect limits will fail.*

# Creating Waveforms

Use the **Create** menu to configure waveforms for your target instrument. The possible configurations are approximately equivalent to the output of a multifunction signal generator. Create, modify, or combine waveforms and set waveform limits with the following menu selections:

- **Equation** — Create a waveform from an equation. The equation entry defines the characteristics of the waveform.
- **Sine** — Create sine waves from specified parameters.
- **Triangle** — Create triangle waves from specified parameters.
- **Pulse** — Create waveform pulses from specified parameters.
- **Square** — Create square waves from specified parameters.
- **Envelope Tolerance** — Define an envelope waveform by adding vertical and or horizontal tolerances to existing normal or envelope waveforms.
- **Envelope Couple** — Use two waveforms to define the upper and lower boundaries of an envelope.
- **Envelope Decouple** — Separate an envelope waveform into two uncoupled waveforms, one defined by the upper boundary of the envelope, and the other by the lower boundary.

## Parameter Definitions

The following terms are used in the menu discussions to follow. Most terms are general; some terms are waveform specific and identified as such.

**Amplitude** — The peak-to-peak magnitude of a waveform.

**Offset** — Deviation of a waveform from a base or reference level. Also called baseline offset. This parameter is incorporated into the waveform data.

**Max, Min** — The highest and lowest amplitude levels of a waveform. If you enter a maximum and minimum level, offset is calculated as the level half-way between *Max* and *Min*, and *Amplitude* is set to *Max* minus *Min*.

**Frequency/Period** — Determined by the number of points in a waveform and the specified clock rate. The calculation is based on *Start Point*, *Stop Point*, or the number of *Cycles* by menu selection.

**Pulse Width** — The time interval a pulse is at 50% or more of its peak amplitude. Calculation is based on *Start Point*, *Stop Point*, and *Cycles*. See Figure 3-24.

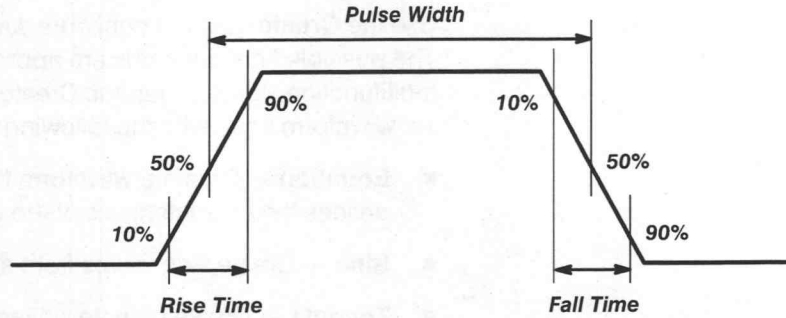


Figure 3-24: Timing Parameters

**Cycles** — The number of times the waveform alternates through its starting point. Calculation is based on *Start Point*, *Stop Point*, and *Frequency*.

**Phase** — Specifies the waveform starting point expressed as an angular deviation from a reference point. Can be expressed in degrees or radians.

**Start Point** — The position, in time or points, at which the waveform begins. Calculation is based on *Stop Point*, *Frequency*, and *Cycles*. The Start Point is different from, and does not necessarily coincide with, the *Start Marker*.

**Stop Point** — The position, in time or points, at which the waveform ends. Calculation is based on *Start Point*, *Frequency*, and *Cycles*. The Stop Point is different from, and does not necessarily coincide with, the *Stop Marker*.

**Rise/Fall Type** — Positive and negative going transitions can be defined as either *Ramp* or *Sine Squared*. (See Figure 3-25.) If *Ramp* is selected, the complete transition time is 1.25 times the entered transition time. If *Sine Squared* is selected, the complete transition time is 2.073878 times the entered transition time.

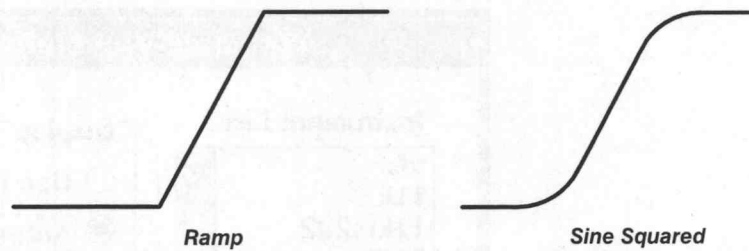


Figure 3-25: Ramp vs. Sine Squared

**Rise/Fall Time** — The transition time between 10 and 90 percent of the rising or falling amplitude. See Figure 3-24.

**Duty Cycle** — The ratio of the pulse duration to the period, expressed in percent.

**Delay** — The difference between the beginning of a waveform and the beginning of a pulse wave transition. Can be specified in either points or time. The *Delay* cannot be a point or a time beyond the length of the waveform.

#### NOTE

*Some parameter combinations may result in an "Invalid number" error message. For example, the Start Point cannot be a negative value.*

### Setting Waveform Characteristics

You define waveform characteristics by setting or modifying parameters in dialog boxes that follow a Create menu selection.

If you created a new waveform and are closing an Equation, Sine, Triangle, Pulse, or Square dialog box (with **OK**), the Associate Waveform with Instrument dialog box appears as shown in Figure 3-26.

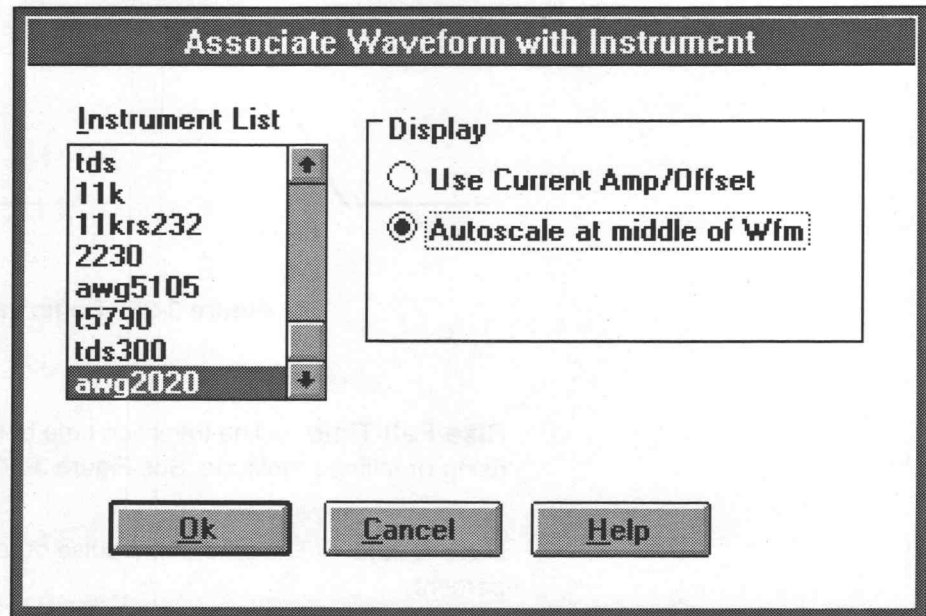


Figure 3-26: Associate Waveform with Instrument Dialog Box

Complete the dialog boxes with the following selections.

**Instrument List** — Associate the new waveform with a target instrument from the *Instrument List* box.

**Display** — Select one of two options:

- **Use Current Amp/Offset** — The Axis Ranges for the new waveform will be identical to those of the current (selected) waveform.
- **Autoscale at middle of Wfm** — The waveform is displayed as if the **Display Autoscale at middle of Wfm** menu were selected.

**OK** — Associates the new waveform with the designated target instrument and adjusts the amplitude offset as specified in the Display group.

**Cancel** — Select **Cancel** to abort and return to the main menu.

**Help** — Select **Help** to display information relating to this menu selection. Use the scroll bar, if present, to read the entire Help text. To return to the previous dialog box, select the **Control-menu** box, then select *Close*.

## Equation

You can create waveforms from an equation. The equation defines the characteristics of the waveform mathematically. Equations can be saved in the library (see *Add Equation to Library*) and recalled for future use (see *Library*). When you select *Equation* from the Create menu, the dialog box in Figure 3-27 appears.

### Equation Elements

You need to consider and set the following elements when creating an equation:

- **Start/Stop Points** — The *Start* and *Stop Points* describe the time range (*t*) from the beginning to the end of the waveform segment. Enter the point values in either points or seconds. Points are converted to time when the calculation is complete.
- **Time (*t*)** — Time is the running variable represented by *t*. When creating an equation, *t* is initially the time at the *Start Point* and is incremented to the time at the *Stop Point*. This is true for all actions except “insert”. In this case, time is initially zero and increments to time = (Stop – Start).
- **Clock Rate** — The system clock rate.
- **Frequency** — Defined as:  $1/(\text{points/cycle} \times \text{clock rate})$
- **Amplitude** — The waveform amplitude.
- **Offset** — The DC offset of the waveform.

The screenshot shows the 'Equation' dialog box with the following details:

- Title:** Equation
- Equation:** 1.5+2.0\*sin(2\*pi\*1000\*t)
- Horizontal:**
  - Start Point: 0
  - Stop Point: 999
  - Radio buttons:  Points,  Seconds
- Action:**
  - Replace
  - Insert
  - Add
  - New Waveform
- Waveform Name:** 1khzsin
- Buttons:** Add Equation to Library, Library, Ok, Cancel, Help

Figure 3-27: Equation Dialog Box

**Equation** — The *Equation* edit box allows entry of a mathematical expression to define the waveform. Character and operator entries must be a string with no spaces.

WaveWriter supports the following operators:

( )	parenthesis	+	addition
-	subtraction	*	multiplication
/	division	^	exponentiation

The following functions are supported:

<b>sqrt ()</b>	square root	<b>sin/sine ()</b>	sine
<b>cos ()</b>	cosine	<b>tan ()</b>	tangent
<b>asin ()</b>	arcsine	<b>acos ()</b>	arccosine
<b>atan ()</b>	arctangent	<b>sinh ()</b>	hyperbolic sine
<b>cosh ()</b>	hyperbolic cosine	<b>tanh ()</b>	hyperbolic tangent
<b>abs ()</b>	absolute value	<b>ceil ()</b>	ceiling
<b>floor ()</b>	floor	<b>log10 ()</b>	log <sub>base10</sub>
<b>log ()</b>	natural log	<b>rand</b>	random noise
<b>exp ()</b>	exponentiation, base e		

The statement **pi** can be substituted for the numeric value of the symbol  $\pi$ .

**Horizontal** — The *Start Point* and *Stop Point* for the equation can be set in either *Points* or *Seconds*. Note that the equation start and stop points are not the same as the *Start Marker* and *Stop Marker*. The values entered in these edit boxes define the range of the time variable (**t**) when the waveform is calculated.

**Action** — Specify the placement of the new waveform:

- **Replace** — Writes over the current waveform between and including the equation *Start* and *Stop* points, calculating the waveform at time = start to time = stop.
- **Insert** — Inserts the newly defined equation waveform into the current waveform beginning at the equation *Start Point*. The previously defined portion of the current waveform (after and including the equation *Start Point*) shifts to follow the end of the inserted waveform. The waveform is calculated at time = 0 to time = (stop – start).
- **Add** — Arithmetically adds the newly defined equation waveform to the current waveform between and including the equation *Start* and *Stop* points.
- **New Waveform** — Creates a new waveform. You are prompted to enter a new waveform name. If the equation *Start Point* is not defined as zero, all data points preceding *Start* are set to zero volts. The equation *Stop Point* defines the end of the waveform.

**Waveform Name** — If you select *New Waveform*, this edit box is displayed. Enter a name for the new waveform.



**Add Equation to Library** — This feature adds newly created equations to the library. You are prompted for a name to identify the new waveform; selecting **OK** accepts the name. WaveWriter does not check for duplicate library filenames.

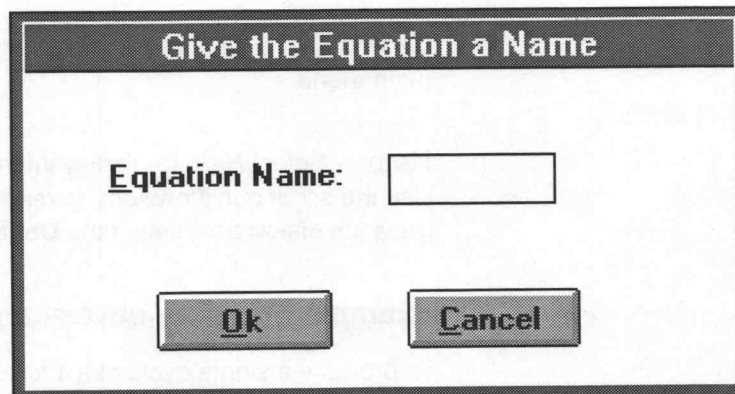


Figure 3-28: Give the Equation a Name Dialog Box

**Library** — Use this selection to access the Equation library. A list of equations appears as shown in Figure 3-29. Highlight to select an equation from the list.

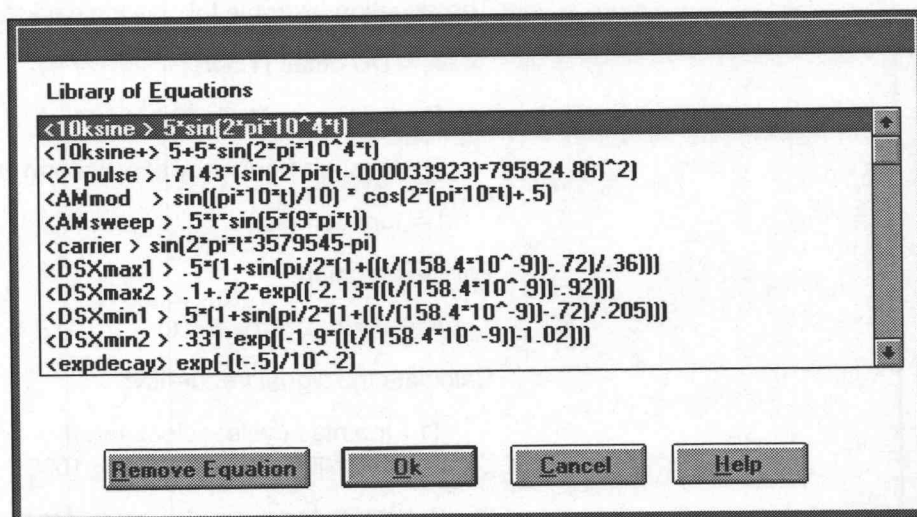


Figure 3-29: Library of Equations List Box

- **Remove Equation** — Removes a highlighted equation from the library list.
- **OK** — Accepts deletions, if any, and returns to the Equation dialog box. The selected equation is placed in the Equation edit box.

- **Cancel** — Ignores deletions and returns to the *Equation* dialog box.
- **Help** — Select **Help** to display information relating to this operation.

**OK** — Select **OK** to implement the specified parameters.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

**Help** — Select **Help** to display information relating to this menu selection. Use the scroll bar, if present, to read the entire Help text. To return to the previous dialog box, select the **Control-menu** box, then select *Close*.

### Example Equation (AWG 2020)

To produce a single cycle of a 1 kHz sine wave with a 4 V peak-to-peak amplitude and +1.5 VDC offset:

1. Set the clock rate to "1 $\mu$ s" with the **Waveforms** → **Change Clock Rate** menu.
2. Select *Points* on the **Create** → **Equation** menu and enter the following parameters:

Start Point = 0

Stop Point = 999

The equation example follows the basic form for trigonometric functions:

A = DC offset (1.5 V)

B = peak amplitude (2.0 V)

F = desired frequency of waveform (1 kHz)

f = function (sin)

For the equation:

$$A + B \times f ( 2 \times \pi \times F \times t )$$

Calculate the signal frequency:

$$[1 / (\text{points} / \text{cycle} \times \text{clock rate})]$$

$$F = 1 / (1000 \times (1 \times 10^{-6})) = 1000$$

3. Substitute the example values into the equation and enter into the *Equation* edit box:

$$1.5 + 2.0 * \sin(2 * \pi * 1000 * t)$$

4. Select the *New Waveform* option button and enter a name for the waveform in the *Name Waveform* edit box. Select **OK** to proceed to the next step.

5. When the Associate Waveform with Instrument dialog box appears, select *GENERIC* from the Instrument List and click the *Autoscale at middle of Wfm* option button.
6. Select **OK** to create the waveform, then implement **Display** → **Auto-scale Current Waveform** → **At Zero Volts** to view its full amplitude.

The waveform should be identical to that shown in Figure 3-30.

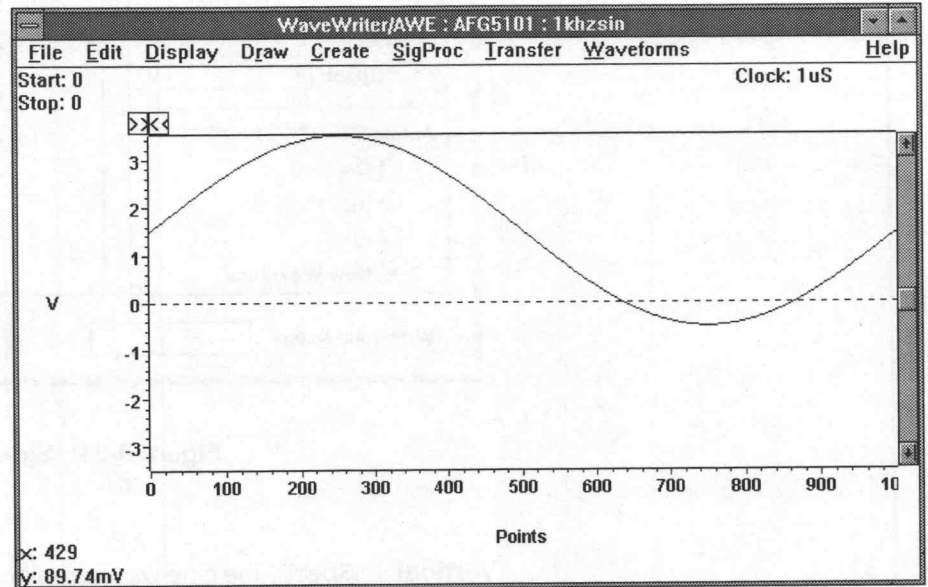


Figure 3-30: Equation Example

You can find additional equation examples in the Sample Equations section of the *Appendices*.

## Sine

When you select **Sine** from the Create menu, the dialog box in Figure 3-31 appears. Use the dialog box to specify sine wave parameters.

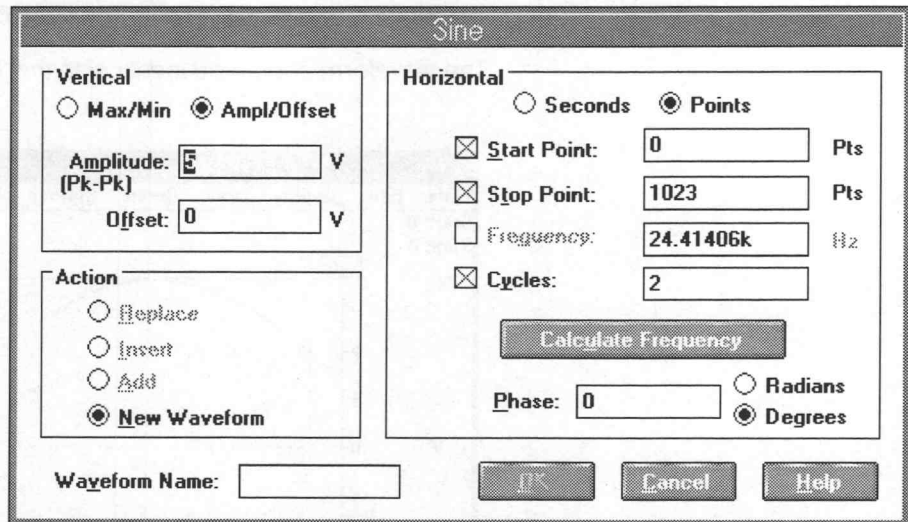


Figure 3-31: Sine Dialog Box

**Vertical** — Specify the sine wave amplitude parameters:

- **Max/Min** — Enter the highest desired voltage level in the *Max* edit box and lowest level in the *Min* box. Values should not exceed the limits of the target instrument.
- **Ampl/Offset** — Enter the desired peak-to-peak voltage in the *Amplitude* edit box. Enter the offset voltage in the *Offset* edit box. For example, a waveform with 4 V peak-to-peak amplitude and a 1 V offset would vary from –1 to 3 V. Values should not exceed the limits of the target instrument.

**Horizontal** — Specify the sine wave horizontal parameters:

### NOTE

*Clock Rate is a fundamental parameter used in calculating waveforms. Use the **Waveforms** → **Change Clock Rate** menu to set the system clock rate.*

- **Seconds** — Specify that the units for the *Start* and *Stop Point* parameters are in seconds.
- **Points** — Specifies that the units for the *Start* and *Stop Point* parameters are in points

- **Start Point** — Enter (or calculate) the horizontal starting position of the sine wave. Do not confuse the *Start Point* location with the *Start Marker* location. They are not necessarily the same point.
- **Stop Point** — Enter (or calculate) the horizontal ending location of the sine wave. Do not confuse the *Stop Point* location with the *Stop Marker* location. They are not necessarily the same point.
- **Frequency** — Enter (or calculate) the frequency of the waveform.
- **Cycles** — Enter (or calculate) the number of cycles to be created. The sine wave extends from the Start Point to the Stop Point over the defined number of cycles.

One of the last four parameters above will always be calculated automatically when **OK** is pressed. If the check box against a parameter is checked, the parameter must be set by the user. To set it so that it will be calculated automatically, click on the check box so that its check mark disappears. When you do this the check marks will appear in the boxes for the (other) parameters that must be set by the user.

- **Calculate <....>** — Selecting this button causes the indicated parameter (the one with the empty check box) to be calculated so that you can preview it prior to selecting **OK**. In Figure 3-31, Start Point, Stop Point and Cycles was entered, and Frequency was calculated. Selecting this button is optional: if you do not select it, the value will be calculated automatically when **OK** is selected.
- **Phase** — Enter the beginning phase of the sine wave in radians or degrees.

**Action** — Specify the placement of the sine wave:

- **Replace** — Writes over the current waveform between and including the Start and Stop Points.
- **Insert** — Inserts the sine wave into the current waveform at the Start Point. The previously defined portion of the current waveform (after and including the Start Point ) shifts to follow the end of the inserted waveform.
- **Add** — Arithmetically adds the sine waveform to the current waveform between and including the Start and Stop Points.
- **New Waveform** — Creates a new waveform. You are prompted to enter a new waveform name. If the *Start Point* is not defined as zero, all data points preceding Start are set to zero volts. Stop defines the end of the waveform.

**Waveform Name** — Identify the new waveform by entering a DOS-compatible file name. The Waveform Name edit box appears only when *New Waveform* is selected in the Action group box.

**OK** — Select **OK** to implement the defined parameters and create the sine wave.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

**Help** — Select **Help** to display information relating to this menu selection. Use the scroll bar, if present, to read the entire Help text. To return to the previous dialog box, select the **Control-menu** box, then select *C*lose.

## Triangle

When you select **Triangle** from the Create menu, the dialog box in Figure 3-32 appears.

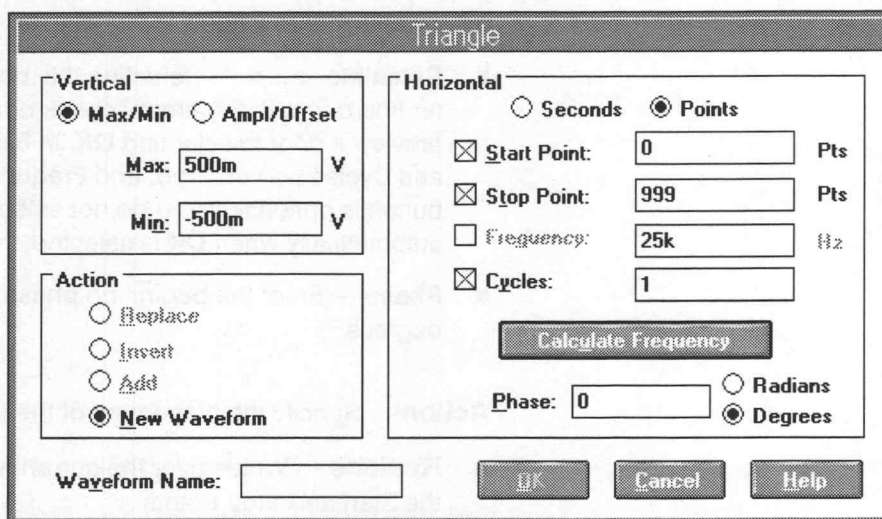


Figure 3-32: Triangle Dialog Box

**Vertical** — Specify the triangle wave amplitude parameters:

- **Max/Min** — Enter the highest desired voltage level in the *Max* edit box and lowest level in the *Min* box. Values should not exceed the limits of the target instrument.
- **Ampl/Offset** — Enter the desired peak-to-peak voltage in the *Amplitude* edit box. Enter the offset voltage in the *Offset* edit box. For example, a waveform with 4 V peak-to-peak amplitude and a 1 V offset would vary from  $-1$  to 3 V. Values should not exceed the limits of the target instrument.

**Horizontal** — Specify the triangle wave horizontal parameters:

**NOTE**

*Clock Rate is a fundamental parameter used in calculating waveforms. Use the **Waveforms** → **Change Clock Rate** menu to set the system clock rate.*

- **Seconds** — Specifies that the units for the *Start* and *Stop Point* parameters are in seconds.
- **Points** — Specifies that the units for the *Start* and *Stop Point* parameters are in points.
- **Start Point** — Enter (or calculate) the horizontal starting position of the triangle wave. Do not confuse the *Start Point* location with the *Start Marker* location. They are not necessarily the same point.
- **Stop Point** — Enter (or calculate) the horizontal ending location of the triangle wave. Do not confuse the *Stop Point* location with the *Stop Marker* location. They are not necessarily the same point.
- **Frequency** — Enter (or calculate) the frequency of the waveform.
- **Cycles** — Enter (or calculate) the number of cycles to be created. The triangle wave extends from the *Start Point* to the *Stop Point* over the defined number of cycles.

One of the last four parameters above will always be calculated automatically when **OK** is pressed. If the check box against a parameter is checked, the parameter must be set by the user. To set it so that it will be calculated automatically, click on the check box so that its check mark disappears. When you do this the check marks will appear in the boxes for the (other) parameters that must be set by the user.

- **Calculate <....>** — Selecting this button causes the indicated parameter (the one with the empty check box) to be calculated so that you can preview it prior to selecting **OK**. In Figure 3-31, *Start Point*, *Stop Point* and *Cycles* was entered, and *Frequency* was calculated. Selecting this button is optional: if you do not select it, the value will be calculated automatically when **OK** is selected.
- **Phase** — Enter the beginning phase of the triangle wave in radians or degrees.

**Action** — Specify the placement of the triangle wave:

- **Replace** — Writes over the current waveform between and including the *Start* and *Stop Points*.
- **Insert** — Inserts the triangle wave into the current waveform at the *Start Point*. The previously defined portion of the current waveform (after and including the *Start Point* ) shifts to follow the end of the inserted waveform.

- **Add** — Arithmetically adds the triangle waveform to the current waveform between and including the Start and Stop points.
- **New Waveform** — Creates a new waveform. You are prompted to enter a new waveform name. If the Start Point is not defined as zero, all data points preceding Start are set to zero volts. Stop defines the end of the waveform.

**Waveform Name** — Identify the new waveform by entering a DOS-compatible file name. The Waveform Name edit box appears only when *New Waveform* is selected in the Action group box.

**OK** — Select **OK** to implement the defined parameters and create the triangle wave.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

**Help** — Select **Help** to display information relating to this menu selection. Use the scroll bar, if present, to read the entire Help text. To return to the previous dialog box, select the **Control-menu** box, then select *Close*.



## Pulse

When you select **Pulse** from the Create menu, the dialog box in Figure 3-33 appears.

Figure 3-33: Pulse Wave Dialog Box

**Vertical** — Specify the pulse amplitude parameters:

- **Maximum** — Enter the highest desired voltage level in this edit box. The value should not exceed the limit of the target instrument.
- **Minimum** — Enter the lowest desired voltage level in this edit box. The value should not exceed the limit of the target instrument.

**Horizontal** — Specify the pulse horizontal parameters as well as other functions:

### NOTE

*Clock Rate is a fundamental parameter used in calculating waveforms. Use the **Waveforms** → **Change Clock Rate** menu to set the system clock rate.*

- **Seconds** — Specify that the units for the *Start* and *Stop Point* parameters are in seconds.

- **Points** — Specify that the units for the *Start* and *Stop Point* parameters are in points
- **Start Point** — Enter (or calculate) the horizontal starting position of the pulse. Do not confuse the *Start Point* location with the *Start Marker* Location. They are not necessarily the same point.
- **Stop Point** — Enter (or calculate) the horizontal ending location of the pulse. Do not confuse the *Stop Point* location with the *Stop Marker* Location. They are not necessarily the same point.
- **Period** — Enter (or calculate) the period of the waveform.
- **Cycles** — Enter (or calculate) the number of cycles. The pulse extends from the *Start Point* to the *Stop Point* over the defined number of cycles.

One of the last four parameters above will always be calculated automatically when OK is pressed. If the check box against a parameter is checked, it must be set by the user. To set it so that it will be calculated automatically, click on the check box so that its check mark disappears. When you do this the check marks will appear in the boxes for the (other) parameters that must be set by the user.

- **Calculate <....>** — Selecting this button causes the indicated parameter (the one with the empty check box) to be calculated so that you can preview it prior to selecting **OK**. In Figure 3-33, *Start Point*, *Stop Point* and *Cycles* was entered, and *Period* was calculated. Selecting this button is optional: if you do not select it, the value will be calculated automatically when **OK** is selected.
- **Delay** — Enter the delay before the first transition.
- **Pulse Width** — Enter the width of the pulse at 50% of the peak-to-peak amplitude.

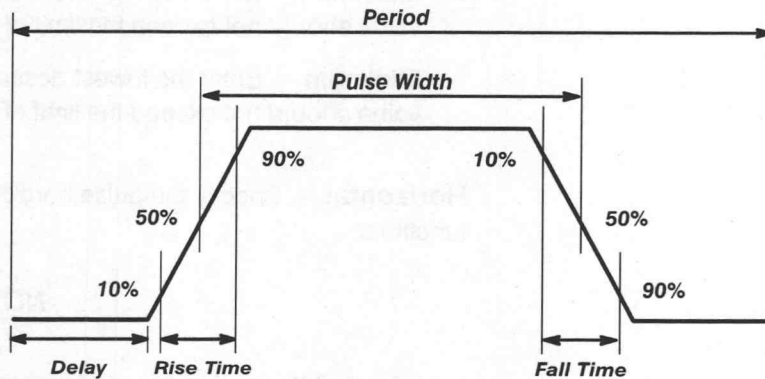


Figure 3-34: Pulse Timing Parameters

**Transitions** — Define the pulse transition parameters:

- **Pulse Direction** — Specify whether the leading edge of the pulse is Positive (*Pos*) going or Negative (*Neg*) going.
- **Risetime** — Enter the horizontal distance required for the leading edge of a pulse from 10 to 90% of its amplitude. (Amplitude is the difference between the Maximum and Minimum values entered.)

**Ramp** — When selected, the contribution of the transition time to the period is 1.25 times the entered transition time. See Figure 3-35.

**Sine<sup>2</sup>** — When selected, the contribution of the transition time to the period is 2.073878 times the entered transition time. See Figure 3-35.

- **Falltime** — Enter the horizontal distance required for the trailing edge of a pulse from 90 to 10% of its amplitude. (Amplitude is the difference between the Maximum and Minimum values entered.)

**Ramp** — When selected, the contribution of the transition time to the period is 1.25 times the entered transition time. See Figure 3-35.

**Sine<sup>2</sup>** — When selected, the contribution of the transition time to the period is 2.073878 times the entered transition time. See Figure 3-35.

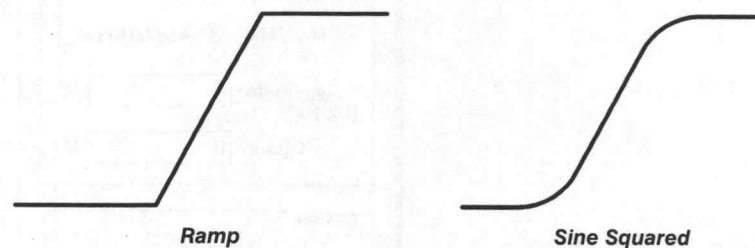


Figure 3-35: Ramp vs. Sine<sup>2</sup>

**Action** — Specify the placement of the pulse waveform:

- **Replace** — Writes over the current waveform between and including the Start and Stop Points.
- **Insert** — Inserts the pulse into the current waveform at the Start Point. The previously defined portion of the current waveform (after and including the Start Point) shifts to follow the end of the inserted waveform.
- **Add** — Arithmetically adds the pulse waveform to the current waveform between and including the Start and Stop points.
- **New Waveform** — Creates a new waveform. You are prompted to enter a new waveform name. If the Start Point is not defined as zero, all data points preceding Start are set to zero volts. Stop defines the end of the waveform.

**Waveform Name** — Identify the new waveform by entering a DOS-compatible file name. The Waveform Name edit box appears only when *New Waveform* is selected in the Action group box.

**OK** — Select **OK** to implement the defined parameters and create the pulse.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

**Help** — Select **Help** to display information relating to this menu selection. Use the scroll bar, if present, to read the entire Help text. To return to the previous dialog box, select the **Control-menu** box, then select *Close*.

## Square

When you select **Square** from the Create menu, the dialog box in Figure 3-36 appears.

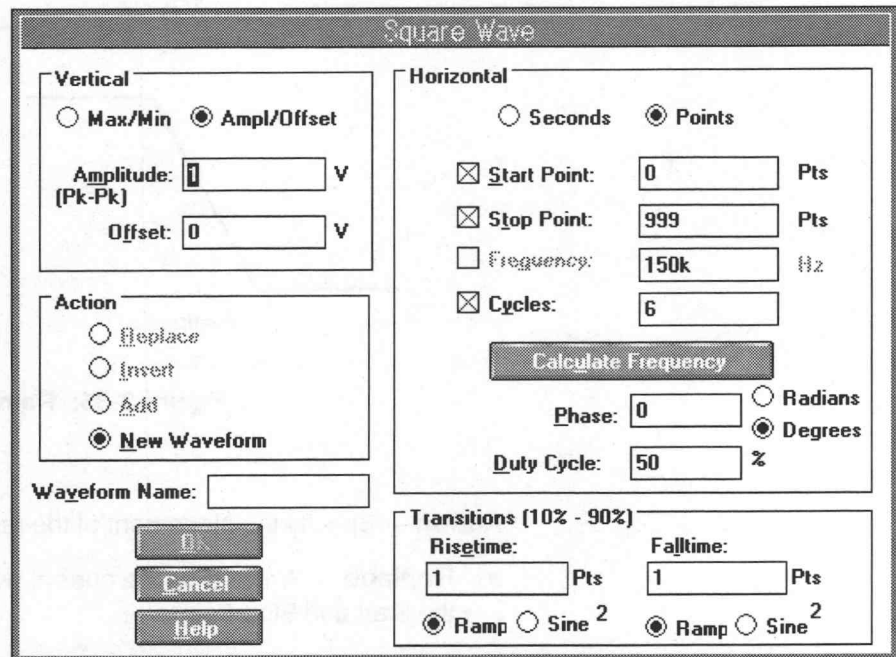


Figure 3-36: Square Wave Dialog Box

**Vertical** — Specify the square wave amplitude parameters:

- **Max/Min** — Enter the highest desired voltage level in the *Max* edit box and lowest level in the *Min* box. Values should not exceed the limits of the target instrument.
- **Ampl/Offset** — Enter the desired peak-to-peak voltage in the *Amplitude* edit box. Enter the offset voltage in the *Offset* edit box. For example, a waveform with 4 V peak-to-peak amplitude and a 1 V offset would vary from -1 to 3 V. Values should not exceed the limits of the target instrument.

**Horizontal** — Specify the square wave horizontal parameters:

#### NOTE

*Clock Rate is a fundamental parameter used in calculating waveforms. Use the **Waveforms** → **Change Clock Rate** menu to set the system clock rate.*

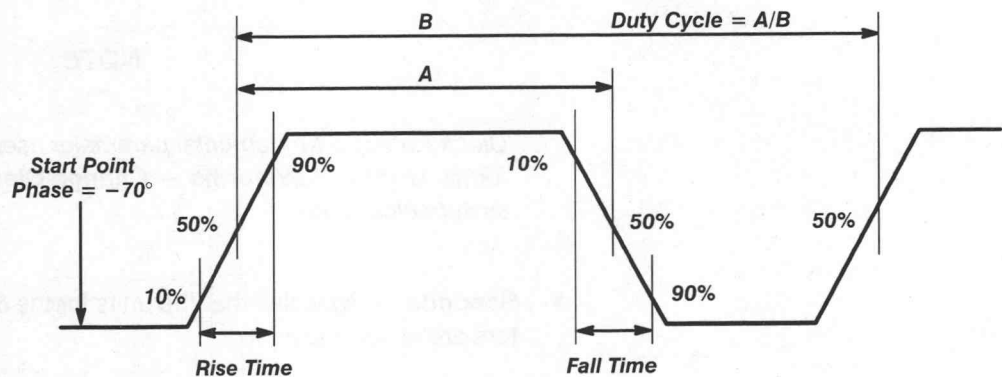
- **Seconds** — Specifies that the units for the *Start* and *Stop Point* parameters are in seconds.
- **Points** — Specifies that the units for the *Start* and *Stop Point* parameters are in points
- **Start Point** — Enter (or calculate) the horizontal starting position of the square wave. Do not confuse the *Start Point* location with the *Start Marker* location. They are not necessarily the same point.
- **Stop Point** — Enter (or calculate) the horizontal ending position of the square wave. Do not confuse the *Stop Point* location with the *Stop Marker* location. They are not necessarily the same point.
- **Frequency** — Enter (or calculate) the frequency of the waveform.
- **Cycles** — Enter (or calculate) the number of cycles. The square wave extends from the *Start Point* to the *Stop Point* over the defined number of cycles.

One of the above five parameters will always be calculated automatically when OK is pressed. If the check box against a parameter is checked, the parameter must be set by the user. To set it so that it will be calculated automatically, click on the check box so that its check mark disappears. When you do this the check marks will appear in the boxes for the (other) parameters that must be set by the user.

