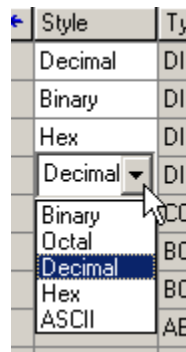


Ethernet



Module 2

Number Conversion

Student Materials

Student Materials for Module 2: Number Conversion

Lesson Objective

By the end of this session, students should be able to:

1. Covert numbers to and from Binary
2. Convert numbers to and from Decimal.
3. Convert numbers to and from hexadecimal

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When working with PLCs and computers having a basic understanding of decimal, binary and hexadecimal number formats is extremely useful. Working with Ethernet conversion between number formats makes addressing easier to understand. Different types and / or versions of addressing use different formats.

Version 6 IP addressing and MAC addressing use hexadecimal notation.

Decimal or Base 10 numbers is the number representation we are most familiar with. There are ten characters to represent decimal numbers (0-9).

Example:

$$\begin{array}{r} 1 \ 2 \ 3 \\ | \ | \ | \underline{\hspace{1cm}} 3 \times 10^0 = 3 \\ | \ | \ | \underline{\hspace{1cm}} 2 \times 10^1 = 20 \\ | \underline{\hspace{1cm}} 1 \times 10^2 = \underline{100} \\ 123 \end{array}$$

Viewing decimal numbers in ControlLogix tags:

Scope: B11_compare_lab2(Shgw: Show All	Sort: Tag Name
Tag Name	Value	F	Style
+ -comp_var1	5000		Decimal
+ -comp_var2	2#0000_0000_0000_0000_0011_1010...		Binary
+ -comp_var3	16#0000_1f40		Hex
+ -comp_var4	13000		Decimal

With the Style column set to Decimal, the number in the Value column represents a decimal value.

Viewing decimal numbers in RSLogix 5/500 software:

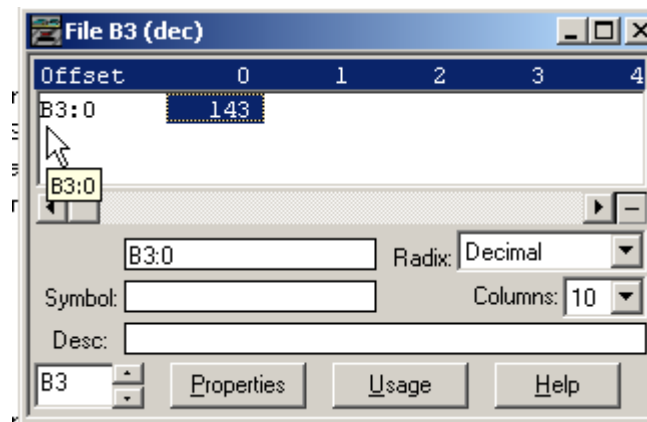


Figure 2-A

With Radix window set to Decimal values in the Data Files appear as Decimal.

Binary Numbers:

Binary or Base 2 numbers is the number representation native to computers and PLCs. There are two characters to represent binary numbers (0-1).

Binary numbers are represented by multiplying placeholder values to increasing powers of two moving from right to left in the value.

Example:

$$\begin{array}{r}
 1 \ 0 \ 1 \ 0 \ 1 \\
 | \ | \ | \ | \ | \\
 | \ | \ | \ | \ 1 \times 2^0 = 1 \\
 | \ | \ | \ 0 \times 2^1 = 0 \\
 | \ | \ 1 \times 2^2 = 4 \\
 | \ 0 \times 2^3 = 0 \\
 1 \times 2^4 = 16 \\
 \hline
 21
 \end{array}$$

Note: Any number to the power of zero is equal to one.

Viewing binary numbers in ControlLogix tags:

Scope:	B11_compare_lab2(i)	Show:	Show All	Sort:	Tag Name
Tag Name	Value	F	Style	Type	
+comp_var1	5000		Decimal	DINT	
+comp_var2	2#0000_0000_0000_0000_0011_1010...		Binary	DINT	
+comp_var3	16#0000_1f40		Hex	DINT	
+comp_var4	13000		Decimal	DINT	

Figure 3-A

With the Style column set to Binary, the number in the Value represents a binary value. The notation of 2# also means the value is a binary number format

Viewing binary numbers in RSLogix 5/500 software:

