Understanding Color: A Programmer's Guide to Mixing RGB Colors

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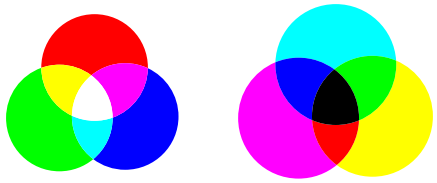
This document describes how the additive Red-Green-Blue color model is used to mix colors via hue/saturation/brightness. Computer screens add colors to another (red + green + blue = white) whereas printers subtract colors (cyan + magenta + yellow = black).

The following three pages show how you via HUE, SATURATION and BRIGHTNESS can create any color in the RGB color space. These three values are often referred to as HSB.



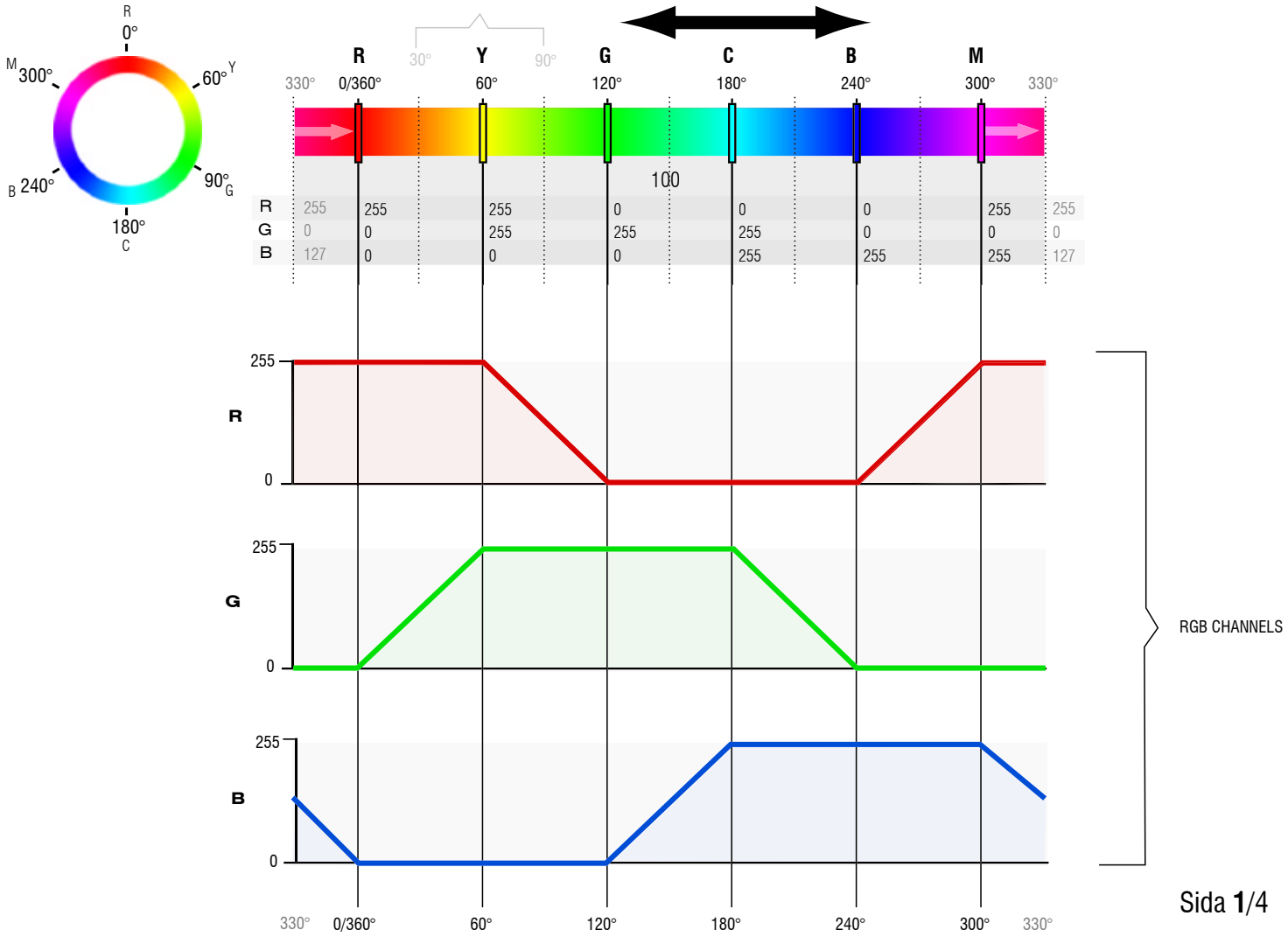
HUE

To mix an RGB color, begin with selecting the hue (the nuance of the color, like pure red or pure lime). This color lacks both blackness (saturation) and whiteness (brightness).

