OPCUG Computer Basic

Number Base

STEPHANE RICHARD

18 JAN 2023

Common number bases used in computing

- A number base is the number of digits or combination of digits that a system of counting uses to represent numbers.
- Base 10 – Decimal: 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9.
- Base 2 – Binary: 0, and 1.
- Base 8 – Octal: 0, 1, 2, 3, 4, 5, 6, and 7.
- Base 16 – Hexadecimal: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, and F:
  - Sometime shown starting with the symbol $ or 0x to indicate the base 16.

Counting to 17 in different number bases

Decimal (10)	Binary (2)	Octal (8)	Hexadecimal (16)
0	00000	0	0
1	00001	1	1
2	00010	2	2
3	00011	3	3
4	00100	4	4
5	00101	5	5
6	00110	6	6
7	00111	7	7
8	01000	10	8
9	01001	11	9
10	01010	12	A
11	01011	13	B
12	01100	14	C
13	01101	15	D
14	01110	16	E
15	01111	17	F
16	10000	20	10
17	10001	21	11

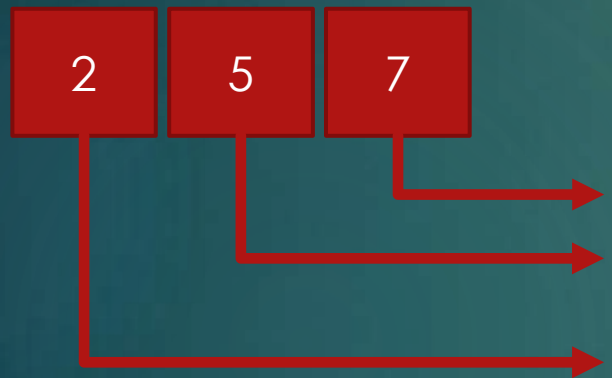
You can easily determine if a number is even or odd in binary:

if most right bit is a 0, then even

if most right bit is a 1, then odd.

How to get the decimal value of a number expressed in a different base? Example with base 10 and 2

2	1	0	Digit Position
100	10	1	Digit weight



Digit Weight=Base$^{(\text{Digit Position})}$

$10^0 * 7 = 1 * 7 = 7$

$10^1 * 5 = 10 * 5 = 50$

$10^2 * 2 = 100 * 2 = 200$

$$(D_n D_{n-1} \cdots D_1 D_0)_{Base}$$

$$Value = Base^0 \times Digit_0 + Base^1 \times Digit_1 + \cdots + Base^{n-1} \times Digit_{n-1} + Base^n \times Digit_n$$

$$Value = \sum_{k=0}^{n} Base^k \times Digit_k$$

Weight	32	16	8	4	2	1
Base 2	1	1	0	1	1	0

32 X 1 + 16 X 1 + 4 X 1 + 2 X 1 = 54

Hexadecimal base

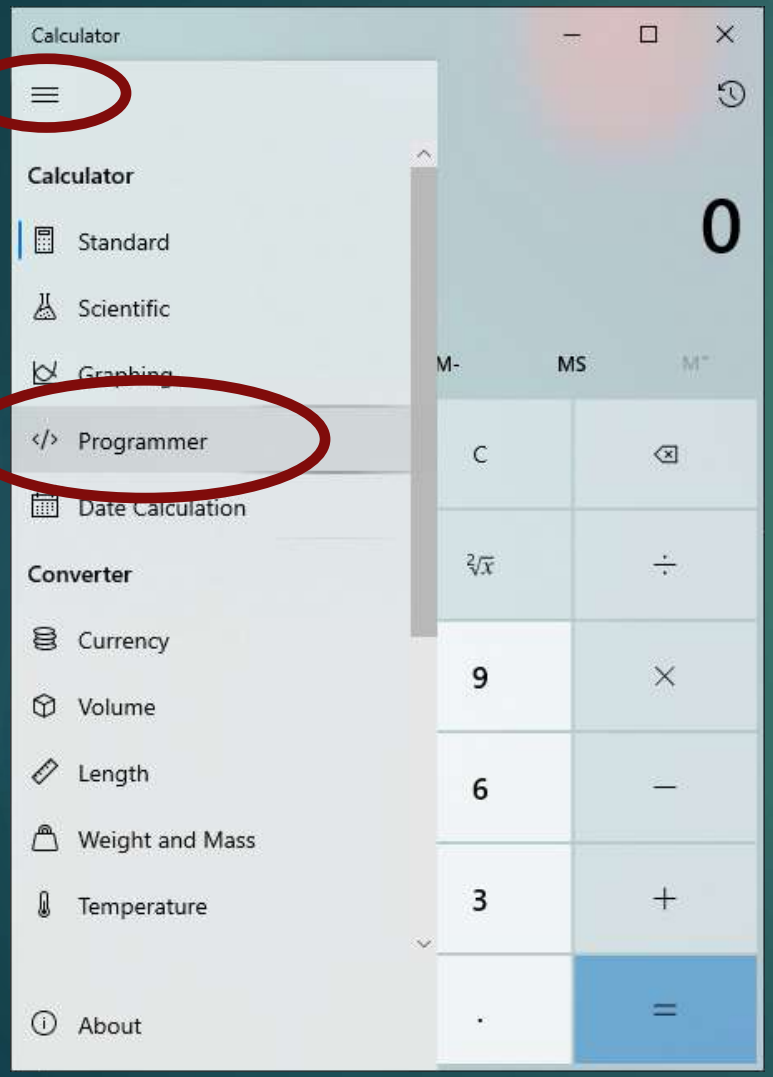
- Examples of hexadecimal to decimal to binary:
- $00 = 16 X 0 + 0 = 0 in binary 00000000
- $10 = 16 X 1 + 0 =16 in binary 00010000
- $11 = 16 X 1 + 1 = 17 in binary 00010001
- $EC = 16 * 14 + 12 = 236 in binary 11101100
- $FF = 16 X 15 + 15 = 255 in binary 11111111
- $DF3 = 256 X 13 + 16 X 15 + 3 = 3,571 in binary 110111110011

