User Manual

ArbConnection 4.x

Waveform Creation Software

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Tabor Electronics Ltd.

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PROPRIETARY NOTICE

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Chapter 1
Getting Started

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What's in This Chapter

This chapter contains a general overview of the **ArbConnection** 4.x Waveform Creation Software, with explanations on what you can expect from your new, innovative software.

Why Use ArbConnection?

ArbConnection is a graphical tool that provides a source of unlimited waveforms. Thanks to the **ArbConnection** software, now you can control instrument functions, modes and features, as well as quickly and easily breadboard a multitude of test waveforms including: arbitrary waveforms, sequences, pulses and modulation.

The Freehand Sketch Mode allows you to draw your own custom waveforms for quick analysis of analog signals, or you can use the built-in Equation Editor to create your own exotic functions. Add or subtract components of a Fourier series to characterize digital or analog filters or inject random noise into a signal to test immunity to auxiliary noise.

Without an easy way to create arbitrary waveforms, an Arbitrary Waveform Generator is destined to remain idle for most of the time, only partially used as a function generator. An external software utility such as **ArbConnection** can unleash the virtually unlimited waveform generation capabilities built into the product. **ArbConnection** is a powerful, Windows-based waveform generation software that not only allows on-screen creation and editing of waveforms, but also provides the means to access all instrument functions and features and exploit the product's full potential.

Highlights of the **ArbConnection:**

- Multiple and powerful tools in one software package including: complete instrument control, pulse, arbitrary waveform, pulse patterns, 3D and FM composers.
- Detailed virtual front panels control all your **Tabor Waveform Generator** functions and modes.
- Wave Composer generates edits and downloads complex waveforms.
- Pulse Composer generates extremely complex pulse patterns and levels.
- FM Wave Composer generates and downloads complex modulating signals.
- Serial Data Composer generates and downloads serial data that is generated from the analog outputs.
- Pattern Composer generates edits and downloads extremely complex patterns of up to 16bit of data.
- Easy, on-screen generation of complex pulses using the pulse

composer.

- Equation Editor generates waveforms from equations.
- SCPI Command and Response Editor simulates ATE operation.
- Translates waveform coordinates from ASCII and other formats.
- Simplifies generation of complex sequences.

Please note that not all functions described in this manual are available on all Tabor Waveform Generator instruments.

For detailed step-by-step installation instructions, please see Chapter 2: **Installing ArbConnection.**

Overview

The **ArbConnection** software is the ideal solution for easy waveform creation and control. Very intuitive and user-friendly, **ArbConnection** is a utility program that serves as a perceptive aid for programming your **Tabor Waveform Generator**.

The **ArbConnection** has many exacting functions and virtually infinite options, to make controlling your Tabor Waveform Generator functions remotely a simple, precise and accurate process. Before starting, make sure you have the following tools:

1. Computer, Pentium III or better
2. Windows 2000/XP/Vista, or higher
3. High resolution screen, at least 1024 x 768 pixels
4. Pointing device, mouse or ball
5. Visa 2.6, or higher installation
6. Last, but not least, some basic knowledge about computer and Windows-based program operation.

ArbConnection operation is divided into two main functions:

1) Panel control, 2) Waveform generation and editing. These operation options are described in detail, but please note that you must install **ArbConnection** before you can use it.

Please note that not all functions described in this manual are available on all Tabor Waveform Generator models.

Familiarize Yourself with ArbConnection

Before you start browsing through menus and editing commands, we strongly recommend that you familiarize yourself with the **ArbConnection** basics and concepts. It is a good idea to quit the program and spend some more time with this section of the manual. Point the mouse cursor to the File menu and click on the left mouse button. Move the mouse cursor to the Exit command and click on the left mouse button.

For New and Advanced Users

For the New User:
Learning to use **ArbConnection** is easy, intuitive and quick, even if you have never used similar programs before. After you have installed **ArbConnection** on your computer, please read the following paragraphs to learn how to find your way around **ArbConnection**'s menus.

Once you are familiar with the basics, you'll continue to learn about features, programming, and editing commands. If you can't find the answer to a question in this guide, call your distributor or the Tabor customer support service near you and we'll gladly assist you with your concerns.

For the Advanced User:
If you are already familiar with computer conventions and have basic knowledge of Windows programming, you may want to skip some of the following sections.

Icon Conventions Used in this Manual

The following icon conventions may appear in this manual:

NOTE

A Note contains information relating to the use of this product

CAUTION

A Caution contains information that should be followed to avoid personal damage to the instrument or the equipment connected to it.

WARNING

A Warning alerts you to a potential hazard. Failure to adhere to the statement in a WARNING message could result in personal injury.

The following symbol may appear on the product:

CAUTION: Refer to Accompanying Documents

This refers you to additional information contained in this manual. The corresponding information in the manual is similarly denoted.

Typographical Conventions Used in this Manual

This manual uses certain typographical conventions to make it easier for you to follow instructions. These conventions are as follows:

[Enter, or ↵] Press the Enter or Return key.

[Esc] Press the Escape key.

[Alt-F] Press the Alt key and the key that follows, simultaneously. In this example the key that follows is F.

[Ctrl-S] Press the Control key and the letter that follows, simultaneously. In this example, the key that follows is S. The control key also appears in the menus as a target sign.

[↑] [↓] [→] [←] Press the Arrow key with the symbol pointing in the direction specified (i.e., up, down, left, or right).

<+> Press the key for the character or word enclosed in angle brackets. In this example, the plus sign key.

New Looks - Skin Technology

This new technology was designed for the **ArbConnection** Virtual Panels. Change the way your panel looks as often as you would like—just a simple “click” and your customized program skin is all yours!

Virtual Panels

Using the virtual control panels, you can easily access all functions and features that control the instrument. These panels look and feel like real instruments, except functions and modes are grouped into logical panels that control specific modes of operations to simplify operation. For example, there are panels that control standard waveforms and their parameters, arbitrary waveforms and their parameters, trigger modes etc. The virtual space that is available on the computer screen makes it easy to tile more than one panel and view many functions at a glance, without having to scroll through front panel menus.

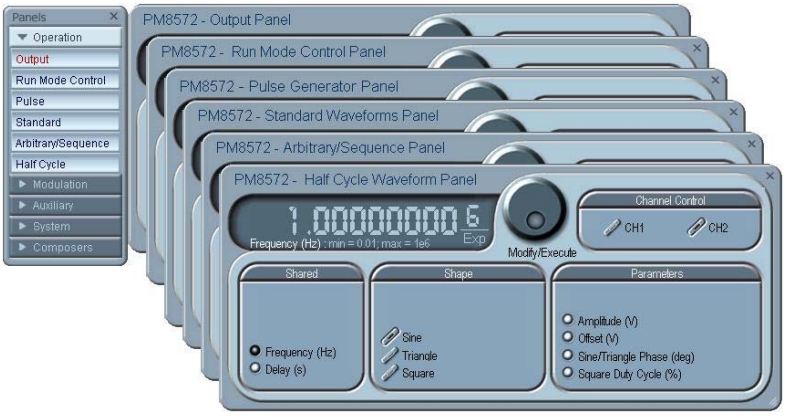

Figure 1-1: ArbConnection – The Virtual Control Panels

The Wave Composer

Use the Wave Composer to draw waveforms on the screen. Waveforms can be drawn in different ways with on-screen drafting tools such as: sketch and autoline. They can be formulated from fragments of a built-in library of common waveforms such as sine triangle etc. However, for accurate descriptions of waveform coordinates, you can use the equation editor to write equations that describe your waveform mathematically. Alternatively the equation editor can be used to perform mathematical functions on entire waveforms, for example creating a waveform that is the sum of two different waveforms.The Wave Composer separates the entire memory into smaller segments and loads segments with individual waveforms that were created on-screen. Waveforms can be stored in the memory for subsequent sessions. Similarly, waveform coordinates can be generated externally using Matlab, Excel, or any other text editor and converted by the Wave Composer to coordinates that can be downloaded to the instrument.

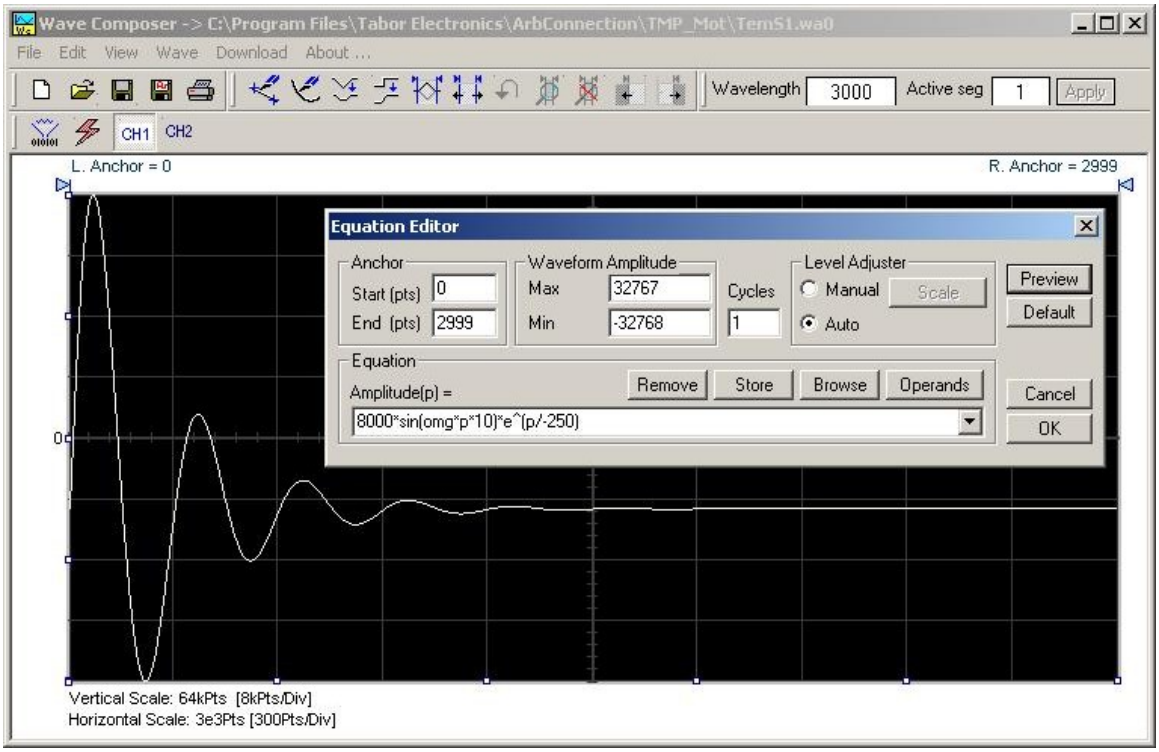

Figure 1-2: ArbConnection – The Wave Composer

The FM Composer

The FM wave composer generates and downloads arbitrary modulating waveforms, which can be very complex. Because the FM system works by modulating the frequency of the clock, you can generate very complicated waveforms, and then frequency modulate them with other arbitrary waveforms. The FM Composer looks and feels almost like the Waveform Composer with a major difference--these waveforms represent frequency changes and not amplitude changes. It's a powerful tool for controlling frequency agility by generating the agility curve as an arbitrary waveform. The resolution and accuracy of the modulated waveform is unsurpassed and can only be duplicated by mathematical simulation.

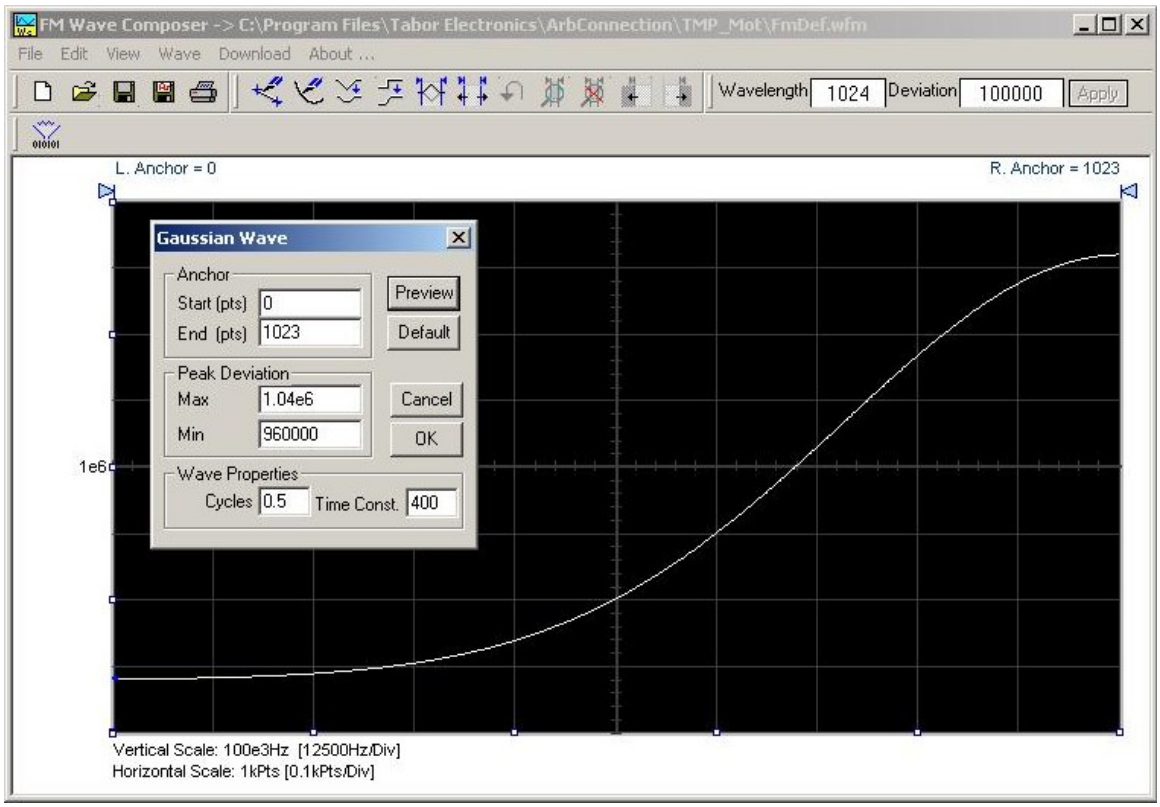

Figure 1-3: ArbConnection – The FM Wave Composer

The Pulse Composer

Generating complex pulse trains has never been easier. The Pulse Composer is a powerful tool that converts your Arbitrary Waveform Generator to a very sophisticated Pulse/Pattern Generator. It allows you to create pulses exactly as you would draw them on a blank piece of paper. Design your pulse using transition points or level intervals. Once designed, the pulse composer defines and distributes the pulse sections in different segments without user intervention and selects the appropriate function and mode that will best suit your pulse train requirements.

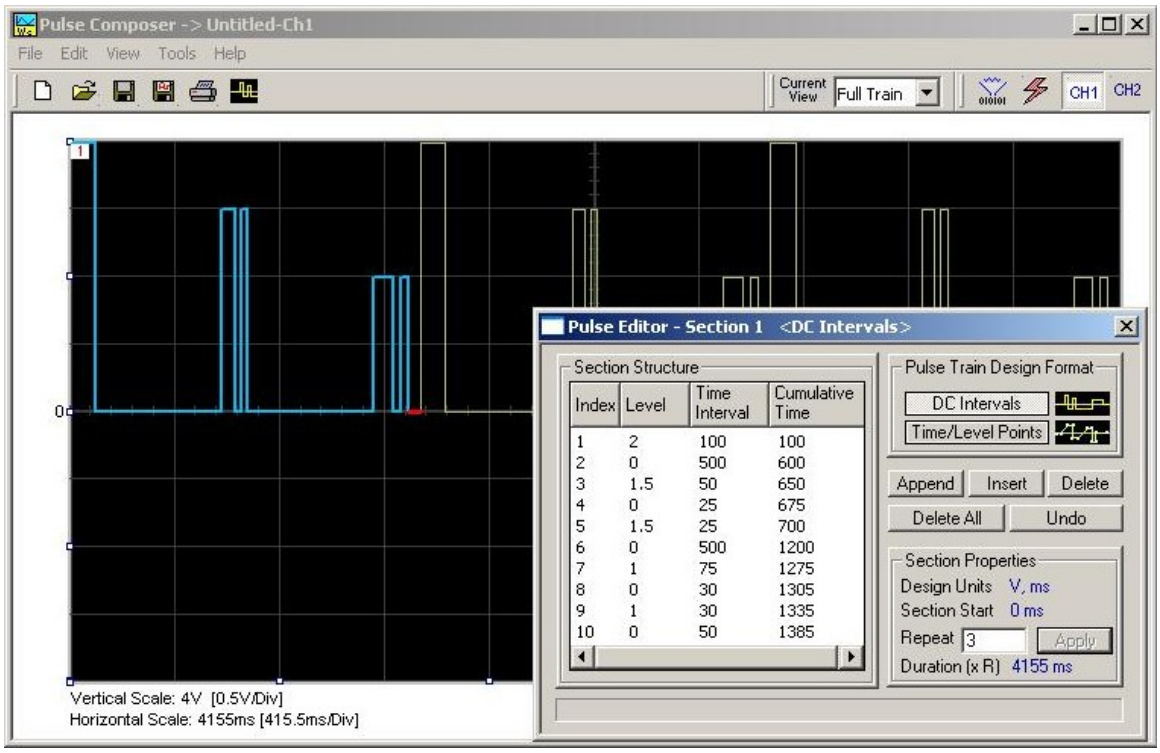

Figure 1-4: ArbConnection – The Pulse Composer

The 3D Composer

The 3D Composer is a unique and powerful tool for generating carrier waveforms (sinewaves) that have simultaneous variations of amplitude, frequency and phase. The profiles for each channel are drawn separately for each channel right on the screen and downloaded to the instrument as modulation profiles. Frequency and phase profiles are common to both channels, but each channel can be designed to output a unique amplitude pattern.

The Serial Data Composer

The Serial Data composer is a tool designed to easily generate and download serial data signals. Each channel can be easily programmed with 1 and 0 bits, the length of the signal and bit duration.

The Pattern Composer

The Patter Composer is a tool specially designed to generate complex digital patterns. Each bit can be separately filled with the variety of tools that are at the user's disposal. These tools help in generating complex digital patterns easily and quickly.

The Equation Editor

One of **ArbConnection**'s most powerful features, and probably the most useful, is the Equation Editor. The Equation Editor lets you write equations the same way as you would on a blank piece of paper. Just write it and **ArbConnection** processes the mathematical expressions and converts them into waveform coordinates displayed on the waveform screen. The Equation Editor detects and informs you of syntax errors and, with its self-adjusting feature, will automatically adjust parameters so that none of the points on your waveform exceeds maximum scale limits.

The Waveform Gallery

The Waveform Gallery is comprised of the most common waveforms usually required for most applications. Waveforms are added constantly to the pool, making it even easier for the user to develop applications from a known and demonstrated starting line. The Waveform Gallery supports an array of applications, including everything from standard sine waveforms to complex video signals.

The Waveform Studio

Having a large memory to store waveforms does not necessarily mean that you have to use the entire memory every time you download a waveform. The Waveform Studio is essentially the Sequence Generator Manager of the instrument. It allows you to either capture or upload waveforms into the various segments, displaying them on a small preview screen. These segments can be either used as individual arbitrary waveforms or replayed as part of the complete waveform, without losing valuable memory space and avoiding scarifying waveform coherences or integrity.

The Command Editor

ArbConnection also includes an editor for SCPI remote control commands. Using this, **ArbConnection** can be used as a controller for testing sequences of SCPI commands, which can then be used in applications such as ATE. Validate or test various commands using the Command Editor, to assure that commands or syntax used in your application will respond exactly the same way as it responds to the editor commands.

Info Tips

Computer screens are constantly improving resolution and intensity but unfortunately, as we age, our eyes do the opposite. When panels are tiled, they are resized to fit the screen and sometimes, the letters become difficult to read. Position your mouse on the controls and parameters and an Info Tip turns on, showing the control name and, in some cases, current parameter setting and range.

Resizing of Virtual Panels

Panels can be adjusted to fit different screen resolutions and sizes. Use smallest, normal or largest panel setting for optimum viewing or pull down on the skirt to select intermediate sizes. Just like any other Windows program, you can tile or cascade panels if you have more than one panel open on the screen. Add or remove panels as you program the instrument with a “click.”

Save Configuration, Load and Update Instrument.

Saving your work at the end of the session will store all front panel settings for subsequent use or for a different test setup. Front panel parameters and waveform coordinates are saved in a familiar format, which can be edited and adjusted with an external text editor. Save as many settings as you need and use the Update Front Panel feature in **ArbConnection** to download the required test configuration to the instrument registers.

Logging ArbConnection History

ArbConnection commands are logged automatically in a log file, enabling programmers to validate remote interface programming by sending commands to the instrument from the virtual panels and then evaluating the way the commands are executed. The commands can be saved in a text file and used in external applications, exactly as **ArbConnection** used them.

Multi-Instrument Synchronization Center

Need to synchronize multiple channels? **ArbConnection** does it all for you, including setting up the master and slave units for their functions in the system. The interface is clear and easy to set up. **ArbConnection** will even set phase offsets between channels for you, without the hassle of programming individual instruments.

Interfaces

Uniformity is important for a line of products that shares functionality but not platforms, so **ArbConnection** utilizes every interface supported by **Tabor**. These include: GPIB, RS232, USB, LAN PCI, PXI and VXI. LAN and USB are evolving as the industry standards of the future and therefore, not only **ArbConnection**, but also all future **Tabor** products will be equipped with these interfaces.

Applications

For expert technical assistance with your specific needs and objectives, contact your local sales representative or our in-house applications engineers. Our international team is always available to help you.

Complimentary Free-of-Charge Solution

Every instrument comes equipped with a dedicated copy of the **ArbConnection** software. However, if your copy is lost or outdated, simply log on to the **Tabor Electronics** Download Center and get the latest version “in a click”. It can be used to access the controls to various parameters and modes and the Waveform Composers will assist you in creation of arbitrary waveforms, modulated waveforms and complex pulses. The program can also be used offline as a demonstration or learning tool before new users write their own interfaces. ***Either way, ArbConnection is a “must have” for programmers and sales personnel. It is easy to use, intuitive and feels as if you are operating a real instrument from your computer screen.***

Product Demonstrations

For your convenience, if you want to evaluate the software before purchasing the instrument, feel free to download a demo version of the **ArbConnection** to use as a real-time, hands-on demonstration.

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Installation

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What's in This Chapter

This chapter contains detailed instructions on how to install your **ArbConnection** software.

How to Install ArbConnection

1. Choose the **ArbConnection 4.3** option from the menu on the left, as shown in Figure 1.
2. An Installation Wizard welcome screen will appear. Click "next" on the bottom of the screen to continue. (Figure 2-2)

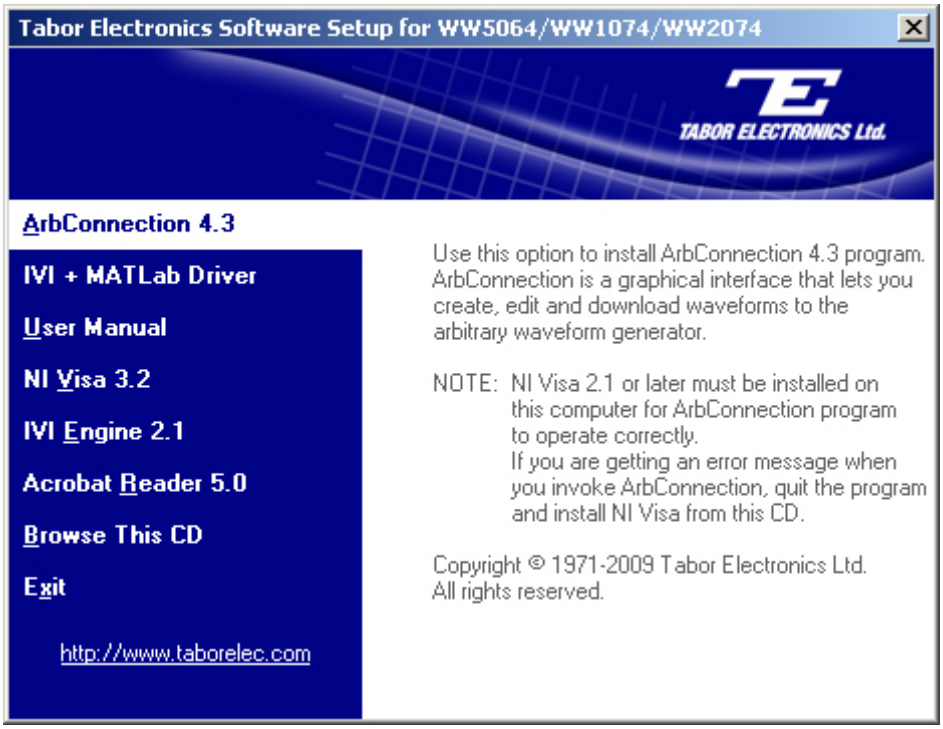

Figure 2-1: Choose ArbConnection Option

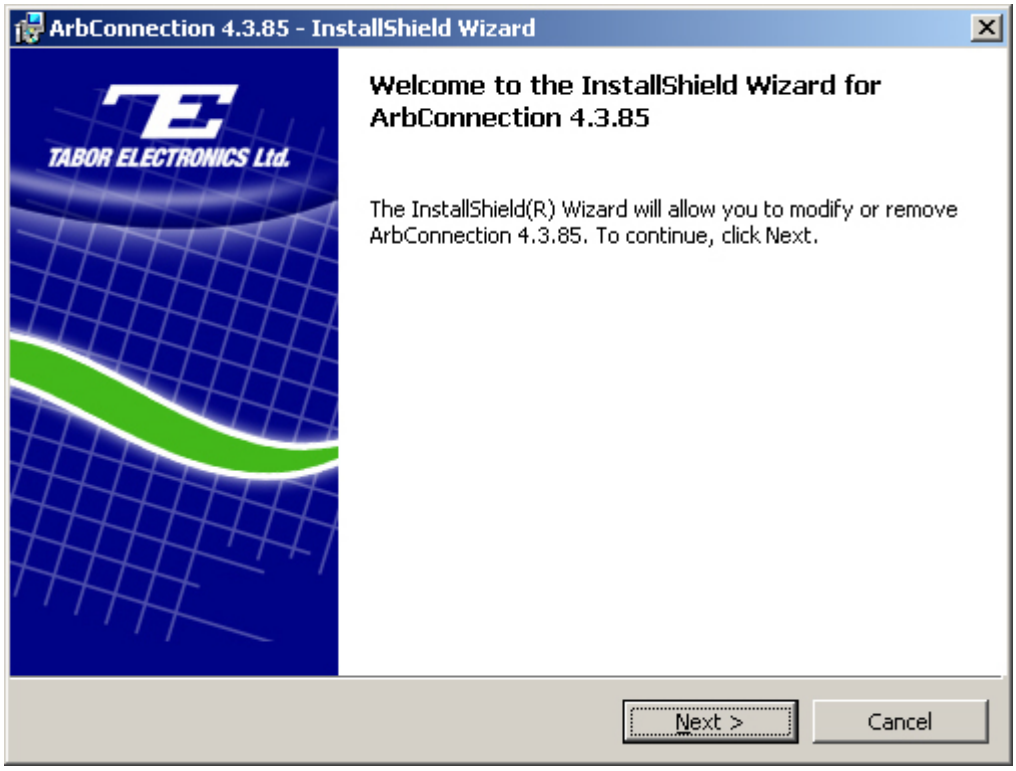

Figure 2-2: Installation Wizard Entry Screen

3. Setup will then begin. Please wait while the Wizard is installed on your computer, as you can see in Figures 2-2 and 2-3.
4. When setup is complete, you will be asked to enter your name and the name of your company or organization. You then have the option of limiting software usage to only one user, or allowing access to all users, as shown in Figure 2-4.

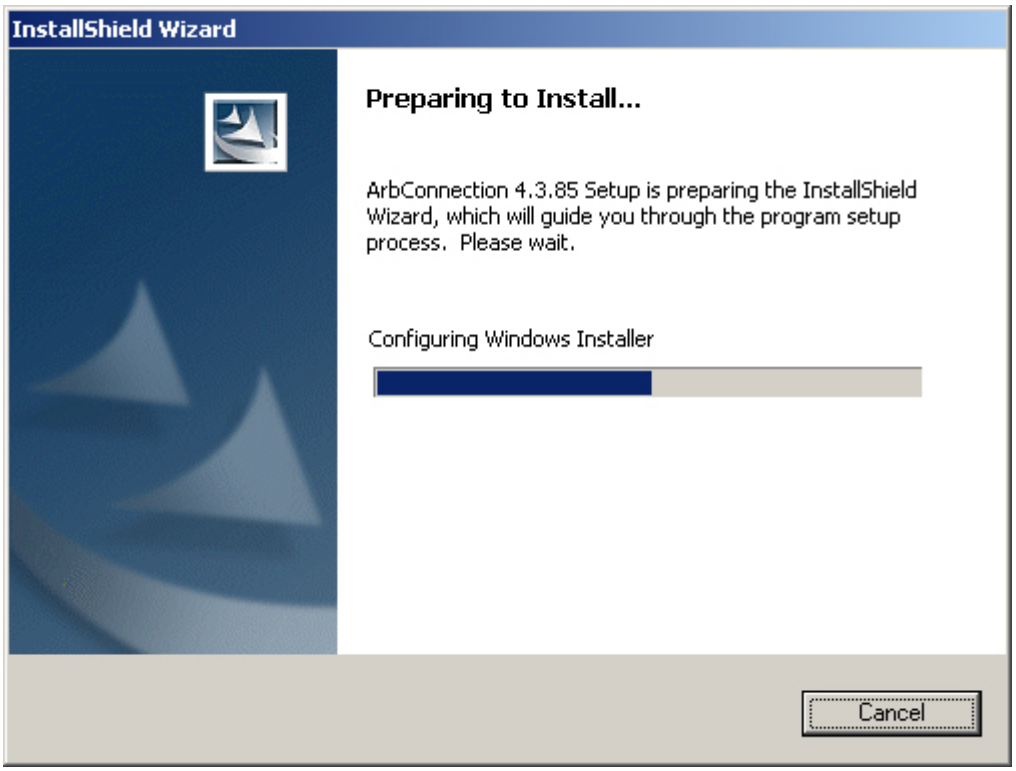

Figure 2-3: Automatic Configuration of ArbConnection Installation Wizard

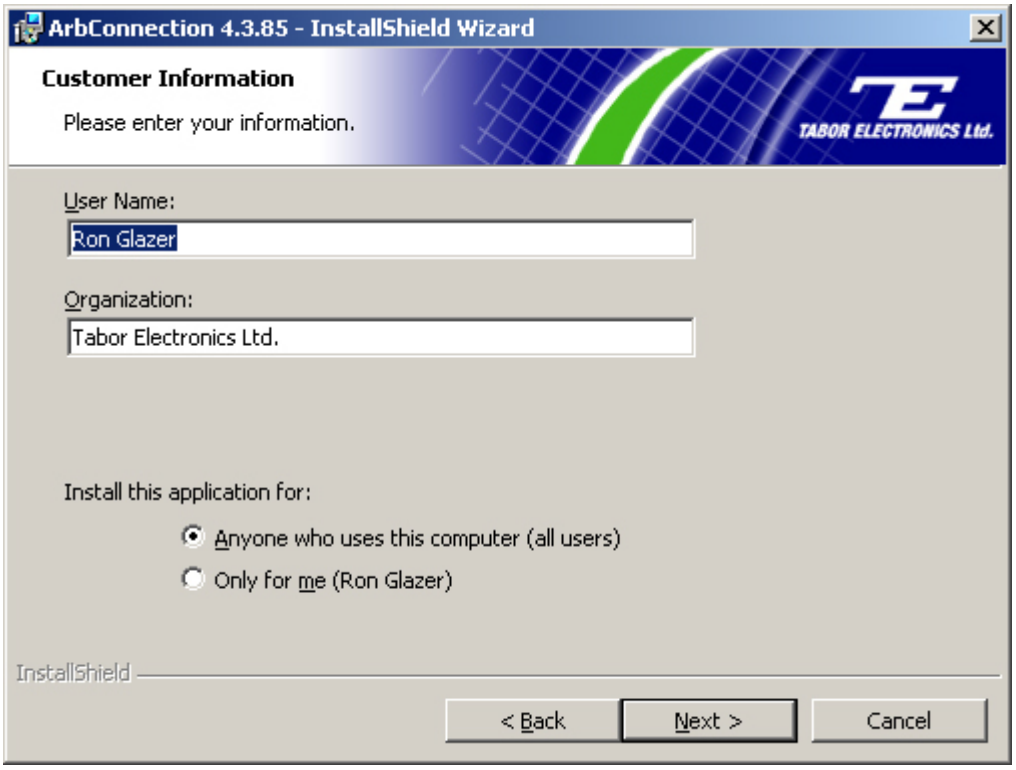

Figure 2-4: Enter Customer Information

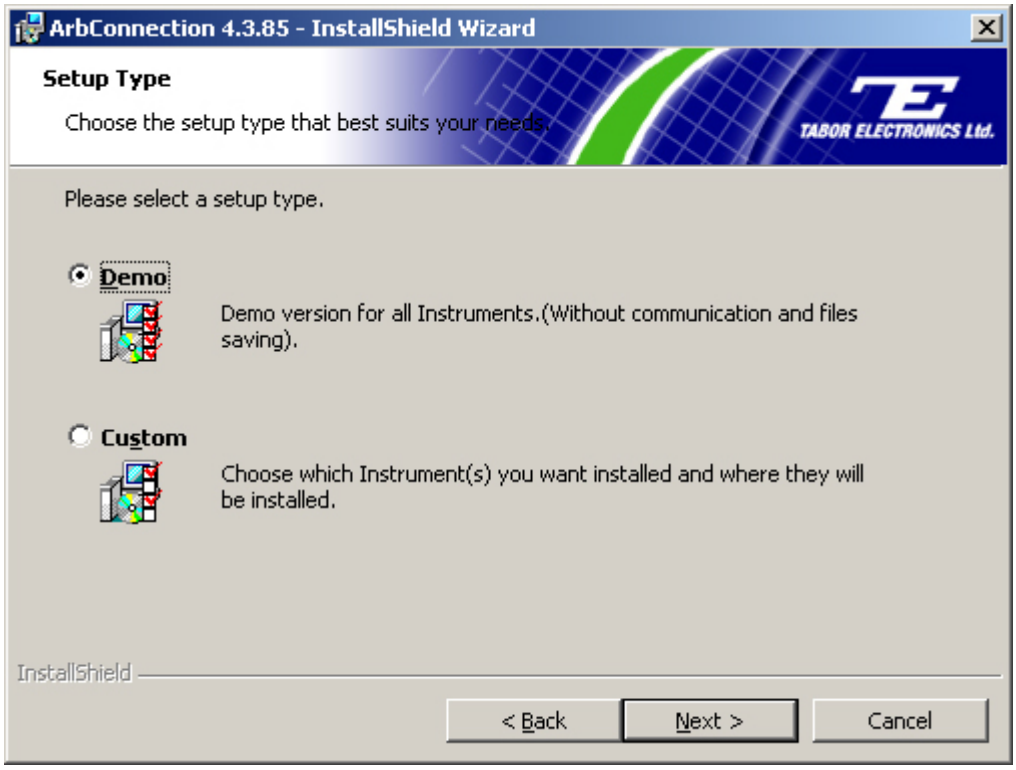

Figure 2-5: Demo Setup Selected

5. Choose either “Demo” or “Custom” installation (Figure 2-5). Choose “Demo” if you would like to learn more about the “look, touch and feel” of **ArbConnection** before actual usage. This option does not include communication with your waveform generator or saving any new files created.

6. Choose “Custom” (Figure 2-6) if you are ready to start working with your new software. This option takes you to a screen where you choose which instrument(s) you would like to install.

