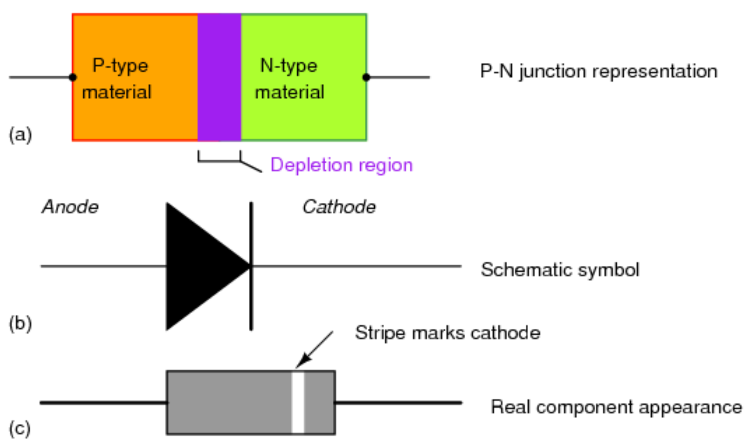
Current:

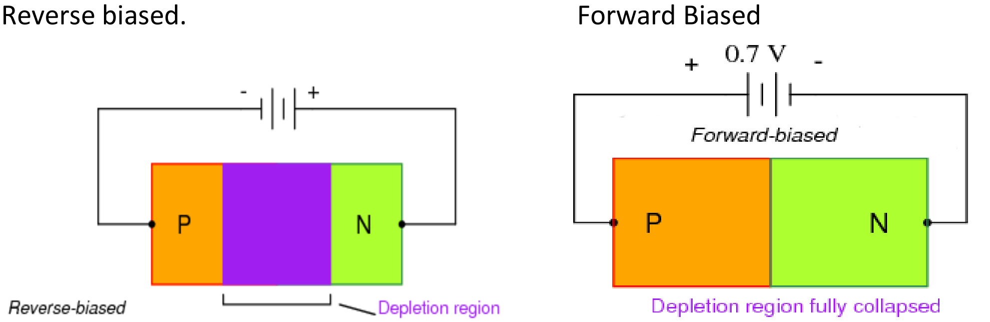
Depending upon which book you read, you may see electrical current described as a flow of positives OR as a flow of negatives. This creates a great deal of confusion.   Conventional current is the flow of positives from higher voltage to lower voltage. That is the current we will be using in all of our discussions when we use the word current. If we want to talk about the flow of negatives from lower voltage to higher voltage we will call that electron flow.

Diode

A DIODE is a two-terminal device which acts as a one-way valve for electrical current. The schematic symbol is shown in diagram (b) below. Note the arrow points from the Anode to the Cathode. That is the direction in which conventional current can pass through the diode. If you connect a diode into the circuit so that the conventional current tries to flow from the Cathode to the Anode, the diode will block the flow. **An easy way to remember the polarity is ACID (Anode Current Into Device).** Remember current means conventional current.

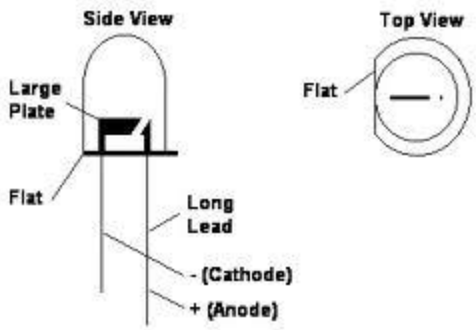


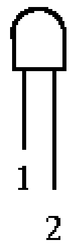
Current will not flow when the diode is Reverse biased.	Current will flow when the diode is Forward Biased

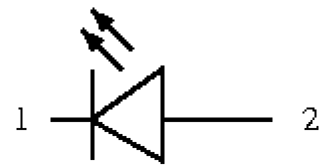


That is why a diode permits current to flow in one direction only.

The Light Emitting Diode (LED)







What an LED looks like

Schematic symbol

The LED is a special diode which, when forward biased, will conduct and also at the same time produce light.

The following article gives a lot of background about the LED
http://electronics.howstuffworks.com/led.htm

Application note: Because a diode (including a Light emitting diode) has low resistance when forward biased, you usually need to include a resistor in series with the diode in order to limit the current through it to a safe value.

Well, if we need a series resistor, what size resistor do we need?

So… you just want to light up an LED. What resistor should you use?

That question generates more questions. What kind of LED? What voltage power supply? How much current?

