

## Pulse Width Modulation (PWM)











## How we spin it: Pulse Width Modulation (PWM)

The most efficient method for cooling electronic products is to regulate the fan speed according to the temperature inside the electronic enclosure. Pulse-width-modulation (PWM) fan-speed control is the best way to achieve this regulation because it can decrease energy consumption, improve fan reliability and reduce acoustics while providing wider operational speed bandwidth.

#### **BENEFITS:**

- Energy efficient because it doesn't generate additional heat.
- Improved fan reliability because the fan doesn't run at full speed all the time.
- Improved acoustics of the fan with high-frequency driving signals.
- It provides thermal engineers with added operational speed bandwidth because the fan can run at either high or remarkably low speeds.



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What is PWM? PWM, or Pulse Width Modulation, refers to the method of apply-



T is the period in (s). F = 1/T is the frequency in (Hz). ( tON / T ) is the Duty Cycle in (%).

The frequency is always constant, what changes is the duty cycle: An 80% duty cycle indicates that the fan is ON 80% of the time and OFF 20% of the time. A 50% duty cycle signal indicates that the fan is ON 50% of the time and OFF 50% of the time (similar to a perfect square waveform signal)





#### 4-WIRE PWM:

The best approach to using PWM speed-control is to use a 4-wire PWM fan. The PWM and the tachometer line are connected to the PWM controller, leaving the fan power and ground lines uninterrupted, as shown below. In this way, the circuit inside the fan is working normally, sending a valid speed signal and accepting PWM control to change motor speed accordingly. As a result, a simple automatic closed-loop speed control system is formed.



With closed-loop speed control, the tolerance of the fan PWM duty cycle vs. the speed curve can be very wide. The controller can command the fan to achieve a desired speed (RPM) goal by adjusting the PWM duty cycle. If the speed is below the goal, the PWM duty cycle will be increased, and vice versa. The speed goal will also be maintained when there is voltage variation or load variation on the fan.

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