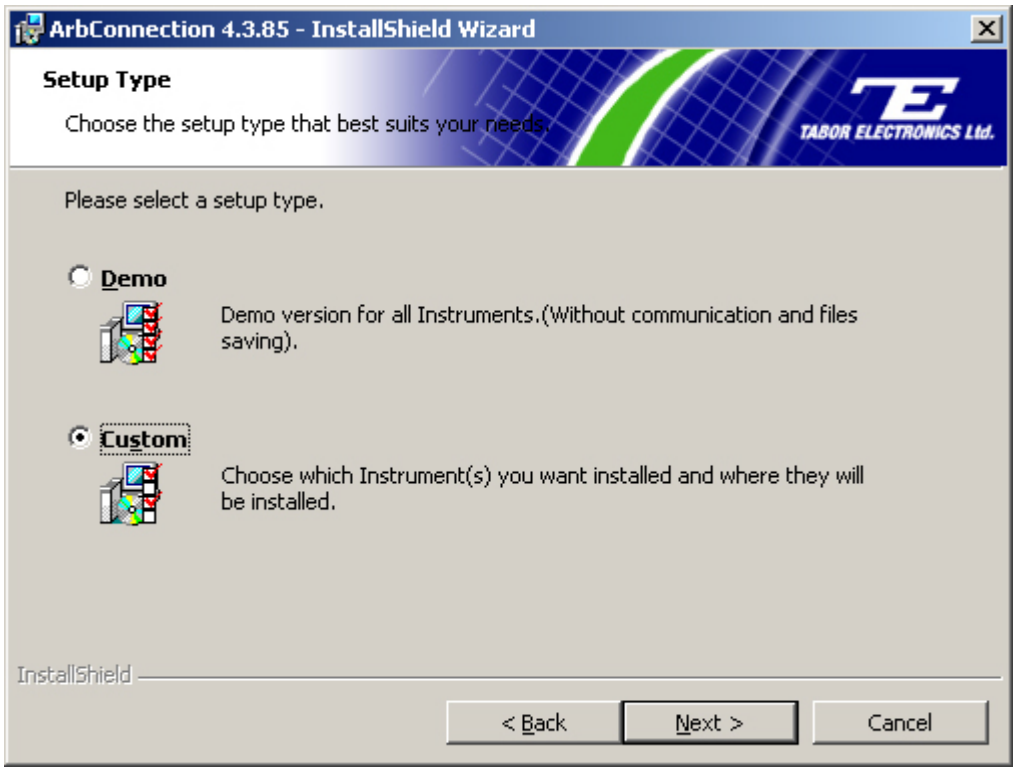

Figure 2-6: Custom Setup Selected

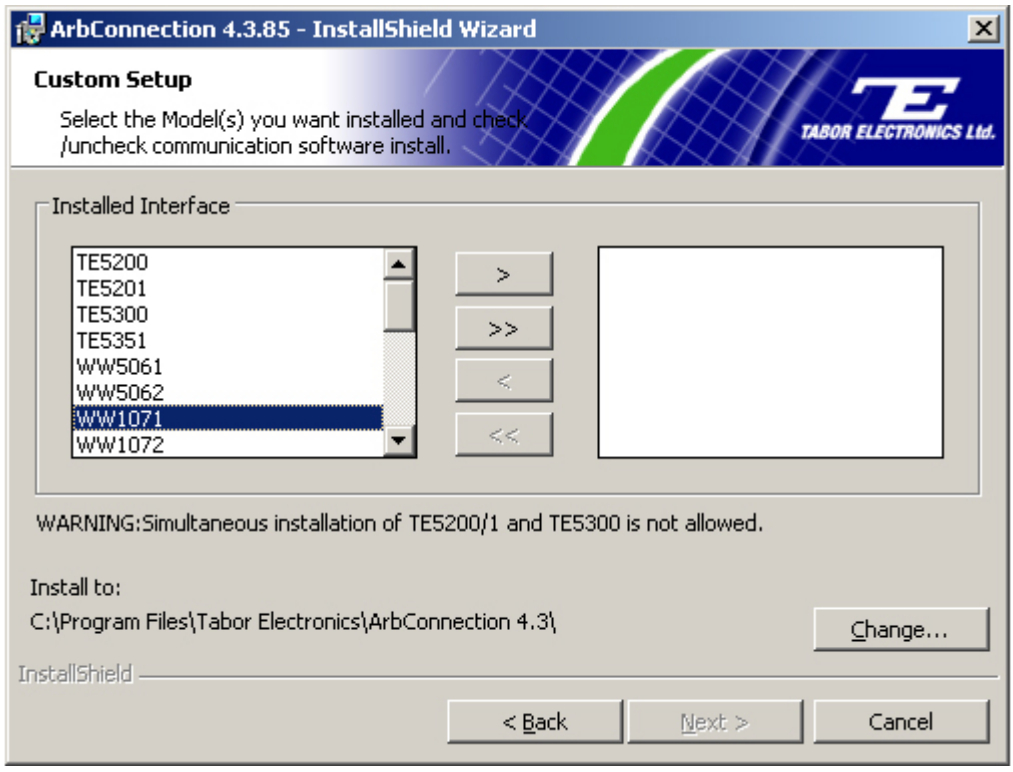

Figure 2-7: Installed Interface Chosen and Selected

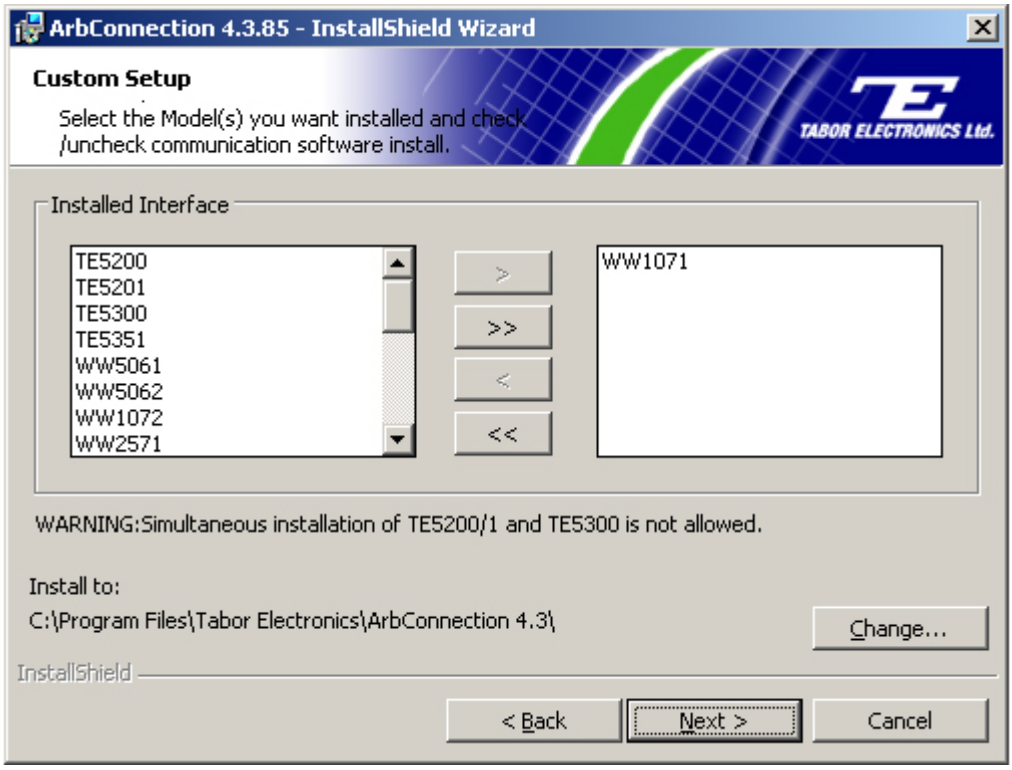

Figure 2-8: Installed Interface Chosen and Clicked on

7. Select the model(s) you want installed and where you would like them installed (Figures 2-7 and 2-8).

8. At this point you can opt to change the destination folder by browsing until you find the correct location. Click on “ok” and your **ArbConnection** software will finish the installation process. (Figure 2-9)

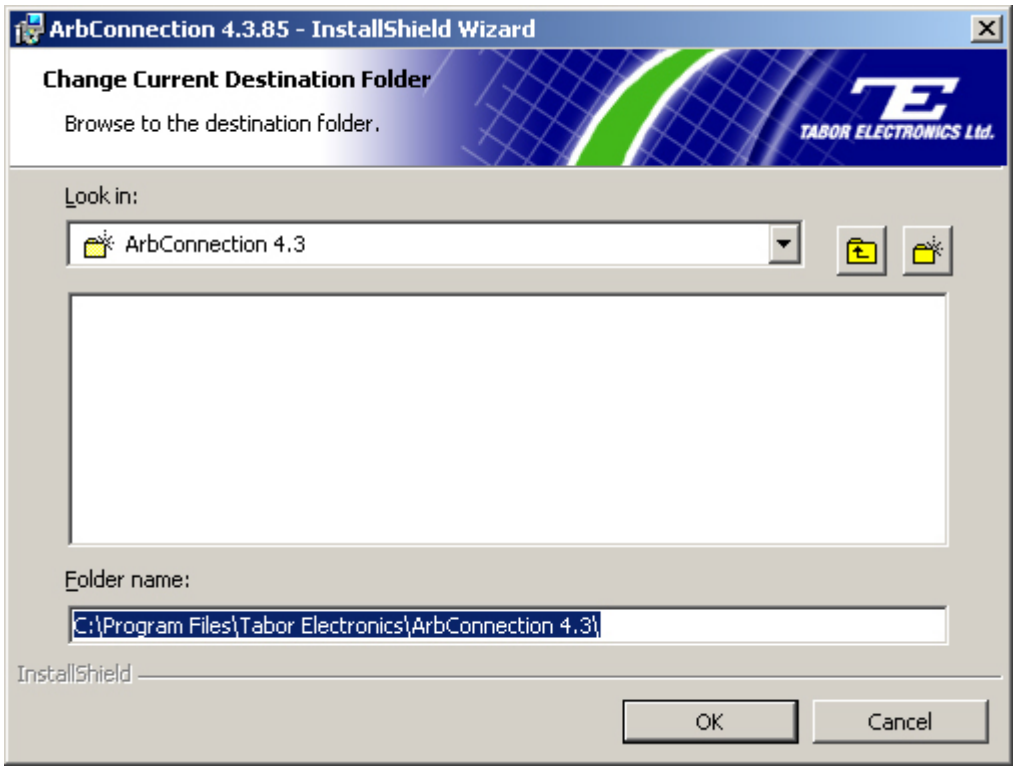

Figure 2-9: Select Alternative Destination Folder

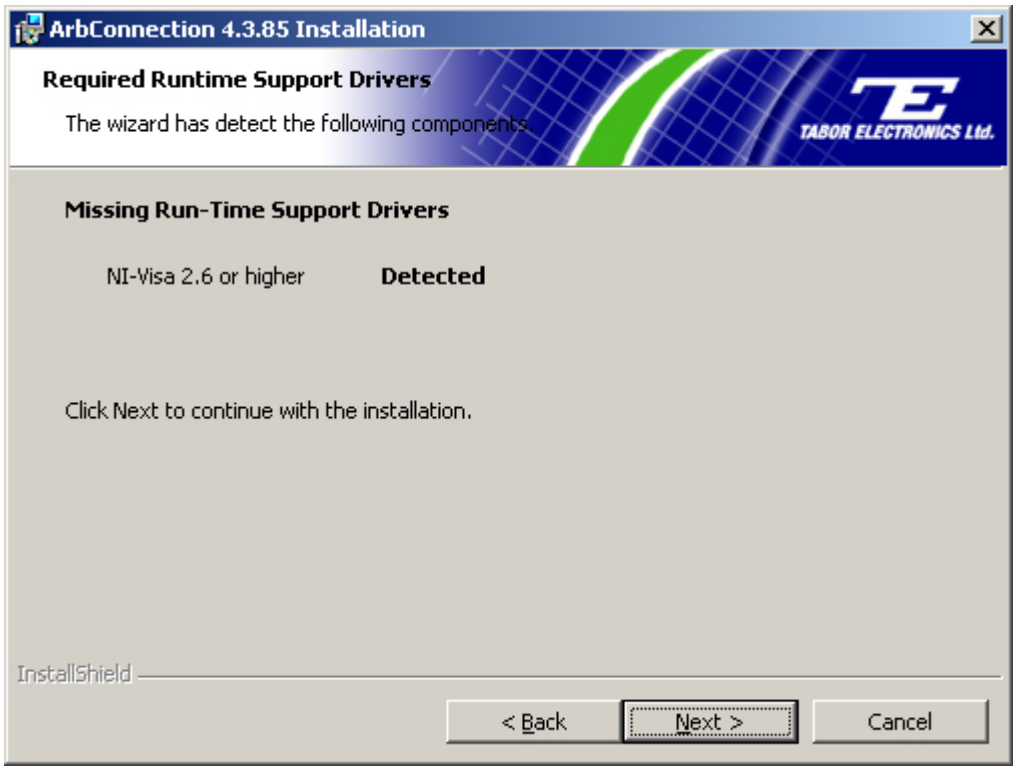

Figure 2-10: Missing Drivers Detected

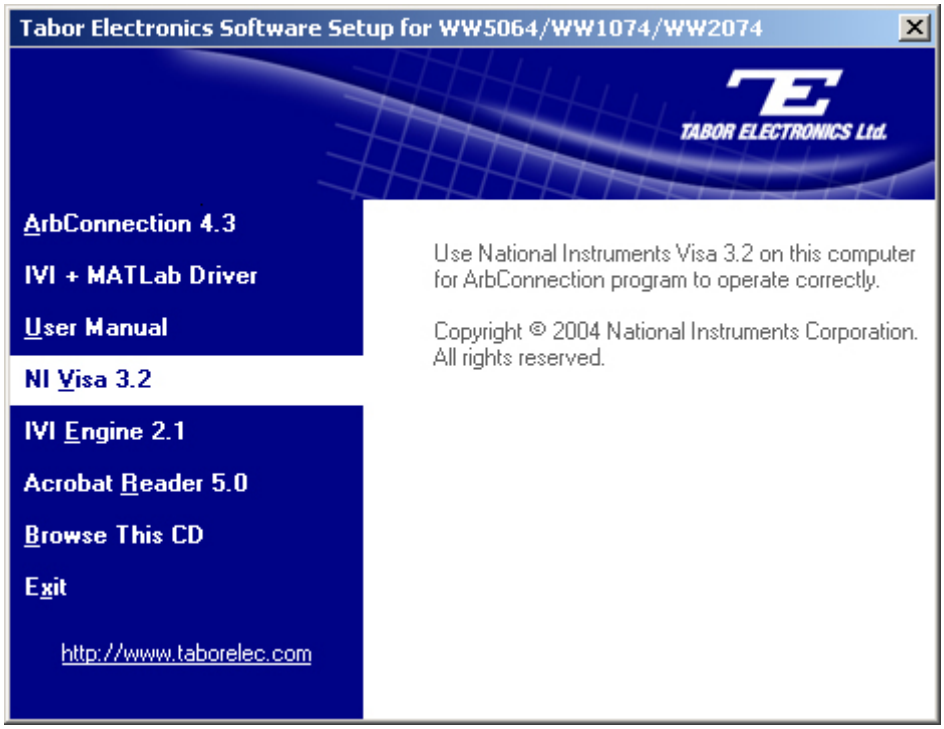

Figure 2-11: Missing Drivers Selected for Download

9. In some cases, the wizard will detect missing drivers, which are necessary for installation. (see Figure 2-10) Click on "next" and select the missing driver from the list on the left, in this case, NI VISA 3.2 (Figure 2-11).

10. Click on the install button to begin the installation. (Figure 2-12) and your program will complete the installation. (Figures 2-13 and 2-14)

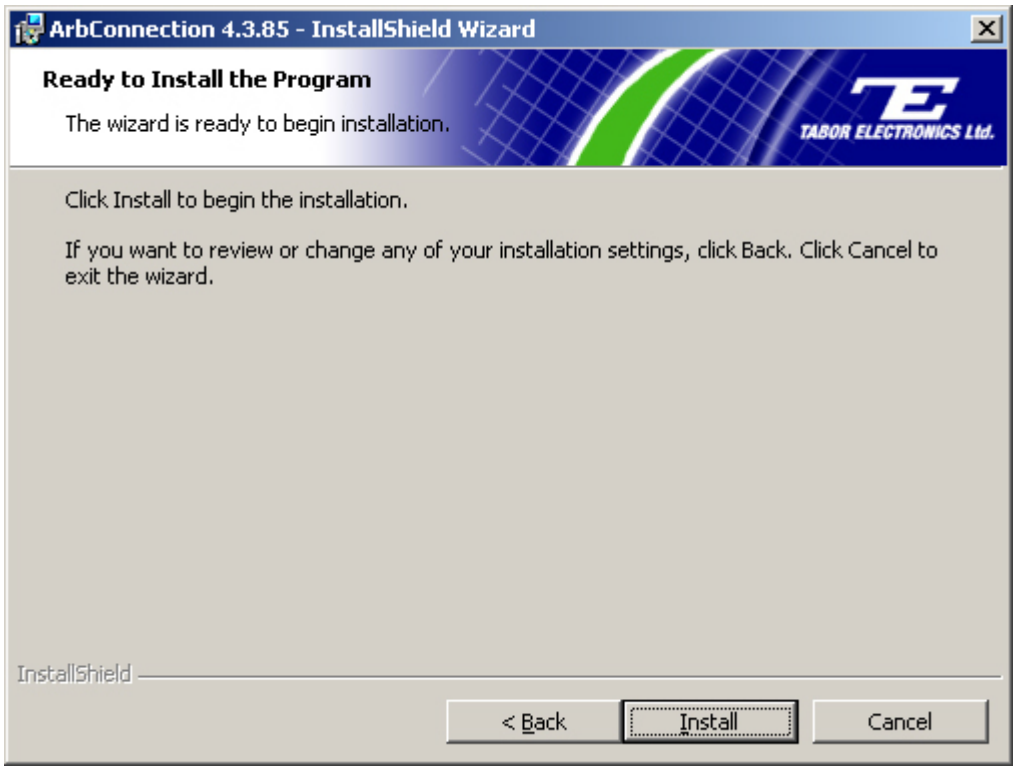

Figure 2-12: Ready to Install the Program

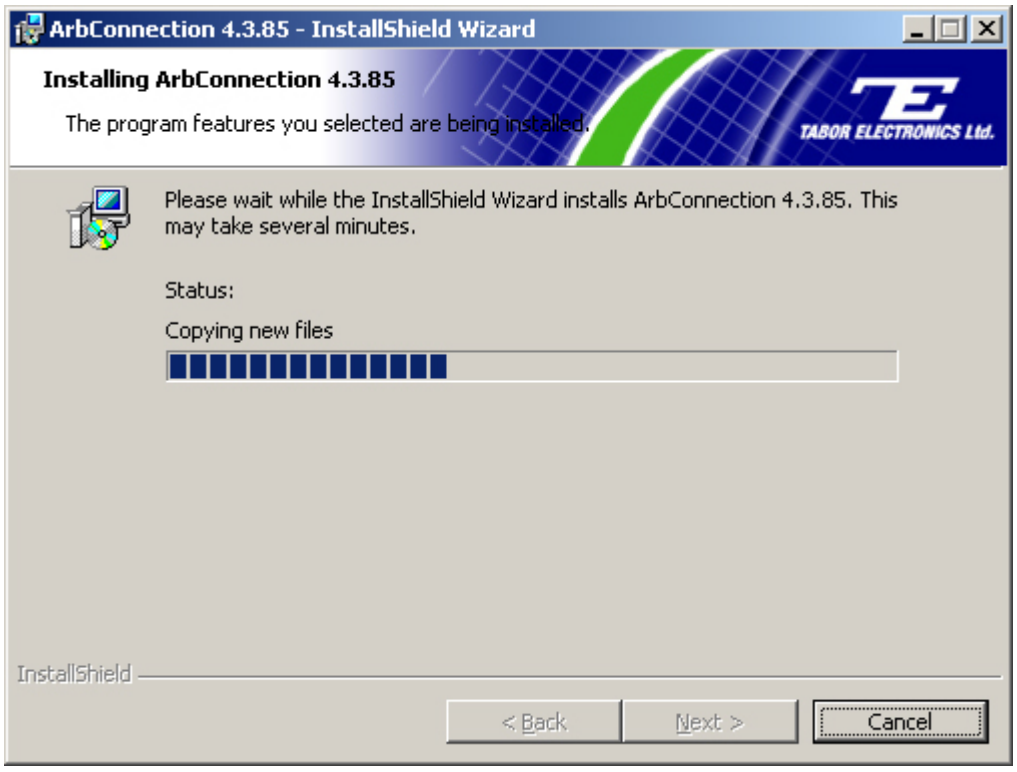

Figure 2-13: Installing ArbConnection

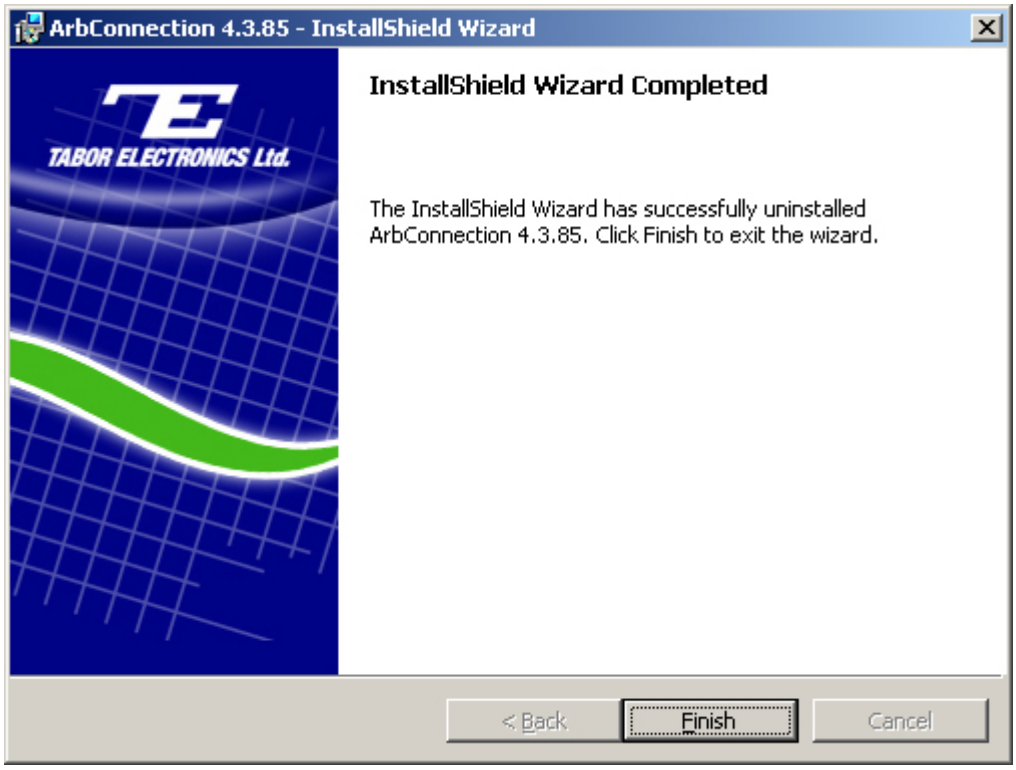

Figure 2-14: Your installation is completed

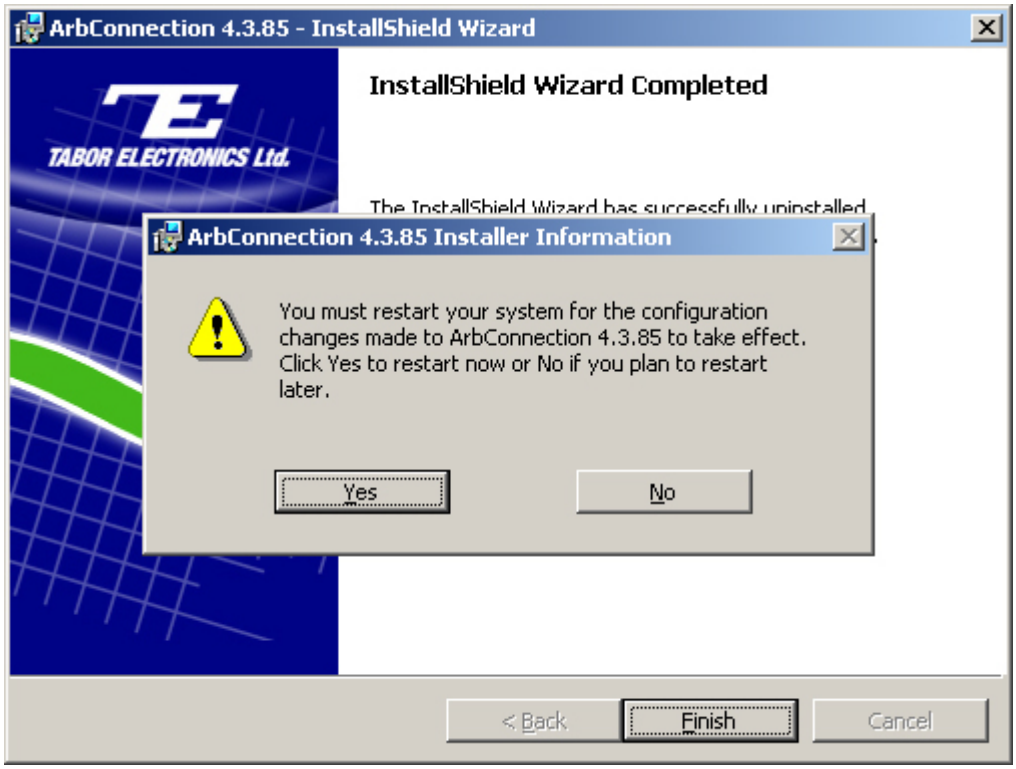

Figure 2-15: Installation Completed: Choose to Restart Now or Not

11. Your computer must be restarted for **ArbConnection** configuration changes to take place. Choose “yes” or “no” (Figure 2-15) and then click on “finish”.

Removing ArbConnection Software

Should you wish to uninstall your **ArbConnection** software, please do the following:

1. Go to “Add or Remove Programs” on the Control Panel of your PC and select “ArbConnection 4.3” as shown in Figure 2-16.
2. Click on “remove”
3. In the Program Maintenance screen, select “Remove” as shown in Figure 2-17, and then click on “next”.
4. If you are sure you want to continue, click on “remove” and your ArbConnection will be permanently removed. Please see Figures 2-18 to 2-20 to view the rest of the removal process.

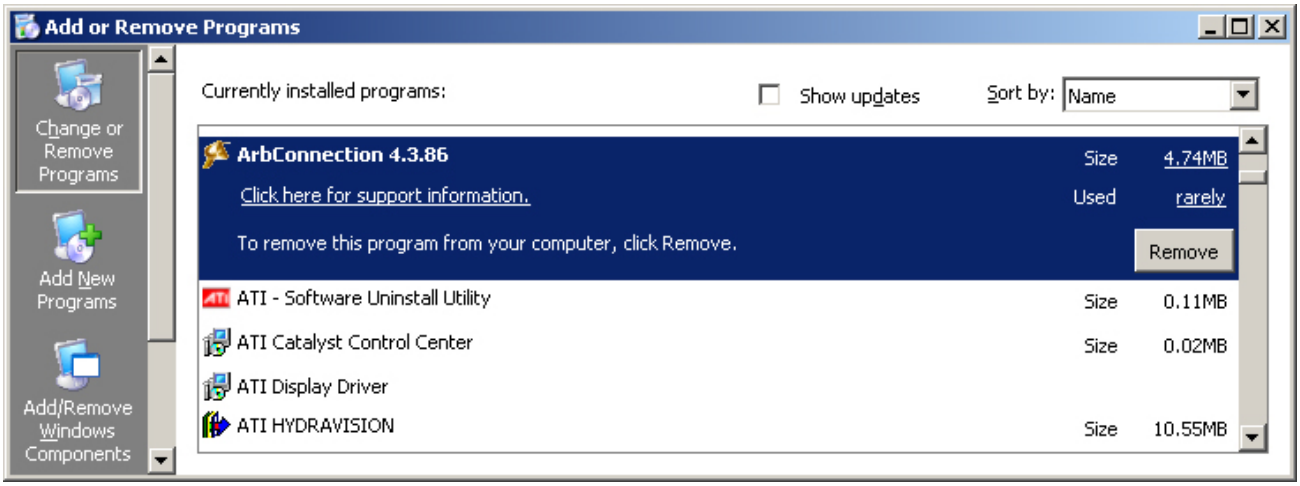

Figure 2-16: Removing ArbConnection Software

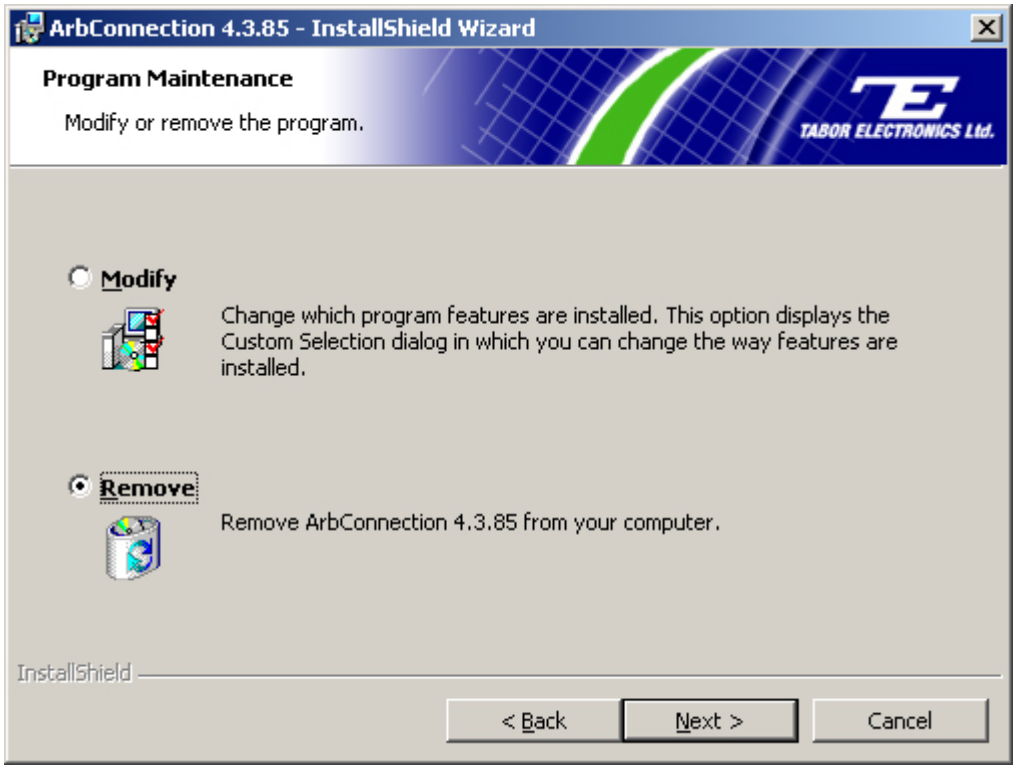

Figure 2-17: Removing ArbConnection Software

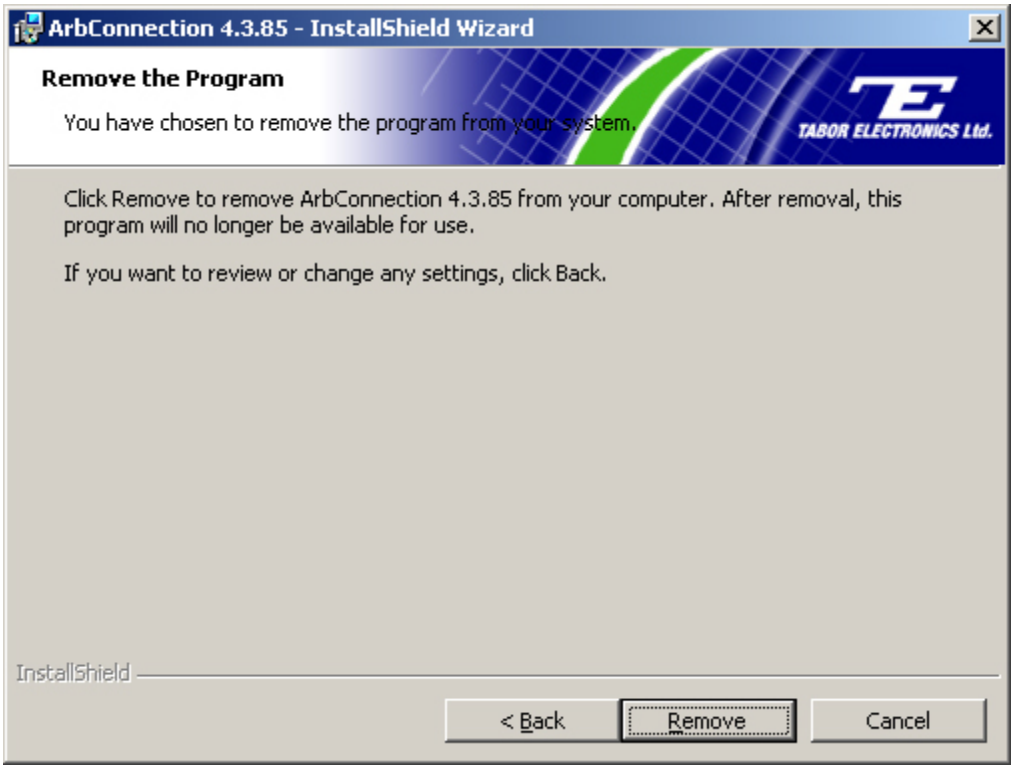

Figure 2-18: Removing ArbConnection Software

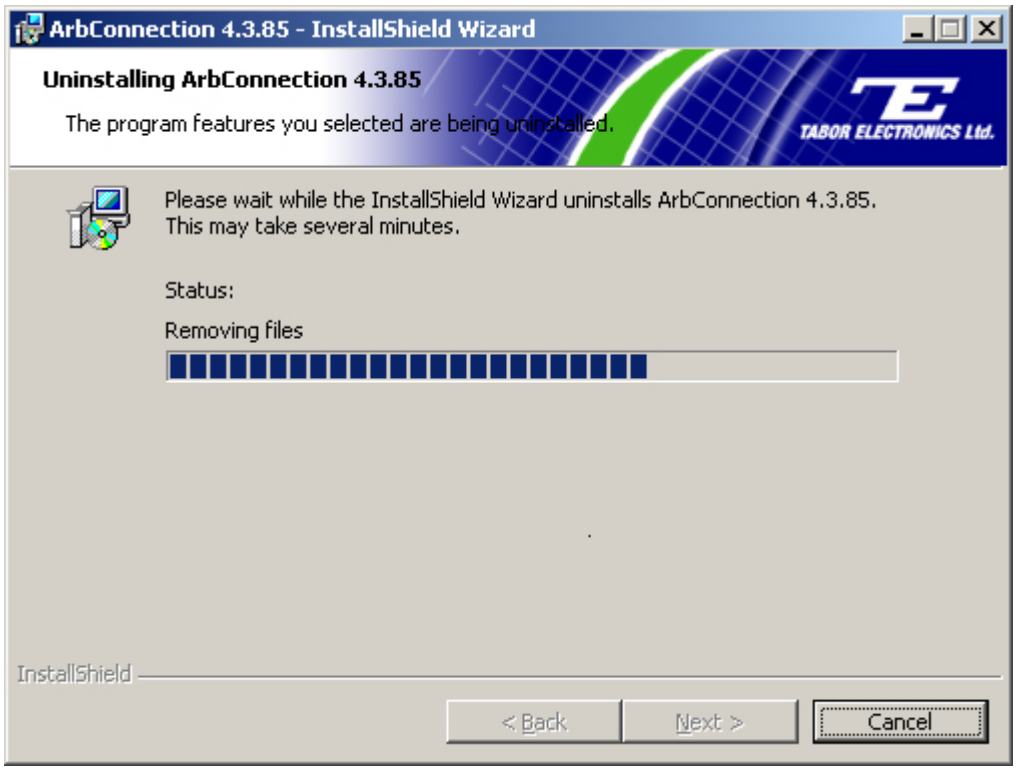

Figure 2-19: Removing ArbConnection Software

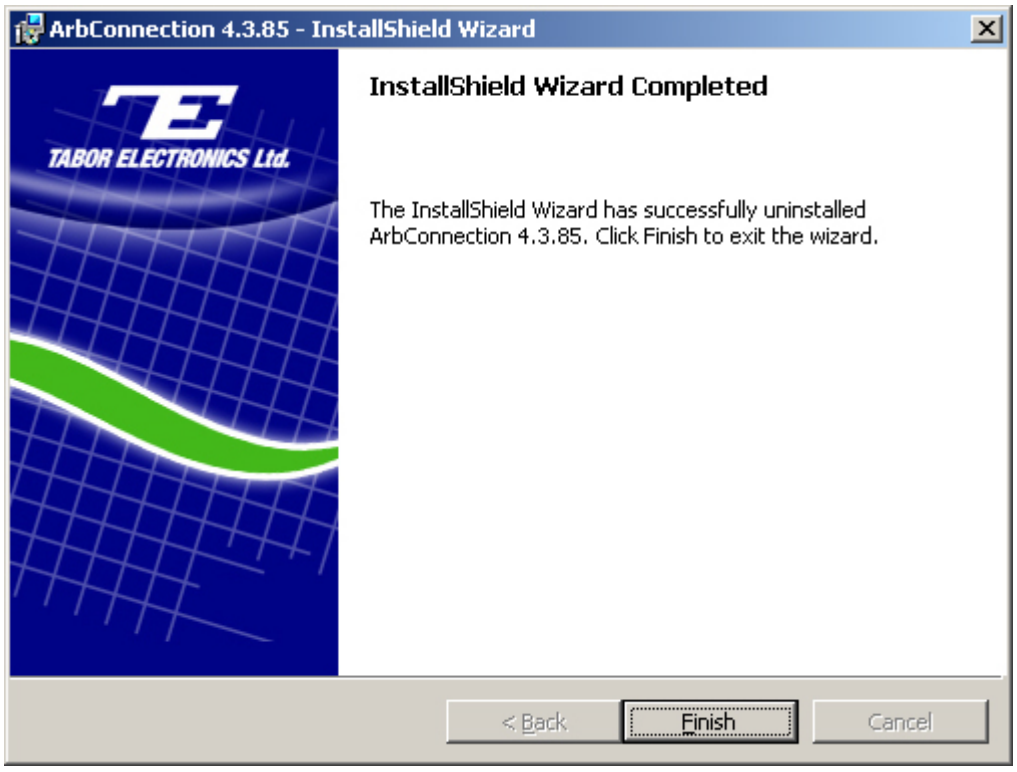

Figure 2-20: Removing ArbConnection Software

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Chapter 3
Using the Software

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The Opening Screen

Invoke **ArbConnection** by double clicking on the icon. If you cannot find the icon on your desktop, click on Start> Programs>Tabor Electronics->Arbconnection4.3->**ArbConnection**. The opening screen will show. If you installed the program correctly, your screen should look as shown in Figure 3-1.

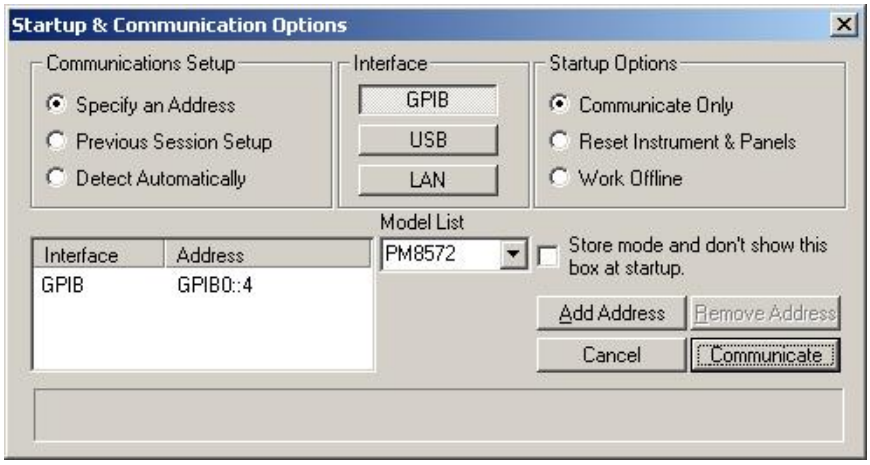

Figure 3-1: Startup & Communication Options

The Startup & Communication Options dialog box is displayed. You can check the "Store mode and don't show…" so next time you invoke **ArbConnection**, this dialog box will not be displayed. The purpose of this dialog box is to update the program to the way you intend to use it. For example, if you are using a GPIB device that has address 4, you can click on the "Specify an Address" option and type in the required address, so the next time you use **ArbConnection**, the program will automatically resume communication with the same address as was originally detected.

If you chose to hide this dialog box, you can still access and change the options from the System command, at the top of the screen.

Make your selection and click OK. The Startup & Communication Options dialog box will be removed from the screen. The Main panel will now be accessible, but before going into panel operation, please look at the toolbars at the left top of the screen, as shown in Figure 3-2.

Figure 3-2: ArbConnection's Toolbars

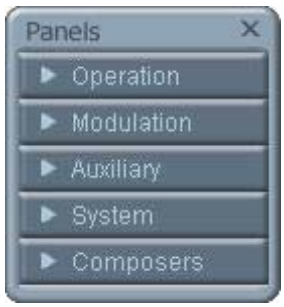

Figure 3-2a: Panels Toolbar

The standard **Windows Menu Bar** is the top bar. It provides access to main system controls like saving files, and viewing or removal of screen images.

The second bar is called **Link** bar. It provides direct access to different instruments that are active on the active interface bus. **ArbConnection** can control a number of waveform generator units simultaneously. If the instruments were connected to the interface while invoking **ArbConnection**, they will automatically be detected by the program and will be placed in the Link pull-down window. The active instrument is displayed with its associated address. If you run **ArbConnection** in offline mode, the Link bar will show your waveform generator unit, Offline.

The **Panels** toolbar, as shown in Figure 3-2a, provides direct access to instrument control panels. The individual control panels are explained later in this chapter. The Main, Standard, Arbitrary, Trigger and the other buttons will bring up to the screen panels that are associated with these names. The Composers button provides access to the Waveform, Pulse, FM, Serial Data, Pattern and 3D composers. The first time you launch **ArbConnection**, the opening screen will have the Main panel open. Click on other buttons and interactively get the feel of how **ArbConnection** opens and closes control panels.

ArbConnection Features

ArbConnection's main purpose is controlling waveform generators' functions and parameters. Your **Tabor Waveform Generator** can generate standard waveforms from a built-in library, arbitrary waveforms from user-downloaded coordinates, modulated waveforms, digital patterns and much more. The only way to access all of these features is through software utilities such as Plug & Play drivers, and soft front panels. **ArbConnection** is designed to provide complete control over your waveform generator unit.

ArbConnection has four main screens: control panels, waveform composers and various utility control panels. The various screen images along with instructions how to access and use them are described below in detail.

The Control Panels

The control panels look and feel just as if you would operate an instrument from its front panel. They even look like instrument front panels, so operating functions and changing parameters is easy and intuitive. Please look at the first panel that is featured at the opening screen. This panel, as shown in Figure 3-3 (below), is called the Main Panel.

To begin with, let's explore the panel controls to see how they feel, react and what they do. All other panels share almost the same feel, so the description of how to operate the Main Panel can serve as a general guide for controlling the rest of the panels.

Looking at the panel, you can identify the following controls: Push buttons, LED's, radio buttons, Dial and Digital display. The function of each control is described below.

Push Buttons – These are used for toggling a function on and off. For example, the Output Enable button in the Output group toggles the output on and off. The first mouse click will push the button inwards and will turn on a red bar at the center of the button, indicating that the function is on. The second mouse click will turn the function off.

Radio Buttons – Are used for changing operating modes, or selecting between mode options. One of the radio buttons is always on with a dark dot in its center, indicating its state condition.

LEDs – The LEDs indicate which of the parameters are displayed on the Digital Display. Dark LED indicates that the parameter name next to this LED is selected. Only one LED can be ON at a time.

HINT

LED's are turned on by clicking on the LED or the text next to it. The selected parameter is flagged by a darker LED shade.

Dial – Use the dial to modify displayed reading. To use the dial, press and hold the mouse cursor on the dial and move the mouse in a clockwise circle to increase the number, or counterclockwise circle to decrease the displayed number. The dial modifies digits at the cursor position and will allow modification within the legal range of the displayed parameter. If you reach the end of the range, the dial will have no further effect on the display. If you do not want to use the dial, you can still change the display reading by using the [↑], or [↓] keys, or simply type the required number using the standard keyboard features.

NOTE

After you change the displayed readout, the unit will be updated with the new parameter only after you press the Execute button.

Digital Display – The display is used for displaying and reading various waveform generator parameters, just as you would use it on your instrument.

Note

The normal color of the digital reading is dark blue. If you modify the reading, the color changes to a lighter shade of blue, indicating that the waveform generator

has not yet been updated with the new parameter. Pressing "Execute" will update the instrument and restore the color of the digital readout to dark blue, indicating that the displayed value is the same as the generator setting.

