Experiment No.: 09

Experiment Name: Calibrate Color Sensor and read RGB values from it

Objective:

Theory:

Required Hardwares with Quantity:

Required Software:

Working Procedure:

Hardware Arrangement Diagram:

Sketch:

**Result and Output:**

Conclusion:

<u>Basic Knowledge</u>:

The **TCS3200** is a programmable color light-to-frequency converter sensor, commonly used for detecting and identifying colors in electronic projects. It's widely applied in robotics, automation, and embedded systems for color-sensing applications.

The TCS230 senses color light with the help of an 8 x 8 array of photodiodes. Then using a Current-to-Frequency Converter the readings from the photodiodes are converted into a square wave with a frequency directly proportional to the light intensity. Finally, using the Arduino Board we can read the square wave output and get the results for the color.
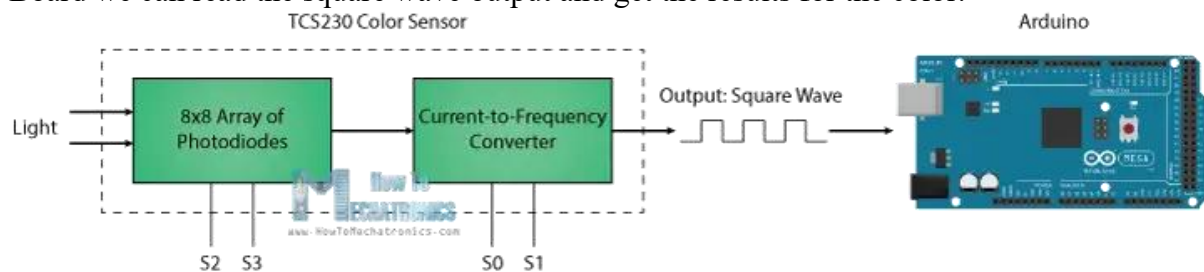
If we take a closer look at the sensor we can see how it detects various colors. The photodiodes have three different color filters. Sixteen of them have red filters, another 16 have green filters, another 16 have blue filters and the other 16 photodiodes are clear with no filters.
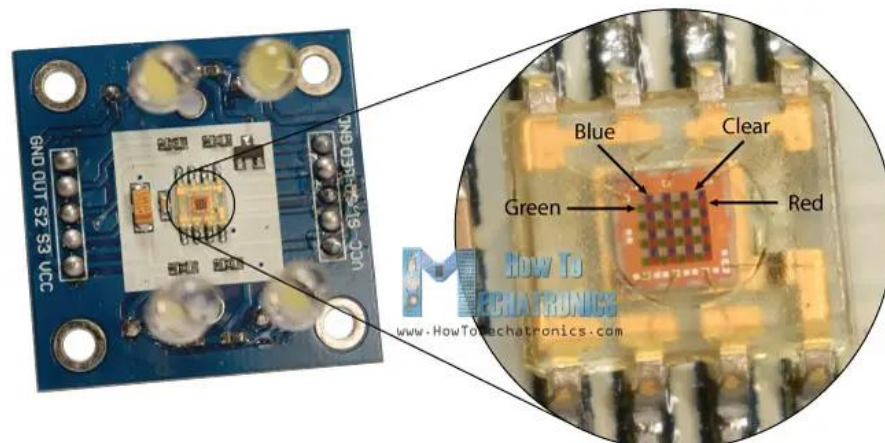
Each 16 photodiodes are connected in parallel, so using the two control pins S2 and S3 we can select which of them will be read. So for example, if we want to detect red color, we can just use the 16 red filtered photodiodes by setting the two pins to low logic level according to the table.

S0	S1	Output Frequency Scaling
L	L	Power down
L	H	2%
H	L	20%
H	H	100%

S2	S3	Photodiode Type
L	L	Red
L	H	Blue
H	L	Clear (no filter)
H	H	Green

The sensor has two more control pins, S0 and S1 which are used for scaling the output frequency. The frequency can be scaled to three different preset values of 100 %, 20 % or 2%. This frequency-scaling function allows the output of the sensor to be optimized for various frequency counters or microcontrollers.

Frequency scaling in the context of the **TCS3200 sensor** refers to the ability to adjust the proportion of the sensor's output frequency relative to the light intensity it detects. The output frequency is a square wave signal, where the frequency is directly proportional to the intensity of the light passing through the selected color filter (red, green, blue, or clear).

The TCS3200 allows you to scale down this frequency by specific percentages (100%, 20%, or 2%) using the **S0** and **S1** control pins.

Why is Frequency Scaling Used?

- The TCS3200 generates a frequency that represents the detected light intensity.
- In high-intensity light conditions, the frequency output may become very high (e.g., hundreds of kHz), which some microcontrollers may struggle to measure accurately.
- Frequency scaling reduces the output to a more manageable range.
- Reducing the frequency scaling enables the sensor to perform better in bright environments where light intensity might otherwise saturate the sensor.
- Allows the sensor to adapt to both bright and dim lighting environments without requiring external circuit modifications.

