# CO2015

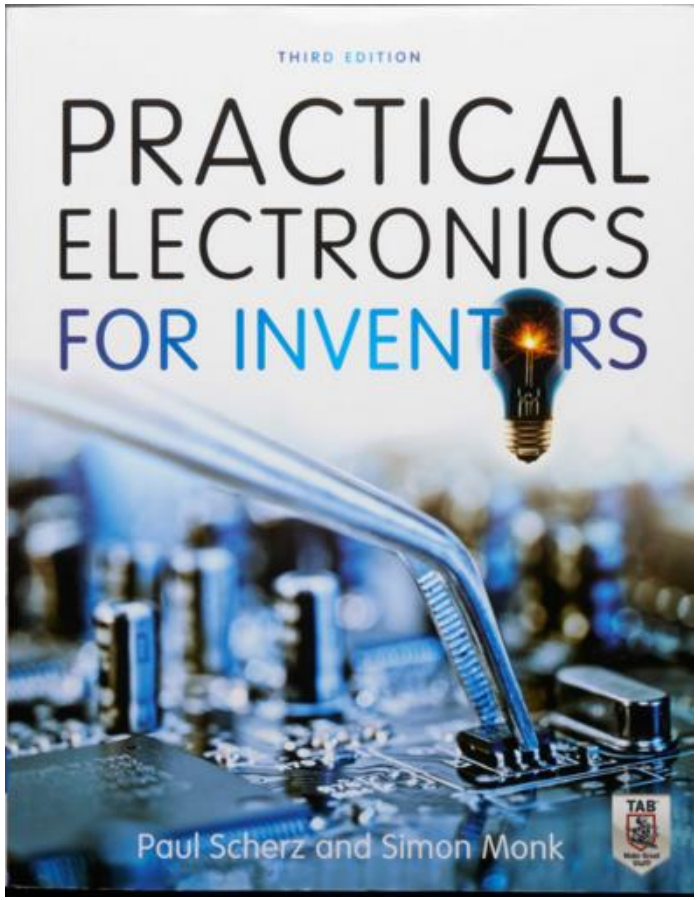
# Basic Electronic Circuit Components

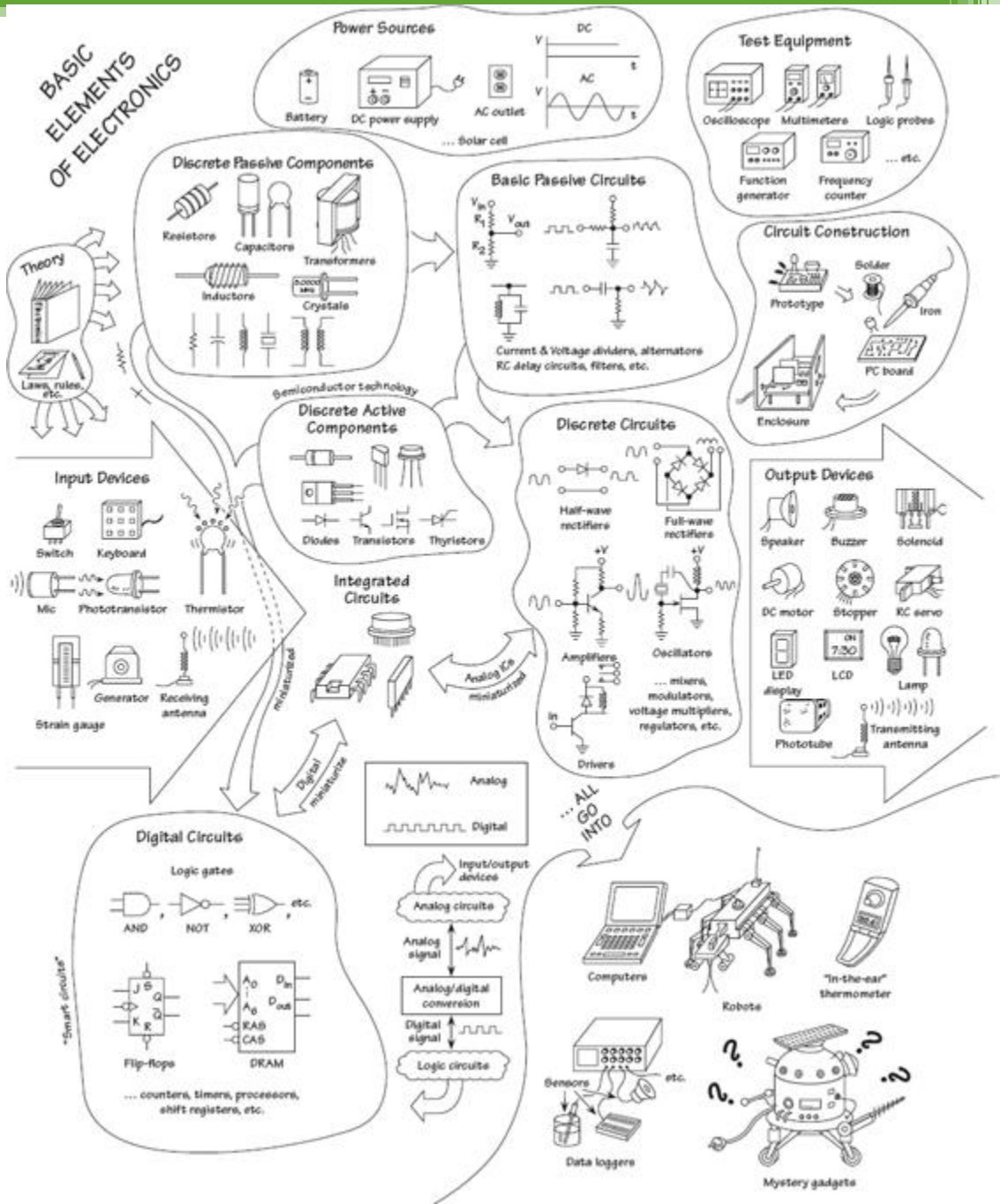
DCE
Dept. of Computer Engineering

# Course Introduction

- Objectives
  - Knowledge about structure and operation of electronic devices
  - An understanding of how devices such as semiconductor diodes and transistors are modeled and how the models are used in the analysis of useful circuits.
  - The capability to analyze and simulate behavior and performance of application electronic circuit

- Grading
  - Midterm Exam: **20%**
  - Final Exam: **50%**
  - Labs: **30%**


THIRD EDITION
PRACTICAL ELECTRONICS FOR INVENTORS
Paul Scherz and Simon Monk
TAB


BASIC ELEMENTS OF ELECTRONICS
Power Sources
Battery
DC power supply
AC outlet
Solar cell
DC
AC
Test Equipment
Oscilloscope
Multimeters
Logic probes
Function generator
Frequency counter
... etc.
Discrete Passive Components
Resistors
Capacitors
Transformers
Inductors
Crystals
Basic Passive Circuits
Current & Voltage dividers, alternators
RC delay circuits, filters, etc.
Circuit Construction
Prototype
Solder
Iron
PC board
Enclosure
Theory
Laws, rules, etc.
Semiconductor technology
Discrete Active Components
Diodes
Transistors
Thyristors
Discrete Circuits
Half-wave rectifiers
Full-wave rectifiers
Amplifiers
Oscillators
... mixers, modulators, voltage multipliers, regulators, etc.
Drivers
Input Devices
Switch
Keyboard
Mic
Phototransistor
Thermistor
Strain gauge
Generator
Receiving antenna
Integrated Circuits
Analog ICs miniaturized
Output Devices
Speaker
Buzzer
Solenoid
DC motor
Stepper
RC servo
LED display
LCD
Lamp
Phototube
Transmitting antenna
miniaturized
Digital miniature
Analog
Digital
... ALL GO INTO
Digital Circuits
Logic gates
AND
NOT
XOR
etc.
"Smart" circuits
Flip-flops
DRAM
... counters, timers, processors, shift registers, etc.
Input/output devices
Analog circuits
Analog signal
Analog/digital conversion
Digital signal
Logic circuits
Computers
Robots
"In-the-ear" thermometer
Sensors
etc.
Data loggers
Mystery gadgets

# Basic Electronic Circuit Components

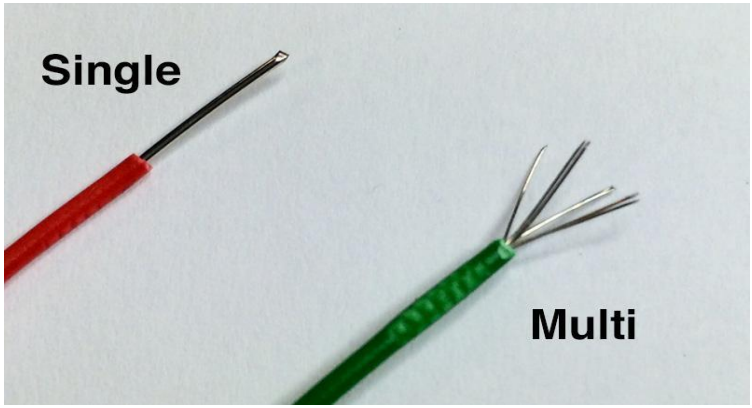
- Wires, Cables, and Connectors
- Batteries
- Switches
- Resistors
- LED (Light Emitted Diode)