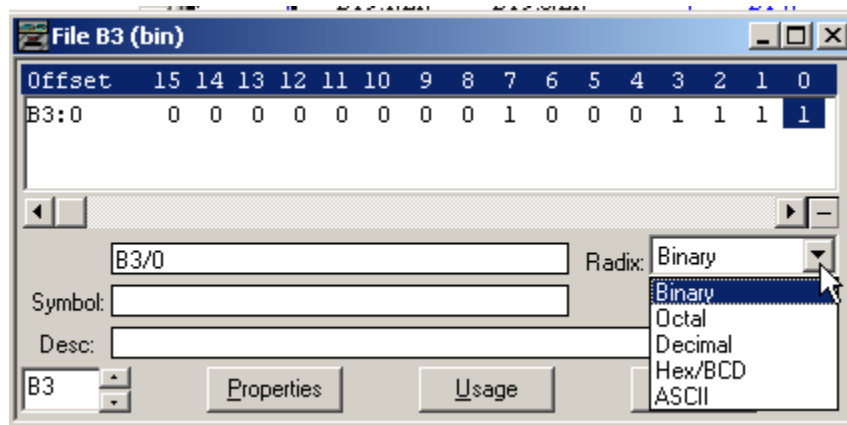


Figure 4-A

With Radix window set to Binary, values in the Data Files appear as Binary values.

Hexadecimal Numbers:

Hexadecimal (Hex) or Base 16 numbers is the number representation used as a short-cut for binary numbers. Each Hex character takes the place of four binary characters.

There are sixteen characters to represent binary numbers (0-F).

0-9 same as decimal

A=10

B=11

C=12

D=13

E=14

F=15

Hex numbers are represented by multiplying placeholder values to increasing powers of sixteen moving from right to left in the value.

Example:

$$\begin{array}{r}
 1 \text{ F} \\
 | \quad | \quad \underline{\hspace{1cm}} 15 \times 16^0 = 15 \\
 | \quad \underline{\hspace{1cm}} 1 \times 16^1 = \underline{16} \\
 \hline
 31
 \end{array}$$

Note: Any number to the power of zero is equal to one.

Viewing binary numbers in ControlLogix tags:

Scope: B11_compare_lab2(i)		Show: Show All	Sort: Tag Name		
	Tag Name	Value	F	Style	Type
	+comp_var1	5000		Decimal	DINT
	+comp_var2	2#0000_0000_0000_0000_0011_1010...		Binary	DINT
	+comp_var3	16#0000_1f40		Hex	DINT
	+comp_var4	13000		Decimal	DINT

Figure 5-A

With the Style column set to Hex, the number in the Value column represents a hexadecimal value.

The notation of 16# also means the value is a hexadecimal number format

Viewing hexadecimal numbers in RSLogix 5/500 software:

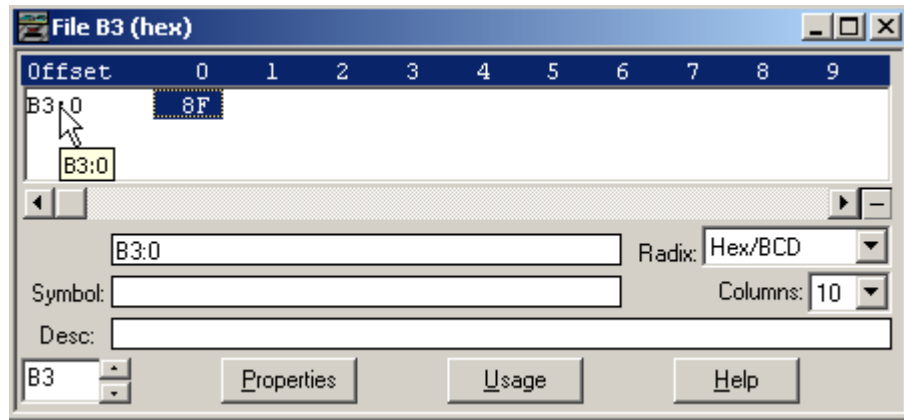


Figure 6-A

With Radix Selection Bbox set to Hex/BCD values in the Data Files appear in a Hex format.

