

MEASUREMENT TIPS

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Using Pulse-Width Modulation to Simulate Control Signals



The use of pulse-width modulation (PWM) has become an increasingly popular technique for controlling analog circuits with a digital signal. PWM is employed in a wide variety of applications including engine control, power management and supply, and analog translation of digital audio. Many microcontrollers include PWM capabilities as a simple method for digital control logic to create an analog equivalence. Using a product such as the Agilent 33220A function/arbitrary waveform generator places these same waveforms right at your fingertips.

TESTING DESIGNS WITH SIMULATED SIGNALS

Snapshot: Testing Brushless Motors

Engineers are using brushless motors more often, partly because of the decreasing cost difference compared to brush motors. One manufacturer wanted to investigate the benefits of switching to a brushless motor in one of its existing products. By eliminating the use of the brush as the commutator, the manufacturer hoped to achieve a longer life with no maintenance and quieter operation. To compare different models of brushless motors, the manufacturer wanted to test the airflow and acoustic noise at different operating speeds. Increasing the duty cycle to the brushless motors provides more average power and operates the motors at faster speeds. By using pulse-width modulation, the manufacturer could continually vary the motor speeds for lengthy automated tests. The manufacturer was pleased with the results and migrated the product design to use the new brushless motors for improved reliability and lower costs.



PWM basics

The basis of pulse-width modulation is a square wave with a duty cycle of 50%. You can change the duty cycle and use the resulting variation in the pulse width to either convey information or control the power sent to a load. Examples:

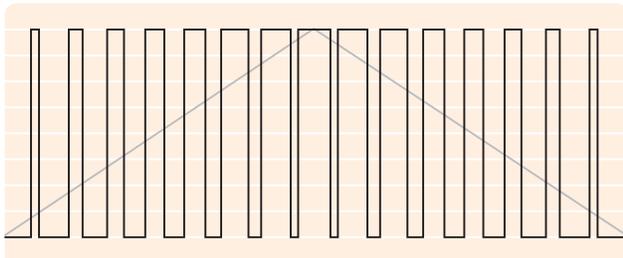
- A servo motor in a remote-controlled toy conveys information by changing the duty cycle. The servo receives a series of pulses, then moves to a position linearly proportional to the width of the pulses.
- Changing the duty cycle in a light dimmer controls the power sent to a load. We reduce the amount of time the signal is “on” by lowering the duty cycle, causing the light to dim.

Creating PWM waveforms

Some function generators, such as the Agilent 33220A, offer a built-in pulse function with PWM. Having quick access to all the PWM parameters (frequency, amplitude, and modulation depth) makes it easy to modify and experiment with a waveform.

The first step is to set up your basic pulse. The 33220A makes it easy to adjust similar parameters, such as frequency or period. To edit the parameter most convenient for you, press the blue softkey repeatedly to toggle between the parameters. In this same fashion you can make changes to either the pulse width or the duty cycle

The next step is to turn on the modulation and adjust the parameters. On the 33220A, selecting modulation while you are in pulse mode will automatically turn on PWM. The “duty cycle deviation” will modify the duty cycle you selected when you set up your basic pulse. For example, if you selected a 50% duty cycle with a 35% deviation, the 33220A will produce a duty cycle between 15% and 85%. If you used a pulse width to set up your basic sine wave, the 33220A automatically uses “width deviation” instead of duty cycle.



Modulation with signals such as a triangle wave make it possible to create dynamic PWM signals like this one, which will open and close an engine venturi.

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Duty cycle or pulse width modulation?

- **Use duty cycle** if your application specifies duty cycle or if you want the width of the pulse to be relative to the overall period. If you change your period, your pulse width will change to maintain the same duty cycle.
- **Use pulse width** if your application calls for a specific “on” time or pulse width, or if you want the width of the pulse to be unrelated to the overall period. If you change your period, your pulse width will stay the same.

Summary

You can use general-purpose function generators to create the pulse waveforms and provide PWM capabilities that are increasingly used in microcontrollers. We have explained the basics of PWM and how varying the pulse width can be used to either convey information or control the power sent to a load. Finally, we have demonstrated how to set up a PWM signal on a general-purpose function generator.



Learn more about the Agilent 33220A function generator (TOP) at www.agilent.com/find/33220A

Learn more about the Agilent 33250A function generator (BOTTOM) at www.agilent.com/find/33250A

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