

Resistor is also a type of Electric Conductor. This type of Electric Conductor is used for its specific **"Resistance Values"**, often added to an electrical circuit to control the amount of Electric Current going into a device. They come in various sizes and shapes.

Some Resistor have fixed resistance value, some with variable resistance values.

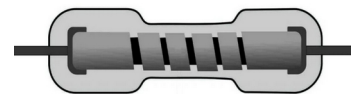
In this example, we will just look at the fixed value resistor that is commonly used in Arduino based projects, the 0.25w film Resistor

0.25w is the maximum amount of Power (Voltage x Current) that it can handle

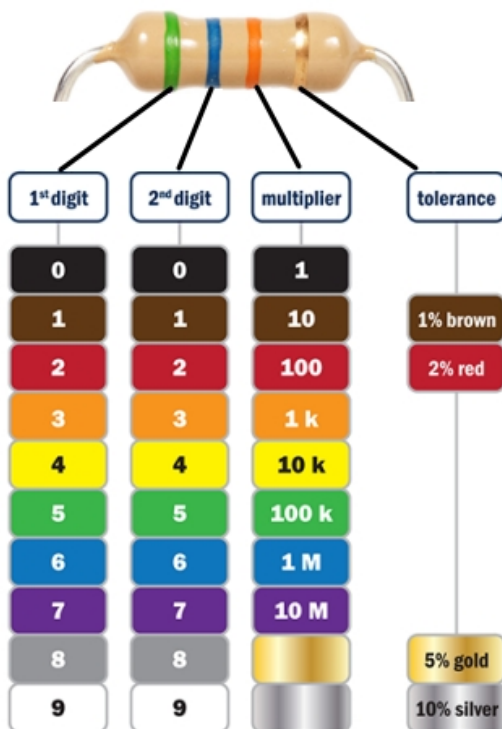


0.25w Carbon Film Resistor
has carbon film inside,
cheaper but less accurate

0.25w Metal Film Resistor
Has metal film inside, more
expensive but more accurate



0.25w Resistor are color coded for their Resistance Value.



Example: 3 Color Band Resistor

Green = 5
Blue = 6
Orange = 1000 (multiplier)
 $56 \times 1000 = 56,000$

56kilo-ohm

5% tolerance (deviations)

Sometimes colors are hard to see and we are too busy to decode the color codes. **The best option** is to use **multimeter** to find out the resistance value of a Resistor. A multimeter can also help to detect faulty resistors (we can't do that with color codes)

There are many types of multimeters with different functions, fortunately all the multimeters can read resistor values. You can use any of them.



Resistor Value Calculation when used with 5mm LED

RESISTOR FOR regular 5mm "bulb" LED used with Arduino Uno

220 Ohm Resistor is often used together a regular 5mm "bulb" LED in a 5V electrical circuit (example, the Arduino Uno board). This is important because a regular 5mm "bulb" LED will be damaged if used without a Resistor in this setup.

**Why 220 Ohm Resistor ?**

We have following information from our circuit and devices:

- 1.Total Supply Voltage = 5V (Arduino Uno board)
- 2.Regular 5mm "bulb" LED (information from manufacturer, datasheet)
 - 2.1.LED Voltage Drop = 1.8V
 - 2.2.Electric Current Limit = 20mA (or 0.02A)

These two (3. and 4.), we need to find out on our own

- 3.Resistor Voltage Drop (RVD) = ?
- 4.Resistor Value (RV) to get 20mA = ?

3.Resistor Voltage Drop (RVD) = ?

Kirchhoff's Voltage Law,
Total Supply Voltage = Total Voltage Drop

$$5V(\text{Arduino Uno}) = 1.8V(\text{LED}) + \text{RVD}(\text{Resistor})$$

$$\text{RVD} = 5V - 1.8V = 3.2V \text{ (Voltage at our Resistor)}$$

m

4.Resistor Value (RV)to get 20mA(0.02A) = ?

20mA is not available yet, we want to achieve the 20mA at the LED with our Resistor because we know that is the limit (data provided by the manufacturer of LED). Now we want to find out what Resistor can help to achieve that.

Ohms Law,
Resistance(RV) = Voltage / Current

$$RV = 3.2V \text{ (from our RVD)} / 0.02A$$

$$RV = 160 \text{ Ohm}$$

The ideal Resistor to be used with the regular 5mm LED (based on our specs above) on a 5V circuit will be the 160 Ohm Resistor because it allows the exact 20mA Electric Current into the LED.

