LED Basics **8/5/2018**

Hello, in this video we are going to talk about LED's.

First, LED stands for: **Light Emitting Diode** and is actually a specific type of diode. So to understand an LED we first need to understand what a diode is.

But first let's first review what electricity is: A very simple definition for electricity is just the flow of electrons. And electrons are the negatively charged parts of an atom that orbit outside of the atom's nucleus (or its center).

When we talk about electricity we find there are some materials that allow electricity to flow through freely, they are called **conductors** (such as copper, iron, and aluminum). And other materials that block the flow of electricity (such as wood, plastic, and rubber), they are called **insulators**. But, there exist some materials that allow electricity to flow only under certain conditions, they are called **semiconductors**. And a diode is an electrical device that is made of a semiconductor material (such as silicon – Si, Gallium Arsenide – GaAs, and Gallium Phosphide - GaP).

Let's skip the science behind why they act the way they do and go straight to how they work. For a simple diode if a high enough voltage (this voltage level is called the "forward voltage") is applied, electricity flows. If you change the polarity (switch the positive and negative connections between the battery and diode) it will block the flow of electricity at the same voltage level. Simply put, a diode acts like an on/off switch, dependent on which side of the diode the positive voltage is applied. Note, the forward voltage for a typical diode is 0.3 to 0.7 volts dependent on the type of material the diode is made of.

Now moving to the LED, it is again a diode just made of a specific semiconductor material that emits light when electricity flows through it. But again if the polarity (that is the positive and negative leads of the battery) is switched, the flow of electrons is blocked and no light is emitted.

By changing the composition of the material used, you can change the color of the light emitted. Red is the most common. Other colors include green, yellow, orange, amber, and blue.

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The LED's leads are polarized, meaning one lead must be connected to the positive side of the power supply and the other to the negative. This is generally identified by one lead longer than the other. The longer lead being the positive side (also called the anode). Others have a flat side on the LED casing where the closest lead to the flat side is the negative (also called the cathode).

A side note: A simple definition for an Anode is the "lead or terminal" that positive current flows INTO (from the outside) the device, and the cathode is the "lead or terminal" that it flows FROM (to the outside). Note this definition refers to positive current. We have previously defined electricity as the flow of electrons, which is a flow of negative charges. This difference goes back to the early days of electricity, when scientists thought that electricity was the flow of positive particles. And it was so pervasive that when they actually discovered it was negative charges they decided to keep the existing definition for circuits and call it "Conventional Flow" of current or positive current. So, in reality current flows from negative to positive and is referred to as "Electron Flow" of current. A nice trivia fact!

The forward voltage for an LED can range from 1.8 to 3.3 volts depending on the material, or color, of the LED. So when building an LED circuit you will need to take into account the voltage drop across the specific LED you are going to use. For example a circuit capable of operating a red LED (which has a low forward voltage) may not work for a blue LED (which has a higher forward voltage). Note the total battery voltage needs to be higher than the forward voltage of the LED to drive the current required to illuminate the LED.

Below are listed typical forward voltages for various LED colors. (based on single LED with leads, 5mm diameter, clear lens LEDs running at 20 mA) using Digikey data, based on approximately 500 different LED's).

Color	Typical Forward Voltages, always check the data sheet for your LED
Red	1.8 to 2.2 VDC (VDC = volts Direct Current – the type a battery provides)
Orange	1.8 to 2.2 VDC
Yellow	2.0 to 2.2 VDC
Amber	2.0 to 2.1 VDC
Green	3.1 to 3.5 VDC
Blue	3.2 to 3.8 VDC

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Another key thing to know is that an LED cannot handle large currents so you will need to include a resistor to limit it to a safe level. Generally an LED runs around 10 to 20 milliamps. Here is where you will need to do a little math to figure out what size resistor you will need – but we will leave that math to be covered in the video lesson on "Ohms Law".

Some other things to know are:

1) LED's come in many sizes and shapes. We generally use the round, 5mm diameter LED's.

2) You can get LED's with clear or colored lens. The light color generated is the same; it just allows you to know the color of the LED when not lighted.

3) You may also need to consider brightness of the LED, called intensity and the best viewing angle.

Hope this is helpful.