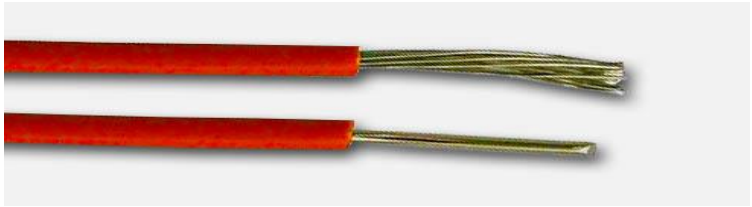
# Solid Core Wires

- Strong
- High current

# Solid Core Applications

# Stranded Wires (Multicore Wires)

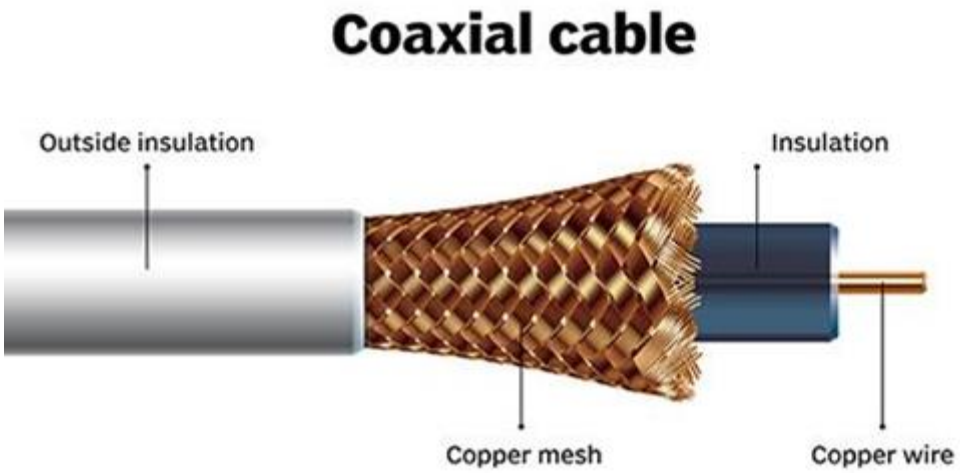



- Soft
- Smaller current
- **Easy to Draw**

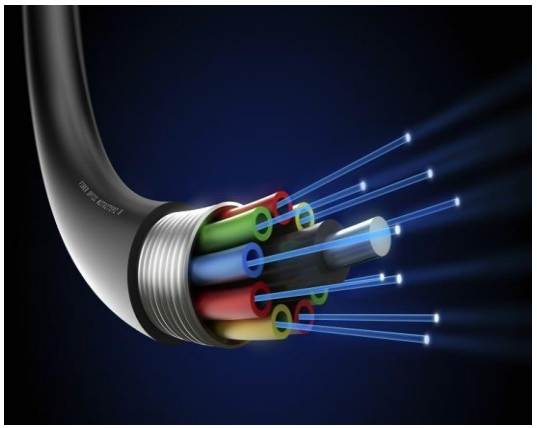
# Braided Wires


- **Soft and High current**

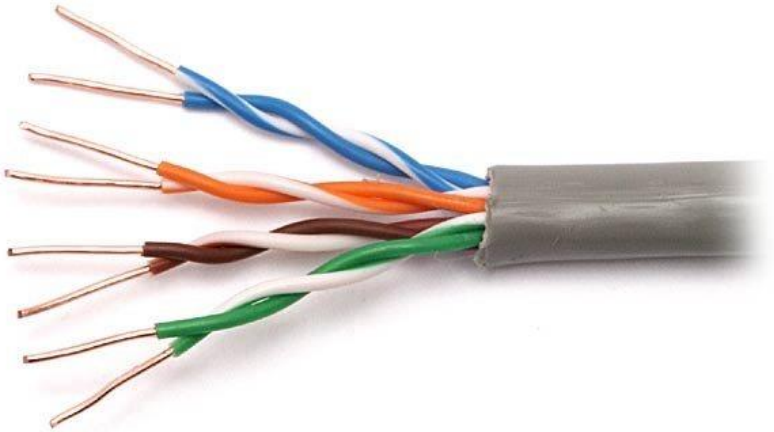
# Coaxial Cables




- High speed communication systems



# Twisted Pair Cables



- Pulse noise avoidance
- ADSL Modem (RJ45)

# Battery

- The most popular storage device

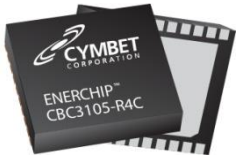
# Rechargeable Batteries



- Battery capacity: 3500mAh

# Super Capacitors


# Rechargeable Batteries vs Super Capacitor




[Cymbet ]

**500** recharge cycles

Difficult to estimate the state of charge

**Low leakage current**

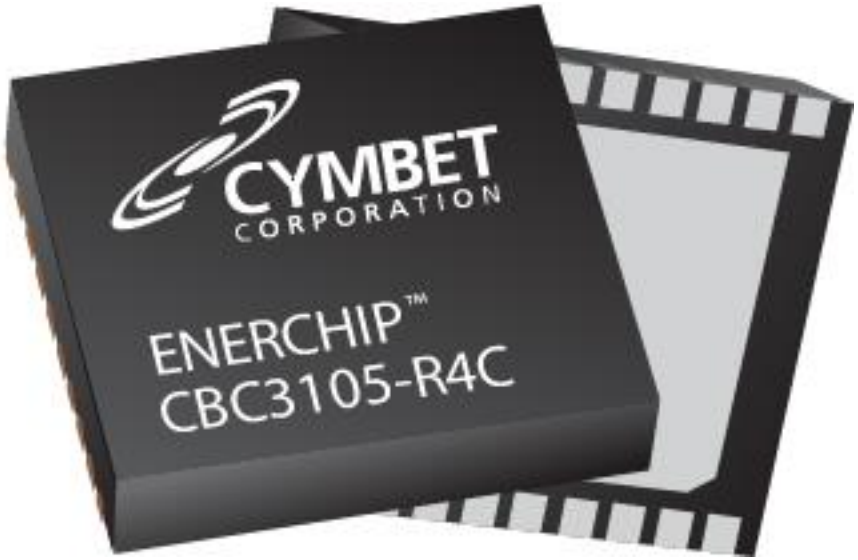

[CapXX]

**500 000** recharge cycles

Easy to estimate the state of charge

**High leakage current**

# New Generation of Batteries





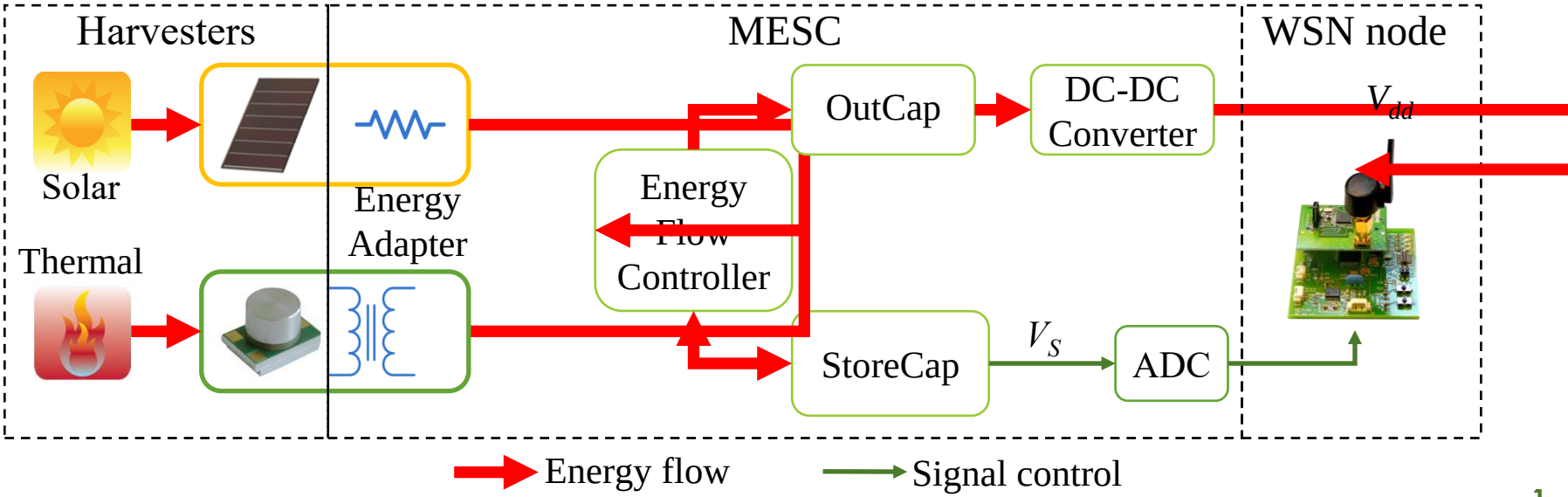
- IC Rechargeable Batteries
- Hybrid Batteries (Batteries + Capacitors)

# Internet of Things Platforms

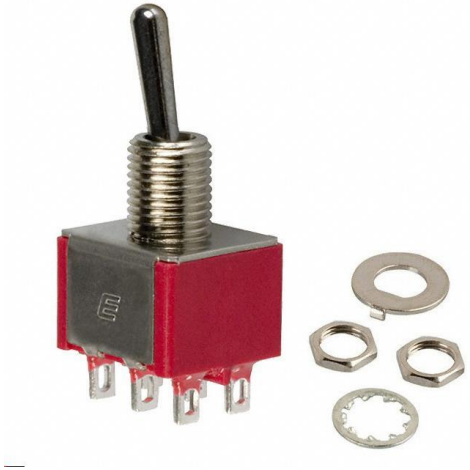
PowWo
w

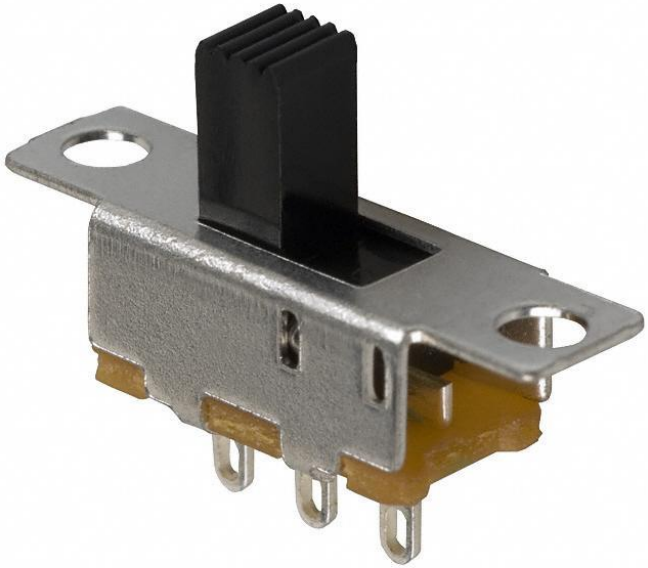
MicaZ

Wasp Mote



# Switch

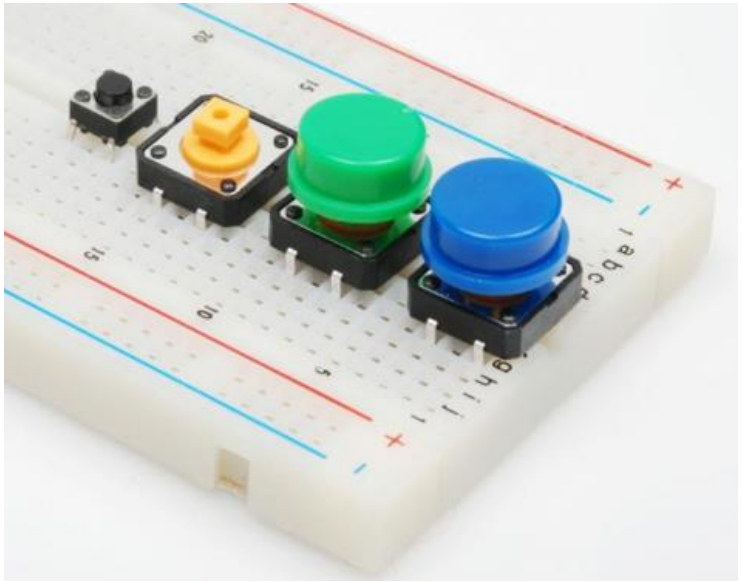


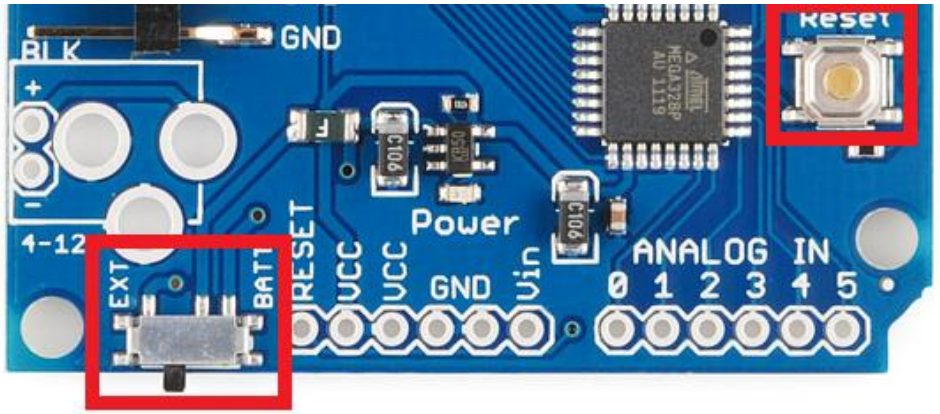


- A switch is a mechanical device that interrupts or diverts electric current flow within a circuit