- **Calculate <....>** — Selecting this button causes the indicated parameter (the one with the empty check box) to be calculated so that you can preview it prior to selecting **OK**. In Figure 3-36, *Start Point*, *Stop Point* and *Cycles* was entered, and *Frequency* was calculated. Selecting this button is optional: if you do not select it, the value will be calculated automatically when **OK** is selected.

**Calculate** The **Calculate** <....> option button is linked to the parameter to be calculated (empty check box). If you wish to preview the parameter, select the *Calculate* button. (The calculation is done automatically when **OK** is selected.) In Figure 3-36, Start Point, Stop Point, and Cycles were entered and Frequency was calculated.

- **Phase** — Enter the beginning phase of the triangle wave in radians or degrees.
- **Duty Cycle** — The time between 50% of the rise and 50% of the fall time divided by the period (50% of the rise to 50% of the next rise). Duty cycle is expressed in percent. See Figure 3-37.



**Figure 3-37: Square Timing Parameters**

**Transitions** — Define the square wave transition parameters:

- **Risetime** — Enter the horizontal distance required for the leading edge of a pulse from 10 to 90% of its amplitude. (Amplitude is the difference between the Maximum and Minimum values entered.)

**Ramp** — When selected, the contribution of the transition time to the period is 1.25 times the entered transition time. See Figure 3-38.

**Sine<sup>2</sup>** — When selected, the contribution of the transition time to the period is 2.073878 times the entered transition time. See Figure 3-38.

- **Falltime** — Enter the horizontal distance required for the trailing edge of a pulse from 90 to 10% of its amplitude. (Amplitude is the difference between the Maximum and Minimum values entered.)

**Ramp** — When selected, the contribution of the transition time to the period is 1.25 times the entered transition time. See Figure 3-38.

**Sine<sup>2</sup>** — When selected, the contribution of the transition time to the period is 2.073878 times the entered transition time. See Figure 3-38.

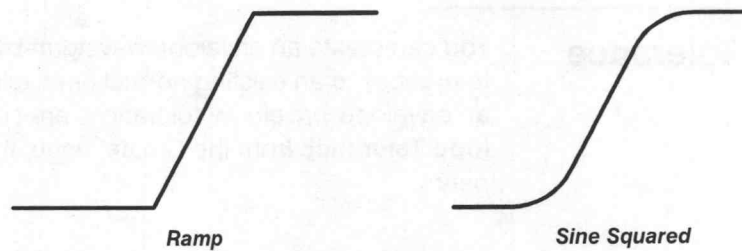


Figure 3-38: Ramp vs. Sine<sup>2</sup>

**Action** — Specify the placement of the square wave:

- **Replace** — Writes over the current waveform between and including the Start and Stop Points.
- **Insert** — Inserts the square wave into the current waveform at the Start Point. The previously defined portion of the current waveform (after and including the Start Point) shifts to follow the end of the inserted waveform.
- **Add** — Arithmetically adds the square wave to the current waveform between and including the Start and Stop points.
- **New Waveform** — Creates a new waveform. You are prompted to enter a new waveform name. If the Start Point is not defined as zero, all data points preceding Start are set to zero volts. Stop defines the end of the waveform.

**Waveform Name** — Identify the new waveform by entering a DOS-compatible file name. The Waveform Name edit box appears only when *New Waveform* is selected in the Action group box.

**OK** — Select **OK** to implement the defined parameters and create the square wave.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

**Help** — Select **Help** to display information relating to this menu selection. Use the scroll bar, if present, to read the entire Help text. To return to the previous dialog box, select the **Control-menu** box, then select *Close*.

## Envelope Tolerance

You can create an envelope waveform by adding vertical and or horizontal tolerances to an existing normal or envelope waveform. (If you are modifying an envelope waveform, tolerances are cumulative.) When you select **Envelope Tolerance** from the Create menu, the dialog box in Figure 3-39 appears.

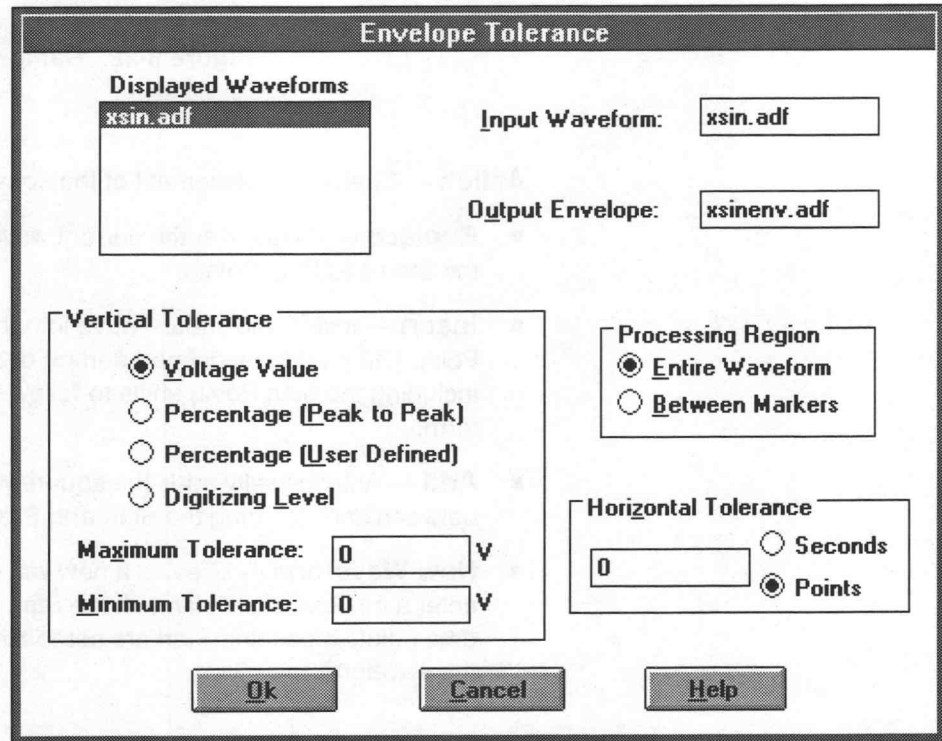


Figure 3-39: Envelope Tolerance Dialog Box

### NOTE

*Double-clicking on a name in the Displayed Waveforms list box enters the waveform name in the Input Waveform edit box. Double-clicking on a second name enters that waveform name in the Output Waveform edit box.*

**Displayed Waveforms** — Lists all waveforms currently loaded. (Waveforms must be created as the current waveform or loaded from the File menu to be displayed.)



**Input Waveform** — To apply a tolerance to a waveform, enter the waveform name (the waveform **must** be one of the waveforms listed in the *Displayed Waveforms* list box) or make a selection from the Displayed Waveforms list box by pointing and double-clicking the LEFT mouse button or highlighting the entry with the arrow keys and pressing **[ENTER]**.

**Output Envelope** — Enter a name for the envelope waveform output. Unique names should be chosen. If an existing name is entered (or chosen from the Displayed Waveforms list box), the current version replaces the previous one.

**Vertical Tolerance** — Define the amplitude tolerances as voltages, percentages, or digitizing levels. Maximum and minimum tolerances must be specified. You can reduce the tolerance of an existing envelope by using a negative value.

- **Voltage Value** — Adds the specified *Maximum Tolerance* in volts to the waveform or the upper limit of the envelope. Subtracts the specified *Minimum Tolerance* in volts from the waveform or the lower limit of the envelope.
- **Percentage (Peak to Peak)** — Calculates the maximum and minimum tolerances as percentages of the peak-to-peak amplitude of the waveform.
- **Percentage (User Defined)** — To calculate percentage values, *WaveWriter* uses your values as 0 and 100%. Enter the *Maximum* and *Minimum Tolerance* and select **OK**. Dialog boxes then appear requesting a 0 and 100% level. The Waveform Display Area cursors automatically appear for this operation:

Move the horizontal crosshair vertically to the desired 0% level. Press either **[ENTER]** or the LEFT mouse button to accept the value.

The next dialog box requests a 100% level to be entered. Use the same procedure as the 0% level above. When the 100% level is entered, the envelope is calculated and displayed.

- **Digitizing Level** — The specified *Maximum Tolerance* in digitizing levels is added to the waveform or the upper limit of the envelope. The specified *Minimum Tolerance* in digitizing levels is subtracted from the waveform or the lower limit of the envelope.

**Maximum Tolerance** — Adds the specified tolerance to the waveform or envelope upper limit. The entry format is specific to your selection: Voltage, Percentage, or Digitizing Level.

**Minimum Tolerance** — Subtracts the specified tolerance from the waveform or the envelope lower limit. The entry format is specific to your selection: Voltage, Percentage, or Digitizing Level.

**Processing Region** — Specify the portion of the waveform affected:

- **Entire Waveform** — Envelope the entire waveform.
- **Between Markers** — Envelope only the area between and including the markers.

**Horizontal Tolerance** — Each waveform point in the Processing Region shifts left and right by the entered amount, creating a band double the specified amount. Specify the tolerance in *Seconds* or in *Points*.

**OK** — Select **OK** to implement the defined parameters and create the envelop waveform.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

**Help** — Select **Help** to display information relating to this menu selection. Use the scroll bar, if present, to read the entire Help text. To return to the previous dialog box, select the **Control-menu** box, then select *Close*.

## Envelope Couple

You can use two waveforms to define the upper and lower boundaries of an envelope. When you select **Envelope Couple** from the Create menu, the dialog box in Figure 3-40 appears.

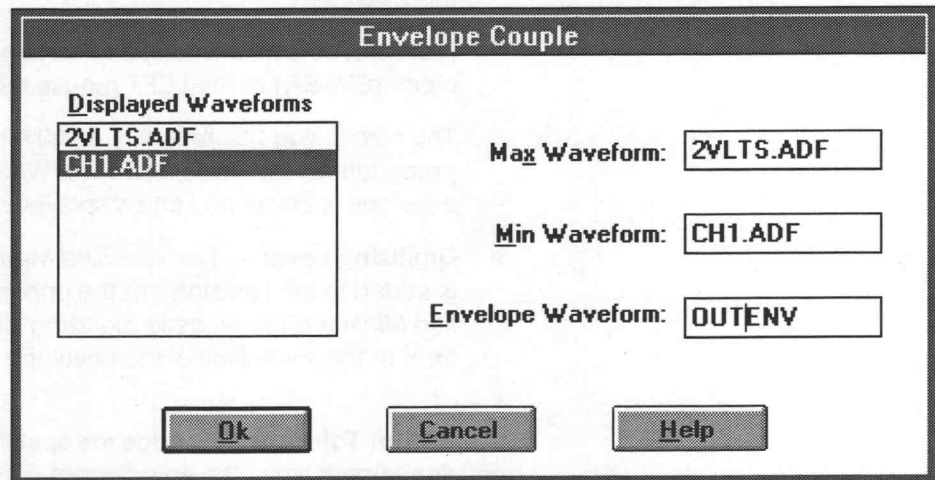


Figure 3-40: Envelope Couple Dialog Box

**Displayed Waveforms** — Lists all waveforms currently loaded. (Waveforms are either created as the current waveform or loaded from the File menu.) From this list box, you can identify waveforms for the upper and lower boundaries of the envelope.

**Max Waveform** — Type in the name of the waveform to be used as the upper limit input waveform in this edit box (the waveform **must** be one of the waveforms listed in the *Displayed Waveforms* list box) or from the *Displayed Waveforms* list box: point at the entry and double-click the LEFT mouse button or highlight an entry with the arrow keys and press **[ENTER]**. The selection must be a nonenvelope waveform.

**Min Waveform** — Specify the lower limit input waveform in the Displayed Waveforms list box or enter a name from the keyboard (the waveform **must** be one of the waveforms listed in the *Displayed Waveforms* list box). The selection must be a nonenvelope waveform.

**Envelope Waveform** — To store the modified waveform, identify an existing name from the Displayed Waveforms list box or enter a new name in the edit box. The output waveform cannot have the same name as either of the input waveforms. If an existing envelope name is entered (or chosen from the Displayed Waveforms list), the current version replaces the previous version and the original data is lost.

**OK** — Select **OK** to implement the defined parameters and create the envelope waveform.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

**Help** — Select **Help** to display information relating to this menu selection. Use the scroll bar, if present, to read the entire Help text. To return to the previous dialog box, select the **Control-menu** box, then select *Close*.

## Envelope Decouple

An existing envelope waveform can be separated into two uncoupled waveforms: one defined by the upper boundary of the envelope, the other defined by the lower boundary. When you select **Envelope Decouple** from the Create menu, the dialog box in Figure 3-41 appears.

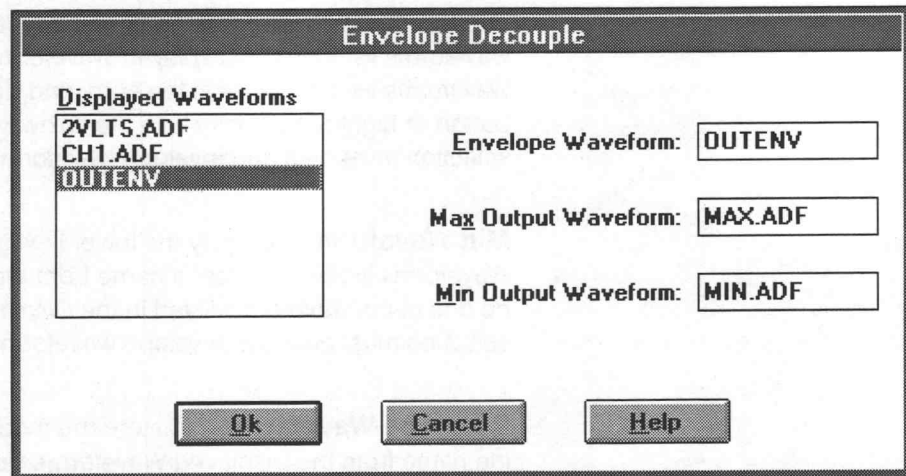


Figure 3-41: Envelope Decouple Dialog Box

**Displayed Waveforms** — Lists all waveforms currently loaded. (Waveforms are either created as the current waveform or loaded from the File menu.) From this list box, you can specify the waveform that will split into two nonenvelope waveforms.

**Envelope Waveform** — Type in the name of the waveform to be decoupled in this edit box (the waveform **must** be one of the waveforms listed in the *Displayed Waveforms* list box) or in the *Displayed Waveforms* list box: point at the entry and double-click the LEFT mouse button or highlight an entry with the direction keys and press **[ENTER]**. The selection must be an envelope waveform.

**Max Output Waveform** — Identify the name of the upper boundary waveform in the *Displayed Waveforms* list box or enter a name from the keyboard.

**Min Output Waveform** — Identify the name of the lower boundary waveform in the *Displayed Waveforms* list box or enter a name from the keyboard.

**OK** — Select **OK** to create the two nonenvelope waveforms. The Max Output Waveform is created by using the upper boundary of the envelope and the Min Output Waveform is created by using the lower boundary. The Max Output Waveform becomes the current waveform.

**NOTE**

*The original envelope waveform is not replaced when decoupled.*

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

**Help** — Select **Help** to display information relating to this menu selection. Use the scroll bar, if present, to read the entire Help text. To return to the previous dialog box, select the **Control-menu** box, then select *Close*.



# Processing Waveforms

Waveforms can be added, subtracted, multiplied, or divided by another waveform and added or multiplied by a constant. Use the following **SigProc** (Signal Processing) menu selections to mathematically modify waveforms:

- **Add Scalar** — Add a constant value to each point of a waveform.
- **Multiply by Scalar** — Multiply each point of a waveform by a constant value.
- **Add Waveforms** — Add a waveform to another waveform.
- **Subtract Waveforms** — Subtract a waveform from another waveform.
- **Multiply Waveforms** — Multiply a waveform by another waveform.
- **Divide Waveforms** — Divide a waveform by another waveform.

---

## Add Scalar, Multiply by Scalar

Each point of the current waveform in the selected Processing Region is modified by the scalar value. You can either add the scalar value to the current waveform or multiply the current waveform by the scalar value. When you select one of the **Scalar** options, the dialog box in Figure 3-42 appears. The dialog box is the same for the add or multiply options, except for the title bar at the top and the edit box label.

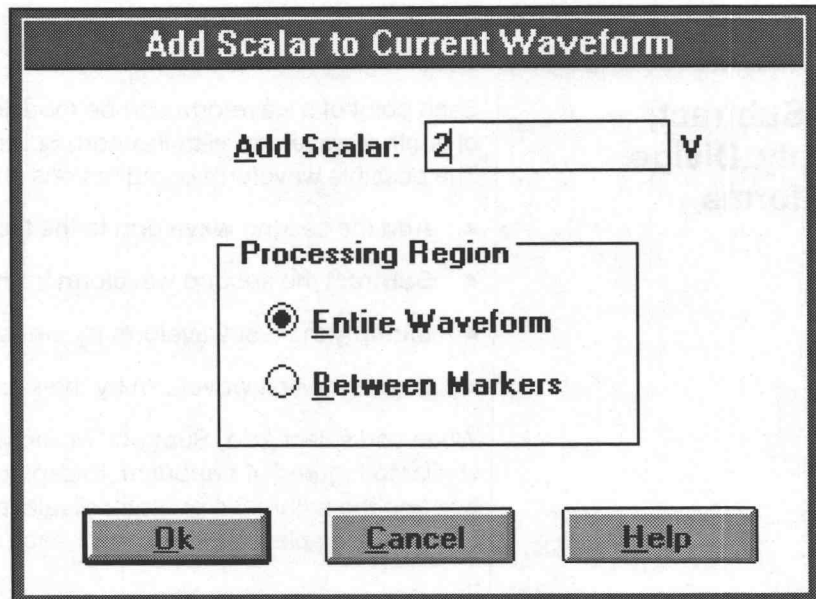


Figure 3-42: Add Scalar to Current Waveform Dialog Box

**Add Scalar** — Enter the scalar value. The value is added to each point of the current waveform in the Processing Region. The scalar value can be either positive or negative.

**Multiply by Scalar** — Enter the scalar value. Each point of the current waveform in the Processing Region is multiplied by this value. For an increase in amplitude, enter a value greater than one. For a decrease in amplitude, enter a decimal value less than one.

**Processing Region** — Apply scalar to:

- **Entire Waveform** — Performs signal processing operations on the entire length of the waveform.
- **Between Markers** — Performs signal processing operations on that portion of the waveform between and including the Start and Stop markers.

**OK** — Selecting *OK* applies the specified scaling factor to each point of the current waveform in the Processing Region.

**Cancel** — Select *Cancel* to abort the current operation and return to the main menu.

**Help** — Select *Help* to display information relating to this menu selection. Use the scroll bar, if present, to read the entire help text. To return to the previous dialog box, select the **Control-menu** box, then select *Close*.

---

## Add, Subtract, Multiply, Divide Waveforms

Each point of a waveform can be modified by the corresponding time point of another waveform with the Add, Subtract, Multiply, or Divide selections. The possible waveform combinations are:

- **Add** the second waveform to the first waveform.
- **Subtract** the second waveform from the first waveform.
- **Multiply** the first waveform by the second waveform.
- **Divide** the first waveform by the second waveform.

When you select Add, Subtract, Multiply, Or Divide Waveforms a dialog box similar to Figure 3-43 appears. Except for the title bar at the top of the dialog box and the arithmetic operator displayed between Waveform 1 and Waveform 2, the display is the same for each of the menu options.



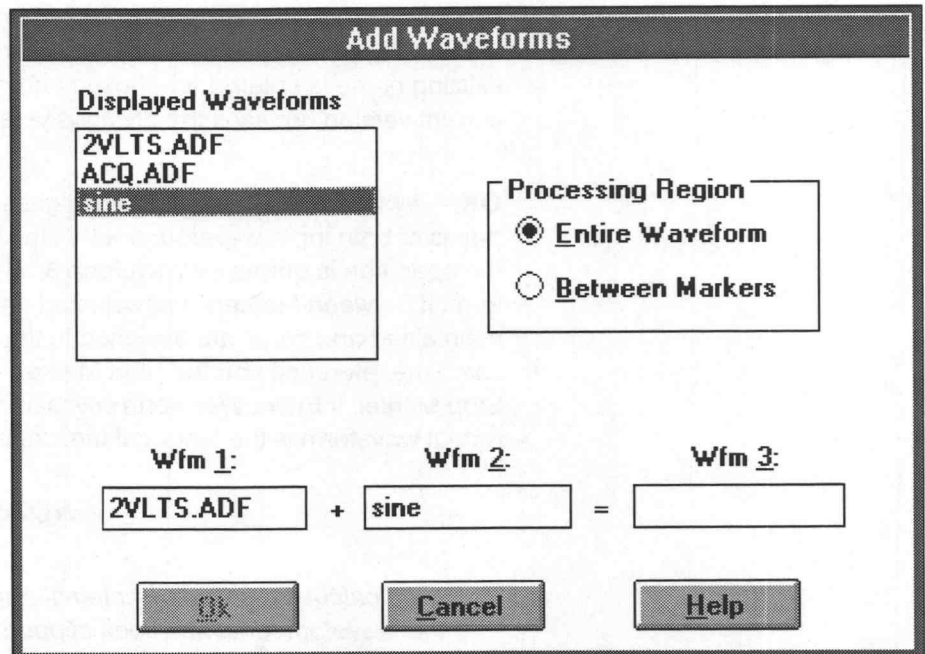


Figure 3-43: Add Waveforms Dialog Box

**Displayed Waveforms** — Displays all waveforms currently in memory. (Waveforms are either created as the current waveform or loaded from the File menu.) You can identify waveforms for processing from this list box.

**Processing Region** — Apply the menu selection to:

- **Entire Waveform** — Performs signal processing operations to all portions of the waveforms.
- **Between Markers** — Performs signal processing operations on those portions of the waveforms between and including the Start and Stop markers.

**Wfm 1** — Type in the name of the waveform to be processed in this edit box (the waveform **must** be one of the waveforms listed in the *Displayed Waveforms* list box) or in the *Displayed Waveforms* list box: point at the entry and double-click the LEFT mouse button or highlight an entry with the direction keys and press [ENTER].

**Wfm 2** — Type in the name of the waveform to be processed in this edit box (the waveform **must** be one of the waveforms listed in the *Displayed Waveforms* list box) or in the *Displayed Waveforms* list box: point at the entry and double-click the LEFT mouse button or highlight an entry with the direction keys and press [ENTER].

**Wfm 3** — To store the modified waveform, identify an existing name from the Displayed Waveforms list box or enter a new name in the edit box. If an existing name is entered (or chosen from the Displayed Waveforms list), the current version replaces the previous version and the original data is lost.

**OK** — When you select *OK*, the designated operation is performed to all points of both input waveforms within the Processing Region. The result of the operation is output as Waveform 3, which becomes the current waveform. If *Between Markers* was selected and Waveform 3 is new, timing is maintained and zeros are assigned to the undefined points between the zero time reference and the Start Marker. The new waveform ends at the Stop Marker. If *Entire Waveform* was selected as the Processing Region, the output waveform is the length of the longer of the two input waveforms.

**NOTE**

*If the calculation exceeds internal system limits, you are warned that waveform data has been clipped.*

**Cancel** — Select *Cancel* to abort the current operation and return to the main menu.

**Help** — Select *Help* to display information relating to this menu selection. Use the scroll bar, if present, to read the entire help text. To return to the previous dialog box, select the **Control-menu** box, then select *Close*.

After selecting *OK* on an Add, Subtract, Multiply, or Divide dialog box, the Associate Waveform with Instrument dialog box appears (Figure 3-44), if Waveform 3 was a new waveform.

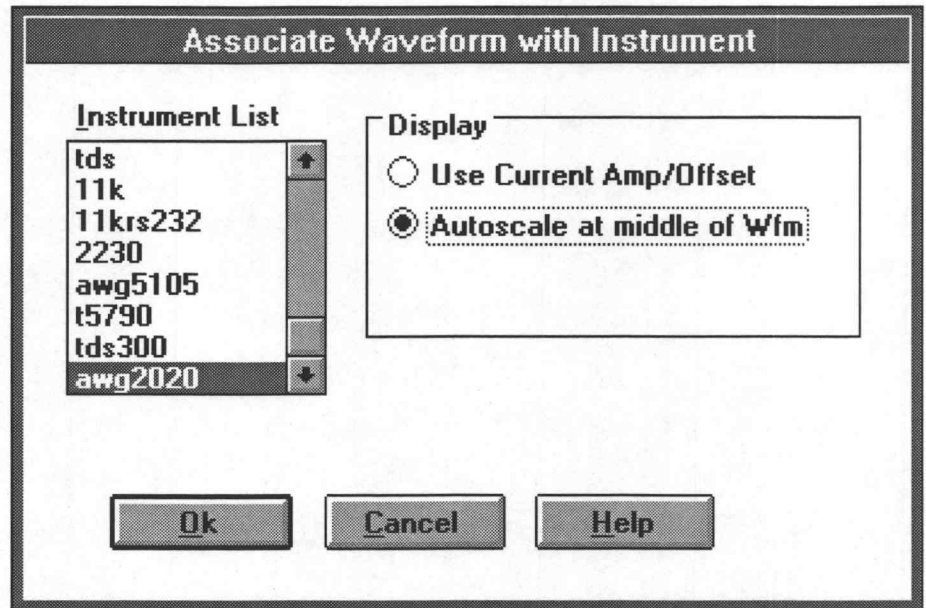


Figure 3-44: Associate Waveform with Instrument Dialog Box

**Instrument List** — Associate Waveform 3 with a target instrument from the *Instrument List*.

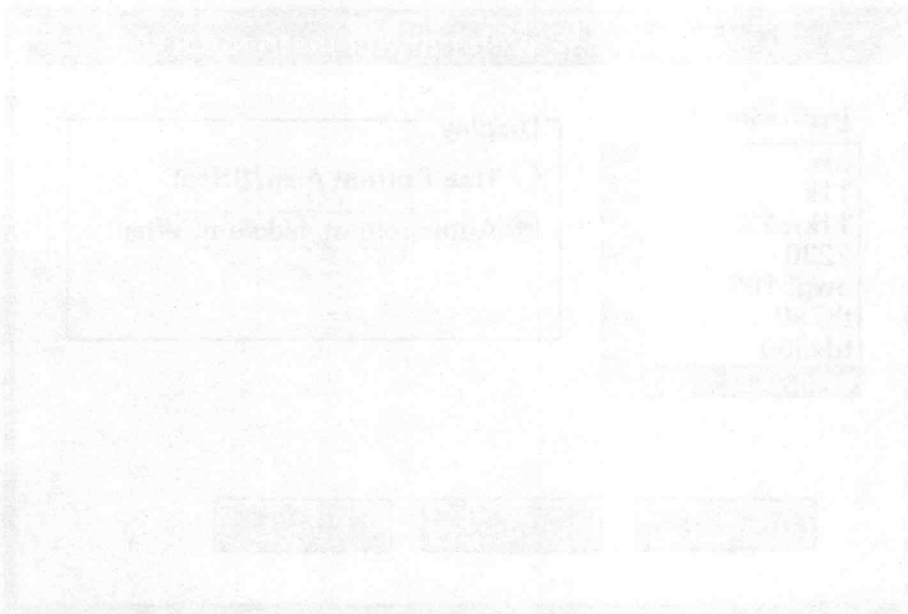
**Display** — Choose one of two options:

- **Use Current Amp/Offset** — Sets the Axis Ranges for the new waveform to those of the current (selected) waveform.
- **Autoscale at middle of Wfm** — Displays the new waveform as if the **Display** → **Autoscale at middle of Wfm** sub-menu were selected.

**OK** — Associates the new waveform with the designated target instrument and adjusts the amplitude offset as specified in the Display group.

**Cancel** — Select *Cancel* to abort the current operation and return to the main menu.

**Help** — Select *Help* to display information relating to this menu selection. Use the scroll bar, if present, to read the entire help text. To return to the previous dialog box, select the **Control-menu** box, then select *Close*.



# Transferring Waveforms

Use the **Transfer** menu to set up communication parameters between your computer and the target instrument; then use the Acquire and Send menu selections to transfer waveforms. You can acquire a waveform from a specific instrument and send the waveform to a specific instrument. Selections in the Transfer menu are:

- **Configure Instruments** — Assigns output drivers and port protocol to target instruments.
- **Acquire** — Identifies the target instrument for waveform acquisition.
- **Send** — Identifies the target instrument for waveform transfer.

## Configure Instruments

When you select **Configure Instruments**, the dialog box in Figure 3-45 appears. Use this command to configure new instruments on the bus.

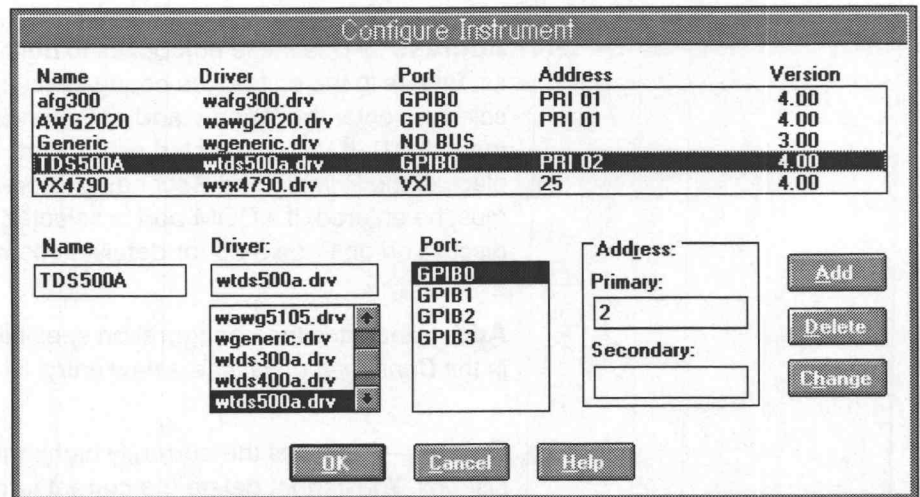


Figure 3-45: Configure Instrument Dialog Box

Each instrument name in the top list box is associated with a Driver, communication Port, communication Address, and driver Version number. To modify an entry, click on the instrument *Name*. Selecting the entry highlights the line and places its associated parameters in the appropriate edit boxes. Select the *Change* button to designate an edit as permanent part of the configuration list. If *Name* represents a new instrument, click the *Add* button to append the list.

**NOTE**

*WaveWriter includes a general purpose driver (**wgeneric.drv**) for reading in arbitrary ADIF and Comma Separated files, and creating waveforms. Driver limits for amplitude/offset, clock rate, and record size are set to the maximum limits. The driver **wgeneric.drv** is associated with the **NO BUS** protocol. You cannot acquire/send waveforms or read/write ISF files. All other functions can be used.*

**Name** — Use this edit box to create or modify names that uniquely identify each instrument and its configuration. You can enter up to 12 alphanumeric characters for each name. Selecting an entry from the Configuration List displays the instrument name in this edit box; you can accept it or modify it.

**Driver** — Lists the software device drivers available to support various instruments. Highlight an entry from this list to identify a driver.

**Port** — Lists the PC hardware ports or busses available for data transfer. Highlight an entry from this list to identify your port configuration.

**Address** — Use these edit boxes to define the target instrument addresses. Entries in the edit boxes change with the Port selection. If a GPIB port is selected, enter the *Primary* and or *Secondary* address of the target instrument (0-31). If VXI is selected as the port, the dialog changes slightly, and in place of the Primary and Secondary addresses, a single Logical Address must be entered. If a COM port is selected, read the *Set RS232 Options* discussion on Page 3-85 for detailed information.

**Add** — Includes the configuration specified in the lower edit and list boxes in the *Configuration List* as a new entry.

**Delete** — Removes the currently highlighted entry from the *Configuration List* box. You cannot delete the current target instrument or an instrument that has waveforms associated with it.

**Change** — The configuration specified in the lower edit and list boxes replaces the parameters of the currently highlighted entry in the *Configuration List*.

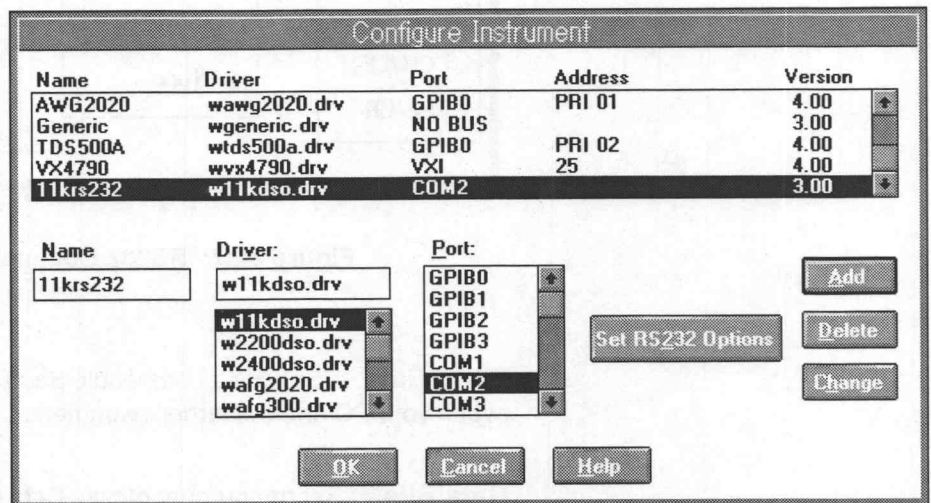
**OK** — Incorporates the specified additions, deletions, and changes into the Configuration List. If you have just created or modified an existing configuration, and forgot to select Add or Change, you are prompted to save the configuration. Following a reply, you are returned to the main menu.

**Cancel** — Select *Cancel* to abort the current operation and return to the main menu.

**Help** — Select *Help* to display information relating to this menu selection. Use the scroll bar, if present, to read the entire help text. To return to the previous dialog box, select the **Control-menu** box, then select *Close*.

## Set RS232 Options

If **COM<#>** is chosen as a Port selection, the Set RS232 Options button replaces the Address edit boxes as shown in Figure 3-46.



**Figure 3-46: Configure Instrument Dialog Box when using a COM Port**

Selecting the *Set RS232 Options* button displays the RS232 Communications dialog box (Figure 3-47). The dialog box configures RS232 communications between your PC and the target instrument. Incorrect set up will result in a communications failure. Check your instrument manual for correct RS232 settings.

Figure 3-47: RS232 Communications Dialog Box

**Baud Rate** — Specify a compatible *Baud Rate* for communications between your PC and the target instrument.

**Data Bits** — Set the number of bits. Data is usually transmitted in 8-bit bytes.

**Stop Bits** — Set this value identical to the target instrument.

**EOL** — Specify the End of Line Character(s) the instrument expects to see at the end of a transmission. The setting is necessary if you use no Flow Control.

**Flow Control** — Specify the action if the buffer overflows data from the instrument. If *None* is selected, data is lost. If *Xon/Xoff* is selected, software flags are used to stop and start the data flow. (If the instrument is transmitting binary data, this method should not be used.) If *Hardware* is selected, hardware signals are incorporated to control data flow. Ensure the instrument and cable are configured for the flow control specified.

**Parity** — Specify the parity type. *None* is normally selected for 8-bit data. Check your instrument for allowable settings.



**OK** — Incorporates the specified changes into the instrument Configuration List.

**Cancel** — Select *Cancel* to abort the current operation and return to the Configure Instrument dialog.

**Help** — Select *Help* to display information relating to this menu selection. Use the scroll bar, if present, to read the entire help text. To return to the previous dialog box, select the **Control-menu** box, then select *Close*.

## Acquire

Use the **Acquire** selection to capture waveforms from any configured instrument.

When you select Acquire, the Acquire Waveform dialog box containing a list of configured instruments similar to Figure 3-48 appears. Only instruments incorporated with the Configure Instruments menu are listed. If there is only one such instrument, this dialog box is bypassed and the instrument-specific dialog box appears.

See the Appendices at the end of this manual from Appendix E to the end of the manual for details of instrument specific dialogs.

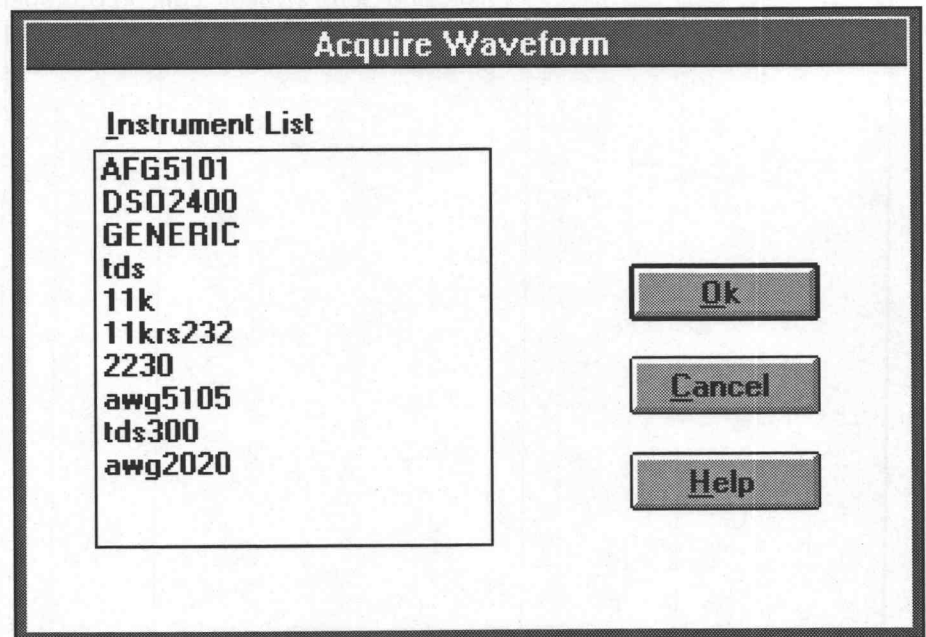


Figure 3-48: Acquire Waveform Dialog Box

**Instrument List** — Select the instrument from which waveform data is to be acquired from the list. This is also the associated instrument of the newly acquired waveform after it has been copied into WaveWriter's memory. Double clicking on a list entry is equivalent to selecting an entry and then selecting the **OK** button.

**OK** — On selecting this button, a dialog box specific to the selected instrument will appear prompting the user for further instrument specific acquisition options. After the user has completed setting these options, the waveform will be copied from the instrument into WaveWriter's memory, and will be associated with the selected instrument.

