APPLICATION NOTE 400

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Developing Complex Synchronized Test Programs Using Programmable Multi-Sync Output Pulses

Introduction

The purpose of this application note is to provide a summary of the synchronous outputs function of TEGAM's arbitrary waveform generators (AWGs), and to offer a quick-start guide for their operation and use. Synchronous outputs allow the user to trigger other test equipment by a waveform event. This allows instruments to be synchronized by hardware, which is faster and more accurate than software-based synchronization.

When it comes to synchronous outputs, all AWGs are not created equal. Some have one output and others have several. Most have limited programmability, while the best are fully programmable. Engineers who need to develop complex test programs where multiple instruments are synchronized to different waveform events, find that AWGs equipped with multiple, fully - programmable outputs are the best choice.

The TEGAM Models 2414B and 2411B meet these requirements. These AWG's formerly manufactured by Pragmatic, each have four fully-programmable synchronous outputs. The outputs are TTL-compatible to match the trigger inputs of most test & measurement equipment. They use standard BNC connections and are designed for 50Ω terminations.

Test engineers and integrators often overlook programmable multi-sync outputs because they are not common in the AWG industry. Engineers and integrators who use the programmable multi-sync feature state that it is one of the main reasons for their selection of TEGAM AWGs. The multiple TTL outputs allow up to four separate instruments to receive hard-wired trigger or gate signals from a single AWG. In addition, the location and length of the output pulses is fully programmable creating the widest possible flexibility of the test system for current needs or future expansion or modification. An unlimited number of pulses may be programmed into a single sync output using WaveWorks Pro+ software or other remote control. In addition, multiple AWGs can be cascaded using a master-slave approach. The Master AWG can control up to 4 slaves, which can then control 16 instruments.

Programmable Address Modes

Each of the outputs has a primary mode of operation called the Programmable Address Mode. In this mode, the sync pulse may be defined using the front panel, remote interface (GPIB or RS232), or WaveWorks Pro+™ wave creation software. The starting address point, "S", and the length, "L", of the synchronous pulse is defined relative to the output waveform's digital data. This output data can represent either a standard or a custom waveform. For example, let's say that we have a standard waveform that is by default, 1000 data points long. We wish for the sync pulse to appear at the beginning of the waveform, Data #0, and last for 5 clock cycles. The data to create such a sync pulse would simply be S=0 & L=5.

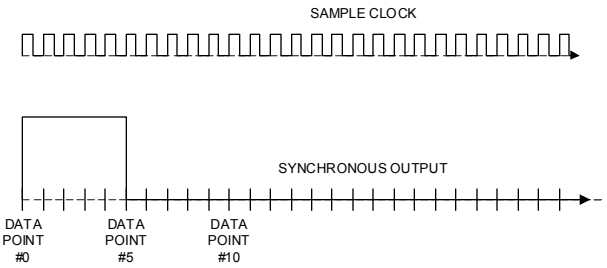

FIGURE 1: Example of basic Sync pulse definition of S=0 and L=5.

Programming Sync with Software

Front panel operation limits each SYNC output to only one pulse. When using RS232, GPIB or WaveWorks Pro+™ software, an expanded capability allows the user to define an unlimited number of sync pulses for each output. The only limitation would be in the number of data points that compose the entire output waveform. In remote operation, this is accomplished by including several definitions for S and L in a single command line. For example, to define three pulses in sync output #3 beginning at 0, 5, and 10 and with corresponding lengths of 1, 2, 13, the ASCII command string would look like:

WVFM: SYNCX 3, 0,1,5,2,10,13

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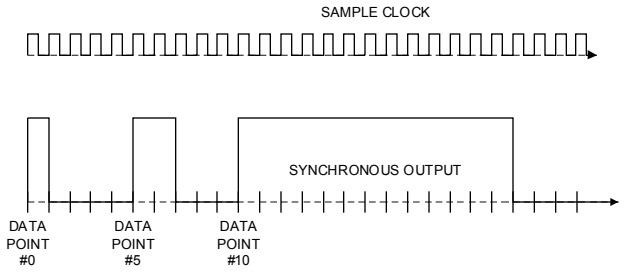

FIGURE 2: Example of multiple sync pulses produced at SYNC3 output.

You can also write sync pulse data into memory by using the block sync method. This is where the sync data for the four outputs is represented by the four lower bits of a binary pattern from 0-15. It is used as a convenient means for block filling large sections of sync memory. A typical command line would look like:

WVFM:MEMS 0,1,2,4,8,8

And would yield the following sync outputs:

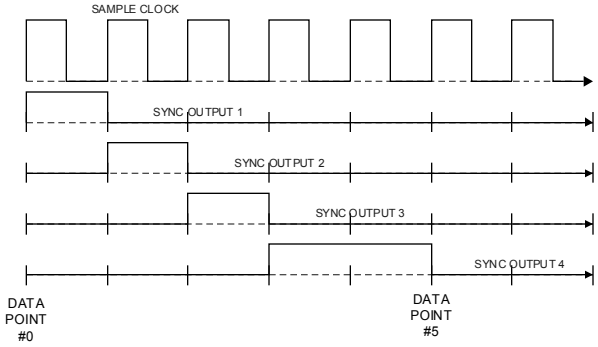

FIGURE 3: Example of sync outputs as a result of the block fill command.

Where the pulse data would begin at sample 0 and the subsequent binary pulse data would follow to produce the binary pattern. More information on this programming is located in the user's manual.

