**Pulse Width Modulation**

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In pulse width modulation (PWM), the output signal alternates between on and off within a specified period of time. We use the concept of duty cycles to control the power received by the device.

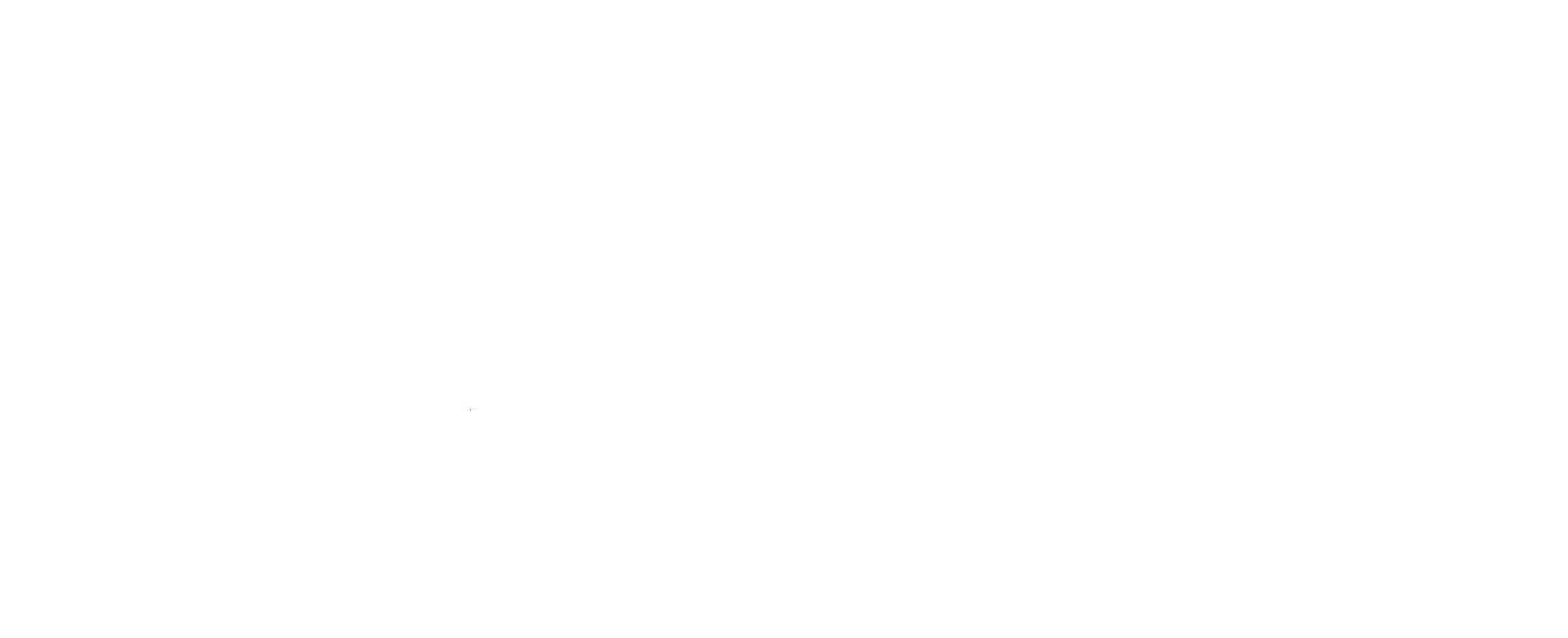
A PWM signal consists of two components. Firstly, we have the frequency, which determines how long the signal will take to complete a cycle. Secondly, we have the duty cycle, which would determine the amount of time for which the signal is high, compared to the total time for the cycle.

## Applications

If we were to use a DC voltage for all our devices, the costs would be extremely high. Instead, we use PWM signals. By doing this, the signal appears to be an AC signal. The changes from the on state to the off state happen so fast that we are unable to tell the difference. This also saves energy, since the device is technically only on for a shorter period of time.

Say we have a fan that has a high voltage of . If we run this fan at a duty cycle, it would only be on for of the time in each clock cycle. The voltage would begin to drop when the device is turned off and would increase again when it is turned on. The average voltage is given by

Thus, since the duty cycle is , the average voltage is . If we want to increase the average voltage, and thus make the fan spin faster, we would have to increase the duty cycle.



