TABOR ELECTRONICS

WAVE DESIGN STUDIO
Simulate, Stimulate, Test

Wave Design Studio (WDS)

User Manual

Rev. 1.1

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Document Revision History

Table Document Revision History

Revision	Date	Description	Author
1.1	01-Feb-2021	• Supporting Proteus Driver Ver. 1.1.100, WDS Ver. 1.3.200 and TE Update Tool Ver. 1.1.000. • Changed tab names WAVE COMPOSER to COMPOSER and SCENARIO COMPOSER to SCENARIO. • 5 WDS Window Layout, page 35 – The light/dark theme color icons have been replaced by Command Editor and Log File icons. • 6.2 Switch Model, page 38 – Supported. • 6.5 Settings, page 40 – Added Light Theme. • 6.6 Languages, page 41 – Added French. • Figure 6.6 Options, page 42 – New “Export Registers to HTML File”. • Figure 6.9 View Help, page 44 – Added View Help. • 15 Appendix FPGA Firmware Update, page 141 – New.	Jakob Apelblat
1.0	17-Sep-2020	• Original release supporting WDS Rev. 1.2.192.	Jakob Apelblat

Acronyms & Abbreviations

Table Acronyms & Abbreviations

Acronym	Description
µs or us	Microseconds
ADC	Analog to Digital Converter
AM	Amplitude Modulation
ASIC	Application-Specific Integrated Circuit
ATE	Automatic Test Equipment
AWG	Arbitrary Waveform Generators
AWT	Arbitrary Waveform Transceiver
BNC	Bayonet Neill–Concelm (coax connector)
BW	Bandwidth
CW	Carrier Wave
DAC	Digital to Analog Converter
dBc	dB/carrier. The power ratio of a signal to a carrier signal, expressed in decibels
dBm	Decibel-Milliwatts. E.g., 0 dBm equals 1.0 mW.
DDC	Digital Down-Converter
DHCP	Dynamic Host Configuration Protocol
DSO	Digital Storage Oscilloscope
DUC	Digital Up-Converter
ENoB	Effective Number of Bits
ESD	Electrostatic Discharge
EVM	Error Vector Magnitude
FPGA	Field-Programmable Gate Arrays
GHz	Gigahertz
GPIB	General Purpose Interface Bus
GS/s	Giga Samples per Second
GUI	Graphical User Interface
HDMI	High-Definition Multimedia Interface
HP	Horizontal Pitch (PXIe module horizontal width, 1 HP = 5.08mm)
Hz	Hertz

Acronym	Description
IF	Intermediate Frequency
I/O	Input / Output
IP	Internet Protocol
IQ	In-phase Quadrature
IVI	Interchangeable Virtual Instrument
JSON	JavaScript Object Notation
kHz	Kilohertz
LCD	Liquid Crystal Display
LO	Local Oscillator
MAC	Media Access Control (address)
MDR	Mini D Ribbon (connector)
MHz	Megahertz
ms	Milliseconds
NCO	Numerically Controlled Oscillator
ns	Nanoseconds
PC	Personal Computer
PCAP	Projected Capacitive Touch Panel
PCB	Printed Circuit Board
PCI	Peripheral Component Interconnect
PRBS	Pseudorandom Binary Sequence
PRI	Pulse Repetition Interval
PXI	PCI eXtension for Instrumentation
PXIe	PCI Express eXtension for Instrumentation
QC	Quantum Computing
Qubits	Quantum bits
RADAR	Radio Detection And Ranging
R&D	Research & Development
RF	Radio Frequency
RT-DSO	Real-Time Digital Oscilloscope
s	Seconds
SA	Spectrum Analyzer

Acronym	Description
SCPI	Standard Commands for Programmable Instruments
SFDR	Spurious Free Dynamic Range
SFP	Small Form-Factor Pluggable
SFP	Software Front Panel
SMA	Subminiature version A connector
SMP	Subminiature Push-on connector
SPI	Serial Peripheral Interface
SRAM	Static Random-Access Memory
TFT	Thin Film Transistor
T&M	Test and Measurement
TPS	Test Program Sets
UART	Universal Asynchronous Receiver-Transmitter
USB	Universal Serial Bus
VCP	Virtual COM Port
Vdc	Volts, Direct Current
V p-p	Volts, Peak-to-Peak
VSA	Vector Signal Analyzer
VSG	Vector Signal Generator
WDS	Wave Design Studio

1 General

1.1 Scope

The scope of this manual is to describe the setup and operating procedures of the Wave Design Studio (WDS). WDS is a software package that comes on a CD supplied with the device and can be downloaded from the Tabor web site. It enables full control and programming of your Tabor Electronics device via a user-friendly graphical user interface. The manual covers the following models listed in the below ordering information.

Table 1.1 Ordering Information TBD

Model	Description
P1282M	PXIe 1.25GS/s, AWG, 1GS Memory, 2CH, 4 Markers
P1284M	PXIe 1.25GS/s, AWG, 1GS Memory, 4CH, 4 Markers
P2582M	PXIe 2.5GS/s, AWG, 1GS Memory, 2CH,8 Markers
P2584M	PXIe 2.5GS/s, AWG, 1GS Memory, 4CH, 8 Markers
P9082M	PXIe 9GS/s, AWG, 4GS Memory, 2CH, 8 Markers
P1282D	1.25GS/s, 16Bit, AWG, 1GS Memory, 2CH, 4 Markers
P1284D	1.25GS/s, 16Bit, AWG, 1GS Memory, 4CH, 4 Markers
P1288D	1.25GS/s, 16Bit, AWG, 2GS Memory, 8CH 8 Markers
P12812D	1.25GS/s, 16Bit, AWG, 2GS Memory, 12CH 12 Markers
P2582D	2.5GS/s, 16Bit, AWG, 2GS Memory 2CH, 8 Markers
P2584D	2.5GS/s, 16Bit, AWG, 2GS Memory, 4CH, 8 Markers
P2588D	2.5GS/s, 16Bit, AWG, 2GS Memory, 8CH 16 Markers
P25812D	2.5GS/s, 16Bit, AWG, 2GS Memory, 12CH, 24 Markers
P9082D	9GS/s 16Bit, AWG, 4GS Memory 2CH, 8 Markers
P9084D	9GS/s 16Bit, AWG, 4GS Memory 4CH, 16 Markers
P9086D	9GS/s 16Bit, AWG, 4GS Memory 6CH, 24 Markers
P1282B	1.25GS/s, 16Bit, AWG, 1GS Memory, 2CH, 4 Markers
P1284B	1.25GS/s, 16Bit, AWG, 1GS Memory, 4CH, 4 Markers
P1288B	1.25GS/s, 16Bit, AWG, 2GS Memory, 8CH 8 Markers
P12812B	1.25GS/s, 16Bit, AWG, 2GS Memory, 12CH 12 Markers
P2582B	2.5GS/s, 16Bit, AWG, 2GS Memory 2CH, 8 Markers

Model	Description
P2584B	2.5GS/s, 16Bit, AWG, 2GS Memory, 4CH, 8 Markers
P2588B	2.5GS/s, 16Bit, AWG, 2GS Memory, 8CH 16 Markers
P25812B	2.5GS/s, 16Bit, AWG, 2GS Memory, 12CH, 24 Markers
P9082B	9GS/s 16Bit, AWG, 4GS Memory 2CH, 8 Markers
P9084B	9GS/s 16Bit, 4GS Memory 4CH, 16 Markers
P9086B	9GS/s 16Bit, AWG, 4GS Memory 6CH, 24 Markers
SE5082	5GS/s Dual Channel Arbitrary Waveform Generator
WS8351	350MHz Single Channel Arbitrary Function Generator
WS8352	350MHz Dual Channel Arbitrary Function Generator
WX1281B	1.25GS/s Single Channel Arbitrary Waveform Generator
WX1282B	1.25GS/s Dual Channel Arbitrary Waveform Generator
WX1281C	1.25GS/s Single Channel Arbitrary Waveform Generator
WX1282C	1.25GS/s Dual Channel Arbitrary Waveform Generator
WX2181	2.1GS/s Dual Channel Arbitrary Waveform Generator
WX2181B	2.3GS/s Single Channel Arbitrary Waveform Generator
WX2182B	2.3GS/s Dual Channel Arbitrary Waveform Generator
WX2181C	2.3GS/s Single Channel Arbitrary Waveform Generator
WX2182C	2.3GS/s Dual Channel Arbitrary Waveform Generator
WX1284	1.25GS/s Four Channel Arbitrary Waveform Generator
WX2184	2.3GS/s Four Channel Arbitrary Waveform Generator
WX1284C	1.25GS/s Four Channel Arbitrary Waveform Generator
WX2184C	2.3GS/s Four Channel Arbitrary Waveform Generator

Note

- The WDS GUI supports the unique parameters of all the devices. Thus, there are some dedicated windows and fields for each device.

Figure 1.1 WDS Splash Screen

1.2 Document Conventions

1.2.1 General

Convention	Description	Example
Bold Writing	Indicates an item/message in the user interface.	Click the **On** button.
<Angled and Bolded Brackets>	Indicates a physical key on the keyboard.	Press <Ctrl>+<B>.

Caution!

- A Caution indicates instructions, which if not followed, may result in damage to the equipment or to the loss of data.

Note

- A Note provides additional information to help obtain optimal equipment performance.

Idea

- An Idea provides an alternate procedure to obtain the same results.

1.2.2 Programming

Convention	Description	Example
{}	Braces indicate that parameters may be used in the command once, or several times, or not at all.	:LIST:POWer <val>{,<val>} a single power listing: :LIST:POWer 5 a series of power listings: :LIST:POWer 5,10,15,20
<>	Angle brackets indicate that their contents are not to be used literally in the command. They represent the required parameters.	:FREQuency:STARt <val><unit> In this command, the words <val> and <unit> should be replaced by the actual frequency and unit. :FREQuency:STARt 2.5GHZ
[]	Square brackets indicate that the enclosed keywords or parameters are optional when composing the command. The commands will be executed even if they are omitted.	:FREQuency[:CW]? SOURce and CW are optional items.
|	A vertical stroke between keywords or parameters indicates alterative choices. For parameters, the effect of the command varies depending on the choice.	:AM:MOD DEEP|NORMal DEEP or NORMal are the choices.

2 Introduction

The WDS is the latest in instrument control and signal creation software. It enables full remote control of Tabor's waveform generators and simplifies the creation of complex signals. With a powerful and intuitive graphical user interface, WDS offers easy access and control of all the instruments features and capabilities. In addition to the standard waveform creation tools, WDS offers optional waveform creation add-ons for radar, and future microwave, RF, and general-purpose applications.

Key features:

- Windows 10 PC based software for instrument control and signal creation.
- Dedicated optional add-ons for radar applications, signal correction, digital modulations and more.
- Easy to use waveform creation tools for generating chirps, pulses, and modulations.
- Powerful and intuitive graphical user interface including preview of the generated scenario and simultaneous multi-channel and markers view.
- Automatic detection of all connected instruments, and offline mode for creating waveform, scenarios, and setups without a connected instrument.
- Even for those planning to use third party software for controlling the Tabor generator the log file and SCPI command editor in WDS will help to quickly learn how to program the instrument.

2.1 Minimum System Requirements

Minimum host system requirements for WDS are:

- A PC running Windows 10.
- 8 GB of RAM, 16 GB or higher recommended.
- 200 MB of available hard drive space.
- Communication interface (LAN, USB, GPIB, PXI) for connecting to the instrument
- An optional CD device if no Internet connection is available for downloading the SW installation from the Tabor download site at www.taborelec.com/downloads.

2.2 Wave Design Studio Installation

The following installation procedure will install both the Proteus driver and Wave Design Studio (WDS) control software that will enable remote control of the Proteus device.

Locate the ***Tabor Electronics Wave Design Studio Setup - x.y.zzz.exe*** installation file on the supplied CD. If the CD is not available, you can download the latest installation package from the Tabor website at www.taborelec.com/downloads.

Notes

- Verify that the relevant device drivers are installed. The WDS installation will install the Proteus drivers, and other device drivers can be downloaded from the Tabor website at www.taborelec.com/downloads.
- The WDS installation requires a user with Administrator access rights. Right-click on the installation file and select “Run as administrator”.

1. Double-click the Tabor Electronics Wave Design Studio Setup - 1.X.X.exe installation file. The User Account Control screen is displayed. Click **Yes**.

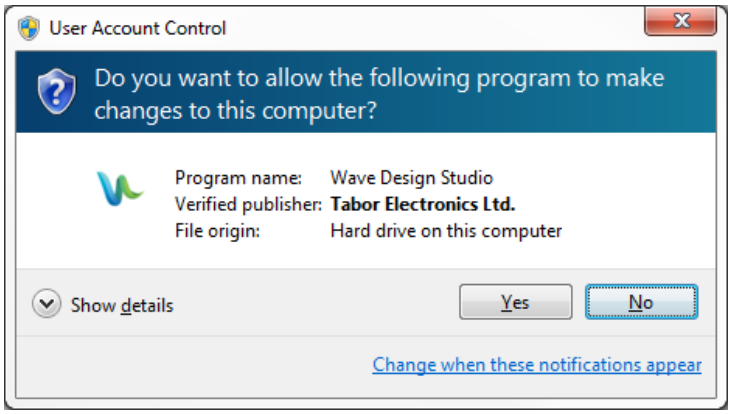


Figure 2.1 User Account Control

2. The welcome screen is displayed.

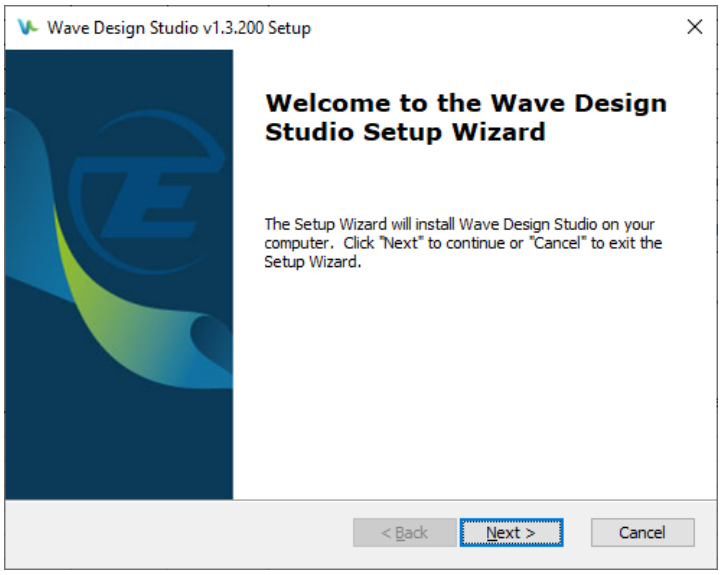


Figure 2.2 Welcome to the Wave Design Studio Setup Wizard

3. Click **Next.** The Optional features to install screen is displayed.

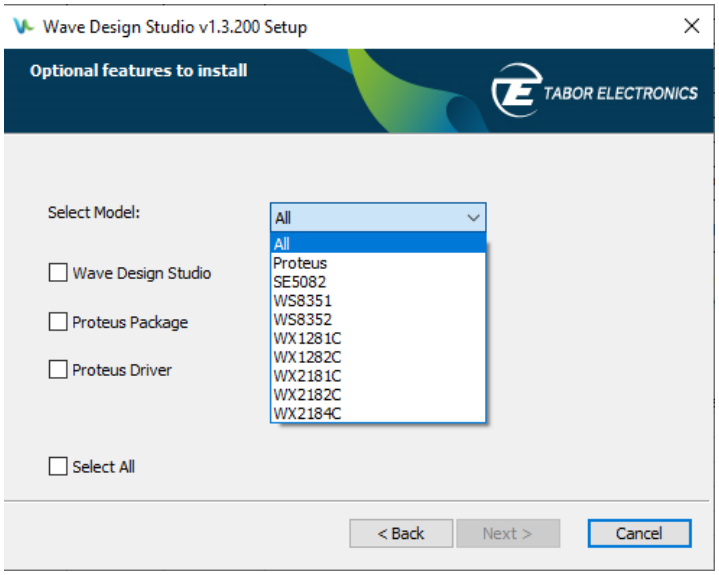


Figure 2.3 Optional Features to Install

4. Select what features you wish to install. If you would like to control the Proteus device with Tabor's dedicated control software check the **Select All** check box. If you will be using a third-party software such as MATLAB or Python applications, you need only to check the **Proteus Package** and **Proteus Driver** check boxes and can skip steps 7 to 13.

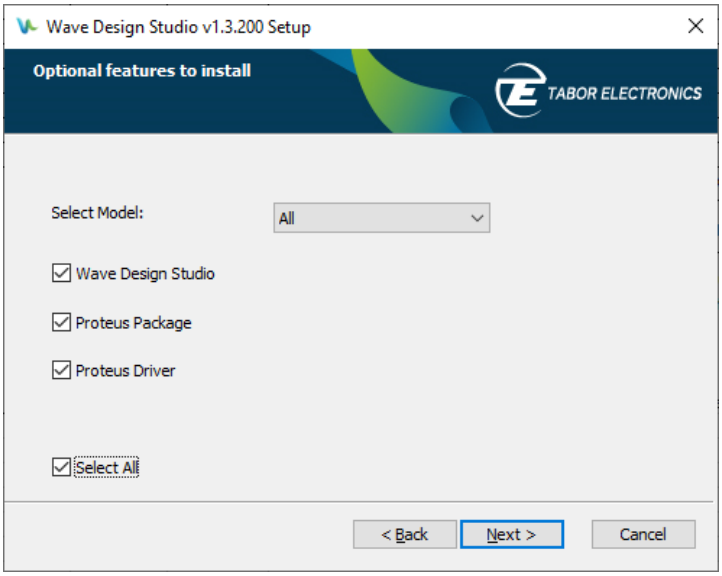


Figure 2.4 Installing All Components

5. Click **Next.** Enter the destination directory for the WDS software or browse to a destination directory by clicking the **Browse** button.

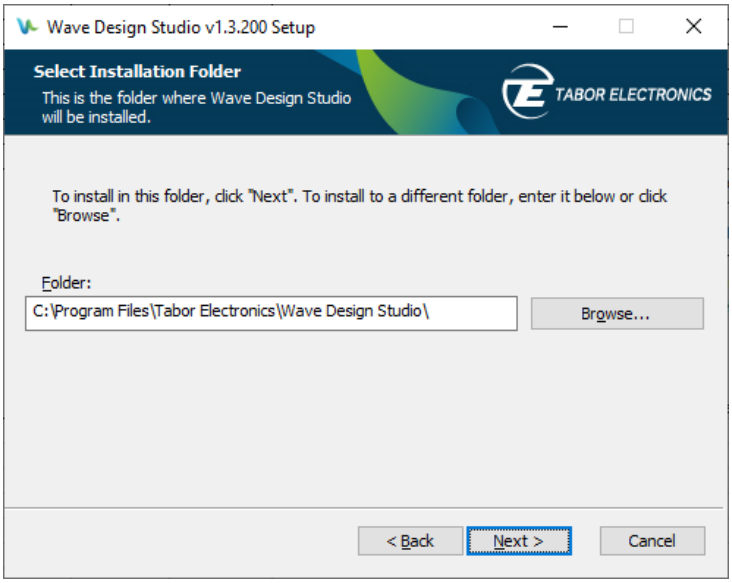


Figure 2.5 Select Installation Folder

6. Click the **Next** button. A confirmation prompt is displayed.

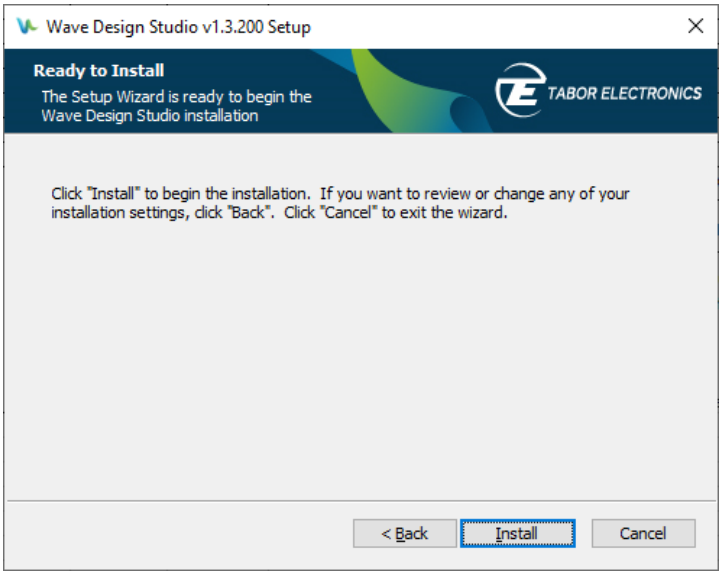


Figure 2.6 Ready to Install

7. Click the **YES** button. The installation starts

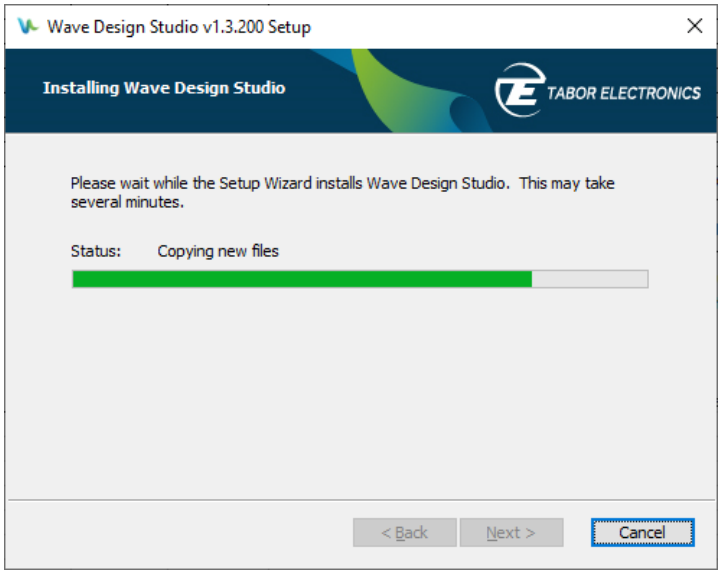


Figure 2.7 Installing Wave Design Studio

8. Once the WDS is installed a new pop-up window for the driver installation is displayed.

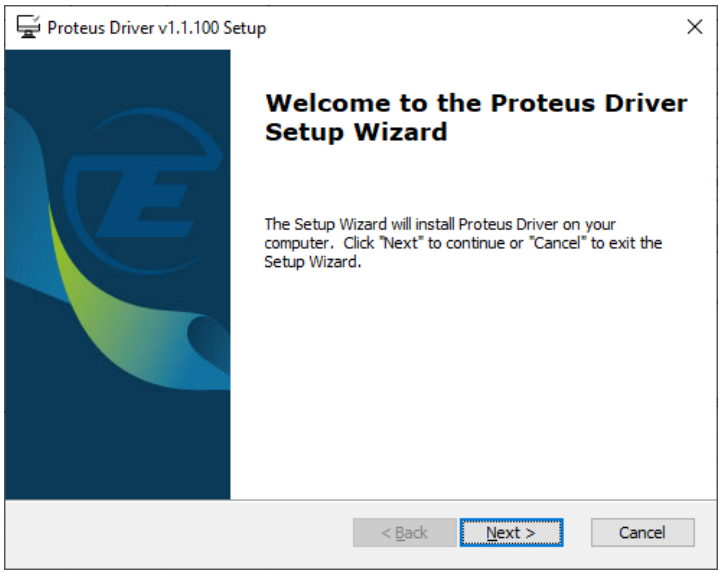


Figure 2.8 Welcome to the Proteus Driver Setup Wizard

9. Click **Next.** The driver is ready to install. Click the **Install** button.

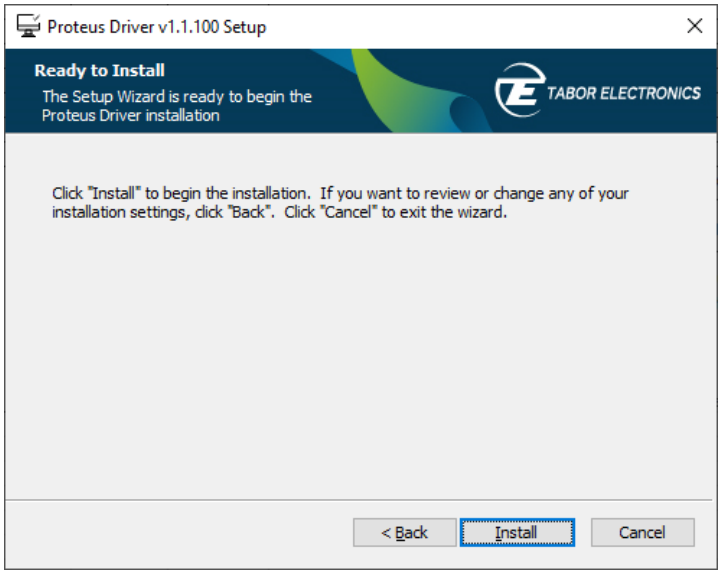


Figure 2.9 Ready to Install

10. Click the **YES** button. The driver installation starts.

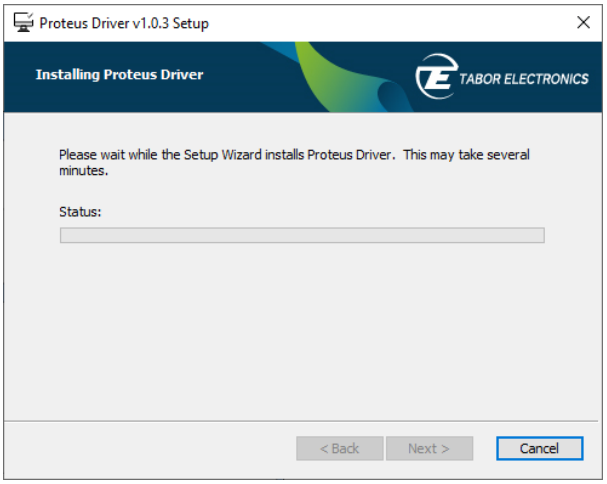


Figure 2.10 Installing Proteus Driver

11. Wait for the installation to complete. The following window is displayed when completed.

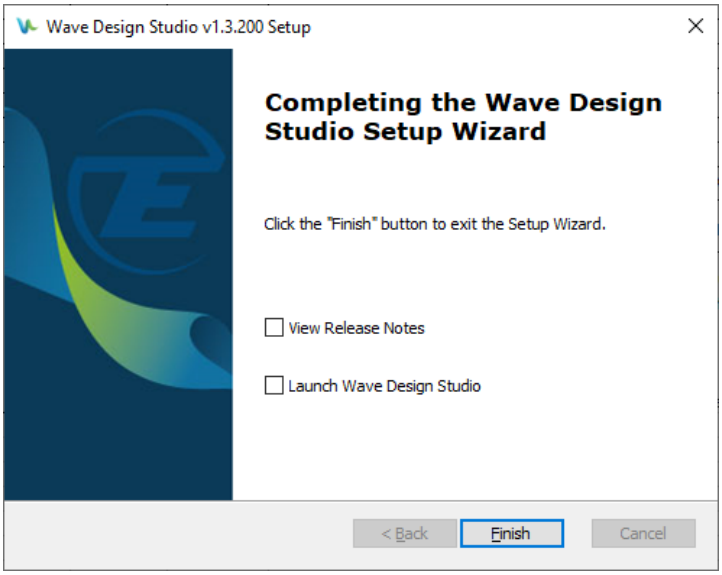


Figure 2.11 Completing the Proteus Driver Setup Wizard

12. Click **Finish**. Click **Finish** in the Completing the Wave Design…window.

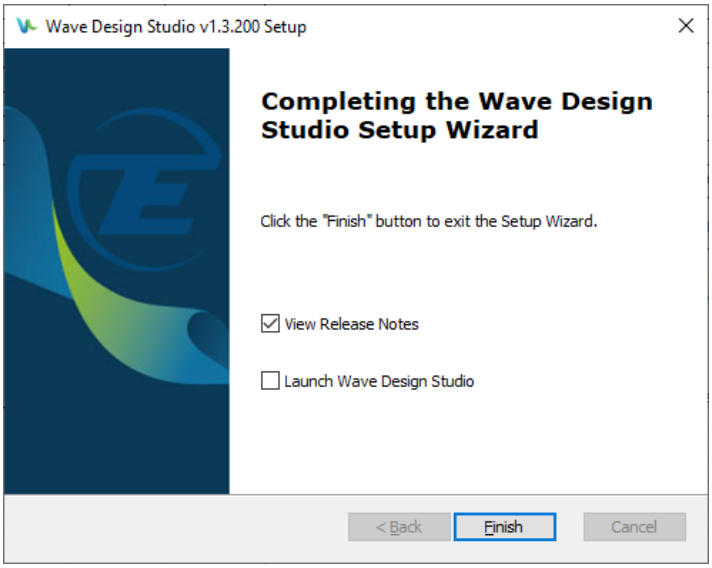


Figure 2.12 Completing the Wave Design Studio Setup Wizard

13. The Wave Design Studio software, Proteus Driver and Proteus Package have been installed.
14. A Wave Design Studio shortcut is installed on the desktop  .

3 Quick Guide

3.1 Prerequisites

- The WDS software should be installed as described in 2.2 Wave Design Studio Installation, page 19.
- The WDS should be connected to the device as explained in 4 WDS Communication, page 31.

3.2 Quick Start Workflow

Note

- The Quick Start mode is only available for the SE- and WX-series.

This section provides a quick guide how to create and output a standard waveform. The following chapters offer a detailed description of the WDS functionality including all options.

1. Click the **QUICK START** tab and then the **Standard** button.
2. Click the **Channel Control** to select active channel and enable the output.
3. Click the waveform button for the requested wave.
4. Click the **Markers** button for adding markers to the waveform.
5. The wave will be transmitted on the channel output.

3.3 Arbitrary Waveform Creation Workflow

This section provides a quick guide how to create and output an arbitrary waveform. The following chapters offer a detailed description of the WDS functionality including all options.

1. Click the **COMPOSER** tab and then the **Arbitrary** button.
2. Click the **Channel Control** to select active channel and enable the output.

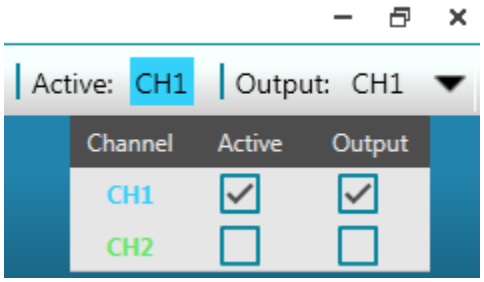


Figure 3.1 Channel Control

3. Click the arrow button to display all waves. Click the wave symbol you want to use.

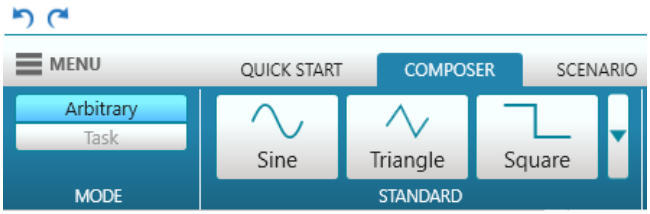


Figure 3.2 Standard Waves

Figure 3.3 Standard Waves (Expanded List)

4. Click the **Apply** button in the **Waveform Parameters** pane to display the wave in the composer screen.

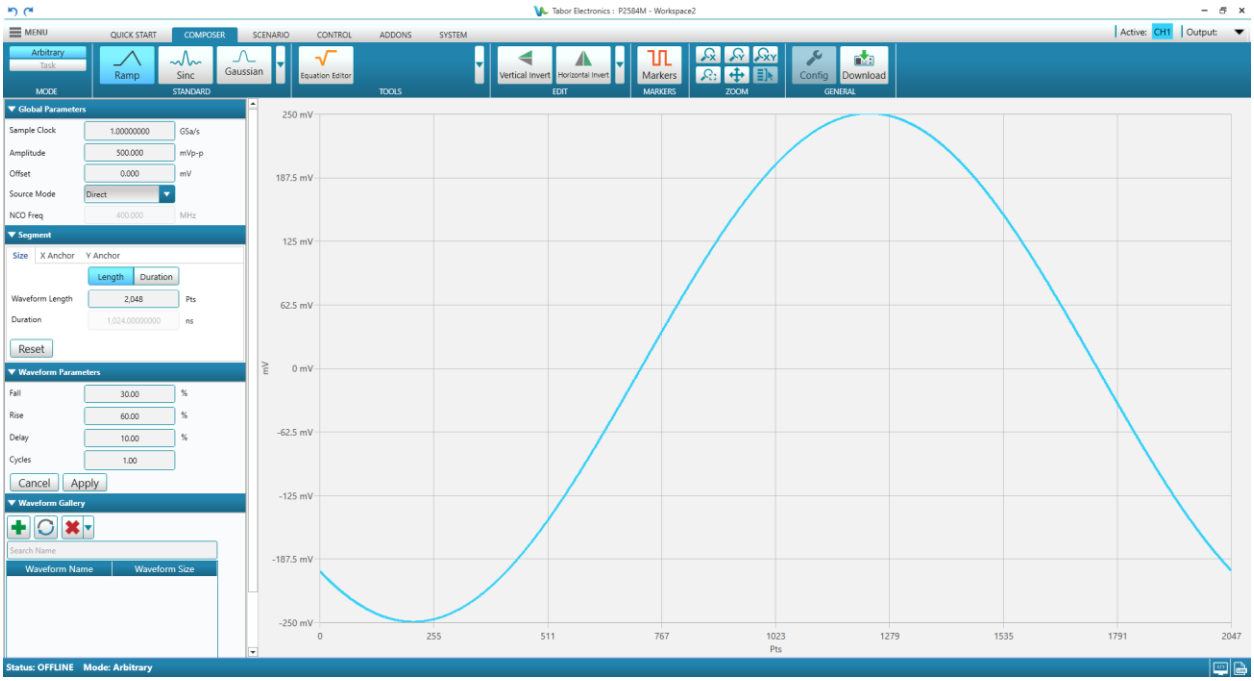


Figure 3.4 Sine Wave

5. Click the  button in the Waveform Gallery to add the displayed wave into the gallery.

6. Click the **Markers** button to display the Markers pane. Define the markers for the active channel.

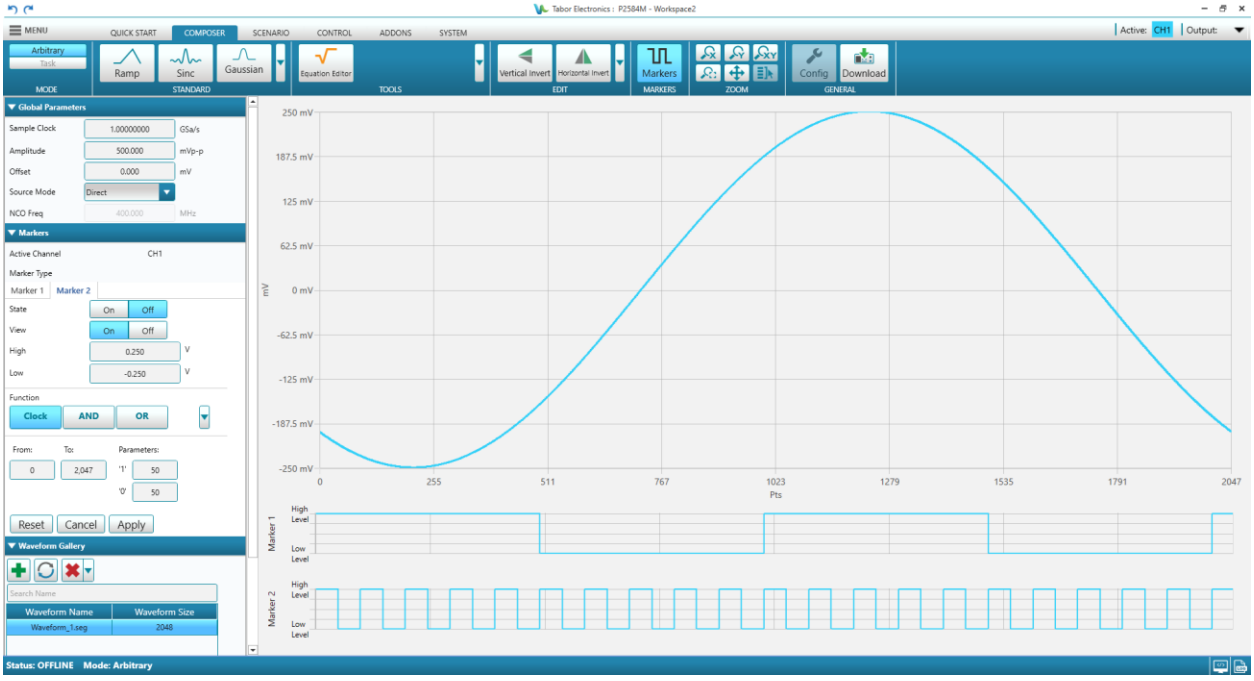


Figure 3.5 Sine Wave with Two Markers

7. Click the **SCENARIO** tab.

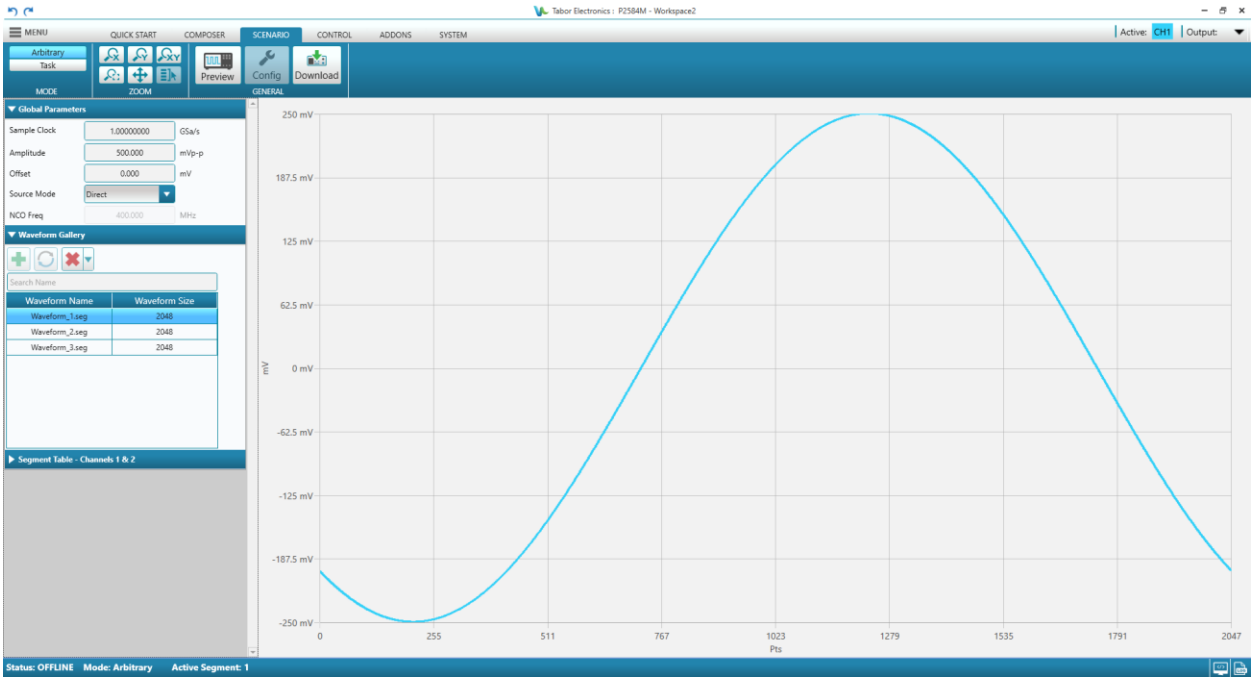


Figure 3.6 Scenario

8. Click the  button in the Segment Table to add selected waveform in the Waveform Gallery to the Segment Table.

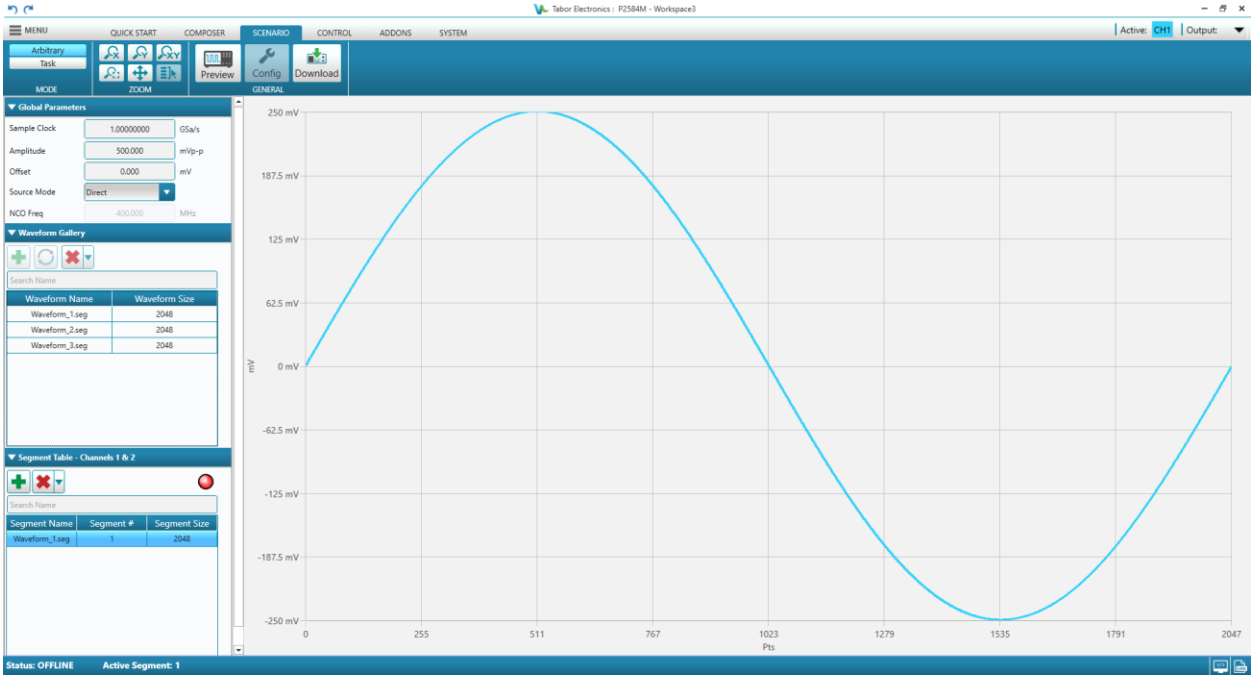


Figure 3.7 Scenario Segment Table

Note

- For the WX 4-channels device a segment of the same length must be defined to the other channel that the DAC controls.

9. Click **Task** for Proteus or Sequence and **Adv. Sequence** for SE- WX-series for programming the required scenario for each channel.

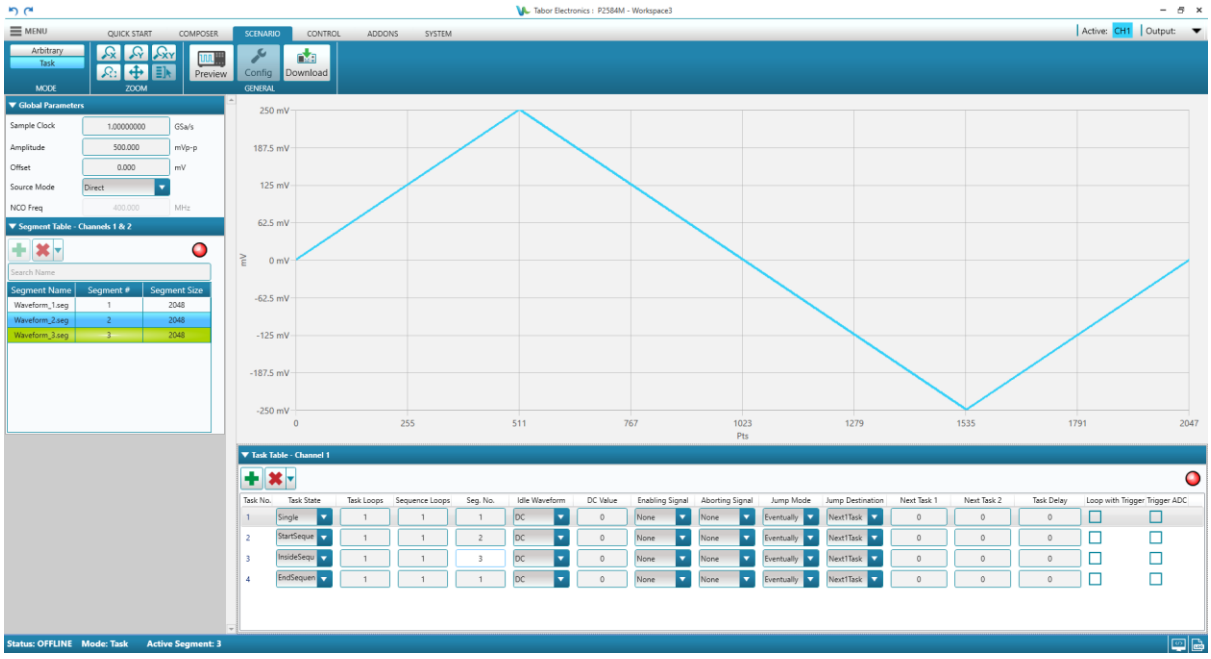


Figure 3.8 Scenario Task

10. Click the **CONTROL** tab on the ribbon to show the control window. Here you can select how the waveform generation will be executed. Refer to 10 Control, page 102.
11. Click the **SCENARIO** tab and then click the **Download** button to download the waveform to the device RAM memory.
12. The waveform will now be sent to the output port according to the Channel Control settings.

4 WDS Communication

1. Double-click the WDS shortcut on the desktop  . The WDS program is launched.

Figure 4.1 Initializing Applications

2. The communication screen is displayed. From here the user establishes communication with all the connected instruments.

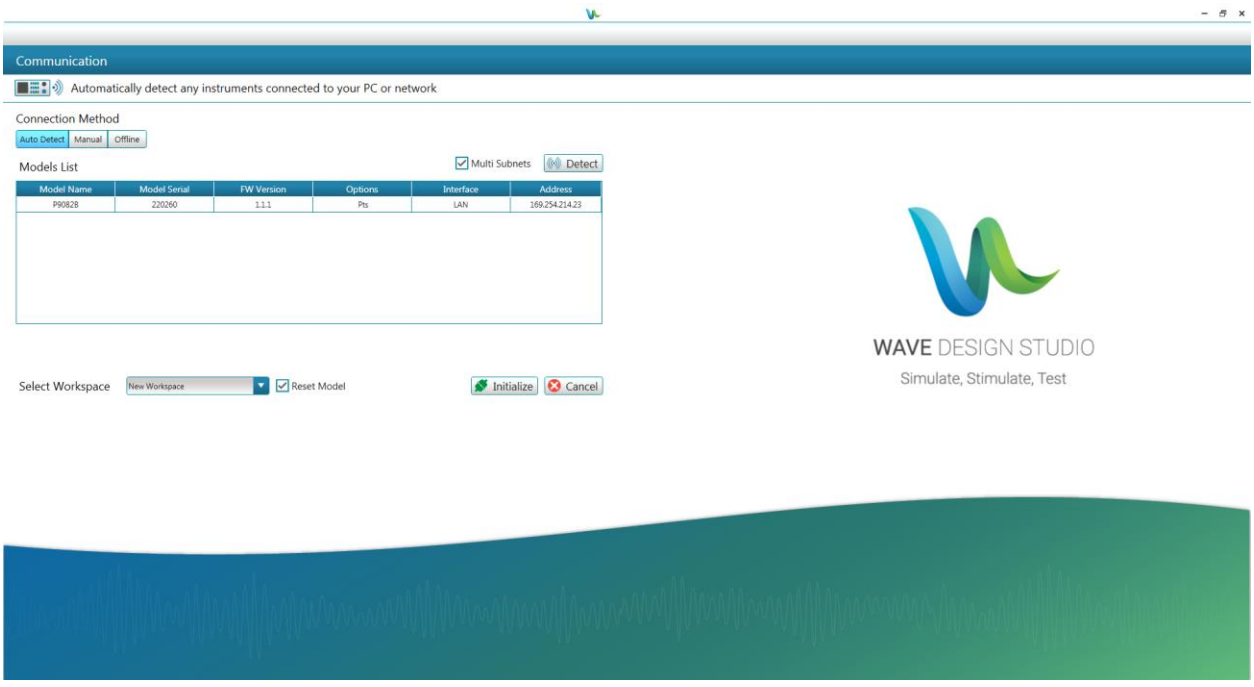


Figure 4.2 Communication

Note

- The WDS GUI is optimized for a PC display text size of 100% (Recommended). If you choose a bigger text size the WDS GUI will not fit in the window and you will have to scroll.

- **Auto Detect** –Click the button to enable the WDS software to automatically detect all connected instruments. The Tabor devices are configured for DHCP and will get an IP address from the network DHCP server.
  - **Multi Subnets** – Detect devices on LAN subnets.
  - **Detect** – Click the button to initialize the detection process. At the end of the process, the following information is displayed:
    - **Model Name** – Ordering information model, e.g. LS1291D.
    - **Model Serial** – The serial number of the device.
    - **FW Version** – The firmware version of the device.
    - **Options** – The options included in the device.
    - **Interface** – The active communication interface.
      - PXI
      - USB
      - LAN
      - GPIB
    - **Address** – The address shown depends on the active communication interface.
      - LAN IP address
      - USB physical address
        - ✓ **vid** – Vendor ID.
        - ✓ **pid** – Product ID.
        - ✓ **serial** – A unique serial string programmed at the factory and used to distinguish between devices.
- **Manual** – Click this button to enable manually connecting to the device. Refer to the device user manual how to get the device IP address.
  - **Enter Address** – Set the device LAN IP address, USB resource address, PXI or GPIB.
  - **Enter Port** – Valid only for Proteus. Set the SCPI port for communication. User should use a free port in the range 1 to 65535.
  - **Select Model** – Click  to select the device model from the drop-down list
- **Offline** – Click this button and then select a model from the **Select Model** drop-down list and simulate as if the software is connected to the generator.
- **Select Workspace –** You can select your WDS work session workspace. The workspace includes all your session parameters, tables, waveforms, and working environment.
  - **New Workspace** – Open a new workspace.
  - **Load Workspace** – Load a previous WDS session.

