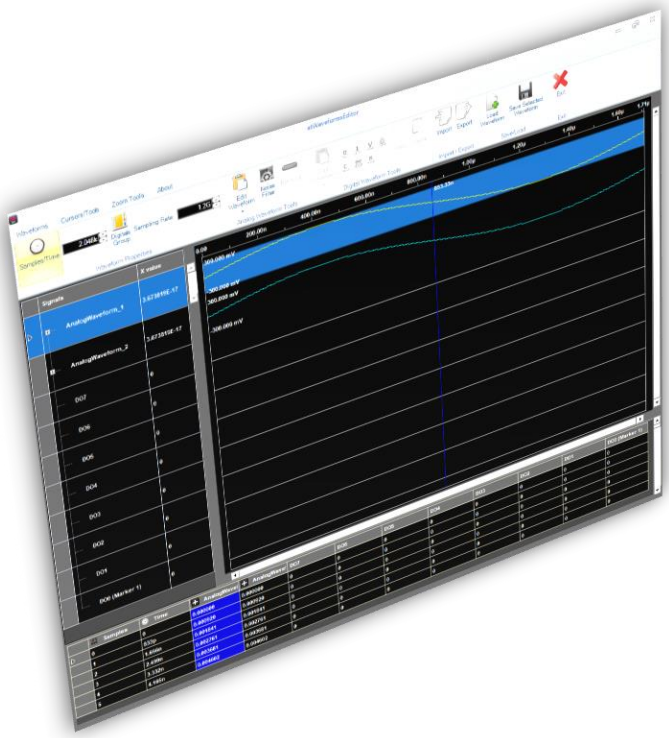
TELEDYNE TEST TOOLS
Everywhereyoulook™

# Waveforms Editor SW User's Guide



# Summary

# List of Figures

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# Preface

This manual describes the installation and operation of the Waveform Editor.

Basic operations and concepts are presented in this manual.

# Introduction

## General Features

## Obtaining the Latest Version Releases

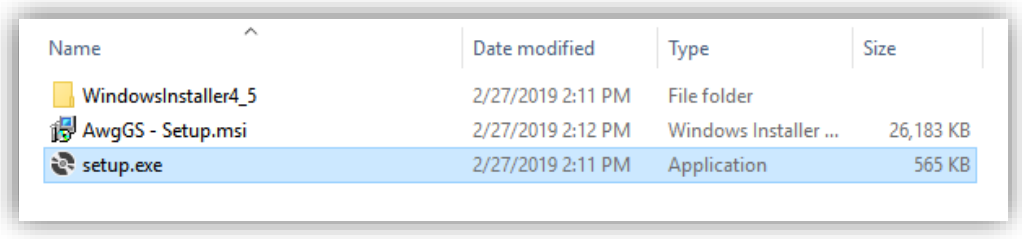
The instrument that you have receiver may not have the latest software release installed.

The latest version could be found on Teledyne LeCroy website (www.teledynelecroy.com) in the support area.

## Install atWaveformsEditor Application

If a different version of the atWaveformsEditor app is already installed, you must first uninstall it:

1. Download the atWaveformsEditor setup package from Teledyne LeCroy website and uncompress it to instrument's local disk.




2. Double click on the setup.exe file
3. When the application has been installed, press Return to continue.

# atWaveformsEditor Overview

The objective of this chapter is to give brief introduction for a quick use of the software atWaveformsEditor (hereafter abbreviated as WE).
After installing the SW the following icon will be available on the desktop:

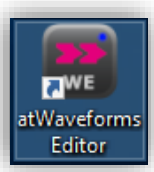



*Figure 1: atWaveformsEditor desktop icon*

The program starts by double clicking on the icon. Below is the image of the main screen of the WE.

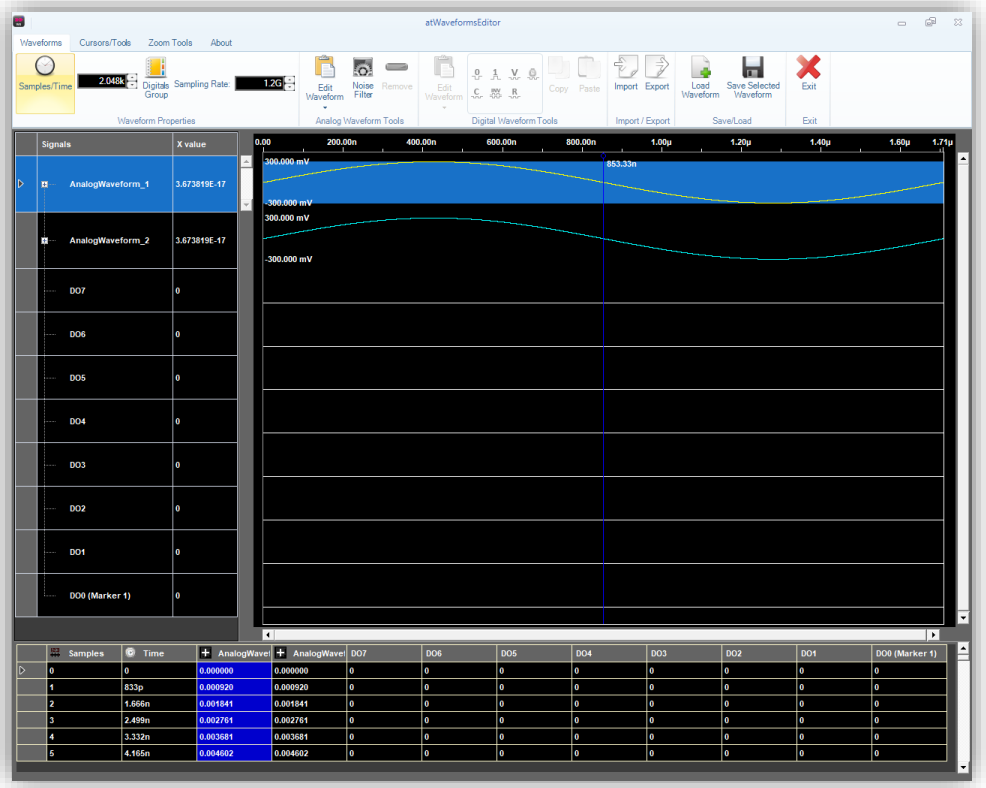



*Figure 2: atWaveformsEditor main view*

In the following example we will show how to create a pulse with 50% duty cycle made of ten thousand samples and save it in proprietary Zip binary format.
To do this you must execute the following steps:

1. The default waveform length is 2048 samples. Change the samples number of the waveform to 10K samples.

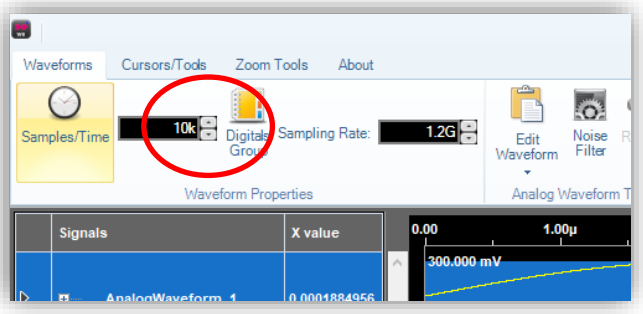



*Figure 3: Waveforms samples*

2. Select one of the two analog waveforms shown in the waveform graph, in this example the second one. To select a waveform, simply click on the corresponding line.

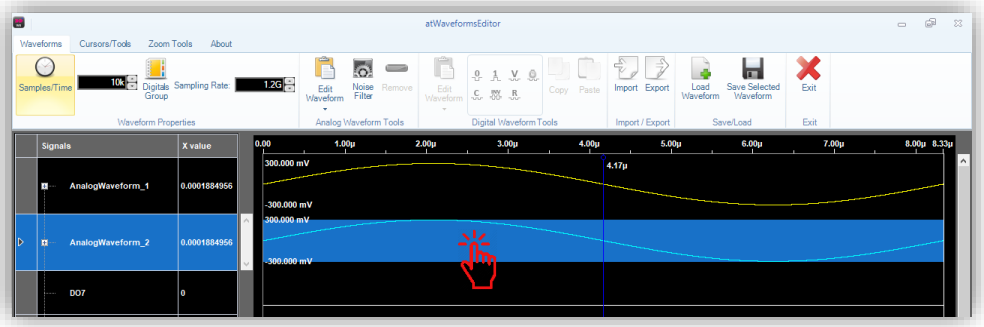



*Figure 4:Waveform Selection*

3. In the "Analog Waveform Tools" menu, click the "Edit Waveform" button to open the Waveform Standard Editor and to configure the waveform parameters.

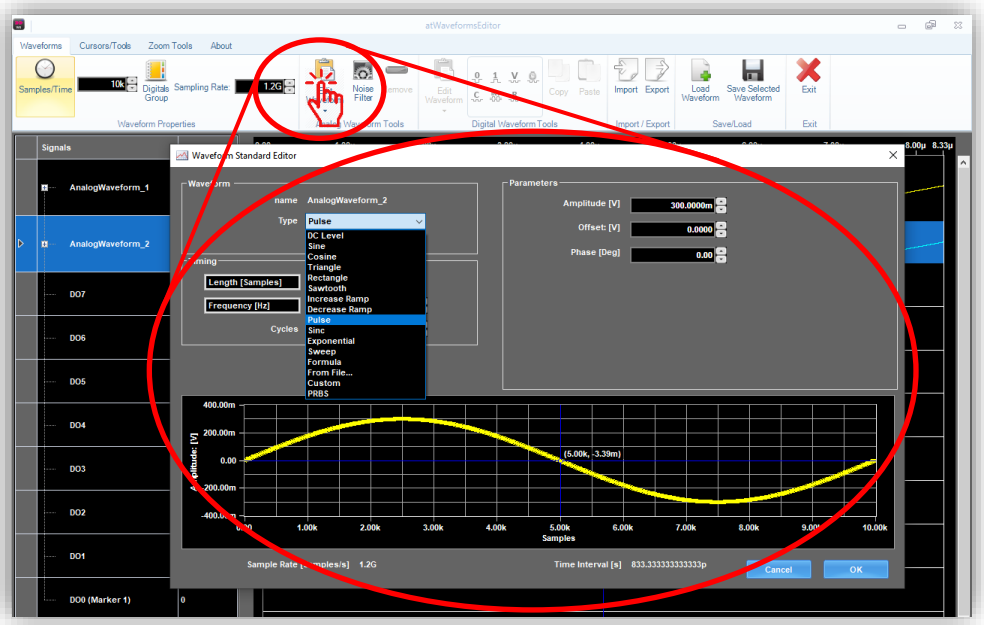



*Figure 5: How to open the Analog Waveform Standard Editor*

4. Select the "Pulse" type from the dropdown list.

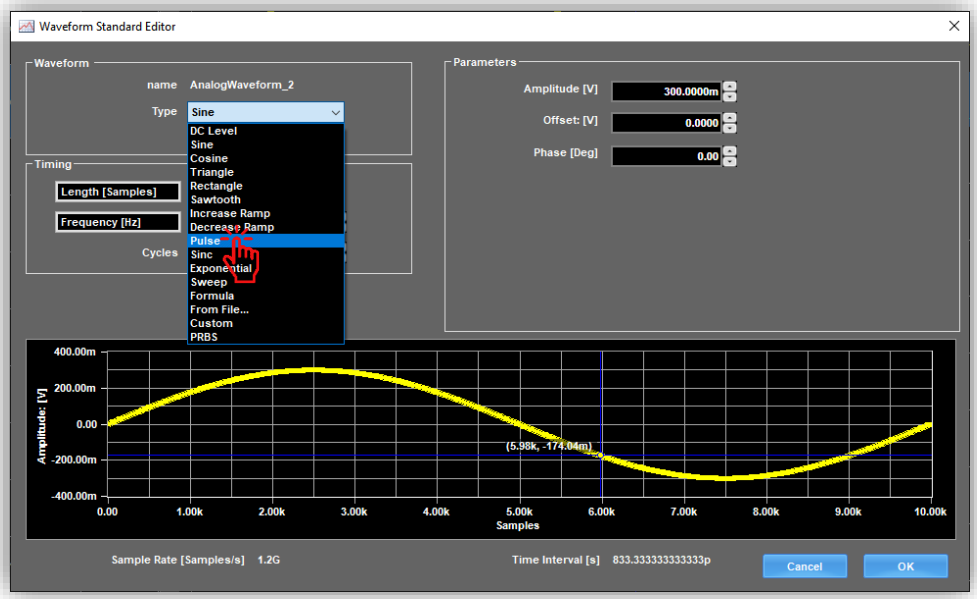



*Figure 6: Analog Waveform Standard Editor*

5. Set the Pulse width to 50%.

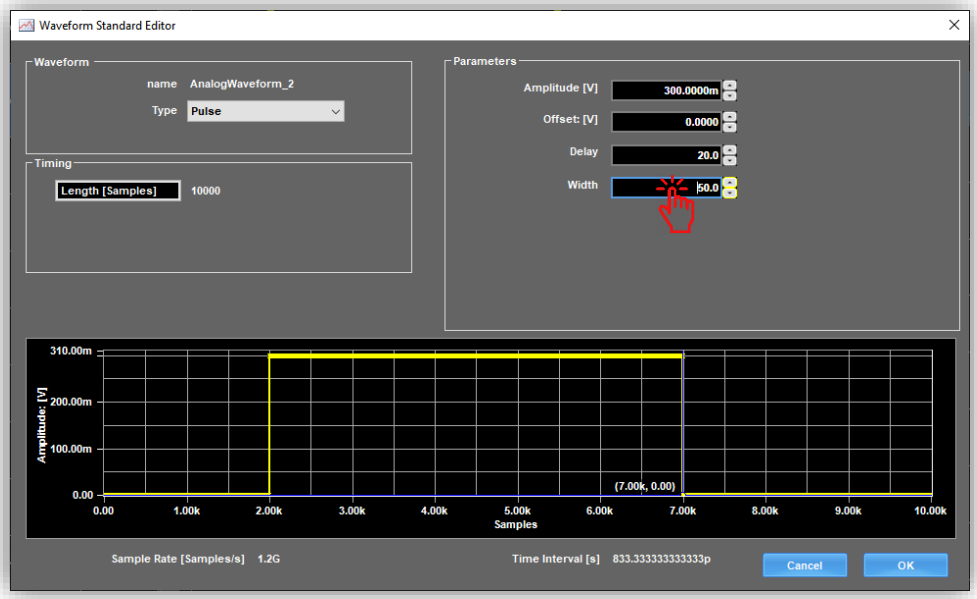



*Figure 7: Pulse Configuration*

6. Click Ok and the selected waveform will be updated as needed.

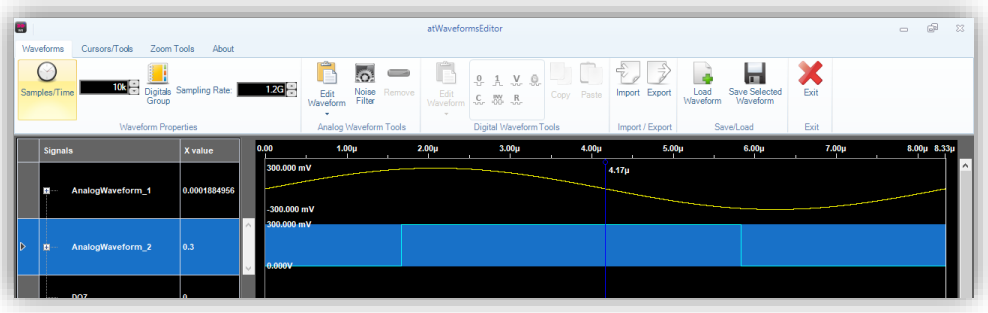



*Figure 8: Analog Waveform editing*

7. The modified analog waveform can now be saved in proprietary Zip binary format by pressing the "Save Selected Waveform" button in the "Save / Load" menu of the main bar.
   By clicking on the "Save Selected Waveform" button a dialog box will open asking to specify the name of the waveform, the description and the path where the waveform will be saved.

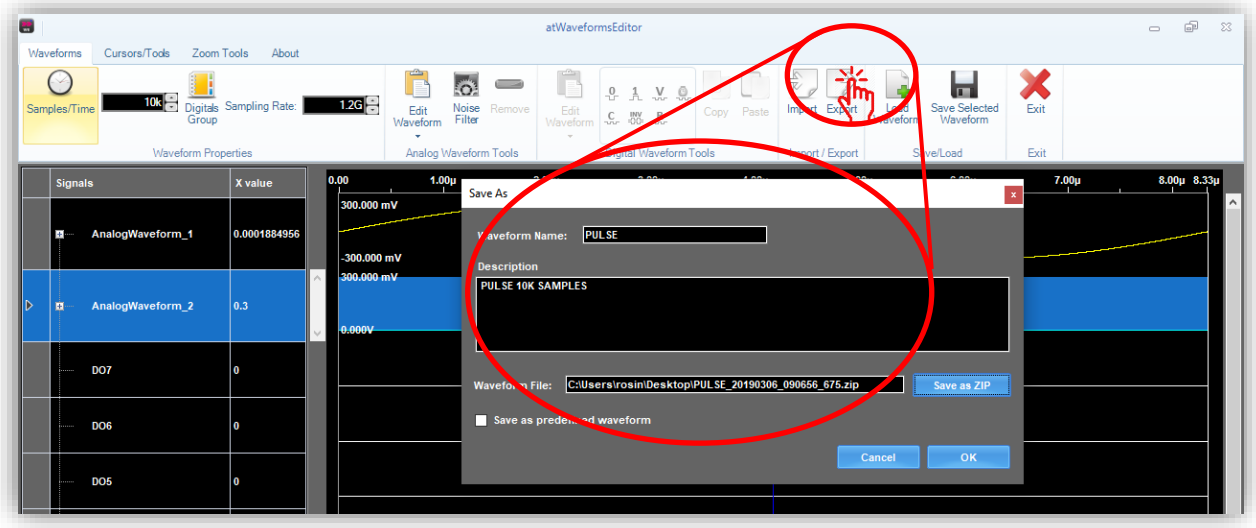



*Figure 9: Save Selected Waveform menu*

# The Waveform Editor – Integrated/Online Mode

In the previous section it was described how to use the WE as a standalone application. The WE can also be used integrated with the TrueArb application (hereinafter referred to as TA).
In this way the WE retrieves the waveforms directly from the Waveform List of TA. WE works in integrated mode each time it is started directly from the TA.
In the TA there are two ways to launch the WE:

1. The first one is by pressing the "Edit" button in the Waveform List page the WE will be launched and it will be possible the edit the selected analog or digital waveform.

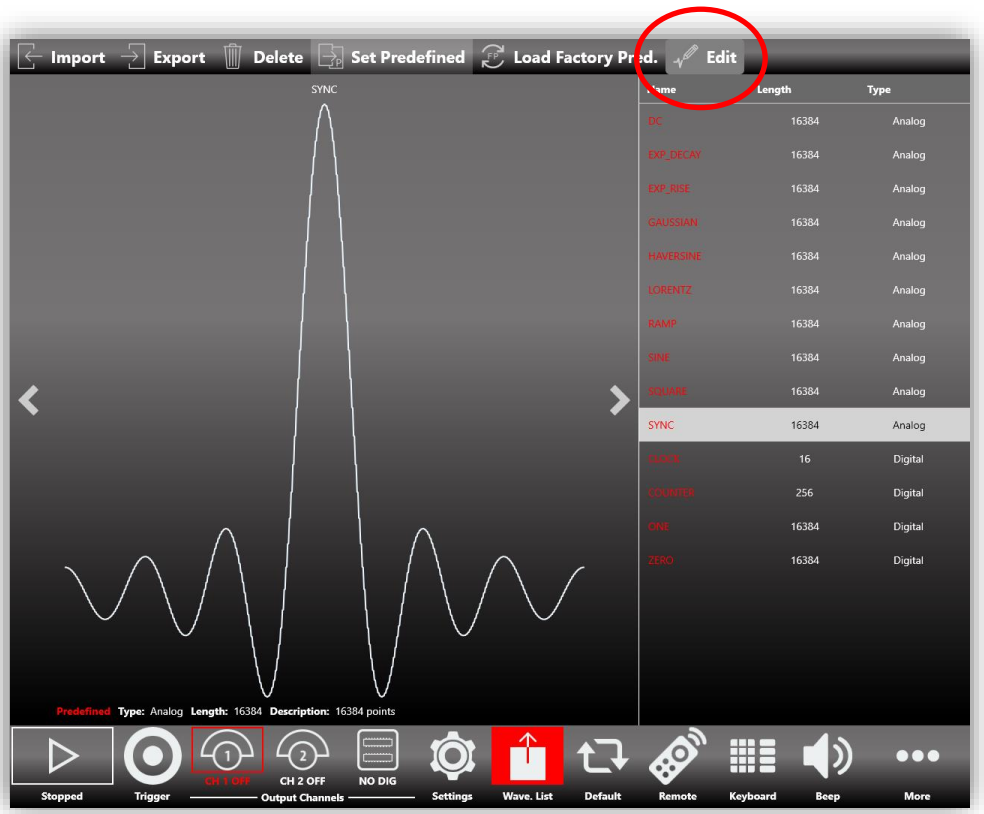
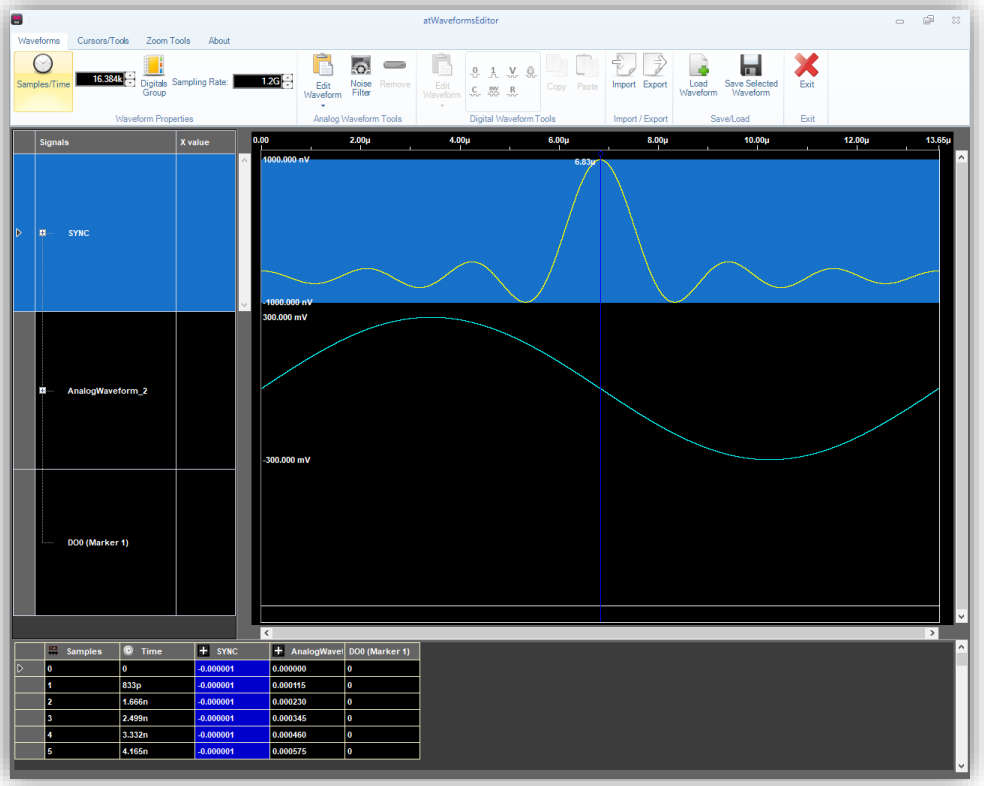



*Figure 10: atTrueArbRider Waveform List*



2. The second way to open the WE is by pressing the "Wav. Editor" button in the "More" menu. When you press this button the Waveform Editor will be started with default analog and digital waveforms. You can also retrieve the waveforms from the TA waveform list as described in the following paragraph.

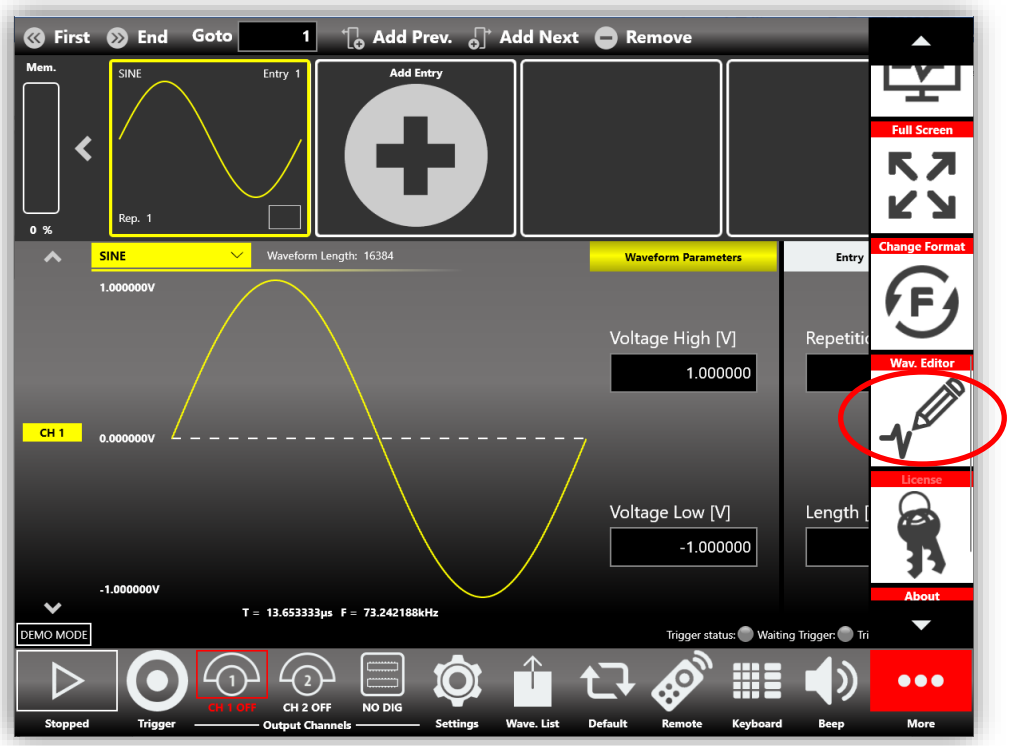



*Figure 11: atTrueArbRider - More menu*

## Load and Save from the TrueArb Waveform List

In the integrated mode the WE can retrieve the waveforms directly from the TA waveform list. By clicking the "Load Waveform" button the "Select Waveform" window opens with the TA waveform list. If an analog waveform was selected when pressing the "Load Waveform" button, the list waveform list will show only analog waveforms otherwise only the digital waveforms will be shown.
The predefined waveforms are shown in red, while the not predefined waveforms are shown in white.