Using Windows Calculator Windows XP OS:

The Windows calculator program can easily convert between binary, decimal and Hex..
Open Calculator program: Start>Program>Accessories>Calculator

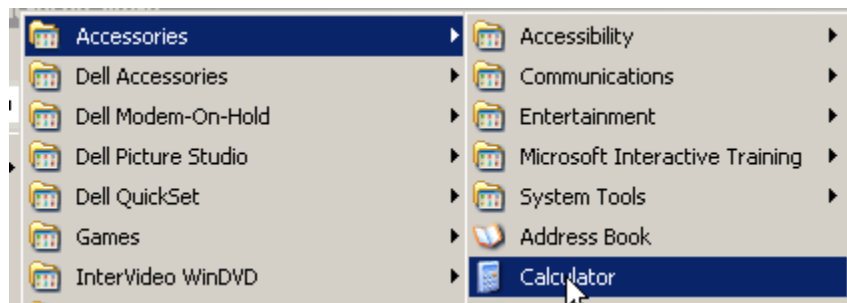


Figure 7-A

Change the calculator to Scientific mode:

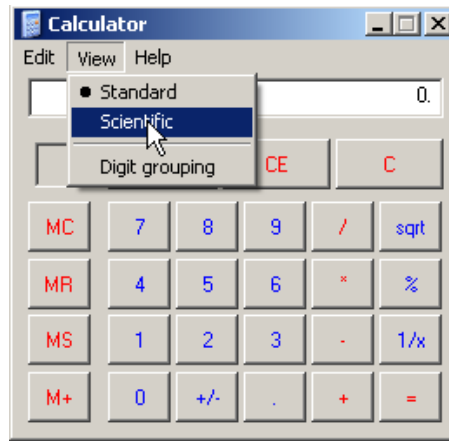


Figure 8-A

Convert values by choosing the proper radio button for the required number format.

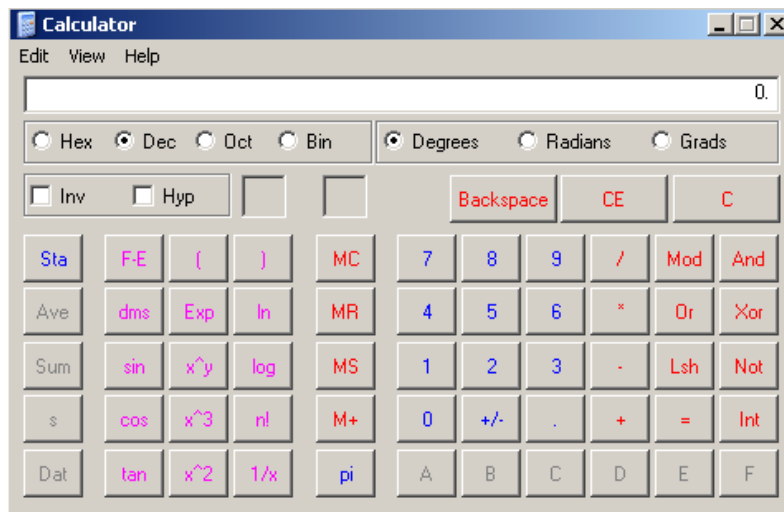


Figure 9-A

Enter number using keypad:

Number represents a Decimal value since the Dec radio button is selected.

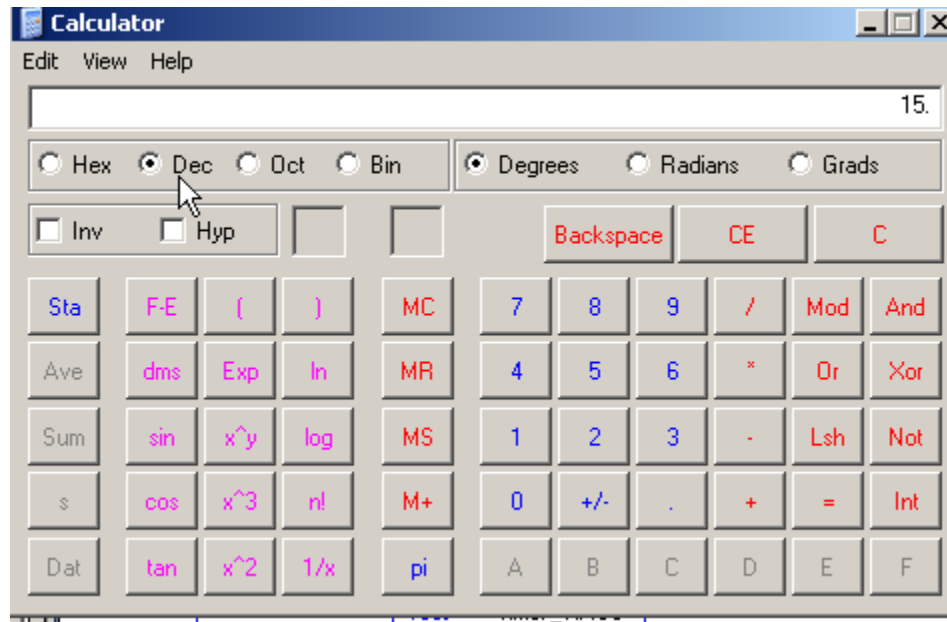


Figure 10-A

To convert to Hexadecimal choose the Hex radio button.

