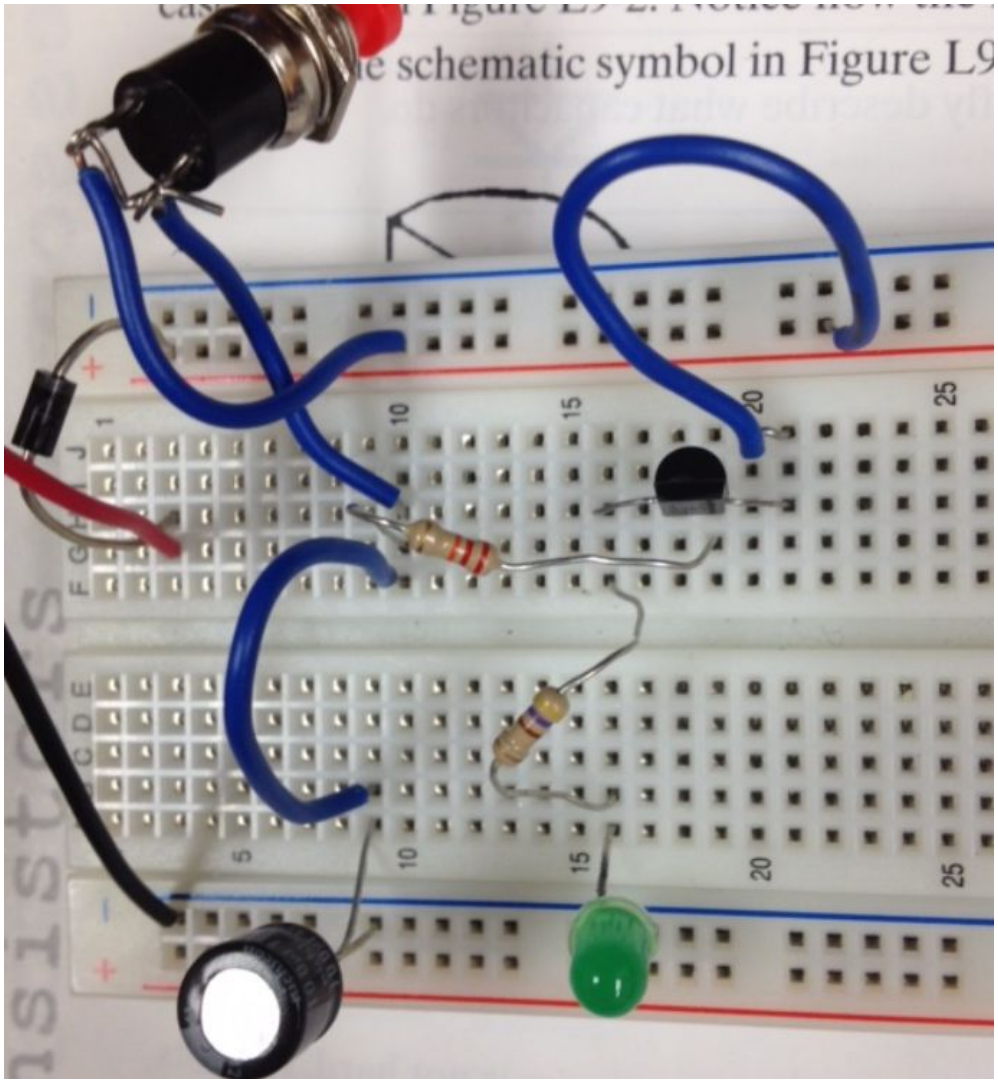
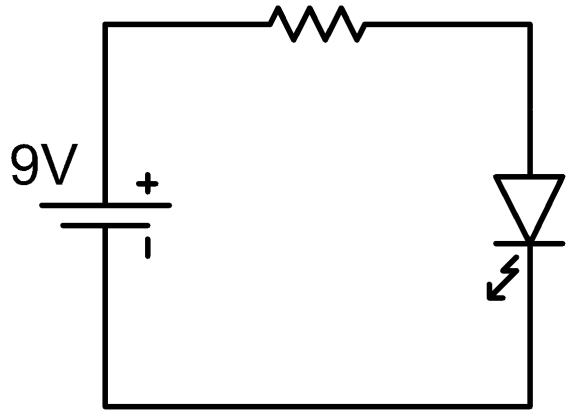
Introduction to Electricity/ Electronics

Example of a circuit



What's an Electrical Circuit?