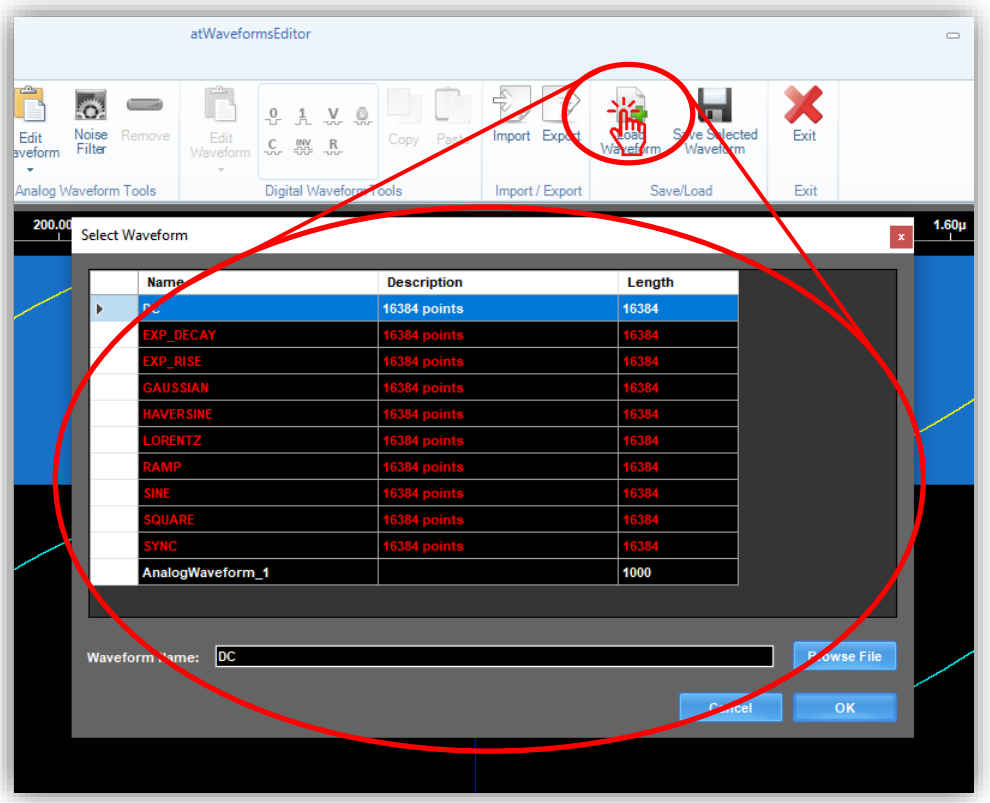



*Figure 12: Load Waveform window*

As shown in the image below, by clicking on the "Save Selected Waveform" button, it is possible to save an analog or a digital waveform directly in the TA waveform list.

**Please note the following:**

- Click the "Save as predefined waveform" checkbox to save a waveform as Predefined in the TA waveform list
- If you overwrite an existing waveform you cannot change the "Predefined" flag.
- Click the "Save in the waveform list" button to save the waveform directly in the True Arb Waveform List. This button will appear only in Integrated mode or if the TrueArb has been installed and run at least one time.

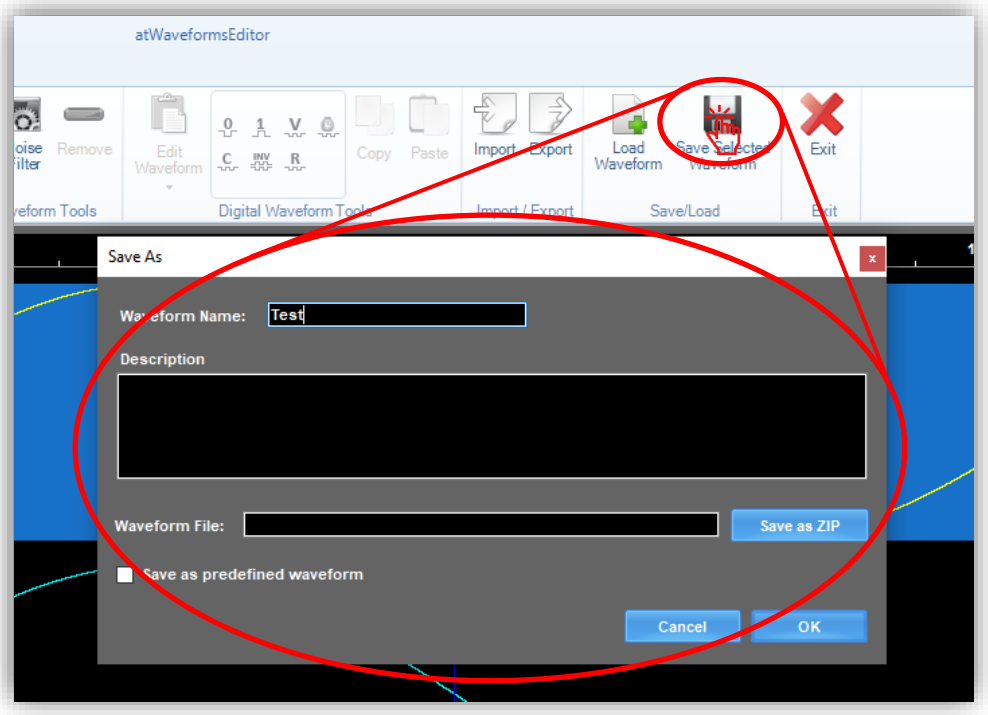



*Figure 13: Save As window*

## Digital Waveform Editing

In the previous paragraph we quickly described how to edit an analog waveform. In this section we will briefly show how to edit a digital waveform.

When opening the WE in standalone mode a digital waveform composed of 8 digital signals (DO 0-7) is displayed. In the following example it will be explained you how to create a digital waveform that represents a counter made of 8 digital signals. To do this please follow the steps below:

1. Group the digital signals into a single bus.
   Click on the "Digitals Group" button of the "Waveform Proprieties" menu: the "Digital Logical name and Grouping" window will open.

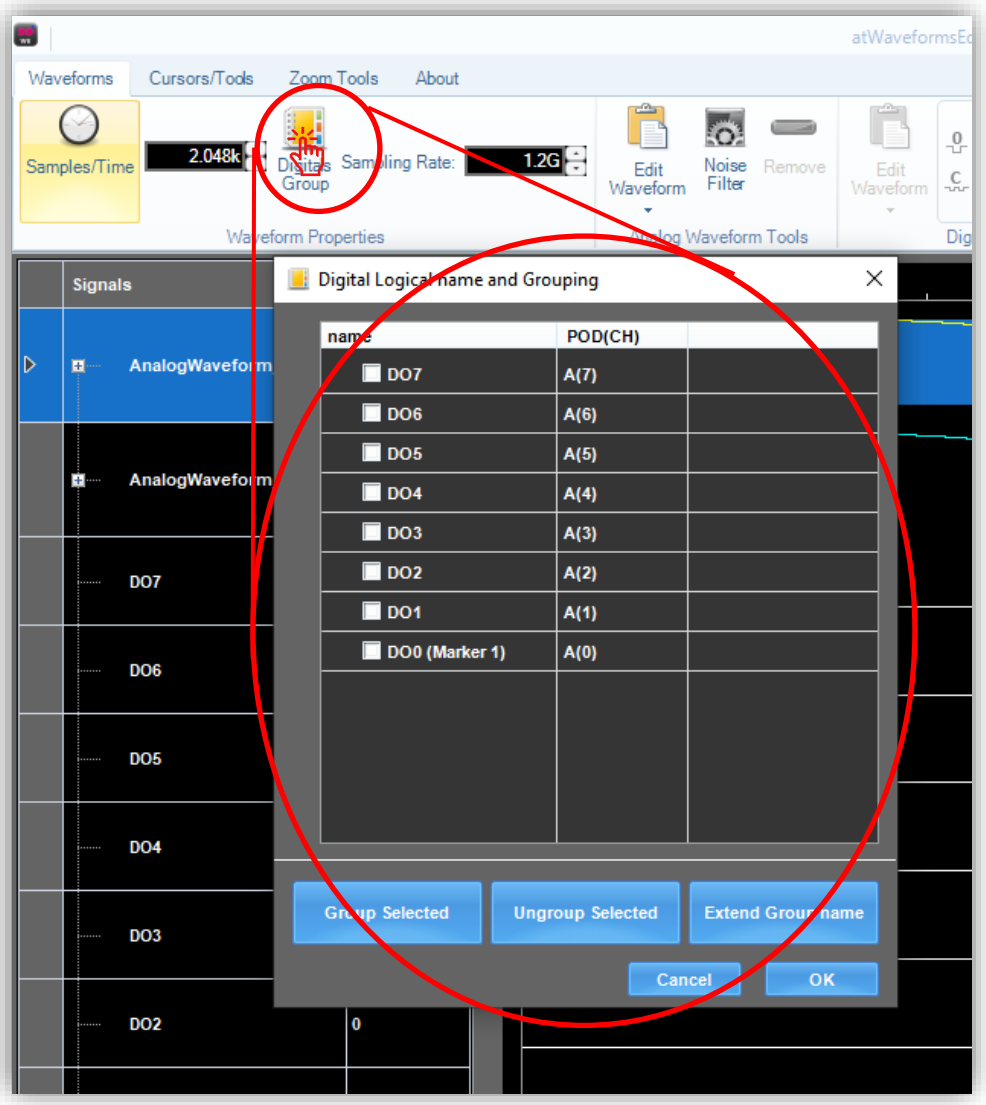



*Figure 14: Digitals Grouping*

2. Select all the digital lines using the checkboxes and then press the "Group Selected" button. Press "OK" to confirm the grouping.

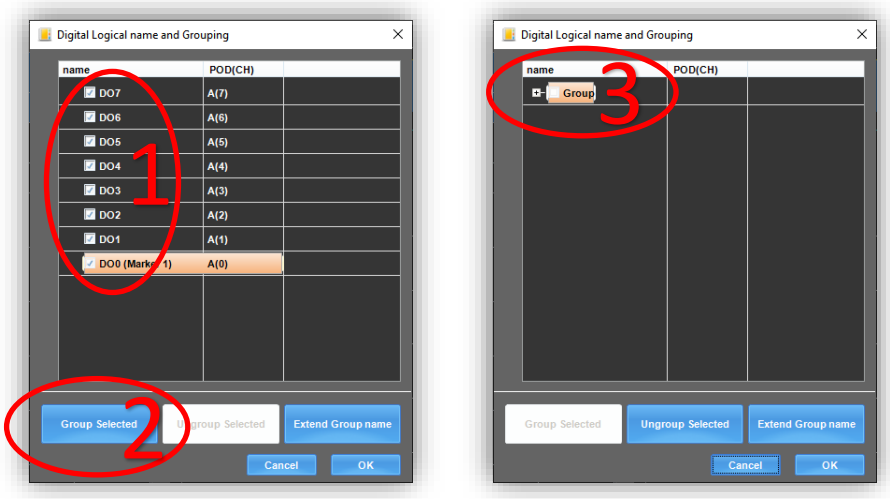



*Figure 15: Digitals Grouping*

3. Click on the digital bus.

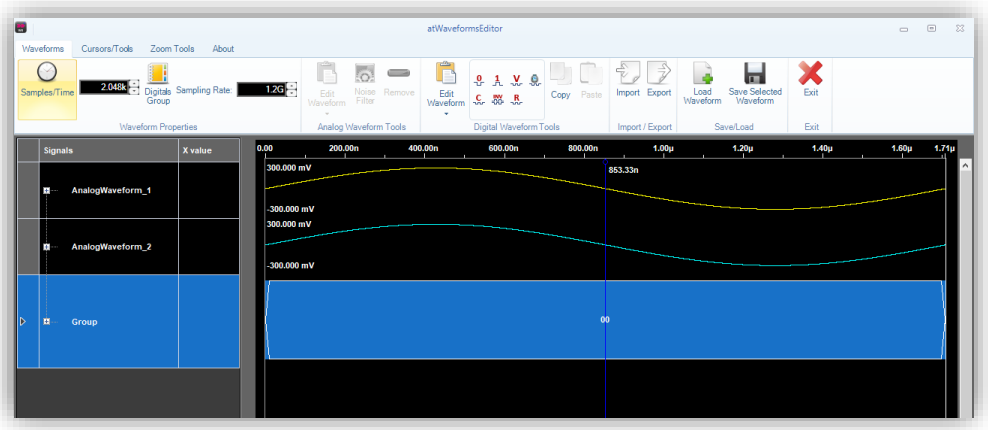



*Figure 16: Digitals Group Selection*

4. Click on the "C" (C stands for Counter) button on the "Digital Waveform Tools".

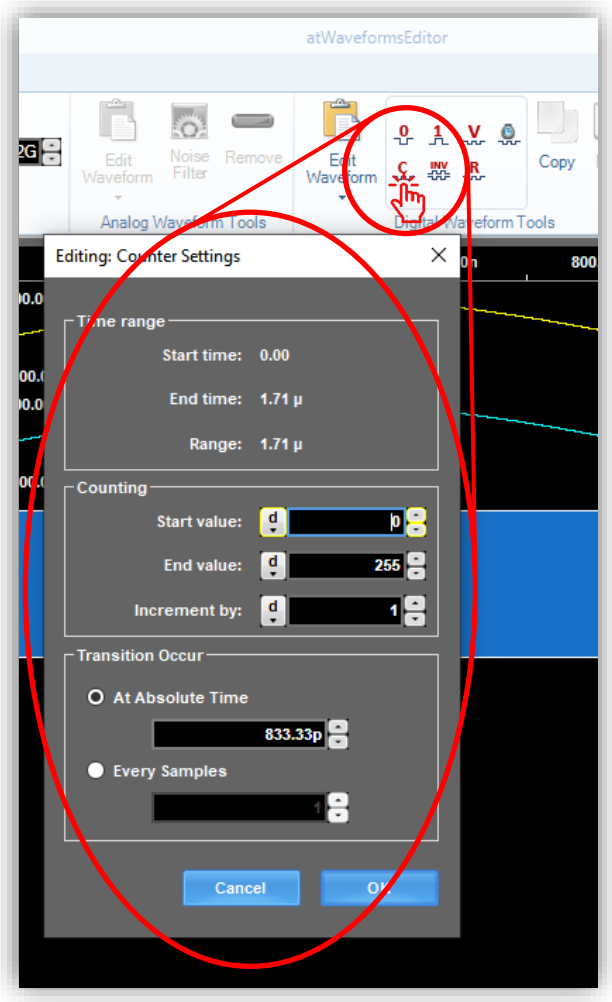



*Figure 17: Digital Counter Editing*

5. Set the counter parameters as in the figure above: set 40ns in the "At Absolute Time" parameter. Press OK.

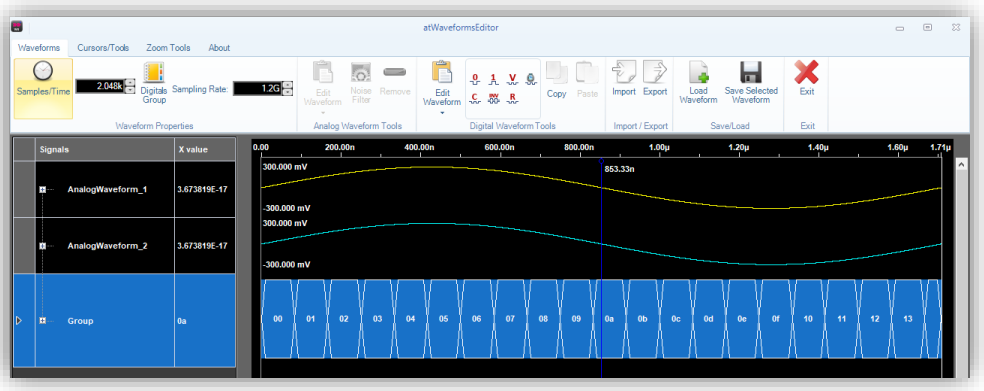



*Figure 18: Digitals Waveform as Counter*

6. Press "Save Selected Waveform" button to save the digital waveform in proprietary Zip binary format.

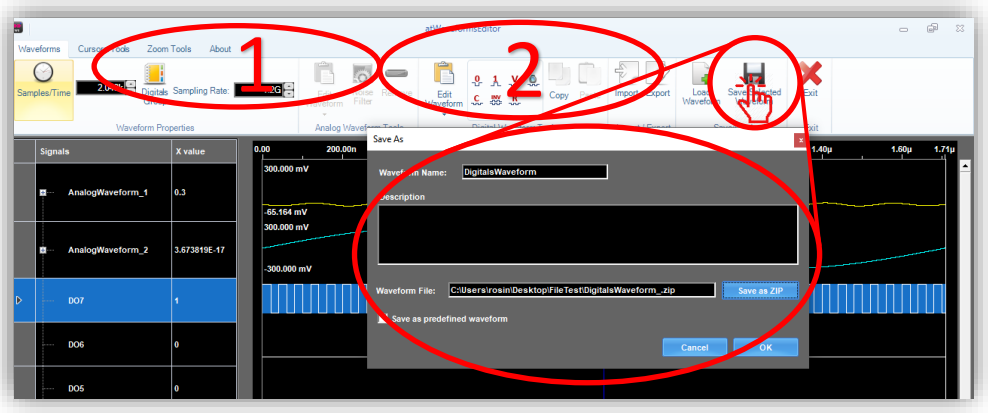



*Figure 19: Save the Digitals Waveform*

## How to modify a waveform in the TrueArb Waveform List

In this section we want to describe the steps necessary to modify a waveform of the TrueArb waveform list. In the following example, we want to change the number of samples and the shape of the "SINC" waveform.

1. Select the waveform called "SINC in the "Waveform List" page of the TA then and press the "Edit" button.

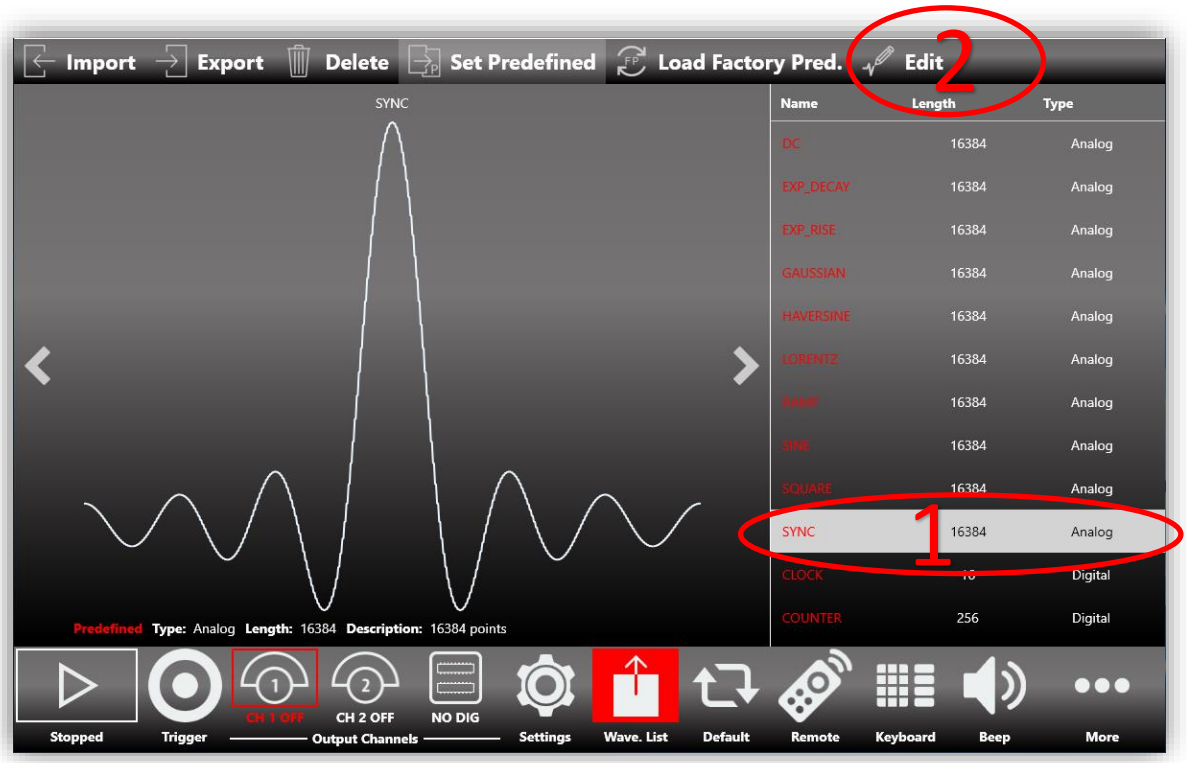



*Figure 20: TA WaveformList*

2. Once the WE has started, change the length to 20000 points.
   Since the loaded waveform was composed of 16384 points, the remaining points are filled with zeros.

**Please note** that if you decrease the number of points of the loaded waveform, it will be trunked.

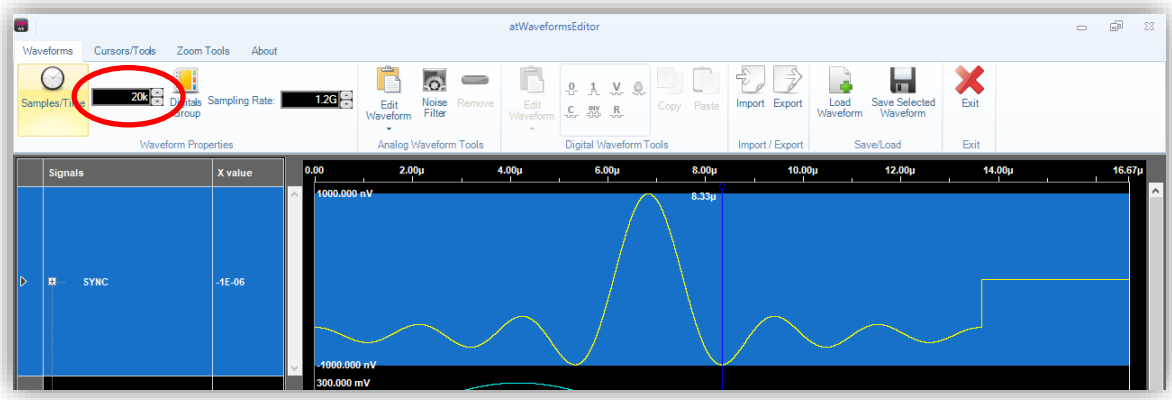



*Figure 21: the SINC waveform after the length change*

3. Open the "Waveform Standard Editor" by pressing the "Edit Waveform" button to modify the "SINC" waveform parameters as shown in the picture below.
   Press "OK" to confirm the change.


*Figure 22: the SINC waveform editing*

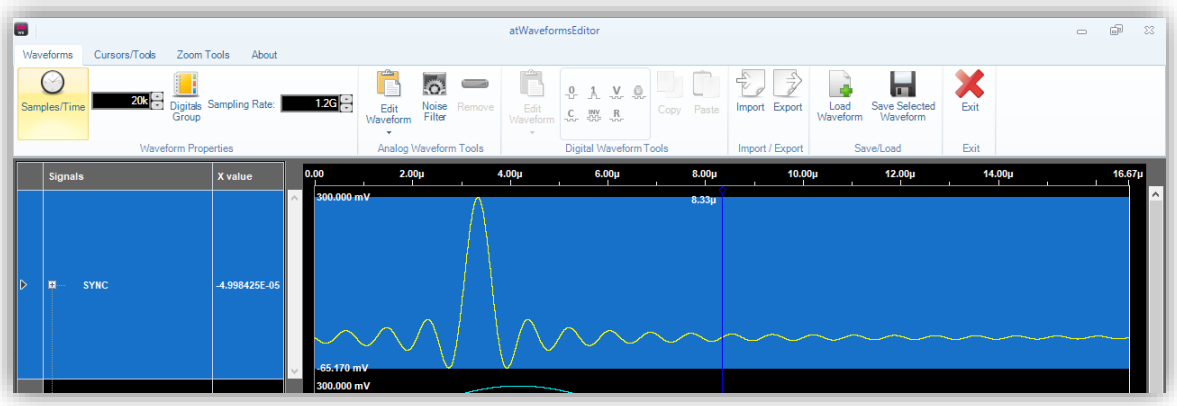



*Figure 23: the new SINC waveform*

4. Save the "SINC" waveform by pressing the "Save Selected Waveform" button keeping the same name.
   The Save As window shows that a waveform with the same name is already present in the waveform list.
   Press the "Save in the Waveform List" button to save the waveform.