Also note that the digital readout has an auto-detect mechanism for the maximum and minimum limits. You cannot exceed the limits if you are using the dial, but only if you use the keypad. In case you go beyond the limits, the program will not let you download an illegal parameter and you'll be requested to correct your settings.

The Operation Panels

Figure 3-2b: Operation Panels

The Operation tab provides access to a group of panels that control the basic operation of the generator. From this group you can set the output function, run mode, turn the outputs on and off and adjust the parameters for the various functions. There are six panels in this group: Output, Run Mode, Pulse, Standard, Arbitrary/Sequence and Half Cycle. The Output panel is always visible because this is the panel that controls operating functions, run modes and sets the outputs on and off. The other panels can be made visible by clicking on the appropriate tab in the Operation group. The Operation set of panels is described below.

Output

The Output Panel, as shown in Figure 3-3, is the first panel you see after invoking **ArbConnection**. Notice how buttons and LEDs are grouped; this is done specifically so that common parameters are placed in functional groups. The Main Panel groups allow (from left to right) adjustment of amplitude and offset, selection of waveform mode, selection of run mode and control over SYNC and Main output parameters. Controls, where applicable, are provided for each channel separately.

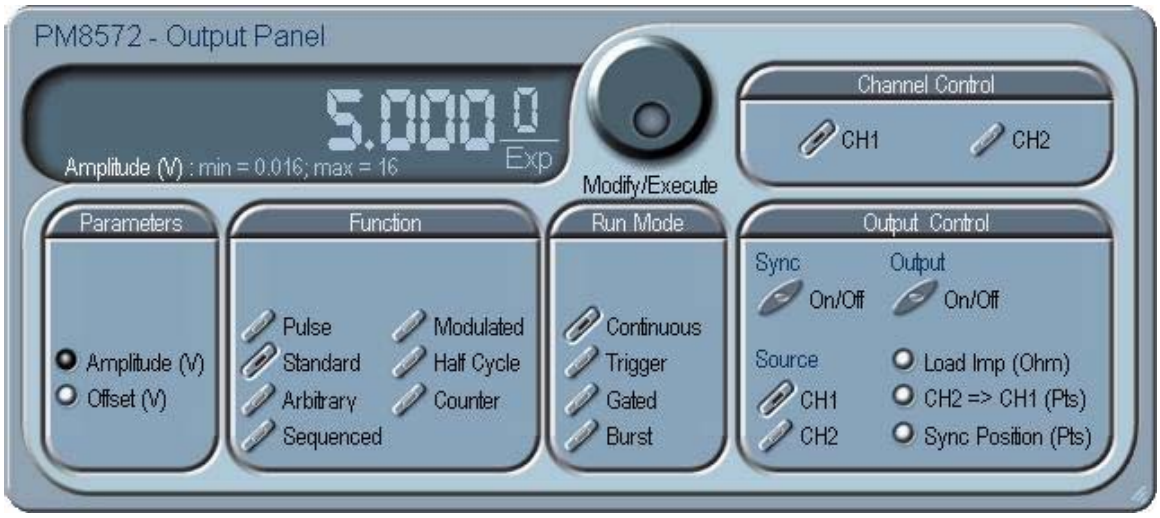

Figure 3-3: Output Panel

If you are properly connected to a PC and **ArbConnection** has detected your instrument, then every time you press a button, you are getting an immediate action on the waveform generator. It is different if you are changing parameters on the display. Doing this, you'll have to press the "Execute" button for the command to update the instrument. The functional groups in the Main Panel are explained below.

Channel Control

The Channel Control group has two buttons: CH1 and CH2. These buttons determine which of the channels is currently active. The active channel will be sensitive to changes that are made on the Output panel, while the other channel remains passive. Note however, that Function and Run Mode parameters are common for both channels and therefore, every time you change one of the functions or run modes, expect that the other channel will be updated accordingly.

Parameters

The Parameters group contains two parameters: Amplitude and Offset. The values that are exhibited in this group might be duplicated on other panels, so every time you change amplitude and offset in the Parameters group, the other panels are updated automatically. When you program a specific parameter, make sure that the appropriate channel is selected in the channel control group.

To access the required parameter, click on the parameter name. The LED next to the required parameter turns on. The value that is associated with the lit LED is displayed on the digital display. You can use the dial, keyboard, or the [↑] [↓} keys to adjust the readout to the required setting. After you modify the reading, press Execute to update the waveform generator with the new reading.

Function
The Function group is used for selecting between function types. The waveform generator provides seven types of waveforms: Pulse, Standard, Arbitrary, Sequenced, Modulated Half Cycle and Counter/Timer. By pressing one of these buttons output waveform will change to the selected option. The default function type is Pulse. If you want to change the pulse waveform parameters, you can select Pulse from the Panels bar.

Run Mode
The Run Mode group is used for selecting the active run mode for the instrument. You can select between continuous, triggered, gated and burst modes. There is no additional panel associated with the continuous mode, but if you press one of the other run mode options, you'll be able to adjust the trigger parameters from the Run Mode Panel.

Output Control
The Output Control group controls the state of the main outputs and the state of the SYNC output. Click on the State buttons to toggle the outputs on and off.

From this group you also control the position of the SYNC pulse and the source of the sync. If you select the SYNC source to come from channel 1, the waveform that is generated at the CH1 output connector will be synchronized with the rising edge of the SYNC output pulse. Selecting the SYNC source as CH2, transfers the synchronization to the second channel. Note that you'll notice the difference only if you have different waveforms and waveform length in Channels 1 and 2.

The load impedance buttons allow you to adjust the display amplitude reading to your actual load impedance value. The default value is 50 Ω and the output range is calculated in reference to this value. If your actual load impedance is higher than 50 Ω and you increase the load impedance value in this group, the output of the waveform generator will display the correct value as is measured on your load impedance.

Run Mode Control

The Run Mode Control panel, as shown in Figure 3-4, is invoked by pressing the Run Mode button on the Panels bar. Note that if you invoke the Run Mode from the Panels menu, the waveform generator will not change its trigger mode. To modify the instrument's run mode, use the Output Panel. The trigger parameters and setting in the Run Mode Control Panel will have an effect on the waveform generator only if an appropriate run mode setting has been selected. The Run Mode Control Panel groups allow (from left to right) adjustment of Trigger Modifier and their associated Trigger Parameters. The functional groups in the Run Mode Control panel are described below.

Channel Control
The Channel Control group has two buttons: CH1 and CH2. These buttons determine which of the channels is currently active. The active channel will be sensitive to changes that are made on the Run mode panel while the other channel remains passive. Note however, that some parameters and modes are common for both channels and therefore, every time you change one of these functions, expect that the other channel will be updated accordingly.

Trigger Modifier
The Trigger Modifier group provides access to delayed trigger state and its delay parameter and to the Re-trigger state and its parameter. The Manual button operates in conjunction with the BUS mode only. Use this button when an external generator is not available. Pressing the Manual button is stimulating the instrument as if an external trigger has been applied.

To change the trigger delay or the re-trigger interval, point and click on one of these parameters. The value that is associated with the lit LED is displayed on the digital display. You can use the dial, keyboard, or the [↑] [↓} keys to adjust the readout to the required setting. After you modify the reading, press Execute to update the waveform generator with the new reading.

Figure 3-4: Run Mode Control Panel

Trigger Parameters
Slope **-** The Slope group lets you select edge sensitivity for the trigger input connector. If you click on Positive, the instrument will trigger on the rising edge of the trigger signal. Likewise, if you click on Negative, the instrument will trigger on the falling edge of the trigger signal.

Source **-** The wave generator can accept triggers from a number of sources: BUS, External, Internal or Mixed. When the Bus option is selected, only bus commands trigger the instrument. The External position is the default trigger option, which enables the rear panel trigger input and the front panel manual trigger button. The Internal position is available only in Pulse mode and operates in conjunction with the Timer parameter. The Internal trigger mode, when selected, disables the external trigger input and enables an internal, none synchronized, trigger generator. This is especially useful when you do not have an external source to trigger the generator. The Mixed position disables the rear-panel trigger input until a software command is executed; the trigger source then reverts to the rear-panel trigger input.

Burst - Programs the burst count for burst mode. Note that in all functions, except pulse, the burst count is separate for each channel. However, for the pulse output, the burst count is the same for Channel 1 and Channel 2.

Timer – The timer field programs the trigger period of the free-running internal trigger generator. The internal trigger timer is programmed in units of seconds. Note that the internal trigger generator function is available in pulse mode only. Other output functions use the re-trigger generator that has a different interpretation than the internal trigger period. The time period programmed in the re-trigger generator is defined as the time interval from end of the waveform until a valid trigger, whereas the internal trigger period is defined as the time interval from beginning of waveform until a valid trigger.

Trigger Level – Programs the trigger level parameter. Depending on the slope setting, the waveform generator will be stimulated to output waveforms when the trigger level threshold has been crossed.

Pulse Generator Panel

The Pulse Generator Panel, as shown in Figure 3-5, is accessible after you click on the Pulse button in the Panels bar. The Pulse Generator Panel groups allow (from left to right) adjustment of Parameters, Hold Control, Output Control and Channel Control. This panel demonstrates the default condition where the output pulse mode is Single, the amplitude level hold control is High/Low and the pulse transitions are Fast.

Notice that only four parameters are visible in the Parameters group, while there are many other parameters that can program the pulse shape. This was done to simplify the operation and the parameters that are not visible show up on the panel only with the relevant output mode. For example, if you select the linear transition mode, the leading and trailing edge parameters will become visible on the panel. Also, if you use the hold duty cycle mode, the width parameter will be replaced by the duty cycle parameter because the width has no meaning when the hold duty cycle mode is selected.

Figure 3-6 shows the same Pulse Generator Panel with the linear transitions mode turned on and the hold duty cycle pulse selected for the pulse output mode.

Figure 3-5: Default Pulse Generator Panel

Figure 3-6: Pulse Generator Panel with Linear Transitions and Hold Cycle Output

As explained above, not all pulse parameters are visible at default. Regardless, all of the parameters that are available in the parameters group are explained in the following paragraphs, along with explanations for when they become active and when they apply to pulse shape programming.

Channel Control
The Channel Control group has two buttons: CH1 and CH2. These buttons determine which of the channels is currently active. The active channel will be sensitive to changes that are made on the pulse panel, while the other channel remains passive. Note however, that some parameters and modes are common for both channels and therefore, every time you change one of these functions, expect that the other channel will be updated, accordingly.

Parameters
Period - The period parameter defines the period of the pulse, regardless of the pulse mode. The period parameter is not visible in external pulse width mode because the period and the width are generated from an external signal.

Width - The width parameter defines the width of the pulse, regardless of the pulse mode. The width parameter is not visible in external pulse width mode because the period and the width are generated from an external signal. The width is replaced by the duty cycle parameter, when the hold duty cycle pulse mode is selected.

Duty Cycle - The duty cycle parameter defines the width of the pulse in reference to its period. The duty cycle parameter is visible only when the hold duty cycle pulse mode is selected.

High Level - The high level parameter defines the high level of the pulse. It is visible in the following level hold modes: High/Low and Positive.

Low Level - The low level parameter defines the low level of the pulse. It is visible in the following level hold modes: High/Low and Negative.

Amplitude - The amplitude parameter defines the amplitude of the pulse. It is visible only when the Ampl/Offset hold level is selected

Offset - The offset parameter defines the offset of the pulse. It is visible only when the Ampl/Offset hold level is selected

Delay - The delay parameter defines the delay from the SYNC leading edge to the leading edge of the pulse. This parameter is visible only in delayed pulse mode.

Double Delay - The double delay parameter defines the delay between the leading edges of the pulse pairs. This parameter is visible only in double pulse mode.

There are two special pulse modes that need separate sets of parameters; These are: External Width and Pulse Width Modulation (PWM). The parameters of these two functions are described separately in this chapter.

Hold Control
The hold control group has dual functionality; It determines how you program the level of your signal and defines if the signal has fast transitions or controllable linear transitions.

The level control provides flexibility in the way that you place your pulse along the vertical axis. There are four options:

High/Low – when this option is selected you enter your pulse amplitude using two parameters: High Level and Low Level. In this case, the instrument automatically determines the required amplitude from your inputs and offsets to place the pulse exactly where you intended. This level-hold mode is especially useful for applications that require precise settings of both the high and low levels.

Amplitude/Offset – this option is useful for applications that require an absolute magnitude and precise placement of the pulse offset. This setting option is common for waveform generators where signals are normally generated symmetrically around the 0V level, but is not as frequently used for pulse applications. Nevertheless, this option is available and sets the amplitude and offset separately.

Positive – this option fixes the low level at the 0V level and every change in the positive level setting moves the positive level only. This level setting is extremely useful for applications that require control over the high level only, while keeping the low level fixed.

Negative – this option fixes the high level at the 0V level and every change in the negative level setting moves the negative level only. This level setting is extremely useful for applications that require control over the low level only, while keeping the high level fixed.

Output Control
The output control group defines the shape and the polarity of the pulse. The menu provides a selection from six pulse mode options: Single, Delayed, Double, Hold Duty Cycle, External Width and PWM1. These pulse modes are described in detail below.

Single – this pulse mode defines single pulse with properties that can be programmable to suit even the most complex application. The single pulse mode may be generated in continuous, triggered, gated and counted burst run modes, while retaining all of its pulse characteristics. The SYNC output is synchronous with the start of the pulse and appears every time a cycle is initiated. The parameters that control the single pulse output are: period, width, high and low levels, leading and trailing edge transitions and polarity.

Delayed – this pulse mode defines single pulse with properties that can be programmable to suit even the most complex applications. The delayed pulse mode may be generated in continuous, triggered, gated and counted burst run modes, while retaining all of its pulse characteristics. The SYNC output is synchronous with the

start of the pulse except, the pulse is always delayed from the SYNC position by a programmable interval. The delay parameter is extremely stable and may be programmed with resolutions as small as 10 ps. The parameters that control the delayed pulse output are: period, width, high and low levels, delay, leading and trailing edge transitions and polarity.

Double – this pulse mode defines double pulse with properties that can be programmable to suit even the most complex application. The double pulse mode may be generated in continuous, triggered, gated and counted burst run modes, while retaining all of its pulse pair characteristics. The SYNC output is synchronous with the start of the first pulse and appears every time a cycle is initiated. The double pulse delay parameter is extremely stable and may be programmed with resolutions as small as 10 ps. The parameters that control the double pulse output are: period, width, high and low levels, double delay, leading and trailing edge transitions and polarity.

Hold Duty Cycle – this pulse mode defines a special case of the single pulse mode except, instead of programming the pulse width, the duty cycle is held fixed at a value set by the duty cycle parameter. The fixed duty cycle pulse mode may be generated in continuous, triggered, gated and counted burst run modes, while retaining all of its pulse characteristics. The SYNC output is synchronous with the start of the pulse and appears every time a cycle is initiated. The parameters that control the single pulse output are: period, duty cycle, high and low levels, leading and trailing edge transitions and polarity.

Figure 3-7: External Width Control Parameters

External Width – unlike any of the other pulse modes, the pulse is regenerated from an external input and by setting the trigger level and the trigger slope at the trigger input connector. Every time the external signal crosses the trigger level threshold, the output generates pulse high level, or pulse low level, depending on the trigger slope selection. When you select the external width mode, the panel, as shown in Figure 3-7, appears, allowing modification of the trigger level and the trigger slope. Notice that the period and width parameters have no meaning in this case, because they are reconstructed from the external shape.

The parameters that control the external pulse width output are: trigger level, trigger slope, high and low levels and leading and trailing edge transitions.

PWM CH1 – the pulse width modulation function is another special characteristic of the pulse generator output. In this mode, the pulse width is modulated by a built-in signal that has known properties and timing characteristics. When you select the pulse width modulation mode, the panel, as shown in Figure 3-8, appears, allowing modification of the PWM parameters. Notice that the width parameter has a primary meaning only as it varies with the modulating signal.

The parameters that control the primary pulse output are: period, width, high and low levels, leading and trailing edge transitions and polarity. The modulating waveforms have additional parameters: Source, which defines the shape of the modulating signal, Period, which define the period of the modulating signal and Deviation, which define the depth of the modulation.

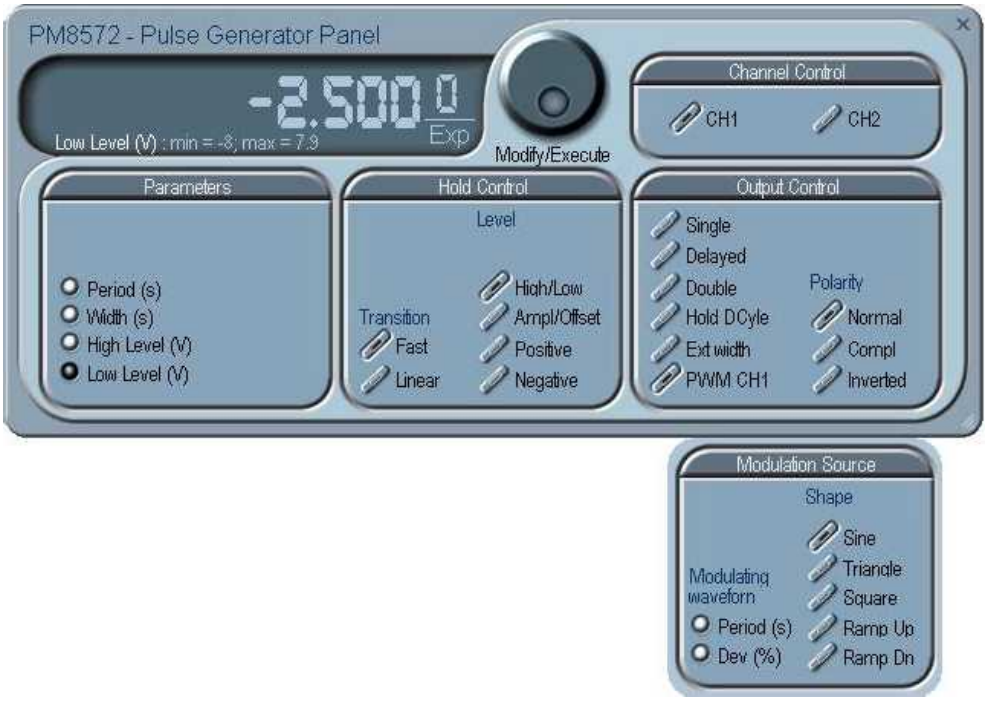

Figure 3-8: PWM Control Parameters

Standard Waveforms Panel

The Standard Panel, as shown in Figure 3-9, is accessible after you click on the Standard button in the Panels bar. The Standard Waveform Panel groups allow adjustment of channel control, parameters, 10 MHz reference and waveforms. The functional groups in the Standard Waveforms panel are described below.

Figure 3-9: Standard Waveforms Panel

Channel Control
The Channel Control group has two buttons: CH1 and CH2. These buttons determine which of the channels is currently active. The active channel will be sensitive to changes that are made on the standard waveforms panel, while the other channel remains passive. Note however, that some parameters and modes are common for both channels and therefore, every time you change one of these functions, expect that the other channel will be updated accordingly.

Parameters
The parameters group contains buttons that control the setting of the amplitude, offset and output frequency for the standard waveforms function. Note that by selecting amplitude and offset values, other functions are automatically updated with these values and the same numbers will be displayed when you migrate from panel to panel, except when you select the pulse panel that has a different set of amplitude and offset values.

The Frequency control lets you program the output frequency of the selected waveform shape. The parameters may be modified when the LED illuminates. You can use the dial, keyboard, or the [↑] [↓} keys to adjust the readout to the required setting. After you modify the reading, press Execute to update the waveform generator with the new reading.

10 MHz Ref
The 10 MHz group contains buttons that control the source of the 10MHz reference for the standard waveforms function.

The 10MHz Ref controls toggle between internal and external references. The default setting is internal, which provides frequency accuracy of 1ppm. If such accuracy is not sufficient for your application, click on the external option but make sure that a reference source is applied to the rear panel connector; otherwise, the accuracy of the output will deteriorate completely.

Waveforms
The Waveforms group provides access to a library of built-in standard waveforms. The library includes: Sine, Triangle, Square, Pulse Ramp, Sinc, Exponential, Gaussian and DC waveforms. Each waveform has one or more parameters that can be adjusted for the required characteristics of the output. For example, phase start can be adjusted for the sine and triangle waveforms and duty-cycle can be adjusted for the square waveform. The pulse waveform can be adjusted for rise and fall time as well as width and delay. Parameters that are associated with each waveform are automatically displayed when the waveform is selected.

Note that by clicking a button in this group, you are immediately updating the waveform generator output with this waveform shape.

Arbitrary/Sequence Panel

The Arbitrary & Sequence panel, as shown in Figure 3-10, is invoked by pressing the Arbitrary/Sequence button on the Panels bar. Note that if you invoke the Arbitrary & Sequence Panel from the Panels menu, the waveform generator will not change its output type. On the other hand, if you select the arbitrary, or the sequenced options from the Main Panel, the waveform generator will immediately change its output to the selected waveform type. The functional groups in the Arbitrary Waveforms Panel are described below.

Channel Control
The Channel Control group has two buttons: CH1 and CH2. These buttons determine which of the channels is currently active. The active channel will be sensitive to changes that are made on the Arbitrary/Sequence panel while the other channel remains passive. Note however, that some parameters and modes are common for both channels and therefore, every time you change one of these functions, expect that the other channel will be updated accordingly.

Parameters
The Parameters group contains three parameters: Amplitude, Offset and Segment. Actually, the amplitude and offset values exhibited in this group are exactly the same as in the Main Panel, so every time you change amplitude and offset in the Parameters group, the other panels are updated automatically. The segment parameter provides access to the active segment for each channel.

To access the required parameter, click on the parameter name. The LED next to the required parameter turns on. The value that is associated with the lit LED is displayed on the digital display. You can use the dial, keyboard, or the [↑] [↓} keys to adjust the readout to the required setting. After you modify the reading, press Execute to update the waveform generator with the new reading.

Figure 3-10: Arbitrary/Sequence Panel

SCLK
The SCLK (Sample Clock) group provides access to programming the source of the sample clock and the value of the sample clock frequency. The sample clock setting affects the waveform generator in arbitrary mode only; It is programmed in units of S/s (samples per second) and will affect the instrument only when it is programmed to output arbitrary or sequenced waveforms. The SCLK parameter has no effect on the frequency of the standard waveforms.

The two switches in the SCLK group select between internal and external sample clock inputs. The internal is the default setting. When you select the external sample clock option, make sure an appropriate signal is connected to the external sample clock connector on the rear panel.

To access the required parameter, click on the button until the LED next to the required parameter turns on. The value that is associated with the lit LED is displayed on the digital display. You can use the dial, keyboard, or the [↑] [↓} keys to adjust the readout to the required setting. After you modify the reading, press Execute to update the waveform generator with the new reading.

***10MHz* Ref**
The 10MHz Ref controls toggle between an internal and external references. The default setting is internal, which provides frequency accuracy of 1ppm. If such accuracy is not sufficient for your application, click on the external option but make sure that a reference source is applied to the rear panel connector; otherwise, the accuracy of the output will deteriorate completely.

Sequence
The Sequence Advance Mode group provides control over advance modes for the sequence generator. Advance options are: Auto, Stepped, Single and Mixed. Refer to your waveform generator manual to find out more when and how to use these advance modes. You should be careful while selecting modes because it is possible to cause settings conflict, for example, if you select the Single option before you modified the run mode to Triggered.

Memory Management
The memory management group provides access to the memory partition and waveform studio screens. The Waveform Partition button opens a screen as shown in Figure 3-11 and the Waveform Studio button opens a screen as shown in Figure 3-12. Information how to use these screens is given in the following paragraphs.

Using the Memory Partition Table

In general, the waveform generator can generate arbitrary waveforms but, before it can generate waveforms, they must be downloaded to the instrument from a host computer. Waveforms are downloaded to the instrument as coordinates and are stored in the waveform generator in a place designated as “waveform memory”. The waveform memory has a finite size of 1M and optional extension to 2M and 4M.

Having such long memory does not necessarily mean that you have to use the entire memory every time you download a waveform. On the contrary, the waveform generator allows segmentation of the memory so that up to 4096 smaller waveforms could be stored in this memory. There are two ways to divide the waveform memory to segments: 1) Define a segment and load it with waveform data, define the next and load with data, then the third etc. or 2) Use what **ArbConnection** has to offer and that is to make up one long waveform that contains many smaller segments, download it to the instrument in one shot and then download a memory partition table that splits the entire waveform memory into the required segment sizes. Want to use it? Here is how it is done. Point and click on the Memory Partition. A dialog box as shown in Figure 3-11 will pop up.

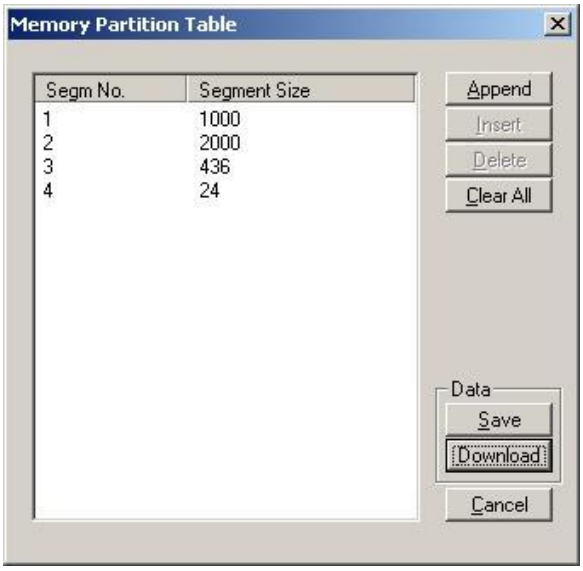

Figure 3-11: Memory Partition Table

The two main fields in the segment table are Segment number and segment size. The **Segm. No** (segment number) is an index field that can only have values, from 1 to 2048. The **Segment Size** is always associated with the segment number. You can program any segment size from 16 to 4M (1M is the standard memory size, 2M and 4M are optional).

Use the **Append** key to add a segment at the end of the segment list. If you highlighted a segment, use the **Insert** key to insert a segment at the cursor location. The **Delete** key is used for deleting a segment at the cursor position.

The **Clear All** key will remove all segments from the table and will let you start designing your segment table from fresh.

Click on the **Close** to discard any changes made to the contents of the dialog box without saving your last actions and to remove the Segment Table from the screen.

The **Save** key saves the current session so you can start the Memory Partition table from the same point after you close this session. The **Download** key updates the waveform generator with the present segment table settings.

TIP

The Memory Partition table does not download waveforms. Use the memory partition table only if you merged a few waveforms to one. The partition table then divides the memory to the individual and original size of each waveform. If you download waveforms using the waveform studio, they already contain segment size and there is no need for further use of the memory partition table.

Using the Waveform Studio

The Waveform Studio, as shown in Figure 3-12 has two parts: 1) Segment Table and 2) Sequence Table. The purpose of the waveform studio is to provide access to waveform files that are already resident in the system. These files can be delegated to various segments and later be used as individual waveforms or combined into complex sequences.

The Segment Table

Using the Segment Table, you may list and download waveform files that were previously stored on the computer. The table shows the segment number and its associated file name, length and its download status. There are other means to download waveforms to memory segments such as the Wave Composer and individual function calls; The waveform studio makes it easier by combining multiple and complex commands into one simple dialog box.

To access the Segment table, click anywhere on the Segment Table area. If it was not yet, it will turn white as opposed to the Sequence Table area that turns gray. The Segment Table area is divided into three parts: the table area, the waveform shape area and control buttons. When you point and click on one of the waveforms, its shape is shown in the Waveform Shape window.

The Segment Table has four fields:

The **Seg** field contains numbers from 1 through 10K, designating the programmed memory segment. Note that memory segments are numbered from 1 to 10K.

The **State** field shows the current status of the memory segment. It can be *Free*, if no file has yet been assigned to this segment number, or *Mapped*, if file name has been assigned to the segment but the Download button has not been used yet to move the file to the waveform generator's memory, or *Loaded*, if the process has been completed by pressing either the Download button or the All (download all) button.

The **File** field is an edit field that lets you browse and select file names to be applied to a specific memory segment. To change or add file name, point and click on the File name field and either type your path or browse to the file location and let Windows find the right path.

The **Length** field displays the length of the selected memory segment. Memory segments size may be programmed from 16 to 4M. Note that the length field is not accessible and shown for reference purpose only.

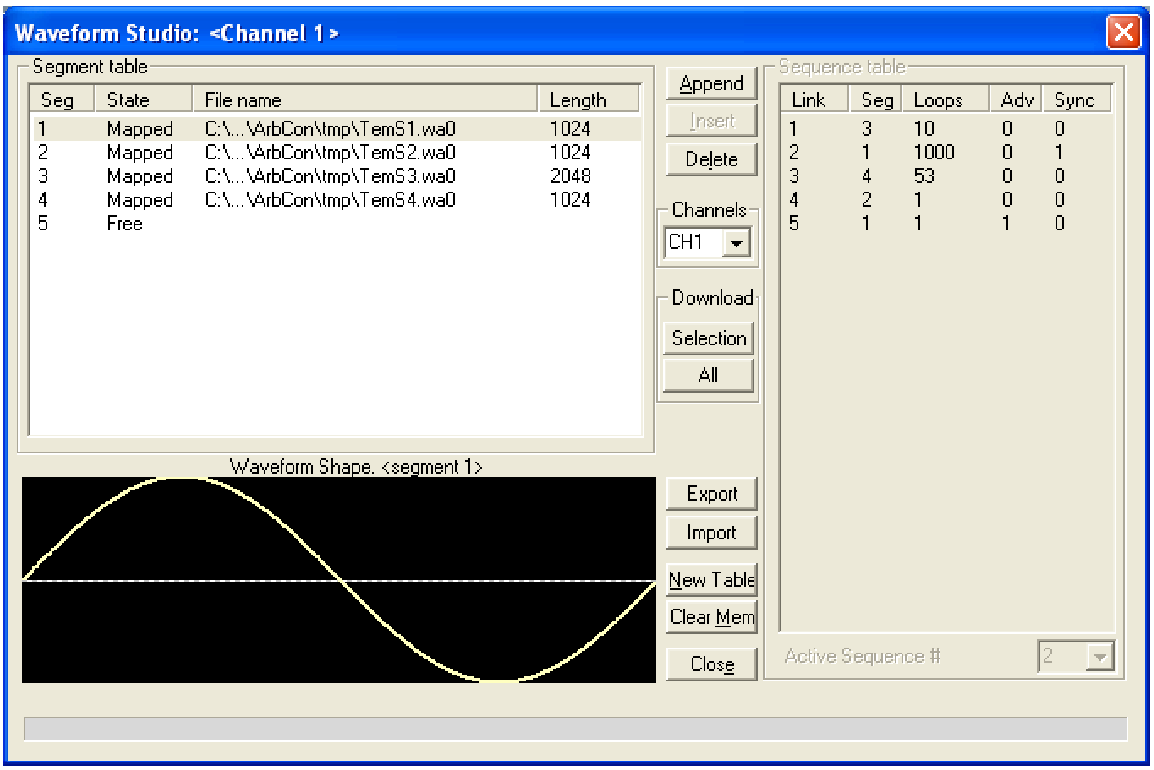

Figure 3-12: Waveform Studio

TIP

Point and click on one of the segments to show its shape in the Waveform Shape window.

Description of the various buttons in the Segment Table is given below.

Append – adds segment number at the end of the table

Insert – adds a segment above a highlighted segment line

Delete – removes a highlighted segment

Channels – Drop down menu selects between channel 1 and channel 2. Shows the segment table for the selected channel only

(Download) Selection – downloads a highlighted segment only to the waveform generator's memory

(Download) All – downloads the complete table to the waveform generator's memory

Export – Enables the user to save the segment table.

Import – Enables the user to open a segment table.

New Table – Resets the segment table.

Clear Mem – wipes out the entire memory and clears the table for fresh settings

Close – removes the Waveform Studio from the screen

The Sequence Table

As was explained in the above, the waveform memory can be divided into smaller segments and up to 10k segments can be defined and used as individual arbitrary waveforms. Having a limited size of waveform memory can, for some applications, pose a limitation however, if sections of the waveform are repetitive, one may use the sequence generator to take these segments and replay them as part of the complete waveform without losing valuable memory space and without scarifying waveform coherences, or integrity. The tool for using repetitive and multiple segments in one long waveform is called Sequence Generator. The waveform generator has two separate sequence generators, one for each channel and **ArbConnection** has a special dialog box where sequences are designed. This tool is called – Sequence Table.

Using the Sequence table you can use waveforms that you already downloaded to the waveform generator from the Segment table, link and loop in random order to create one long and complex waveform that combines the individual memory segments.

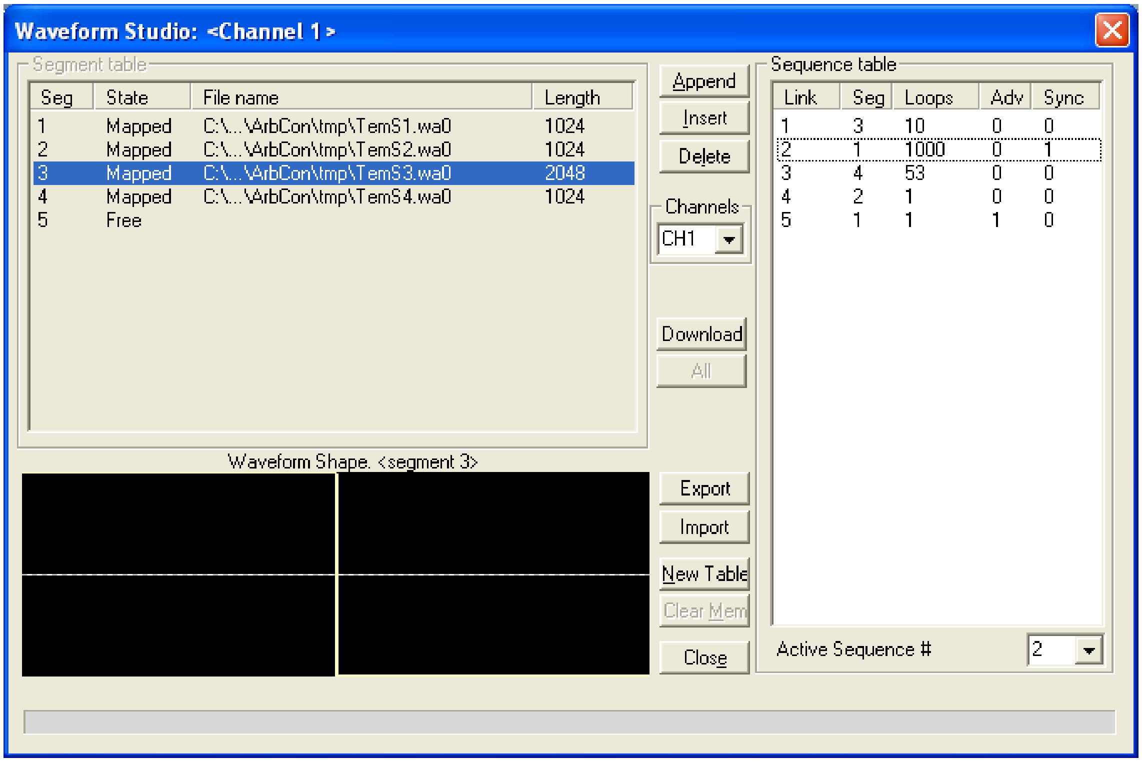

Figure 3-13: Sequence Table

The Sequence Table is demonstrated in Figure 3-13. To access the Sequence table, click anywhere on the Sequence Table area. It will become white (if it wasn't white already) as opposed to the Segment Table area that turns gray.

There are five major elements that you should consider while programming a sequence table. They are: Link, Seg, Loops, Adv. and Sync. These terms are explained below.

Link - This parameter defines an index array for the sequence generator. When generating sequences, the instrument steps through the links in descending order therefore, make sure that you enter your waveform segments in exactly the order you would like them at the output.

Seg - This parameter associates waveform segments with links. You can use different segments for different links or you can use the same segment for a number of links. There are no limitations how you associate links to segments, except you cannot program in the sequence table segments that were not defined earlier.

Loops – This parameter defines how many times the segment will loop for the selected link. For example, if you program 2, the waveform will cycle twice through the same segment before transitioning to the next link.

Adv – This parameter flags the advance mode for the specific segment. This flag is active when the advance mode is Stepped. When set to 0, the sequence will advance through the list automatically until a segment that is flagged 1 is encountered. When 1 is encountered, the generator will idle on this segment until an external trigger is applied. Learn more about the sequence advance modes in the instrument's User Manual.

Sync – This parameter flags the Sync output for the specific segment. When set to 0 no Sync will be generated until a segment that is flagged 1 is encountered. When 1 is encountered a Sync signal is generated for every time the segment is repeated. Note that this feature works only with Sync output type BIT.

Figure 3-13 shows an example of a 5-step sequence of which the first waveform is made of segment 3, which will loop 10 times; segment 1, looping 1000 times; segment 4, looping 53 times; segment 2, once and segment 1once. The Adv bit on link 5 is set to 1 and therefore, external triggers are required for the sequencer to step through this link. The Sync bit in link 2 is set to 1 and therefore a Sync will be generated for each time segment 1 is repeated.

HINT

The waveform generator has two separate sequence generators, one for each channel. If the waveform generator is programmed to continuous run mode, make sure both channels have the same sequence length for inter-channel synchronization. For triggered run mode, each channel can be programmed for a unique sequence length.

The control buttons on the left of the Sequence Table have the same functionality as for the Segment Table.

Use the **Append** key to add a step at the end of the sequence list. Use the **Insert** key to insert a step at the cursor location. The **Delete** key is used for deleting a step at the cursor position.

Click on the **Close** key to remove the sequence Table from the screen. The **Export** and **Import** keys allow to save and Load a segment table.

The **Download** key has double action, it will download the sequence table to the instrument and will save the contents of your table so the next time you open this table, it will have the same contents as you saved in your previous session.

Active Sequence

The active sequence field let you select between 10 different sequences. You may program each sequence separately and replay them individually as required. The output is updated with the

selected sequence number as soon as the active sequence is selected.

Half Cycle Waveform Panel

The Half Cycle panel contains controls that select the half cycle functions and adjust the half cycle parameters. The half cycle functions are generated with variable and controllable delay between the halves. In trigger mode, one half at a time is generated as a result of a trigger signal regardless of the programmed delay value. The half cycle functions have different limitations compared to the standard functions; These are listed in Appendix A. The half cycle panel and the various parameters that control these functions are described below.

Figure 3-14: Half Cycle Waveform Panel

Channel Control

The Channel Control group has two buttons: CH1 and CH2. These buttons determine which of the channels is currently active. The active channel will be sensitive to changes that are made on the half cycle waveform panel while the other channel remains passive. Note however, that some parameters and modes are common for both channels and therefore, every time you change one of these functions, expect that the other channel will be updated accordingly.

Shared

The shared group has parameters that are shared by the two channels. The shared parameters are: Frequency and Delay. Note that the frequency value is a bit different than the standard frequency parameter because it describes the frequency as if the two halves were combined (which is never the case). Since two halves are always separated by certain delay, the frequency value has a meaning as if the two halves were combined.

Shape
The Shape group has controls that select the shape of the half cycle function. Each channel can have an independent half cycle shape.

Parameters
The Parameters group has controls for programming the amplitude, offset, start phase and duty cycle. Each channel can have an independent set of these parameters.

The Modulation Panels

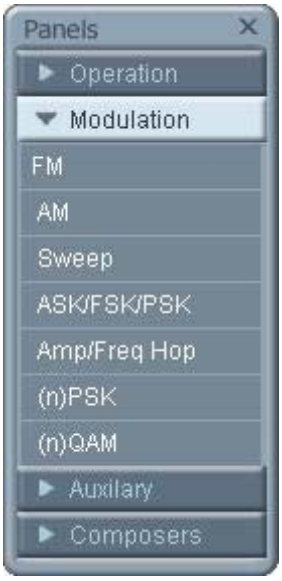

Figure 3-15: Modulation Panels

The Modulation functions were designed over seven separate panels, as shown in Figures 3-15 through 3-23. The panels are invoked by pressing the Modulation header and then one of the modulation panels that appear below it (Figure 3-15). These panels provide access to all modulation functions and their respective run modes and parameters. The modulation functions that are available on these panels are: FM (frequency modulation), AM (amplitude modulation), Sweep, FSK (frequency shift keying), PSK (phase shift keying) and ASK (amplitude shift keying) and Amplitude and Frequency hops. There are also two other panels for controlling the I&Q modulation modes – (n)PSK and (n)QAM. All modulation functions are programmed simultaneously for both channels except AM where each channel can be programmed separately with a different set of parameters.