# Mounting Style

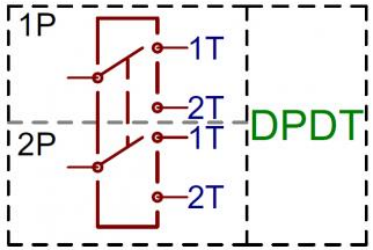
- A switch always comes down to either surface mount (SMD) or through-hole (PTH).

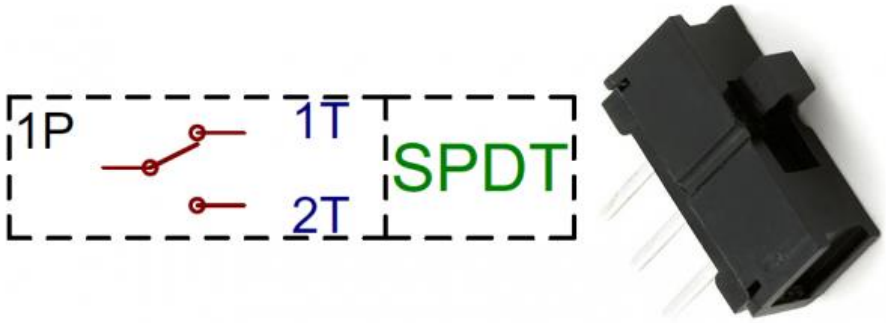




# Poles and Throws, Open and Closed

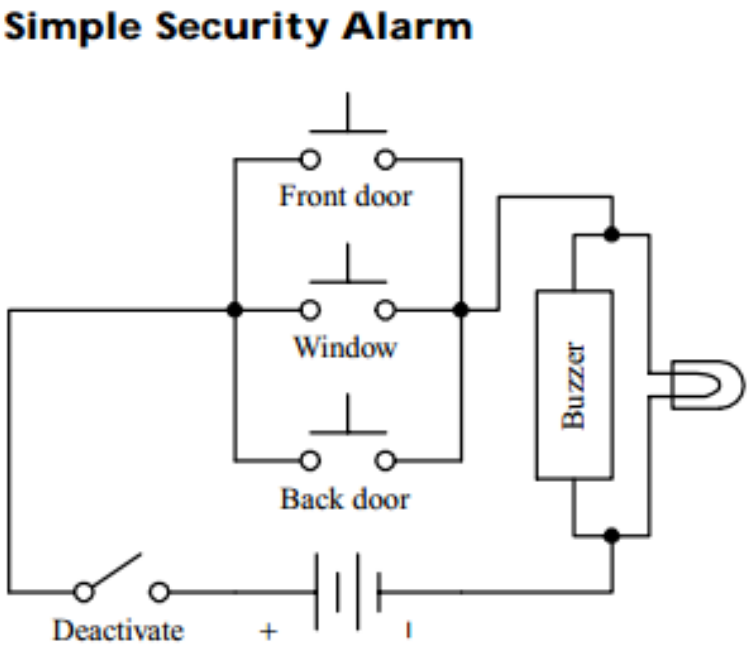
- Single-pole, Single-throw (**SPST**)
- Single-pole, Double-throw **(SPDT)**
- Double-pole, Double-throw (**DPDT**)

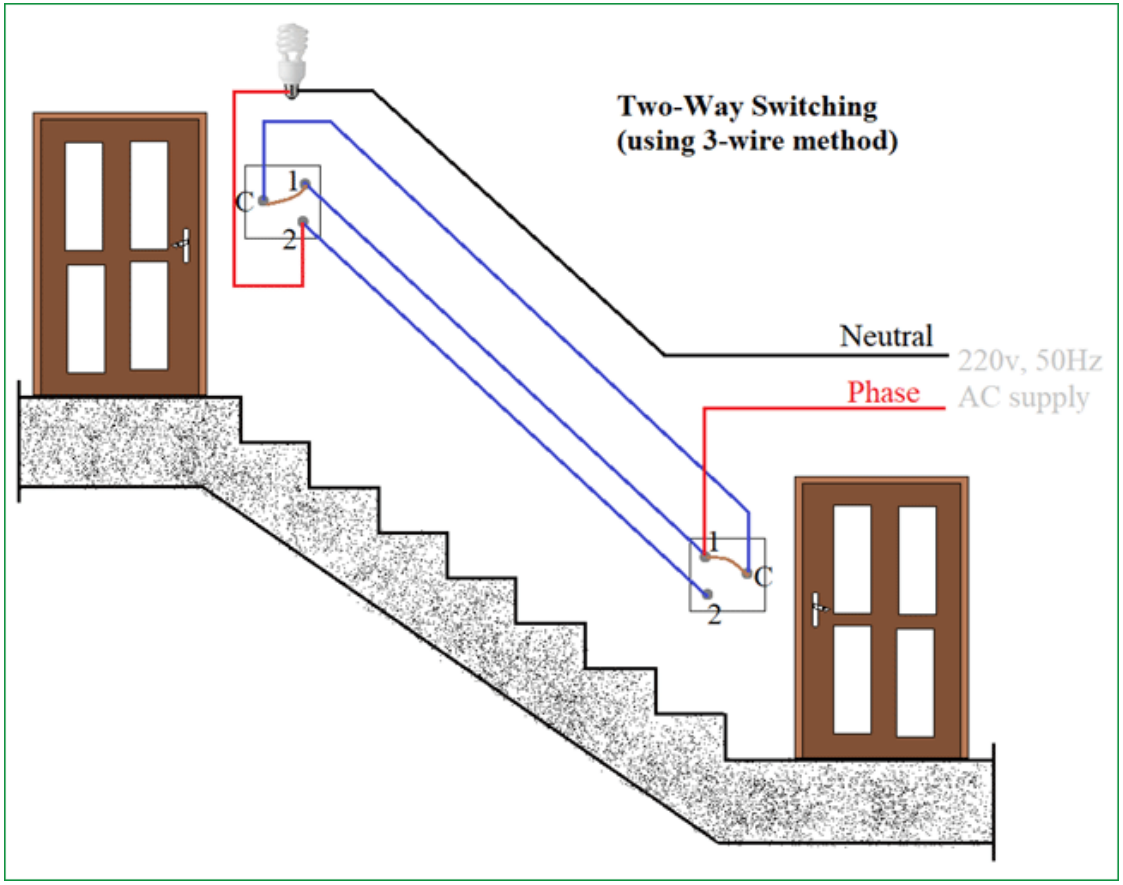



# Switch Applications (1)

- Here's a simple home security alarm that's triggered into action (buzzer and light go on) when one of the normally open switches is closed. Magnetic reed switches work particularly well in such applications.



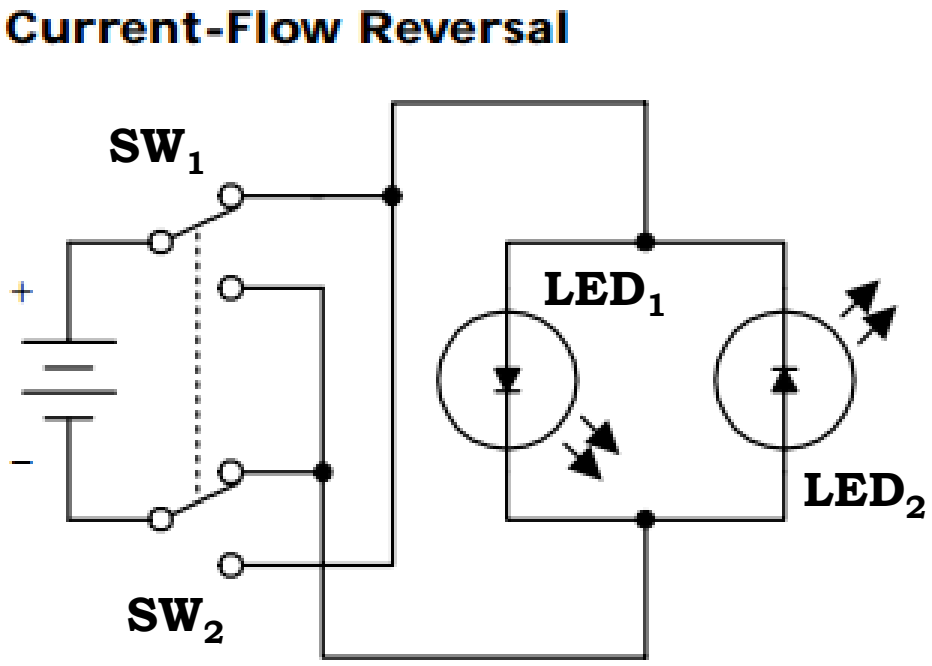
# Switch Applications (2)