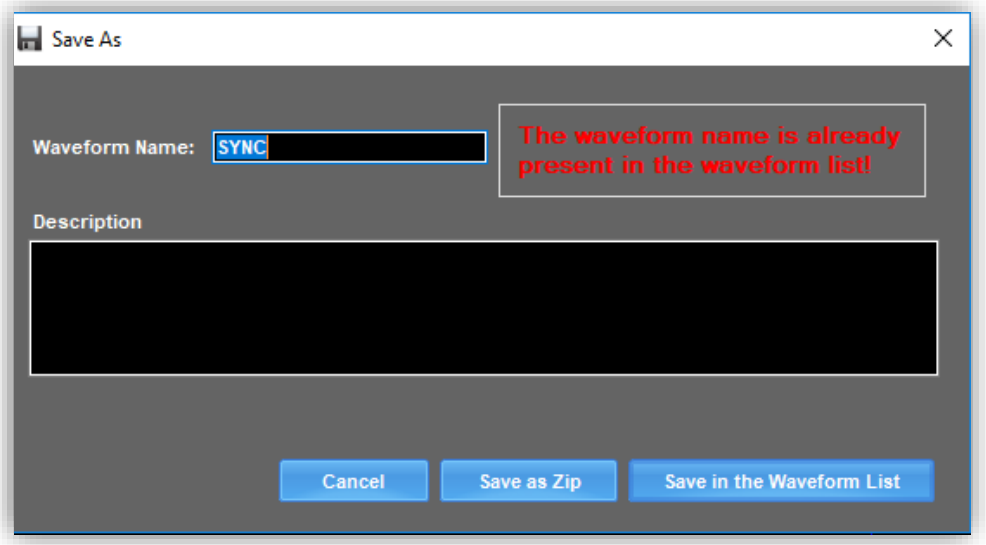



*Figure 24: Save the waveform with the same name*

5. The SINC waveform will be updated in the TA waveform list.

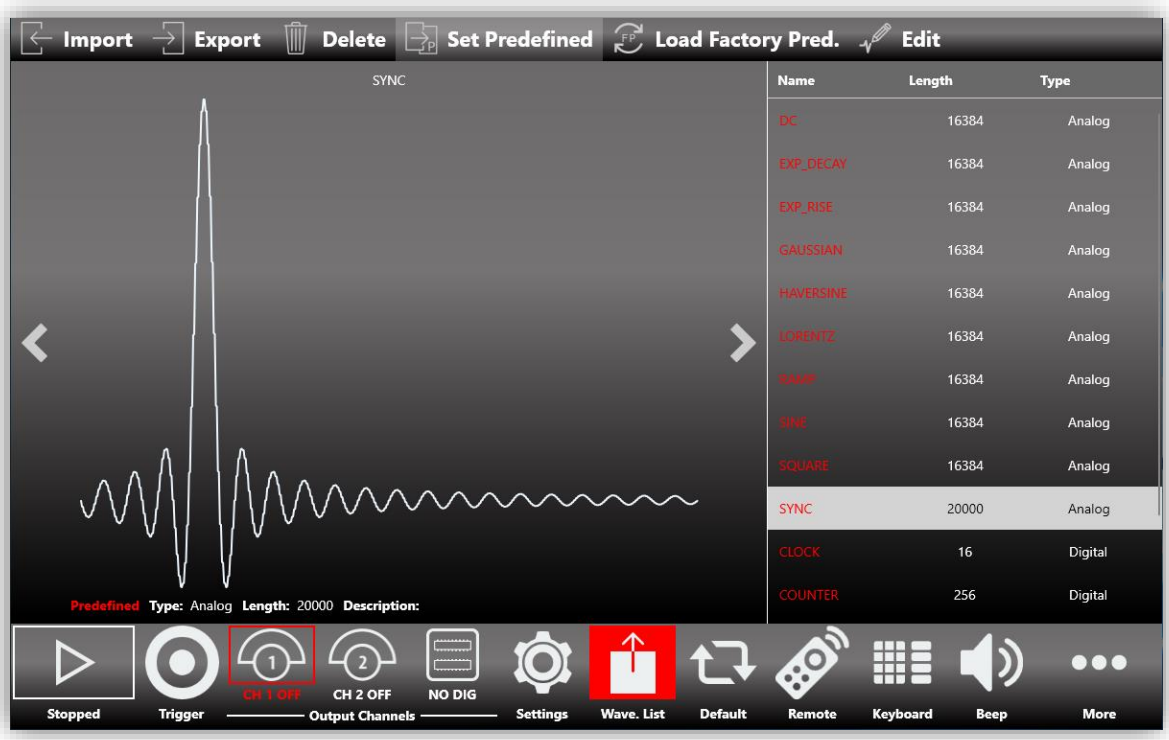



*Figure 25: the updated Waveform List*

# atWaveformsEditor in detail

The main window of the Waveform Editor consists of three main parts:

1. The **Command Bar**.
2. The **Waveform Graph Editor**: it is an area where you can edit the analog and digital waveform in a graphical format.
3. The **Data Editor**: it contains a table with the samples of the analog and digital waveforms.

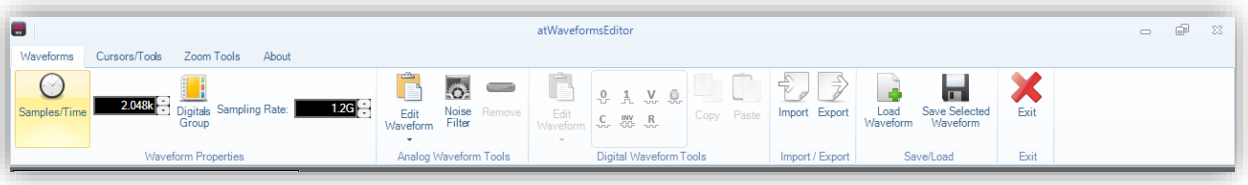



*Figure 26: the Command Bar*

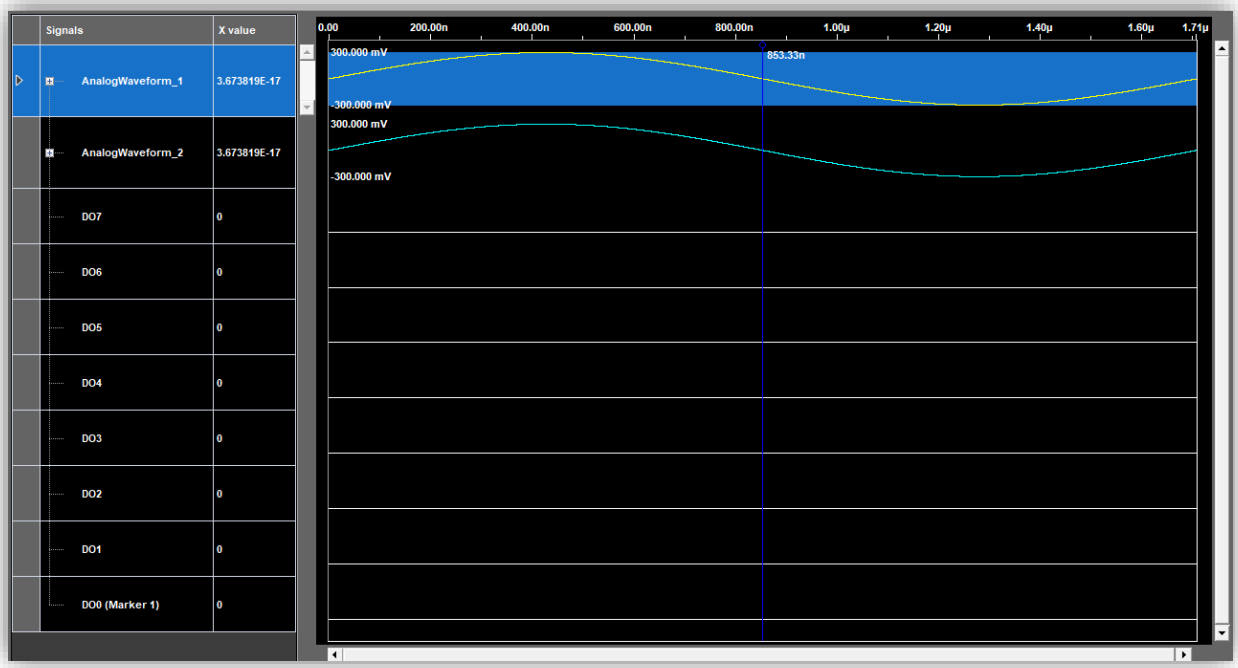



*Figure 27: the Waveform Graph Editor*

| Samples | Time | AnalogWavef | AnalogWavef | DO7 | DO6 | DO5 | DO4 | DO3 | DO2 | DO1 | DO0 (Marker 1) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0.000000 | 0.000000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 833p | 0.000920 | 0.000920 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 1.666n | 0.001841 | 0.001841 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 2.499n | 0.002761 | 0.002761 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 3.332n | 0.003681 | 0.003681 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 4.165n | 0.004602 | 0.004602 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

*Figure 28: the Data Editor*

# The Command Bar

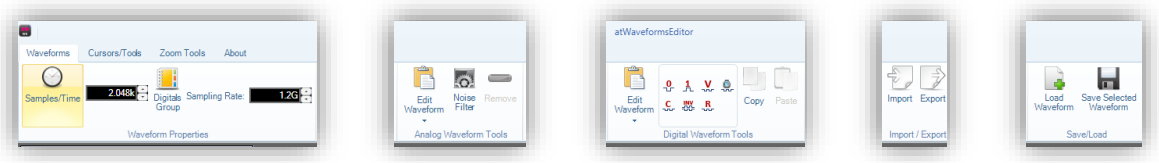



*Figure 29: the main command bar*

The main command bar consists of the following submenus

1. The **Waveform Properties**
    a. Number of samples or duration
    b. Sampling rate
    c. Digitals Group

Each time these parameters are modified, the representation of the waveforms is automatically updated.

2. **Analog Waveform Tools**: it contains tools to edit and modify the analog waveforms.
3. **Digital Waveform Tools**: it contains tools to edit and modify the digital waveform.
4. **Import/Export** menu: these buttons allow you to import and export analog and digital waveform data.
5. **Save/Load**: you can save and load waveforms in proprietary format; moreover, you can transfer analog and digital waveforms from and to the True Arb application.

## Waveform Properties

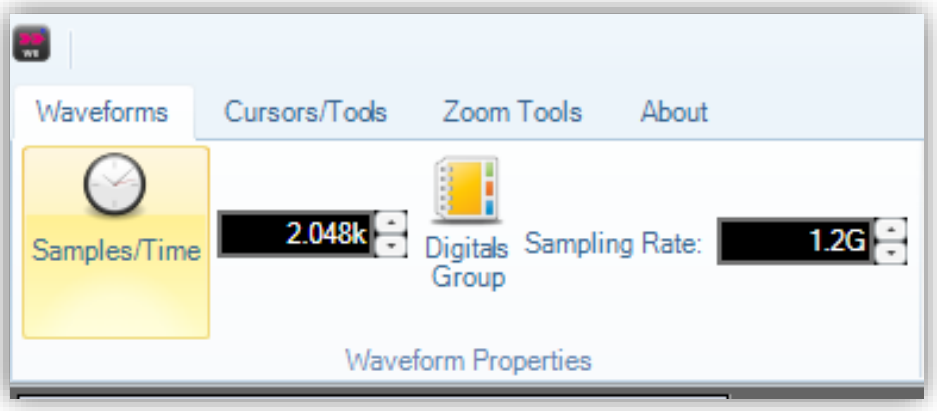



*Figure 30: the waveform properties menu*

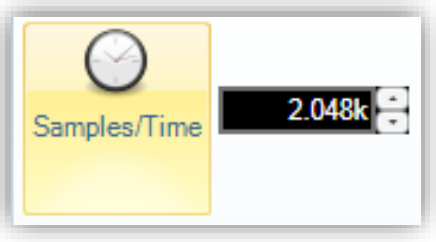
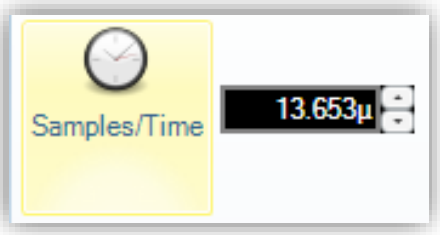
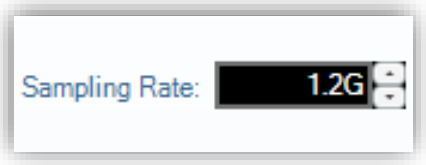
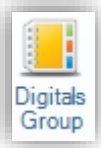
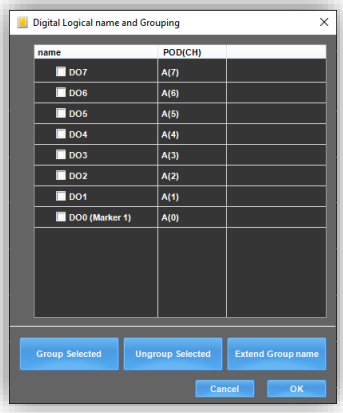
| | |
|---|---|
|  <br>  | The "Samples/Time" button switches the waveform length representation between **number of samples** to **seconds**.<br><br>Using the textbox, it is possible to modify the number of samples or the duration of the waveform. The duration depends both on the number of selected samples and on the selected sampling rate. |
|  | You can change the sampling rate of all the waveforms that will be created into the Waveform Editor.<br>**Please note the following:**<br><br>• The sampling rate is related to the frequency of the waveforms that will be defined with the Analog and the Digital Waveform tools<br>• If the WE is launched by the True Arb application the Sampling Rate parameter is transferred from the TA to the Waveform Editor.<br><br>If the Samples/Time button is set to **Samples** then changing the sampling rate also the duration will change while the number of samples will be kept fixed.<br>If the Samples/Time button is set to **Time**, then changing the sampling rate also the number of samples will change while the duration will be kept fixed. |
|  <br>  | The "Digital Group" button opens a form that allows you to group and rename the digital signals as needed to create busses.<br>Digital grouping can simplify the editing of the digital signals. |

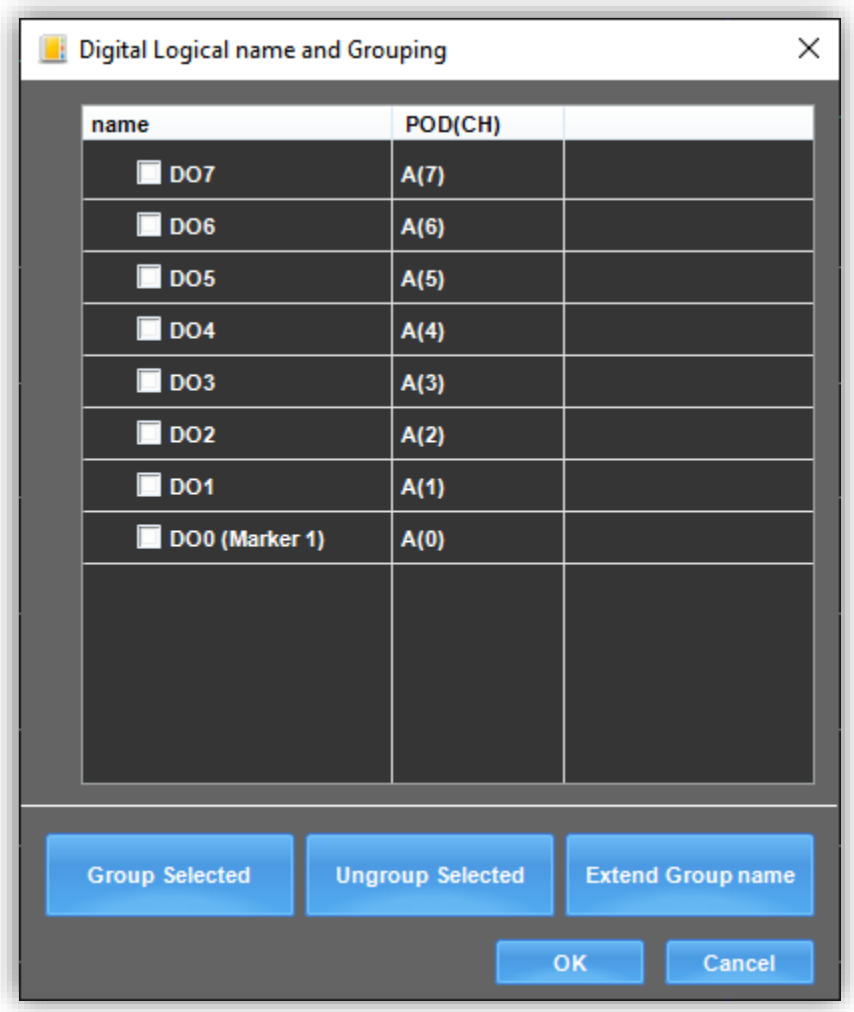
*Table 1: the waveform parameters menu*

## Digitals Grouping

Digital grouping window allows to group single signals into a bus, rename single signals or busses, ungroup busses into single signals.
Please note that the changes will be updated on the Digital Waveform Editor, while in the True Arb application the digital lines will be always displayed as single lines with their original names.

- **Press the Digitals Group** 

button.



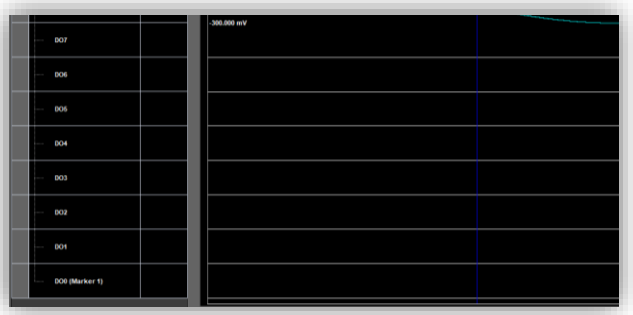
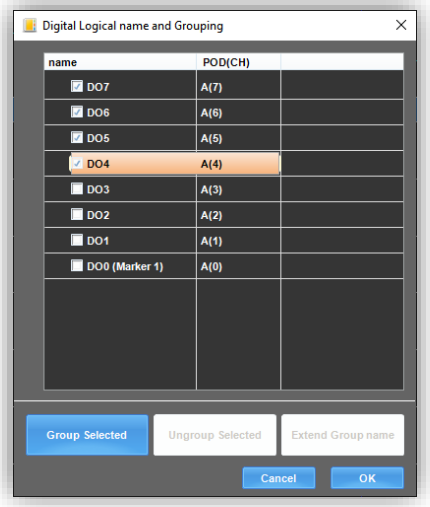
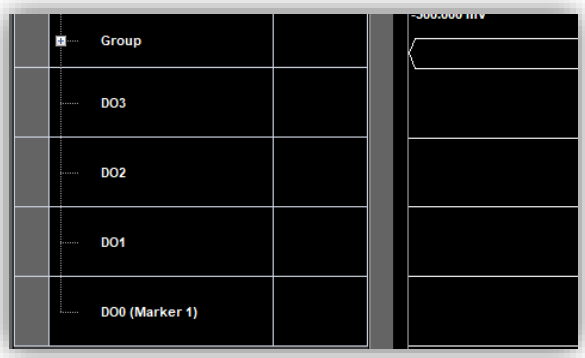

The *Digital Logical Name and Grouping Window* is shown.

- The first column displays the logical names that can be assigned to the digital channels.
- The second column displays the *digital output channel* that it is associated to the *digital logical name*.
- The third column displays the device name associated to the digital channel.
- Click on the checkboxes to select multiple DO single digital lines, then press the **Group Selected** button to make a bus.
- Keep pressed the left mouse button on single signal or bus name to rename it.
- Select a bus and press the **Extend Group Name** button to copy the Group name into the

name of the single lines of the group.

- Select a bus and press the **Ungroup Selected** button to ungroup a bus into single lines.

The following table shows the various grouping steps.

| | |
|---|---|
|  | This view indicates that the digital units have not been grouped and in the Waveform graph area the single digital signals are displayed separately.<br>  <br>. |
|  | To group the digital lines, select the signals, press the "Group Selected" button and press "OK" to confirm. The Waveform graph will update as follows.<br>  |

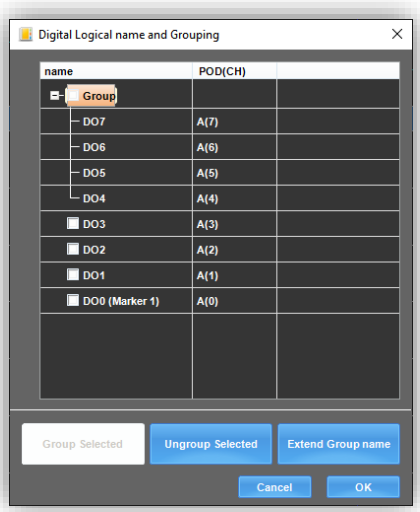
| | |
|---|---|
|  | To Ungroup a bus, select the bus and press the "Ungroup Selected" button. Then press "OK" to confirm. |

*Table 2: Digitals Grouping*

## Analog Waveform Tools

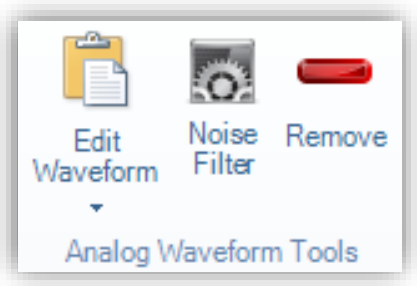
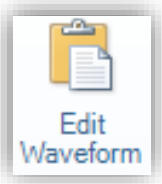
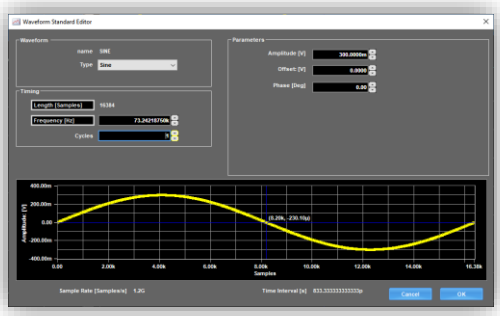



*Figure 31: Analog Waveform Tools menu*

| | |
|---|---|
|  <br>  | Press the "Edit Waveform" button to open the Waveform Standard Editor window and create a basic waveform like DC Level, Sine, Increase Ramp, Triangle, Sawtooth, Rectangle etc.; for each waveform you can modify its own parameters. |

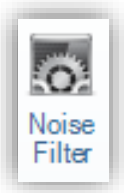
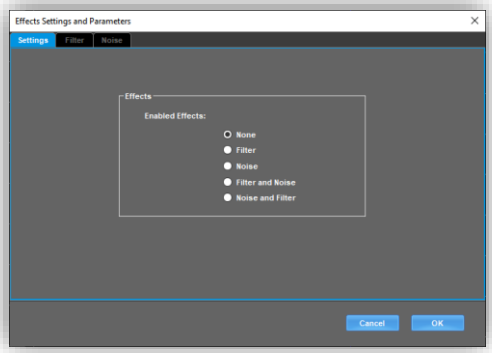
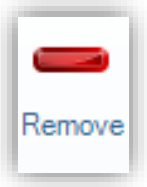
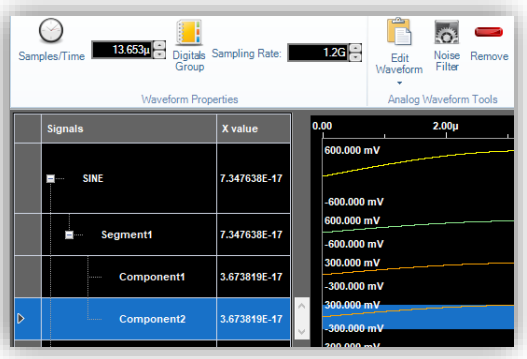
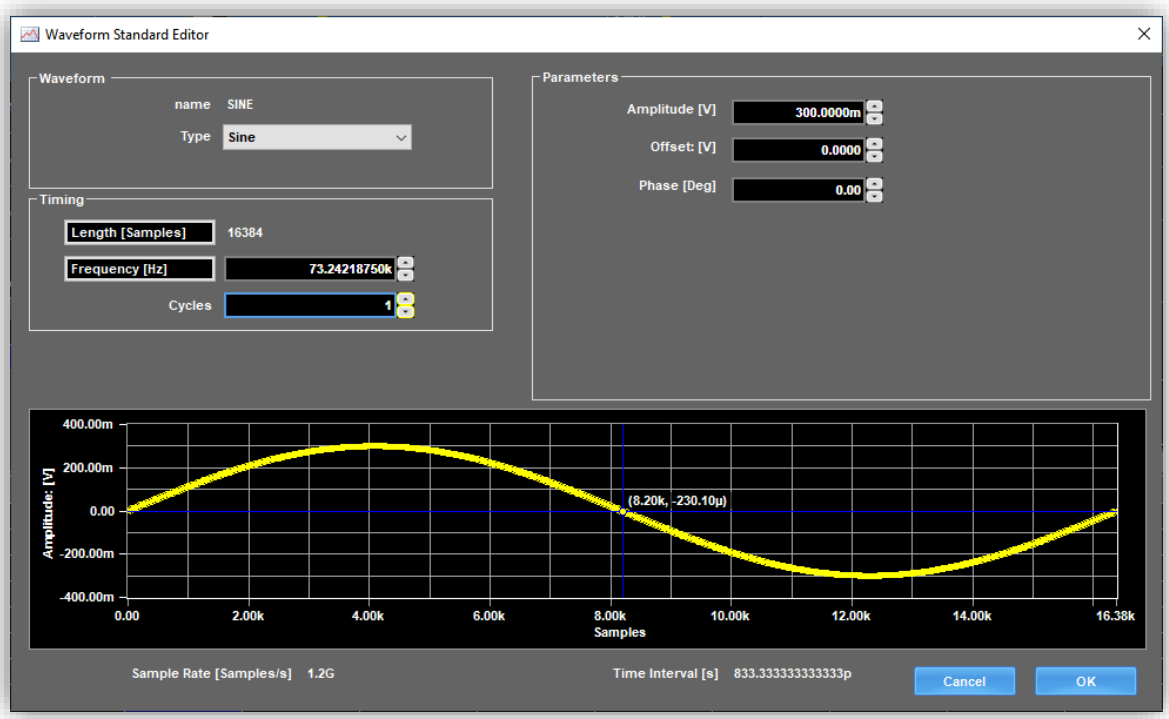
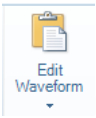
| | |
|---|---|
|  <br>  | Press the **Noise/Filter**  button and the *Effects Settings and Parameters* window is shown.<br>On the *Settings* Tab for each waveform you can select to add a noise effect, a filter, noise then filter (noise and filter), filter then noise (filter and noise). |
|  <br>  | As will be shown later, each analog waveform can be made of multiple segments and components. Through the "Remove" button it will be possible to delete a segment or component of the waveform. |

*Table 3: the Analog Waveform Tools menu*

## *The Waveform Standard Editor*




Press the 

button to open the Waveform Standard Editor.