## Types of Pulse Width

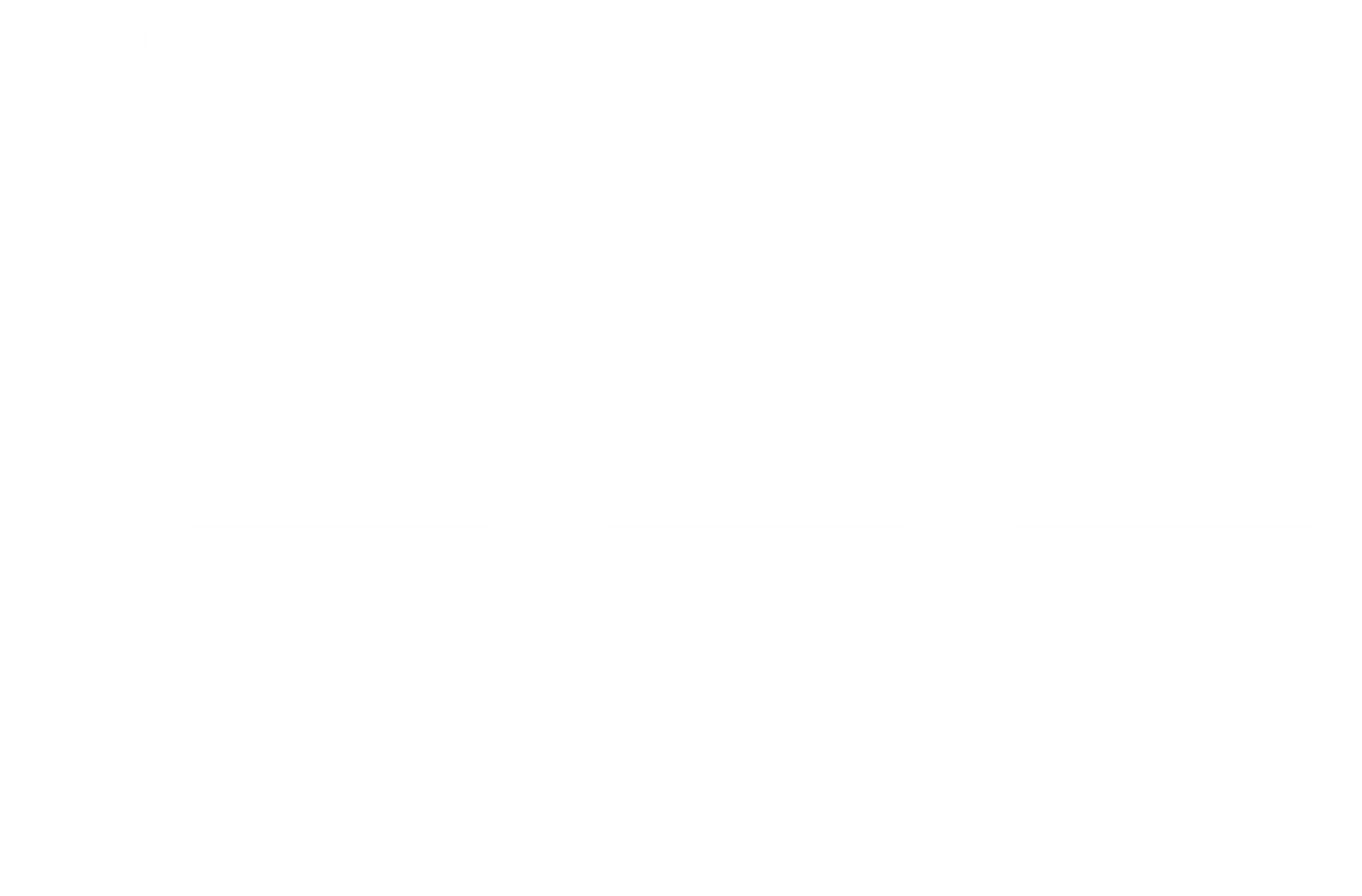
Pulse width modulation signals can be of four types:

1. Pulse Centre Fixed, with the edges modulated
2. Leading Edge Fixed, with the tailing edge modulated
3. Tailing Edge Fixed, with the leading edge modulated
4. Pulse Width Constant, with the period modulated

We do not need to know details about the differences between these types.

## Servo Motors

A servo motor is a special type of motor that uses PWM signals to provide precise angular control. It is not a normal motor that spins continuously, but rather something that can adjust its position to a certain angle and stay in that position. Generally, a servo motor can turn in either direction for a total of movement. The angle at which it will rest depends on the width of the pulses sent to it. Of course, the width of the pulses is determined by the duty cycle.



### Applications

Servo motors have countless applications, some of which are:

* Robotics: Every joint of a robot requires a servo motors so that the different parts can be moved at precise angles.
* Camera Auto-Focus: A highly precise servo motor corrects the lens of the camera on our phones to automatically sharpen an out-of-focus image.
* Solar Tracking System: Servo motors are used to adjust the angle of solar panels throughout the day so that they continue to face the Sun.
* Automatic Door Openers: The position of the door is changed using servo motors connected to sensors.
* Arduino: Servo motors are even incorporated onto simple devices like Arduino devices where the motor can be attached to an output and a switch can be used to control the angle of the motor.