LED Light Show

Guided Project Instructor Set

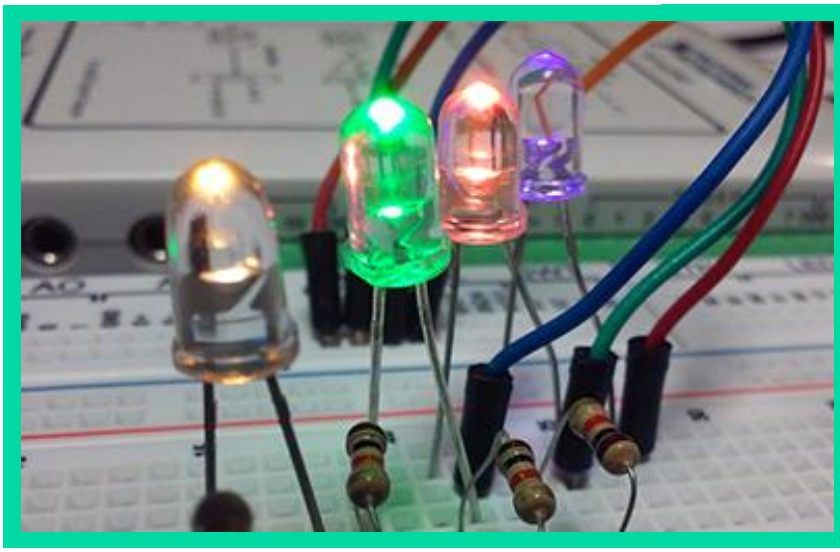

Figure 1 Example completed Light Show circuit

Related Core Concepts:

Lumens

Electret Microphone

Mini Mixer (Optional)

"Data is transmitted using things like cell phones, wireless routers, radios and Ethernet cables."

Learn It!

Information can be transmitted in various forms. Two common forms are Amplitude and frequency modulation. Both of these methods vary different parameters of a signal (known as a carrier) in order to pass a message. Amplitude modulation changes the carrier's amplitude based on the variation in the messages amplitude. Frequency modulation changes the carries instantaneous frequency based on the message amplitude variation. Both methods allow us to send and receive data across many different mediums (electrical wire, water, air, ect). Data is transmitted using things like cell phones, wireless routers, radios and Ethernet cables. In all of these methods, modulation is used in order to increase the amount and efficiency of data transfer.

In this module you will explore two forms of data transmission. You will build both a simple circuit that can transmit analog information as well as a circuit that can transmit digital information.

Build It!

LED Intensity Modulation

An LED turns on once the voltage applied to its anode exceeds its threshold voltage. After this, the intensity of the light the LED emits will change with any increase or decrease in the applied voltage. If the LED is properly set to its threshold voltage then any change in the applied voltage will be seen as a change in the LED brightness. We can therefore apply a varying signal to an LED achieve light intensity amplitude modulation.

Task 1: Build an LED series circuit with a 220 ohm resister. Connect the anode of the LED as well as the unconnected leg of the resister to your measurement device's analog output port.

Task 2: Create code that will output a basic sine function to your LED. You may modify this step to instead output music received from the audio input port of you acquisition device. Run the code and observe the intensity of the LED. Increase the amplitude of your signal and see if you can tell the difference in the change of the modulating signal. If you are using the basic sine function, increase the frequency and find the point where you can no longer decipher the modulating signal.

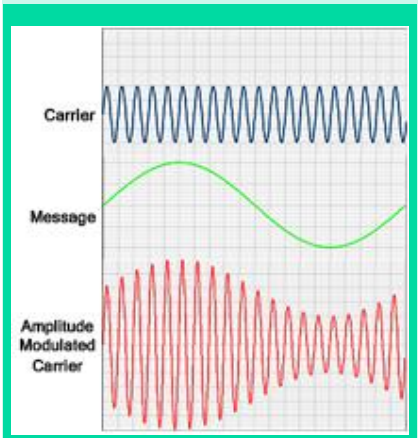

Figure 2 Amplitude Modulation

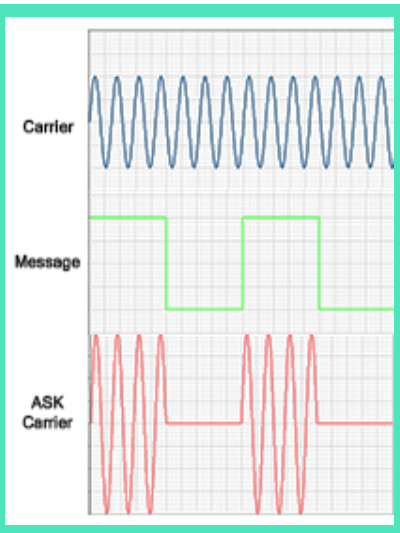

Figure 3 Amplitude Shift Keying

Light Show

Amplitude modulation can be used to transmit discrete digital levels. This is called Amplitude Shift Keying (ASK). Using ASK we can transmit different kinds of messages from warnings to binary data and even information about the frequency content of a signal over time.

