



Chapter 2: Sensors, Actuators, and Microcontrollers



IoT Fundamentals Connecting Things 2.01

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Chapter 2 - Sections & Objectives

- 2.1 Learn Electronics
 - Explain how components and devices are used to build and measure values in electronic circuits.
- 2.2 Microcontrollers: The SparkFun Inventor's Kit
 - Create circuits and microcontroller programs with the Arduino and a variety of components.
- 2.3 Packet Tracer 7.0 and the IoT
 - Explain how Packet Tracer models IoT systems.



2.1 Learn Electronics



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Learn Electronics

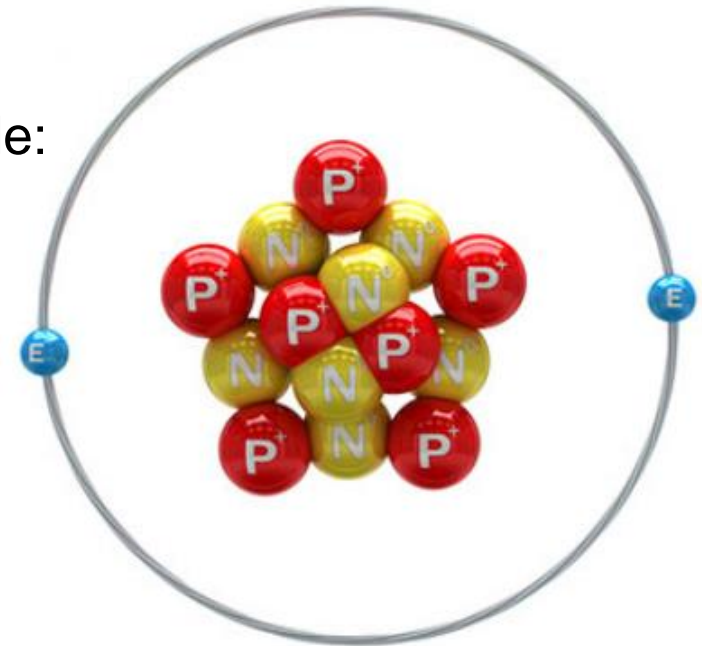
2.1.1 Basic Electronic Terminology & Concepts

■ What is Electronics?

- Electronics is the field of study focused on the control of electricity and the physical components and circuits that help direct electrical energy.

■ Definitions

- Terms commonly used in electronics include:
 - Electrons, atoms, and chemical elements
 - Electric current
 - Electrical conductors, insulators, and circuits
 - Voltage, Amperes (amps), and Power





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Basic Electronic Terminology / Concepts (cont'd)

■ Ohm's Law

- Ohm's Law states that within a circuit, voltage (V) is directly proportional to the strength of current (I) multiplied by resistance (R).
- Resistance is measured in ohms (Ω)

■ Basic Circuit

- An electrical circuit is a closed conductive path that allows electrons to flow and create an electric current.
- A circuit also needs an electrical energy source like a battery to start the flow of electricity.

$$V = I \times R$$

$$R = V / I$$

$$I = V / R$$



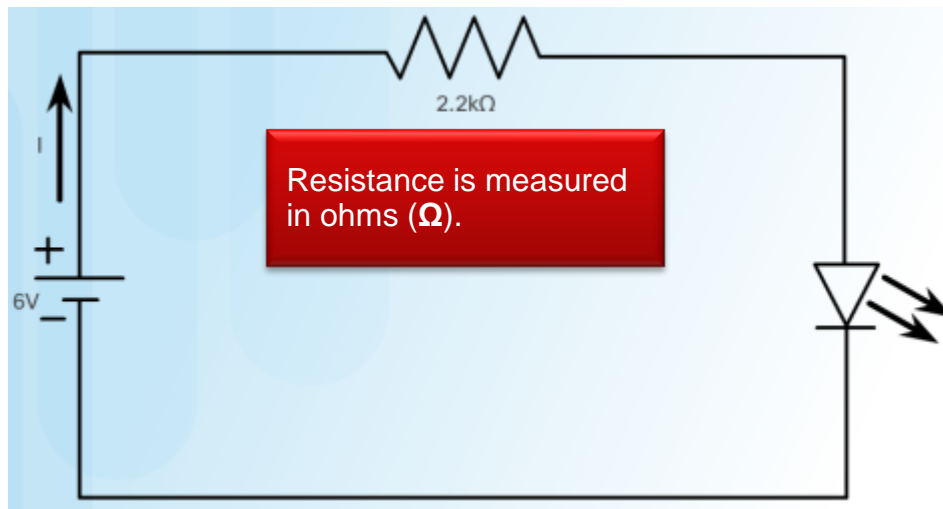
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Basic Electronic Terminology / Concepts (cont'd)

■ Basic Circuit (Cont.)