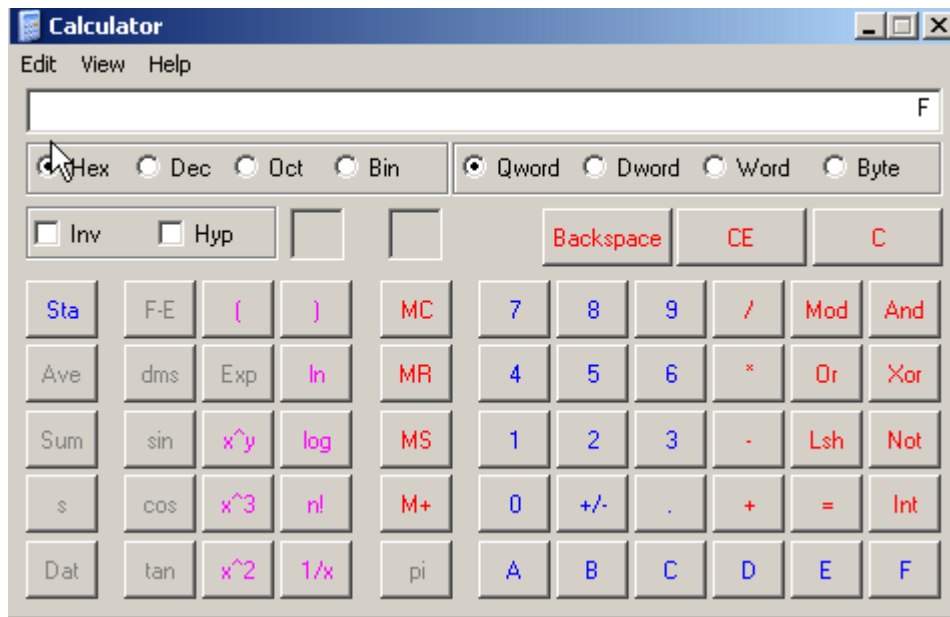


Figure 11-A

Convert to binary by choosing the Bin radio button.

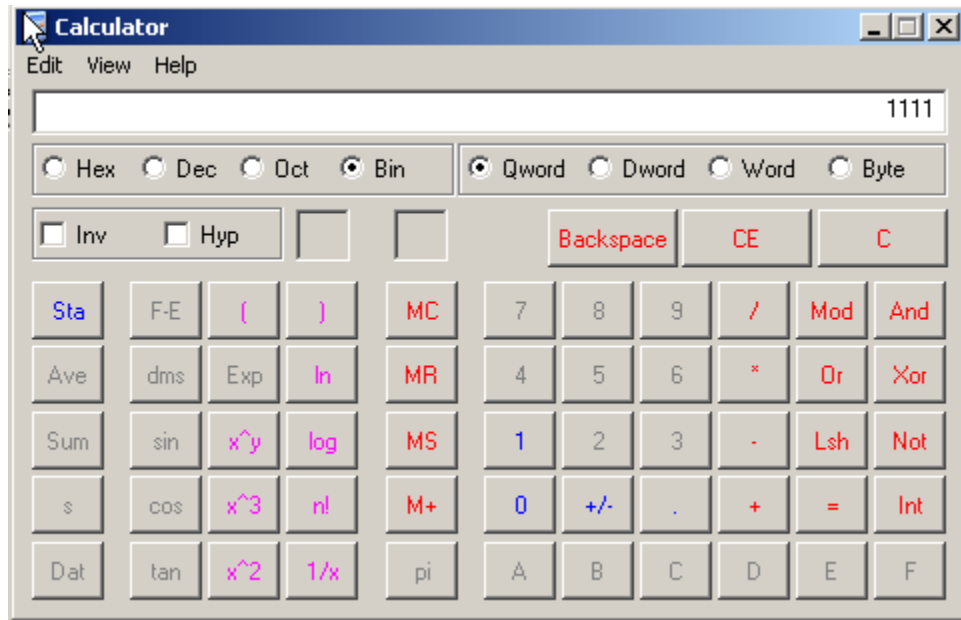


Figure 12-A

15 decimal = F hex = 1111 binary

Using Windows Calculator Windows 7 OS:

