

# **Chapter 6 – LEDs and Pulse Width Modulation**

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Part 4 of this tutorial series described how to blink an LED. With just a bit more knowledge we can make them appear to flicker, which can be useful in flame effects.

If you look closely at the larger Arduino boards, you can see a dash next to digital pins 3, 5, 6, 9, 10 and 11; on smaller boards this may be hard to see. These pins are special in that they support PWM, Pulse Width Modulation. PWM allows these pins, at the coders discretion, to rapidly turn themselves on and off without having to do any complex programming.

In a previous part of this tutorial series, we set the value of a digital pin to HIGH or LOW to turn a LED connected to the pin either on or off. What we are now disclosing is that these special PWM pins can also take on a value from 0 to 255, alternately making them appear very dim, very bright or anything in between. And if we use the “random” function to set this brightness value inside the LOOP, we can make the LED appear to flicker.

Consider the following sketch:

```
void setup()
{
  pinMode(3, OUTPUT);
  pinMode(5, OUTPUT);
  pinMode(6, OUTPUT);
  Serial.begin(9600);
}

void loop() {
  analogWrite(3, 135+random(120));
  analogWrite(5, 135+random(120));
  analogWrite(6, 135+random(120));
  delay(random(100));
}
```

In the setup function above we define the pins for output. We just learned that these pins are capable of performing Pulse Width Modulation, so they can be given values from 0 to 255 in addition to “HIGH” or “LOW” (think of 255 as synonymous with “HIGH”, and zero as synonymous to “LOW”). Every time we execute the loop, the sketch alters

their PWM value from 135 to 255, thus alternating their brightness. Furthermore, the delay function alters the elapsed time between each iteration. If we use red and yellow LEDs attached to these pins, using the same 180Ω resistor in each one, the result will be flickering, flame-like lumination. Cool!

We could use all 6 PWM pins for an even larger effect. But be advised; if a servo motor is used in a sketch, pins 9 and 10 lose their PWM ability.

For a great in-depth explanation of PWM by Paul McWhorter visit <https://www.youtube.com/watch?v=YfV-vYT3yfQ>, and also take a look at an example of PWM applied to a campfire from Ron's Trains and Things (<https://www.youtube.com/watch?v=wBn7pHEldWI>), starting at about 14:45.