3. Select a model and click **Initialize** to initialize communication with the selected instrument.

4. If you have selected **New Workspace** in **Select Workspace** the **Create New Workspace** window is displayed. Give a name to the workspace and click on save.

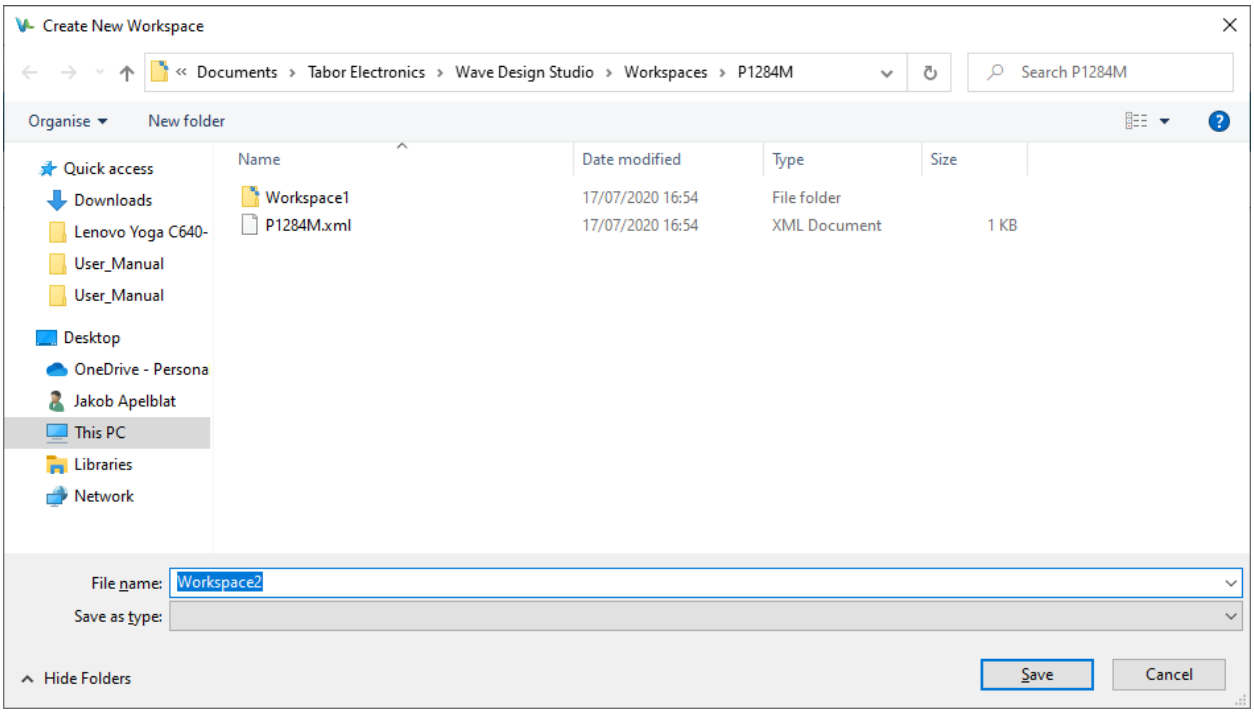


Figure 4.3 Create New Workspace

5. If you have selected **Load Workspace** in **Select Workspace** the **Load Workspace** window is displayed. Select the Project.xml file in your workspace and click **Open**.

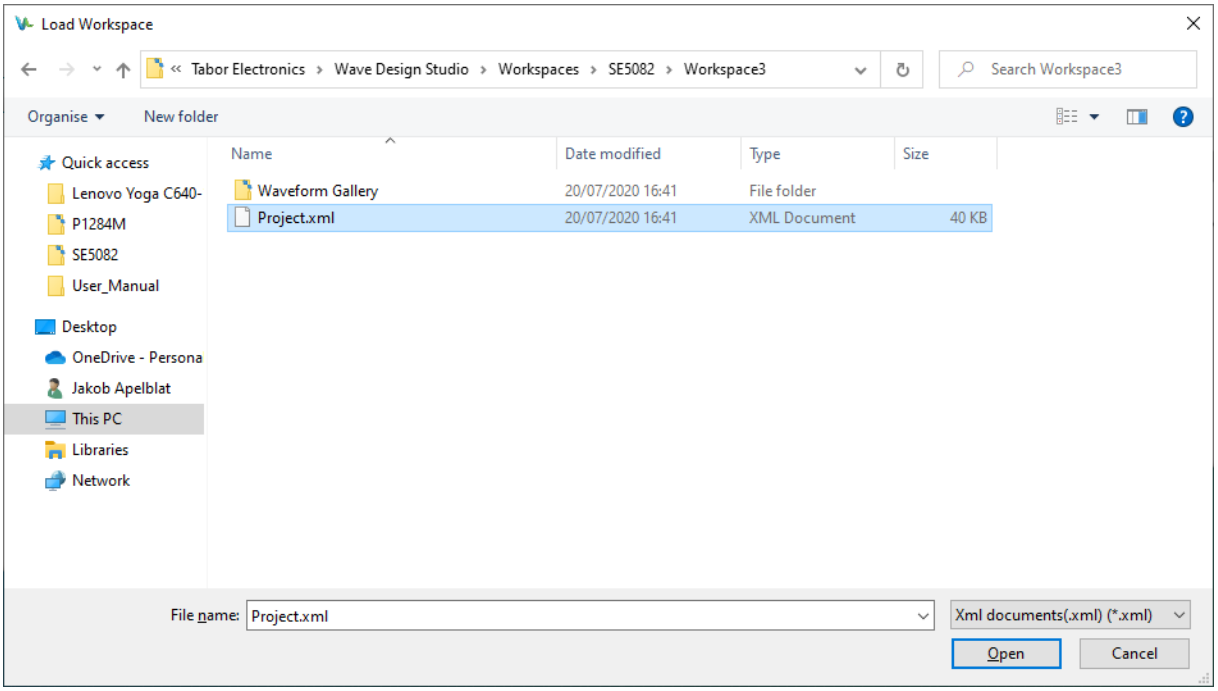


Figure 4.4 Load Workspace

6. The WDS software is now connected to the instrument.

5 WDS Window Layout

The WDS window is composed of several basic elements such as the menu, ribbon tabs, configuration pane, composer screen, channel control and status bar as shown in the figure below.

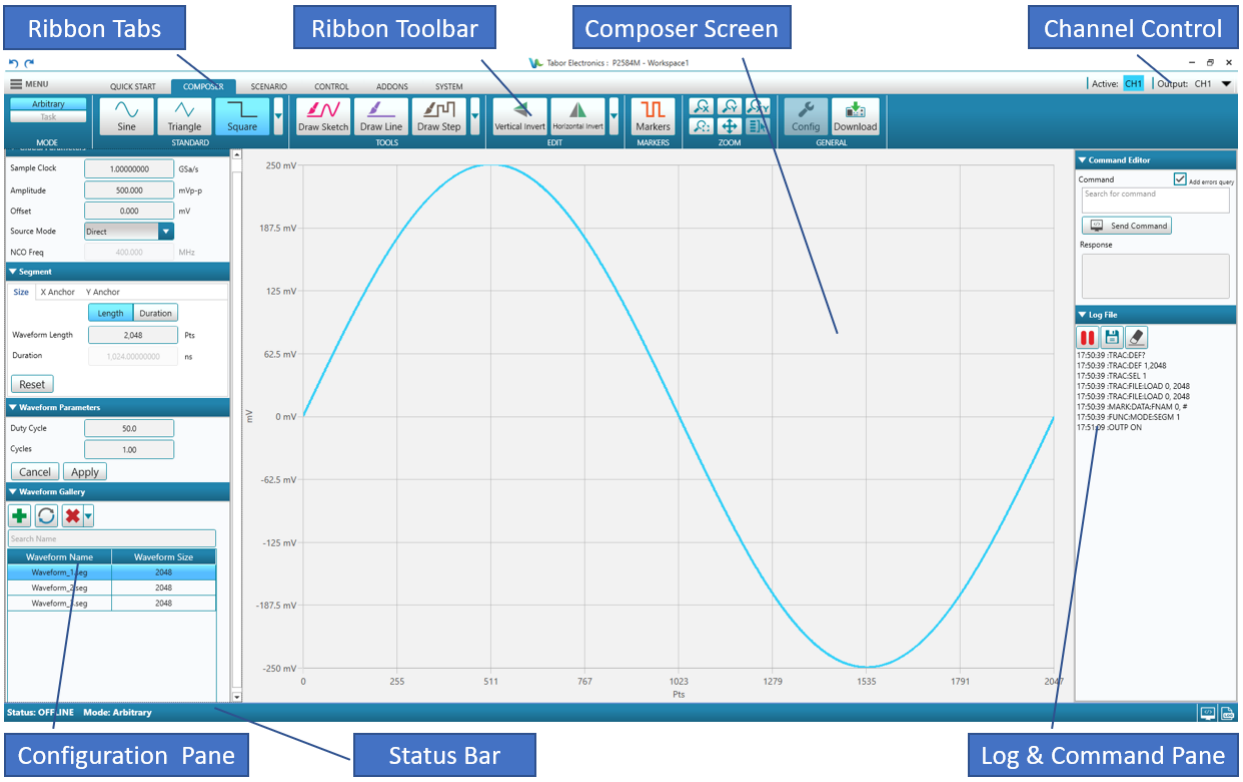


Figure 5.1 WDS Screen Layout

There are the following main elements in the GUI:

- The ribbon tabs enable the user to access the software menu and navigate between the various modes and control windows.
- The channel control provides easy access and visual indication of the state of the channels. Channels can be set as active and the output can be turned on/off.

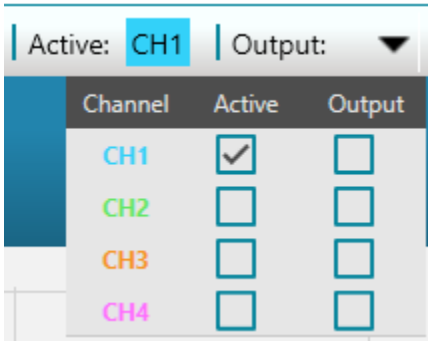


Figure 5.2 Channel Control Menu for Proteus and SE-Series

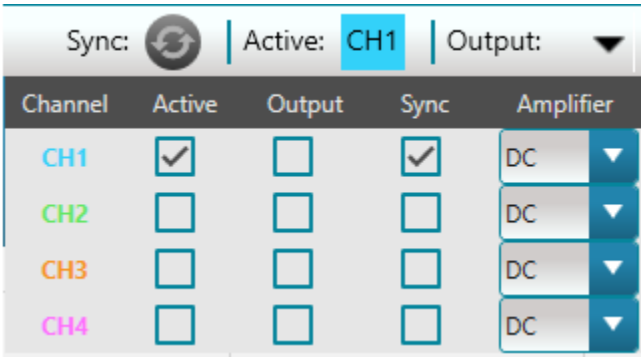
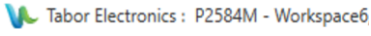


Figure 5.3 Channel Control Menu for WX Series

- **Active** – Select the channel to configure.
- **Output** – Enable the signal output.
- **Sync** – Invoke the sync output of the selected channel, only for SE- and WX-series.
- **Amplifier** – Select the analog signal amplifier, only for WX series.
  - **DC** – Select a DC-coupled amplifier path for the output amplifier.
  - **HV** – Select a high voltage DC-coupled amplifier path for the output amplifier.
  - **AC** – Select a high bandwidth AC amplifier path for the output amplifier.

- The composer screen displays the current waveform that is being edited by the user.
- On the left part of the screen is the configuration pane. This is where all the waveform and control parameters can be accessed and changed by the user. Click the arrow to expand a pane window.
- On the bottom of the screen is the status bar which gives the user the current state of the unit.
  - **Status** – Shows if WDS is connected to the device. Values are ONLINE or OFFLINE.
  - **Active Channel** – The active channel number as specified in the Channel Control dialog box.
  - **Active Segment** – The segment number, as specified in the Scenario Segment Table, for the wave that is displayed on the Composer Screen.
- On the right part of the screen is the Log and Command Pane that is accessed from the Options item in the Menu. You can view a log file that shows the SCPI commands sent to the device by WDS. You can also open a command editor to send your own SCPI commands to the device.
- There are 6 tabs in the ribbon, QUICK START, WAVE, SCENARIO, CONTROL, ADDONS, and SYSTEM. The general workflow of the WDS is as follows or refer to 3.3 Arbitrary Waveform Creation Workflow, page 26:
  1. You can use the **QUICK START** to display a predefined waveform. This is only applicable for the SE- and WX-series.
  1. You create and design all waveforms in the **COMPOSER** tab and add them to the waveform gallery.
  2. Once all waveforms are defined, you proceed to the **SCENARIO** tab where all the segment tables, task tables and scenario tables can be defined.
  3. The **CONTROL** tab is for various system and run mode settings.

4. The **ADDONS** tab is where optional software packages are displayed, such as Radar, and future Signal correction, Digital modulations, Serial data and more.
5. The SYSTEM tab provides information about the device.

-  – Undo/redo last keyboard input and drawing tools (top left corner of WDS). TBD.
- 

– Displays the device model and the allocated workspace.
- **Sync** – Click the Sync button 

to invoke the sync output of the connected device (not available for Proteus).
-  – Click the icon to display the command editor pane.
-  – Click the icon to display the log file pane.

6 WDS Menu

Click the Menu to display the drop-down list.

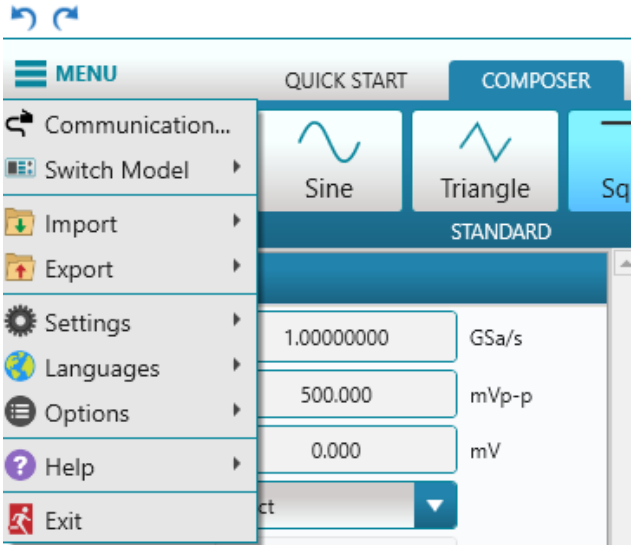


Figure 6.1 Menu

6.1 Communication

- **Communication** – Select the **Communication…** to display the Communication window. Refer to 4 WDS Communication, page 31.

6.2 Switch Model

- **Switch Model** – Switch between the devices that are connected to your PC.

6.3 Import

Select **Import** to display a drop-down list. The elements in the list are context sensitive and only accessible for the relevant ribbon tab (WAVE) and device.

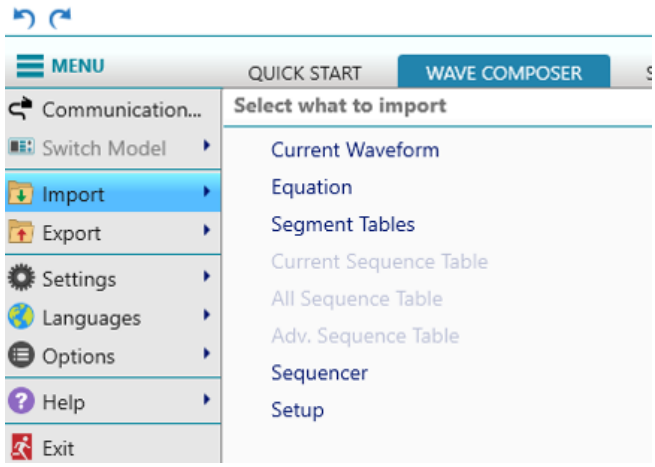


Figure 6.2 Select what to Import

- **Current Waveform** – Load a saved waveform. Supported waveform formats are:
  - Waveform (*.seg)
  - CSV (*.csv)
  - ArbConnection CSV (*.csv)
  - WAV (*.wav)
  - MATLAB (*.mat)
- **Equation** – Import a text file (x.eqe) with the waveform equation.
- **Segment Tables** – The table in the Scenario that has all the segments defined for a specific channel.
- **Current Sequence Table** – The sequence table for the active channel.
- **All Sequence Table** – The sequence tables for all channels.
- **Adv. Sequence Table** – The advance sequence table has a table of sequences.
- **Sequencer** – Import of Segment Tables, Sequence Tables and Adv. Sequence Tables.
- **Setup** – Load a previous WDS session.

6.4 Export

Select **Export** to display a drop-down list. The elements in the list are context sensitive and only accessible for the relevant ribbon tab (WAVE) and device.

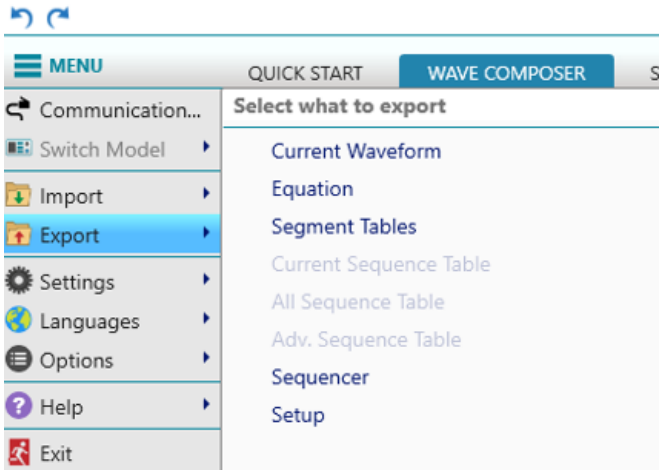


Figure 6.3 Select what to Export

- **Current Waveform** – Save the waveform.
- **Equation** – Save the waveform equation as a text file (x.eqe).
- **Segment Tables** – The table in the Scenario that has all the segments defined for a specific channel.
- **Current Sequence Table** – The sequence table for the active channel.
- **All Sequence Table** – The sequence tables for all channels.
- **Adv. Sequence Table** – The advance sequence table has a table of sequences.
- **Sequencer** – Export of Segment Tables, Sequence Tables and Adv. Sequence Tables.
- **Setup** – Save the WDS session workspace into the workspace you selected when you started the application. Refer to **Select Workspace** in section 4 WDS Communication, page 31. (No confirmation message box is displayed.)

6.5 Settings

Select **Settings** and then an operation from the drop-down list.

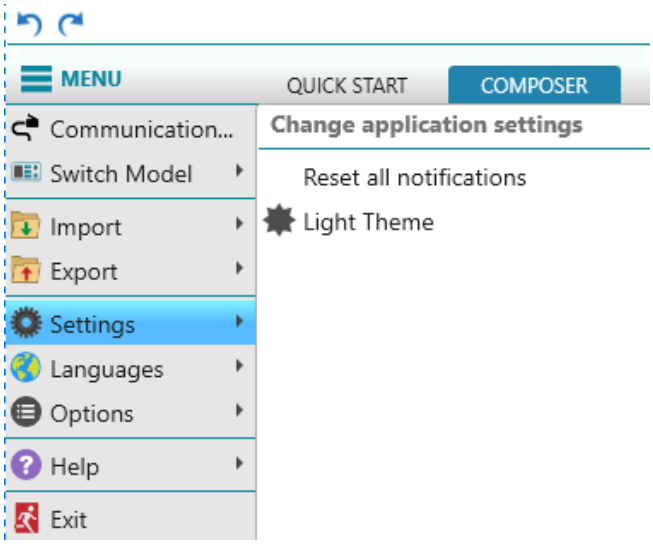


Figure 6.4 Change application settings

- **Reset all notifications** – Get new system notification pop-ups.
- **Light Theme** – Change to WDS display light/dark theme colors.

6.6 Languages

Select **Languages** and then your WDS GUI language.

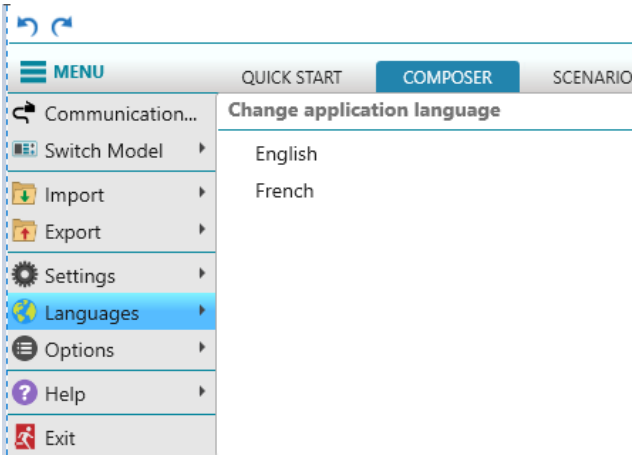


Figure 6.5 Change Application Language

6.7 Options

Select **Options** and then a utility from the drop-down list.

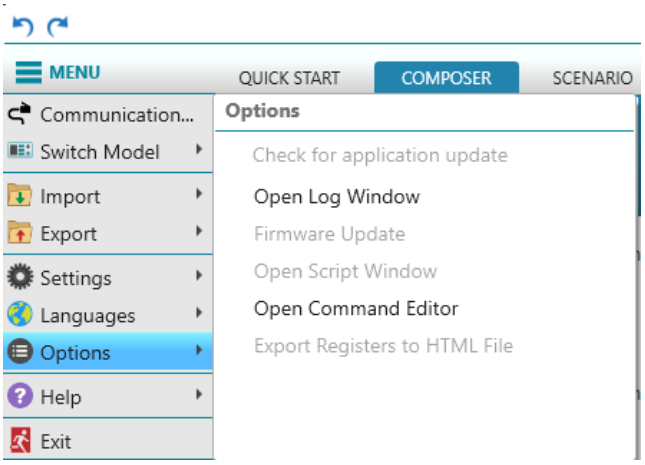


Figure 6.6 Options

- **Check for application update** – TBD.
- **Open Log Window** – Opens the log file in the right-side pane. The log file records all commands, queries and data sent from the PC to the instrument and any response sent from the instrument to the PC. You can stop, start, save, and load the log file. You can copy text lines from the log file window and paste them into other programs such as, MATLAB, Python, Visual studio, and etc.

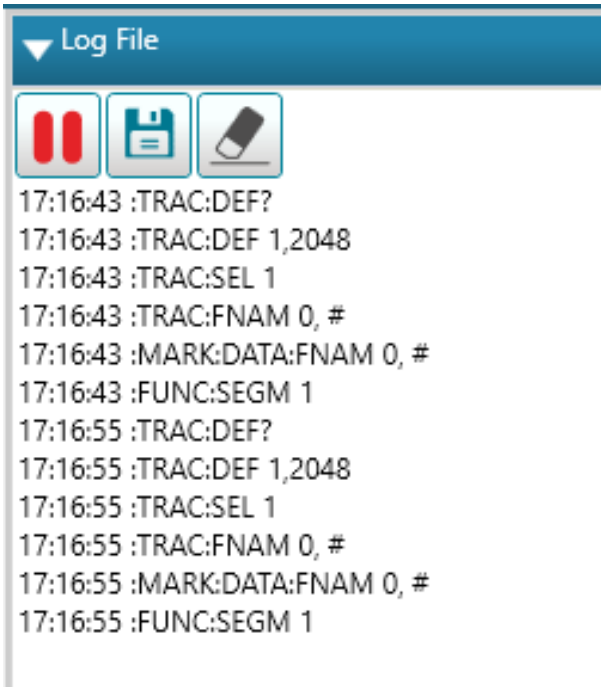


Figure 6.7 Log File

- **Play/Pause** – Toggle between displaying/not displaying the SCPI commands sent to the device.
- **Save** – Save the log to a text file (.txt).
- **Erase** – Erase the log.

- **Firmware Update** – Opens the **Tabor Electronics Update Tool** that comes with the WDS installation package. TBD.
- **Open Script Window** – TBD
- **Open Command Editor** – Opens the Command Editor in the right-side pane. It enables you to send SCPI commands and queries to the instrument and read the instrument response. It will also autocomplete the command with a list of available commands.

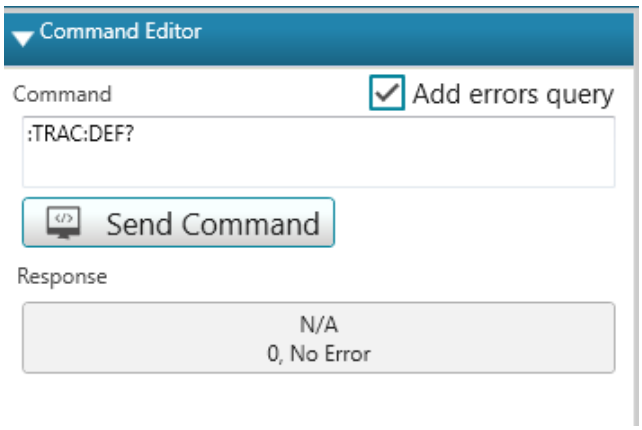


Figure 6.8 Command Editor

Note

- Refer to the device's programming manual for a list of available SCPI commands. E.g. the **Proteus Series Arbitrary Waveform Transceiver Programming Manual** can be downloaded from the Tabor website at www.taborelec.com/downloads.

  - **Add errors query** – When checked every command that is sent to the instrument is followed by a :SYST:ERR? query.

- **Export Registers to HTML File** – Export the FPGA register values to an HTML file. If you encounter any issue with the device you can send this file to Tabor support for further analysis.

6.8 Help

Select **Help** and then an item from the drop-down list.

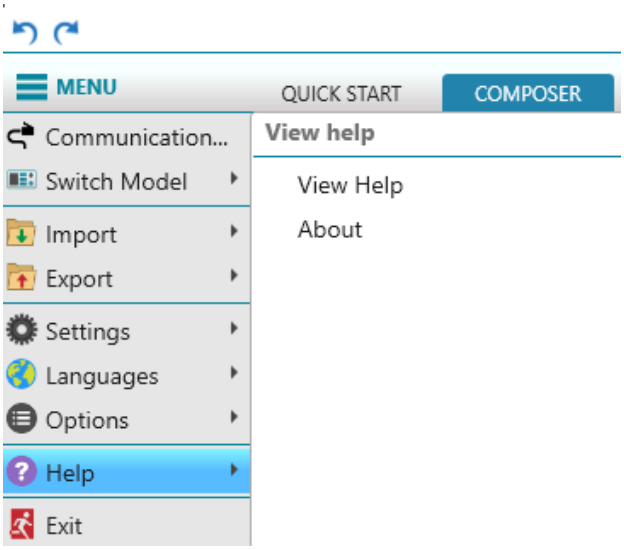


Figure 6.9 View Help

- **View Help** – Displays the WDS User Manual in PDF format in your browser. The file can also be downloaded from the Tabor website at www.taborelec.com/downloads.
- **About** – Displays the WDS version.

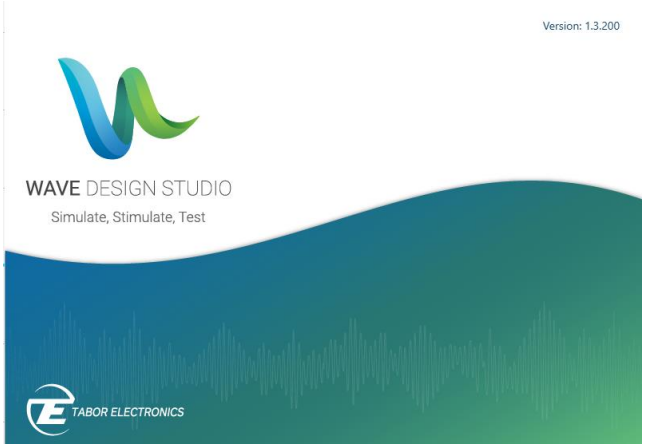


Figure 6.10 About

6.9 Exit

Select **Exit** to terminate the application. You will be asked if you want to save your workspace.

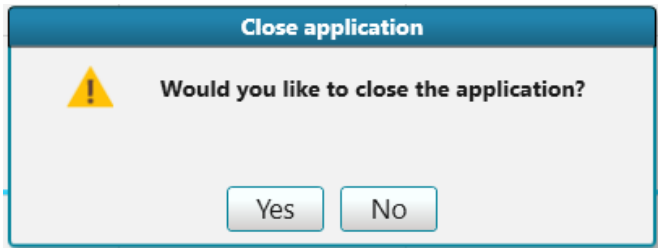


Figure 6.11 Close Application

7 Quick Start

Note

- The Quick Start mode is only available for the SE- and WX-series.

Click the **QUICK START** tab on the ribbon to display a waveform from the device library of waveforms. You define only the waveform frequency and the SCLK and the waveform length (number of points/samples) is calculated automatically.

The selected wave will immediately be generated on the device and transmitted to the output channel that is enabled. Refer to channel control in 5 WDS Window Layout, page 35.

7.1 Standard

The Standard function provides a selection of standard waves.

7.1.1 Sine

Sine displays a standard sine wave.

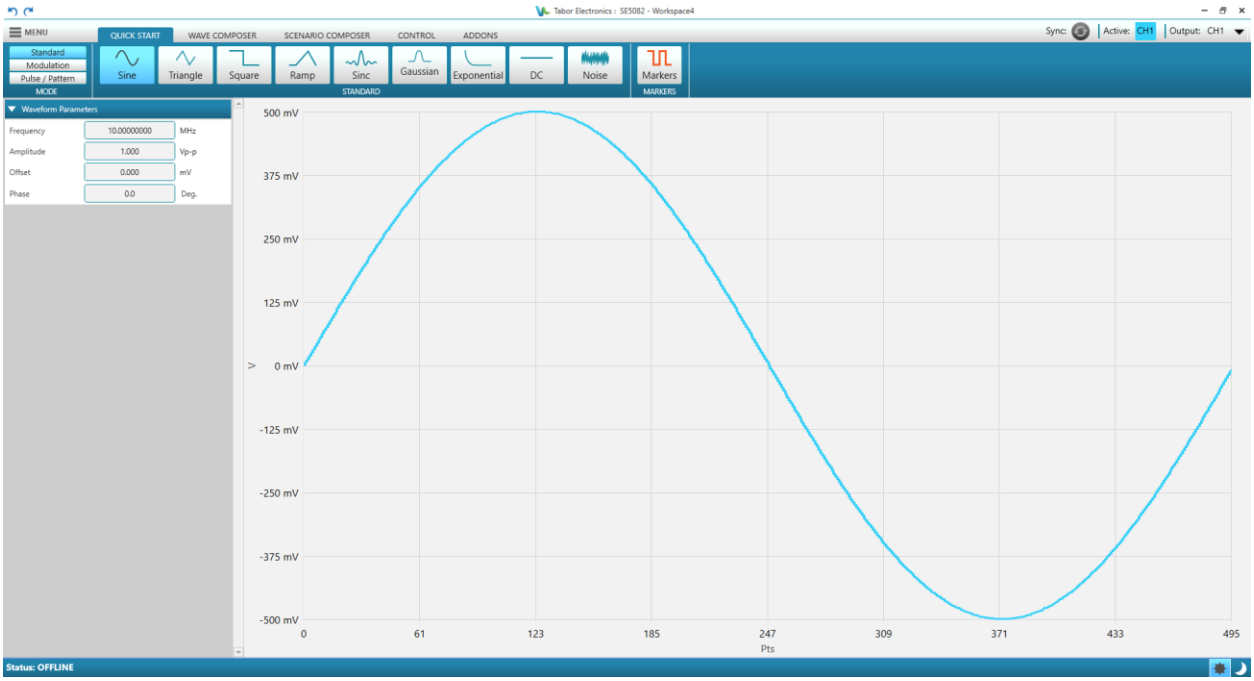


Figure 7.1 Quick Start Standard Sine

- **Waveform Parameters**
  - **Frequency** – Set the wave frequency (µHz, mHz, Hz, kHz, MHz, GHz).
  - **Amplitude** – Set the point-to-point amplitude of the wave (mVp-p, Vp-p).
  - **Offset** – Set the DC offset of the wave (mV, V).
  - **Phase** – Set the phase offset of the wave. Phase offset range is between 0 degrees to 360 degrees. The default value is 0 degrees.

7.1.2 Triangle

Triangle displays a standard triangle wave.

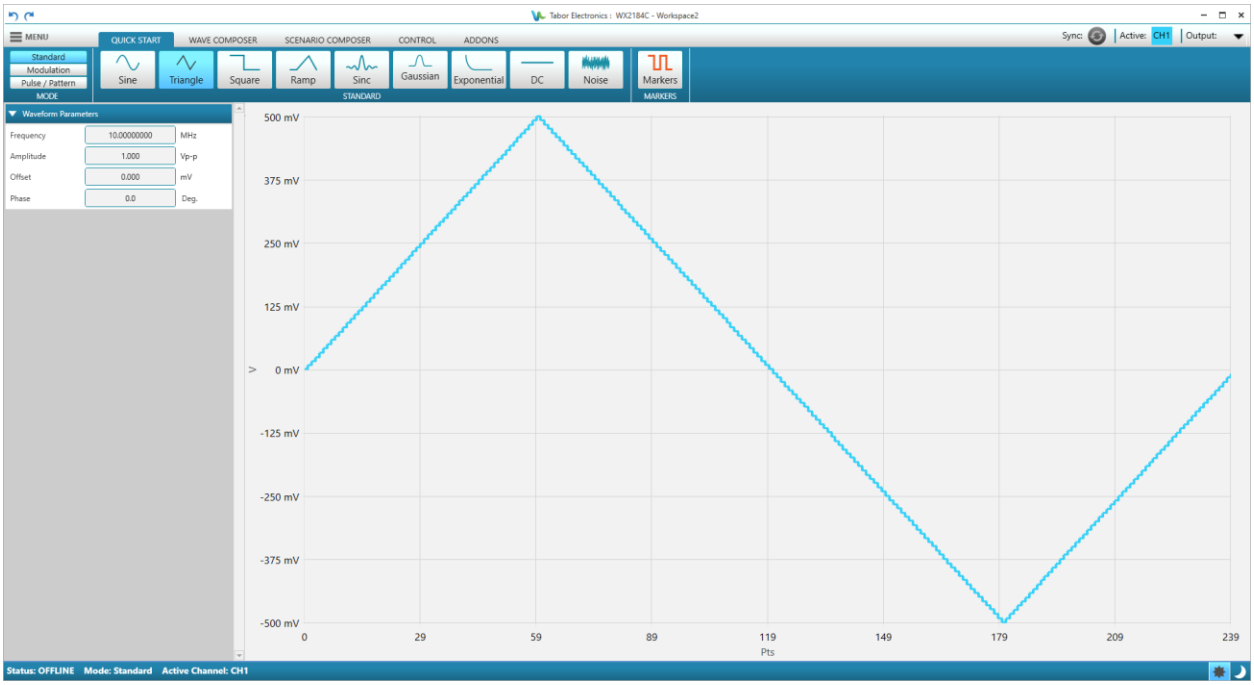


Figure 7.2 Quick Start Standard Triangle

- **Waveform Parameters**
  - **Frequency** – Set the wave frequency (µHz, mHz, Hz, kHz, MHz, GHz).
  - **Amplitude** – Set the point-to-point amplitude of the wave (mVp-p, Vp-p).
  - **Offset** – Set the DC offset of the wave (mV, V).
  - **Phase** – Set the phase offset of the wave. Phase offset range is between 0 degrees to 360 degrees. The default value is 0 degrees.

7.1.3 Square

Square displays a standard square wave.

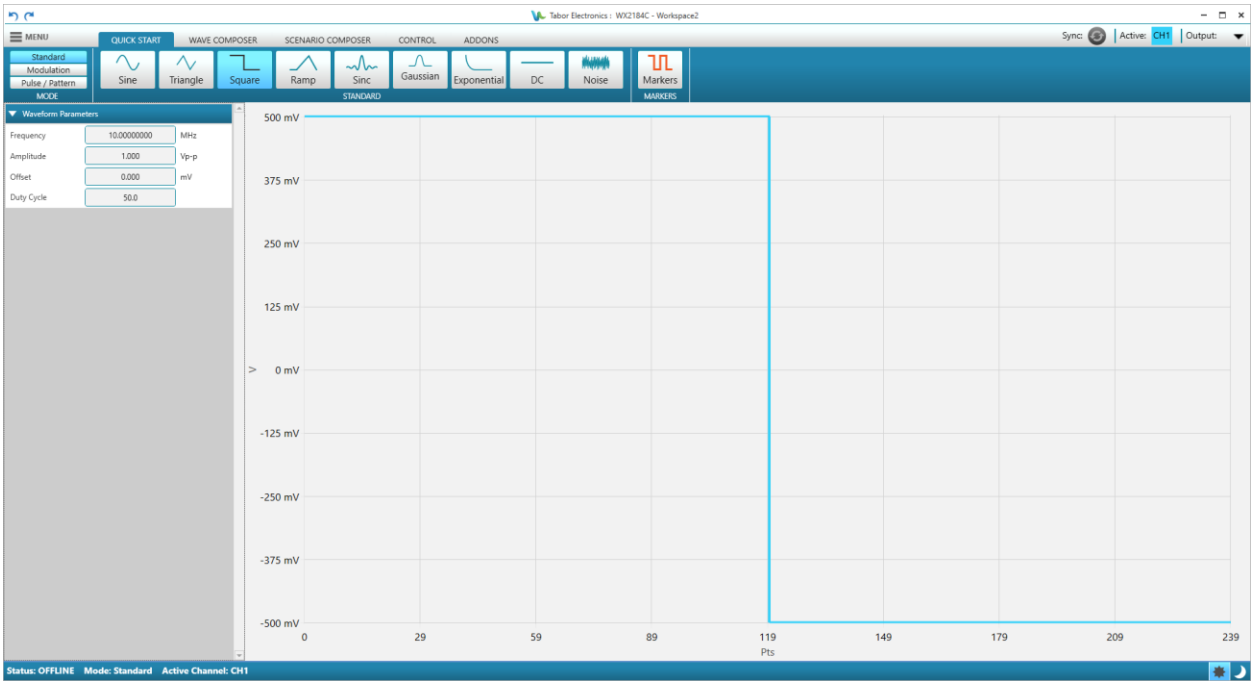


Figure 7.3 Quick Start Standard Square

- **Waveform Parameters**
  - **Frequency** – Set the wave frequency (µHz, mHz, Hz, kHz, MHz, GHz).
  - **Amplitude** – Set the point-to-point amplitude of the wave (mVp-p, Vp-p).
  - **Offset** – Set the DC offset of the wave (mV, V).
  - **Duty Cycle** – Set the width of the pulse as a percentage of its period.

7.1.4 Ramp

Ramp displays a standard ramp wave.

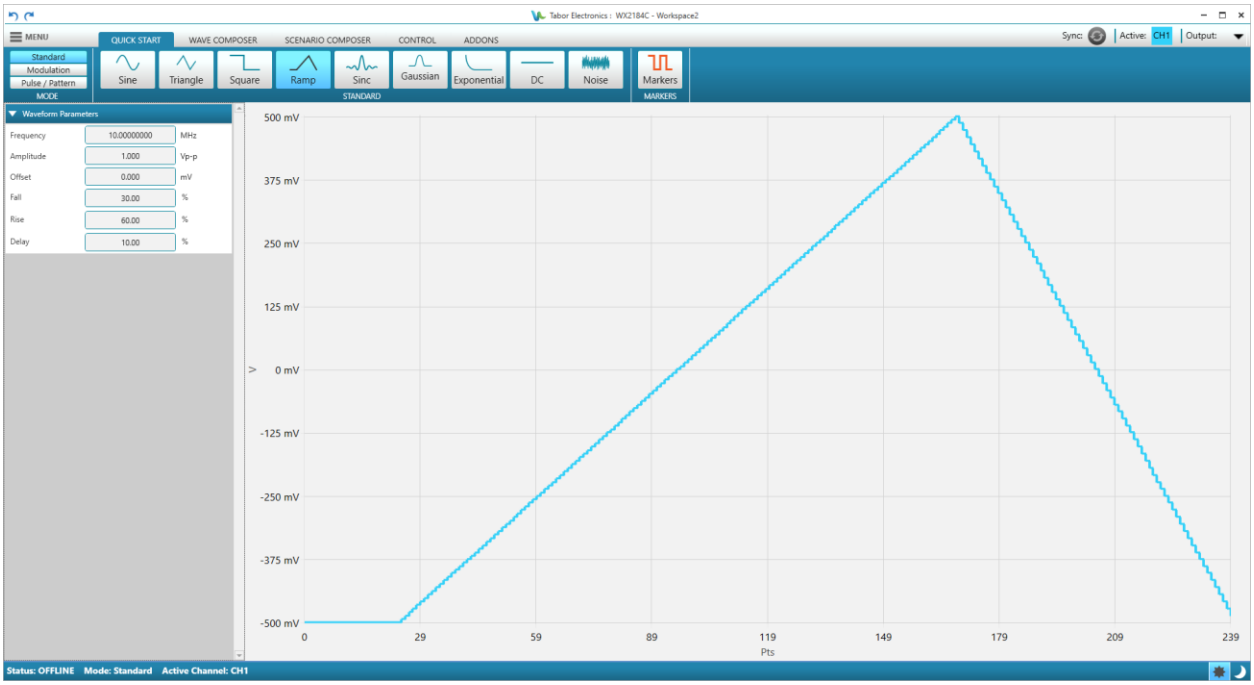


Figure 7.4 Quick Start Standard Ramp

- **Waveform Parameters**
  - **Frequency** – Set the wave frequency (µHz, mHz, Hz, kHz, MHz, GHz).
  - **Amplitude** – Set the point-to-point amplitude of the wave (mVp-p, Vp-p).
  - **Offset** – Set the DC offset of the wave (mV, V).
  - **Fall** – Set the transition to the minimum amplitude in percent of the total number of wave points in the period.
  - **Rise** – Set the transition to the maximum amplitude in percent of the total number of wave points in the period.
  - **Delay** – Set the delay in percent of the total number of wave points in the period.

7.1.5 Sinc

Sinc displays a standard sinc wave.

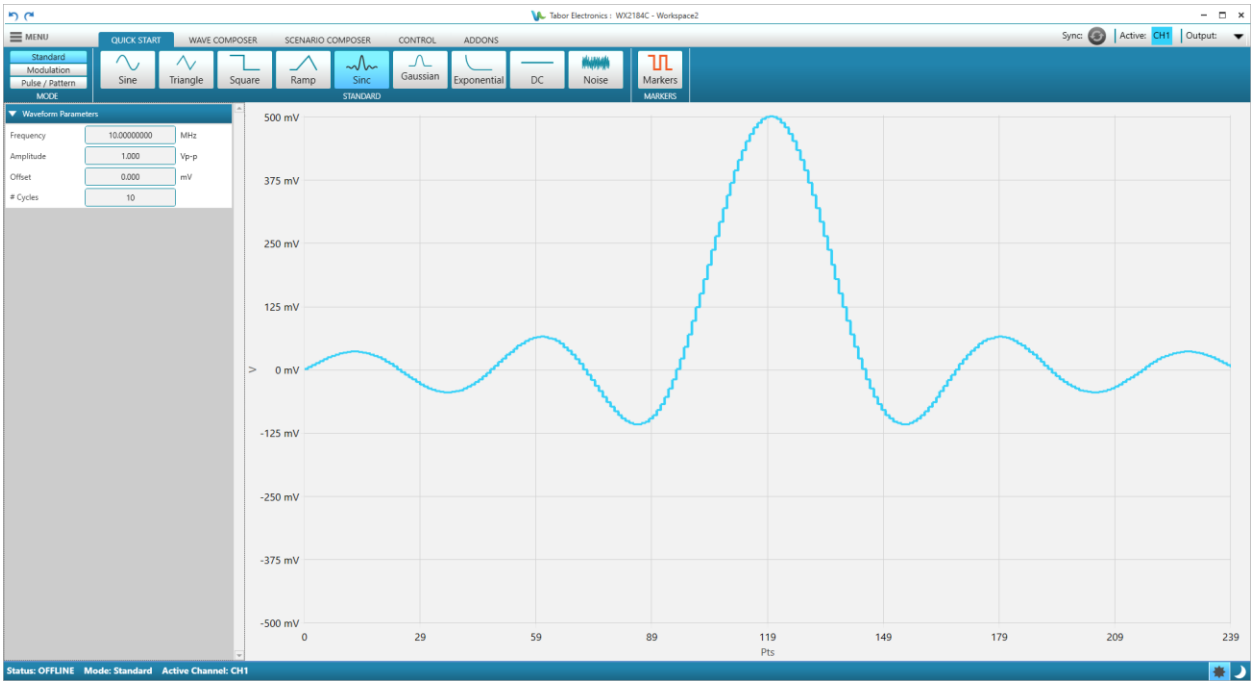


Figure 7.5 Quick Start Standard Sinc

- **Waveform Parameters**
  - **Frequency** – Set the wave frequency (µHz, mHz, Hz, kHz, MHz, GHz).
  - **Amplitude** – Set the point-to-point amplitude of the wave (mVp-p, Vp-p).
  - **Offset** – Set the DC offset of the wave (mV, V).
  - **# Cycles** – Set how many zero-crossings of the sinc wave. Use only even numbers.

7.1.6 Gaussian

Gaussian displays a standard gaussian wave.

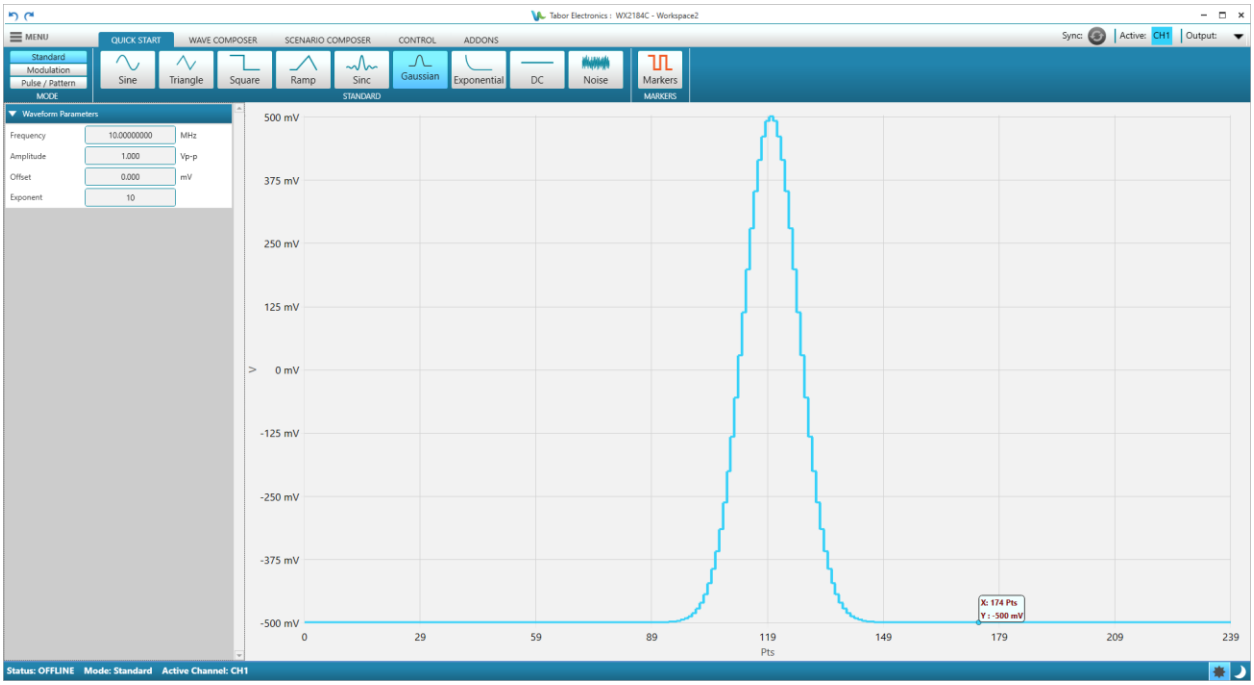


Figure 7.6 Quick Start Standard Gaussian

- **Waveform Parameters**
  - **Frequency** – Set the wave frequency (µHz, mHz, Hz, kHz, MHz, GHz).
  - **Amplitude** – Set the point-to-point amplitude of the wave (mVp-p, Vp-p).
  - **Offset** – Set the DC offset of the wave (mV, V).
  - **Exponent**– Set the width of the gaussian "bell".

7.1.7 Exponential

Exponential displays a standard exponential wave.

