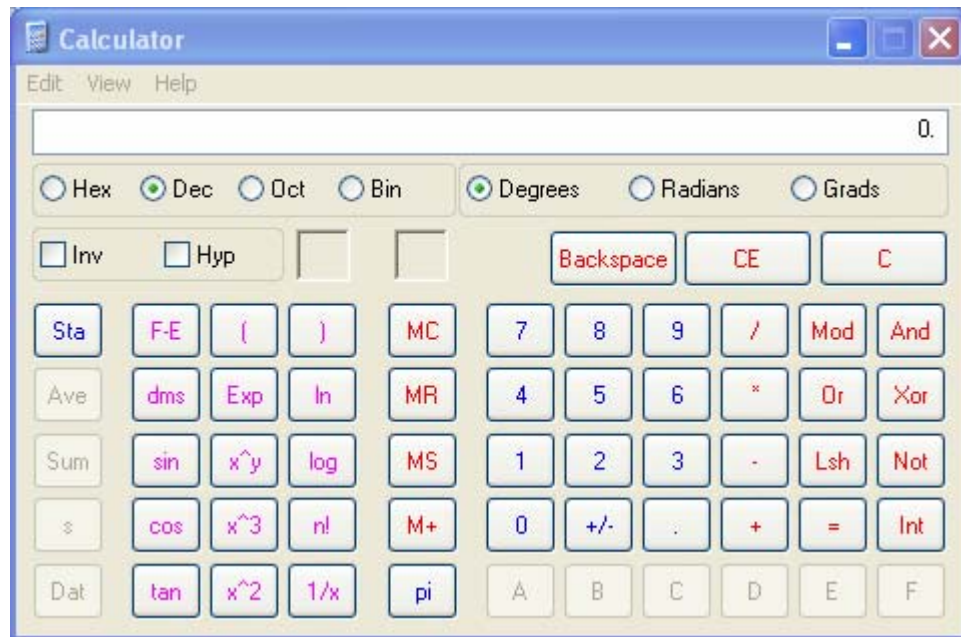


Lab 5.1.4 Using the Windows Calculator with Network Addresses



Objectives

- Switch between the two Windows Calculator modes.
- Use Windows Calculator to convert between decimal, binary, and hexadecimal.
- Use Windows Calculator to determine the number of hosts in a network with powers of 2.

Background / Preparation

Network technicians work with binary, decimal, hexadecimal numbers with computers and networking devices. In this lab you will use the Windows Calculator application to convert between the binary, decimal, and hexadecimal number systems. You will also use the powers function to determine the number of hosts that can be addressed based on the number of bits available.

The following resources are required:

- PC with Windows XP installed and functional

Step 1: Access Windows Calculator and determine mode of operation

- From the Start button menu, select **All Programs > Accessories**, and click on **Calculator**. An alternate method of starting the Calculator application is to access the **Start** menu, click on **Run**, type **calc** and press **Enter**. Try both methods.
- Once the Calculator application opens, select the **View** menu option.
- Which mode [Standard | Scientific] is currently active? _____
- Select the Standard mode. This is a basic mode for simple calculations. How many mathematical functions are available in this mode? _____
- From the View menu option, select the Scientific Calculator mode.

- f. How many mathematical functions are available in this mode? _____

Step 2: Convert between number systems

- a. Access **Scientific** mode. Notice the number system modes available—Hex (Hexadecimal), Dec (Decimal), Oct (Octal), and Bin (Binary).
- b. Which number system is currently active? _____
- c. Which numbers on the number pad are active in Decimal mode? _____
Click on the **Bin** (Binary) mode radio button. Which numbers on the number pad are now active?

- d. Why do you think the other numbers are grayed out? _____
- e. Click on the **Hex** (Hexadecimal) mode radio button.
- f. Which characters on the number pad are now activated? _____
- g. Click on the **Dec** radio button. Using your mouse, click on the number **1** followed by the number **5** on the number pad. The decimal number 15 has now been entered. Click on the **Bin** radio button.
- h. What happened to the number 15 listed in the textbox at the top of the window? _____
- i. By selecting different modes, numbers are converted from one number system to another. Select **Dec** mode again. The number in the window converts back to decimal. Select the **Hex** mode.
- j. Which hexadecimal character (0 through 9 or A through F) represents decimal 15? _____
- k. Clear the hexadecimal value representing 15 in the window. Select **Dec** mode again. Not only can the mouse be used to enter numbers, but the numerical keypad on the keyboard as well as numbers on the keyboard can also be used. Using the numerical keypad to the right of the ENTER key, type the number **22**. Note that if the number does not enter into the calculator, press the **Num Lock** key to enable the numeric keypad. While the number 22 is showing in the calculator, use the number keys across the top of the keyboard to add a **0** to the number 22 (220 should now be on the calculator). Select the **Bin** radio button.
- l. What is the binary equivalent of 220? _____
- m. Clear the binary value representing 220 in the window. From Binary mode, type in the following binary number: **11001100**. Select the **Dec** radio button.
- n. What is the decimal equivalent to the binary number of 11011100? _____
- o. Convert the following decimal numbers to binary.

Decimal	Binary
86	
175	
204	
19	

- p. Convert the following binary numbers to decimal.

Binary	Decimal
11000011	
101010	
111000	
10010011	

Step 3: Convert host IP addresses

- a. Computer hosts usually have two addresses, an Internet Protocol (IP) address and an Ethernet Media Access Control (MAC) address. For the benefit of humans, the IP address is normally represented as a dotted decimal notation, such as 135.15.227.68. Each of the decimal octets in the address or a mask can be converted to 8 binary bits. Remember that the computer only understands binary bits. If all 4 octets were converted to binary, how many bits would there be? _____
- b. IP addresses are normally shown with four decimal numbers ranging from 0 to 255 and separated by a period. Convert the 4 parts of the IP address 192.168.10.2 to binary.