The **Type** menu allows to select the waveform among a list of possible signals or functions. Depending on the selected Type, different parameter may be edited. The different possibilities include the following:

| Type | Available Parameters |
|---|---|
| DC Level | Offset [V] |
| Sine | Frequency[Hz/cycles], Amplitude[V], Phase[°], Offset[V] |
| Cosine | Frequency[Hz/cycles], Amplitude[V], Phase[°], Offset[V] |
| Triangle | Frequency[Hz/cycles], Amplitude[V], Phase[°], Offset[V] |
| Rectangle | Frequency[Hz/cycles], Amplitude[V], Phase[°], Offset[V], Duty Cycle [%] |
| Saw tooth | Frequency[Hz/cycles], Amplitude[V], Phase[°], Offset[V] |
| Increase Ramp | Amplitude[V], Offset[V] |
| Decrease Ramp | Amplitude[V], Offset[V] |
| Pulse | Amplitude[V], Delay[s], Width[s], Offset[V] |

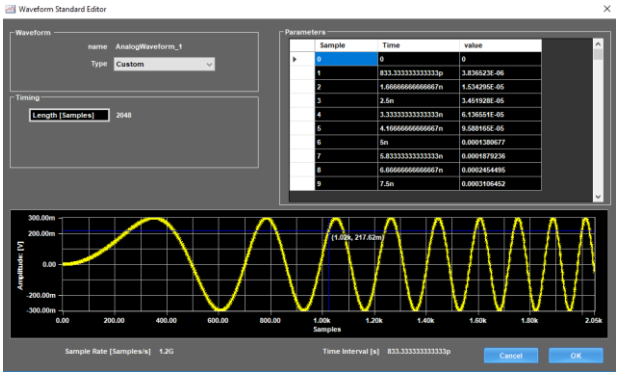
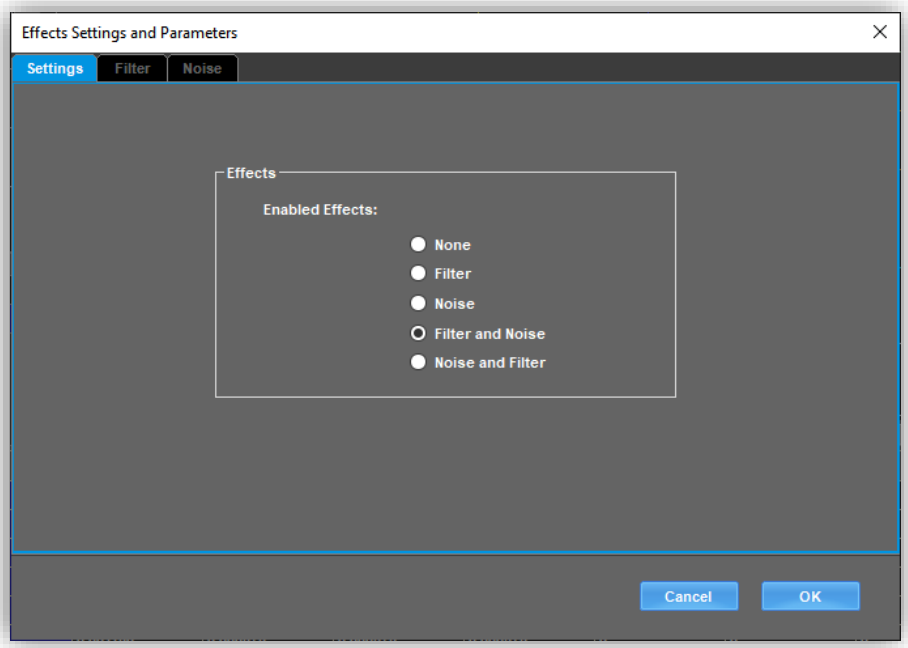
| | |
|---|---|
| Sinc | Amplitude[V], Offset[V], Peak Position[s], Lobe Width[s], |
| Exponential | Frequency[Hz/cycles], Vo[V], Vinf[V], Time Constant[s] |
| Sweep | Amplitude[V], Offset[V], Start Frequency[Hz], Stop Frequency[Hz] |
| Formula | Calculator Window |
| From File | Explorer Window |
| Custom | The waveform samples are specified in a table  |
| PRBS (PRBS pattern) | Amplitude[V], Offset[V],Equation, Invert |

*Table 4: standard editor parameters*

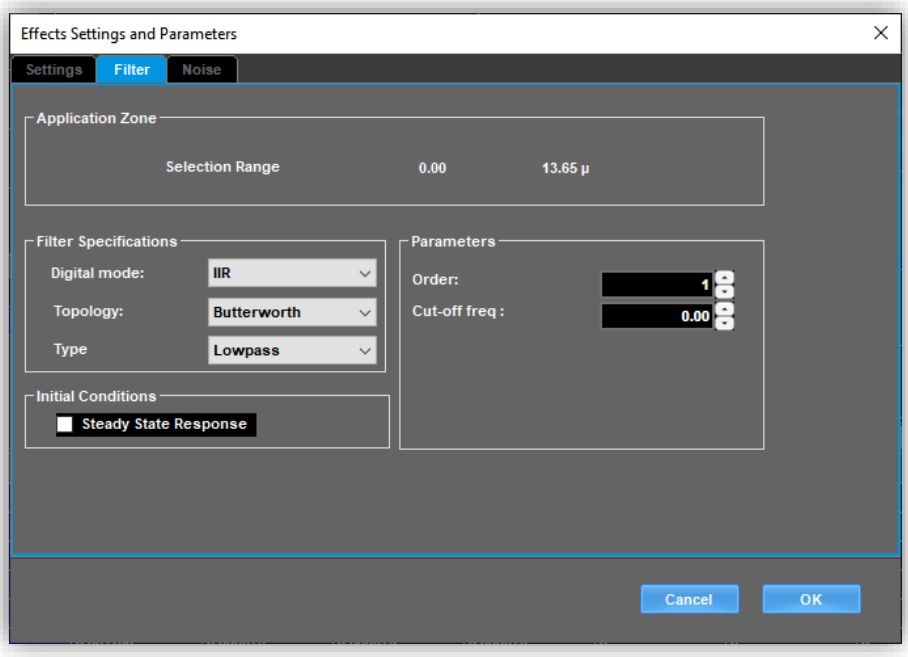
The Formula type allows defining the waveform by means of a mathematical expression.
The waveform is edited by using the Formula Editor window that can be activated by clicking the Edit Formula button. The mathematical expression can be a function of time or a function of samples by using the **t** or **x** variables, respectively. The software verifies, at run time, that the output of the formula does not exceed the limits of the selected output and that the formula syntax is correct. In case of error an Error message box will open showing the cause of the error.

### *Filters and Noise*




### *FILTER*

This section allows to apply a digital filter to the entire waveform or to a portion of it.
If you select the entire waveform by clicking on its name in the *Analog Waveform* Editor, the selection range indicators will display the entire waveform limits.
If you need to apply the filter to a limited part, click with the left mouse button and keep it pressed while dragging the cursor inside the graph area to create a rectangle that will define the waveform section to be filtered. The range of the selection will be shown in the Application Zone section.



### *FILTER Specifications*

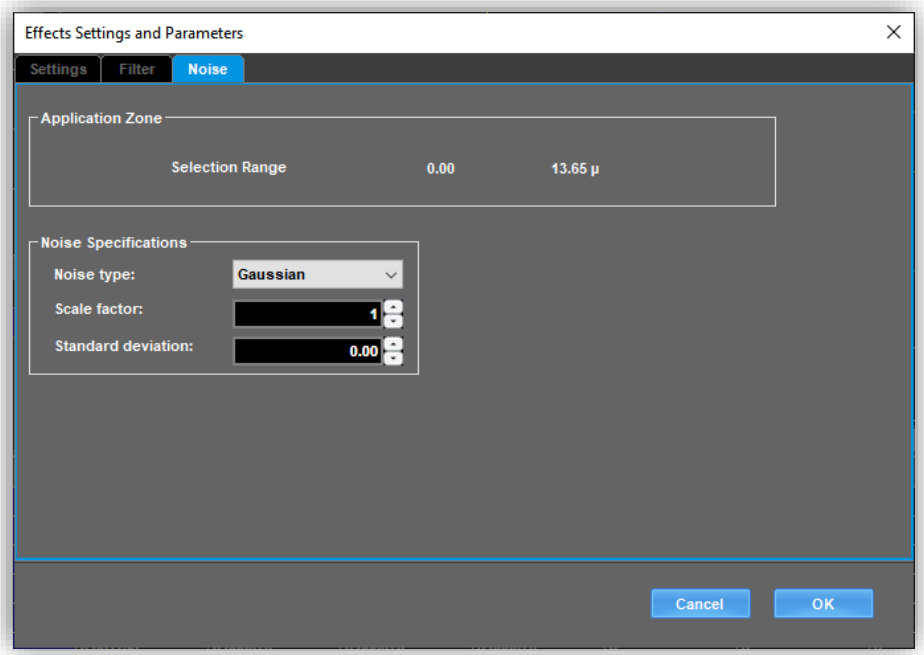
This section will define all the properties of the filter.

- **Digital Mode IIR (Infinite Impulse Filter)** - Bessel, Butterworth, Chebyshev, Inverse Chebyshev, and Elliptic.
- **Digital Mode FIR (Finite Impulse Filter)** - EquiRipple, Kaiser, and Windowed.
- **Type** - Low Pass, High Pass, Band Pass, Band Stop, and General.
- **Initial Condition** – Steady State Response means the output is in *steady-state*, since the input has fully engaged the filter.

Type, Topology and filter Order options depend on the specific filter characteristics.
By clicking the **OK** button a preview of the filter/noise effects applied to the waveform will be shown in the graph area.
You can remove a filter applied to a waveform by selecting the waveform and then pressing the *Noise Filter* button and choosing the **None** option in the Setting tab of the *Effect Setting and Parameters* window.

## *NOISE*

This TAB allows to apply a digital noise to the entire waveform or to a portion of it.

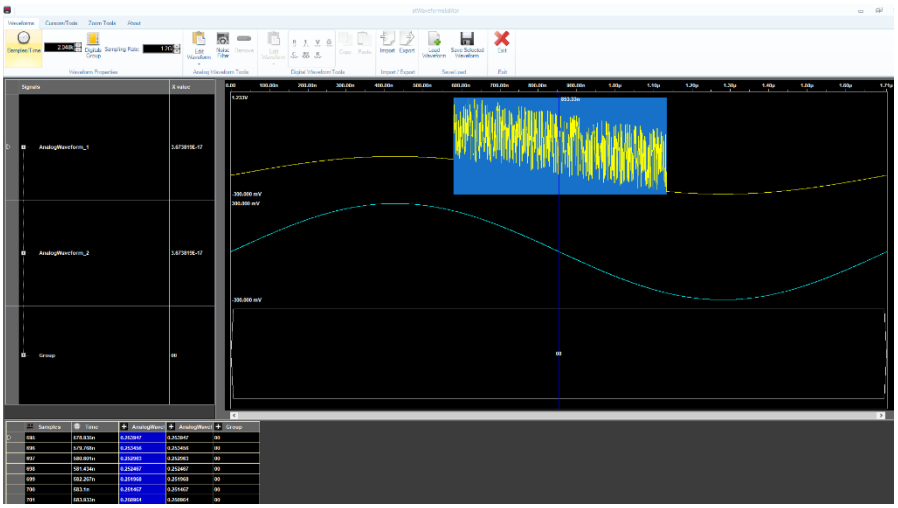



The Noise setting tab is divided into two sections: the Application Zone and the Noise Specification section.

## *NOISE Application Zone*

This section allows to apply a digital noise to the entire waveform or to a portion of it.
If you select the entire waveform by clicking on its name in the *Analog Waveform* Editor, the selection range indicators will display the entire waveform limits.
If you need to apply the digital noise to a limited part, click with the left mouse button and keep it pressed while dragging the cursor inside the graph area to create a rectangle that will define the

waveform section to be filtered. The range of the selection will be shown in the Application Zone section



### *NOISE Specifications*

This section defines all the properties of the noise.

**Noise Type** - Use this drop-down list to select the noise type: **Gaussian**, **Uniform**, and **White**.

Depending on the selected noise type, specific parameters (**Standard Deviation** or **Amplitude**) will be enabled together with the **Scale Factor** field, for increasing/decreasing the noise intensity.

By clicking the **OK** button, a preview of the filter/noise effects applied to the waveform will be shown in the graph area.

You can remove a filter applied to a waveform by selecting the waveform and then pressing the *Noise Filter* button and choosing the **None** option in the Setting tab of the *Effect Setting and Parameters* window.

## Digitals Waveform Tools

This toolbar contains several commands editing digital waveforms:

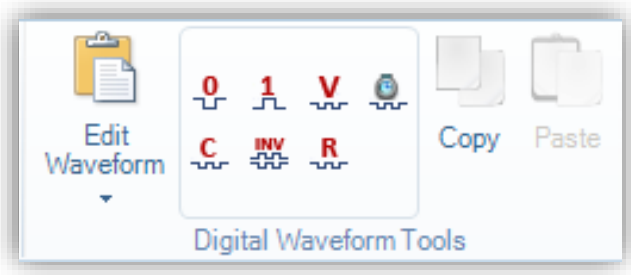
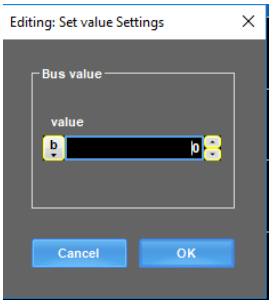
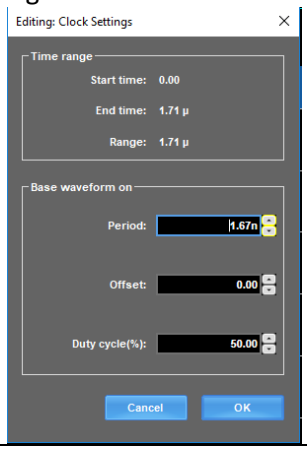



*Figure 32: the Digital Waveform Tools menu*

| | |
|---|---|
|  | Signal/bus to 0. |
|  | Signal/bus to 1. |

| | |
|---|---|
|  | Signal/bus to Arbitrary Value. Arbitrary Value allows overwriting a digital value over the entire selected waveform or a waveform interval or across one or more digital signals or groups.<br>Overwrite a node value using the following steps:<br>1. Select a digital signal or a bus and click the **Value** button on the Digital Editor toolbar. The **Arbitrary Value** dialog box appears.<br>  <br>2. In the Radix button, select the radix type.<br>3. Specify the new value that you want to overwrite in the numeric control.<br>4. Click OK. |
|  | Clock Editor for selected signal.<br>The Clock feature can be used to generate a digital clock waveform.<br>The start time, the end time, the period, the offset and the duty cycle of the clock signal can be defined.<br>  |
|  | Counter Editor for selected bus.<br>The counter editor applies a digital count value to a single signal or to a bus which increments its value by a specified about at a specified time interval.<br>It is possible to specify the starting value of the counter and the time intervals when it will increment. |

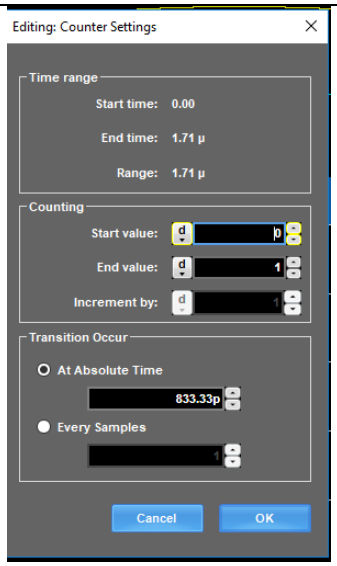
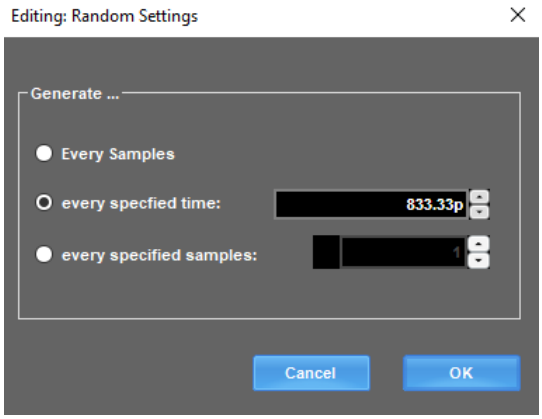
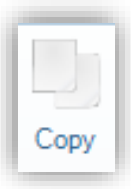
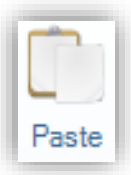
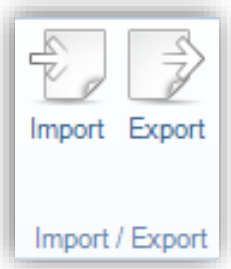
| | |
|---|---|
| |  |
|  | Inverts signal/bus value. |
|  | Random Value for signal/bus.<br>Random Value generates random values on a single digital signal or on a bus waveform. The random values cab be applied to the entire waveform duration or just in an interval or across one or more signals or groups.<br>Random node values can be generated at every sample or at every specified time interval or at every specified number of samples.<br>  |
|  | Copy Waveform.<br>Select the entire waveform clicking on the signal/bus name on the left column or select a portion of it with the mouse selection.<br>Press the **Copy Waveform** button to copy the waveform. |
|  | Paste Waveform.<br>Paste the copied waveform into a selected area of the graph (mouse selection) or from the start of another waveform. |

*Table 5: the digital waveform tools*

## Import and Export




### *IMPORT of Analog Waveform*

Data import functions allow to import waveform data created outside the arbitrary waveform generator. You can import data to create a new waveform or to replace existing waveform data.

The waveform editor supports the following file formats:
The supported file formats are:

- TXT - Tab separated value file
- CSV – Comma separated value file
- TRC – Teledyne LeCroy digital oscilloscope format
- MAT – Matlab .mat file format
- ISF
- WFM – Tekscope Series waveform (depend on scope model)
- PAT – AWG Series pattern file
- TFW - AFG3000 Series waveform file format
- RFD – RFXpress file format

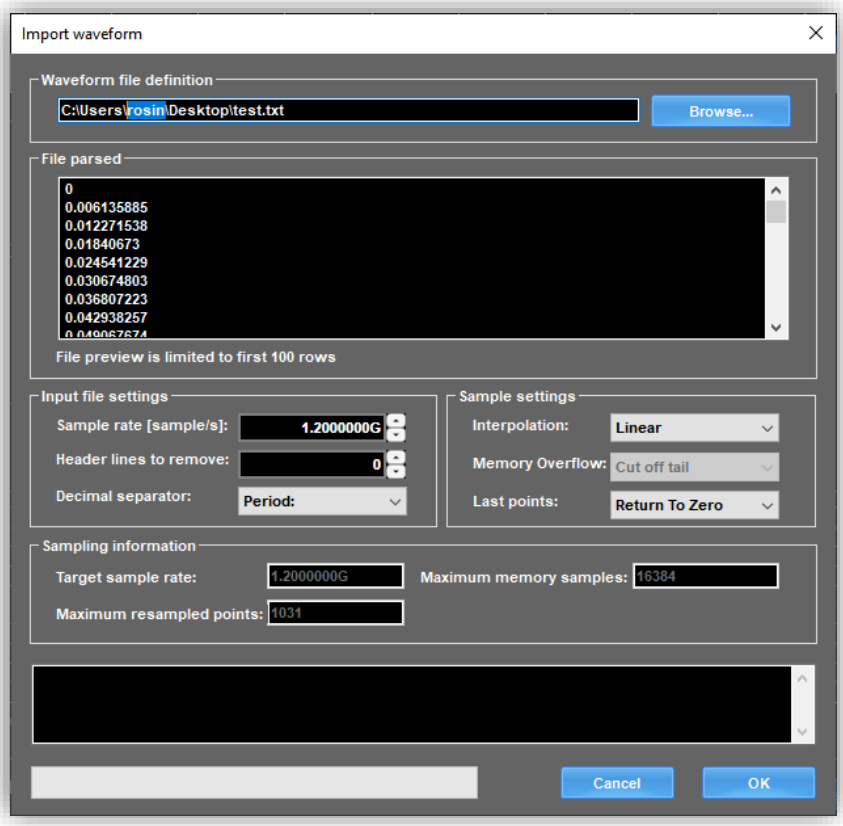
The Matlab file format needs to follow this format:

```
NumPoints = 2400; %Waveform length
t = (0:1:NumPoints-1)'; %Define t vector
waveform = single(sin(2*pi*1/NumPoints*t)); %Create single sinewave
%% Save Waveform
Waveform_Name_1 = 'SINE'; %Name Waveform
Waveform_Data_1 = waveform; %Assign waveform data
Waveform_Sampling_Rate_1 = 1.2e9; %You can specify sample rate in S/s
Waveform_Amplitude_1 = 0.300; %and amplitude in V
save('SingleCycleSine', '*_1', '-v7.3'); %Save all variables ending in _1 to .mat file
```

### *How to Import an Analog Waveform (TXT Files)*

- Select the destination Analog Waveform and press the Import button.

The import form will open




The following options are available on the Import Waveform form:

- Sample rate (sample/s): it is sampling rate of the samples that will be imported.
- Header lines to remove: the import file could have some header lines that needs to be removed before importing it.
- Decimal separator: it can be . or ,
- Interpolation: if the file sampling rate is different from the instrument sampling rate, you can choose the Interpolation method between Linear, Coerce and Polynomial.
- Memory Overflow: if the import file has more points than the current waveform, you can choose to cut off the last points ("Cut off tail") or the first points ("Cut off head")
- Last Points: Return to Zero means that the last points of the waveform will be zero in case the imported waveform is shorter than the actual total samples points.
  Otherwise if Last value is selected, it will maintain the last waveform sample.

If the imported TXT file has only one column, it will be interpreted as an analog waveform and so it will be imported applying the options above.

If the selected TXT file has more than one column, the following cases can happen:

1. TXT Mixed Waveform File with Header (#AO1,#0,#1…..,#n).

   The first column contains the analog data, while the other columns will be interpreted as the digital lines. Please note that the digital lines that will be imported depend on the number of lines available in the current project. For example if the header is #AO1,#0,#1…..,#15, but the project has 8 digital lines, only the first 8 digital lines will be imported according to the header.

2. .TXT file: 2 columns without header.

   The first column will be imported as an analog waveform while the second column will be imported as DO0(Marker1).

3. .TXT file: 3 columns without header.

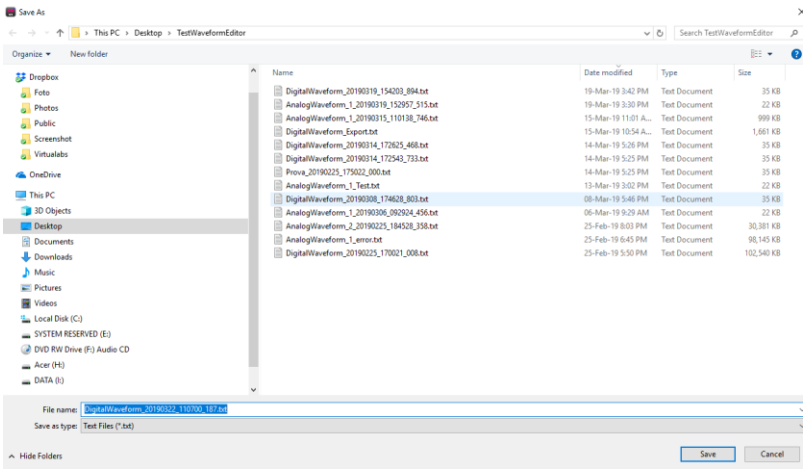
   The first column will be imported as an analog waveform while the second column will be imported as DO0(Marker1). The third column will be ignored.

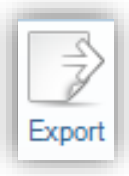
4. .TXT file: more than 3 columns without header.

   The first column will be imported as Analog data, the other columns will be imported as digital lines.
   #Analog,#D0,#D1,#D2,#D3,#D4…….

### *EXPORT of Analog,Digital*

Press the Export  button to open *the Export Waveform* window:






### *EXPORT of Analog/Digital waveforms*

If an Analog Waveform is selected in the Waveform Editor, the Export file format for the analog waveforms is a one column comma separated file where the values in the column represent the samples of the selected analog channel.
The first two rows of the exported file is a header that represent the sample rate and the number of samples (# Sample rate: 1200000000 # Samples: 2048).
The exported values representation is double.

If a Digital Waveform is selected in the Waveform Editor, the Export file format for digital waveforms is a multiple column comma separated file where the values in each column represent the samples of one digital channel.
The first row of the file is a header that represent the number of the digital channel (#0,#1,#2……..,#7) associated to the logical name.

Example 1(POD A 8 digital lines):

***#0,#1,#2,#3,#4,#5,#6,#7***

*0,0,0,0,0,1,0,0*

*0,0,0,0,0,1,0,0*

*0,0,0,0,0,1,0,0*

*0,0,0,0,0,1,0,0*

*0,0,0,0,0,1,0,0*

*0,0,0,0,0,1,0,0*

*0,0,0,0,0,1,0,0*

*0,0,0,0,0,1,0,0*

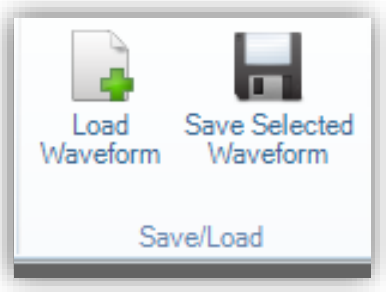
*0,0,0,0,0,1,0,0*

*0,0,0,0,0,1,0,0*

*Table 6: export of Analog/Digital waveforms*

Please note that the import/export operation can be quite slow with large amount of data to import or export.

