Calibration

Calibrating the Sensor

The output is a square wave (50% duty cycle) with frequency (f_o) directly proportional to light intensity:

$$f_O = f_D + (Re)(Ee)$$

where

- f_o is the output frequency
- f_d is the output frequency for dark condition (when *Ee* = 0)
- *Re* is the device responsivity for a given wavelength of light in kHz/(mW/cm^2)
- *Ee* is the incident irradiance in mW/cm^2.

f_d is an output frequency resulting from leakage currents. As shown in the equation above, this frequency represents a light-independent term in the total output frequency f_o. At very low light levels (dark colors), this dark frequency can be a significant portion of f_o. The dark frequency is also temperature dependent.

As f_o is directly proportional to frequency, it is possible to map between the frequency and RGB color value (0-255 for each of R, G and B) using linear interpolation.

Two points on the RGB line are well determined – pure Black (RGB 0, 0, 0) and pure White (255, 255, 255). The values returned by the sensor can be read using easily obtainable color swatches:

- A black color card gives us the dark condition constant f_d. This is the origin (zero value) for the RGB straight line conversion.
- A white color card gives us the extreme RGB point f_w, also known as white balance. Knowing f_d, this value can be used to scale all intermediate frequencies to a corresponding RGB value.

The proportional relationship is expressed by the standard straight line equation *y* = *mx* + *b* where

- *y* is the reading obtained (in our case f_o)
- *x* is the normalized RGB value
- *b* is the value of y when x is 0 (in our case f_d)
- *m* is the slope, or proportionality constant, of the line (in our case [f_w - f_d]/255.

The resulting equation is

$$f_O = f_D + \frac{x \cdot (f_W - f_D)}{255}$$

or, rearranging to give us the desired RGB value

$$x = \frac{255 \cdot (f_O - f_D)}{(f_W - f_D)}$$

References

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