Decimal	Binary
192	
168	
10	
2	

- c. Notice in the previous problem how the 10 converted to only four digits and the number 2 converted to only two digits. When IP addresses can have any number from 0 to 255 in each position, eight digits are normally used to represent each number. In the previous example, eight digits were needed to convert 192 and 168 to binary, but 10 and 2 did not need as many digits. Normally 0s are added to the left of the digits to have eight digits in binary for each IP address number. The number 10 would be shown as 00001010. Four extra zeros are added to the front of the other four binary digits.
- d. On the calculator in Binary mode, enter the digits **00001010** and select the **Dec** radio button.
- e. Which decimal number is equivalent to 00001010? _____
- f. Did adding "leading" zeros affect the number any? _____
- g. What would the number 2 (in the previous example) be if you were to make it eight digits? _____

Step 4: Convert host IP subnet masks

- a. Subnet masks, such as 255.255.255.0, are also represented as dotted decimal. A subnet mask will always consist of four 8-bit octets, each one represented as a decimal number. With the exception of decimal 0 (all 8 binary zeros) and decimal 255 (all 8 binary ones), each octet will have some number of ones on the left and some number of zeros on the right. Convert the 8 possible decimal subnet octet values to binary.

Decimal	Binary
0	
128	
192	
224	
240	
248	
252	
254	
255	

- b. Convert the four parts of the subnet mask 255.255.255.0 to binary.

Decimal	Binary
255	
255	
255	
0	

Step 5: Convert broadcast addresses

- a. Computer hosts and network devices use broadcast addresses to send messages to all hosts. Convert the following broadcast addresses.

Address	Binary
IP broadcast 255.255.255.255	
MAC broadcast FF:FF:FF:FF:FF:FF	

Step 6: Convert IP and MAC addresses for a host

- a. Click the **Start** button, select **Run**, type **cmd**, and press **Enter**. From the command prompt, type **ipconfig /all**.
- b. Make a note of the IP address and physical address (also known as a MAC address).

IP Address: _____

MAC Address: _____

- c. Using the calculator, convert the four numbers contained in the IP address to binary.

Decimal	Binary

- d. The MAC or physical address is normally represented as 12 hexadecimal characters, grouped in pairs and separated by dashes (-). Physical addresses on a Windows-based computer are shown in a format of xx-xx-xx-xx-xx-xx, where each x is a number from 0 to 9 or a letter from a to f. Each of the hex characters in the address can be converted to 4 binary bits which is what the computer understands. If all 12 hex characters were converted to binary, how many bits would there be?

- e. Convert each of the hexadecimal pairs to binary. For example, if the number CC-12-DE-4A-BD-88 was the physical address, convert the hexadecimal number CC to binary (11001100). Then convert the hexadecimal number 12 to binary (00010010) and so on. Be sure to add the leading zeros for a total of 8 binary digits per pair of hex digits.

Hexadecimal	Binary

Step 7: Manipulate powers of 2 to determine the number of hosts on a network

- a. Binary numbers use two digits, 0 and 1. When you calculate how many hosts can be on a subnetwork, you use powers of two because binary is being used. As an example, we have a subnet mask that leaves six bits in the host portion of the IP address. In this case, the number of hosts on that network is 2 to the 6th power minus 2 (because you need a number to represent the network and a number that can be used to reach all the hosts—the broadcast address). The number 2 is always used because we are working in binary. The number 6 is the number of bits that are used for the host bits.
- b. On the calculator, in **Dec** mode, input the number **2**. Select the **x^y** key, the key which raises a number to a power. Input the number **6**. Click on the **=** key, press **Enter** on the keyboard, or press the **=** key on the keyboard—all give the total. The number 64 appears in the output. To subtract two, click on the minus (-) key and then the **2** key followed by the **=** key. The number 62 appears in the output. This means 62 hosts could be utilized.
- c. Using the previously described process, determine the number of hosts if the following number of bits are used for host bits.

No. of Bits Used for Hosts	No. of Hosts
5	
14	
24	
10	

- d. Using a similar technique as learned previously, determine what 10 to the 4th power equals.
-
- e. Close the Windows Calculator application.

Step 8: (Optional) Determine the network number and number of hosts based on subnet mask

- a. Given the IP network address of 172.16.203.56 and a subnet mask of 255.255.248.0, determine the network portion of the address and calculate how many hosts can be created from host bits left.
- b. Start by converting the 4 octets of the decimal IP address to binary and then convert the decimal subnet mask to binary. Remember to include leading zeros when converting to binary in order to make a total of 8 bits per octet.

Decimal IP address and subnet mask	Binary IP address and subnet mask
172.16.203.56	
255.255.248.0	

- c. Align the 32 bits of the subnet mask to the 32 bits of the IP address and compare them. The bits in the IP address that align with the ones bits in the subnet mask represent the network number. What is the binary and decimal network number for this IP address? Determine the binary address first (include all 32 bits) and then convert it to decimal.

Binary network address: _____

Decimal network address: _____

- d. How many ones bits are in the subnet mask? _____
- e. How many bits are left for host bits? _____
- f. How many hosts can be created with the bits left? _____

Step 9: Reflection

- a. List one other thing for which you might use the Windows Calculator scientific mode. It does not have to be related to networking.