## Save and Load




This toolbar allows to load and save waveforms from/to the TrueArb application.

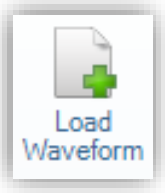
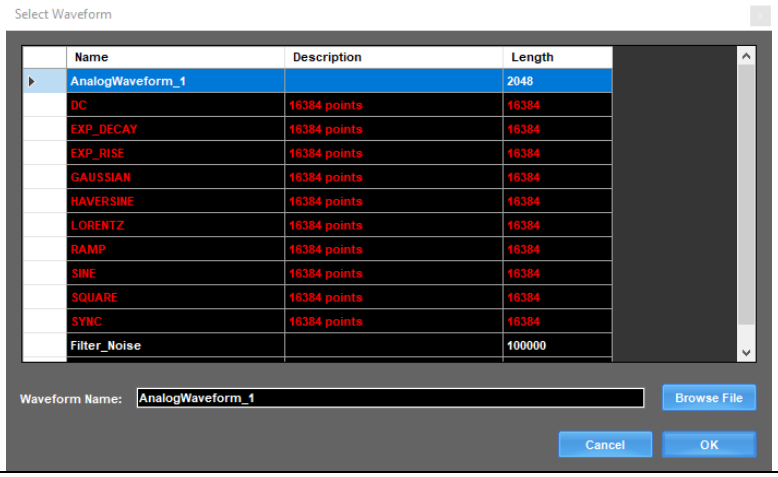
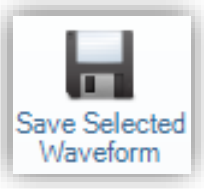
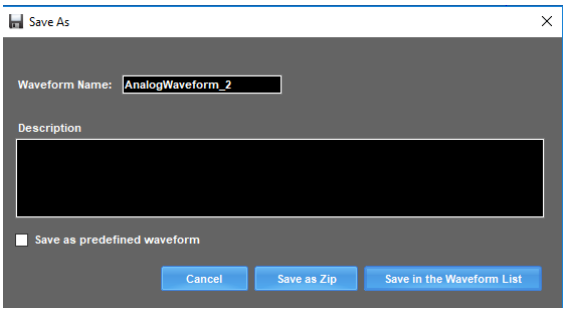
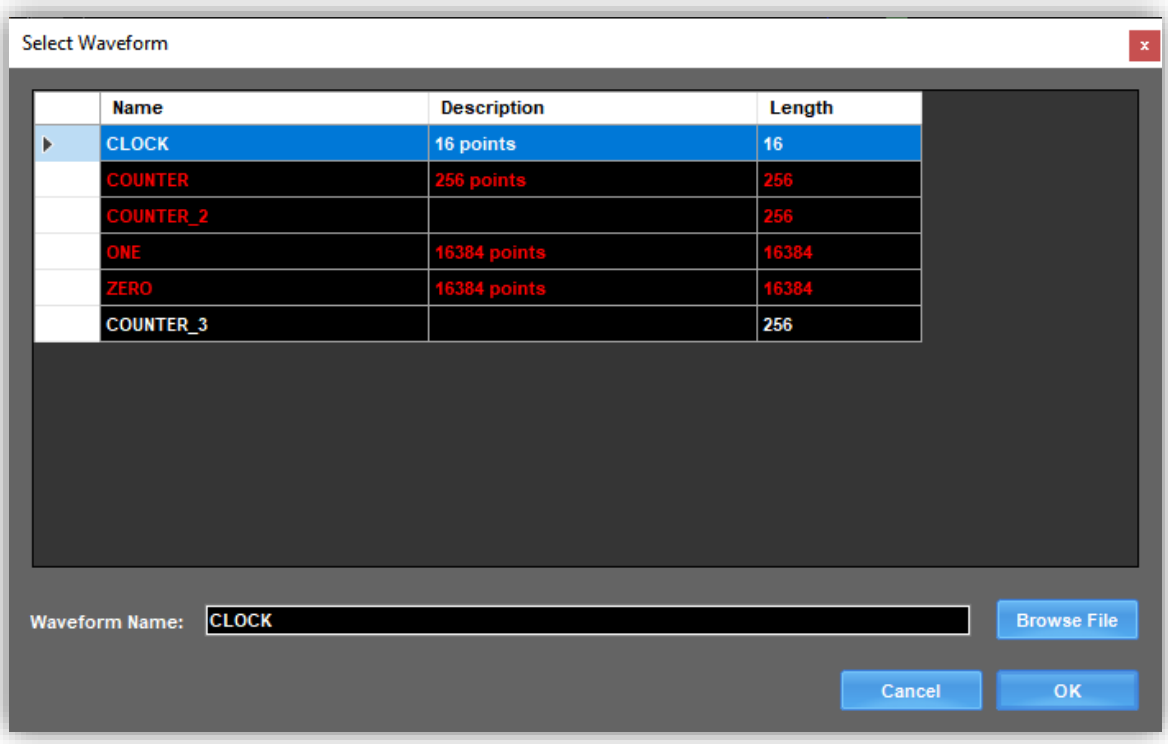
| | |
|---|---|
|  | **Load Waveform**<br>If the Waveform Editor in used in "Offline mode", the Load Waveform button allows to load .zip files previously saved with the TrueArb application. The Zip files are in proprietary binary format that can contain both analog or digital waveform data.<br><br>If the Waveform Editor works in "Integrated Mode", by pressing the Load Waveform button the Select Waveform form will open.<br>This window contains the list of the analog and digital waveforms available in the TrueArb application.<br><br>  |
|  | **Save Selected Waveform**<br>By pressing this button, the Save As form will open. This window allows to save the selected analog or digital waveform in Zip binary proprietary format or in the TrueArb waveform list.<br><br>  |

*Table 7: Save and Load*

### *Load*




Please note:
The length of the waveform that will be loaded from the TrueArb waveform list or from a file can be longer or shorter than the current one and the loaded waveform needs to be **adapted** to be inserted into the Waveform Editor.

If the loaded waveform is longer than the current waveform there are three options to adapt it:

- Decrease the current waveform length to that of the loaded waveform length
- Cut the tail of the loaded waveform
- Cut the head of the loaded waveform

If the loaded waveform is shorter than the current waveform there are four options to adapt it:

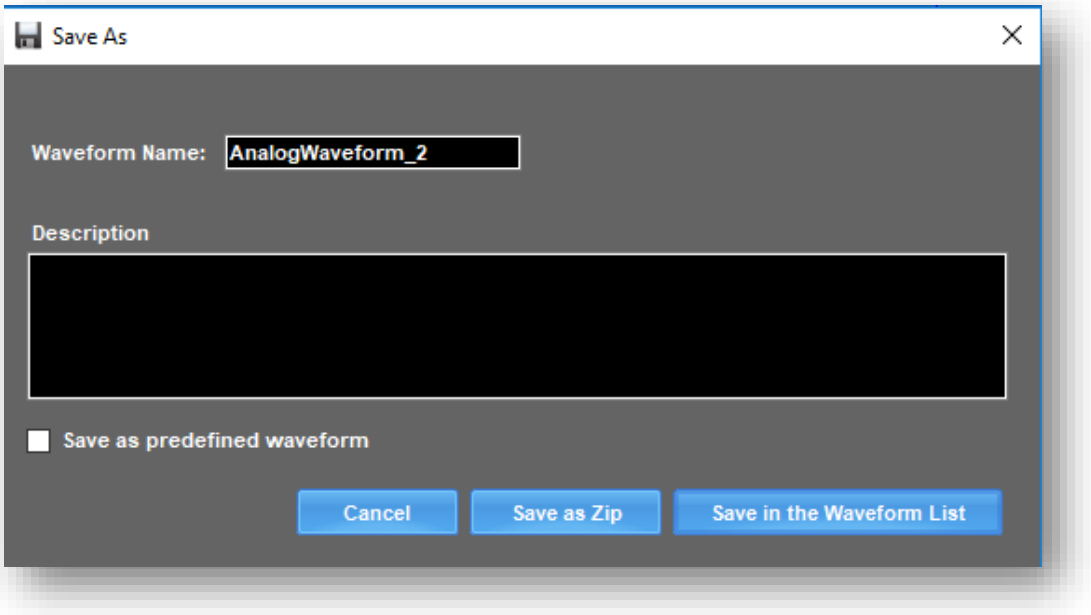
- Increase the current waveform length to that of the loaded waveform length
- Fill the head of the waveform with the first sample of the loaded waveform
- Fill the end of the waveform with the last sample of the loaded waveform
- Fill the end of the waveform with zeros

The **structure** of the waveform (Segments and Components) will be maintained only if the "Adapt the current length" option is chosen.

### *Save As*

Pressing the 

button the "Save As" window will open.




This window allows to save the selected analog or digital waveform in the proprietary binary Zip file or directly in the TrueArb waveform list.

Please note the following:

- **Waveform Name**: by default, this textbox contains the name of the selected analog or digital waveform and it can be changed as preferred.
  If the waveform name is already present in the waveform list it is not possible to save it as predefined and the "Save as predefined" checkbox will not appear.
- **Description**: it provides a description of the waveform that will appear on Description field of the TrueArb Waveform List.
- **Save as Zip**: pressing this button the analog/digital waveform is saved in a proprietary binary Zip format. The Zip waveform file can be loaded in the True Arb application by pressing the Import button in the Waveform List page and then selecting the Zip file.
- **Save in Waveform List**: by pressing this button it is possible to save an analog/digital waveform directly in the TrueArb waveform list. As soon as the waveform is saved into the list, the waveform is automatically updated into the TrueArb application. This button is only available in Integrated mode.
- **Save as predefined waveform**: this checkbox allows to save the waveform as predefined in the TrueArb waveform list. This checkbox will disappear if the waveform is already present in the TrueArb waveform list.

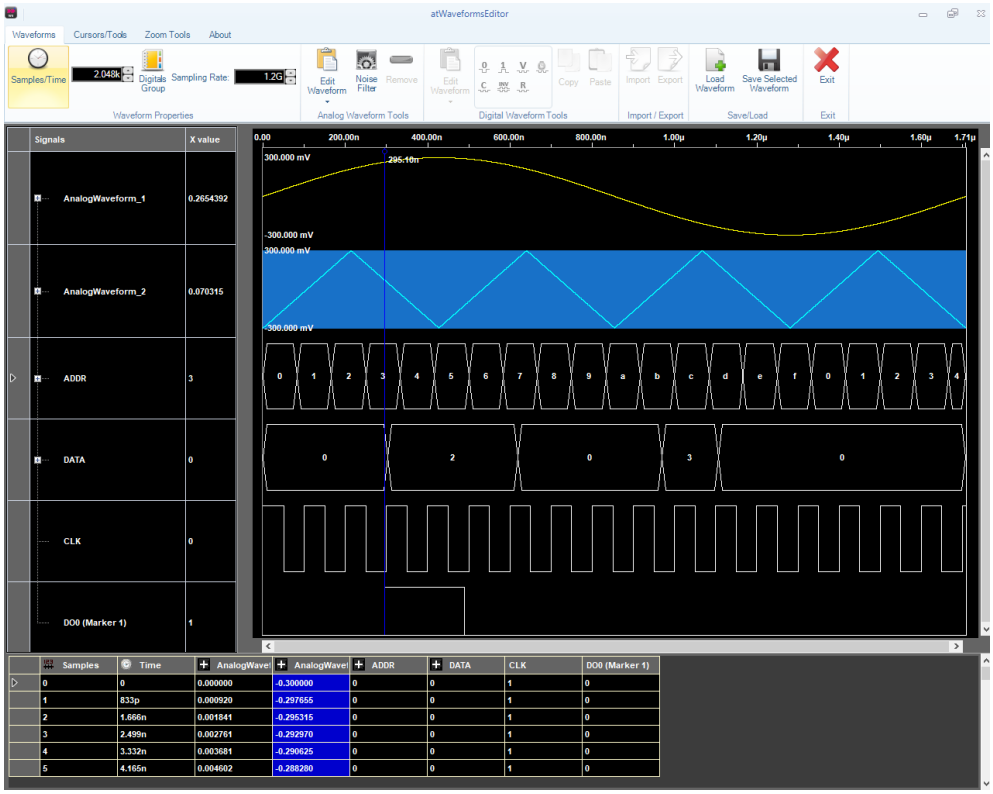
# The Waveform Graph Editor


The **Waveform Graph Editor** screen is used to create or edit *analog* and *digital* waveforms in a graphic format.

Single signals are displayed as analog or digital signals, while grouped signals are represented as buses.

It is possible to edit simultaneously 2 analog waveforms and 8 digital channels.

It is possible to save one analog waveform at a time.




## Analog Waveform Editor

### *Analog Waveform*

An **analog waveform** is a sequence of elementary **Segments** that are in temporal succession. The segments combine in temporal succession to create the final waveform.
Each segment is made of one or more **Components**. All the component of one segment have of the same length and they share the same time frame. The components of one segment combine by means of by means of an elementary operation (Add/Subtract/Multiply) to create the final segment.
By selecting the waveform or one segment or one component or just a portion of them (selection operations
are described below) and then pressing the **Edit Waveform** button it is possible to define a basic waveform like DC Level, Sine, Increase Ramp, Triangle, Sawtooth, Rectangle etc. The basic waveform definition will propagate down in the waveform sub-structure that starts from the selected element and will be assigned to all the components contained in the bottom of the sub-structure.
By default, a waveform is made of just one segment and component. To generate more advanced waveforms additional segments can be added to the waveform or mode components can be added to a segment

### ***Segment***

A Segment contains one or more Components, all the same length, that are combined by means of an elementary Add/Subtract/Multiply operation (***OP***).
If one Segment contains more than one Component, the following formula will be applied:

Segment = Component1 ***OP*** Component2 ***OP*** Component 3 … ***OP*** Component N
where ***OP*** = Add/Subtract/Multiply

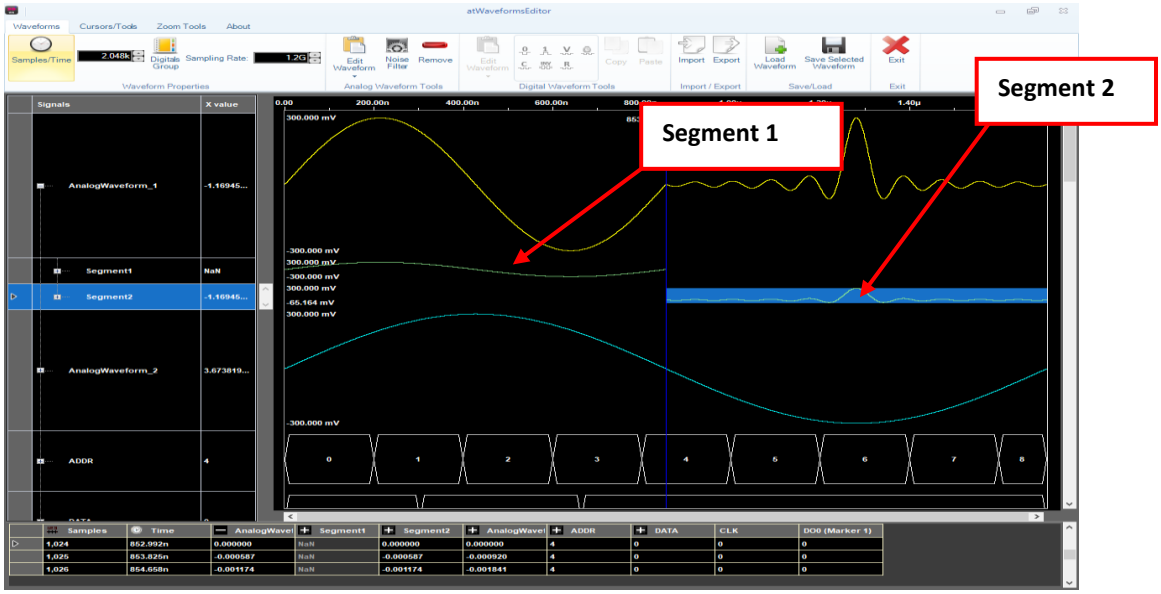
***Component***

A Component is the basic element for the definition of a Segment. Each Component can be represented by a standard waveform (DC Level, Sine, Cosine, Exponential, Triangle, Rectangle, Ramp, Pulse, Sinc, Sawtooth, Sweep, Formula) or by a raw list of samples defined manually or loaded from a text file.

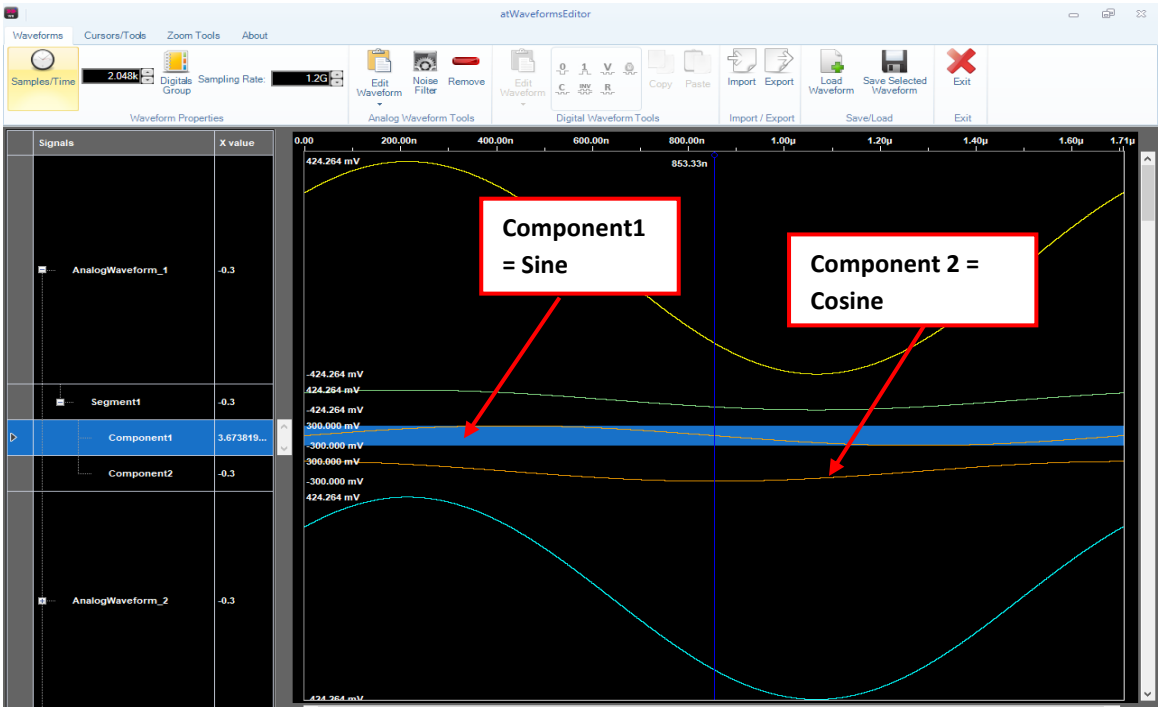
The samples of a component generated by a standard waveform will depend on the current sample rate and on the length of the component (number of points).

So in synthesis a waveform is a list of **Segments**, where each segment can contain one or more **Components**, all the same length, combined by means of the an elementary Add, Subtract, Multiply operations.

Each waveform may be constituted by an arbitrary number of segments and each segment can have its own length.




The waveform in the picture above is the composition of two segments. Each segment is made of one component.




The waveform in the picture above is made of one segment. The segment is the composition of two Components multiplied together: Segment1 = Component1 * Component2.
You can use this technique for example to generate **IQ** modulated signals.

The **Selection**, **Left Click**, **Right Click** operations (described in detail below) can be performed on waveforms, segments and components. Drag and Drop operation between analog waveforms is not allowed.

***LEFT CLICK AND SELECTION***

- Click the left mouse button on the analog *Signals cell* to select the entire waveform that will be enlightened in blue.
- Click the left mouse button then drag the mouse inside the graph area to create a rectangle delimiting the waveform section. Waveform editing and Noise/Filters can be applied within the selected rectangle only.
- Click the left mouse button on the analog Signals cell tree item 

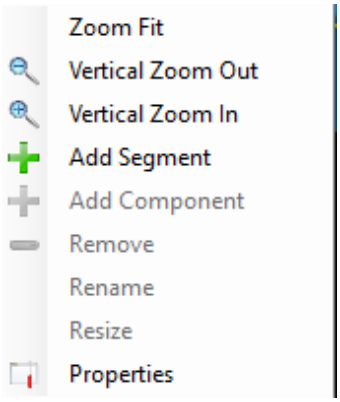
to expand/collapse the segment structure of the waveform.
- Click the left mouse button on the Segment tree item 

to expand/collapse the component structure of the single segment.
- Resize the signal amplitude by dragging the line between two signal name cells.
- The column at the right of every analog signal shows the value of the signal at the time position of the master cursor.

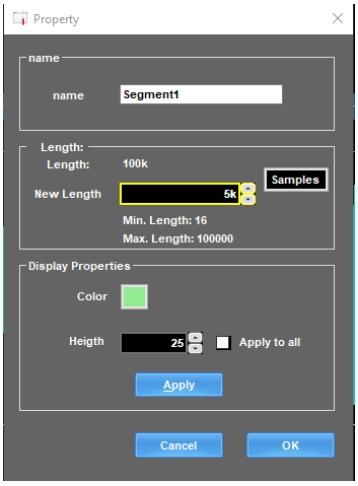
***RIGHT CLICK***

Clicking the right mouse button on a Waveform tree item activates a pop-up menu with different available options depending on the selected item, Waveform or Segment.

If the item is an analog waveform the pop-up appears as follow:




- **Zoom Fit** – Resets the Vertical Zoom
- **Vertical Zoom Out** –Zoom out function.
- **Vertical Zoom In** – Zoom in function.
- **Add Segment** – To add a segment the existing segments must be resized or deleted to free space for the new segments.
  For example, with a 10k sample waveform made of a single segment to add a second segment the following operations muse be performed:
  - Right click on the existing segment to activate the pop-up menu and select *Property*. The Segment1 Property window is shown: resize the Segment1 length from 10K to 5K. Press the OK button.

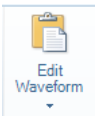



  - Right click on the Waveform or on the existing Segment to activate the pop-up menu and select Add Segment.
    The Segment2 Property window is shown. Insert the new segment length and press OK. The new segment will be added to the waveform.

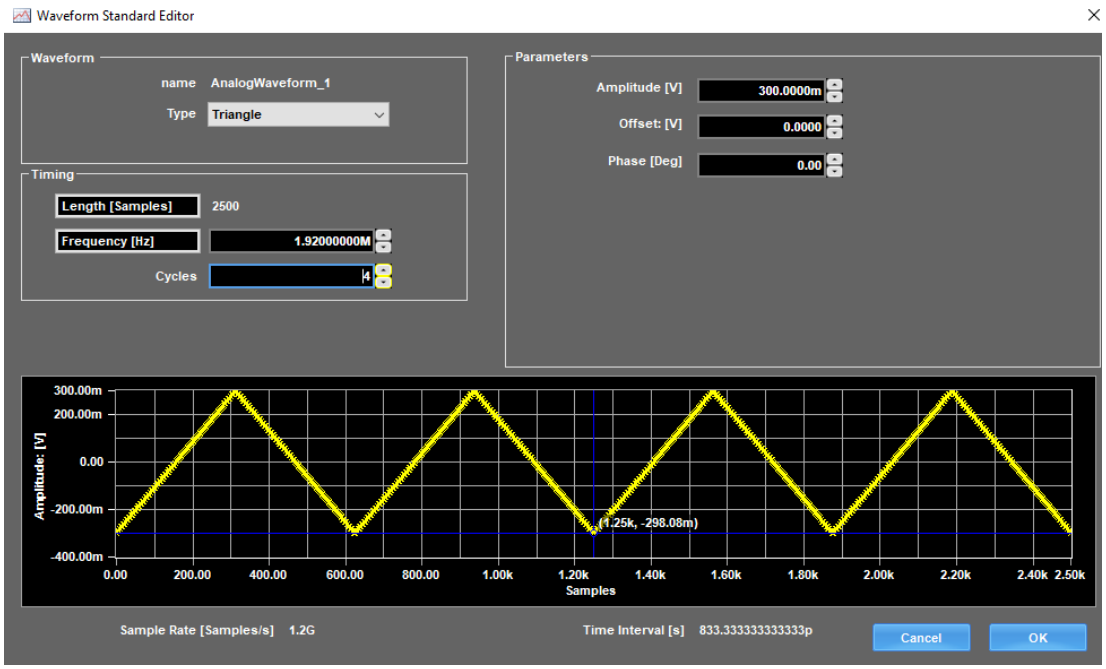
    **NOTE**:
    If you select the *Add Segment* option from the Segment pop-up menu, the new segment will be added at the end of the waveform. On the contrary if you select the *Add Segment* option from the Waveform pop-up menu the new segment will be added at the beginning of the waveform.

- **Add Component –** Adds a Component at the selected Segment.
- **Remove –** Removes the selected Segment or Component.
- **Rename –** Renames the selected Segment or Component.
- **Resize –** Resizes the selected Component.

