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## Hexadecimal Number System

\* Binary to Hexadecimal

(1) Convert  $(1011011011)_2$  to Hexadecimal.

$0 \rightarrow 0$

$1 \rightarrow 1$

$10 \rightarrow A$

$11 \rightarrow B$

$12 \rightarrow C$

$13 \rightarrow D$

$14 \rightarrow E$

$15 \rightarrow F$

1011 0110 11

0010 1101 1011

(2 D B)<sub>16</sub>

$= (2DB)_{16}$

(2) Convert  $0101111011.01111$

00101111011.01111

0010 1111 1011 . 0111 1100

2 F B . 7 C

$= (2FB.7C)_{16}$

\* Hexadecimal to Binary :-

(1) Convert  $(4BAC)_{16}$  to Binary

4 B A C

0100 1011 1010 1100

$= (0100101110101100)_2$

(2) Convert  $(3A9E.B2D)_{16}$  to Binary

3 A 9 E . B 2 D

0011 1010 1001 1110 . 1011 0010 1101

## \* Hexadecimal to decimal.

(1) convert  $(5C7)_{16}$  to decimal.

$$\begin{array}{ccc} 5 & C & 7 \\ \downarrow & \downarrow & \downarrow \\ 16^2 & 16^1 & 16^0 \end{array} = 5 \times 16^2 + C \times 16^1 + 7 \times 16^0$$

$$= 5 \times 16^2 + 12 \times 16 + 7 \times 16^0$$

$$= 1280 + 192 + 7$$

$$= (1479)_{10}$$

(2) convert  $(A0F9.0EB)_{16}$  to decimal.

$$\begin{array}{ccccccc} A & 0 & F & 9 & . & 0 & E & B \\ \downarrow & \downarrow & \downarrow & \downarrow & & \downarrow & \downarrow & \downarrow \\ 16^3 & 16^2 & 16^1 & 16^0 & & 16^{-1} & 16^{-2} & 16^{-3} \end{array}$$

$$= 10 \times 16^3 + 0 \times 16^2 + 15 \times 16^1 + 9 \times 16^0 + 0 \times 16^{-1} + 14 \times 16^{-2} + 11 \times 16^{-3}$$

$$= 40960 + 0 + 240 + 9 + 0 + 0.546 + 0.004$$

$$= (41209.550)_{10}$$

Ex

$$\rightarrow (1) AB6 \rightarrow 2742$$

$$(2) DEB7 \rightarrow 11959$$

$$(3) A08F.EA \rightarrow 41103.879$$

$$(4) 8F47.AB \rightarrow 36423.629$$

16 25 46  
16 1 0 1

## \* Decimal to Hexadecimal

(1) Convert  $(2598.675)_{10}$  to Hexadecimal

|    |      |
|----|------|
| 16 | 2598 |
| 16 | 162  |
| 16 | 10   |
|    | 0    |

Remainder

6

2

10  $\rightarrow$  A

$2598 = A26$

10  $\rightarrow$  A  
11  $\rightarrow$  B  
12  $\rightarrow$  C  
13  $\rightarrow$  D  
14  $\rightarrow$  E  
15  $\rightarrow$  F

$$0.675 \times 16 = 10.8 \rightarrow A$$

$$0.800 \times 16 = 12.8 \rightarrow C$$

$$0.800 \times 16 = 12.8 \rightarrow C$$

$$0.800 \times 16 = 12.8 \rightarrow C$$

$(A26.ACCC)_{16}$

(2) Convert  $(49056)_{10}$  to Binary

$\rightarrow$  This number is very large. So it is very tedious to convert directly to the Binary.

|    |       |
|----|-------|
| 16 | 49056 |
| 16 | 3066  |
| 16 | 191   |
| 16 | 11    |
|    | 0     |

0

0 0

0000

10 (E2 A)

1010

15 F

1111

11 (E)

1011

$= (0AFFE)_{16}$

$= (000010101111011)_{2}$

$\rightarrow$  (a) 452  $\rightarrow$  1C4

(b) 4796  $\rightarrow$  12BC

(c) ~~10000000~~

(d) ~~10000000~~

(e) 1948.56  $\rightarrow$  4ED.8E5

(f) 8957.75  $\rightarrow$  22FD.C

## \* Octal to Hexadecimal

(1) convert  $(756.603)_8$  to Hexadecimal.