When another run mode other than continuous is selected, there are two options that control the idle state between triggers: 1) Carrier baseline and 2) DC baseline. When the first option is selected, the instrument generates non-modulated carrier frequency (CW) until a valid stimuli signal is applied and when the second option is selected, the instrument generates a dc level signal until stimulated to generate a modulation cycle. The modulation options, their associated parameters and the various run mode options are described separately for each of the panels.

FM Panel

The FM panel contains parameters for controlling the amplitude modulation function. To turn the FM function on and off, click on the FM button in the State group. The various groups in the FM panel are described below.

FM Parameters - This group contains parameters that allow complete control over the FM function. These include:

CW Frequency
The CW Frequency is the frequency of the pre-modulation carrier waveform. In case the modulating waveform is one of the built-in standard waveforms, the modulation will be symmetrical about the CW frequency setting.

Baseline
The Baseline parameter affects the output characteristics in one of the interrupted run modes (i.e., triggered, burst). In this case this parameter defines where the signal idles between triggers. There are two options: CW and DC. The DC option will set the idle state to a dc level, meaning that in between triggers, the output resides on a dc level and generates modulation when a trigger is accepted. The CW is similar except the signal idles on the pre-trigger CW frequency setting, executes the modulation upon receipt of a legal trigger signal and returns to continuous CW frequency output.

Standard FM Parameters
These parameters are active only when one of the built-in waveforms is selected as the modulating signal. These are: Sine, Triangle, Square, or Ramp. The modulation frequency, deviation and marker frequency control the standard FM modulation scheme.

Modulating Wave
Defines the shape of the modulating waveform. There are two basic options: Standard (built-in) waveforms and Arbitrary waveforms. If you do not need exotic waveforms, you can use one of the built-in standard wave shapes: Sine, Triangle, Square, or Ramp. These waveforms can be adjusted for their frequency and deviation range. On the other hand, you can select the arbitrary modulating wave option where you can use any shape however, you must load the modulating waveform from an external application, such as the FM composer in **ArbConnection**. Information on the standard and arbitrary FM functions is given in the instrument's user manual. Click on the button next to the required modulating waveform shape to select it.

Arbitrary FM Parameters
Allowing adjustment of the sample clock of the modulating waveform, these parameters are active only when the arbitrary modulating waveform option is selected. The modulating waveform must be downloaded from an external utility such as **ArbConnection** and the sample clock is programmed from this location.

To access the required parameter, click on the parameters name and observe that the LED next to the required parameter turns on. The value that is associated with the lit LED is displayed on the digital display. You can use the dial, keyboard, or the [↑] [↓} keys to adjust the readout to the required setting. After you modify the reading, press Execute to update the waveform generator with the new setting.

Figure 3-16: FM Panel

AM Panel

The AM panel contains parameters for controlling the amplitude modulation function. To turn the AM function on and off, click on the AM button in the State group. The various groups in the AM panel are described below.

Although both channels are set to output amplitude modulations simultaneously, each channel can be programmed to be modulated using a unique envelop waveform. Select the appropriate parameters for each channel, using the channel control description as described below.

Channel Control
The Channel Control group has two buttons: CH1 and CH2. These buttons determine which of the channels is currently active. The active channel will be sensitive to changes that are made on the AM panel while the other channel remains passive. Note however, that some parameters and modes are common for both channels and therefore, every time you change one of these functions, expect that the other channel will be updated accordingly.

AM Parameters - This group contains parameters that allow complete control over the AM function. These are:

CW Frequency
The CW Frequency is the frequency of the carrier waveform.

Baseline
The Baseline parameter affects the output characteristics in one of the interrupted run modes (i.e., triggered, burst). In this case this parameter defines where the signal idles between triggers. There are two options: CW and DC. The DC option will set the idle state to a dc level, meaning that in between triggers, the output resides on a dc level and generates modulation when a trigger is accepted. The CW is similar except the signal idles on the pre-trigger CW frequency setting, executes the modulation upon receipt of a legal

trigger signal and returns to continuous CW frequency output.

Modulating Wave
Defines the shape of the modulating waveform. There are four built-in standard wave shapes: Sine, Triangle, Square, or Ramp. These waveforms can be adjusted for their frequency and deviation range. Click on the button next to the required modulating waveform shape to select it. The modulating waveform can be selected independently for each channel

Freq
Programs the frequency of the modulating waveform. Note that the frequency setting must be smaller than the CW frequency for the AM function to operate correctly. Note that the modulating frequency setting is common to both channels.

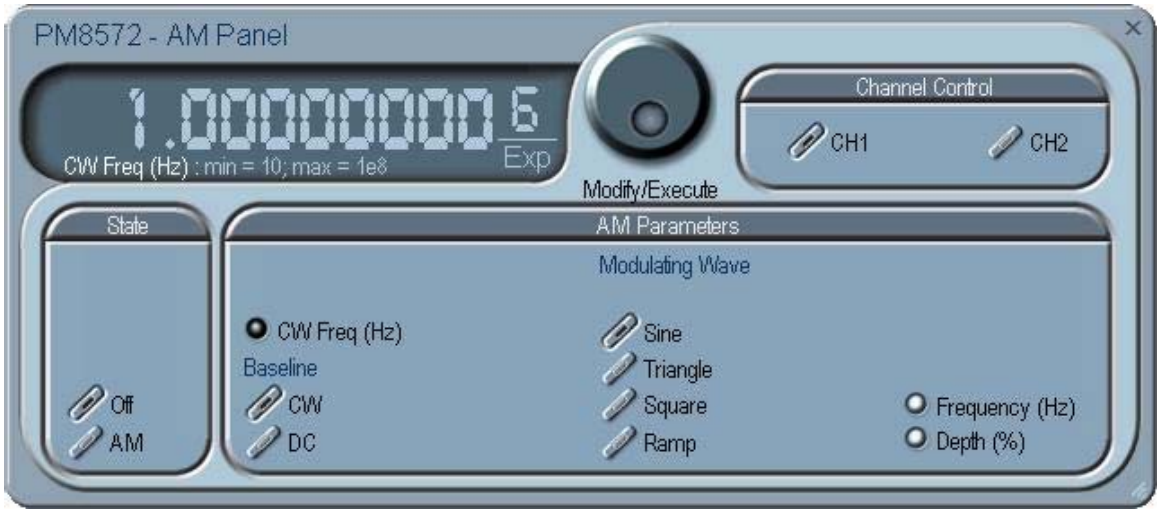

Figure 3-17: AM Panel

Depth
The depth parameter programs the modulation depth or index as a percentage of the CW amplitude. The depth is symmetrical about the center of the CW amplitude. Each channel can have a unique setting of the modulation depth.

To access the required parameter, click on the parameters name and observe that the LED next to the required parameter turns on. The value that is associated with the lit LED is displayed on the digital display. You can use the dial, keyboard, or the [↑] [↓} keys to adjust the readout to the required setting. After you modify the reading, press Execute to update the waveform generator with the new setting.

Sweep Panel

The Sweep panel contains parameters for controlling the sweep function. To turn the sweep function on and off, click on the Sweep button in the State group. The various groups in the Sweep panel are described below.

Sweep Parameters - This group contains parameters that allow complete control over the sweep function. These are:

Baseline
The Baseline parameter affects the output characteristics in one of the interrupted run modes (i.e., triggered, burst). In this case this parameter defines where the signal idles between triggers. There are two options: CW and DC. The DC option will set the idle state to a dc level, meaning that in between triggers, the output resides on a dc level and generates modulation when a trigger is accepted. The CW is similar except the signal idles on the pre-trigger CW frequency setting, executes the modulation upon receipt of a legal trigger signal and returns to continuous CW frequency output. Note that in sweep modulation, the Start parameter replaces the CW value.

Step
Use these keys to select sweep step from two increment options: linear, or logarithmic.

Figure 3-18: Sweep Modulation Panel

Direction
Use these keys to program sweep direction. “Up” selects sweep from Start to Stop sample clock setting and “Down” selects sweep from the Stop to Start sample clock setting. Refer to the instruments user manual to learn more about sweep operation.

Parameters
Allow adjustment of Sweep Start (CW), Stop and Sweep Time. You can also place a marker at a position programmed by the Mark parameter. To access the required parameter, click on the parameters name and observe that the LED next to the required parameter turns on. The value that is associated with the lit LED is displayed on the digital display. You can use the dial, keyboard, or the [↑] [↓} keys to adjust the readout to the required setting. After you modify the reading, press Execute to update the waveform generator with the new setting.

FSK/PSK/ASK Panel

The FSK/PSK/ASK panel, as shown in Figure 3-19, contains parameters for controlling the shift keying modulation function. To turn one of the functions on and off, click on the appropriate button in the State group. The various groups in this panel are described below.

General

CW Frequency
The CW Frequency is the frequency of the pre-modulation carrier waveform.

Baseline
The Baseline parameter affects the output characteristics in one of the interrupted run modes (i.e., triggered, burst). In this case this parameter defines where the signal idles between triggers. There are two options: CW and DC. The DC option will set the idle state to a dc level, meaning that in between triggers, the output resides on a dc level and generates modulation when a trigger is accepted. The CW is similar except the signal idles on the pre-trigger CW frequency setting, executes the modulation upon receipt of a legal trigger signal and returns to continuous CW frequency output.

FSK

Control Data
The Control Data button in the FSK group provides access to the data string that controls the sequence of base frequency and shifted frequency. It contains a list of “0” and “1” and the output will repeatedly follow the frequency shift keying sequence in the same order as programmed.

“0/1” Frequency
In FSK, the carrier waveform (CW) has two frequencies: an initial frequency level which is set by the “0” Frequency parameter and shifted frequency which is set by the “1” Frequency. The control data table has a list of “0” and “1” values that flag when the frequency shifts from base to shifted frequency.

Baud
The baud parameter sets the rate of which the generator steps through the sequence of the FSK Control Data bits.

Marker Index
The marker setting programs a specific step (index) in the control data string to output a pulse at the SYNC output connector. The SYNC State button must be turned on to generate the FSK marker output.

Figure 3-19: FSK/PSK/ASK Modulation Panel

PSK

Control Data
The Control Data button in the PSK group provides access to the data string that controls the sequence of base phase and shifted phase. It contains a list of “0” and “1” and the output will repeatedly follow the phase shift keying sequence in the same order as programmed.

“0/1” Phase
In PSK, the carrier waveform (CW) has two phase settings: an initial phase which is set by the “0” Phase parameter and shifted phase which is set by the “1” Phase. The control data table has a list of “0” and “1” values that flag when the phase shifts from base to shifted phase.

Baud
The baud parameter sets the rate of which the generator steps through the sequence of the PSK Control Data bits.

Marker Index
The marker setting programs a specific step (index) in the control data string to output a pulse at the SYNC output connector. The SYNC State button must be turned on to generate the PSK marker.

ASK

Control Data
The Control Data button in the ASK group provides access to the data string that controls the sequence of base amplitude and shifted amplitude. It contains a list of "0" and "1" and the output will repeatedly follow the amplitude shift keying sequence in the same order as programmed.

"0/1" Amplitude
In ASK, the carrier waveform (CW) has two amplitudes: an initial amplitude level which is set by the "0" Amplitude parameter and shifted amplitude which is set by the "1" Amplitude. The control data table has a list of "0" and "1" values that flag when the amplitude shifts from base to shifted amplitudes.

Baud
The baud parameter sets the rate of which the generator steps through the sequence of the ASK Control Data bits.

Marker Index
The marker setting programs a specific step (index) in the control data string to output a pulse at the SYNC output connector. The SYNC State button must be turned on to generate the ASK marker output.

To access the required parameter, click on the button below parameters sub-group until the LED next to the required parameter turns on. The value that is associated with the lit LED is displayed on the digital display. You can use the dial, keyboard, or the [↑] [↓} keys to adjust the readout to the required setting. After you modify the reading, press Execute to update the waveform generator with the new reading.

Amp/Freq Hop Panel

The Amp/Freq panel, as shown in Figure 3-20, contains parameters for controlling the hop modulation function. To turn one of the functions on and off, click on the appropriate button in the State group. The output has two hop options: Fixed and Variable. In the Fixed mode, the output steps through the pre-assigned hop values at a constant rate, as programmed using the dwell time parameter. In the variable mode, the output dwells on each step for a period of time that is programmed in the Dwell Time field in the hop data table that is programmed for the Variable Hold option.

The various groups in this panel are described below.

General

CW Frequency
The CW Frequency is the frequency of the pre-modulation carrier waveform.

Baseline
The Baseline parameter affects the output characteristics in one of the interrupted run modes (i.e., triggered, burst). In this case, this parameter defines where the signal idles between triggers. There are two options: CW and DC. The DC option will set the idle state to a dc level, meaning that in between triggers, the output resides on a dc level and generates modulation when a trigger is accepted. The CW is similar except the signal idles on the pre-trigger CW frequency setting executes the modulation upon receipt of a legal trigger signal and returns to continuous CW frequency output.

Amplitude Hop

Hop Data
The Hop Data button in the Amp Hop group provides access to the data string that controls the sequence of amplitude hops. The hop data table contains a list of amplitude levels and the output steps from one amplitude level to another in the same order as programmed in the hop data table.

Fixed Hold
The hold parameter determines how long each step of amplitude remains on this particular setting before moving to the next amplitude setting. By selecting the Fixed Hold, the hold time remains constant throughout the entire hop table.

Figure 3-20: Amp/Freq Hop Panel

Variable Hold
The hold parameter determines how long each step of amplitude remains on this specific setting before moving to the next amplitude setting. By selecting the Variable Hold, the hold time changes automatically from one step to the next, depending on the hold time value that is affixed to the hop step. The values can be programmed in the HOP Data table.

Dwell Time
The Dwell Time parameter programs the period of time that will lapse before the amplitudes hops to the next amplitude setting. The Dwell time is associated with the Fixed Dwell option only.

Marker Index
The marker setting programs a specific step (index) in the hop data string to output a pulse at the SYNC output connector. The SYNC State button must be turned on to generate the hop marker output.

Freq Hop

Hop Data
The Hop Data button in the Freq Hop group provides access to the data string that controls the sequence of frequency hops. The hop data table contains a list of frequencies and the output will step from one frequency to another in the same order as programmed in the hop data table.

Fixed Hold
The hold parameter determines how long will certain step of frequency dwells on this specific setting before it will step to the next frequency setting. By selecting the Fixed Hold, the hold time remains constant throughout the entire hop table.

Variable Hold
The hold parameter determines how long will certain step of frequency dwells on this specific setting before it will step to the next frequency setting. By selecting the Variable Hold, the hold time changes automatically from one step to the next, depending on the hold time value that is assigned to the hop step. The values can be programmed in the HOP Data table.

Dwell Time
The Dwell Time parameter programs the period of time that will lapse before the frequency moves to the next frequency setting. The Dwell time is associated with the Fixed Dwell option only.

Marker Index
The marker setting programs a specific step (index) in the hop data string to output a pulse at the SYNC output connector. The SYNC State button must be turned on to generate the hop marker output.

To access the required parameter, click on the button below parameters sub-group until the LED next to the required parameter turns on. The value that is associated with the lit LED is displayed on the digital display. You can use the dial, keyboard, or the [↑] [↓} keys to adjust the readout to the required setting. After you modify the reading, press Execute to update the waveform generator with the new setting.

(n)PSK Panel

The (n)PSK panel, as shown in Figure 3-21, contains parameters for controlling multiple PSK modulation functions. To turn the (n)PSK function on and off, click on the appropriate button in the State group. The various groups in this panel are described below.

Type

The Type group allows selection of one of the PSK types. The list has seven PSK options. To select one of the (n)PSK functions, click on BPSK, QPSK, DPSK, OPSK, 8PSK, 16PSK, or User PSK.

(n)PSK Parameters

CW Frequency
The CW Frequency is the frequency of the pre-modulation carrier waveform.

Figure 3-21: (n)PSK Modulation Panel

Baseline
The Baseline parameter affects the output characteristics in one of the interrupted run modes (i.e., triggered, burst). In this case this parameter defines where the signal idles between triggers. There are two options: CW and DC. The DC option will set the idle state to a dc level, meaning that in between triggers, the output resides on a dc level and generates modulation when a trigger is accepted. The CW is similar except the signal idles on the pre-trigger CW frequency setting, executes the modulation upon receipt of a legal trigger signal and returns to continuous CW frequency output.

Marker Index
The marker setting programs a specific step (index) in the control data string to output a pulse at the SYNC output connector. The SYNC State button must be turned on to generate the PSK marker output.

Baud
The baud parameter sets the rate of which the generator steps through the phase symbols.

Carrier On/Off
This button toggles between PSK modulation with or without the carrier. (Having or not having a carrier depends on the specified application.)

Data Table
The Data Table provides means of programming the phase steps sequence. An example of a 16PSK data table sequence is shown in Figure 3-21a. Note that the value of each symbol is pre-defined and therefore, every time you enter a vector, the associated symbol is automatically obtained from the list and displayed in the Phase field. The sequence of which the symbols are generated at the output is the same order as was entered in the Vector list. For applications requiring non-standard phase values, use the Symbol Design option to design your custom symbols.

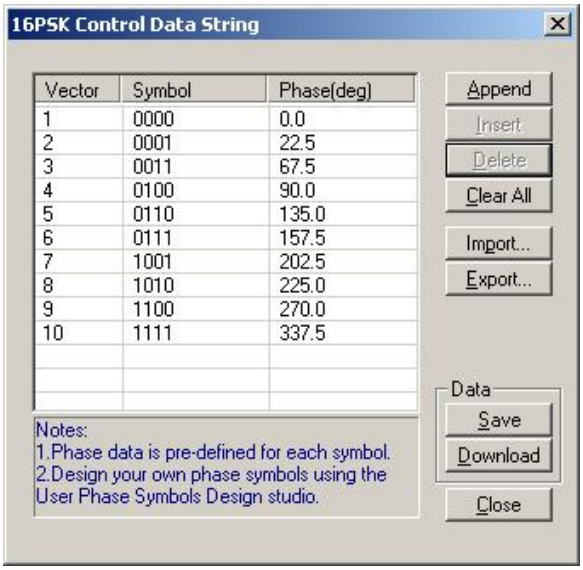

Figure 3-21a: 16PSK Data Table Sample

Symbol Design
The Symbol Design table, as shown in Figure 3-22, is used for generating custom symbols. While the standard (n)PSK modulation functions use pre-defined phase values, using the Symbol Design table, you can design and associate any symbol with any vector as you desire.

Demo
The demo button loads demo data to the generator. The list is pre-defined and is created just for demonstration purpose. There is no specific application that this demo file is built for.

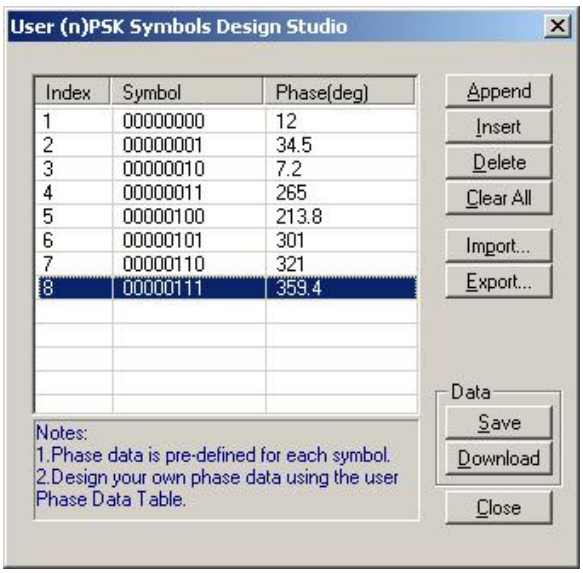

Figure 3-22: Symbol Design Table Sample

(n)QAM Panel

The (n)QAM panel, as shown in Figure 3-23, contains parameters for controlling multiple QAM modulation functions. To turn the (n)QAM function on and off, click on the appropriate button in the State group. The various groups in this panel are described below.

Type

The Type group allows selection of one of the QAM types. The list has four QAM options. To select one of the (n)QAM functions, click on 16QAM, 64QAM, 256QAM, or User QAM.

(n)QAM Parameters

CW Frequency
The CW Frequency is the frequency of the pre-modulation carrier waveform.

Baseline
The Baseline parameter affects the output characteristics in one of the interrupted run modes (i.e., triggered, burst). In this case this parameter defines where the signal idles between triggers. There are two options: CW and DC. The DC option will set the idle state to a dc level, meaning that in between triggers, the output resides on a dc level and generates modulation when a trigger is accepted. The CW is similar except the signal idles on the pre-trigger CW frequency setting, executes the modulation upon receipt of a legal trigger signal and returns to continuous CW frequency output.

Marker Index
The marker setting programs a specific step (index) in the control data string to output a pulse at the SYNC output connector. The SYNC State button must be turned on to generate the QAM marker.

Figure 3-23: (n)QAM Modulation Panel

Baud
The baud parameter sets the rate of which the generator steps through the amplitude-phase symbols.

Carrier On/Off
This button toggles between QAM modulation with or without the carrier. Having or not having a carrier depends on the application.

Data Table
The Data Table provides means of programming the amplitude-phase steps sequence. An example of a 64QAM data table sequence is shown in Figure 3-24.

Note that the value of each symbol is pre-defined and therefore, every time you enter a vector, the associated symbol is automatically obtained from the list and displayed in the “I” and “Q” fields. The sequence of which the symbols are generated at output has the same order as was entered in the Vector list. For applications requiring non-standard amplitude-phase values, use the Symbol Design option to design your custom symbols.

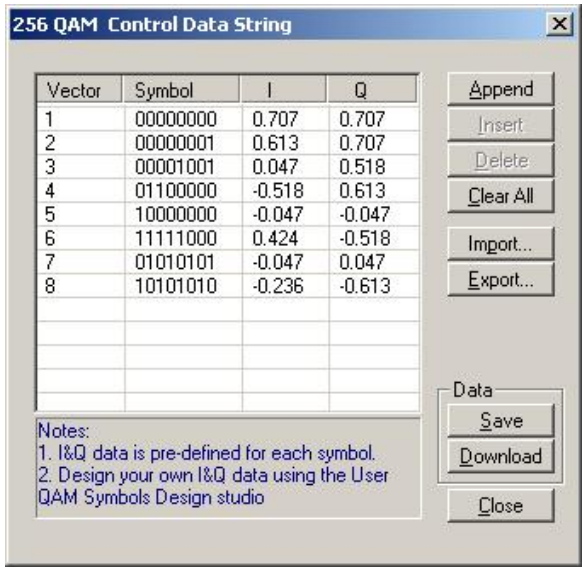

Figure 3-24: 64QAM Data Table Sample

Symbol Design

The Symbol Design table, as shown in Figure 3-25, is used for generating custom symbols. While the standard (n)QAM modulation functions use pre-defined amplitude-phase values, using the Symbol Design table, you can design and associate any symbol with any vector as you desire.

Demo

The demo button loads demo data to the generator. The list is pre-defined and created just for demonstration purpose. There is no specific application that this demo file is built for.

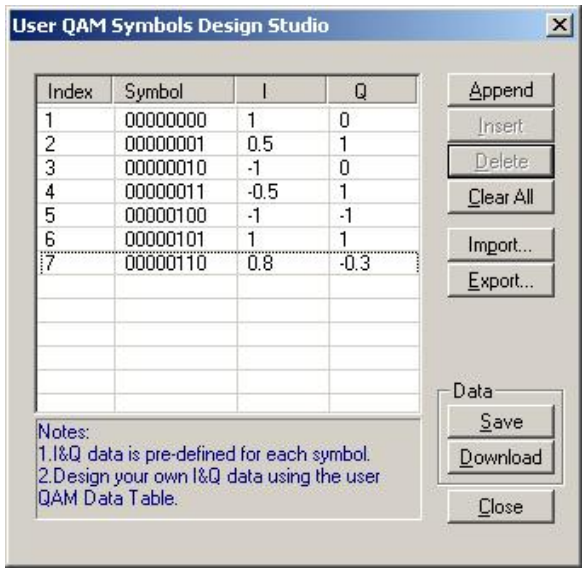

Figure 3-25: Symbol Design Table Sample

Auxiliary Panels

Figure 3-25a: Auxiliary Panels

The Auxiliary tab provides access to a group of panels that control some auxiliary and Utility functions.

There are three panels in this group: Counter/Timer, which provides access to the auxiliary Counter/Timer function; Digital Patterns, which provides access to the auxiliary digital pattern generator function; and X-Instrument Sync for multi instrument synchronization control.

The Auxiliary set of panels are shown in Figure 3-25a. Each of the panels is described below.

Counter/Timer Panel

The Counter/Timer panel, as shown in Figure 3-26, contains controls that select the measurement function and adjusts the counter/timer parameters for measuring external signals. The counter/timer measures signals that are connected to the TRIG IN input. The various parameters that control the counter/timer features are described below.

State
The State Group has controls to turn the counter on and off and to reset the counter and arm it for the next measurement cycle. Note that when the counter function is turned on, all other waveform generation features of the waveform generator are purged.

Measurement Function
The measurement function group has control to select the measurement function for the counter/timer operation. The waveform generator can measure the following functions: Frequency, Period, Period Averaged, Pulse Width, and Totalize. The Totalize function has two options: if the Totalize Infinite function is selected, the input will count every legal pulse at the counter input for an indefinite period of time, and display the total number of pulses until the counter has been reset. If the Totalize Gated function is selected, the input will count every legal pulse at the trigger input for a period of time defined with the Gate Time parameter.

Figure 3-26: Counter/Timer Panel

Display
The Display Group features controls to select the display mode and to select if the display shows measurement or gate time readings.

In normal mode, the counter is armed to receive signals at the trigger input. When a signal is sensed, the gate to the counter opens for the duration (as was programmed with the Gate Time parameter), processes the result, displays the reading and continues with the same process as long as the signal is available at the input.

In hold mode, the counter is armed to receive the signal at the trigger input. When a signal is sensed, the gate to the counter opens for duration (as was programmed with the Gate Time parameter), processes the result, displays and holds the reading until the next Reset/Arm command.

To display and modify the gate time parameter, click on the Gate Time LED and modify the gate time per your requirements. Gate time rage is from 100 μs to 1 s. Normal counter/timer readings are displayed when the Reading LED is selected.

Digital Patterns Panel

The Digital Patterns panel (Figure 3-27), contains controls that control the functionality of the pattern output and provide access to the pattern source. The Digital Pattern panel and the various parameters that control this function are described below.

State
The state button toggles the pattern output on and off. When the state is on, patterns are routed to the rear panel connector. Note that the channel 1 output connector can also be activated and then both the rear and front outputs generate waveforms and patterns.

Figure 3-27: Digital Patterns Panel

Data Source
This Data Source has two buttons, which select between the Data Table and an Arbitrary Segment as the source for the digital pattern output. If you select the Data Table option, you must generate pattern data as shown in Figure 3-28. Pattern data for the Data Table option can be generated from the Pattern Data group.

If you select the Arbitrary Segment as your data source, data is stored as a normal waveform and can be generated simultaneously from the front-panel output connector, as an arbitrary waveform and from the rear-panel Digital Pattern output, as a pattern sequence.

The question of using one data source option or the other is relevant only if your pattern data is longer than 128k sequences. Below 128k, you can use the Data table entry and additionally, you can look at the data from the display. Larger blocks of data can be stored in the same memory location as arbitrary waveforms are stored, but this type of data cannot be displayed on the front panel. On the other hand, multiple blocks of data can be stored in the arbitrary waveform data, as long as the total pattern lengths do not exceed the arbitrary waveform memory capacity of the waveform generator.

Baud
The baud parameter programs the rate of which the output step through the pattern sequence, which was programmed in the Pattern Design table.

Pattern Data
This opens a table that allows programming of the digital patterns. Patterns are 16 bits and are programmed in hex format.

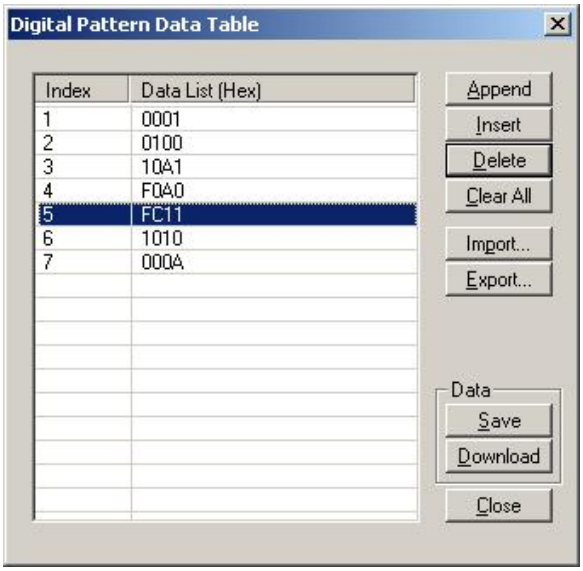

Figure 3-28: Digital Pattern Data Table Example

X-Instrument Sync

The X-Instrument Sync serves the multi-instrument synchronization format. It is a bit different than the other panels, as it serves only one function: providing an environment for setting up the various instruments and therefore, a dialog box is invoked when you hit the X-Instrument Sync button.

There are some preliminary actions you must take before you can synchronize instruments. The first is to connect the cables and set up LAN addresses. Follow the procedure as described:

Tip

Multiple Instrument synchronization requires that all instruments be connected to a Local Area Network (LAN) system. If just two instruments are to be synchronized, connection between the two instruments can be made with a crossed wire LAN cable. However, activation and operation is possible from the front panel only.

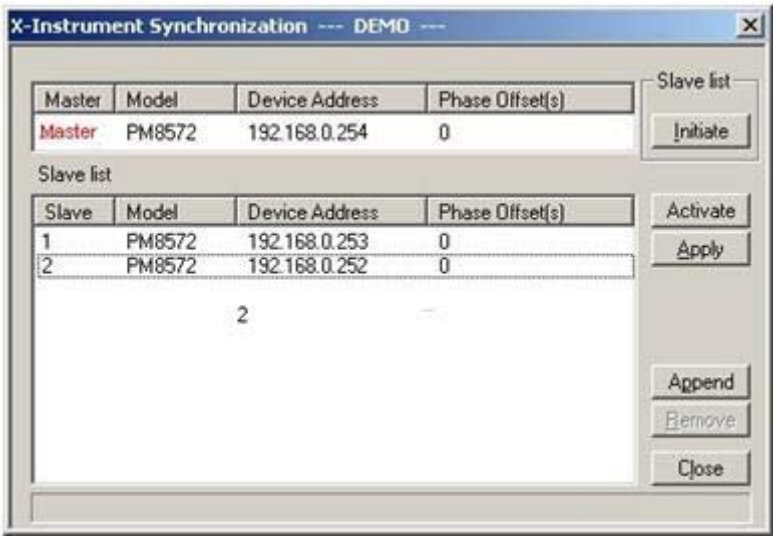

Figure 3-29: Multi-Instruments Synchronization Dialog Box Example

1. First, and most importantly, designate which of the instruments will be set up as master and which will serve as slaves.
2. Locate the multi-instrument cluster of connectors on the back of the waveform generator. They are grouped under the X-Inst Sync title. There are four SMB connectors. These should be connected as follows: The SCLK OUT from the master should be connected to the SCLK IN on the first slave unit and the COUPLE OUT from the master connected to the COUPLE IN on the first slave.
3. Connect LAN cables from your LAN system to both the master and slave units. If more than two units are connected to the system, proceed with connecting wires as described in step 2 above, in a daisy-chain pattern, OUT to the next IN connector. Connect all instruments in the chain in this way.
4. Turn on the instruments and set all of them up to operate from a LAN interface. Information how to set up the waveform generator to operate from a LAN interface is given in the instruments user manual. An example of mater and slave IP address setting is shown in Figure 3-30. The master was assigned the highest IP address …254 and the two slaves were assigned …253 and …252, respectively.

Tip

The IP address determines if instruments are to be set up as master or slave. The highest IP address setting designates the master instrument. Lower IP addresses designate slave instruments.

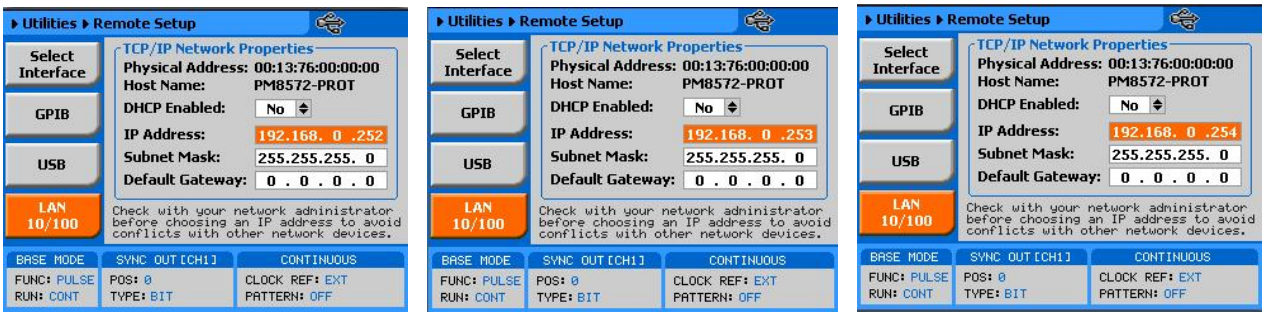

Figure 3-30: IP Address Setup Example (from right to left) Master and two Slaves

5. Invoke the System->Setup and Communication Options. Select the Communicate Only in the Startup Options group and select the Specify an Address Option in the Communications Setup group.
6. Select the LAN Interface and add the master and slave addresses as shown in Figure 3-31.
7. **ArbConnection** can communicate with one instrument at a time and for that reason, highlight the master IP address and then click on Communicate. Regardless, each of the assigned addresses will be tested for LAN accessibility and made available in the Link field for future programming.

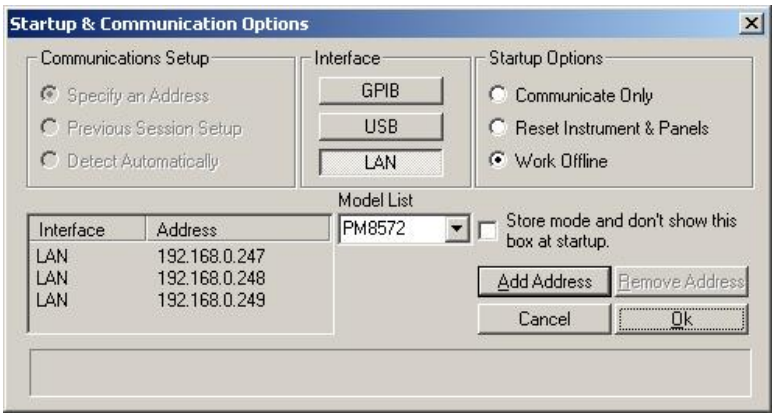

Figure 3-31: Assigning Master and Slave Addresses

8. The final step is to activate the synchronization. This is done from the X-Instruments Synchronization dialog box, as shown in Figure 3-29. Click on Activate to start the synchronization, click on the same button to toggle synchronization off.
9. Adjust the parameters and the functions on the master and slave units however, bear in mind that some functions are

shared by all modules and therefore can only be modified on the master instrument refer to the instrument's user manual for description of the synchronization aspects and the multi-instruments specifications and limitations.

System Panels

Figure 3-32a: System Panels

The System tab provides access to a group of panels that control some general system parameters and provides access to the calibration. There are three panels in this group: General/System, which provides access to some system commands, utilities and filters; Calibration and Calibration Pulse, which provides access to the remote calibration utility. Note however, that access to the calibration panel is permitted to qualified service persons and requires special user name and password. Information how to access the calibration panel is given in the instrument's user manual.

The System set of panels is shown in Figure 3-32a. Each of the panels is described in detail below.

General/Filters

The General/Filters panel provides access to some general system common commands, allows read-back of information that is stored in the flash and provides the means for adding filters to the output path. The General/Filters panel and the various parameters that control these functions are described below.

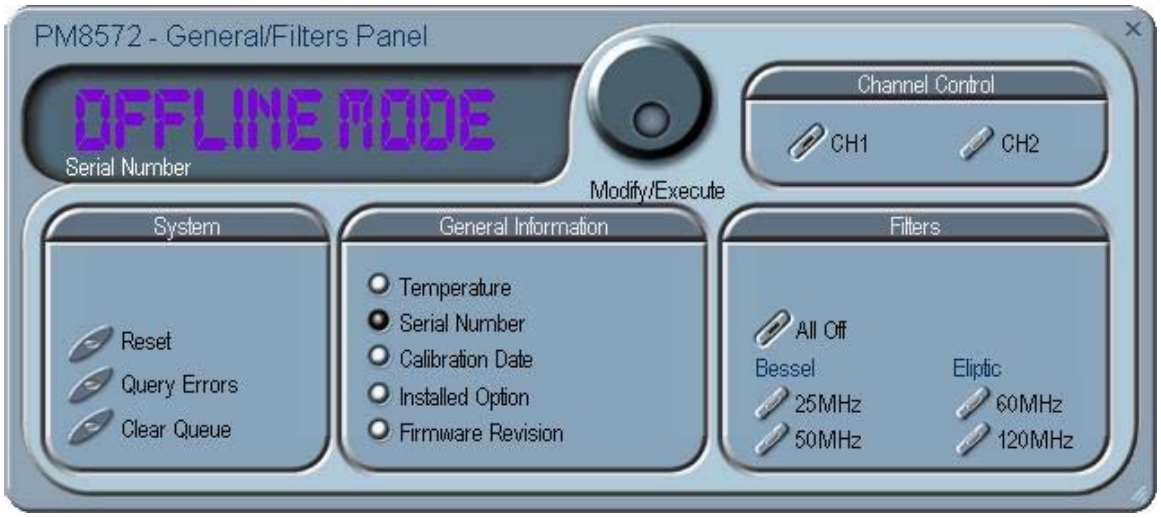

Figure 3-33: the General/Filters Panel

Channel Control
The Channel Control group has two buttons: CH1 and CH2. These buttons determine which of the channels is currently active. The active channel will be sensitive to changes that are made on the Filter group, while the other channel remains passive. Other parameters on the General Panel are not specifically associated with a single channel and therefore, the channel control has no meaning when one of these parameters is accessed.

System
The System group has three buttons that are normally associated with system control. These are:

Reset – generates soft reset to the instrument controls and dialog boxes and modifies all parameters to factory default. A list of factory defaults is given in the instrument's user manual.

Query Error – queries the waveform generator for programming errors. This command is normally not necessary because **ArbConnection** makes sure that programming errors cannot be made from the panels however, while executing commands from the Command Editor, errors can be generated and the only way to monitor the errors is by using this command.

Clear Queue – clears the error queue. The error queue can buffer up to 35 errors and then generates an error queue overflow message, while ignoring new errors. This command clears the error queue and allows fresh errors to be captured.

General Information
General information group buttons are used for displaying or monitoring certain parameters that are stored in the flash memory. These are: Instrument serial number, Last calibration data, waveform generator-installed options and the installed firmware version.

Filters
The Filters group has a set of selectors that select a particular low pass filter. Filters can be turned on and off freely, as long as you are not generating the standard sine waveform. The following filter options are available:

All Off – no filter is applied to the output path

25MHz – a Bessel type filter that has 25 MHz cutoff frequency.

50MHz – a Bessel type filter that has 50 MHz cutoff frequency.

60MHz – an Elliptic type filter that has 60 MHz cutoff frequency.

120MHz – an Elliptic type filter that has 120 MHz cutoff frequency.

Base Calibration Panel

The Base Calibration panel provides access to remote calibration procedures. To access the remote calibration panel, you will need to have a valid User Name and Password. To qualify to perform this type of calibration, you'll need to be trained and certified by Tabor Electronics. Information how to access the calibration panel and how to perform the calibration is given in the instrument's user manual. The picture below is for reference on how the calibration panel looks after gaining access to this panel.

