

Integer Number Base Conversions

Method1: We use decimal-to-hexadecimal conversion as an example. This method can also be applied to decimal-to-binary conversion.

Converting Decimal to Hexadecimal

Steps:

1. Divide the decimal number by 16. Treat the division as an integer division.
2. Write down the remainder (in hexadecimal).
3. Divide the result again by 16. Treat the division as an integer division.
4. Repeat step 2 and 3 until result is 0.
5. The hex value is the digit sequence of the remainders from the last to first.

Note: a *remainder* in this topic refers to the left over value after performing an integer division.

Example 1

Convert the number **1128** DECIMAL to HEXADECIMAL

NOTES	DIVISION	RESULT	REMAINDER (in HEXADECIMAL)
Start by dividing the number by 16. In this case, 1128 divided by 16 is 70.5. So the integer division result is 70 (throw out anything after the decimal point). The remainder is (70.5 - 70) multiplied with 16; or (0.5 times 16), which is 8.	1128 / 16	70	8
Then, divide the result again by 16 (the number 70 on the	70 / 16	4	6

<p>DIVISION column comes from the previous RESULT).</p> <p>In this case, $70/16=4.375$. So the integer division result is 4 (throw out anything after the decimal point)</p> <p>The remainder is (0.375 multiplied with 16, which is 6.</p>			
<p>Repeat. Note here that $4/16=0.25$. So the integer division result is 0.</p> <p>The remainder is (0.25-0) multiplied with 16, which is 4.</p>	4 / 16	0	4
<p>Stop because the result is already 0 (0 divided by 16 will always be 0)</p>			
<p>Well, here is the answer. These numbers come from the REMAINDER column values (read from bottom to top)</p>			468

Side note: You can get the remainder of a division using the **Modulus** or **%** operator. Ie: $1128\%16=8$.

Example 2

Convert the number **256** DECIMAL to HEXADECIMAL

DIVISION	RESULT	REMAINDER (in HEX)
256 / 16	16	0
16 / 16	1	0
1 / 16	0	1
ANSWER		100

Example 3

Convert the number **921** DECIMAL to HEXADECIMAL

DIVISION	RESULT	REMAINDER (in HEX)
921 / 16	57	9
57 / 16	3	9
3 / 16	0	3
ANSWER		399

Example 4

Convert the number **188** DECIMAL to HEXADECIMAL

DIVISION	RESULT	REMAINDER (in HEX)
188 / 16	11	C (12 decimal)
11 / 16	0	B (11 decimal)
ANSWER		BC

Note that here, the answer would not be 1112, but BC. Remember to write down the remainder in hex, not decimal.

Example 5

Convert the number **590** DECIMAL to HEXADECIMAL

DIVISION	RESULT	REMAINDER (HEX)
590 / 16	36	E (14 decimal)
36 / 16	2	4 (4 decimal)
2 / 16	0	2 (2 decimal)
ANSWER		24E


Method2: We use decimal-to-binary conversion as an example. This method can also be applied to decimal-to-hexadecimal conversion.

Converting Decimal To Binary

To convert a decimal number to binary, first subtract the largest possible power of two that is less than or equal to the number you are converting, and keep subtracting the next largest possible power from the remainder, marking 1s in each column where this is possible and 0s where it is not.


Example 1 - (Convert Decimal 44 to Binary)

4	4						
-	3	2					
<hr/>							
1	2						
-	8						
<hr/>							
4							
-	4	32	16	8	4	2	1
<hr/>							
0	1	0	1	1	0	0	



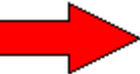
Example 2 - (Convert Decimal 15 to Binary)

1	5						
-	8						
<hr/>							
7							
-	4						
<hr/>							
3							
-	2	32	16	8	4	2	1
<hr/>							
1	0	0	1	1	1	1	



Example 3 - (Convert Decimal 62 to Binary)

6	2						
-	3	2					
<hr/>							
3	0						
-	1	6					
<hr/>							
1	4						
-		8					
<hr/>							
	6						
-		4					
<hr/>							
2	32	16	8	4	2	1	
-	2	1	1	1	1	1	0
<hr/>							



111110

Converting Decimal to Hex

To convert from decimal to hex, find the largest possible power of 16 less than or equal to the number you are converting, subtract that number and repeat for the remainder.

13,117 decimal to hex:

$3000_{\text{h}} = 12,288$ which is less than or equal to 13,117

$13,117 - 12,288 = 829$

$0300_{\text{h}} = 768$ which is less than or equal to 829

$829 - 768 = 61$

$0030_{\text{h}} = 48$ which is less than or equal to 61

$61 - 48 = 13$ which is $000D_{\text{h}}$

Therefore $13,117$ decimal = $333D_{\text{h}}$

Convert the following numbers from decimal notation to 16-bit 2's complement binary and hexadecimal notation:-620

We can do the 2's complement binary, change binary into hexadecimal, and decimal into hexadecimal.

Or we can Add 2^{16} then convert to hex.

So:

$$=-620 + 2^{16}$$

$$=-620 + 65536$$

$$=64916$$

$$=0xFD94 \text{ (Answer)}$$

$$=1111\ 1101\ 1001\ 0100 \text{ (2's)}$$

$$=0000\ 0010\ 0110\ 1100$$

$$=0x26C$$

$$=620 \text{ (Checking)}$$

how to convert signed hex directly to decimal? For instance 0xC9?

There are two ways to convert negative two's complement hexadecimal numbers to decimal.

- 1) The first is the way the computer does it. To convert negative hexadecimal numbers to decimal, start by flipping all of the bits--each 0 becomes a 1, and each 1 becomes a 0. The result is the "complement" of the starting number. For instance, 0xA432 becomes 0x5BCD.

The second step is to add one. 0x5BCD becomes 0x5BCE.

Convert the resulting hexadecimal number to decimal, and put a minus sign in front. 0x5BCE is 23502 decimal, so the value 0xA432 is -23502.

- 2) The second method is to convert the original number to decimal, then subtract 65536, which is 2 raised to the power 16. Sixteen is also, you'll notice, the number of bits in a four-digit hexadecimal number. A432 converts to decimal 42034, and $42034 - 65536$ is, you guessed it, -23502.

As another example, say 0xC (in two's complement) is -4. So it can be $(12 - 2^4) = -4$.

Or $0xC9 = -55 = (12 * 16 + 9 - 2^8)$