Pulse Width Modulation

Module 17

12/3/2023

1 Pulse With Modulation

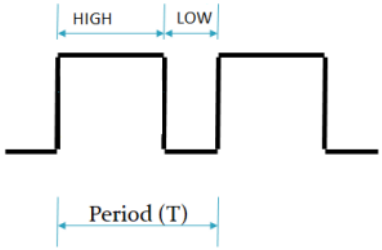
Pulse Width Modulation: Conrtolling the pulse of a digital signal for a given period

- Typically, the width of the pulse is HIGH half of the period and LOW the other half, but can changed
- HIGH 40% of the period, and LOW 60%
- HIGH 75% of period, and LOW 25%

Things that use PWMs:

- Motors
- Lighting for dimmer or brighter light
- Audio signals

Duty cylce is th epercent of the pulse HIGH compared to the period → PWM is expressed as a duty cycle



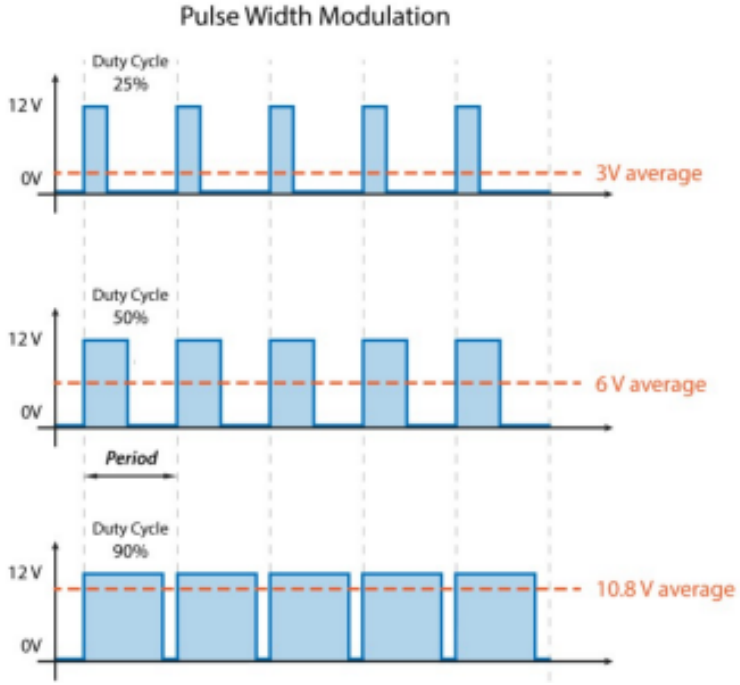
$$Duty\,Cycle\,(\%) = \frac{HIGH\,Time}{Period} * 100\,\%$$

1.1 Average Voltage Value

A smaller duty cycle delivers an effective lower voltage value

- Motor turn slower or light appear dimmer

- $V_{average} = DutyCycle * V_{HIGH}$

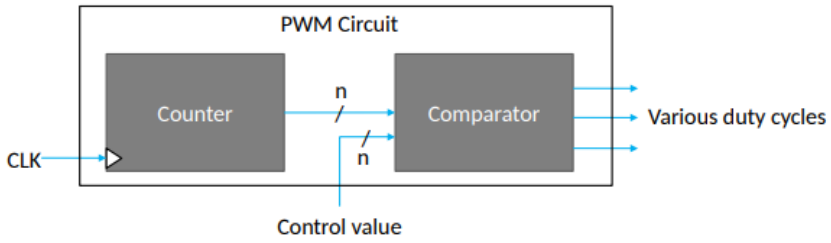


2 Creating PWM

created by comparing a control to a count Value

- `Frequency:` determined by the master clock and the size of the counter
- `resolution:` determined b the size of the counter and the comparator
- `duty cycle:` determined by how the outputs of the comparator are used.

* This technique is not exclusive to this course, microcontrollers generate PWM using this method of a counter with a comparator



The resolution of the duty cycle is a function of the size of the counter → Every change in one bit of the control value will adjust the duty cycle by the resolution.

$$\text{DC resolution}(\%) = \frac{1}{2^n} * 100$$

where n is the number of bits in counter.

- Frequency of the PWM is a function of the master clock and size of the counter.

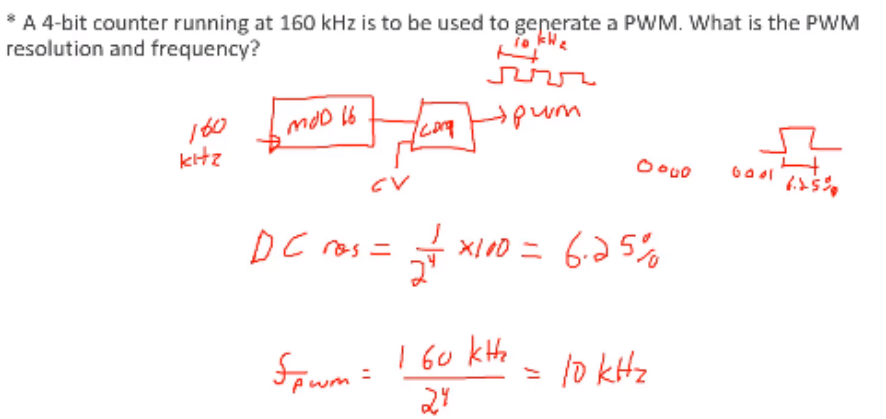
$$f_{PWM} = \frac{f_{CLK}}{2^n}$$

Where n is the number of bits in counter

2.1 PWM control Value

The control value is used to specify a duty cycle

- It is compared to the current count of the counter
- The output of the comparator will create different duty cycle → Equal | Less than | Greater than



The output of the comparator will create different duty cycle

- Equal→ $Duty\ Cycle(\%) - \frac{1}{2^n} * 100$
- Less Than→ $Duty\ Cycle(\%) - \frac{ControlValue}{2^n} * 100$
- Greater Than→ $Duty\ Cycle(\%) - \frac{2^n - Control\ \ value - 1}{2^n} * 100$

2.1.1 Achieving 100% Duty Cycle

- OR equal and less than together
- $Duty\ Cylce(\%) - \frac{ControlValue+1}{2^n} * 100$