The Windows calculator program can easily convert between binary, decimal and Hex..
Open Calculator program: Start> All Program>Accessories>Calculator

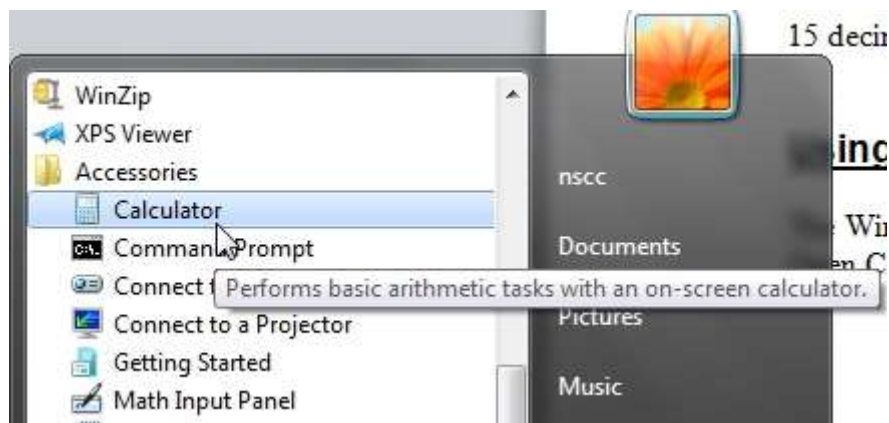


Figure 13-A
Calculator Utility – Windows 7

Change the calculator View to Programmer and Basic:
See Figure 14-A

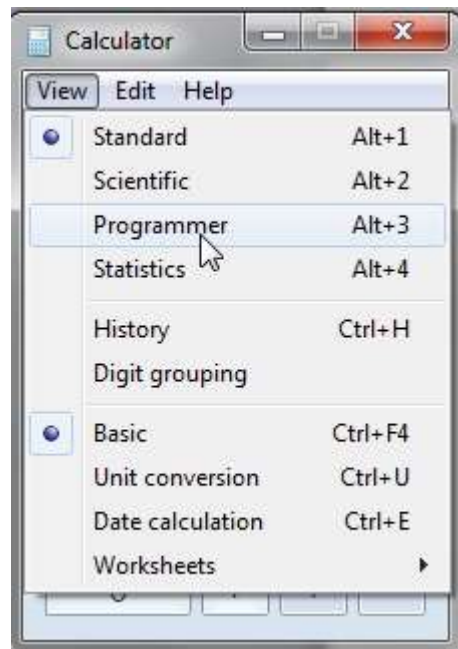


Figure 14-A

Convert values by choosing the proper radio button for the required number format.

