

# How to Easily Create an Arbitrary Waveform Without Programming

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## Creating Arbitrary Waveforms Doesn't Have to be Difficult!

Creating arbitrary waveforms on a modern function generator or arbitrary waveform generator (AWG) is not as difficult as you might think. Many engineers try to avoid creating arbitrary waveforms (arbs) at all costs. When they hear the word “arb”, they picture the tedious process of learning how to use some type of waveform software or, worse yet, having to write a program to generate a waveform and then remotely connecting to your AWG to upload the arb. With modern AWGs, creating an arbitrary waveform no longer has to be looked upon with doom and gloom.

Let's look at two easy examples of how to create an arbitrary waveform and transfer it to an AWG.

1. Create an arb from scratch using Excel and then transfer it to an AWG.
2. Capture a waveform from an oscilloscope and then transfer it to an AWG.

In both examples two common elements will be used, a USB memory stick and the Comma Separated Value (CSV) file format.

### Use Excel to build an arbitrary waveform and transfer it to an arbitrary waveform generator

To build an arb from scratch most engineers turn to either an engineering programming environment, like Matlab, LabVIEW, or VEE, or a custom arb waveform software package that may or may not be free. These are great tools, but they are costly and time consuming if you do not use them on a regular basis. Another option that most engineers do not consider is Excel. Excel is a great tool for building custom arbs since it provides advanced mathematical functions built-in, it can handle large amounts of data (waveform points), and it is already on just about everybody's computer. Then the question becomes, “how do you get the waveform from Excel to the AWG?” Excel and modern AWGs have something in common; - the CSV file format. Excel can read CSV files and Excel spreadsheets can be saved as CSV files. Modern AWGs can read and create arbs from CSV files. To transfer the CSV to the AWG, simply transfer the file from a PC to an AWG's front panel and load it into the waveform memory.

Let's look at an example. Using Excel, an arb waveform was created that consisted of a sine wave summed with third harmonic noise and random noise. A screen shot of the Excel spreadsheet can be seen below (see Figure 1). Notice the resulting arb is plotted, and the built-in Excel functions used to create the waveform are circled in red.

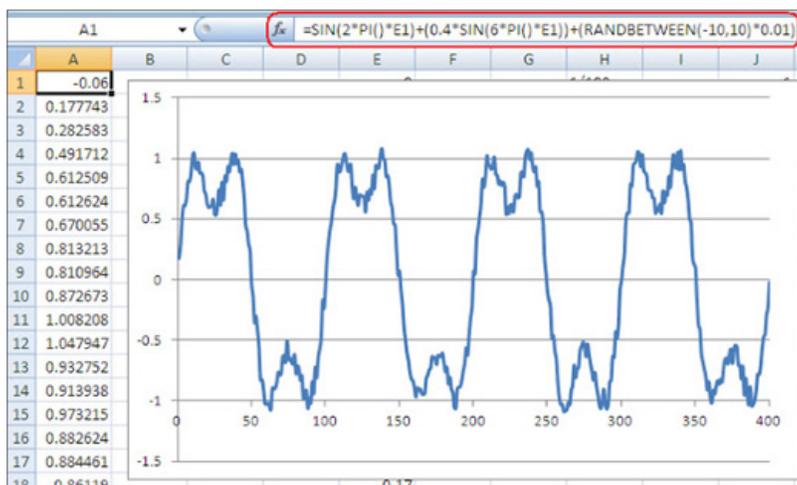


Figure 1. An arbitrary waveform in Excel

The Excel spreadsheet was then saved as a CSV file. Using a USB memory stick it was then uploaded to an arbitrary waveform generator. The resulting arb was recreated by the AWG and then captured in the below oscilloscope screenshot (see Figure 2).

