NUMBER SYSTEM IN COMPUTERS

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Number system

- **Number systems** are the technique to represent numbers in the computer system architecture, every value that you are saving or getting into/from computer memory has a defined number system.

- Computer architecture supports following number systems.
- **Binary number system**
- **Octal number system**
- **Decimal number system**
- **Hexadecimal (hex) number system**

Popular number systems

- **1) Binary Number System:**

Binary number system has only two digits that are **0 and 1**. Every number (value) represents with 0 and 1 in this number system. The base of binary number system is 2, because it has only two digits.

- **2) Octal number system:**

Octal number system has only eight (8) digits from **0 to 7**. Every number (value) represents with 0,1,2,3,4,5,6 and 7 in this number system. The base of octal number system is 8, because it has only 8 digits.

Popular number systems

- **3) Decimal number system:**

Decimal number system has only ten (10) digits from **0 to 9**. Every number (value) represents with 0,1,2,3,4,5,6, 7,8 and 9 in this number system. The base of decimal number system is 10, because it has only 10 digits.

- **4) Hexadecimal number system:**

Hexadecimal number system has sixteen (16) alphanumeric values from **0 to 9** and **A to F**. Every number (value) represents with 0,1,2,3,4,5,6, 7,8,9,A,B,C,D,E and F in this number system. The base of hexadecimal number system is 16, because it has 16 alphanumeric values. Here **A is 10**, **B is 11**, **C is 12**, **D is 13**, **E is 14** and **F is 15.**

Popular number systems

- **Table of the Numbers Systems with Base, Used Digits and their examples:**

Number system	Base	Used digits	Example
Binary	2	0,1	$(11110000)_2$
Octal	8	0,1,2,3,4,5,6,7	$(360)_8$
Decimal	10	0,1,2,3,4,5,6,7,8,9	$(240)_{10}$
Hexadecimal	16	0,1,2,3,4,5,6,7,8,9, A,B,C,D,E,F	$(F0)_{16}$

Number system conversions

- There are three types of conversions:

- **Decimal Number System to Other Base**
  [for example: Decimal Number System to Binary Number System]
- **Other Base to Decimal Number System**
  [for example: Binary Number System to Decimal Number System]
- **Other Base to Other Base**
  [for example: Binary Number System to Hexadecimal Number System]

Decimal Number System to Other Base

- To convert Number system from **Decimal Number System** to **Any Other Base** is quite easy; you have to follow just two steps:

A) Divide the Number (Decimal Number) by the base of target base system (in which you want to convert the number: Binary (2), octal (8) and Hexadecimal (16)).

B) Write the remainder from step 1 as a Least Signification Bit (LSB) to Step last as a Most Significant Bit (MSB).

Decimal to binary conversion

Decimal to Binary Conversion	Result
Decimal Number is : $(12345)_{10}$	Binary Number is $(11000000111001)_2$

2	12345	1	LSB
2	6172	0	
2	3086	0	
2	1543	1	
2	771	1	
2	385	1	
2	192	0	
2	96	0	
2	48	0	
2	24	0	
2	12	0	
2	6	0	
2	3	1	
	1	1	MSB

Decimal to octal conversion

Decimal to Octal Conversion	Result
Decimal Number is : $(12345)_{10}$	Octal Number is $(30071)_8$

8	12345	1	LSB
8	1543	7	
8	192	0	
8	24	0	
	3	3	MSB

Decimal to hexadecimal conversion

Decimal to Hexadecimal Conversion	Result
Example 1 Decimal Number is : $(12345)_{10}$ 16 | 12345 — 9 LSB 16 | 771 — 3 16 | 48 — 0 8 | 3 — 3 MSB	Hexadecimal Number is $(3039)_{16}$
Example 2 Decimal Number is : $(725)_{10}$ 16 | 725 — 5 | 5 LSB 16 | 45 — 13 | D 2 — 2 | 2 MSB	Hexadecimal Number is $(2D5)_{16}$ **Convert** **10, 11, 12, 13, 14, 15** **to its equivalent...** **A, B, C, D, E, F**