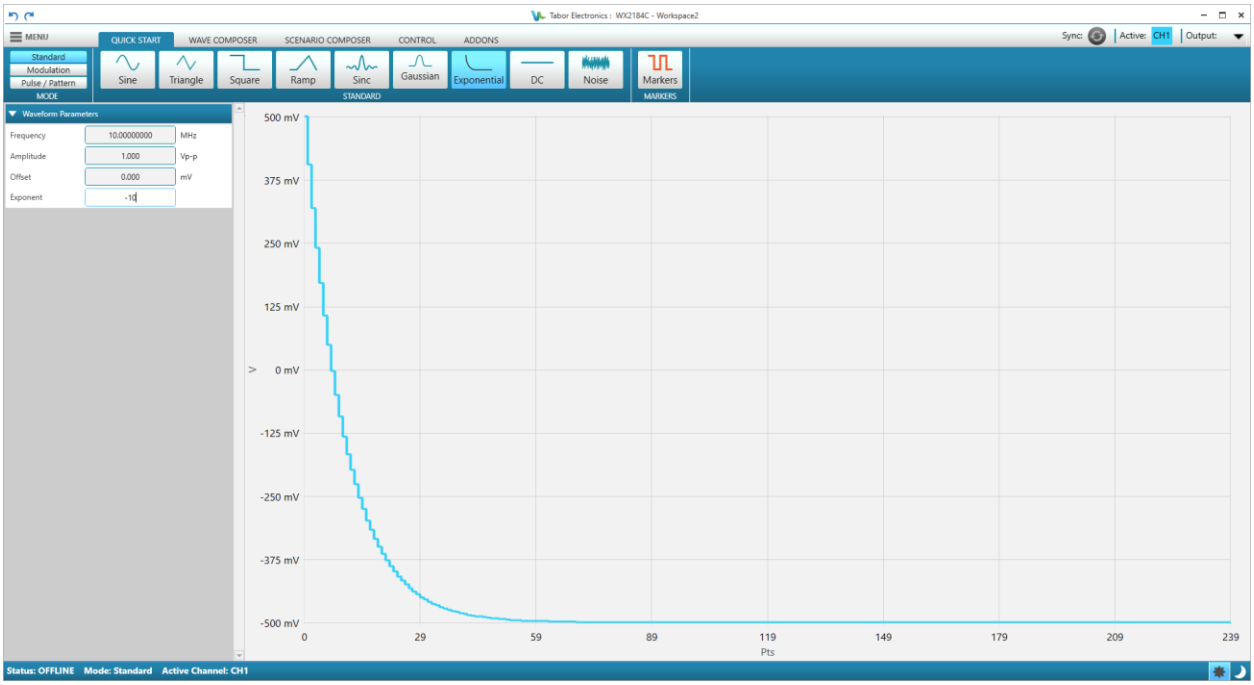


Figure 7.7 Quick Start Standard Exponential

- **Waveform Parameters**
  - **Frequency** – Set the wave frequency (µHz, mHz, Hz, kHz, MHz, GHz).
  - **Amplitude** – Set the point-to-point amplitude of the wave (mVp-p, Vp-p).
  - **Offset** – Set the DC offset of the wave (mV, V).
  - **Exponent** – Set the exponent constant.

7.1.8 DC

DC displays a DC level signal.

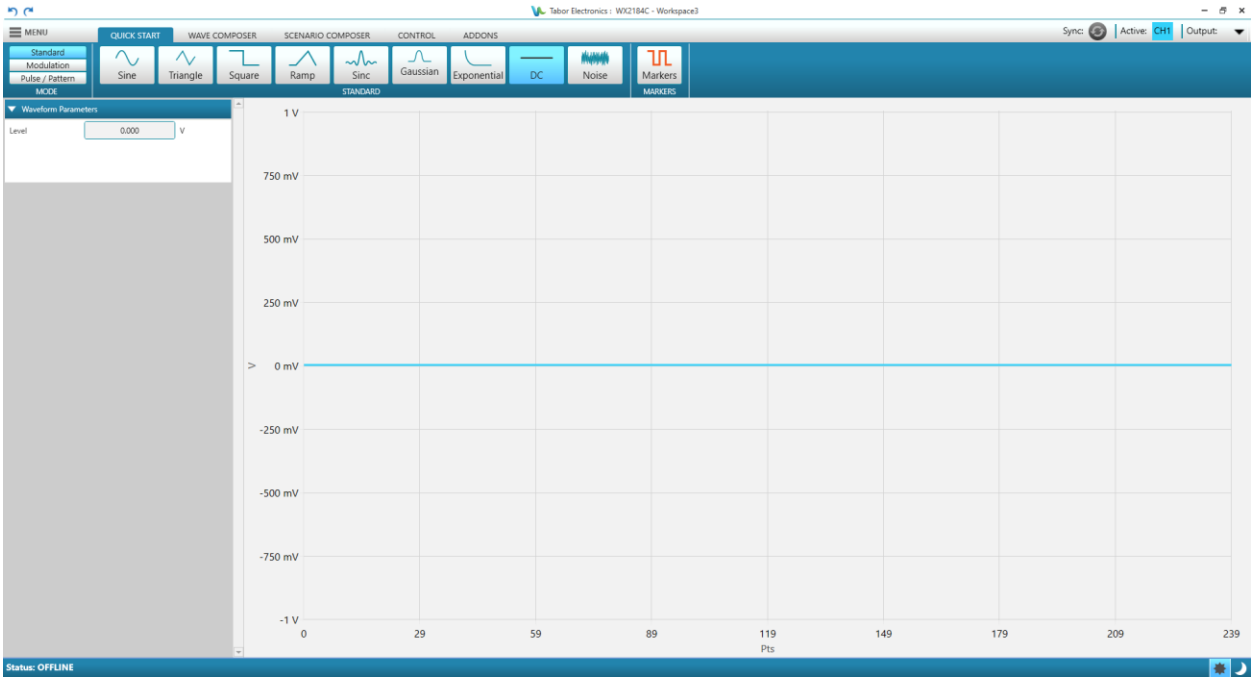


Figure 7.8 Quick Start Standard DC

- **Waveform Parameters**
  - **Level** – Set the DC level (mV, V).

7.1.9 Noise

Noise displays a random noise wave.

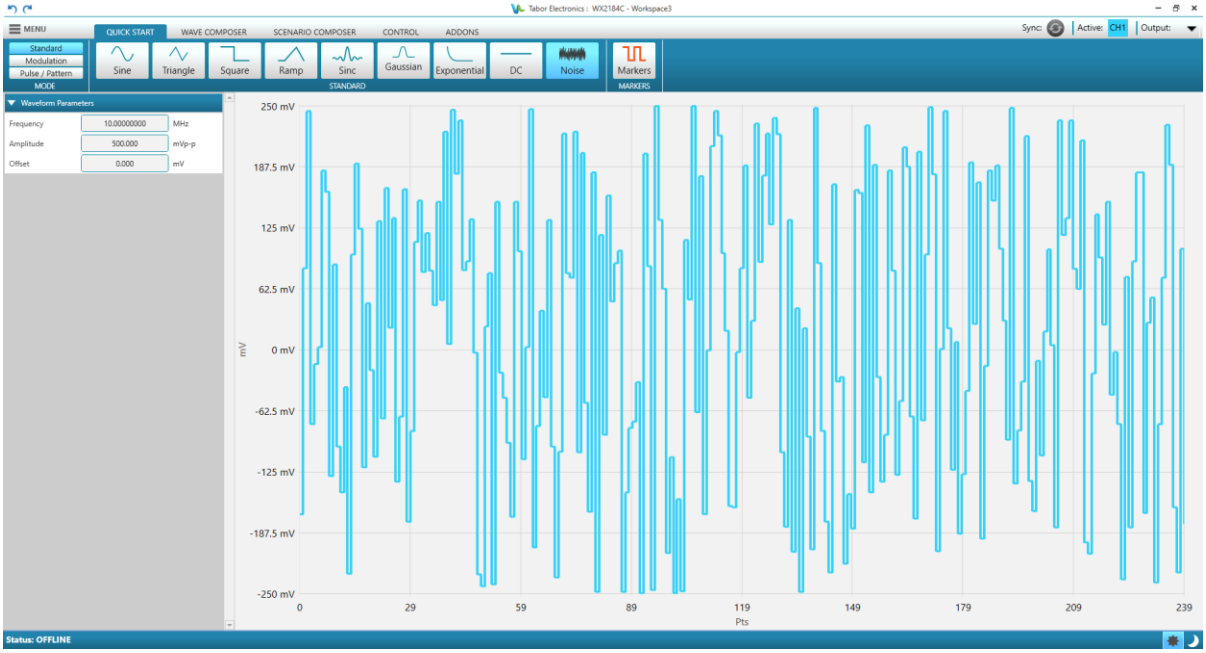


Figure 7.9 Quick Start Standard Random Noise

- **Waveform Parameters**
  - **Frequency** – Set the wave frequency (µHz, mHz, Hz, kHz, MHz, GHz).
  - **Amplitude** – Set the point-to-point amplitude of the wave (mVp-p, Vp-p).
  - **Offset** – Set the DC offset of the wave (mV, V).

7.1.10 Markers

Markers displays marker signals. Click the **Markers** button to display the Markers pane.

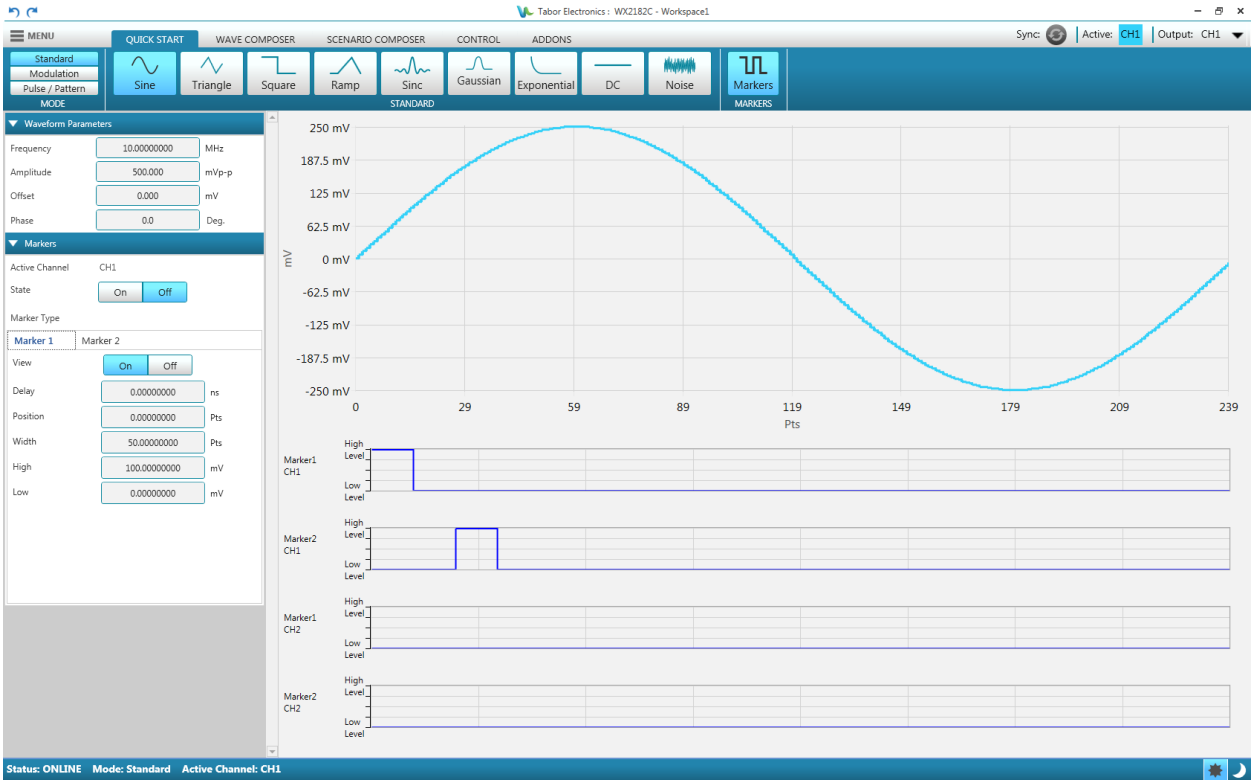


Figure 7.10 Sine Way with Markers

- **Active Channel** – The markers will be defined for the active channel selected in the Channel control, refer to 5 WDS Window, page 35.

- **Marker 1/2** – Click the tab to select the marker to configure.
  - **State** – Click **On**/**Off** to activate/deactivate the marker output.
  - **View** – Click **On**/**Off** to view/hide the marker on the composer screen.
  - **Delay** – The delay is measured from the sync output in units of seconds. The marker has an initial delay of 0 sample clock periods, not including initial skew.
  - **Position** – Start the marker from this wave sample. Note that the resolution is device dependent.
  - **Width** – The width of the marker pulse in wave samples (Pts, kPts, MPts).
  - **High** – Set the maximum amplitude of the marker signal.
  - **Low** – Set the minimum amplitude of the marker signal.

When you select the COMPOSER tab a message box is displayed that states that the global wave parameters are common for all waveforms (sample clock, amplitude, offset).

Figure 7.11 Welcome to Wave Composer

7.2 Modulation

Modulation displays a selection of modulation types.

Note

- The selected wave will be generated exactly by the device, but a static graph will be displayed on the composer screen.

7.2.1 Off

Off displays the carrier wave without any modulation.

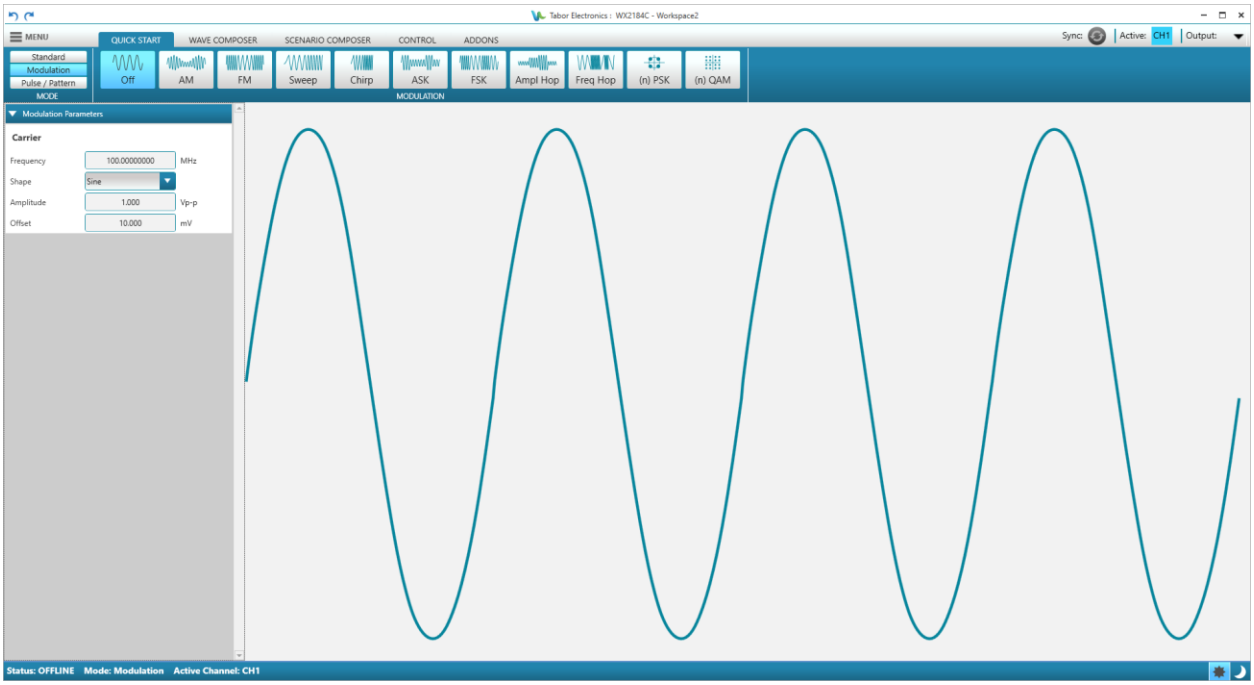


Figure 7.12 Quick Start Modulation Off

- **Carrier** – Set the carrier wave parameters.
  - **Frequency** – Set the wave frequency (µHz, mHz, Hz, kHz, MHz, GHz).
  - **Shape** – Set the modulation shape to Sine, Triangle, Square, or Ramp.
  - **Amplitude** – Set the point-to-point amplitude of the wave (mVp-p, Vp-p).
  - **Offset** – Set the DC offset of the wave (mV, V).

7.2.2 AM

AM displays an amplitude modulated wave.

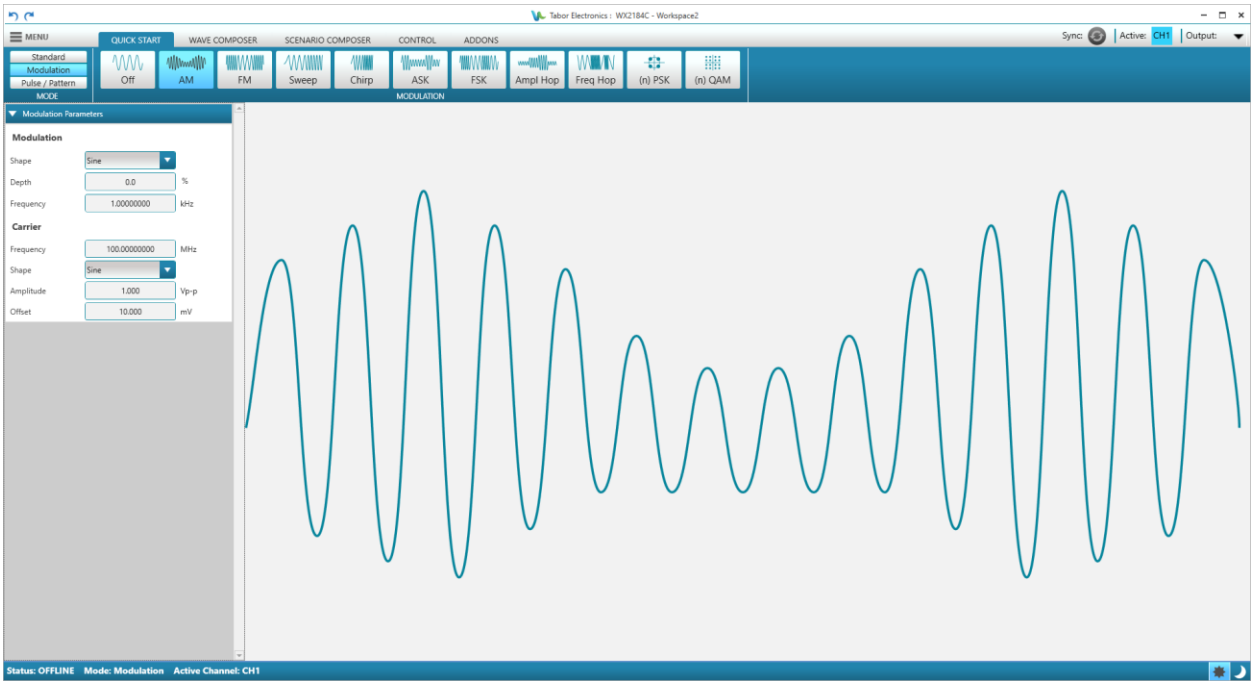


Figure 7.13 Quick Start Modulation AM

- **Modulation** – Set the modulation parameters.
  - **Shape** – Set the modulation shape to Sine, Triangle, Square, or Ramp.
  - **Depth** – Set the AM modulation in percent of the carrier wave amplitude.
  - **Frequency** – Set the modulation frequency (Hz/kHz).
- **Carrier** – Set the carrier wave parameters.
  - **Frequency** – Set the wave frequency (µHz, mHz, Hz, kHz, MHz, GHz).
  - **Shape** – Set the modulation shape to Sine, Triangle, Square, or Ramp.
  - **Amplitude** – Set the point-to-point amplitude of the wave (mVp-p, Vp-p).
  - **Offset** – Set the DC offset of the wave (mV, V).

7.2.3 FM

FM displays a frequency modulated wave.

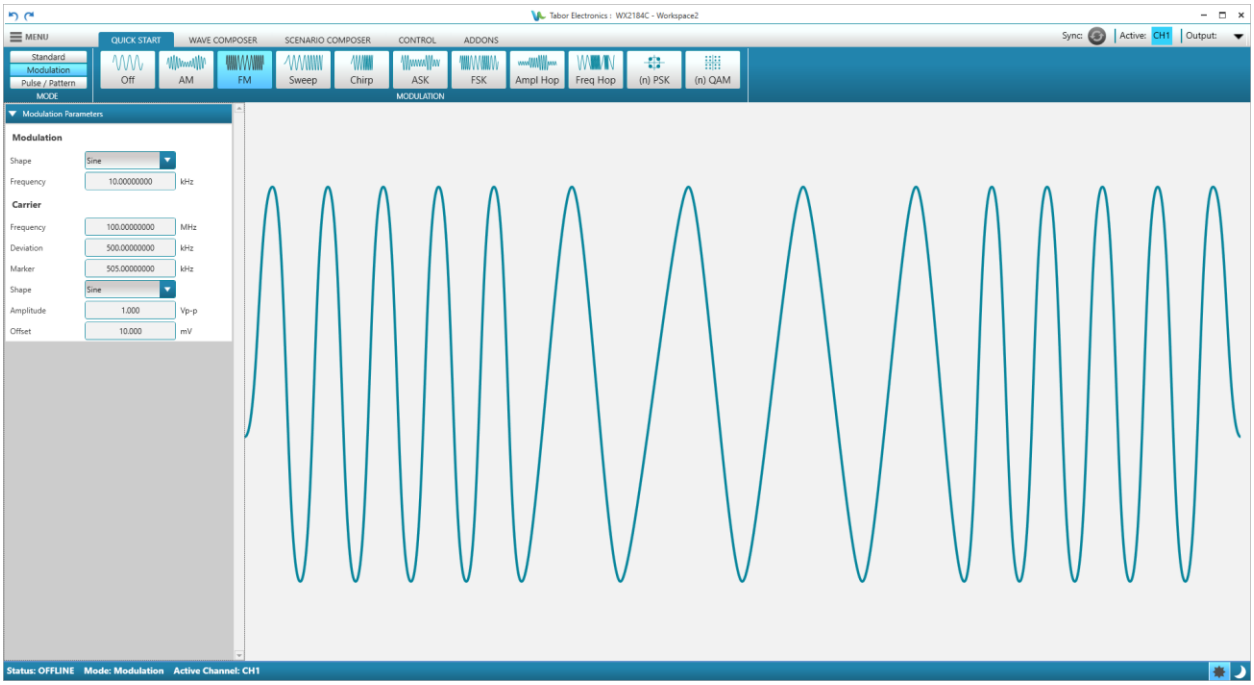


Figure 7.14 Quick Start Modulation FM

- **Modulation** – Set the modulation parameters.
  - **Shape** – Set the modulation shape to Sine, Triangle, Square, or Ramp.
  - **Frequency** – Set the modulation frequency (Hz/kHz).
- **Carrier** – Set the carrier wave parameters.
  - **Frequency** – Set the wave frequency (µHz, mHz, Hz, kHz, MHz, GHz).
  - **Deviation** – Set the frequency deviation of the carrier wave in (Hz).
  - **Marker** – Set the marker pulse frequency. The marker pulse is output at the SYNC output connector.
  - **Shape** – Set the carrier shape to Sine, Triangle, Square, or Ramp.
  - **Amplitude** – Set the point-to-point amplitude of the wave (mVp-p, Vp-p).
  - **Offset** – Set the DC offset of the wave (mV, V).

7.2.4 Sweep

Sweep displays a sweep frequency modulated wave.

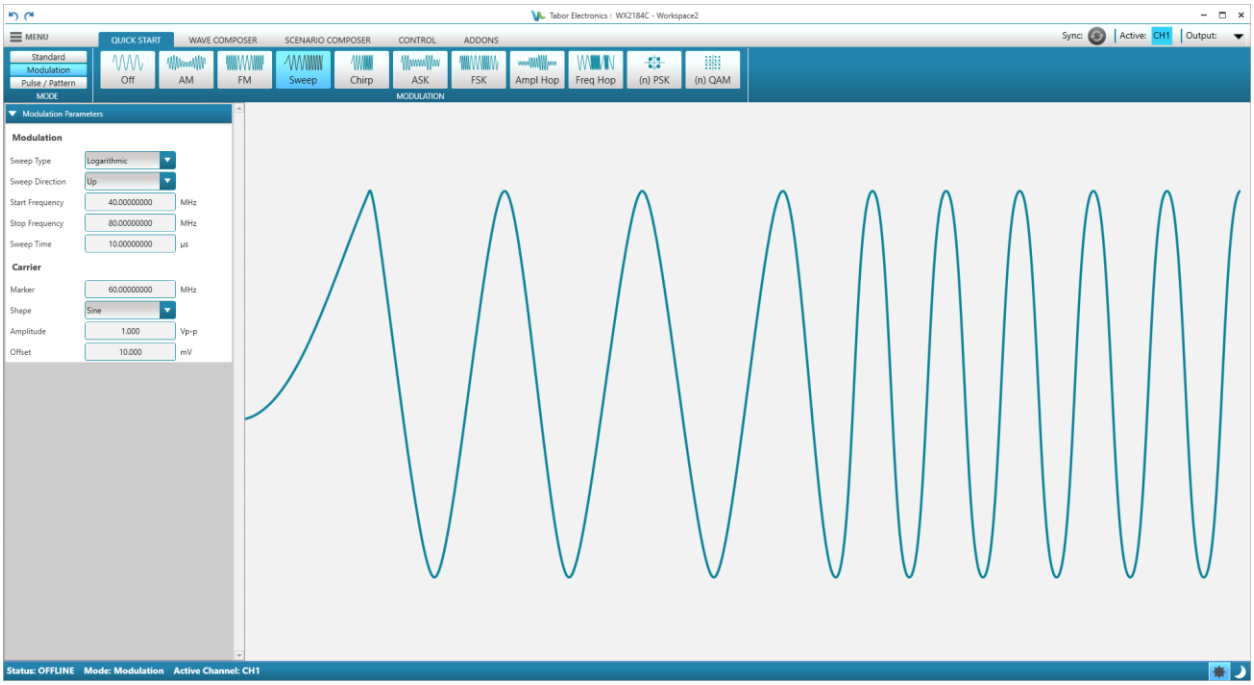


Figure 7.15 Quick Start Modulation Sweep

- **Modulation** – Set the modulation parameters.
  - **Sweep Type** – The type of sweep.
    - **Linear** – The sweep steps are incremented linearly.
    - **Logarithmic** – The sweep steps are incremented logarithmically.
  - **Sweep Direction** – Set the sweeping direction:
    - **Up** – Sweep from start frequency to stop frequency.
    - **Down** – Sweep from stop frequency to start frequency.
  - **Start Frequency** – Set the sweep start frequency (kHz/MHz/GHz).
  - **Stop Frequency** – Set the sweep stop frequency (kHz/MHz/GHz).
  - **Sweep Time** – Set the duration of the entire sweep.
- **Carrier** – Set the carrier wave parameters.
  - **Marker** – Set the marker pulse frequency. The marker pulse is output at the SYNC output connector.
  - **Shape** – Set the carrier shape to Sine, Triangle or Square.
  - **Amplitude** – Set the point-to-point amplitude of the wave (mVp-p, Vp-p).
  - **Offset** – Set the DC offset of the wave (mV, V).

7.2.5 Chirp

Chirp displays a chirp modulated wave, where both the frequency and amplitude are changed.

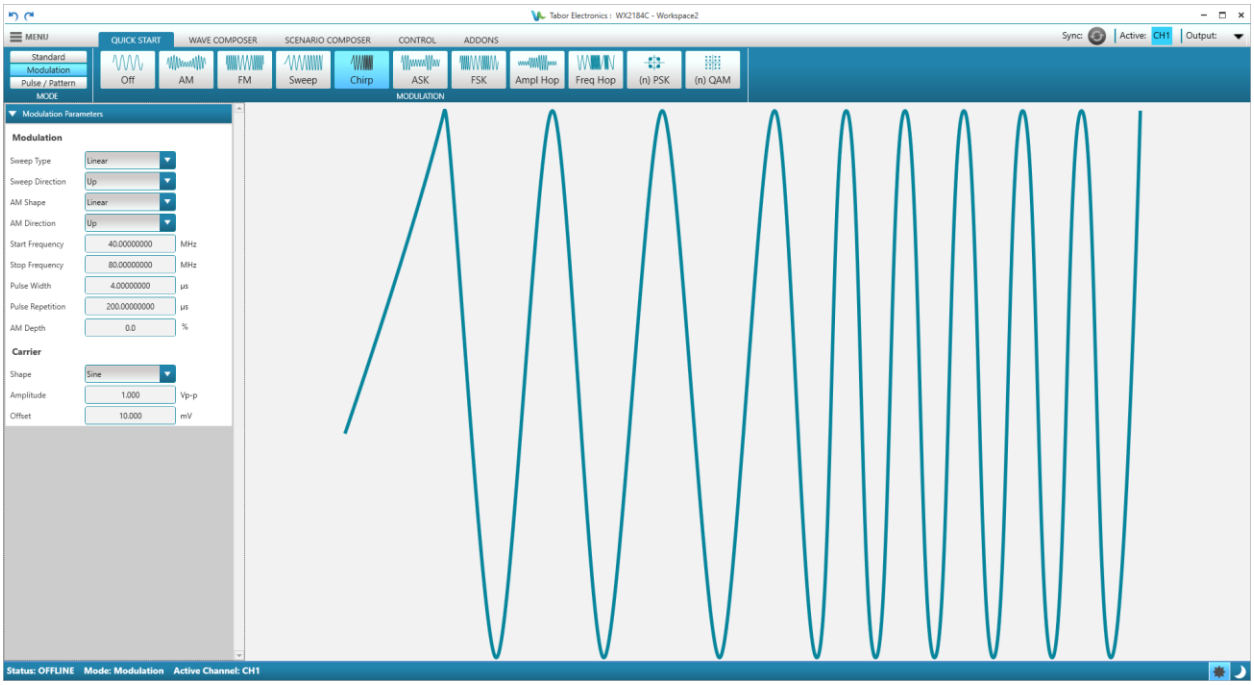


Figure 7.16 Quick Start Modulation Chirp TBD

- **Modulation** – Set the modulation parameters.
  - **Sweep Type** – The type of sweep.
    - **Linear** – The chirp steps are incremented linearly.
    - **Logarithmic** – The chirp steps are incremented logarithmically.
  - **Sweep Direction** – Set the chirp direction:
    - **Up** – Chirp from start frequency to stop frequency.
    - **Down** – Chirp from stop frequency to start frequency.
  - **AM Shape** – Set the AM shape.
    - **Linear** – The amplitude steps are incremented linearly.
    - **Logarithmic** – The amplitude steps are incremented logarithmically.
  - **AM Direction** – Set the AM direction.
    - **Up** – Select the chirp amplitude modulation up direction.
    - **Down** – Select the chirp amplitude modulation down direction.
  - **Start Frequency** – Set the chirp start frequency (kHz/MHz/GHz).
  - **Stop Frequency** – Set the chirp stop frequency (kHz/MHz/GHz).
  - **Pulse Width** – Set the width of the pulse (ms, µs).
  - **Pulse Repetition** – Set the pulse repletion (ns, µs, ms, s).
  - **AM Depth** – Set the AM modulation in percent of the carrier wave amplitude.
- **Carrier** – Set the carrier wave parameters.
  - **Shape** – Set the carrier shape to Sine, Triangle or Square.
  - **Amplitude** – Set the point-to-point amplitude of the wave (mVp-p, Vp-p).

- **Offset** – Set the DC offset of the wave (mV, V).

7.2.6 ASK

ASK displays an amplitude shift keying modulated wave.

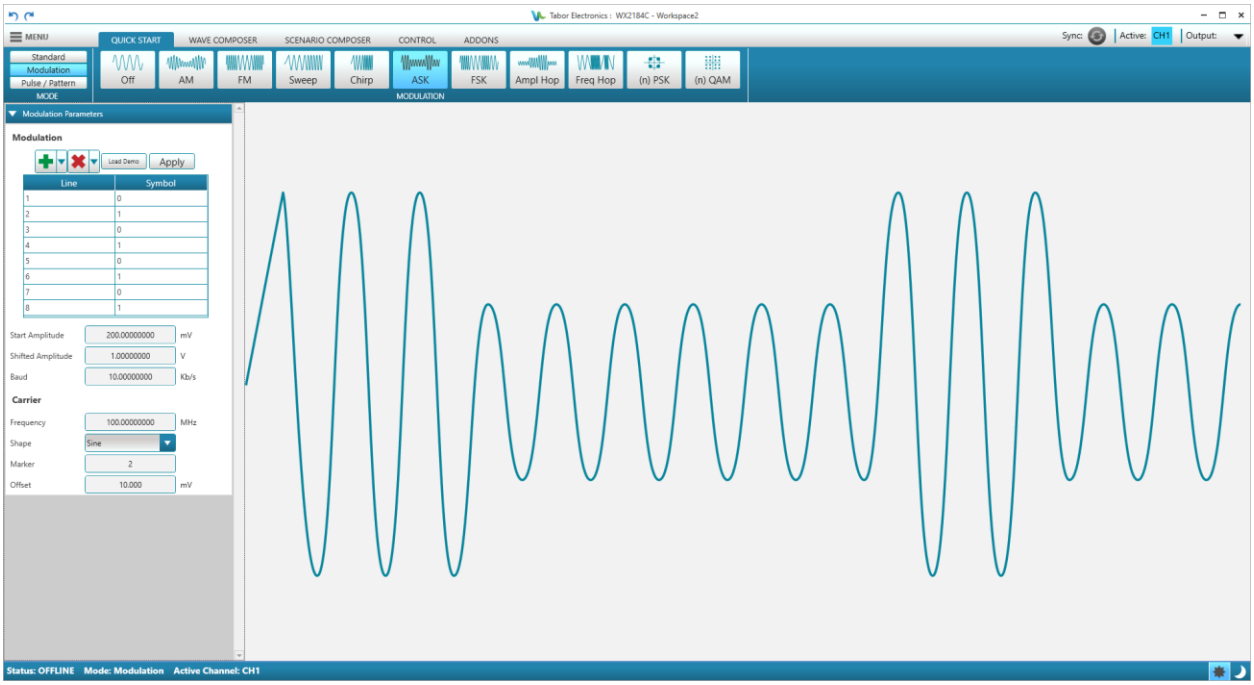


Figure 7.17 Quick Start Modulation ASK

- **Modulation** – The sequence of the modulation control data bits controls the sequence of base amplitude and shifted amplitude. It contains a table of "0" and "1" and the output will repeatedly follow the amplitude shift keying sequence in the same order as programmed.
  -  – Add a line (Above/Below) of the modulation control data bits. This 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.
  -  – Remove selected line.
  - **Load Demo** – Load a demo table with modulation control data bits.
  - **Apply** – Download the modulation data table to the device.
  - **Line** – Line number in the control data list.
  - **Symbol** – Symbol bit.
  - **Start Amplitude** – The start amplitude (mV/V).
  - **Shifted Amplitude** – The shifted amplitude (mV/V).
  - **Baud** – The baud parameter sets the rate of which the generator steps through the sequence of the ASK Control Data bits.
- **Carrier** – Set the carrier wave parameters.

- **Frequency** – Set the wave frequency (kHz, MHz, GHz).
- **Shape** – Set the carrier shape to Sine, Triangle or Square.
- **Marker** – Set the symbol line number at which a sync signal will be generated from the sync output.
- **Offset** – Set the DC offset of the wave (mV, V).

7.2.7 FSK

FSK displays a frequency shift keying modulated wave.

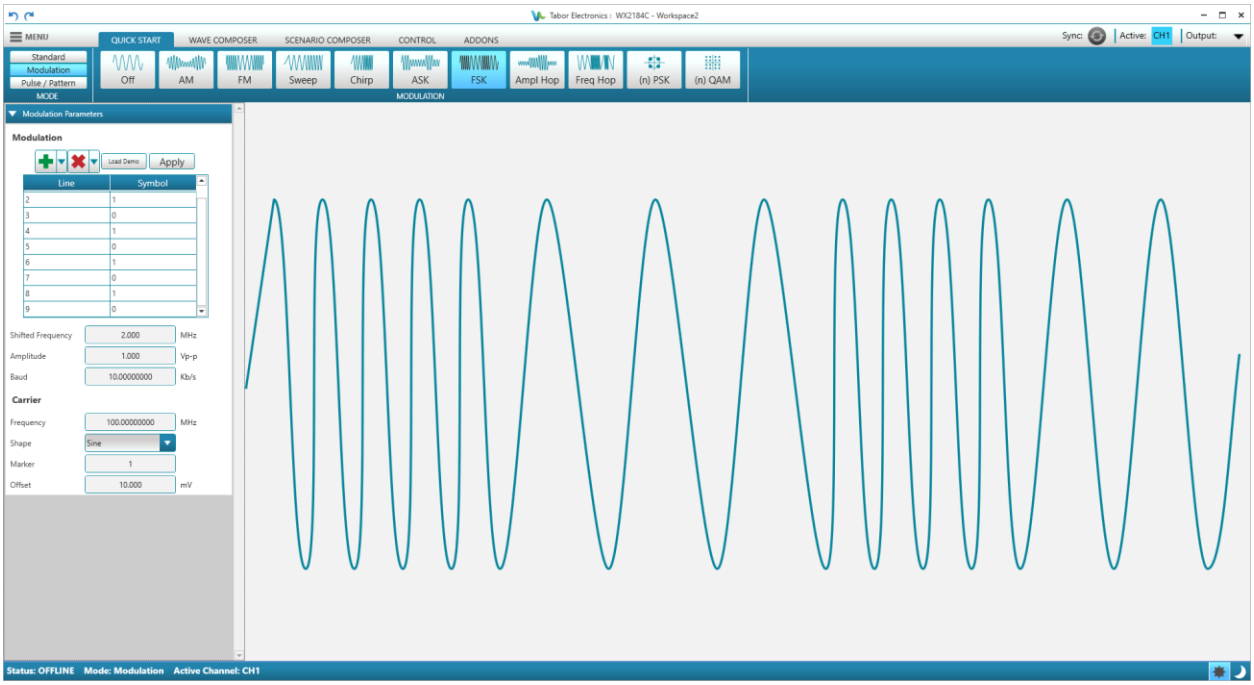


Figure 7.18 Quick Start Modulation FSK

- **Modulation** – The sequence of the modulation control data bits controls the sequence of base frequency and shifted frequency. It contains a table of "0" and "1" and the output will repeatedly follow the frequency shift keying sequence in the same order as programmed.
  - – Add a line (Above/Below) of the modulation control data bits. This 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.
  - – Remove selected line.
  - **Load Demo** – Load a demo table with modulation control data bits.
  - **Apply** – Download the modulation data table to the device.
  - **Line** – Line number in the control data list.
  - **Symbol** – Symbol bit.
  - **Shifted Frequency** – The shifted frequency (kHz/MHz/GHz).

- **Amplitude** – The carrier wave amplitude (mV/V).
- **Baud** – Set the rate of which the generator steps through the sequence of the FSK Control Data bits.

- **Carrier** – Set the carrier wave parameters.
  - **Frequency** – Set the wave frequency (kHz, MHz, GHz).
  - **Shape** – Set the carrier shape to Sine, Triangle or Square.
  - **Marker** – Set the symbol line number at which a sync signal will be generated from the sync output.
  - **Offset** – Set the DC offset of the wave (mV, V).

7.2.8 Ampl Hop

Ampl Hop displays an amplitude hopping modulated wave. In this mode, the output waveform (sine wave) hops from amplitude to amplitude in a sequence defined by the hop table.

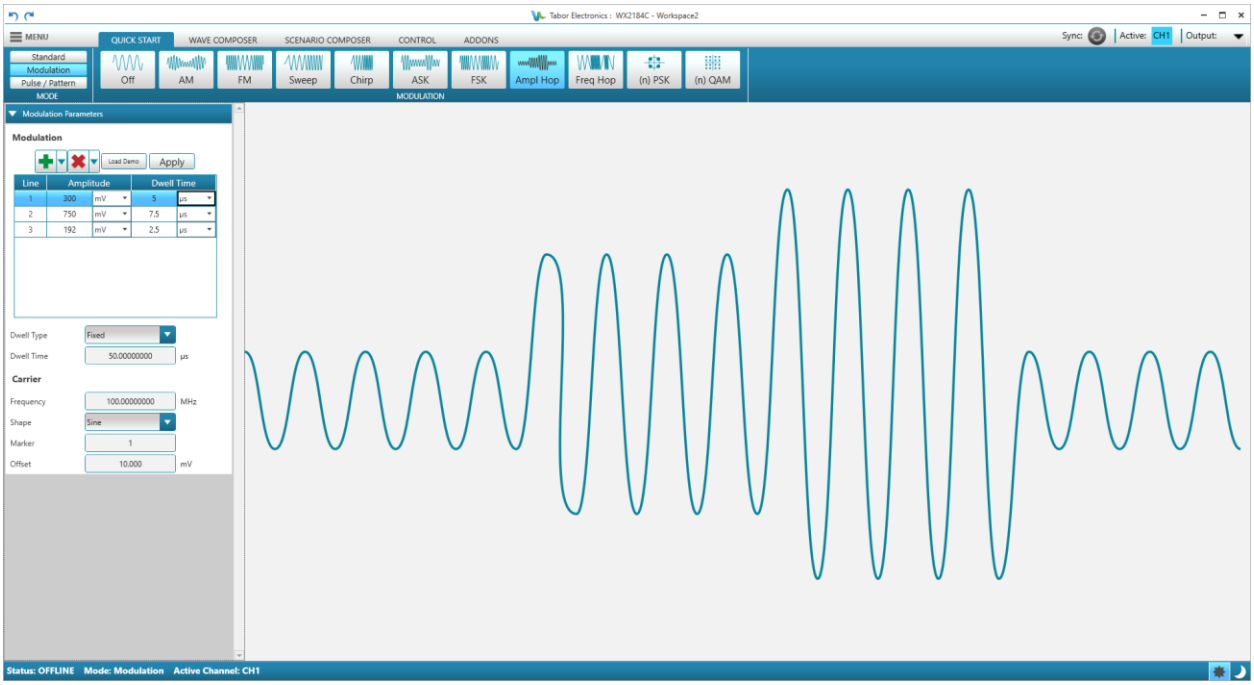


Figure 7.19 Quick Start Modulation Ampl Hop

- **Modulation** – The hop data table controls the output sequence of amplitudes and its duration.
  -  – Add a line (Above/Below) of the hop data table. This controls the sequence of the amplitude hops.
  -  – Remove selected line.
  - **Load Demo** – Load a demo table with modulation hops.
  - **Apply** – Download the hop data table to the device.
  - **Line** – Line number in the hop data table.
  - **Amplitude** – Set the amplitude of the hop (mV, V).

- **Dwell Time –** Set the time to remain in this line with specified amplitude before moving to next line with its amplitude (ns, µs, ms, s).
- **Dwell Type** – Defines how to use the dwell time in the hop data table.
  - **Variable** – The dwell time is according to the modulation hop data table.
  - **Fix** – The dwell time is fixed according to the Dwell Time field below and not according to the modulation hop data table.
- **Dwell Time** – Sets the period of time that will lapse before the amplitudes hops to the next amplitude setting (ns/µs/ms/s). Only valid when the Dwell Type is Fixed.

- **Carrier** – Set the carrier wave parameters.
  - **Frequency** – Set the wave frequency (kHz, MHz, GHz).
  - **Shape** – Set the carrier shape to Sine, Triangle or Square.
  - **Marker** – Set the hop data table line number at which a sync signal will be generated from the sync output.
  - **Offset** – Set the DC offset of the wave (mV, V).

7.2.9 Freq Hop

Freq Hop displays a frequency hopping modulated wave. In this mode, the output waveform (sine wave) hops from frequency to frequency in a sequence defined by the hop table.

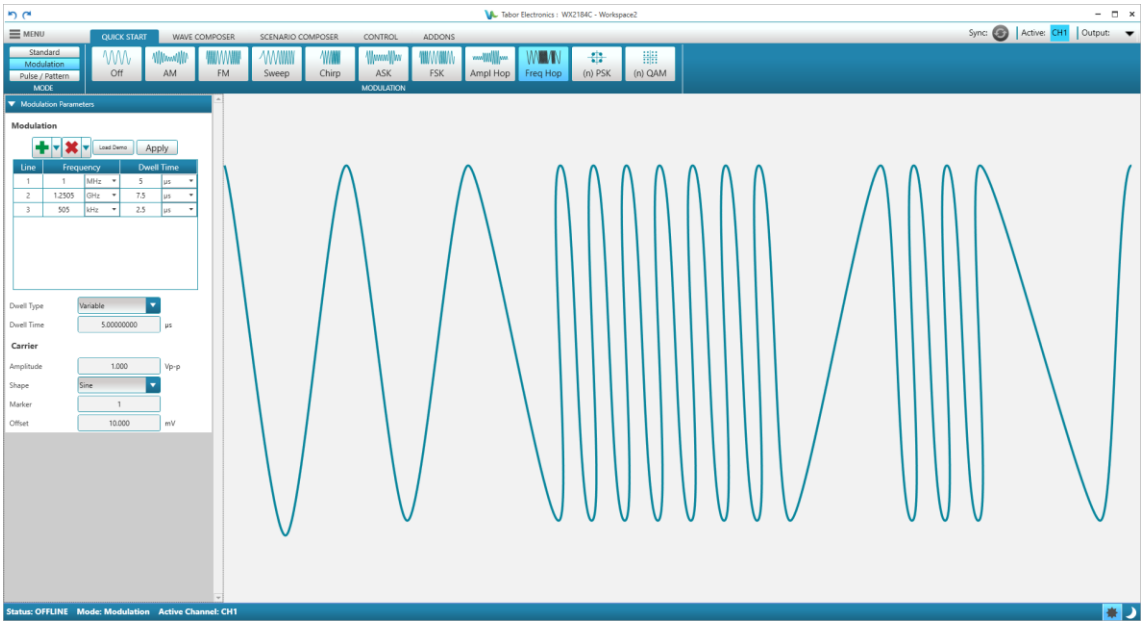


Figure 7.20 Quick Start Modulation Freq Hop

- **Modulation** – The hop data table controls the output sequence of frequency and its duration.
  -  **–** Add a line (Above/Below) of the hop data table. This controls the sequence of the frequency hops.
  -  – Remove selected line.

- **Load Demo** – Load a demo table with modulation hops.
- **Apply** – Download the hop data table to the device.
- **Line** – Line number in the hop data table.
- **Frequency** – Set the amplitude of the hop (kHz, MHz, GHz).
- **Dwell Time –** Set the time to remain in this line with specified frequency before moving to next line with its frequency (ns, µs, ms, s).
- **Dwell Type** – Defines how to use the dwell time in the hop data table.
  - **Variable** – The dwell time is according to the modulation hop data table.
  - **Fix** – The dwell time is fixed according to the Dwell Time field below and not according to the modulation hop data table.
- **Dwell Time** – Sets the period of time that will lapse before the frequency hops to the next frequency setting (ns/µs/ms/s). Only valid when the Dwell Type is Fixed.

- **Carrier** – Set the carrier wave parameters.
  - **Amplitude** – Set the wave amplitude (mVp-p, Vp-p).
  - **Shape** – Set the carrier shape to Sine, Triangle or Square.
  - **Marker** – Set the hop data table line number at which a sync signal will be generated from the sync output.
  - **Offset** – Set the DC offset of the wave (mV, V).

7.2.10 (n) PSK for WX-Series

(n) PSK provides a number of phase shifted keying modulated waves. The (n)PSK function is very similar to the standard PSK function except the output can shift to multiple phase and amplitude positions to form phase shift constellations.

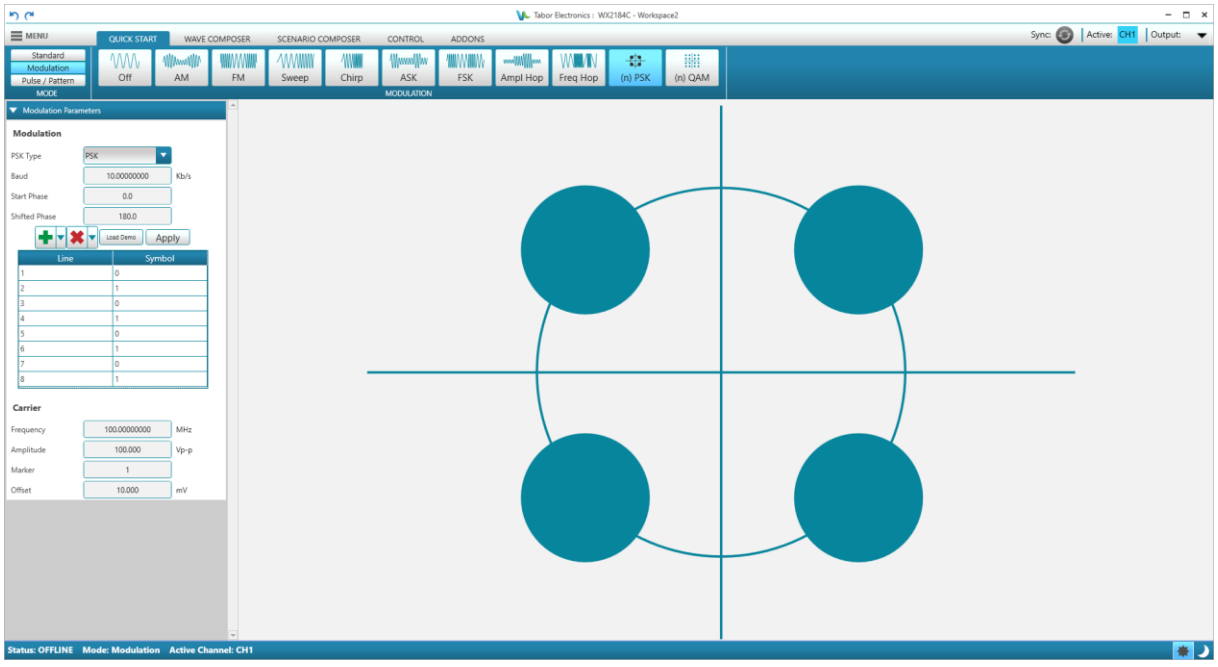


Figure 7.21 Quick Start Modulation (n) PSK

- **Modulation** – The sequence of the modulation control data bits controls the sequence of base amplitude and shifted amplitude. It contains a table of "0" and "1" and the output will repeatedly follow the amplitude shift keying sequence in the same order as programmed.
  - **PSK Type** – Available types are PSK, BPSK, QPSK, OQPSK, pi / 4DQPSK, 8PSK, 16PSK, or User defined PSK.
  - **Baud** – Set the rate of which the generator steps through the sequence of the Control Data bits (mb/s, b/s, kb/s, Mb/s).
  - **Start Phase** – The start phase (degrees).
  - **Shifted Phase** – The shifted phase (degrees).
  -  **–** Add a line (Above/Below) of the modulation control data bits. This 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.
  -  – Remove selected line.
  - **Load Demo** – Load a demo table with modulation control data bits.
  - **Apply** – Download the modulation data table to the device.
  - **Line** – Line number in the control data list.
  - **Symbol** – Symbol bit.
- **Carrier** – Set the carrier wave parameters.
  - **Frequency** – Set the wave frequency (kHz, MHz, GHz).
  - **Amplitude** – Set the point-to-point amplitude of the wave (mVp-p, Vp-p).
  - **Marker** – Set the symbol line number at which a sync signal will be generated from the sync output.
  - **Offset** – Set the DC offset of the wave (mV, V).