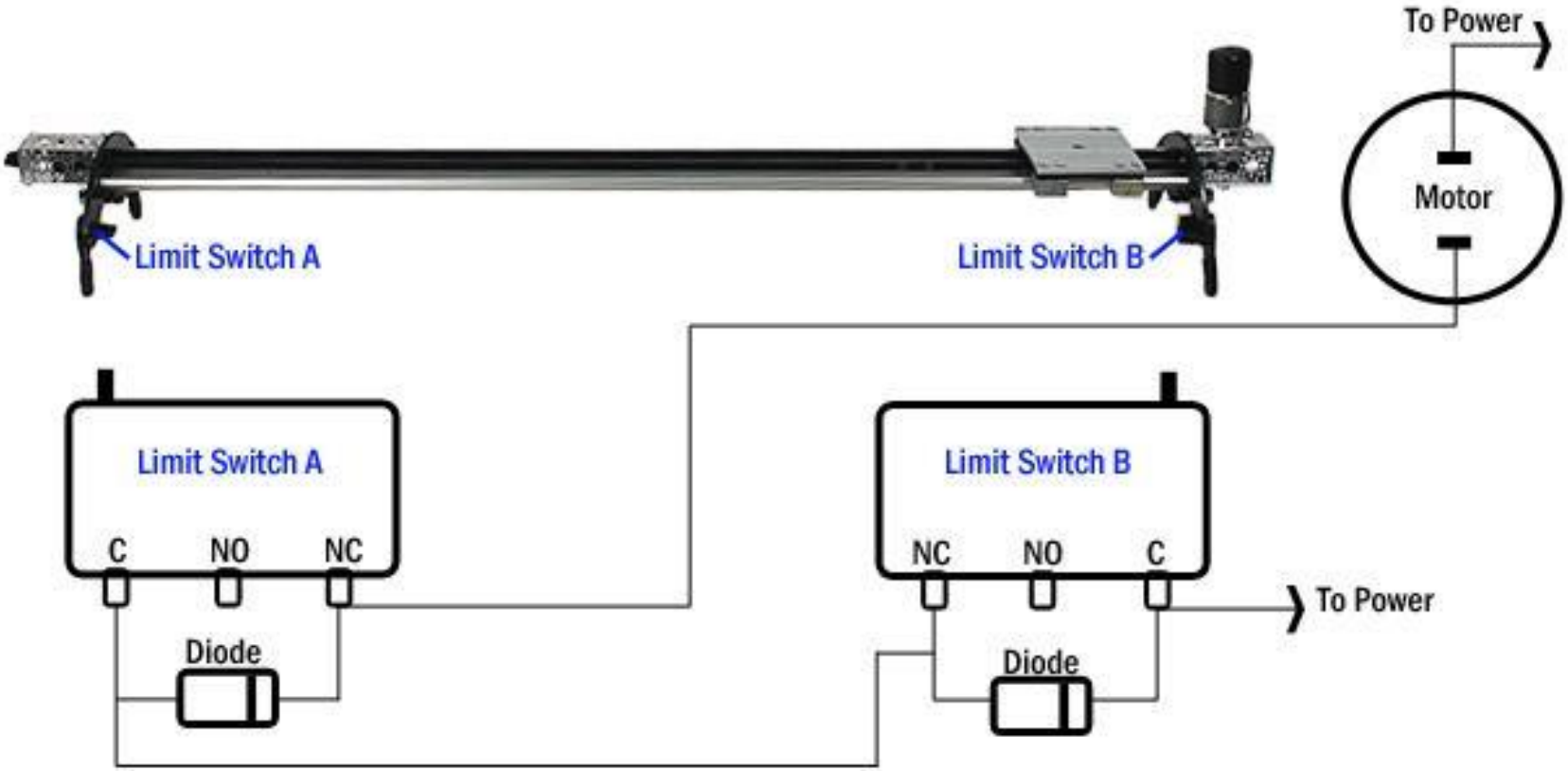

- Here's a switch network that allows an individual to turn a light on or off from either of two locations. This setup is frequently used in household wiring applications.

# Switch Application (3)

- A DPDT switch, shown here, can be used to reverse the direction of current flow. When the switch is thrown up, current will flow throw the left light-emitting diode (LED). When the switch is thrown down, current will flow throw the right LED. (LEDs only allow current to flow in one direction.)