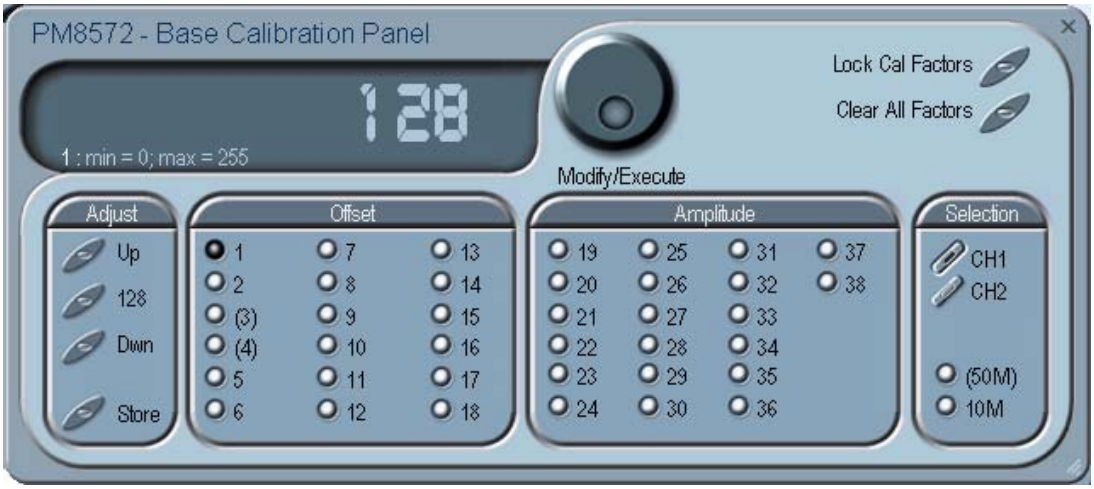

Figure 3-34: Calibration Panel

Pulse Calibration Panel

The Pulse Calibration panel provides access to remote calibration procedures of the built in pulse generator. To access the remote calibration panel, you will need to have a valid User Name and Password. To qualify to perform this type of calibration, you'll need to be trained and certified by Tabor Electronics. Information how to access the calibration panel and how to perform the calibration is given in the instrument's user manual. The picture below is for reference on how the calibration panel looks after gaining access to this panel.

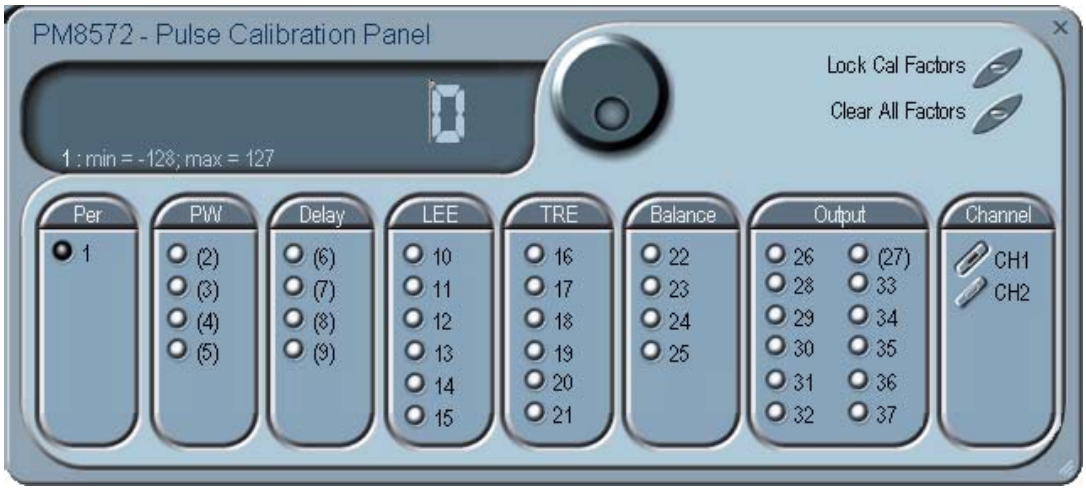

Figure 3-34a: Calibration Panel

The Composers Panels

The Composers tab provides access to a group of composers that allow generation and editing of arbitrary waveforms, pulse shapes, arbitrary frequency modulation, 3D profiling and pattern generation. Without utilities such as the above, the operation of an arbitrary waveform generator is extremely limiting.

There are six waveform composers built into **ArbConnection**:

Wave – for generating arbitrary waveforms. Arbitrary waveforms can be generated from standard libraries, from an equation editor, or imported to the composer from external utilities such as MatLAB. The waveforms can be edited and stored on hard or soft disks.

Pulse – for generating complex pulse trains. Unlike a standard pulse generator, you can design and edit multiple pulse trains with linear transitions and variable amplitudes.

FM – for generating arbitrary frequency modulation profiles without being limited by the standard sine, triangle and square modulating shapes.

3D – for generating chirps and simultaneous variations of amplitude, frequency and phase.

Serial Data – for generating serial data patterns from the main output of the unit.

Pattern – for generating digital pattern using the 16bit LVDS output at the rear of the unit.

The Composers' set of panels are shown in Figure 3-34b. Each of the composers is described below.

Figure 3-34b: Composers Panels

The Wave Composer

Being an arbitrary waveform generator, your Tabor waveform generator has to be loaded with waveform data before it can start generating waveforms. The waveform generation and editing utility is part of **ArbConnection** and is called The Waveform Composer. This program gives you tools to create definitions for arbitrary waveforms. It can also convert coordinates from other products, such as oscilloscopes, and use them directly as waveform data. The program is loaded with many features and options so use the following paragraphs to learn how to create edit and download waveforms to your Tabor waveform generator using the Waveform Composer.

To launch the wave composer point and click on the Wave tab in the Panels bar. The Wave Composer has 3 main sections: Commands bar, Toolbar and Waveform screen. Refer to Figure 3-

35 throughout the description of these sections.

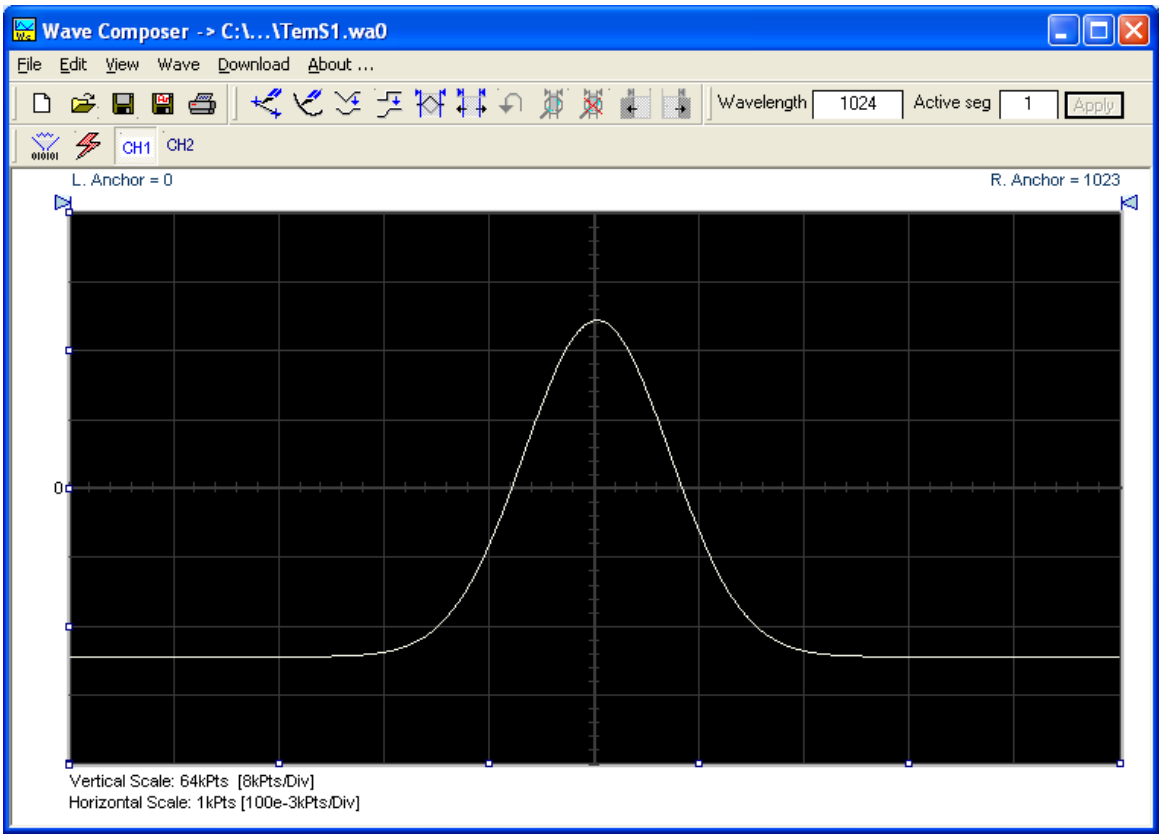

Figure 3-35: Wave Composer Opening Screen

The Commands Bar

The Commands Bar provides access to standard Windows commands such as File and View. In addition, there are **ArbConnection-**specific commands such as Edit, Wave and System.

In general, clicking on one of the commands opens a dialog box with an additional list of commands. Then, clicking on an additional command, may open a dialog box, or generate an immediate action. For example, Clicking on File and then Exit will cause an immediate termination of the Wave Composer. On the other hand, clicking on Wave and then on Sine, will open a Sine Wave dialog box that lets you program and edit sine wave parameters. The various commands in the Commands bar are listed and described below.

File Commands

The File command has 4 command lines that control waveform files. Also use this command to print the active waveform, or exit the wave composer program. Description of the various commands

under File is given below.

New Waveform

The New Waveform (Ctrl+N) command will remove the waveform from the screen. If you made changes to the waveform area and use the New Waveform command, you should save your work before clearing the screen. The New Waveform command is destructive to the displayed waveform.

Open Waveform…

The Open Waveform… (Ctrl+O) command will let you browse your disk for previously saved waveform files and load these waveforms to the waveform area. This command is also very useful for converting waveform files to a format that is acceptable by the Wave Composer. The Open Waveform command can convert ASCII. *CSV (comma delimited text), *PRN (space delimited text), *txt and two Lecroy formats *trc and *.0*. The Open dialog box in Figure36 shows the various file extensions that can be opened into the Wave Composer environment. The file that is opened is automatically converted to *.wav format and can later be saved as a standard **ArbConnection** file.

Save Waveform

The Save Waveform (Ctrl+S) command will store your active waveform in your waveform generator directory as a binary file with an *.wav extension. If this is the first time you save your waveform, the Save Waveform As… command will be invoked automatically, letting you select name, location and format for your waveform file.

Save Waveform As…

Use the Save Waveform As… command the first time you save your waveform. It will let you select name, location and format for your waveform file.

Print

With this command you may print the active Waveform Window. The standard printer dialog box will appear and will let you select printer setup, or print the waveform page.

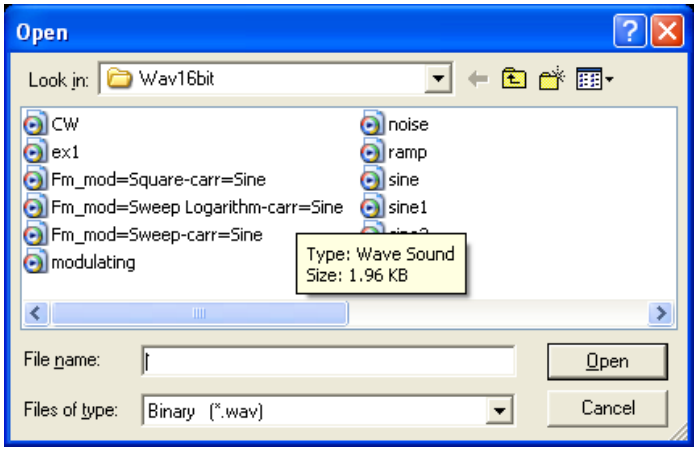

Figure 3-36: Open Waveform Dialog Box

Exit
The Exit command ends the current Wave Composer session and takes you back to the Panels screen. If you made changes to your waveform since it was last saved, the Wave Composer will prompt you to Save or Abandon these changes.

Edit Commands

The Edit commands are used for manipulating the waveform that is drawn on the screen. The editing commands are explained in the following paragraphs.

Autoline
The Autoline command lets you draw straight-line segments. To draw a line, click and hold the left mouse button at the start point. Click again at the next point and then click on the right mouse button to terminate this operation.

Sketch
The Sketch command lets you draw free-hand segments. To draw a line using this command, click and hold the left mouse button at the start point. Release the mouse button when you want to stop and then click on the right mouse button to terminate this operation.

Smooth
The Smooth command lets you smooth-out rough transitions on your waveform. This is done mathematically by multiplying waveform coordinates by the non-linear portion of a cubic parabola.

The Smooth operation is done on segments of the waveform that are bound by anchors. Anchor operation is described later in this chapter. Place the anchors on the left and right of your waveform segment and select the Smooth command. The waveform will change its shape immediately to follow the mathematical pattern of a parabolic curve.

Note that small segments with fast transitions, when combined with parabolic expressions, have tendencies to generate even larger transitions. Therefore, make sure you omit such sections of the waveform when you use this operation.

Filter
The Filter used with this command is moving average. This is done by recalculating each point as an average of symmetrical number of adjacent points. You can filter the entire waveform, or you may chose to filter a segment of the waveform by placing the anchors as boundaries on the left and right of the segment.

Invert
The Invert command lets you invert entire waveforms, or marked segments of waveforms. The waveform is inverted about the 0-point axis.

Trim Left
The trim left command lets you trim waveforms to the left of the anchor point. This command is grayed-out if the left anchor was not moved from its original left position. The waveform is trimmed and the point at the left anchor point becomes the first point of the waveform.

Trim Right
The trim right command lets you trim waveforms to the right of the anchor point. This command is grayed-out if the right anchor was not moved from its original right position. The waveform is trimmed and the point at the right anchor point becomes the last point of the waveform.

Unmark
The unmark command removes the anchors from the waveform screen and resets anchor positions to point 0 and the last waveform point.

Undo
The Undo command undoes the last editing operation.

View Commands

The View commands have commands that let you view various sections of the waveform area. The View commands include: Zoom-In, Zoom-Out, Hide/Show Toolbars and Channel 1 or Channel 2 waveforms. Description of the view commands is given in the following.

Zoom-In
The zoom-in command operates between anchors. Anchors are marked as left and right hand triangles. The default position of the anchors is the start and the end of the waveform. To move an anchor to a new location, click and hold on the triangle and drag the anchor to left or right as required. If you move the left anchor to the right and the right anchor to the left, the area between the anchors

will zoom in as you select this command.

Looking at the Waveform Map, as shown in Figure 3-37, you'll see that the white portion is the zoomed area. Click and hold on the white area and move your cursor around and the waveform screen will be updated accordingly.

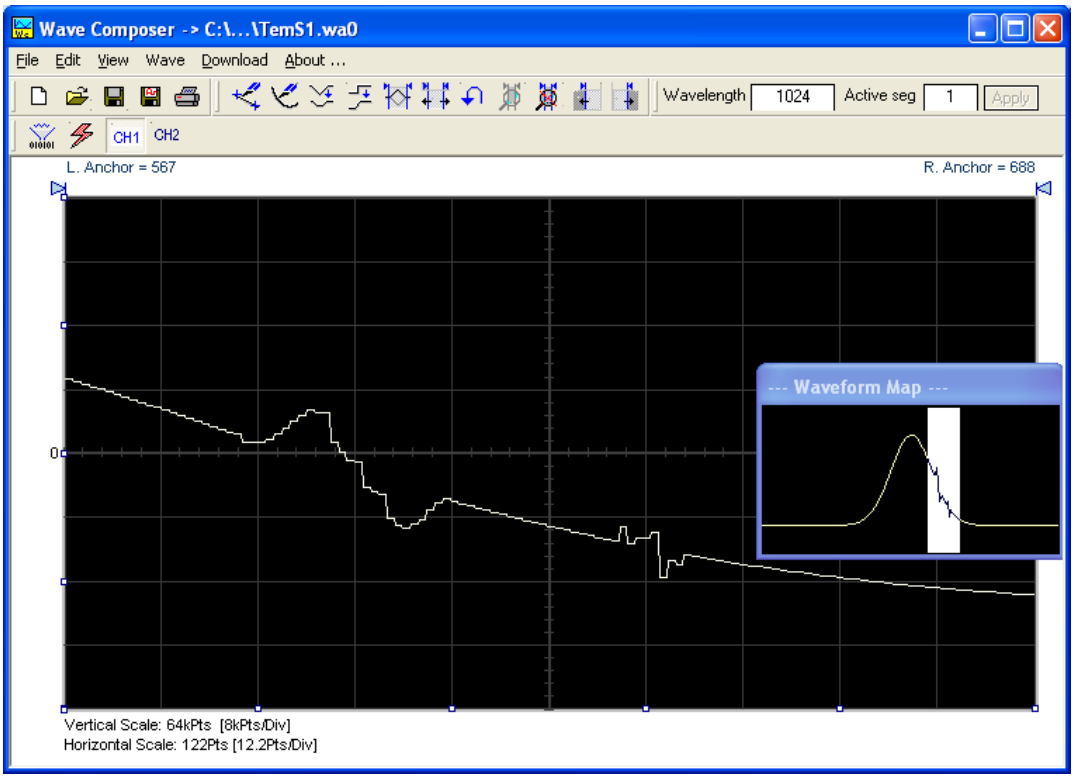

Figure 3-37: Zooming In on Waveform Segments

While zoomed-in, you can perform Autoline and sketch editing, or zoom-in further by clicking and holding the mouse at one corner and releasing the mouse button at the other corner.

Zoom-Out

The zoom-out restores the screen to display the complete waveform.

Channel 1

The Channel 1 Waveform command updates the waveform screen with the Channel 1 waveform. If you have not yet generated a waveform for channel 1, the waveform screen will show a dc level at vertical point 0.

Channel 2

The Channel 2 command updates the waveform screen with the Channel 2 waveform. If you have not yet generated a waveform for Channel 2, the waveform screen will show a dc level at vertical point 0.

Wave Commands

The Wave Commands let you create waveforms on the screen. The Wave command has a library of 9 waveforms: Sine, Triangle, Square, Sinc, Gaussian, Exponent, Pulse, Noise and DC. It also lets you create waveforms using the Equation Editor. Information how to create waveforms using the Wave commands is given below.

Creating Waveforms From the Built-in Library

You can create any waveform from the built-in library using the Wave command. Clicking on one of the Wave options will open a dialog box. An example of the Sine waveform dialog box is shown in Figure 3-37. This dialog box is representative of the rest of the waveforms, so other waveforms will not be described.

Creating Sine Waveforms

Use the following procedure to create sine waveforms from the built-in library. Click on Wave, then sine… the dialog box as shown in Figure 3-38 will appear. You can now start programming parameters that are available in this box.

Start Point – Defines the first point where the created wave will start. Note that if you change the start point, the left anchor will automatically adjust itself to the selected start point. The example shows start point set at point 0.

End Point – Defines where the created waveform will end. Note that as you change the end point, the right anchor will automatically adjust itself to the selected end point. The example shows end point set at point 499.

Cycles – The Cycles parameter defines how many sine cycles will be created within the specified start and end points. The example below shows five sine cycles.

Amplitude – 16-bit of vertical define 65536 incremental steps. The Amplitude parameter defines how many of these steps are used for generating the sine. The example shows a sine waveform with maximum peak-to-peak amplitude. Any number below the maximum will generate an attenuated sine.

Start Phase – The Start Phase parameter defines the angle of which the sine will start. The example shows start phase of 90°.

Power – The example shows sine cubed. Sine to the power of 1 will generate a perfect sine. Power range is from 1 through 9.

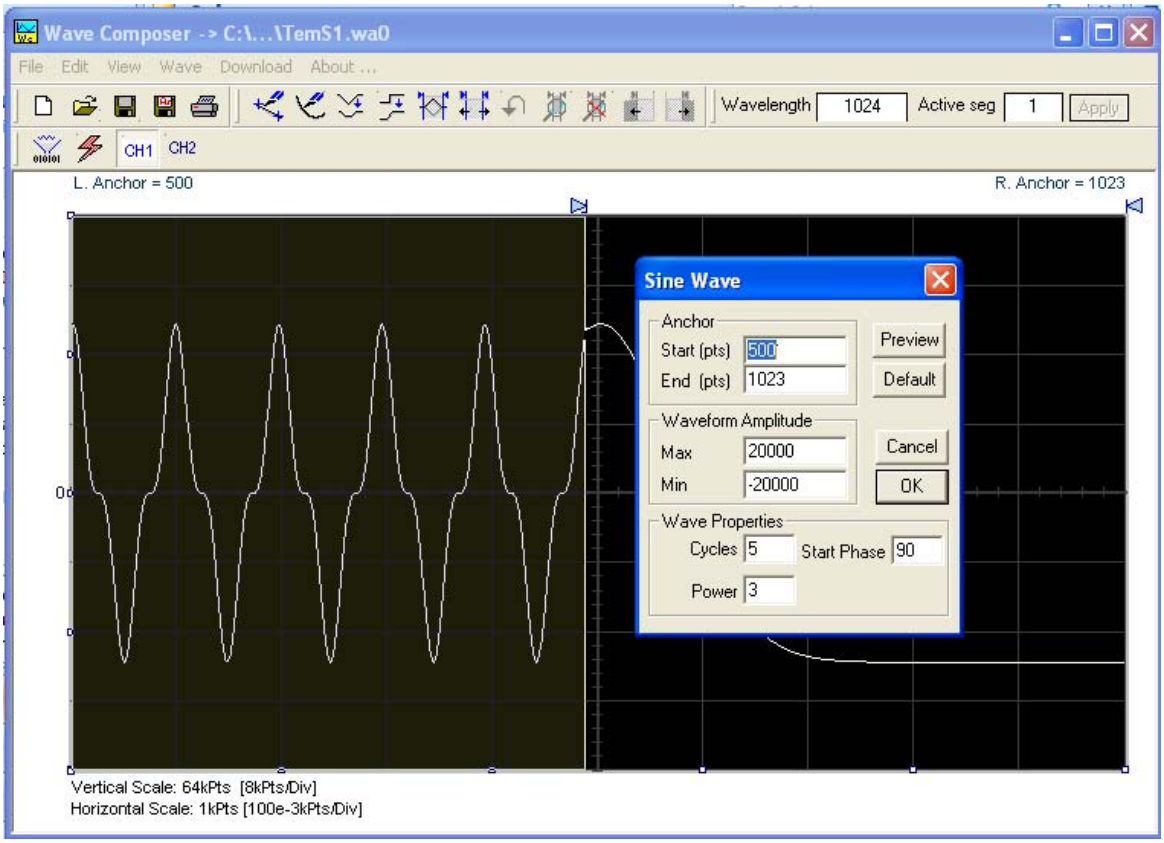

Figure 3-38: Generating Distorted Sine Waves from the Built-in Library

The Toolbar

The Toolbar contains icons for editing the waveform screen, icons for saving and loading waveforms, fields for selecting an active channel and for adjusting segment length and more. The Toolbar is shown in Figure 3-38a. For the individual icons, refer to the descriptions above of the Wave Composer Menus.

Figure 3-38a: The Toolbar Icons

The Waveform Screen

Waveforms are created and edited on the waveform screen. Figure 3-39 shows an example of a waveform created using the equation editor. The various elements of the waveform screen are described below.

The waveform screen has two axes – vertical and horizontal. Both axes are divided into points.

The vertical axis is labeled from -32,768 through 32,767 for a total of 65536 point. This number represents 16 bits of vertical resolution and cannot be changed because it is critical to the range of which the waveform generator operates.

The horizontal axis, by default has 1024 points (from point 0 to 1023). This number can be changed using the Wave Length field in the Toolbar. The maximum length depends on the option installed in your instrument.

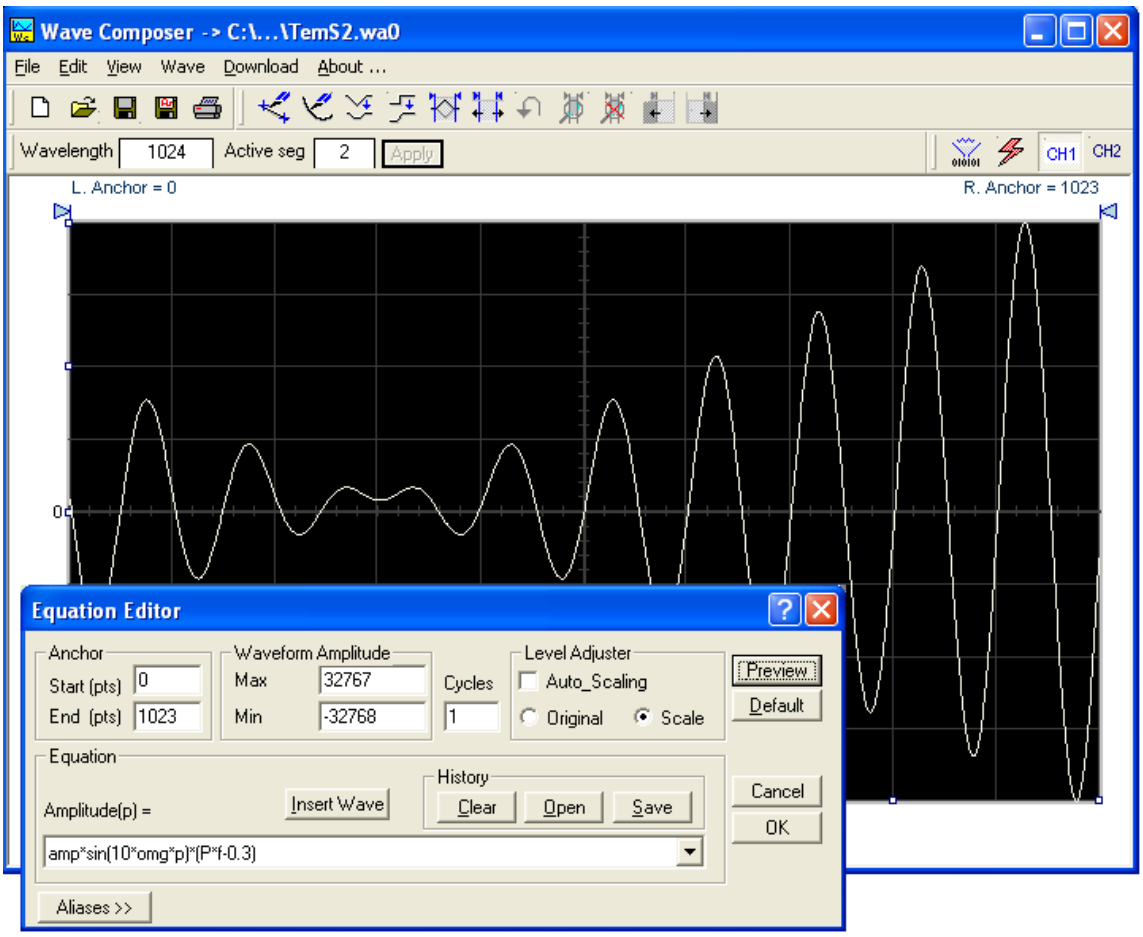

Figure 3-39: The Waveform Screen

Notice on the left top and on the right top there are two triangles pointing to the center of the screen. These are the anchors. The anchors are used as the start and end pointers where your waveform will be created. For example, if you want to create a sine waveform between point 100 and point 500, you place the left anchor at point 100 and the right at point 500 and then generate the sine from the built-in library.

There are two ways to control anchor placements.

1) Click and hold your mouse cursor on the left anchor triangle and then drag the curtain to the left position. Do the same for the right anchor. Notice the X and Y coordinates at the top of the waveform screen and how they change to correspond to your anchor placement.

2) You can also place your anchors in a more precise manner from the waveform library by programming the start and end points for the waveform. An example of anchor placement using the sine dialog box is shown in Figure 3-40.

Finally, when you are done creating and editing your waveform, you can save your work to a directory of your choice. The name at the title will show you the name you selected for storing your waveform and its path.

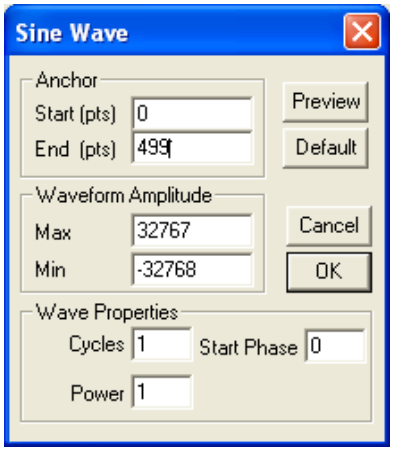

Figure 3-40: Anchor Placement

Generating Waveforms Using the Equation Editor

One of the most powerful features of the **ArbConnection** software, and probably the feature that will be used most, is the Equation Editor. The Equation Editor lets you write equations the same way you would do on a blank piece of paper. The equations are then translated to sequential points that form waveforms and are displayed on the waveform screen. The Equation Editor will detect and inform you on syntax errors and, with its self adjusting feature, will automatically adjust your parameters so that none of the points on your waveform will exceed the maximum scale limits.

When you invoke the Equation Editor, the dialog box, as shown in Figure 3-41 will display. Use the following paragraphs to learn how to use this dialog box and how to write your equations.

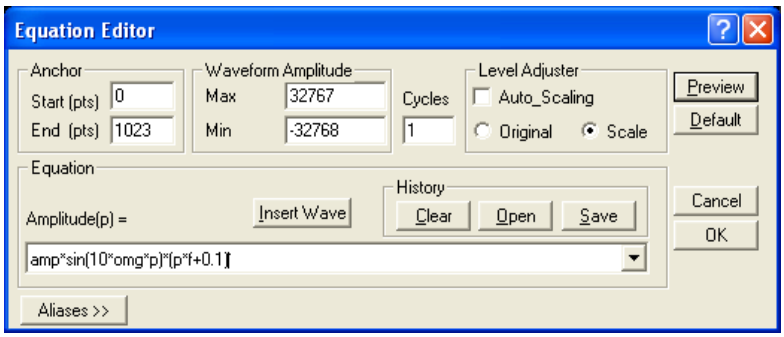

Figure 3-41: The Equation Editor Dialog Box

There are four sub-group parameters in the equation editor plus control buttons and equation field. These parts are described below.

Anchor
The anchors define the start and end points from which the equation will be generated. By default, the anchors are placed at the start and the end of the horizontal (time) scale. However, the equation can be limited to a specific time scale by moving the anchor points from their default locations.

Start – defines the first point where the created wave will start. Note that if you change the start point, the left anchor will automatically adjust itself to the selected start point.

End – defines where the created waveform will end. Note that as you change the end point, the right anchor will automatically adjust itself to the selected end point.

Waveform Amplitude
The vertical axis of the Wave Composer represents 16-bits of vertical resolution. That means that the equation is computed, resolved and generated with 1/65536 increments and accuracy. The Waveform Amplitude fields in the Equation Editor are used in two cases: 1) when the “amp” parameter is used in the equation or 2 if the Level Adjuster is set to Auto. Information on these two operations is given later.

Max – defines the positive peak of the vertical axis

Min – defines the negative peak of the vertical axis

Cycles
The Cycles parameter defines how many waveform cycles will be created within the specified start and end anchor points.

Level Adjuster
The Level Adjuster is a convenient tool that helps you adjust the amplitude and offset without modifying your equation. The Level Adjuster mode does not interfere with your calculations and displays the waveform as computed from your equation. The only difference is that your final calculations are stretched, shrunk or offset on the vertical scale to fit the new amplitude and offset boundaries.

If you check the Auto_scaling box or the Scale option whenever you change the Max and Min setting in the Waveform Amplitude fields your waveform amplitude will be scaled automatically. If the Original option is checked then the waveform will not be scaled automatically and the equation will be presented as with the original amplitude setting.

Equation
The Equation Group contains four buttons, the equation field and the aliases button. You will be using the Equation field for writing your equations. Equation syntax and conventions are discussed in the following paragraphs. The *Insert Wave* button allows you to

open a previously saved waveform which you would like to use in your equation. The History Group contains three buttons. Click on the Save button to save your equation for future use. The Open button provides access to previously saved equations.

While you type and store equations, they are collected in a history file and can be used again by expanding the history log from the equation field. The Clear button clears the history of the equation field.

To facilitate the task of writing equations ArbConnection offers the Aliases feature. As the name might suggest this feature lets you define expressions with Aliases. The Aliases table contains an index column for the number of aliases defined, an Alias column and an expression column that corresponds to the given alias. There are four buttons in the Aliases group. To add an alias click on the add button. It is possible to delete the entire Aliases table by pressing Delete All or just a single alias by selecting the desired alias and clicking delete. When editing the expression field the Insert Wave button will be highlighted. Clicking this button will allow the user to insert a previously stored waveform

Control Buttons
There are four control buttons at the right corner of the dialog box. Use the *Preview* button to preview an image of your equation, click accept to place your waveform on the screen or back to go back to the equation editor. Use the *OK* button to place your waveform on the waveform screen and to leave the dialog box on the screen. The *Default* button restores the parameters in the equation editor to their original factory default values. The *Cancel* button will remove the dialog box from the screen and will discard of any waveforms that you previewed with your Equation Editor.

Writing Equations

The Equation Editor lets you process mathematical expressions and convert them into waveform coordinates. As you probably already know, waveforms are made of vertical samples. The number of samples on your waveform is determined by the wavelength parameter. For example, if you have 1024 horizontal points, your equation will be computed along 1024 points as a function of the vertical scale. Each vertical sample is computed separately and placed along the horizontal axis. The points are graphically connected to form a uniform and continuous waveform shape however, if you zoom in on a waveform line, you'll see that the points are connected like a staircase. In reality, the Tabor waveform generator generates its waveforms exactly as shown on the screen, but if the waveform has many horizontal points, the steps get smaller and harder to see without magnification.

Equations are always computed as a function of the vertical (Amplitude) axis therefore the left side of your equation will always look as Amplitude(p)=, where "p" is the equation variables in units of waveform points. You can write equations with up to 256 characters. If the equation is too long to fit in the visible field, parts

to the left or right will scroll off the ends.

Equation Convention

The following paragraphs describe the conventions that are used for writing an equation. To avoid errors, it is extremely important that you familiarize yourself with these conventions before planning your waveforms.

Equations are written in conventional mathematical notation. You may only enter the right part of the equation. The only limitation is that the equation must be of a single variable that is directly related to the current horizontal axis setting. Case is not important and spaces are ignored. Numbers are entered in scientific notation. All calculations are done with double-digit precision. For the trigonometric functions, all angles are expressed in radians.

A number of constants are provided: e, which is the base of the natural logarithm; pi, which is the circumference of a unit-diameter circle; per, which equals the programmed horizontal range; f, which equals 1 /per; omg, which equals 2 * pi / per, and numerals in the range of -1E^20 to 1E^20.

There are three classes of precedence: ^ (raise to power) has the highest precedence; (multiply) and / (divide) come second; + and - have the lowest precedence. Parentheses may be used to change the order of precedence. The following table summarize the mathematical expressions and their respective abbreviated commands that can be used with the Equation Editor.

Equation Editor Operands

^	Raise to the power
*	Multiply
/	Divide
+	Add
Ä	Subtract
( )	Parentheses
e	Base of natural Logarithm
pi (π)	Circumference of unit-diameter circle
per	Horizontal wavelength in points
f	I/per
omg (Ω)	2*π / per
amp	Amplitude in units of points or seconds
sin(x)	The sine of x(*)
cos(x)	The cosine of x
tan(x)	The tangent of x
ctn(x)	The cotangent of x
log(x)	The base IO logarithm of x
ln(x)	The natural (base e) logarithm of x
abs(x)	The absolute value of x
-1E^20<>1E^20	Numerals, equation constants

(*)x = argument mathematical expression

After you are familiar with the operands and conventions, you can commence with a few simple equations and see what they do to your waveform screen. Once you get the idea, you'll be able to explore your own creativity to generate much more complicated and complex waveforms.

In the top right corner of the Equation Editor dialog box there is a '?' button. Pressing on this button and then in the dialog box will bring up a dialog box with all the above mentioned operands.

Typing Equations

If you remember from your old high school studies, the simplest curve of Y as a function of X is defined by the equation Y=aX+b. You can use the same "technique" to generate straight lines with the Equation Editor. Assuming first that p=0, try this:

Amplitude(p)=1000

Press [Preview] and see what you get. Of course, you get an uninteresting line that runs parallel to the X-axis. Now, lets give the line some angle by typing:

Amplitude(p)=-2*p+2000

Press [Preview] and see that the line slopes down. It may still be not very interesting. However, pay close attention to the convention that is used in this equation. You cannot type: Amplitude(p)=-2p+1000, like you would normally do in your notebook; You must use the * (multiply) sign, otherwise you'll get a syntax error. Now we'll try to generate a simple sine waveform. Try this:

Amplitude(p)=sin(10)

Press [Preview] and… sorry, you still get nothing on the screen. The Wave Composer did not make a mistake! The sine of 10 in radians is exactly what it shows. You are unable to see the result because the line on your screen is running across the 0 vertical point.

REMEMBER

The equation must be a function of a single variable and that variable must be directly related to the Horizontal Axis Scale setting.

Now try this:

Amplitude(p)=sin(omg*p)

Still no good, but now select the scale option in the level adjuster group and here is your sinewave. So what's wrong? Well, if you give it a little amplitude, it might help. So, try it exactly as follows:

Amplitude(p)=8000*sin(omg*p)

There you go! You should now see a perfect sine waveform with a period of 1024 points. This is because you have asked the Equation Editor to compute the sine along p points (“p” is the equation variable, remember?). If you want to create 10 sine waveforms, you should multiply p by 10. Try this:

Amplitude(p)=8000*sin(omg*p*10)

Equation Samples

So far, you have learned how to create two simple waveforms: straight lines and trigonometric functions. Let’s see if we can combine these waveforms to create something more interesting. Take the straight line equation and add it to the sinewave equation:

Amplitude(p)=12000*sin(omg*p*l0)-8*p+4000

Press [Preview]. Your screen should look like Figure 3-42.

Now let’s try to modulate two sine waves with different periods and different start phase. Type this:

Amplitude(p)= 12000*sin(omg*p)*cos(omg*p*30)

Press [Preview]. Your screen should look like Figure 3-42.

