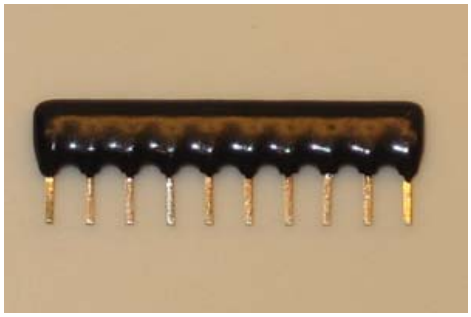
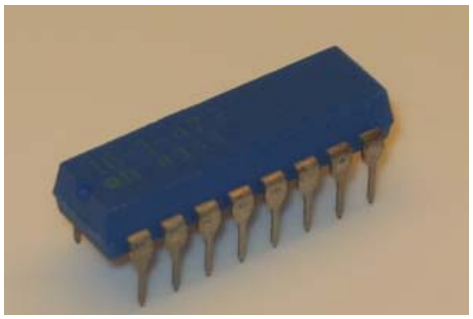
Resistor Tutorial
Cornerstone Electronics Technology and Robotics I Week 8

- Administration:
  - Prayer
  - Turn in quiz
- Electricity and Electronics, **Section 3.5**, Resistors:
  - Function: Resistors restrict the flow of electric current, for example a resistor is placed in series with a light-emitting diode (LED) to limit the current passing through the LED. They convert electrical energy into mechanical energy (heat).
    - Resistors are used to:
      - Provide a voltage drop
      - Provide a current limit
      - Dissipate (converting) electrical energy
      - Some electrical components have resistance that varies with temperature or light. They serve as sensors used in various applications.
  - A larger value in ohms represents a larger resistance.
  - **Fixed Resistors:**
    - Example and Symbol:

    - Carbon composite resistor
    - Thin film resistor
    - Film resistors
    - Resistors networks:
      - SIP - Single In-line Package
      - DIP - Dual In-line Package



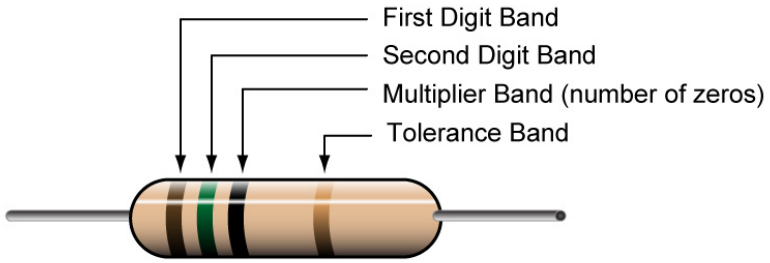
SIP



DIP

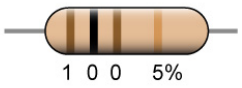
    - Wire wound resistors are used where the resistor has to dissipate a lot of heat.

4-Band Resistor Color Code



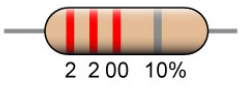
First Digit	Second Digit	Multiplier # of Zeros	Tolerance	Color
	0	no zeros		Black
1	1	1 zero		Brown
2	2	2 zeros	2 %	Red
3	3	3 zeros		Orange
4	4	4 zeros		Yellow
5	5	5 zeros		Green
6	6	6 zeros		Blue
7	7	7 zeros		Violet
8	8	n/a		Grey
9	9	n/a		White
		x 0.1	5%	Gold
		x 0.01	10%	Silver

Examples:



