

Re: very simplistic potentiometer question

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- *From:* jpopelish@xxxxxxxxx
 - *Date:* 1 Jul 2005 04:30:37 -0700
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Barbara wrote:

> I am just beginning to tinker with electronics. I've decided to start
> very simply and work my way up to the fun stuff. I like the thought
> of playing with LEDs for some reason so I'm starting there. I've
> figured out already that without a resistor that LEDs last about .2
> seconds before they fry. Now that I can keep one going for more than
> 5 seconds I'd like to add a pot to control the brightness. I know a
> pot is a variable resistor that basically adds resistance. I had this
> idea that I would simply insert it between my resistor and the
> positive lead on my power source (a 9 volt battery in this case.) I
> bought an assortment pack of pots and was astonished to find they have
> 3 leads. This doesn't fit into my notion of how they work so I am
> obviously missing the big picture here. I figure the answer is simple
> so I've done a lot of searches on Google and yahoo and I can't find
> simple enough circuits to make sense of how they work. I need some
> basic info on how to wire a circuit using one led, a resistor, a pot
> and a battery.

You need some basic info on both LEDs and potentiometers. LEDs are junction diodes that have all the normal properties of any other diodes. When you apply reverse voltage to them, they conduct only a small leakage current, till that voltage gets to some breakdown level, and then the current rises very fast. In the forward direction, the current rises with an exponential relation to the voltage. Equal increments of voltage increase raises the current by equal multiples. every 60 millivolts or so increases the current by a factor of 10. That means that once the forward voltage is in the normal working range, very small additional voltage will drive way too much current through them, and you see a flash and it is all over, as you have noticed.

The series resistor acts as a current stabilizer, using up all the extra voltage as the LED current passes through it, also. Resistors have a linear relation between current and voltage, so that doubling the voltage across them simply doubles the current through them. This linear relationship is called Ohm's law.

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Potentiometers are resistors with a connection to each end of a strip of resistance material and also a sliding contact that can be moved to any spot along that strip. The sliding contact is almost always the center of the three terminals.

If you want to use one as a variable resistor (make connections to a variable length of resistance material) you use one of the end connections and the sliding contact.

Most LEDs have a maximum current rating of 20 milliamps (.02 amperes) and pass this current when there is a volt or three across them. The voltage depends on the color. Red photons have less energy each, so it takes electrons falling through about 1.5 volts to produce them. Blue photons are about twice as energetic, so electrons have to fall through about 3 volts to produce them.

So, based on the color of your led and the total voltage available, you can calculate the minimum resistance needed to keep from overloading the LED. Leds say you have a red LED and a 9 volt battery. This means that you have about $9 - 1.5 = 7.5$ volts to burn up across the resistor. $7.5 \text{ volts} / .02 \text{ amperes} = 350 \text{ ohms}$. Ohms is just a label that means volts per ampere. So if you put something close to that in series with the LED, you can expect it to shine with about rated light output and still last a long time.

Then you can connect a pot in series with that pair (using the center and one end connection) to allow you to turn the current down lower than the rated current and see how the light varies. I recommend you get a \$20 digital multi-meter at Walmart and make a table of LED current versus LED voltage to get familiar with the exponential diode current voltage relationship I spoke of earlier. You can keep the meter set on voltage and use the voltage drop across the fixed resistor (dividing the voltage by the resistance to calculate the current) to make this table for various pot settings.

- **References:**

- ◆ [very simplistic potentiometer question](#)

◇ From: Barbara

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