- Every circuit requires these three things:
  - Power Source
  - Load
  - Conductor



- Optionally, a circuit may include a "control device" such as a switch

Three Main Invisible Quantities

- **Voltage** - Provides the "push"

  symbol - V, units - Volts

- **Current**,
- Flow of Electrons
- Amount of Current is dependent on Voltage and Resistance

  symbol - I, units - Amperes (Amps)

  1 Amp = 6.24×10^{18} electrons move through a wire every second

- **Resistance**
- Limits the amount of current
- Represents the "load" of the circuit

  symbol - R, units - Ohms (Ω)

Unit Name	Unit Symbol	Quantity
Ampere **(amp)**	**A**	**Electric current (I)** **1 Amp = 6.24×10^{18} electrons move through a wire every second**
Volt	**V**	**Voltage**
Ohm	**Ω**	**Resistance (R)**
Farad	**F**	**Capacitance (F)**

Ohm's Law

"Current (I) is proportional to Voltage (V) and inversely proportional to Resistance (R)"

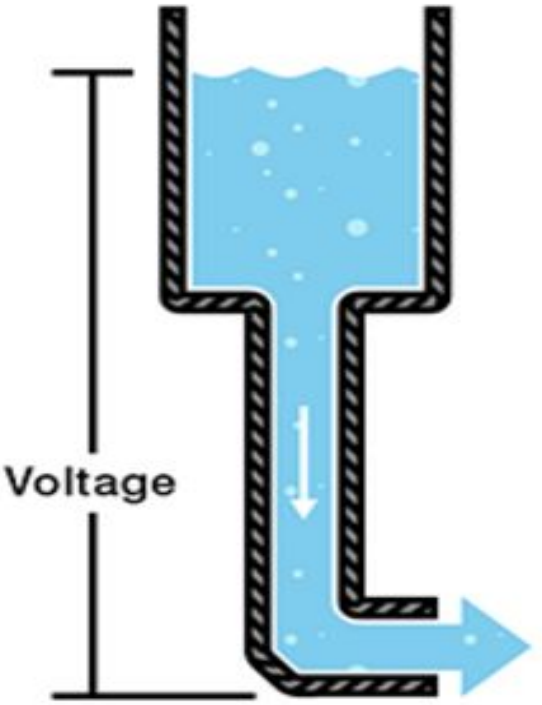
$$I = \frac{V}{R} \qquad V = I \times R \qquad R = \frac{V}{I}$$

Prefix	Prefix Symbol	Prefix factor	Example
nano	**n**	10^{-9}	$1nF = 10^{-9}F$
micro	**μ**	10^{-6}	$1\mu A = 10^{-6}A$
milli	**m**	10^{-3}	$1mA = 10^{-3}A$
kilo	**k**	10^{3}	$1k\Omega = 1000\Omega$
mega	**M**	10^{6}	$1MHz = 10^{6}Hz$
giga	**G**	10^{9}	$1GHz = 10^{9}Hz$

Waterfall Analogy

- The voltage is equivalent to the water pressure, the current is equivalent to the flow rate, and the resistance is like the pipe size.

- Water = Charge
- Pressure = Voltage
- Flow = Current



Types of Electricity

Direct Current (DC)

- Batteries, fuel cells and solar cells all produce something called **direct current** (DC).

- The positive and negative terminals of a battery are always, respectively, positive and negative.