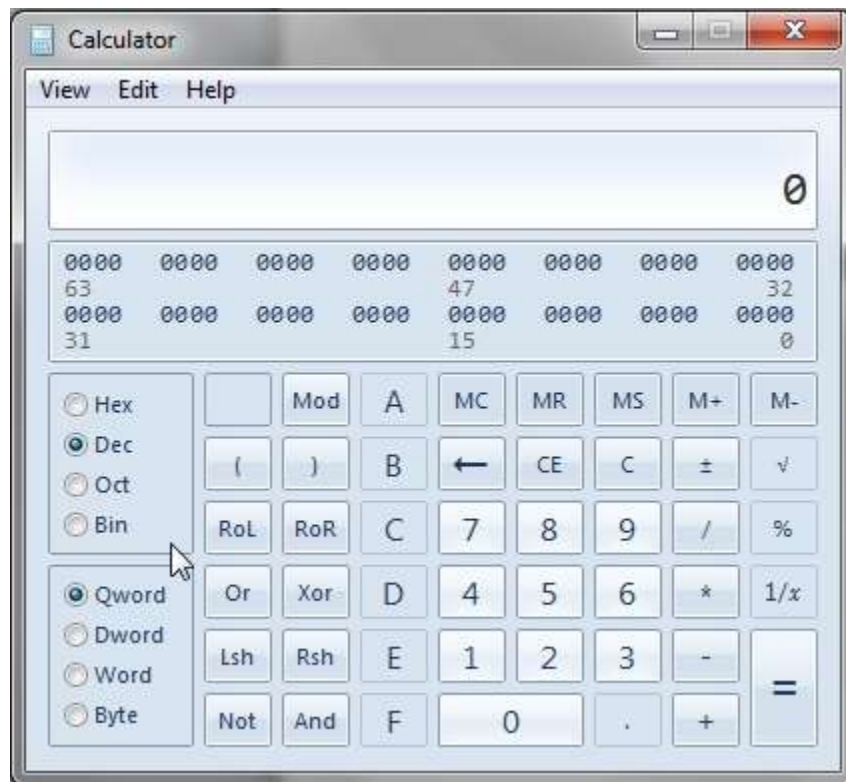


Figure 15-A- Programmer View

Enter numbers using Calculator keypad:

Number represents a Decimal value since the Dec radio button is selected.

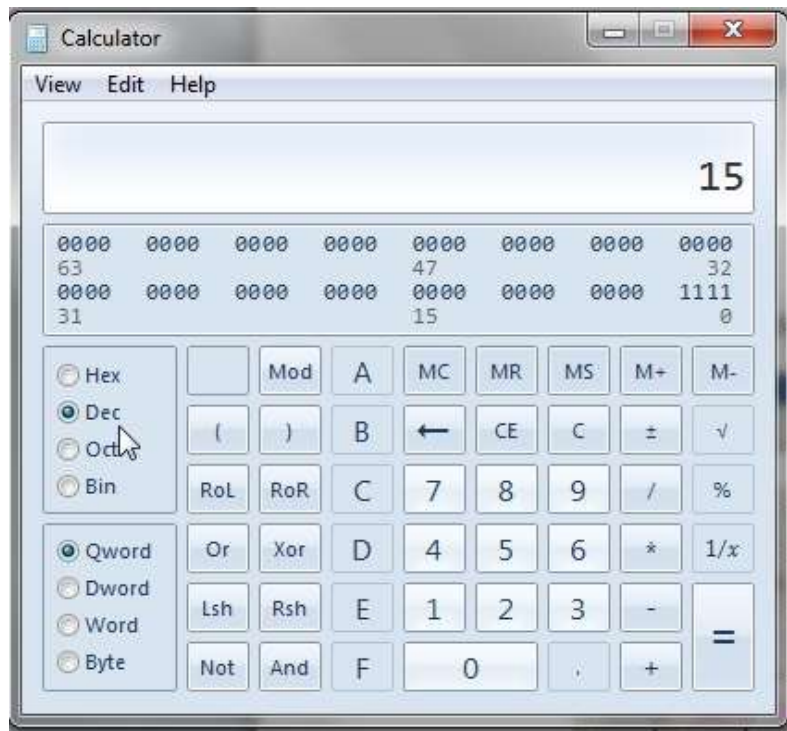


Figure 16-A

To convert to Hexadecimal - Choose the Hex radio button.

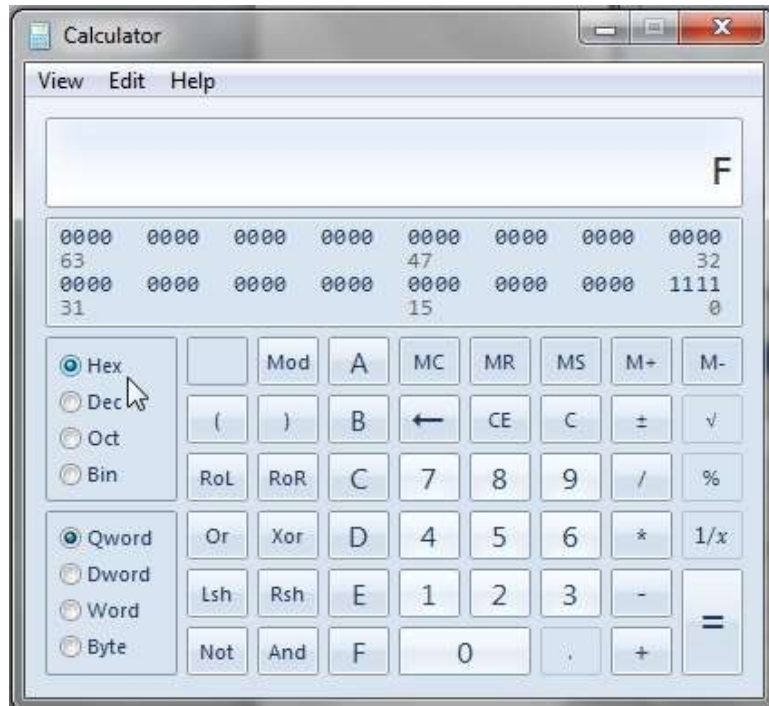


Figure 17-A

Convert to binary by choosing the Bin radio button.