Task 1: Build a series of LED circuits following Figure 4 that will act as our transmitters. We will use different colored LEDs since they transmit at different frequencies.

Guiding Questions:

- Research and describe other use cases for Amplitude Shift Keying.
- How would you receive the information being transmitted by an optical ASK system? Explain the hardware and software that may be required.

Task 2: Build on the code you created in the "Light Intensity Modulation" section to filter the incoming signal with four separate filters. The same input signal should go into all four filters so that the frequency content of the signal at specific bands can be analyzed. After filtering, apply a Fast Fourier Transform to each filtered signal then find the maximum power in decibels achieved by each band. Experiment with different signals to see what a good maximum power would be for each band then use that as a threshold for the power of the respective band. Create indicators on your code's front panel to show when a signal has exceeded your set threshold for frequencies in each band.

Guiding Questions:

- Explain the different types of filters used most often. What does cutoff frequency mean? Give a detailed explanation of passband, stop band and the 3dB point.
- List some applications that use the frequency content of a signal to make decisions. Explain how signal conditioning such as filtering could influence data either positively or negatively.

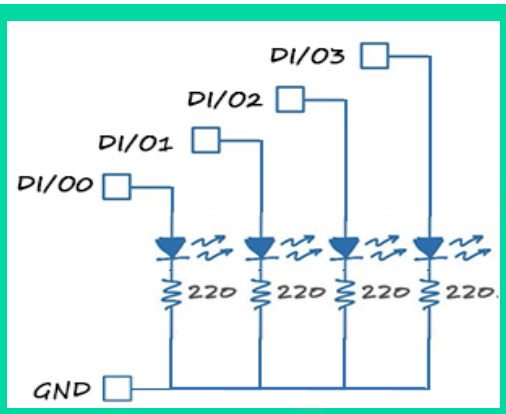

Figure 4 LED Array

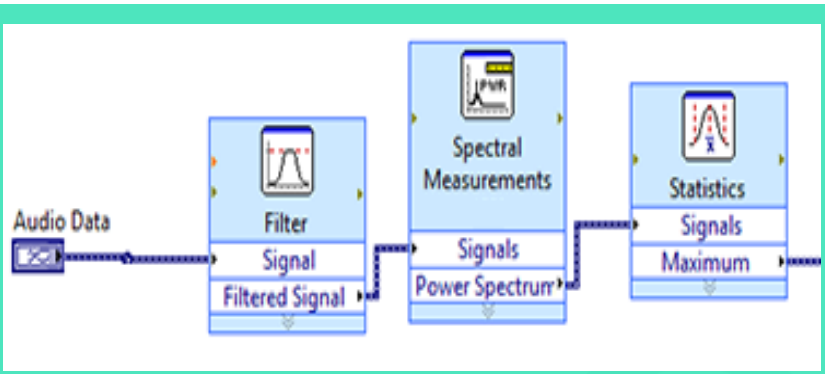

Figure 5 Example analysis code for one filter

Task 3: Create code that takes the threshold indication information from each band and outputs it to the digital lines that are connected to the LEDs from task 1. Continue experimenting with your circuit and code to get the LEDs to turn on and off without flickering too quickly. This means you should choose thresholds that are far enough away from the noisy lower portion of your signal but still include one or two high peaks from the band.

Expand it!

- Add hysteresis to your threshold to make it so that your LEDs don't flicker due to excess fluctuation in the power at each band.
- Include an extra set of LEDs to track when each band crosses a second threshold.
- Create patterns that your LEDs can run through if different threshold conditions are met in your signal. Choose different conditions such as all of the thresholds being crossed at the same time or frequency thresholds being crossed for a predetermined duration.

Research It!

Amplitude Shift Keying

http://en.wikipedia.org/wiki/Amplitude-shift_keying

Amplitude Modulation

http://www.expertsmind.com/topic/data-transmission/amplitude-modulation-for-voice-91055.aspx

How Radio Works

http://electronics.howstuffworks.com/radio7.htm