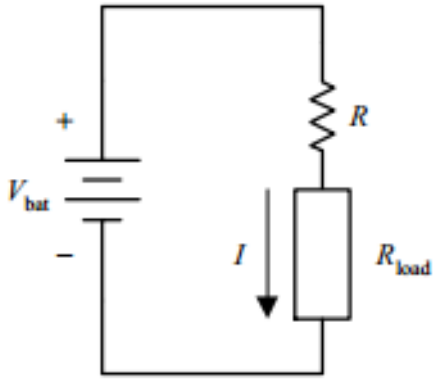


# Switch Application (4)

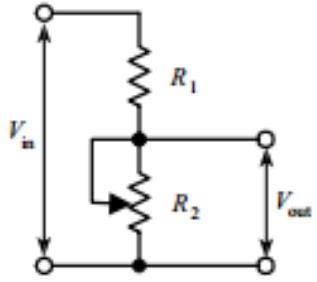


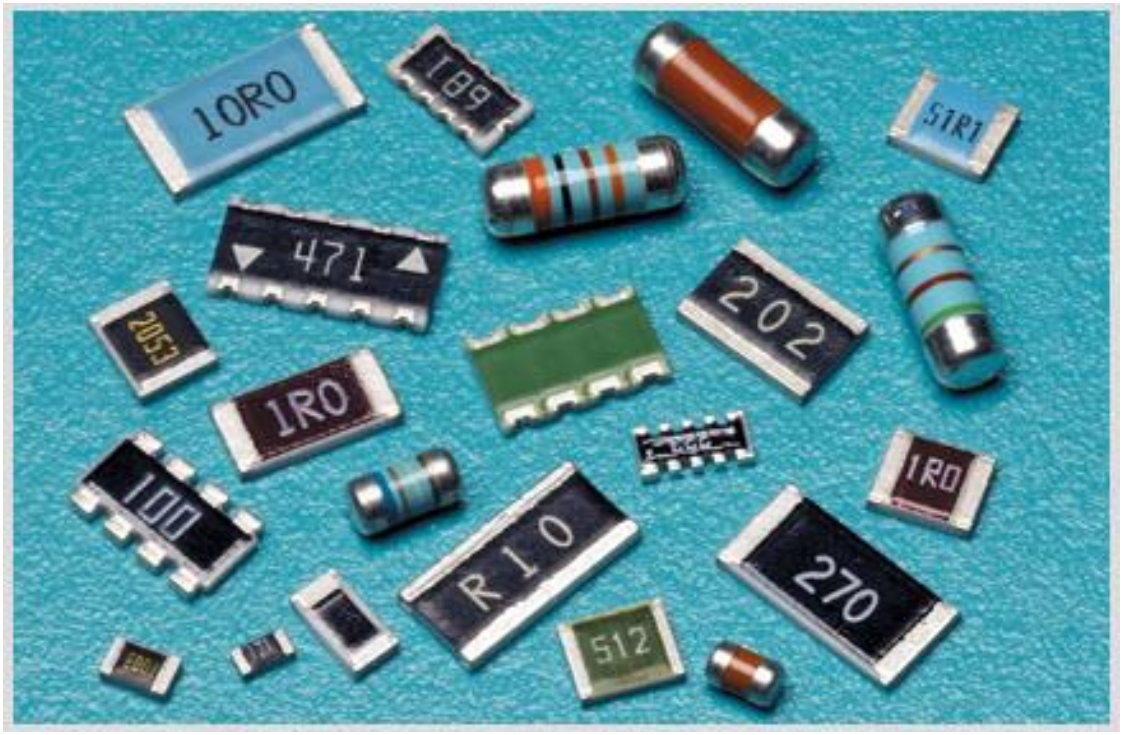
# Resistors

## Current Limiter

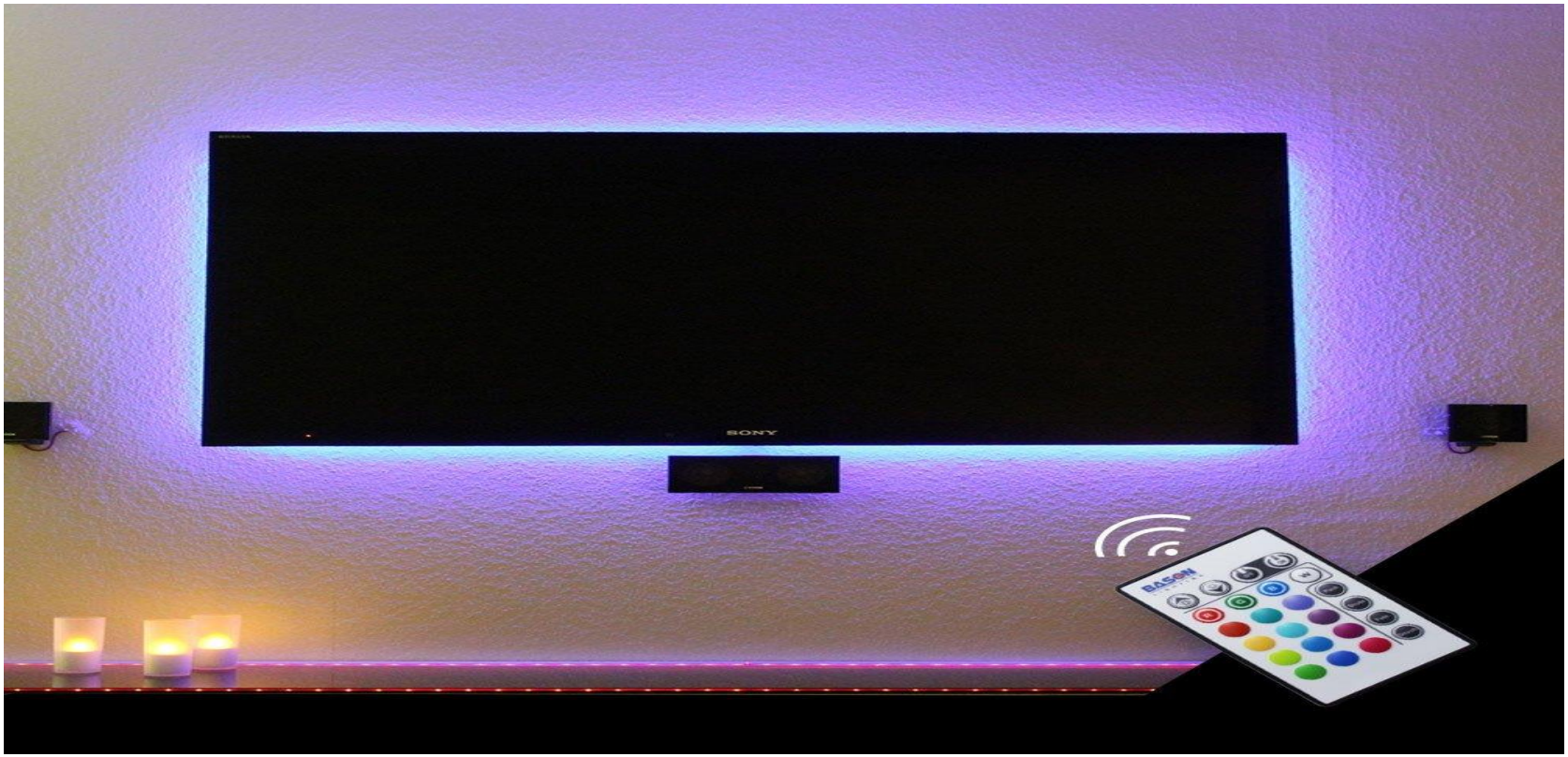



## Voltage Divider



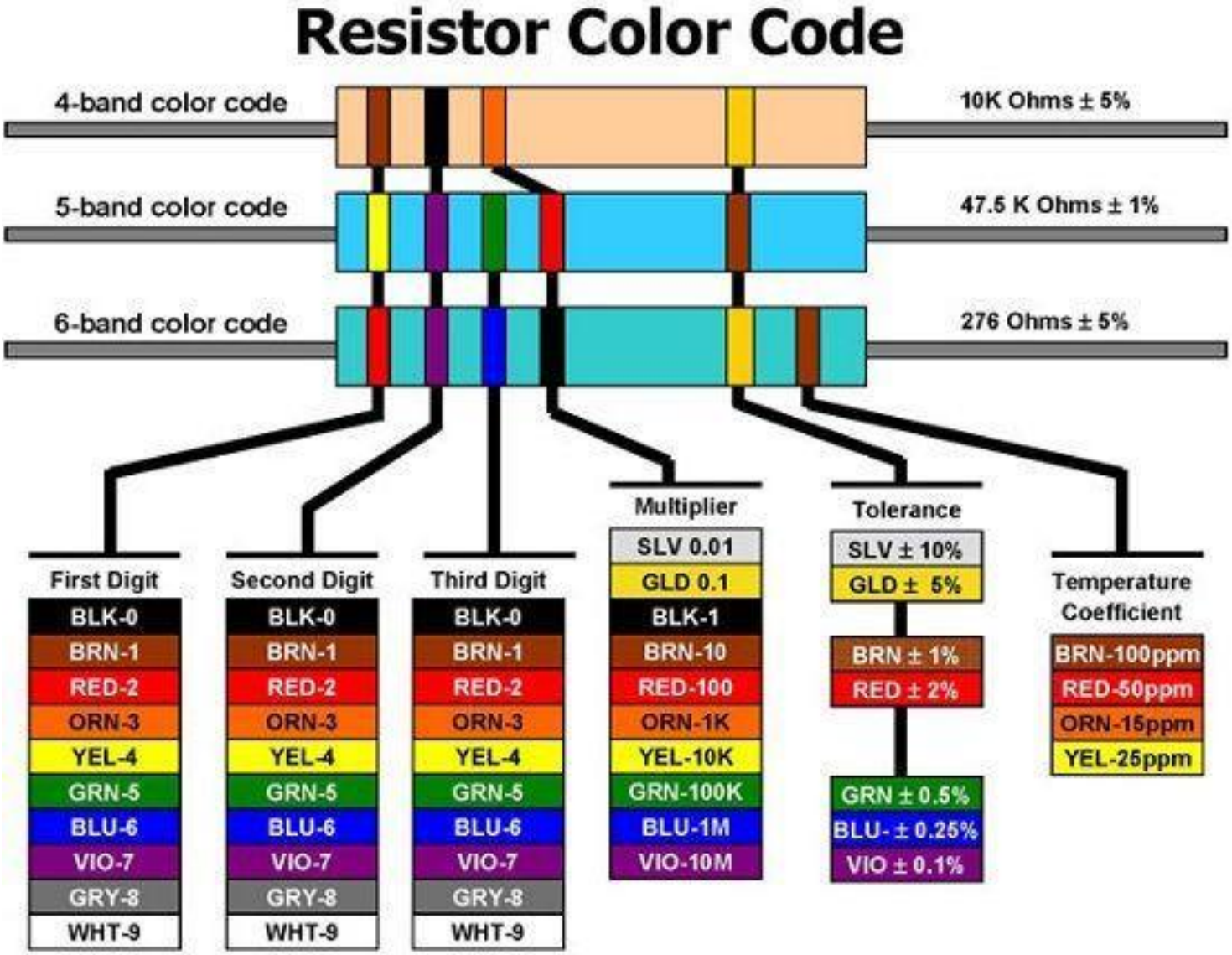



# Current Limiter

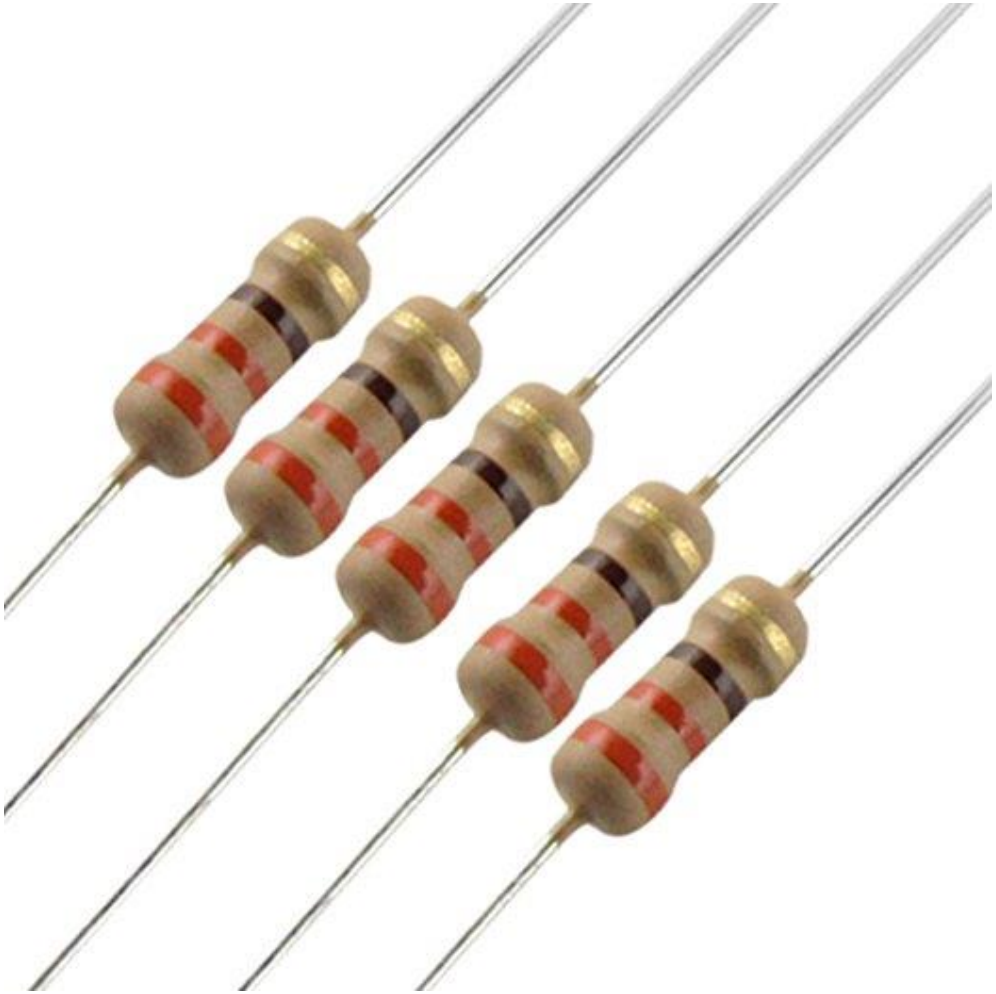



- Key point for color LED TIVI

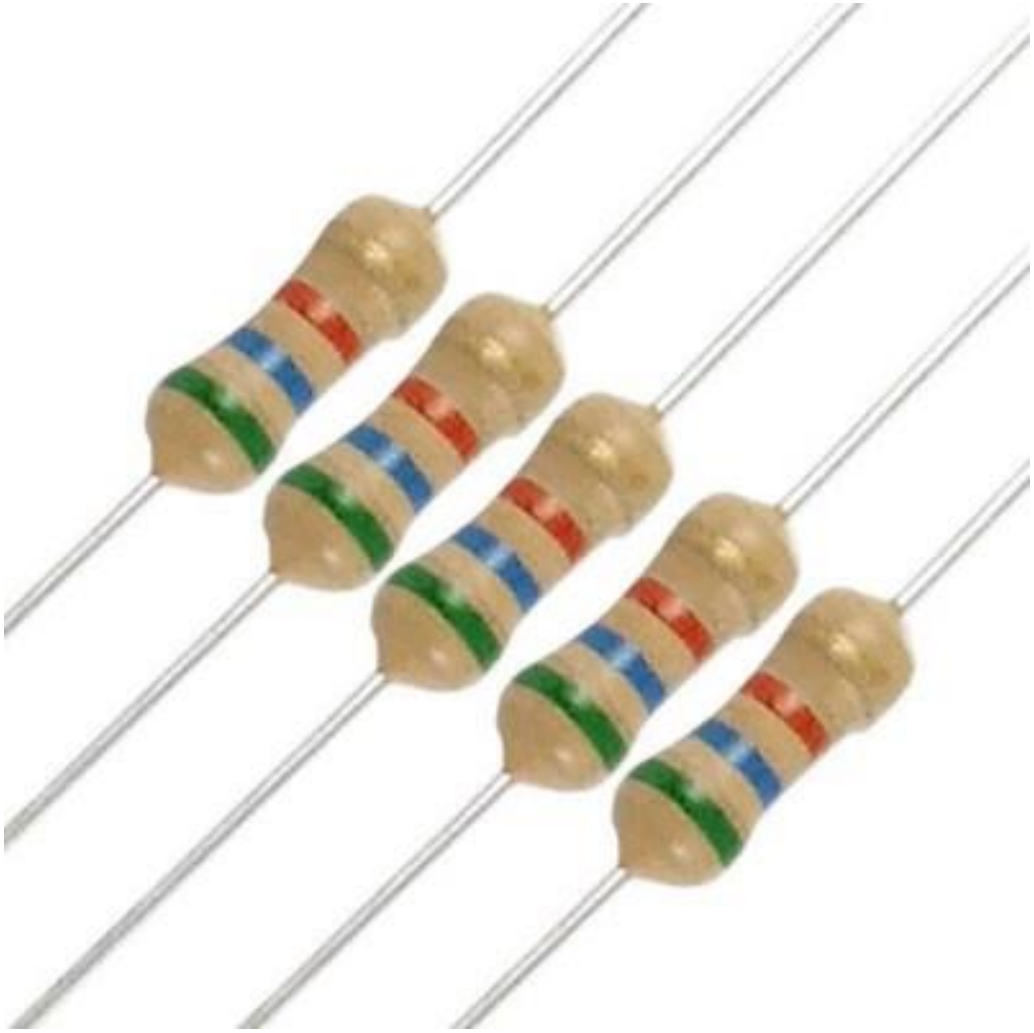
# Understanding Resistor Labels



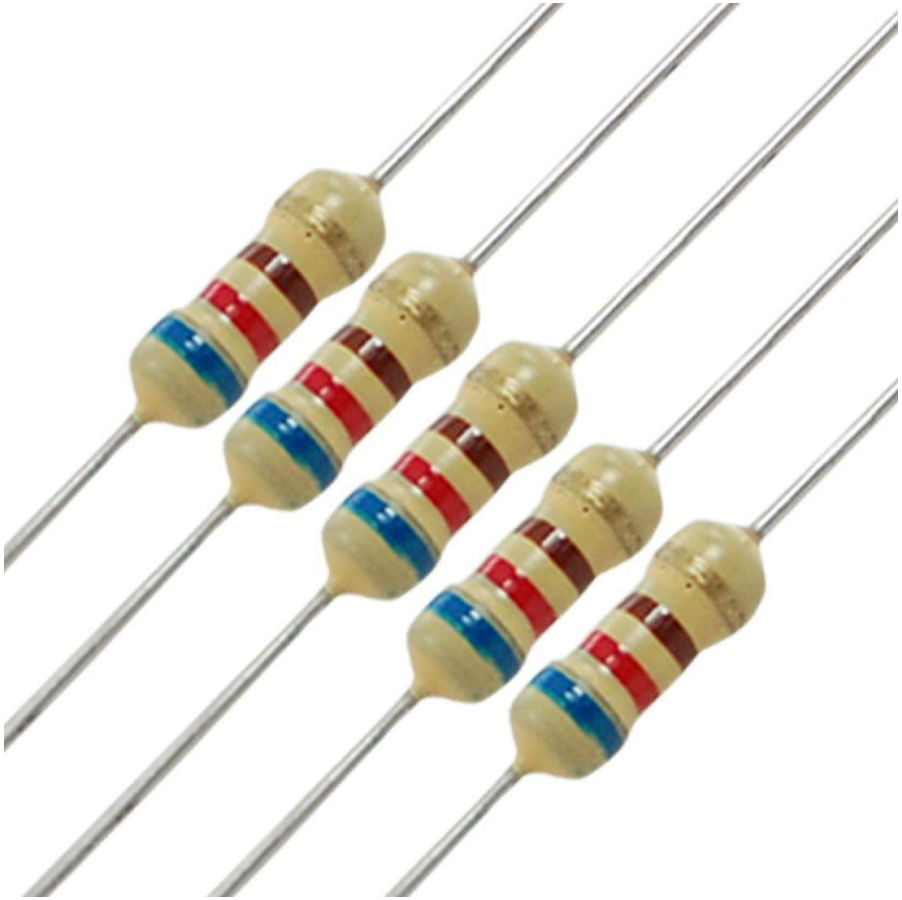
# Examples



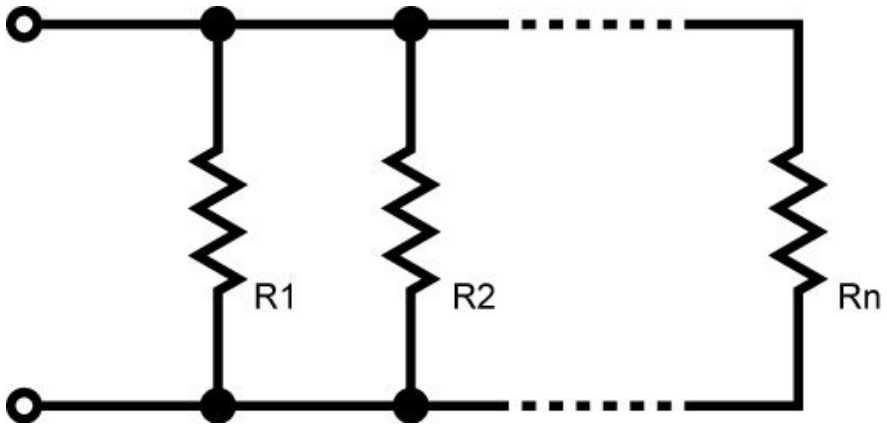
# Examples



# Examples



# Parallel Resistance Calculator

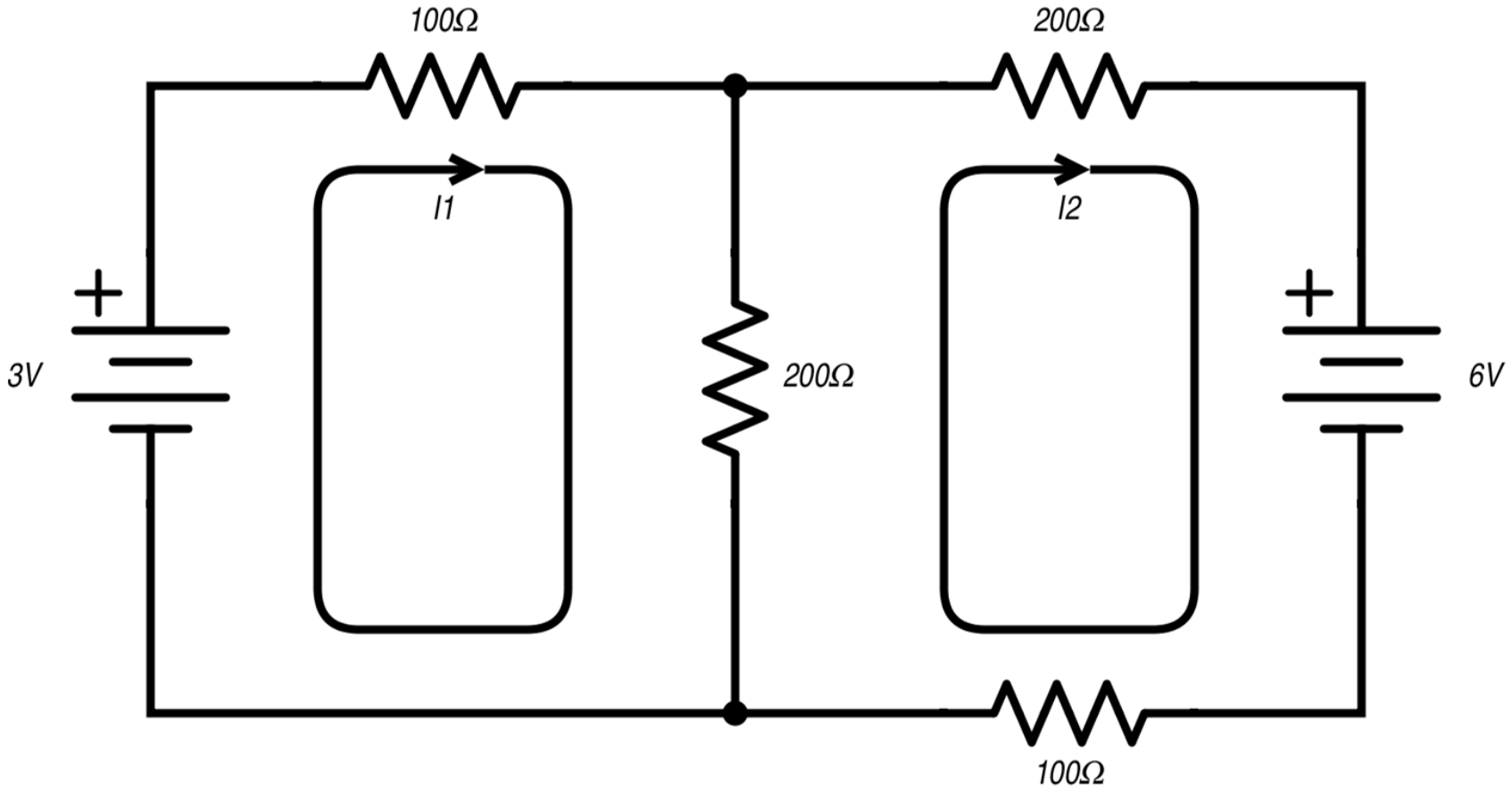



$$\frac{1}{R_{EQ}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots + \frac{1}{R_N}$$

When you have only two resistors in parallel: $R_{EQ} = \frac{R_1 \times R_2}{R_1 + R_2}$

# Ohm Law

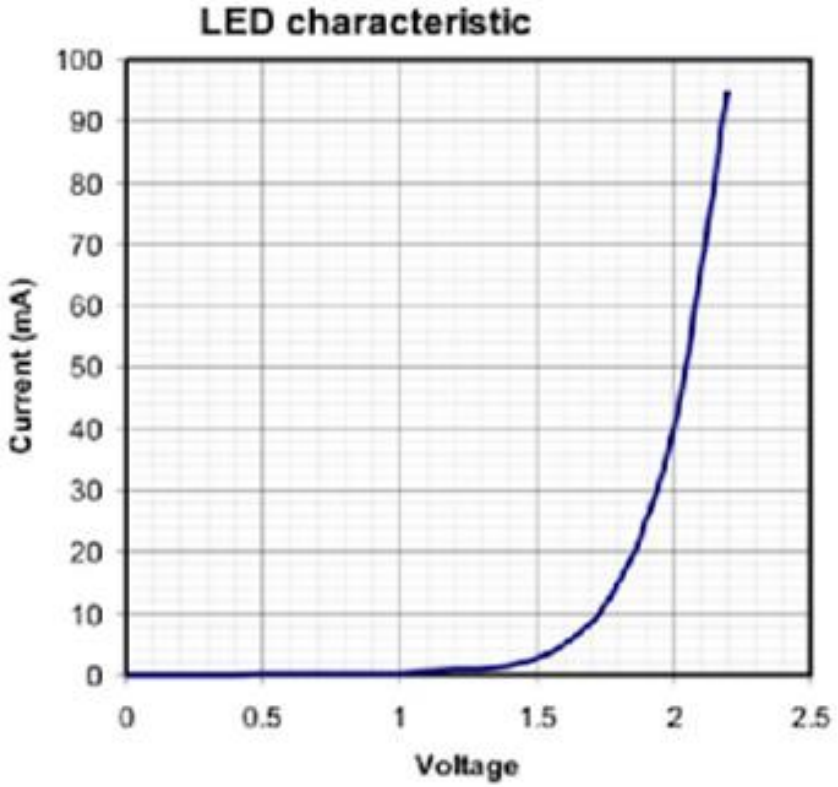