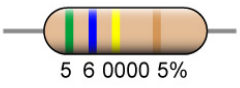
Brown - Black - Brown - Gold
1 0 0 5%

100 Ω +/- 5%



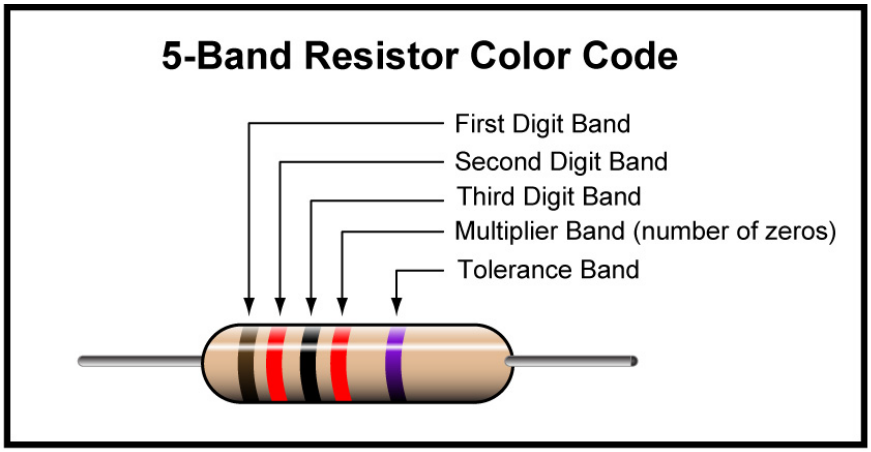
Red - Red - Red - Silver
2 2 00 10%

2,200 Ω (2.2K) +/-10%



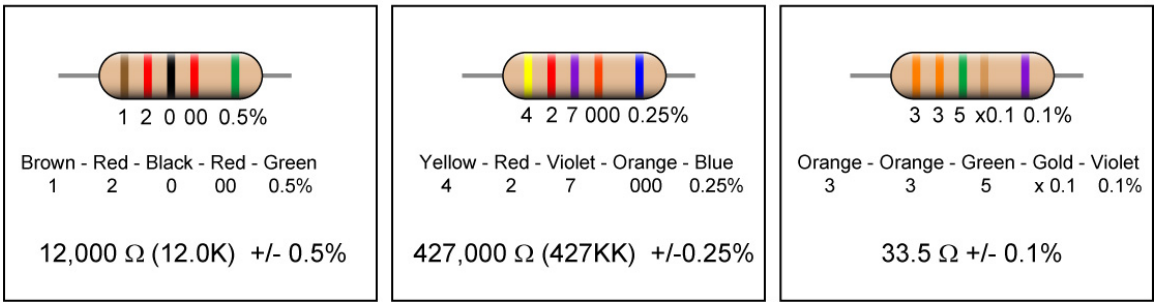
Green - Blue - Yellow - Gold
5 6 0000 5%

560,000 Ω (560K) +/- 5%



First Digit	Second Digit	Third Digit	Multiplier # of Zeros	Tolerance	Color
	0	0	no zeros		Black
1	1	1	1 zero	1%	Brown
2	2	2	2 zeros		Red
3	3	3	3 zeros		Orange
4	4	4	4 zeros		Yellow
5	5	5	5 zeros	0.5%	Green
6	6	6	6 zeros	0.25%	Blue
7	7	7	7 zeros	0.1%	Violet
8	8	8	n/a		Grey
9	9	9	n/a		White
			x 0.1		Gold
			x 0.01		Silver

Examples:



- See resistor color code applet:
  - http://www.dannyg.com/examples/res2/resistor.htm

- Percentage and Tolerance Calculations:
  - Percent means "out of 100." For example, instead of saying "30 out of every 100 professional basketball players are female," we can say "30% of professional basketball players are female."
  - 1% of anything is one hundredth part of it.
  - Here are three ways to write the same thing:

    $$25\% = 25/100 = 0.25$$

    To convert percent to a decimal, move the decimal to the left 2 places.

  - Find 10% of 470:
    - First change 10% to a decimal by moving the decimal point 2 places to the left.

      $$10\% = 0.10$$

    - Then multiply,

      $$0.10 \times 470 = 47$$

    - 10% of 470 is 47
  - Find the upper and lower limits for a 470 Ω resistor with a 10% tolerance:
    - The allowable resistance within tolerance can be from 470 Ω + 10% to 470 Ω – 10%.
    - From above, 10% of 470 is 47
    - Upper Limit: 470 Ω + 10% = 470 Ω + 47 = 517 Ω
    - Lower Limit: 470 Ω – 10% = 470 Ω – 47 = 423 Ω
    - Therefore the range for a 470 Ω resistor with a 10% tolerance is from 423 to 517 ohms.
- Perform Resistors Lab 1 – Resistor Color Code
- Resistor Failure:
  - Open circuit
  - Changed in value
  - They never go short circuit.
- Physical characteristics:
  - Different resistance values are created by mixing or doping different impurities with the carbon.
  - Electrical current running through a resistor causes it to become heated. Resistors have a wattage rating. The higher this rating the more heat they can dissipate. The wattage in a resistor is the <u>maximum</u> amount of heat energy it can safely dissipate without damage.