**Cancel** — Select *Cancel* to abort the current operation and return to the main menu.

**Help** — Select *Help* to display information relating to this menu selection. Use the scroll bar, if present, to read the entire help text. To return to the previous dialog box, select the **Control-menu** box, then select *Close*.

---

### Send

The **Send** command transfers either the entire current waveform, or a defined portion as set by the Start and Stop markers, to the target instrument.

Selecting **Send** invokes a dialog box specific to the target instrument and current waveform. See the Appendices at the end of this manual from Appendix E to the end of the manual for details of instrument specific dialogs.

# Modifying and Listing Waveforms

The **Waveforms** menu provides the following selections for listing waveforms and setting parameters:

- **Change Clock Rate** — Sets the clock rate of the current waveform.
- **Change Amplitude/Offset** — Sets the amplitude and offset of the current waveform.
- **Associate Waveform** — Associates the current waveform with a target instrument.
- **Rename Waveform** — Changes the name of a waveform.
- **Clear Waveform(s)** — Deletes all, or selected waveforms from memory.
- **Waveform Summary** — Lists all waveforms currently loaded into memory and some basic parameters.
- **Waveform Detail** — Provides a sub-menu listing of all waveforms currently loaded in memory. Selecting from the sub-menu provides a detailed summary of the characteristics of each waveform.
- **Waveform List** — Lists the waveforms currently loaded into memory with a check mark next to the currently selected waveform. Designate any waveform on the list as the current waveform.

---

## Change Clock Rate

Use this selection to modify the clock rate of the current waveform. Changing the clock rate does not alter the waveform shape or size (number of points). However, the time-per-point or the Waveform Display Area may be modified to reflect the change.

Selecting *Change Clock Rate* invokes a dialog box specific to the target instrument. See the instrument-specific *Appendices* for examples of these dialog boxes.

When you enter a clock rate and select *OK*, the Clock readout above the Waveform Display Area updates, reflecting the change. If the horizontal axis is displayed in seconds, the axis label updates to reflect the new rate.

---

## Change Amplitude/Offset

The Change Amplitude/Offset selection modifies the actual point value of the waveform. Values are transferred to the instrument with the waveform. (Do not confuse this command with the **Display** → **Set Axis Ranges** selection that modifies the display scaling without changing the actual waveform. Scaled levels do not transfer to the instrument.)

When you select *Change Amplitude/Offset* from the Waveforms menu, the dialog box in Figure 3-49 appears.

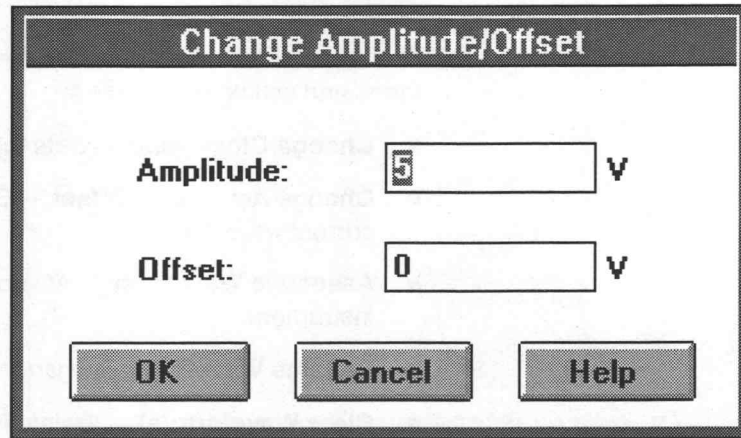


Figure 3-49: Change Amplitude/Offset Dialog Box

**Amplitude** — Enter an amplitude value. If the waveform was not auto-scaled, the change in amplitude is proportional to the total value. The amplitude must be within the limits of the target instrument. If not, WaveWriter will reset the limit.

**Offset** — Enter an offset value; each point of the waveform is modified by this number. The offset must be within the limits of the target instrument. If not, WaveWriter will reset the offset to zero.

**OK** — Selecting *OK* applies the new amplitude and offset values to the waveform and display.

**Cancel** — Select *Cancel* to abort the current operation and return to the main menu.

**Help** — Select *Help* to display information relating to this menu selection. Use the scroll bar, if present, to read the entire help text. To return to the previous dialog box, select the **Control-menu** box, then select *Close*.

---

## Associate Waveform

The Associate Waveform with Instrument dialog box (Figure 3-50) configures a target instrument for the current waveform. You can also create an identical copy of a waveform (for the same or a different target instrument) with a different waveform name.

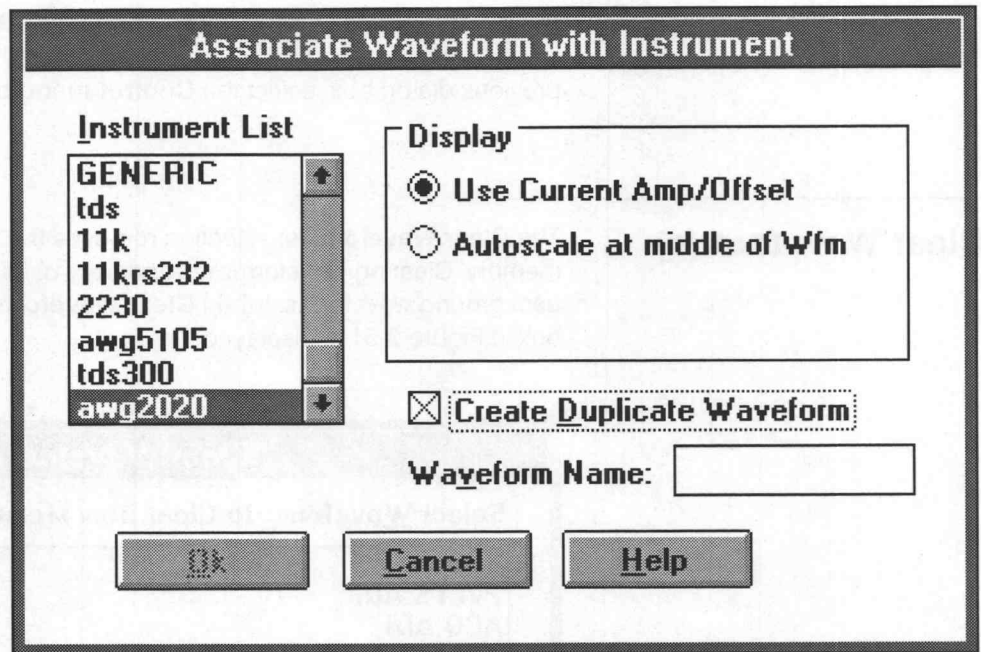


Figure 3-50: Associate Waveform with Instrument Dialog Box

**Instrument List** — Select a target instrument from the *Instrument List* to associate with the current or copied waveform.

**Display** — Select one of two options:

- **Use Current Amp/Offset** — Sets the Axis Ranges for the new waveform to those of the current (selected) waveform.
- **Autoscale at middle of Wfm** — Displays the waveform as if the **Display** → **Autoscale at middle of Wfm** sub-menu were selected.

**Create Duplicate Waveform** — Check this box if you wish to create a duplicate of the current waveform.

**Waveform Name** — Enter a unique name for the new waveform if *Create Duplicate Waveform* is checked.

**OK** — Selecting *OK* associates the new or current waveform with the specified target instrument and adjusts the display as specified.

**Cancel** — Select *Cancel* to abort the current operation and return to the main menu.

**Help** — Select *Help* to display information relating to this menu selection. Use the scroll bar, if present, to read the entire help text. To return to the previous dialog box, select the **Control-menu** box, then select *Close*.

## Clear Waveform(s)

The **Clear Waveform(s)** selection removes the specified waveform(s) from memory. Clearing waveforms is especially useful in deleting unwanted background waveforms. When **Clear Waveform(s)** is selected, the dialog box in Figure 3-51 is displayed.

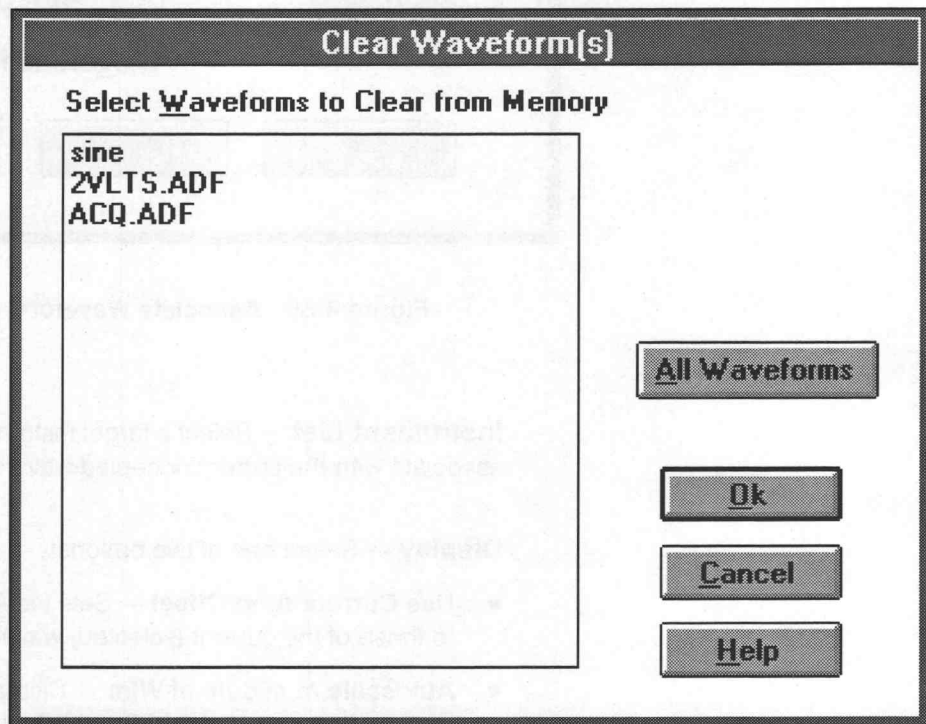


Figure 3-51: Clear Waveform(s) Dialog Box

**Select Waveforms to Clear from Memory** — The List Box displays all currently loaded waveforms. Select one or more waveforms to clear from memory.

To select more than one waveform, first click the mouse on the first waveform name, then click the mouse on the other names with the Ctrl key pressed down.

To select a group of waveforms which have their names displayed contiguously in the list, first click on the name at one end of the group, and then click on the name at the other end of the list with the Shift key pressed down.

Double clicking on a waveform name is equivalent to selecting a waveform, and then the OK button. Double clicking causes just one waveform to be deleted.



*Cleared waveforms cannot be restored with Undo. Save all changes before selecting **OK**.*

**All Waveforms** — Selecting *All Waveforms* removes all waveforms from memory.

**OK** — When **OK** is selected, the specified waveforms are removed from memory and are cleared from the display. If an altered waveform has not yet been saved, you are given the option with the Save dialog box.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

**Help** — Select **Help** to display information relating to this menu selection. Use the scroll bar, if present, to read the entire Help text. To return to the previous dialog box, select the **Control-menu** box, then select *Close*.

## Rename Waveform

The **Rename Waveform** selection is used to change the name of the current waveform. When **Rename Waveform** is selected, the dialog box in Figure 3-52 is displayed.

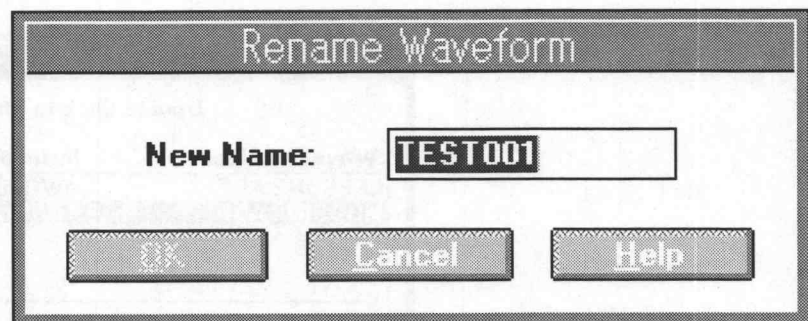


Figure 3-52: Rename Waveform Dialog Box

**New Name** — This edit box initially displays the name of the current waveform. Enter the new name here. The new name must conform with WaveWriter waveform naming conventions: it can be a combination of up to eight characters followed by a three character extension which together make a file name acceptable to DOS. The extension is optional, since it is appended automatically when the waveform is saved to a disk file. (See the description of the **File** → **Save** menu selection for recommended extensions.) Certain reserved words are not permitted: aux, con, prn, nul, com1, com2, com3, com4, lpt1, lpt2, lpt3.

**OK** — When **OK** is selected, the name of the current waveform is changed to the name entered in the New Name edit box, and control returns to the main menu.

**Cancel** — When **Cancel** is selected, control returns to the main menu without any changes being made to waveform names.

**Help** — When **Help** is selected, a dialog box appears giving information about the use of the **Rename Waveform** feature.

## Waveform Summary

Select *Waveform summary* to list the waveforms currently loaded into memory. When the Waveforms Summary dialog box appears (Figure 3-53), the selected waveform is the current waveform. To designate a different waveform as the current waveform, point to the desired entry and double-click the LEFT mouse button or use the arrow keys to highlight the desired waveform, then press the **[SPACEBAR]** or **[ENTER]**.

Each line of the Waveform Summary list identifies the instrument, record length, and waveform type associated with the specified waveform. The record Length is the number of data points in the waveform; the waveform Type is either Norm for normal waveforms, or Env for envelopes.

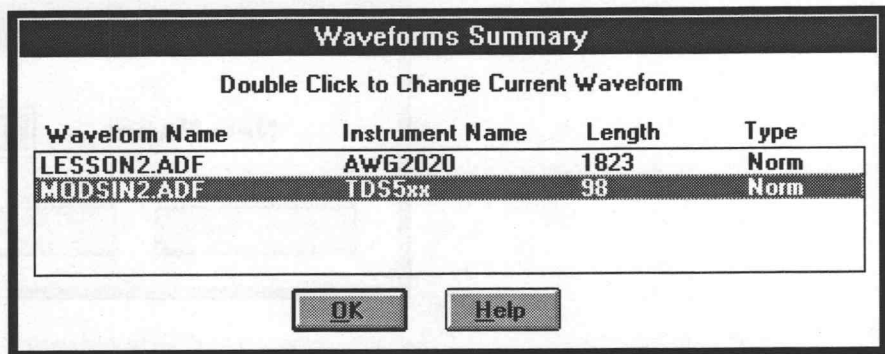


Figure 3-53: Waveforms Summary Dialog Box



**Waveform Name** — Lists the currently loaded waveforms.

**OK** — Selecting *OK* clears the dialog box. Double-clicking an entry to change the current waveform does not clear the dialog box.

**Help** — Select *Help* to display information relating to this menu selection. Use the scroll bar, if present, to read the entire help text. To return to the previous dialog box, select the **Control-menu** box, then select *Close*.

## Waveform Detail

When you select *Waveform Detail*, a sub-menu appears next to the selection listing all currently loaded waveforms. To obtain waveform-specific information, such as display amplitude/offset, record length, clock rate, waveform resolution, or display and markers settings, click on the desired waveform. A Waveform Detail dialog box appears like that shown in Figure 3-54.

Waveform Detail			
<b>Wfm Name:</b>	2VLTS.ADF	<b>Type:</b>	Normal
<b>Instr Name:</b>	11k	<b>Wfm Resolution:</b>	16 bits
<b>Display</b>		<b>Display</b>	
<b>Amplitude:</b>	7.5 V	<b>Start:</b>	0 Pts
<b>Offset:</b>	1 V	<b>Stop:</b>	999 Pts
<b>Length:</b>	1000 Pts	<b>Markers</b>	
<b>Clock Rate:</b>	10u S/pt	<b>Start:</b>	0 Pts
<b>External Clock:</b>	No	<b>Stop:</b>	499 Pts
<b>Instrument-dependent Details</b>		<b>OK</b>	<b>Help</b>

Figure 3-54: Waveform Detail Dialog Box

**Wfm Name** — Identifies the queried waveform.

**Type** — Specifies the waveform type: Normal or Envelope.

**Instr Name** — Identifies the instrument type associated with the specified waveform.

**Wfm Resolution** — Specifies the waveform resolution in bits. This is the resolution with which the waveform was created, which is not necessarily the same as the resolution of the instrument with which the waveform is currently associated. Nor is this affected by the Vertical Resolution selection in the **Edit** menu. If the associated instrument does not have equivalent resolution, the data is adjusted before being sent to the instrument.

**Display Amplitude/Offset** — Lists the display Amplitude/Offset vertical limits specified by the *Set Axis Ranges* menu selection.

**Display Start/Stop** — Lists the display Start/Stop horizontal limits specified by the *Set Axis Ranges* menu selection. If the specified horizontal units are seconds, values are given in Secs, otherwise points are used.

**Length** — Lists the total length of the waveform.

**Clock Rate** — Lists the time-per-point horizontal waveform data.

**External Clock** — Indicates the use of an external clock by the instrument, if any.

**Markers** — Lists the Marker Start/Stop values in points or seconds.

**Instrument-dependent Details** — Invokes additional instrument-related information.

**OK** — Selecting *OK* clears the Waveform Detail dialog box.

**Help** — Select *Help* to display information relating to this menu selection. Use the scroll bar, if present, to read the entire help text. To return to the previous dialog box, select the **Control-menu** box, then select *Close*.

---

## Waveform List

Following the Waveform Detail menu selection, the Waveforms menu lists all currently loaded waveforms as menu items (see Figure 3-55); the current waveform appears with a check to its left. To designate a new waveform as the current waveform, select another waveform from the list.

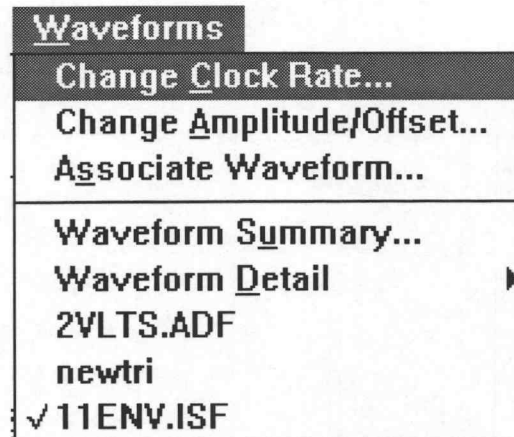
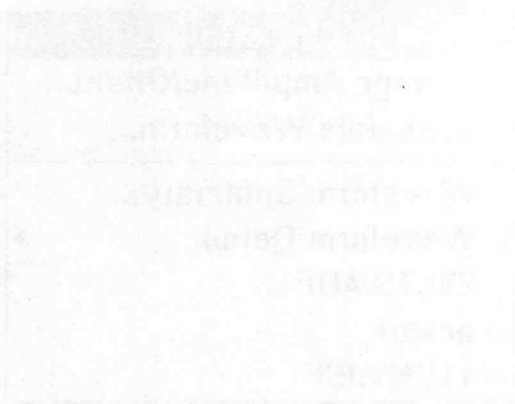


Figure 3-55: Waveforms Menu





# Appendices

Appendix

# Appendix A: Error and Warning Messages

This section describes system errors and warning messages. These messages are listed in numerical order followed by a brief explanation and corrective actions.

Error and warning messages are specific to the actions that create them. For example, if a message is related to an invalid edit box entry and you select the error message **OK** box, *WaveWriter* returns you to the original dialog box to correct the action. In general, *WaveWriter* does not check entered values for validity until you select **OK**.

An error or warning message item enclosed in square brackets ( [ ] ), appears with actual values in the error message box when displayed.

If you receive an error or warning message that is not included here, it may be a message that is specific to an instrument that you are using with *WaveWriter*. Refer to the instrument's appendix for details of instrument specific error and warning messages.

If the message cannot be found here, or in the appendix for your instrument, it is probably a Microsoft *Windows* message. Refer to the Microsoft User manual for exact information.

---

## Error Messages

### **E300** — Out of memory.

*WaveWriter* has insufficient memory available to perform the selected operation. Clear any unneeded waveforms or programs from memory and try again.

### **E301** — Window creation failed.

*WaveWriter* has insufficient memory available to create a window. Clear any unneeded waveforms or programs from memory.

### **E302** — Error accessing list box.

Insufficient memory is available to fill a list box and complete a list of entries. Clear any unneeded waveforms or programs from memory and try again.

### **E303** — Initialization failed.

When loading *WaveWriter*, insufficient memory was available to initialize the defaults. Clear any unneeded programs from memory and try again.

**E304** — Waveform name **[name]** already exists.

You attempted to create a waveform that already exists. Specify a new waveform name to proceed with the operation.

**E305** — Error reading file **[filename]**.

*WaveWriter* detected an error reading the indicated filename. Check for a disk error or corrupt file.

**E306** — Error creating file **[filename]**.

*WaveWriter* detected an error creating the filename shown. Check for a disk error.

**E307** — Error closing file **[filename]**.

*WaveWriter* detected an error when attempting to close the filename indicated. Check for a disk error or full disk.

**E308** — Error opening file **[filename]** for read.

Opening the indicated filename produced an error. Check for a disk error.

**E309** — Error creating temporary file.

Creating a temporary file produced an error.

**E310** — Error removing temporary files.

Deleting temporary files created an error. The files may only be partially deleted.

**E311** — Error writing to disk. Check for disk full.

*WaveWriter* detected an error creating or writing to an output file; check for a full disk. If necessary, free up disk space by deleting unneeded files. To avoid losing waveform data, minimize *WaveWriter* and use the *Windows* Control Panel to delete files.

**E312** — Premature EOF.

*WaveWriter* detected the End of File before reading all data. Check for a disk error or corrupt file. Also, check for a full disk.

**E313** — Access denied. File cannot be overwritten, or directory full, or directory not found, or path specifies a directory.



Executing the requested command violated the access mode of the file, subdirectory, or device involved. This can occur when:

- attempting to write to a file marked read or write only
- attempting to open a subdirectory as a file
- the specified directory does not exist

**E314** — Sharing mode specified when file sharing not installed or access-mode value invalid.

This can occur for the following reasons:

- the given path name is a directory
- you attempted to open a read-only file for writing
- a sharing violation occurred (the file's sharing mode does not allow the specified operations)

**E315** — **[name]** — Path or file not found.

The path or file specified does not exist. Check the name and try again.

**E316** — Too many open file handles.

Too many files are already open. Close unneeded files or increase the CONFIG.SYS **FILES** = value and reboot.

**E317** — Error creating Cut/Copy buffer. Cut/Copy operation aborted.

For either menu selection *Cut* or *Copy*, *WaveWriter* is not able to store the selected waveform segment on disk. Check for a full disk; eliminate unused disk files.

**E318** — Cannot open Cut/Copy buffer. Cut/Copy operation aborted.

For either menu selection *Cut* or *Copy*, the Cut/Copy buffer cannot be opened. The operation is aborted.

**E319** — Problem reading Cut/Copy buffer. Insert/Replace/Append operation aborted.

For the menu selection *Insert*, *Replace*, or *Append*, the Cut/Copy buffer could not be read. *WaveWriter* aborted the selected operation.

**E320** — Wave.cfg corrupted or wrong version. Partial file only read in.

*WaveWriter* found the configuration file WAVE.CFG corrupt when loading. Default values were assigned. Exiting *WaveWriter* saves a new configuration file with the current (selected) defaults.

**E321** — Not enough memory. Only part of the configure file was read.

When loading, *WaveWriter* found that a portion of the configuration file WAVE.CFG was missing; default values were assigned. Exiting *WaveWriter* saves a new configuration file with the current defaults.

**E322** — [filename] is not a valid library file.

The library file selected is an improper format for the equation library.

**E323** — Only 1 Help window may be opened at a time.

Select one Help window for display at a time. To display another Help window, close the current Help window.

**E324** — Help topic not found.

The Help topic you selected is unavailable.

**E325** — Help file [filename] not found.

The Help text topic you selected cannot be found. All Help text files reside within the subdirectory HELP, located with the *WaveWriter* executable files. If this file was inadvertently deleted, reinstall the *WaveWriter* software.

**E326** — Error reading help topics and files.

The file HLPTOPIC.HLP, a list of all Help topics available from the Help selection in the Main Menu, is unavailable or corrupt. Reinstall the *WaveWriter* software.

**E328** — File [filename] cannot be read in either ADIF, ISF, or CSV format.

The selected file (from the *Open* menu) cannot be read in ADIF, ISF, or CSV format for the selected target instrument. If the ADIF file was not created by *WaveWriter*, it may be an incompatible version. If the file cannot be read in Instrument Specific Format, it may have been created for a different instrument.

Select *Open* again and attempt to read the file with another instrument from the Choose ISF Instrument dialog box.

**E329** — Improper ADIF file format.

The internal format of the ADIF file is incompatible due to an incorrect field format or invalid value.

**E350** — Invalid number.

In response to an edit box, you entered an invalid number. Check the value and try again.

**E351** — Must be a digit 0 – 9.

In response to an edit box, you entered a character that was not a combination of the digits 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9. Check the value and try again.

**E352** — Invalid number. The number must be greater than **[number]**.

In response to an edit box, you entered an out-of-range number. The error box indicates the acceptable lower limit. Check the value and try again.

**E353** — Invalid number. The number must be less than **[number]**.

In response to an edit box, you entered an out-of-range number. The error box indicates the acceptable upper limit. Check the value and try again.

**E354** — Invalid number. The number must be between **[number – number]**.

In response to an edit box, you entered a number outside the acceptable range. The error box indicates the acceptable lower and upper limits. Check the value and try again.

**E355** — Invalid number. The number must be non-negative.

In response to an edit box, you entered a number outside the acceptable range. Enter a number greater than or equal to zero.

**E356** — New Amplitude too small for instrument to handle. Display amplitude will be adjusted

You entered a value or autoscaled the amplitude to a value below the acceptable range of the target instrument.

**E358** — Invalid filename.

In response to a filename edit box, you entered an invalid filename.

*WaveWriter* does not allow the following characters:

- . " / \ ( ) : | [ ] + = ; ,
- ASCII characters less than 20H

*WaveWriter* does not allow the following reserved words: aux, con, prn, nul, com1, com2, com3, com4, lpt1, lpt2, lpt3.

**E359** — Invalid displayed waveform name.

In responses to an edit box prompt for a waveform name, you entered a name that does not exist. Check the spelling of the entry or use the *Waveform Summary* menu to display a list of all waveforms currently in *WaveWriter* memory.

**E360** — Name already exists.

For the menu selection *Configure Instrument*, you entered a name that already exists and selected *Add* to append a new entry to the Instrument List. Either provide a unique name and select *Add*, or select *Change* to overwrite the existing information for the selected instrument.

**E361** — Invalid offset for current display amplitude.

You entered a value or autoscaled the offset to a value unacceptable to the target instrument. (This error is generated for instruments that require the offset to be within a certain range based on amplitude.) For offset limitations, see the Appendix specific to your instrument.

**E362** — Parameters given cause the waveform to be greater than the period.

For the menu selection *Pulse* or *Square*, the values entered were inappropriate. The component parameters when entered together, exceed the waveform period.

Satisfy the following relationship for Pulse entries:

$$\text{Delay} + \text{Pulse Width} + \text{Rise} + \text{Fall} < \text{Period}$$

Satisfy the following relationship for Square entries:

$$\text{Rise} + \text{Fall} < (\text{Stop} - \text{Start}) / \text{Cycles}$$

The *Rise* and *Fall* in the above equations is not the Rise and Fall you enter in the edit boxes; they are modified based on the Ramp or Sine-squared selection. For *Ramp*, Rise and Fall are altered by a factor of 1.25. For *Sine-squared*, they are altered by a factor of 2.073878. Check your entries and correct any invalid responses.

**E364** — Invalid Number.  $0 < \text{Duty Cycle} < 100$ .

For the menu selection *Square*, the Duty Cycle entered was invalid. The duty cycle must be greater than 0 and less than 100.

**E365** — An envelope waveform cannot be coupled.

For the menu selection *Envelope Couple*, you entered an input waveform name that is already an envelope waveform. To use *Envelope Couple*, supply two input waveform names that are not envelope waveforms and another name for the output waveform.

**E366** — An envelope waveform must be selected to decouple.

For the menu selection *Envelope Decouple*, you entered a nonenvelope waveform name in response to the prompt for an input waveform. To use *Envelope Decouple*, supply an input waveform name of an envelope waveform already in memory and two waveform names to identify the output.

**E367** — The **[name]** waveform is the same as the envelope waveform. They must be unique.

For the menu selection *Envelope Couple*, one of the input waveform names is identical to the name selected as the output waveform. Enter a unique name for the input.

**E368** — No tolerance has been entered. Try again or cancel.

For the menu selection *Envelope Tolerance*, no tolerance was entered. To proceed with the operation enter a tolerance or select **Cancel** to abort.

**E369** — Cannot add, subtract, multiply, or divide envelopes.

For the menu selection *Add, Subtract, Multiply, or Divide Waveforms*, you specified an envelope waveform name. Use nonenvelope waveforms only with these functions.

**E370** — Could not complete horizontal resolution.

For the menu selection *Horizontal Resolution*, the selected operation could not be completed.

**E374** — Invalid device name.

The *Windows* configuration file WIN.INI has invalid device names specified for printer devices. If WIN.INI is corrupt, make a new copy using the appropriate *Windows* disk.

**E375** — Printer not available.

The printer is unavailable for the menu selection *Hardcopy*. Confirm the printer is powered on, on line, cables firmly connected, paper loaded, etc.

**E376** — Feature currently not supported for **[driver]**.

You selected a menu inappropriate for the current target instrument.

**E377** — GPIB error.

Check all GPIB cables to ensure secure attachment. Verify the address is correct; if not, use the **Transfer** → **Configure Instruments** menu to set the proper value and try again.

**E378** — Illegal symbol: **[symbol]**.

For the menu selection *Equation*, you entered an illegal symbol in the equation edit box. Use t as a placeholder for the running variable, for example,  $\sin(2*\pi*t)$ .

**E379** — YACC internal stack overflow.

For the menu selection *Equation*, the equation is too complex for the parser to handle. Try simplifying the equation.

**E380** — Syntax error.

For the menu selection *Equation*, *WaveWriter* detected a syntax error in the equation edit box. Acknowledge the error for more specific information.

**E381** — Missing variable (t), operator, or parenthesis.

For the menu selection *Equation*, the entry lacked the variable t, an operator, or had mismatched parentheses. Check the equation and try again.

**E382** — Maximum and minimum waveforms cannot be the same.

For the menu selection *Envelope Decouple*, you selected the same waveform for the *Max* and *Min Output Waveform*. Please specify different filenames in these edit boxes.

**E383** — Invalid number for the function **[function name]**.

The number entered as a parameter for the specified function is invalid.

**E384** — Instrument cannot be deleted because there are waveforms associated with it.

To delete the instrument, clear all associated waveforms from memory.

**E385** — Markers cannot be set longer than the maximum length the instrument can accept: **[number]** pts.

The number of points specified by the markers must be less than the maximum record length.

**E386** — Driver **[filename]** not loaded — incorrect version.

You are attempting to load a driver incompatible with this version of *WaveWriter*. Ensure the driver for this version is in the same directory as your executable. Do not attempt to run a previous version of *WaveWriter* in the same *Windows* session.

**E387** — ISF Save File function not available for this driver.

The selected driver is incapable of saving data in the ISF format. Save the data in ADIF or CSV format.

**E388** — Instrument cannot be deleted because it is the target instrument.

Move the associated default waveform to another instrument and delete the current target instrument.

**E390, E391, E392** — These messages are equivalent to E352, E353 and E354.

---

## Warning Messages

**W400** — Replace existing **[filename]** file?

The selected output file already exists. Enter *Y* to replace the existing file or *N* to cancel the operation.

**W401** — **[filename]** has changed. Do you wish to save?

For the menu selection *Clear Waveform(s)*, you chose to delete a waveform not previously saved. Enter *Y* to save the waveform or *N* to clear it. This option is also exercised when exiting *WaveWriter* without saving a created or modified waveform. Select **Cancel** to abort the operation.

**W402** — Configuration values changed but not saved. Exit still?

You altered the value(s) of the highlighted entry without specifying *Add* or *Replace*. Enter *Y* to leave the value(s) unchanged; enter *N* to return to the dialog box to reenter a value.

**W405** — Attempt to divide by zero.

For the menu selection *Divide*, one or more points of the divisor waveform was zero. Instead, *WaveWriter* substituted the smallest adjacent nonzero data point. If all adjacent points were 0, *WaveWriter* divided by 1.

**W406** — SYSTEM LIMITS EXCEEDED! Resultant waveform was clipped at **[value]**.

For the menu selections *Add Scalar*, *Multiply by Scalar*, *Add Waveforms*, *Subtract Waveforms*, *Multiply Waveforms*, or *Divide Waveforms*, the resultant waveform had a value exceeding the system limits. The upper/lower bound value was assigned instead.

**W407** — Unable to create Undo buffer. Undo will not be available.

Insufficient disk space is available to preserve a waveform copy before altering it. Minimize *WaveWriter* and use the *Windows* Control Panel to delete files as necessary, then select **OK** to continue. Select **Cancel** at any time to abort.

**W408** — Current display amplitude is too large for selected target instrument. Display amplitude will be adjusted.

For the menu selection *Configure Instrument*, you changed the target instrument. The current vertical axis range now exceeds the maximum allowed for the instrument; *WaveWriter* will adjust the vertical axis to the maximum. Waveforms may appear clipped on the display but no data is lost.

**W409** — Full autoscale needs a display amplitude which is too large for the selected target instrument. Display amplitude will be adjusted to the maximum possible.

When attempting to autoscale the current waveform, the waveform amplitude exceeded the maximum allowed for the target instrument. The viewport was adjusted to the maximum. Waveforms may appear clipped on the display but no data is lost.

**W411** — The path in **[fully specified filename]** will be ignored.

You entered a path and filename in response to a Filename edit box. *WaveWriter* ignored the path. Either change the default path with the *Open* menu or specify the path when you save the file.



# Appendix B: Waveform Formats

This section discusses the *WaveWriter*-compatible file formats. In each sub-section, you will find an overview of the file format, structural details, and specific file examples.

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## The ADIF Format

The Analog Data Interchange Format (ADIF) is a data object description language that combines a description of the data with the data itself. ADIF requires a minimum of description and can optionally associate a wide range of information with the actual data. The ADIF block structure permits simple data representation, yet it is capable of representing complex data-dimensional sets. ADIF is part of the SCPI standard adopted by the SCPI consortium.

ADIF Version 1.0 is compatible with SCPI version 1992.0. At Tektronix, version 0.99 is used by some software packages such as TekTMS. ADIF makes it easier to share waveforms and other analog information between software packages and supported instruments. ADIF is flexible, extendable, and accommodates a wide range of data structures and formats.

The hierarchically structured ADIF format may subordinate to other structures. It is well suited as a file format being easily transmitted across IEEE 488.1/488.2, RS-232, SCSI, Ethernet, and other transmission media and protocols.

The accommodation of digital data is one of several possible extensions to ADIF. While it can represent digital and other kinds of structured data, ADIF is somewhat cumbersome.

### Overview

An ADIF data set generally consists of several description blocks and a data block. Blocks typically contain keywords and may contain subordinate blocks. Keywords can have one or more values.

Some blocks require modifiers. Modifiers allow a block to have a value as well as keywords and subordinate blocks. Modifiers also allow multiples of the same block type to be uniquely distinguished from one another.

### Block Descriptions

The ADIF data and description blocks are defined as follows:

- **STD** — Specifies the ADIF version standard used to create the data set, as well as any optional protocols.

- IDENTIFY — Names the data set and describes the generation environment. The environment description includes project name, test number and series, date and time, and source.
- DIMENSION — Dimension blocks specify the data structure and format of the DATA (CURVE) blocks. Provision is made for data scaling, offset, naming, and units specification. The DIMENSION, ENCODE, and ORDER blocks, taken together, completely describe the structure and physical format of data in the DATA (CURVE) blocks.
- ENCODE — Specifies the data encoding format of the DATA and ENCODE blocks, including signal values for underflow, overflow, and no value, as well as the range and precision of data.
- TRACE — Logically groups dimensions as functions, surfaces, sets, etc. TRACE blocks provide data semantic information and they are used in the construction of VIEW blocks. (They also provide a convenient and powerful mechanism for sub-setting data.)
- DATA — Contains the actual data. Various subordinate blocks describe dimensioned data, pulse parameter measurements, sine parameter measurements, statistical measurements, and point values.

### Block and Keyword Organization

The following listing of blocks and keywords exemplifies the ADIF hierarchical structure; blocks are followed by parentheses. A block followed by an ellipse is a repeat of a previous definition. If multiple occurrences of a block or keyword are permitted, they are marked with [m].

The ADIF standard and revision control block:

```
STD ( )
    VERSION
```

The ADIF environment description blocks:

```
IDENTIFY ( )
    NAME
    DATE
    TIME
    SOURCE ( )
        PACKAGES
```

The ADIF data structure and format block:

```
DIMENSION = <dimension label> ( ) [m]
    NAME
    UNITS
    SCALE
    OFFSET
    SIZE
    ENCODE ( ) ...
    NOTE
```

The ADIF blocks for semantic information:

```
TRACE = <trace label> ( ) [m]
    NAME
```

```

INDEPENDENT ( )
    DIMENSION ( ) [m]
    LABEL
    START
    STOP
DEPENDENT ( )
    DIMENSION ( ) [m]
    LABEL

```

The ADIF data block:

```

DATA = <data label> ( ) [m]
CURVE ( )
VALUES

```

---

## The CSV Format

The Comma Separated Values (CSV) format is commonly used to exchange data sets between databases, spreadsheets, and other analysis packages. Since the data is stored in plain ASCII characters, it is easily transferred to other platforms and can be read and edited manually.

While *WaveWriter* will read and write future ASCII formats supported by Tektronix, this file format provides a simple way to move waveform data in and out of *WaveWriter*.

### Overview

The standard format for a CSV waveform read or written by *WaveWriter* is as follows:

```
<value>,<value>[,<value>]<CR><LF>
```

```
<value>,<value>[,<value>]<CR><LF>
```

etc.

Where <value> must be a number in decimal or scientific notation ( $\pm n.nnnE\pm nnn$ ). Data in square brackets ( [ ] ) is optional. What is expected is determined by the first data line. If the first line has three values, the format of the remaining is expected to be identical. The number of values on a line determines the type of waveform. A normal waveform is represented by two values per line; an envelope waveform is represented by three.

