About Hexadecimal Numbers

Bob Brown
Computer Science Department
Southern Polytechnic State University

Like decimal and binary numbers, the *hexadecimal,* or base 16 number system is a positional number system. We know that there must be 16 symbols, and we choose 0, 1, …, 9, A, B, C, D, E, and F. Symbols 0 through 9 have the same unit values they have in the decimal system, but of course the positional multiplier is different. Hexadecimal (or *hex*) **A** has the value 10_{10}, **B** is 11_{10}, **C** is 12_{10}, **D** is 13_{10}, **E** is 14_{10}, and **F** is 15_{10}.

The positions in a hexadecimal number have as their values powers of 16, starting with 16^0 at the right, then 16^1, 16^2 or 256, 16^3 or 4096, and so on. Four hexadecimal digits let us represent numbers up to $15\times16^3 + 15\times16^2 + 15\times16^1 + 15$, or $15\times4096 + 15\times256 + 15\times16 + 15$, or 61,440 + 3840 + 240 + 15, or 65,535. This number would be represented as FFFF. A value of 0100_{16} is equal to 256_{10}.

Hexadecimal numbers can be used as a kind of shorthand for binary numbers, to avoid writing out long strings of ones and zeroes. Study the following table:

Hex	*Binary*	*Decimal*
0	0000	0
1	0001	1
2	0010	2
3	0011	3
4	0100	4
5	0101	5
6	0110	6
7	0111	7
8	1000	8
9	1001	9
A	1010	10
B	1011	11
C	1100	12
D	1101	13
E	1110	14
F	1111	15

As you can see, each hex digit is exactly equivalent to one of the possible combinations of four binary digits, so we could write 7_{16} instead of 0111_2. This works for numbers larger than four bits or one hex digit. $7A_{16}$ is equivalent to 01111010_2. Four hex digits let us express a 16-bit binary number in four symbols instead of 16.

It is common to use indications other than a subscript 16 to identify numbers as hexadecimal when it is not clear form the context. The following are all examples of indicators of hexadecimal numbers: x'7A', 0x7A, and 7Ax. In the Motorola 68000 assembler we will be using in Cs2224, hexadecimal numbers are indicated by a dollar sign, so \$08 is 8_{16}.