

# TAOS/Parallax TCS230 Color-Matching Demo Program

## Introduction

The TAOS/Parallax TCS230 color-matching demo program is PC-resident host software that demonstrates the TCS230's color-matching capabilities. With it, you can program up to 100 different colors for matching to whatever color the sensor is viewing. The programming is done by showing the sensor a color and selecting one of 100 locations in which to store it. Then, when the sensor is shown another color, it will select the stored color with the closest match.

Color matching is done using a "minimax" approach in the RGB color space. In this method, the distance between two colors is the absolute value of the difference between the RGB component that differs most:

$$D_i = \max\{|R - R_i|, |G - G_i|, |B - B_i|\}$$

where **R**, **G**, and **B** are the red, green, and blue coordinates of the color being scanned; and **R<sub>i</sub>**, **G<sub>i</sub>**, and **B<sub>i</sub>** are the coordinates of stored color **i**. The color with the closest match is taken to be the one whose **D<sub>i</sub>** is the smallest, i.e. minimizing the maximum difference. Hence the term "minimax".

There are many other equally valid ways to measure color distance, and the selection of which one to use depends as much on perceptual factors as anything else. You may notice that when this program can't find an exact match, what it calls the closest color may not be the one you'd pick. This is because your perceptual color space is different from the one the program uses for measuring color distance. Color perception and color spaces have been the subject of intense research for many

decades. You can learn more by typing "color-spaces" into Google to uncover a wealth of information.

## Using the Program

To use the host program, you need to load the included **TCS230DEMO.bpe** into the BASIC Stamp to which the TCS230 is connected. After doing so, leave the serial cable attached, but exit the debug window. *This is important*, as the demo program won't work with an open debug window.

Next, start the host program. It will scan your serial ports until it finds the BASIC Stamp with the running demo program. At that point you should see a display similar to the one on the next page.

The current color is displayed in two ways: 1) as RGB components, and 2) as a composite color. Ideally, the composite color displayed on your screen should match the color the sensor is looking at. There are several things that could prevent this, however:

1. *The input might be saturating.* This will be evident from a message in the message box that *says* the input is saturating, with one or more color components showing a value of 255. If this happens, you will need to modify the BASIC Stamp demo program. There are three constants in this program that govern the interval over which each of the RGB components is sampled. They are **pRED**, **pGREEN**, and **pBLUE**. You will want to adjust each one so that, while looking at a white piece of paper, each color component will have a value of just under 255. You can use the debug output to do this most efficiently.

2. *You may have a poor white balance.* The host program has two modes for viewing colors: raw and balanced. In raw mode, you see the same uncalibrated colors the sensor sees. You can calibrate the sensor by doing a white balance. With a white piece of paper under the sensor, click the "Do White Balance" button. This will scale each of the RGB outputs to 255 (pure white) and enter balanced mode. You can switch back and forth between raw and balanced modes with the buttons provided. You *must* be in balanced mode, however, to store and match colors.

3. *You may have a poor gamma setting.* Computer monitors are inherently non-linear devices and display colors poorly without precompensating for the nonlinearity. The amount of precompensation necessary is referred to as *gamma*. You can adjust this value by using the slider provided to get the best match across a range of colors.

Once you're getting good visual matches, you can start saving and matching colors. To save a color (until you exit the program), just present that color to the sensor, and left-click on the desired color number. To delete a color, right-click on its number. Once you've saved several colors, you can present colors to the sensor, and the program will select the best match from the colors you've saved. The best match is indicated by that color's number flashing on and off. The degree of match for each saved color can be observed visually in the black space at the bottom. The farther left the color's number is, the better the match.

Raw and Balanced buttons.  
 Select Raw for raw RGB data.  
 Select Balanced for data  
 after white-balancing is  
 done.

Do White Balance: Click  
 this when the sensor is  
 looking at a white target.

Current RGB values

Current rendered color

Gamma Correction.  
 Affects PC display only.  
 Use lower values for more  
 pre-emphasis on dark  
 colors.

Message box. Shows progress scanning serial ports, and alerts to saturation condition.

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Color definition buttons.  
 Left click to define as current color.  
 Right click to undefine.  
 Flashing number indicates closest  
 color to current color.

Color matching space.  
 The further left a number is,  
 the closer that color matches  
 the current color.

Figure 1. Example screen from TCS230MATCH.EXE