|                        |      |      |      |   |      |      |      |
|------------------------|------|------|------|---|------|------|------|
| Octal                  | 7    | 5    | 6    | . | 6    | 0    | 3    |
| Each Octal to Binary   | 111  | 101  | 110  | . | 110  | 000  | 011  |
| Each of four for Hexa. | 0001 | 1110 | 1110 | . | 1100 | 0001 | 1000 |
|                        | 1    | E    | E    | . | C    | 1    | 8    |

$\Rightarrow (1EE.C18)_{16}$

## \* Hexadecimal to Octal:-

(1) convert  $(BAF.AE)_{16}$  to Octal.

|                   |      |      |      |     |      |      |     |     |
|-------------------|------|------|------|-----|------|------|-----|-----|
| Hex. Number       | B    | A    | F    | .   | A    | E    |     |     |
| Binary of Hex     | 1011 | 1010 | 1111 | .   | 1010 | 1110 |     |     |
| Making group of 3 | 101  | 110  | 011  | 111 | .    | 101  | 011 | 100 |
| Octal             | 5    | 6    | 3    | 7   | .    | 5    | 3   | 1   |

Ans  $\Rightarrow (5637.531)_8$

## \* Hexadecimal Addition

Ex  $\rightarrow$

- Q15 (1) Convert following Octal Number to Hexadecimal
- $256 \rightarrow AE$
  - $2035 \rightarrow 41D$
  - $1762.46 \rightarrow 3F2.98$
  - $BCA9.0E \rightarrow$
  - $654.203 \rightarrow C2C.598$

- \* Convert following Hexadecimal numbers to decimal.
- (a)  $2A13 \rightarrow 1053$
- (b)  $42FD \rightarrow 1715$
- (c)  $4F7.A6 \rightarrow 2067.52$
- (d)  $BC70.0E \rightarrow 48000.14$

### \* Hexadecimal Addition

(b) Add  $(2A7C.E30D)_{16}$  and  $(8D9.E8B)_{16}$

$$\begin{array}{r} \begin{array}{ccccccc} 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 2 & A & 7 & C & . & E & 3 & 0 & D \\ & 8 & D & 9 & . & E & 8 & B & \end{array} \\ \hline \end{array}$$

$$\begin{array}{r} 3 \quad 3 \quad 5 \quad 6 \quad . \quad 1 \quad 9 \quad 8 \quad 0 \quad 3 \end{array}$$

$$D + B = 13_{10} + 11_{10} = (24)_{10} = (18)_{16} \quad (\text{Sum} = 8, \text{carry} = 1)$$

$$0 + 8 + 1 = (8)_{10} + (1)_{10} = (9)_{10} = (9)_{16}$$

$$E + 3 = (14)_{10} + (3)_{10} = (17)_{10} = (11)_{16} \quad (\text{Sum} = 1, \text{carry} = 1)$$

$$1 + C + 9 = 1_{10} + 12_{10} + 9_{10} = (22)_{10} = (16)_{16} \quad (\text{Sum} = 6, \text{carry} = 1)$$

$$1 + 7 + D = 1_{10} + 7_{10} + (13)_{10} = (21)_{10} = (5)_{16} \quad (\text{Sum} = 5, \text{carry} = 1)$$

$$1 + A + 8 = 1_{10} + 10_{10} + 8_{10} = (19)_{10} = (13)_{16} \quad (\text{Sum} = 3, \text{carry} = 1)$$

$$\Rightarrow \text{Ans} = (3356.19803)_{16}$$

$$\begin{array}{r} 16 \overline{) 17} \\ 16 \overline{) 1} \\ \hline 1 \end{array}$$

$$\Rightarrow \text{Add } (3BCA \cdot 5078)_{16} + (9EBD \cdot 97F3)_{16} + (5FB \cdot \dots)$$

$$\begin{array}{r} 3 \text{ B C A } 5 0 7 8 \\ 9 \text{ E B D } 9 7 F 3 \\ 5 \text{ F B } \cdot \text{E} \end{array}$$

