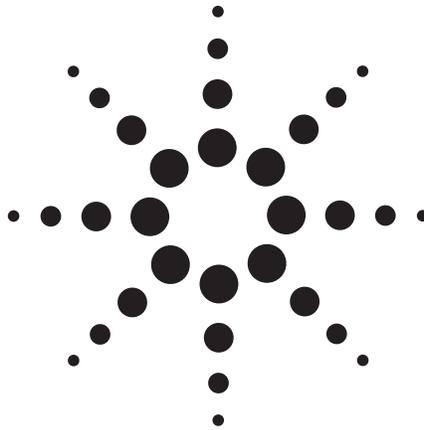


How to Generate Low Duty-Cycle Pulses with a Function Generator

Application Note 1407



Introduction

If you are characterizing digital devices, you typically would use a pulse generator to provide the signals you need. However, for low-frequency applications like microcontroller characterization, you can generate low duty-cycle pulses with a relatively inexpensive general-purpose function generator.

Today's general-purpose function generators are highly versatile signal sources that typically use some sort of digital signal-generation scheme like direct synthesis. They offer many types of waveforms and frequently have built-in sweep and modulation. Some offer arbitrary waveform generation capability as well. While they typically offer extremely stable frequency and low distortion, they are not particularly well suited for generating low duty-cycle pulses.

When you generate a variable duty-cycle square wave with a general-purpose function generator, the duty cycle is typically limited from 20 percent to 80 percent in 1 percent increments. Another limitation is the function generator's bandwidth; a typical function generator can generate square waves up to 15 MHz. The limited bandwidth causes the rise and fall times to be approximately 20 nsec – so a minimum pulse width would be 40 nsec.

This application note describes how to use the burst mode capability of a general-purpose function/arbitrary waveform generator to output square waves at extended intervals in order to produce low duty-cycle pulses.



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Step-by Step Guide

You can produce low duty-cycle pulses using the burst mode capability available in many of today's function generators. You start by setting up a square wave with a period corresponding to the short pulse width that is required. Since a square wave is continuous, we need a way to “gate” the signal. We will set up the generator to repetitively send a single cycle or burst of that square wave at a much lower frequency that corresponds to the desired interval between pulses.

To give you a clear understanding of the process, we will walk through an example using the Agilent 33120A function/arbitrary waveform generator. In this example, we will generate a 1- μs pulse that occurs once every 200 μs , corresponding to a duty cycle of 0.5 percent.

Before you start, you need to calculate the frequency of a square wave that has a 1- μs positive pulse width (i.e. a 2- μs period). Taking the inverse of the period gives you a frequency of 500 kHz. Set your function generator's output to this frequency.

However, since the objective is to burst a single pulse of this waveform once every 200 μs , the inverse will give a 5-kHz repetition rate. This is called the burst rate (see Fig. 1.)

Step 1. Set up the pulse: First, select the square wave function and set the output amplitude for the pulse to 1 V_{pp} . Next, set the appropriate frequency for the pulse width. As we calculated earlier, the frequency is 500 kHz for a 2- μs period (positive for 1 μs , negative for 1 μs).

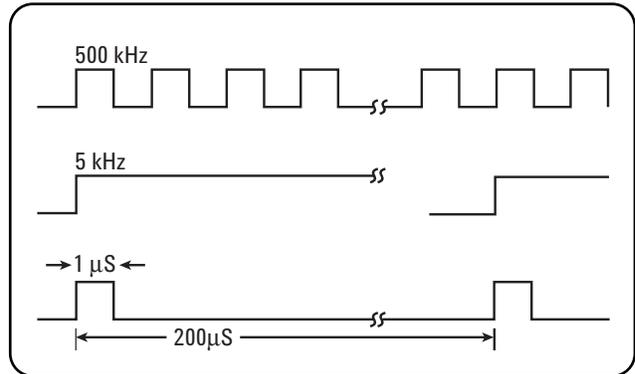


Fig. 1: A graphical representation of burst rate, generating a 1- μs pulse with a 0.5 percent duty cycle

Step 2. Set up burst mode: Select burst mode on the 33120A by pressing **Shift** then **Burst** (the burst indicator should light up). Then set the burst count to 1 by pressing **Shift** then **Recall Menu**, which takes you directly to the BURST COUNT command in the display. Verify that the count is set to 1 by moving down a level in the menu structure (press the down arrow, \downarrow). To save this value in memory, press **Enter**. Next, to make sure there isn't any phase shift in the 500-kHz signal, set the BURST PHASE to zero degrees. Once again, press **Shift** then **Recall Menu**, then the right arrow (\rightarrow) until BURST PHASE appears in the display. Use the down arrow (\downarrow) to set the phase to zero degrees. Again, press **Enter** to save this value and exit menu.