7.2.11 (n) QAM WX-Series

(n) QAM provides several quadrature amplitude modulated waves. The (n)QAM function is similar to the standard ASK function except the output can shift to multiple amplitudes and phase positions to form amplitude/phase shift constellations.

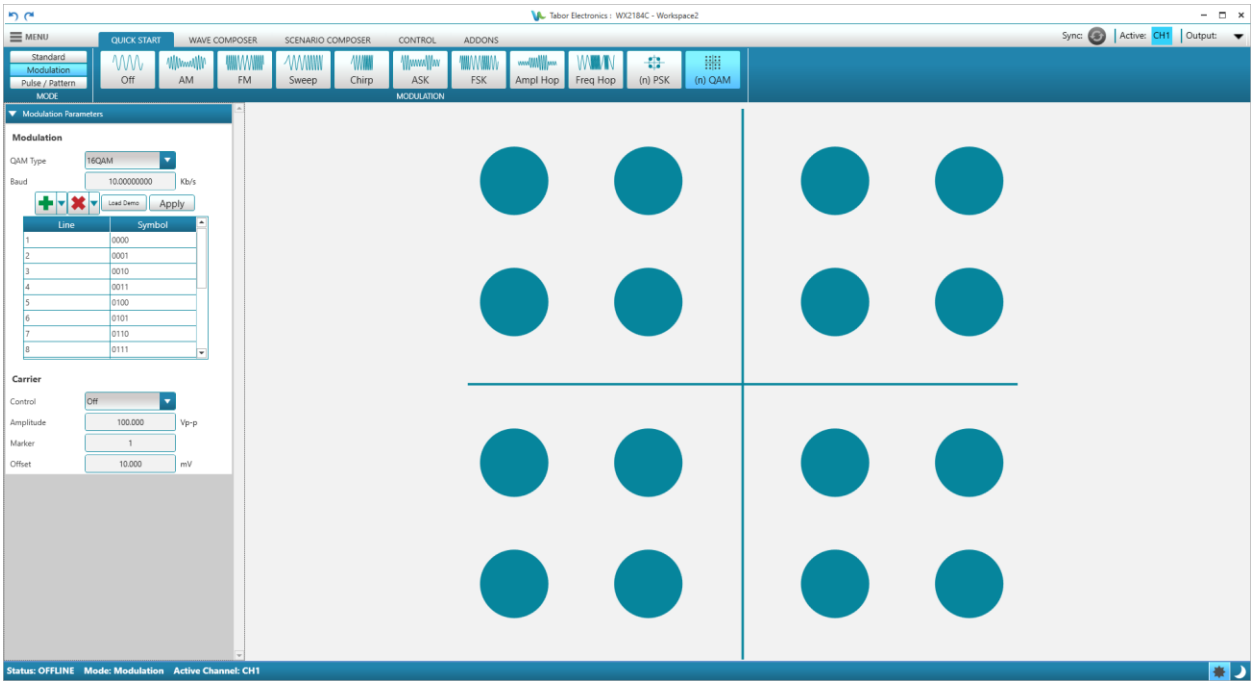


Figure 7.22 Quick Start Modulation (n) QAM

- **Modulation** – The sequence of the modulation control data bits controls the sequence of amplitudes. It contains a table of "0" and "1" and the output will repeatedly follow the shift keying sequence in the same order as programmed.
  - **QAM Type** – Available types are 16QAM, 64QAM, 256QAM, or user defined QAM.
  - **Baud** – The baud parameter sets the rate of which the generator steps through the sequence of the Control Data bits (mb/s, b/s, kb/s, Mb/s).
  - – Add a line (Above/Below) of the modulation control data bits. This controls the sequence of the output signal amplitude. It contains a list of "0" and "1" and the output will repeatedly the sequence in the same order as programmed.
  - – Remove selected line.
  - **Load Demo** – Load a demo table with modulation control data bits.
  - **Apply** – Download the modulation data table to the device.
  - **Line** – Line number in the control data list.
  - **Symbol** – Symbol bits. Binary value of the amplitude.
- **Carrier** – The carrier wave parameters.
  - **Control** –
    - **On** – Enable the carrier wave.
    - **Off** – Use only the modulation without any carrier wave.
  - **Amplitude** – The carrier wave amplitude peak-to-peak (mVp-p/Vp-p).
  - **Marker** – Set the symbol line number at which a sync signal will be generated from the sync output.

- **Offset** – The DC offset of the carrier wave (mV/V).

7.3 Pulse/Pattern

Pulse/Pattern displays a selection of pulse types.

Note

- The pulse will be generated exactly by the device but will be displayed schematically on the composer screen.

7.3.1 Pulse

Pulse displays a pulse signal.

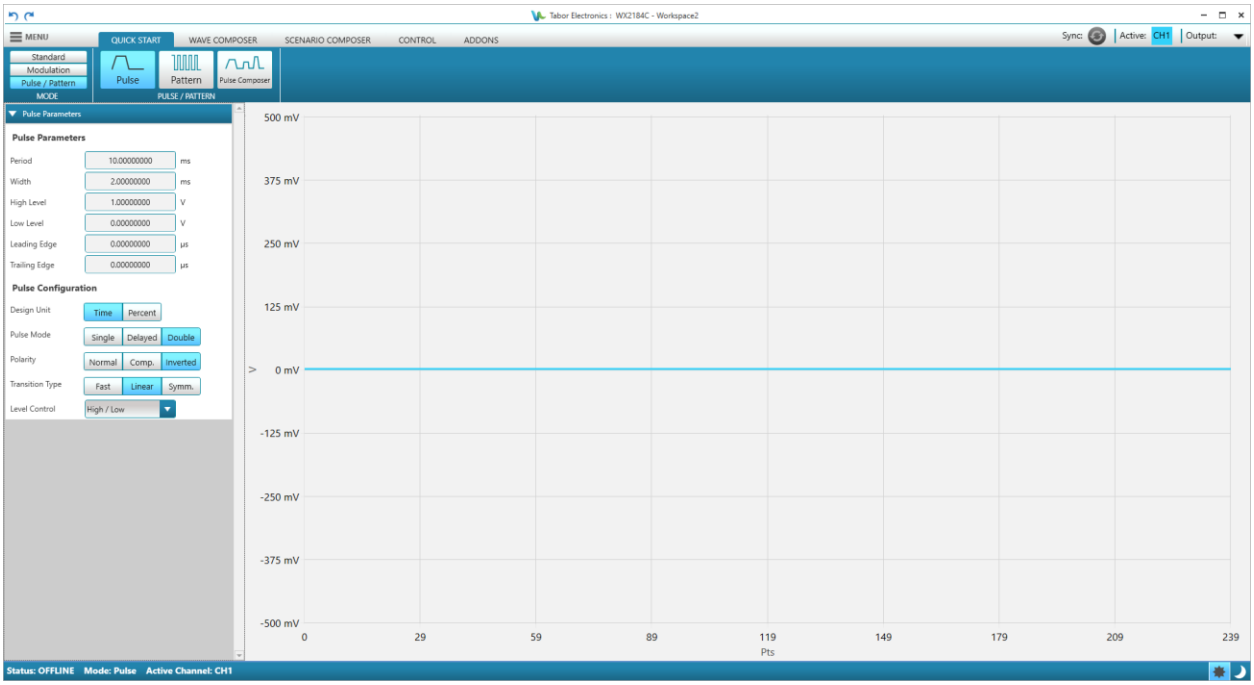


Figure 7.23 Quick Start Pulse TBD.

- **Pulse Parameters** –
  - **Period** – Set the period of the pulse, regardless of the pulse mode (ns, µs, ms, s).
  - **Width** – Set the width of the pulse regardless of the pulse mode (ns, µs, ms, s).
  - **High Level** – Set the high level of the pulse (mv, V).
  - **Low Level** – Set the low level of the pulse (mv, V).
  - **Leading Edge** – Valid for WX-Series. The rise time of the first edge of the pulse (ns, µs, ms). Valid for Transition Type Linear/Symm.
  - **Trailing Edge** – Valid for WX-Series. The fall time of the second edge of the pulse (ns, µs, ms). Valid for Transition Type Linear/Symm.
- **Pulse Configuration** –
  - **Design Unit** –

- **Time** – The programming of pulse parameters in units of time (seconds).
- **Percent** – The programming of certain pulse parameters in units of percent. The ratio is computed in reference to the period frequency.

- **Pulse Mode** –
  - **Single** – Set a 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.
  - **Delayed** – Set the delay from the SYNC leading edge to the leading edge of the pulse.
  - **Double** – Set the delay between the leading edges of the pulse pairs.
- **Polarity** – The pulse polarity parameter determines if the pulse is generated in normal, complemented, or inverted shape

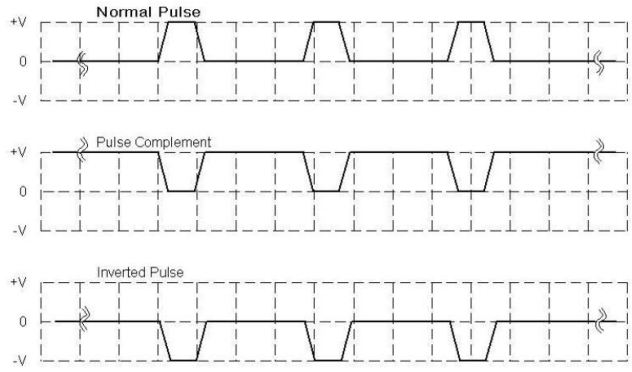


Figure 7.24 Quick Start Pulse Polarity

- **Normal** – Normal pulse polarity.
- **Comp**. – The complemented pulse is a mirror of the normal pulse. It is mirrored around the horizontal axis in a way that the high level becomes low ,and the low level becomes the high level.
- **Inverted** – The normal pulse is mirrored at the 0 V horizontal axis.

- **Transition Type** – The pulse transition time from low to high and from high to low.
  - **Fast** – Set a fast transition <1ns.
  - **Linear** – Set a linear transition where you can define the rise and fall times.
    - **Leading Edge** – The leading edge rise time (ns, µs, ms).
    - **Trailing Edge** – The trailing edge fall time (ns, µs, ms).

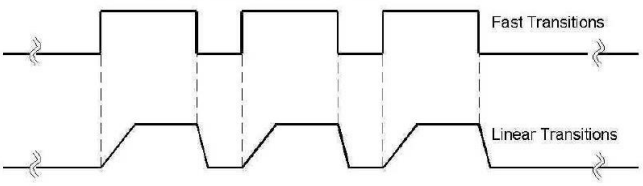


Figure 7.25 Quick Start Pulse Transition Types

- **Symm**. – Set a symmetrical transition, where programming the rise time automatically adjusts the fall time to the same value and vice versa.
  - **Leading Edge** – The leading edge rise time (ns, µs, ms).
  - **Trailing Edge** – The trailing edge fall time (ns, µs, ms).

♦ **Level Control** –

- **High/Low** – Set the pulse amplitude using two parameters: High Level and Low Level. In this case, the instrument automatically determines the required amplitude from the inputs and offsets to place the pulse exactly.
- **Amplitude / Offset** – This 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 rarely used for pulse applications.
- **Positive** – Set the low level at the 0 V 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** – Set the high level at the 0 V 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.

7.3.2 Pattern

Pattern displays a pulse pattern signal

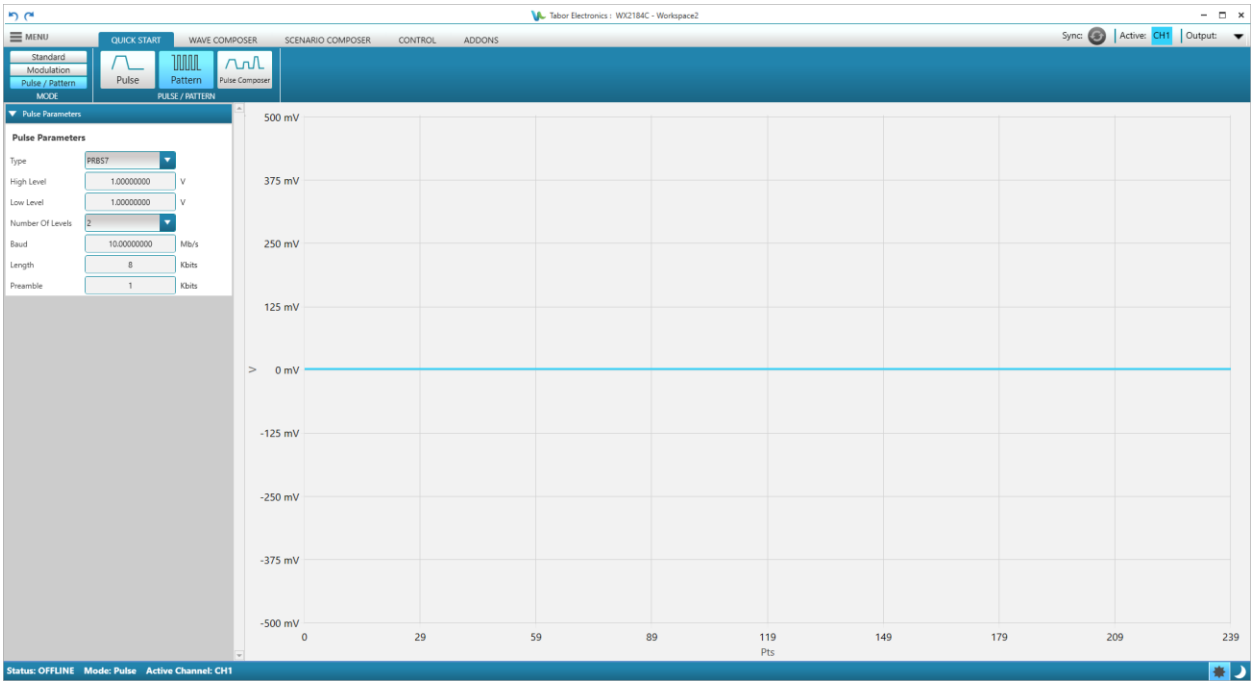


Figure 7.26 Quick Start Pattern TBD

- **Pulse Parameters** –

- **Type** – Type of pulse pattern, PRBS7 (Pseudo-random Binary Sequence), PRBS9, PRBS11, PRBS15, PRBS23, PRBS31, and User defined.
- **High Level** – Set the high voltage level of the pattern (mv, V).
- **Low Level** – Set the low voltage level of the pattern (mv, V).
- **Number of Levels** – Set the number of pulse levels between Low Level and High Level (2, 3, 4, 5).
- **Baud** – Set the pulse pattern sample sequence in in units of bits per second (b/s, kb/s, Mb/s).
- **Length** – Set he pulse length of the PRBS pattern in units of bits (b, kb, Mb).
- **Preamble** – The length of the syncword that indicates the start of the data (b, kb, Mb).

7.3.3 Pulse Composer

The Pulse Composer is a tool for creating and editing pulses without the need to think about sample clock, number of points and complex equations.

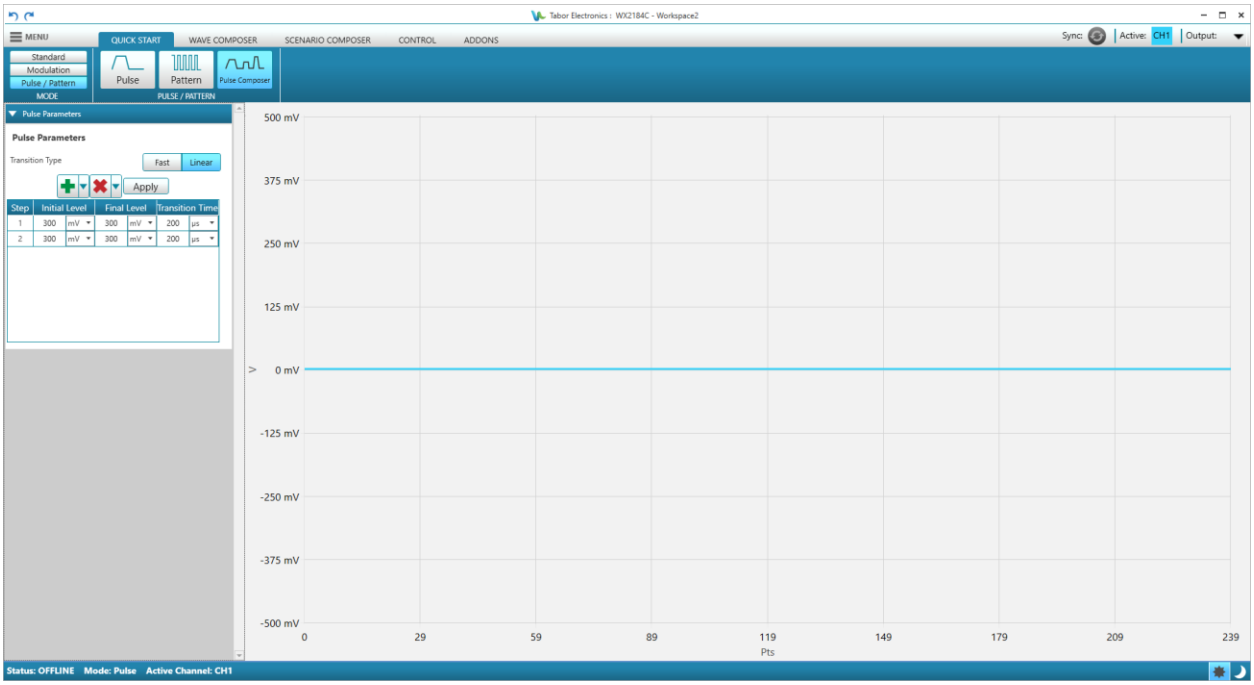


Figure 7.27 Quick Start Pulse Composer TBD

- **Pulse Parameters** –
  - **Transition Type** – The pulse transition time from low to high and from high to low.
    - **Fast** – Set a fast transition <1ns.
    - **Linear** – Set a linear transition where you can define the rise and fall times.
  - – Add a line (Above/Below) of the pulse data table. This controls the sequence of the output pulses.
  - – Remove selected line.
  - **Apply** – Download the pulse data table to the device.

- **Step** – Line number in the pulse data table.
- **Transition Type Fast**
  - **Level** – The amplitude level of the pulse (mV, V).
  - **Duration** – The length of the pulse (ps, ns, µs, ms, s).
  - **Pattern Duration** – The total length of the pulse train (µs, ms, s).
- **Transition Type Linear**
  - **Initial Level** – Set the initial voltage level of the pulse.
  - **Final Level** – Set the final voltage level of the pulse.
  - **Transition Time** – Set the rise/fall time of the pulse.

8 Composer

Click the **COMPOSER** tab on the ribbon to invoke the wave composer window, and then click the **Arbitrary** button. Here you can create new waveforms and add them to the waveform gallery. After that you can define markers for the waveforms in the waveform gallery.

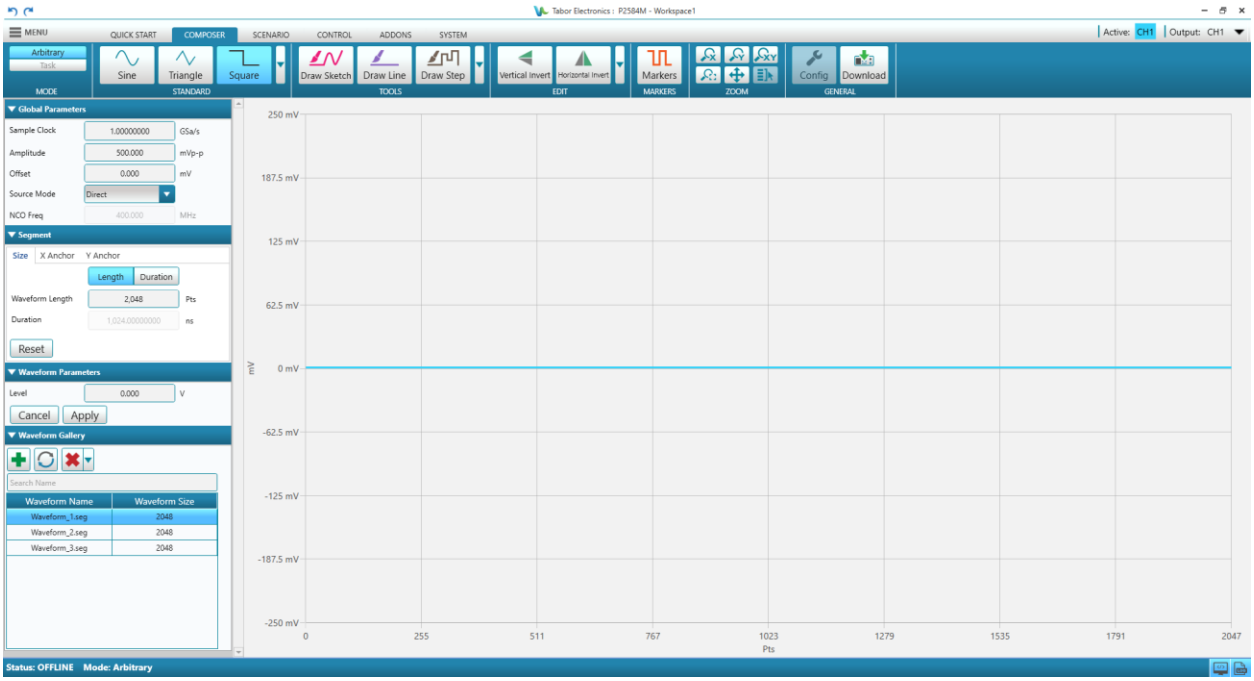


Figure 8.1 Composer

8.1 Ribbon

In the ribbon you can select a standard wave, choose a tool to modify the wave, edit the wave, add markers to the wave that is in the Waveform Gallery, zoom a section of the wave, and finally download the wave to the device.

8.1.1 Standard Waves

Click the **COMPOSER** tab on the ribbon and then click the **STANDARD** arrow button to display all wave options. Click the wave symbol for the wave you want to create.

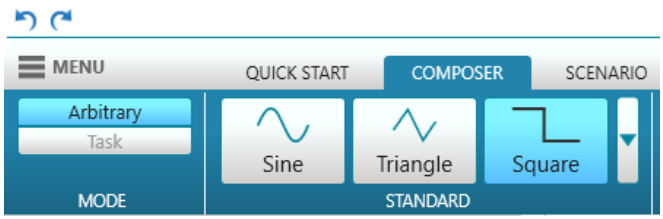


Figure 8.2 Standard Waves

Figure 8.3 Standard Waves (Expanded List)

Refer to 7 Quick Start, page 46 for a detailed description of the various waves.

See 3.3 Arbitrary Waveform Creation Workflow, page 26 for a quick guide how to create and output a waveform.

Go to section 8.2 Configuration Pane, page 87 for instructions how to set the waveform parameters.

Note

The wave frequency is calculated as follows:

$$Frequency = \frac{Sample\ Clock}{Segment\ length\ in\ points}$$

8.1.2 Tools

Click the **COMPOSER** tab on the ribbon and then click the **TOOLS** arrow button  to display all tools. Click on the tool you want to use to modify the wave displayed on the composer screen or to draw a new wave.

Idea

- Click the right mouse button to exit the draw tool.

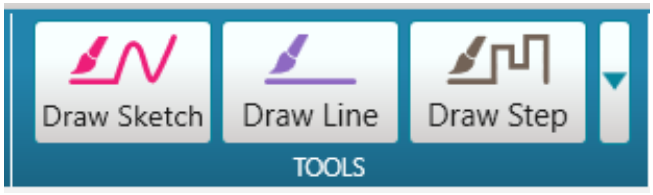


Figure 8.4 Tools

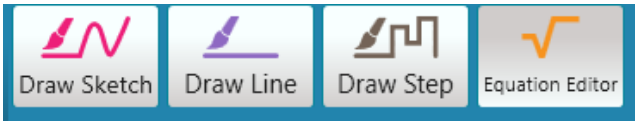


Figure 8.5 Tools Expanded Menu

- **Draw Sketch** – Draw a freehand wave on the composer screen using your cursor.
- **Draw Line** – Draw a line on the composer screen using your cursor.
- **Draw Step** – Draw a step wave on the composer screen using your cursor.
- **Equation Editor** – Define a wave using mathematical functions and operators.

Equation Editor

Click the **COMPOSER** tab on the ribbon and then click the **TOOLS** arrow button to display all tools. Click the **Equation Editor** icon.

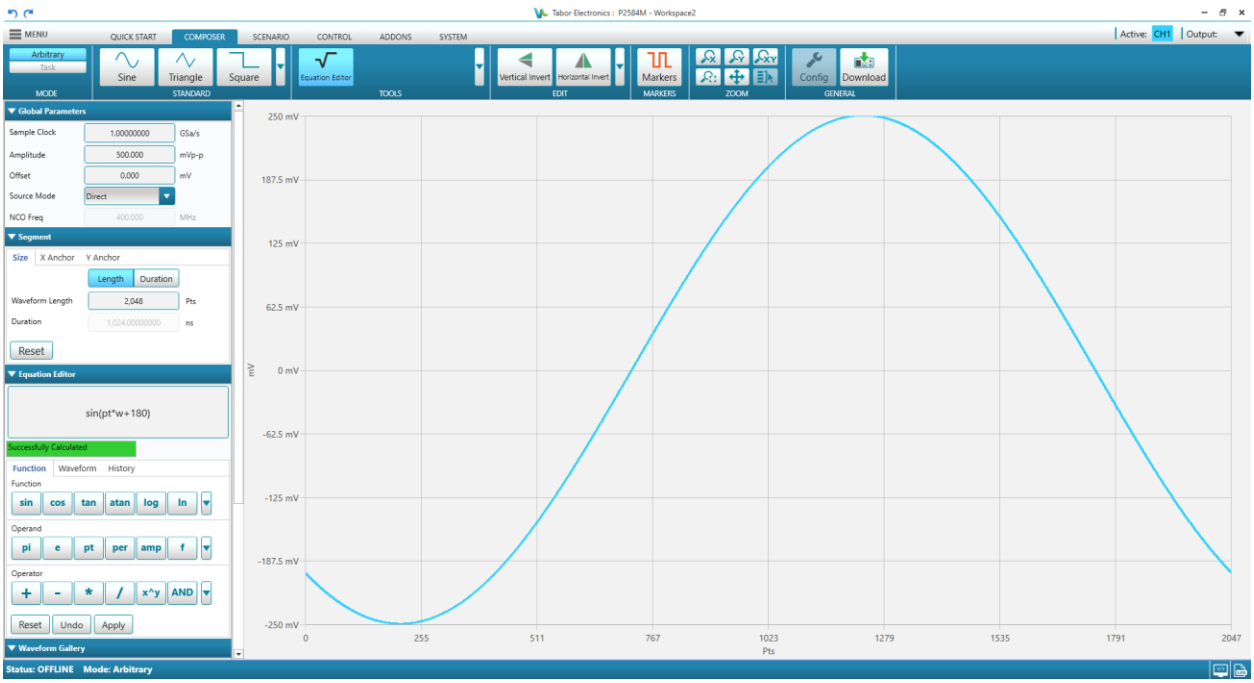


Figure 8.6 Equation Editor

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. Equations are not case-sensitive, and spaces are ignored. Numbers are entered in scientific notation. All calculations are done with double-digit precision with truncation. 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; w, which equals 2 * pi / per, and numerals in the range of -1E^20 to 1E^20.

Calculation precedence is according to arithmetic rules. 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.

Function Tab

The function tab provides all the functions, operands, and operators to write an equation. In addition, you can write an equation directly in the Equation Editor screen using your keyboard.

Figure 8.7 Function Tab

- **sin** –The sine of x (sin(x)), where x is an argument of a mathematical expression.
- **cos** – The cosine of x (cos(x)), where x is an argument of a mathematical expression.
- **tan** – The tangent of x (tan(x)), where x is an argument of a mathematical expression.
- **atan** – The arctan is the inverse of the tangent function.
- **log** – The base 10 logarithm of x (log(x)), where x is an argument of a mathematical expression.
- **ln** – The natural (base e) logarithm of x (ln(x)), where x is an argument of a mathematical expression.
- **abs** – The absolute value of x (abs(x)), where x is an argument of a mathematical expression.
- **sweep** – Frequency sweep according to following equation:
  amp*sin((2*pi/SCLK)*pt*(START_FREQ+(BANDWIDTH/(2*(SEG_LENGTH+1)))*pt))
  Refer to the sweep example in 13.1 Sweep, page 125.

Operand

- **pi** – π circumference of unit-diameter circle
- **e** – Base of natural logarithm (~2.718..).
- **pt** – Point, horizontal axis coordinate (sample).
- **per** – Horizontal wavelength cycle (period) in points.
- **amp** – Amplitude in units of DAC bit-resolution or volt.
- **f** – 1/per.
- **w** – Omega Ω, 2*π / per

Operator

- **+** – Add.
- **-** – Subtract.

- ***** – Multiply.
- **/** – Divide.
- **x^y** – x^y.
- **xey** – Multiply x with 10^y.
- **AND** – Boolean operator AND.
- **OR** – Boolean operator OR.

Waveform Tab

Click the Waveform tab to import previously defined waveforms that you want to include in the equation.

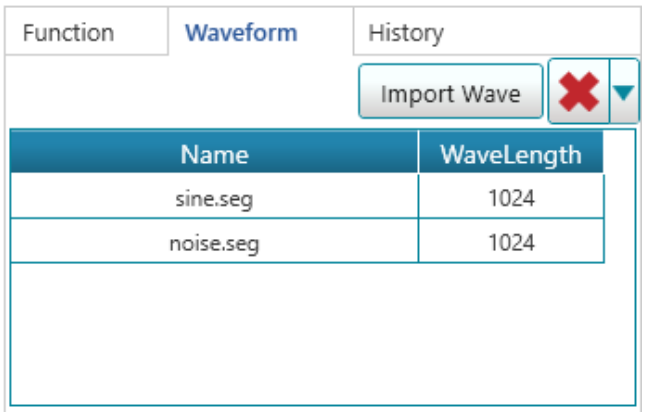


Figure 8.8 Waveform Tab Import Wave

- **Import Wave** – Click the **Import Wave** button to import a previously saved waveform and use it in your equation. Refer to 6.4 Export, page 39.
-  – Click the button to remove selected/all waveform.

History Tab

Click the **History** tab to display a list of used equations. Double-click with your mouse on an equation in the list to display it in the **Equation Editor** window, then click **Apply** to display the equation's waveform. If you select another equation you may want to remove the old equation by clicking **Undo**.

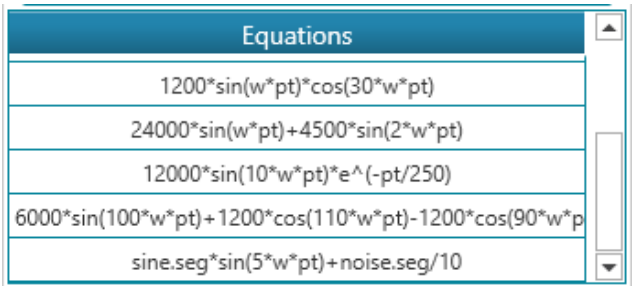


Figure 8.9 History Tab

Buttons

- **Reset** – Click the **Reset** button to undo the whole equation in the Equation Editor.
- **Undo** – Click the **Undo** button to undo the last keyboard input to the Equation Editor.
- **Apply** – Click the **Apply** button to display the equation on the Composer screen.

8.1.2.1.1 Equation Editor Workflow

1. Enter your equation in the Equation Editor. You can click on **Function**, **Operand** and **Operator** buttons to get the right syntax. There is no limitation of the equation length, and a scroll bar will be displayed if the equation exceeds the window size.
2. Click **Apply** to evaluate and calculate the equation and display it in the Composer Screen. An error message will be displayed if any syntax error is found.
3. A Scaling check box is displayed if the amplitude doesn't fit in the DAC range. Check the **Scaling** check box.
4. Click the  button in the Waveform Gallery to save the equation as a waveform.
5. Click the SCENARIO tab.
6. In the Segment Table click  to add the waveform to the segment table. The same segment must be added to the other channel that the DAC controls. If this is not the case an error message will be displayed when clicking **Download**. Select in the Channel Control the DAC pair channel and add the waveform for this channel.

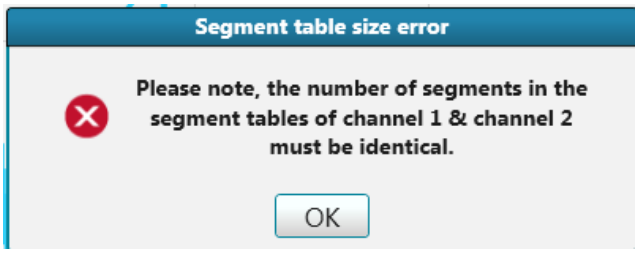


Figure 8.10 Equation Editor – Segment Table Size Error

7. Click **Download** to download the waveform to the device RAM memory.

Refer to section 13 Appendix Equation Examples, page 125.

8.1.3 Edit

Click the **COMPOSER** tab on the ribbon and then click in the **EDIT** group the button for modifying the wave displayed on the composer screen.

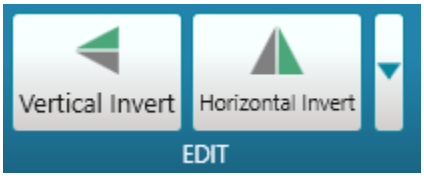


Figure 8.11 Tools

- **Vertical Invert** – Turn the wave around the X-axis.
- **Horizontal Invert** – Turn the wave around the Y-axis.

8.1.4 Markers for Proteus

Click the **COMPOSER** tab on the ribbon and then click the **MARKERS** button to open a pane for defining markers for the selected wave in the waveform gallery.

The device offers programmable digital output signals that are synchronized to the main analog outputs. These signals are referred to as markers. The purpose of these markers is to provide auxiliary outputs, that are fully synchronized with the output waveforms, for control of peripheral equipment or as an additional digital data stream. Each channel output can have between 1 – 4 corresponding marker outputs depending on the model and the configuration. The number of markers is divided evenly among the channels, e.g., for the 2 channel 4 marker models each channel can have two markers M1, M2.

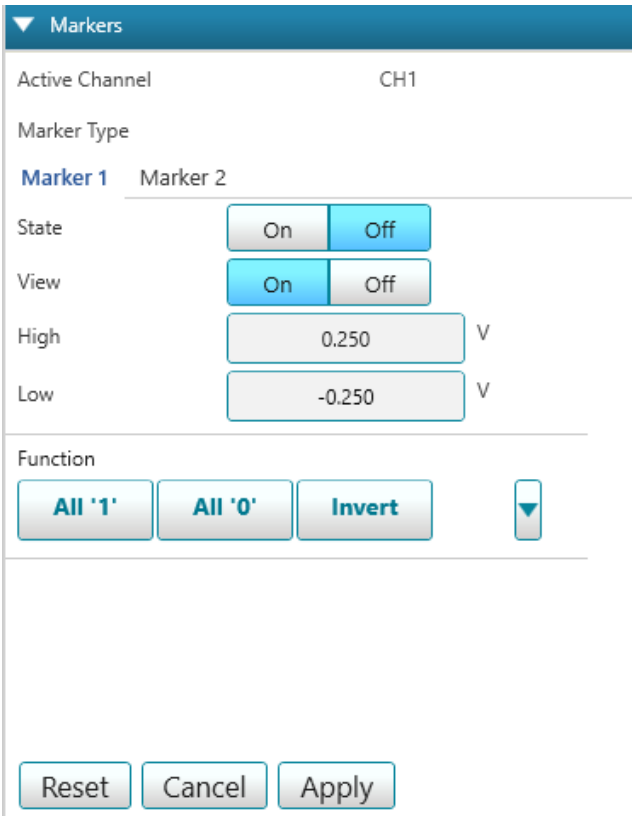


Figure 8.12 Markers

- **Active Channel** – The markers will be defined for the active channel selected in the Channel control, refer to 5 WDS Window, page 35.

- **Marker 1/2** – Click the button to select the marker to configure.
  - **State** – Click On/Off to activate/deactivate the marker.
  - **View** – Click On to display the markers in the composer screen. Valid only for the Proteus series. TBD.
  - **High** – Set the maximum amplitude of the marker signal.
  - **Low** – Set the minimum amplitude of the marker signal.
- **Function** – Click the arrow to display all the marker functions.

Figure 8.13 Marker Functions

  - **All '1'** – All points in specified point range (From:, To:) are assigned the value '1'.
  - **All '0'** – All points in range are assigned the value '0'.
  - **Invert** – All points value in range are inverted.
  - **Random** – Each point in range is given a random '1' or '0' value.
  - **Shift Right** – All points are shifted specified points right in a cyclical manner. Number must be divisible by the marker resolution for the device.
  - **Shift Left** – All points are shifted X bits left in a cyclical manner. Number must be divisible by the marker resolution for the device.
  - **Clock** – Enter the number of points the marker is high and the following number of points the marker is low for the clock data pattern.
  - Perform one of these logical operation on two of the available markers. The result is the data of the currently selected marker.
    - **AND**
    - **OR**
    - **NAND**
    - **XOR**
    - **NOR**
- **From:** – Start the marker from this wave sample. You can only enter point N so that N+1 is divisible by the marker resolution, refer to the device manual. If you don't enter a legal number then the number is rounded down to the nearest legal number.
- **To:** – Stop the marker at this wave sample. You can only enter point N so that N+1 is divisible by the marker resolution. If you don't enter a legal number then the number is rounded down to the nearest legal number.
- **Reset** – Remove the marker.
- **Cancel** – Changes that were made (prior to pressing the apply button) will be undone.
- **Apply** – The configured marker will be displayed in the composer screen. The marker data will become part of the waveform data.

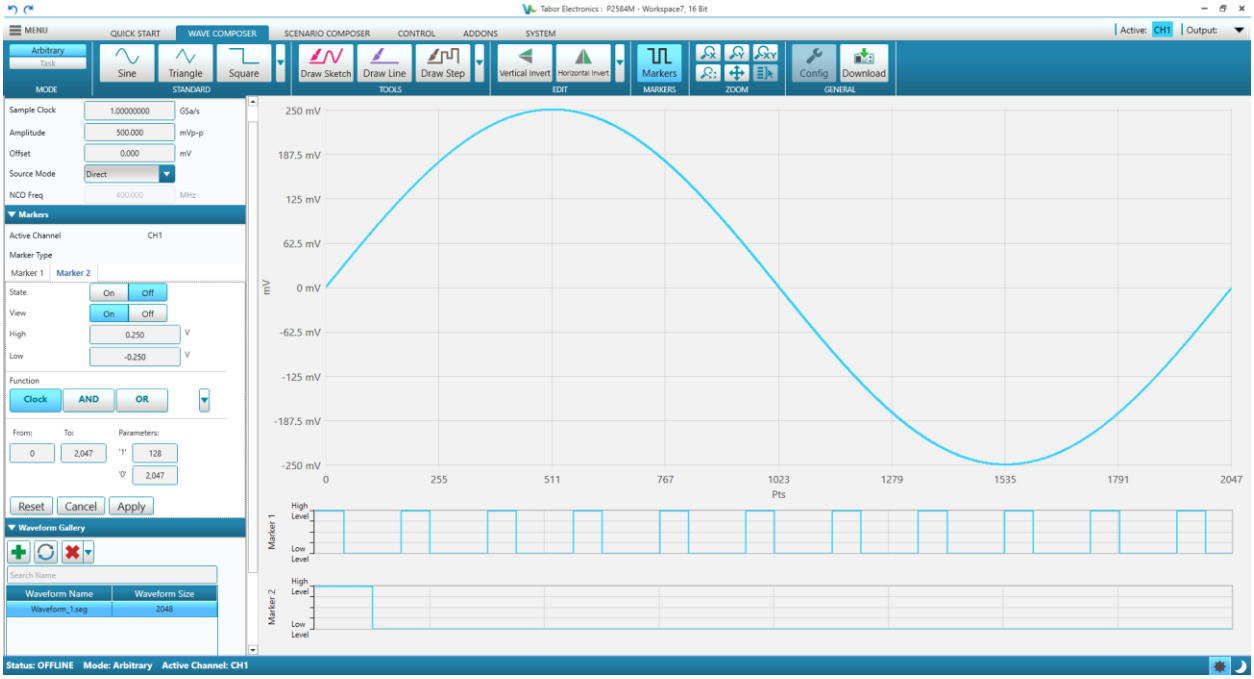


Figure 8.14 Sine Wave with Two Markers

8.1.5 Markers for SE- and WX-Series

Click the **COMPOSER** tab on the ribbon and then click the **MARKERS** button to open a pane for defining markers for the selected wave in the waveform gallery.

The device offers programmable digital output signals that are synchronized to the main analog outputs. These signals are referred to as markers. The purpose of these markers is to provide auxiliary outputs, that are fully synchronized with the output waveforms, for control of peripheral equipment or as an additional digital data stream. Each channel or channel pair has 2 corresponding marker outputs depending on the model and the configuration.

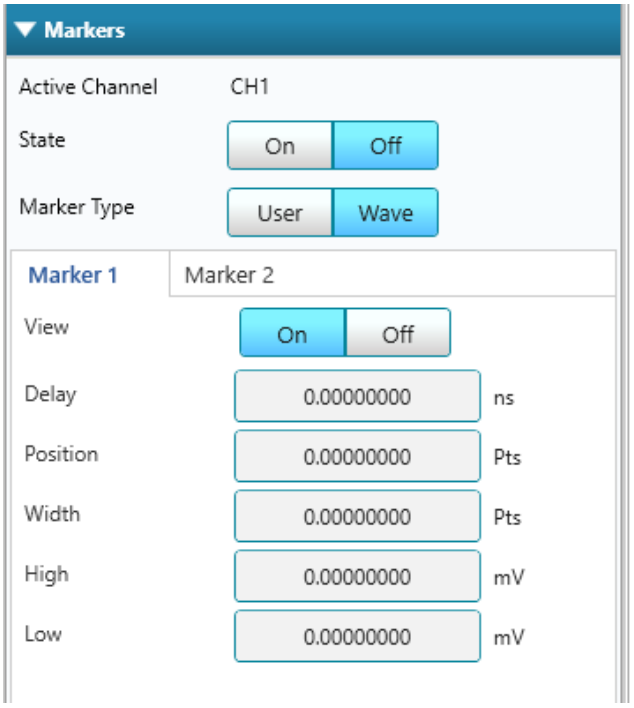


Figure 8.15 Markers Wave for SE- and WX-Series

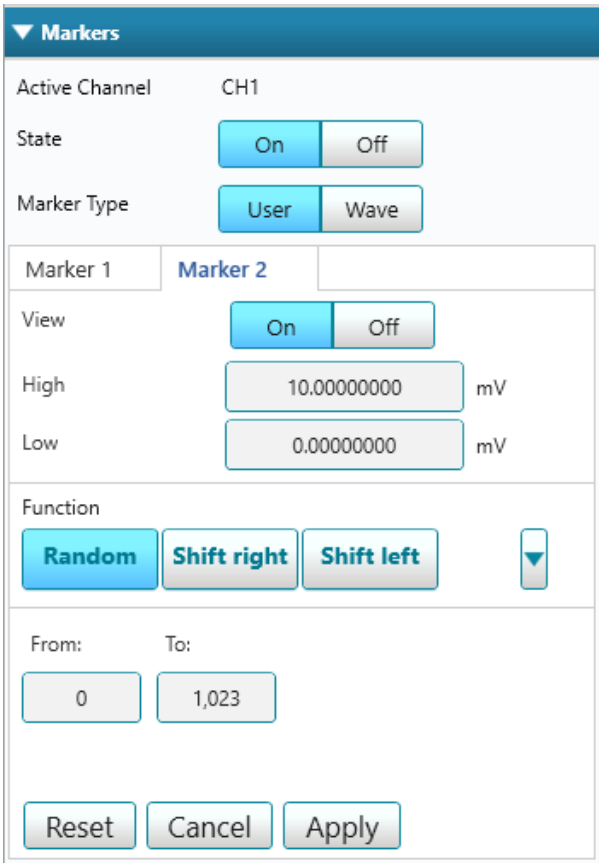


Figure 8.16 Markers User for SE- and WX-Series

- **Active Channel** – The markers will be defined for the active channel selected in the Channel control, refer to 5 WDS Window, page 35.
  - **Marker Type** –
    - **User –** You can program the marker data. You have to click **Apply** to send the marker data to the device.
    - **Wave –** Marker outputs a single pulse. You can control pulse position, width, and delay.
- **Marker 1/2** – Click the tab to select the marker to configure.
  - **State** – Click **On**/**Off** to activate/deactivate the marker output.
  - **View** – Click **On**/**Off** to view/hide the marker on the composer screen.

> **Note**
> - Use the **Marker Type Wave** for defining a single pulse, and the **Marker Type User** for defining a pattern of pulses.

Marker Type Wave –

- **Delay** – The delay is measured from the sync output in units of seconds. The marker has an initial delay of 0 sample clock periods, not including initial skew.
- **Position** – Start the marker from this wave sample. Note that the resolution is device dependent.
- **Width** – The width of the marker pulse in wave samples (Pts, kPts, MPts).
- **High** – Set the maximum amplitude of the marker signal (mV, V).
- **Low** – Set the minimum amplitude of the marker signal (mV, V).

Marker Type User

- **High** – Set the maximum amplitude of the marker signal (mV, V).
- **Low** – Set the minimum amplitude of the marker signal (mV, V).

- **Function** – Click the arrow to display all the marker functions.

Figure 8.17 Marker Functions

- **All '1'** – All points in specified point range (From:, To:) are assigned the value '1'.
- **All '0'** – All points in range are assigned the value '0'.
- **Invert** – All points value in range are inverted.
- **Random** – Each point in range is given a random '1' or '0' value.
- **Shift Right** – All points are shifted specified points right in a cyclical manner. Number must be divisible by the marker resolution for the device.
- **Shift Left** – All points are shifted X bits left in a cyclical manner. Number must be divisible by the marker resolution for the device.
- **Clock** – Enter the number of points the marker is high and the following number of points the marker is low for the clock data pattern.

- Perform one of these logical operation on two of the available markers. The result is the data of the currently selected marker.
  - **AND**
  - **OR**
  - **NAND**
  - **XOR**
  - **NOR**

- **From:** – Start the marker from this wave sample. You can only enter point N so that N+1 is divisible by the marker resolution, refer to the device manual. If you don't enter a legal number then the number is rounded down to the nearest legal number.
- **To:** – Stop the marker at this wave sample. You can only enter point N so that N+1 is divisible by the marker resolution. If you don't enter a legal number then the number is rounded down to the nearest legal number.
- **Reset** – Remove the marker.
- **Cancel** – Changes that were made (prior to pressing the apply button) will be undone.
- **Apply** – The configured marker will be displayed in the composer screen. The marker data will become part of the waveform data.

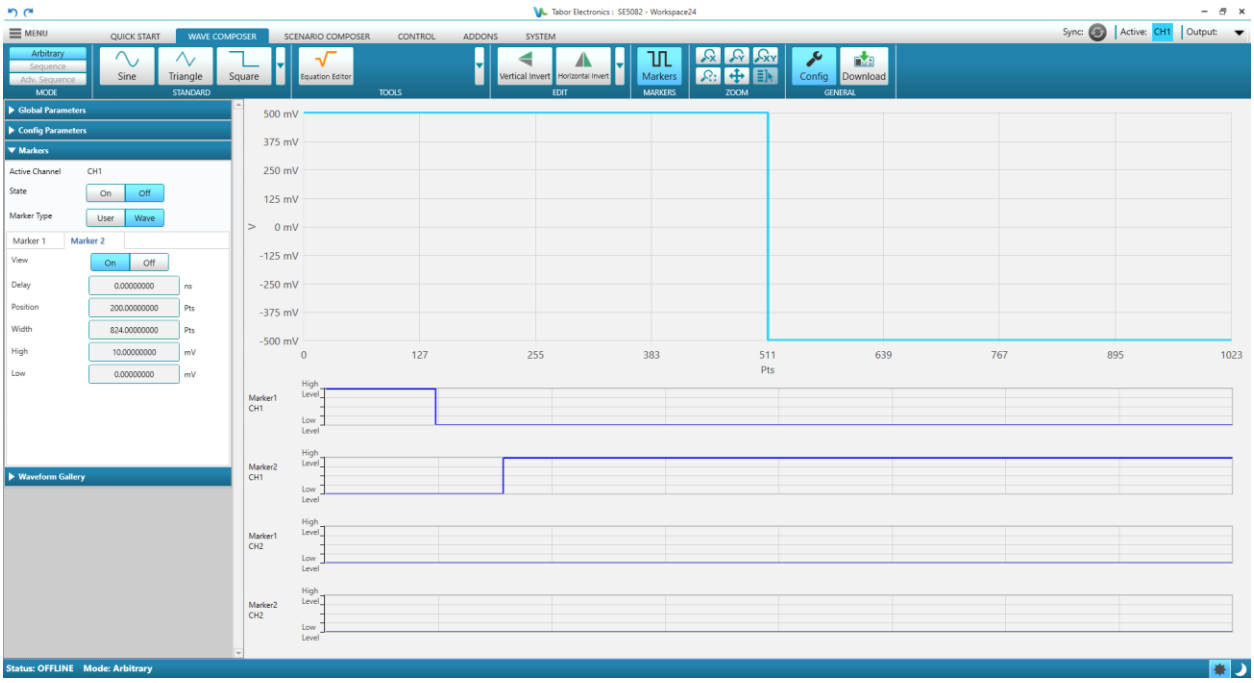


Figure 8.18 Sine Wave with Two Markers

8.1.6 Zoom

Click the **COMPOSER** tab on the ribbon and then click one of the **ZOOM** buttons to modify the view of the graph displayed on the composer screen.

