Binary, Octal & Hexadecimal to Decimal

(By Angel Cool; Wednesday, August 8, 2012)

This tutorial will demonstrate how to manually convert Binary, Octal and Hexadecimal numbers to Decimal.

Binary to Decimal

Each binary position represents a doubling of the previous value (base2), so we get a decimal sequence of 1, 2, 4, 8, 16...; The total number of bits indicate how many times we have to double, so for an 8 bit binary number we will have to double 8 times: 1, 2, 4, 8, 16, 32, 64 and 128. Note that only binary 1s are taken into account when converting to decimal.

1.- Convert **01011100** to decimal:

Step a.- Write a doubling sequence of decimal numbers starting from right to left:

128	**64**	**32**	**16**	**8**	**4**	**2**	**1**

Step b.- Write the binary number below the decimal doubling sequence:

128	64	32	16	8	4	2	1
0	**1**	**0**	**1**	**1**	**1**	**0**	**0**

Step c.- Add the decimal equivalent of all binary 1s:

128	64	32	16	8	4	2	1	
0	1	0	1	1	1	0	0	
	64	**+**	**16**	**+ 8 +**	**4**		**=**	**92**

So, **01011100** in binary is equal to **92** in decimal.

2.- Convert **110010110** to decimal:

Step a.- Write a doubling sequence of decimal numbers starting from right to left; in this case we have 9 bits, so we will double nine times:

256	**128**	**64**	**32**	**16**	**8**	**4**	**2**	**1**

Step b.- Write the binary number below the decimal doubling sequence:

256	128	64	32	16	8	4	2	1
1	**1**	**0**	**0**	**1**	**0**	**1**	**1**	**0**

Step c.- Add the decimal equivalent of all binary 1s:

256	128	64	32	16	8	4	2	1	
1	1	0	0	1	0	1	1	0	
256 +	**128**	**+**		**16**	**+**	**4 +**	**2**		**= 406**

So, **110010110** in binary is equal to **406** in decimal.

Hexadecimal to Decimal

Each hexadecimal position represents an increment of 16 times the previous value (base16), so we get a decimal sequence of 1, 16, 256, 4096...; The total number of digits/letters in a hexadecimal value indicates the number of increments. We will demonstrate two different procedures of converting hexadecimal values to decimal.

Procedure A

1.- Convert **A7BC** to decimal:

Step a.- Write an increment sequence of decimal numbers starting from right to left:

4096 256 16 1

Step b.- Obtain the decimal equivalent of each hexadecimal digit in the original value:

A = **10** decimal
7 = **7** decimal
B = **11** decimal
C = **12** decimal

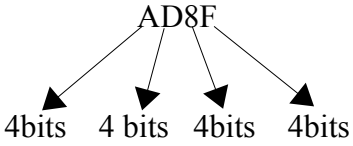
Step c.- Multiply each equivalency found in step b by each increment and add the results:

4096		256		16		1	
x 10		x 7		x11		x12	
40960	**+**	**1792**	**+**	**176**	**+**	**12**	**= 42940**

So, **A7BC** in hexadecimal is equal to **42940** in decimal.

Procedure B

Each hexadecimal position represents a four bit binary number. We will use this principle to convert a hexadecimal number to binary and from binary to decimal.

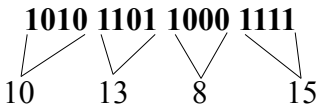


2.- Convert **AD8F** to decimal:

Step a.- Obtain the decimal equivalent of each hexadecimal digit in the original value:

A = **10** decimal
D = **13** decimal
8 = **8** decimal
F = **15** decimal

Step b.- Convert each equivalency found in step a to binary:



Step c.- Convert the binary number to decimal:

32768	16384	8192	4096	2048	1024	512	256	128	64	32	16	8	4	2	1	
1	0	1	0	1	1	0	1	1	0	0	0	1	1	1	1	
32768	+	**8192**	+	**2048**	**+1024**	+	**256**	**+128**		+		**8+4**	**+2+**	**1**		**= 44431**

So, **AD8F** in hexadecimal is equal to **44431** in decimal.

Octal to Decimal

Each octal position represents an increment of 8 times the previous value (base8), so we get a decimal sequence of 1, 8, 64, 512, 4096...; The total number of digits in an octal value indicates the number of increments.

1.- Convert **5414** to decimal:

Step a.- Write an increment sequence of decimal numbers starting from right to left:

512 64 8 1

Step b.- Multiply each octal digit by each increment and add the results:

512		64		8		1	
x 5		x 4		x 1		x 4	
2560	+	**256**	+	**8**	+	**4**	**= 2828**

So, **5414** in octal is equal to **2828** in decimal.