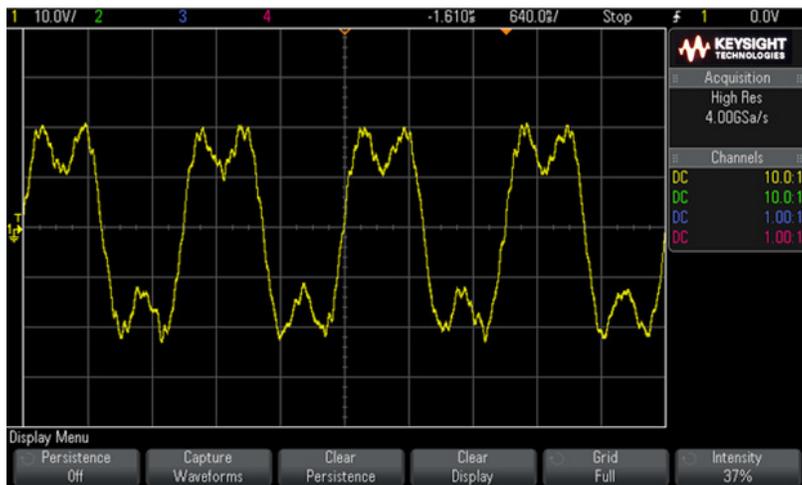


Figure 2. An arbitrary waveform created by a 33600A Trueform arbitrary waveform generator and captured on an InfiniiVision 2000 X-Series Oscilloscope

As you can see Excel provides an easy, no cost way to create an arbitrary waveform and, the CSV file format provides a means to easily transfer an arb to an AWG. If you prefer to use a software environment to generate your arb, or if you need more advanced math functions than what Excel can provide, you can still avoid having to remotely connect and program your arbitrary waveform generator. Most programming environments, like Matlab and LabView, have APIs for writing and reading CSV files. Simply have your program write the arb to a CSV file and “sneaker network” it to the AWG.

### Capture a waveform from an oscilloscope and transfer it to an arbitrary waveform generator

For the second example, we will capture a digitized signal from an oscilloscope and transfer it to an AWG. In the past, this was typically done using some type of arb waveform software package that would remotely connect to the scope, grab the digitized signal, and connect to the AWG to create an arb. With today’s scopes and AWGs the process has been streamlined. For our example a Keysight MSO-X 3054A scope was used to capture a Data Word from a Mil-Std-1553 signal. The captured waveform is shown in Figure 3.

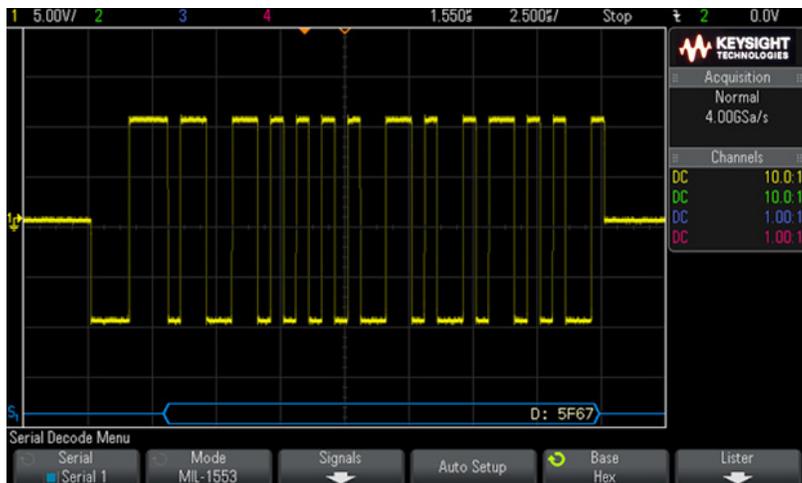


Figure 3. An Oscilloscope screen capture of a Data Word from a Mil-Std-1553 signal

As shown at the bottom of Figure 3, the Mil-Std-1553 signal in blue is 5F67, which is the hexadecimal decoded value of the Data Word. The AWG used in this example was again the 33600A series arbitrary waveform generator. Here is how to capture a signal from an oscilloscope and load it into an arbitrary waveform generator:

1. Plug the USB memory stick into the front panel of the scope.
2. Save the digitized waveform to the USB memory stick as a CSV file.
3. “Sneaker network” the USB memory from the scope to the front panel of the AWG.
4. Import the CSV to the AWG’s memory.

It is really that easy! To do some receiver testing, the Mil-Std-1553 arb on the 33600A series AWG was modulated with a lower frequency pulse to simulate coupled transient noise into the signal channel. The modulated arb can be seen below (Figure 4).