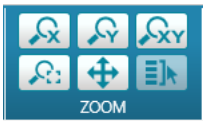


Figure 8.19 Zoom

Idea

- Use the mouse wheel to zoom in/out the graph. On the composer screen double-click on the left mouse button to restore the original graph view.

- **Zoom X-axis**  – Click the icon, then click on the composer screen, and drag in the X-axis direction to select the area of the X-axis you want to magnify. Click the zoom icon to return to previous view.

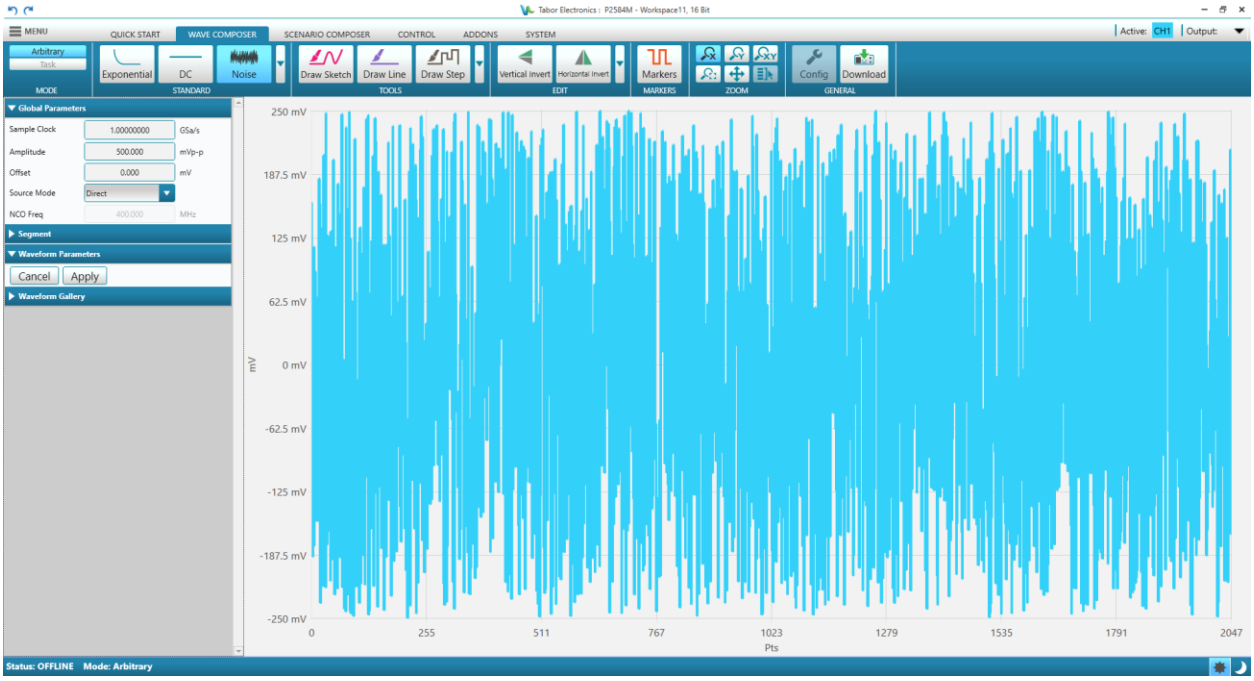


Figure 8.20 Noise Graph without Zoom

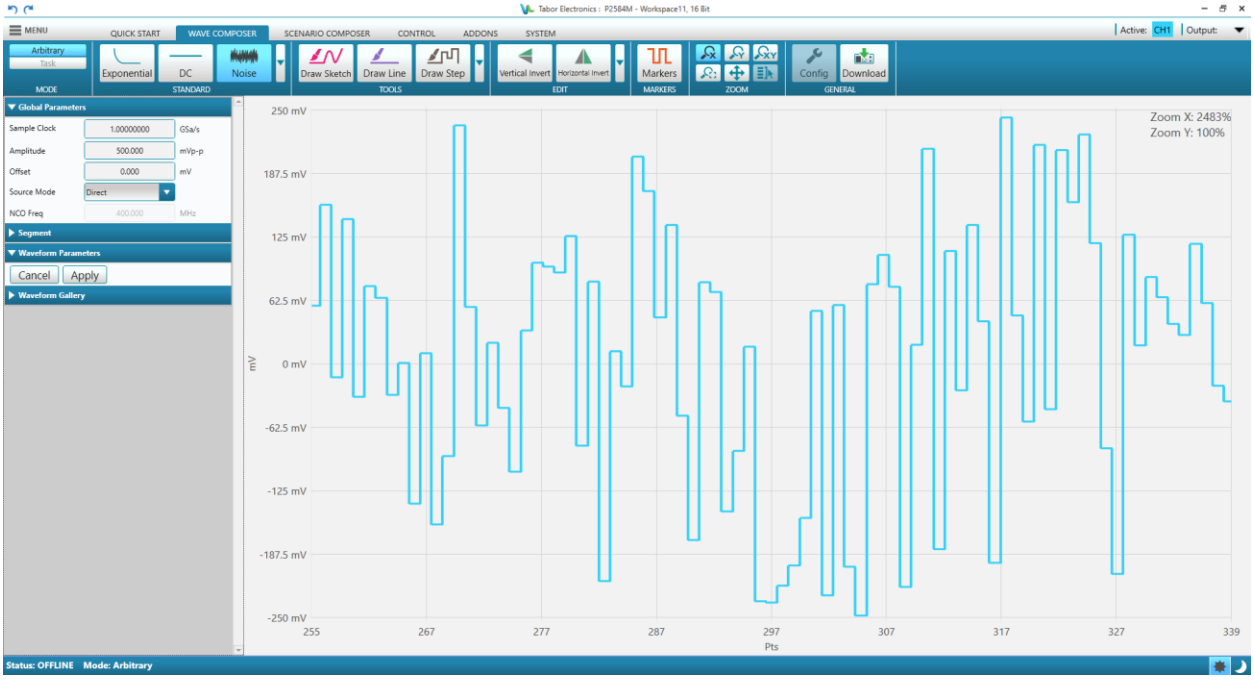


Figure 8.21 Noise Graph with Zoom X-axis

- **Zoom Y-axis** – Click the icon, then click on the composer screen, and drag in the Y-axis direction to select the area of the Y-axis you want to magnify. Click the zoom icon to return to previous view.
- **Zoom Area** – Click the icon, then click on the composer screen, and drag in the XY-axis direction to select the area of the XY-axis you want to magnify. Click the zoom icon to return to previous view.
- **Zoom** – Click the icon to cancel the zoom and return to previous view.
- **Panning** – Click the icon, then click on the composer screen and drag left or right to pan (navigate) on the zoomed graph.
- **Select All** – Use this function when using the Preview in the Scenario. Click the icon, then click on the composer screen, and drag in the XY-axis direction to select the area of the XY-axis you want to magnify. All other graphs will also be magnified exactly the same. TBD.

8.1.7 General

[redacted] Config for SE- and WX-Series

Click the **COMPOSER** tab on the ribbon and then click the **Config** button in the **GENERAL** group to open the **Config Parameters** pane.

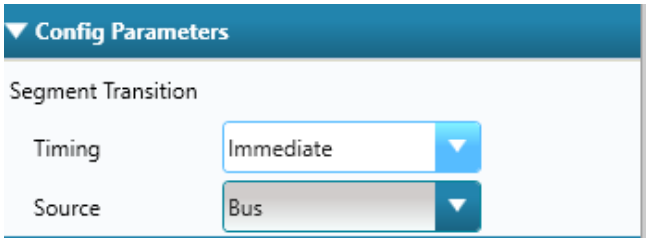


Figure 8.22 Config

- **Segment Transition** – Define the segment transition and segment number.
  - **Timing** –
    - **Immediate** – Switch immediately to next segment without waiting for this segment to complete.
    - **Coherent** – Switch to next segment at the end of this segment.
  - **Source** –
    - **Bus** – A CPU SCPI bus command will initiate the jump to another specified segment.
    - **External** – An external source, connected to the segment control port, will initiate the jump to another specified segment.

8.1.8 Download

Click the **COMPOSER** tab on the ribbon and then click the **Download** button in the **GENERAL** group to download the defined waveform to a RAM segment in the device. This provides a fast sanity check of the waveform. The operational download should be made from the Scenario.

8.2 Configuration Pane

Click the **COMPOSER** tab on the ribbon to invoke the composer window, and then click the **Arbitrary** button. Click the arrows to show the configuration pane windows.

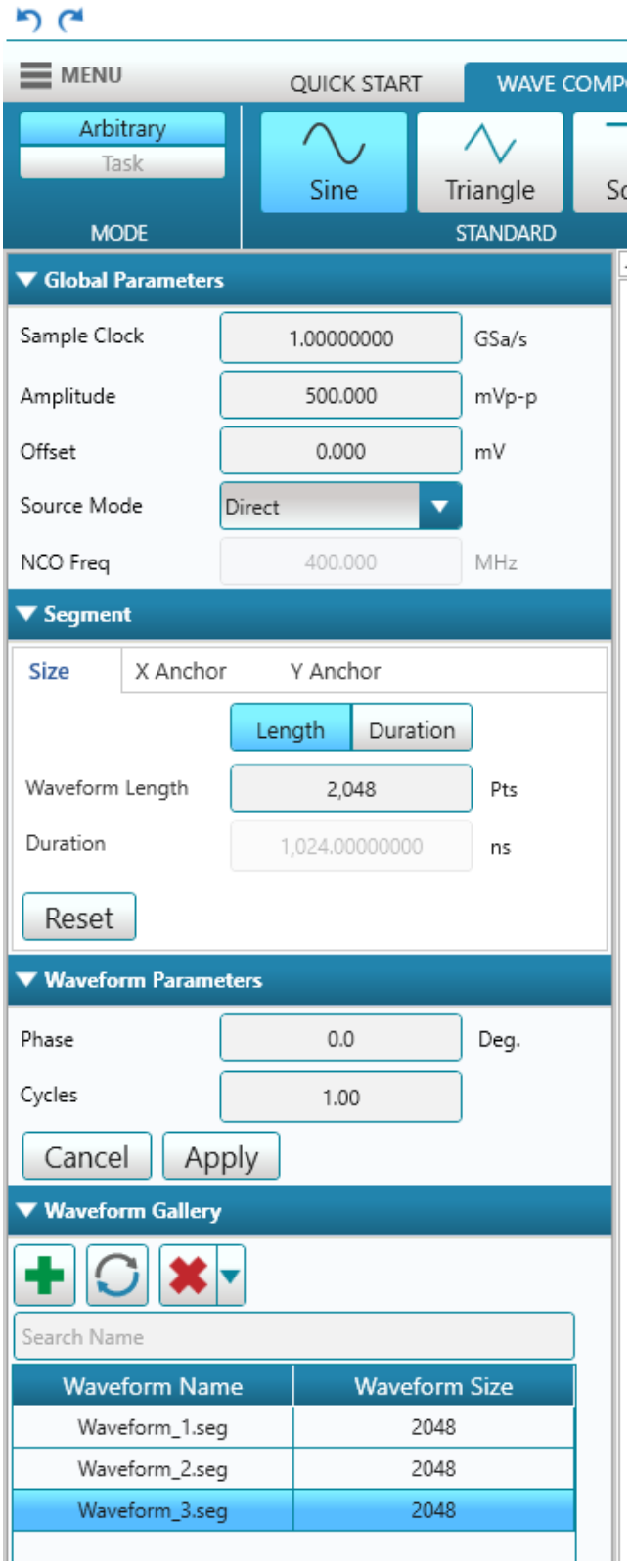


Figure 8.23 Configuration Pane

- **Global Parameters** – Define the basic parameters for the wave.
  - **Sample Clock** – Sets the number of giga samples per second.
  - **Amplitude** – Define the amplitude of the wave in mV peak-to-peak.
  - **Offset** – Sets the DC offset of the wave in mV.
  - **Source Mode** – Sets the clock source of the wave (valid for Proteus devices only).
    - **Direct** – Samples are sent to the DAC without further processing.
    - **NCO Mode** – A sinewave will be generated directly by the internal NCO in the DAC.
    - **IQ Mode** – IQ sample pairs will be fed to the internal quadrature (IQ) modulator to modulate a carrier defined by the internal quadrature NCO pair. The resulting IQ modulated waveform will be fed to the DAC.
  - **NCO Freq** – Set the NCO frequency (Hz, kHz, MHz, GHz) (valid for Proteus devices only).
- **Segment** – Waveforms are downloaded to segments in the generator's RAM waveform memory.
  - **Size** – The size of the waveform in number of points.
    - **Length** –
      - **Waveform Length** – The length of the waveform in number of points (Pts, kPts, MPts, GPts). The Duration will be changed accordingly.

Note

- The Waveform Length and Duration depend on the Waveform Granularity. Refer to your device's User Manual.

    - **Duration** –
      - **Duration** – The time duration of the waveform (ns, µs, ms, s). The Waveform Length will be changed accordingly.
    - **X Anchor** – Define a sub-segment with the x-axis start and end point.
      - **Start** – Set the start point (time) of the wave on the x-axis (Pts).
      - **End** – Set the end point (time) of the wave on the x-axis (Pts).

Note

- When you select an X anchor end value that is smaller than the actual wavelength, after you click the Apply button, WDS will update the anchor values after the change has been made. E.g. if the wavelength is 2047 Pts and the X anchor is 1024 – 1535 the values after clicking apply will become start 1536 and end 2047. This will assist you when adding a new wave at the end of the old one.

    - **Y Anchor** – Set the amplitude of the wave.
      - **Volts** –
        - ✓ **Max** – Max amplitude of the wave (mV).
        - ✓ **Min** – Min amplitude of the wave (mV).
      - **DAC** –
        - ✓ Max – Max amplitude of the wave in DAC resolution-bits. Refer to the device user manual specifications for the number of DAC resolution-bits.
        - ✓ Min – Min amplitude of the wave in DAC resolution-bits.

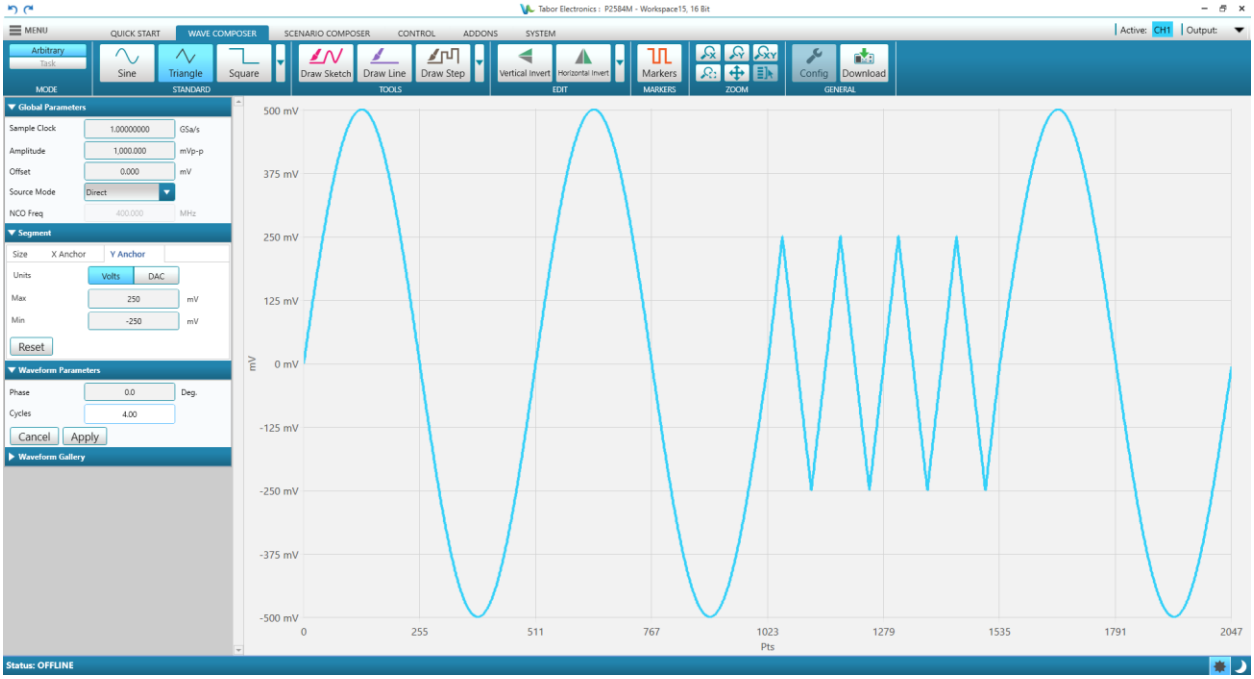


Figure 8.24 Sine Waves with a Triangle Waves (X Anchor Start 1,024, End 1535 Pts, Y Anchor Max 250, Min -250 mV)

- **Waveform Parameters** – This pane is displayed when a wave is selected from the ribbon. Depending on the selected standard waveform only a subset of the following parameters is shown.
  - **Phase** – Set the phase offset of the wave. Phase offset range is between 0 degrees to 360 degrees. The default value is 0 degrees.
  - **Cycles** – Set how many waveform cycles will be created within the specified start and end anchor points.
  - **Duty Cycle** – Set the width of the pulse as a percentage of its period.
  - **Fall** – Set the transition to the minimum amplitude in percent of the total number of wave points in the period.
  - **Rise** – Set the transition to the maximum amplitude in percent of the total number of wave points in the period.
  - **Delay** – Set the delay in percent of the total number of wave points in the period.
  - **# Cycles** – Set how many zero-crossings of the sinc wave.
  - **Exponent (Gaussian)** – Set the width of the "bell" for a gaussian graph.
  - **Exponent (Exponential)** – Set the exponent constant for an exponential graph.
  - **Level** – Set the DC level (mV, V).
  - **Cancel** – Click the Cancel button to cancel last entered value.
  - **Apply** – Click the Apply button to display the waveform on the composer screen.
- **Waveform Gallery** –
  -  – Click the button to add the waveform displayed on the composer screen to the Waveform Gallery. The waveforms in the Waveform Gallery will be used in the Scenario.

-  – Click the button to update the selected waveform according to the modified wave in the Composer screen. The following dialog box will be shown.

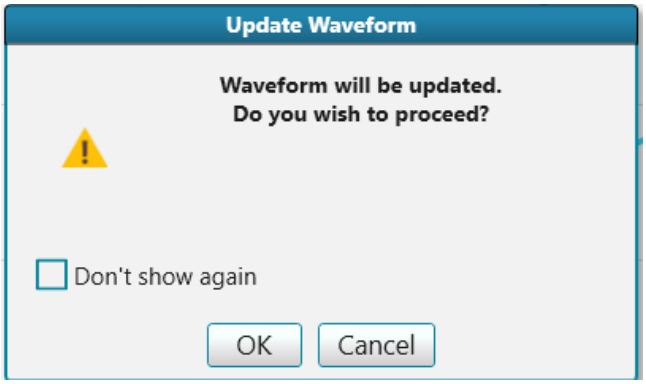


Figure 8.25 Update Waveform

-  – Delete selected waveform or all waveforms in the Waveform Gallery.

9 Scenario

9.1 Arbitrary

Click the **SCENARIO** tab on the ribbon to invoke the scenario composer window, and then click the **Arbitrary** button. Here you can assign the waveforms in the Waveform Gallery to a device memory segment and channel. You should have previously created waveforms in the Waveform Gallery in the **COMPOSER**.

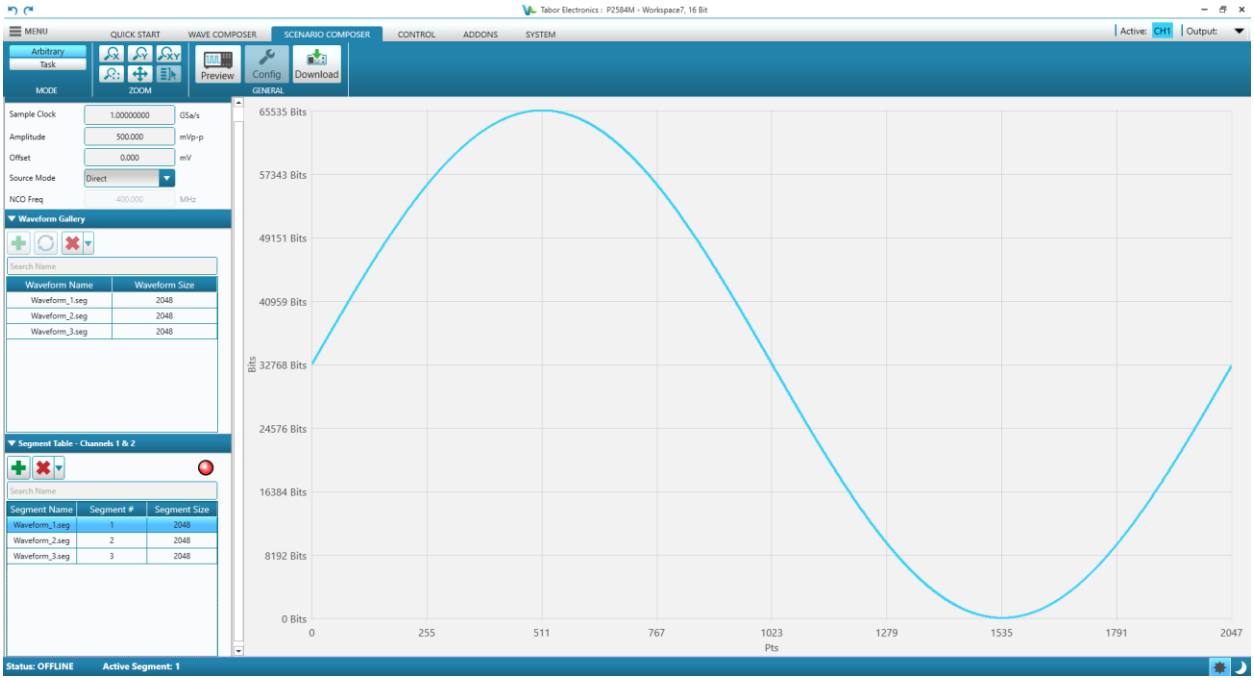


Figure 9.1 Scenario Arbitrary

For a description of the Global Parameters and Waveform Gallery refer to 8.2 Configuration Pane, page 87.

- **Segment Table** – Click the arrow to show the Segment Table pane window.
  - – Click the button to add the selected waveform into the Segment Table.
  - – Delete selected segment or all segments in the Segment Table.
  - – LED that shows if WDS is synchronized with the device.
    - **Red** – The segments and segment table have not been downloaded to the device.
    - **Green** – The segments and segment table have been downloaded to the device.
  - **Segment Name** – The segment name is the waveform name in the Waveform Gallery.
  - **Segment #** – A consecutive unique integer number.
  - **Segment Size** – The number of points/samples in the segment. The minimum segment size is device dependent, see the “Arbitrary Mode Minimum Segment Length” in the specification section of the device user manual.

Workflow

1. Select in the Channel control for which output channel you want to define the segments.
2. Select the waveforms in the Waveform Gallery which you want to download to the device.
3. In the Segment Table click the  button to add the selected waveforms to the segment table.
4. Click the **Download** button to download the selected waveform and segment table to the device.
5. The LED will turn green.
6. The highlighted segment in the segment table will be transmitted to the output of the channel if the output is checked in the Channel Control.
7. To generate a different segment, you should click the desired segment in the segment table. The blue highlighted segment in the figure below will be generated on the device.

Segment Name	Segment #	Segment Size
Waveform_1.seg	1	2048
Waveform_2.seg	2	2048
Waveform_3.seg	3	2048

Figure 9.2 Generating Different Segments

Idea

- You can view the SCPI commands sent to the device when clicking **Download**. Click **Menu**, select **Options** and then click **Open Log Window**.

9.2 Task

Note

- The Task function is only available for Proteus. The WX- and SE-series offer sequence and advanced sequence modes.

Click the **SCENARIO** tab on the ribbon to invoke the scenario composer window, and then click the **TASK** button.

WDS supports an advanced waveform generation mode named Task Mode. Within Task Mode, users can define a table for each channel made of up to 65,536 entries. Each entry fully specifies the way a given segment is going to be generated. One segment can be assigned to any number of task entries or not any entry. Tasks can be simple, independent single segment generation schemes, or they may be part of a complex sequence with synchronous or asynchronous, conditional, or unconditional jumps to other tasks depending on events defined for each task. Tasks also define what to output during idle periods (before the task enabling event or after the current task has been completed and the generator is waiting for the next jumping event).

Each task points to a single segment and the same segment may be pointed by different tasks. For the P128X and P258x models, segments are shared by channel pairs (CH1/CH2 and CH3/CH4 pairs) so even tasks from different channels can point to the same segment.

The Task Table can be defined entry by entry from the WDS (Wave Design Studio) GUI (Graphical User Interface) or through SCPI (Standard Commands for Programmable Instruments) commands. These commands allow for the definition in a readable format of each entry and the corresponding parameters

one by one, or they can be handled in a more efficient, fast, and compact way by transferring the whole or parts of those tables in binary format to the device.

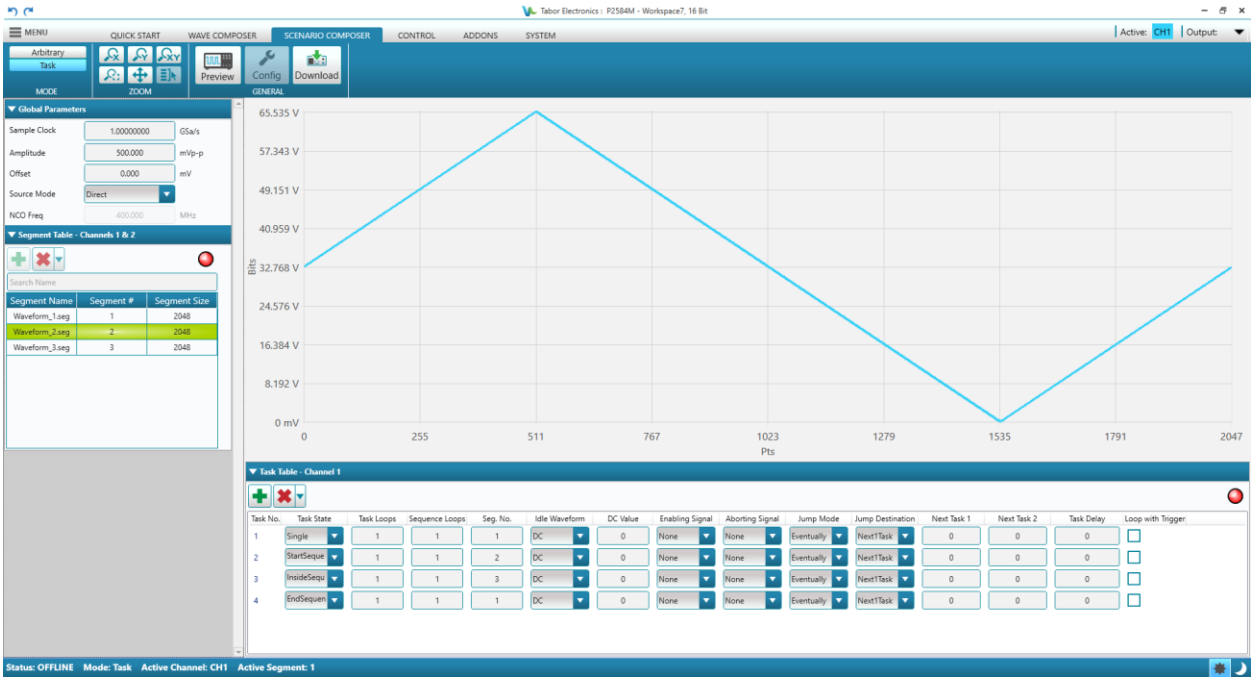


Figure 9.3 Scenario Task

Tasks are defined by a series of parameters associated to each task. Although all these parameters are included in the Task Table for each entry, not all of them may be active as there are some interdependencies. Below are the buttons, LED, parameters, their possible values and states, and a description of the corresponding functionality.

-  – Click the button to add a new task in the Task Table.
-  – Delete selected task or all tasks in the Task Table.
-  – LED that shows if the Task Table is synchronized with the device.
  - **Red** – The task table has not been downloaded to the device.
  - **Green** – The task table has been downloaded to the device.
- **Task No. –** The number of the entry in the table. It is automatically assigned when a new task is defined. Task can be selected by using this unique number.
- **Task State –** It indicates the type of task for that entry. It allows for the definition of groups of tasks that can be used together as a single entity so looping for it can be defined independently of the member tasks. These are the possible choices:
  - **Single** – An independent task not being part of a group of tasks.
  - **StartSequence –** This type of task defines the beginning of a group of tasks to be used as a group. The loops for the group must be defined for these tasks in the corresponding parameter “Sequence Loops”.

- **InsideSequence** – This type of task defines a task within the grouped tasks.
- **EndSequence** – This sequence defines the final task within the group. After terminating this task, the group will be looped again from the StartSequence task until the defined number of loops have been completed. Once this condition is matched, the next task will be controlled by the jump definition parameters for this task.

- **Task Loops** – The number of times for the task to be looped. It can go from 0 (continuous looping) until 1,048,576 times.
- **Sequence Loops** – This is the number of times for the grouped tasks to be looped. It can go from 0 (continuous looping) until 1,048,576 times. This parameter is only active when Task State is set to StartSequence.
- **Seg. No.** – This is the segment number pointed by the current task. This will be the segment fed to the DAC for generation. The same segment can be referenced by any number of tasks. Channel 1&2 and 3&4 in the P128X and P258X models share the same segments for each pair so the same segments can be referenced by tasks in Task Tables for each channel.
- **Idle Waveform** – It states the behavior of the output before the effective generation of the waveform segment pointed by the current task takes place, the so called “idle state”. The “idle state” can be active while the sequencer is waiting for the enabling event or when a delay is forced through the Task Delay parameter. These are the possible choices:
  - **DC** – This is just a user-defined fixed voltage specified in DAC levels (0-255 for the P908X and 0-65,535 for the P128X and P258X models).
  - **FirstPoint** – This is a fixed voltage level specified by the value of the first sample in the segment pointed by the current task.
  - **CurrentSeg** – The segment pointed by the current task will be generated during the “idle state”.
- **DC Value**: This is the user-defined fixed voltage specified in DAC levels (0-255 for the P908X and 0-65,535 for the P128X and P258X models) for the Idle Waveform state while in the “DC” mode.

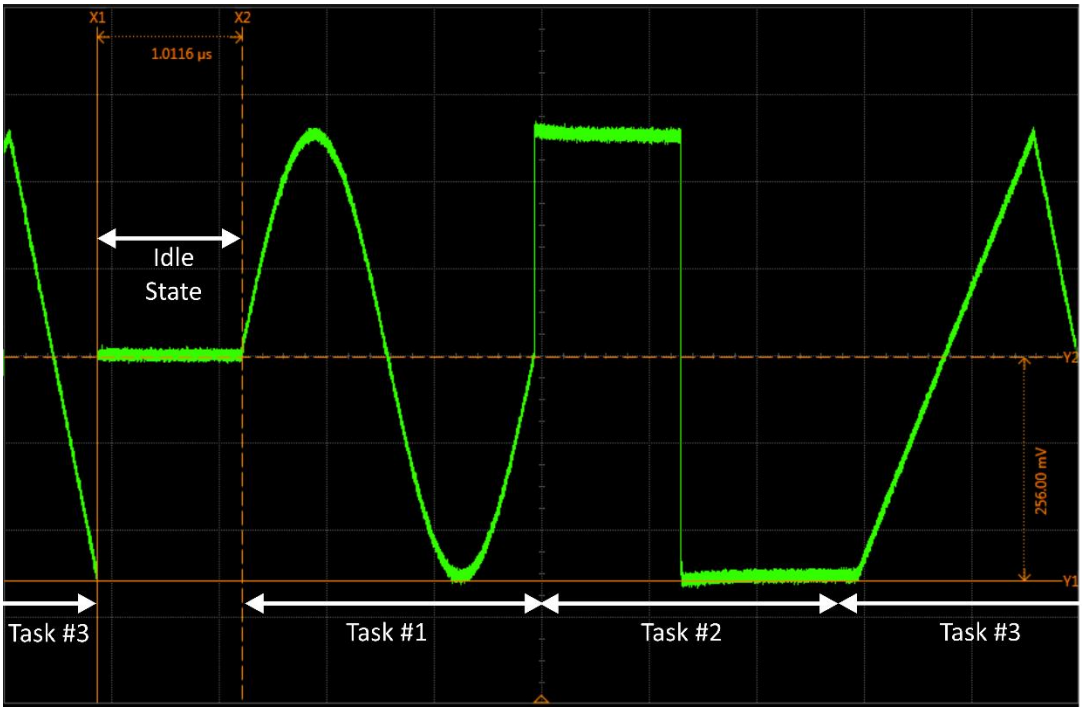


Figure 9.4 DC Level Idle State Associated to Task #1

- **Enabling Signal**: The following sources can be used to initiate the execution of a given task:
  - **None** – The task is initiated immediately (after the time set by the Task Delay parameter).
  - **ExternTrig1** – External Trigger input 1. Trigger 1 settings are set independently.
  - **ExternTrig2 –** External Trigger input 2. Trigger 2 settings are set independently.
  - **InternTrig** – Internal Trigger Source.
  - **CPU** – Bus trigger through SCPI commands (*TRG).
  - **FeedbackTrig** – Trigger from the digitizer block in the optional AWT module (decision block). The trigger conditions are set independently.
  - **HwControl** – Using the optional FS1/2 module (Proteus).
- **Aborting Signal**:
  - **None** – The task is terminated immediately after the number of loops defined in the Task Loops parameter.
  - **ExternTrig1** – External Trigger input 1. Trigger 1 settings are set independently.
  - **ExternTrig2** – External Trigger input 2. Trigger 2 settings are set independently.
  - **InternTrig** – Internal Trigger Source.
  - **CPU** – Abort signal through SCPI commands (*TRG).
  - **FeedbackTrig** – Trigger from the digitizer block in the optional AWT module (decision block) associated to the digitizer section (AWT models) . The trigger conditions are set independently.

- **AnyExternTrig** – Any of the external trigger inputs (Trigger 1 and Trigger 2) when activated according to the respective settings set independently.

- **Jump Mode** – Jumping can be synchronous or asynchronous with the generation associated to the task. According to the expected behavior, Jump Mode can be set to one of these two modes:
  - **Eventually** – After detecting a valid trigger signal for jumping, jump is carried out after full play back of the current loop of the associated segment.
  - **Immediately** – This is used in conjunction with an abort signal or conditional jump. Jump is carried out as fast as possible after detection of the jumping conditions. The latency between a valid trigger to a change in the output is determined by the system delay of the unit and varies depending on the sampling clock. However as long as the system settings are constant the latency time is deterministic (not including the trigger jitter).

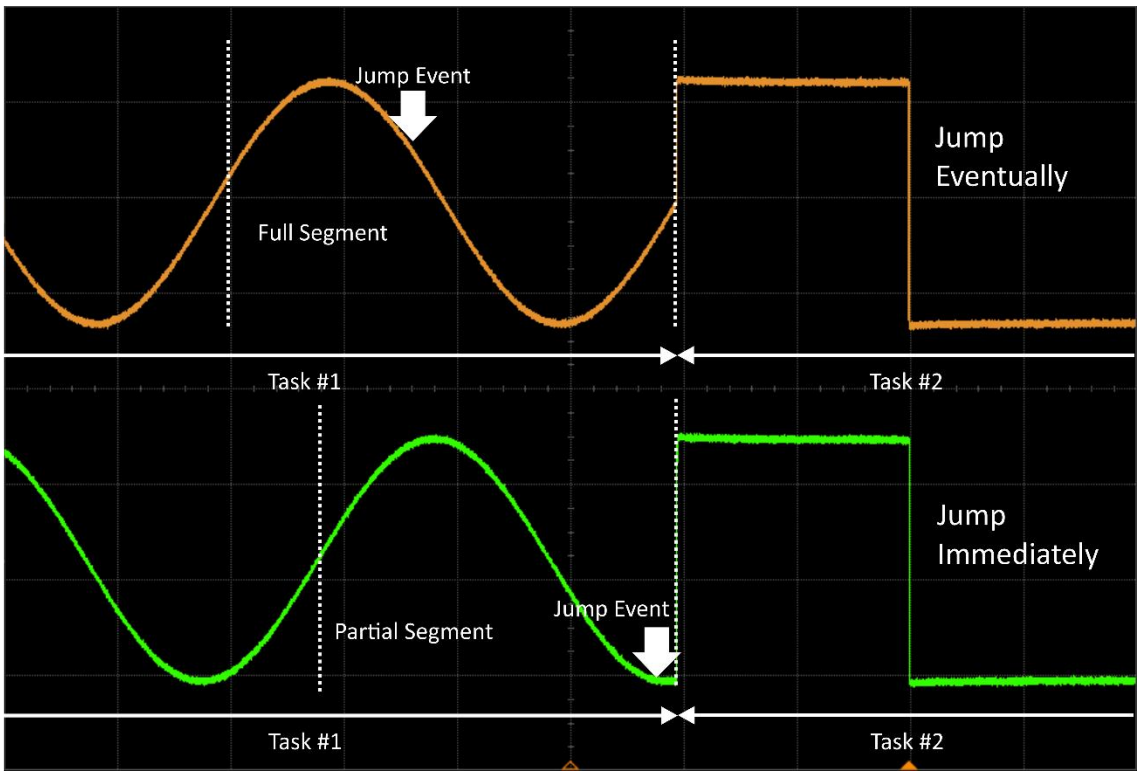


Figure 9.5 Different Types of Jumps. Jump Eventually (Top) and Jump Immediately (Bottom)

- **Jump Destination** –
  - **Next1Task** – Next task as designated by the Next Task 1 parameter.
  - **FeedbackTrigValue** – Task number set by the Feed-Back Trigger coming from the decision block associated to the digitizer section in the optional AWT.
  - **SwitchNext1Next2** – Next task will be defined by either the Next Task 1 (TRIG1) or the Next Task 2 (TRIG2) parameter depending on the first valid trigger event detected from either the External Trigger 1 or External Trigger 2 sources.
  - **NextTaskSel –** TBD.

- **NextScenario** – TBD.

- **Next Task 1** – Task 1 number for the Next1Task and SwitchNext1Next2 jump destination.
- **Next Task 2** – Task 2 number for the SwitchNext1Next2 jump destination.
- **Task Delay** – This is a delay expressed in an integer number of sample periods to effectively start the current task. During this period, the output is in the "idle state".
- **Loop with Trigger** – When a task has an enable signal and a task loop count larger than 1 this selects whether a trigger outputs all of the task loops or just one loop. For example, a task is looped three times and TRIG1 is the enable signal, when the Loop with Trigger is disabled, a single trigger is required to advance to the next task. When the Loop with trigger is enabled three triggers are required to advance to the next task.

9.2.1 Task Table Limitations

While the task mode offers powerful and flexible sequencing features there are certain limitations that the user must adhere to when programming the task table.

[redacted]Conditional Jump

When using the conditional jump capability, the destination task must meet the following conditions:

1. The segment must be a Fast Short Segment that are fully stored in the internal fast SRAM.
2. There cannot be an enable signal, an abort signal, a task delay, or a task loop greater than 1.
3. Task state cannot be end of sequence.
4. Jump destination must be Next1Task.

[redacted]Segment Transitions

When transitioning between segments it is not possible to transition from a Fast-Short Segment to a regular segment. Only Fast Segments can transition to regular segment.

[redacted]Trigger Signal

When using a trigger signal in task mode in conjunction with jump mode eventually there is a minimum hold off time that must be observed in order for the unit to detect the trigger. The trigger signal must be at least 64 sample clocks after the end of the segment in the 9 GS/s units and 16 sample clocks after the end of segments in all the other units.

9.3 Sequence for SE- and WX-Series

Click the **SCENARIO** tab on the ribbon to invoke the scenario composer window, and then click the **Sequence** button.

To create a sequence, you must first create waveforms. The sequence table is constructed from two or more arbitrary waveforms and three sequence steps, which are linked and looped in any way you decide.

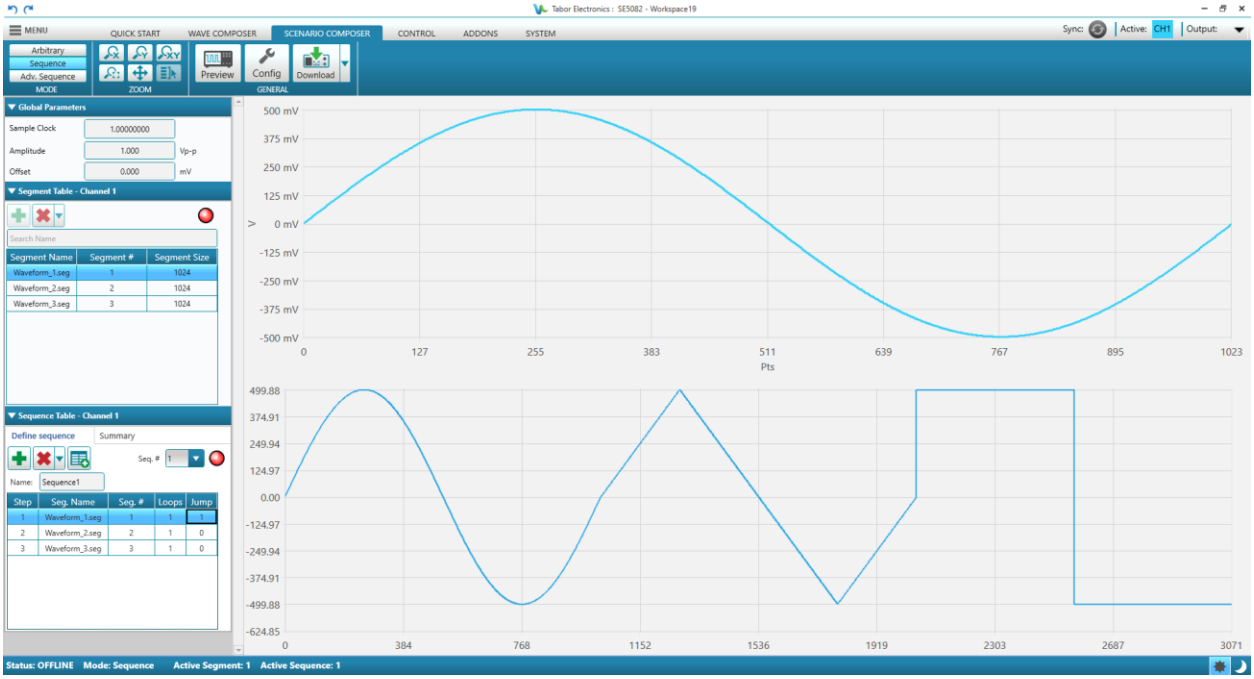


Figure 9.6 Scenario Sequence for SE- and WX-Series

Click the arrow to show the Sequence Table pane window.

- **Define sequence** –
  - – Click the button to add the selected segment into the Sequence Table.
  - – Delete selected segment or all segments in the Sequence Table.
  - – Add a new sequence table. This is used in the Adv. Sequence as a reference for defining link and jumps between the sequences.
  - **Seq. #** – Show the sequence table number.
  - – LED that shows if WDS is synchronized with the device.
    - **Red** – The current segments and sequence table have not been downloaded to the device.
    - **Green** – The current segments and sequence table have been downloaded to the device.
  - **Step** – The number of the entry in the table. It is automatically assigned when a new segment is added.
  - **Seg. Name** – The segment name is the waveform name in the Segment Table.
  - **Seg. #** – Segment number. A consecutive unique integer number.
  - **Loops** – The number of times for the segment to be looped. It can go from 0 (continuous looping) until 1,048,576 times.
  - **Jump** –
    - **0** – Continuous.
    - **1** – Wait for an event signal (external or bus).
- **Summary** – Shows a summary of the defined sequences.

- **Seq. Name** – Sequence name.
- **Seq. #** – Sequence number.
- **Lng. Steps** – Length steps. Shows the number of segments in the sequence.
- **Lng. Pts** – Length points. Shows the number of wave points in the sequence.

9.4 Adv. Sequence for SE- and WX-Series

Click the **SCENARIO** tab on the ribbon to invoke the scenario composer window, and then click the **Adv. Sequence** button.

To create an advanced sequence, you must first create waveforms and sequence tables. In the Adv. Sequence Table, you can link and loop the sequences in any way you decide.

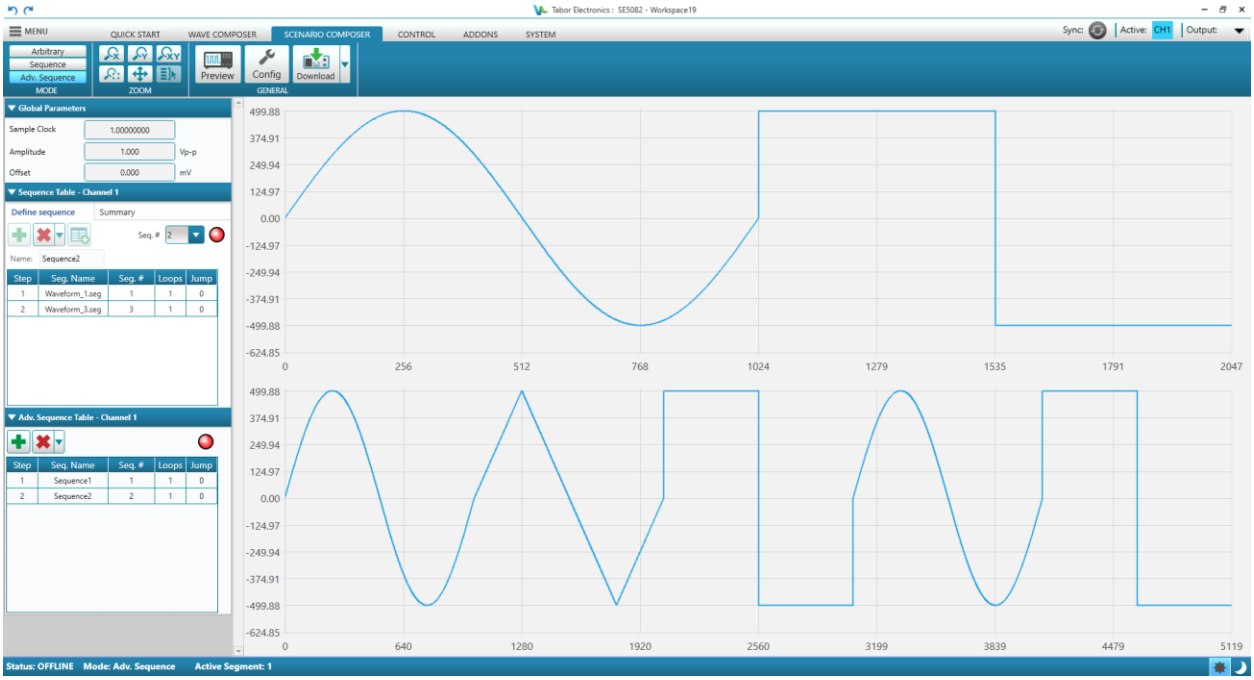


Figure 9.7 Scenario Adv. Sequence for SE- and WX-Series

Click the arrow to show the Adv. Sequence Table pane window.

- – Click the button to add the selected sequence into the Adv. Sequence Table.
- – Delete selected sequence or all sequence in the Adv. Sequence Table.
- – LED that shows if WDS is synchronized with the device.
  - **Red** – The current segments, sequence, and advanced sequence tables have not been downloaded to the device.
  - **Green** – The current segments, sequence, and advanced sequence table have been downloaded to the device.
- **Step** – The number of the entry in the table. It is automatically assigned when a new sequence is added.

- **Seq. Name** – The sequence name is the name above the Sequence Table.
- **Seq. #** – Sequence number.
- **Loops** – The number of times for the sequence to be looped. It can go from 0 (continuous looping) until 1,048,576 times.
- **Jump** –
  - **0** – Continuous.
  - **1** – Wait for an event signal (external or bus).

9.5 Zoom

Refer to section 8.1.6 Zoom, page 84.

9.6 Preview

Click the **SCENARIO** tab on the ribbon to invoke the scenario composer window, and then click the **Preview** button. Here you can view all the channels in one window. The color of the graph denotes the channel number.