The number of data lines is limited by the number of points *WaveWriter* can hold in a waveform. The number of data points is determined by counting the data lines in the CSV file.

When defining scientific notation, use a capital E to guarantee recognition by *WaveWriter*. When using either numerical format, the mantissa may be of arbitrary precision (although the data is converted to a signed 32-bit integer by *WaveWriter*).

To determine the clock rate of a CSV waveform, *WaveWriter* calculates the difference between the first and second X values, and ignores the remaining X values in the file. If you are creating or editing a CSV file to be read by *WaveWriter*, the X values must be equally spaced in time.

Even if the first X value is a nonzero, the initial data point read by *WaveWriter* is assumed to begin at zero. If you want your waveform to start at  $t = 1$  s, insert the appropriate number of 0 volt Y values to shift the data.

Depending on the waveform type, *WaveWriter* will write CSV files in one of two ways: Normal or Envelope.

### Normal Waveforms

Normal waveforms, or waveforms with only one Y value associated with each X value, are written and read in the following format:

```
0, -3.05E-05
1.00E-06, 0.025117
2.00E-06, 0.050203
3.00E-06, 0.07535
4.00E-06, 0.100436
5.00E-06, 0.125523
6.00E-06, 0.150609
7.00E-06, 0.175695
8.00E-06, 0.20072
9.00E-06, 0.225684
1.00E-05, 0.250649
```

### Envelope Waveforms

Envelope waveforms, or waveforms with two Y values associated with each X value, are written and read in the following format:

```
0, 0.5, -0.5
2.00E-06, 0.5252, -0.4749
4.00E-06, 0.5503, -0.4497
6.00E-06, 0.5754, -0.4246
8.00E-06, 0.6004, -0.3995
1.00E-05, 0.6255, -0.3744
1.20E-05, 0.6506, -0.3493
1.40E-05, 0.6757, -0.3243
```

1.60E-05, 0.7007, -0.2992

1.80E-05, 0.7258, -0.2743

2.00E-05, 0.7507, -0.2493

When *WaveWriter* reads or writes CSV data, the values listed in the Ymax column are not always greater than the values listed in the Ymin column. (*WaveWriter* represents the data internally by this method.) When using an envelope with an instrument having a maximum value less than a minimum value, the waveform comparison will always fail.

---

## CSV (K3) Format

There is another variation of CSV format referred to as 'CSV (K3)'. This format is included for backward compatibility with *WaveWriter* version 3 which used CSV (K3) as its CSV format.

The format is the same as the standard CSV except that there is an additional line of explanatory text at the start of the file. For normal waveforms the first line of a CSV (K3) file written by *WaveWriter* will be:

X(sec), Y(volts)

For envelope waveforms, the first line will be:

X(sec), Ymax(volts), Ymin(volts)

For reading by *WaveWriter*, the first lines of CSV (K3) files should be of the form:

<label1>, <label2>                    for normal waveforms, or  
<label3>, <label4>, <label5>        for envelope waveforms.

Where <labelN> can be any ASCII text of the characters other than 0 thru 9, or + or -.

---

## The ISF Format

The Instrument Specific Format files created by *WaveWriter* are structured for instrument specific use. These files may be called with external routines and sent to the digital memory of target instruments. You should be cautious when attempting to read or write this format to non*WaveWriter* software packages.

ISF formatted file examples for each instrument type follow below. In each example, the data values shown enclosed in brackets are descriptive rather than literal, and must be replaced with actual data. Similarly, the brackets are not part of the actual data string. Although each item in the example is shown on a separate line, the data is sequential. There is no implied carriage return/line feed separator:

### AFG 320/310

ISF files for the AFG 320/310 are formatted as shown below. The text in parentheses is commentary and is not part of the ISF format. Although the text is divided up into lines below, this for clarity only; there are no newline characters in AFG 320/310 ISF files.

```

:SOUR1:VOLT:OFFS 0;           (Initially, set the offset to zero.)
:SOUR1:VOLT:AMPLITUDE n.nnnV; (Amplitude – engineering notation)
:SOUR1:VOLT:OFFSET n.nnnV;   (Offset – engineering notation)
:SOUR1:FREQUENCY 10mHz;      (Waveform Frequency – engineer-
                               ing notation)

:FORM:BORD NORM;            (Select normal byte order.)
:DATA:EMEM, #                (start of waveform data – waveform
                               to edit buffer)

[length of byte-count string] (ASCII character string)
[byte-count string]          (ASCII character string)
[high byte][low byte]        (first data point)
[high byte][low byte]
.
.
.
[high byte][low byte]        (last data point)
    
```

Amplitude, Offset and frequency values can be integer or decimal. Point data values can be in the range 0 to 4094.

The frequency value is the instrument's waveform repetition frequency (wrf), not the clock frequency. For a clock frequency of F the waveform repetition frequency is given by

$$wrf = F/N$$

where N is the number of points.

You will notice that the offset voltage is set twice in the above file format. The first time sets it to zero, and the second time sets it to the required value. If the zero setting is not done, and the instrument happens to have an offset that is of greater magnitude than the required value, some amplitude values that are legal in combination with the required value will be rejected by the instrument. Setting the offset to zero allows any value of amplitude up to the absolute maximum. The first offset setting must use the abbreviated command **OFFS**, not the full command **OFFSET**. This allows WaveWriter to find the correct setting when reading the file.

**Data Conversion** – To convert a high byte/low byte pair to an integer value, use the following expression.

$$WfmValue = (high\ byte \ll 8) | (low\ byte \& 255).$$

PointValue ranges from 0 to 4094. To convert to a signed integer, subtract 2047.

**AFG 2020**

ISF files for AFG 2020 arbitrary function generators are formatted as follows. The text shown in parentheses is commentary and not part of the .ISF format.

```

:OUT1:RANGE AUTO;
AMPLITUDE [n.nn]V;           (Amplitude Value)
OFFSET [n.nn]V;             (Offset Value)
FREQUENCY [n.nn]Hz;         (Engineering notation)
:CURVE #42048                (ASCII character string including the
                             length of the binary block)
                             (First data point)
[High byte][low byte]
.
.
[High byte][low byte]      (1024th data point)

```

Amplitude and offset values can be integer or decimal.

Binary data values range from 0 to 4094.

**Data Conversion** — To convert a high byte/low byte pair to an integer value, use the equation:

$$\text{WfmValue} = (\text{HighByte} \ll 8) | (\text{LowByte} \& 255);$$

WfmValue ranges from 0 to 4094. To convert WfmValue to a signed integer, subtract 2047.

**AWG 2000 Series**

ISF files for AWG 2000 series arbitrary waveform generators are formatted as follows. The text shown in parentheses is commentary and not part of the .ISF format.

```

:WFMPRE:BYT_NR 2;BIT_NR 12;ENCDG BIN;BN_FMT RI;BYT_OR MSB;
NR_PT [nnn];                 (number of points)
PT_FMT Y;XUNIT "S";
XINCR [nn.nnEnn];           (Time per point)
PT_OFF 0;XZERO 0.000;YUNIT "V";
YMULT [nn.nnEnn];           (Volts per level)
YOFF 2.047E+03;
YZERO [nn.nnEnn];           (offset)
:CURVE#                      (ASCII character string)
[length of Byte Count string] (ASCII character string)
[Byte Count]                 (byte count as ASCII character string)
[High byte][low byte]       (First data point in binary)
.
.
[High byte][low byte]       (nth data point)

```

XINCR, YMULT, and YZERO values can be integer, decimal, or exponential notation.

The Byte count is twice that number of data points.

**Data Conversion** — To convert a high byte/low byte pair to an integer value, use the following expression.

$$\text{WfmValue} = (\text{HighByte} \ll 8) | (\text{LowByte} \& 255).$$

For instruments with 12-bit resolution (i.e all except for the AWG2040 and 2041) WfmValue ranges from 0 to 4094. To convert to a signed integer, subtract 2047.

The AWG2040 and 2041 have 8-bit resolution and the least significant four bits are always set to zero; WfmValue ranges from 0 to 4064. To convert to a signed integer, subtract 2032.

### AWG 5105

ISF files for AWG 5105 arbitrary waveform generators are formatted as follows. The text shown in parentheses is commentary and not part of the .ISF format.

```
:SOUR:VOLT:AMPL [n.nn];      (Amplitude Value) :SOUR:VOLT:OFFS
[n.nn];                      (Offset Value) :ARB:PRAT [n.nnEnn];
(time rate per point) :ARB:DATA#
(ASCII character string) [length of Byte Count string]
(ASCII character string) [Byte Count]
(byte count as ASCII character string) [High byte][low byte]
(First data point in binary)
. . . . [High byte][low byte]
(nth data point)
```

Amplitude, offset, and rate values can be integer, decimal, or exponential notation.

Binary data values range from 0 to 4095.

The Byte count is twice that number of data points.

**Data Conversion** — To convert a high byte/low byte pair to an integer value, use the following expression.

$$\text{WfmValue} = (\text{HighByte} \ll 8) | (\text{LowByte} \& 255).$$

For instruments with 12-bit resolution (i.e all except for the AWG2040 and 2041) WfmValue ranges from 0 to 4094. To convert to a signed integer, subtract 2047.

The AWG2040 and 2041 have 8-bit resolution and the least significant four bits are always set to zero; WfmValue ranges from 0 to 4064. To convert to a signed integer, subtract 2032.



## AFG 5101 and AFG 5501

ISF files for AFG 5101/5501 arbitrary generators are formatted as follows. The text shown in parentheses is commentary and not part of the .ISF format.

OFFSET 0;	(Offset initialized; see text)
AMPL [n.nn];	(Amplitude Value)
OFFSET [n.nn];	(Offset Value)
RATE [n.nnEnn];	(Exponential notation)
ARGDATA%	(ASCII character string)
[High byte][low byte]	(byte count)
[High byte][low byte]	(First data point)
.	
.	
[High byte][low byte]	(nth data point)
[checksum byte]	(Checksum byte)

The first OFFSET parameter initializes the instrument to prevent an invalid amplitude/offset combination. Subsequent amplitude and offset values can be integer, decimal, or exponential notation.

Binary data values range from 0 to 4,095.

The Byte count is twice the number of data points plus one for the checksum byte (the byte count is always an odd integer).

**Data Conversion** — To convert a high byte/low byte pair to an integer value, use the equation:

$$\text{WfmValue} = (\text{HighByte} \ll 8) | (\text{LowByte} \& 255);$$

WfmValue ranges from 0 to 4,095. To convert WfmValue to a signed integer, subtract 2,047.

## AFG 5102 and AFG 5502

ISF files for AFG 5102/5502 arbitrary waveform generators are formatted as follows. The text shown in parentheses is commentary and not part of the .ISF format.

OFFSET 0;	(Offset initialized; see text)
AMPL [n.nn];	(Amplitude Value)
OFFSET [n.nn];	(Offset Value)
RATE [n.nnEnn];	(Exponential notation)
ARGDATA%	(ASCII character string)
[High byte][low byte]	(byte count)
[High byte][low byte]	(First data point)
.	.
.	.
[High byte][low byte]	(nth data point)
[checksum byte]	(Checksum byte)

The first OFFSET parameter initializes the instrument to prevent an invalid amplitude/offset combination. Subsequent amplitude and offset values can be integer, decimal, or exponential notation.

Binary data values range from 0 to 4095.

The Byte count is double the number of data points plus one for the checksum byte (the byte count is always an odd integer).

**Data Conversion** — To convert a high byte/low byte pair to an integer value, use the equation:

$$\text{WfmValue} = (\text{High Byte} \ll 8) | (\text{Low Byte} \& 255);$$

WfmValue ranges from 0 to 4095. To convert WfmValue to a signed integer, subtract 2047.

## TDS Series Oscilloscopes

ISF files for TDS Series Digital Storage Oscilloscopes are formatted in ASCII (the data points are in binary) as follows. The text shown in parentheses is commentary and not part of the .ISF format.

```

:WFMPRE:BYT_NR 1;BIT_NR 8;ENCDG BIN;BN_FMT RI;
BYT_OR MSB;CH1:WFID "CH1";
NR_PT [nnn]; (number of points)
PT_FMT [Y or ENV];
XUNIT "s";
XINCR [n.nnEnn]; (clockrate)
PT_OFF 0;
YUNIT "Volts";YMULT [n.nnEnn];
YOFF [nnn]; (offset in levels)
YZERO [nn.nnEnn]; (offset in volts)
:DATA:START 1;STOP [nnn]; (number of points)
:CURVE# (ASCII character string)
[length of Byte Count string] (ASCII character string)
[Byte Count] (byte count as ASCII character
string)
[byte] (First data point in binary)
.
.
.
[byte] (nth data point)

```

XINCR, YMULT, YOFF, and YZERO values can be integer, decimal, or exponential notation.

Each data byte value ranges from -128 to +127.

### NOTE

*The driver also reads ISF files from TD100 software, which varies slightly from the above format.*

## 2400 Series Oscilloscopes

ISF files for the 2400 Series DSO is formatted in ASCII (the data points are in binary) as follows. The text shown in parentheses is commentary and not part of the .ISF format.

```

WFMPRE WFI:"2400DSO",ENCD:BINA,BN.F:RI,XINC:[clock-
rate],YMULT:[Volts per level],YOFF:[offset],PT.F:[Y or enve-
lope];CURVE%[high byte of count][low byte of count][data point
1]...[data point 1024][checksum]

```

High byte and low byte are the byte count (1025).

High byte = 04, low byte = 01 hex;

Each data byte value ranges from -128 to +127.

## 11000 Series Oscilloscopes

ISF files for the 11000/DSA Series Oscilloscopes are formatted in ASCII (the data points are in binary or ASCII) as follows. Text shown in parentheses is commentary and not part of the .ISF format.

The ISF format for the 11000/DSA configured on a COM port with XON/XOFF (Soft) handshaking is:

```
BIT/NR:16,BN.FMT:RI,BYT/NR:2,BYT.OR:LSB,CRVCHK:NONE,
ENCDG:ASCII,NR.PT:[ number of points ],PT.FMT:[Y or Env],
XINCR:[clock rate],YMULT:[Volts per level],YZERO:[offset];CURV [ASCII
number for point 1],[ASCII number for point 2] ...[ASCII number for last
point ]
```

The ISF format for all others is:

```
WFMPRE BIT/NR:16,BN.FMT:RI,BYT/NR:2,BYT.OR:LSB,CRVCHK:NONE,
ENCDG:BINARY,NR.PT:[ number of points ],PT.FMT:[Y or Env],
XINCR:[clockrate],YMULT:[Volts per level],YZERO:[offset];CURV %][low
byte of count][high byte of count][low byte of point 1][high byte of point
1] . . . [low byte of last point][high byte of last point]
```

The value of the Count Bytes is double the number of data points

**Data Conversion** — To convert a low byte/high byte pair to an integer value, use the equation:

$$\text{WfmValue} = (\text{HighByte} << 8) | (\text{LowByte} \& 255);$$

Each data point value ranges from -32768 to 32767.

**VX4790A**

The format of VX4790A Arbitrary Waveform Generators has a different style from other instruments. Other instrument drivers write ISF files that contain GPIB commands which can be sent to the instrument; the VX4790A is a VXI instrument with no GPIB interface, so such a file would not be very useful. Instead, files in the binary format used by the LabWindows soft front panel for the instrument are produced.

The format is a simple array of 16-bit words, one word for each point

```
[high byte][low byte]          (first data point)
[high byte][low byte]
.
.
.
[high byte][low byte]          (last data point)
```

Notice that there is no Amplitude, Offset or Clock Period information in file. WaveWriter uses default values when reading these files.

**Data Conversion** — To convert a high byte/low byte pair to an integer value, use the following expression.

$$\text{WfmValue} = (\text{HighByte} \ll 8) | (\text{LowByte} \& 255).$$

PointValue ranges from 0 to 4095. To convert to a signed integer, subtract 2048.

**Note**

*As with other instrument drivers, the default filename extension for VX4790 ISF files is '.ISF'. However the LabWindows soft front panel uses the extension '.BIN' as the default when reading the files.*

**VX4792**

The VX4792 is closely related to the AWG 2000 series of arbitrary waveform generators, so the driver has been designed to read and create ISF files in the same format as that series. To be precise, the format used is the same as for 12-bit instruments such as the AWG 2020. See the AWG 2000 section in this Appendix for details.



# Appendix C: Equation Library

This section discusses each equation in the Equation Library. Access the Equation Library with the **Create**→**Equation**→**Library** dialog box.

## 10ksine

$$5*\sin(2*\pi*10^4*t)$$

10ksine is a 10 kHz sine wave with a 5 volt peak amplitude.

View at: Amp = 10 V, Offset = 0 V, Start = 0 s, Stop = 100  $\mu$ s,  
Clock = 100 ns.

Edit the 5 to change the peak amplitude.

Edit  $10^4$  to change the frequency.

## 10ksine+

$$5+5*\sin(2*\pi*10^4*t)$$

10ksine+ is a 10 kHz sine wave with a 5 volt peak amplitude and 5 volt DC offset.

View at: Amp = 10 V, Offset = 5 V, Start = 0 s, Stop = 100  $\mu$ s,  
Clock = 100 ns.

Edit the first 5 to change the DC offset.

Edit the second 5 to change the peak amplitude.

Edit  $10^4$  to change the frequency.

## 2Tpulse

$$.7143*(\sin(2*\pi*(t-.000033923)*795924.86)^2)$$

See the *Tutorial* for use.

## AMmod

$$\sin((\pi*10*t)/10)*\cos(2*(\pi*10*t)+.5)$$

AMmod is an AM modulated signal. The carrier is a 10 Hz cosine wave with a 1 V peak amplitude and a 0.5 s time advance (a negative delay). The signal is 0.5 Hz sine wave with a 1 volt peak amplitude.

View at: Amp = 2 V, Offset = 0 V, Start = 0 s, Stop = 1 s,  
Clock = 1 ms.

Edit 10 to change the signal frequency.

Edit the 10 to change the carrier frequency.

Edit +.5 to change the time shift.

### AMsweep

$$.5*t*\sin(5*(9*\pi*t))$$

The AMsweep carrier signal is a 22.5 Hz sine wave with 0.5 volt peak amplitude. The t factor will cause the signal to be ever increasing in amplitude.

View at: Amp = 2 V, Offset = 0 V, Start = 0 s, Stop = 1 s,  
Clock = 1 ms.

Edit .5 to change the rate of growth (currently at 0.5 volt.)

Edit 9 to change the carrier frequency.

### Carrier

$$\sin(2*\pi*t*3579545-\pi)$$

A more realistic carrier wave is the 3579545 MHz sine wave with a 1 volt peak amplitude and a pi-phase shift. (This delays the wave 180 degrees.)

For a few cycles, view at: Amp = 2 V, Offset = 0 V, Start = 0 s,  
Stop = 1 s, Clock = 1 ms.

Edit 3579545 to change the carrier frequency.

Edit  $-\pi$  to change the time delay or phase.

### DSXmax1

$$.5*(1+\sin(\pi/2*(1+((t/(158.4*10^{-9}))- .72)/.36)))$$

See sample equation DSX-2 on Page D-5 for use.

### DSXmax2

$$.1+.72*\exp((-2.13*((t/(158.4*10^{-9}))- .92)))$$

See sample equation DSX-2 on Page D-5 for use.

### DSXmin1

$$.5*(1+\sin(\pi/2*(1+((t/(158.4*10^{-9}))- .72)/.205)))$$

See sample equation DSX-2 on Page D-5 for use.



**DSXmin2**

$$.331 * \exp((-1.9 * ((t / (158.4 * 10^{-9})) - 1.02)))$$

See sample equation *DSX-2* on Page D-5 for use.

**expdecay**

$$\exp(-(t - .5) / 10^{-2})$$

Expdecay is an exponentially decaying waveform time shifted to have a value of 1 at  $t = 0.5$  s.

View at: Amp = 200 V, Offset = 0 V, Start = 450 ms, Stop = 700 ms, Clock = 1 ms.

Edit .5 to change the time shift.

Edit  $10^{-2}$  to change the time constant (larger constant = slower decay.)

**NOTE**

*Create this function from 0.5 s to the end only. The first half second will be filled with 0's.*

**expSine**

$$5 * \sin(2 * \pi * 10^3 * t) * \exp(-t / 10^{-2})$$

ExpSine is an exponentially decaying sine wave with a frequency of 1 kHz, a 5 volt peak amplitude, and a decaying time constant of 10 ms.

View at: Amp = 10 V, Offset = 0 V, Start = 0 s, Stop = 50 ms, Clock = 100  $\mu$ s.

Edit the 5 to change the peak amplitude of the sine wave.

Edit  $10^3$  to change the frequency of the sine wave.

Edit  $10^{-2}$  to change the time constant of the decay.

**FMstereo**

$$(\sin(80 * (\pi * t - \pi)) + .97) * \cos((80 * (\pi * t - \pi)) / 20)$$

FMstereo is a FM modulated signal. The carrier is a 40 Hz sine wave with a 0.97 VDC offset. The signal is a 2 Hz cosine wave.

View at: Amp = 4 V, Offset = 0 V, Start = 0 s, Stop = 500 ms, Clock = 500  $\mu$ s.

Edit 80 to change the frequency of the carrier sine wave.

Edit .97 to change the DC offset of the carrier sine wave.

Edit 20 to change the frequency of the signal cosine wave.

**HalfAM**

$$\text{abs}((\sin(8*\pi*10*t) + .97)*\sin((8*\pi*10*t)/20))$$

HalfAM is an AM modulated wave with the bottom half inverted and added to the top half. The carrier wave is a 40 Hz sine wave with a DC offset of 0.97 volts. The signal is a 2 Hz sine wave.

View at: Amp = 4 V, Offset = 0 V, Start = 0 s, Stop = 500 ms,  
Clock = 500  $\mu$ s.

Edit 10 to change the frequency of the carrier sine wave.

Edit .97 to change the DC offset of the carrier sine wave.

Edit the last 20 to change the frequency of the signal sine wave.

**haversin**

$$.5*(1 - \cos(2*\pi*t))$$

Haversin is a 1 Hz cosine wave with a 0.5 volt peak amplitude (making the 0.5 negative inverts the waveform vertically) with a 0.5 volt DC offset.

View at: Amp = 2 V, Offset = 0 V, Start = 0 s, Stop = 1 s,  
Clock = 1 ms.

Edit .5 to change the peak amplitude of the cosine wave.

**havertri**

$$((\text{asin}(\text{abs}(\sin((\pi*t)))))/\pi)/*2$$

Havertri is a 1 Hz triangle wave with the negative portion inverted.

View at: Amp = 2 V, Offset = 0 V, Start = 0 s, Stop = 2 s,  
Clock = 2 ms.

Edit the 2 to change the peak amplitude.

**InterMod**

$$.2*\sin(15*(7*\pi*t)) + \sin((7*\pi*t)/7)$$

InterMod is an IM modulated wave. The carrier is a 52.5 Hz sine wave with 0.2 volt peak amplitude. The signal wave is a 0.5 Hz sine wave. The two waves have been added rather than multiplied.

View at: Amp = 3 V, Offset = 0 V, Start = 0 s, Stop = 1 s,  
Clock = 1 ms.

Edit .2 to change the peak amplitude of the carrier wave.

Edit 15 to change the frequency of the carrier wave.

Edit /7 to change the frequency of the signal wave.

**modsin<sup>2</sup>**

$$.7143 * ((\sin((2 * \pi * (t - .000037413) * 3579545) - \pi)) + 1) * .5 * (\sin(2 * \pi * (t - .000037413) * 146190) ^ 2)$$

The modsin<sup>2</sup> waveform represents the square of a modulated sine wave.

View at: Amp = 2 V, Offset = 0 V, Start = 0 s, Stop = 10  $\mu$ s,  
Clock = 10 ns.

Edit .7143 to change the peak amplitude of the wave.

Edit .000037413 to change the time delay for both primary waves.

3579545 is the original frequency of the carrier wave.

.5 controls the amplitude before squaring (could be moved outside the square as 0.25.)

Edit 146190 to change the frequency of the signal wave.

### NoiseSyn

$$\sin(7 * t * \pi) + .3 * \text{rand}$$

NoiseSyn is a 3.5 Hz sine wave with random noise added. The added noise has a maximum magnitude of 0.3 volt.

View at: Amp = 3 V, Offset = 0 V, Start = 0 s, Stop = 1 s,  
Clock = 1 ms.

Edit 7 to change the frequency of the sine wave.

Edit .3 to change the maximum possible magnitude of the noise.

### sin<sup>2</sup>

$$\sin(2 * \pi * t * 146190) ^ 2$$

Sin<sup>2</sup> is a sine-squared waveform with an original frequency of 146.19 kHz. After squaring, the wave has a 0.5 VDC offset (half the square of the peak amplitude), a peak amplitude equal to the offset, and has doubled in frequency.

View at: Amp = 2 V, Offset = 0 V, Start = 0 s, Stop = 10  $\mu$ s,  
Clock = 10 ns.

Edit 146910 to change the original frequency of the wave.

### sinc200n

$$\frac{(\sin(2\pi \cdot 10^5 \cdot (t - 10^{-4})) + 10^{-10})}{(2\pi \cdot 10^5 \cdot (t - 10^{-4}) + 10^{-10})}$$

Sinc200n is a  $\sin(x)/x$  or sinc waveform. The peak of the sinc is at  $t = 200$  s with a frequency of 100 kHz. The  $10^{-10}$  factors are used to avoid division-by-zero problems. (The factors are small enough to not change the waveform significantly.)

View at: Amp = 2 V, Offset = 0 V, Start = 0 s, Stop = 200  $\mu$ s,  
Clock = 10 ns.

The argument to the sine function and the denominator of the fraction must be identical to preserve the  $\sin(x)/x$  relationship.

Edit  $10^5$  to alter the frequency of the wave.

Edit  $10^{-4}$  to alter the center of the sinc (where the peak is.)

### SqrWave

$$\sin(6t\pi) + .333\sin(3(6t\pi)) + .2\sin(5(6t\pi)) + .1428\sin(7(6t\pi)) + .111\sin(9(6t\pi))$$

SqrWave is a series expansion which reduces a square wave to its component sine waves. This is only the first five members of the series.

The base waveform is a 3 Hz sine wave.

View at: Amp = 4 V, Offset = 0 V, Start = 0 s, Stop = 1 s,  
Clock = 1 ms.

Edit the 6 in all of the series members to alter the frequency of the square wave.

# Appendix D: Sample Equations

The derivation of several equations is briefly described in this section. The equations reside in the Equation Library accessed through the **Create**→**Equation**→**Library** dialog box.

The basic trigonometric function is:

$$A + B \times f(2 \times \pi \times F \times t)$$

where:

A = DC offset

B = Peak Amplitude in volts

f = trigonometric function (e.g. sin, cos, tan)

F = Frequency of waveform [ $1/(\text{points/cycle} \times \text{clock rate})$ ]

t = Time, a running variable initialized at the start point and incremented to stop point.

$\pi = 3.14159265$  (internal constant)

## 10 V Sine Wave

To create a 10 V peak-to-peak 10 kHz sine wave with no DC offset:

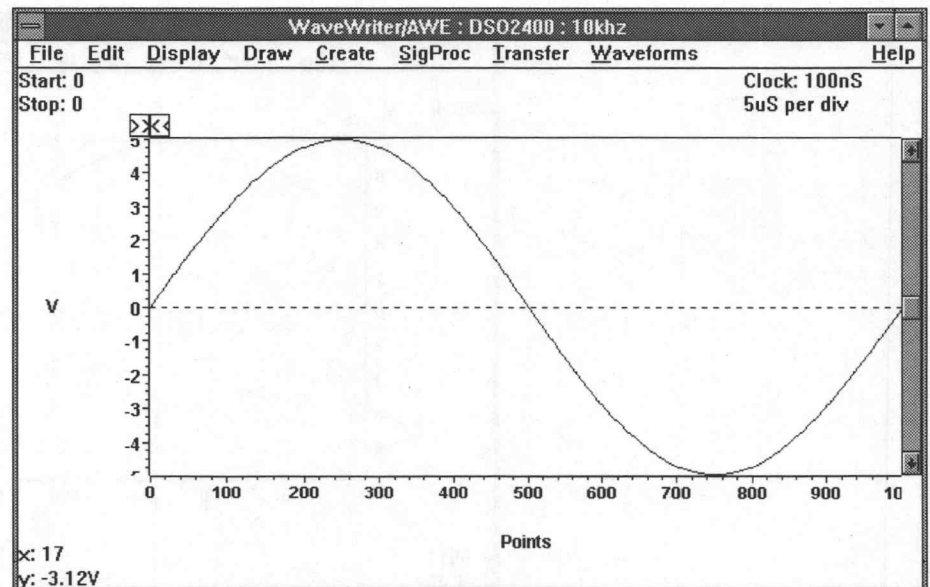


Figure D-1: 10 V Sine Wave

Start point = 0 pt

Stop point = 999 pt

Clock = 100 ns

Cycles = 1

In the equation:

$$5 \times \sin(2 \times \pi \times 10^4 \times t)$$

The 5 represents the peak amplitude. The sine function returns a value between 1 and -1. Multiplying by 5 adjusts the amplitude to be between 5 and -5. The frequency of the equation is calculated based on the clock rate and points/cycle of the waveform. The formula is:

$$F = 1/((\text{points/cycle}) \times \text{clock}) \text{ or } 1/(1000 \times 100) \text{ ns which is } 10 \text{ kHz} (10^4 \text{ in equation}).$$

In the *Equation* edit box enter:  $5 * \sin(2 * \pi * 10^4 * t)$

If you were to change the clock rate to 10 ns and wanted to maintain the same number of cycles, you would have to change the frequency to  $1/(1000 \times 10 \text{ ns}) = 100 \text{ kHz}$ . The new equation would be:

$$5 \times \sin(2 \times \pi \times 10^5 \times t)$$

In the *Equation* edit box enter:  $5 * \sin(2 * \pi * 10^5 * t)$

## 10 V Sine Wave with Offset

To create a 10 V peak-to-peak 10 kHz sine wave (identical to the 10 V example above) with a 5 VDC offset:

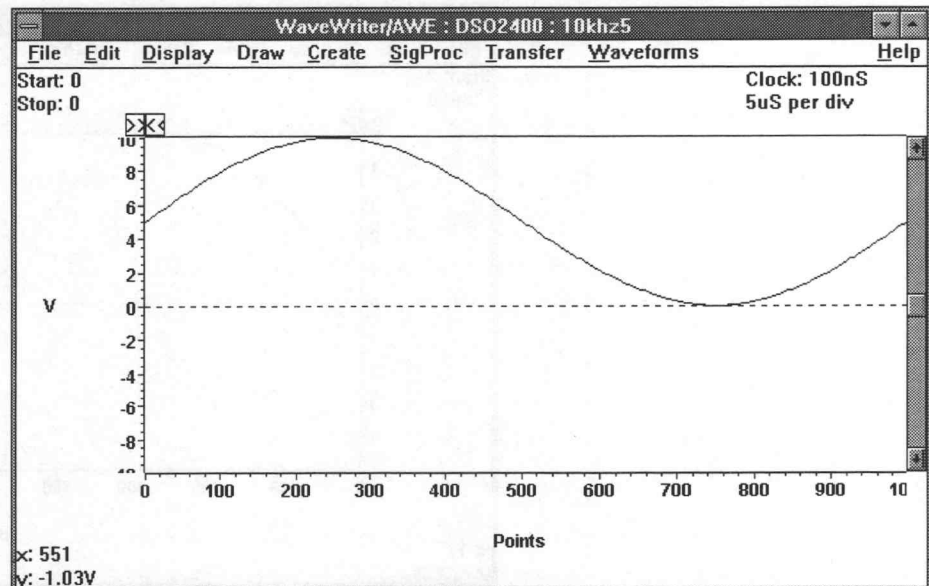


Figure D-2: 10 V Sine Wave with Offset

The equation is:

$$5 + 5 \times \sin(2 \times \pi \times 10^4 \times t)$$

In the *Equation* edit box enter:  $5+5*\sin(2*\pi*10^4*t)$

## Exponentially Decaying Sine Wave

To create a 1 kHz sine wave with a 10 V peak-to-peak amplitude and exponential decay with 10 ms time constant:

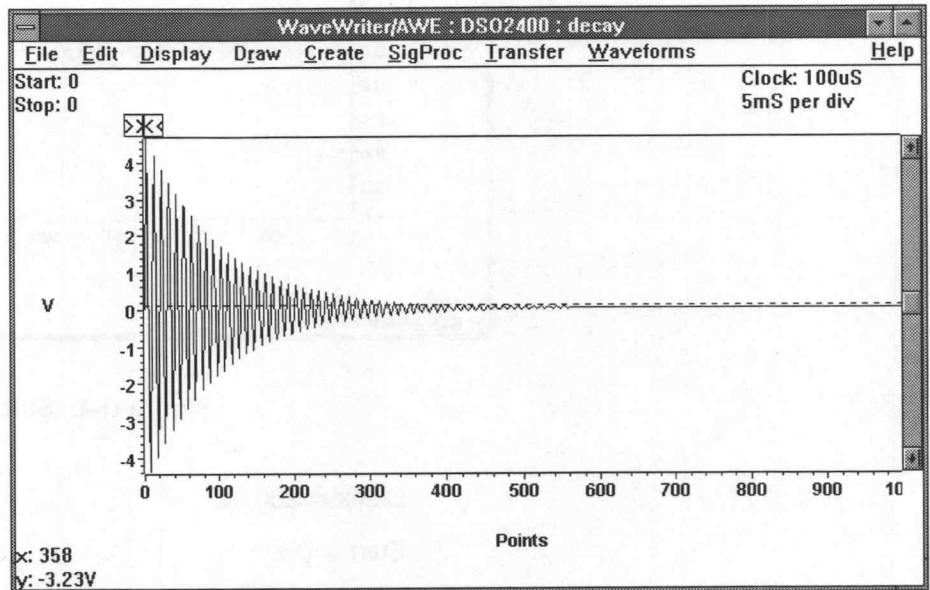


Figure D-3: Exponentially Decaying Sine Wave

Clock = 100  $\mu$ s

Start = 0 pt

Stop = 999 pt

Cycles = 100

The equation is:

$$5 \times \sin(2 \times \pi \times 10^3 \times t) \times \exp(-t/10^{-2})$$

The 5 represents the amplitude. The frequency is calculated based on the clock rate and the points per cycle:

$$1/(1000 \text{ pt}/100 \text{ cycles} \times 100 \mu\text{s}) = 1 \text{ kHz or } 10^3$$

The exponential function starts at 1 and decays to 0 which, when multiplied by the sine function, changes the amplitude from full scale to zero.

In the *Equation* edit box enter:  $5*\sin(2*\pi*10^3*t)*\exp(-t/10^{-2})$

## Sinc Waveform

To create a sinc curve centered around 100  $\mu\text{s}$  with a frequency of 100 kHz:

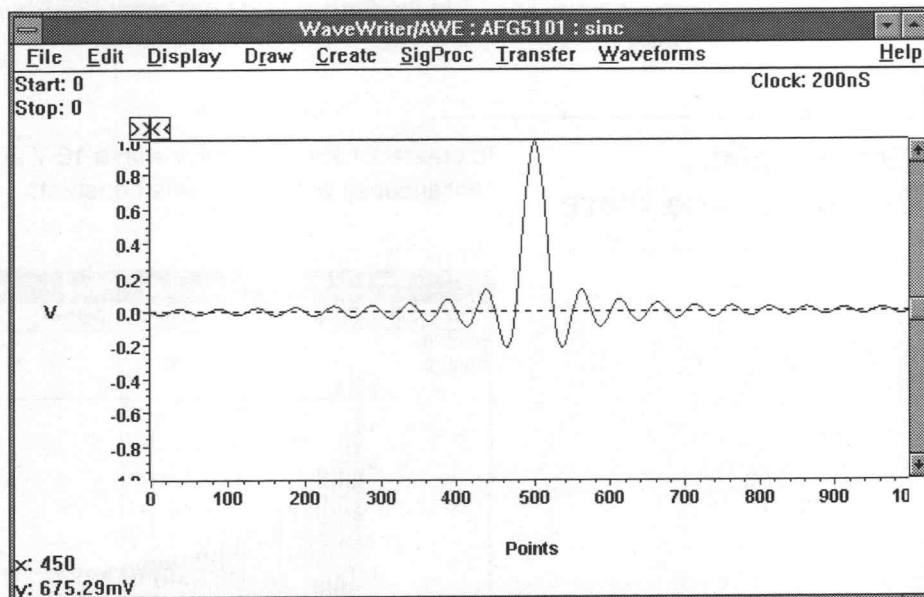


Figure D-4: Sinc Waveform

Clock = 200 ns

Start = 0 s

Stop = 199.8  $\mu\text{s}$

Cycles = 20

The equation is:

$$\frac{(\sin(2 \times \pi \times 10^5 \times (t - 10^{-4})) + 10^{-10})}{(2 \times \pi \times 10^5 \times (t - 10^{-4}) + 10^{-10})}$$

The  $10^{-10}$  terms are included to eliminate division by zero and provide the correct value at the singularity point  $t = 100 \mu\text{s}$ . The frequency is calculated to be  $1/(1000 \text{ pt}/20 \text{ cycles}) \times 200 \text{ ns} = 100 \text{ kHz}$ . Since the time variable  $t$  begins at  $t = 0 \text{ s}$  and goes to  $t = 199.8 \mu\text{s}$ , the starting time is reduced by  $100 \mu\text{s}$  in the equation  $(t - 10^{-4})$  to provide the correct value at the singularity point  $t = 100 \mu\text{s}$ .