- Current always flows in the same direction between those two terminals.

Voltage Can Be Provided From…

- A battery - DC (Direct Current)

Alternating Current (AC)

- The power that comes from a power plant, on the other hand, is called **alternating current** (AC).

- The direction of the current reverses, or alternates, 60 times per second

- The power that is available at a wall socket in Canada is **120-volt, 60-cycle AC power**

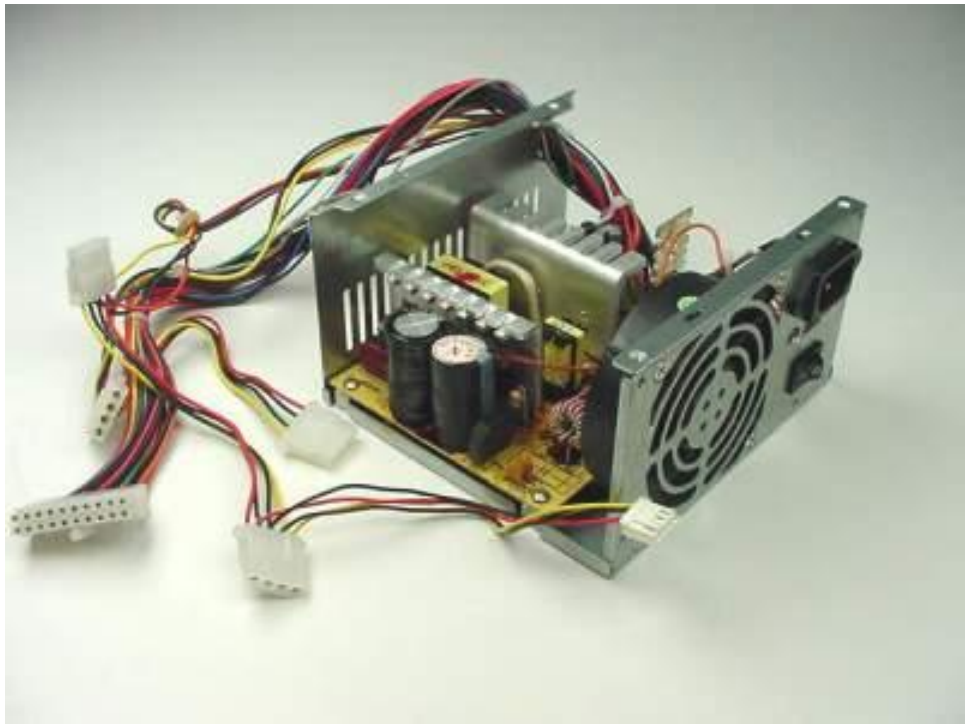
AC Cont'd

- Home and office outlets are almost always AC because generating and transporting AC across long distances is easy (using transformers)

- capable of powering electric motors (converting electrical energy into mechanical energy) – useful for dishwashers and refrigerators which run on AC

Voltage Can Be Provided From…

- Computer Power Supply or Electrical Point on the wall – AC (Alternating Current)