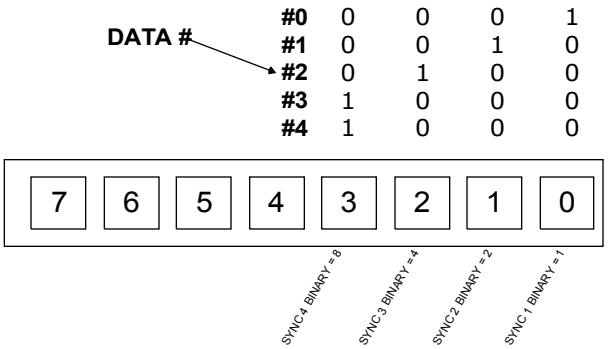

FIGURE 4: Binary representation of sync pulse operation. The binary data is defined relative to the output waveform.

WaveWorks Pro+ makes programming sequences simple. 5-A illustrates the graphical representation of the output waveform and respective sequence outputs. Figure 5-B displays the dialog box for parameter entry. Sync variables are defined by start and length parameters, and WaveWorks Pro+ allows for unlimited pulses to be programmed for each SYNC output.

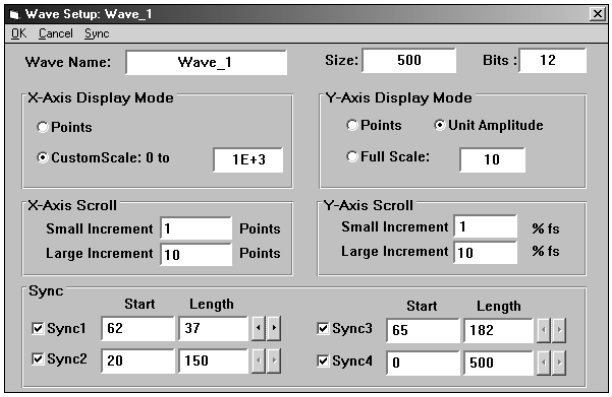

FIGURE 5A: WaveWorks allows easy definition of multiple pulses for each SYNC output.

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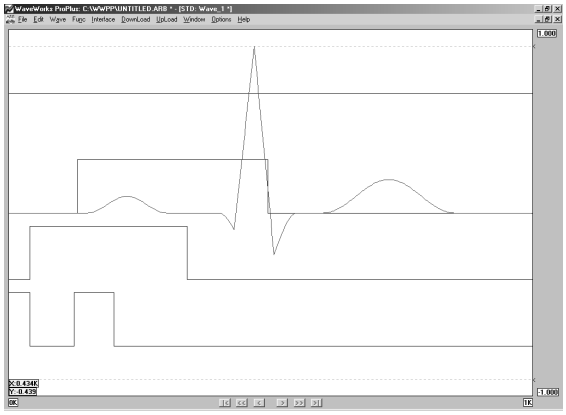

FIGURE 5B: The resulting SYNC outputs are visible on WaveWorks waveform editing screen.

Secondary Sync Functions

In addition to ADDRESS mode, three of the four outputs have secondary sync functions. These are preset sync settings that are stored within the instrument's functional memory. Secondary sync functions are programmable by the instrument's front panel or via software. The illustration below summarizes the secondary operation of the sync outputs.

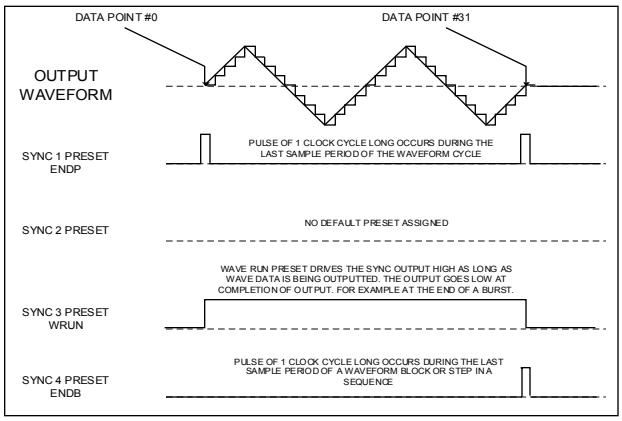

FIGURE 6: Secondary functions of the programmable sync outputs. All sync outputs except Sync 2 have dual functionality.

Next, each of the secondary functions will be explained in further detail. Use Figure 6 as a reference.

SYNC1 – The ENDP (End Point) preset creates a trigger pulse of one clock cycle long during the last sample period of the output waveform. When using this function, the pulse's location follows the waveform data regardless of the waveform size. This is because it is defined as a function and not as actual waveform data. Either ADDRESS or ENDP mode may be selected from SYNC1 via front panel OUTPUT settings or remote commands.

SYNC2 – operates in the ADDRESS mode only. There is no dual functionality for this output.

SYNC3 – May operate in either the WRUN (Wave Run) mode or ADDRESS mode. The WRUN function holds the SYNC3 line high as long as waveform data is being produced. This function is useful when using the burst mode to indicate that the preset number of bursts has been reached and the output is in a quiescent state. Once all of the waveform data has been exhausted, the SYNC3 output returns to a low-logic state.

SYNC4 shares its dual functionality with a ENDB (End of Block) function. This action creates a pulse of one sample clock period in the last sample of each step of a sequence. It is different from the ENDP function in that the ENDP is specific to each waveform where ENDB is specific to each waveform block or step of a sequence.

Summary

TEGAM AWG Models 2411B and 2414B have several unique design characteristics that distinguish them from other models. The most popular design characteristics amongst test engineers and integrators are the multiple synchronous outputs, which have full programmability.

The multiple outputs allow the user to synchronize up to four separate instruments to the master AWG unit. Because the outputs are fully programmable, unique triggering or gating profiles may be produced at each output with no limit on the number or orientation of pulses produced at the outputs. This allows multiple instruments to be synchronized by hardware, which is much more accurate than software-based synchronization.

Contact TEGAM for more information or to request a demonstration of SYNC outputs and other unique features of our high-quality arbitrary waveform generators. TEGAM

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