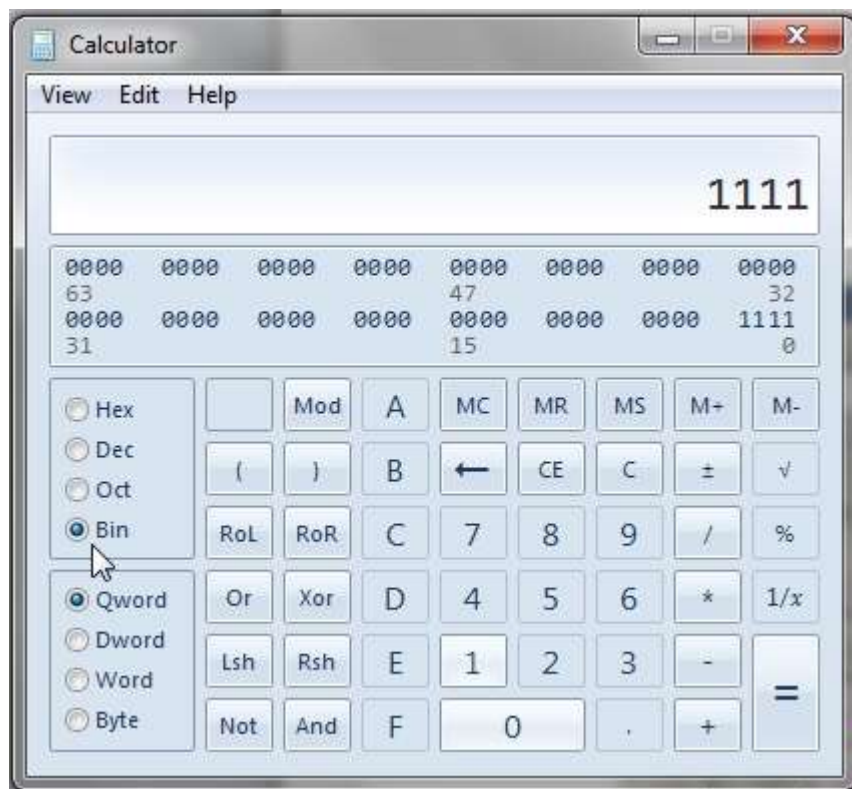


Figure 18-A

15 decimal = F hex = 1111 binary

Note: Below the number's screen on the Calculator is a Binary representation of the value appearing on the number screen.

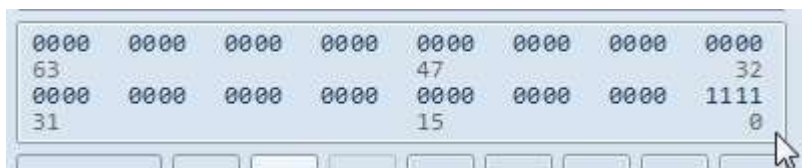


Figure 19-A 64 bits shown

The number of bits shown is based on the setting in the lower left-side portion of the Calculator utility



Figure 20-A -Number of bits

Qword – 64 bits
Dword – 32 bits
Word – 16 bits
Byte – 8 bits

Figure 21-A - Shows a hexadecimal value in number screen – Hex format selected
16 bit binary representation shown below the number screen –
Word format selected.



Figure 21-A

Other notation for value representations

10b – binary
77h – hexadecimal
0x45- hexadecimal
2# - binary
16#- hexadecimal
56d - decimal

Exercise:

Convert the following values

1. 15 d = _____ b
2. 15d = _____ h
3. 255 d = _____ b
4. 255 d = _____ h
5. 16#1F = _____ d
6. 2#1001 = _____ h
7. 2#1001= _____ d
8. F91Fh = _____ b
9. 10001001b = _____ h
10. 14d = _____ h

Answer for Exercise Problems

1) 1111

2) F

3) 11111111

4) FF

5) 31

6) 9

7) 9

8) 1111100100011111

9) 89

10) E



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