If the sensor detects intense red light and would normally output 100,000 Hz at **100% scaling**:

- At **20% scaling**, the output would be 20,000 Hz.

- At **2% scaling**, the output would be 2,000 Hz.

The lower frequency is easier for many microcontrollers to measure using functions like pulseIn() or timers.

When to Use Different Scaling Levels

- **100% (High Sensitivity)**: Use in dim light conditions where more resolution is needed.

- **20% (Moderate Sensitivity)**: Best for general-purpose applications, balancing resolution and frequency range.

- **2% (Low Sensitivity)**: Use in bright light conditions to avoid high-frequency saturation or when working with slower microcontrollers.
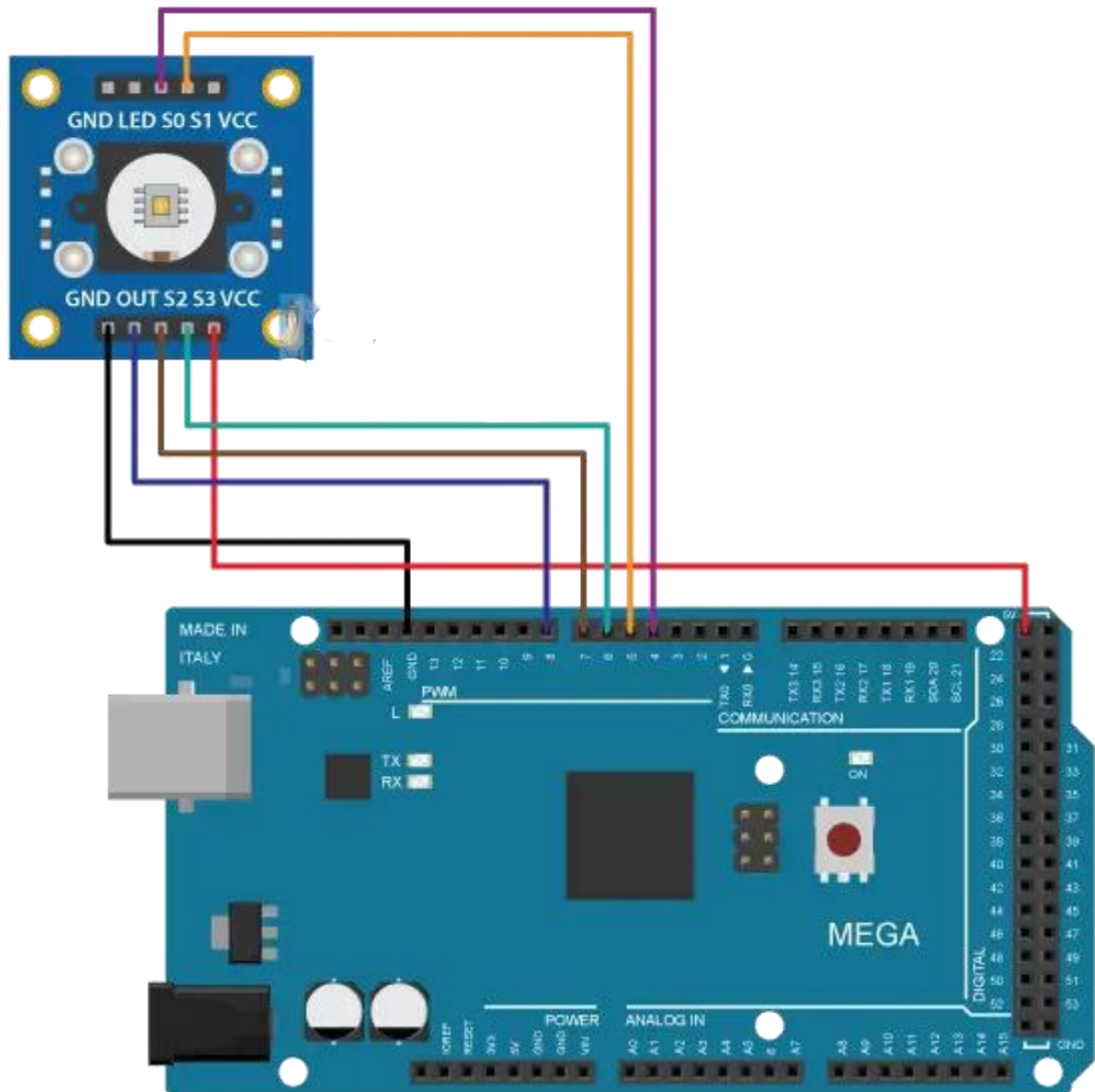
Calibrating the Sensor

We will actually use two sketches to work with the TCS230 color sensor.

1. The first sketch (calibration sketch) will help us to obtain the raw data from the sensor.

2. The second sketch (main Arduino sketch) will use the raw data previously received to display RGB values for the color being sensed.

Load the sketch to your Arduino and mount the sensor so that it is facing the objects. Start by finding a reference object for white and black color. These reference objects will produce readings at both maximum and minimum values for all three colors.

CODE:

https://randomnerdtutorials.com/arduino-color-sensor-tcs230-tcs3200/