All pure colors can be arranged on a circle with red, green and blue positioned at 120 degrees intervals. Note that cyan, magenta and yellow is found in between these three positions.

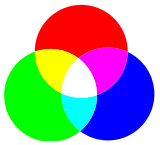
The hue always contains 1 or 2 channels (like R, R+B, R+G) but never a third. For a 24-bit color model, each channel is made up from 8 bits. The maximum value for each channel is 255 and the minimum 0.

The hue circle holds colors that never uses more than two channels at the time (like R+B). In between pure red, pure green and pure blue all other colors are interpolated. This is done by increasing or decreasing one of the two used channels (either R, G or B is always 0).



SATURATION

The amount of white in a color is called saturation. By adding white you raise the “minimum value” that the RGB channels adopt. This means that colors are washed out and becomes more and more pale the lower the saturation.

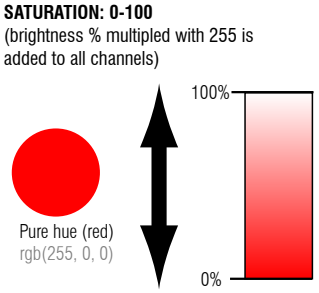


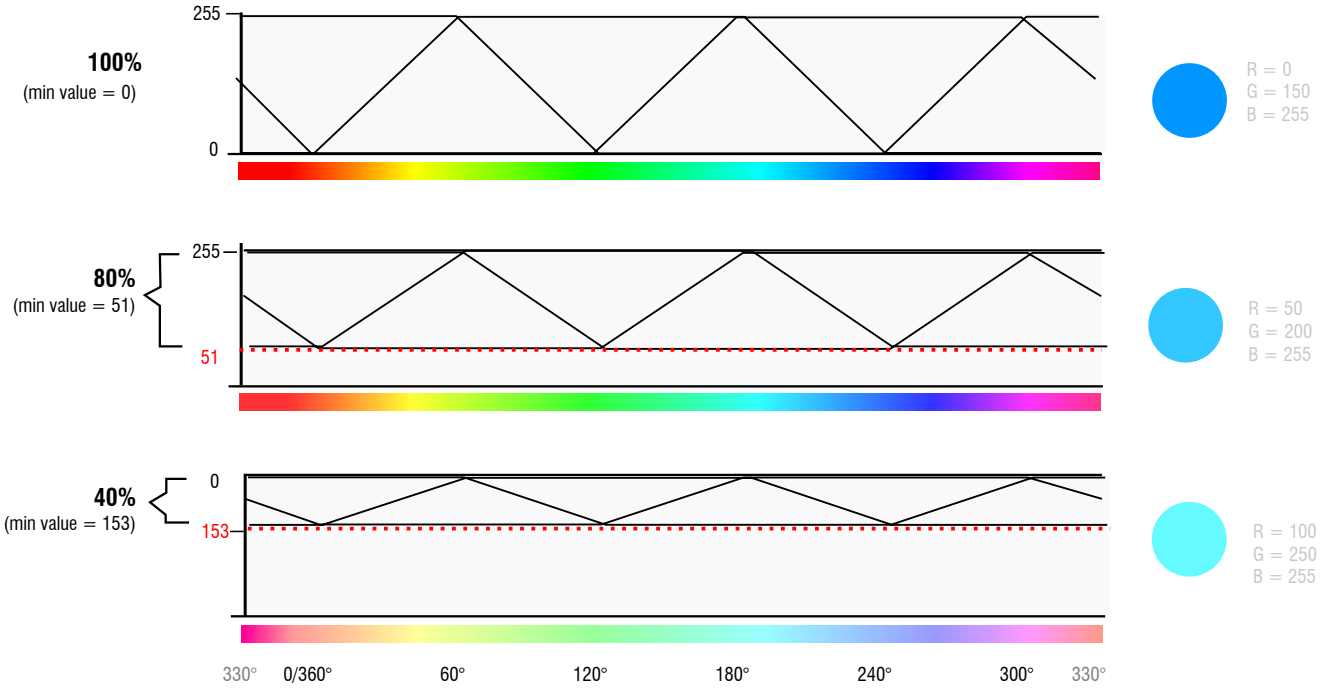
R = rgb(255, 0, 0)
G = rgb(0, 255, 0)
B = rgb(0, 0, 255)