Step 3. Set the burst rate: Now, set the burst rate to the desired frequency of 5 kHz. Again, use the key sequence **Shift** then **Recall Menu** to jump into the menu. Press the right arrow (\rightarrow) until BURST RATE appears in the display, and use the down arrow (\downarrow) to enter the value of 5 kHz. Again, press **Enter** to save this value.

Step 4. Set the burst source to internal: With the 33120A, burst mode can be triggered either externally or internally. In this case, we will use the internally triggered burst mode. For a final time, press **Shift >** **Recall Menu**, then the right arrow (>) until BURST SOURCE appears in the display. Use the down arrow (↓) to verify that the burst source is set to INT (internal). You can set it to INT by turning the knob to zero (only one knob). Again, hit **Enter** to save this value. Check the output on an oscilloscope that shows an expanded scale (Fig. 2 shows how it should look). You will see that the readouts indicate that the frequency is 5 kHz, the pulse width is 1 ms, and the duty cycle is 0.5 percent, just as we desired.

You can use this technique for waveforms other than square waves. It works for sine waves, triangle waveforms, and even arbitrary waveforms. You can also adjust the phase and offset for whatever type of pulse you want.

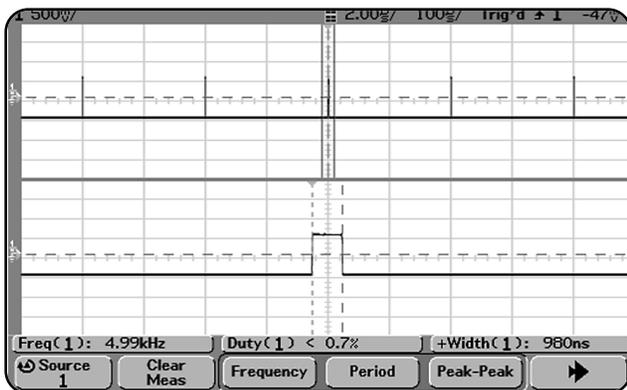


Fig. 2: Scope display showing a 1- μ s, 0.5 percent duty-cycle pulse

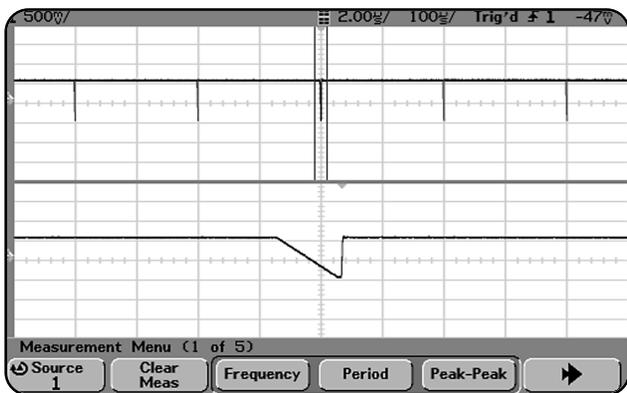


Fig. 3: Using burst mode to output an arbitrary waveform with a low duty cycle

Conclusion

You can use this technique to generate low duty cycle pulses with general-purpose function generators that have burst triggering capability. Depending on the frequency capabilities of the function generator, there will be limitations on the width of the pulse you can generate and on the repetition rate you can use. However, using this technique will allow you to generate low duty-cycle pulses from a general-purpose function generator without having to resort to a much more expensive pulse generator.

Glossary

Duty cycle – the percentage of time a pulse train is at its higher voltage compared to the overall period

Period – how long before the signal repeats

Pulse width – how long the pulse is in the “true state” (pulses can be positive or negative)

Related Agilent Literature

Data sheet – 33120A 15 MHz Function/Arbitrary Waveform Generator, pub no. 5968-0125EN

Data sheet – 33250A 80 MHz Function/Arbitrary Waveform Generator, pub no. 5968-8807EN

This application note is based on an article written by Mark D. Bailey, Agilent Technologies, and published in *chipcenter.com*, 1999.



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Printed in the USA August 26, 2002

5988-7507EN