- Analyze the circuit

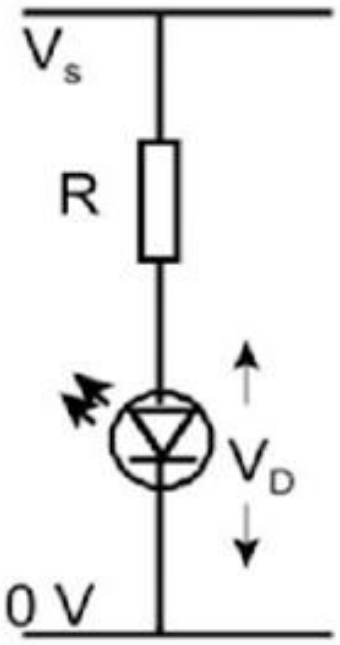


# Answer

- $3V = 300I_1 – 200I_2$
- $6V = 200I_1 – 500I_2$

# Midterm Exam BK172



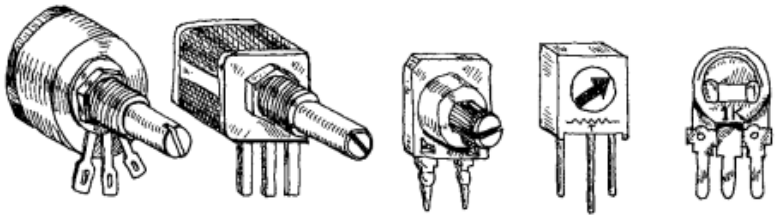



# Midterm Exam BK172

- An LED which has the characteristics shown in this graph is to be used in the circuit below in which both VS and R can be varied. For this LED the switch on voltage (VD) is 1.7 volt which produces a current of 10 mA at which point the LED will just glow dimly. Let us say that the LED operates brightly at 40 mA, but will fail if the current exceeds 90 mA for too long.
- Initially the power supply is set at Vs = 6V. What value is required for the resistor so that the LED operates at 40 mA?
- If a current of 20 mA is flowing and the resistor is 200 Ohm, what is the supply voltage?
- Find the minimum value of the resistor that could be used without damaging the LED