Playing with LEDs can be fun, and can be instructive! There's a simple formula that you use for figuring it out, Ohm's Law. That formula is $V = I \times R$, where V is the voltage, I is the current, and R is the resistance. But how do you know what numbers to plug into that formula to get out the right resistor value?

To get the V in our formula, we need to know two things: the voltage of our power supply, and the voltage of our LED.

Lets start with a concrete example. Suppose that we are using a 3 V power supply and are going to use a yellow LED.

LEDs have a characteristic called “forward voltage” which is often shown on the datasheets as Vf. This forward voltage is the amount of voltage “lost” in the LED when operated at a certain reference current, usually defined to be about 20 milliamps (mA), i.e., 0.020 amps (A).

Standard red, orange, yellow and yellow-green LEDs have a Vf of about 1.8 V, while pure-green, blue, white, and UV LEDs have a Vf of about 3.3 V.

***

Different LEDs have different forward voltage requirements. Non-bright LEDs tend to require less voltage than bright LEDs, since bright LEDs need more power to work. Typical VLED values are 1.7V for non-high-brightness red, 1.9V for high-brightness high-efficiency low-current red, 2V for orange and yellow, 2.1V for green, and 3.4 to 3.6V for bright white and most blue types.

In order to make sure that this voltage gets dropped across the LED, you should use a voltage greater than the LED's forward voltage. Use at least 3V supply voltage for lower-voltage LEDs and 4.5V for 3.4V types. Also add a resistor in series with the LED to limit excess current from burning out the LED, usually so that the current flowing through the LED is about 20mA. Make sure that the current doesn't exceed the maximum current specified on the LED's datasheet.

***

The *V* in our formula is found by subtracting the LED’s forward voltage from the voltage of the power supply.

3 V (power source) − 1.8 V (LED voltage drop) = 1.2 V

In this case, we’re left with 1.2 V which we’ll plug into our $V = I \times R$ formula.

The next thing we need to know is the *I*, which is current we want to drive the LED at. LEDs have a maximum continuous current rating (often listed as If, or Imax on datasheets). This is often around 25 or 30 mA. What this really means is that a typical current value to aim for with a standard LED is 20 mA to 25 mA—slightly under the maximum current. It is never a good idea to run an electronic component at the limit of its tolerance. You can always provide less current.

So, 25 mA is the “desired” current— what we’re hoping to get when we pick a resistor, and also the *I* that we’ll plug into our $V = I \times R$ formula.

1.2 V = 25 mA × *R*

1.2 V / 25 mA = *R*

1.2 V / 25 mA = 1.2 V / 0.025 A = 48 Ω

Our version of the formula now looks like this:

(Power supply voltage − LED voltage) / current (in amps) = desired resistor value (in ohms)

We end up with a resistor value of 48 Ω. And, that's a fine starting resistor value for use with a yellow LED and a 3 V source.

Let's look at resistor values for a moment. Resistors are usually available in values such as 10 Ω, 12 Ω, 15 Ω, 18 Ω, 22 Ω, 27 Ω, 33 Ω, 39 Ω, 47 Ω, 51 Ω, 56 Ω, 68 Ω, 75 Ω, and 82 Ω (and their multiples, 510 Ω, 5.1K Ω, 51K Ω, etc.), and (unless you specify higher precision while shopping) have a tolerance value of about ±5%.

Resistors are also rated by how much power they can handle. We will deal with that later. For the moment we will assume we have ¼ watt resistors.

Now, the resistor value we calculated above was 48 Ω, which isn't one of our common values. But that's okay, because we'll be using a resistor with a ±5% tolerance, so it won't necessarily be exactly that value anyway. To be on the safe side, we generally select the next higher value that we have on hand; 51 Ω in this example.

For another example, assume our power supply is 6.0 V and the current we want is 0.020 A.

(6 V – 1.8 V) /.020 A = 210 ohm

Another example: 3.3 volts power and 0.015A

(3.3 V -1.8V)/0.015A = 100 Ohms

During this lesson you met the metric prefix m which stands for milli, or 10^{-3}. Below are listed several metric prefixes which you will meet in many different contexts. Know them!

T = tera => 1,000,000,000,000 or 10^{12}
G = giga => 1,000,000,000 or 10^{9}
M = mega => 1,000,000 or 10^{6}
k = kilo => 1,000 or 10^{3}

m = milli => 1/1000 or 10^{-3}
μ = micro => 1/1,000,000 or 10^{-6}
n = nano => 1/1,000,000,000 or 10^{-9}
p = pico => 1/1,000,000,000,000 or 10^{-12}