# LESSON 10: TRANSISTOR 2N2222

INTRODUCTION

 It's a fantastic and simple, yet comprehensive, overview of basic transistor principles, function, and applications. I highly recommend reading the entire article if you're looking for a good starting place with transistors. Because they did such a great job at explaining the fundamentals, I won't go into them here (i.e. how NPN or PNP transistors are constructed and the physics behind their operation).

As most probably do, I started with a simple NPN transistor (2N2222). Again, I'll default to the Sparkfun tutorial for the major details, but I'll briefly explain some principles. The NPN (and PNP) have 3 pins: collector, base, and emitter. NPN transistors are usually configured on the low-side, with the emitter tied to ground. The collector side in this configuration contains the load being powered. By varying current at the base pin, we can control the current across the load and out the emitter to ground

COMPONENTS

- Arduino UNO board
- 1x 2N2222 NPN Transistor
- 1x 330Ω Resistor
- 1x 1K Resistor
- 1x LED
- Breadboard
- Jumper wire

CONNECTION
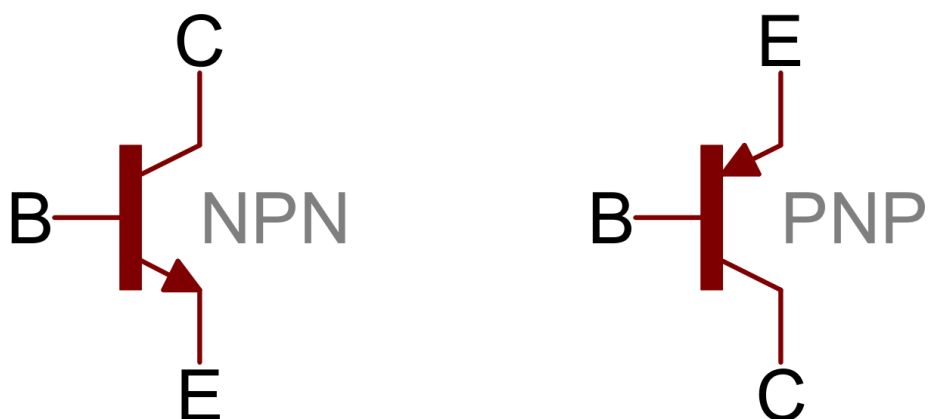
There are 4 possible ways we can use a transistor in the low-side switch configurations:

1. **Cut-off ("open-circuit"):** VB < VC & VE. No current flow from C to E.
2. **Saturation ("short-circuit"):** VB > VC & VE. Full current flow from C to E.
3. **Forward Active ("current valve"):** VE < VB < VC. Current flow from C to E proportional to current flowing into base pin.
4. **Reverse Active ("current valve"):** VC < VB < VE. Current flow from E to C proportional to current flowing into base pin. Not a common configuration, but it technically works.

I wanted to try both using the transistor as a simple switch ("saturation") and control LED brightness by varying current at the base pin ("forward active").