Other base to decimal conversion

- To convert Number System from **Any Other Base System** to **Decimal Number System**, you have to follow just three steps:

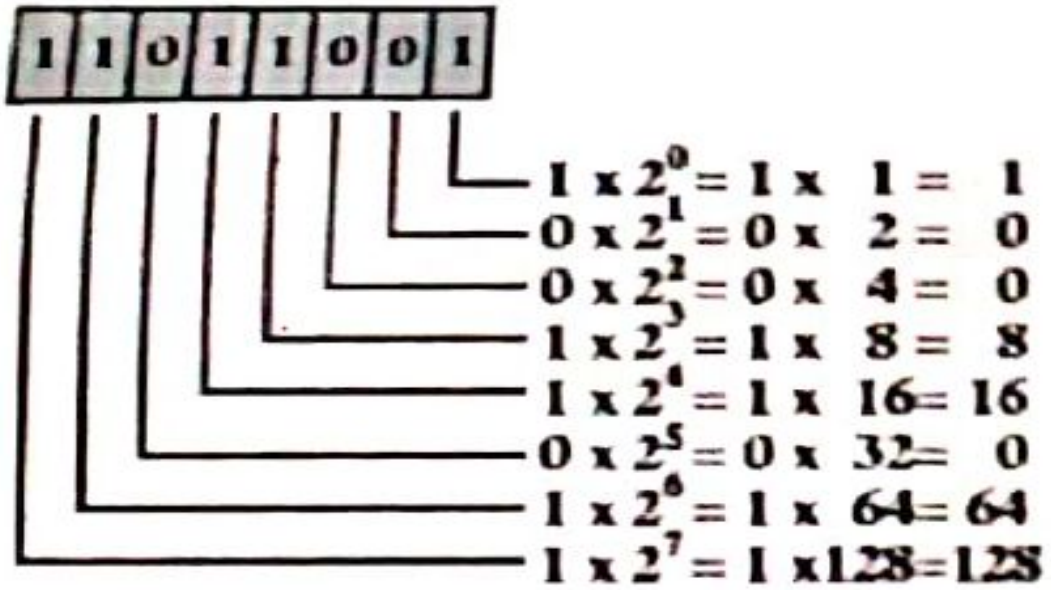
A) Determine the base value of source Number System (that you want to convert), and also determine the position of digits from LSB (first digit's position – 0, second digit's position – 1 and so on).
B) Multiply each digit with its corresponding multiplication of position value and Base of Source Number System's Base.
C) Add the resulted value in step-B.

Other base to decimal conversion

- Explanation regarding examples:

Below given examples contains the following rows:
A) Row 1 contains the **DIGITs** of number (that is going to be converted).
B) Row 2 contains the **POSITION** of each digit in the number system.
C) Row 3 contains the multiplication: **DIGIT* BASE^POSITION**.
D) Row 4 contains the calculated result of **step C**.
E) And then add each value of **step D**, resulted value is the Decimal Number.

Binary to decimal conversion



$1 + 8 + 16 + 64 + 128 = 217$

Octal to decimal conversion

Octal to Decimal Conversion	Result
Octal Number is : $(30071)_8$	$=12288+0+0+56+1$ $=12345$ Decimal Number is: $(12345)_{10}$

3	0	0	7	1
4	3	2	1	0
$3*8^4$	$0*8^3$	$0*8^2$	$7*8^1$	$1*8^0$
12288	0	0	56	1

Hexadecimal to decimal conversion

Hexadecimal to Decimal Conversion	Result
Hexadecimal Number is : $(2D5)_{16}$	=512+208+5
	=725
	Decimal Number is: $(725)_{10}$

2	D (13)	5
2	1	0
$2*16^2$	$13*16^1$	$5*16^0$
512	208	5

Thank you