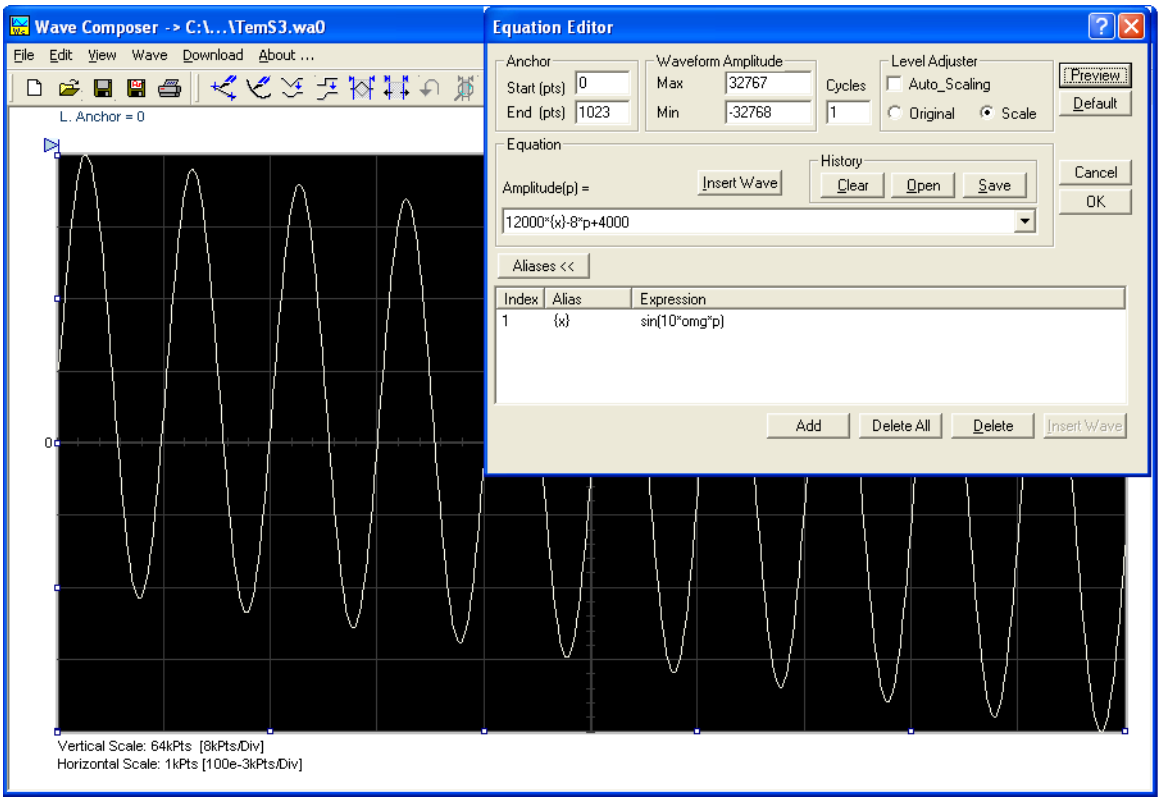

Figure 3-42: Equation Editor Example

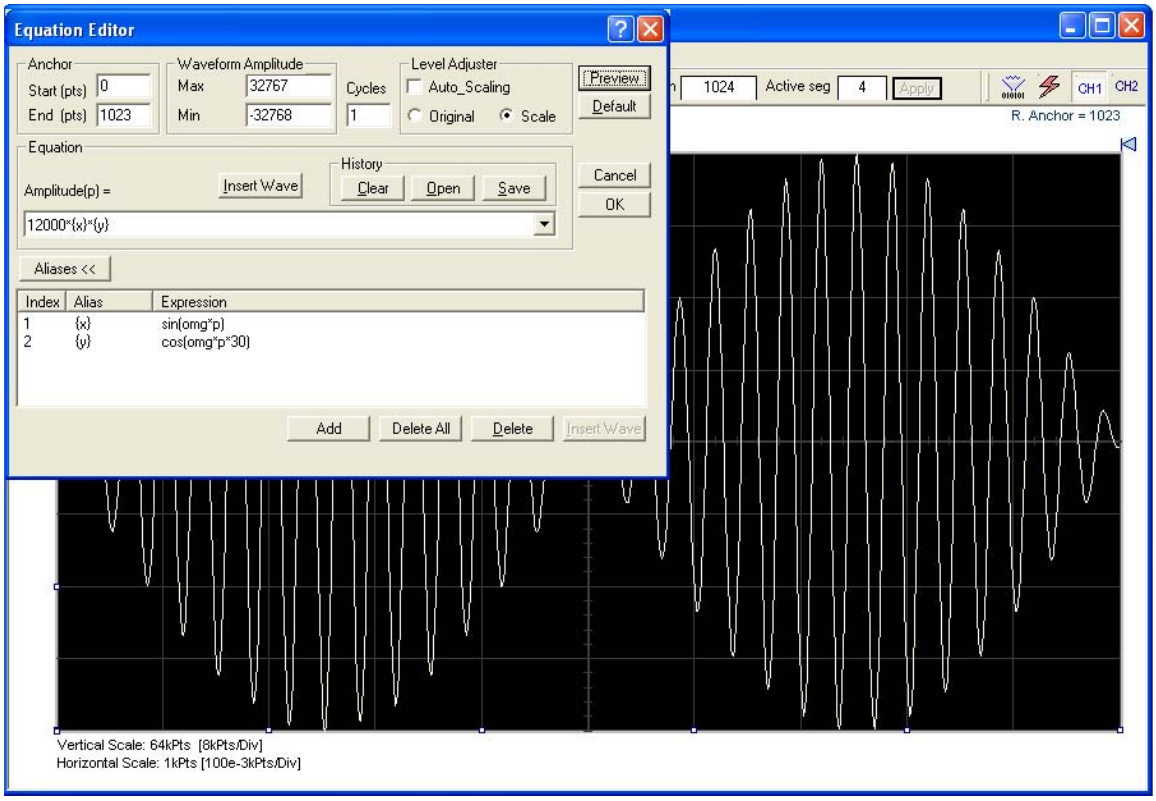

Figure 3-43: Using the Equation Editor to Modulate Sine Waveforms

In the following example, 20% second harmonic distortion has been added to a standard sinewave. The original waveform had a peak-to-peak value of 24000 points so 19% second harmonic is equivalent to 4500 points. The frequency of the second harmonic is obviously double that of the fundamental, so term +4500*sin(2*omg*p) is added to the original sine wave equation. Use the following equation:

Amplitude(p)=24000*sin(omg*p)+4500*sine(2*omg*p)

Press [Preview]. Your screen should look like Figure 3-44.

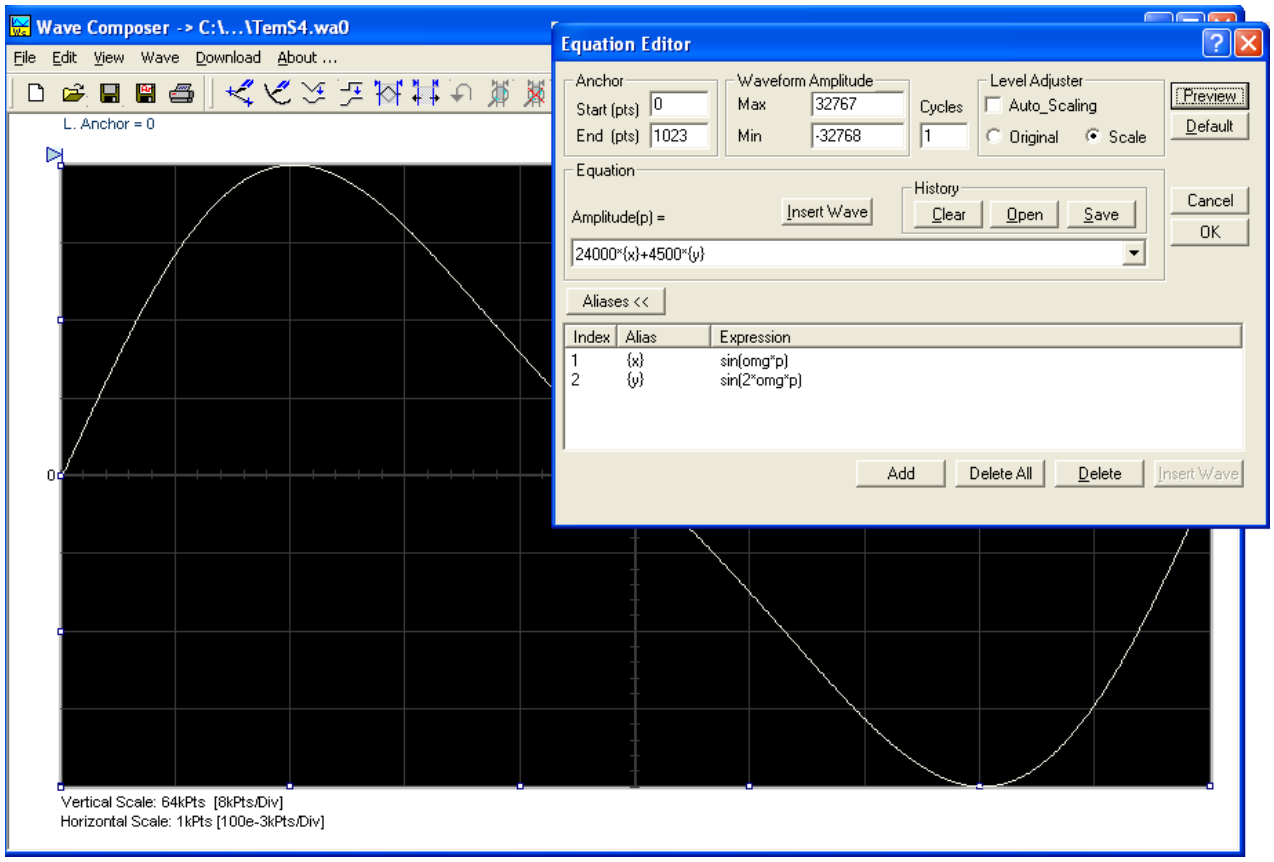

Figure 3-44: Using the Equation Editor to Add Second Harmonic Distortion

In Figure 3-45 we created 10 cycles of sinewave made to decay exponentially. The original expression for a standard sinewave is multiplied by the term e^(p/-250). Increasing the value of the divisor (200 in this case) will slow down the rate of decay.

Use the following equation:

Amplitude(p)=12000*sin(omg*p*10)*e^(p/-250)

Press [Preview]. Your screen should look like Figure 3-45.

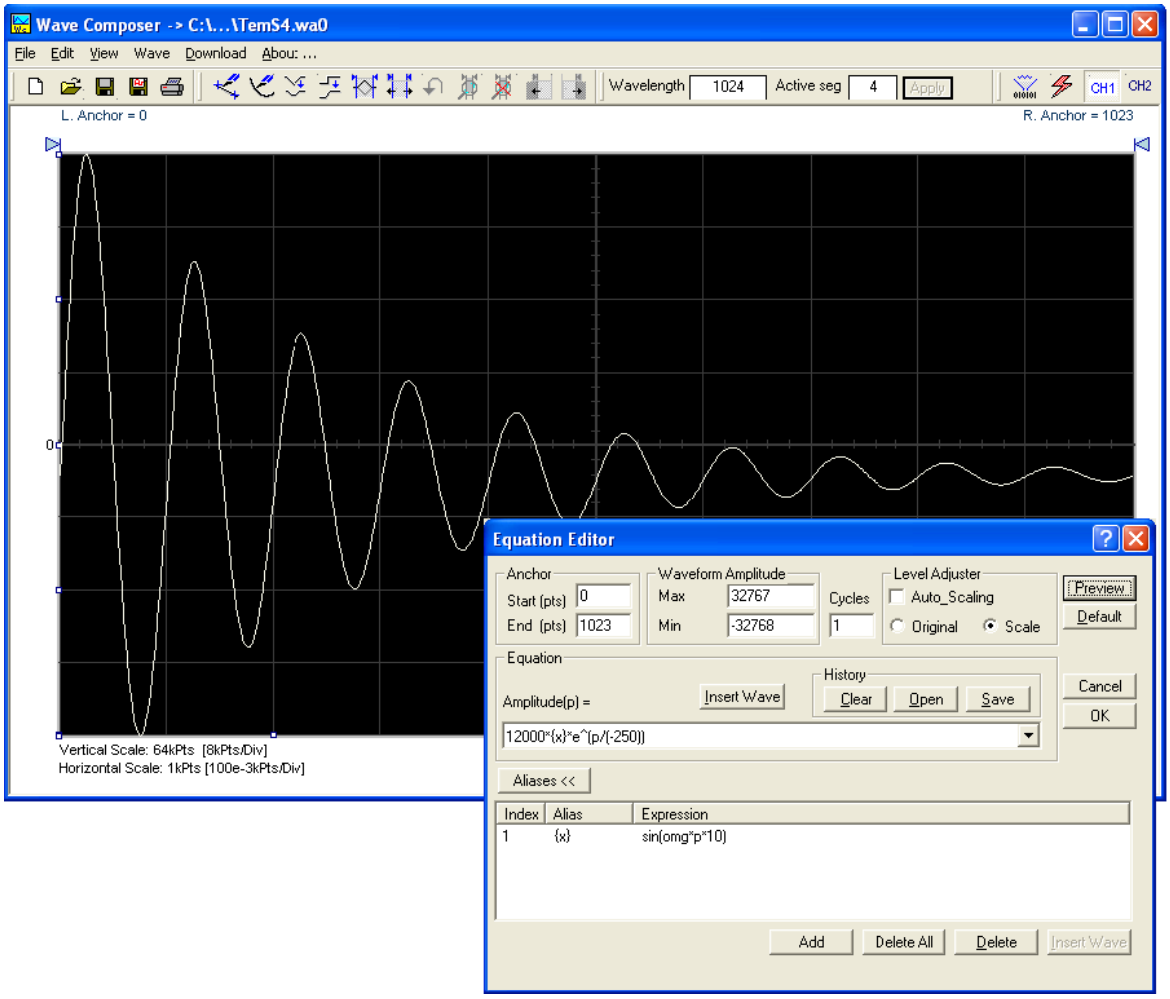

Figure 3-45: Using the Equation Editor to Generate Exponentially Decaying Sinewave

The last example as shown in Figure 3-46, is the most complex to be discussed here. Here, 100 cycles of sinewave are amplitude modulated with 10 cycles of sine wave with a modulation depth of 20%. To achieve this, the upper and lower sidebands are defined separately and added to the fundamental or carrier. The upper sideband is produced by the expression 100*cos(110*omg*p) and the lower sideband by the term 100*cos(90*omg*p).

Use the following equation:

Ampl(p)=6000*sin(100*omg*p)+1200*cos(110*omg*p)-1200*cos(90*omg*p)

Press [Preview]. Your screen should look like Figure 3-46.

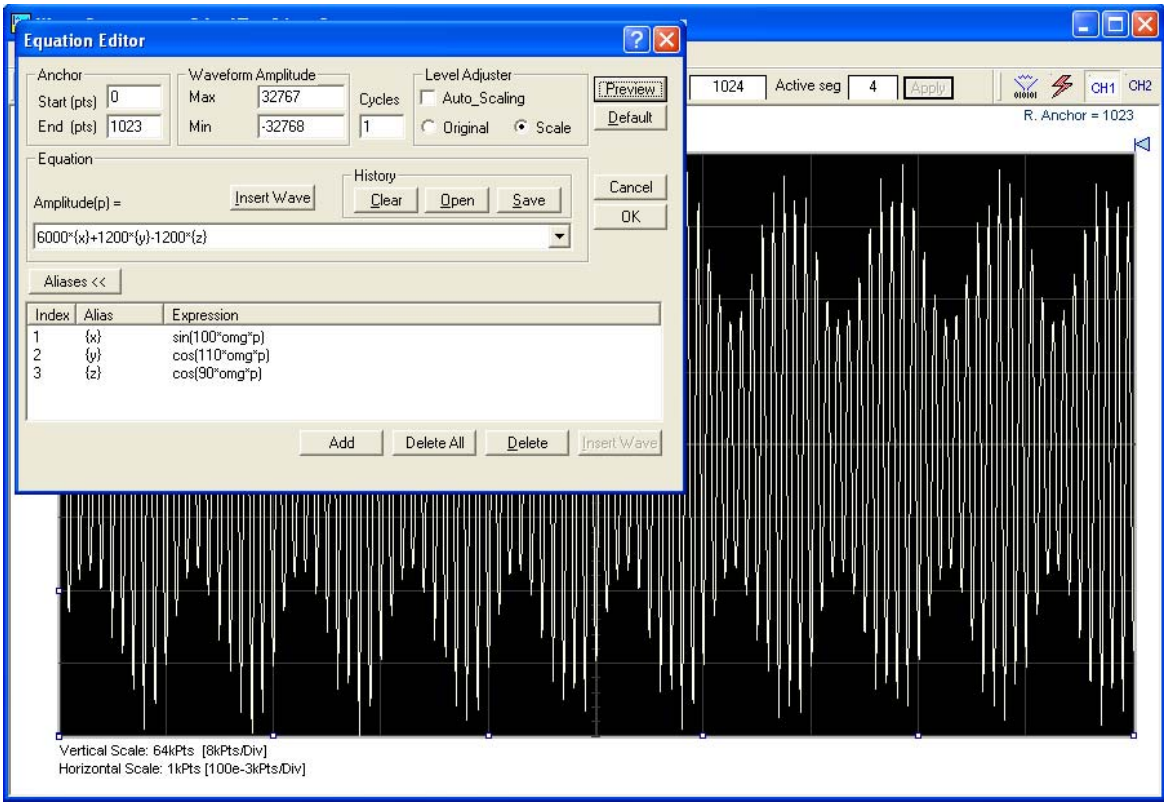

Figure 3-46: Using the Editor to Build Amplitude Modulated Signal with Upper and Lower Sidebands

Combining Waveforms

The last, but not least, powerful feature allows you to combine waveforms, which you previously stored on your hard drive. You can write mathematical expressions that contain waveforms, simple operands and trigonometric functions similar to the example given below. If you want to use waveforms in your equations, you must first generate these waves and store them on your hard drive. You identify waveforms by adding the *.wav extension as shown in the example below.

Amplitude(p)= Sine.wav*sin(omg*p*10)+Noise.wav/1000

The above equation will generate amplitude-modulated waveform with added noise. The following steps demonstrate how to create, store and combine waveforms using this equation.

Step 1 – Create and store sine.wav. Invoke the Wave command and generate a sine waveform. Press OK and then select the Save Waveform As… from the File command. Save this file using the name Sine.wav. Note where you store this waveform as you need to know the path for the next step.

Step 2 – Create and store Noise.wav. From the Wave command select *Noise*. Click OK and watch your waveform screen draw a

noisy signal. From the File menu select Save Waveform As… and save this waveform using the name Noise.wav.

Step 3 – Write and compute the original equation:

Amplitude(p)= c:/Sine.wav*sin(omg*p*5)+c:/Noise.wav/10

If you did not make any errors, your waveform screen should look as shown in Figure 3-47.

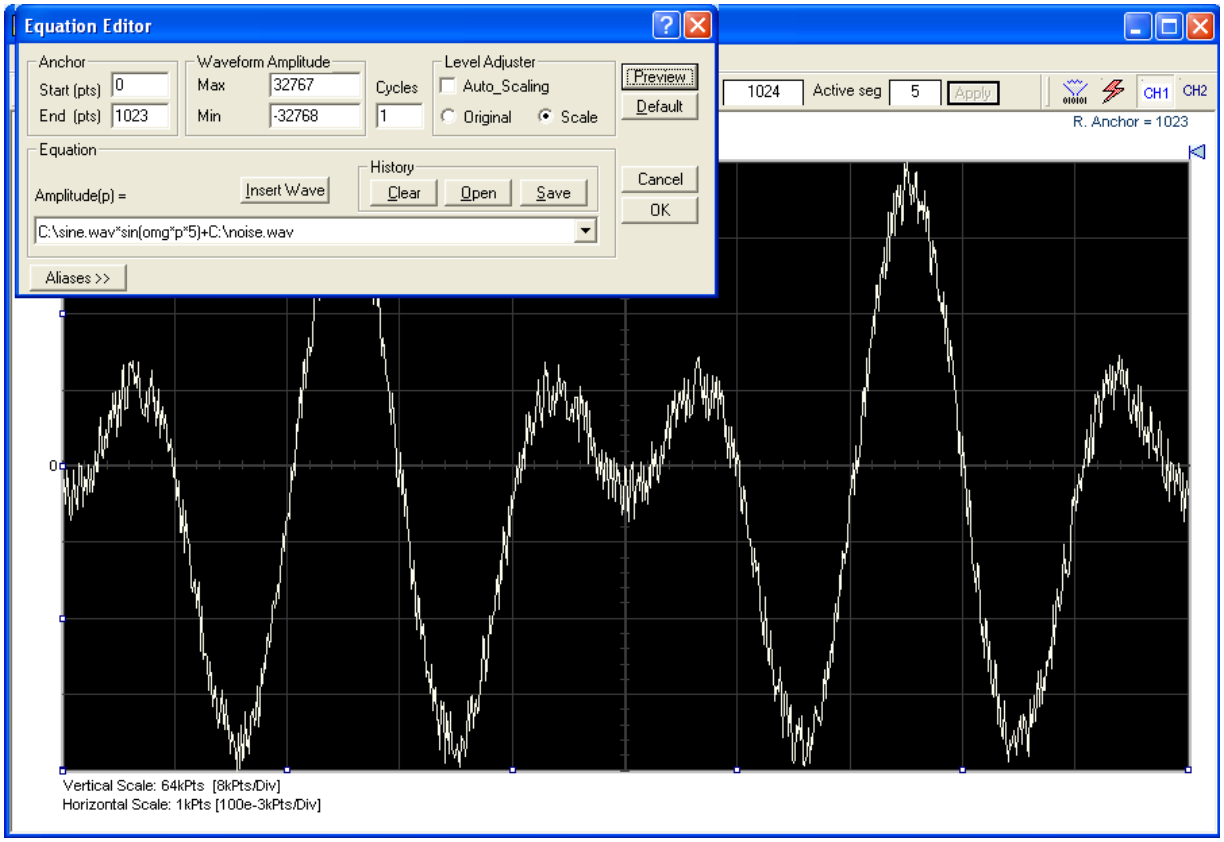

Figure 3-47: Combining Waveforms into Equations

The Pulse Composer

The Pulse Composer is a great tool for creating and editing pulses without the need to think about sample clock, number of points and complex equations. Pulses are created on the screen, simply and efficiently in a special dialog box, by typing in the width and level, or by using the “rubber band” method to place straight-line segments with the exact amplitude and time duration. The Pulse Composer can also multiply pulse sections to create pulse duplication along lengthy time intervals.

When you finally have your pulse design on the screen, the program determines if the pulse design will fit in one memory segment or use multiple segments and employ the sequence generator for repeatable segments. In either case, keep in mind that if you already have some waveforms stored in memory segments, these will be erased to make room for the new pulse design. If you insist on keeping arbitrary waveforms and still download complex pulses, you can check the “Force pulse to one segment” option and the waveform generator will do some extra “muscle flexing” to fit the pulse as required.

To launch the Pulse Composer, point and click on the Pulse tab in the Panels bar. Figure 3-48 shows an example of the pulse composer. The Pulse Composer has three main sections: Commands Bar, Toolbar and Waveform screens.

Refer to Figure 3-48 throughout the description of these sections.

The Pulse Composer Commands Bar

The Commands Bar provides access to standard Windows commands such as File, View, Tools and Help. In addition, there is Edit Train which is and **ArbConnection**-specific command.

In general, clicking on one of the commands opens a dialog box with an additional list of commands. Then, clicking on an additional command, will either open a dialog box, or generate an immediate action. For example, Clicking on File and then Exit will cause an immediate termination of the Pulse Composer. The various commands in the Commands bar are listed and described below.

File Commands

The File command has 4 command lines that control pulse waveform files. Also, use this command to print the active waveform, or exit the Pulse Composer program. Description of the various commands under File is given below.

New

The New (Ctrl+N) command will remove the waveform from the screen. If you made changes to the waveform area and use the New command, you should save your work before clearing the screen. The New command is destructive to the displayed waveform.

Open…
The Open… (Ctrl+O) command will let you browse through your disk space for previously saved pulse waveform files and load them to the pulse screen area. File extension that can be read to the pulse composer is *.pls.

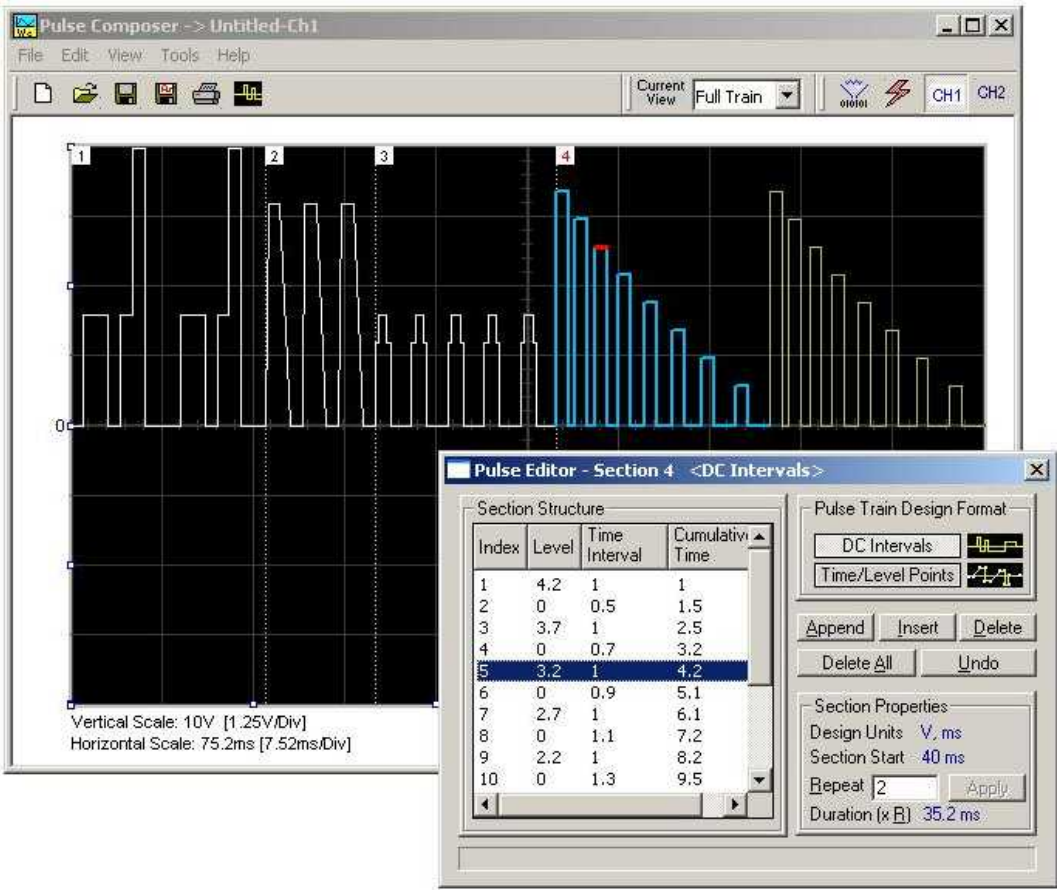

Figure 3-48: Pulse Composer Screen

Save
The Save (Ctrl+S) command will store the active waveform in your waveform generator directory with a *.pls extension. If this is the first time you save your waveform, the Save As… command will be invoked automatically, letting you select name, location and format for your waveform file.

Save As…
Use the Save As… command the first time you save your waveform. It will let you select name, location and format for your waveform file.

Print
With this command you may print the active Pulse Window. The standard printer dialog box will appear and will let you select printer setup, or print the waveform page.

Exit
The Exit Command ends the current Pulse Composer session and takes you back to the Panels screen. If you made changes to your waveform since it was last saved, the Wave Composer will prompt you to Save or Abandon these changes.

Edit Train Commands

The Edit Train Commands are used for adding or removing pulse train sections. Use these commands to Append, Delete, Insert, or Undo last operation. The editing commands are explained in the following paragraphs.

Append Section
The Append Section command lets you append a new section at the end of the pulse train. Only one new section can be appended at the end of the train. If an empty section already exists, the append command will alert for an error. New sections are always appended at the end of the pulse train.

Insert Section
The Insert Section command lets you insert a new section in between sections that were already designed. Only one new section can be inserted at the middle of the train. If an empty section already exists, the insert command will alert for an error.

Delete Section
The Delete Section command lets you remove sections from the pulse train without affecting the rest of the train. If you use this command from the Edit menu, make sure that the section you want to remove is currently the active section.

Remove all Sections
The Remove all Sections command lets you remove the entire pulse design from the pulse screen and start from a fresh page.

Undo
The Undo command undoes the last editing operation. This command is extremely useful in cases where you unintentionally delete a section from the pulse train and want to restore it to the screen.

View Commands

The View Commands allow you to view various sections of the pulse area. The View commands include: Pulse Editor, Full Train or individual Sections, Channel 1 and 2 screens and Options. Description of the View Commands is given in the following.

Pulse Editor
The View Pulse Editor Command invokes a dialog box as shown in Figure 3-49. In general, the Pulse Editor is used for placing straight-line segments on the screen in intervals that define pulse width, rise/fall times and amplitude. Information how to use the Pulse Editor to create pulse trains is given later in this chapter.

Full Train
The Full Train view shows all sections of the pulse train on the pulse screen. Eventually, when all pulse sections have been designed, the entire pulse train, as shown when the Full Train option has been selected, will be downloaded to the instrument as a single waveform.

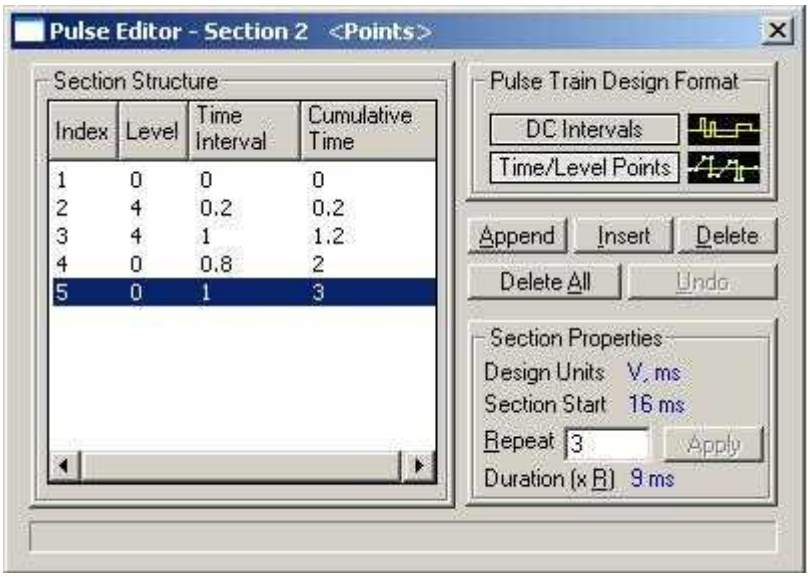

Figure 3-49: Pulse Editor

Single Section
The Single Section view shows one section at a time on the pulse screen. Eventually, when all pulse sections have been designed, the entire pulse train (as shown), when the Full Train option has been selected, will be downloaded to the instrument as a single waveform.

Channel 1
The Channel 1 view command updates the waveform screen with the Channel 1 pulse train. If you have not yet generated a waveform for channel 1, the waveform screen will show a clear display.

Channel 2
The Channel 2 view command updates the waveform screen with the Channel 2 pulse train. If you have not yet generated a waveform for channel 2, the waveform screen will show a clear display.

Options
The view options command opens the dialog box as shown in Figure 3-50. Use this dialog box to fine-tune the Pulse Composer to direct how it should deal with operational modes and the waveform memory. Information on options is given later in this chapter.

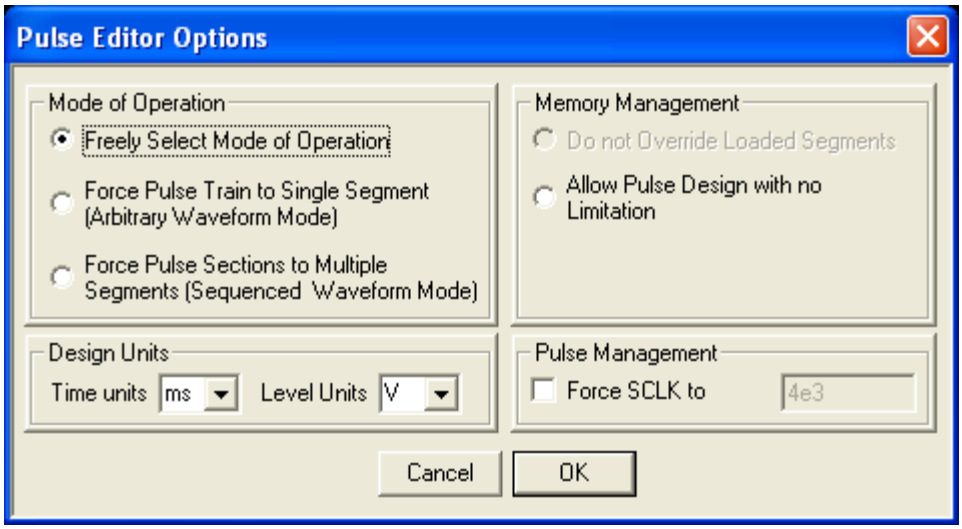

Figure 3-50: Pulse Editor Options

Tools Commands

The Tools Commands let you download pulse trains to either Channel 1 or Channel 2. You can also clear the entire waveform memory using the Clear Memory command.

Note

The Clear Memory command affects the entire waveform memory of the waveform generator and therefore, be careful not to erase memory segments that you'll need to use with the arbitrary function.

The Pulse Composer Toolbar

The toolbar contains icons for editing the waveform screen, icons for saving and loading waveforms, fields for selecting an active channel and more. The Toolbar is shown in Figure 3-51. The icons, from left to right, operate the following functions: New waveform, Open an existing waveform file, Save pulse train, Save pulse train As, Print the screen and Open the Pulse Editor dialog box. Other icons select the current view on the screen, show Channel 1 and Channel 2 waveforms, clear the memory and download the displayed pulse train to the active channel.

Figure 3-51: Pulse Composer Toolbar Icons

Creating Pulses

As mentioned above, creating pulses with the Pulse Editor is simple and intuitive, just as you would draw the pulse on a piece of paper. The Pulse Editor then processes the information, determines the appropriate mode and converts to waveform coordinates for downloading to the instrument, for it to generate the required pulse shape.

There are a number of terms that will be used throughout the following description. Familiarize yourself with these terms before proceeding with the actual design of your pulse.

Pulse Editor
The Pulse Editor is the prime tool for creating pulses. To invoke the Pulse Editor, point and click on the Pulse Editor icon on the Pulse Composer toolbar. You can also invoke the editor by the Pulse Editor dialog box is shown in Figure 3-51.

Pulse Train
The Pulse Train identifies the entire pulse design. When downloading the waveform to the instrument, the entire pulse train will be downloaded, even if part of the pulse train is displayed on the pulse composer screen.

Pulse Section
The Pulse Train is constructed from 1 or more sections. If the pulse is simple, it can be created using one section only. For a more complex pulse train, the train can be divided into smaller sections and each section designed separately, for simplicity. Figure 3-52 shows a complex pulse train, which was made from five simpler sections. Figure 3-52a shows the design of the fifth section only, of the pulse train.

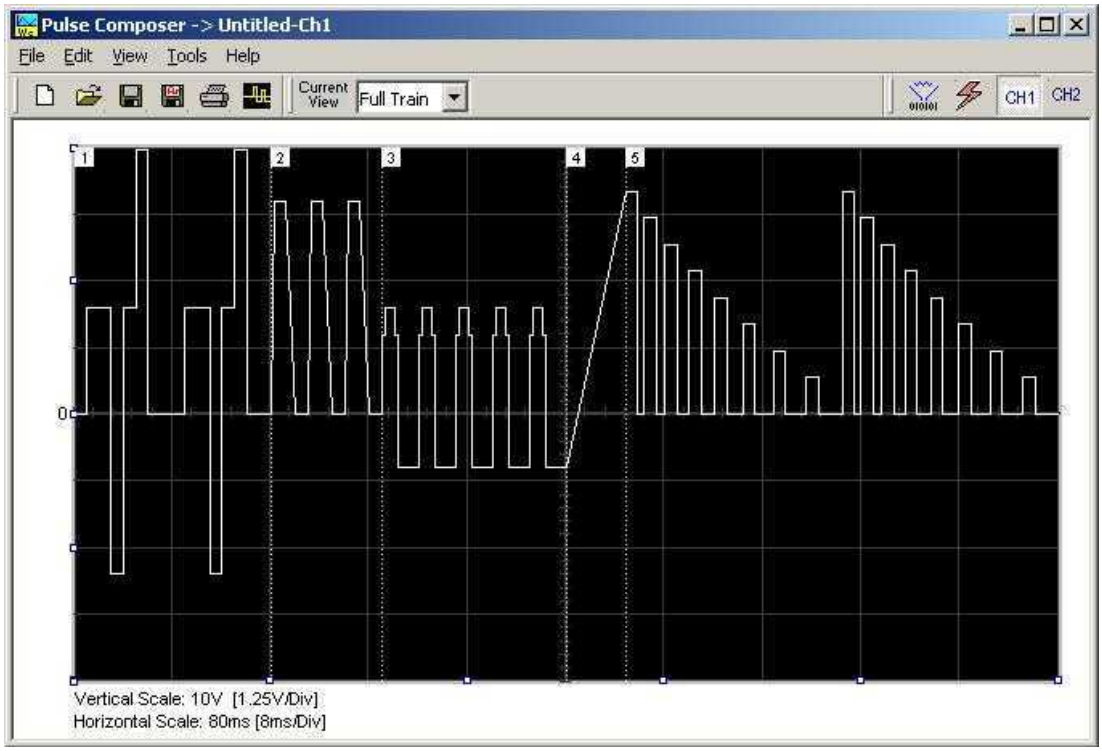

Figure 3-52: Complete Pulse Train Design

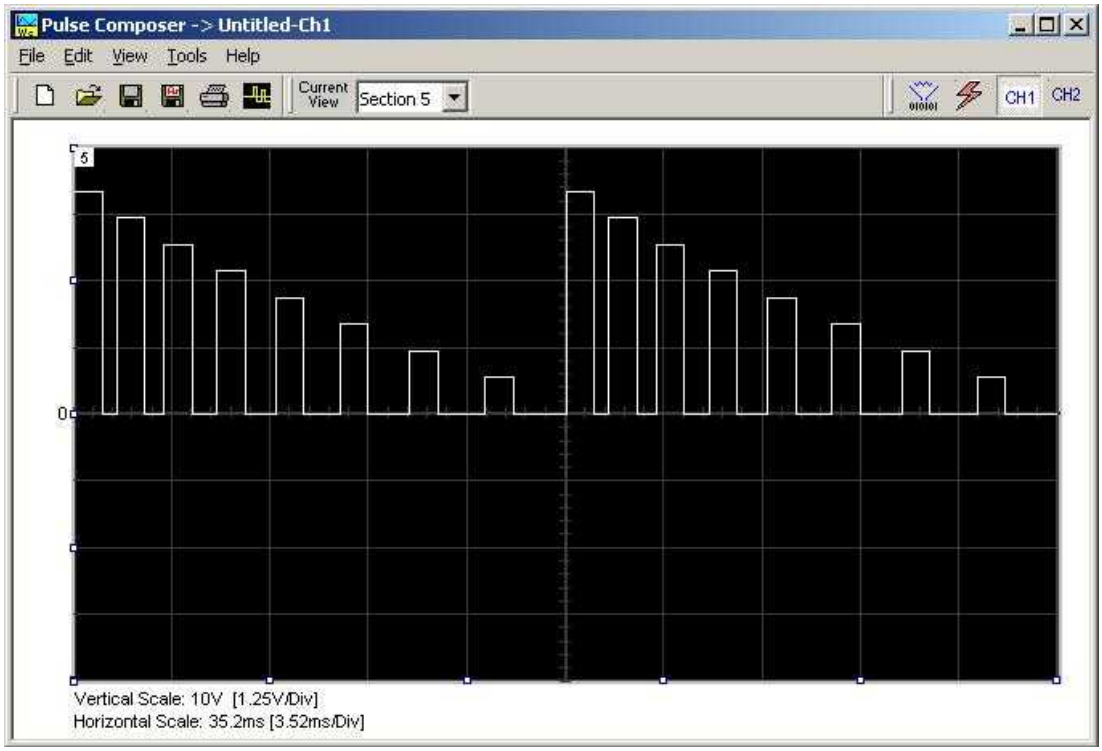

Figure 3-52a: Section 5 of the Pulse Train Design

Now that we somewhat understand the terms we use for the pulse design, we can start with an example on how to design the pulse train as shown in Figures 3-52 and 3-52a. If you already have some pulses shown on your pulse composer screen, click on New to start from a fresh page. Another step before you design your pulse train is to set the design parameters in the options menu that will determine the way that the pulse will be distributed in your waveform memory. Click on View→Options and refer to Figure 3-54 throughout the following description.

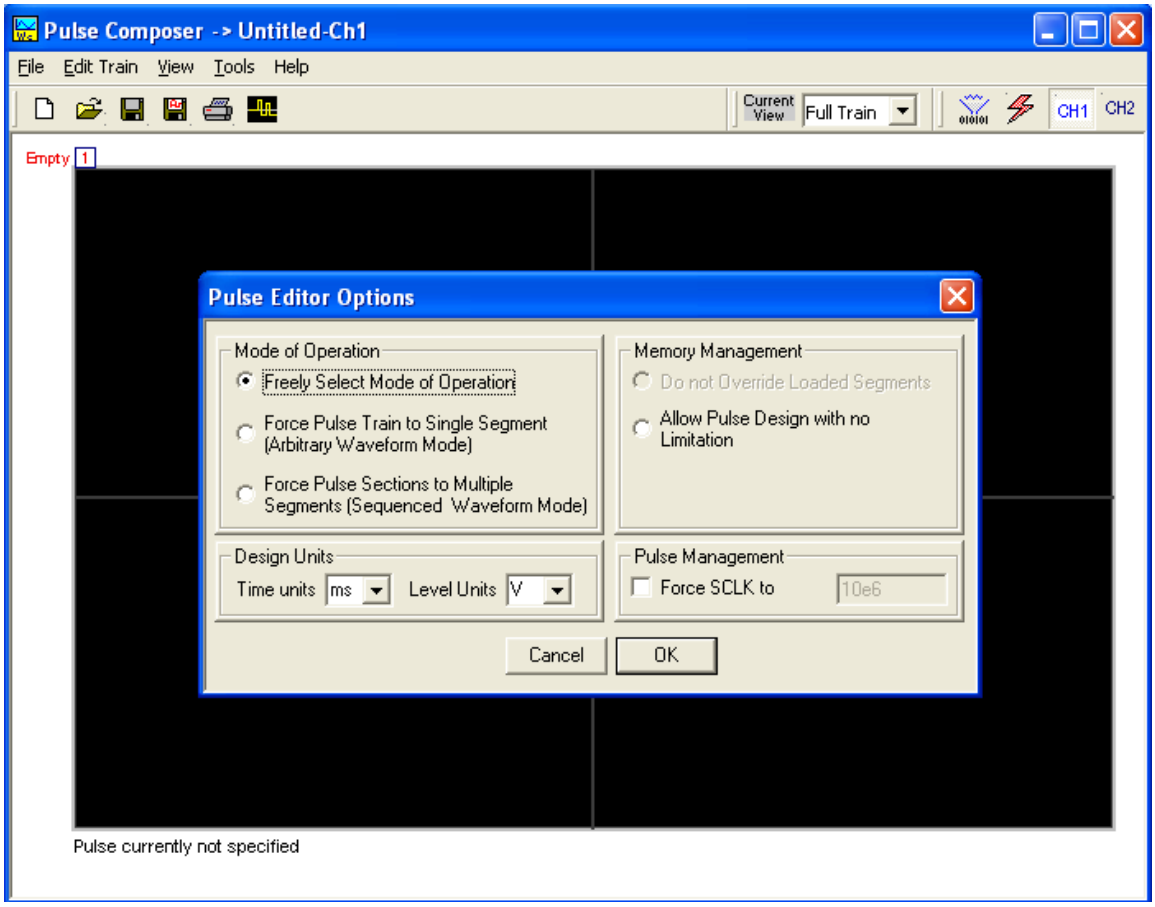

Figure 3-53: Selecting Pulse Editor Options

Setting the Pulse Editor Options

As shown in Figure 3-53, the Pulse Editor option dialog box is divided to functional groups: Mode of Operation, Design Units, Memory Management and Pulse Management. These groups are described below.