2

$$\begin{array}{r} 3 \text{ B C A } \cdot 5 0 \cdot 7 8 \\ 9 \text{ E B D } \cdot 9 7 \cdot F 3 \\ 5 \text{ F B } \cdot \text{E} \end{array}$$

$$\text{E D 8 3} \cdot \text{C B} \cdot \text{2 B}$$

$$8 + 3 = (11)_{10} = B_{16} \quad (\text{Sum} = B, \text{carry} = 0)$$

$$7 + F + C = 7_{10} + 15_{10} + 12_{10} = 34_{10} = (22)_{16} \quad (\text{Sum} = 2, \text{carry} = 2)$$

$$0 + 7 + 2 + 0 = (9)_{10} = 9_{16} \quad (\text{Sum} = 9, \text{carry} = 0)$$

$$5 + 9 + E = 5_{10} + 9_{10} + 14_{10} = 28_{10} = 1C_{16} \quad (\text{Sum} = C, \text{carry} = 1)$$

$$A + D + B + 1 = 10_{10} + 13_{10} + 11_{10} + 1_{10} = (35)_{10} = (23)_{16} \quad (\text{Sum} = 3, \text{carry} = 2)$$

$$C + B + F + 2 = 12_{10} + 11_{10} + 15_{10} + 2_{10} = (40)_{10} = (28)_{16} \quad (\text{Sum} = 8, \text{carry} = 2)$$

$$B + E + 5 + 2 = 11_{10} + 14_{10} + 5_{10} + 2_{10} = (32)_{10} = (20)_{16} \quad (\text{Sum} = 0, \text{carry} = 2)$$

$$3 + 9 + 2 = (14)_{10} = E_{16} \quad (\text{Sum} = E, \text{carry} = 0)$$

## Hexadecimal Addition

- (1)  $AC6 + B59 \rightarrow 161F$
- (2)  $A0FC + B75E \rightarrow 1585B$
- (3)  $E0F3.5D + 49E6.F7 \rightarrow 12ADA.54$
- (4)  $ABC7.54 + 26F3.AB + DAC9.6F \rightarrow 1AD84.6E$

## Hexadecimal Subtraction

- (1)  $BC5 - A2B \rightarrow 19A$
- (2)  $F27 - B9E \rightarrow 389$
- (3)  $CDF7.52 - AB5.8 \rightarrow (341).02$
- (4)  $62F2.6E - 4A0E.A9 \rightarrow 10E3.C5$

## Hexadecimal Multiplication

- (1)  $28A \times B \rightarrow 1BEE$
- (2)  $5A9B \times 7 \rightarrow 27A3D$
- (3)  $5032.6E \times 6 \rightarrow 1E19E.94$
- (4)  $92.5 \times B.3 \rightarrow 664.DF$

# \* Hexadecimal Subtraction:

(1) Subtrahend 78D6.3B16 from Minuend B08E.A1

$$\begin{array}{r} \text{A} \quad 15 \quad 16 \quad \quad \quad 9 \quad 16 \\ \text{B} \quad 0 \quad 8 \quad \text{E} \quad \text{A}1 \\ - \quad 7 \quad 8 \quad \text{D} \quad 6 \quad 3 \text{B} \end{array}$$

$$\underline{3 \quad 7 \quad \text{B} \quad 8 \quad 6 \quad 6}$$

(1)  $16 + 1 - \text{B} = 17 - \text{B} = 17 - 11 = 6$

$16 + 8 - \text{D} = 24 - 13 = 11 = \text{B}$

$15 - 8 = 7$

Subtrahend 0CAB.6B16 from (5074.56)16

using 15's complement method.

$$\text{FFFF.FF}$$

$$- \text{0CAB.6B}$$

$$\underline{\text{FB54.94}}$$

$$5074.56$$

$$+ \text{FB54.94}$$

$$\text{14BC8.EA}$$

$$\underline{4BC8.EB}$$

Carry indicate that result is +ve.

\* Substrate 507 D. 56 form 4AB. 68 using 16's complement method

$$\begin{array}{r}
 FFFF.FF \\
 507 D. 56 \\
 \hline
 AF82.A9 \\
 \hline
 AF82.AA
 \end{array}$$

No carry 16's comp out

$$\begin{array}{r}
 FFFF.FF \\
 - B42E.11 \\
 \hline
 4BD1.EE \\
 + \\
 \hline
 4BD1.EE
 \end{array}$$

$$\begin{array}{r}
 04AB.68 \\
 AF82.AA \\
 \hline
 B42E.11 \\
 \hline
 17
 \end{array}$$

\* Substrate 4816. 216 using 11's complement

①

$$\begin{array}{r}
 8421 \quad 8421 \\
 2 \quad 6 \\
 0010 \quad 0110 \\
 8421 \quad 8421 \\
 \hline
 1101 \quad 1001 \\
 \hline
 10 \quad 9
 \end{array}$$

Hexadeci

$$\begin{array}{r}
 48 \\
 + 09 \\
 \hline
 21 \\
 + 1 \\
 \hline
 22
 \end{array}$$

