

# Pulse Width Modulation Signal Generation with MCUs

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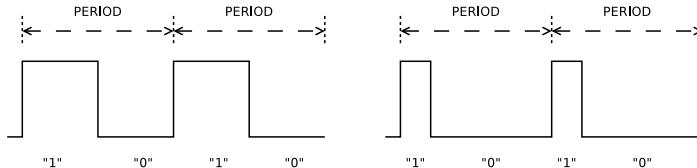
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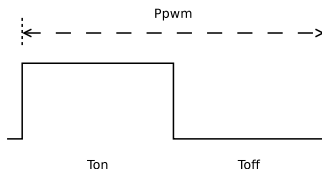
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# Pulse Width Modulation



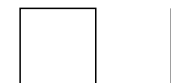
- **Pulse Width Modulation (PWM)** is a technique of *modulation* of a digital signal in order to obtain an analog value.
- It based on generating a **square wave** with a given **frequency**
- In the square wave, the “0” part and the “1” part have **different duration**
- The difference, in percentage, is called **duty cycle**

# Duty Cycle: Definition



- The **Duty Cycle** is defined as the percentage of  $T_{on}$  with respect to the total period  $P_{pwm}$  of the signal:

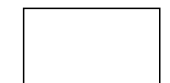
$$Duty\ Cycle = \frac{T_{on}}{P_{pwm}} \cdot 100$$



Duty Cycle = 50%



Duty Cycle = 10%

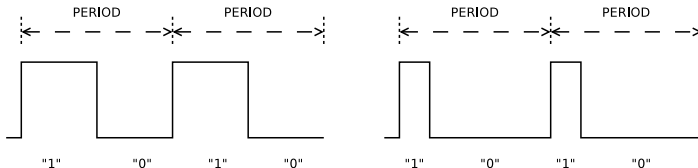


Duty Cycle = 90%

Duty Cycle = 0%

Duty Cycle = 100%

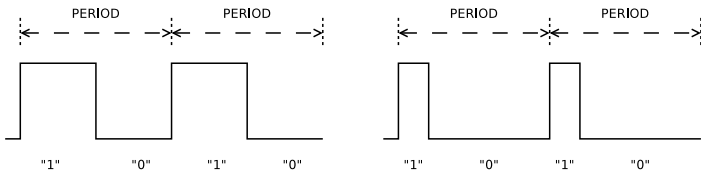
# Usage of Pulse Width Modulation



PWM has multiple utilisations:

- 1 **To simply transfer an analog value over a digital line**; devices receiving a PWM signal can interpret the “analog value” by measuring the duration of the “1” part with respect to the total frequency;
- 2 **To modulate a typical on/off system**; e.g. to change the intensity of a light generated by a lamp, a LED, etc.;
- 3 **To drive power systems without affecting performances**; e.g. to drive a DC motor.

# Generation of a PWM signal



- Microcontrollers often have peripheral able to generate a PWM signal in hardware, however...
- ... to generate a PWM signal is not harder than flashing a LED. The differences are:
  - Frequency is higher;
  - **On** and **Off** times are different;
  - The timer has to be set-up by taking into account the **resolution** we need.

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