Anything smaller than 160 Ohm Resistor will let more than 20mA Electric current flowing into the LED, we risk destroying the LED.

Sometimes because of variations/defects in manufacturing process, the LED will still survive when used with Resistors lower than 160 Ohm, sometimes the LED gets damaged with 160 Ohm Resistor.

So, we just use something safer and common, "220 Ohm Resistor". We can also use Resistor with bigger resistance value safely with our LED, for example, the "1,000 Ohm or 10,000 Ohm resistor" (the LED will still work, just dimmer because the LED gets less Electric Current)

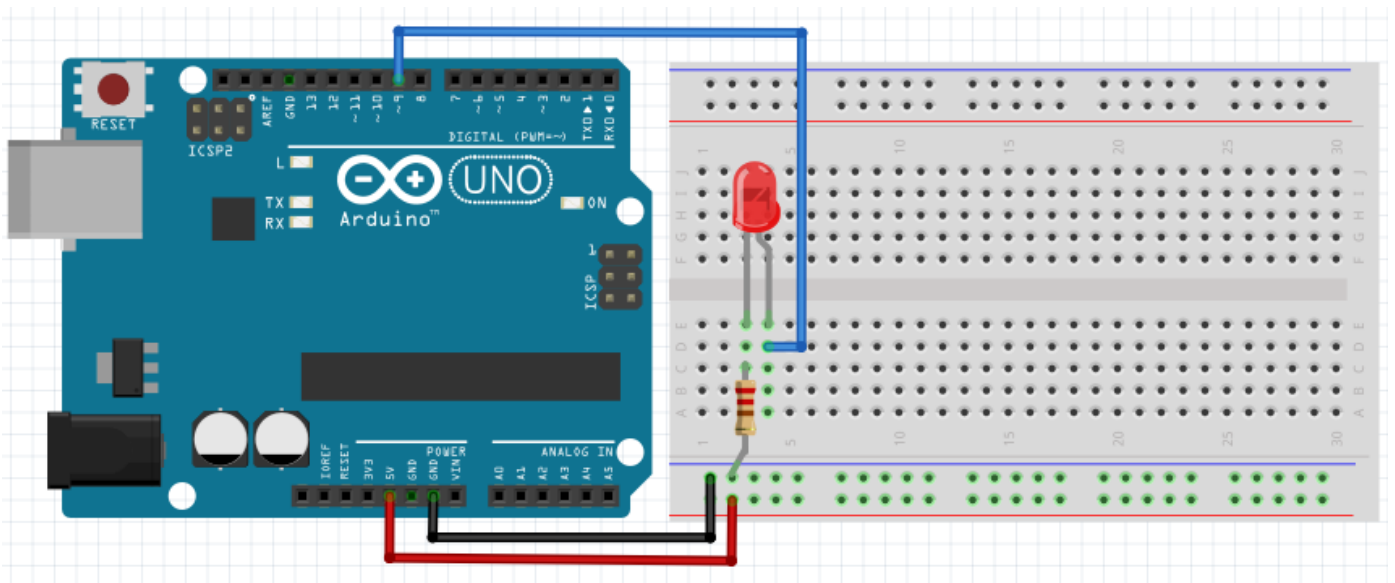
This Resistor Calculation example is for an LED, this same calculation can apply for other devices. LED is a very good tool for learning this.

Description:

Switch ON an External LED with a Fixed Value Resistor from Arduino Uno
(Atmega328 micro-controller)

Parts Required

- 1 x Arduino UNO with USB 2.0 type A/B Data Cable connected to Computer with Arduino IDE Software installed
- 1 x Half-size Solderless Breadboard
- 2 x Jumper Wire (M-M)
- 1 x Light Emitting Diode 5mm (LED)
- 1 x Resistor (220 Ohm)
- 1 x Jumper Wire (M-M)
- 1 x Resistor 50K Ohm (or any bigger resistor for experiment) - optional



```
// Program Name: resistor_led
#define LED_PIN 9
void setup() {
  pinMode(LED_PIN, OUTPUT);
  digitalWrite(LED_PIN, HIGH);
}
void loop() {}
```

Watch the LED on Arduino Pin 9

Try replace the resistor with a higher resistance value, for example 50K Ohm or more, you will noticed that the LED will become dimmer.

However, do not replace the Resistor with a lower value ones, the LED may be damaged if too much current goes into the LED.