STEP 1: The circuit. The breadboard and schematic of the circuit I constructed can be seen below.
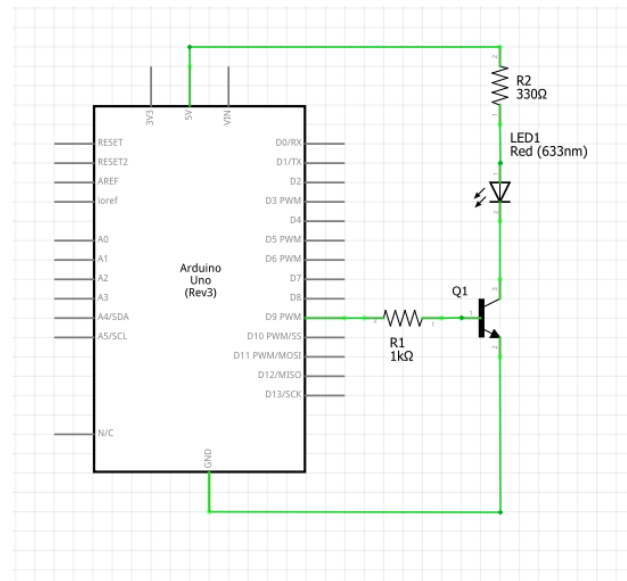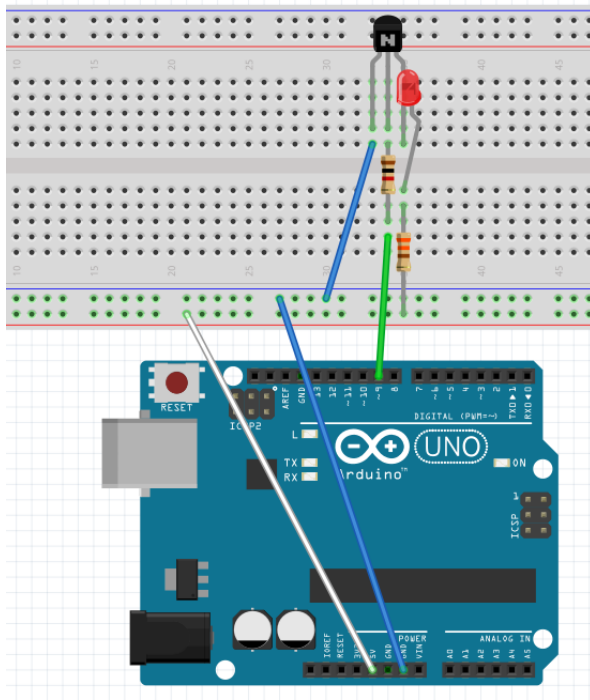
By connecting the base pin to a PWM-capable pin on the Arduino, I was then able to vary voltage/current at this pin at my discretion. I wrote a simple Arduino sketch that does this, using a for-loop to slowly ramp PWM with analogWrite() from 0 (minimum) to 255 (maximum) then back down again. It's all very simple, but I was admittedly proud and was happy that I both proved that I could use a transistor as both a switch and a "current valve" for controlling output from a load.
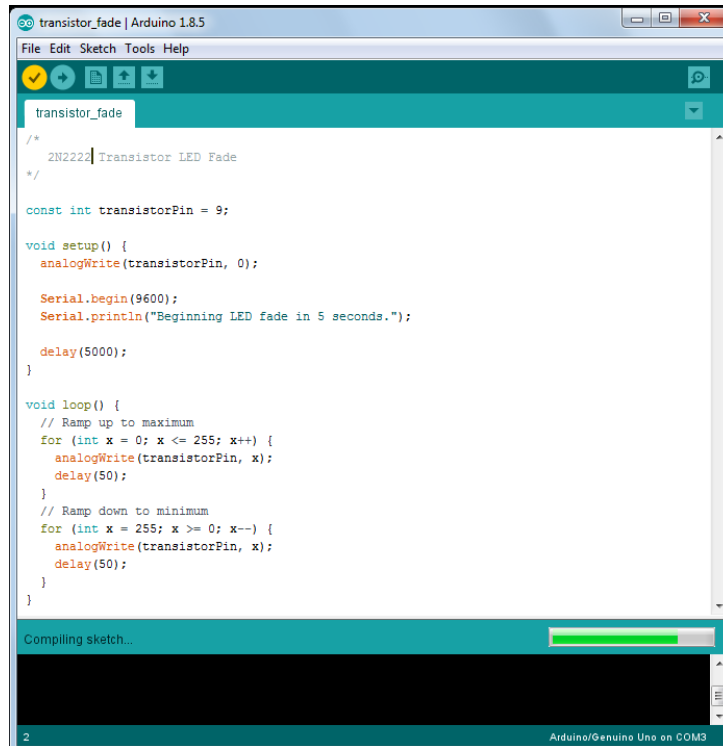
STEP 2: Program

```
/*
  2N2222 Transistor LED Fade
*/
const int transistorPin = 9;

void setup() {
  analogWrite(transistorPin, 0);

  Serial.begin(9600);
  Serial.println("Beginning LED fade in 5 seconds.");
  delay(5000);
}

void loop() {
  // Ramp up to maximum
  for (int x = 0; x <= 255; x++) {
    analogWrite(transistorPin, x);
    delay(50);
  }
  // Ramp down to minimum
  for (int x = 255; x >= 0; x--) {
    analogWrite(transistorPin, x);
    delay(50);
  }
}
```

STEP 3: Compile the code. Click the Verify button on the top left. It should turn orange and then back to blue.

STEP 4: Upload the sketch to Arduino UNO. Click the Upload button. It will also turn orange and then blue once the sketch has finished uploading to your Arduino board.

RESULT: Driving an LED with PWM from an Arduino

COM3 (Arduino/Genuino Uno)

Send

Beginning LED fade in 5 seconds.

☑ Autoscroll   No line ending ▾   9600 baud ▾   Clear output