## *How to create a Standard Analog Waveform*

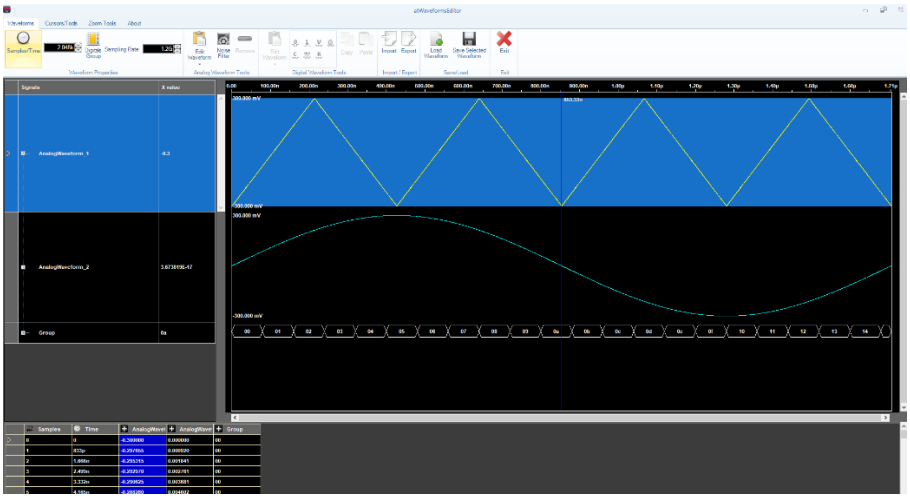
- Select an Analog Waveform on the Analog Waveform Editor
- Press the **Edit** button 

and the Waveform Standard Editor Window is shown



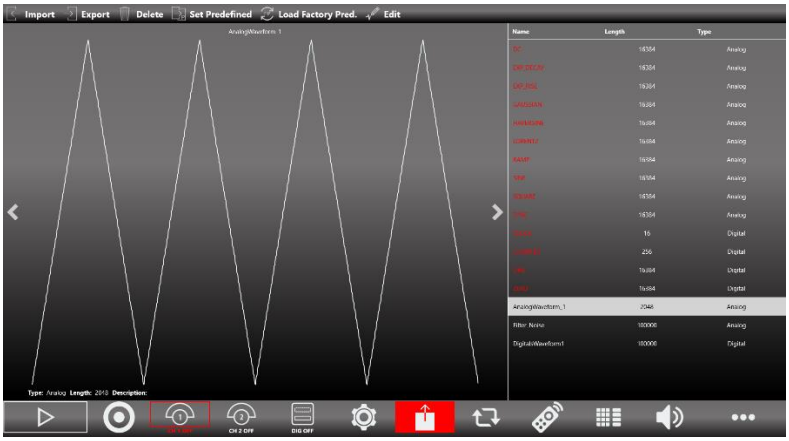

This window allows editing standard waveforms/segments/components parameters.

- Select Triangle with 4 cycles.
- Press the OK button to confirm.

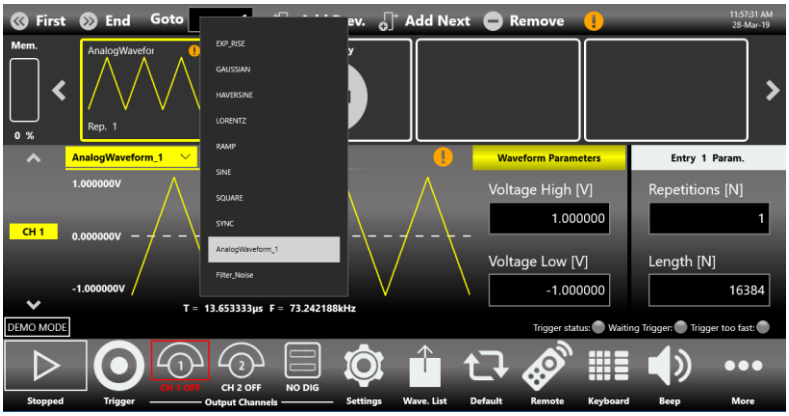


- Now the Standard Waveform is ready to be used in your Arbitrary Waveform Generator.
- Press the Save Selected Waveform Button 

. The Save As form will open.
  If you are working in Integrated Mode, select Save in the Waveform List.
- The waveform "AnalogWaveform_1On" will automatically appear on the Waveform List of the TrueArb application.

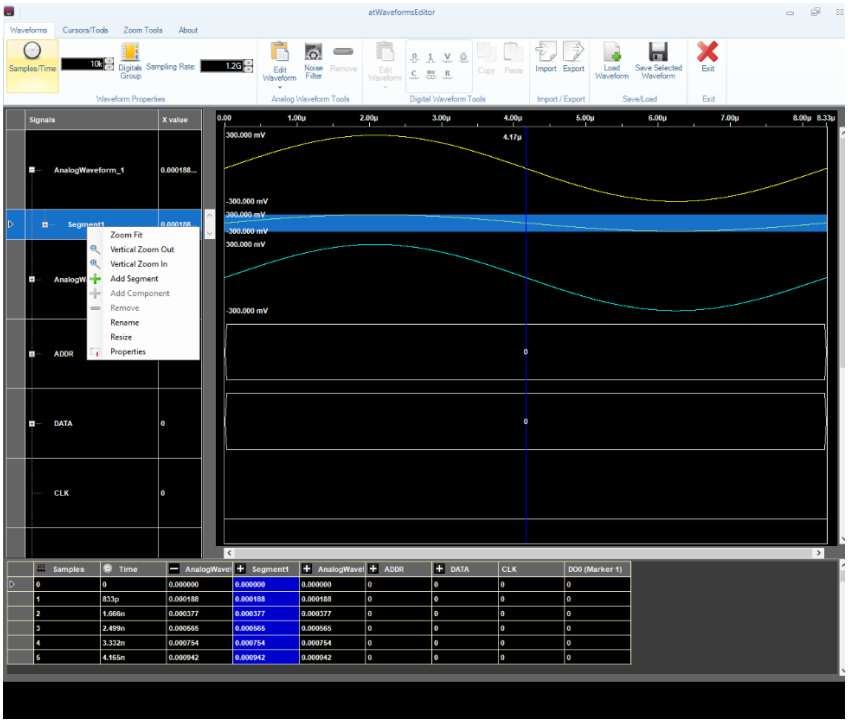



- Now the "AnalogWaveform_1" is ready to be inserted into the sequencer.



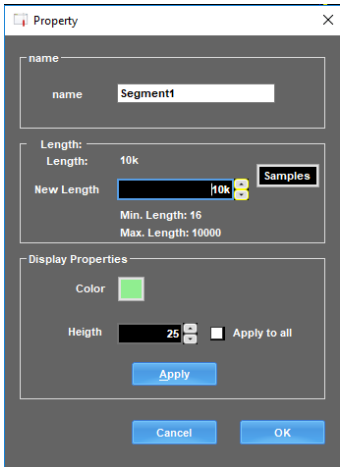

## *How to create an Advanced Analog Waveform*

- Open the Waveform Editor and change the Waveform length to 10k
- The **Waveform Editor** is shown. Right click on Segment1 of the AnalogWaveform_1 to open the pop-up menu.

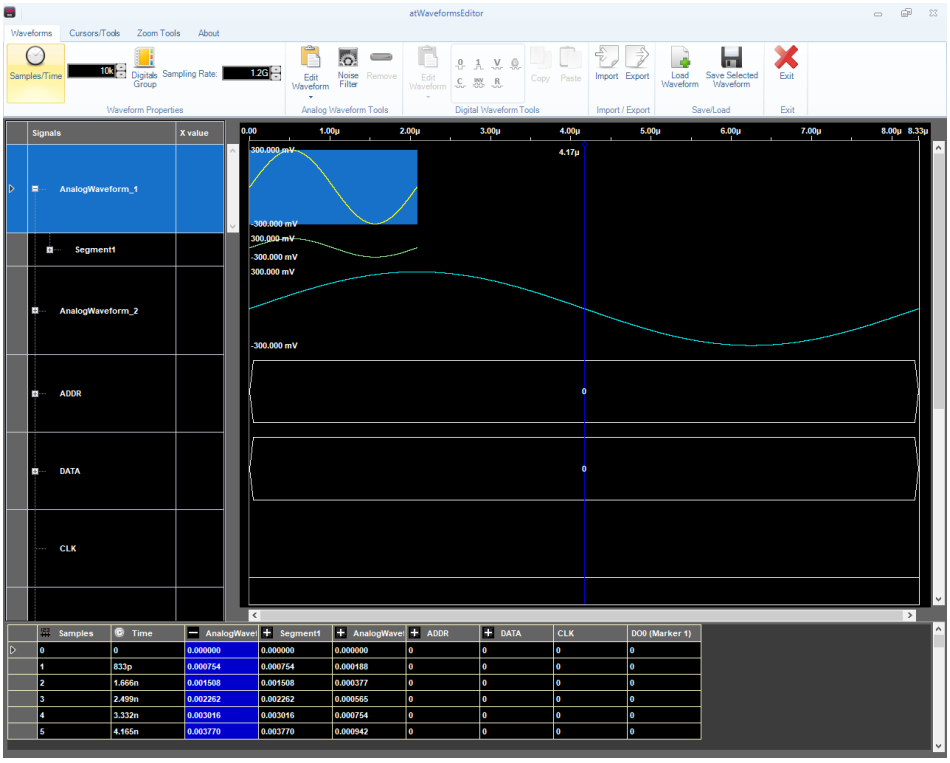



- Select **Properties** on the pop-up menu.

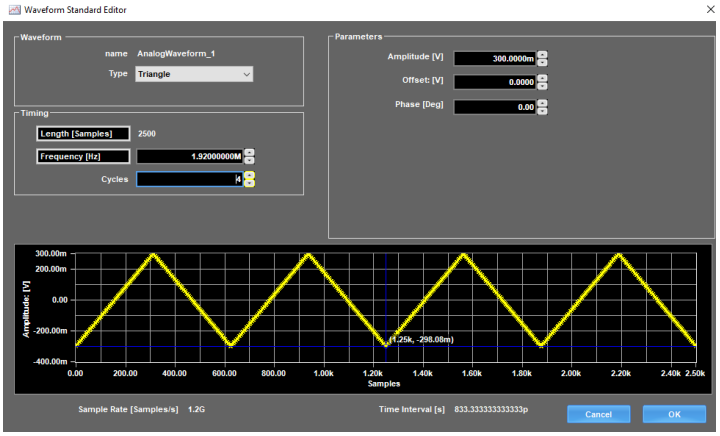
- Change the segment length: insert 2.5k in the New Length field.




- The AnalogWaveform_1 and the Segment1 will be re-sampled to match the new length.



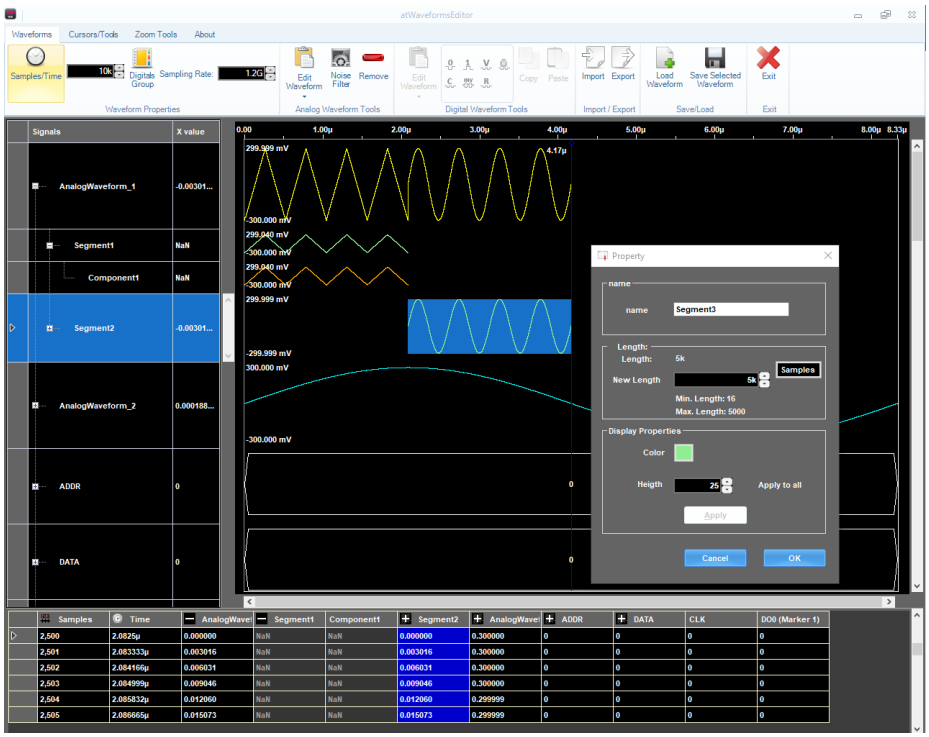

- Select the Segment1 and click the **Edit Waveform** button on the toolbar.
- The Standard Waveform Editor window will open.



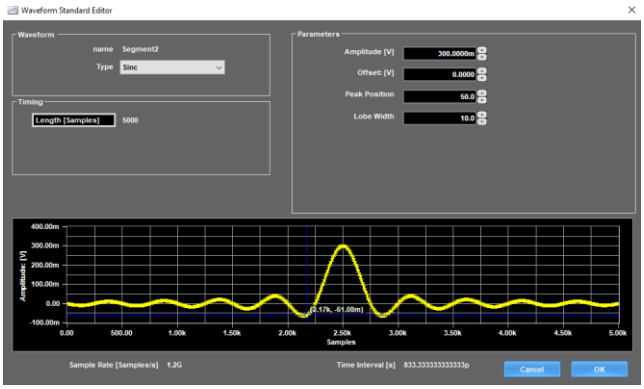

- Select Triangle as waveform Type and 4 as number of Cycles. Click **OK**

- Right click on the Segment1 of AnalogWaveform_1 to open the pop-up menu and select **Add Segment**. The Property window will open. Select 2.5k as Segment2 length, select Sine Wave as waveform Type and change the color. Click **OK**

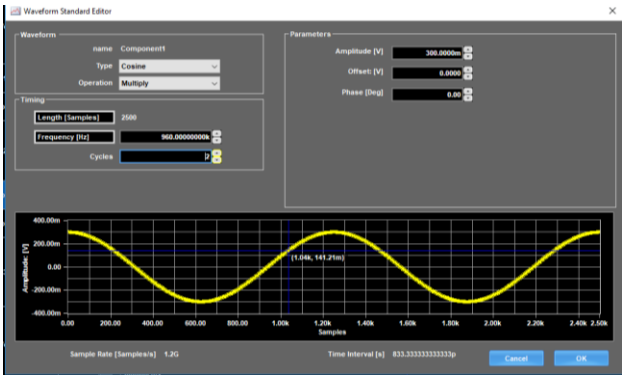
- Right click on the Segment2 of AnalogWaveform_1 to open the pop-up menu and select **Add Segment**



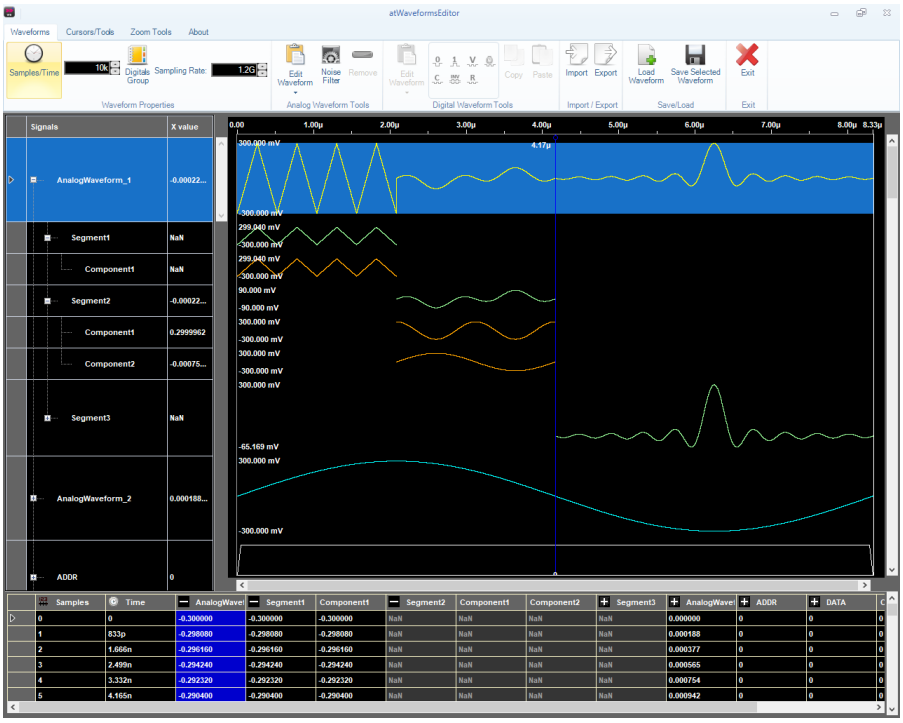

- The Property window is shown. Select 5k as Segment3 length and change the color. Click **OK**.
- Select the Segment3 and click the **Edit** button on the toolbar.




- The Waveform Standard Editor will open. Select Sinc as waveform Type. Click **OK**.
- Right click on the Segment3 of AnalogWaveform_1 to open the pop-up menu then select **Add Segment**.
- Right click on the Component1/Segment2 of AnalogWaveform_1 to open the pop-up menu then select **Add Component**
- Select the Component 1 and press the Edit Waveform button. The Standard Waveform Editor window will open. Select Cosine as waveform Type and Multiply as Operation. Press **OK**.

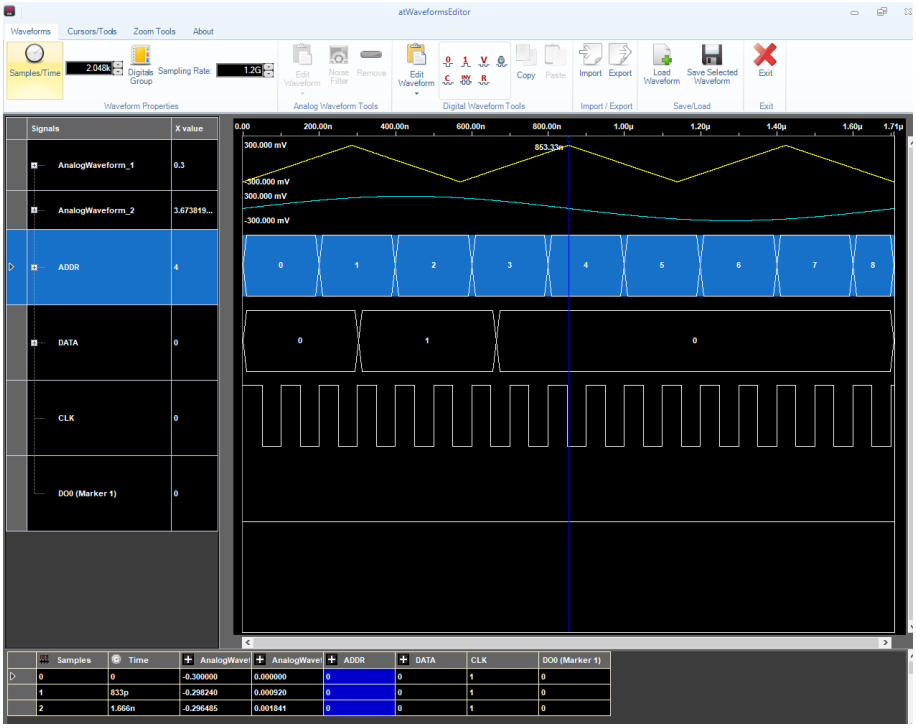



- The **Advanced Waveform** is now ready to be transferred to the TrueArb application.



## Digital Waveform Editor

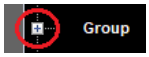
The instrument can be configured to work as a powerful Digital Pattern Generator.
It provides the capability to emulate standard serial or parallel bus transitions or custom digital interfaces for system debugging and characterization.




Single signals are displayed as digital signals, while grouped signals are represented as buses.
It is possible to change the name of the signals and create / rename buses pressing the **Digitals Group**  button on the *atWaveformEditor* command bar.

The **Selection**, **Left Click**, **Right Click** operations can be performed on digital single signals or buses. Drag and Drop operation between digital waveforms is not allowed.

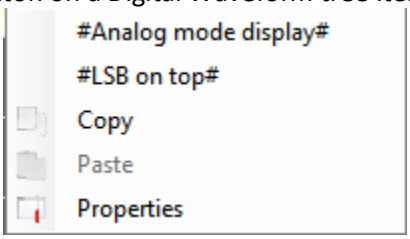
***LEFT CLICK AND SELECTION***

- Click the left mouse button digital *Signals cell* to select the entire digital single signal or bus that will be enlightened in blue.
- Click the left mouse button then drag the mouse inside the graph area to create a rectangle delimiting the digital waveform section. Digital Waveform editing tools can be applied within the selected rectangle only or on the entire waveform.
- Click the left mouse button on the digital Signals cell tree item 

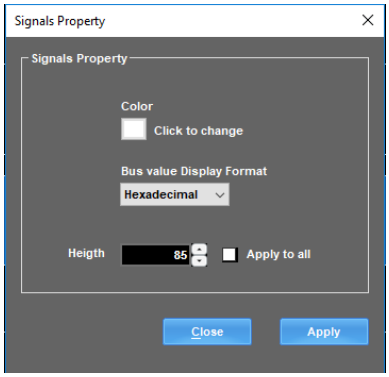
to open/close the bus.
- Resize the digital signal amplitude by dragging the line between a signal name cell.
- The column at the right of every digital signal or bus shows the value the signal or bus at the time position of the master cursor.

***RIGHT CLICK***

Clicking the right mouse button on a Digital Waveform tree item will open a pop-up menu:

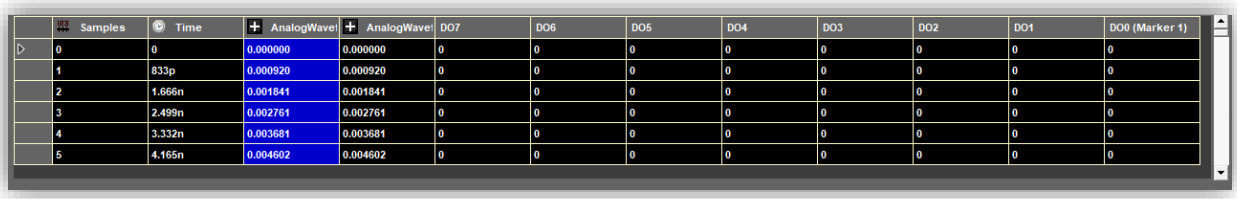



- **Analog mode display** - This option (available only for buses) will represent a bus as an analog waveform. This is useful if an ADC or a DAC must be tested.
- **Properties-** Opens the digital waveform Property Window to change signal/bus colors, plot height and the display format of the bus value.



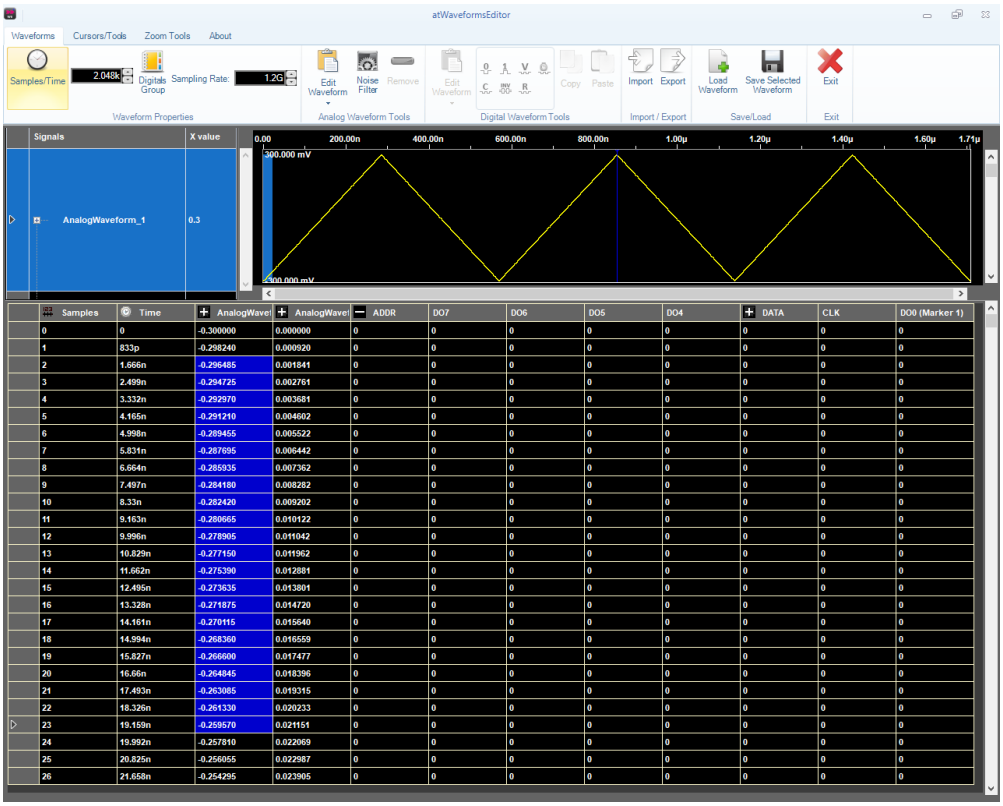

- **LSB on Top** - Bus values are calculated considering the bit at the Top of the bus as the MSB. Select LSB to make the bit at the Top of the bus as the LSB.
- **Copy -** Copy Waveform. Copies the entire waveform clicking on the signal/bus name on the left column or just a section of it if only a portion of the digital waveform is selected.
- **Paste -** Paste Waveform. Paste the copied waveform into a selected area of the graph (mouse selection) or from the beginning of another waveform.

## The Data Editor



| | Samples | Time | AnalogWave | AnalogWave | DO7 | DO6 | DO5 | DO4 | DO3 | DO2 | DO1 | DO0 (Marker 1) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ▷ | 0 | 0 | 0.000000 | 0.000000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 1 | 833p | 0.000920 | 0.000920 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2 | 1.666n | 0.001841 | 0.001841 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 3 | 2.499n | 0.002761 | 0.002761 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 4 | 3.332n | 0.003681 | 0.003681 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 5 | 4.165n | 0.004602 | 0.004602 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

The Data Editor can be used to edit analog/digital signals and bus values in tabular format. Data is visualized numerically in columns. Values can be edited point by point like in a spreadsheet editor.




The Data Editor contains the following two additional columns:

- **Samples** - Shows a progressive index of the waveform samples.
- **Time** - Shows the progressive absolute time of every sample.

### *BUSSES*

A bus node is indicated by the **Expandable Bus** icon located on the left of the bus name.

