

# Hexadecimal Number System and Color Representation

Emmett J. Ientilucci 3-10-2000

Our base 10 system goes from 0-9 (10 digits), i.e., 0,1,2,3,4,5,6,7,8,9. The base 16 will go from 0-15 (16 digits). But we have no way to represent 10,11,12,13,14,15 so we use letters. That is, A, B, C, D, E, F. Therefore, base 16 system goes from 0-15, i.e., 0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F

## ***Hex-to-Decimal Conversion***

The quick solution to your problem lies in your conversion to hex. A hex number can be converted to its decimal equivalent by using the fact the each hex digit position has a weight that is a power of 16. The first position has a weight of  $16^0$  (that is 16 raised to the zero power) which equals 1. The next higher digit has a weight of  $16^1$ . Which equals 16. The next higher digit has a weight of  $16^2 = 256$ , and so on. The conversion process is demonstrated in the examples below. Here we convert the hex numbers 356 and 9900CC to decimal. The subscripts "16" and "10" differentiate the numbering systems.

$$\begin{aligned} 356_{16} &= (3 \times 16^2) + (5 \times 16^1) + (6 \times 16^0) \\ &= 768 + 80 + 6 \\ &= 854_{10} \end{aligned}$$

$$\begin{aligned} 9900CC_{16} &= (9 \times 16^5) + (9 \times 16^4) + (0 \times 16^3) + (0 \times 16^2) + (12 \times 16^1) + (12 \times 16^0) \\ &= 9,437,184 + 589,824 + 0 + 0 + 192 + 12 \\ &= 10,027,212_{10} \end{aligned}$$

## ***Decimal-to-Hex conversion***

Decimal –to-hex conversion can be done using repeated division by 16. The examples below will illustrate.

Convert  $423_{10}$  to hex

$$\begin{array}{r}
 \frac{423}{16} = 26 + \text{remainder of } 7 \\
 \downarrow \\
 \frac{26}{16} = 1 + \text{remainder of } 10 \\
 \downarrow \\
 \frac{1}{16} = 0 + \text{remainder of } 1
 \end{array}$$

$423_{10} = 1A7_{16}$

Convert  $414_{10}$  to hex

$$\begin{array}{r}
 \frac{214}{16} = 13 + \text{remainder of } 6 \\
 \downarrow \\
 \frac{13}{16} = 0 + \text{remainder of } 13
 \end{array}$$

$214_{10} = D6_{16}$

### **Hexadecimal in Color**

Each position in (99, 00, CC) represents an 8-bit number. That is (8-bit number, 8-bit number, 8-bit number). This is because we think in terms of 8-bit grayscale or in this case, color one position for *red* one for *green* and one for *blue*. As you know, with these three additive primaries, we can formulate or reproduce any color of visible electromagnetic spectrum.

Lets look at the red position for a moment. With one place value, that is, just one 9, in hex (or base 16 number system) we can have 16 possible numbers (or red values). This means we have 4-bits (bit is short for a binary digit) to play with. This is because 2 raised to the power "x" equals the total possible numbers (16). In this example, x = 4bits, e.g.,  $2^4 = 2 \times 2 \times 2 \times 2 = 16$  possible numbers.

The two stems from the base 2 number system, which is the only number system computers really understand. As expected, the base 2 system goes from 0-1 (2 digits), i.e., 0,1. The computer sees it as "on" (a one), or "off" (a zero). So that's why we use HEX, because it's directly related to the base 2 system. There is more to this, but I'll spare you the details.

Now back to the hex example. Before we had one place value, now lets use a second place value, i.e., 99. The maximum this can take on is FF, where as before it was F. This gives us 256 possible numbers or 256 possible shades of red. This is really nice because we can represent 8-bits with two digits, nice!

Finally, we give ourselves a hex number with six places as seen in the example above, 9900CC. Now we can think of each "2-position" section as 256 possible shades of red, 256 possible shades of blue, and 256 possible shades of green. In all, this is (8-bits x 3) = 24-bits. This is sometimes called 24-bit color. Now you know why. In combination, we have one 24-bit hex number, 9900CC. Broken up into its separate digital count color values we have;

$$\begin{aligned} 99_{16} &= 153 \\ 00_{16} &= 0 \\ CC_{16} &= 204 \end{aligned}$$

From this we see that we have no green, a moderate amount of red, and a lot of blue. Since red and blue yield magenta, what we have here is a purple-like color.