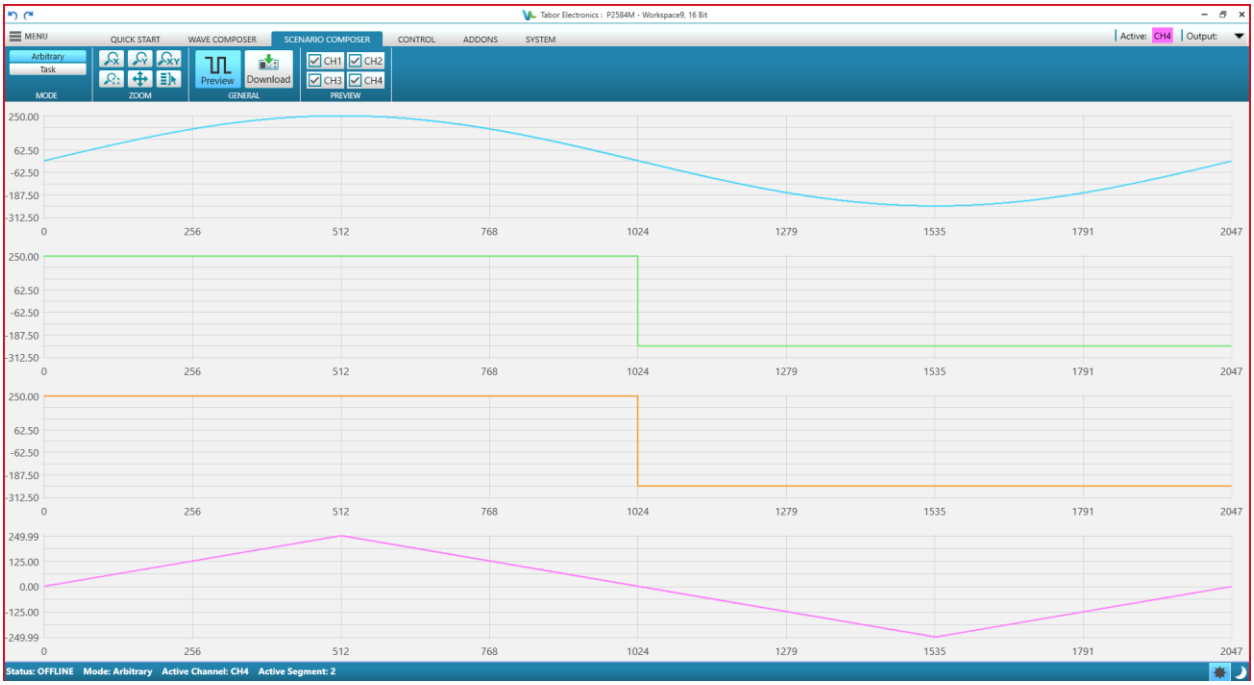


Figure 9.8 Preview

10 Control

Click the **CONTROL** tab on the ribbon to show the control window. Here you can set the device run mode and various configurations such as channel delay, reference clock and more.

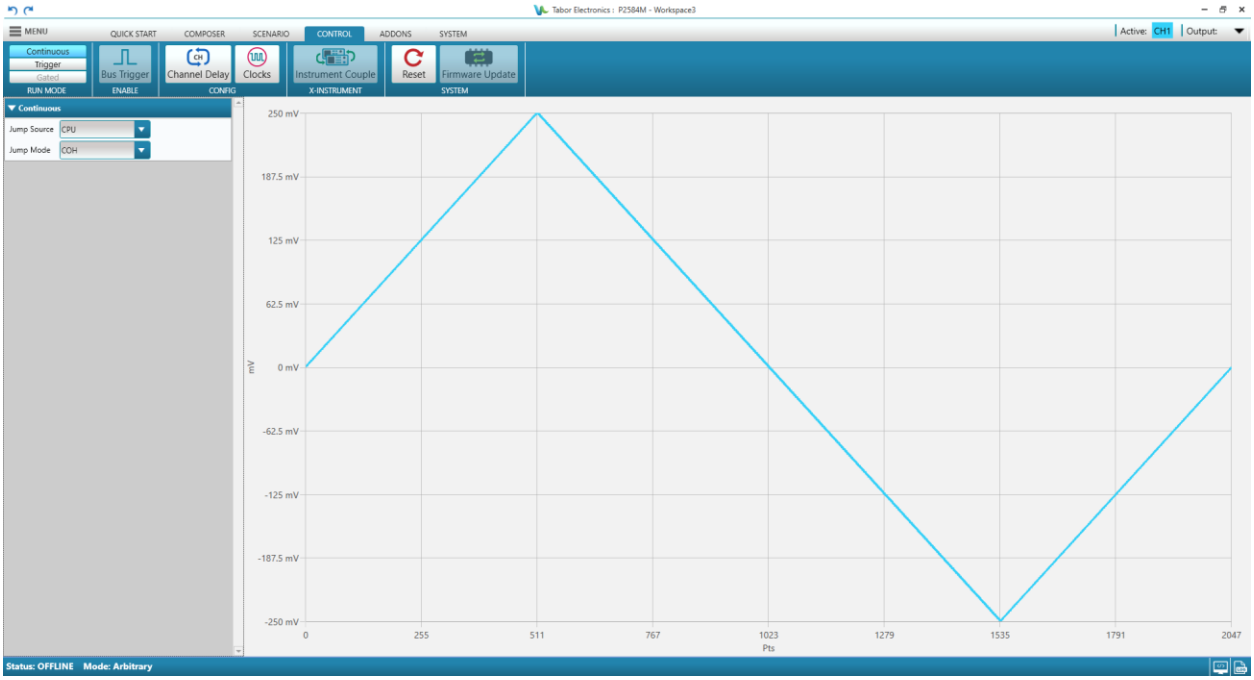


Figure 10.1 Control

10.1 RUN MODE

In Run Mode you can select how the waveform generation will be executed.

10.1.1 Continuous for Proteus

Click the **CONTROL** tab on the ribbon to invoke the Control window and then click the **Continuous** button to display the Continuous pane. This mode enables running the signal continuously, as defined in the other tabs, and regardless of the trigger events. All trigger-oriented parameters are not accessible.

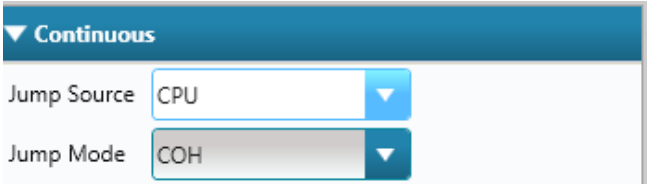


Figure 10.2 Run Mode Continuous for Proteus

- **Jump Source** – Defines the trigger source for jumping to another segment.
  - **CPU** – A CPU SCPI bus command trigger the jump to another segment.

- **EXT HW** – External Hardware. An external source, connected to the segment control port, issues the trigger.

- **Jump Mode** – When a new waveform segment is selected, the generator is presented with a choice:
  - **COH** – Coherent switch, i.e. switch to next segment at the end of this segment.
  - **IMM** – Switch immediately to next segment without waiting for this segment to complete.

10.1.2 Continuous for SE- and WX-Series

Click the **CONTROL** tab on the ribbon to invoke the Control window and then click the **Continuous** button to display the Continuous pane. This mode enables running the signal continuously, as defined in the other tabs, and regardless of the trigger events. All trigger-oriented parameters are not accessible.

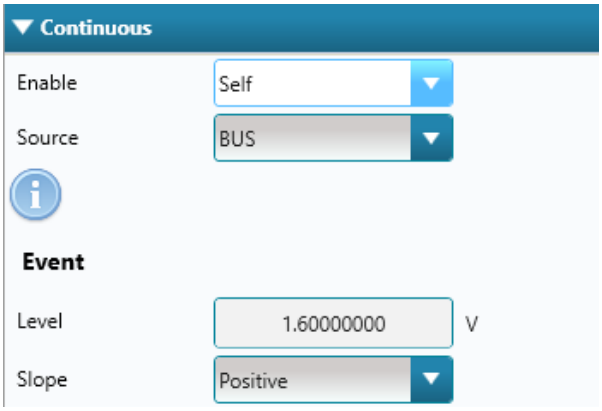


Figure 10.3 Run Mode Continuous

Enable –

- **Self** – The device outputs waveforms immediately after turning the device output on.
- **Armed** – The device waveform output is controlled by commands, events, and triggers.

- **Source** – Defines the source for jumping to another segment.
  - **BUS** – A CPU SCPI bus command initiates the jump to another segment.
  - **EVENT** – External event input.
  - **TRIG** – External trigger input.

- **Event** – An event input signal enables the waveform only when Enable is Armed and Source is Event.
  - **Level** – The event input signal level defines the necessary voltage level that the event signal needs to cross for it to stimulate the instrument (mV, V).
  - **Slope** –
    - **Positive** – Any voltage level that is higher the **Level** will output the waveform signal.
    - **Negative** – Any voltage level that is lower the **Level** will output the waveform signal.
    - **Either** – Both positive and negative transition will output the waveform signal.

10.1.3 Trigger for Proteus

Click the **CONTROL** tab on the ribbon to invoke the Control window, and then click the **Trigger** button to display the Trigger pane. Here you can configure all the trigger parameters. Click the **Bus Trigger** button to send the trigger to the device.

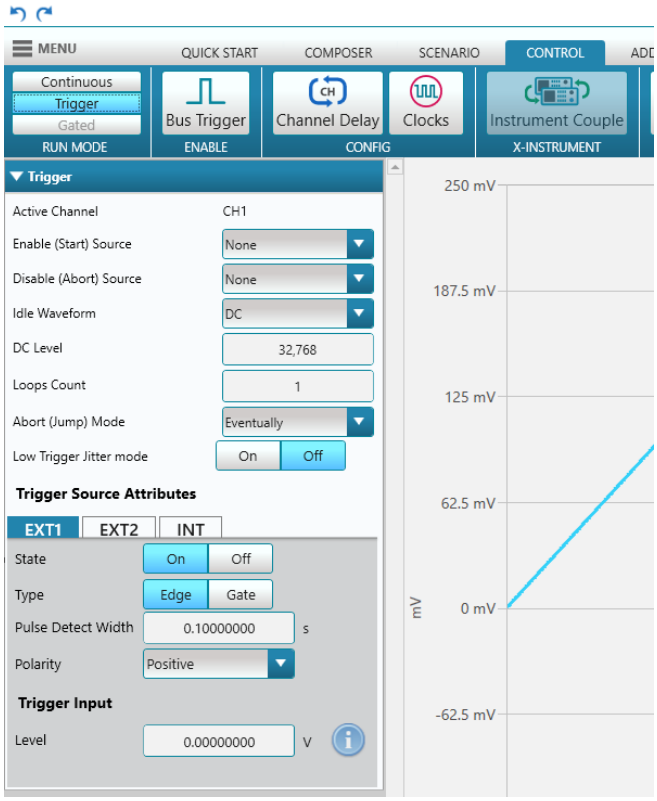


Figure 10.4 Trigger for Proteus

- **Trigger** – Configure the trigger parameters.
  - **Active Channel** – The trigger will be defined for the active channel selected in the Channel Control, refer to 5 WDS Window, page 35.
  - **Enable (Start) Source** – Set the trigger source for enabling the channel output.
    - **None** – The signal is transmitted to the output port.
    - **ExternTrig1** – An external source, connected to the TRIGGER IN 1 port, issues the trigger.
    - **ExternTrig2** – An external source, connected to the TRIGGER IN 2 port, issues the trigger.
    - **InternTrig** – The software generates the triggers.
    - **CPU** – A CPU SCPI bus command triggers the jump to another segment.
    - **FeedbackTrig** – The received wave triggers the signal. This is only valid for arbitrary waveform transceiver, e.g. Proteus with option AWT.
    - **HWControl** – An external source, connected to the segment control port, issues the trigger.
  - **Disable (Abort) Source** – Set the trigger source for ending the trigger output.
    - **None** – The signal is transmitted to the output port.

- **ExternTrig1** – An external source, connected to the TRIGGER IN 1 port, issues the trigger.
- **ExternTrig2** – An external source, connected to the TRIGGER IN 1 port, issues the trigger.
- **InternTrig** – The software generates the triggers.
- **CPU** – A CPU SCPI bus command triggers the jump to another segment.
- **FeedbackTrig** – The received wave triggers the signal. This is only valid for arbitrary waveform transceiver, e.g. Proteus with option AWT.
- **HWControl** – An external source, connected to the segment control port, issues the trigger.

♦ **Idle Waveform**: It states the behavior of the output before the effective generation of the waveform segment pointed by the current task takes place, the so called “idle state”. The “idle state” can be active while the sequencer is waiting for the enabling event or when a delay is forced through the Task Delay parameter. These are the possible choices:

- **DC**: This is just a user-defined fixed voltage specified in DAC levels (e.g., 0-255 for the P908X and 0-65,535 for the P128X and P258X models).
- **FirstPoint**: This is a fixed voltage level specified by the value of the first sample in the segment pointed by the current task.
- **CurrentSeg**: The segment pointed by the current task will be generated during the “idle state”.

♦ **DC Level**: This is the user-defined fixed voltage specified in DAC levels (0-255 for the P908X and 0-65,535 for the P128X and P258X models) for the Idle Waveform state while in the “DC” mode.

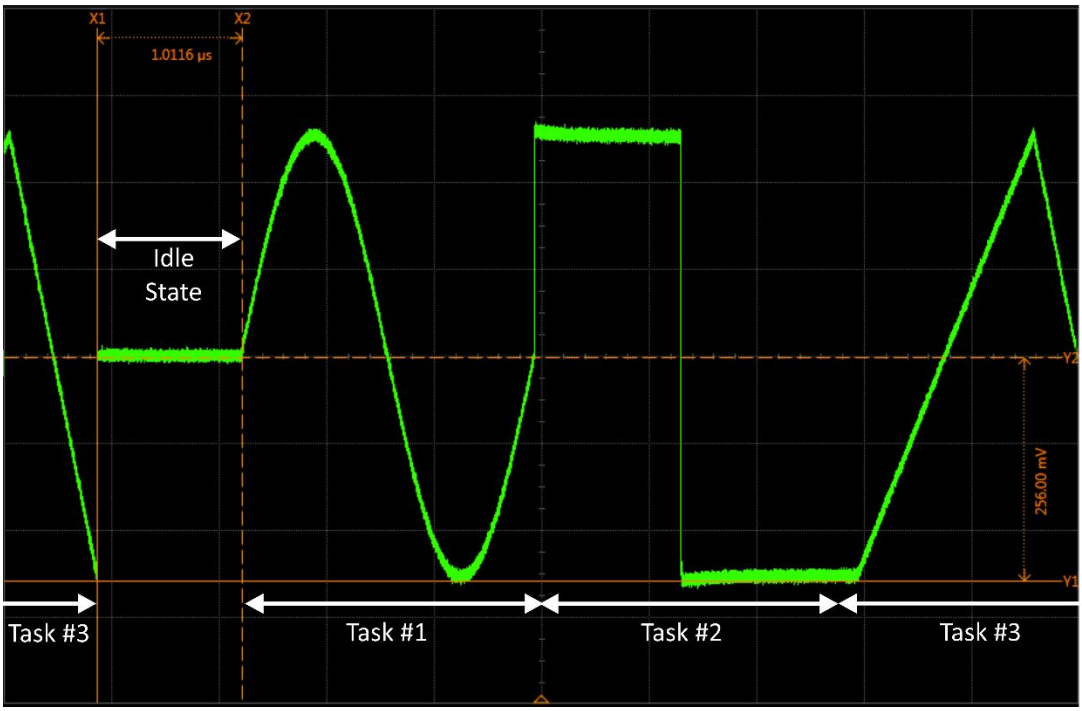


Figure 10.5 DC Level Idle State Associated to Task #1

♦ **Loops Count** – The number of times that segment is to be repeated once the device receives a valid trigger signal.

- **Abort (Jump) Mode** – There are many applications where the device receives a valid trigger while a segment is being generated. The abort mode parameter enables the user to control exactly how the instrument reacts in such a case.
  - **Eventually** – In Eventually mode, the first valid trigger that is received is accepted by the device. However, the current segment that is played is completed before the trigger action is initiated. Any consecutive triggers that are received while the segment is being played are ignored.
  - **Immediately** – In Immediately mode, the instrument does not complete playing the current segment but performs the trigger action on the next clock cycle. Any consecutive valid trigger that is received is accepted and the programmed trigger action is executed.
- **Low Trigger Jitter Mode** – For asynchronous trigger signals there is the Low Trigger Jitter option (LTJ). This option can be added when ordering your Proteus device. Using this option can reduce the trigger jitter by a factor of more than 10.
  - **On** – Turn the low trigger jitter state on.
  - **Off** – Turn the low trigger jitter state off.
- **Trigger Source Attributes** – External trigger inputs **EXT1** and **EXT2** have the following attributes:
  - **State** – Enable or disable the trigger state for the specified channel.
    - **On** – The trigger input is armed for the active channel.
    - **Off** – The trigger input is inactive and ignores all trigger signals.
  - **Type** – Select the type of trigger signal.
    - **Edge** – Defines the valid trigger on the transition of the trigger signal.
    - **Gate** – Trigger signal outputs the waveforms on a stable gate level between two gate transitions. The gate opens on the first positive trigger transition and closes on the next negative transition.
  - **Pulse Detect Width** – Set a time interval during which the trigger signal valid level must be kept in order for the trigger signal to be valid (ns, µs, ms, s).
  - **Polarity** – The field is valid when trigger Type is Edge.
    - **Positive** – The trigger is initiated on the rising edge of the trigger signal.
    - **Negative** – The trigger is initiated on the falling edge of the trigger signal.
- **Trigger Input** –
  - **Level** – The trigger level defines the necessary voltage level that the trigger signal needs to cross for it to stimulate the instrument (mV, V).
- **Trigger Source Attributes** – Internal trigger **INT** generator operates as a free running asynchronous trigger generator. It may be used for applications that require periodical and constant generation of output cycles, or to replace external trigger devices. The following attributes can be programmed:
  - **State** – Enable or disable the trigger state for the specified channel.
    - **On** – The internal trigger generator is active.
    - **Off** – The internal trigger generator is inactive.
  - **Period** – Set the time period between triggers for the internal trigger generator (ns, µs, ms, s).

Note

- In order to prevent errors, the period of the internal trigger must be larger than the period of the output waveform.

10.1.4 Trigger for SE- and WX-Series

Click the **CONTROL** tab on the ribbon to invoke the Control window, and then click the **Trigger** button to display the Trigger pane. Here you can configure all the trigger parameters.

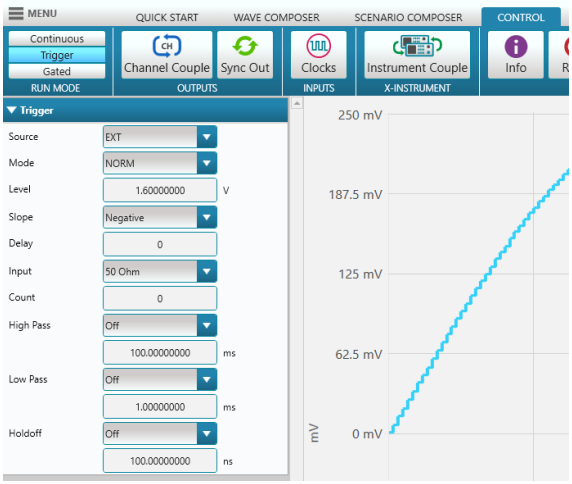


Figure 10.6 Trigger for SE- and WX-Series

- **Trigger** – Configure the trigger parameters.
  - **Source** – Set the trigger source for starting the trigger output.
    - **EXT** – An external source, connected to the TRIG IN port, issues the trigger. The trigger is used for initiating the waveform output
    - **BUS** – A CPU SCPI bus command triggers the jump to another segment.
    - **INT** – The device has a timer that generates the triggers.
    - **EVENT** – An external source, connected to the EVENT IN port, issues the trigger. The most common use is to cause a sequence step to advance to another step.
  - **Mode** – Set the trigger mode for ending the waveform output.
    - **NORM** – Coherent, end the waveform output at the end of the segment.
    - **OVER** – Immediately, end the waveform output immediately.

Note

- The **OVER** trigger must precede the end of the signal by at least 64 sample clock periods.

  - **Level** – Set the input voltage threshold level of the trigger signal (mV, V).
  - **Slope** –
    - **Positive** – Any voltage level that is higher the **Level** will output the waveform signal.
    - **Negative** – Any voltage level that is lower the **Level** will output the waveform signal.
    - **Either** – Both positive and negative transition will output the waveform signal.

- **Delay** – Set the time that will lapse from a valid trigger (hardware or software) until the waveform is generated to the output in addition to the system delay.
- **Input** – The input impedance of the external trigger connector.
  - **50 Ohm** – Set the impedance to 50 ohm.
  - **10 kohm** – Set the impedance to 10 kohm.
- **Count** – The number of times that segment is to be repeated once the device receives a valid trigger signal.
- **High Pass** – Set the trigger minimum valid pulse width for generating a waveform output.
  - **Off** – Not in use.
  - **On** – Use the valid pulse width as defined in the following field (ns, µs, ms, s).
- **Low Pass** – Set the trigger maximum valid pulse width for generating a waveform output.
  - **Off** – Not in use.
  - **On** – Use the valid pulse width as defined in the following field (ns, µs, ms, s).
- **Holdoff** – Set a holdoff period where no triggers are accepted.
  - **Off** – Not in use.
  - **On** – Use the holdoff time as defined in the following field (ns, µs, ms, s).

10.1.5 Gated for SE- and WX-Series

Note

- Gated doesn't yet support Proteus devices.

Click the **CONTROL** tab on the ribbon to invoke the control window and then click the **Gated** button to display the Gated pane. When a gated trigger signal is true the waveform is generated.

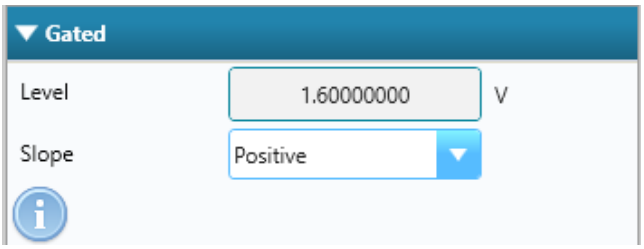


Figure 10.7 Gated

- **Level** – Set the input voltage level of the trigger signal (mV, V).
- **Slope** –
  - **Positive** – Any voltage level that is higher the level will generate a waveform.
  - **Negative** – Any voltage level that is lower the level will generate a waveform.

10.2 OUTPUTS for SE- and WX-Series

10.2.1 Channel Couple

Click the **CONTROL** tab on the ribbon to invoke the Control window and then click the **Channel Couple** button to display the Channel Couple pane.

The device channels (2 or 4) can be synchronized to operate from a single sample clock source and in this case, the output frequency is identical, and the generator provides a tight relationship between phase offset and waveform start. Still, while synchronized, the channels can generate different waveform functions, amplitudes, and DC offsets, but the same run mode option should be selected.

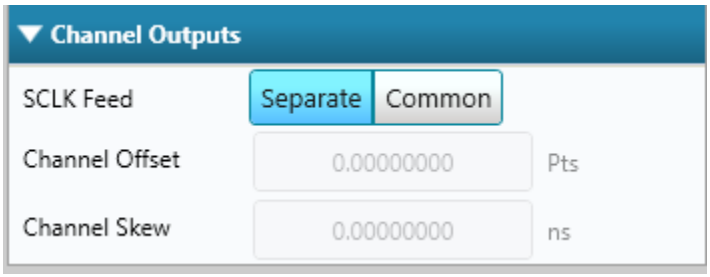


Figure 10.8 Channel Couple

- **SCLK Feed** – Sample clock feed. There are two SCLKs in the device.
  - **Separate** – The SCLK will be separate for the channels.

> **Note**
> - In the WX four channel units each channel pair, CH1 & CH2 and CH3 & CH4, has a common SCLK.

  - **Common** – The SCLK will be common for the channels.
    - **Channel Offset** – Set the offset between channels in sample points with relation to channel 1. Use this for coarse tuning.
    - **Channel Skew** – Set the skew between channels in units of time with relation to channel 1. Use this for fine tuning up to 5 ns (device dependent). Skew is defined as the time difference between corresponding edges on the channels.

10.2.2 Sync Out

Click the **CONTROL** tab on the ribbon to invoke the Control window and then click the **Sync Out** button to display the Sync Out pane. Here you can set the source of the sync out pulse.

The SYNC output generates single or multiple TTL pulses for synchronizing other instruments (i.e., an oscilloscope) to the output waveform. The SYNC signal always appears at a fixed point relative to the waveform. The location of the sync pulse along the waveform is programmable. Since there is only one SYNC output, the output is associated with the channel 1 output, but can be changed to be sourced and synchronized to channel 2. Note that the SYNC output is also used as a frequency marker.

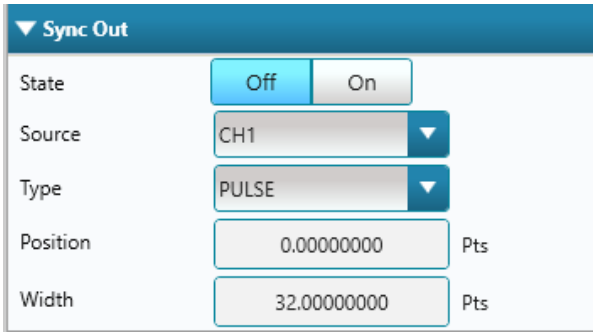


Figure 10.9 Sync Out

- **State** –
  - **Off** – Disable the sync out.
  - **On** – Enable the sync out.
- **Source** – Select the channel source of the sync out signal.
- **Type** –
  - **PULSE** – The pulse has a minimum width of 32 waveform points and its position along the waveform can be adjusted, as well as its width.
  - **WCOM** – The Waveform COMplete has a fixed width that cannot be modified, nor moved from its original position.
- **Position** – Valid for PULSE only. Set the position of the SYNC pulse along the output waveform. The position is programmed in units of waveform points (or sample clock periods). Placement resolution is 32 points. As default, the sync signal is positioned at the beginning of the waveform.
- **Width** – Valid for PULSE only. Set the width of the SYNC pulse along the output waveform. This parameter can modify the width of the SYNC pulse from a minimum of 32 waveform points to the maximum length of the waveform in increments of 32 points.

10.2.3 Sampling Mode for SE-Series

Click the **CONTROL** tab on the ribbon to invoke the Control window and then click the **Sampling Mode** button to display the Sampling Mode pane. Here you can select the sampling mode. Refer to the SE5082 User Manual section Sampling Modes for more information.

Figure 10.10 Sampling Mode

- **CH1/CH2** – Select one of the four available sampling modes.
  - **NRZ** – Non-return to zero.
  - **RTZ** – Return to zero.

- **NRTZ** – Narrow return to zero.
- **RF** – Broadband operation.

Table 10.1 Comparison Between the Four Sampling Modes

Mode	ONZ*	Advantages	Trade-offs
NRZ	1st only	Best 1st NZ (Nyquist Zone) noise performance.	Steep dynamic tail off > 1st NZ. Legacy mode.
RTZ	2nd & 3rd	Best SFDR mode. Extended bandwidth. Possible operation in 4th & 5th NZ.	6 dB carrier power loss in 1st NZ. Reduced SFDR. Strong spur at Fclk.
NRTZ	1st & 2nd	Peak carrier power in 1st & 2nd NZ. Extended 2nd NZ dynamics (better than NRZ).	3rd NZ notch, spur at Fclk.
RF	2nd & 3rd	Best for 2nd & 3rd NZ power. Validated operation in 4th NZ. Peak power at Fs! Uses 2x rate clock	Clock spurs at Fclk and 2xFclk
*ONZ = Optimum Nyquist Zone			

10.3 CONFIG

Here you can configure the channel delays and the sample clocks.

10.3.1 Channel Delay for Proteus

Click the **CONTROL** tab on the ribbon to invoke the control window and then click the **Channel Delay** button to display the Channel Delay pane.

For devices with multiple channels each channel has its own output stage and therefore offset are independent and can be set per channel in the Channel Delay pane.

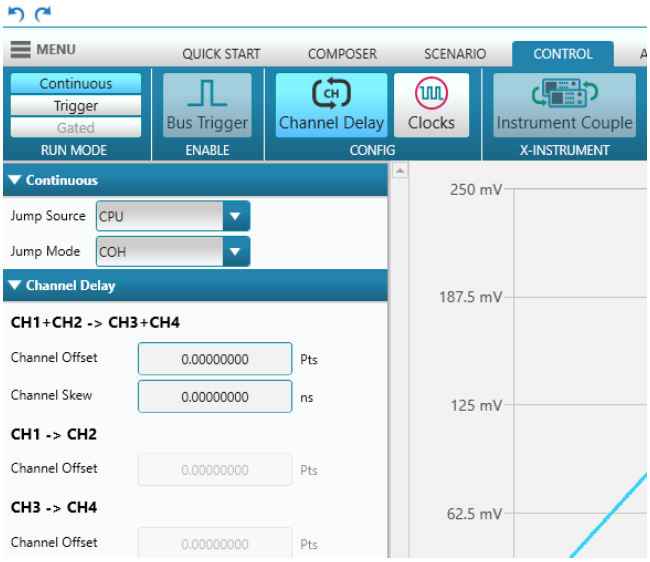


Figure 10.11 Channel Delay

- **CH1+CH2 -> CH3+CH4** –
  - **Channel Offset** – Set the CH3+CH4 offset (Pts) in relation to CH1+CH2. Use this for coarse tuning.
  - **Channel Skew** – Set the CH3+CH4 skew (ns) in relation to CH1+CH2. Use this for fine tuning up to 5 ns. Skew is defined as the time difference between corresponding edges on the channels. Refer to the Proteus User Manual section Channels Characteristics for the skew resolutions (5 ps).
- **CH1 -> CH2** –
  - **Channel Offset** – Set the CH2 offset (Pts) in relation to CH1.
- **CH3 -> CH4** –
  - **Channel Offset** – Set the CH4 offset (Pts) in relation to CH2.

10.3.2 Clocks

Click the **CONTROL** tab on the ribbon to invoke the control window and then click the **Clocks** button to display the clocks pane.

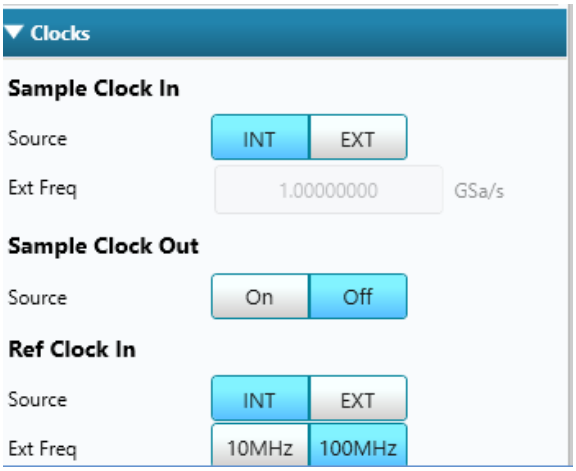


Figure 10.12 Clocks

- **Sample Clock In** –
  - **Source** – Set sample clock source.
    - **INT** – Use the internal sample clock generator.
    - **EXT** – Use an external clock signal that will replace the internal sample clock generator.
  - **Ext Freq** – Set the external frequency of the sample clock signal (MSa/s, GSa/s).
  - **Divider** – Valid for SE- and WX-Series only. Set a dividing ratio for the external clock (2n, 1 – 256).
- **Sample Clock Out** – Valid for Proteus only. Outputs the internal sample clock generator or if used the external sample clock.
  - **Source** –
    - **On** – Output the sample clock.
    - **Off** – Do not output the sample clock.
- **Ref Clock In** – The reference clock input is used for synchronizing system components to a single clock reference.
  - **Source** –
    - **INT** – Use the internal reference clock.
    - **EXT** – Use the external reference clock input.
  - **Ext Freq** – Set the external frequency of the clock input.
    - **10MHz** – Set the reference clock input frequency to 10 MHz.
    - **20MHz** – Set the reference clock input frequency to 20 MHz. Not valid for Proteus.
    - **50MHz** – Set the reference clock input frequency to 50 MHz. Not valid for Proteus.
    - **100MHz** – Set the reference clock input frequency to 100 MHz.

10.4 X-INSTRUMENT

10.4.1 Instrument Couple for SE- and WX-Series

Click the **CONTROL** tab on the ribbon to invoke the control window and then click the **Instrument Couple** button to display the Instrument Couple pane.

For applications that require several channels the built-in synchronization feature allows for synchronizing two devices to create a fully synchronized multi-channel system. The two instruments "TWO INSTRUMENT SYNC" connectors are inter-connected via a dedicated sync cable.

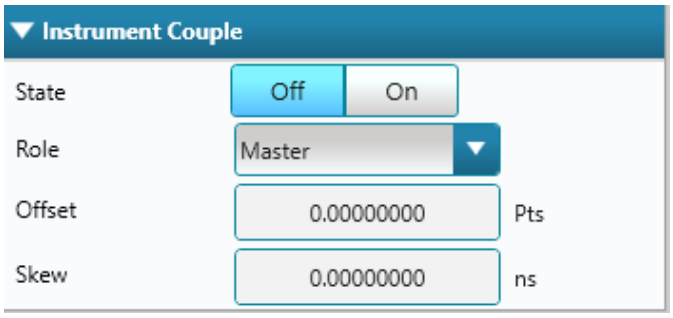


Figure 10.13 Instrument Couple

- **State** –
  - **Off** – Set the couple mode to off.
  - **On** – Sets the couple mode to on.
- **Role** – Define master and slave instruments
  - **Master** – Set this instrument as the controlling master in a two-instrument system. Only channel 1 in each instrument can be defined as master. The rest of the channels are defined as slaves.
  - **Slave** – Set this instrument as a slave in a two-instrument system.
  - **Mslave** – Defines the slave instrument as a master in a two-instrument system.
- **Offset** – Set the offset between the start phase of the slave instrument in relation to the master.
- **Skew** – Set the skew between the two instruments. Skew defines the fine offset between instruments in units of time. The skew is computed for the slave in relation to the master.

10.4.2 Reset

Click the **CONTROL** tab on the ribbon to invoke the control window and then click the **Reset** button to reset all instrument parameters to factory defaults. A pop-up window is displayed.

Figure 10.14 Factory Reset

10.4.3 Firmware Update

Click the **CONTROL** tab on the ribbon to invoke the control window and then click the **Firmware Update** button to open the Tabor Electronics Update Tool that comes with the WDS installation package. TBD

Note

- You can download the latest firmware file from the Tabor Electronics website at http://www.taborelec.com/downloads.

11 Addons

Idea

- Click the arrow to show a pane window.

11.1 Radar

Note

- The Radar function is optional.

Click the **ADDONS** tab on the ribbon and then click the **Radar** button to display the Radar Parameters pane. Here you can generate waveforms to test radar applications.

Refer to 8.2 Configuration Pane, page 87 for a description of the **Global Parameters**.

You need to specify numerous parameters for creating a radar waveform. The parameters are grouped by function that can be selected in the **Define** list box. The list box item order, RF, Pulse Sequence, Pulse Parameters, and Pulse Modulation reflects the natural workflow to define a radar waveform.

11.1.1 RF

You are recommended to first set the RF before configuring the pulses.

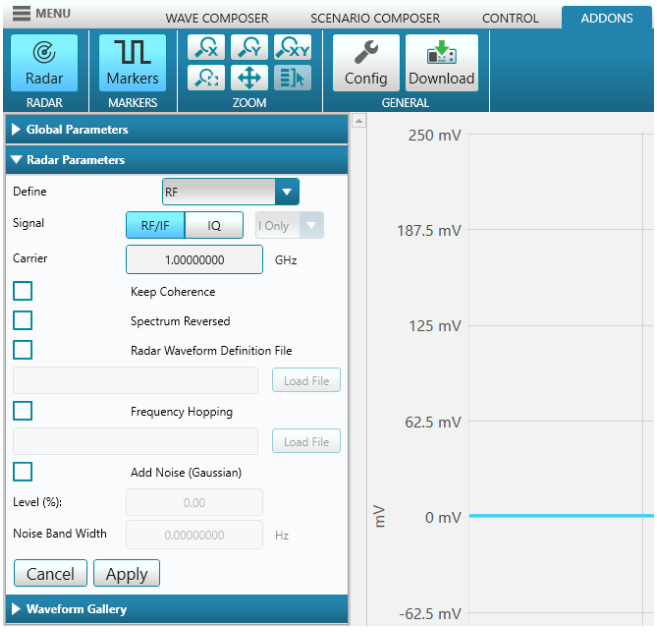


Figure 11.1 Radar RF

- **Radar Parameters** –
  - **Define** –
    - **RF** – Set the RF parameters for the radar.
    - **Pulse Sequence** – Set the timing parameters for the pulse sequence of pulses.

- **Pulse Parameters** – Set the timing parameters for the pulse.
- **Pulse Modulation** – Set the intra-modulation scheme for the pulses.

- **Signal** – Generation of Baseband (IQ) and RF/IF signals. IQ baseband signals are usually generated by two physical channels in the target AWG to feed an external quadrature modulator. IF (Intermediate Frequency) signals generated by a single channel typically feed an external up-converter while RF signals are typically generated by the target AWG right at the final carrier frequency. IF/RF waveforms can optionally keep carrier coherence when the waveform is continuously generated by seamlessly looping them.
  - **RF/IF** – Radio Frequency/Intermediate Frequency.
  - **IQ** – In-phase Quadrature.
    - **I Only** –
    - **Q Only** –
- **Carrier** – Set the carrier wave frequency (µHz, mHz, Hz, kHz, MHz, GHz).
- **Offset Freq.** – Valid for IQ signals. A frequency shift, positive or negative, will be added.
- **Keep Coherence** – Check this box to keep coherence (phase synchronized) when the waveform is looped. It may affect the accuracy of the carrier frequency.
- **Spectrum Reversed** – Check this box for reversing the spectrum (left will become right and vice versa on a spectrum analyzer).
- **Radar Waveform Definition File** – Check this box and then click **Load File** for loading a radar waveform definition text file from your PC. This file has more parameters and functionality than provided by the WDS GUI. WDS will compile the file and then create the waveform (successfully parsed). Refer to 14 Appendix Radar Waveform Definition File, page 134.
- **Frequency Hopping** – Check this box and then click **Load File** for loading a radar frequency hopping definition text file from your PC. This file has more parameters and functionality than provided by the WDS GUI. WDS will compile the file and then create the waveform. Refer to 14.4 Radar_Waveform_Definition_File_Frequency_Hopping_Rev._1.0.csv, page 139.
- **Add Noise (Gaussian)** – Check this box for adding bandwidth-limited white Gaussian noise to the radar waveform.
  - **Level (%)** – Noise RMS amplitude level as a percentage of the DAC's full scale.
  - **Noise Bandwidth** – Maximum frequency component for Gaussian noise (Hz, kHz, MHz, GHz).
- **Cancel** – Click the Cancel button to cancel last entered value. TBD.
- **Apply** – Click the Apply button to display the waveform on the composer screen.

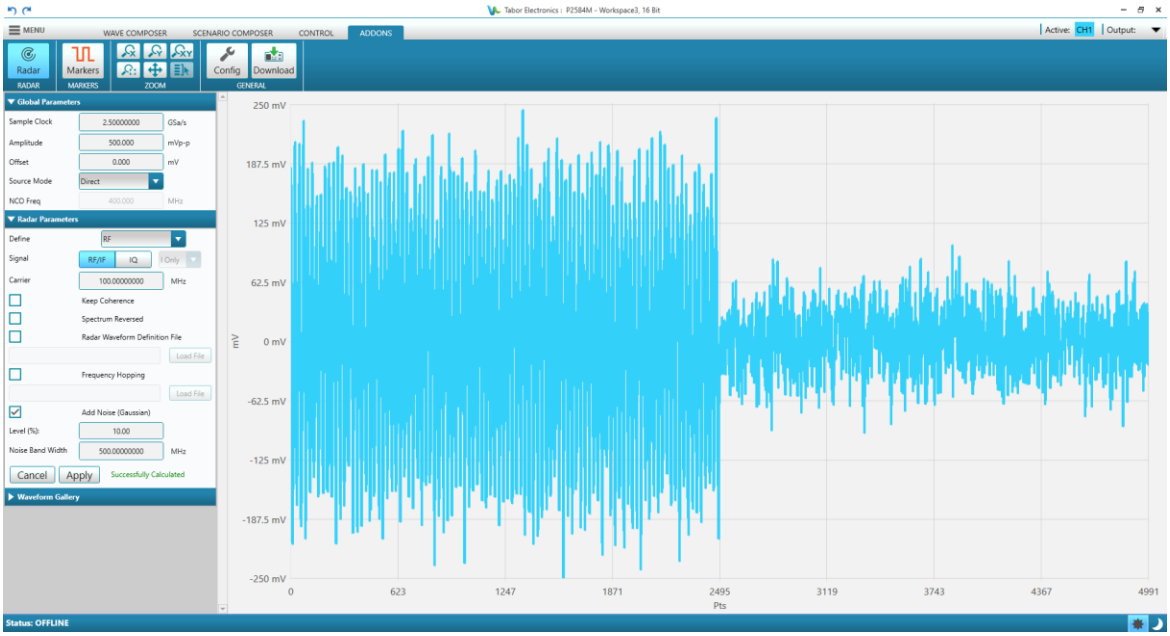


Figure 11.2 Radar RF with Noise

11.1.2 Pulse Sequence

Click the **ADDONS** tab on the ribbon and then click the **Radar** button to display the Radar Parameters pane. Select **Define Pulse Sequence**.

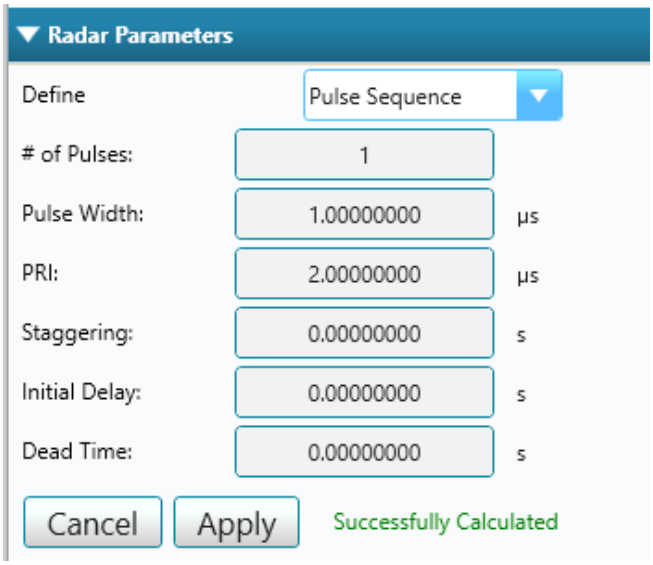


Figure 11.3 Radar Parameters Pulse Sequence

- **Radar Parameters** –
  - **Define** –
    - **Pulse Sequence** – Set the timing parameters for the pulse sequence of pulses.
  - **# of Pulses** – Number of pulses in the pulse sequence.

- **Pulse Width** – The width of the pulse at 50% of the pulse amplitude (ns, µs, ms, s).
- **PRI** – Pulse repetition interval (ns, µs, ms, s).
- **Staggering** – Increase the PRI with the staggering time. E.g. PRI_n = PRI + (n-1) x Staggering, where n is the n:th pulse.
- **Initial Delay** – Initial delay for the pulse sequence to start.
- **Dead Time** – The time between the end of the last pulse and the end of the waveform.
- **Cancel** – Click the Cancel button to cancel last entered value. TBD
- **Apply** – Click the Apply button to display the waveform on the composer screen.

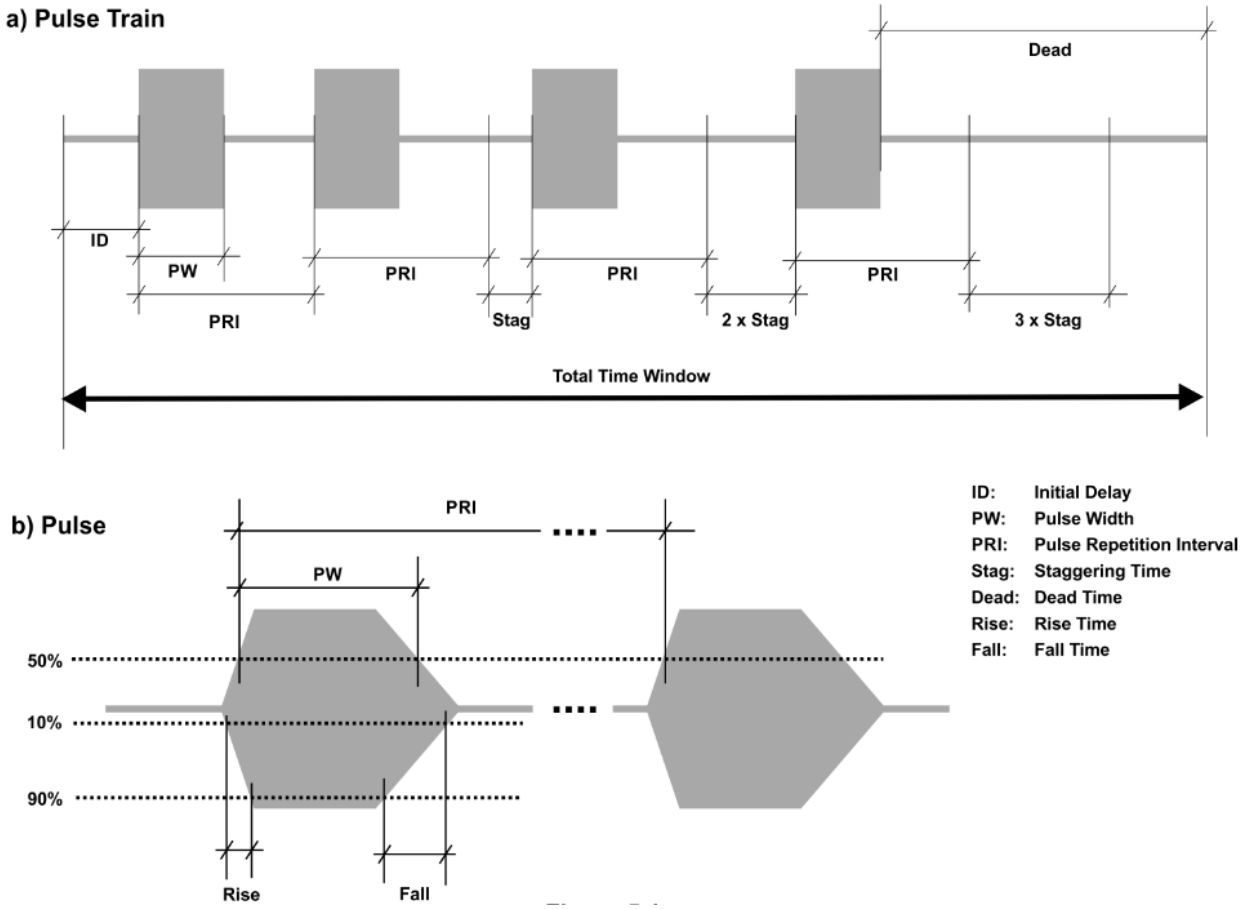


Figure 11.4 Explanation of Radar Pulse Parameters

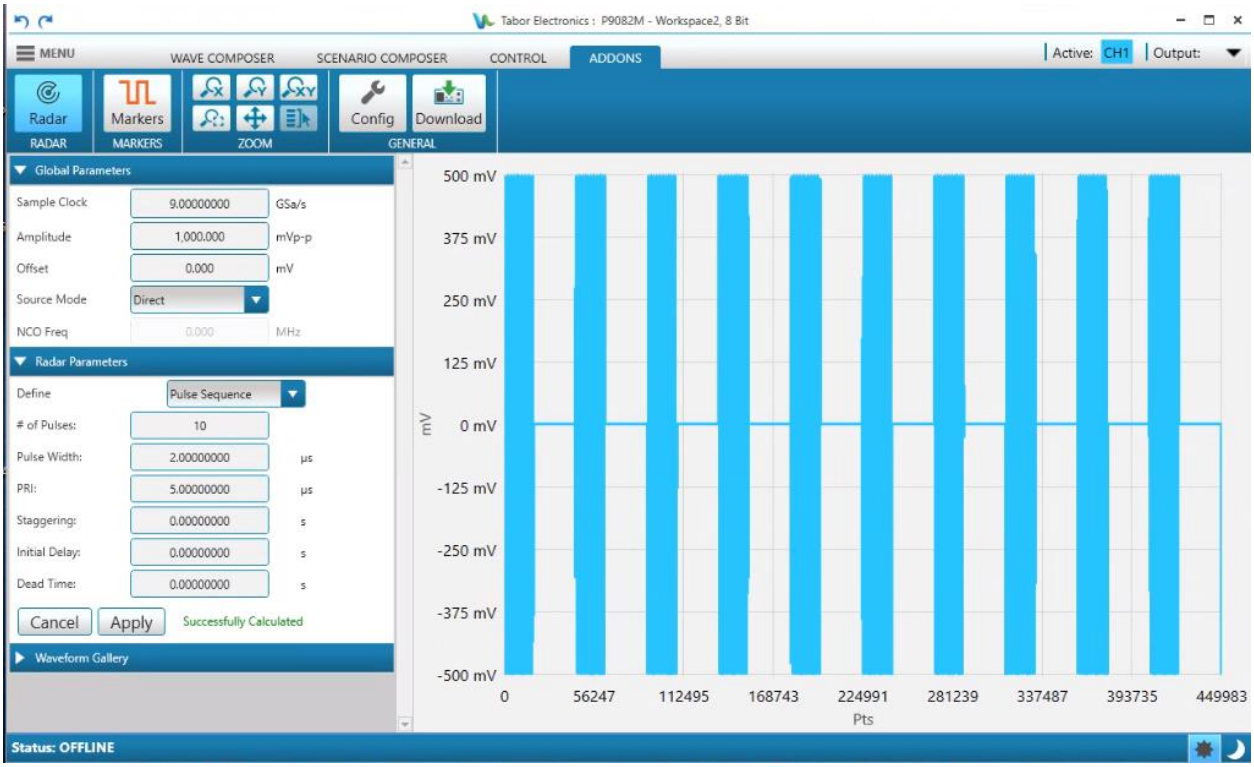


Figure 11.5 Radar Pulse Sequence Graph

11.1.3 Pulse Parameters

Click the **ADDONS** tab on the ribbon and then click the **Radar** button to display the Radar Parameters pane. Select **Define Pulse Parameters**.

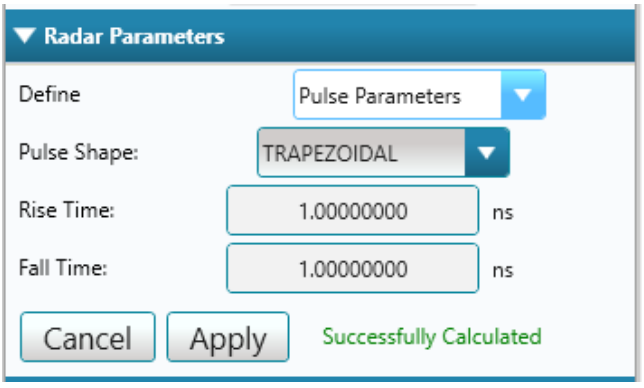


Figure 11.6 Radar Pulse Parameter

- **Radar Parameters** –
  - **Define** –
    - **Pulse Parameters** – Set the timing parameters for the pulse.
  - **Pulse Shape:** –
    - **RECTANGULAR** – Set a rectangular pulse shape.
    - **TRAPEZOIDAL** – Set a trapezoidal pulse shape.