When expanding an *analog waveform* its segmented structure is shown. When expanding a segment its component structure is shown. When expanding a *digital bus* all the single digital lines of the bus are shown.

To expand a bus double click the  icon. To collapse a bus double click the  icon.

The **Selection**, **Left Click**, **Right Click** operations can be performed on table. Drag and Drop operation between table columns is not allowed.

### *LEFT CLICK AND SELECTION*

- Click the left mouse button on the signal name to select the entire analog/digital single signal or bus that will be enlightened in blue.
- Click the left mouse button then drag inside the table cells to create a rectangle delimiting the analog/digital waveform section. Analog or digital waveform editing can be applied just on a selection or on the entire waveform.
- Keep pressed the left mouse button on single cell to edit the value.
- Resize the column amplitude by dragging the line between two signal names.

The digital values in the table can be changed by pressing Digital Editor Waveform toolbar buttons or writing directly the value on the data grid. Multiple value can be selected and edited simultaneously by using the Digital Waveform Editing tools in the toolbar.

To Export digital data click on the export menu  icon. Digital data will be exported into a .txt file; the file is comma separated with a header on the first line.

To Import digital data, click on the import menu  icon. Digital data import format is a .csv or .txt; the file is comma separated with a header on the first line.

**NOTE:**

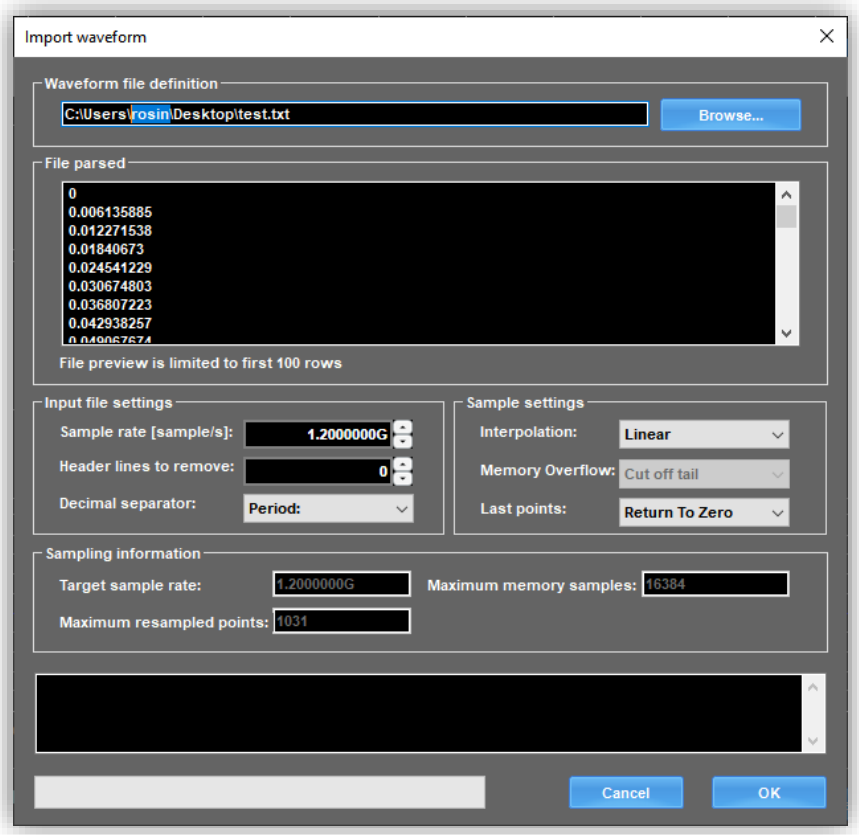
- The disabled cells in the Digital single signals/buses are not editable.
- The changes made on the table cells will automatically update also to the Mixed Waveform.

The analog values in the table can be changed by pressing Analog Editor Waveform toolbar buttons or writing directly the values on the data grid. Multiple values can be selected and edited simultaneously by using the Edit Waveform or Noise Filter buttons in the toolbar

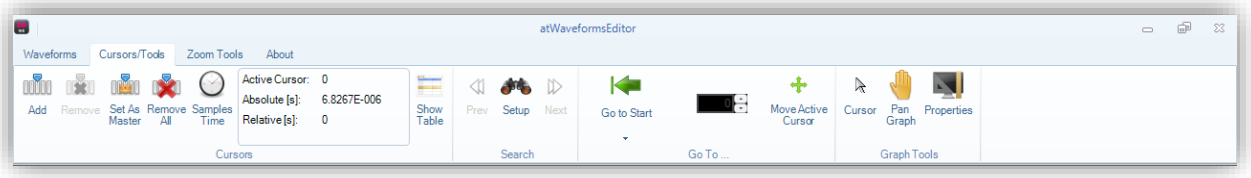
*Effects…* menu item will open the Filter & Noise window and *Search…* item will open the "Search Settings" window.

To Export analog data, click on the export menu  icon. Analog data will be exported into a .csv file; the file is comma separated with a header on the first line that represents the Sample rate and the number of samples.
*# Sample rate: 1.2E+09*
*# Samples: 16000000*

To Import analog data, click on the import menu  icon. The analog data import format is a .csv or .txt; the file is comma separated and it can have a header on the first line.
The Import Waveform window will open. Please refer to the Import File section for a detailed description of the import options.



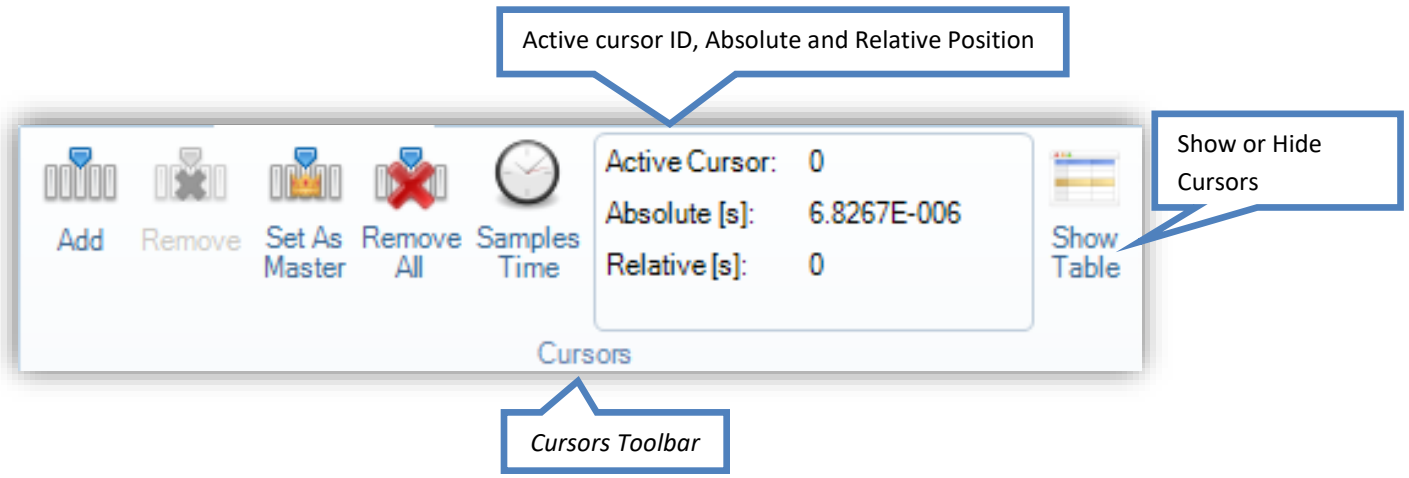

## The Cursor Menu



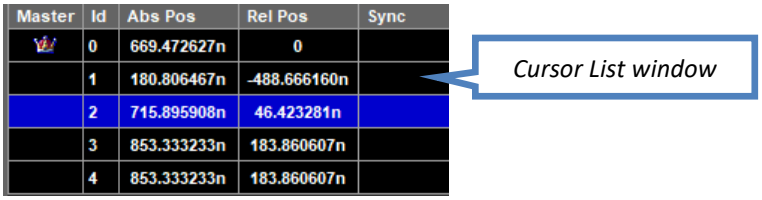

The Cursor/Tools TAB is made of the following subitems:

1. Cursors
2. Search
3. Go To …
4. Graph Tools

## Cursors




Cursors are useful to identify and enlighten waveform data for improved organization and viewing.
Clicking the "Show Table" button located in the *Cursors Toolbar* will show or hide the *Marker List* window that will show all the cursors present in the *Waveform Editor Window* and their absolute position or their relative position to the Master cursor position. Any time one of the cursors is moved, all the values are automatically updated.




In the *Cursors Toolbar* there are also fields showing the ID of the **Active** cursor (i.e. the currently selected cursor) and its **Absolute** and **Relative** positions.

The Master Cursor is identified by the  icon located in the first column of the *Cursor List* window.

Relative cursor positions are referred to the master cursor position.

The master cursor automatically moves to the target position of a data search operation to show search result.
A cursor can be made the master cursor by selecting the desired cursor and then pressing the  icon located in the *Cursors Toolbar*.

It is possible to add a new cursor by pressing the  icon located in the *Cursors Toolbar* or to remove one cursor or all cursors by pressing the  icon or the  icon respectively.

Below a table with all the possible operations available in the *Cursor Toolbar*.

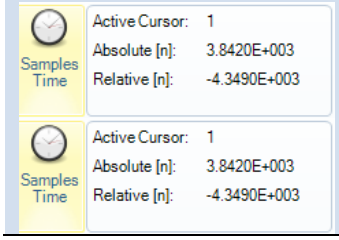
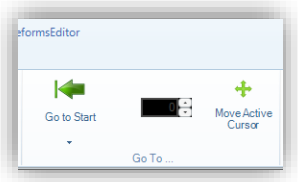
| | |
|---|---|
|  | **Set As Master** the selected cursor |
|  | The **Add** button adds a new cursor in the Waveform graph area and in the *Cursor List* window. |
|  | The **Remove** button deletes the cursor selected in the *Cursor List* window. |
|  | Move a marker by clicking and dragging a selected cursor. |
|  | **Remove All** button removes all cursors. |
|  | **Samples Time** button changes the format of the Absolute and Relative position of the selected cursor from time to samples and vice versa. |

*Table 8: Cursor tools*

**NOTE**:

- It is possible to perform most of the cursor operations by right clicking inside the *Cursor List* window and choosing the desired operation from the dropdown list that will open.
- All cursors can be deleted except the master cursor.
- Multiple cursors can be created as needed.

## Go To a Selected Target




The *Go to…* toolbar located in the *Cursor/Tools* tab contains functions to locate the position of the master cursor at a specific time event. All the possible Go to options are available in the dropdown list that will open by clicking in the lower side of the Go to Start  icon. The Go to options are listed in the table below:

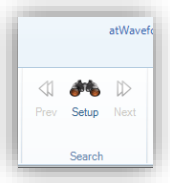
| | |
|---|---|
|  | **Go to time** - Moves the master cursor at the time position specified in the text field of the control located beside the button. |
|  | **Go to start samples** - Moves the master cursor and visualization area to the start of the acquisition. |

| | |
|---|---|
|  | **Go to end samples** - Moves the master cursor and visualization area to the end of the acquisition. |
|  | **Cursor n** - Centers the visualization area on the cursor n |
|  | Moves the master cursor and visualization area at the sample number specified in the text field of the control located beside the button. |
|   | Moves the active cursor in the center of the current visualization area. |

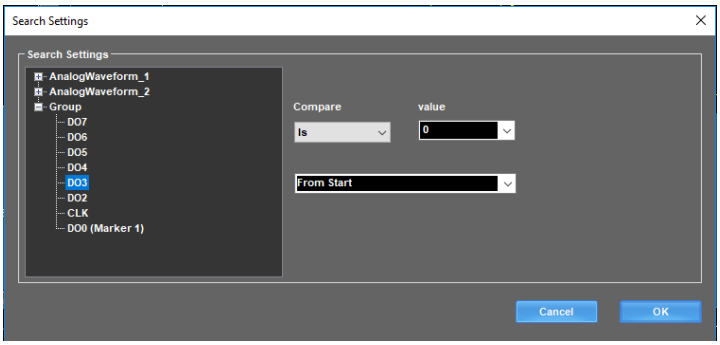
*Table 9: Go To tools*

## Search

The *Search* toolbar in the *Cursor/Tools* tab contains functions to identify a specific time event. It is possible to search for a specific bus value, signal value, rising, or falling edge event.




The search operation is defined by clicking the **Search Settings** button  . The *Search Settings* window will open to define the search criteria




On the left side of the window there is a list showing all defined analog/digital signals and busses. Here you can select the signal or bus where the search operation will be performed.
Depending on the selected item in the list the **Compare** and **Value** fields will provide different options.

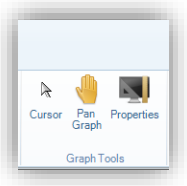
The Compare field provides the following search logic operators:

- **=** or **Is** - Find the same value.
- **!=** or **Is not** - Find a different value.
- **>** - Find a value greater than the specified one (only available for analog waveforms or digital busses).
- **<** - Find a value smaller than the specified one (only available for analog waveforms or digital busses).

On digital signals the **Value** field will provide the following options:

- **0** - Searches for a logic **0**.
- **1** - Searches for a logic **1**.
- **Rise** - Searches for a Rising Edge condition 
- **Fall** - Searches for a Falling Edge condition
- **Change** - Searches for any variation. 

## Graph Tools




The *Graph* toolbar gives a set of functionalities to manage the Waveform graph area. The following functions are provided:

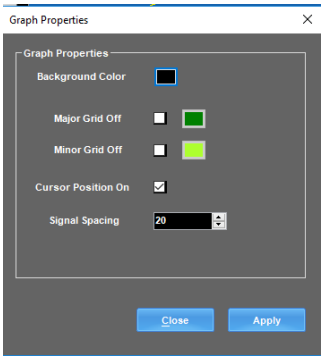
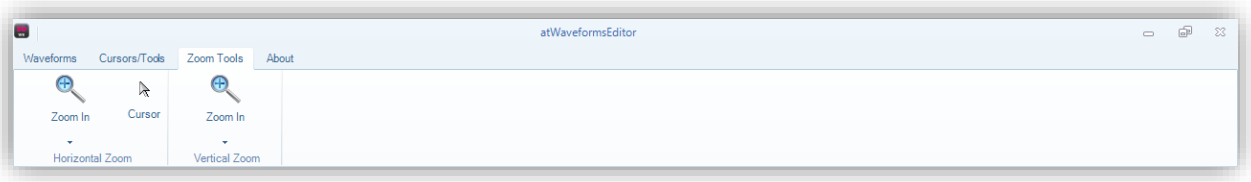
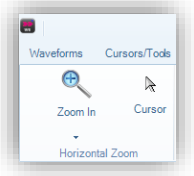
| | |
|---|---|
|  | *Cursor:* This button changes the mouse functionality from hand tool to pointer. The pointer allows to make an area selection in the waveform graph, to move the graph cursors, to select the data in the table. |
|  | *Pan Graph:* The hand tool allows to manually drag the graph visualization area. |
|  | *Graph Property:* allows to change the properties of the graph display area.<br>  <br><br>The following options are available:<br>• Definition of the Background Color<br>• Turn on or off the **Major** and **Minor Grids** and define their colors<br>• Turn on and off the **Cursor Position indicator**<br>• Define the **Spacing** between signals |

*Table 10: Graph Tools*

# The Zoom Menu




The Zoom tab menu contains tools to perform vertical and horizontal zoom on an analog or digital waveform.



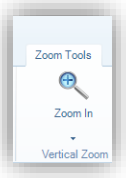

The following tools are available:

## *Horizontal Zoom*

| | |
|---|---|
|  | *Cursor:*<br>This button deactivates the Zoom operation and changes the cursor functionality from Zoom to cursor. |
|  | Zoom IN. Performs a horizontal zoom in operation. |
|  | Zoom Out. Performs a horizontal zoom out operation. |
|  | *Zoom Manual.* Performs a zoom in on a selected area of the graph. Click and drag inside the graph area to define the zoom rectangle. |
|  | *Zoom All.* Resets all previous horizontal zoom operations |

*Table 11: Horizontal Zoom*

## *Vertical Zoom*




The vertical zoom only works with analog waveforms.

| | |
|---|---|
|  | *Zoom Fit.* Fits vertically the waveform adapting it to the height of the graph trace |
|  | Zoom IN. Performs a vertical zoom in operation. |
|  | Zoom Out. Performs a vertical zoom out operation. |

*Table 12: Vertical Zoom*

# Creating Waveforms Using Formulas

## Overview

When waveform creation cannot be accomplished by using segment or component combinations of standard waveforms (sine, triangle, square,…) it can be created analytically using equations. This section of the manual shows you how to create various waveforms using formulas.
The next paragraph in this section covers the standard steps required to create an advanced waveform component using formulas. Remaining topics will show formula examples to create various waveform types.

## Steps to Create Advanced Waveform Components Using Formulas

Select an Analog Waveform and then press the 

button on the command bar. The Waveform Standard Editor will open.


On the Type drop-down list select *Formula*. The Formula Editor is then shown on the right.
The editor helps creating your waveform analytically using equations. The equation can be based on time(**t**) or samples(**x**).
The software verifies at run time that the resulting waveform will not exceed the amplitude limits and that the formula syntax is correct. In case of error a message box will open showing the explanation of the root cause of the error.

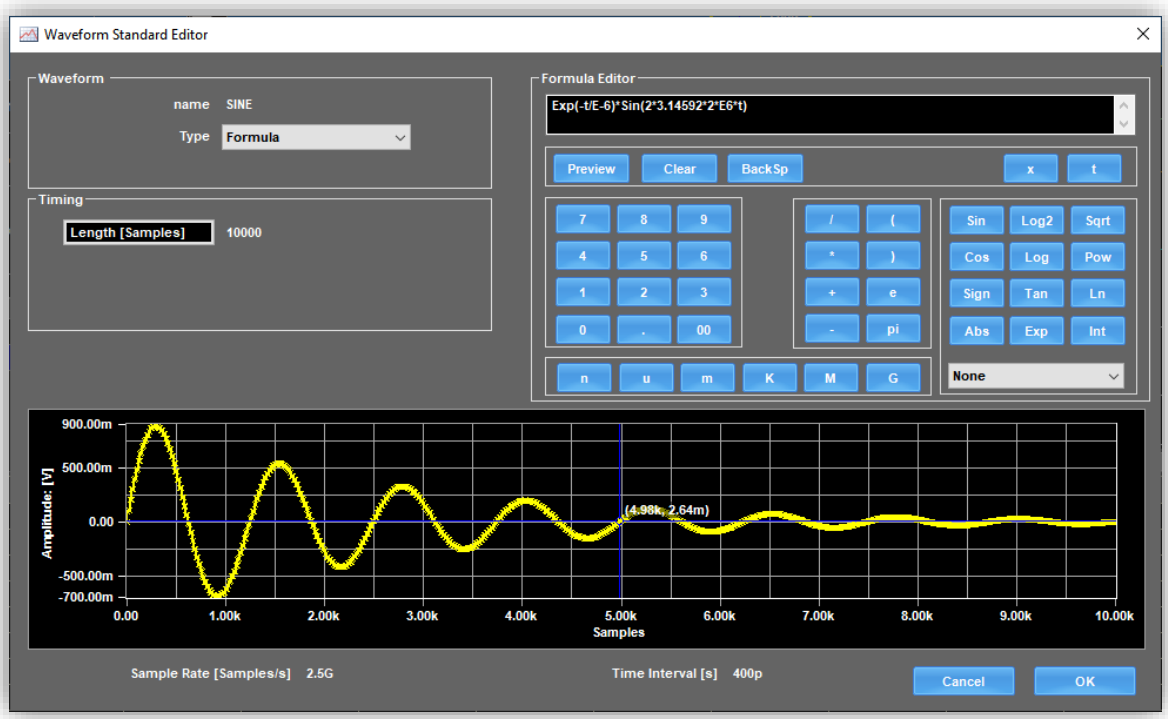
NOTE:

- Your complete formula is shown in a text box located at the top of the formula calculator.
- Numeric values can be entered using the keypad. n (nano), µ (micro), m (milli), K (kilo), M (Mega), and G (Giga) multipliers are available to simplify the editing.
- Available math functions are: Sin, Cosine, Log base 2, Log Base 10, Pow (rise to a power), Square Root, Sign, Tan, Ln (Natural Log), Abs, Exp, Integer, ArcSine, Arc Cosine, Arc Tan, Ceiling, and Floor along with the basic arithmetic operators + (addition), - (subtraction), * (multiplication), and / (division).
- The Preview button compiles your formula and displays the result in the graph located in the bottom of the Waveform Standard Editor window.
- The OK button saves your formula and exits from the Waveform Standard Editor window.

Pressing the OK button, the Waveform Standard Editor window will close and the new waveform created using the formula is saved in the waveform/segment/component selected in the waveform graph.

The next topics will show some formula example to create various waveform types.

## Exponentially Decaying Sine Waveform




An exponentially decaying 2 MHz sine wave. The formula used in this example is:
Exp(-t/E-6)*Sin(2*3.14592*2*E6*t).

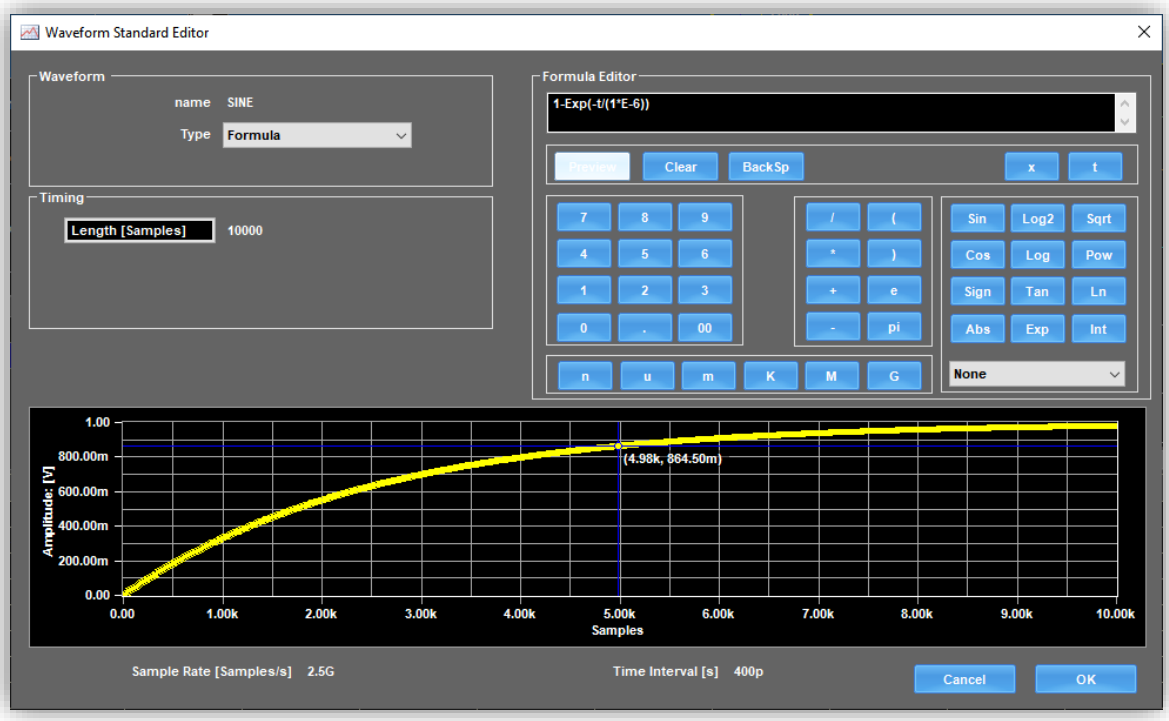
### Formula general format for an exponential decaying waveform

$$V*Exp(-t/T_c)*Sin(2*pi*t*F_s)$$

Where

- $T_C$ – Time Constant in seconds
- $F_S$ - Sine wave frequency in Hertz
- V – Signal amplitude in Volts peak

## Rising Exponential Waveform




A rising exponential waveform. The formula used in this example is:
1-Exp(-t/(1*E-6)).

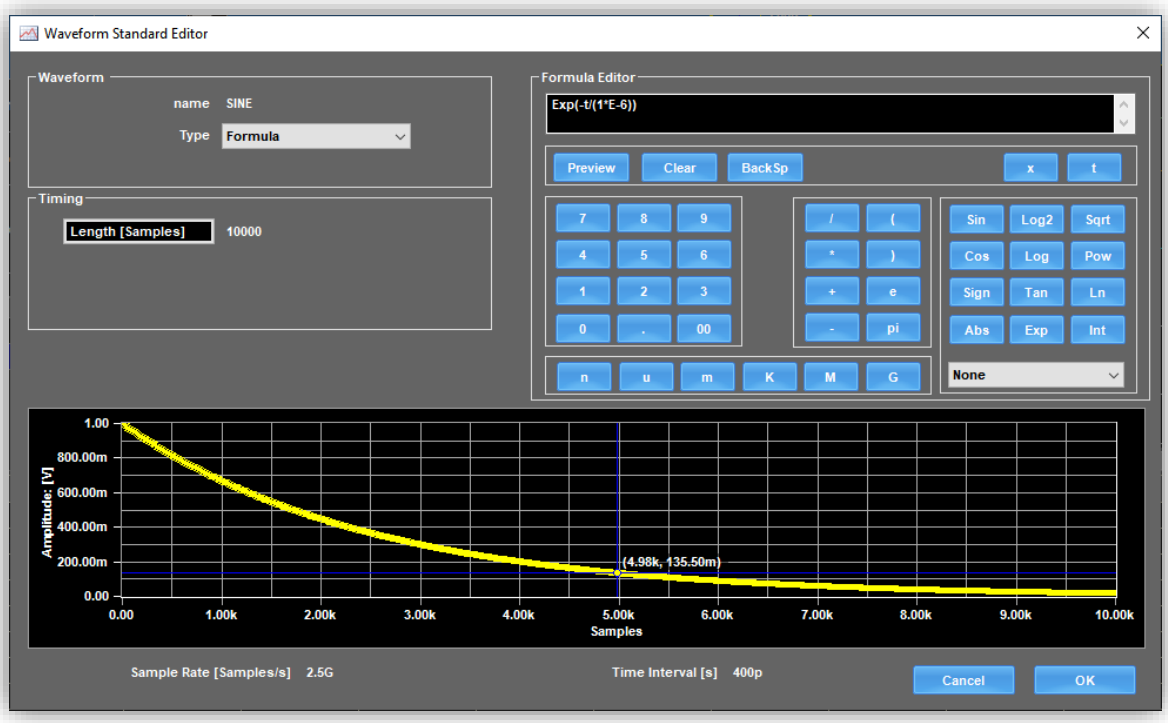
### Formula general format for e rising exponential waveform

$$1-Exp(-t/T_c)$$

Where

- $T_c$ – Time Constant in seconds.