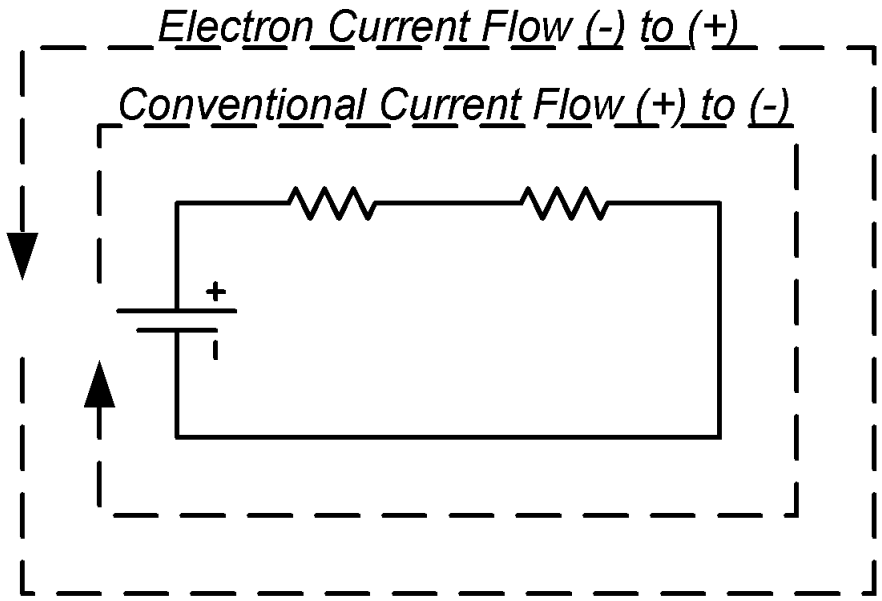


- Red: 5V
- Yellow: 12V
- Black: Ground

Current

- …is simply the flow of electrons
- Direction depends on convention

- Electron flow is from (-) to (+) *(flow of electrons)*
- Conventional flow is from (+) to (-) *(hole flow)*



Resistors – Basic Specs

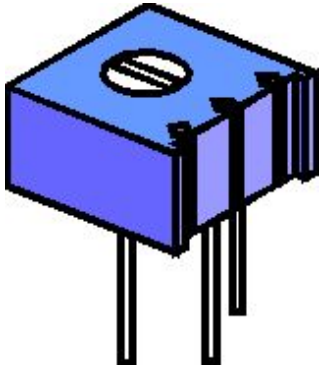
- Can be rated by…
  - Resistance (Ohms, Ω)
  - Tolerance (% of nominal value)
  - Power Rating (Watts)

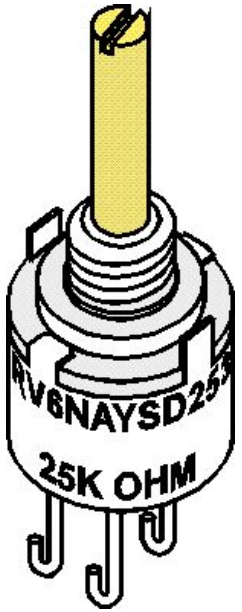
- Schematic Symbol… 

Resistors – Types

- Fixed

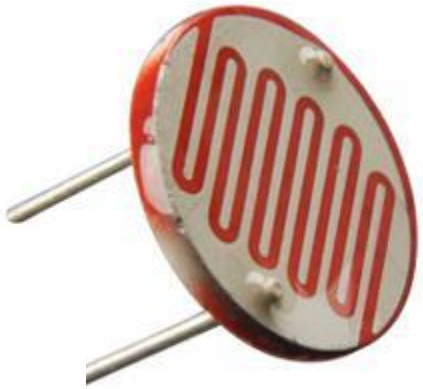
- Variable (Potentiometer, Rheostat)



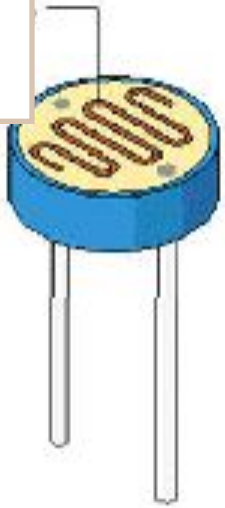


Resistors - Types
LDR (Light Dependant Resistor)

- The resistance changes as intensity of light changes
-



Cadmium Sulphide Track



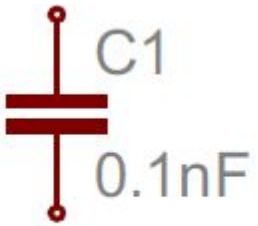
Symbol

Capacitors

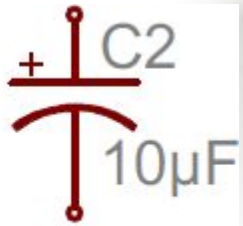
- ***Capacitors store charge,***
- ***Pass high frequencies, and***
- ***Block DC***