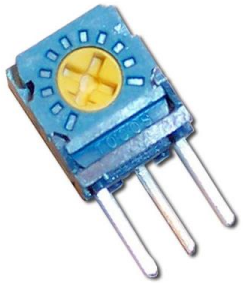
# Variable Resistors

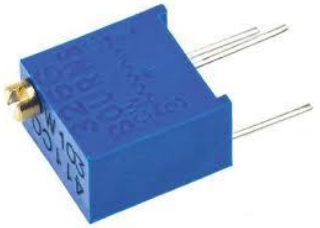
- Special kinds of variable resistors include
  - Potentiometers;
  - Rheostats; and
  - Trimmers.
- Potentiometers and rheostats are essentially the same thing, but rheostats are used specifically for high-power ac electricity, whereas potentiometers typically are used with lower-level dc electricity. Both potentiometers and rheostats are designed for frequent adjustment.
- Trimmers, on the other hand, are miniature potentiometers that are adjusted infrequently and usually come with pins that can be inserted into printed-circuit boards.



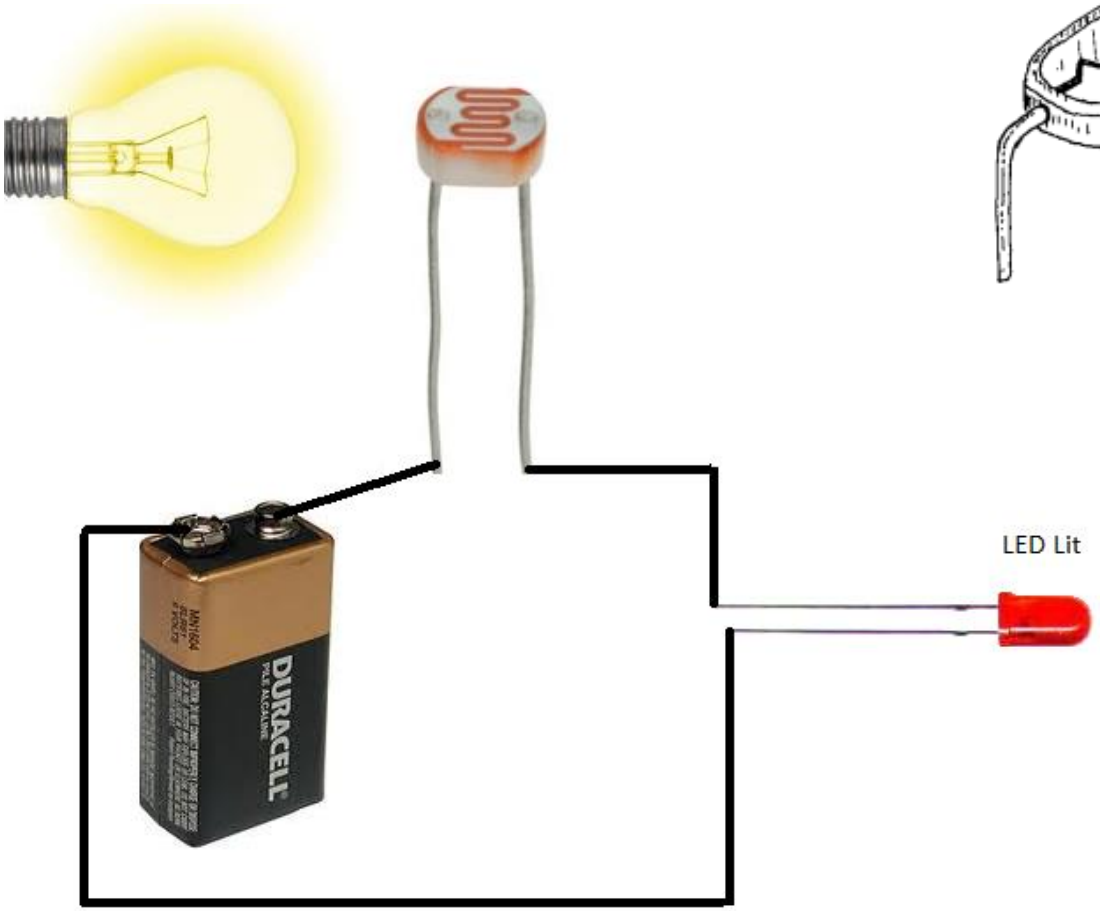

Potentiometers