12

②

$$\begin{array}{r}
 8421 \quad 8421 \\
 45.74 \\
 4 \quad 4 \\
 0111 \quad 0100 \\
 8421 \quad 8421 \\
 \hline
 1000 \quad 1011 \\
 \hline
 8 \quad B
 \end{array}$$

$$\begin{array}{r}
 45 \\
 + 8B \\
 \hline
 00
 \end{array}$$

No carry 11's

$$11 + 5 = 16 = 10$$

$$\begin{array}{r}
 16/16 \\
 16/10 \\
 \hline
 01
 \end{array}$$

$$\begin{array}{r}
 1101 \quad 0000 \\
 0010 \quad 1111 \\
 \hline
 \end{array}$$

|    |   |
|----|---|
| 10 | A |
| 11 | B |
| 12 | C |
| 13 | D |
| 14 | E |
| 15 | F |

# Hexadecimal multiplication:

$$\begin{array}{r} \text{Q A 8} \text{ By } \text{6 16} \\ \underline{\phantom{000}} \\ \text{3} \quad \text{A} \quad \text{8} \\ \text{2} \quad \text{A} \quad \text{8} \\ \text{0} \quad \text{A} \quad \text{8} \\ \hline \text{F} \quad \text{F} \quad \text{0} \end{array}$$

$$\begin{array}{r} 16 \overline{) 48} \\ 16 \overline{) 30} \\ \hline 0 \quad 9 \end{array}$$

$$\begin{array}{r} 3 \quad 6 \\ \underline{5} \\ 0 \end{array}$$

$$\begin{array}{r} 16 \overline{) 60} \\ 16 \overline{) 30} \\ \hline 0 \quad 3 \end{array}$$

$$\begin{array}{r} 3 \quad C \\ \underline{3} \\ 3 \quad F \end{array}$$

$$\begin{array}{r} 3 \quad C \\ \underline{5} \\ 4 \quad 7 \end{array}$$

$8 \times 6 = 48 = 30$   
 $0 \times 6 = 0 \times 6 = 00 = 0 \times 6 = 00 = 30 + 3 = 3F$   
 $6 \times 2 = 12 = C = C + 3 = F$   
 $8 \times B = 8 \times 11 = 88 = 56 + 32 = 56 + 32 = 88$   
 $A \times 6 = 10 \times 6 = 60 = 36 + 24 = 36 + 24 = 60$

$$\begin{array}{r} \text{Q A 8} \\ \times \text{6} \\ \hline \text{F F 0} \end{array}$$

# \* Octal Subtraction

(1)  $\begin{array}{r} 84 \\ - 37 \\ \hline \end{array}$

$\begin{array}{r} 84 \\ - 37 \\ \hline \end{array}$

$\begin{array}{r} 84 \\ - 37 \\ \hline 25 \end{array}$

$8+4-7 = 12-7 = 5$

(2)

$\begin{array}{r} 358 \\ 462 \\ - 175 \\ \hline \end{array}$

$\begin{array}{r} 358 \\ 462 \\ - 175 \\ \hline \end{array}$

$\begin{array}{r} 358 \\ 462 \\ - 175 \\ \hline 265 \end{array}$

$8+2-5 = 10-5 = 5$

$8+5-7 = 13-7 = 6$

$= 6$

(3)

$\begin{array}{r} 688 \\ 1756 \\ - 477 \\ \hline \end{array}$

$\begin{array}{r} 688 \\ 1756 \\ - 477 \\ \hline \end{array}$

$\begin{array}{r} 688 \\ 1756 \\ - 477 \\ \hline 1257 \end{array}$

$8+6-7 = 14-7 = 7$

$8+4-7 = 12-7 = 5$

(4)

$\begin{array}{r} 1788 \\ 2014 \\ - 1647 \\ \hline \end{array}$

$\begin{array}{r} 1788 \\ 2014 \\ - 1647 \\ \hline \end{array}$

$\begin{array}{r} 1788 \\ 2014 \\ - 1647 \\ \hline 0145 \end{array}$

$8+4-7 = 12-7 = 5$

(5)

$\begin{array}{r} 277878 \\ 800655 \\ - 265716 \\ \hline \end{array}$

$\begin{array}{r} 277878 \\ 800655 \\ - 265716 \\ \hline \end{array}$

$\begin{array}{r} 277878 \\ 800655 \\ - 265716 \\ \hline 012767 \end{array}$

$8+5-6 = 13-6 = 7$

$8+6-7 = 14-7 = 7$