Measured in Farads, Usually in microfarads

SYMBOL



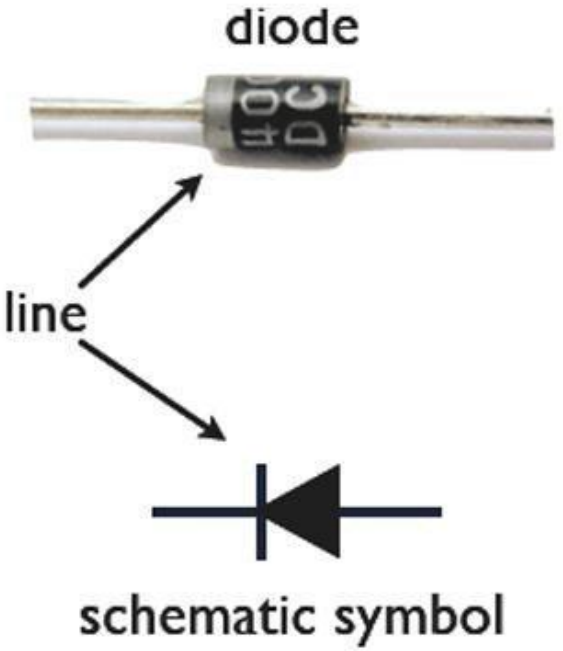
Non-polarized



Polarized

Diodes

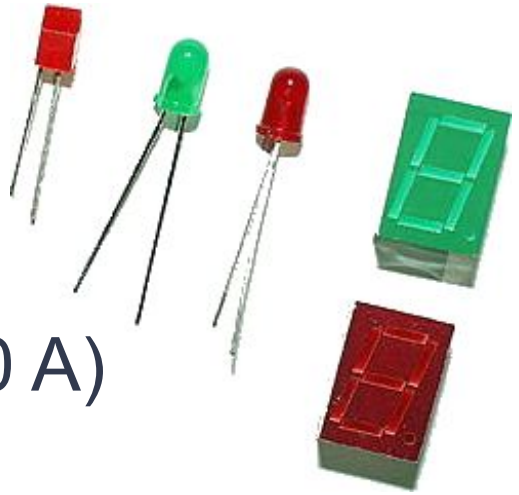
- ***restricts current in one direction***
- ***Some give out light (LED)***
- ***Others maintain fix voltage***

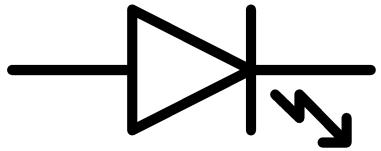


SYMBOL

Light Emitting Diodes

- A type of diode designed to emit light
- Can be visible or IR
- 2 V voltage drop
- Typically draws 20 mA (0.020 A)
- Schematic Symbol…





Grounding Circuits

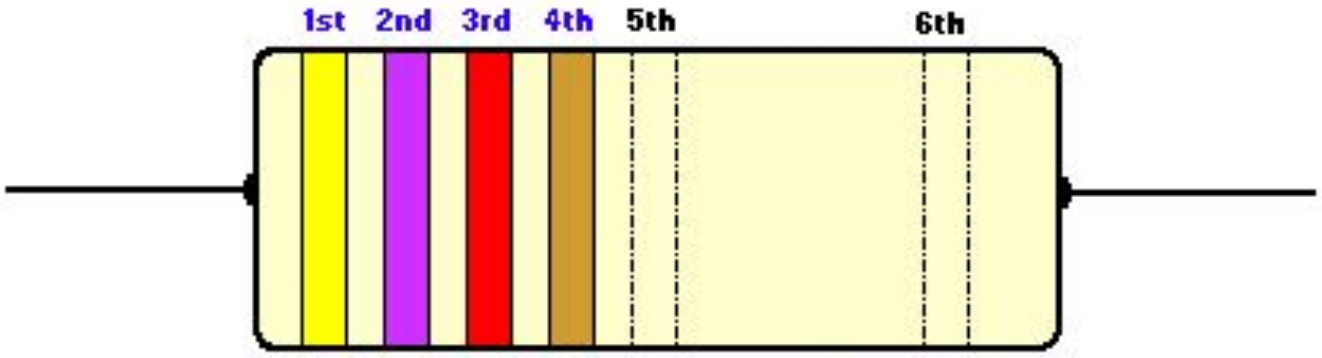
- Ground in the power-distribution grid is literally "the ground" that's all around you when you are walking outside.

