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Pulse Width Modulation

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***Abstract*: This paper presents pulse width modulation which can be controlled by duty cycle. Pulse width modulation(PWM) is a powerful technique for controlling analog circuits with a digital signal. PWM is widely used in different applications, ranging from measurement and communications to power control and conversions, which transforms the amplitude bounded input signals into the pulse width output signal without suffering noise quantization. The frequency of output signal is usually constant. By controlling analog circuits digitally, system cost and power consumption can be reduced. The PWM signal is still digital because, at any instant of time, the full DC supply will be either fully_ ON or fully _OFF. Given a sufficient bandwidth, any analog signals (sine, square, triangle and so on) can be encoded with PWM.**

***Keywords*: decrease-duty, duty cycle, increase-duty, PWM (pulse width modulation), RTL view**

1. Introduction

Pulse width modulation (or pulse duration modulation) is a method of reducing the average power delivered by an electrical signal, by effectively chopping it up into discrete parts. The average value of voltage (or current) fed to the load is controlled by turning the switch supply and load (ON & OFF) at a faster rate. The longer the switch is ON compared to the OFF periods, the higher the total power supplied to the load. The period of time is known as the 'duty cycle', a low duty cycle corresponds to low power, because the power is off for the most of the time. Usually the duty cycle is expressed in percentage for example, 50%, 10%, 75% etc.

When a digital signal is on half of the time and off the other half of the time, the digital signal has a duty cycle of 50% and resembles a "square" wave. When a digital signal spends more time in the on state than the off state, it has a duty cycle of >50%. When a digital signal spends more time in the off state than the on state, it has a duty cycle of <50%. Here is a pictorial representation for the above conditions.

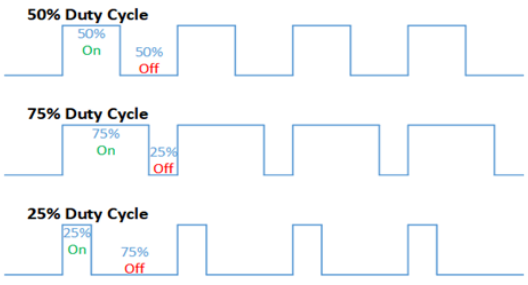

Fig. 1. Duty cycle

2. Principle

Pulse width modulation uses a rectangular pulse wave whose pulse width is modulated resulting in the variation of the average value of the waveform. If we consider a pulse signal f(t), with period T, low value Y-min, high value Y-max and a duty cycle D. Average value of the output signal is given by,

$$\bar{y}=\frac{1}{T}\int_0^T f(t)dt$$

3. PWM generator

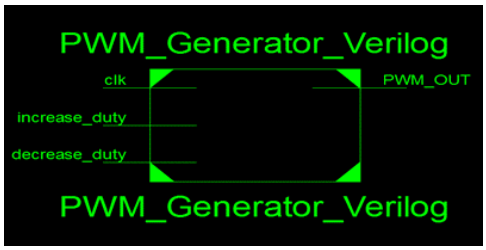

Fig. 2. RTL view of PWM generator

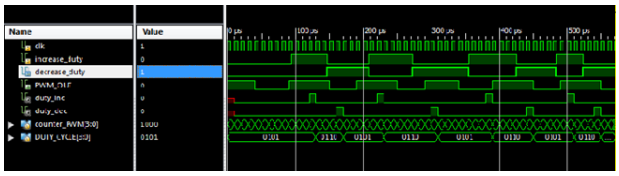

Fig. 3. Executed output using Xilinx ISE 13.1 (software)

4. Discussion

The Verilog code for PWM generator creates a 10MHz PWM signal with variable duty cycle. It has two buttons which are used to control the duty cycle. The first button increase-duty is used to increase the duty cycle by 10%, while the other button decrease duty is used to decrease the duty cycle by 10%. Whenever there is a change in inputs (increase-duty and decrease-duty) the output gets updated at the positive edge of the clock pulse.

Case 1: increase-duty=1 and decrease-duty=0 then duty-inc is increased by 10% i.e., the duty cycle is increased by 10%.

Case 2: increase-duty=0 and decrease-duty=1 then duty-dec is decreased by 10% i.e., the duty cycle is decreased by 10%.

5. Applications

- PWM is used to control servo-mechanisms.
- PWM is a form of modulation where the width of the

pulses corresponds to specific values which are encoded at one end and decoded at the other end of the communication system. Pulses of various lengths (the information or the message) will be transmitted at regular intervals of the carrier signal of the modulation.

- PWM is used in voltage regulator circuits efficiently. By switching voltage to the load with the appropriate duty cycle, the output will be an approximate desired voltage. The noise is usually filtered with an inductor and a capacitor. When it is lower than the desired voltage, it turns ON the switch. When the output voltage is above the desired voltage, it turns OFF the switch.
- PWM is used in sound (audio) synthesis, as it gives a sound effect similar to chorus or slightly detuned oscillators played together. The main advantage of the PWM is power loss in the switching device is very less.

6. Result

It works well with digital control because of their ON and OFF nature, which can easily set the required duty cycle.

7. Conclusion

In conclusion, PWM generators are very useful in modern communication as they reduce the power loss during transmission and receiving of the signal by effectively slicing it into discrete parts.

References

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