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

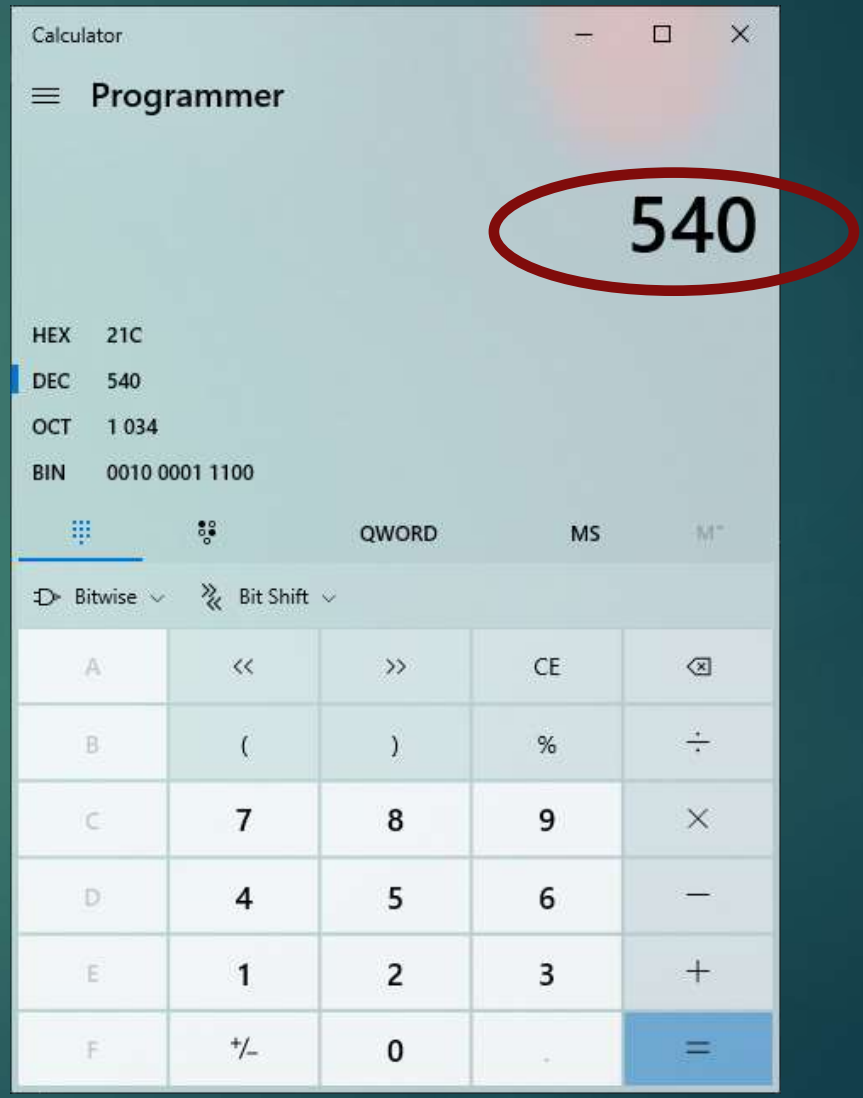
How to convert decimal to hexadecimal?

- 1. Divide the decimal number by 16. Treat the division as an integer division.
- 2. Write down the remainder in hexadecimal (0 to F).
- 3. Repeat step 1 and 2 until result is 0.
- 4. The hexadecimal value is the digit sequence of the remainders from the last to first.
- Example convert 540 decimal in hexadecimal:
  - Result of the first integer division: 33 with remainder of C (or 12 decimal)
  - Result of the second integer division: 2 with a remainder of 1
  - Result of the third integer division: 0 with a remainder of 2
  - 540 decimal is 0x21C (0x indicates that 21C is a hexadecimal number)

Or use the Windows Calculator…



Select input DEC




Any
Questions