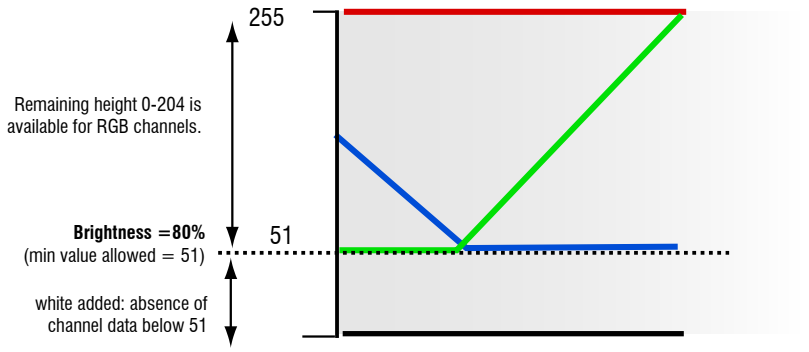
R = rgb(255, 127, 127)
G = rgb(127, 255, 127)
B = rgb(127, 127, 255)

The saturation dictates a common value that is added to ALL channels in the same amount. 100% saturation adds nothing, 0% saturation adds 255 to all channels.
50% saturation means adding 127 to all channels, regardless of their original value.

If all channels are set to 255 we end up with pure white.



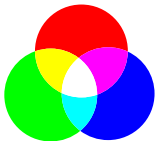




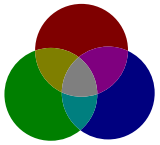
BRIGHTNESS

A pure hue can be made darker by adding black. 100% brightness is the same as leaving the hues pure and clear (no black), 0% brightness makes the color black.

The brightness value determines the maximum value for the RGB channels. 100% brightness means that the RGB channels can dispose of all 0-255 values. Lower brightnes means lowering the maximum values the RGB channels can climb to.



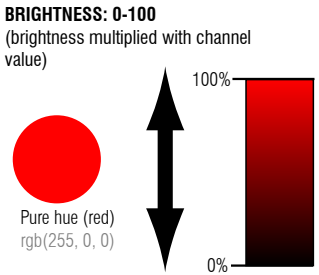
R = rgb(255, 0, 0)
G = rgb(0, 255, 0)
B = rgb(0, 0, 255)