## Exponential Decaying Waveform



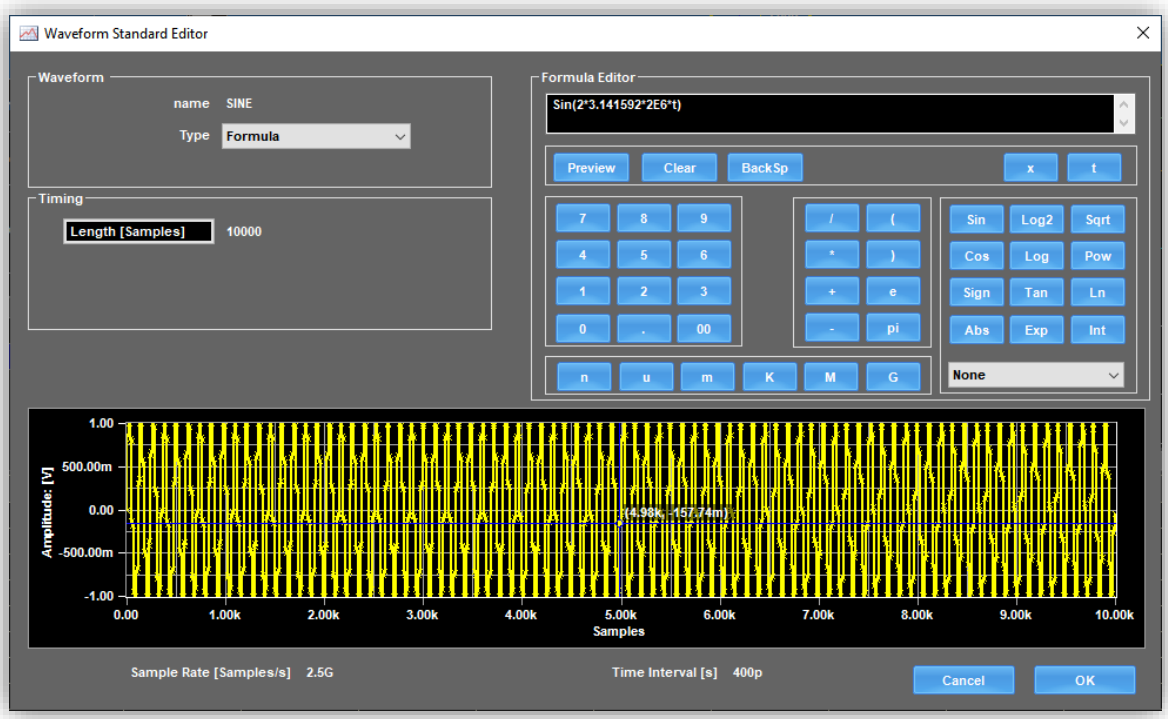

An exponential decaying waveform. The formula used in this example is:
Exp(-t/(1*E-6))

### Formula general format for an exponential decaying waveform

$Exp(-t/T_c)$
Where

- $T_c$ – Time Constant in seconds.

## Sine Waveform




A fixed amplitude 1 MHz sine waveform. The formula used in this example is: Sin(2*3.141592*2E6*t).

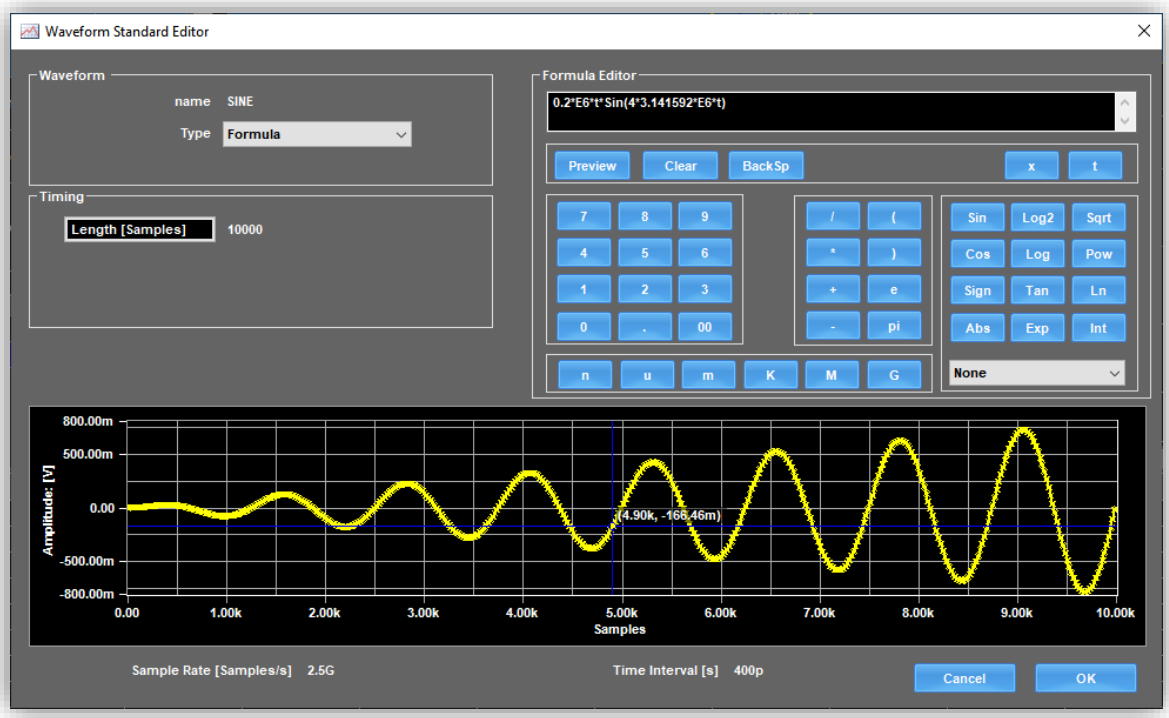
### Formula general format for a fixed frequency sine waveform

$V*Sin(2*pi*t*F_s)$

Where

- $F_S$ – Sine Wave frequency in Hertz.
- $V$ – Signal amplitude in Volts peak.

## Linear Amplitude Sweep Sine Waveform




A Sine waveform. The formula used in this example is:
0.2*E6*t*Sin(4*3.141592*E6*t).

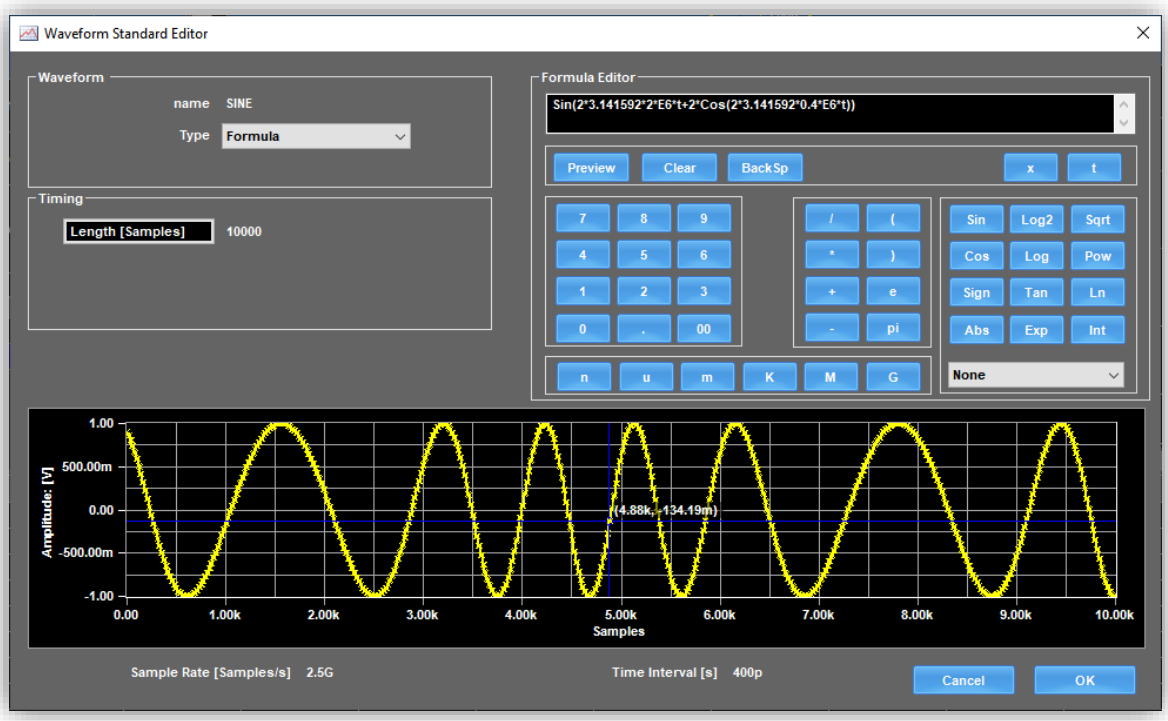
### Formula general format for a linear amplitude sweep sine waveform

$(A*t)\ *Sin(2*pi*t*\ F_s)$

Where

- $F_S$ – Sine Wave frequency in Hertz.
- $A$ – Slope of the ramp in Volts/second.

## Frequency Modulated Sine Waveform




A frequency modulation waveform. The formula used in this example is:
Sin(2*3.141592*2*E6*t+2*Cos(2*3.141592*0.4*E6*t)).

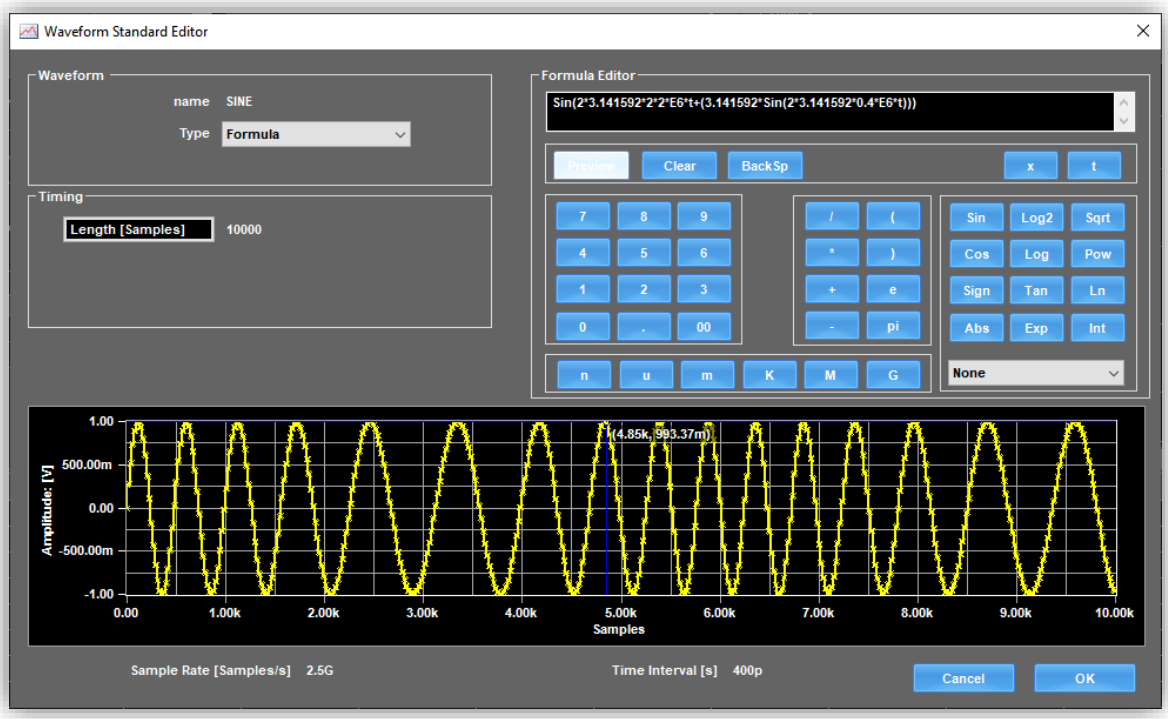
### Formula general format for a frequency modulated sine waveform

$$Sin\ (2*pi*t*F_c+(F_D/F_M)*Cos(2*pi*t*F_M))$$

Where

- $F_C$ – Carrier frequency in Hertz.
- $F_D$ – Frequency deviation in Hertz.
- $F_M$ – Modulation frequency in Hertz.

## Phase Modulated Sine Waveform




A phase modulated sine waveform. The formula used in this example is:
Sin(2*3.141592*2*2*E6*t+(3.141592*Sin(2*3.141592*0.4*E6*t)))

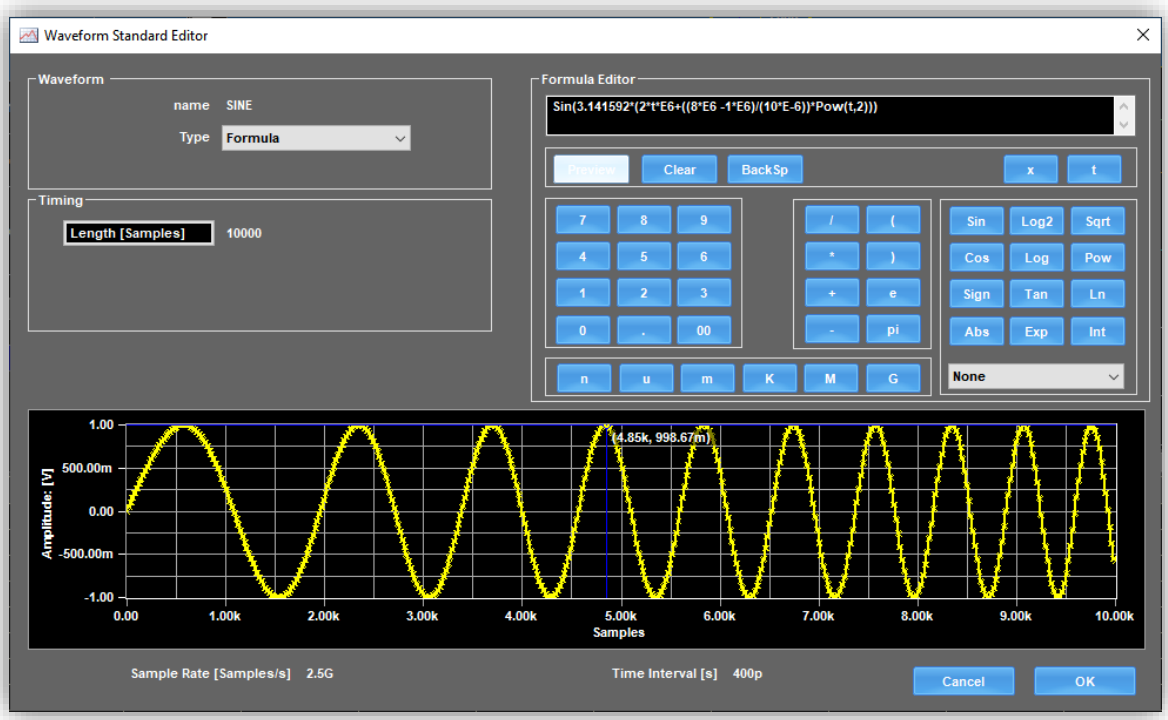
### Formula general format for a phase modulated sine waveform

$$\mathrm{Sin}((2*\mathrm{pi}*t*F_C + K*\mathrm{Sin}(2*\mathrm{pi}*t*F_M))$$

Where

- $F_C$ – Carrier frequency in Hertz.
- K – Peak phase excursion in radians.
- $F_M$ – Modulation frequency in Hertz.

## Linear Frequency Sweep Sine Waveform




A linear frequency sweep sine waveform. The formula used in this example is:
Sin(3.141592*(2*t*E6+((8*E6 -1*E6)/(10*E-6))*Pow(t,2)))

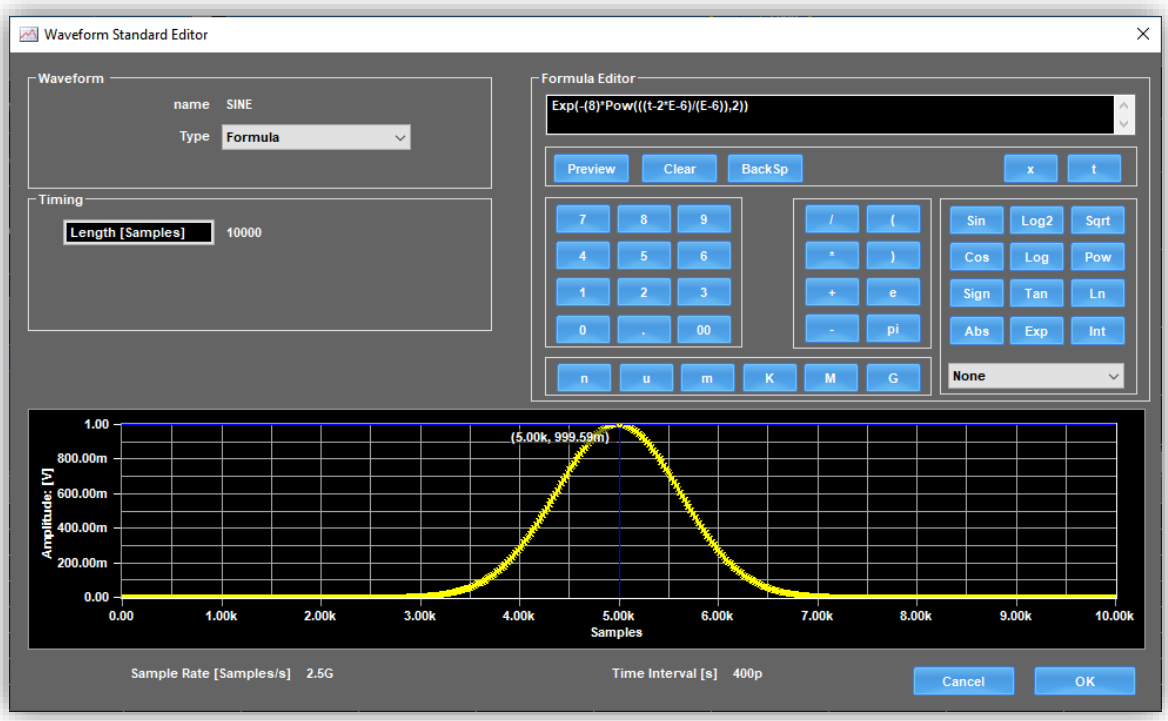
### Formula general format for a linear frequency sweep sine waveform

$$Sin(pi*(2*t*F_S+((F_E-F_S)/T_S)*T\hat{}2))$$

Where

- $F_S$ – Start frequency in Hertz.
- $F_E$ – End frequency in Hertz.
- $T_S$ – Sweep duration in seconds.

## Gaussian Pulse Waveform




A Gaussian pulse waveform. The formula used in this example is:
Exp(-(8)*Pow(((t-2*E-6)/(E-6)),2)

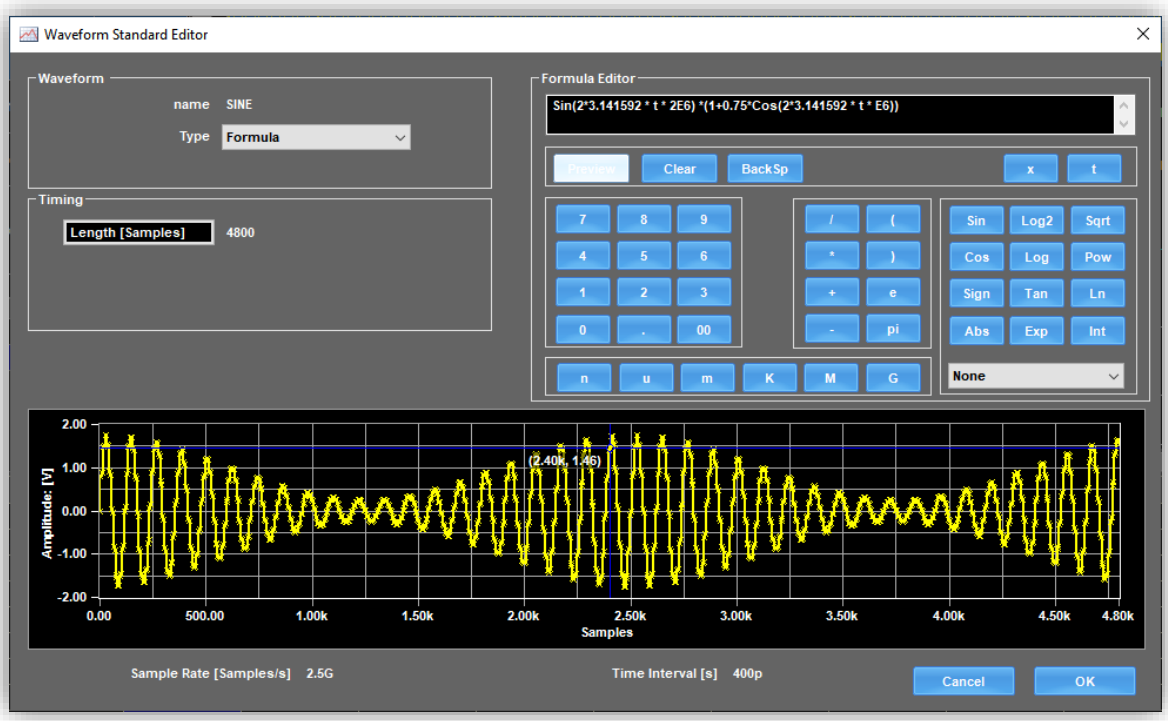
### Formula general format for a gaussian pulse waveform

$Exp(-(1/2)*((T-T_M)/T_\sigma)\text{^}2$

Where

- $T_M$ – Time location of the mean of the Gaussian pulse.
- $T_\sigma$ – Half width point of Gaussian pulse corresponds to the standard deviation σ.

## Amplitude Modulated Sine Waveform




An amplitude modulated sine waveform. The formula used in this example is:
0.5*Sin(2*3.141592*2*E6*t)*(1+0.75*Cos(2*3.141592*0.2*E6*t)).

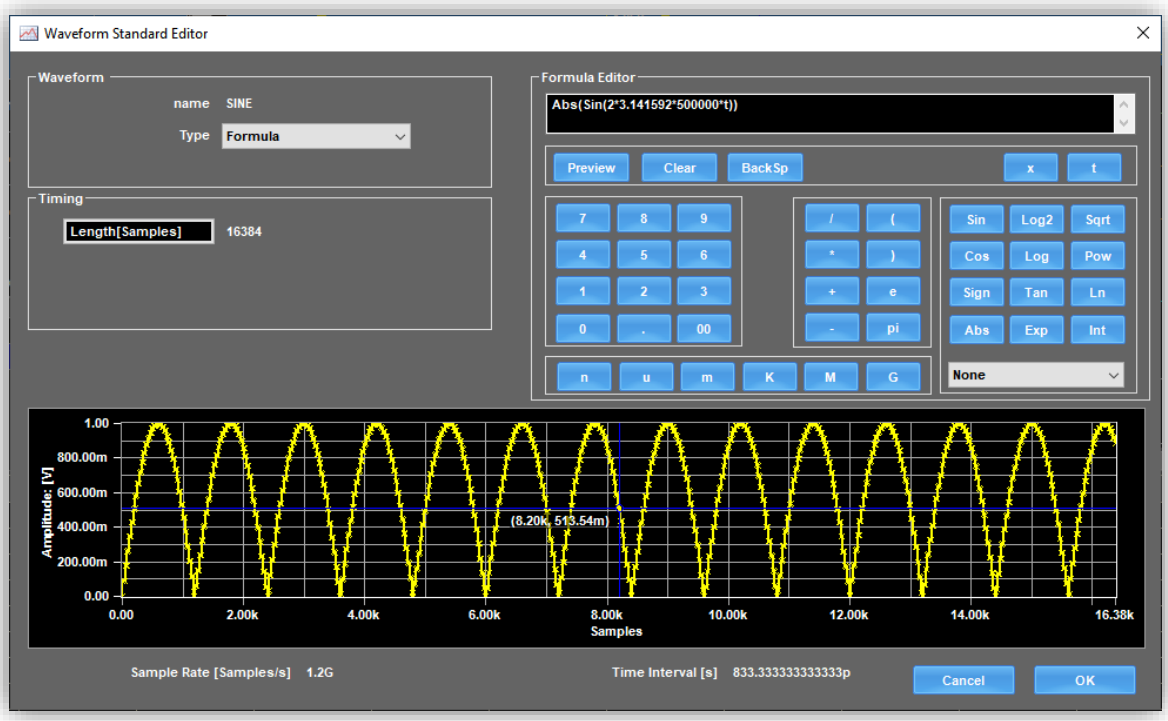
### Formula general format for an amplitude modulated sine waveform

$$Sin(2*pi*t*F_s) *(1+K*Cos(2*pi*t*F_M))$$

Where

- $F_S$ – Sine wave frequency in Hertz.
- $F_M$ – Modulation frequency in Hertz.
- $K$ – Modulation index, 0<K<1.

## Full-Wave Rectified Sine Waveform




A full-wave rectified sine waveform. The formula used in this example is:
Abs(Sin(2*3.141592*5E6*t))

### Formula general format for a full-wave rectified sine waveform

$$Abs(Sin(2*pi*F_s*t))$$

Where

- $F_S$ – Sine wave frequency in Hertz.