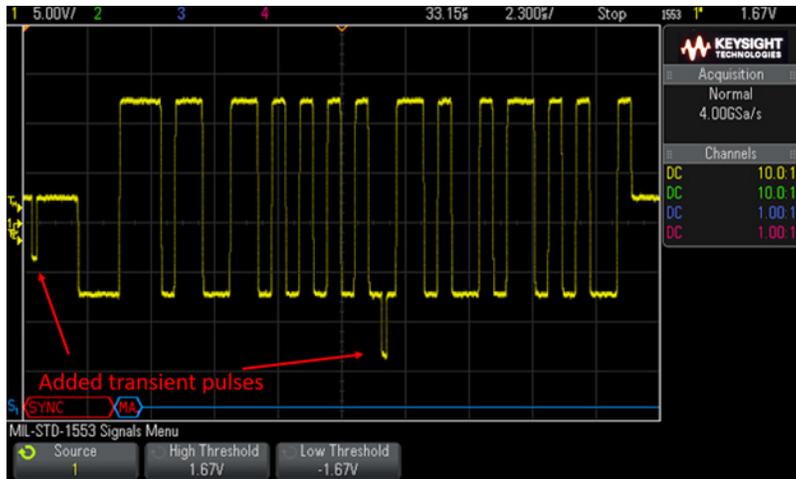


Figure 4. An Oscilloscope screen capture of a Data Word from a Mil-Std-1553 signal modulated with a lower frequency pulse to simulate coupled transient noise

You can see the simulated transient noise in the figure at the beginning and middle of our arb. Notice at the bottom of the scope in red and blue, which shows that with the transient noise, the receiver cannot decode the Data word.

The two examples above will let you get going creating your own arbs and “sneaker network” them into your AWG. For more seamless testing, arbitrary waveforms can also be created and automatically loaded into your AWG using BenchVue.

## Create Arbitrary Waveforms in BenchVue

BenchVue is a PC software platform that allows you to easily connect, record and obtain results across multiple test and measurement instruments without programming. Plug and play functionality enables you to connect your instrument to your PC and immediately begin controlling it in BenchVue. BenchVue's Test Flow app provides an easy way to create custom test sequences using a drag-and-drop interface.

When you open BenchVue and connect to your AWG, you will see a graphical instrument control window of your waveform generator as shown below (Figure 5). You can easily setup normal sine, square, ramp, pulse, triangle, noise, PRBS and DC waveforms with desired parameters using its graphical user interface.

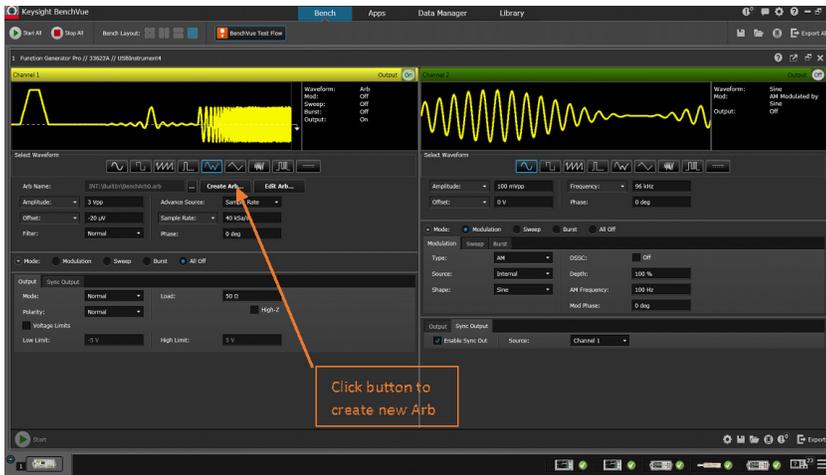


Figure 5. BenchVue's Function Generator application

To create an arbitrary waveform in BenchVue, select the “Create Arb” button. Then you can load an existing arb from your PC or AWG. Or, you can also create a new arbitrary waveform from scratch using the waveform editor.

A Waveform Builder editor window will pop up when you click on the “create Arb” button as shown on Figure 6 below. You can create basic waveforms, advanced waveforms, and even use the computer mouse to draw custom waveforms.

