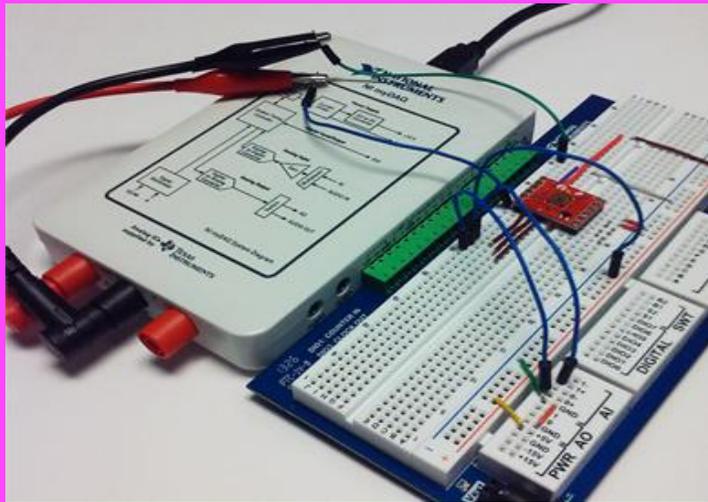# Build a Color Swatch

## Core Concept Instructions



Light Emitting Diodes

**Materials:**

*myDAQ*

*HDJD-S822 Color Sensor*

*Wires*

## Learn It!

*In the automation world the use of sensors to decode your surroundings is essential. From sonar to infrared receivers, all kinds of applications meant to run autonomously or with very little user interaction benefit from the use of these sensors. One such component is a color sensor. Color sensors are made up of three photodiodes that are each designed to be sensitive to a specific color either red green or blue. When light of a certain color hits the sensor, the three diodes react and output a voltage equal to the intensity of their specific color. Using the ratio of the output voltages form the photodiode we can determine the color of the light hitting the sensor. Color sensors can be used in a variety of vision applications that range from quality control to obstacle avoidance.*

*This module will aid you in creating a program that uses the HDJD-S822 color sensor to read in and store colors that it can later use to decipher colors shown to it on the fly!*

*"Color sensors can be used in a variety of vision applications that range from quality control to obstacle avoidance."*

## Build It!

The HDJD-S822 uses three photodiodes connected to operational amplifiers to provide a readable voltage signal. We must first properly wire the sensor to our myDAQ so we can perform 3 analog reads at a time. This will require the use of the DMM channel which will acquire slower than the other two channels.

**Build a Color Swatch**

*Step 1:* Using Figure 2, wire the color sensor to your myDAQ. Feel free to use the myProto to make your connections. Make sure the LED is wired; this will provide a constant source for anything the sensor needs to analyze.

*Step 2:* *Open the "Build Your Own Color Swatch_Student.vi" and go to the block diagram. This code is built using the event driven state machine architecture. This architecture uses an event structure to pick up user inputs and goes to the appropriate state depending on different button presses. The event structure has already been built but take some time to understand what is happening in each event case.*
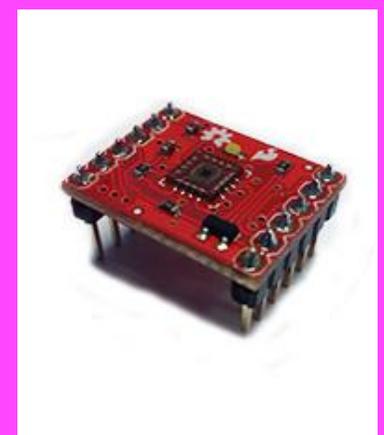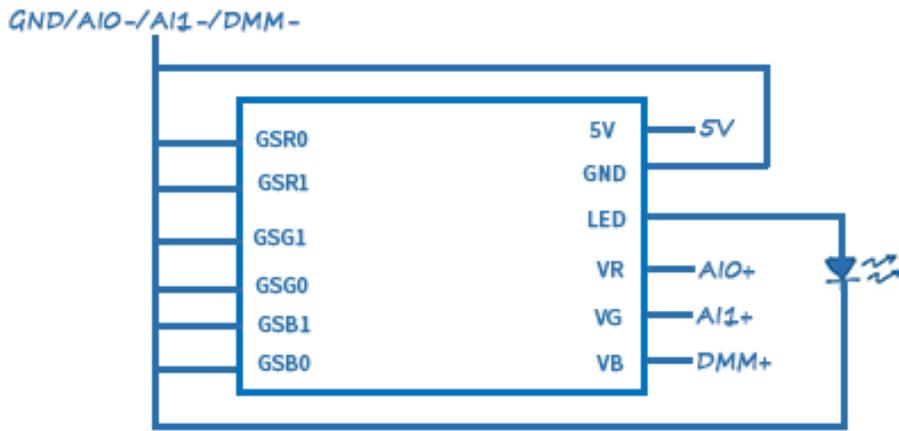


Figure 1 Analog Color Sensor

Figure 2 Color sensor wiring diagram

**Step 3:** Navigate to the "Collect Color" case of the main case structure by clicking on the top selector box with the dropdown arrow and choosing the case by name. Create a For Loop in the area marked "For Loop" by right clicking and navigating to **Programming>>Structures>>For Loop**. Then Clicking and dragging to select the area where the for loop would encompass. Create a numeric constant, set the value to 5 and wire it into the count terminal of the for loop.

