

Lumens

Core Concept Instructor Set

nPoints
BY NTS PRESS



Light Emitting Diodes

Materials:

myDAQ

1 Red LED

1 Green LED

1 Blue LED

1 White LED

1 220 ohm Resistor

Learn It!

Light emitting diodes (LEDs) are p-n junctions that emit photons, or packets of light energy, when negatively charged electrons at higher energy levels combine with positively charged holes at lower energy levels. Electrons start in the lower energy valence band and require a high enough voltage to be pushed to the conduction band (Threshold voltage). Between the two is what is called a band gap. The frequency, or color, of the light depends on the amount of energy released which is directly related to the

amount of voltage applied to move electrons to the conduction band. LEDs are an essential part of an endless list of applications from indicators in circuits to traffic lights and TV screens. An increase in energy efficiency and lifespan of the LED make it a necessity in low power reliable systems.

In this module you will build simple LED circuits and analyze their voltage and current properties. You will explore how to control an LED using LabVIEW and gain an understanding of how to vary the intensity of LEDs.

Build It!

Light emitting diodes don't allow significant current to flow through them when the voltage applied is below the threshold ideally acting like an open circuit. They act like a short once the threshold voltage is reached and can potentially be damaged if too much current passes through them. Let's explore the voltage versus current of several LEDs in a series circuit.

LED Electrical Characteristics

Step 1: Build a series circuit from your Red LED and 220 ohm resistor with A00 acting as the power supply. You may follow the wiring diagram in Figure 1. Wire A10+ to the node that connects the LED and resistor, wire A10- to ground (AGND).

Note: In most cases the control of an LED can be done with the Digital lines of the myDAQ. For this module we are exploring what the voltage versus current curve looks like for each LED which is why the analog lines are being used.

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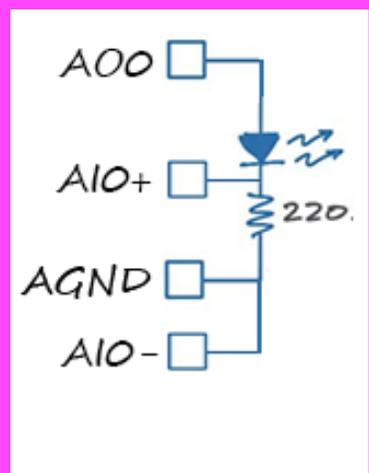


Figure 1 LED series circuit

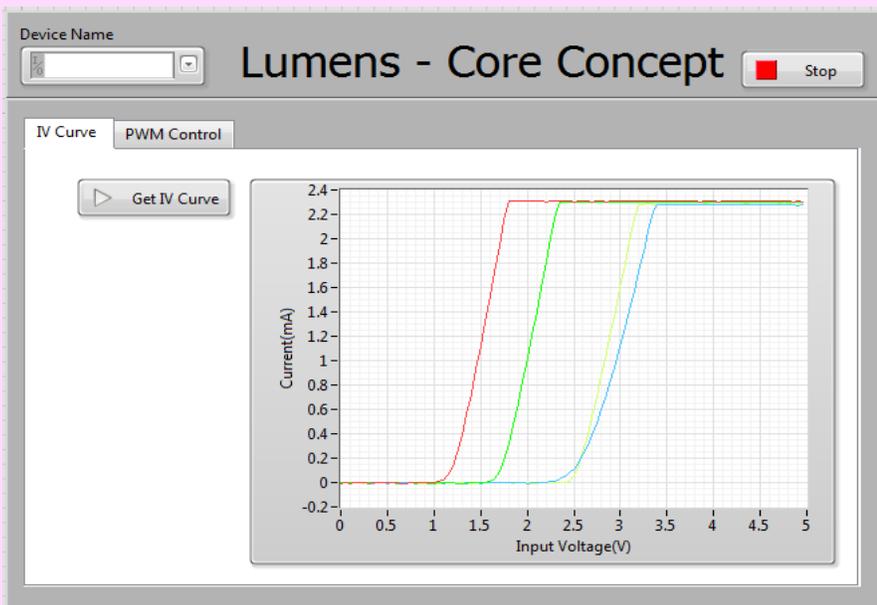


Figure 2 Lumens Front Panel

Guiding Questions:

- Explain the difference in the curves for different colors. Research and find what the ideal IV curve for an LED looks like and explain the differences between it and the curves obtained from this module.
- Where on the plot do you think an Infrared LED IV curve would fall? Ultra Violet?
- Explain the inefficiencies of this circuit. How much power is lost when the LED is off? How much power is lost when it is on?
- What were the results of flipping the LED around? Is there a limit to how much voltage can be applied in this configuration?