- Remember, all circuits must complete the path by returning to the positive side of the source.

- A ground completes all circuits by “grounding” the flow of electrons after they have done their job.

RESISTORS – COLOUR CODES

Example: 4K7 or 4700 ohms (Carbon)



Band 1, first #

Band 2, secnd #

Band 3, multiplier with '0's

Band 4, tol. in %

Band 1: Yellow - 4 4
Band 2: Violet - 7 7
Band 3: Red - 2 00
Band 4, Gold, 5% Tolerance 4700 Ohms

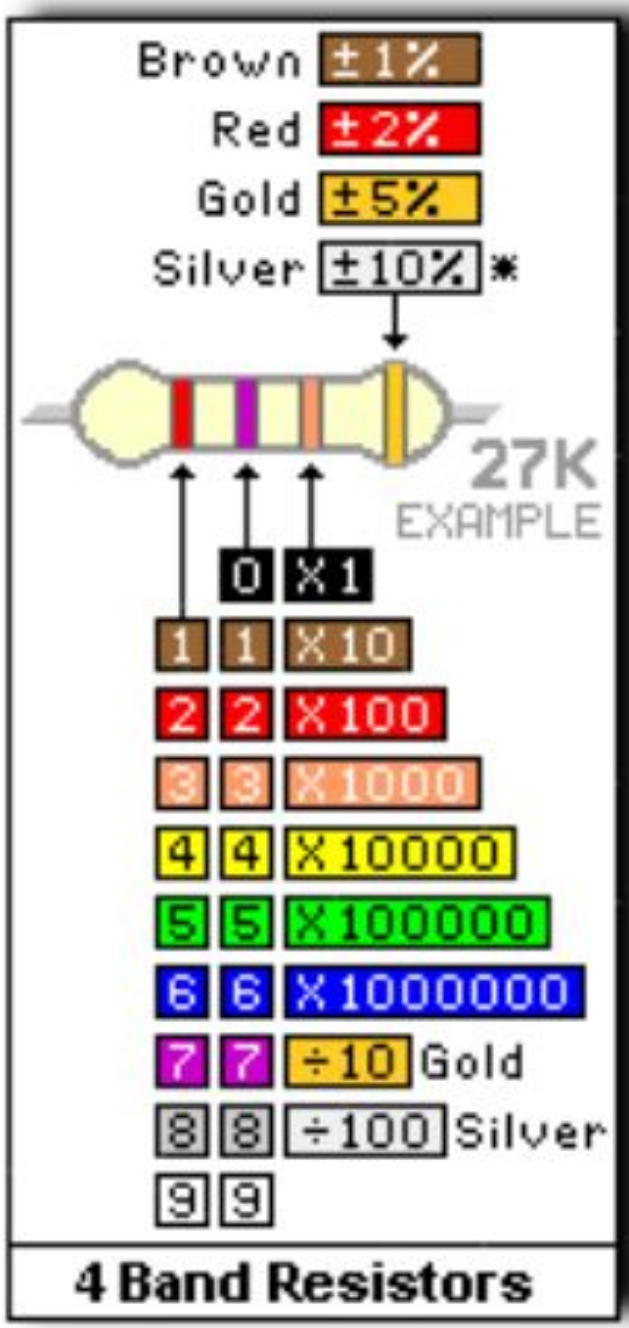
Band 1, 2, 3

Black = 0
Brown = 1
Red = 2
Orange = 3
Yellow = 4
Green = 5
Blue = 6
Violet = 7
Gray = 8
White = 9
Gold = 0.1