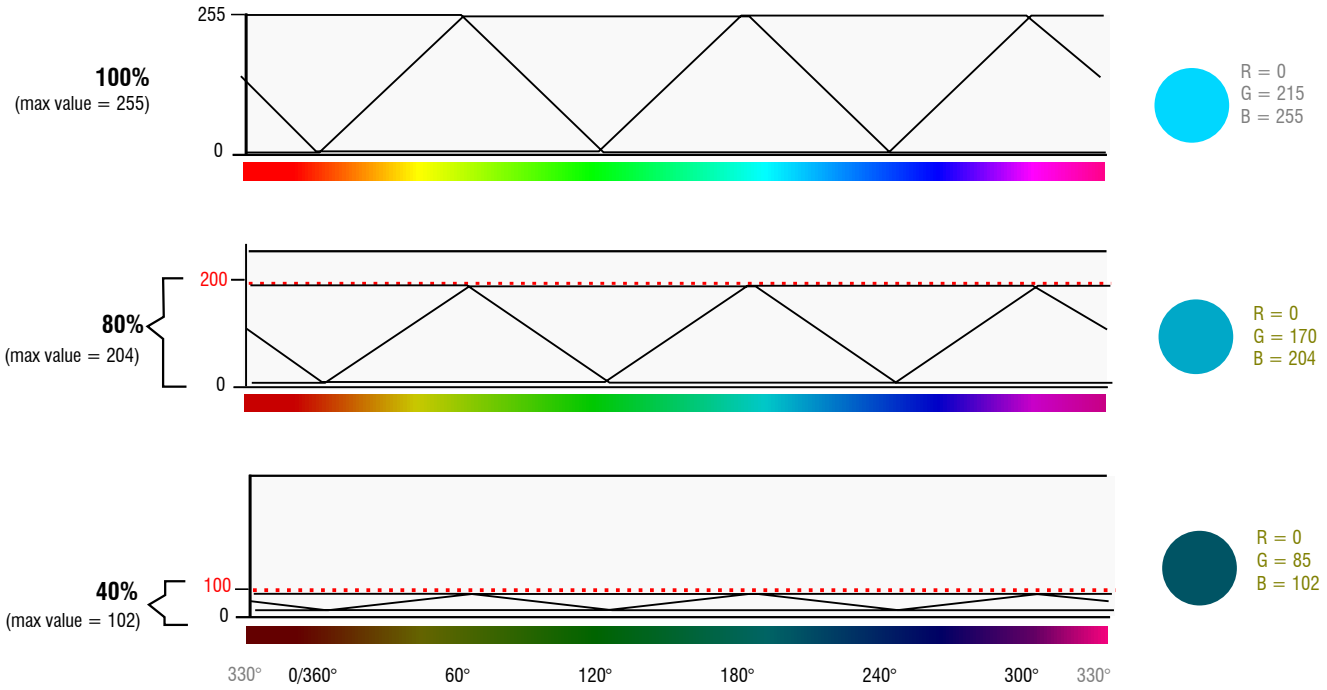


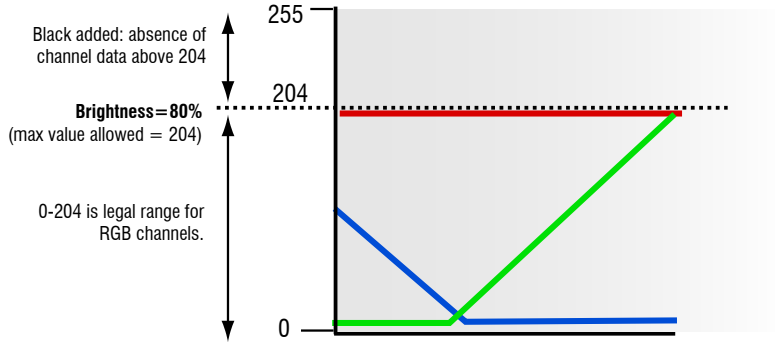
R = rgb(127, 0, 0)
G = rgb(0, 127, 0)
B = rgb(0, 0, 127)

50% brightness means that all channels are reduced to 50% of their original strength (all channels are reduced proportionally).

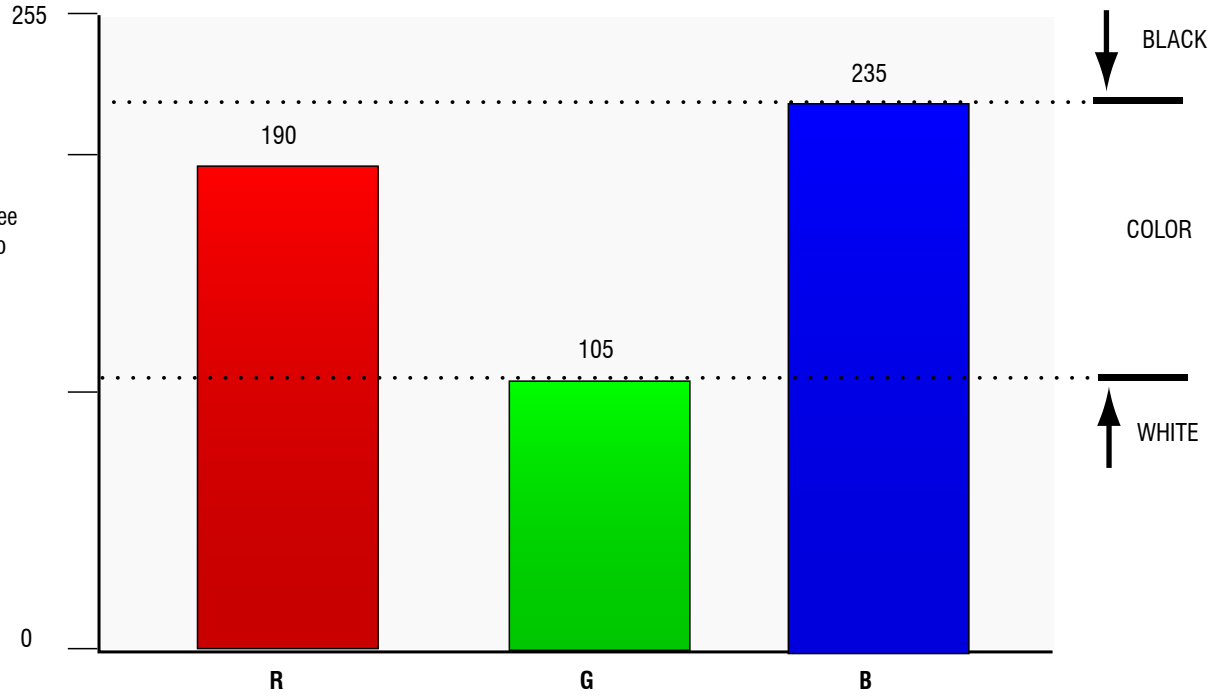
If all channels are multiplied with 0 we get black.

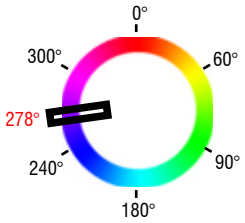




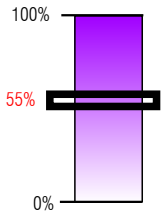


If the smallest component (G) is subtracted from the three channels, only R and G is left. There is more B than R so the color is bluish magenta.

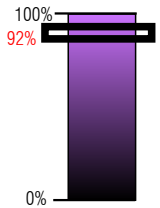




HUE: 278°



SATURATION: 55%



BRIGHTNESS : 92%

=

Violet
R = 190
G = 105
B = 235

RESULT