

Pulse Width Modulation

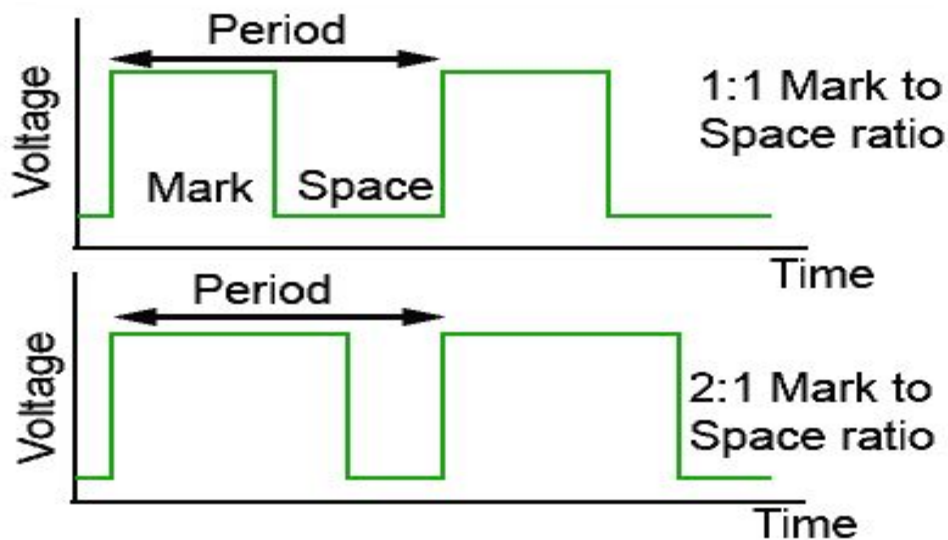
PWM

We know, in the digital realm, the only two allowed states are High and Low, 1 and 0. However, in certain cases, we need to be able to achieve analog states, states in between 0 and 1. A technique that allows this is PWM.

Suppose you want to send less than the maximum power to a certain device, say dimming an LED. Digital logic allows us to only turn it fully on, or completely off. But what happens when we rapidly switch the signal between 0 and 1, so quick, the human senses can't perceive. We only see the LED at a brightness lower than its maximum value. This exploitation of rapid switching between 0 and 1 in order to decrease the power is the essence of PWM.

The switching will produce a square waveform.

Now for a little terminology:



- The time period of the repeating square wave signal is called, well, the **time period**
- The reciprocal of the time period is called the **frequency**
- The amount of time set High is called the **mark time** or **pulse width** or **pulse duration**
- The amount of time set Low is called the **space time**
- The ratio of mark time to time period is called the **duty cycle**, expressed in percentages

Now it will be clear that at 100% duty cycle, the LED will glow at full brightness, gradually getting dimmer as the duty cycle decreases, and finally off at 0%. Also, the human persistence of vision is about 100ms, so the time period of the PWM must be at most 50ms, or else the blinking of the LED will be perceptible.

This same principle may be applied to DC motors as well, to change the speed of the motor.

Most microcontrollers have native support for PWM, but it may be hardcoded as well.

On the Arduino, this is achieved on using the `analogWrite()` function

The `analogWrite()` function takes two arguments:

- The pin to write to. That is the pin on which the PWM output has to be given. This can be any of the pins that support native/hardware PWM. These pins are denoted by a ~ sign on the physical arduino board.
- The duty cycle of the PWM to be produced, on a scale of 0 (0% duty cycle) to 255 (100% duty cycle)