## Guiding Questions:

- The color sensor returns three voltages based on the color it is reading. What do these three voltages correspond to?
- Why are the Gain Select (GSR0-GSB0) all connected to ground? How is the chip configured?
- Explain what impact averaging has on a sample returned by the DMM channel.
- Explain why the built in white LED on the color sensor is needed. Talk in detail about how it relates to what the color sensor is picking up. Expand on the theory of how color is interpreted.
- Explain methods that can be used to increase the speed of the color collection process.

**Step 4:** Place a DAQ Assistant function in your for loop that will acquire from the AI0 and AI1 channels of your myDAQ. This can be found by right clicking and navigating to **Measurement I/O>>NI-DAQmx>>DAQ Assistant.** When placed the DAQ Assistant will cause a configuration window to open which will ask to perform an acquisition of generation. Choose to acquire Voltage data then choose two analog input lines (ai0,ai1) from the list of available channels.
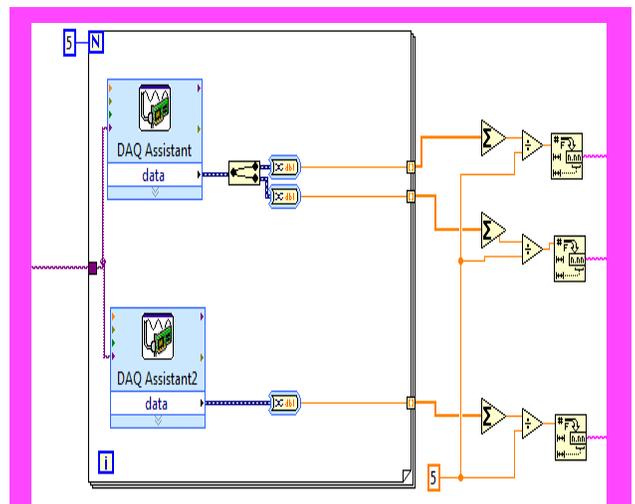
**Step 5:** Place another DAQ assistant and now configure it to acquire from the DMM channel. Wire the purple "DAQmx Device Name" signal into the "Device Name" for each DAQ assistant.

**Step 6:** Wire a "Split Signals" function to the output of the first DAQ assistant then wire the two outputs of the Split Signals function to two "Convert From Dynamic Data" functions. Wire the output of the second DAQ assistant to another "Convert From Dynamic Data" function. Wire the output of all three "Convert From Dynamic Data" functions to the right side of the For Loop. You will find both the "Split Signals" and "Convert From Dynamic Data" functions by right clicking and navigating to **Express>>Signal Manipulation.**

**Step 7:** Wire the data from the for loop to the 3 "Add Array Elements" functions.

Note: The DMM channel has to be specified in a different DAQ assistant because it performs averaging calculations on a set of data before returning a data point and this would not follow the timing of the ai0 and ai1 input lines. Having the two DAQ assistants in the same loop will slow the response time down but will ensure you get 5 data points from all three channels. Your code should now look like Figure 3.



Figure 3 Data Collecting For Loop

*Step 8:* Navigate to the "Detect Color" case and repeat steps 3-7 in the location marked "For Loop". The collect and detect color cases are very similar. The collect color case acquires and stores the values of the output voltage from the color sensor. The detect color case performs another acquire then creates an array of correlation values between the recently acquired voltage data and those that were stored. The name corresponding to the highest correlation value is output as the matching color.

**Guiding Questions:**
- Write out and explain the correlation equation. What special consideration must be taken for the two data sets?
- Explain possible areas where error could be introduced in this method for detecting a matching color.
- What happens if you try to push the stop button while either the collect or detect processes are running? Is there a way this can be avoided?

## Expand it!
- Implement a calibration process that would allow you to map out different colors based off of just reading in white and black. Be sure to adjust the individual output gains of the sensor to properly map to your new range.
- Derive a way to read in three analog values with two analog input lines. Create a system diagram that shows the current setup along with any additional hardware needed. Include steps that would need to be taken in the code to get the proper data.

## 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/