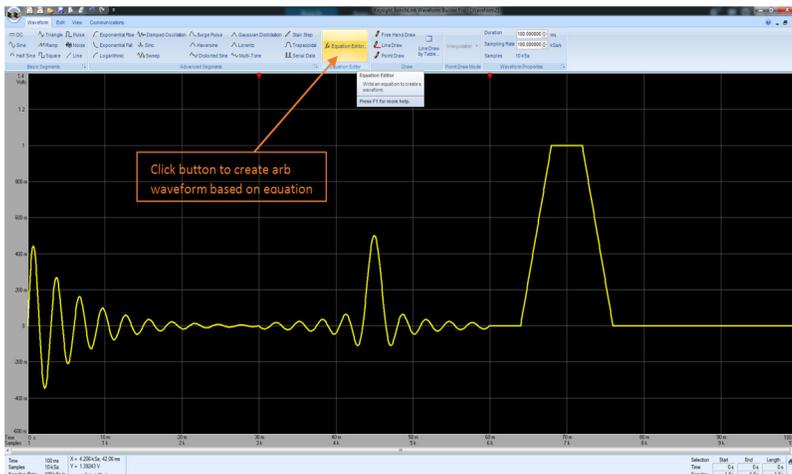


Figure 6. Keysight's Waveform Builder (33503A) window

If you prefer, you can also create waveforms using the equation editor (Figure 7). You can build your math equation by simply selecting the math functions and operators, evaluate and preview your equation graphically before loading it into your AWG.

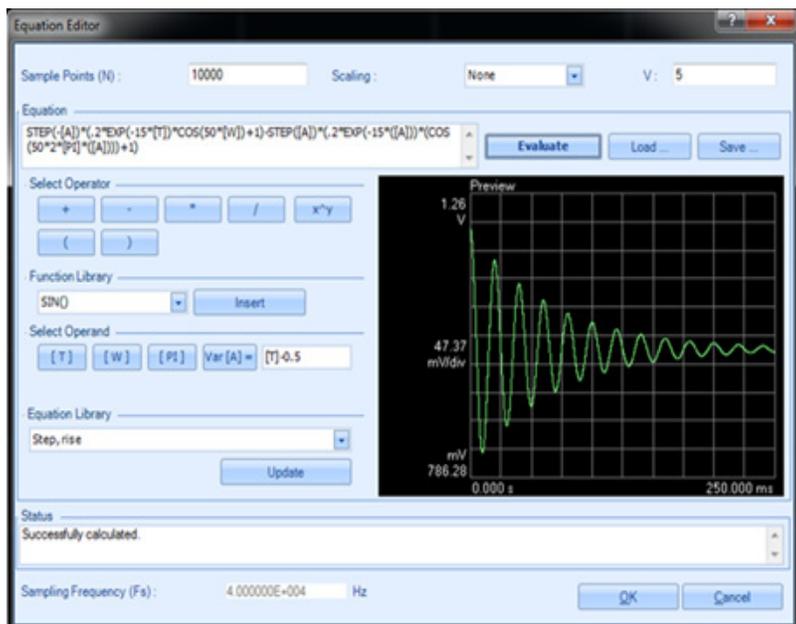


Figure 7. Waveform Builder's Equation editor

One benefit of building arbitrary waveforms in BenchVue is that it allows you to sequence multiple different waveforms together. You can set the waveform order and make segments repeat as many times as you want. Transferring of the created arb waveform is easy, too. You do not have to create a CSV file and manually transfer to your AWG, BenchVue will transfer it with just a few clicks.

## Creating Arbitrary Waveforms Isn't Very Difficult

Clearly, it's easy to create arbitrary waveforms when using modern AWGs. If you want to quickly create your own arbitrary waveform, you can use Excel. If you want to recreate or modify an existing waveform, you can capture and save the waveform using an oscilloscope. Then, use a flash memory drive to load the resulting CSV file into your AWG – no programming required.

If you regularly need to create arbitrary waveforms or need more advanced creation capabilities, check out the BenchVue software, available for download here <http://www.keysight.com/find/benchvue>

To learn more on Keysight's waveform generators and function generators, go to <http://www.keysight.com/find/function-generators>

Learn more at: [www.keysight.com](http://www.keysight.com)

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