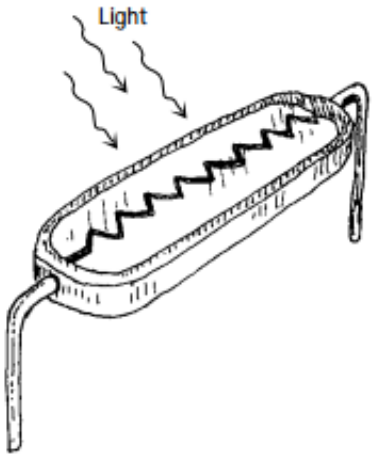
Trimmers



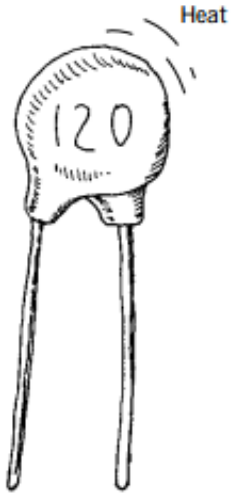


# Photo-Resistors and Thermistors



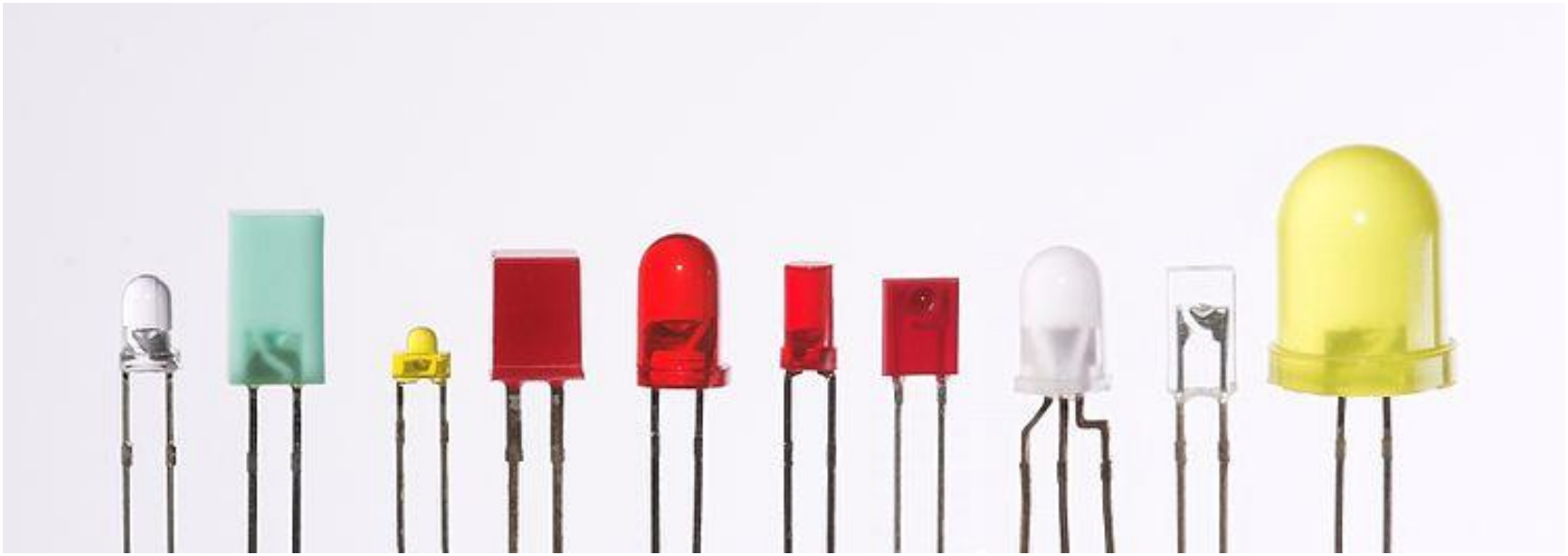



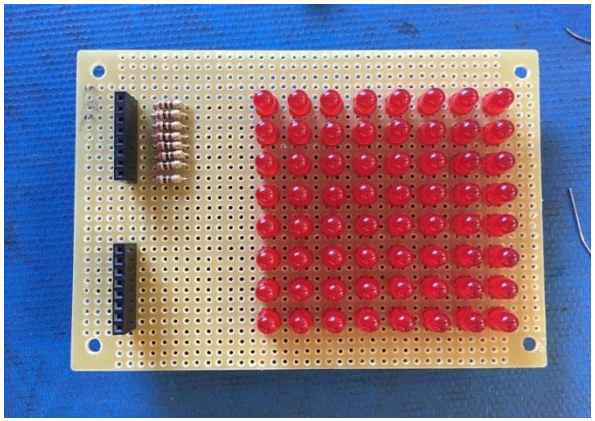

Photoresistor

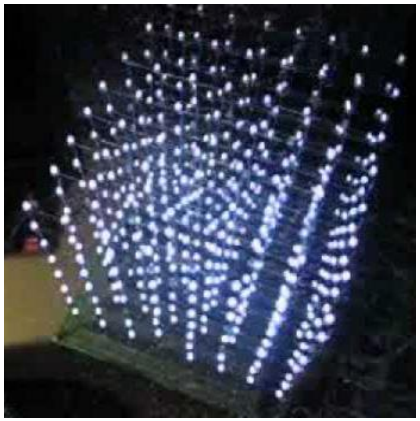


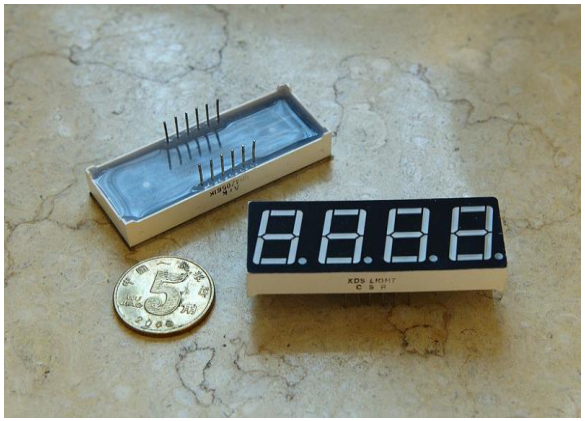

Thermistor

# Light Emitted Diode (LED)

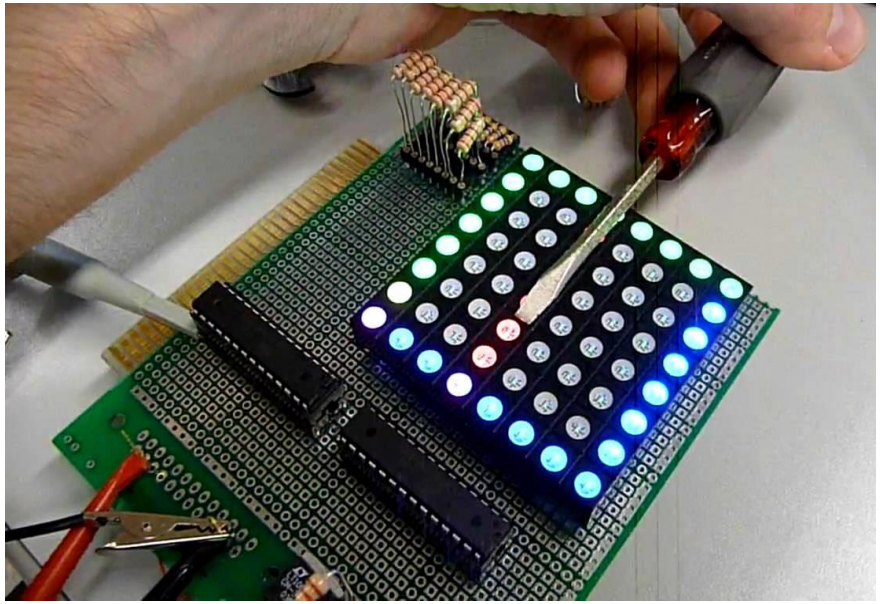


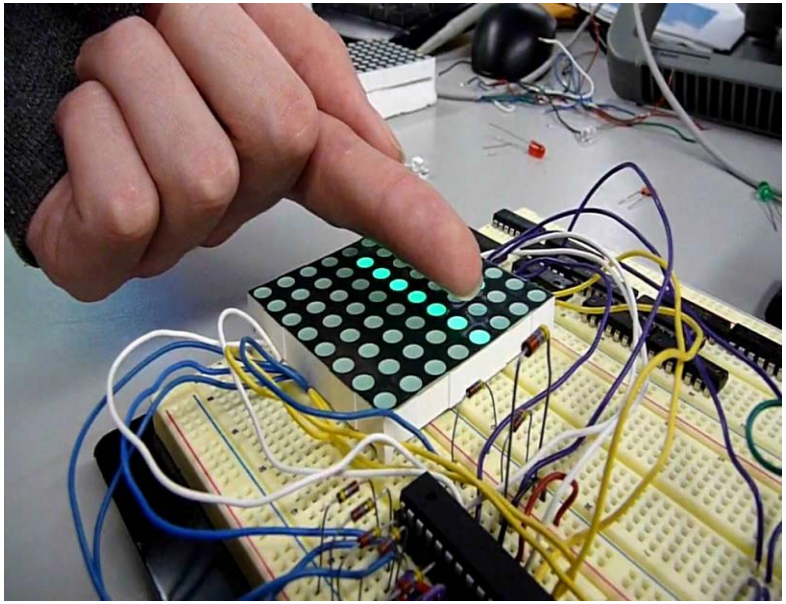




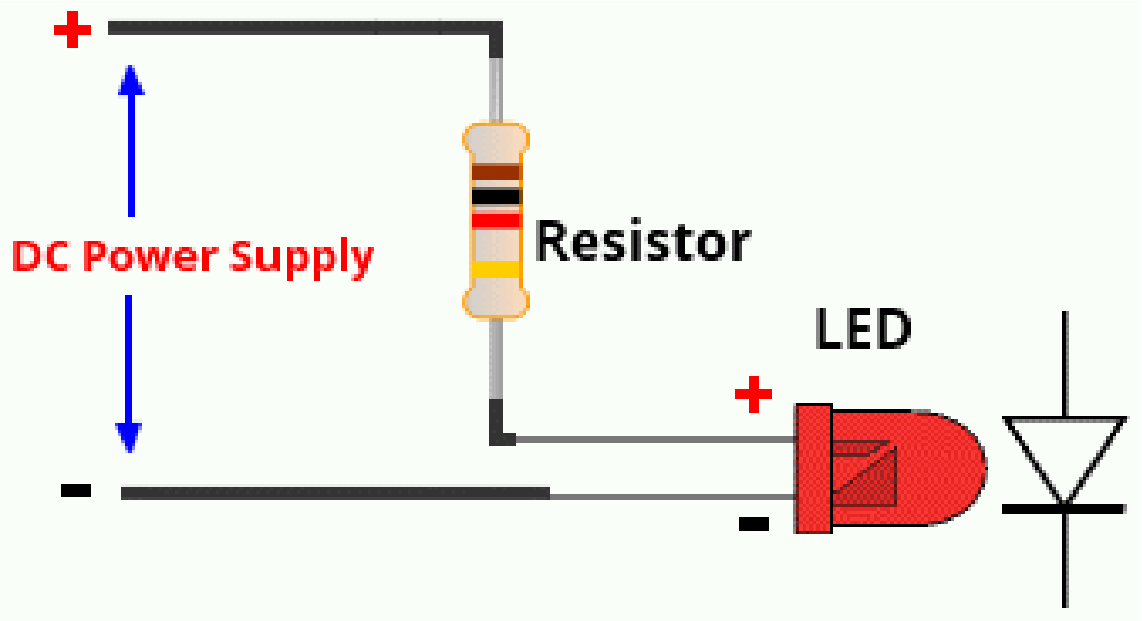


# Optical Touch LED Matrix



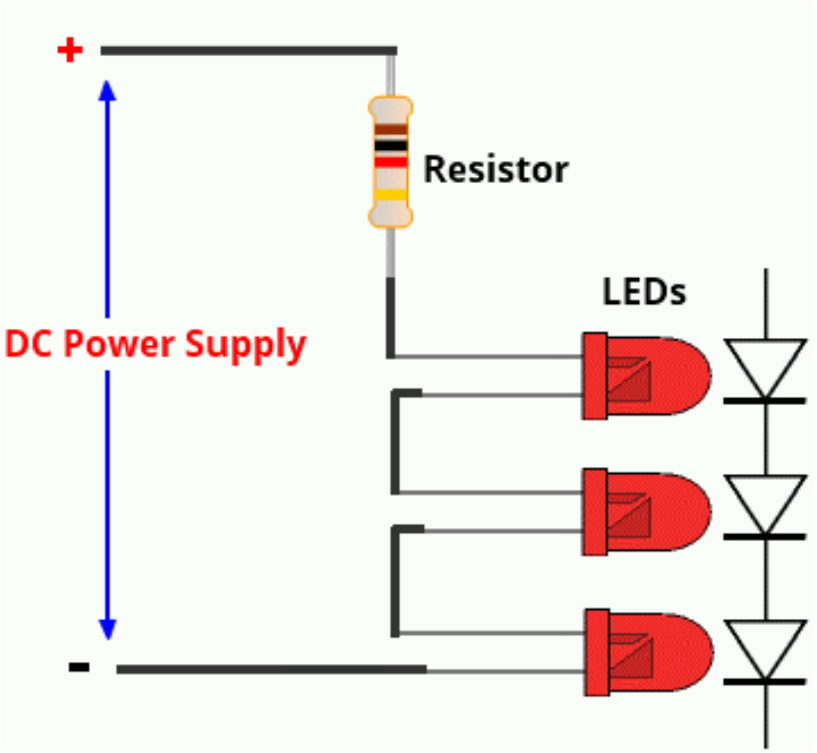


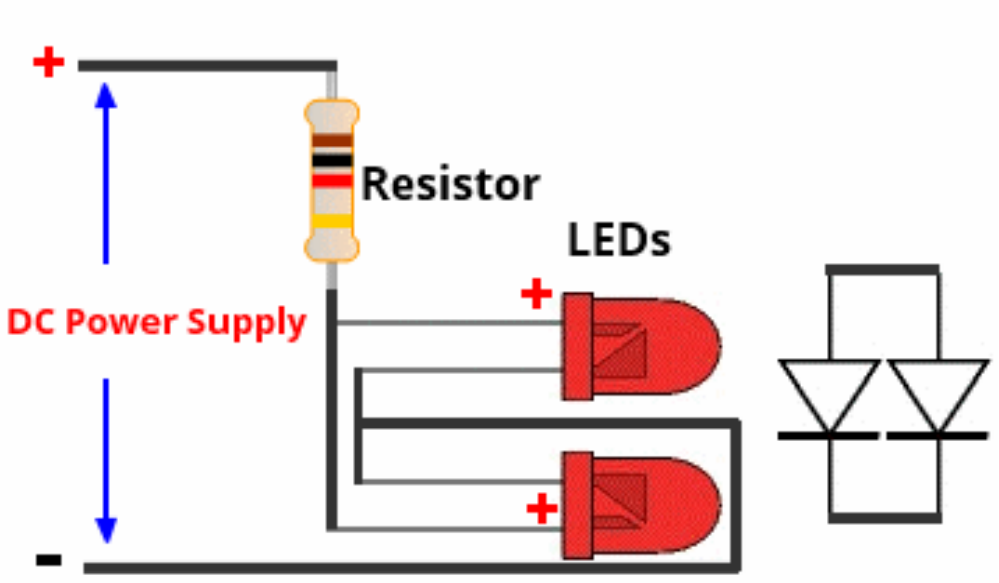
# LED and Resistor Calculation




$$R = \frac{(V_s - V_{LED})}{I_{LED}}$$

# LED and Resistor Calculation



# LED Applications