        - Demonstration: use a 150 ohm ½ watt and ¼ watt resistors with various currents from a robust power supply. Note how the heat from the resistors varies. Verify the value of the resistor as the voltage increases.
        - Resistors carrying large currents must be physically large so the heat can radiate quickly to the surrounding air.
        - Demonstration: use a small (1/4 watt) and a larger (10 watt) resistor, both having a resistance of 10 ohms. The current through each resistor will be the same. Note the variation in heat given off by the two resistors.
    - Complete Resistors Lab 2 – Resistors and Current

- Suggested homework, Student Activity Sheets 3-2, 3-3.

Electronics Technology and Robotics I Week 8
Resistor Lab 1 – Resistor Color Code

- **Purpose:** The purpose of this lab is to acquaint the student with the resistor color code and tolerance calculations.

- **Apparatus and Materials:**

    - 10 – Fixed Resistors Labeled 1 – 10

- **Procedure:**
    - Using the resistor color code, determine the value of 10 resistors and record the values in the table below.
    - Calculate the limits that are within tolerance
    - Measure the resistance of each resistor and compare with the coded value.

- **Results:**

Resistor	Coded Value	Product of Tolerance x Value	Upper Limit	Lower Limit	Measured Value
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

- **Conclusions:**
    - Are the measured values of each resistor within the tolerance limits?

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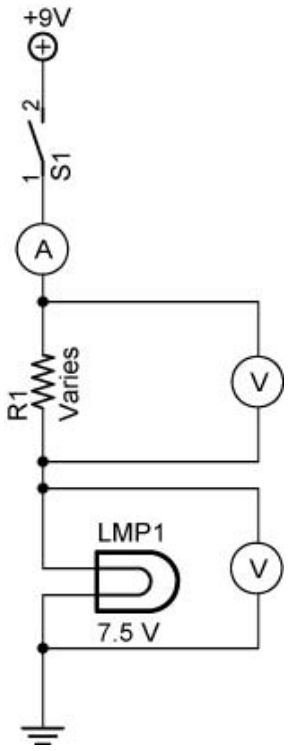
Resistor Lab 2 – Resistors and Current

- **Purpose:** The purpose of this lab is to demonstrate to the student that resistors restrict current and that an increase in resistance increases the voltage drop across the resistor.

- **Apparatus and Materials:**

    - 1 – Breadboard with 9 V Supply
    - 3 – Digital Multimeters
    - 1 – 1, 10, 22, 47, 68, and 100 Ohm Resistor
    - 1 – 7.5 V Lamp with Lamp Base
    - 1 – SPDT Switch

- **Procedure:**
    - Assemble the circuit below on the breadboard using 1, 10, 22, 47, 68, and 100 ohm resistors as R1.
    - Measure the current for each change in resistor value.
    - Calculate the voltage drop across R1 using Ohm's law.
    - Now measure the voltage drop across R1 and the lamp.
    - Compare the calculated voltage drop across R1 with the measured value.
    - Add the measured voltage drops across R1 and the lamp to get the total measured voltage drop.
    - Compare the total measured voltage drop with the measured source.
    - Note the brightness variation in each case.



- **Results:**

Voltage Drops Lab 2						
Circuit	**R1**	**Current**	**Calculate Voltage Drop R1**	**Measured Voltage Drop R1**	**Measured Voltage Drop LMP1**	**Total Measured Voltage Drop**
1						
2						
3						
4						
5						
6						

- **Conclusions:**
  - Is the calculated voltage drop across R1 close to the measured voltage drop across R1?

  - As the value of R1 is increased, what happens to the voltage drop across R1?

  - As the value of R1 is increased, what happens to the brightness of the lamp? Why?