Programming Lab #7c

Resistor Color Codes

Topics: Replacing division by reciprocal multiplication, replacing multiplication by a sequence of addition, subtraction and shift instructions.

Prerequisite Reading: Chapters 1-8
Revised: December 11, 2020

Background[1]: Resistors use color bands to identify their value (in ohms) and a percentage tolerance. In 1952, the code was standardized by the International Electrotechnical Commission (IEC) in IEC 62:1952 and since 1963 also published as EIA (Electronic Industries Alliance) RS-279. Originally only meant to be used for fixed resistors, the color code was extended to also cover capacitors with IEC 62:1968.

To distinguish left from right there is a gap between the last two bands. The most common type of resistors has four color bands; the two left-most bands specify the two most-significant digits of the resistance, the third band specifies a multiplier (the number of trailing zeros), and the fourth specifies the percentage tolerance. If there is no fourth band, the tolerance is $\pm 20\%$. (Although not considered here, resistors that require more precision use an additional band for a third significant digit.)
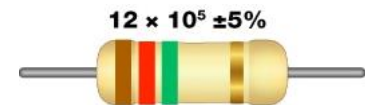
Assignment: You are to implement three assembly language functions that are used by the main program to translate the color code into a resistance value:

$12 \times 10^5 \pm 5\%$

Color	1st Band	2nd Band	3rd Band (Multiplier)	4th Band (Tolerance)
Black	0	0	10^0	
Brown	1	1	10^1	
Red	2	2	10^2	
Orange	3	3	10^3	
Yellow	4	4	10^4	
Green	5	5	10^5	
Blue	6	6	10^6	
Violet	7	7	10^7	
Gray	8	8	10^8	
White	9	9	10^9	
Gold				$\pm 5\%$
Silver				$\pm 10\%$
No Color				$\pm 20\%$

```
uint32_t Mul32X10(uint32_t multiplicand) ;

uint64_t Mul64X10(uint64_t multiplicand) ;

uint32_t Div32X10(uint32_t dividend) ;
```

The first function (`Mul32X10`) returns the 32-bit unsigned product of ten times its 32-bit argument, the second (`Mul64X10`) returns the 64-bit unsigned product of ten times its 64-bit argument, and the third (`Div32X10`) returns the 32-bit unsigned quotient of its argument divided by 10.

Important: The objectives of this assignment are to (1) implement the first two functions without using a multiply instruction, and (2) to implement the third function without a divide instruction. No loops, IT blocks, or conditional branch instructions are allowed. Use this webpage to find instruction sequences to perform ***unsigned*** division by a constant.

Test your code with the main program found here. Touching any of the color bands on the displayed resistor changes the color of that band and thus the displayed values.

ARM Assembly
for Embedded Applications

$2\ 6\ 10^5\ 5\%$

Resistance:
   2.600 MegaOhms

Minimum:
   2.470 MegaOhms

Maximum:
   2.730 MegaOhms

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[1] Adapted from https://en.wikipedia.org/wiki/Electronic_color_code