In the *Equation* edit box enter:

$$\frac{(\sin(2*\pi*10^5*(t-10^{-4}))+10^{-10})}{(2*\pi*10^5*(t-10^{-4})+10^{-10})}$$



## DSX-2 Isolated Pulse Template

To create a DSX-2 Isolated pulse template for telecommunications:

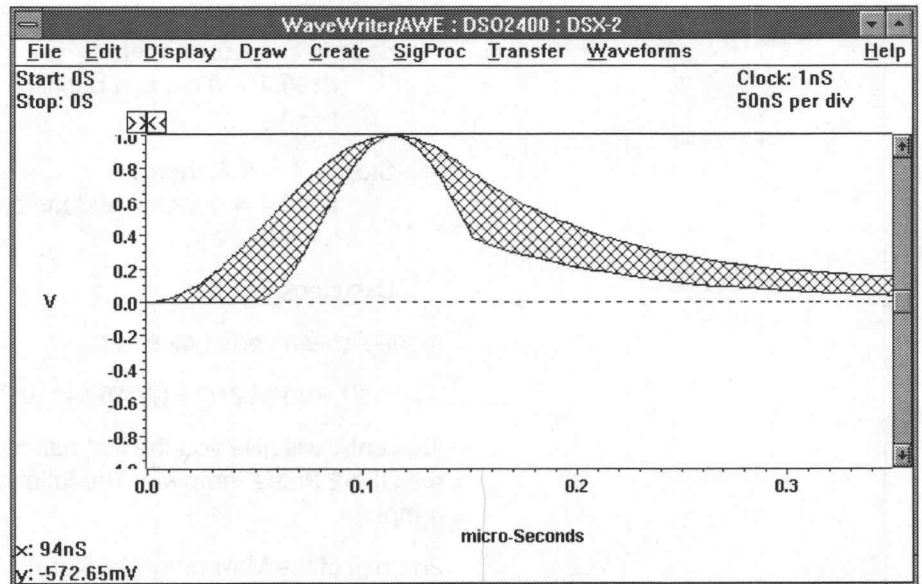


Figure D-5: DSX-2 Isolated Pulse Template

The equations defining this and other telecommunications templates may be normalized. So, assume a normalized equation such as:

$$v(T) = 0.5 \times (1 + \sin(\pi/2 \times (1 + T/0.36)))$$

$$\text{where } -0.72 \leq T \leq 0.2$$

First translate the variable  $T$  into the variable  $t$  which starts at 0 and increases.

$$-0.72 \leq T \leq 0.2$$

$$0 \leq (T + 0.72) \leq 0.92$$

$$\text{Let } t = T + 0.72. \text{ Thus } 0 \leq t \leq 0.92$$

Substitute  $t - 0.72 = T$  to get:

$$v(t - 0.72) = 0.5 \times (1 + \sin(\pi/2 \times (1 + (t - 0.72)/0.36)))$$

The variable  $T$  is normalized to the period of the signal.

Assume the signal of interest is 6.312 MHz, the clock frequency for a DS2 digital communication system. The period is 158.4 ns. To transform the variable  $t$  into a normalized form, simply divide all occurrences of  $t$  by the signal period or 158.4 ns for this example.

The final equation is:

$$v(t - 0.72) = 0.5 \times (1 + \sin(\pi/2 \times (1 + ((t / (158.4 \times 10^{-9})) - 0.72) / 0.36)))$$

You can now use the equation to generate a waveform by calculating the appropriate *Start* and *Stop Points*. From the **Create** → **Equation** dialog box select the *New Waveform* option button. Then enter the following parameters:

$$\begin{aligned} \text{Start} = T &= -0.72, \text{ then} \\ t/158.4 &= 0 \text{ ns, and hence} \\ t &= 0 \end{aligned}$$

$$\begin{aligned} \text{Stop} = T &= 0.2, \text{ then} \\ t/158.4 &= 0.92 \text{ ns, and hence} \\ t &= 145.8 \text{ ns} \end{aligned}$$

Use clock = 1 ns

In the *Equation* edit box enter:

$$.5*(1+\sin(\pi/2*(1+((t/(158.4*10^{-9}))-0.72)/.36)))$$

This entry will give you the first half of the maximum waveform defining the DSX-2 Pulse Template. The following equations define the rest of the template.

2nd half of the Maximum Waveform:

With the 1st half of the DSX-2 pulse template as the current waveform, select **Create** → **Equation** and choose *Replace* as the Action. Then enter the following values:

Equation:

$$0.1 + 0.72 \times \exp((-2.13 \times ((t/(158.4 \times 10^{-9}) - 0.92)))$$

$$\text{Start} = 147 \text{ ns}$$

$$\text{Stop} = 350 \text{ ns}$$

In the *Equation* edit box enter:

$$.1+.72*\exp((-2.13*((t/(158.4*10^{-9}))-0.92)))$$

To generate the minimum waveform from the template create a new waveform consisting of the following two parts:

1st half of the Minimum Waveform:

From the **Create** → **Equation** menu select the *New Waveform* option button and enter the following parameters:

Equation:

$$0.5 \times (1 + \sin(\pi/2 \times (1 + ((t/(158.4 \times 10^{-9}) - 0.72)/0.205))))$$

$$\text{Start} = 50 \text{ ns}$$

$$\text{Stop} = 150 \text{ ns}$$

$$\text{Clock} = 1 \text{ ns}$$

In the *Equation* edit box enter:

$$.5*(1+\sin(\pi/2*(1+((t/(158.4*10^{-9}))-0.72)/.205)))$$

2nd half of the Minimum Waveform:

From the **Create** → **Equation** dialog box again, choose the *Replace* option button. Then enter the following parameters:

Equation:

$$0.331 \times \exp((-1.9 \times ((t/(158.4 \times 10^{-9})) - 1.02)))$$

Start = 151 ns

Stop = 350 ns

In the *Equation* edit box enter:

$$.331 * \exp((-1.9 * ((t / (158.4 * 10 ^ -9)) - 1.02)))$$

Now use **Create** → **Envelope Couple** to combine these two waveforms and create your DSX-2 Template.

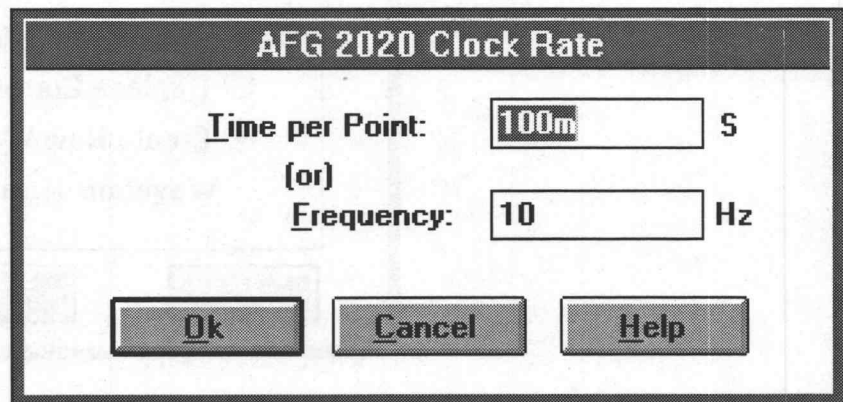


# Appendix E: AFG 2020 Dialogs and Messages

This appendix describes the dialog boxes and error messages specific to the AFG 2020.

## Change Clock Rate

Use the following dialog box (see Figure E-1) to change the current clock rate. This reassigns the time per point and does not change the waveform size or shape.



The dialog box is titled "AFG 2020 Clock Rate". It features two input fields: "Time per Point:" with a value of "100m" and a unit "S", and "Frequency:" with a value of "10" and a unit "Hz". The text "(or)" is positioned between the two input fields. At the bottom of the dialog are three buttons: "Ok", "Cancel", and "Help".

Figure E-1: AFG 2020 Clock Rate Dialog Box

**Time per Point** — Enter the time per point in seconds. The valid range is 4 ns to 1.953 ms.

**Frequency** — Enter the frequency in Hz. The valid range is 512 MHz to 250 mHz.

**OK** — When the new clock rate is entered and **OK** selected, the clock rate display above the Waveform Display Area updates with the new clock rate. If the horizontal axis is displayed in seconds, the scale updates to reflect the new clock rate.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

### Acquire Waveform

Use this dialog box (see Figure E-2) to select the source and destination of the waveform. You may choose one of 32 Arbitrary waveforms stored in the instrument.

You are prompted for the following information before acquiring the waveform:

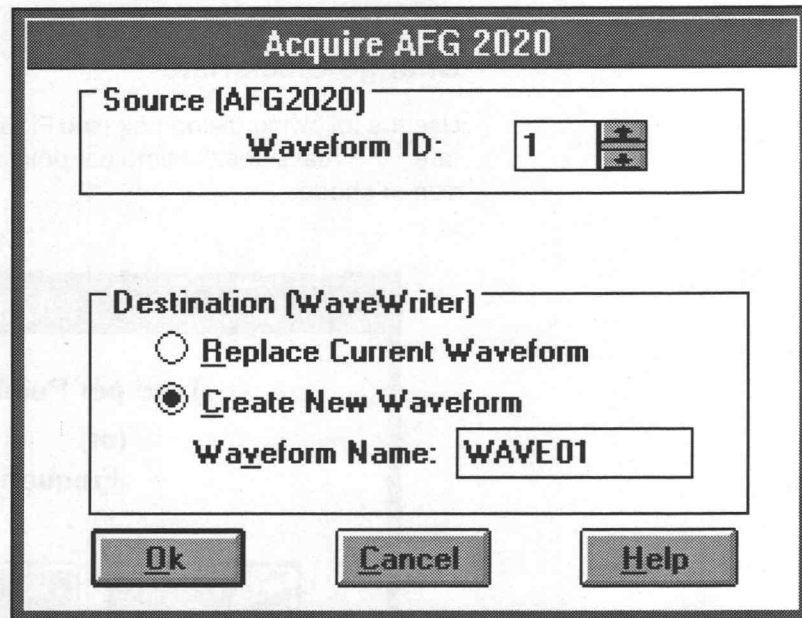


Figure E-2: Acquire AFG 2020 Dialog Box

**Source (AFG2020)** — The **Waveform ID** edit box displays the numbers corresponding to the 32 arbitrary waveforms stored in the instrument. The number visible is the one currently selected for transfer.

**Destination (WaveWriter)** — You have a choice of how to store the acquired waveform:

- **Replace Current Waveform** — The current waveform is overwritten by the acquired waveform. The acquired waveform record length is the new current record length.
- **Create New Waveform** — You are prompted for a new waveform name. The acquired waveform becomes the current waveform. The previous current waveform is now a background waveform.
- **Waveform Name** — Enter a valid name for the waveform being acquired.

**OK** — When **OK** is selected, the waveform is acquired, loaded into memory, and displayed as the current waveform.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

### Conformance to Target

If the acquired waveform data does not conform to the target instrument's ranges, voltage and timing data are affected.

**Voltage** — If the acquired waveform amplitude exceeds the display window limits, the waveform is clipped on the display. No data is lost however.

**Clock Rate** — If the clock rate does not conform, a warning is displayed and you are prompted for one of the following solutions:

- Change the clock rate of the incoming waveform to the current clock rate.
- Massage (expand or compress) the incoming waveform to maintain a timing match.
- Change the current clock rate to match the incoming waveform. If the incoming clock rate is not valid for the selected target instrument, this option is grayed out and unavailable.
- Cancel the acquisition and return to the main menu.

## Send Waveform

You can send the current waveform to an arbitrary numbered location in the AFG 2020 with the following dialog box (see Figure E-3).

Figure E-3: Send AFG 2020 Dialog Box

**Entire Waveform** — Sends the entire waveform. The number of points sent must be 1024.

**Between Markers** — Sends only the portion between and including the markers. The number of points sent must be 1024.

**Destination** — Displays the numbers of the corresponding 32 arbitrary waveforms stored in the instrument. The number visible is the one currently selected for transfer.

**Synthesizer On** — Allows you to use the DDS synthesizer in outputting the waveform on the channel selected. Note that the clock, phase, filter, and frequency are affected by this setting.

**Selected Waveform to Channel 1** — Sends the waveform and its frequency, amplitude, and offset parameters to Channel 1.

**Turn Channel 1 Output On** — Enables waveform transfer through Channel 1. You must specify the following:

- **Channel 1 Filter** — the filter characteristics of Channel 1: full pass, 50 MHz, 100 MHz.



- **Channel 1 Phase** — the phase characteristics of Channel 1: from –360 to +360 degrees.

**Selected Waveform to Channel 2** — Sends the waveform and its frequency, amplitude, and offset parameters to Channel 2.

**Turn Channel 2 Output On** — Enables waveform transfer through Channel 2, in place of or in addition to, Channel 1. You must specify the following:

- **Channel 2 Filter** — the filter characteristics of Channel 2: full pass, 50 MHz, 100 MHz.
- **Channel 2 Phase** — the phase characteristics of Channel 2: from –360 to +360 degrees.

**OK** — When you select **OK**, the waveform is sent to the instrument.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

### Driver Limits

This driver uses the limits listed below to determine valid display amplitude, offset, and clock rate.

**Display Amplitude** — The valid range is 9.82 mV to 10.00 V.

**Offset** — The amplitude and offset together must conform to the following relationship:

$$\text{Amplitude}/2 + \text{Absolute Value of Offset} \leq 5 \text{ V.}$$

**Time per Point** — The valid time per point ranges from 32.05 ns to 2 s.

**Number of Points** — The number of points that can be sent to the instrument is 1024.

## AFG 2020 Error Messages

**E1000** — Error acquiring waveform from AFG 2020.

An error was detected when acquiring a waveform from the AFG 2020. Check the GPIB cables for secure attachment and try again.

**E1001** — Error sending waveform to AFG 2020.

An error was detected when sending a waveform to the AFG 2020. Check the GPIB cables for secure attachment and try again.

**E1002** — No AFG 2020 found.

The address specified in the configuration was checked for the presence of an AFG 2020 and none were found. Check the configuration and try again.

**E1003** — Current clock rate is invalid for AFG 2020. Accept upper limit of 2 s?

A clock rate which is above the upper limit for the AFG 2020 was entered. The acceptable range is 32.05 ns to 2 s. You are offered the opportunity to change the clock rate to the upper limit.

**E1004** — Current clock rate is invalid for the AFG 2020. Accept a lower limit of 32.05 ns?

A clock rate that is below the lower limit for the AFG 2020 was entered. The acceptable range is 32.05 ns to 2 s. You are offered the opportunity to change the clock rate to the lower limit.

**E1006** — Waveform for AFG 2020 must be equal to 1024 points.

All waveforms sent to the AFG 2020 must be 1024 points. No partial waveforms can be sent. Change the markers or the waveform so that 1024 points are sent.

**E1007** — AFG 2020 does not support envelope waveforms.

You attempted to either save an instrument specific file or send an envelope waveform to the AFG 2020. The instrument does not support envelopes. You may wish to use *Envelope Decouple* to break the envelope into two components and save or send them individually.

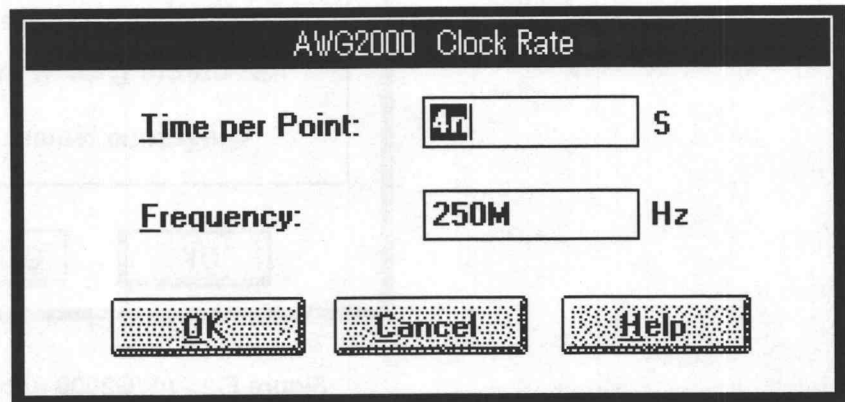
# Appendix F: AWG 2000 Series Dialogs and Messages

This appendix describes the dialog boxes and error messages specific to the AWG 2000 series arbitrary waveform generators.

The dialog boxes for the AWG 2000 series all contain the same controls even though the features of the different types vary. The example dialog boxes in this appendix are taken from the AWG2020 driver. If the instrument being used does not have a feature, that feature is grayed in the dialog box, and cannot be used. In other cases, selections that are available in one instrument type (e.g. a filter with a particular cut off point) may not be available in another. Non-available selections are not displayed.

## Change Clock Rate

Use the following dialog box (see Figure F-1) to change the current clock rate. This changes only the time per point, and does not change the waveform size or shape.



The image shows a dialog box titled "AWG2000 Clock Rate". It has two input fields. The first is labeled "Time per Point:" and contains the value "4n" followed by a unit "S". The second is labeled "Frequency:" and contains the value "250M" followed by a unit "Hz". At the bottom of the dialog are three buttons: "OK", "Cancel", and "Help".

Figure F-1: AWG 2000 Clock Rate Dialog Box

**Time per Point** — Enter the time per point in seconds. The range of valid input values depends on the particular instrument. See the Driver Limits section (page F-8) of this appendix for details.

**Frequency** — Enter the frequency in Hz. The range of valid input values depends on the particular instrument. See the Driver Limits section (page F-8) of this appendix for details.

**OK** — When the new clock rate is entered and **OK** selected, the clock rate display above the Waveform Display Area updates with the new clock rate. If the horizontal axis is displayed in seconds, the scale updates to reflect the new clock rate.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

### Acquire Waveform

Use this dialog box (see Figure F-2) to select the source and destination of the waveform.

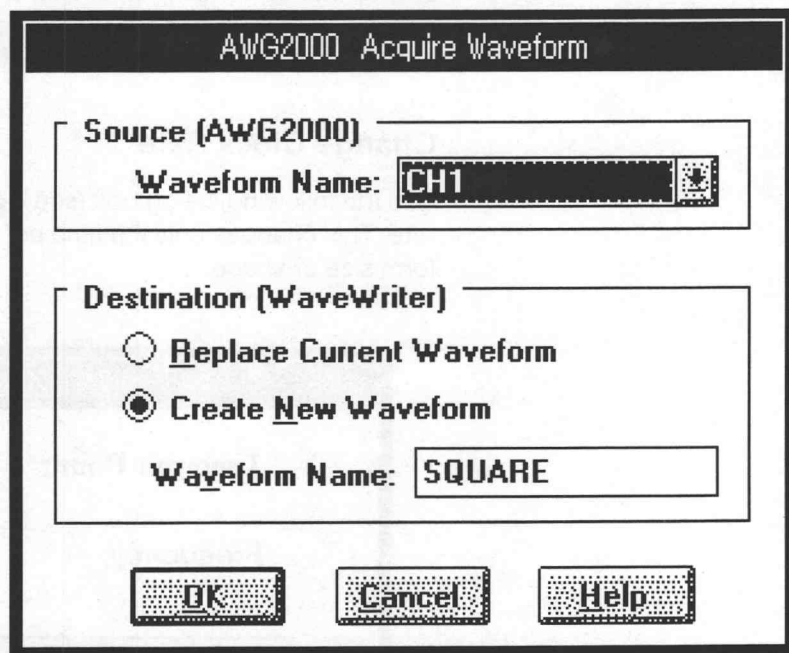


Figure F-2: AWG2000 Acquire Waveform Dialog Box

**Source (AWG2000)** — Used to select the waveform that will be acquired from the instrument. This will be either a waveform in instrument memory, or a channel. The box lists all the waveforms in instrument memory, and all channels in the instrument.

**Destination (WaveWriter)** — You have a choice of how to store the acquired waveform:

- **Replace Current Waveform** — The current waveform is overwritten by the acquired waveform. The acquired waveform record length is the new record length.

- **Create Waveform** — You are prompted for a new waveform name. The acquired waveform becomes the current waveform. The previous current waveform is now a background waveform.
- **Waveform Name** — Enter a valid name for the waveform being acquired.

**OK** — When **OK** is selected, the waveform is acquired, loaded into memory, and displayed as the current waveform.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

### Conformance to Target

If the acquired waveform data does not conform to the target instrument's ranges, voltage data and timing data are affected.

**Voltage** — If the acquired waveform amplitude exceeds the display window limits, the waveform is clipped on the display. No data is lost however.

**Clock Rate** — If the clock rate does not match, a warning is displayed and you are prompted for one of the following solutions:

- Change the clock rate of the incoming waveform to the current clock rate.
- Massage (expands or compresses) the incoming waveform to maintain a timing match.
- Change the current clock rate to match the incoming waveform. If the incoming clock rate is not valid for the selected target instrument, this option is grayed out and unavailable.
- Cancel the acquisition and return to the main menu.

### Send Waveform

You can send the current waveform to a file in AWG 2020 memory with the following dialog box (see Figure F-3).

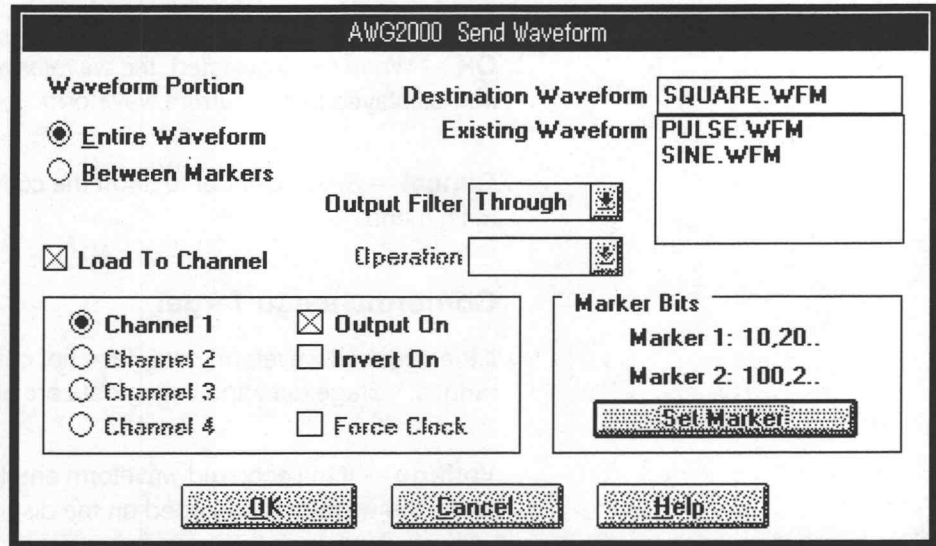


Figure F-3: AWG 2000 Send Waveform Dialog Box

**Entire Waveform, Between Markers** — These two buttons allow the user to choose between sending all of the selected waveform, or only those points between, and including, the markers. The number of points sent must be within certain values, and must be a multiple of a certain value. The values applied depend on the particular instrument. See the Driver Limits section (page F-8) of this appendix for details.

**Destination** — The Destination Waveform edit box initially displays the name of the waveform with the instrument's .WFM extension. The List box lists all the waveforms currently in the instrument's memory. You can change the destination filename to any legal name. If you enter the name of a file already in memory, *WaveWriter* asks if you wish to overwrite it.

**Operation** — Identify any signal processing to be applied to the waveform on Channel 1. For the AWG2005 all the following selections are available.

Normal	Applies no operation
Add	Adds the output of Channel 2 to Channel 1 and turns off Channel 2
ExtAdd	Add the signal input to the external BNC connectors to channel 1
AM	Multiplies the output of Channel 2 to Channel 1 and turns off Channel 2
Ext AM	Multiplies Channel 1 by the external signal applied through the external BNC connector

The AWG 2040 and 2041 have no operation feature, so this box will be grayed when those instruments are being used.

The ExtAdd selection is not displayed when an AWG2020 or AWG2021 is being used.

If Load to Channel is not selected, or the selected channel is not channel 1, Operation is grayed, and cannot be used.

**Load to channel** — By selecting this button, the waveform is loaded into an output channel as well as being copied into a file in the instrument. When selected, the Channel buttons and various other things related to channel output are enabled in the dialog box; otherwise they are grayed.

**Channel 1,2,3,4** — These are used to select which channel the waveform is loaded into. If Load to channel is not selected all of these buttons are grayed. Otherwise, the buttons for channels that are available on the instrument being used are enabled. All four channels are available when an AWG 2005 is being used, 1 and 2 are available when an AWG 2020 or 2021 is being used, and only Channel 1 when an AWG 2040 or 2041 is being used. Channel 2 is not enabled if an AWG2020/2021 without the channel 2 option is being used.

**Output On** — When this button is selected, the switch on the output of the selected channel will be closed. After sending, the waveform will be output when the instrument's trigger conditions are satisfied. This control is grayed if Load to Channel is not selected.

**Invert On** — When this button is selected, the instrument's inverted output is turned on. This is only available when the instrument is an AWG2040 or 2041.

**Force Clock** — The clock rates of different channels cannot be set independently. The clock frequencies for channels 2 and above are the same as channel 1, or are the frequency of channel 1 divided by a power of two. This power of two is the instrument's Clock Divider setting (set using the instrument's SETUP menu). When Force Clock is selected, the instrument's clock rate will be set the same as WaveWriter's current rate, and the divider value

will be set to 1. This ensures that the waveform is output using WaveWriters current clock rate, but may cause the clock rates for the other channels to change.

If the selected channel is channel 1 or Load to Channel is not selected, Force Clock is grayed.

**NOTE**

*The AWG 2005 has no divider; in effect the divider value is always one. However, Force Clock works just the same.*

**Output Filter** — This is used to select the low-pass filter that is applied to the output of the selected channel, or to select that no filter is applied (the Through selection). The choices available depend on the instrument:

AWG 2005:	5 MHz, 2 MHz, 1 MHz, 500 kHz
AWG 2020/2021:	50 MHz, 20 MHz, 5 MHz, 1 MHz
AWG 2040/2040:	100 MHz, 50 MHz, 20 MHz, 10 MHz

Output Filter is grayed if Load to Channel is not selected.

**Marker Bits** — This is used to set whether, and when, marker signals are output by the instrument. Marker 1 and Marker 2 show the current On/Off state of the markers for the currently selected channel. Clicking on the Set Marker button causes the Marker Setup dialog box to be displayed, allowing the user to input marker signal state and position settings. See below for a description of the Marker Setup dialog box.

**NOTE**

*Marker signals should not be confused with WaveWriter's marker flags; they are entirely different things. The Between Markers button (above) and Marker Bits have no connection with each other. Nor do marker flag positions have any effect on marker signal positions set in the Marker Setup dialog box (see Below).*

**OK** — Clicking on **OK** sends the waveform, and sets the selected settings. If the length of the waveform is not acceptable to the instrument, a dialog box informing the user will be displayed. The dialog presents a choice of actions: truncating to the closest legal length, rounding up to the nearest legal length, or cancelling the send and returning to the main menu. Depending on the situation, choices that are not possible are grayed in the dialog box.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.



## Marker Setup

This dialog box appears after the Set Marker button in the Send AWG 2000 dialog box is pressed. It allows the user to set the On/Off state and position of marker signals. (See Figure F-4.) A marker signal is an instrument output that assumes its on value when waveform output is at particular points.

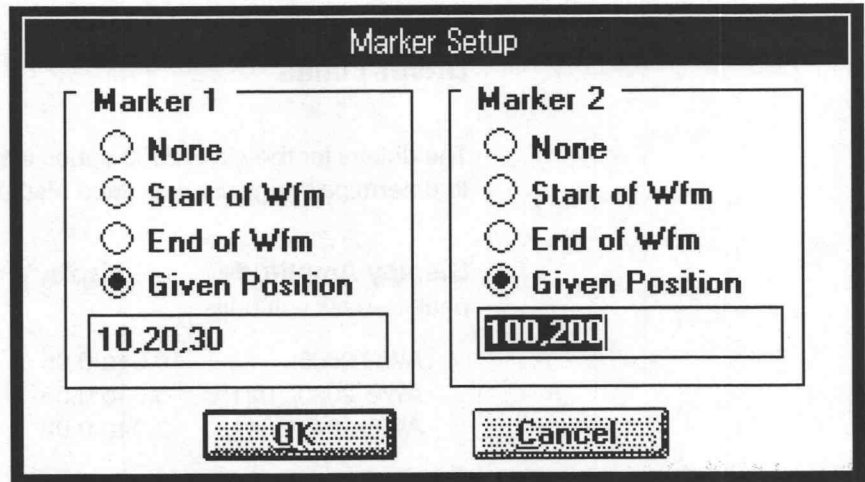


Figure F-4: Marker Setup Dialog Box

**Marker 1, Marker 2** — A maximum of two marker signals can be set for the channel that is currently selected in the Send AWG 2000 dialog box. However, if the instrument is an AWG 2005 only one marker can be set in each channel, and all references to Marker 2 in the dialog box will be grayed.

Each marker can be set to assume its on value for the duration of specified points in the waveform. At all other times, it will take its off value.

**None** — When this button is selected the marker signal is always at its off value.

**Start of Wfm** — When this button is pressed, the marker signal assumes its on value while the first point in the waveform is being output.

**End of Wfm** — When this button is pressed, the marker signal assumes its on value while the last point in the waveform is being output.

**Given Positions** — When this button is pressed, the marker signal assumes its on value while the points specified by the numbers in the box just below the button are being output. The points must be separated by commas or spaces. The position box is grayed if Given Position is not selected.

**OK** — Return to the Send Waveform dialog. The marker settings input by the user will be applied when the waveform is sent to the instrument.

**Cancel** — Return to the Send Waveform dialog. The marker settings input by the user this time will be ignored. The settings applied when the waveform is sent to the instrument will be as they were before the Marker Setup dialog box was displayed.

### Driver Limits

The drivers for the AWG 2000 series instruments use the limits given below to determine things such as valid display amplitude, offset and clock rate.

**Display Amplitude** — The display amplitude limits described below are all peak-to-peak volt units.

AWG 2005:	10.0 to 0.05
AWG 2020/2021:	5.0 to 0.05
AWG 2040/2041:	2.0 to 0.02

**Offset** — Offset limits in volts are as follows.

AWG 2005:	-5.0 to 5.0
AWG 2020/2021:	-2.5 to 2.5
AWG 2040/2041:	-5.0 to 5.0

**Time per Point** — Clock Rate limits expressed as the time between points are as follows.

AWG 2005:	50 ns to 100 s
AWG 2020/2021:	4 ns to 100 ms
AWG 2040/2041:	1 ns to 1 ms

**Maximum Number of Points** — The maximum number of points that a single waveform can contain are limited as follows.

AWG 2005:	65536
AWG 2020/2021:	262144
AWG 2040/2041:	4194304

**Minimum Number of Points** — The minimum number of points that a single waveform can contain are limited as follows.

AWG 2005:	16
AWG 2020/2021:	64
AWG 2040/2041:	32

**Number-of-Points Multiple** — Waveform lengths in an instrument are always a multiple of a certain number of points as follows.

AWG 2005:	1
AWG 2020/2021:	8
AWG 2040/2041:	32

### AWG 2000 Series Error Messages

The error messages specific to the AWG 2000 series are listed below. These messages are common to all types in the series although each type has different capabilities. When an error results from a limit being exceeded, the user can refer to Driver Limits (above) to resolve the problem. When the symbol '<device>' appears, the type of your instrument will be included in the message.

**E1000** — Error acquiring data from <device>.

An error was detected when acquiring a waveform from the instrument. Check the GPIB or RS232 cables for secure attachment and try again.

**E1001** — Error sending data to <device>.

An error was detected when sending a waveform to the instrument. Check the GPIB or RS232 cables for secure attachment and try again.

**E1002** — No <device> found on the bus.

All primary addresses were checked for the presence of an instrument and none were found. Check the GPIB or RS232 cables for secure attachment and try again.

**E1003** — Clock rate too slow... Accept limit?

A clock rate above the upper limit for the instrument was entered. You are offered the opportunity to change the clock rate to the upper limit.

**E1004** — Clock rate too fast... Accept limit?

A clock rate below the lower limit for the instrument was entered. You are offered the opportunity to change the clock rate to the lower limit.

**E1006** — Waveform too long.

When attempting to send a waveform to an AWG 2000 series instrument, the waveform size was greater than the maximum record length. See Driver Limits (page F-8) in the section for the record length limit for your instrument. Use the markers to segment off a smaller section of the waveform and send only that portion to the instrument.

**E1007** — Envelope not supported.

You attempted to either save an envelope to an instrument specific file or send an envelope to the instrument. AWG 2000 series instruments do not support envelopes. Consider using *Envelope Decouple* to break the envelope into two component waveforms, then send them individually.

**E1009** — Cannot acquire waveform associated with a sequence.

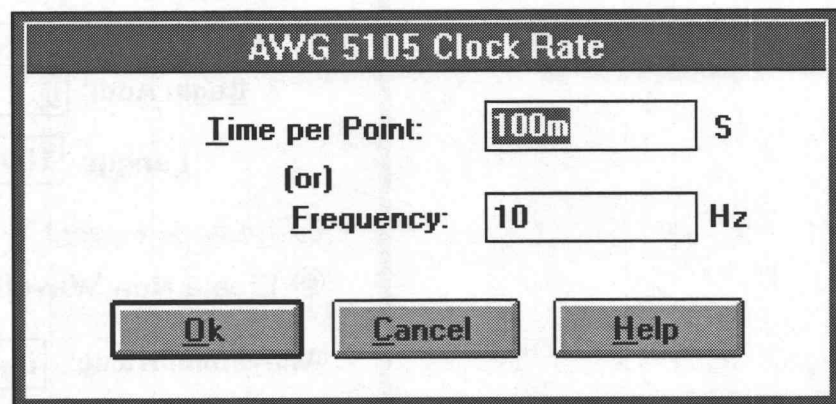
Sequence file waveform data is not available for transfer over the communications interface. You need to transfer the parts of the sequence individually.

# Appendix G: AWG 5105 Dialogs and Messages

This appendix describes the dialog boxes and error messages specific to the AWG 5105.

## Change Clock Rate

Use the following dialog box (see Figure G-1) to change the current clock rate. This reassigns the time per point and does not change the waveform size or shape.



The dialog box is titled "AWG 5105 Clock Rate". It contains two input fields: "Time per Point:" with a value of "100m" and a unit of "S", and "Frequency:" with a value of "10" and a unit of "Hz". The text "(or)" is placed between the two fields. At the bottom, there are three buttons: "Ok", "Cancel", and "Help".

Figure G-1: AWG 5105 Clock Rate Dialog Box

**Time per Point** — Enter the time per point in seconds. The valid range is 20 ns to 150 s.

**Frequency** — Enter the frequency in Hz. The valid range is 6.67 to 50 MHz. Frequency for the AWG 5105 is calculated as follows:

$$1.0 / (\text{Time per Point} \times \text{Number of Points in Waveform})$$

If there is no current waveform, the number of points is 1.

**OK** — When the new clock rate is entered and **OK** is selected, the clock rate display above the Waveform Display Area updates with the new clock rate. If the horizontal axis is displayed in seconds, the scale updates to reflect the new clock rate.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

### Acquire Waveform

Use this dialog box (see Figure G-2) to acquire a waveform from either Channel 1 or Channel 2.

You are prompted for the following information before acquiring the waveform:

The dialog box is titled "Acquire AWG 5105". It contains the following elements:

- Acquire From:** A group box containing two radio buttons:  Channel 1 and  Channel 2.
- Begin Addr:** A text input field containing the value "1".
- Length:** A text input field containing the value "1000".
- Waveform Creation:** Two radio buttons:  Replace Current Waveform and  Create New Waveform.
- Waveform Name:** A text input field containing the value "untitled".
- Buttons:** Three buttons at the bottom: "Ok", "Cancel", and "Help".

Figure G-2: Acquire AWG 5105 Dialog Box

**Acquire From** — Identifies the waveform source; choose Channel 1 or Channel 2.

**Beginning Address** — Enters the beginning address of the waveform being acquired. The valid range is 0 to 262143.

**Length** — Enters the waveform length. The valid range is 2 to 65536.

**Replace Current Waveform** — Overwrites the current waveform with the acquired waveform. The acquired waveform record length is the new current record length.

**Create New Waveform** — Prompts for a new waveform name. The acquired waveform becomes the current waveform. The previous current waveform is now a background waveform.

**Waveform Name** — Enter a valid name for the waveform being acquired.

**OK** — When **OK** is selected, the waveform is acquired, loaded into memory, and displayed as the current waveform.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

### Conformance to Target

If the acquired waveform data does not conform to the target instrument's ranges, voltage and timing data are affected.

**Voltage** — If the acquired waveform amplitude exceeds the display window limits, the waveform is clipped on the display. No data is lost however.

**Clock Rate** — If the clock rate does not match, a warning is displayed and you are prompted for one of the following solutions:

- Change the clock rate of the incoming waveform to the current clock rate.
- Massage, (expands or compresses), the incoming waveform to maintain a timing match.
- Change the current clock rate to match the incoming waveform. If the incoming clock rate is not valid for the selected target instrument, this option is grayed out and unavailable.
- Cancel the acquisition and return to the main menu.

## Send Waveform

You can send the current waveform to a reference memory location in the AWG 5105 with the following dialog box (see Figure G-3).

Figure G-3: Send AWG 5105 Dialog Box

**Send** — Specify the portion of the waveform sent to the instrument:

- **Complete Waveform** — Sends the entire waveform, 262145 pt maximum.
- **Waveform Between Markers** — Sends only the portion between and including the markers, 262145 pt maximum.

**Send To** — Specify the instrument channel receiving the data:

- **Channel One** — Channel 1 receives data.
- **Channel Two** — Channel 2 receives data.

**Begin Addr** — Specifies the beginning address of the waveform data from 1 to 262143. The Beginning Address + Waveform Length cannot exceed 262145.



**Amplitude** — Shows the peak-to-peak output voltage into 50  $\Omega$  sent to the instrument. The valid range is 0.015 to 15.00 V. The default value is the current *WaveWriter* axis amplitude.

**Offset** — Shows the offset voltage of the output signal sent to the instrument. The amplitude offset must be within the range  $-7.49$  to  $7.49$  V, into a 50  $\Omega$  load. The output amplitude and offset must conform to the following relationship:

$$\text{Absolute Offset} + \text{Amplitude}/2 \leq 7.5 \text{ V}$$

**Point Rate** — Shows the clock rate or internal trigger interval. The valid range is 20 ns to 150 s.

**Frequency** — Shows the frequency of the current waveform. Frequency is a function of the number of data points in the waveform and the waveform execution rate. The total time for one period is the number of points  $\times$  rate.

The output frequency of the waveform is:

$$\text{frequency} = 1/(\text{number of points} \times \text{rate})$$

**Filter** — Select one of four low-pass filters applied to the output:

- **1.5 MHz** — filter with 1.5 MHz cut-off.
- **150 kHz** — filter with 150 kHz cut-off.
- **15 kHz** — filter with 15 kHz cut-off.
- **1.5 kHz** — filter with 1.5 kHz cut-off.

**Output On** — In addition to the cut-off selection, the filter output can be toggled on or off. For *Output On* you must specify the following:

- **Output Start** — Sets the starting address for the executable waveform.
- **Output Length** — Sets the length of the executable waveform. Usually the start and length values match the waveform start address and length.