Tolerance: Brown = 1%
Red = 2%
Band 4 Gold = 5%
Silver = 10%
None = 20%

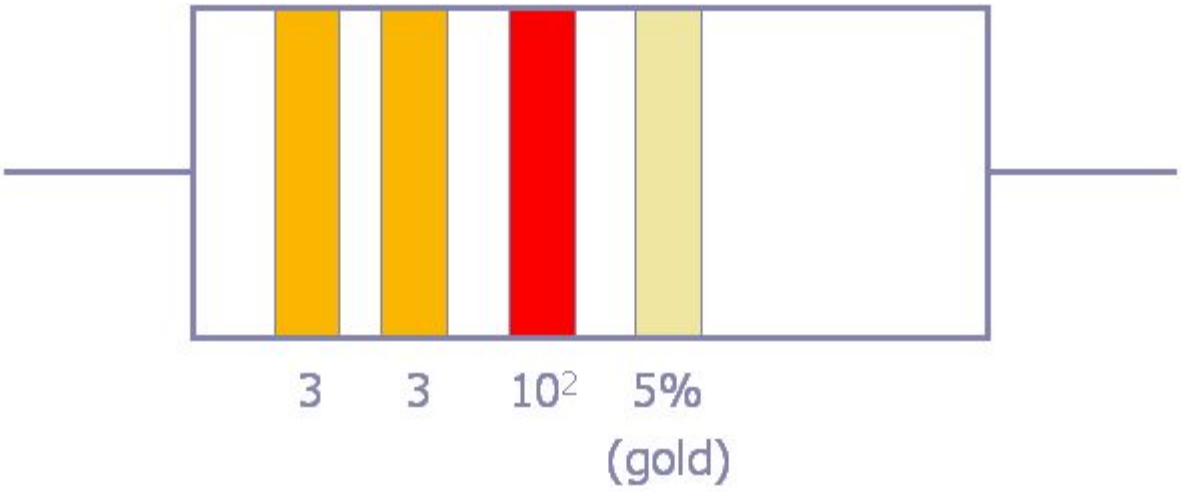
Band 5 & 6 usually for 1% metal film types. Band 6 for temp. coefficient.


0 1 2 3 4 5 6 7 8 9
0 Black
1 Brown
2 Red
3 Orange
4 Yellow
5 Green
6 Blue
7 Purple
8 Grey
9 White
±5% Gold
±10% Silver
Color Codes


Brown ±1%
Red ±2%
Gold ±5%
Silver ±10% *
27K
EXAMPLE
0 X1
1 1 X10
2 2 X100
3 3 X1000
4 4 X10000
5 5 X100000
6 6 X1000000
7 7 ÷10 Gold
8 8 ÷100 Silver
9 9
4 Band Resistors

Color	Digit	Multiplier	Tolerance (%)
Black	0	10^0 (1)	
Brown	1	10^1	1
Red	2	10^2	2
Orange	3	10^3	
Yellow	4	10^4	
Green	5	10^5	0.5
Blue	6	10^6	0.25
Violet	7	10^7	0.1
Grey	8	10^8	
White	9	10^9	
Gold		10^{-1}	5
Silver		10^{-2}	10
(none)			20

RESISTORS EXAMPLE



1st band: orange = 3

2nd band: orange = 3

3rd band: red = 2 (i.e. 10^2)

4th band: gold = 5%

33×10^2

$= 3300\ \Omega$

$= 3.3\ k\Omega$

Work on the Resistor Worksheet handout

20 questions in total