Step 3: Open and run the Lumens.vi in the “Lumens” folder, navigate to the “IV Curve” tab on the front panel and click “Get IV Curve” in order to run the voltage test to get a voltage versus current curve for your Red LED. Flip the LED around in the circuit so that the cathode is tied to AO0 and the Anode is connected to the resistor, click the “Get IV Curve” button a second time and observe the results.

Step 4: Replace the Red LED with the Blue one in your circuit in the proper orientation and click “Get IV Curve” once again. Examine the differences in the two curves. Repeat this for every LED.

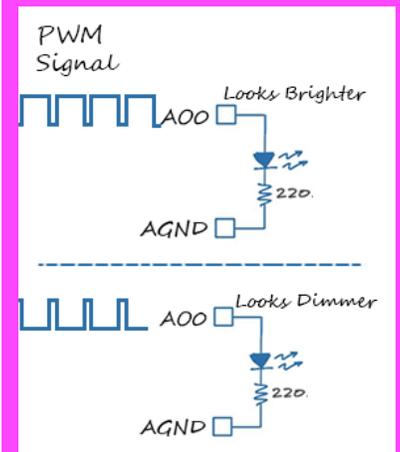


Figure 3 Controlling LED brightness with PWM

LED PWM

The light intensity or brightness of an LED is measured in lumens. There are a few ways you can control the light intensity of an LED. One method is to flash the light on and off fast enough to not be recognizable. The brightness could then be varied by changing the amount of time the LED stays on. This method is realized by sending a square wave to the LED whose high voltage is adequately larger than the threshold voltage of the LED to ensure it turns on every time. The square wave will have a fixed frequency and the high time or pulse width will be varied in order to vary the perceived brightness of the LED. Let's examine this concept at work.

Step 1: Click on the “PWM Control” tab then click on the “Start PWM” button and examine the analog output waveform going to the LED. Vary the “Duty Cycle” control and observe how the graph data and brightness of the LED change. Reduce the frequency control until the LEDs blinking becomes noticeable take note of that frequency.

Step 2: Change the LED you are using and repeat the process of varying the frequency and duty cycle of the analog output signal. Keeping the frequency the same, take note of which color LED looks brighter at different duty cycles.

Guiding Questions:

- What do you see with the same duty cycle and frequency on different color LEDs? Why is this happening?
- Using what you observed in this portion of the module and your understanding of colors, explain how you would gain different colors using the Red Green and Blue LEDs.
- You began to notice the LED flickering once you reduced the frequency below a certain point. Television screens that use LEDs need to be aware of this frequency to make sure their picture looks clear. Determine a theoretical frequency at which a 1080p screen must update if the screen must cycle through each individual LED at a time to provide it with color data.

Step 3: Explore the Block diagram, the architecture is a Producer Consumer where user interaction information is collected from the front panel in the producer loop while the myDAQ's generation and acquisition functions are handled in the consumer loop. Observe how information is sent between the loops and how each loop is stopped.

Expand it!

- Using a tricolor LED and your myDAQ, devise a way to create different colors and control it using three controls on your VI front panel to represent the amount of each color you would like to use.
- Create an automatic section that cycles through all of the possible colors and starts over.

Research It!

How Light Emitting Diodes Work

<http://www.howstuffworks.com/led.htm>

Light-emitting diode

http://en.wikipedia.org/wiki/Light-emitting_diode

Light Emitting Diodes (LEDs)

<http://www.ni.com/white-paper/14803/en/>