**Markers Address** — Four markers are available. Markers are enabled by selecting the check box next to the desired marker and specifying the address value the marker is to appear at. In addition, a synchronization signal is available; check the box and set the address.

**Summing** — The opposite channel and or an external signal can be summed with the current channel.

**Mode** — Selects a clock mode: *Continuous*, *Trigger*, *Gate*, or *Burst*.

**Clock Source** — Selects a clock source: *External*, *Internal*, or the opposite channel.

**Trigger** — Select the trigger source: *Manual*, *Internal*, *External*, or the opposite channel. Depending on the trigger source, you can also specify a trigger rate, level, or slope setting. The slope may be positive or negative.

**AutoUpdate** — Allows waveform updating after every operation.

**Amplitude Modulation** — Toggle amplitude modulation on or off.

**OK** — Selecting **OK** sends all settings and the waveform to the instrument, saves all changes to instrument parameters, and closes the dialog box.

**Cancel** — Select **Cancel** to abort the current operation and close the dialog box; nothing is sent to the instrument, all dialog box changes are lost.

**Send** — Sends only the instrument settings to the instrument. The dialog box is not closed.

**Clear All** — Clears all instrument waveform memory by setting it to zero.

**Clear Selected** — Clears the AWG waveform memory from the start address for the indicated length.

### Driver Limits

This driver uses the limits listed below to determine valid display amplitude, offset, and clock rate.

**Display Amplitude** — The valid range is 15 mV to 15 V.

**Offset** — The amplitude and offset must conform to the following relationship:

$$\text{Amplitude}/2 + |\text{Offset}| \leq 7.5 \text{ V.}$$

**Time per Point** — The valid time per point ranges from 20 ns to 150 s.

**Maximum Number of Points** — The maximum number of points that can be sent to the instrument is 262145.

## AWG 5105 Error Messages

**E1001** — Error sending waveform to AWG 5105.

An error was detected when sending a waveform to the AWG 5105. Check the GPIB cables for secure attachment and try again.

**E1002** — All addresses searched. No AWG 5105 found.

All primary addresses were checked for the presence of an AWG 5105 and none were found. Check the GPIB cables for secure attachment and try again.

**E1003** — Current clock rate is invalid for AWG 5105. Accept upper limit of 150 s?

A clock rate that is above the upper limit for the AWG 5105 was entered. The acceptable range is 20 ns to 150 s. You are offered the opportunity to change the clock rate to the upper limit.

**E1004** — Current clock rate is invalid for AWG 5105. Accept lower limit of 20ns?

A clock rate that is below the lower limit for the AWG 5105 was entered. The acceptable range is 20ns to 150 s. You are offered the opportunity to change the clock rate to the lower limit.

**E1006** — Waveform exceeds limit for AWG 5105. Must be less than or equal to 262144.

You attempted to send a waveform to the AWG 5105, the waveform size was greater than the maximum allowable length of 8,192 pt. Use the markers to segment off a smaller section of the waveform and send only that portion to the instrument.

**E1007** — AWG 5105 does not support envelope waveforms.

You attempted to either save an instrument specific file or send an envelope waveform to the AWG 5105. The instrument does not support envelopes. You may want to use *Envelope Decouple* to break the envelope into two components and save or send them individually.

**E1008** — Number of points to send + Beginning Address exceeds 262145.

When attempting to send a waveform to the AWG 5105, the specified beginning address plus the number of waveform points selected exceeds the maximum record length of 262145. Either change the beginning address to a smaller value or move the markers to change the number of points in the waveform.

**E1009** — Invalid trigger delay value for AWG 5105. Must be in 1  $\mu$ S to 1000 S range.

The number you entered was invalid. Reenter a value within the range.

**E1010** — Invalid trigger level value for AWG 5105. Must be in -10 to 10 V range.

The number you entered was invalid. Reenter a value within the range.

**E1011** — Start + Length exceeds waveform address space of 262,143 maximum.

The number you entered was invalid. Reenter a value in the range of 1 to 263143.

**E1012** — Invalid number of bursts. Must be within the 2 to 999,999 range.

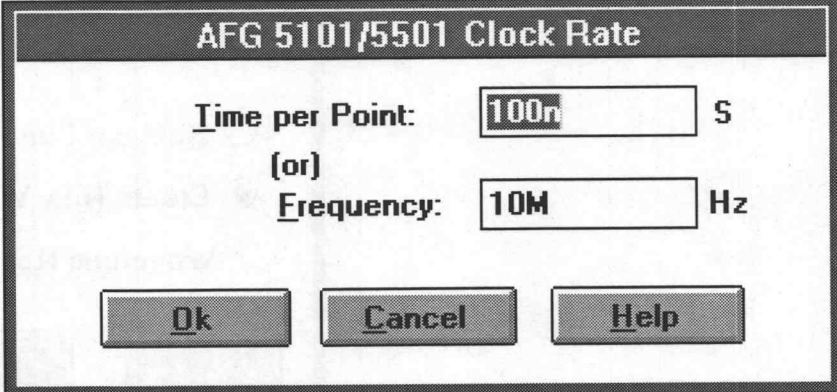
The number you entered was invalid. Reenter a value within the range.

# Appendix H: AFG 5101/5501 Dialogs and Messages

This appendix describes the dialog boxes and error messages specific to the AFG 5101/5501.

## Change Clock Rate

Use the following dialog box (see Figure H-1) to change the current clock rate when the target instrument is the AFG 5101. This reassigns the time per point and does not change the waveform shape or size.



The dialog box is titled "AFG 5101/5501 Clock Rate". It contains two input fields: "Time per Point:" with a value of "100n" and a unit of "S", and "Frequency:" with a value of "10M" and a unit of "Hz". Below the input fields are three buttons: "Ok", "Cancel", and "Help".

Figure H-1: AFG 5101/5501 Clock Rate Dialog Box

**Time per Point** — Enter the time per point in seconds. The valid range is 100 ns to 999.9 s.

**Frequency** — Enter the frequency in Hz. The valid range is 1 to 10 MHz.

**OK** — When the new clock rate is entered and **OK** is selected, the clock rate display above the Waveform Display Area updates with the new clock rate. If the horizontal axis is displayed in seconds, the scale updates to reflect the new clock rate.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

### Acquire Waveform

Use this dialog box to acquire a waveform from either Bank 1 or Bank 2 of the AFG 5101/5501 (see H-2). Each bank can hold up to an 8192 point waveform.

You are prompted for the following information before acquiring the waveform:

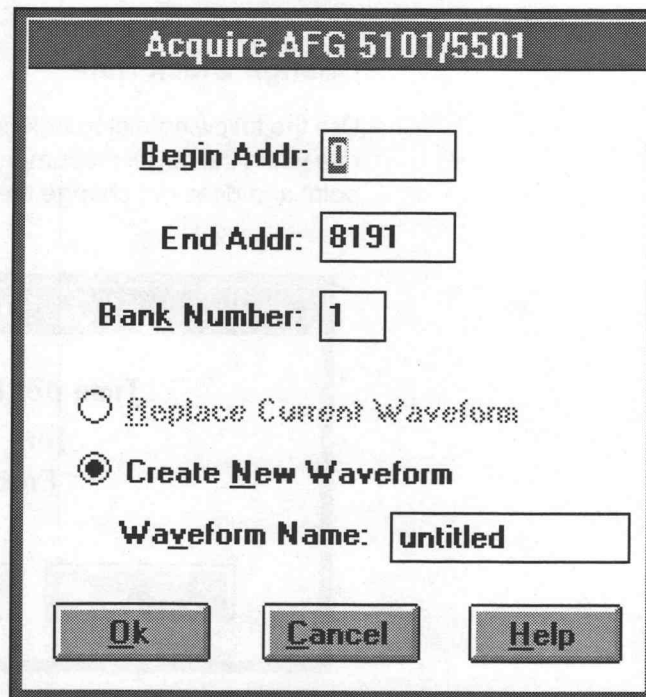


Figure H-2: Acquire AFG 5101/5501 Dialog Box

**Beginning Address** — Enters the beginning address of the waveform being acquired. The valid range is 0 to 8191.

**Ending Address** — Enters the ending address of the waveform being acquired. The valid range is 0 to 8191.

**Bank Number** — Enters the bank number of the waveform being acquired. Enter either 1 or 2.

**Replace Current Waveform** — Overwrites the current waveform with the acquired waveform. The acquired waveform record length becomes the new current record length.

**Create New Waveform** — Prompts for a new waveform name. The acquired waveform becomes the current waveform. The previous current waveform is now a background waveform.

**Name** — Enter a valid name for the waveform being acquired.

**OK** — When **OK** is selected, the waveform is acquired, loaded into memory, and displayed as the current waveform.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

### Conformance to Target

If the acquired waveform data does not conform to the target instrument's ranges, voltage and timing data are affected.

**Voltage** — If the acquired waveform amplitude exceeds the display window limits, the waveform is clipped on the display. No data is lost however.

**Clock Rate** — If the clock rate does not match, a warning is displayed and you are prompted for one of the following solutions:

- Change the clock rate of the incoming waveform to the current clock rate.
- Massage (expands or compresses) the incoming waveform to maintain a timing match.
- Change the current clock rate to match the incoming waveform. If the incoming clock rate is not valid for the selected target instrument, this option is grayed out and unavailable.
- Cancel the acquisition and return to the main menu.

### Send Waveform

Send the current waveform to either Bank 1 or Bank 2 of the AFG 5101/5501 (see Figure H-3) with the following dialog box.

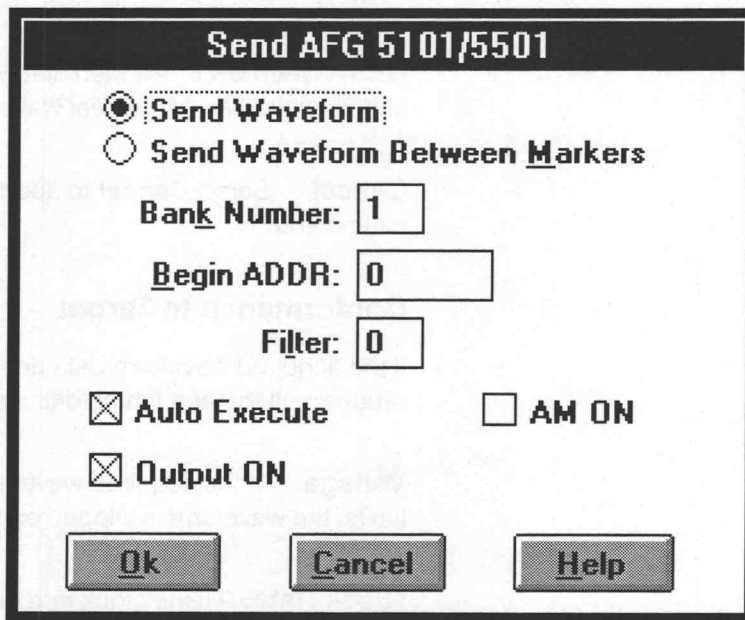


Figure H-3: Send AFG 5101/5501 Dialog Box

**Send Waveform** — Sends the entire waveform. The number of points sent, plus the beginning address value selected, must be less than the maximum of 8192.

**Send Waveform Between Markers** — Sends only the portion between and including the markers. The number of points sent, plus the beginning address value selected, must be less than the maximum of 8192.

**Bank Number** — Enters the bank number you want the waveform sent to. Enter either 1 or 2.

**Begin ADDR** — Sets the address of the selected bank you want the waveform to start at. The valid range is 0 to 8191.

**Filter** — Applies one of four fixed low-pass filters to the arbitrary waveform output. The valid selections are:

- 0 — no filter
- 1 — filter with 1 MHz cut-off



2 – filter with 100 kHz cut-off

3 – filter with 11 kHz cut-off

4 – filter with 1.3 kHz cut-off

**Auto Execute** — Moves the contents of the AFG memory into the execution buffer.

**Output On** — Toggles the AFG Output on or off.

**AM On** — Toggles the AFG amplitude modulation on and off.

**OK** — Selecting **OK** sets all parameters and sends the current waveform to the specified reference memory.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

### Driver Limits

This driver uses the limits listed below to determine valid display amplitude, offset, and clock rate.

**Display Amplitude** — The valid range is 10 mV to 9.99 V.

**Offset** — The amplitude and offset must conform to the following relationship:

$$\text{Amplitude}/2 + \text{Offset} = \text{Absolute Peak Amplitude} + \text{Offset into } 50 \Omega$$

Amplitude Range	Peak Amplitude Absolute Offset into 50 $\Omega$	Resolution into 50 $\Omega$
1 V – 9.99 V	44.99 V	10 mV
0.1 V – 0.999 V	0.499 V	1 mV
0.01 V – 0.099 V	0.049 V	1 mV

**Time per Point** — The valid time per point ranges from 100 ns to 999.9 s.

**Maximum Number of Points** — The maximum number of points that can be sent to the instrument is 8192.

## AFG 5101/5505 Error Messages

**E1001** — Error sending waveform to AFG 5101/5501.

An error was detected when sending a waveform to the AFG 5101/5501. Check the GPIB cables for secure attachment and try again.

**E1002** — All addresses searched. No AFG 5101/5501 found.

All primary addresses were checked for the presence of an AFG 5101/5501 and none were found. Check the GPIB cables for secure attachment and try again.

**E1003** — Current clock rate is invalid for AFG 5101/5501. Accept upper limit of 999.9 s?

A clock rate that is above the upper limit for the AFG 5101/5501 was entered. The acceptable range is 100 ns to 999.9 s. You are offered the opportunity to change the clock rate to the upper limit.

**E1004** — Current clock rate is invalid for AFG 5101/5501. Accept lower limit of 100 ns?

A clock rate that is below the lower limit for the AFG 5101/5501 was entered. The acceptable range is 100 ns to 999.9 s. You are offered the opportunity to change the clock rate to the lower limit.

**E1006** — Waveform exceeds limit for AFG 5101/5501. Must be less than or equal to 8,192.

When attempting to send a waveform to the AFG 5101, the waveform size was greater than the maximum record length of 8192. Use the markers to segment off a section of the appropriate size. Send the portion between the markers to the instrument.

**E1007** — AFG 5101/5501 does not support envelope waveforms.

You attempted to either save an instrument specific file or send an envelope waveform to the AFG 5101/5501. The instrument does not support envelopes. You may want to use *Envelope Decouple* to break the envelope into two components and save or send them individually.

**E1008** — Number of points to send + Beginning Address exceeds 8192.

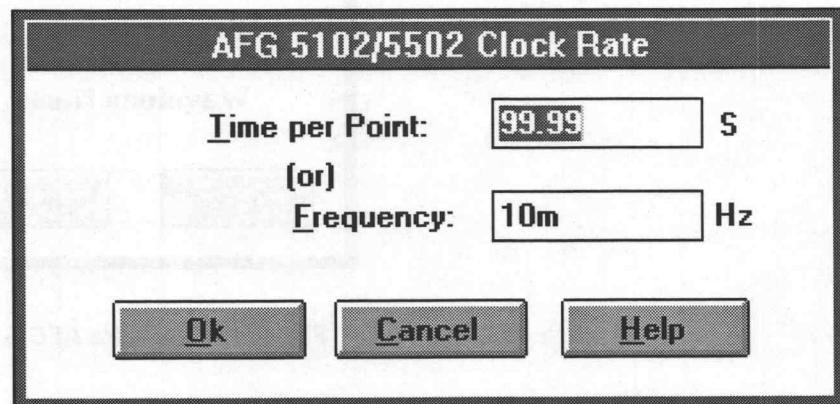
When attempting to send a waveform to the AFG 5101/5501, the beginning address specified, plus the number of waveform points selected, exceeds the maximum record length of 8192. Either change the beginning address to a smaller value or move the markers to alter the number of points being sent.

# Appendix I: AFG 5102/AWG 5102 Dialogs and Messages

This appendix describes the dialog boxes and error messages specific to the AFG 5102/5502 and AWG 5102/5502. The AFG and AWG differ in only a few areas. If you have an AFG 5102/5502, the information also applies to the AWG 5102/5502.

## Change Clock Rate

Use the following dialog box (see Figure I-1) to change the current clock rate. This reassigns the time per point and does not change the waveform shape or size.



The dialog box is titled "AFG 5102/5502 Clock Rate". It contains two input fields: "Time per Point:" with a value of "99.99" and a unit of "S", and "Frequency:" with a value of "10m" and a unit of "Hz". The text "(or)" is positioned between the two fields. At the bottom, there are three buttons: "Ok", "Cancel", and "Help".

Figure I-1: AFG 5102/5502 Clock Rate Dialog Box

**Time per Point** — Enter the time in seconds. The valid range is 50 ns to 99.9 s.

**Frequency** — Enter the frequency in Hz. The valid range is 10 to 20 MHz.

**OK** — When the new clock rate is entered and **OK** is selected, the clock rate display above the Waveform Display Area updates with the new clock rate. If the horizontal axis is displayed in seconds, the scale updates to reflect the new clock rate.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

## Acquire Waveform

Use this dialog box (see Figure I-2) to acquire a waveform from the AFG 5102/5502. The AFG 5102/5502 holds up to a 32768 point waveform.

You are prompted for the following information before acquiring the waveform:

Acquire AFG 5102/5502

Begin Addr: 0

End Addr: 8191

Replace Current Waveform

Create New Waveform

Waveform Name: untitled

Ok Cancel Help

Figure I-2: Acquire AFG 5102/5502 Dialog Box

**Begin Addr** — Enters the beginning address of the waveform being acquired. The valid range is 0 to 32767.

**End Addr** — Enters the ending address of the waveform being acquired. The valid range is 0 to 32767.

**Replace Current Waveform** — Overwrites the current waveform with the acquired waveform. The acquired waveform record length is the new current record length.

**Create New Waveform** — Prompts for a new waveform name. The acquired waveform becomes the current waveform. The previous current waveform is now a background waveform.

**Waveform Name** — Enter a valid name for the waveform being acquired.

**OK** — When **OK** is selected, the waveform is acquired, loaded into memory, and displayed as the current waveform.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

### Conformance to Target

If the acquired waveform data does not conform to the target instrument's ranges, voltage and timing data are affected.

**Voltage** — If the acquired waveform amplitude exceeds the display window limits, the waveform is clipped on the display. No data is lost however.

**Clock Rate** — If the clock rate does not match, a warning is displayed and you are prompted for one of the following solutions:

- Change the clock rate of the incoming waveform to the current clock rate.
- Message (expands or compresses) the incoming waveform to maintain a timing match.
- Change the current clock rate to match the incoming waveform. If the incoming clock rate is not valid for the selected target instrument, this option is grayed out and unavailable.
- Cancel the acquisition and return to the main menu.

## Send Waveform

Send the current waveform to the AFG 5102/5502 (see Figure I-3) with the following dialog box.

Figure I-3: Send AFG 5102/5502 Dialog Box

**Send Waveform** — Sends the entire waveform. The number of points, plus the beginning address value selected, must be less than the maximum of 32768 points.

**Send Waveform Between Markers** — Send only the portion between and including the markers. The number of points, plus the beginning address value selected, must be less than the maximum of 32768 points.

**Begin ADDR** — Sets the address you want the waveform to start at. Enter a number between 0 and 32767.

**MARKER O/P** — Marker output options:

**Location** — Sets the marker output address. The valid range is 0 to 32767.

**Filter** — Selects one of four fixed low-pass filters applicable to the arbitrary waveform output. The valid selections are:

- 0 — no filter
- 1 — filter with 1 MHz cut-off
- 2 — filter with 140 kHz cut-off
- 3 — filter with 11 kHz cut-off

4 — filter with 900 Hz cut-off

**Auto Execute** — Moves the contents of the AFG memory into the execution buffer.

**Output ON** — Toggles the AFG output on or off.

**AM ON** — Toggles output amplitude modulation on or off.

**OK** — Selecting **OK** sets all parameters and sends the current waveform to the specified reference memory location.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

### Driver Limits

This driver uses the limits listed below to determine valid display amplitude, offset, and clock rate.

**Display Amplitude** — The valid range is:

9.8 mV to 15 V for the AFG 5102/5502

9.8 mV to 9.99 V for the AWG 5102/5502

**Offset** — The amplitude and offset must together conform to the following relationship:

$\text{Amplitude}/2 + |\text{Offset}| \leq 7.5 \text{ V (AFG 5102/5502)}$

$\text{Amplitude}/2 + |\text{Offset}| < 5 \text{ V (AWG 5102/5502)}$

**Time per Point** — The valid time per point ranges from 100 ns to 999.9 s.

**Maximum Number of Points** — The maximum number of points that can be sent to the instrument is 32768.

## AFG 5102/5505 Error Messages

**E1001** — Error sending waveform to AFG 5102/5502.

An error was detected when sending a waveform to the AFG 5102/5502. Check the GPIB cables for secure attachment and try again.

**E1002** — All addresses searched. No AFG 5102/5502 found.

All primary addresses were checked for the presence of an AFG 5102/5502 and none were found. Check the GPIB cables for secure attachment and try again.

**E1003** — Current clock rate is invalid for AFG 5102/5502. Accept upper limit of 999.9 s?

A clock rate that is above the upper limit for the AFG 5102/5502 was entered. The acceptable range is 100 ns to 999.9 s. You are offered the opportunity to change the clock rate to the upper limit.

**E1004** — Current clock rate is invalid for AFG 5102/5502. Accept lower limit of 100 ns?

A clock rate that is below the lower limit for the AFG 5102/5502 was entered. The acceptable range is 100 ns to 999.9 s. You are offered the opportunity to change the clock rate to the lower limit.

**E1006** — Waveform exceeds limit for AFG 5102/5502. Must be less than or equal to 32768.

When attempting to send a waveform to the AFG 5102, the waveform size was greater than the maximum record length of 32768. Use the markers to segment off a section of the appropriate size. Send the waveform portion between the markers to the instrument.

**E1007** — AFG 5102/5502 does not support envelope waveforms.

You attempted to either save an instrument specific file or send the waveform to the AFG 5102/5502. The instrument does not support envelopes. You may want to use *Envelope Decouple* to break the envelope into two components and save or send them individually.

**E1008** — Number of points to send + Beginning Address exceeds 32768.

When attempting to send a waveform to the AFG 5102/5502, the beginning address specified plus the number of waveform points selected, exceeds the maximum record length of 32768. Either change the beginning address to a smaller value or move the markers to alter the number of points being sent.



# Appendix J: TDS Series Dialogs and Messages

This appendix describes the dialog boxes and error messages specific to the TDS series Digital Storage Oscilloscopes (DSO). The TDS500 Series instrument dialog boxes are used as examples in the following discussion. TDS Series instruments having different requirements or limits are specifically noted.

## Change Clock Rate

Use the following dialog box (see Figure J-1) to change the current clock rate. This reassigns the time per point and does not change the waveform shape or size.

The dialog box is titled "TDS Series Clock Rate". It contains a prompt "Enter ONE of the following:" followed by three options:

- Time Per Division:** Input field contains "5", followed by "S".
- Time per Point:** Input field contains "100m", followed by "S".
- Frequency:** Input field contains "10", followed by "Points / Second".

At the bottom of the dialog are three buttons: "Ok", "Cancel", and "Help".

Figure J-1: TDS Series Clock Rate Dialog Box

**Time Per Division** — Enter the time in seconds. The values must be in a 1-2-5 sequence from:

TDS300 Series, 1 ns/div to 5 s/div

TDS400 Series, 1 ns/div to 20 s/div

TDS500 Series, 500 ps/div to 10 s/div

TDS620 Series, 500 ps/div to 5 s/div

TDS640 Series, 500 ps/div to 5 s/div

TDS680 Series, 200 ps/div to 2 s/div

TDS700 Series, 200 ps/div to 10 s/div

TDS800 Series, 20 ps/div to 2  $\mu$ s/div

**Time per Point** — Enter the time in seconds. The values must correspond to a time-per-division value in a 1-2-5 sequence and be within range for the instrument:

TDS300 Series, 20 ps/pt to 0.1 s/pt

TDS400 Series, 20 ps/pt to 0.4 s/pt

TDS500 Series, 10 ps/pt to 0.2 s/pt

TDS620 Series, 10 ps/pt to 0.1 s/pt

TDS640 Series, 10 ps/pt to 0.1 s/pt

TDS680 Series, 4 ps/pt to 40 ms/pt

TDS700 Series, 4 ps/pt to 0.2 s/pt

TDS800 Series, 0.4 ps/pt to 40  $\mu$ s/pt

**Frequency** — Enter the frequency in Hz. The values must correspond to a time-per-division value in a 1-2-5 sequence and lie in the range for the instrument:

TDS300 Series, 50 GHz to 10 Hz

TDS400 Series, 50 GHz to 2.5 Hz

TDS500 Series, 100 GHz to 5 Hz

TDS620 Series, 100 GHz to 10 Hz

TDS640 Series, 100 GHz to 10 Hz

TDS680 Series, 250 GHz to 25 Hz

TDS700 Series, 250 GHz to 5 Hz

TDS800 Series, 2.5 THz to 25 kHz

**OK** — When **OK** is selected, the clock rate is verified for appropriate limits. If the specified rate is not a 1-2-5 sequence value, you are offered a choice between the next slower valid value and cancellation. When a valid clock rate is entered, the clock rate display above the Waveform Display Area updates with the new clock rate. If the horizontal axis is displayed in seconds, the scale updates to reflect the new clock rate.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

## Acquire Waveform

Use this dialog box (see Figure J-2) to acquire a waveform from a TDS Series oscilloscope. You can acquire a waveform from channels 1 through 4, reference memories 1 through 4, or math waveforms 1 thru 3. If a waveform selection is grayed out (CH1–4, MATH1–3, REF1–4) verify that it is properly allocated or selected.

You are prompted for the following information before acquiring the waveform:

**Acquire - TDS Series**

**Location**

CH1     REF1     MATH1

CH2     REF2     MATH2

CH3     REF3     MATH3

CH4     REF4

**Replace Current Waveform**

**Create New Waveform**

**Name** CH1

**Ok**    **Cancel**    **Help**

Figure J-2: Acquire – TDS Series Dialog Box

**Location** — Specifies the desired acquisition channel: CH1, CH2, CH3, CH4, REF1, REF2, REF3, REF4, MATH1, MATH2, or MATH3.

**Replace Current Waveform** — Overwrites the current waveform with the acquired waveform. The acquired waveform record length is the new current record length.

**Create New Waveform** — Prompts for a new waveform name. The acquired waveform becomes the current waveform. The previous current waveform is now a background waveform.

**Name** — Enter a valid name for the waveform being acquired.

**OK** — When **OK** is selected, the waveform is acquired, loaded into memory, and displayed as the current waveform.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

### Conformance to Target

If the acquired waveform data does not conform to the target instrument's ranges, voltage and timing data are affected.

**Voltage** — If the acquired waveform amplitude exceeds the display window limits, the waveform is clipped on the display. No data is lost however.

**Clock Rate** — If the clock rate does not match, a warning is displayed and you are prompted for one of the following solutions:

- Change the clock rate of the incoming waveform to the current clock rate.
- Massage (expands or compresses) the incoming waveform to maintain a timing match.
- Change the current clock rate to match the incoming waveform. If the incoming clock rate is not valid for the selected target instrument, this option is grayed out and unavailable.
- Cancel the acquisition and return to the main menu.

## Send Waveform

You can send the current waveform to a reference memory location in the Digital Storage Oscilloscope with the following dialog box (see Figure J-3).

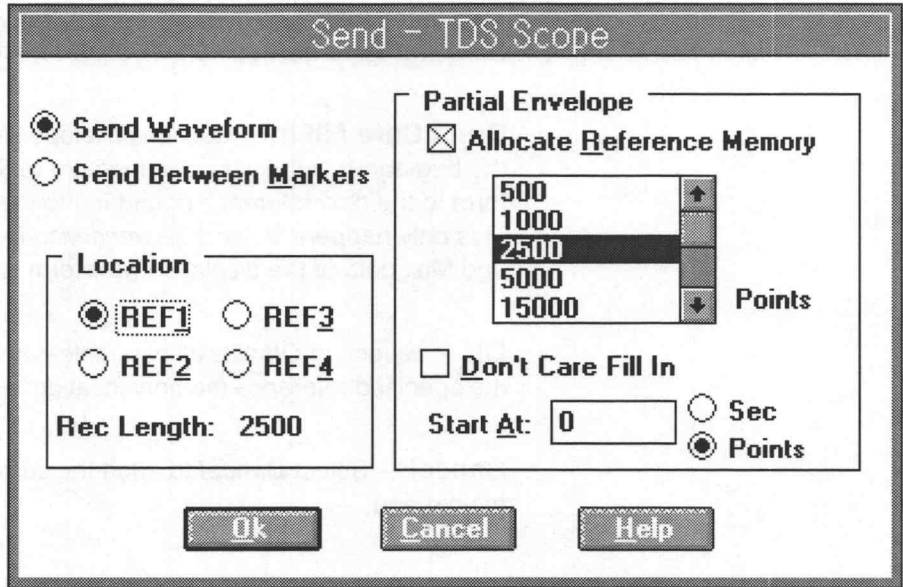


Figure J-3: Send – TDS Series Dialog Box

**Send Waveform** — Sends the entire waveform. The number of points sent, plus the *Start At* value specified, must be less than the maximum allowed by the target instrument (see *Driver Limits — Maximum Number of Points* to follow).

**Send Between Markers** — Sends only the portion between and including the markers. The number of points sent, plus the *Start At* value specified, must be less than the maximum allowed by the target instrument.

**Location** — Specify the target instrument reference memory location (1 through 4). The *Rec Length* is the currently allocated size for the selected reference memory.

**Partial Waveform** — Use this group box to allocate reference memory size.

**Allocate Reference Memory** — When this box is checked, the size specified in the Points box will be allocated to the selected reference memory before sending the waveform data. If this is not checked, the size of the selected reference will remain unchanged.

**Points** — This box is grayed unless *Allocate Reference Memory* is checked. It is used to select a size in points for allocating to a reference memory. Only those sizes that are available in the instrument are displayed in the box.

**Start At** — Aligns the waveform to a desired horizontal point in memory. Data in the reference memory before *Start At* is unaltered except when *Don't Care* and *Send Between Markers* are selected for envelopes.

**Don't Care Fill In** — Sets an envelope lying outside of the markers (from the beginning of the allocated memory to *Start At* and following the waveform to the next reference boundary) to the minimum and maximum levels. This only happens if *Send Between Markers* is selected. Also sets the Min and Max data of the displayed waveform to the *Don't Care* level.

**OK** — Selecting **OK** sets all parameters and sends the current waveform to the specified reference memory location in the target instrument.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

### TDS Series Waveform Detail

This dialog box (see Figure J-4) lists the values used by the instrument to display the waveform on the screen.

TDS Series Display Detail		
XINCR:	2.0000E-6	S/Pt
YSCALE:	5.0000E-1	V/Div
YOFF:	-50	Levels
YZERO:	0.0E+0	V
<input type="button" value="OK"/>		<input type="button" value="Help"/>

Figure J-4: TDS Series Instrument-Dependent Detail Dialog Box

**XINCR** — Lists the X axis seconds per point.

**YSCALE** — Lists the Y axis amplitude in volts per division. The value determines the size of the waveform on the display. To change the value, increase or decrease the display amplitude of the waveform.

**YOFF** — Lists the external offset in unscaled levels.

**YZERO** — Lists the external offset in volts. This field is used when the external offset is too large to express in unscaled levels.

**OK** — Select **OK** to close the dialog box.

### Driver Limits

These drivers use the limits listed below to determine valid display amplitude, offset, and clock rate.

**Display Amplitude** — The valid range is 20.24 mV to 25400 V.

**External Offset** — The valid range is -50000 to 50000 V.

**Time per Point** — The valid range for the clock rate is:

TDS300 Series, 20 ps/pt to 0.1 s/pt

TDS400 Series, 20 ps/pt to 0.4 s/pt

TDS500 Series, 10 ps/pt to 0.2 s/pt

TDS620 Series, 10 ps/pt to 0.1 s/pt

TDS640 Series, 10 ps/pt to 0.1 s/pt

TDS680 Series, 4 ps/pt to 40 ms/pt

TDS700 Series, 4 ps/pt to 0.2 s/pt

TDS800 Series, 0.4 ps/pt to 40  $\mu$ s/pt

**Maximum Number of Points** — The maximum number of points you can send to the instrument are:

TDS300 Series, 1000 pt

TDS400 Series, 120000 pt

TDS500 Series, 50000 pt

TDS620 Series, 2000 pt

TDS640 Series, 2000 pt

TDS680 Series, 15000 pt

TDS700 Series, 15000 pt

TDS800 Series, 500000 pt



## TDS Series Error Messages

The error messages specific to TDS series scopes are listed below. These messages are common to all types in the series although each type has different capabilities. When an error results from a limit being exceeded, the value of the limit may not be included in the message. The user can refer to *Driver Limits* (page J-8) to resolve these problems.

**E1100** — Error acquiring waveform from the instrument.

An error was detected when acquiring a waveform from a TDS oscilloscope. Check the GPIB cables for secure attachment and try again.

**E1101** — Error sending waveform to the instrument.

An error was detected when sending a waveform to a TDS oscilloscope. Check the GPIB cables for secure attachment and try again.

**E1102** — All addresses searched. No appropriate instrument found.

All primary addresses were checked for the presence of a TDS oscilloscope and none were found. Check the GPIB cables for secure attachment and try again.

**E1103** — Data has too many points for the instrument.

You tried to send waveform data that is longer than the maximum possible for the instrument. You can reduce the number of points by sending just the portion of the waveform between the markers.

**E1104** — The instrument cannot run at clock rates slower than the limit.  
<value>

The clock rate for the waveform currently being sent to the instrument is too slow, where the slowest possible value is given by <value>. Set the clock rate within the limit and try again.

**E1105** — Number of points to Send + Start At value exceeds Reference memory size.

When attempting to send a waveform to the instrument, the starting address specified plus the number of points being sent, exceeded the maximum record length for the instrument. Either change the starting address to a smaller value or use the markers to change the number of points sent to the instrument.

**E1106** — Cannot allocate Reference Memory.

The instrument could not allocate the memory needed to store the waveform. Delete references from the front panel to gain additional memory.

21100 - Error

The server has received a request for a resource that does not exist. The client should check the URL and the request headers. The server will return a 404 Not Found status code.

21101 - Error

The server has received a request for a resource that is not allowed. The client should check the request headers and the URL.

21102 - Error

The server has received a request for a resource that is not supported. The client should check the request headers and the URL.

21103 - Error

The server has received a request for a resource that is not supported. The client should check the request headers and the URL.

21104 - Error

The server has received a request for a resource that is not supported. The client should check the request headers and the URL.

21105 - Error

The server has received a request for a resource that is not supported. The client should check the request headers and the URL.

21106 - Error

The server has received a request for a resource that is not supported. The client should check the request headers and the URL.

# Appendix K: 2400 Series Dialogs and Messages

This appendix describes the dialog boxes and error messages specific to the 2400 series Digital Storage Oscilloscope (DSO).

## Change Clock Rate

Use the following dialog box (see Figure K-1) to change the current clock rate. This reassigns the time per point and does not change the waveform shape or size.

**2400 Series Clock Rate**

Enter ONE of the following:

**Time Per Division:**  S

**Time per Point:**  S

**Frequency:**  Points / Second

External Clock

Figure K-1: 2400 Series Clock Rate Dialog Box

**Time Per Division** — Enter the the time in seconds. If no external clock is present, the values must be in a 1-2-5 sequence from:

2440 instrument, 5 s to 2 ns

All other 2400 Series instruments, 5 s to 5 ns

If an external clock is present, the valid values are 50 ms to 500 ns.

**Time per Point** — Enter the time in seconds. If no external clock is present, the values must be in a 1-2-5 sequence from:

2440 instrument, 100 ms to 40 ps

All other 2400 Series instruments, 100 ms to 100 ps

If an external clock is present, the valid values are 1  $\mu$ s to 10 ns

**Frequency** — Enter the frequency in Hz. If no external clock is present, the values must be in a 1-2-5 sequence from:

2440 instrument, 10 Hz to 25 GHz

All other 2400 Series instruments, 10 Hz to 10 GHz

If an external clock is present, the valid values are 1 Mpt/s to 100 Mpt/s

**External Clock** — Indicates that an external clock is to be used.

**OK** — When **OK** is selected, the clock rate is verified for appropriate limits. If you are not using an external clock and the specified rate is not a 1-2-5 sequence, you are offered a choice between the next higher and lower valid values. When a valid clock rate is entered, the clock rate display above the Waveform Display Area updates with the new clock rate. If the horizontal axis scale is displayed in seconds, the scale updates to reflect the new clock rate.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

## Acquire Waveform

Use this dialog box (see Figure K-2) to acquire a waveform from a 2400 Series instrument. You may acquire a waveform from Channel 1, Channel 2, or reference memories 1 through 4.

You are prompted for the following information before acquiring the waveform:

The dialog box is titled "Acquire 2400 Series". It contains a "Location" section with the following options:

- CH1
- CH2
- ADD
- MUL1
- REF1
- REF2
- REF3
- REF4

Below the "Location" section are two radio buttons:

- Replace Current Waveform
- Create New Waveform

There is a "Name" field with the text "CH1" entered.

At the bottom of the dialog are three buttons: "Ok", "Cancel", and "Help".

Figure K-2: Acquire 2400 Series Dialog Box

**Location** — Specifies the desired acquisition channel: CH1, CH2, REF1, REF2, REF3, or REF4.

**Replace Current Waveform** — Overwrites the current waveform with the acquired waveform. The acquired waveform record length is the new current record length.

**Create New Waveform** — Prompts for a new waveform name. The acquired waveform becomes the current waveform. The previous current waveform is now a background waveform.

**Name** — Enter a valid name for the waveform being acquired.

**OK** — When **OK** is selected, the waveform is acquired, loaded into memory, and displayed as the current waveform.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

### Conformance to Target

If the acquired waveform data does not conform to the target instrument's ranges, voltage and timing data are affected.

**Voltage** — If the acquired waveform amplitude exceeds the display window limits, the waveform is clipped on the display. No data is lost however.

**Clock Rate** — If the clock rate does not match, a warning is displayed and you are prompted for one of the following solutions:

- Change the clock rate of the incoming waveform to the current clock rate.
- Massage (expands or compresses) the incoming waveform to maintain a timing match.
- Change the current clock rate to match the incoming waveform. If the incoming clock rate is not valid for the selected target instrument, this option is grayed out and unavailable.
- Cancel the current operation, and return to the main menu.