- **RAISED COSINE** – Set a raised cosine pulse shape.

- **Rise Time** – The leading edge rise time (ns, µs, ms). Not valid for a rectangular pulse shape.
- **Fall Time** – The trailing edge fall time (ns, µs, ms). Not valid for a rectangular pulse shape.
- **Cancel** – Click the Cancel button to cancel last entered value. TBD
- **Apply** – Click the Apply button to display the waveform on the composer screen.

11.1.4 Pulse Modulation

Click the **ADDONS** tab on the ribbon and then click the **Radar** button to display the Radar Parameters pane. Select **Define Pulse Modulation**.

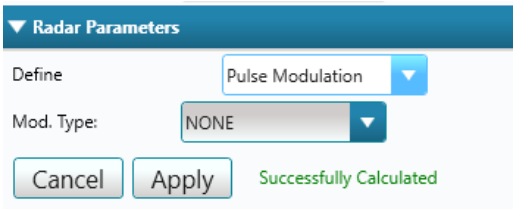


Figure 11.7 Radar Pulse Modulation

- **Radar Parameters** –
  - **Define** –
    - **Pulse Modulation** – Set the intra-modulation scheme for the pulses.
  - **Mod. Type** – Set the intra-pulse modulation scheme.
    - **NONE** –
    - **LINEAR FM CHIRP** –
      - **Freq. Sweep** – Set the sweep frequency range (Hz, kHz, MHz, GHz). The sweep will be centered around the carrier frequency for RF signals and around 0 Hz for baseband I&Q signals.
      - **Sweep Type** – Set one of the following options; Up, Down, Up/Down, Down/Up.
    - **STEP FM** –
      - **Sweep Type** – Set one of the following options; Up, Down, Up/Down, Down/Up.
      - **# of Steps** – Set the number of FM modulation steps.
      - **Step Size** – Set the frequency modulation step size (Hz, kHz, MHz, GHz).
    - **BARKER CODES** –
      - Set one of the following Barker codes; Code 2, Code 3, Code 4, Code 4', Code 5, Code 7, Code 11, Code 13, Code -2, Code -3, Code -4, Code -4', Code -5, Code -7, Code - 11, Code -13.
    - **FRANK CODES** –
      - Set one of the following FRANK CODES; Code 1 … 10.
    - **P1 CODES** –
      - Set one of the following P1 CODES; Code 1 … 10.
    - **P2 CODES** –
      - Set one of the following P2 CODES; Code 1 … 10.

- **P3 CODES** –
  - Set one of the following P3 CODES; Code 1 … 10.
- **P4 CODES** –
  - Set one of the following P4 CODES; Code 1 … 10.

- **Cancel** – Click the Cancel button to cancel last entered value. TBD.
- **Apply** – Click the Apply button to display the waveform on the composer screen.

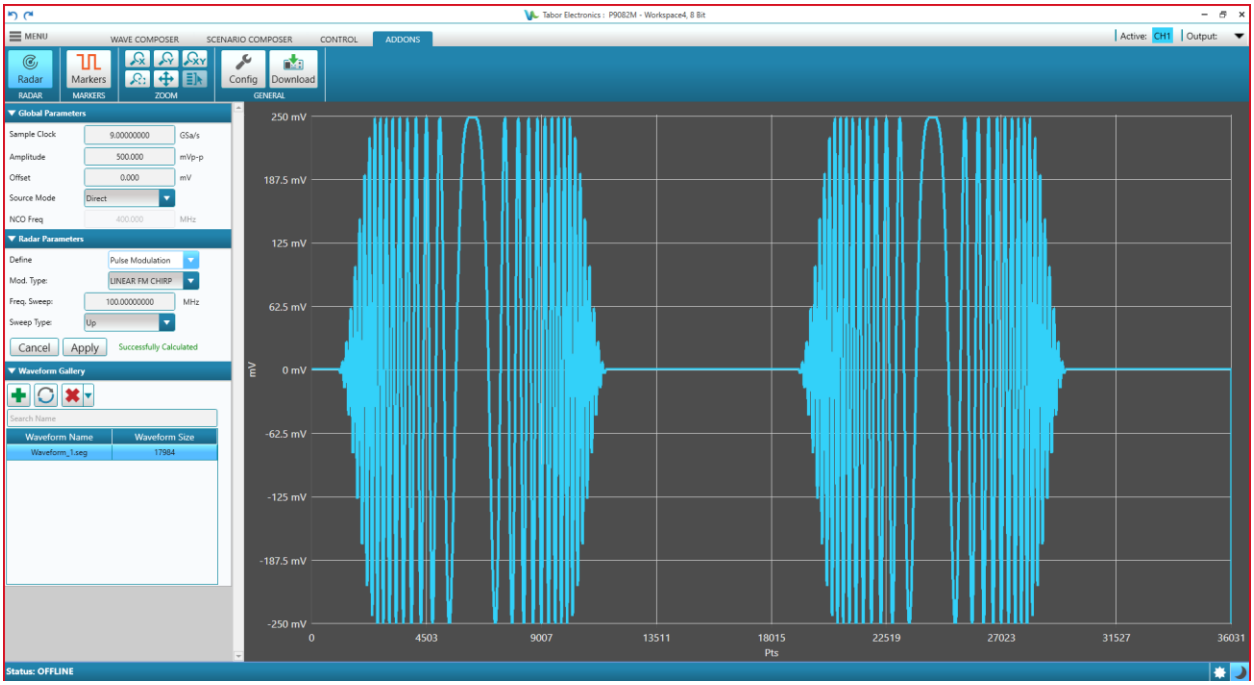


Figure 11.8 Baseband waveform (I component) for Linear FM Chirp Modulation

11.2 Marker for SE- and WX-Series

Refer to 8.1.5 Markers for SE- and WX-Series , page 81.

11.3 Config for SE- and WX-Series

Refer to 8.1.7.1 Config for SE- and WX-Series, page 86.

12 System

12.1 Info Proteus

Click the **SYSTEM** tab on the ribbon to invoke the control window and then click the **Info** button to display the Info pane. The Info pane shows all the HW and SW information about the device.

Figure 12.1 System Info TBD

- **Info** –
  - **Board Version** – HW board version, where XX denotes that the module is not installed.
    - <AB> – The version of the Analog-Base.
    - <AM> – The version of the Analog-Mezzanine.
    - <DB> – The version of the Digital-Base.
    - <DM> – The version of the Digital-Mezzanine.
    - <ADC> – The version of the ADC board.
  - **FPGA Version** – FPGA software version number.
  - **FPGA Build Ver.** – The build date and a consecutive number.
  - **FW Version** – The device FW version number.
    - Major version number (0-999).
    - Minor version number (0-999).
    - Release-type (alpha, beta, rc (release candidate), release).
    - Post-release number (0-99).
  - **FW Build Ver.** – The build date and a consecutive number.
  - **Chassis Slot Num.** – The chassis slot number for the device that is plugged into a PXIe chassis. Only for Proteus.

12.2 Info SE- and WX-Series

Click the **SYSTEM** tab on the ribbon to invoke the control window and then click the **Info** button to display the Info pane. The Info pane shows all the HW and SW information about the device.

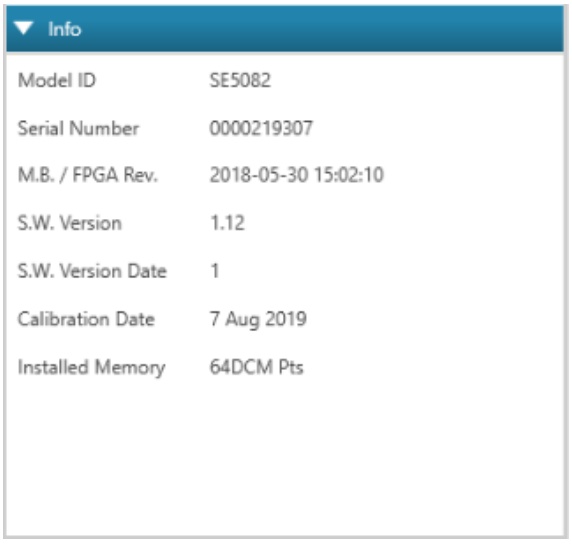


Figure 12.2 System Info SE- and WX-Series

- **Info** – Shows parameters that are stored in the device flash memory.
  - **Model ID** – The ordering information model name.
  - **Serial Number** – Instrument serial number.
  - **M.B. /FPGA Rev.** – Mother Board PCB revision/ FPGA revision.
  - **SW Version** – The device CPU software version number.
  - **SW Version Date** – The device CPU software build date.
  - **Calibration Date** – The date of the last calibration.
  - **Installed Memory –** Optional installed memory.

13 Appendix Equation Examples

13.1 Sweep

The sweep equation is:

amp*sin((2*pi/SCLK)*pt*(START_FREQ+(BANDWIDTH/(2*(SEG_LENGTH+1)))*pt))

The parameters are:

- **SCLK** – The sampling clock should always be as fast as possible for the best sweep resolution. Therefore, it is best to use max SCLK when possible. E.g., for the Proteus P2584M use 2.5GS/s= 2.5e9.
- **START_FREQ** – Start frequency. E.g., 500 MHz = 500e6.
- **BANDWIDTH** – Start frequency – stop frequency. E.g. 1 GHz – 500 MHz = 500 MHz = 500e6
- **SEG_LENGTH** – Segment length = SCLK * sweep duration. E.g. with 10µs sweep duration and 2.5GS; 2.5e9 * 10e-6 = 25,000.

> **Note**
> - The P2584M has a segment resolution of 32 points. Hence, the WDS will round the segment size to 24992 which is divisible by 32.

To generate the frequency sweep with the Equation Editor, enter the following equation, click Apply, and then check Scaling.

amp*sin((2*pi/2.5e9)*pt*(500e6+(500e6/(2*(24992+1)))*pt))

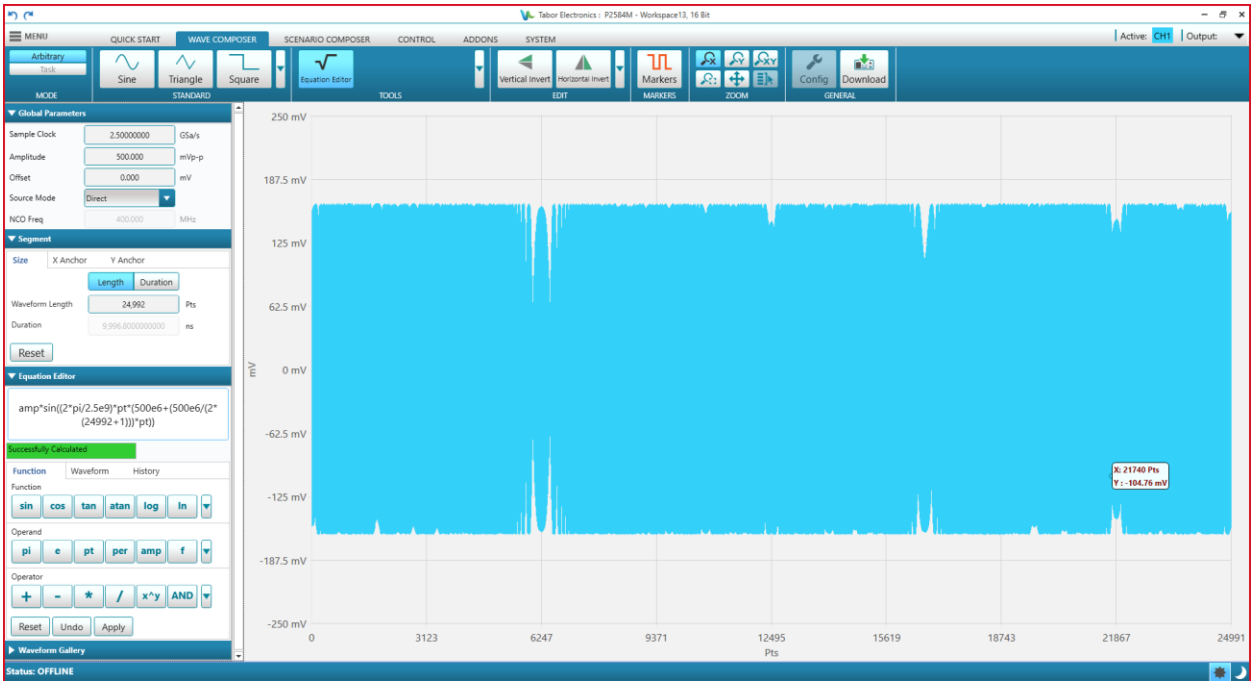


Figure 13.1 Equation Editor – Sweep

13.2 Horizontal Line

To generate a horizontal line that runs parallel to the X-axis with the Equation Editor enter the following equation, click Apply, and then check Scaling..

```
1000
```

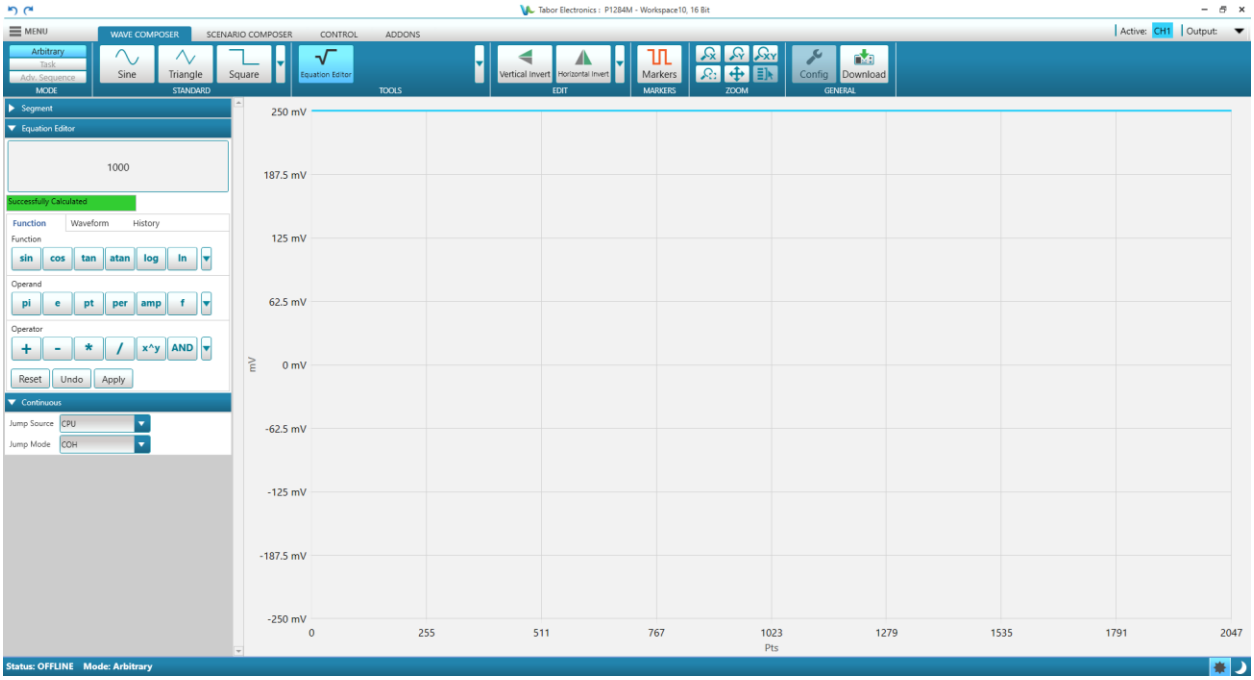


Figure 13.2 Equation Editor – Horizontal Line

13.3 Downslope Line that Slopes Down

To generate a downslope line with the Equation Editor, enter the following equation, click Apply, and then check Scaling.

```
2000-2*pt
```

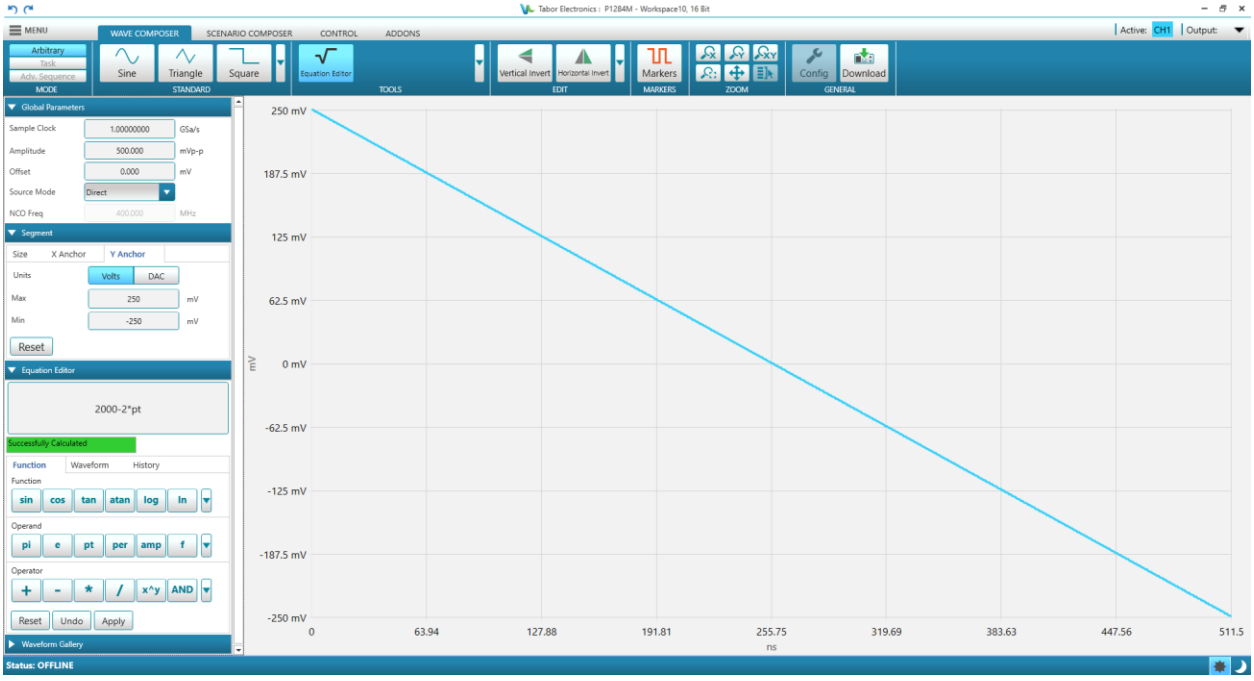


Figure 13.3 Equation Editor – Downslope

13.4 10 Sine Waves

To generate 10 sine waves, enter the following equation, and then click Apply.

```
sin(10*w*pt)
```

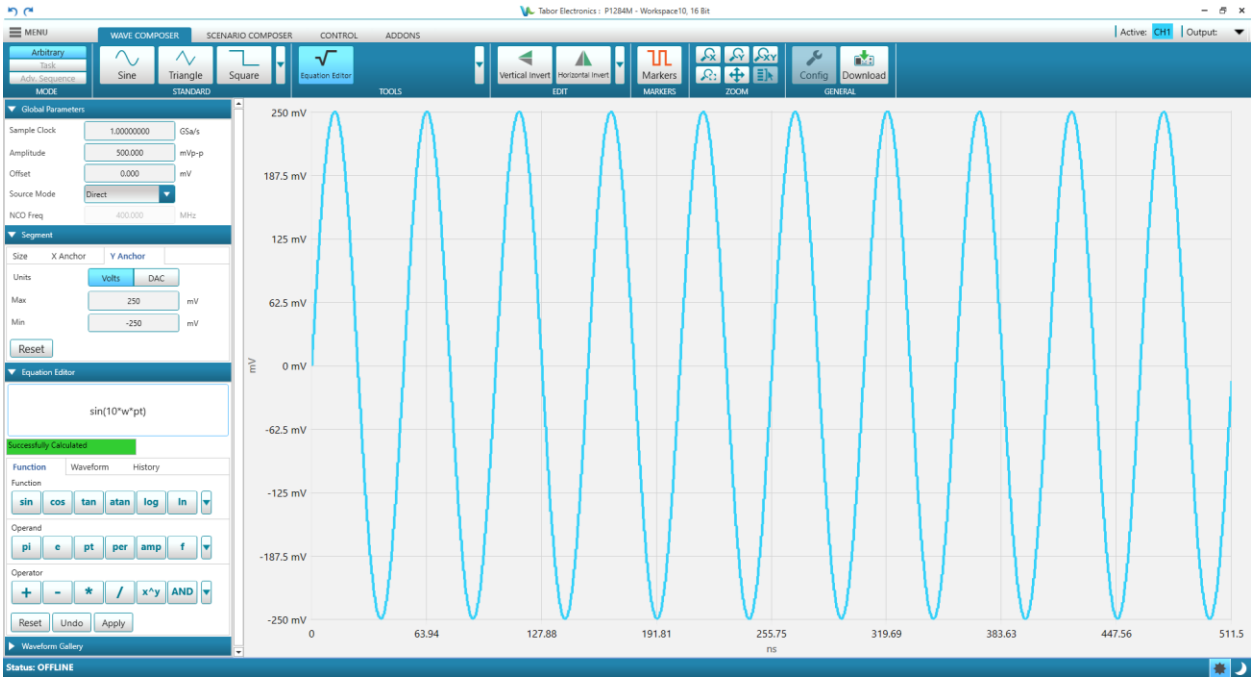


Figure 13.4 Equation Editor – 10 Sine Waves

13.5 Downslope 10 Sine Waves

To generate a downslope 10 sine waves, enter the following equation, and then click Apply.

```
1200*sin(10*w*pt)-8*pt+4000
```

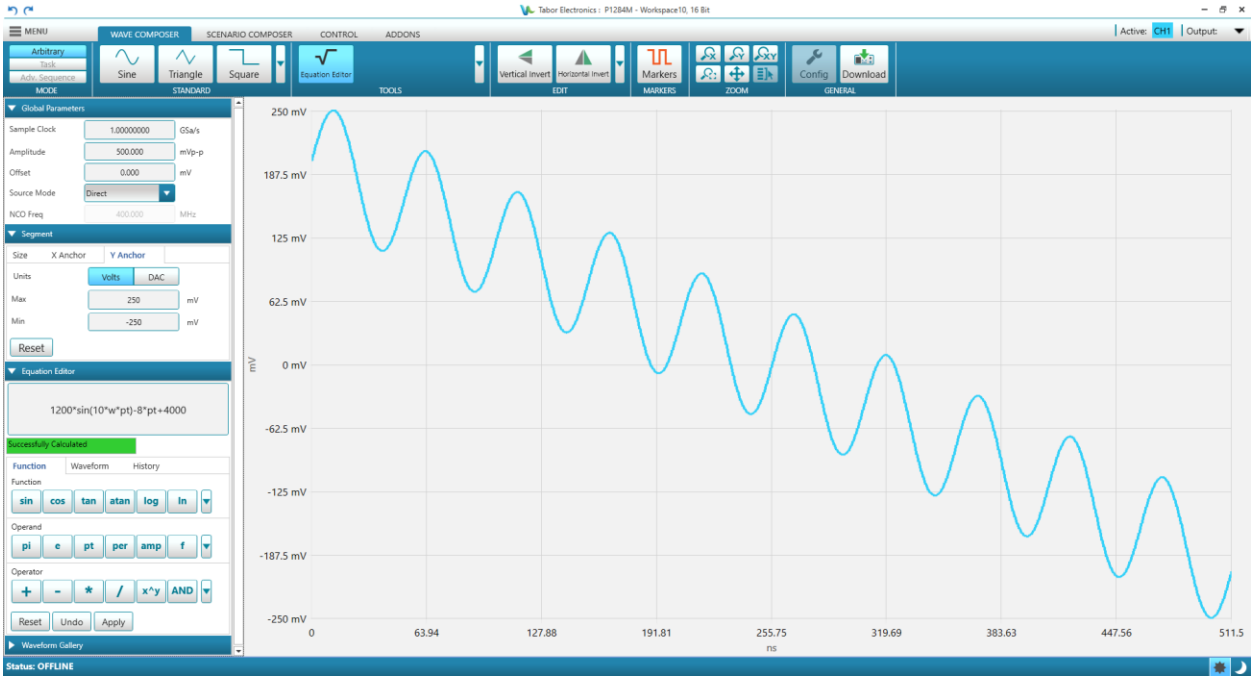


Figure 13.5 Equation Editor – Downslope 10 Sine Waves

13.6 Two Waves Modulation

To generate modulate two waves with different periods and different start phase enter the following equation, and then click Apply.

```
1200*sin(w*pt)*cos(30*w*pt)
```

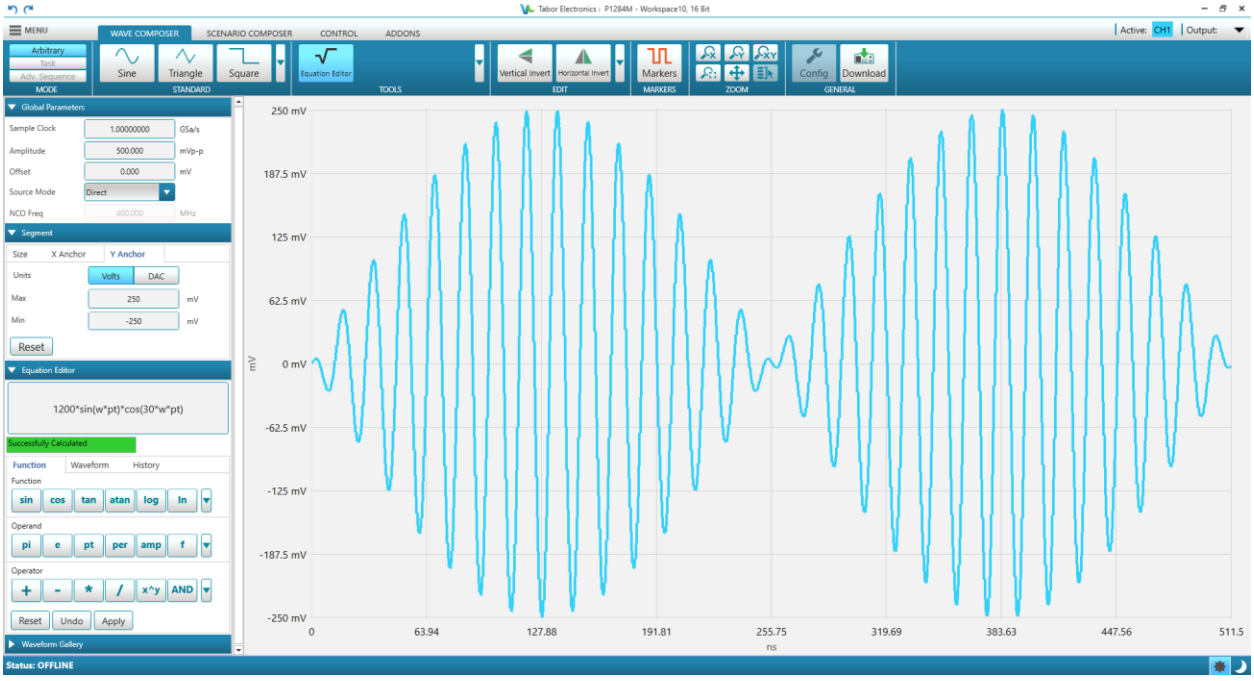


Figure 13.6 Equation Editor – Two Waves Modulation

13.7 Sine Wave

To generate a sine wave, enter the following equation, and then click Apply.

```
sin(w*pt)
```

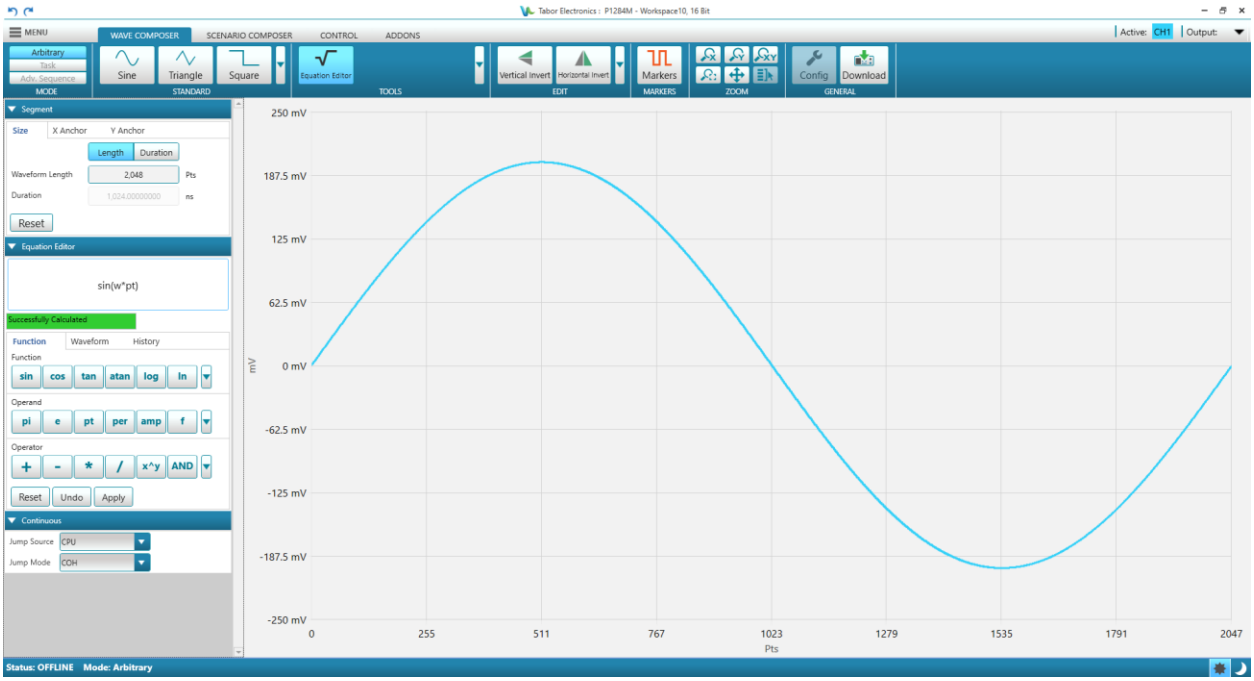


Figure 13.7 Equation Editor – Sine Wave

13.8 Sine Wave with 20% Harmonic Distortion

In this 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 20% second harmonic is equivalent to 4800 points. The frequency of the second harmonic is obviously double that of the fundamental, so term +4800*sin(2*w*pt) is added to the original sine wave equation. Enter the following equation and then click Apply.

```
24000*sin(w*pt)+4800*sin(2*w*pt)
```

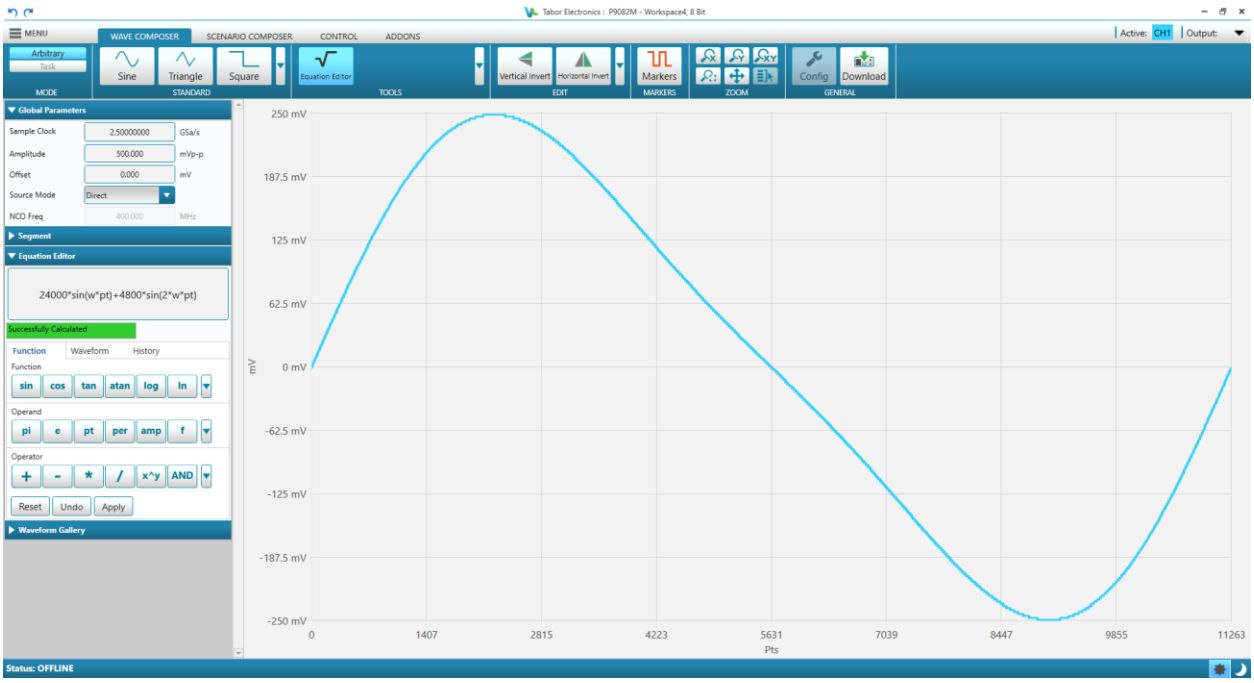


Figure 13.8 Equation Editor – Sine Wave with 20% Second Harmonic Distortion

13.9 Sine Wave with Exponentially Decay

In this example 10 cycles of a sinewave is 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 (250 in this case) will slow down the rate of decay.

```
12000*sin(10*w*pt)*e^(-pt/250)
```

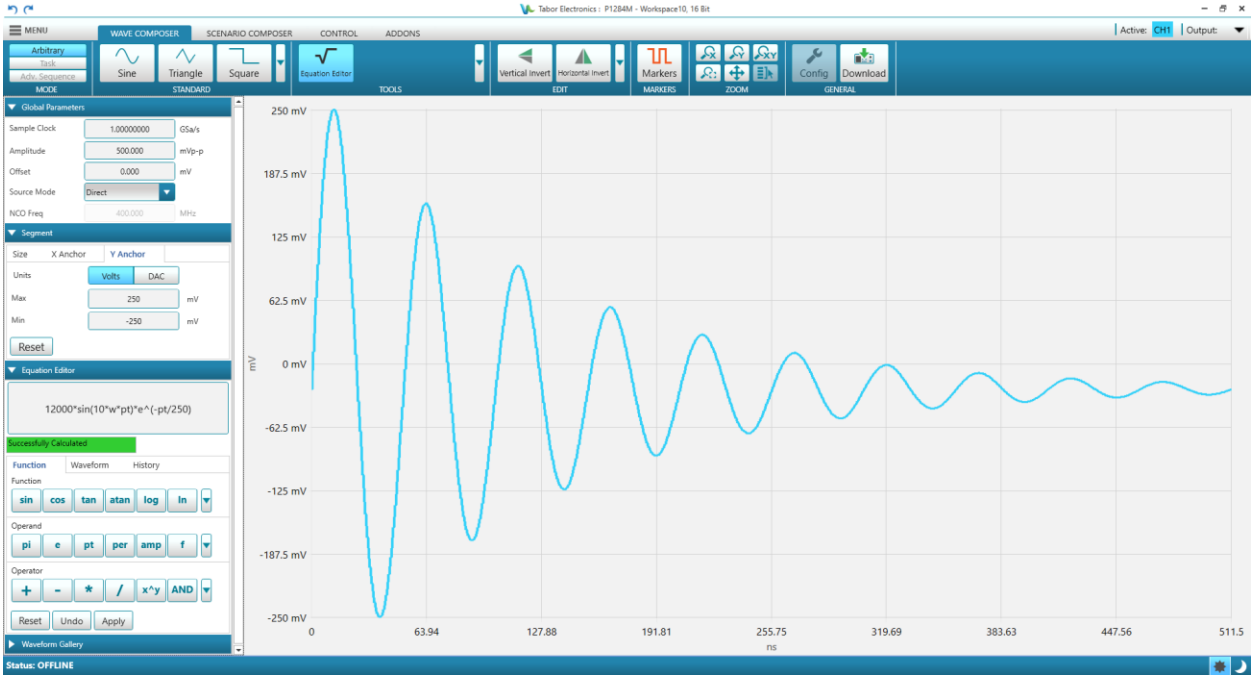


Figure 13.9 Equation Editor – Sine Wave with Exponentially Decay

13.10 100 Cycles Sine Wave with Amplitude Modulation

In this example 100 cycles of a sine wave are amplitude modulated with 10 cycles of a 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 1200*cos(110*w*pt) and the lower sideband by the term 1200*cos(90*w*pt).

```
6000*sin(100*w*pt)+1200*cos(110*w*pt)-1200*cos(90*w*pt)
```

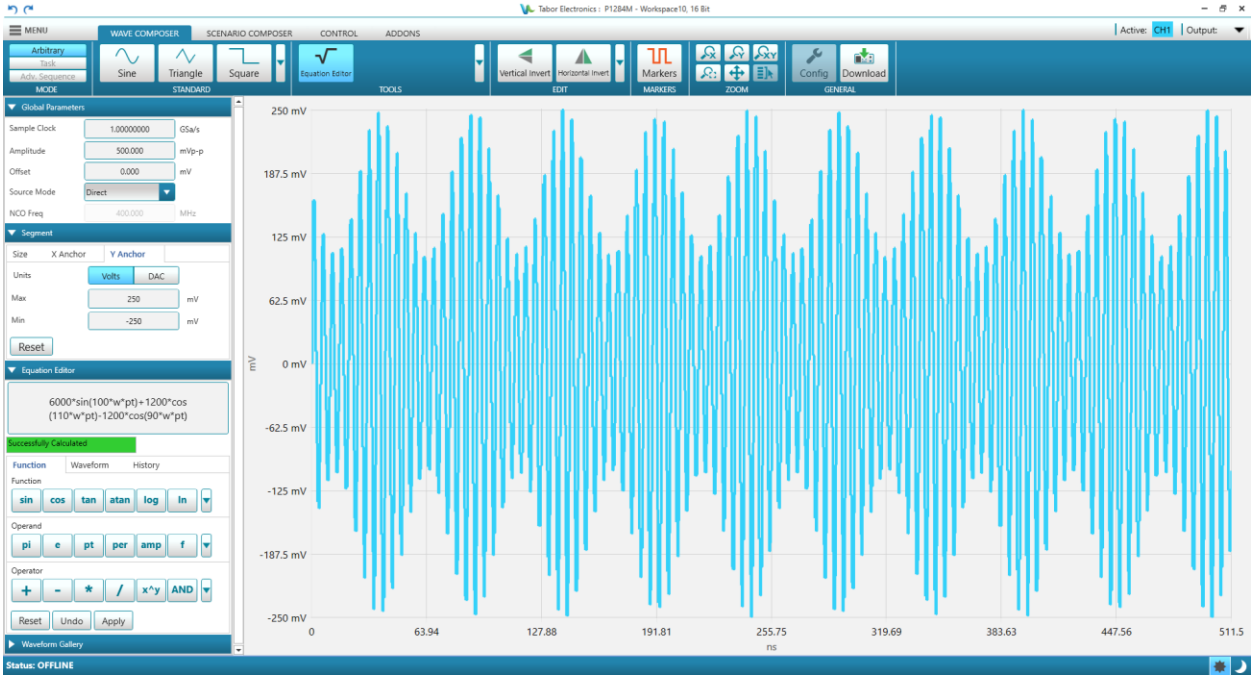


Figure 13.10 Equation Editor – 100 Cycles Sine Wave with Amplitude Modulation

13.11 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 *.seg extension.

The following steps demonstrate how to create, store, and combine waveforms.

1. In the COMPOSER click the **Sine** button and the **Apply** in the Waveform Parameters pane to display a sine wave in the Composer screen.
2. Click the  button in the Waveform Gallery to add the wave to the gallery.
3. Click the MENU and select **Export** > **Current Waveform** and save the wave as sine.seg.
4. In the COMPOSER click the **Noise** button and the **Apply** in the Waveform Parameters pane to display a noise wave in the Composer screen.
5. Click the  button in the Waveform Gallery to add the wave to the gallery.
6. Click the MENU and select **Export** > **Current Waveform** and save the wave as noise.seg.
7. Click the **Equation Editor**.
8. Click **Import Wave** in the Equation Editor pane and select both noise.seg and sine.seg.
9. Write the following equation:

```
sine.seg*sin(5*w*pt)+noise.seg/10
```

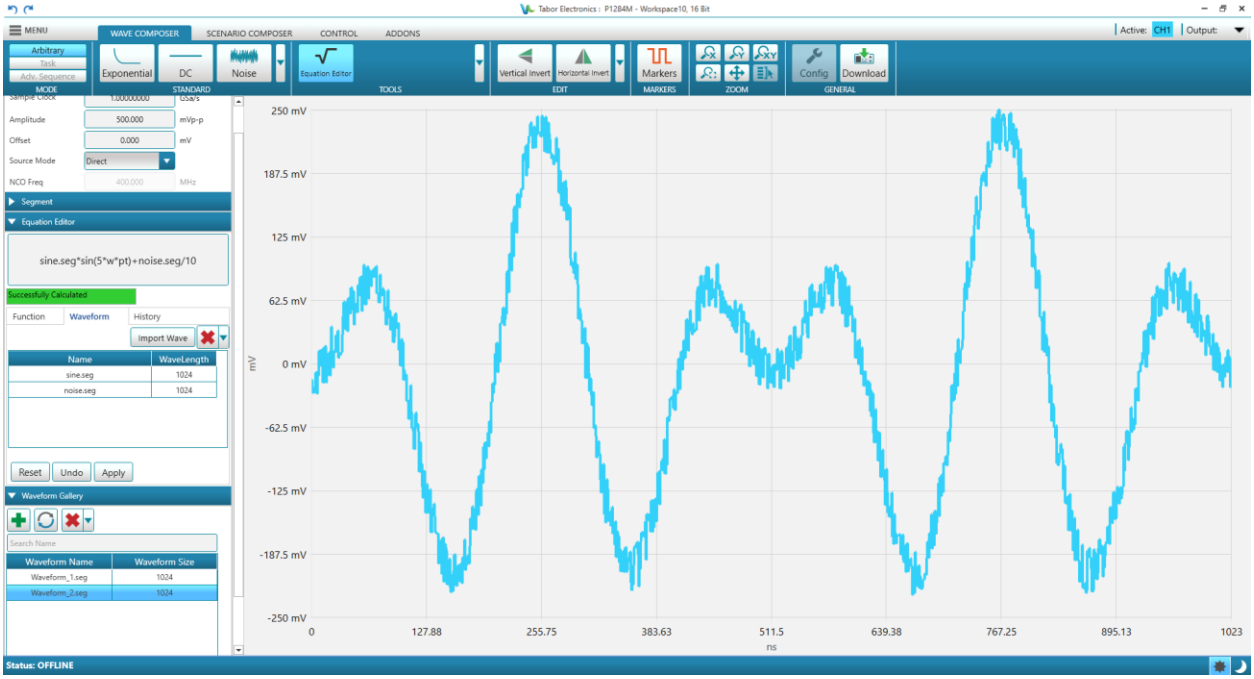


Figure 13.11 Equation Editor – Combining Waveforms

14 Appendix Radar Waveform Definition Files

Radar Waveform Definition Files can be downloaded from the Tabor website at www.taborelec.com/downloads.