Mode of Operation
There are three options in the mode of operation group.

The Force Pulse Train to Single Segment option is recommended if you are using one pulse section only. In this case, the pulse waveform will occupy one segment only and the generator will automatically be set to operate in arbitrary mode.

The Force Pulse Sections to Multiple Segments option will place each section of the pulse train into a different memory segment and the generator will automatically be set to operate in sequenced mode. Select this option for the example we are going to build later.

If you are not sure what to do, select the Freely Select Mode of Operation and the generator will do the work for you.

Design Units
As you design your pulse pattern, it will be easier if you design it using the exact units as you would want to output to your load. Select between μs, ms and s for the pulse intervals and mV or V for the amplitude level. Select ms and V for the example we are going to build later.

Memory Management
There are two options in the Memory Management group.

The Do Not Override Loaded Segments option will make sure that whatever waveforms you already stored for the arbitrary function will stay intact after you save your pulse waveform.

The Allow Pulse Design with no Limitations option may overwrite memory segments that you already used previously for the arbitrary function. However, this is the recommended option for the program and for the example we are going to build later.

Pulse Transition Management
The Pulse Management Parameter enables you to force the instrument to use a specified sample clock. The Pulse Composer creates the designed pulse with the least amount of memory possible. Therefore the Force SCLK allows you to set the increment between points so that a higher resolution can be achieved. This option is also a must when downloading 2 different pulses to 2 channels. Without the Force SCLK each time a pulse is downloaded to a channel a new SCLK will be set changing the Pulse in the other channel.After you complete setting the Pulse Editor options, point and click on OK.

Using the Pulse Editor

The prime tool for building pulse patterns on the Pulse Composer screen is the Pulse Editor. To invoke the Pulse Editor, point and click on the Pulse Editor icon on the tools bar. Refer to Figure 3-54 for the following descriptions.

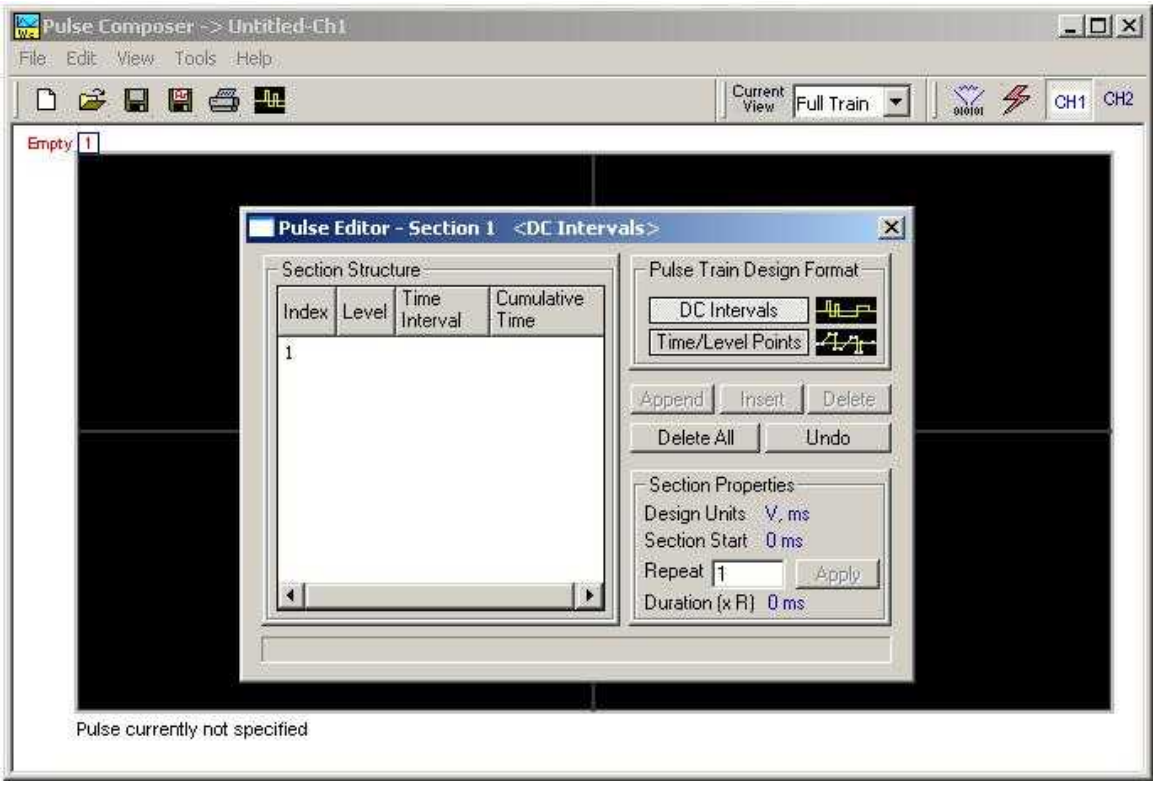

Figure 3-54: Using the Pulse Editor

The Pulse Editor, as shown in Figure 3-54, has four groups: Section Structure, Pulse Train Design Format, Section Properties and control buttons. These groups are described below.

Pulse Train Design Format

There are two methods (or formats) that can be use for designing the pulse shape: DC Intervals and Time/Level Points. The design format is unique for the current section and cannot be switched during the section design.

DC Intervals – programs pulse duration using DC levels only. Transition times for this format are at the maximum rate that the generator can produce. For example, if you want to draw a simple square waveform that has 0V to 3.3V amplitude, 50% duty cycle and 1ms period, you enter the following parameters:

Index = 1, Level = 3.3, Time interval = 0.5 (Cumulative Time = 0.5)
Index = 2, Level = 0, Time Interval = 0.5 (Cumulative Time = 1.0)

Note as you build the segments that the pulse is being drawn on the screen as you type in the parameters. Also note that the Cumulative Time column is updated automatically with the cumulative time lapse from the start of the pulse.

Time/Level Points – programs pulse turning points using level and time markers. This format is a bit more complex to use. However, it allows pulse designs that require linear transition times. For example, if you want to draw a simple square waveform that has 0V to 3.3V amplitude, 50% duty cycle, 1ms period and 100ns transition times, you enter the following parameters:

Index = 1, Level = 0, Time interval = 0, (Cumulative Time = 0)
Index = 2, Level = 3.3, Time Interval = 0.1, (Cumulative Time = 0.1)
Index = 3, Level = 3.3, Time interval = 0.4, (Cumulative Time = 0.5)
Index = 4, Level = 0, Time interval = 0.1, (Cumulative Time = 0.6)
Index = 5, Level = 0, Time interval = 0.4, (Cumulative Time = 1.0)

Note as you build the segments, that the pulse is being drawn on the screen as you type in the parameters and the specified point is marked with a red dot. Also note that the Cumulative Time Column is updated automatically with the cumulative time lapse from the start of the pulse.

Section Structure
The term Section Structure is used to define parts of the pulse train that share common properties. There are four parameters that can be programmed in this group: Index, Level, Time Interval and Cumulative Time.

Index – Is added automatically as you program pulse segments. The index line is highlighted as you point and click on Pulse Segments on the pulse editor screen.

Level – Specifies that peak level of the programmed segment. As you build the pulse, the level window is automatically expanded to fit the required amplitude range. Note however, there is a limit to the level, which is determined by the generator's peak-to-peak specification.

Time Interval – Specifies the time that will lapse for the current index level. You can program the time interval and the cumulative time will be adjusted accordingly.

Cumulative Time – Specifies the time that will lapse from the start of the current pulse section. You can program the cumulative time and the last time interval will be adjusted accordingly.

Section Properties
The Section Properties contain a summary of properties that are unique for the current section.

Design Units – Provide information on the units that are used when you draw the pulse segments. These units can be changed in the Pulse Editor options.

Section Start – Provides timing information for the start of the current section. If this is the first pulse section, the value will always be 0. Subsequent sections will show the start mark equal to the end mark of the previous section.

Repeat – Allows multiplication of pulse segments without the need to re-design repetitive parts. After you enter a repeat value, press the Apply button to lock in the repeat multiplier.

Duration – Displays the time that will lapse from the start of the pulse section to the end. The duration shows the total time lapse, including the repeated sections.

Control Buttons
The Control Buttons allow appending, inserting, and deleting one or all index lines. The Undo button is useful in cases where an error was made and restoration of the last operation is critical.

Pulse Example, Section 1

Now that we are more familiar with the Pulse Editor and its options, we are ready to start building the first section of the pulse as shown in Figure 3-55. Point and click on the New icon and open the pulse editor. Type in the level and time intervals as shown in Figure 3-55. Note that the pulse segments are being created on the screen as you type the values.

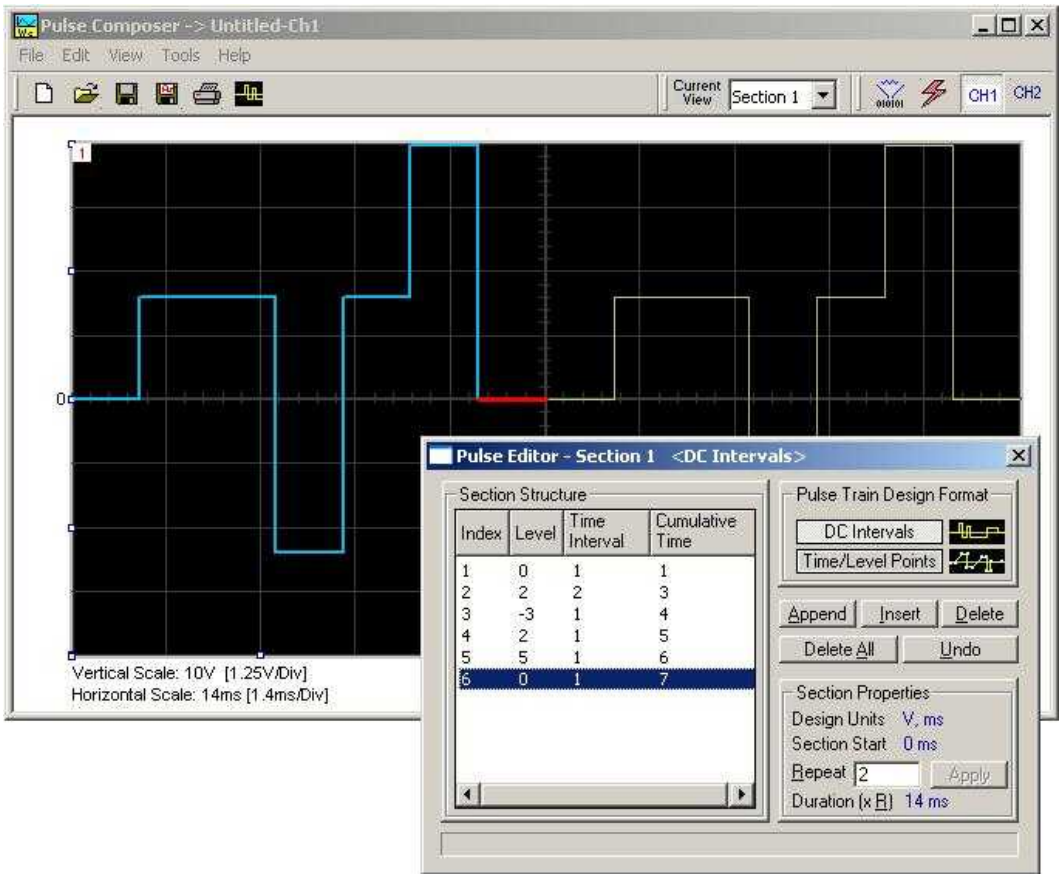

Figure 3-55: Building Section 1 of the Pulse Example

Tips

1. Use the Tab button to edit the Section Structure fields.
2. Use Append to add an index line at the end of the list.
3. Use Insert to add a segment above a focused line.

Before we proceed with the design of the next section, pay attention to some values that are now available on the composer screen. On the left bottom corner of the composer, Vertical Scale is showing 10 V (1.25 V/Div) and Horizontal Scale is showing 14 ms (1.4 ms/Div). These two values are critical for the integrity of the design, because they are later being interpreted by the program and converted to waveform coordinates that the generator can process and output as a pulse shape. These values may change as you add more sections to the pulse train.

Pulse Example, Section 2

The first pulse section is complete. We are ready now to start building the second section of the pulse as shown in Figure 3-56. Point and click on the Edit command and select the Append Section option. A new section number will appear, but it will appear empty next to the section identifier.

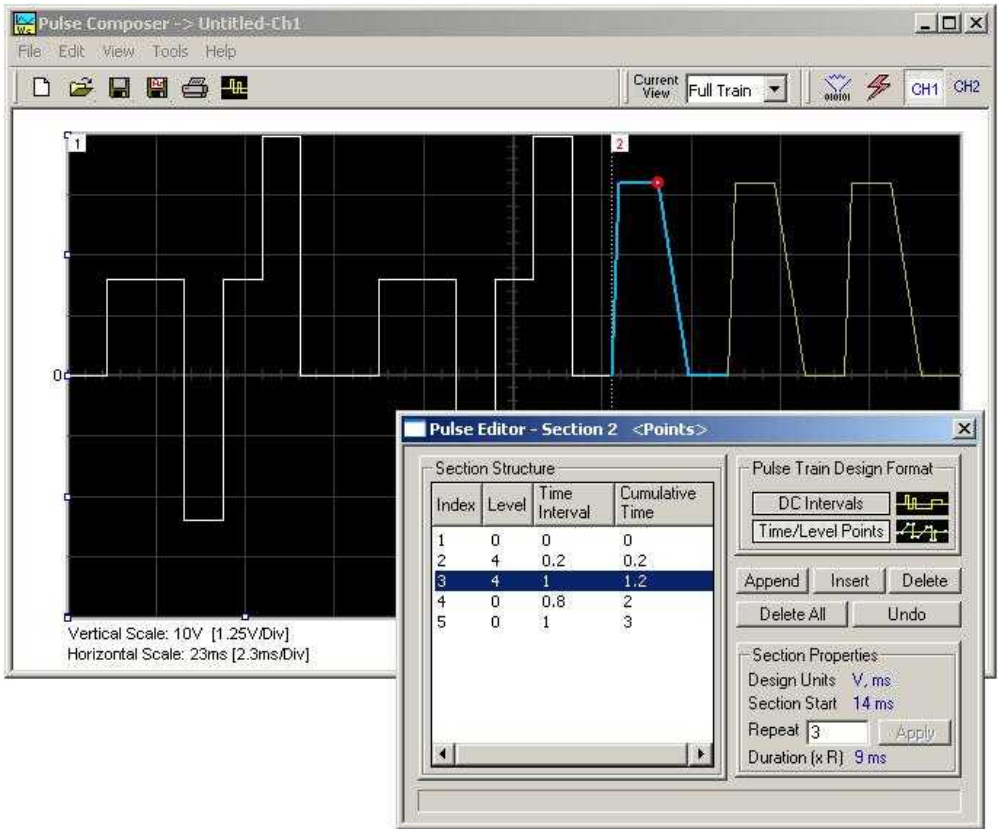

Figure 3-56: Building Section 2 of the Pulse Example

Before you start entering values to this section, note that there are linear transitions required first. Therefore, select the Time/Level Points option in the Pulse Train Design Format. You are now ready to start programming values. In case you made a mistake and want to switch design formats after typing in some values, the Pulse Editor will show an error, alerting you that design format can only be changed for the empty section. In this case, the only way to recover is to delete all entries and start from an empty index list. Type the section entries as shown in Figure 3-56.

Pulse Example, Section 3

The second pulse section is complete. We are ready now to start building the third section of the pulse as shown in Figure 3-57. Point and click on the Edit command and select the Append Section option. A new section number will appear, but it will show empty next to the section identifier.

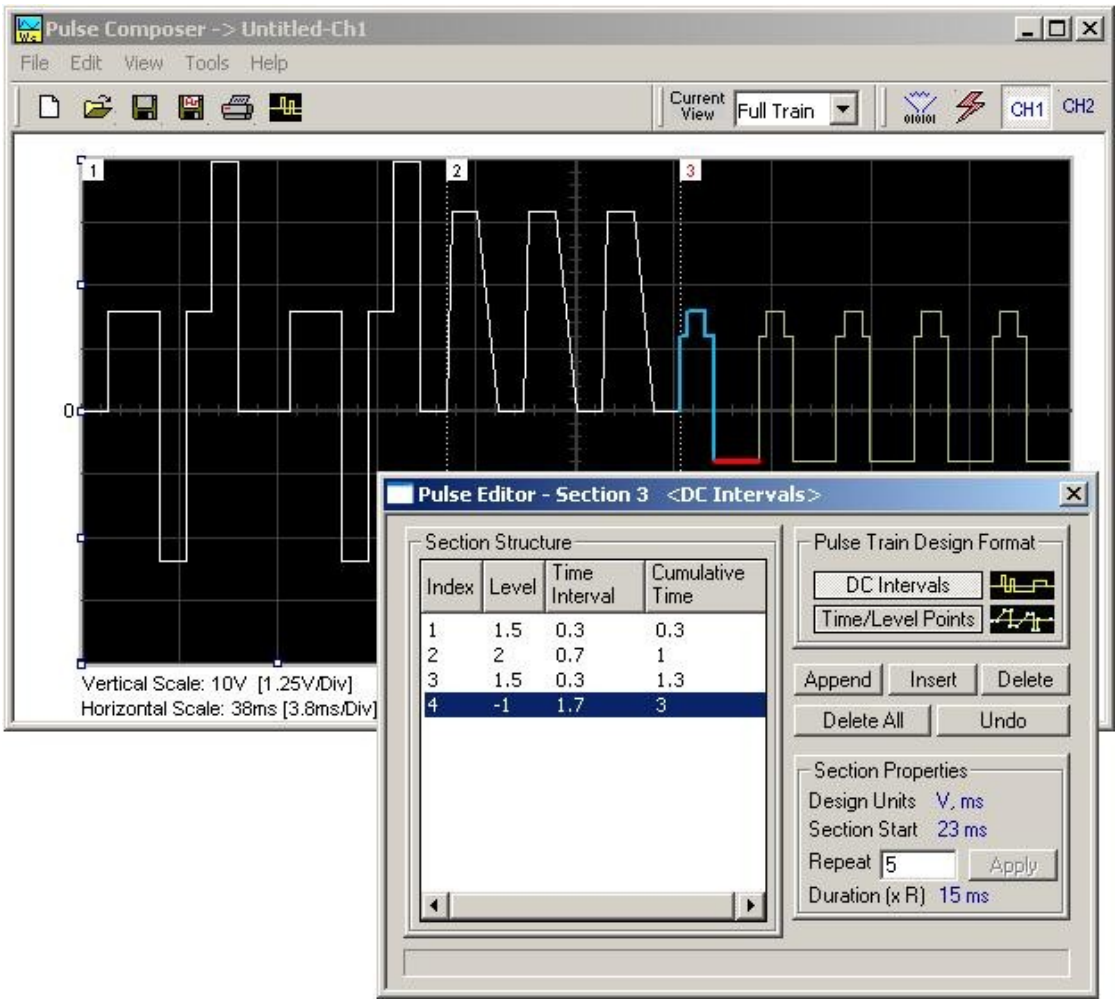

Figure 3-57: Building Section 3 of the Pulse Example

Before you start entering values to this section, note that there are fast transitions required for this section. Therefore, select the DC Intervals option in the Pulse Train Design Format. You are now ready to start programming values. In case you made a mistake and want to switch design formats after typing in some values, the Pulse Editor will show an error alerting you that design format can only be changed for an empty section. In this case, the only way to recover is to delete all entries and start from an empty index list. Type the section entries as shown in Figure 3-57.

Pulse Example, Section 4

The third pulse section is complete. We are ready now to start building the forth section of the pulse as shown in Figure 3-58. Point and click on the Edit command and select the Append Section option. A new section number will appear and will show empty next to the section identifier.

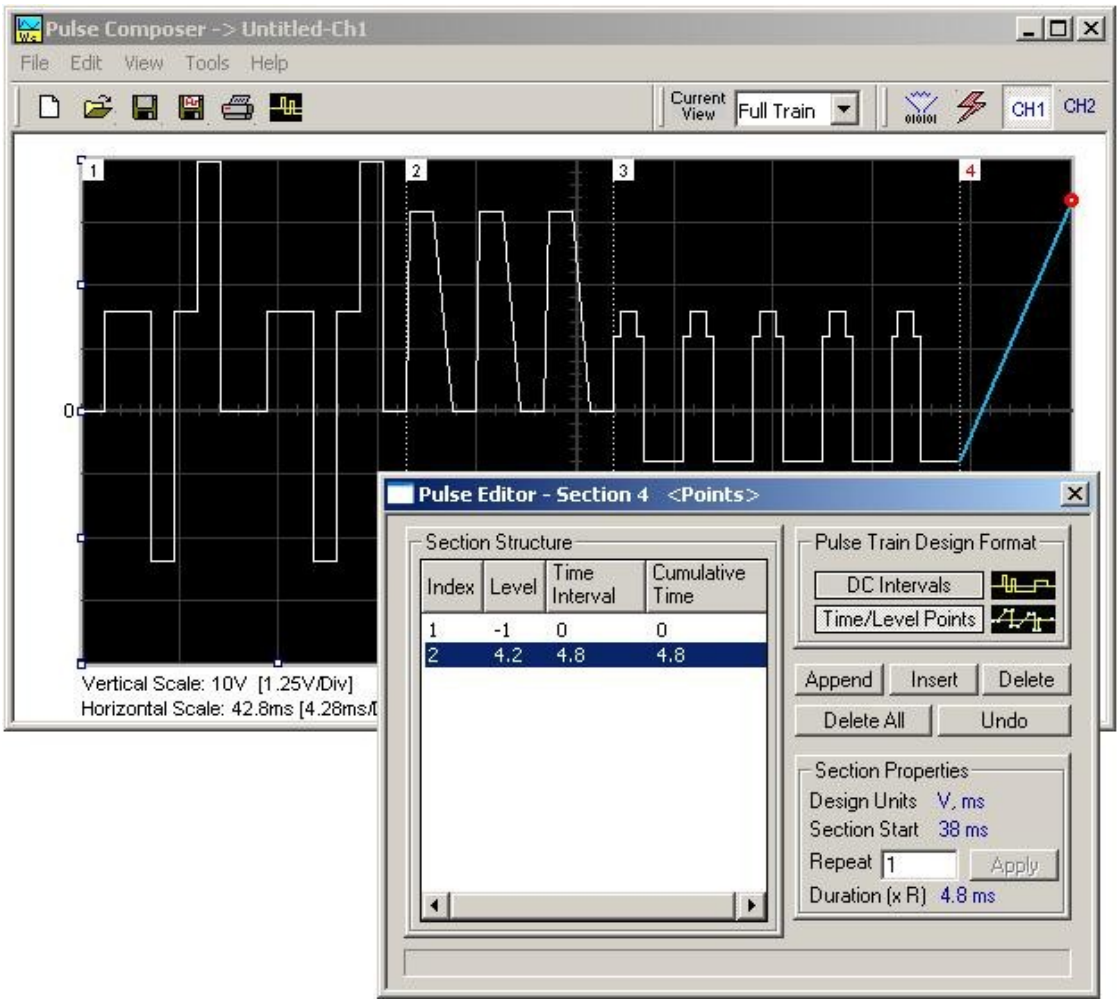

Figure 3-58: Building Section 4 of the Pulse Example

Before you start entering values to this section, note that there is only one linear transition required for this section that starts from the last point of the previous section and connects to the start point of the next section. Therefore, select the Time/Level Points option in the Pulse Train Design Format. You are now ready to start programming values. Type the section entries as shown in Figure 3-58.

Pulse Example, Section 5

The fourth pulse section is complete. We are ready now to start building the fifth and final section of the pulse as shown in Figure 3-59. Point and click on the Edit command and select the Append Section option. A new section number will appear and will show empty next to the section identifier.

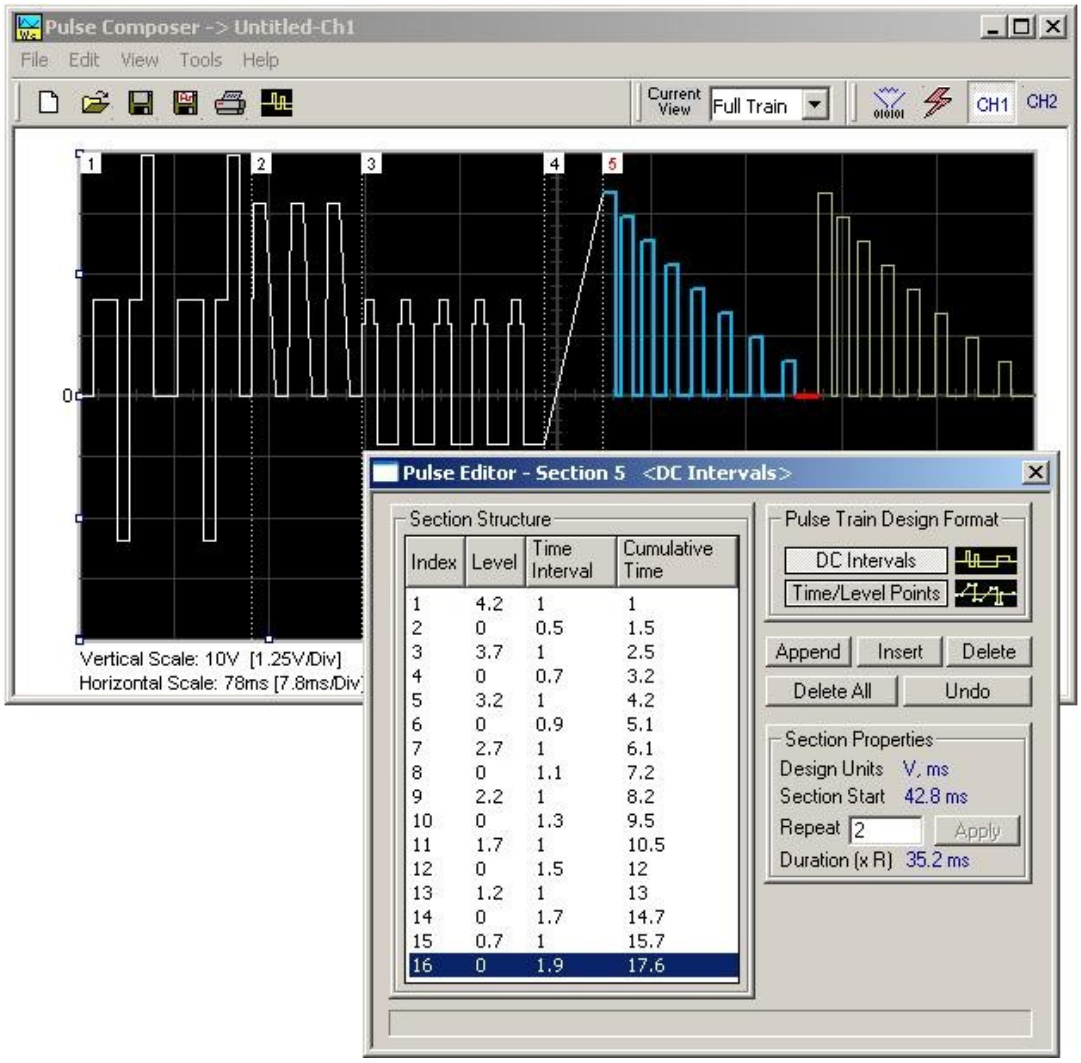

Figure 3-59: Building Section 5 of the Pulse Example

Note that there are fast transitions required for this section that starts from the last point of the previous section and connects to the start point of the next section. Therefore, select the Time/Level Points option in the Pulse Train Design Format. You are now ready to start programming values. Type the section entries as shown in Figure 3-59.

Downloading the Pulse Train

Congratulations for coming this far! If you followed the above description on how to build this pulse example, the screen should look exactly as shown in Figure 3-60. If you are pleased with the results, the next step is to download what you see on the Pulse Composer screen to the generator.

One more step before you download the waveform to the instrument is to check the Pulse Train Download Summary as appears after you press the Download icon. You can also view the same information if you select it from the View menu. Refer to Figure 3-60 and the next section for information on how to interpret your download summary.

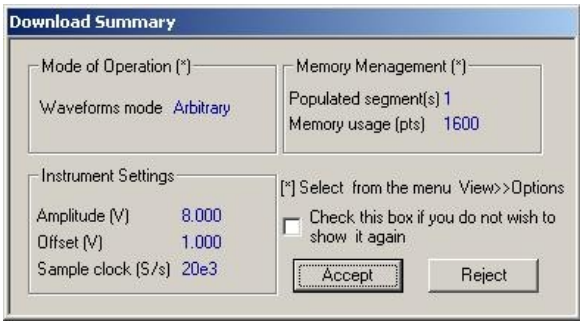

Figure 3-60: Pulse Editor Download Summary

Interpreting the Download Summary

It is very important to understand that when you download a pulse waveform from the Pulse Composer, parameters and mode of operation may change settings on your generator. The download summary shows what will change and allows you to reject the new settings if you do not agree to the changes. Once you press the Accept button, the waveform will be downloaded to the generator and the modes and parameters updated as shown in the dialog box. If you are already familiar with the changes and do not care to see the download summary every time you download a pulse waveform, you can check the box and it will not be shown on your next download. You can restore this summary from the View>>Download Summary command.

Mode of Operation – This describes the new setting of the operating mode. This field could display one of two options: Arbitrary or Sequenced. Pay attention to the note (*) that says "Select from the Menu View>>Options" Since we checked the Force Pulse Train to Single Segment (see Figure 3-53), the generator

determines that the waveform mode is arbitrary and only one segment can be loaded with the pulse train.

Memory Management – By selecting the Arbitrary mode of operation, the pulse train is forced to a single segment. This summary shows which segment has been populated and how much memory was used to build the required pulse train.

Instrument Settings – Shows the amplitude, offset and sample clock settings that will be changed on the generator. The settings in this summary cannot be affected from the Pulse Editor options settings. These are being computed and modified specifically for the current pulse train pattern and will change from pattern to pattern.

Accept/Reject – These buttons are the final step before you download the pulse train to the instrument. If you are unhappy with the instrument setting and want to change some of the options, there is still time: Point and click on the Reject button and make your changes. Point and click on the Accept button to complete the download process.

The FM Composer

The FM Composer looks and feels almost like the Waveform Composer, except there is a major difference in what it does. If you look at the opening screen as shown in Figure 3-61, you'll see that the vertical axis is marked with frequencies. You'll see later that as you draw waveforms on the FM composer screen, these waveforms represent frequency changes and not amplitude changes as are generated by the Waveform Composer.

The FM composer is a great tool for controlling frequency agility by generating the agility curve as an arbitrary waveform. For example, if you create a sine waveform, the Tabor waveform generator will generate frequency-modulated signal that will follow the sine pattern. The resolution and accuracy of the modulated waveform is unsurpassed and can only be duplicated by mathematical simulation. The FM composer is loaded with many features and options, so use the following paragraphs to learn how to create and download modulating waveforms to the Tabor waveform generator using the FM Composer.

Invoke the FM Composer from the Panels bar. The FM Composer has three sections: Commands bar, Toolbar and Waveform screen. Refer to Figure 3-61 throughout the description of these parts.

The Commands Bar

The Commands Bar is an exact duplicate of the Commands Bar in the Wave Composer. It provides access to standard Windows commands such as File and View.

In general, clicking on one of the commands opens a dialog box with an additional list of commands. Subsequently, clicking on an additional command either opens a dialog box, or generates an immediate action. For example, clicking on File and then Exit will cause an immediate termination of the FM Composer. On the other

hand, clicking on Wave and then on Square, will open a Square Wave dialog box that lets you program and edit square wave parameters. The various commands in the Commands Bar are listed and described below.

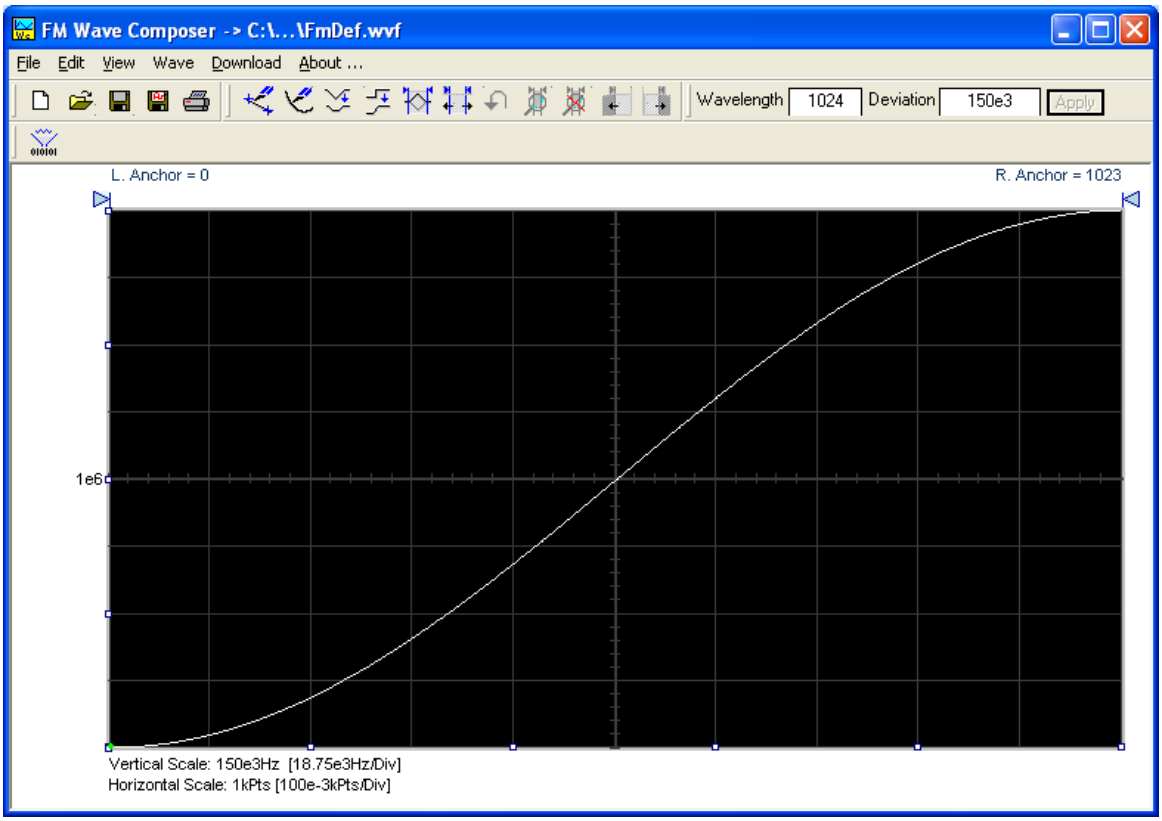

Figure 3-61: The FM Composer Opening Screen

File Commands

The File command has 4 command lines that control waveform files. Additionally use this command to exit the FM composer program. Description of the various commands under File is given below.

New Waveform

The New Waveform command removes the waveform from the screen. If you made changes to the waveform area and use this command, you should save your work before clearing the screen. The New Waveform command deletes the displayed waveform.

Open Waveform…

The Open Waveform… command lets you browse your disk for previously saved waveform files and loads these waveforms to the waveform area. This command is also very useful for converting waveform files to format that is acceptable by the Wave Composer.

Save Waveform
The Save Waveform command will store your active waveform in your waveform generator directory, as a binary file with a *.wvf extension. If this is the first time you save your waveform, the Save Waveform As… command will be invoked automatically, letting you select name, location and format for your waveform file.

Save Waveform As…
Use the Save Waveform As… command the first time you save your waveform. It will let you select name, location and format for your waveform file.

Print
With this command you may print the active Waveform Window. The standard printer dialog box will appear and will let you select printer setup, or print the waveform page.

Exit
The Exit command ends the current FM Composer session and takes you back to the Panels screen. If you made changes to your waveform since it was last saved, make sure to Save your work before you use this command.

Wave Commands

The Wave Commands let you create waveforms on the screen. The Wave Commands has a library of 8 waveforms: Sine, Triangle, Square, Exponent, Sinc, Gaussian, Pulse, and Noise. It also lets you create waveforms using an Equation Editor. Information how to create waveforms using the Wave commands is given below.

Creating Waveforms From the Built-in Library
You can create any waveform from the built-in library using the Wave command. Clicking on one of the Wave options will open a dialog box. An example of the Sine waveform dialog box is shown in Figure 3-62. This dialog box is representative of the rest of the waveforms, so other waveforms will not be described.

Creating Sine Waveforms
Use the following procedure to create sine waveforms from the built-in library. Click on Wave, then Sine… the dialog box as shown in Figure 3-62 will appear. You can now start programming parameters that are available in this box.

Start Point Anchor – Defines the first point where the created wave will start. Note that if you change the start point the left anchor will automatically adjust itself to the selected start point. The example shows start point set at point 200.

End Point Anchor – Defines where the created waveform will end. Note that as you change the end point the right anchor will automatically adjust itself to the selected end point. The example shows end point set at point 500.

Max. Peak Deviation – This parameter defines the forward peak deviation. Note that the forward peak deviation cannot exceed the pre-defined Deviation parameter as shown on the Toolbar. In case you need to exceed the pre-defined peak value, you must quit this box and modify the Deviation parameter to provide sufficient range for the forward peak deviation range.