## Send Waveform

You can send the current waveform to a reference memory location in the 2400 Series oscilloscope with the following dialog box (see Figure K-3).

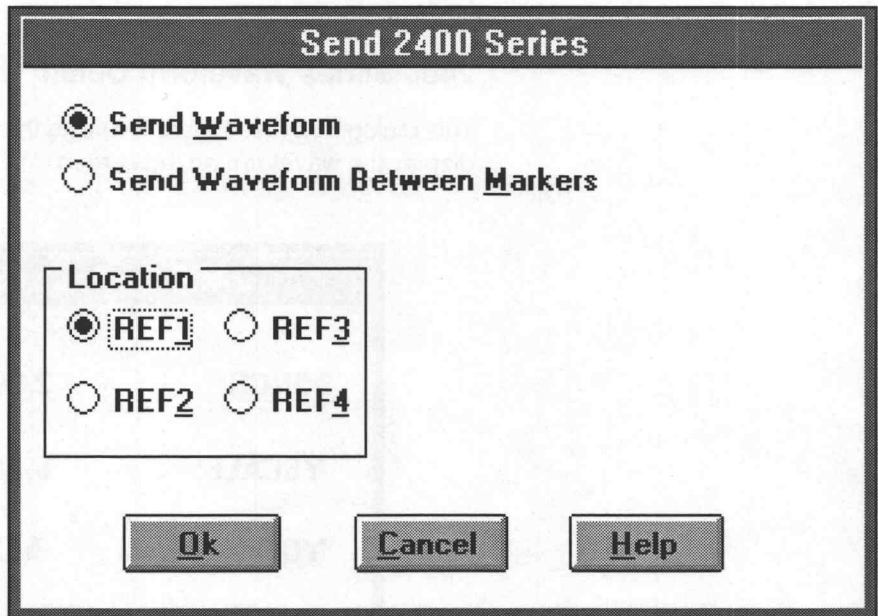


Figure K-3: Send 2400 Series Dialog Box

**Send Waveform** — Sends the entire waveform. The number of points sent must be less than the maximum of 1024.

**Send Waveform Between Markers** — Sends only the portion between and including the markers. The number of points sent must be less than the maximum of 1024.

**Location** — Specify the target instrument reference memory location REF1 through REF4.

**Partial Waveform** — The following two selections appear only if *Between Markers* is selected and there are less than 1024 points in the processing region (or the entire waveform has less than 1024 points.)

- **Start At** — Aligns the waveform to the specified horizontal point on the oscilloscope screen.
- **Don't Care Fill-in** — Sets the envelope outside the markers to minimum and maximum levels. Sets the Min and Max data of the displayed waveform to the *Don't Care* level.

**OK** — Selecting **OK** sets all parameters and sends the current waveform to the specified reference memory location in the target instrument.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

### 2400 Series Waveform Detail

This dialog box (see Figure K-4) lists the values used by the instrument to display the waveform on the screen.

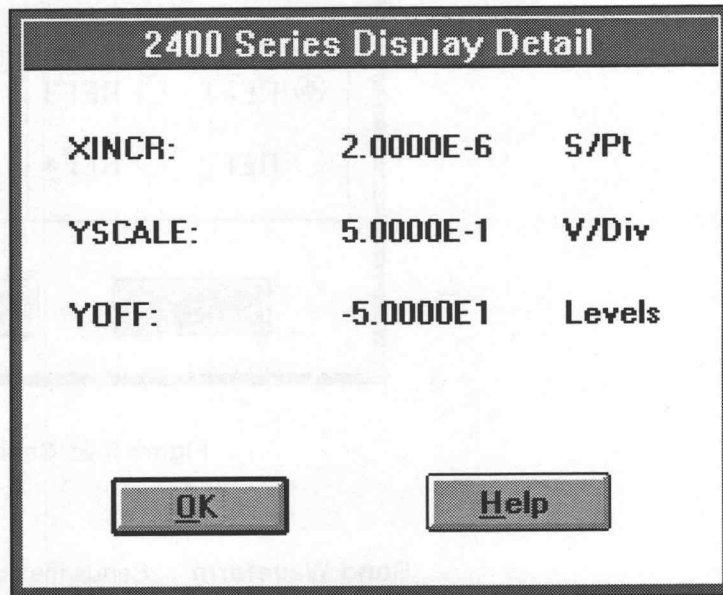


Figure K-4: 2400 Series Instrument-Dependent Detail Dialog Box

**XINCR** — Lists the X axis seconds per point.

**YSCALE** — Lists the Y axis amplitude in volts per division. This value determines the size of the waveform on screen. To change the value, increase or decrease the display amplitude of the waveform.

**YOFF** — Lists the external offset in unscaled levels.

**OK** — Select **OK** to close the dialog box.



## Driver Limits

This driver uses the limits listed below to determine valid display amplitude, offset, and clock rate.

**Display Amplitude** — The valid range is 20.24 mV to 25400 V.

**External Offset** — The valid range is -50000 to 50000 V.

**Time per Point** — For the 2440 instrument, the acceptable range is 40 ps/pt to 0.1 s/pt. For all other 2400 Series instruments, the acceptable range is 100 ps/pt to 0.1 s/pt. Both clock rates must conform to a 1-2-5 sequence.

**Maximum Number of Points** — The maximum number of points you can send to an instrument is 1024.

## 2400 Series Error Messages

**E1100** — Error acquiring waveform from 2400 DSO.

An error was detected when acquiring a waveform from a 2400 Series instrument. Check the GPIB cables for secure attachment and try again.

**E1101** — Error sending waveform to 2400 DSO.

An error was detected when sending a waveform to the 2400 Series instrument. Check the GPIB cables for secure attachment and try again.

**E1102** — All addresses searched. No 2400 DSO found.

All primary addresses were checked for the presence of a 2400 Series instrument and none were found. Check the GPIB cables for secure attachment and try again.

**E1103** — Data has more than 1024 points. Too large for 2400 DSO record length.

When attempting to send a waveform to the 2400 Series instrument, the waveform size was greater than the maximum record length of 1024. Use the markers to segment off a section of the appropriate size. Send the portion between the markers to the instrument.

**E1104** — 2400 DSO cannot run at clock rates slower than 0.1 sec/point (5.0 sec/div). Is 0.1 sec/point acceptable?

A clock rate too slow for the instrument was entered. The acceptable range for 2440 instruments is 40 ps/pt to 1 s/pt. For all other 2400 Series instruments the acceptable range is 100 ps/pt to 0.1 s/pt. Both clock rates must conform to a 1-2-5 sequence. You are offered the opportunity to change the entry to 0.1 s/pt.

**E1105** — Number of Points to Send + Start At value exceeds 1024.

When attempting to send a partial waveform to the 2400 Series instrument, the specified starting address plus the number of points between the markers, exceeded the maximum record length of 1024. Either change the starting address to a smaller value or move the markers to change the number of points sent to the instrument.

**E1106** — Too slow for the 2400 external clock. Accept lower limit of 1  $\mu$ S/pt?

The clock rate entered is invalid for a 2400 Series instrument with an external clock. You are offered the opportunity to change to the lower limit shown.

**E1107** — Too fast for the 2400 external clock. Accept upper limit of 10 nS/pt?

The clock rate entered is invalid for a 2400 Series instrument using an external clock. You are offered the opportunity to change to the upper limit shown.

**E1108** — Cannot send a waveform less than 1024 points to an empty reference.

The instrument requires a waveform minimum of 1024 points to fill an empty reference memory location. Create a waveform larger than 1024 points and send the waveform again.

# Appendix L: 11000 Series Dialogs and Messages

This appendix describes the dialog boxes and error messages specific to the 11000/DSA Series oscilloscopes.

## Change Clock Rate

Use this dialog box (see Figure L-1) to change the current clock rate. This reassigns the time per point and does not change the waveform shape or size.

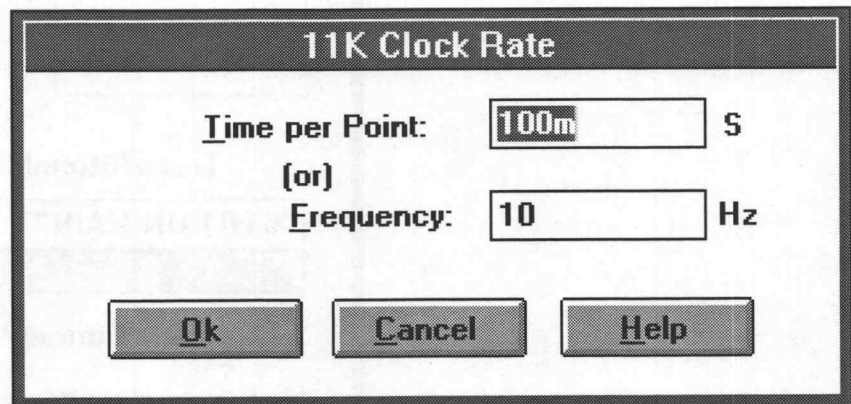


Figure L-1: 11000 Series Clock Rate Dialog Box

**Time per Point** — Enter the time in seconds. The valid range is 10 fs to 2 s.

**Frequency** — Enter the frequency in Hz. The valid range is 100 THz to 0.5 Hz.

**OK** — When **OK** is selected, the clock rate is verified for appropriate limits. If the specified rate is not a 1-2-5 sequence value, you are offered a choice between the next higher and lower valid values. When a valid clock rate is entered, the clock rate display above the Waveform Display Area updates with the new clock rate. If the horizontal axis scale is displayed in seconds, the scale updates to reflect the new clock rate.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

## Acquire Waveform

Use the following dialog box (see Figure L-2) to identify the source and destination of the waveform. Two types of waveforms are available, trace and stored. The waveform description stored with the waveform is displayed to help you with the identification.

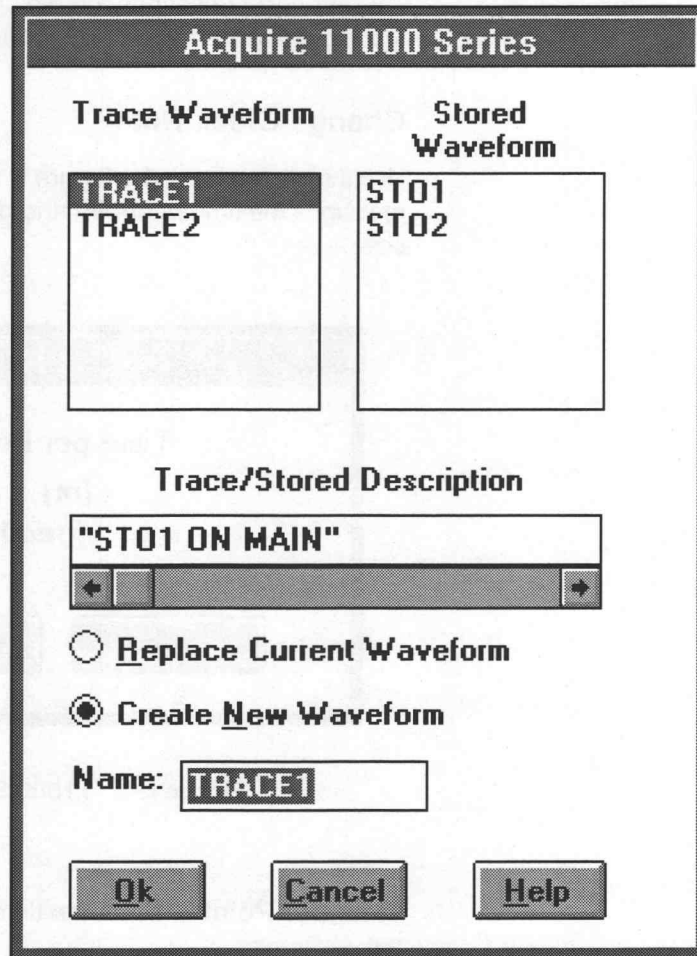


Figure L-2: Acquire 11000 Series Dialog Box

**Trace Waveform** — Displays the active traces currently available from the oscilloscope. If no active traces are available, the message *EMPTY* is displayed in the list box.

**Stored Waveform** — Displays the waveforms stored on the oscilloscope. If no stored waveforms are available, the message *EMPTY* is displayed in the list box.

When you click once on a list box entry, its waveform description appears in the Trace/Stored Description scroll box and the waveform name displays in the Name edit box. You may change the name by editing the contents of the edit box.

Clicking on the EMPTY selection displays the message *No Traces Defined* in the Trace/Stored Description edit box and the **OK** button is grayed out.

Double-clicking on the EMPTY selection or the white space of the list box invokes an error dialog box with the message *Invalid Source Selected*.

#### NOTE

*If there are no traces defined on the oscilloscope and no stored waveforms available, WaveWriter displays the error message "No Valid Sources Available" and the 11000 Series Acquisition dialog box is not displayed.*

**Trace/Stored Description** — Displays the waveform description stored with the waveform. The description automatically updates when you select a source from the Trace Waveform or Stored Waveform list boxes.

#### Destination

When the waveform is acquired, you have a choice of how to store it:

**Replace Current Waveform** — Overwrites the current waveform with the acquired waveform. The acquired waveform record length is the new current record length.

**Create New Waveform** — Prompts for a new waveform name. The acquired waveform becomes the current waveform. The previous current waveform is now a background waveform.

**Name** — Enter a valid name for the waveform being acquired.

**OK** — Specifying a valid source and entering a name in the *Source Name* edit box enables the **OK** button. Selecting **OK** transfers the 11000 Series waveform into *WaveWriter*. If you double click on an invalid source, the error message *Invalid Source Selected* is displayed.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

## Conformance to Target

If the acquired waveform data does not conform to the target instrument's ranges, voltage and timing data are affected.

**Voltage** — If the acquired waveform amplitude exceeds the display window limits, the waveform is clipped on the display. No data is lost however.

**Clock Rate** — If the clock rate does not match, a warning is displayed and you are prompted for one of the following solutions:

- Change the clock rate of the incoming waveform to the current clock rate.
- Massage (expands or compresses) the incoming waveform to maintain a timing match.
- Change the current clock rate to match the incoming waveform. If the incoming clock rate is not valid for the selected target instrument, this option is grayed out and unavailable.
- Cancel the acquisition and return to the main menu.

### NOTE

*WaveWriter does not control the acquisition of the 11000 Series oscilloscope. You must ensure that the waveform is completely acquired before transferring to WaveWriter. For example, if the selected source is a 16 K envelope, it is possible to transfer an incomplete envelope. In such a case, valid data cannot be guaranteed.*

*The 11000 series oscilloscope transfers only that portion of the waveform displayed on the screen. If you acquired a 10 K waveform on an 11403 oscilloscope and expanded the waveform to view only the falling edge of the pulse, only the falling edge would transfer. This may be useful if you intended to perform partial waveform transfers, but to transfer an entire waveform record, you must have PAN/ZOOM OFF or magnification 1x selected.*

## Send Waveform

You can send the current waveform to any of the stored waveform locations (see Figure L-3) with the following dialog box.

Figure L-3: 11000 Send Waveform Dialog Box

**Between Markers** — Sends the entire waveform. The number of points sent must be less than the maximum of 1638.

**Entire Waveform** — Sends only the portion between and including the markers. The number of points sent must be less than the maximum of 16383.

**STO (store) Number** — Specifies the waveform storage location. You have a choice of up to 450 locations depending on the instrument model. If you specify a filled waveform location, it will be overwritten.

**Display as TRACE** — Displays the waveform sent to the *STO Number* location as a trace waveform. Specify a *TRACE Number* from 1 to 8. If the trace is already defined, the new waveform overwrites the old trace.

**OK** — Selecting **OK** sends the current waveform to the selected storage location. The waveform is displayed if Display as TRACE is checked.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

### 11000/DSA Waveform Detail

This dialog box (see Figure L-4) displays the values used by the instrument to display the waveform on the screen.

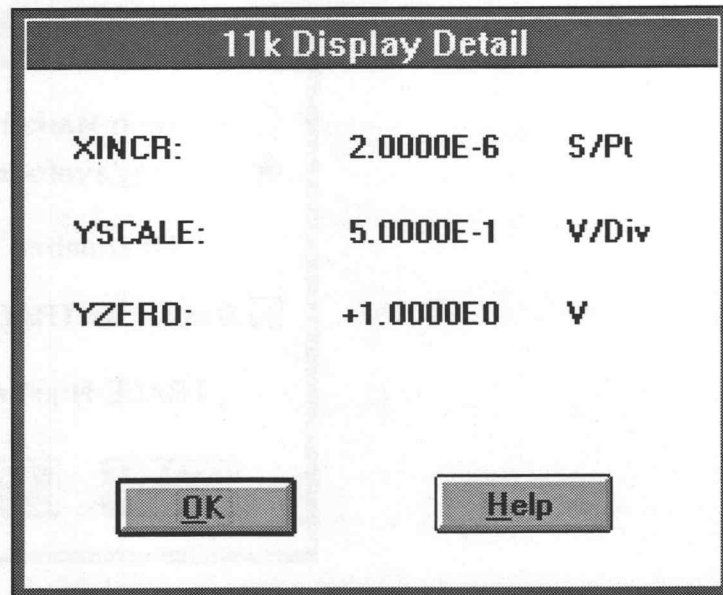


Figure L-4: 11000 Series Instrument-Dependent Detail Dialog Box

**XINCR** — Lists the X axis seconds per point.

**YSCALE** — Lists the Y axis amplitude in volts per division. This value determines the size of the waveform on the display. To change the value, increase or decrease the display amplitude of the waveform.

**YZERO** — Lists the external offset in volts. This field is used when the external offset is too large to express in unscaled volts.

**OK** — Select **OK** to close the dialog box.

### Driver Limits

This driver uses the limits listed below to determine valid display amplitude, offset, and clock rate.

**Display Amplitude** — The valid range is 1.966 mV to 50000 V.

**External Offset** — The valid range is -50000 to 50000 V.



**Time per Point** — The acceptable range is 10 fs/pt to 0.2 s/pt. The clock rate must conform to a 1-2-5 sequence.

**Maximum Number of Points** — The maximum number of points that can be sent to the instrument is 16383.

### 11000/DSA Error Messages

**E1003** — Current clock rate is invalid for 11000/DSA. Accept upper limit of 32000S?

The given or current clock rate is invalid. Answer *Yes* if you accept the current upper limit. If the *No* choice is available, you can answer no and enter a different value.

**E1004** — Current clock rate is invalid for 11000/DSA. Accept lower limit of 100 fS?

The given or current clock rate is invalid. Answer *Yes* if you accept the current lower limit. If the *No* choice is available, you can answer no and enter a different value.

**E1400** — All addresses searched. No 11000 or DSA found.

All primary addresses were checked for the presence of an 11000 or DSA and none were found. Check the GPIB or RS232 cables for secure attachment and try again.

**E1401** — Error acquiring waveform from 11000/DSA DSO.

An error was detected when acquiring a waveform from a 11000 DSO. Check the GPIB or RS232 cables for secure attachment and try again.

**E1402** — Error acquiring preamble from 11000/DSA DSO.

An error was detected when acquiring a preamble from an 11000 DSO. Check the GPIB or RS232 cables for secure attachment and try again.

**E1403** — GPIB Error: Unable to communicate with device at address [number].

Unable to communicate over the GPIB bus. Verify that all cables are securely attached.

**E1404** — No valid sources available.

There are no traces defined and there are no stored waveforms. Apply an input source to the oscilloscope and try again.

**E1405** — Invalid source selected.

The waveform selected for transfer is no longer available on the oscilloscope. Check the available sources and try again.

**E1406** — Error sending waveform to 11000/DSA DSO.

An error was detected when sending a waveform to a 11000 DSO. Check the GPIB or RS232 cables for secure attachment and try again.

**E1408** — Waveform exceeds limit for 11000/DSA. Must be less than or equal to 16383 points.

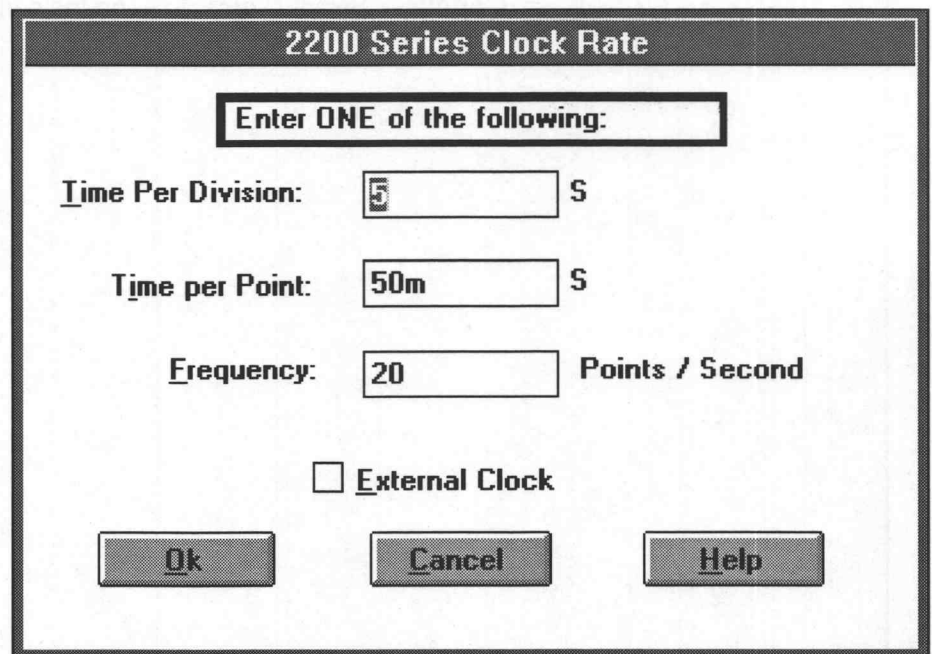
The waveform selected for transfer is larger than 16383 points. Use the markers to segment off a section 16383 or less. Send the portion between the markers to the instrument.

# Appendix M: 2200 Series Dialogs and Messages

This appendix describes the dialog boxes and error messages specific to the 2200 Series Digital Storage Oscilloscopes (the 2221A, 2230, and 2232A are specifically supported). This driver supports the Acquire feature of *WaveWriter* only, it does not send waveforms to an instrument.

## Change Clock Rate

Use the following dialog box (see Figure M-1) to change the current clock rate. This reassigns the time per point and does not change the waveform shape or size.



The dialog box is titled "2200 Series Clock Rate". It contains a prompt "Enter ONE of the following:" in a box. Below this are three input fields: "Time Per Division:" with a value of "5" and a unit "S"; "Time per Point:" with a value of "50m" and a unit "S"; and "Frequency:" with a value of "20" and a unit "Points / Second". There is also an unchecked checkbox labeled "External Clock". At the bottom are three buttons: "Ok", "Cancel", and "Help".

Figure M-1: 2200 Series Clock Rate Dialog Box

**Time Per Division** — Enter the time in seconds. If no external clock is present, the values must be in a 1-2-5 sequence from 5 s to 5 ns.

If an external clock is present, the valid values are 1 ms to 5 ns.

**Time per Point** — Enter the time in seconds. If no external clock is present, the values must be in a 1-2-5 sequence from 50 ms to 50 ps.

If an external clock is present, the valid values are 10 ms to 50 ps.

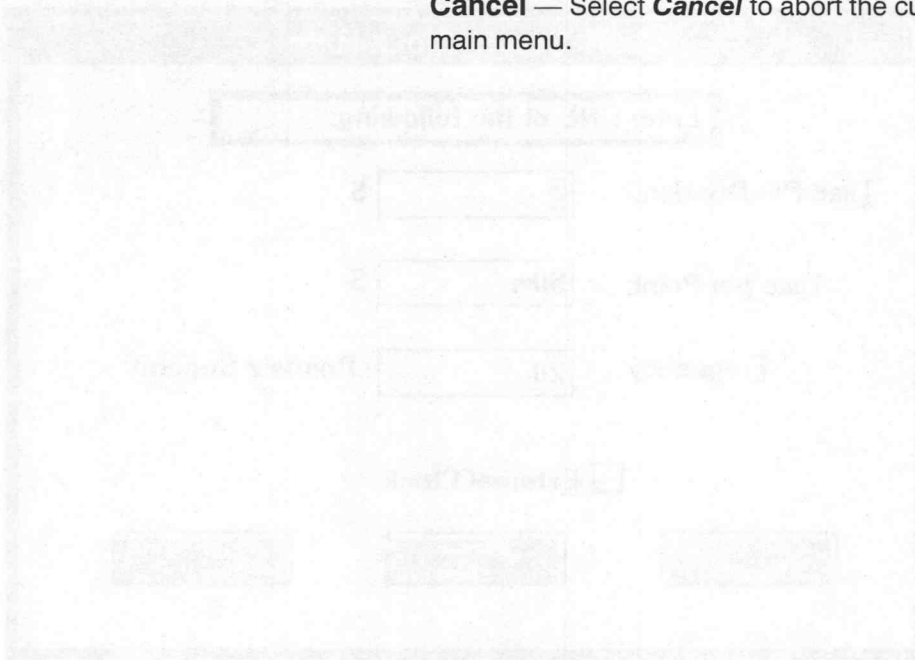
**Frequency** — Enter the frequency in Hz. If no external clock is present, the values must be in a 1-2-5 sequence from 20 Hz to 20 GHz.

If an external clock is present, the valid values are 100 kHz to 20 GHz.

**External Clock** — Indicates that an external clock is to be used.

**OK** — When **OK** is selected, the clock rate is verified for appropriate limits. If you are not using an external clock and the specified rate is not a 1-2-5 sequence, you are offered a choice between the next higher and lower valid values. When a valid clock rate is entered, the clock rate display above the Waveform Display Area updates with the new clock rate. If the horizontal axis scale is displayed in seconds, the scale updates to reflect the new clock rate.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.



## Acquire Waveform

Use this dialog box (see Figure M-2) to acquire a waveform from a 2200 series instrument. You may acquire a waveform from channel 1, channel 2, or reference memories 1 through 4.

You are prompted for the following information before acquiring the waveform:

The dialog box is titled "Acquire 2200 Series". It contains a "Location" section with five radio buttons: "ACQ" (selected), "REF1", "REF2", "REF3", and "REF4". Below the "Location" section are two radio buttons: "Replace Current Waveform" and "Create New Waveform" (selected). A "Name" field contains the text "ACQ". At the bottom are three buttons: "Ok", "Cancel", and "Help".

Figure M-2: Acquire 2200 Series Dialog Box

**Location** — Specifies the desired acquisition channel: CH1, CH2, REF1, REF2, REF3, or REF4.

**Replace Current Waveform** — Overwrites the current waveform with the acquired waveform. The acquired waveform record length is the new current record length.

**Create New Waveform** — Prompts for a new waveform name. The acquired waveform becomes the current waveform. The previous current waveform is now a background waveform.

**Name** — Enter a valid name for the waveform being acquired.

**OK** — When **OK** is selected, the waveform is acquired, loaded into memory, and displayed as the current waveform.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

### Conformance to Target

If the acquired waveform data does not conform to the target instrument's ranges, voltage and timing data are affected.

**Voltage** — If the acquired waveform amplitude exceeds the display window limits, the waveform is clipped on the display. No data is lost however.

**Clock Rate** — If the clock rate does not match, a warning is displayed and you are prompted for one of the following solutions:

- Change the clock rate of the incoming waveform to the current clock rate.
- Massage (expands or compresses) the incoming waveform to maintain a timing match.
- Change the current clock rate to match the incoming waveform. If the incoming clock rate is not valid for the selected target instrument, this option is grayed out and unavailable.
- Cancel the acquisition and return to the main menu.

### Driver Limits

This driver uses the limits listed below to determine valid display amplitude, offset, and clock rate.

**Display Amplitude** — The valid range is 20.24 ms to 25,400 V.

**External Offset** — The valid range is -50,000 to 50,000 V.

**Time per Point** — For 2200 instruments, the acceptable range is 50 ps/pt to 0.50 ms/pt. The clock rate must conform to a 1-2-5 sequence.

## 2200 Series Error Messages

**E1105** — 2200 DSO cannot run at clock rates slower than 0.05 seconds/point (5.0 seconds/div). Is 0.05 seconds/point acceptable?

A clock rate too slow for the instrument was entered. The acceptable range for 2200 Series instruments is 50 ps/p to 0.05 s/pt. The clock rate must conform to a 1-2-5 sequence. You are offered the opportunity to change the entry to 0.05 s/pt.

**E1106** — Too slow for the 2200 external clock. Accept lower limit of 10  $\mu$ S/point?

The clock rate entered is invalid for a 2200 Series instrument with an external clock. You are offered the opportunity to change it to the lower limit shown.

**E1107** — Too fast for the 2200 external clock. Accept upper limit of 50 ps/point?

The clock rate entered is invalid for a 2200 Series instrument with an external clock. You are offered the opportunity to change it to the upper limit shown.

**E1300** — Error acquiring waveform from 2200 DSO.

An error was detected when acquiring a waveform from a 2200 Series instrument. Check the GPIB cables for secure attachment and try again.

**E1301** — All addresses searched. No 2200 DSO found.

All primary addresses were checked for the presence of a 2200 Series instrument and none were found. Check the GPIB cables for secure attachment and try again.

**E1302** — XY Mode is not supported.

Data stored in the Vertical XY mode cannot be read into *WaveWriter*.

**E1303** — Reference memory [number] is empty.

You cannot acquire a waveform from an empty reference. Chose another reference location or store the desired waveform in the specified location and try again.

[The content of this table is extremely faint and illegible. It appears to be a list of dialogues and messages for the 2200 Series, organized in a table with two columns: the left column likely contains the message ID or code, and the right column contains the corresponding text of the message or dialog. Due to the low contrast and blurriness, the specific text within the table cannot be transcribed.]



# Appendix N: AFG 310/320 Dialogs and Messages

This appendix describes dialog boxes and error messages specific to the AFG 310 and AFG 320. The AFG 310 is a single channel instrument; when you are sending a waveform to an AFG 310 all references to Channel 2 in the dialog boxes are grayed (i.e. not selectable.).

## Change Clock Rate

Use the following dialog (see Figure N-1) to change the current clock rate. This changes only the time per point, and does not change the waveform size or shape.

The dialog box is titled "AFG 300 Clock Rate". It features two input fields. The first is labeled "Time per Point:" and contains the text "100n" followed by a unit "S". Below this is the word "(or)". The second input field is labeled "Frequency:" and contains the text "10M" followed by a unit "Hz". At the bottom of the dialog are three buttons: "Ok", "Cancel", and "Help".

Figure N-1: AFG 300 Clock Rate Dialog Box

**Time per Point** — Enter the time per point in seconds. The valid range is 62.5 ns to 10 s.

**Frequency** — Enter the clock frequency in Hz. The valid range is 100mHz to 16MHz.

### NOTE

*Further limiting of the clock rate may occur when the waveform is sent to the instrument. See the Driver Limits section below for the precise definition of the limit applied at send time.*

**OK** — When a new clock rate is input and **OK** is clicked, the clock rate for the current waveform is changed. The clock rate display above the waveform display area updates to show the new rate. If the horizontal axis is displayed in seconds, the scale updates to reflect the new clock rate.

**Cancel** — Select **Cancel** to abort the clock-rate-change operation, and return to the main menu.

### Send Waveform

You can send the current waveform to the AFG 310/320 with the dialog box below (see Figure N-2). If the transfer is successful, the waveform data is always copied to the instrument's EDIT buffer. In addition, it may be optionally copied to another location within the instrument as well.

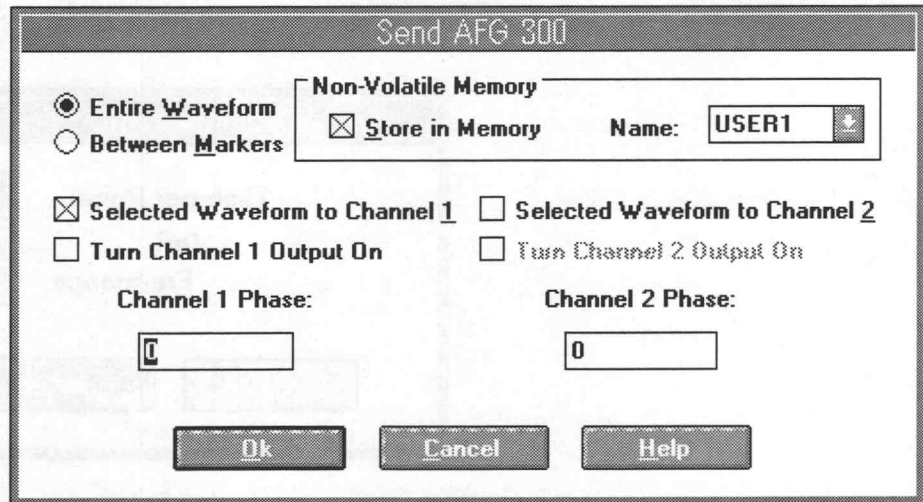


Figure N-2: Send AFG 300 Dialog Box

**Entire Waveform** — Sends the entire waveform.

**Between Markers** — Sends only the portion of the waveform between and including markers. The number of points sent must be between 10 and 16,384.

**Non-Volatile Memory** — When Store in Memory is selected, the waveform will be copied into one of the instrument's four non-volatile memories as well as the EDIT buffer. The names of the non-volatile memories become selectable when Store in Memory is selected.

**Selected Waveform to Channel 1** — Sends the waveform and its frequency, amplitude, and offset parameters to Channel 1 in the instrument.

**Turn Channel 1 On** — Enables output of the transmitted waveform from Channel 1. This item is grayed if Selected Waveform to Channel 1 is not selected.

**Channel 1 Phase** — Used to set the phase of the output when waveform is output from channel 1. Must be between 360 and  $-360$  degrees. This item is grayed if Selected Waveform to Channel 1 is not selected.

**Selected Waveform to Channel 2** — Sends the waveform and its frequency, amplitude, and offset parameters to Channel 2 in the instrument.

**Turn Channel 2 On** — Enables output of the transmitted waveform from Channel 2. This item is grayed if Selected Waveform to Channel 2 is not selected.

**Channel 2 Phase** — Used to set the phase of the output when waveform is output from channel 2. Must be between 360 and  $-360$  degrees. This item is grayed if Selected Waveform to Channel 2 is not selected.

**OK** — When you select OK the waveform is sent to the instrument.

**Cancel** — Select Cancel to abort the current operation, and return to the main menu.

### Driver Limits

This driver uses the limits given below to validate the parameters for send operations, and checking display parameters.

**Display Amplitude** — The absolute limits are 50mV and 10.00V. However, these limits only apply when the offset is zero (see below for details).

**Offset** — The offset and the amplitude together must conform to the following relationship.

Amplitude from 505mV to 10V peak-to-peak:  
 $\text{amplitude}/2 + (\text{absolute value of offset}) \leq 5V$

Amplitude from 50mV to 500mV peak-to-peak:  
 $\text{offset} < 0.75V$

**Time Per Point** — The absolute limits are 62.5ns and 10s, and this is the range that is applied when the user inputs the clock rate to the AFG 310/320 Clock Rate dialog. However, further limiting of the clock rate may occur when the waveform is sent to the instrument. When the selected rate is the

slowest (10s), it will be further limited in all cases except when the number of points sent is the shortest (10 points). In general, when the number of points sent is N, the following expression defines the slowest clock rate limit.

$$100/N$$

**Maximum Number of Points** — The maximum number of points that can be sent to the instrument is 16384.

**Minimum Number of Points** — The minimum number of points that can be sent to the instrument is 10.

### AFG 310/320 Error Messages

**E1001** — Error sending waveform to AFG 300.

An error was detected when sending a waveform to the instrument. Check the GPIB cables for secure attachment and try again.

**E1002** — All addresses searched. No AFG 300 found.

All primary addresses were checked for the presence of an AFG 320/310, but none was found. Check the GPIB cables for secure attachment, and try again.

**E1003** — Current clock rate is invalid for AFG 300. Accept upper limit of 10s?

A clock rate that was outside the slowest limit for the instrument (10s) was entered. You are offered the choice of changing the rate to the slowest value.

**E1004** — Current clock rate is invalid for AFG 300. Accept lower limit of 62.5ns ?

A clock rate that was outside the fastest limit for the instrument (62.5ns) was entered. You are offered the choice of changing the rate to the fastest value.

**E1006** — Waveform for AFG 300 must be from 10 to 16,384 points.

The number of points sent must be within the above range. Change the markers, or the waveform, so that the length of the waveform data being sent is within the above range.

**E1007** — AFG 300 does not support envelope waveforms.

You attempted to save an envelope waveform to an instrument specific file, or send an envelope waveform to the instrument. The AFG 310/320 does not support envelopes. You may wish to use Envelope Decouple to break the envelope into two separate waveforms.

**E1009** — The AFG 300 slowest possible clock rate depends on the number of points sent. setting to limit <clockLimit>.

The slowest clock rate for the instrument varies with the number of points sent. (See the Driver Limits section of page N-3 for details.) The value will be set to the limit as given by clockLimit.

**E1010** — For AFG 300, phase must be between 360 and -360 degrees.

You entered a value for the phase that was outside the permitted range.



# Appendix O: VX4790A Dialogs and Messages

This appendix describes dialog boxes and error messages specific to the VX4790A.

## Change Clock Rate

Use the following dialog (see Figure O-1) to change the current clock rate. This re-assigns the time per point, and does not change the size or shape of the waveform.

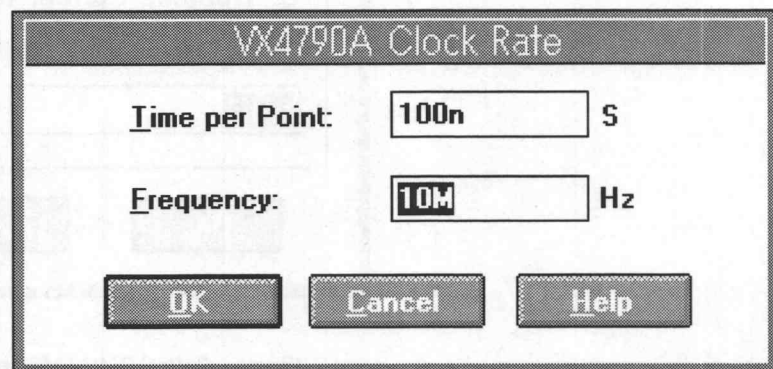


Figure O-1: VX4790A Clock Rate Dialog Box

**Time per Point** — Enter the time per point in seconds. The valid range is 40 ns to 1.33s.

**Frequency** — Enter the clock frequency in Hz. The valid range is 0.75 Hz to 25MHz.

**OK** — When a new clock rate is input and OK is clicked, the clock rate for the current waveform is changed. The clock rate display above the waveform display area updates to show the new rate. If the horizontal axis is displayed in seconds, the scale updates to reflect the new clock rate.