- The following circuit diagram (schematic) consists of:
 - 6 volt (V) battery provides current
 - 2.2 k Ω resistor (protects the LED from receiving too much current and being destroyed)
 - A light-emitting diode (LED)

Current (I) flows from the positive terminal to the negative terminal



Resistance is measured in ohms (Ω).

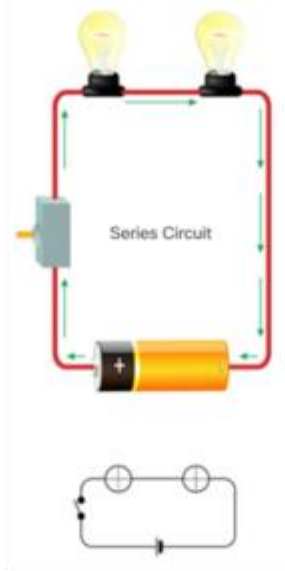
The triangular part represents a diode and the two arrows facing out represent the fact that this diode emits light.

2.1.2 Advanced Electronic Terminology /Concepts

■ Series and Parallel Circuits

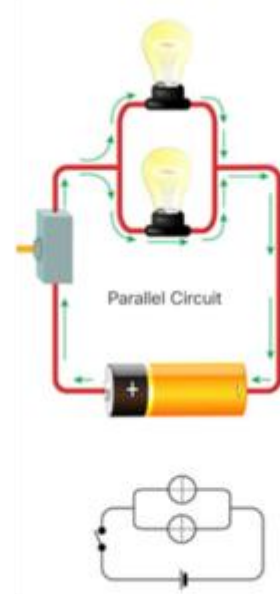
Series Circuit:

- Components are interconnected one after another in a path between the positive and negative terminals of the power source



Parallel Circuit:

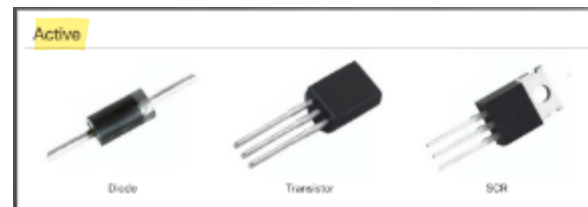
- Current flows from the battery terminal but splits at a junction which leads to parallel pathways through the circuit.
- Components connected along each pathway each get their own share of current



Advanced Electronic Terminology/Concepts (cont'd)

- Passive, Active, Linear, and Nonlinear Circuits
 - Active circuits contain active components; components that rely on external power source to control current flow.
 - Passive circuits contain passive components; components incapable of controlling current flow.
 - Analog circuits are circuits where the signal is contiguous.

- Direct Current vs. Alternating Current
 - In DC current, electron flow is only in one direction.
 - Batteries, power supplies, thermocouples, solar cells, or dynamos generate DC.
 - In AC current, electron flow periodically reverses direction.
 - Hydroelectric plants generate AC.





Advanced Electronic Terminology/Concepts (cont'd)

■ Analog Circuits vs. Digital Circuits

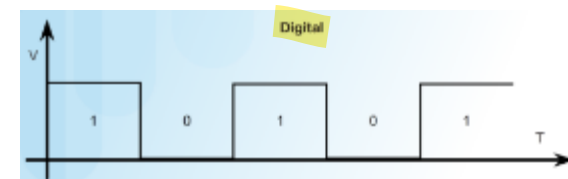
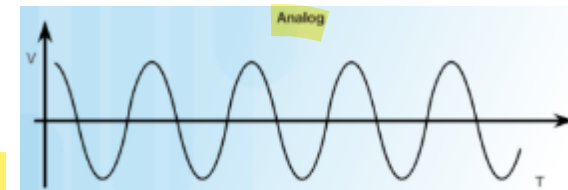
- **Analog Circuits:** Circuits in which signals vary continuously with time.
- **Digital circuits:** Circuits in which signals that take one of two discrete values.

■ Components

- **Electronic components** are specialized devices used in a circuit to control current.
- Components have two or more electrical terminals (leads) that enable them to connect to an electronic circuit.

■ Larger Electronic Building Blocks

- **Solenoids** can be used to electrically open door latches, open or shut valves, move robotic limbs, and even actuate electric switch mechanisms.
- **Relays** allow for controlling a large amount of current and/or voltage with a small electrical signal.





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2.1.3 From Schematic Diagram to Breadboard to Soldered PCB

■ Design Phase:

- Consists of three steps: Concept, Research, Circuit Design.
- A circuit diagram shows the components and interconnections of the circuit using standardized symbolic representations.

■ Prototype Phase:

- Consists of four steps: Hardware, Mechanical, and Software Development, PCB layout, Build prototypes, Product Testing
- A solderless breadboard is a tool commonly used in electronic prototyping.

■ Production Phase:

- Consists of three steps: Production Readiness Review, Production, On-going Maintenance.
- Often employ on printed circuit boards (PCBs).