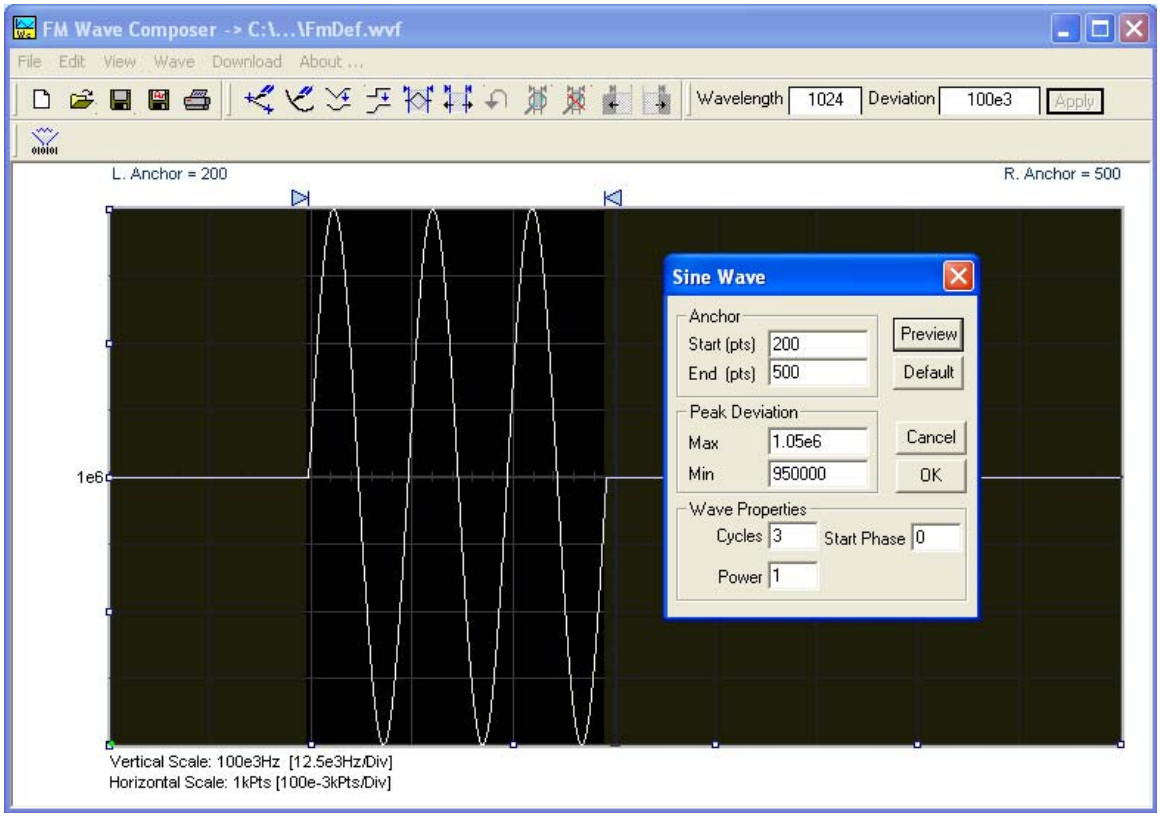

Figure 3-62: Generating Sine Modulation Using the FM Composer

Min. Peak Deviation – This parameter defines the backwards peak deviation. Note that the backwards peak deviation cannot exceed the pre-defined Deviation parameter as shown on the Toolbar. In case you need to exceed the pre-defined peak value you must quit this box and modify the Deviation parameter to provide sufficient range for the backwards peak deviation range.

Cycles – The Cycles parameter defines how many sine cycles will be created within the specified start and end anchor points. The example below shows three sine cycles.

Start Phase – The start phase parameter defines the angle of which the sine will start. The example shows 0° start phase.

Power – Sine to the power of 1 will generate a perfect sine. Power range is from 1 through 9.

Tip

The functionality of the FM Composer is similar to the Wave Composer. If you need more information on the FM composer functions, features and its Equation Editor, refer to the Wave Composer section in this manual information.

The 3D Composer

The 3D Composer was specifically designed for simultaneous profiling of amplitude, frequency and phase. Amplitude profiles can be designed separately for Channels 1 and 2, but both channels share frequency and phase profiles. The following paragraphs will describe the various sections of the 3D Composer and will guide you through some 3D programming examples.

The opening screen of the 3D Composer is shown in Figure 3-63. As you can see, it does not at all look like any of the other composers that were described previously. However, generating waveforms and programming profiles is very similar to other composers, so you will be up and running in no time.

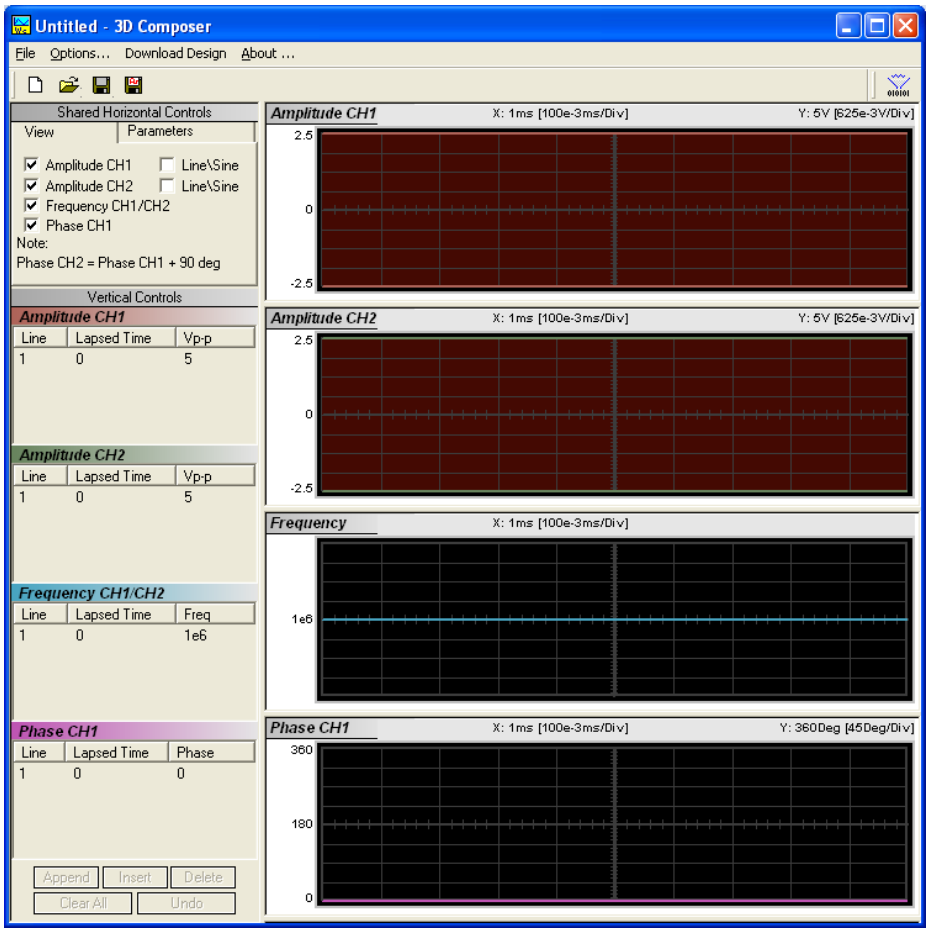

Figure 3-63: 3D Composer Screen

The 3D Composer has three main sections: Shared horizontal Controls, Vertical Controls and Graphical Screens. The panels on the left are used for designing the waveform parameters and the screens on the right side depict the shape of the profile. Below find a detailed description of all of these sections. Refer to Figure 3-63 throughout the description.

Shared Vertical Parameters

The *Shared Horizontal Control* has two tabs: *View* and *Parameters*.

View

The *View* tab is useful if you are interested in programming one or two profiles only and do not need to see other screens. Check the boxes for the profiles you wish to program only, and these will be shown on the screen. For example, if you check the Amplitude CH1 and the Frequency CH1/CH2 options, the Amplitude CH2 and Phase CH1 screens will not be visible.

There is also a check box for each Amplitude profile for a simple sine wave. Click the Line/Sine box for a single cycle of a sine wave.

Parameters

The *Parameters* tab is used for setting up the duration of the signal, the position of the marker (if required) and the amount of memory that is allocated for this purpose. Setting up the parameters correctly in this group is the basic and the most important task, before you start designing 3D waveforms. The duration can be set in units of ns, us, ms and seconds, and can be programmed within the range of 800 ns to 30,000 s.

The 3D Profiler behaves just like an arbitrary waveform. The shape of the profiler is generated using waveform points and a dedicated 3D sample clock. So, just like the basics for an arbitrary waveform design, the duration is derived from the following relationship:

Duration = SCLK / # of waveform points

Where SCLK is the 3D sample clock and the # of waveform points can be programmed from 2 to 30,000.

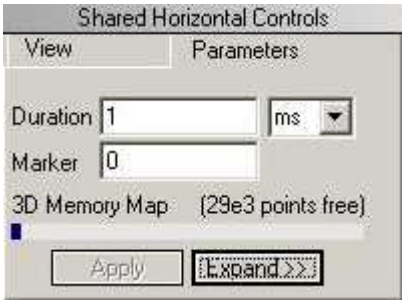

Figure 3-64: Parameters Tab

It is preferable to let the 3D Composer set up the sample clock and the numbers of points automatically for you. However, in some cases you may fine-tune your requirements by pressing the Expand button. Figure 3-65 shows the Expanded Parameters Options dialog box.

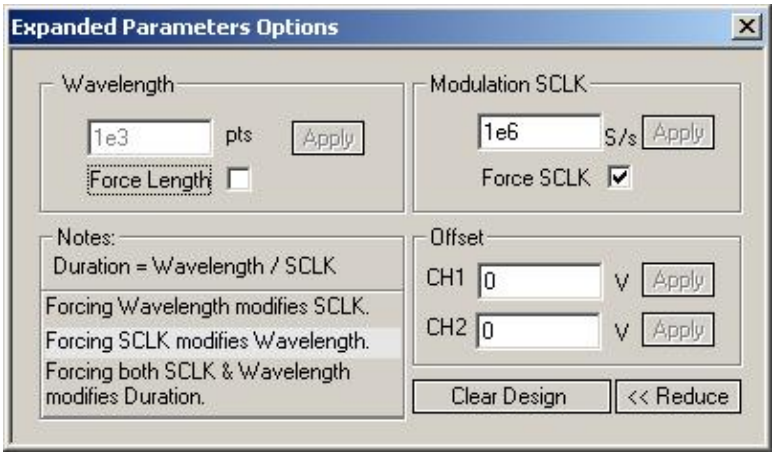

Figure 3-65: Expanded Parameters Options Dialog Box

The Expanded Parameters Options dialog box has three sections: Wavelength, Modulation SCLK and Offset. The wavelength and the modulation SCLK control the duration of the entire wave through the following relationship:

Duration = Modulation SCLK / Wavelength

Each of the parameters has a finite length and therefore, the duration has maximum and minimum intervals. The modulation SCLK has a range of 1 Hz to 2.5 MHz and the Wavelength is limited from 2 points to 30,000 points. As a result, the duration can be programmed from 800 ns to 30,000 s.

If you do not need to control the wavelength and the SCLK, then you can leave the task for the 3D Composer. In that case, you must leave the Force Length and Force SCLK check boxes unmarked. If you check the Force Length box, the wavelength will be modified automatically to match the selected duration, as shown in Figure 3-65. If you check the Force SCLK box, the modulation SCLK will be modified automatically to match the selected duration. Finally, if you check both the Force Length and the Force Modulation SCLK boxes, the duration of the 3D profile will be affected.

To modify wavelength or modulation SCLK, check the appropriate box, modify the value and click on the Apply button to force the selected value. Any successive changes that you make to the edit fields require that you click on the Apply button to accept the new value.

The Offset group controls DC offsets of the modulated waveform. Changing offset does not affect other parameters except the location of the waveform along the vertical axis.

The Clear Design button resets the 3D composer and the Reduce button closes the dialog box.

Vertical Controls

The Vertical Controls are used for profiling amplitude, frequency and phase. When you modify the fields in any of the controls, the associated graphical screens are automatically updated with the assigned values and display the profile as designed in the vertical control fields. The Vertical Controls are shown in Figure 3-66. You can start designing profiles only when one of the control fields is active. Control fields become active when you click on a control field. Note in the Figure 3-66 below that the Amplitude CH2 control was removed from the group. This was done by unchecking the Amplitude CH2 check box in the View group.

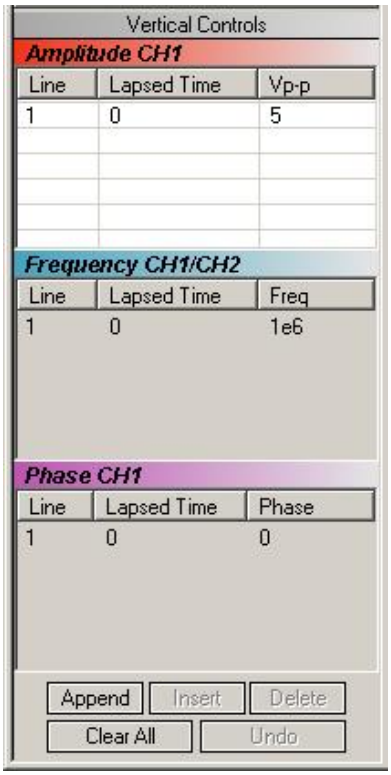

Figure 3-66: 3D Vertical Controls

Graphical Screens

The *Graphical Screens* are shown in Figure 3-67. You cannot change anything on the screens. However, anything that you design in the Vertical Controls fields will automatically be updated and displayed on the graphical screens.

Note in the Figure 3-below that the Amplitude CH2 graphical screen was removed from the group. This was done by not checking the Amplitude CH2 check box in the View group.

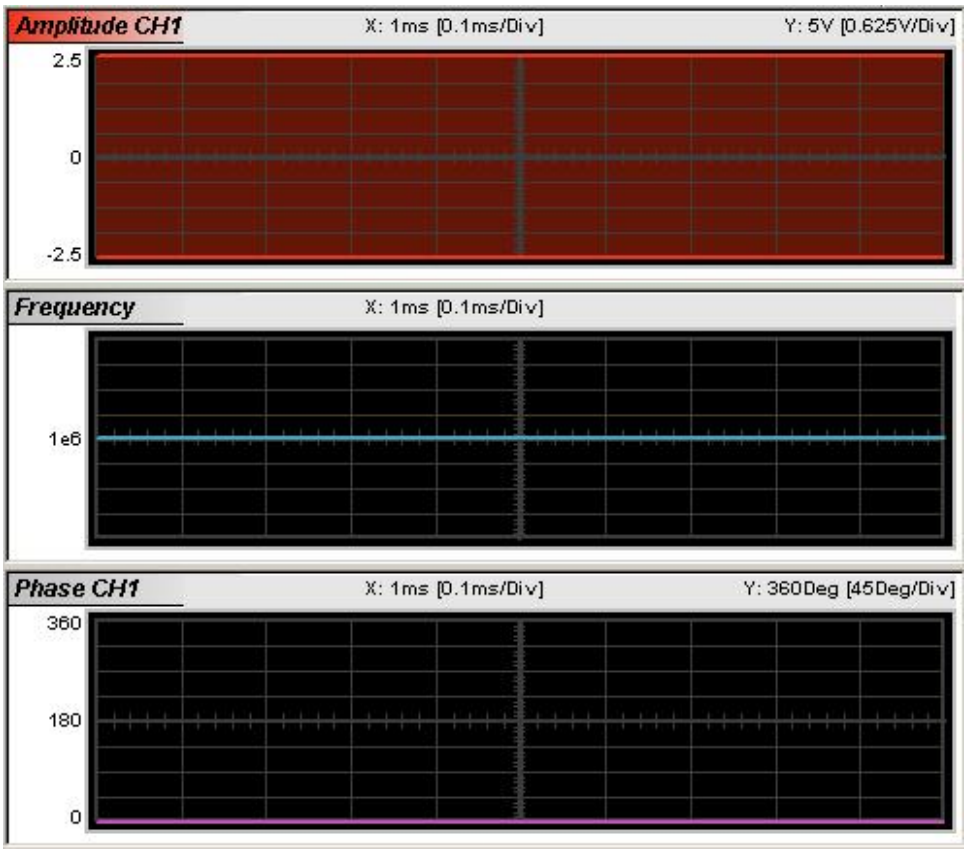

Figure 3-67: 3D Graphical Screens

Designing 3D Profiles

3D Profiles are designed in the Vertical Controls fields. Notice that there are four separate control fields: Amplitude CH1, Amplitude CH2, Frequency CH1/CH2 and Phase CH1. Amplitude control is separate for channels 1 and 2. However, frequency is common to both channels. The phase parameter is designed for channel 1 only but is automatically converted to phase + 90° for channel 2.

Always start the design from the Shared Horizontal Controls group. In the View group, remove profiles that you do not care to change. Click on the Parameters tab and set up the duration of the waveform. An example of a 3D profile (chirp, in this example) is shown in Figure 3-68. Profiles were designed for Channel 1, Frequency and Phase. As you can see, the duration of the waveform was selected to be 100 ms.

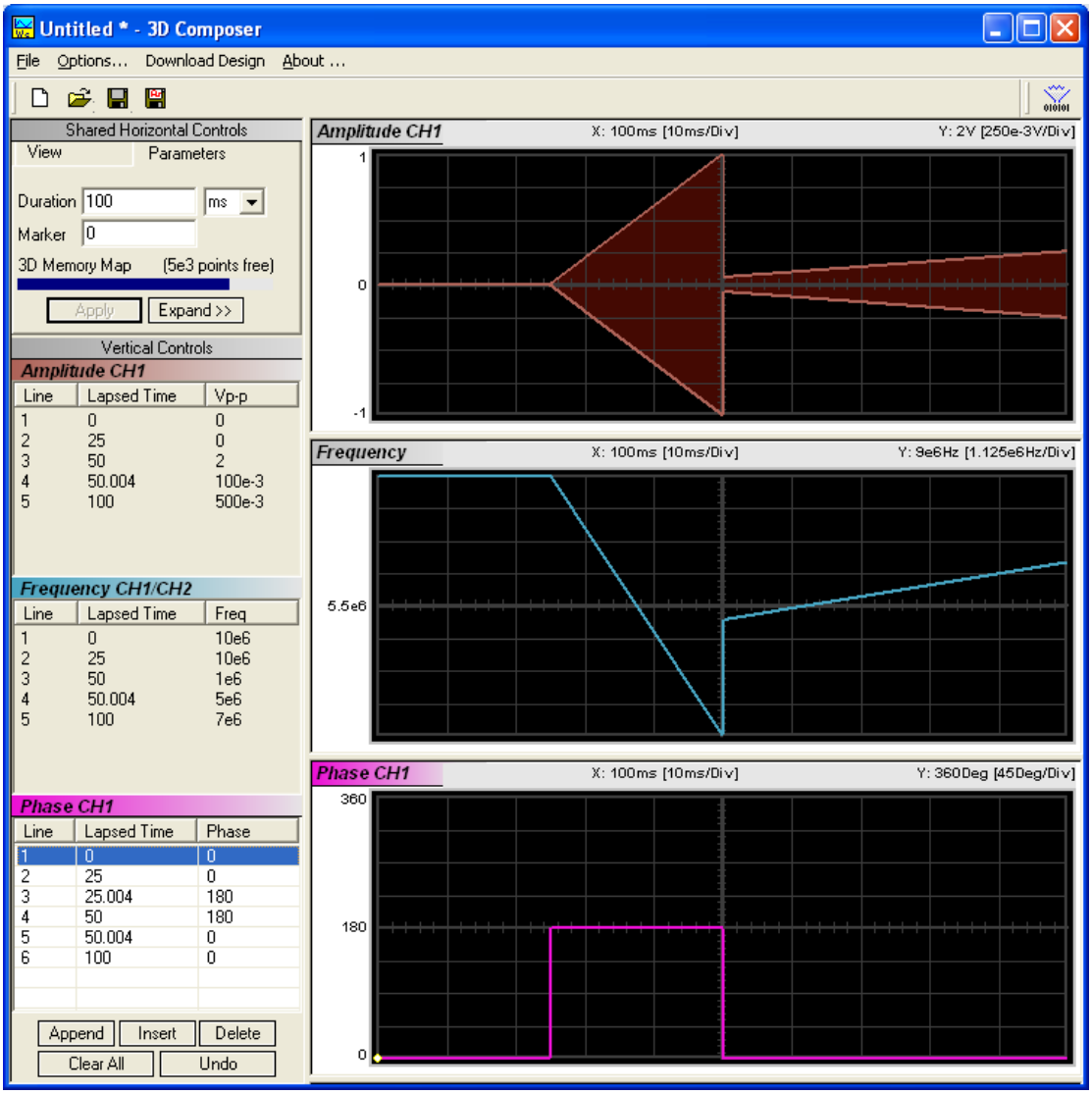

Figure 3-68: 3D Chirp Design Example

The Serial Data Composer

The Serial Data Composer was designed so that serial data patterns could be easily programmed and generated. It allows you to set the length of your pattern and simply and easily fill in the data bits.

Invoke the Serial Data Composer from Panels bar. Each channel is represented by its own graphical screen. In the Data field (bottom blue part of the screen) the user can input the data, only '1' and '0' bit values. Each of these bits has a corresponding graphical representation, high level for '1' and low level for '0'.

The Serial Data Composer has three sections: Commands bar, Toolbar and Waveform screen. Refer to Figure 3-69 throughout the description of these parts.

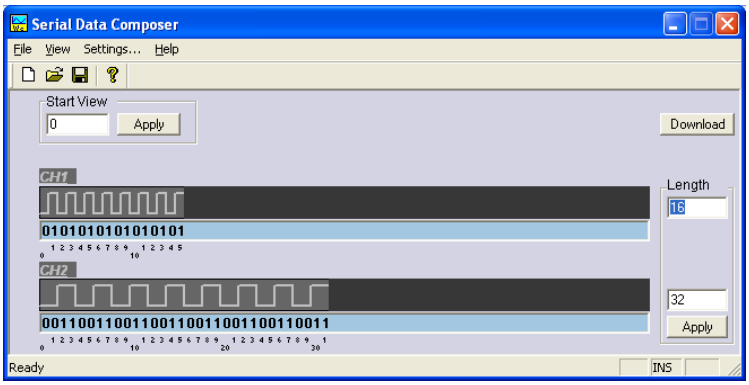

Figure 3-69: Serial Data Composer

The Commands Bar

The Commands Bar provides access to standard Windows commands such as File and View.

In general, clicking on one of the commands opens a dialog box with an additional list of commands. Subsequently, clicking on an additional command either opens a dialog box, or generates an immediate action. For example, clicking on File and then Exit will cause an immediate termination of the Serial Data Composer. On the other hand, clicking on View and then on Option, will open an Option dialog box that lets you edit Pattern parameters. The various commands in the Commands Bar are listed and described below.

File Commands

The File command has 4 command lines that control waveform files. Additionally use this command to exit the Serial Data composer program. Description of the various commands under File is given below.

New
The New Waveform command removes the waveform from the

screen. If you made changes to the waveform area and use this command, you should save your work before clearing the screen. The New Waveform command deletes the displayed waveform.

Open…

The Open… command lets you browse your disk for previously saved waveform files and loads these waveforms to the waveform area.

Save

The Save command will store your active waveform in your waveform generator directory, as a Binary file with a *.txt extension. If this is the first time you save your waveform, the Save Waveform As… command will be invoked automatically, letting you select name, location and format for your waveform file.

Save As…

Use the Save As… command the first time you save your waveform. It will let you select name, location and format for your waveform file.

Exit

The Exit command ends the current Serial Data Composer session and takes you back to the Panels screen. If you made changes to your waveform since it was last saved, make sure to Save your work before you use this command.

The View Commands

The View Command has a single command line Options. The Options command enables to choose the default filling of the serial data, ‘0’ or ‘1’ and to toggle the cursor indicator on and off.

The Settings Commands

The Settings Commands opens a dialog box in which it is possible to set the Sample Clock (hence the time interval of each bit), the High and Low level of each channel, and to select which channel is displayed in the Serial Data Composer window.

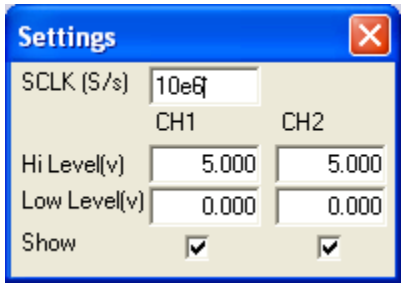

Figure 3-70: Settings Command dialog box

Creating Serial Data Waveforms

The Serial Data Composer waveform screen consists of the Start View group, The graphical screens for each channel, the Length group and a Download button.

Start View

The Start View group allows the user to quickly gain access to the required section of the waveform. Enter the Bit in Start View field and click on Apply to jump the specified start bit.

Graphical Screens

Each Channel has its own graphical screen. Clicking on the Data field (blue part of the screen) invokes a small white box. This box indicates the bit the user is writing. Once the white box is shown the user can insert the data by typing ‘1’ or ’0’. Each bit that is inserted is graphically displayed with a corresponding high or low level. Notice that below the Data field are the corresponding bit number of the waveform.

Length

The Length Group is used to define the length of each waveform. Enter the desired length and click on apply for the changes to take effect. Please note that if the length of an existing waveform is shortened the data will be deleted once the apply button is pressed. Additionally the length of the waveform must be longer than the minimum segment size and divisible by the minimum increment of the instrument.

Download

Clicking on the Download button opens a Summary dialog box of the downloaded waveforms. The user can choose to Accept in which case the waveform is downloaded to the instrument or Reject if he wishes to change the waveform.

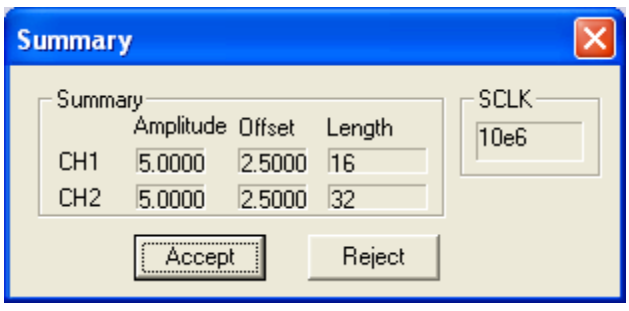

Figure 3-71: Serial Data Composer download summary

The Pattern Composer

The Pattern Composer is an excellent tool for creating and editing digital patterns of up to 16 bits. Each bit can be designed separately by typing in the bits, or it can be filled in using special editing tools. The Pattern Composer is only available on the units with the 16bit LVDS output.

To launch the Pattern Composer, point and click the Pattern tab in the Panels bar. Figure 3-72 shows an example of the pattern composer. The Pattern Composer has three main sections: Command Bar, Toolbar and Waveform screen.

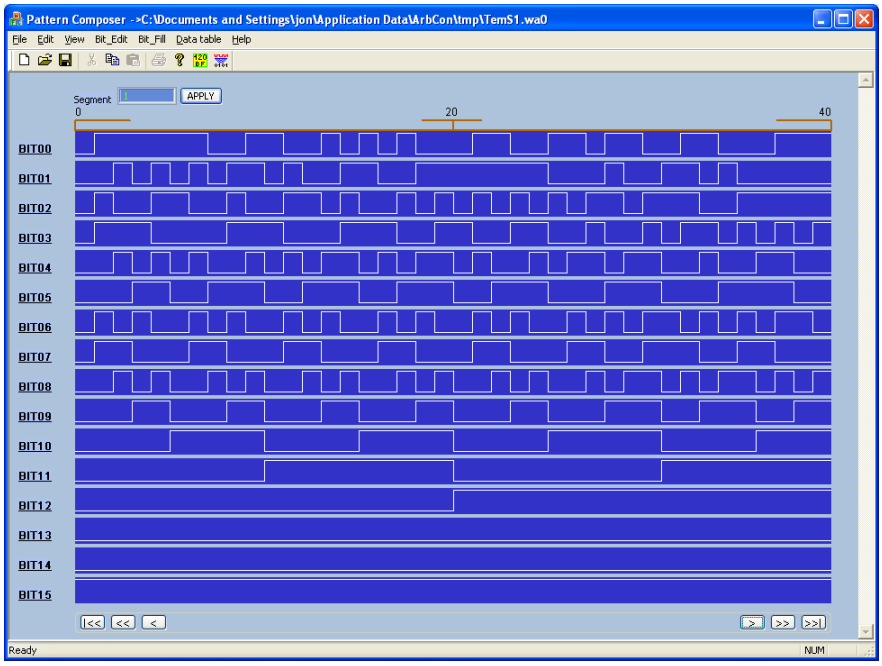

Figure 3-72: Pattern Composer

File Commands

The File command has 4 command lines that control Pattern Composer files. Also, use this command exit the Pattern Composer program. Description of the various commands under File is given below.

New

The New (Ctrl+N) command will remove the Pattern from the screen. If you made changes to the Pattern area and use the New command, you should save your work before clearing the screen. The New command is destructive to the displayed Pattern.

Open…

The Open… (Ctrl+O) command will let you browse through your disk space for previously saved Pattern files and load them to the pattern composer screen area. File extension that can be read to the composer is *.wav

Save

The Save (Ctrl+S) command will store the active pattern in your waveform generator directory with a *.wav extension. If this is the first time you save your pattern, the Save As… command will be invoked automatically, letting you select name, location and format for your waveform file.

Save As…

Use the Save As… command the first time you save your pattern. It will let you select name and location.

Exit

The Exit Command ends the current Pattern Composer session and takes you back to the Panels screen. If you made changes to your pattern since it was last saved, the Pattern Composer will prompt you to Save or Abandon these changes.

Edit Commands

The Edit Commands are used for copying and pasting different bits. Clicking on the Copy command under edit opens a dialog box that allows you to choose the bit to be copied and where to paste it.

View Commands

The View Commands allow you to view various sections of the pattern area. The View commands include: Span, Step Size, Bit Name, Tool Bar and Status bar. Description of the View Commands is given in the following.

Span

The Span command is used for defining the number of bits displayed on screen. The user can select from predefined intervals, the max interval or a custom interval.

Step Size

The Step Size command defines the number of bits the pattern shifts upon clicking on the shift buttons at the bottom of the Pattern Composer screen. Clicking on the Step Size command invokes a dialog box where the small and large deltas are set. The Small delta is the button with the single arrow and the large delta is the button with the double arrow. Clicking on the button with the double arrow and line shifts the pattern to the first or last bit.

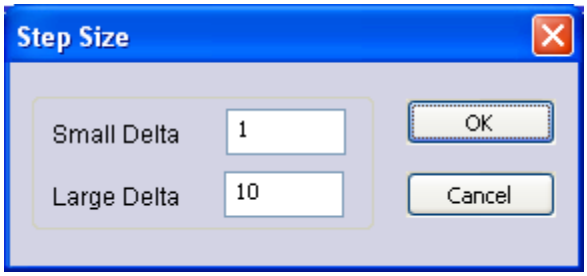

Figure 3-73: Step Size command dialog box

Bit Name

The Bit Name allows for naming the different bits as they might be referred to by the user. Simply click on the Bit Name command and a dialog box will appear. Choose the bit you wish to name and type in the desired name, click on OK to confirm or Cancel to cancel.

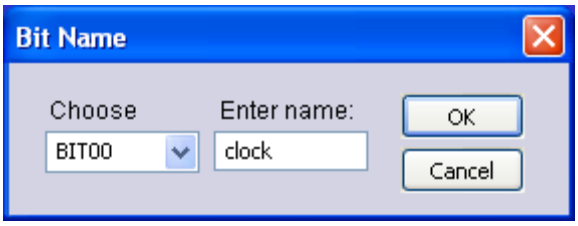

Figure 3-74: Bit Name command dialog box

Toolbar

Clicking on the toolbar command toggles on and off the toolbar shown below the Command Bar.

Status Bar

Clicking on the Status Bar toggles on and off the status bar at the bottom of the Pattern Composer screen.

Bit Edit Commands

The Bit Edit commands provide the user with two functions of bit editing.

Math

The Math command enables the user to define a bit as the result of a logical function between two other bits. The user chooses the

logical operator, the two bits to perform the operation on, and the bit where the result will be outputted. The available logical functions are: AND, OR, NAND, XOR and NOR. Clicking on the Apply button performs the operation without closing the dialog box so that the user can perform the next operation. Clicking on OK performs the operation and closes the dialog box. The Cancel button cancels the operation and closes the dialog box.

Figure 3-75: Math command dialog box

Preset

The Preset command is used to easily design each bit with one of the predefined operators. These operators are: All '1', All '0', Invert, Shift right and Shift left. The user selects the Bit, the operator, the start point where the created waveform will start and the end point where it will end. Clicking on the Apply button performs the operation without closing the dialog box so that the user can perform the next operation. Clicking on OK performs the operation and closes the dialog box. The Cancel button cancels the operation and closes the dialog box.

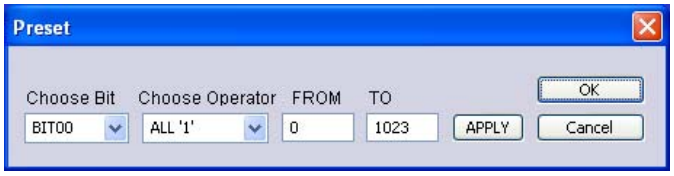

Figure 3-76: Preset command dialog box

Bit Fill Commands

The Bit Fill commands are Random and Clock and are used to create either a random bit pattern or clock pattern.

Random

The Random command generates random bits within the range provided by the user.

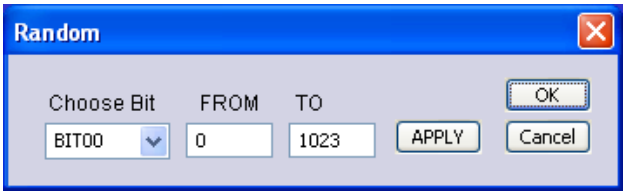

Figure 3-77: Random command dialog box

Clock

The Clock command generates a Clock waveform within the range provided by the user. The user can choose the step size of the High and low levels of the clock.

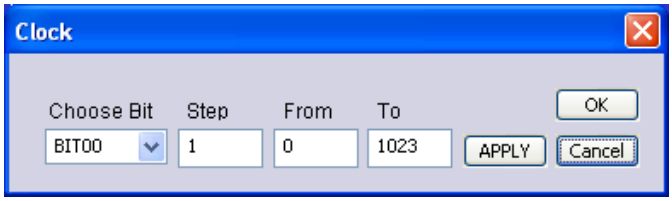

Figure 3-78: Clock command dialog box

Data Table Commands

The Data Table Command invokes a dialog box with a table representation of the digital pattern, and four parameters. The table consists of a point column and its corresponding value. Clicking on the Value column header opens a dialog box that allows the user to select the format of the displayed value. The options are: Hex, Decimal, Octal and Binary representation. Clicking on the value itself allows the user to edit the value of the selected point. The parameters displayed are:

Block

Sets the size of the current segment.

Reference 1,2

Reference 1 and Reference 2 are markers used for measuring the time interval between two points.

Delta

The time interval between the two reference markers.

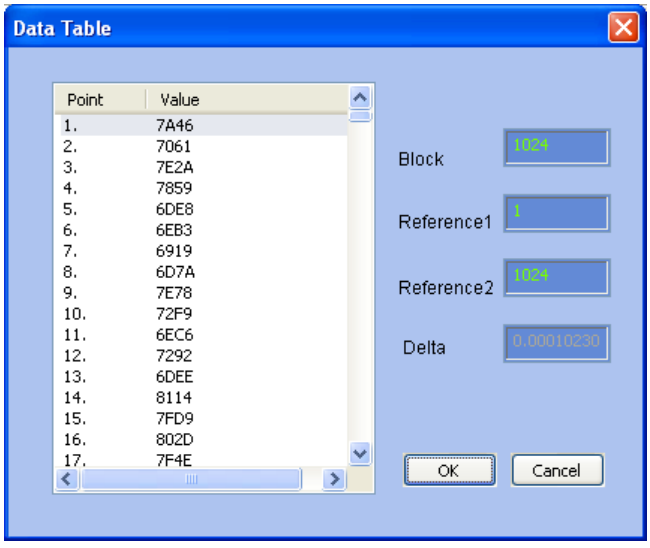

Figure 3-79: Data Table

The Toolbar

The Toolbar contains icons for editing the waveform screen, icons for saving and loading waveforms. The Toolbar is shown in Figure 3-80. For the individual icons, refer to the descriptions above of the Pattern Composer Menus.

Figure 3-80: Pattern composer toolbar

The Waveform Screen

Waveforms are created and edited on the waveform screen. The waveform screen is divided to 16 Bits. As a default the bits are named Bit00 through Bit15. Double clicking on the Bit Name opens a dialog box for editing the bit value. The number of points that can be edited corresponds to the View Span setting. The value of the bit can also be changed by simply clicking on the actual waveform. A high level is changed to a low level and vice versa.

The Horizontal axis is the point number, with a numbered index at the start, middle and end of the waveform. To move along the waveform there are buttons at the bottom part of the waveform screen. There are three buttons for each direction, The first shifts the waveform by the small delta step size, the next shifts the waveform by the large delta step size and the last jumps to the start or end of the waveform.

At the top left corner is the segment number, this allows the user to change the segment to which the waveform will be downloaded to. The segment size can be changed in the Data Table.

The Command Editor

The Command Editor is an excellent tool for learning low level programming of your Tabor waveform generator. Invoke the Command Editor from the System menu at the top of the screen. A Dialog box, as shown in Figure 3-81, will pop up. If you press the Download button, the function call in the Command field will be sent to the instrument.

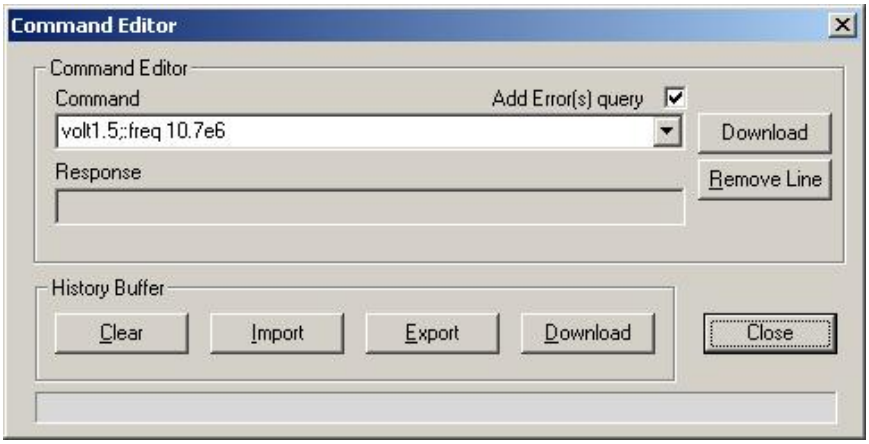

Figure 3-81 Command editor

Low-level SCPI commands and queries can be directly sent to the waveform generator from the Command field and the instrument will respond to queries in the Response field. The Command Editor is very useful while developing your own application. This way, you can be sure that commands or syntax that you use in your application will behave exactly the same way as it responds to the editor commands. A complete list of SCPI commands is available in the instrument's user manual.

Logging SCPI Commands

The Log File is very useful for programmers that do not wish to spend a lot of time on manuals. When you use **ArbConnection,** every time you click on a button or change a parameter, the command is logged in the same format as should be used in external applications. Figure 3-82 shows an example of a log file and a set of SCPI commands as resulted from some changes made on **ArbConnection** panels. You can set up the waveform generator from **ArbConnection** to the desired configuration; log the commands in the log file and then copy and paste to your application without any modifications. Of course, this is true for simple commands that do not involve file download but, on the other hand, this is a great tool to get you started with SCPI programming.

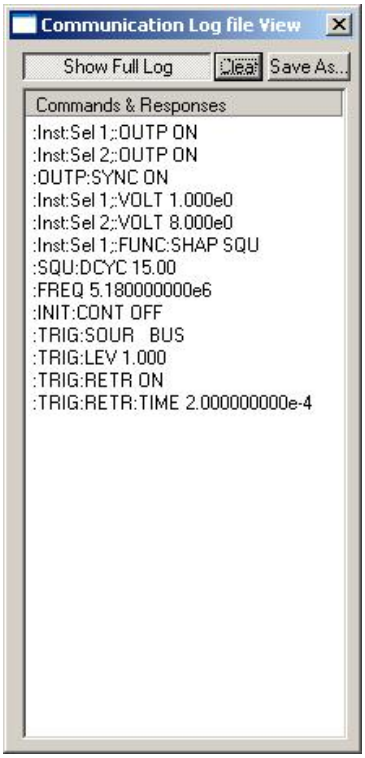

Figure 3-82: Log File Example

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Appendices

Appendix	Title	Page
A	Specifications	A-1

Appendix A
Specifications

MINIMUM PC REQUIREMENTS

OPERATING SYSTEM

Microsoft Windows NT 4.0 SP 6 or higher, Windows 2000 and Windows XP

HARDWARE

Pentium III or better
High resolution screen (at least 1024 x 768 pixels is recommended)
50 MB free disk space
Pointing device, mouse or ball

SOFTWARE

NI-VISA 2.6 or higher (Not needed in DEMO mode)

HARDWARE CONNECTIVITY OPTIONS

Ethernet, GPIB, RS232, USB, PCI, PXI and VXI

SUPPORTED GPIB INTERFACES

NATIONAL INSTRUMENTS

AT-GPIB/TNT, AT-GPIB/TNT (PnP), AT-GPIB/TNT+, PCI-8212, PCI-GPIB, PCI-GPIB/LP, PCI-GPIB+, GPIB-ENET, GPIB-ENET/100, GPIB-USB, GPIB-USB-A, GPIB-USB-B, PCMCIA-GPIB, PCMCIA-GPIB+

KEITHLEY

KPC-488 and KPCI-488 (Only with driver version 6.03 or higher)

CEC

PC-488 and PCI-488 (Only with driver version 6.03 or higher)

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