**Cancel** — Select Cancel to abort the operation and return to the main menu.

## Acquire Waveform

Use this dialog box (see Figure O-2) for copying a waveform from a VX4790A to WaveWriter. The source and destination of the waveform can be selected.

Figure O-2: VX4790A Acquire Waveform Dialog Box

**Source[VX4790]** — The Source is the location in the instrument from which waveform data is to be copied to WaveWriter. When the Paged Memory box is checked, the source will be one of the pages in memory, where the number of the page is the number entered in the Page Number box. The range for the page number will be at the very least 1 to 4, but depending on the options included in your VX4790A, the upper limit may be greater. If Paged Memory is not checked, the entire memory will be used as the source, and the Page Number box will be grayed.

### NOTE

*When the whole memory is selected as the source, data is copied from the start of memory up to the first occurrence of an end-of-data flag, or the end of memory (which ever occurs first). When paged memory is selected, data is copied from the start of the selected page up to the first occurrence of an end of data flag, or the end of the page (which ever occurs first).*



*It is not possible for WaveWriter to know whether the instrument memory contains meaningful data. Copying will be done according to the rules described above regardless of whether any data has been written into the selected source location.*

**Destination[Wave Writer]** — You have a choice of how to store the acquired waveform:

- **Replace Current Waveform** — The current waveform is overwritten by the acquired waveform. The current record length is changed to that of the acquired waveform record.
- **Create New Waveform** — The new waveform name is to be specified in the Waveform Name edit box. The default name is the source file name without extension. You may change it to any legal name. The acquired waveform becomes current after transfer.

**OK** — This button is enabled only when valid source and destination are selected. When replacing the current waveform, a destination name is not required. Once the **OK** button is pressed, the waveform data is transferred to WaveWriter.

### Conformance to Target

If the acquired waveform data does not conform to the target instrument's ranges, voltage data and timing data are affected:

**Voltage** — If the acquired waveform amplitude exceeds the display window limits, the waveform is clipped on the display. No data is lost.

**Clock Rate** — If the clock rate doesn't match, a warning is displayed and you are prompted to choose one of the following actions:

- Change the clock rate of the incoming waveform to the current clock rate.
- Massage (expand or compress) the incoming waveform to maintain a timing match (see the explanation of the **Edit → Horizontal Resolution...** section for details of messaging).
- Change the current clock rate to match the incoming waveform. If the incoming clock rate is not valid for the selected target instrument, this option is grayed and unavailable.
- Cancel the acquisition and return to the main menu.

## Send Waveform

You can Send the current waveform to a location in the VX4790A's memory using the dialog box shown in Figure O-3. You can also cause the output of waveforms that are already in instrument memory.

Figure O-3: VX4790A Send Dialog Box

**Waveform Portion** — You have the option of sending either the entire waveform or only the portion between (and including) the markers.

**Paged Memory** — When the Paged Memory box is checked, the waveform data will be copied into one of the pages in instrument memory, where the number of the page is the number entered in the Page Number box. The range for the page number will be at the very least 1 to 4, but depending on the options included in your VX4790A, the upper limit may be greater. If Paged Memory is not checked, the entire memory will be made available for copying waveform data, and the Page Number box is grayed.

Waveform data with a maximum length of 65536 points can be copied into each page. When paged memory is not being used, waveform data with a maximum length of at least 262144 points can be copied. See Driver Limits (below) for details of waveform length limits.

**NOTE**

*When paged memory is not selected, waveform data is copied to the beginning of memory. When paged memory is selected, waveform data is copied to the beginning of the selected page, where each page starts on a 65536 point boundary. In either case the last point copied is marked with the end-of-data flag.*

*If data that does not fill the entire memory is copied without Paged Memory selected, then depending on the length of the data, the contents of pages not overwritten by the new data will still be usable. The same applies to data copied without Paged Memory selected and data copied afterwards with Paged Memory selected: provided there is no overlap, no data will be lost. However, WaveWriter will not warn you if data is copied into an area that contains data that was copied previously.*

*Each page has a separate copy of various instrument setup options. Changing the options for one page (or for the entire memory) does not affect any other page's setup options.*

**RUN** — Cause the waveform in the currently selected location to be output by sending a soft trigger. The location can be the entire memory or a page, and is selected using the Paged Memory check box together with the Page Number box. The output isolator is also closed, but all other instrument settings remain unchanged regardless of what other options are set in the VX4790A Send Waveform dialog box. No waveform data is sent, and the VX4790A Send Waveform dialog box remains displayed.

**STOP** — If any waveform is being output, stop it. No instrument settings are changed, and no waveform data is sent. The VX4790A Send Waveform dialog box remains displayed.

**ISOLATOR CLOSED** — If this button is not selected, the isolator on the output will be opened. Waveforms can be sent, and depending on the settings may execute, but there will be no waveform output.

**Mode** — This specifies the trigger mode. The following modes can be selected.

- **CONTINUOUS** — output continuously
- **WAIT** — wait for a trigger and then output continuously
- **WAIT ONCE** — wait for a trigger, and then output once
- **BURST** — wait for a trigger and then output a number of times.

**Count** — This is the number of times the waveform is to be output. The box is grayed unless the Mode is BURST.

**Filter** — This specifies which low-pass output filter (if any) is to be applied. The available selections are THRU (no filter applied), or one of the filters 5MHz, 500kHz, 50kHz.

**Operation** — Specifies the modulation operation. The following options can be selected.

- **NONE** — No modulation applied.
- **EXTERNAL AM** — The signal applied to the AM IN input on the instrument is used to amplitude modulate the output.

#### **NOTE**

*When EXTERNAL AM is not selected, WaveWriter sets the amplitude of the waveform by choosing the smallest output range that can accommodate the required amplitude, and then makes a fine adjustment using the instrument's internal attenuator. When EXTERNAL AM is used, these fine adjustments are not possible, so only very coarse settings for the carrier waveform amplitude are possible using just the range setting. This means that the peak-to-peak amplitude of the carrier will be set to one of the following:*

*20.47 V for waveforms where amplitude > 10.235 V  
10.235 V for waveforms where  $10.235 \text{ V} \geq \text{amplitude} > 0.2047 \text{ V}$   
0.2047 V for waveforms where  $0.2047 \text{ V} \geq \text{amplitude}$*

**Trigger** — This is used to set trigger sources and trigger output selections. Using backplane connections as trigger sources and outputs, a number of instruments can be made to trigger together. Depending on what is required, all of the following items may need to be set.

- **Source** — The trigger source can be selected from:
  - **SOFT** — Only the software trigger is effective. (I.e. the RUN button, or the 0T command via the VXI bus).
  - **FRONT** — The EXT TRIG input socket on the front of the instrument
  - **BACKPLANE** — One of the TTLTRGn connections on the backplane. (This allows the instrument to serve as a slave controlled by another instrument on the VXI bus.)

- **Output To Back Plane** — If Source is not set to SOFT or FRONT, this button is grayed. Selecting this button causes a signal to be output from one of the backplane TTLTRGn connections when the instrument triggers. This allows the instrument to serve as a master for controlling other instruments on the VXI bus.
- **Connection** — When Source is set to BACKPLANE, this is used to select which TTLTRGn backplane connection serves as the trigger source. For other sources this box is grayed unless Output To Backplane is selected. In that case, it is used to select the backplane connection from which the trigger signal will be output. When backplane connections are being used by both Trigger and Clock (see below), WaveWriter will not allow the same connection for both.

### NOTE

*When SOFT and Output To Backplane are selected, the user must additionally connect the front panel SYNC output socket to the EXT TRIG input socket. This function is achieved by setting the sync. flag in the first point of the waveform (This done invisibly to the user by WaveWriter.). There is a delay of approximately 100ns between the triggering of the instrument, and the triggering of connected instruments.*

**Clock** — This is used to set clock sources and clock output selections. Using backplane connections as clock sources and outputs, allows the clocking of a number of instruments to be synchronized. Depending on what is required, all of the following items may need to be set.

- **Source** — The clock source can be selected from:
  - **INTERNAL** — The instrument's own clock: (This will be set to the waveform clock rate.)
  - **EXTERNAL** — The EXT CLK input socket on the instrument
  - **BACKPLANE** — One of the TTLTRGn connections on the backplane. (This allows the instrument to serve as a slave clocked by another instrument on the VXI bus.)
- **Output To Back Plane** — If Sources is not set to BACKPLANE, this button is grayed. Selecting this button causes the instrument's clock signal to be output from one of TTLTRGn connections on the backplane. This allows the instrument to serve as a master for clocking other instruments on the VXI bus.

- **Connection** — When Source is set to BACKPLANE this is used to select which TTLTRG backplane connection serves as the clock source. For other sources this box is grayed unless Output To Backplane is selected. In that case, it is used to select the backplane connection from which the clock signal will be output. When backplane connections are being used by both Clock and Trigger (see above), WaveWriter will not allow the same connection for both.

**NOTE**

*When INTERNAL and Output To Backplane are selected, the user must additionally connect the front panel SMP CLK output socket to the EXT CLK input socket.*

**OK** — Clicking on **OK** sends the waveform to the instrument and sets the various settings in the instrument. If, given the settings for the send operation and the instrument options, the length is too long, a dialog is displayed allowing the user to choose between truncating the waveform, or aborting the send and returning to the main menu.

**Cancel** — Abort the send operation and return to the main menu.

**Driver Limits**

This driver uses the limits given below to validate the parameters for send operations, and to check displayed parameters.

**Display Amplitude** — The range is 50 mV and 10.00 V.

**Offset** — The VX4790A has no offset capability, so maximum and minimum limits are both zero.

**NOTE**

*If you want a waveform with an offset to be output, the offset must be added into the waveform data. This can be done at the time the waveform is created, or for an existing waveform, an offset can be added using the Add Scalar selection in the SigProc menu of WaveWriter's main menu.*

**Time Per Point** — The range is 40 ns to 1.33s.

**Maximum Number of Points** — When data is being sent to or acquired from a page in memory the maximum number of points is 65536. (Note however, that the number of pages varies depending on instrument options as shown below.) When paged memory is not being used, the maximum number of points depends on the options that are included in your instrument:

No options:	262,144 points	4 pages
Option01:	524,288 points	8 pages
Option02:	1,048,576 points	16 pages

## VX4790A Error Messages

**E1000** — Error acquiring waveform from VX4790.

An error was detected when acquiring a waveform from the instrument. Check the GPIB cables for secure attachment and try again.

**E1001** — Error sending waveform to VX4790.

An error was detected when sending a waveform to the instrument. Check the GPIB cables for secure attachment, and try again.

**E1002** — No VX4790A found on the bus.

You tried to use an instrument that is not a VX4790A. Check that the instrument's address setting on the board is correct, and is the same as the address being used by WaveWriter (See the Configure Instruments selection in the Transfer menu in WaveWriter's main menu.).

**E1003** — Clock rate too slow. Accept limit ?

A clock rate that was outside the slowest limit for the instrument (1.33s) was entered. You are offered the choice of changing the rate to the slowest value.

**E1004** — Clock rate too fast... Accept limit ?

A clock rate that was outside the fastest limit for the instrument (40ns) was entered. You are offered the choice of changing the rate to the fastest value.

**E1006** — Waveform too long.

You tried to save a waveform that was too long for the instrument in an ISF file.

**E1007** — Envelope not supported.

You attempted to send an envelope waveform to the instrument. The VX4790A does not support envelopes. You may wish to use Envelope Decouple to break the envelope into two separate waveforms.

**E1011** — Cannot configure the bus.

Could not find an instrument at the specified address. Check that the instrument's address setting on the board is correct, and is the same as the address being used by *WaveWriter* (See the Configure Instruments selection in the Transfer menu in *WaveWriter*'s main menu.).

**E1012** — No offset capability. Offset ignored.

The waveform being sent has a non-zero offset voltage. As the VX4790A has no offset capability the value is ignored, and the waveform will be output with no offset added. If an offset is required, it must be added into the waveform data. This can be done at the time the waveform is created, or for an existing waveform, an offset can be added using the Add Scalar selection in the SigProc menu *WaveWriter*'s main menu.

**E1013** — Too many points to send. Limit to <limit>.

You attempted to send a waveform that was too long for the current settings or options in the instrument. You are offered the choice of truncating the data to the number of points given by <limit>. See Driver Limits (page O-8) for the details of data length limits.

**E1015** — Trigger and clock backplane connections the same.

When sending a waveform, the Trigger and Clock settings were such that they were trying to use the same backplane connection.



# Appendix P: VX4792 Dialogs and Messages

This appendix describes dialog boxes and error messages specific to the VX4792.

## Change Clock Rate

Use the following dialog (see Figure P-1) to change the current clock rate. This changes only the time per point, and does not change the waveform size of shape.

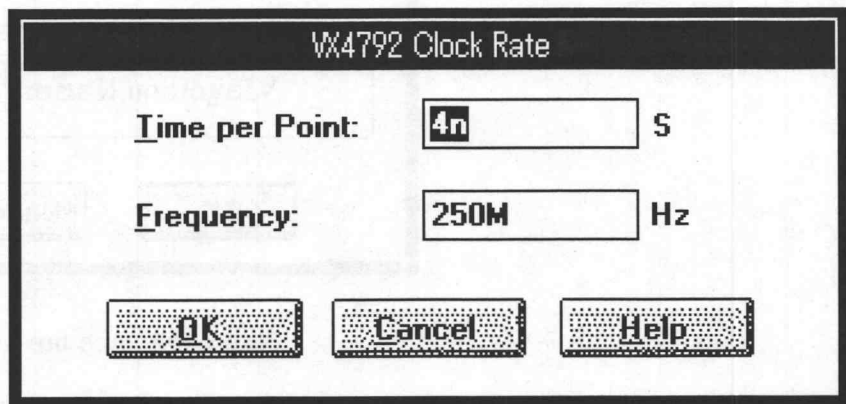


Figure P-1: VX4792 Clock Rate Dialog Box

**Time per Point** — Enter the time per point in seconds. The valid range is 4 ns to 0.1s.

**Frequency** — Enter the clock frequency in Hz. The valid range is 10 Hz to 250 MHz.

**OK** — When a new clock rate is input and **OK** is clicked, the clock rate for the current waveform is changed. The clock rate display above the waveform display area updates to show the new rate. If the horizontal axis is displayed in seconds, the scale updates to reflect the new clock rate.

**Cancel** — Select Cancel to abort the clock-rate-change operation, and return to the main menu.

## Acquire Waveform

Use this dialog box (see Figure P-2) to select the source and destination of the waveform.

VX4792 Acquire Waveform

Source (VX4792)

Waveform Name: CH1

Destination (Wave Writer)

Replace Current Waveform

Create New Waveform

Waveform Name: SQUARE

OK Cancel Help

Figure P-2: Acquire AWG 2000 Dialog Box

**Source (VX4792)** — Used to select the waveform that will be acquired from the instrument. This will be either a waveform in instrument memory, or a channel. The box lists all the waveforms in instrument memory, and all channels in the instrument.

**Destination (WaveWriter)** — You have a choice of how to store the acquired waveform:

- **Replace Current Waveform** — The current waveform is overwritten by the acquired waveform. The acquired waveform record length is the new record length.
- **Create Waveform** — You must enter a new waveform name. The acquired waveform becomes the current waveform. The previous current waveform becomes a background waveform.
- **Waveform Name** — Enter a valid name for the waveform being acquired. Only visible when *Create New Waveform* is selected

**OK** — When **OK** is selected, the waveform is acquired, loaded into memory, and displayed as the current waveform.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

### Conformance to Target

If the acquired waveform data does not conform to the target instrument's ranges, voltage data and timing data are affected.

**Voltage** — If the acquired waveform amplitude exceeds the display window limits, the waveform is clipped on the display. However no data is lost .

**Clock Rate** — If the clock rate does not match, a warning is displayed and you are prompted to select one of the following actions:

- Change the clock rate of the incoming waveform to the current clock rate.
- Massage (expand or compress) the incoming waveform to maintain a timing match.
- Change the current clock rate to match the incoming waveform. If the incoming clock rate is not valid for the selected target instrument, this option is grayed out and unavailable.
- Cancel the acquisition and return to the main menu.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

## Send Waveform

You can send the current waveform to the VX4792 with the dialog box below (see Figure P-3).

Figure P-3: VX4792 Send Dialog Box

**Entire Waveform** — Sends the entire waveform.

**Between Markers** — Sends only the portion of the waveform between and including markers. The number of points sent must be between 64 and 262144, and must be a multiple of 8.

**Destination** — The Destination Waveform edit box displays the name of the waveform with the .WFM extension. The List box lists all the waveforms currently in the instrument's memory. You can change the destination file-name to any legal name. If you enter the name of a file already in memory, *WaveWriter* asks if you wish to overwrite it.

**LOAD** — A waveform file, which already exists in the instrument, is loaded into the output. The file is specified by selecting a file name from the waveform list. The output and trigger options are also set in the instrument. Control returns to the main menu after selecting LOAD.

**DELETE** — A waveform file in the instrument is deleted. The file is specified by selecting a file name from the waveform list. There is no effect on instrument output and trigger options. Control returns to the main menu after selecting DELETE.

**WAVEFORM OUTPUT ON** — When this box is checked, then after the waveform is sent, it will be loaded into the output port, and the switch on the output port will be closed.

**Output** — A number of instrument output options can be set as follows.

- **Mode** — This is used to specify the trigger mode. The following selections are available.
  - **CONTINUOUS** — The waveform is output continuously.
  - **TRIGGERED** — When a trigger is received, the waveform is output once.
  - **GATED** — The waveform is output when a trigger is present, and stops when it is not present.
  - **BURST** — When a trigger is received, the waveform is output the number of times specified in the Count box. (The count box is grayed unless BURST is selected.)
- **Filter** — Specifies the cut-off point of the low pass filter applied to the output. The options available are 50MHz, 20MHz, 5 MHz, 1MHz and Through (full pass).
- **Clock Src** — Allows the user to select the instrument's internal clock or the external clock connection. If INTERNAL is selected, the instrument's clock is set to the clock rate of the current waveform.
- **Operation** — If EXT AM is selected the signal at the instrument's external AM input will amplitude modulate the output.

**Trigger** — This allows trigger conditions to be set.

- **Polarity** — The trigger polarity can be set to POSITIVE or NEGATIVE.
- **Slope** — The trigger slope can be set to POSITIVE or NEGATIVE.
- **Level** — The voltage level that will cause a trigger. The permitted range is -5.0 to 5.0.
- **Impedance** — The trigger impedance can be set HIGH or LOW.

**Marker Bits** — This is used to set whether, and when, marker signals are output by the instrument. Marker 1 and Marker 2 show the current On/Off state of the markers. Clicking on the Set Marker button causes the Marker

Setup dialog box to be displayed, allowing the user to input marker signal state and position settings. See below for a description of the Marker Setup dialog box.

**NOTE**

*Marker signals should not be confused with WaveWriter's marker flags; they are entirely different things. The Between Markers button (page P-4) and Marker Bits have no connection with each other. Nor do marker flag positions have any effect on marker signal positions set in the Marker Setup dialog box (See Below)*

**OK** — Clicking on **OK** sends the waveform, and sets the selected settings. If the length of the waveform is not acceptable to the instrument, a dialog box informing the user will be displayed. The dialog presents a choice of actions: truncating to the closest legal length, rounding up to the nearest legal length, or cancelling the send and returning to the main menu. Depending on the situation, choices that are not possible are grayed in the dialog box.

**Cancel** — Click on **Cancel** to abort the send, and return to the main menu.

**Marker Setup**

This dialog box appears after the Set Marker button in the Send VX4792 dialog box is pressed. It allows the user to set the on/off state and position of marker signals. (See Figure P-4.) A marker signal is an instrument output that assumes its on value when waveform output is at particular points.

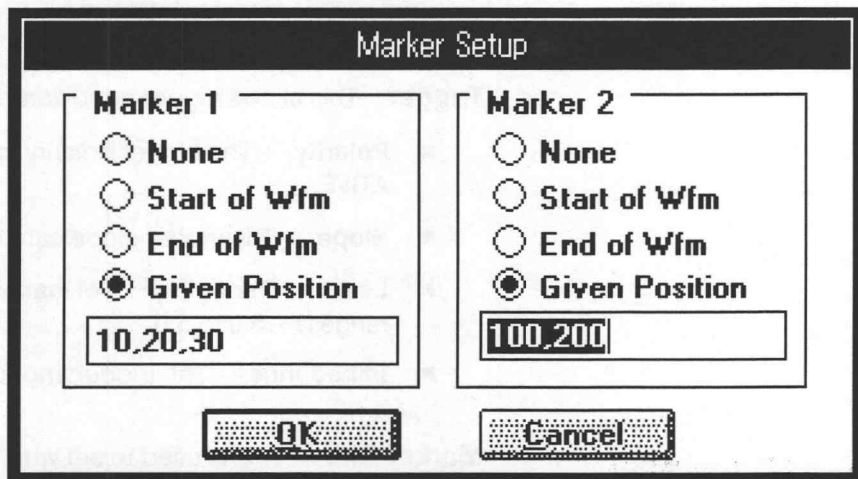


Figure P-4: Marker Setup Dialog Box

**Marker 1, Marker 2** — A maximum of two marker signals can be set. Each marker can be set to assume its on value for the duration of specified points in the waveform. At all other times it will take its off value.

**None** — When this button is selected the marker signal is always at its off value.

**Start of Wfm** — When this button is pressed, the marker signal assumes its on value while the first point in the waveform is being output.

**End of Wfm** — When this button is pressed, the marker signal assumes its on value while the last point in the waveform is being output.

**Given Positions** — When this button is pressed, the marker signal assumes its on value while the points specified by the numbers in the box just below the button are being output. The points must be separated by commas or spaces. The position box is grayed if Given Position is not selected.

**OK** — Return to the Send Waveform dialog. The marker settings input by the user will be applied when the waveform is sent to the instrument.

**Cancel** — Return to the Send Waveform dialog. The marker settings input by the user this time will be ignored. The settings applied when the waveform is sent to the instrument will be as they were before the Marker Setup dialog box was displayed.

### Driver Limits

The driver for the VX4792 uses the limits given below to determine things such as valid display amplitude, offset and clock rate.

**Display Amplitude** — The range is 50 mV to 5.00 V peak-to-peak.

**Offset** — The range is -2.5 V to 2.5 V.

**Time Per Point** — The range is 4 ns to 0.1 s.

**Maximum Waveform Length** — The maximum number of points for a waveform is 262144.

**Minimum Waveform Length** — The minimum number of points for a waveform is 64.

**Number-of-Points Multiple** — Waveform lengths in the VX4792 are always a multiple of 8 points.

## VX4792 Error Messages

**E1000** — Error acquiring waveform from VX4792.

An error was detected when acquiring a waveform from the instrument.

**E1001** — Error sending waveform to VX4792.

An error was detected when sending a waveform to the instrument.

**E1002** — No VX4792 found on the bus.

You tried to use an instrument that is not a VX4792. Check that the instrument's address setting is correct, and is the same as the address being used by WaveWriter. (See the Configure Instruments selection in the Transfer menu in WaveWriter's main menu.)

**E1003** — Clock rate too slow... Accept limit ?

A clock rate that was outside the slowest limit for the instrument (0.1 s) was entered. You are offered the choice of changing the rate to the slowest value.

**E1004** — Clock rate too fast... Accept limit ?

A clock rate that was outside the fastest limit for the instrument (4 ns) was entered. You are offered the choice of changing the rate to the fastest value.

**E1006** — Waveform too long.

You tried to send a waveform that was too long for the instrument, or tried to save it in an ISF file.

**E1007** — Envelope not supported.

You attempted to send an envelope waveform to the instrument. The VX4792 does not support envelopes. You may wish to use Envelope Decouple to break the envelope into two separate waveforms.

**E1011** — Cannot configure the bus.

Could not find an instrument at the specified address. Check that the instrument's address setting is correct, and is the same as that being used by WaveWriter. (See the Configure Instruments selection in the Transfer menu in WaveWriter's main menu.)

**E1012** — Not enough free memory in VX4792



There is insufficient unused memory left in the instrument to hold the waveform that you tried to send. Use the DELETE button in the VX4792 Send Waveform dialog box to delete some waveform files in the instrument, and try sending again.



# Appendix Q: TVS 600 Series Dialogs and Messages

This appendix describes the dialog boxes and error messages specific to the TVS600 Series Waveform Analyzer. The TVS641 instrument dialog boxes are used as examples in the following discussion. TVS600 series instruments having different requirements or limits are specifically noted.

## Change Clock Rate

Use the following dialog box (see Figure Q-1) to change the current clock rate. This reassigns the time per point and does not change the waveform shape or size.

TVS600 Series Clock Rate

Enter ONE of the following:

Time Per Division: 200n \$

Time per Point: 4n \$

Frequency: 250M Points / Second

Ok Cancel Help

Figure Q-1: TVS600 Series Clock Rate Dialog Box

**Time Per Division** — Enter the time in seconds. The values must be in a 1-2-5 sequence from:

TVS621, 50 ns/div to 10 s/div

TVS641, 50 ns/div to 10 s/div

TVS625, 10 ns/div to 10 s/div

TVS645, 10 ns/div to 10 s/div

**Time per Point** — Enter the time in seconds. The values correspond to a time-per-division value in a 1-2-5 sequence and must be within range for the instrument:

TVS621, 1 ns/pt to 200 ms/pt

TVS641, 1 ns/pt to 200 ms/pt

TVS625, 200 ps/pt to 200 ms/pt

TVS645, 200 ps/pt to 200 ms/pt

**Frequency** — Enter the frequency in Hz. The values correspond to a time-per-division value in a 1-2-5 sequence and must lie in the range for the instrument:

TVS621, 1 GHz to 5 Hz

TVS641, 1 GHz to 5 Hz

TVS625, 5 GHz to 5 Hz

TVS645, 5 GHz to 5 Hz

**OK** — When **OK** is selected, the clock rate is verified for appropriate limits. If the specified rate is not a 1-2-5 sequence value, you are offered a choice between the next slower valid value and cancellation. When a valid clock rate is entered, the clock rate display above the Waveform Display Area updates with the new clock rate. If the horizontal axis is displayed in seconds, the scale updates to reflect the new clock rate.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

## Acquire Waveform

Use this dialog box (see Figure Q-2) to acquire a waveform from a TVS600 Series Waveform Analyzer. You can acquire a waveform from channels 1 through 4 or Calculate Subsystems 1 thru 4. If a waveform selection is grayed out (CHAN1–4, CALC1–4) verify that it is properly allocated or selected.

You are prompted for the following information before acquiring the waveform:

The dialog box is titled "TVS600 Series Acquire". It contains a "Location" section with eight radio button options: CHAN1, CHAN2 (selected), CHAN3, CHAN4, CALC1, CALC2, CALC3, and CALC4. Below the location section are two radio buttons: "Replace Current Waveform" and "Create New Waveform" (selected). A "Name" field contains the text "CHAN2". At the bottom of the dialog are three buttons: "OK", "Cancel", and "Help". On the right side of the dialog, there are three buttons: "Initiate", "Setup", and "Help".

Figure Q-2: TVS600 Series Acquire Dialog Box

**Location** — Specifies the desired acquisition channel: CHAN1, CHAN2, CHAN3, CHAN4, CALC1, CALC2, CALC3, or CALC4.

**Replace Current Waveform** — Overwrites the current waveform with the acquired waveform. The acquired waveform record length is the new current record length.

**Create New Waveform** — Prompts for a new waveform name. The acquired waveform becomes the current waveform. The previous current waveform is now a background waveform.

**Setup** — When **Setup** is selected, the TVS600 Setup Dialog Box is displayed, where you may configure the instrument condition such as input range, clock frequency, record length, trigger level and so on.

**Initiate** — When **Initiate** is selected, the TVS600 instrument is caused to acquire a new data record. When no channel is already enabled in the setup dialog, this button is disabled (grayed). If a trigger event successfully occurred after the initiation, the status of the channel/calculation radio buttons will be updated and you will be ready to read data into WaveWriter.

**Name** — Enter a valid name for the waveform being acquired.

**OK** — When **OK** is selected, the waveform is acquired, loaded into memory, and displayed as the current waveform.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

### Conformance to Target

If the acquired waveform data does not conform to the target instrument's ranges, voltage and timing data are affected.

**Voltage** — If the acquired waveform amplitude exceeds the display window limits, the waveform is clipped on the display. No data is lost however.

**Clock Rate** — If the clock rate does not match, a warning is displayed and you are prompted for one of the following solutions:

- Change the clock rate of the incoming waveform to the current clock rate.
- Massage (expand or compress) the incoming waveform to maintain a timing match.
- Change the current clock rate to match the incoming waveform. If the incoming clock rate is not valid for the selected target instrument, this option is grayed out and unavailable.
- Cancel the acquisition and return to the main menu.

## Setup Dialog

Use this dialog box to configure the instrument condition. The instrument parameters for acquiring the input signal are set as specified by various controls in this dialog box.

TVS600 Setup Dialog

Vertical	<input type="checkbox"/> CH1	<input checked="" type="checkbox"/> CH2	<input checked="" type="checkbox"/> CH3	<input type="checkbox"/> CH4
Range(p-p)	1V	2V	2V	1V
Coupling	AC	DC	DC	AC
Filter	FULL	FULL	FULL	FULL
Impedance	1Mohm	50ohm	50ohm	1Mohm

Horizontal	Trigger	
Clock	4ns	Mode AUTO
Length	1024	Source INT2    Level 400m V
Swp Offset	512	Coupling DC    Slope POS

Figure Q-3: TVS600 Setup Dialog Box

### Vertical Group

**CH1,CH2,CH3,CH4** — These boxes are used to select active channels. When a box is checked, the channel will be activated to acquire a new record. For 2-channel models, **CH3** and **CH4** boxes are grayed.

**Range (p-p)** — These combo boxes specify the input voltage range in peak-to-peak value.

**Coupling** — These combo boxes select the input coupling from among AC, DC, and GROUND.

**Filter** — These combo boxes select the input filter from among FULL pass through, 250MHz, and 20MHz.

**Impedance** — These combo boxes select the input impedance from either 1M Ohms or 50 Ohms.

### Horizontal Group

**Clock** — This combo box selects the sampling clock rate as the point duration in the 1–2–4 (reciprocal of 1–2.5–5) sequence.

**Length** — This combo box selects the record length from 256 to 30000. You should be aware that the long record length has some limitations as described in the user's manual, and that this driver does not check if the current parameter violates the limitation.

**Swp Offset** — This edit box specifies the sweep offset value which corresponds to the point of trigger occurrence. If the value 300 is specified, the point 300 in the acquired waveform will represent the trigger point. This value may not be negative and should be less than or equal to the Length value described above.

### Trigger Group

**Mode** — This combo box selects the trigger mode from either NORMAL or AUTO. You should be aware that the AUTO is safer than the NORMAL. If the NORMAL is selected while no appropriate trigger signal is supplied, the instrument may be left waiting for the trigger condition met.

**Source** — This combo box selects the trigger source from among EXTERNAL, INTERNAL 1–4, and VXI mainframe bus signals.

**Coupling** — This combo box selects the trigger input coupling from either AC or DC in combination with optional noise, HF and LF rejection filters.

**Level** — This edit box specifies the trigger level voltage. You should be aware that this driver does not check if the input value is presently valid for the instrument.

**Slope** — This combo box selects the trigger slope from either POSITIVE (going edge) or NEGATIVE (going edge).

**OK** — When this button is selected, the control parameters in this dialog box are sent to the instrument. You will return to the TVS600 Acquire dialog box.

**Cancel** — Select Cancel to abort the current operation and return to the main menu.



**Points** — This box is grayed unless *Allocate Reference Memory* is checked. It is used to select a size in points for allocating to a reference memory. Only those sizes that are available in the instrument are displayed in the box.

**Start At** — Aligns the waveform to a desired horizontal point in memory. Data in the reference memory before *Start At* is unaltered except when *Don't Care* and *Send Between Markers* are selected for envelopes.

**Don't Care Fill In** — Sets an envelope lying outside of the markers (from the beginning of the allocated memory to *Start At* and following the waveform to the next reference boundary) to the minimum and maximum levels. This only happens if *Send Between Markers* is selected. Also sets the Min and Max data of the displayed waveform to the *Don't Care* level.

**OK** — Selecting **OK** sets all parameters and sends the current waveform to the specified reference memory location in the target instrument.

**Cancel** — Select **Cancel** to abort the current operation and return to the main menu.

### TVS600 Series Waveform Detail

This dialog box (see Figure Q-4) lists the values used by the WaveWriter to display the waveform on the screen.

TVS600 Series Display Detail		
XINCR:	2.0000E-4	S/Pt
YSCALE:	2.0000E-1	V/Div
YOFF:	0	Levels
YZERO:	0.0E+0	V
<input type="button" value="OK"/>		<input type="button" value="Help"/>

Figure Q-4: TVS600 Series Instrument-Dependent Detail Dialog Box

**XINCR** — Lists the X axis seconds per point.

**YSCALE** — Lists the Y axis amplitude in volts per division. The value determines the size of the waveform on the display. To change the value, increase or decrease the display amplitude of the waveform.

**YOFF** — Lists the external offset in unscaled levels.

**YZERO** — Lists the external offset in volts. This field is used when the external offset is too large to express in unscaled levels.

**OK** — Select **OK** to close the dialog box.

### Driver Limits

These drivers use the limits listed below to determine valid display amplitude, offset, and clock rate.

**Display Amplitude** — The valid range is 10 mV to 25400 V.

**External Offset** — The valid range is -50000 to 50000 V.

**Time per Point** — The valid range for the clock rate is:

TVS621, 1 ns/pt to 0.2 s/pt

TVS625, 200 ps/pt to 0.2 s/pt

TVS641, 1 ns/pt to 0.2 s/pt

TVS645, 200 ps/pt to 0.1 s/pt

**Maximum Number of Points** — The maximum number of points is 30000.

## TVS600 Series Error Messages

The error messages specific to TVS600 series are listed below. These messages are common to all types in the series although each type has different capabilities. When an error results from a limit being exceeded, the value of the limit may not be included in the message. The user can refer to *Driver Limits* (page Q-8) to resolve these problems.

**E1100** — Error acquiring waveform from the instrument.

An error was detected when acquiring a waveform from a TVS600. Check the configuration and try again.

**E1102** — No TVS600 instrument was found.

The configured address was checked for the presence of a TVS600 and none were found. Check the configuration and try again.

**E1104** — The instrument cannot run at clock rates slower than the limit.  
<value>

The clock rate for the waveform is too slow, where the slowest possible value is given by <value>. Set the clock rate within the limit and try again.

**E1108** — ISF format is not supported by this driver.

The Instrument Specific Format for TVS600 series does not exist at present. The ADF file may be the one you wish.



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# Glossary and Index

Glossary and Index

# Glossary

## **AM**

The amplitude modulation or waveform multiplication operation selectable in the SETUP menu.

## **ARB**

Industry slang that generally refers to instrumentation which converts digital information into an analog waveform. These products are based upon a digital memory array which is clocked out for creation of the output waveform.

## **Arbitrary Function Generator (AFG)**

A hybrid instrument integrating the features of an arbitrary waveform generator with optimal function generator capabilities. It often includes a built-in sweeper.

## **Arbitrary Waveform Generator (AWG)**

Essentially a digital-to-analog converter with built-in memory, plus trigger and output mode settings. Note that some suppliers of Arbitrary Generators use AWG and AFG synonymously.

## **Cont**

An AWG 2020 triggering mode that continuously outputs waveforms.

## **DDS**

Direct Digital Synthesis.

## **FFT**

Fast Fourier Transform algorithm for converting waveforms from the time domain into the frequency domain. The AWG 2020 includes an FFT editor to change frequency domain parameters.

## **Filter**

An output parameter that restricts the frequency band. The desired filter is selectable in the SETUP menu.

## **Foreign Format**

Used when referring to waveform files that have a format that is used by WaveWriter for transferring data to other programs or to instruments. Files in various foreign formats can be read and written by WaveWriter, but the user is encouraged to use native format files for storing waveform data when possible.

## **General purpose knob**

The front panel rotary knob that is used to select items or move the cursor position within the CRT display area.

## **Grayed**

When a control in a dialog box cannot be used, it is usually displayed in different (less prominent) color than when it can be used. This color change is referred to as being grayed. In this condition, no user selection or input operation can be performed on the control.

**Internal memory**

Includes only the AWG 2020 internal random access memory.

**Marker Signal**

An instrument output that indicates when a particular part of the output waveform is being output. Marker signals are used to synchronize the operation of instruments in a measurement system. Marker Signals should not be confused with WaveWriter's marker flags which are completely different things that happen to have the same name.

**Mass memory**

Includes the internal non-volatile random access memory (NVRam) and the external floppy disk memory.

**Native Format**

Used when referring to waveform files that have a formats that are most commonly used by WaveWriter. Files in various native formats can be read and written by WaveWriter. The user is encouraged to use the ADIF 1.0 binary, ADIF 1.0 ASCII, or CSV formats for storing waveform data when possible. These are the formats that are most likely to be supported in future versions of WaveWriter.

**NVRam**

The AWG 2020 internal non-volatile random access memory.

**Offset Binary**

A way of representing a signed integer values in a binary format, sometimes used instead of the more common twos compliment format. Some types of waveform files contain point values written in this format. Each value is represented by a word of a fixed number of bits which contains a positive integer number. Numbers greater than a certain offset represent positive values, and those less than the offset represent negative values.

**Pan**

Allows display of waveform segments across the horizontal time axis of a zoomed waveform.

**Scope**

A commonly used abbreviation of the word *oscilloscope*.

**Standard function waveforms**

A set of predefined waveform algorithms that create typical waveshapes such as sine waves, square waves, triangle waves, and ramps.

**VALUE button**

The front panel button used in conjunction with the general purpose knob and pop-up menu windows to select and enter alphanumeric input in the CRT display area.

**Zoom**

Magnifies the horizontal time axis display of waveform data, but does not actually change the data in internal waveform memory.



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.ASC, file extension, 3-14–3-15  
.BIN, file extension, 3-14–3-15  
.CSV, file extension, 3-8, 3-13  
.DAT, file extension, 3-14–3-15  
.I, file extension, 3-14–3-15  
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