14.1 Radar_Waveform_Definition_File_Template_Rev._1.0.txt

This file is an introduction to writing radar waveform definition files. It explains the syntax and lists all the keywords, options, and parameters.

```
! The character "!" starts the comment section till the end of the line
! Any keyword and field can be separated by any number of spaces, "=", tabs, ",",
";", or ":"
! Uppercase and lowercase characters are accepted even within the same keyword
! Keywords without the corresponding parameter does not change the default value for
that setting
! The number of pulse sections must be aligned with the NUMOFPULSES argument

! Header
CFREQ =            1.0E+10      !Carrier Frequency (in Hz)
OFREQ =            1.0E+09      !Offset Frequency (in Hz)
DELAY =            0.0          !Delay (in s)
SPECTRUMREV        NO           !Reverse Spectrum (YES = Reversed, NO = Straight)
GENIQ              NO           !Generate IQ (YES = BB, NO = RF)
COHERENT           YES          !Carrier Coherence (YES, NO)
NOISEGEN           YES          !Add noise (YES, NO)
NOISERMS =         .01          !Noise rms amplitude (relative value)
NOISEBW =          1.0E+09;     !Noise Baseband Bandwidth (in Hz), RF noise BW = 2 x
NOISEBW
NUMOFPULSES =      2            !Total number of pulses
STARTT =           0.0          !Start Time (in s)
DEADT =            1.0E-06      !Dead Time (in s), it overwrites the PRI parameter
for the last pulse

! Pulse #1
PULSE                           !Keyword to start a new pulse section
PWIDTH =           1.0E-06      !Pulse Width (in s)
PRI =              2.0E-06      !Pulse Repetition Interval (in s)
WIDTHRESHOLD =     50           !Threshold to measure Pulse Width (0 = 0%, 50 = 50%,
100 = 100%)
AMPL =             1.0          !Pulse relative amplitude (in arbitrary units)
PHASE =            0.0          !Pulse relative phase to carrier (in sexagesimal
degrees)
OFREQ =            -2.0E+09     !Offset Frequency respect to carrier (in Hz)
APPLYOFREQ         YES          !Apply Offset Frequency (YES, NO)
SPECTRUMREV        NO           !Reverse Spectrum (YES = Reversed, NO = Straight)
PSHAPE             TRAPEZE      !Pulse Shape (RECTANG, TRAPEZE, RAISEDCOSINE)
RTIME =            1.0E-08      !Rise Time (in s)
FTIME =            1.0E-08      !Fall Tine (in s)
EDGETHRESHOLD      10/90        !Thresholds for edge time definition (0/100 or 0100,
10/90 or 1090, 20/80 or 2080)
```

```
MODULATION          LINEARFM     !Modulation Scheme (NONE, LINEARFM, NONLINEARFM,
STEPFM, MFSK, BARKER, FRANK, P1, P2, P3, P4, POLYPHASE)
SWEEPF =            2E+09        !Sweep frequency (in Hz)
MFSKOFFSET =        200.0E+03    !Frequency offset for MFSK modulation (in Hz)
SWEEPDIR =          UP           !Sweep direction (UP, DOWN, UPDOWN, DOWNUP)
STEPF =             2.5E+08      !Step Frequency increment (in Hz)
NUMOFSTEPS =        4            !Number of steps for STEPFM modulation
BARKERCODE =        13           !Barker Code (2, 4, 4BIS, 5, 7, 11, 13, -2, -4, -
4BIS, -5, -7, -11, -13)
FRANKCODE =         5            !Frank Code (1, 2, 3, 4, 5, 6, 7, 8, 9, 10)
P1CODE =            4            !P1 Code (1, 2, 3, 4, 5, 6, 7, 8, 9, 10)
P2CODE =            6            !P2 Code (1, 2, 3, 4, 5, 6, 7, 8, 9, 10)
P3CODE =            8            !P3 Code (1, 2, 3, 4, 5, 6, 7, 8, 9, 10)
P4CODE =            10           !P4 Code (1, 2, 3, 4, 5, 6, 7, 8, 9, 10)
POLYPHASECHIPS      -30, 0, 120, 45, 36       !Phase (in degrees) for chips for
POLYPHASE modulation scheme, any number of chips
FMPOLYNOMIAL        0.0, 1.0E+18, -2.0E+11    !Polynomial coefficients for NONLINEARFM
modulation scheme (f(t), t=0=Center of pulse), order zero first

! Pulse #2
PULSE                       !Keyword to start a new pulse section
Pwidth =                    1.5E-06
PRI =                       10.0E-06
OFreq =                     0.0
PShape                      RaisedCosine
RTime =                     1.0E-08
FTime =                     2.0E-08
EdgeThreshold               20/80
Modulation                  Polyphase
PolyphaseChips              -30, 0, 120, 45, 36
```

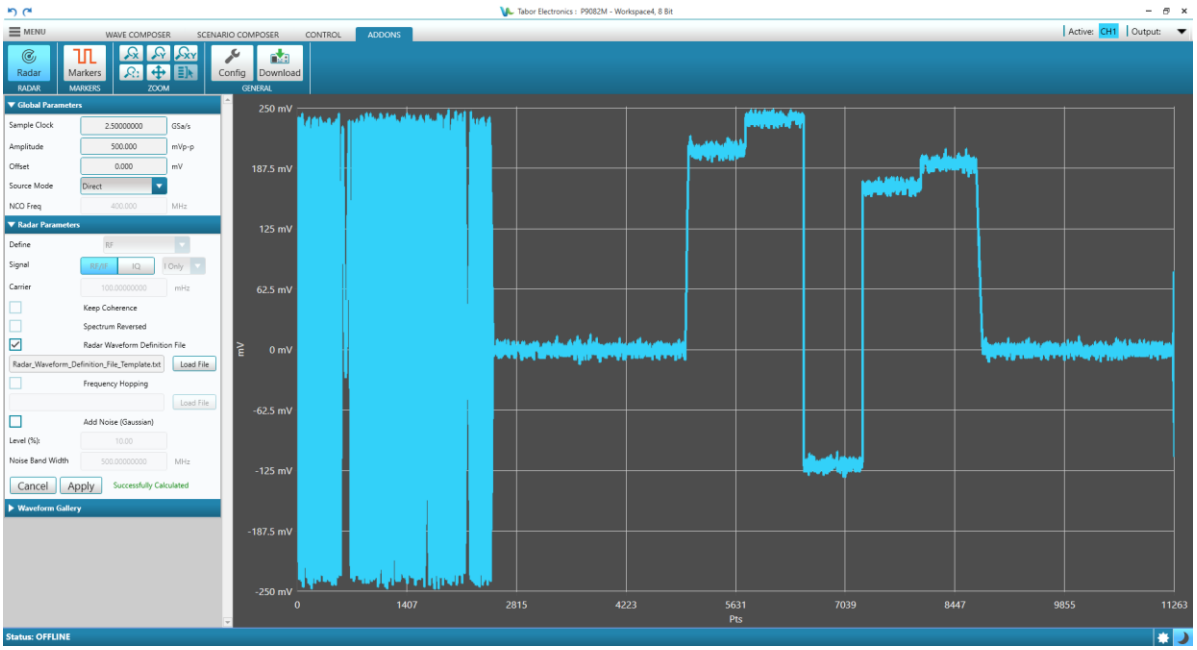


Figure 14.1 Radar_Waveform_Definition_File_Template.txt

14.2 Radar_Waveform_Definition_File_Example_1_Rev._1.0.txt

This file produces a sequence of four similar RF pulses with different intra-pulse modulations.

```
CFREQ 1.0E+10
GENIQ NO
NUMOFPULSES 4
DEADT 9.0E-06

! Pulse #1
PULSE
PWIDTH 1.0E-06
PRI 1.0E-05
OFREQ 0.0
APPLYOFREQ YES
PSHAPE TRAPEZE
RTIME 1.0E-08
FTIME 1.0E-08
MODULATION LINEARFM
SWEEPF 4.0E+09
SWEEPDIR UP

! Pulse #2
PULSE
PWIDTH 1.0E-06
PRI 1.0E-05
OFREQ 0.0
APPLYOFREQ YES
PSHAPE TRAPEZE
RTIME 1.0E-08
FTIME 1.0E-08
MODULATION LINEARFM
SWEEPF 4.0E+09
SWEEPDIR DOWN

! Pulse #3
PULSE
PWIDTH 1.0E-06
PRI 1.0E-05
OFREQ 0.0
APPLYOFREQ YES
PSHAPE TRAPEZE
RTIME 1.0E-08
FTIME 1.0E-08
MODULATION FRANK
FRANKCODE 5

! Pulse #4
PULSE
PWIDTH 1.0E-06
PRI 1.0E-05
OFREQ 0.0
APPLYOFREQ YES
```

```
PSHAPE RAISEDCOS
RTIME 1.0E-09
FTIME 1.0E-09
MODULATION BARKER
BARKERCODE 13
!MODULATION POLYPHASE
!POLYPHASECHIPS 0, 0, 30, -30, 60, -60, 90, -90 ! Commas are optional
```

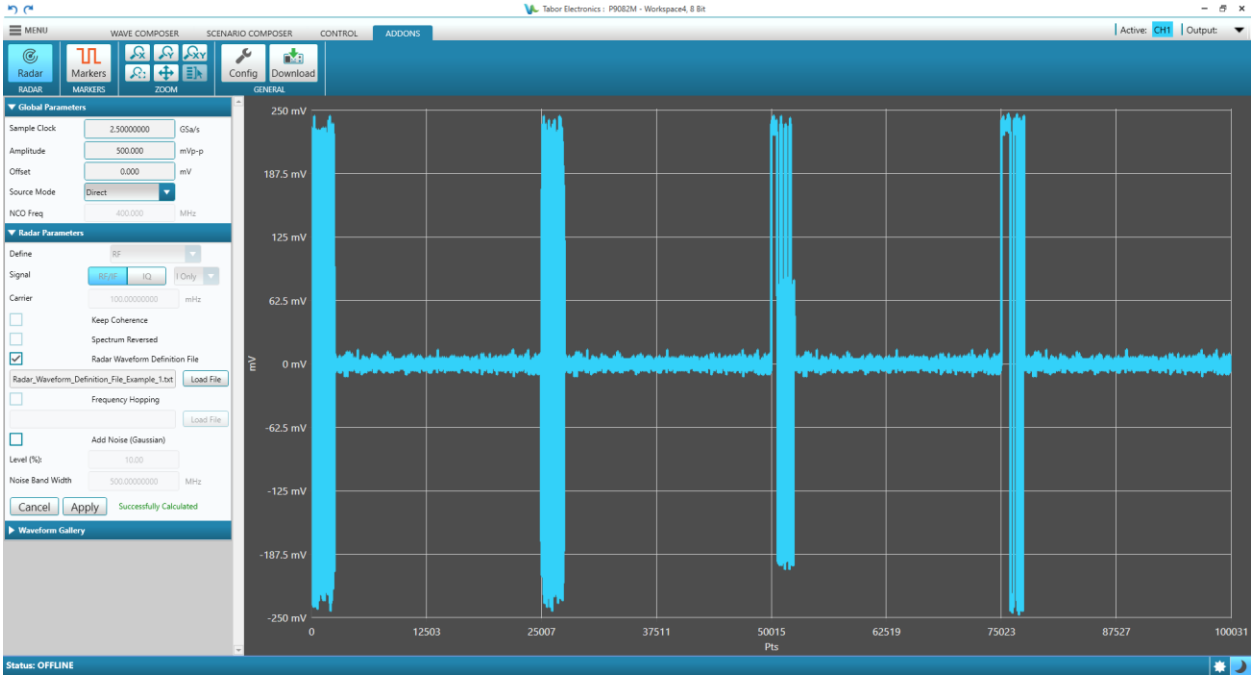


Figure 14.2 Radar_Waveform_Definition_File_Example_1.txt

14.3 Radar_Waveform_Definition_File_Example_2_Rev._1.0

This file produces a sequence of three different pulses with Linear FM intra-pulse modulation.

```
CFREQ 1.0E+10       !Carrier Frequency (in Hz)
OFREQ 1.0E+10       !Offset Frequency (in Hz)
DELAY 0.0           !Delay (in s)
SPECTRUMREV NO      !Reverse Spectrum (YES = Reversed, NO = Straight)
GENIQ NO            !Generate IQ (YES = BB, NO = RF)
COHERENT            !Carrier Coherence (YES, NO)
NUMOFPULSES 3       !Total number of pulses
STARTT 0.0          !Start Time (in s)
DEADT 1.0E-06       !Dead Time (in s)

! Pulse #1
PULSE               !Keyword to start a new pulse section
PWIDTH 1.0E-06      !Pulse Width (in s)
PRI 2.0E-06         !Pulse Repetition Interval (in s)
WTHRESHOLD 50       !Threshold to measure Pulse Width (0 = 0%, 50 = 50%, 100 = 100%)
AMPL 1.0            !Pulse relative amplitude (in arbitrary units)
PHASE 0.0           !Pulse relative phase to carrier (in sexagesimal degrees)
OFREQ -2.0E+09      !Offset Frequency respect to carrier (in Hz)
```

```
APPLYOFREQ YES     !Apply Offset Frequency (YES, NO)
SPECTRUMREV NO     !Reverse Spectrum (YES = Reversed, NO = Straight)
PSHAPE TRAPEZE     !Pulse Shape (
RTIME 1.0E-08
FTIME 1.0E-08
MODULATION LINEARFM
SWEEPF 2E+09
SWEEPDIR UP

! Pulse #2
PULSE
PWIDTH 2.0E-06
PRI 4.0E-06
OFREQ 2.0E+09
APPLYOFREQ YES
PSHAPE TRAPEZE
RTIME 1.0E-08
FTIME 1.0E-08
MODULATION LINEARFM
SWEEPF 1E+09
SWEEPDIR UP

! Pulse #3
PULSE
PWIDTH 4.0E-06
PRI 6.0E-06
OFREQ 2.0E+09
APPLYOFREQ YES
PSHAPE TRAPEZE
RTIME 1.0E-08
FTIME 1.0E-08
MODULATION LINEARFM
SWEEPF 1E+09
SWEEPDIR UP
```

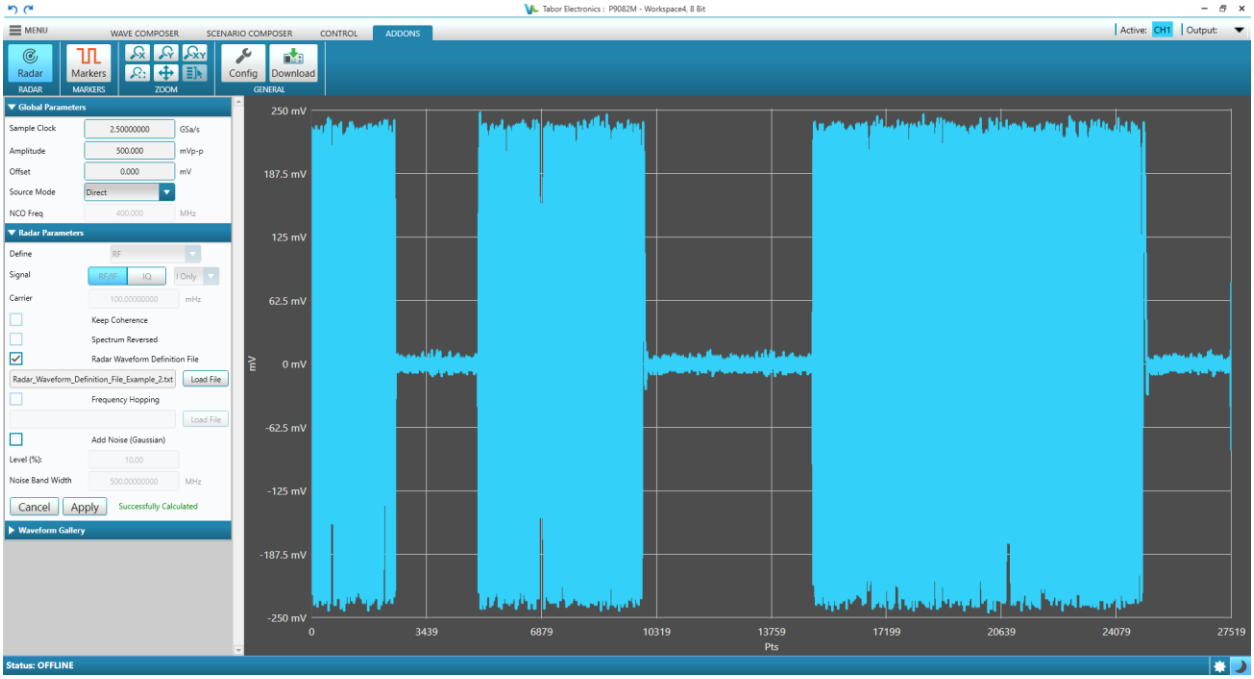


Figure 14.3 Radar_Waveform_Definition_File_Example_2.txt

14.4 Radar_Waveform_Definition_File_Frequency_Hopping_Rev._1.0.csv

This comma-delimited (.csv) file produces 8 frequency hops in a cyclic way for pulses, i.e., the 9th pulse will have frequency hop number 1. The numbers in the file specify the shift frequency respect to the carrier or each successive pulse. Baseband (IQ) waveforms will be also shifted by applying the corresponding rotation. In the example below the first hop has will reduce the carrier frequency with -10MHz, the second hop with no changes, and etc.

```
HOPS 8
-1.00E+07
0
1.00E+07
2.00E+07
1.00E+07
0
-1.00E+07
-2.00E+07
```

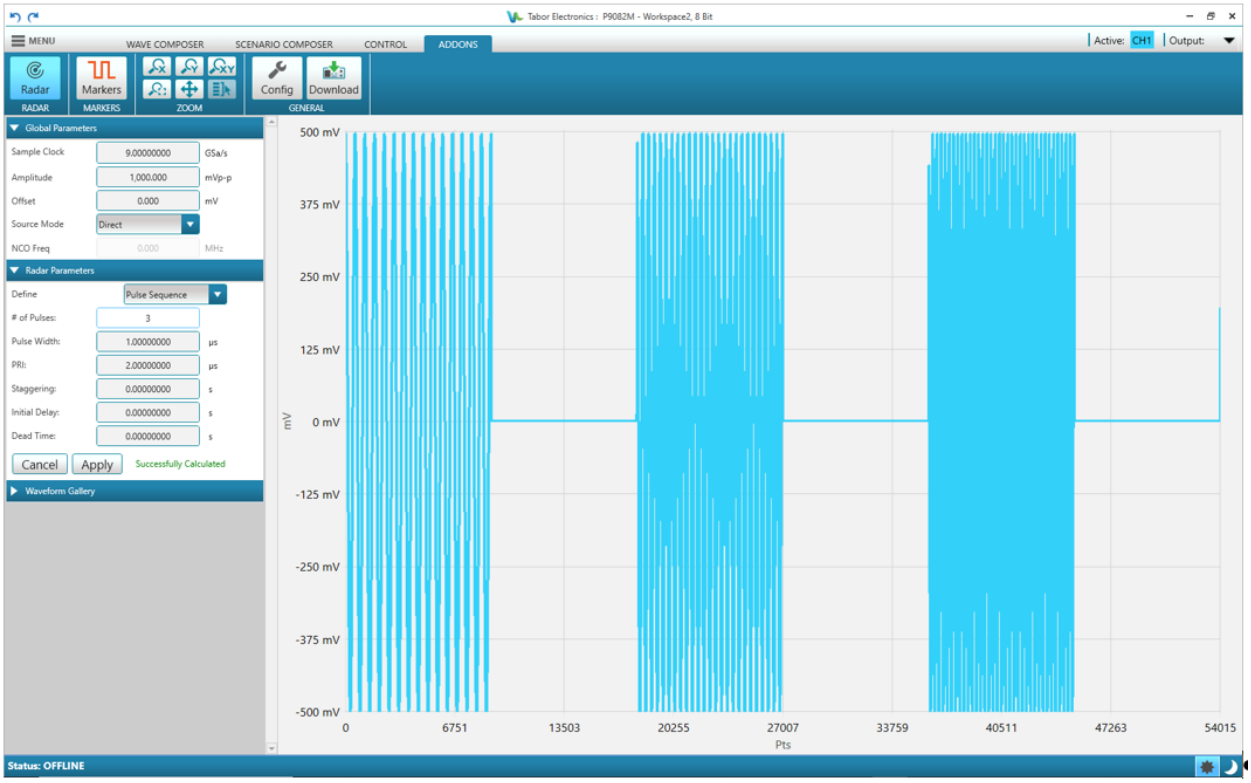


Figure 14.4 Radar_Waveform_Definition_File_Frequency_Hopping.csv

15 Appendix FPGA Firmware Update

The Proteus series models comes with a powerful FPGA (Field-Programmable Gate Arrays). In order to update the FPGA, you should download the Proteus FW (Firmware) file e.g. “PROTEUS_FPGA_FWVer_1.12.zip”, and the FPGA update tool “Tabor Electronics Update Tool Setup – x.y.z” from the Tabor Electronics website at http://www.taborelec.com/downloads.

Notes

- This appendix is applicable for all Tabor instruments. The examples are using Lucid, but it is interchangeable with any Tabor instrument.
- The device drivers provided by the WDS installation shall be installed before installing the TE Update Tool.
- Verify the HW board version of Proteus, e.g. D, E or F, and download the correct FW version.
- Verify the version of the FPGA firmware installed on the device is older than the version on the Tabor website. Refer to Figure 12.1 System Info, page 123.The TE Update Tool does also display the FPGA FW version.

15.1 TE Update Tool Installation

1. Locate the “Tabor Electronics Update Tool Setup – x.y.z.exe” installation file on the supplied CD or in the destination folder to which it was downloaded.

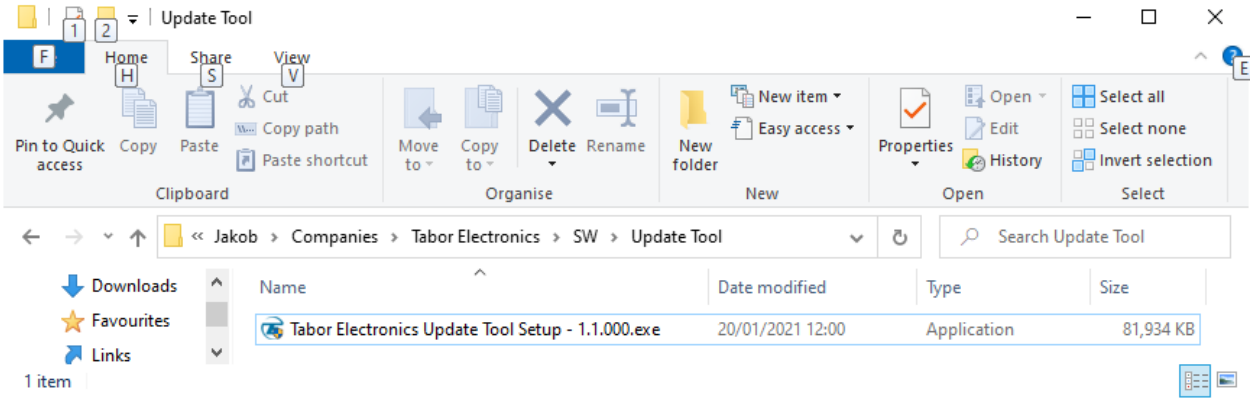


Figure 15.1 TE Update Tool Installation File

2. Double-click the **Tabor Electronics Update Tool Setup – x.y.z.exe** installation file.
3. A windows User Account Control confirmation window is displayed.

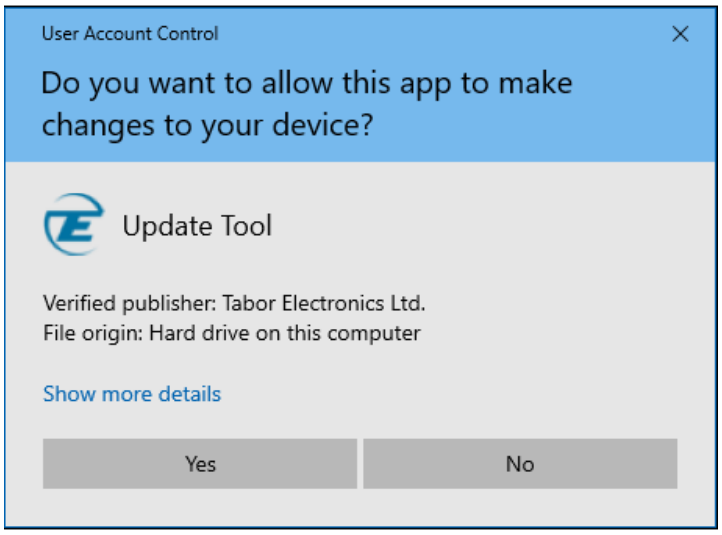


Figure 15.2 User Account Control

4. Click the **YES** button.
5. The welcome screen is displayed.

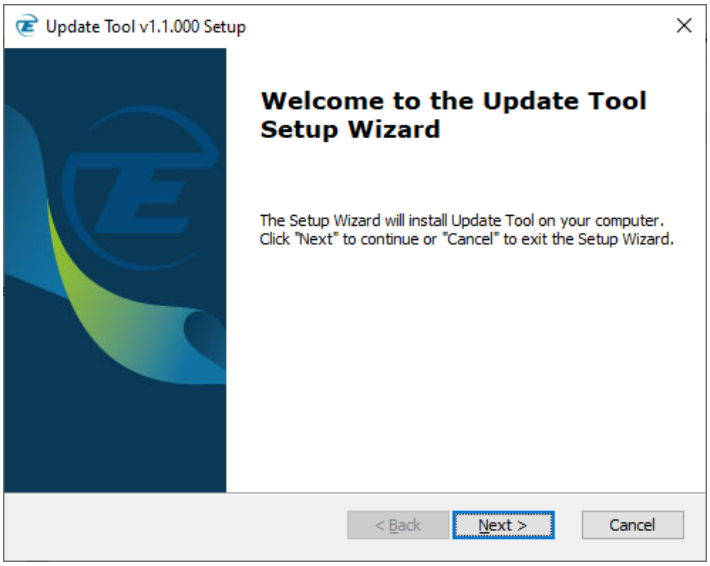


Figure 15.3 Welcome to the Update Tool Setup Wizard

6. Click **Next.**

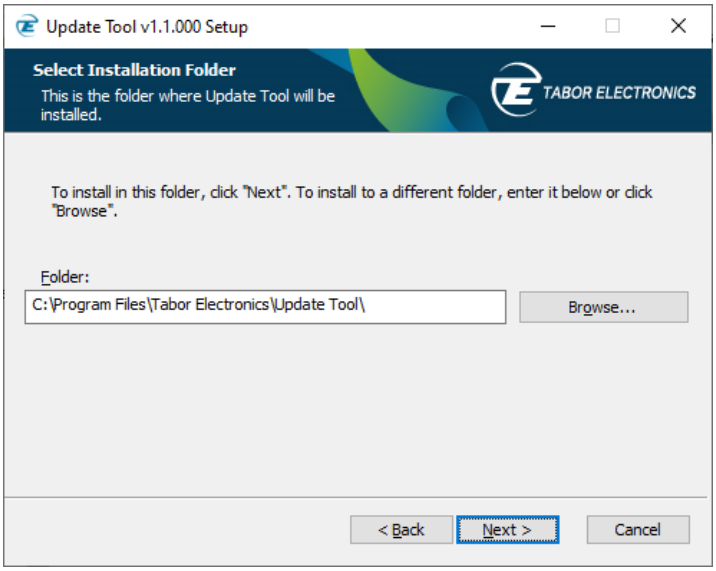


Figure 15.4 Select Installation Folder

7. Enter the destination directory for the **Update Tool** software or browse to a destination directory by clicking the **Browse** button.

8. Click the **Next** button.
   The **Ready to Install** screen is displayed.

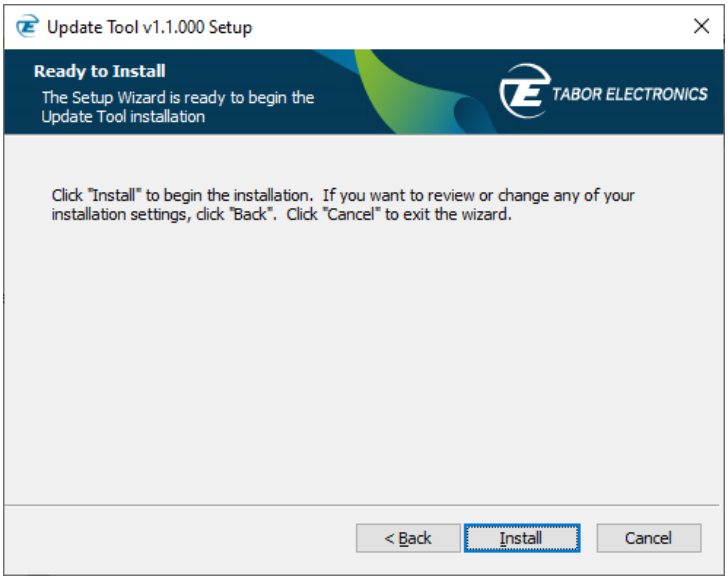


Figure 15.5 Ready to Install

9. Click the **Install** button.

10. The **Update Tool** software installation starts.

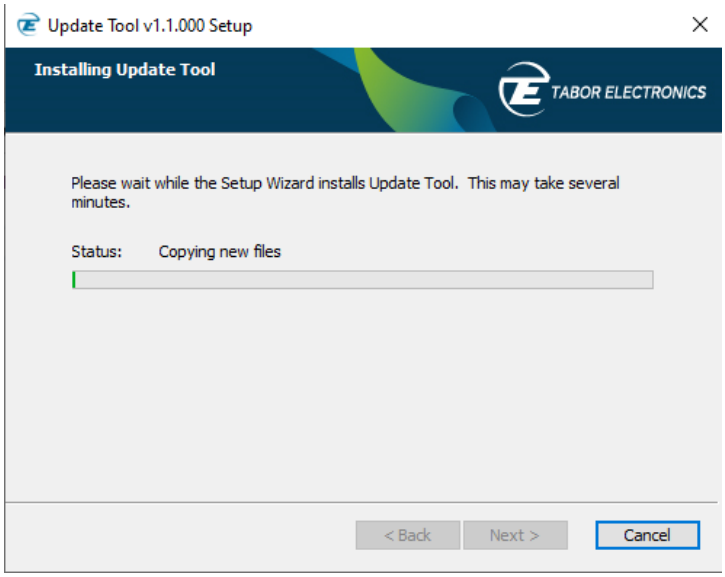


Figure 15.6 Installing Update Tool

11. Wait for the installation process to complete.
    The **Installation Complete** window is displayed.

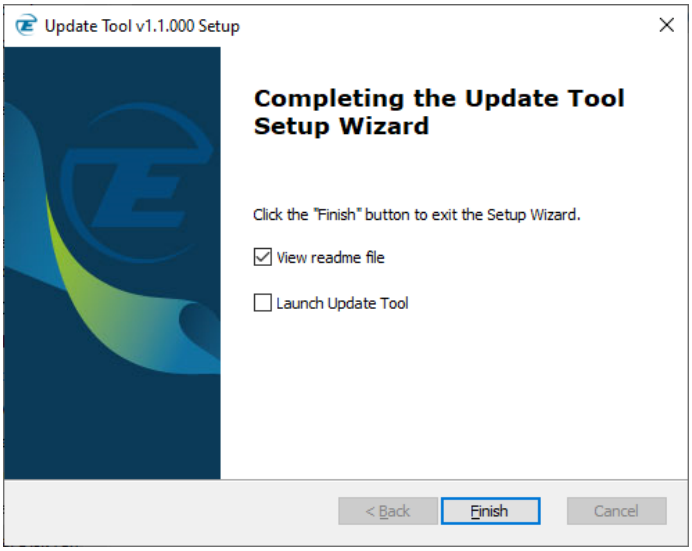


Figure 15.7 Completing the Update Tool Setup Wizard

12. Click the **Finish** button to finish the software installation process.

15.2 TE Update Tool

Double-click the TE Update Tool shortcut on the desktop  .

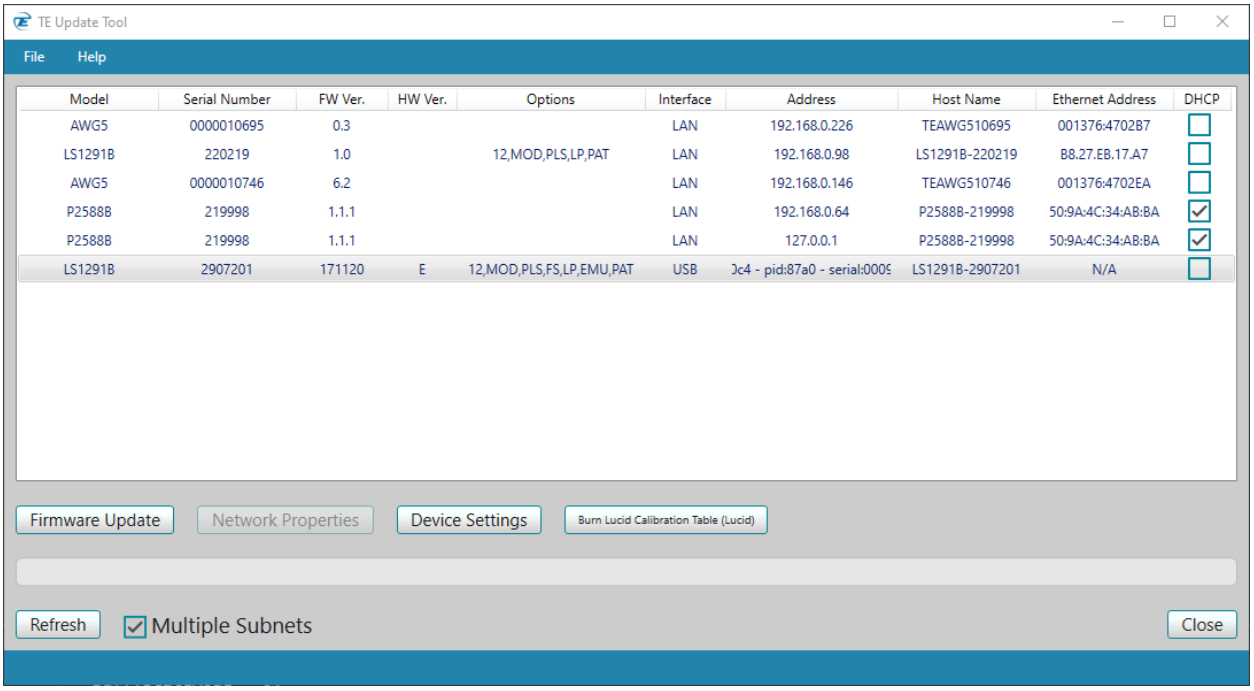


Figure 15.8 TE Update Tool

- **File** –Click the button to display a drop list.
  - **Open Connection** – Enter the IP address of the device you want to update.

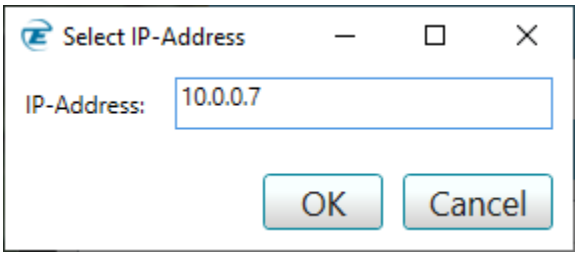


Figure 15.9 Select the IP-Address

  - **Exit** – Exit the TE Update Tool.
- **Help** – Click the button to display a drop list.
  - **About** – Display the application version.

Figure 15.10 About TE Update Tool

- **Model** – The ordering model name.
- **Serial Number** – The serial number of the generator.
- **FW Ver.** – The FPGA firmware version.
- **HW Ver**. – The device hardware board version.
- **Options** – The options available in the generator.
- **Interface** – active communication interface.
  - USB
  - HID TBD (Lucid Benchtop only, no support for updating the FPGA via HID/USB)
  - LAN
- **Address** – IP or USB physical address. For USB, the following parameters are displayed:
  - **vid** – vendor ID.
  - **pid** – product ID.
  - **serial** – a unique serial string programmed at the factory and used to distinguish between devices.
- **Host Name** – The model name and serial number. For older Tabor devices such as WW, WX, SE it is the "model name – 47" + last 4 digits of the serial number in HEX.
- **Ethernet Address** – The device MAC address.
- **DHCP** – Dynamic Host Configuration Protocol.
  - **Fixed** – Define a static IP Address. Verify that the PC running Lucid software is on the same network (default).
  - **Dynamic** – Get an IP address from the DHCP server. The IP Address, Port and Subnet Mask fields are not accessible.
- **Firmware Update** – Click the button to update the selected device's FPGA firmware.

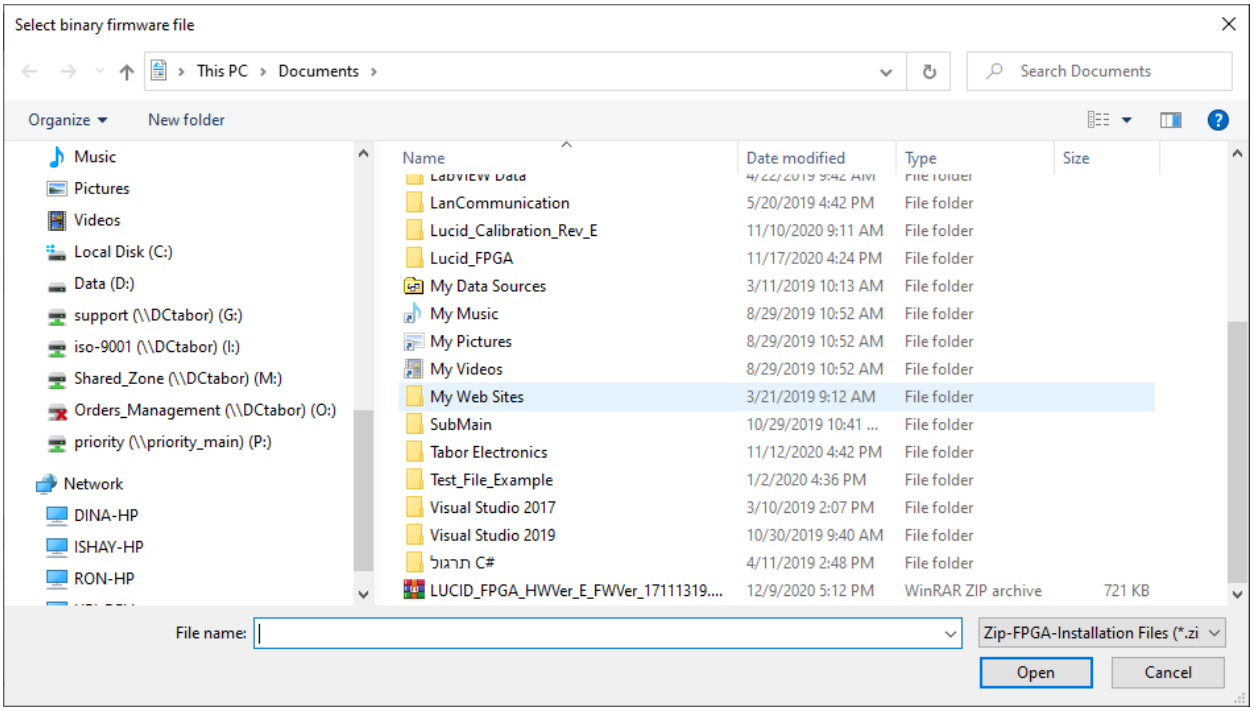


Figure 15.11 Select binary firmware file

- **Network Properties** – Click the button to change selected device's IP parameters.

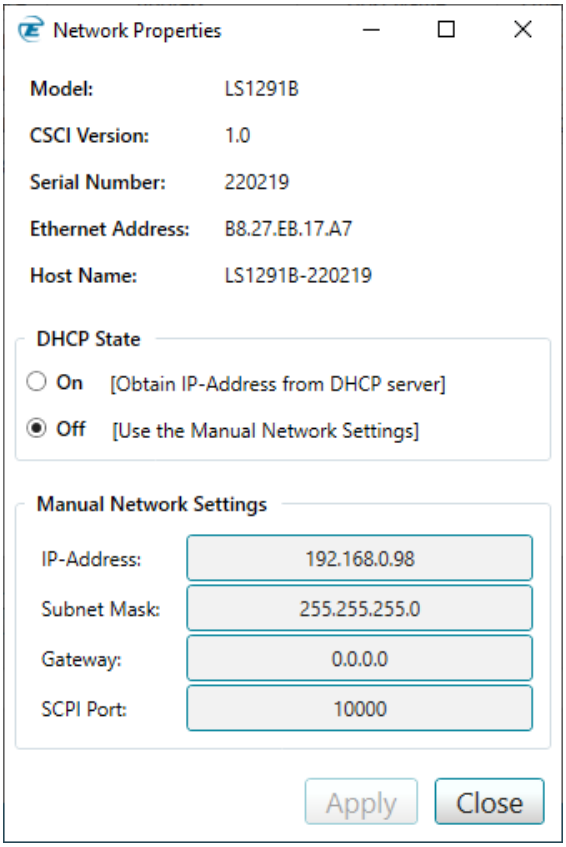


Figure 15.12 Network Properties

- **Refresh** – Click the button to update the display for all connected devices.
- **Multiple Subnets** – Check the box to search for devices in multiple subnets.
- **Close** – Click the button to exit the TE Update Tool.

15.3 Operating Instructions

13. Connect your control PC to the Tabor device using any available LAN, USB or PXI connections.

14. Double-click the TE Update Tool shortcut on the desktop  .

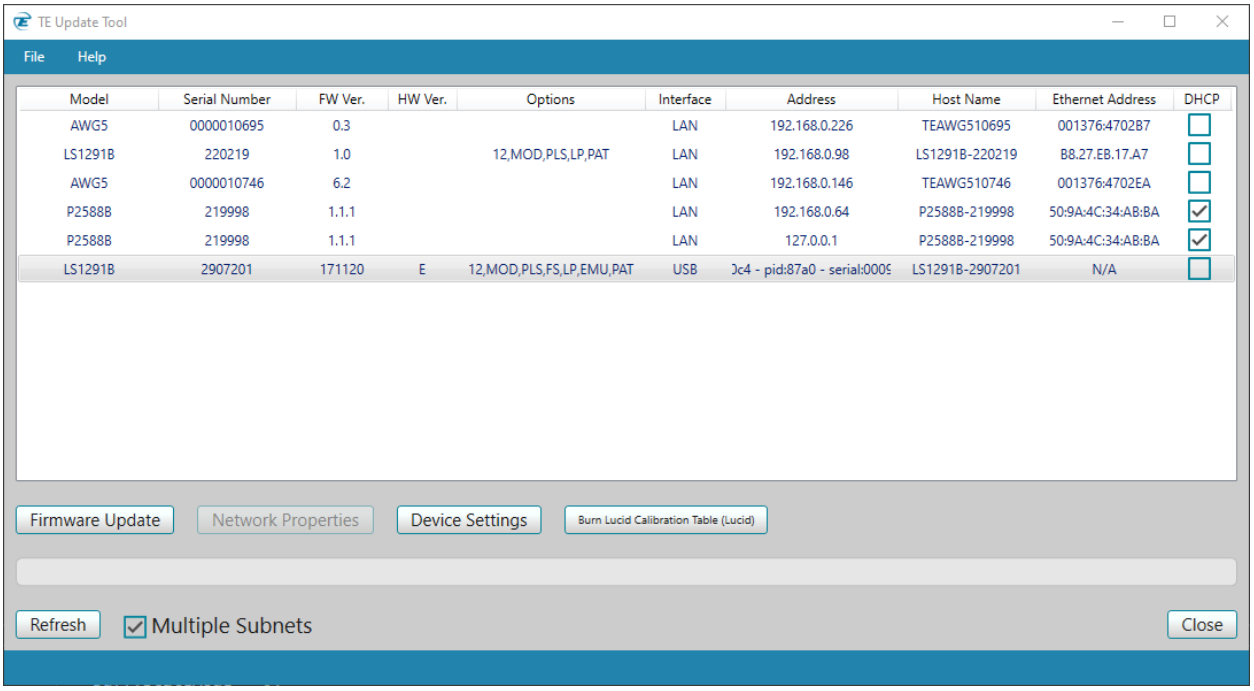


Figure 15.13 TE Update Tool

15. Select the unit and click the **Firmware Update** button.

Notes

- Verify the HW board version of device, e.g. “D”, and download the correct “D” FW version.

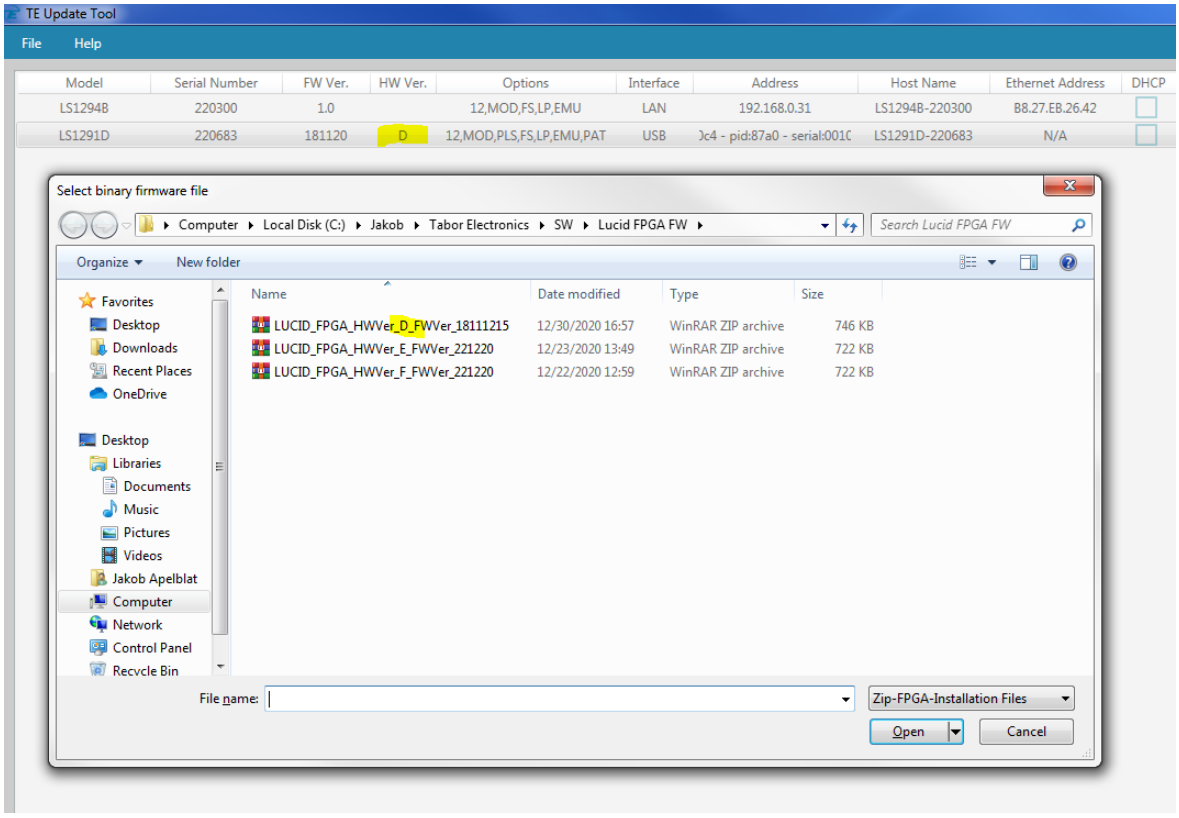


Figure 15.14 Select the FPGA Firmware File

16. Select the applicable zip file according to the HW Ver., and then click **Open.**
17. A warning dialog box will be displayed. Click OK. The update operation will start and it will take several minutes depending on the device interface.

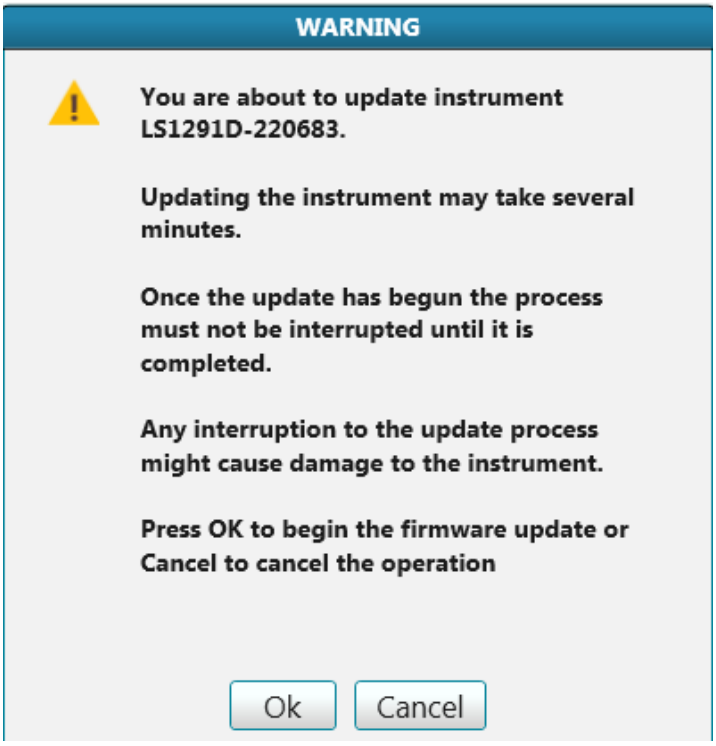


Figure 15.15 Warning

Caution!

- The update operation shall not be interrupted as this will damage the device.

18. The TE Update Tool progress bar will show the update status.

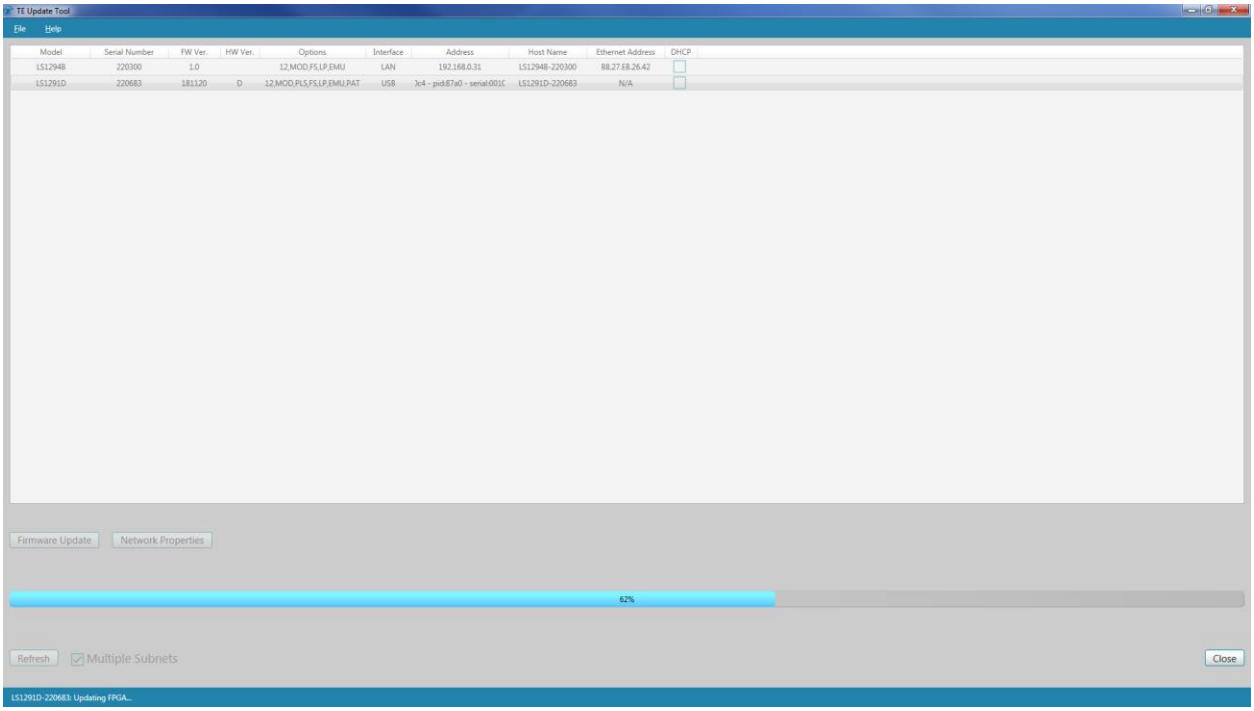


Figure 15.16 Progress Bar

19. When the firmware update has completed the Update Complete message box is displayed. Click **OK**.

Figure 15.17 Update Complete

20. Power cycle the device.

21. Click the Refresh button on the TE Update Tool to verify that the FPGA firmware has been updated.

16 Appendix Log File

The WDS provides a log file at C:\temp that provides all the communication between WDS and the device. If you encounter any issue, include this file when reporting to Tabor support.

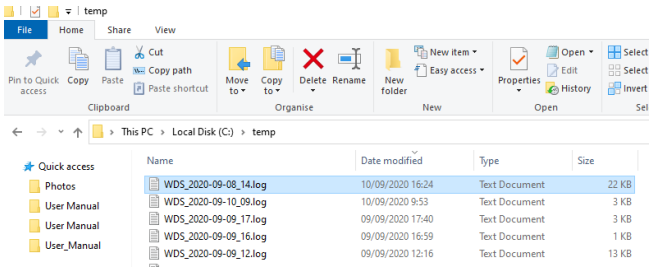


Figure 16.1 WDS Log File Folder

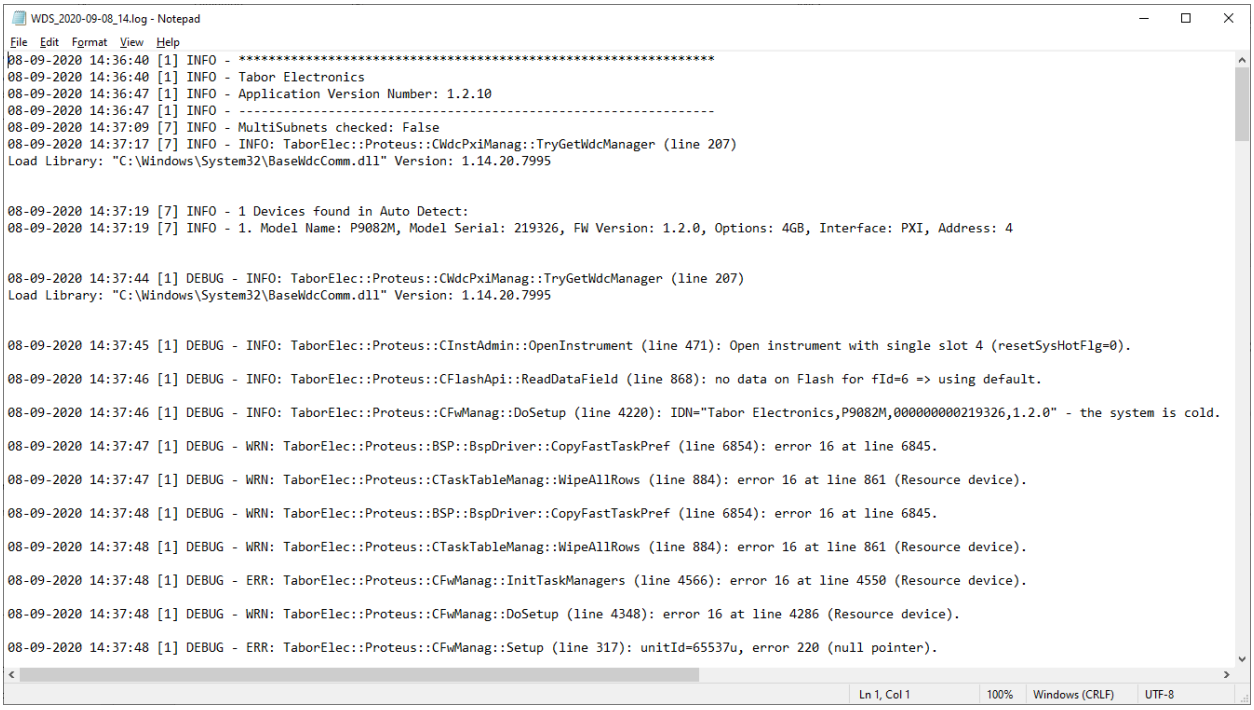


Figure 16.2 WDS Log File