**The Binary Code System**

All information that is entered into the computer as well as all of the information processed by the computer MUST be converted to the **BINARY NUMBER SYSTEM** (*zeros and ones*).

Computers can only work with electrical signals which are interpreted as **0's** (zeros) and **1's** (ones). The binary code system is a **number system** that has only two digits: **0's** (zeros) and **1's** (ones).

The digits of the binary number system are known as **BITs** (**B**inary dig**ITs**). As people we work with the **decimal number system** (uses 10 digits) which includes the digits 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9.

In order for humans to interact with computers, there must be a conversion between the ***binary*** and ***decimal*** number systems when information is exchanged. As the end user you may be unaware that this conversion is happening all the time when you are using the computer. In order to properly understand how computers work, you must know how the binary number system works and how to convert between the binary number system and the decimal number system.

Computers like to handle information in small packets. Most computers like to bundle the **BITs** of information that they process into packets which are called a **byte** (**1 byte = 8 bits**). An example of a byte is the binary number **00110011** which is the equivalent to (same as) the decimal number **51**.

**Note**:

The notation of number in base 2 is to put the number 2 beside it in **subscript.**

For example 001100112 is the number 51 in base 10 (expressed as **5110**).

By default, if a number does not have a base number (in subscript) shown, it is assumed that the number is in base 10 (so 51 is assumed to be ***5110***).

***How do you convert from the binary number system to the decimal number system?***

In the decimal number system (*like all number systems*), we can calculate the value of a number by multiplying each digit in the number by its digit column value and then adding up all of these values. The digit column value, in the decimal system, is multiplied by ten for each column you go to the left. So we say that we have the 1's column, the 10's column, the 100's column and so on.

For Example, the decimal number 23,859 is really :

9 x 1 +   
5 x 10 +   
8 x 100 +   
3 x 1,000 +  
2 x 10,000 = **23,859**

In the binary number system we can calculate the value of a number by multiplying each digit in the number by its digit column value and then adding up all of these values. The digit column value, in the binary system, is multiplied by a factor of two for each column you go to the left. So we say that we have the 1's column, the 2's column, the 4's column and so on.

For Example, the binary number **001100112** is really the decimal number **51** because :

1 x 1 +   
1x 2 +   
0 x 4 +   
0 x 8 +  
1 x 16 +  
1 x 32 +  
0 x 64 +   
0 x 128 = **51 ( *or 5110*)**

**If we would like to get a little more technical you can see how the binary conversion is actually just a multiplication of the exponents of 2:**

**1 x 20 +  
1 x 21 +  
0 x 22 +   
0 x 23 +  
1 x 24 +  
1 x 25 +   
0 x 26 +  
0 x 27 = 51 (or 5110)**

An easy way of converting from the binary system to the decimal system is to create a little chart to help you.

The following chart is easy to set up and use:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **128** | **64** | **32** | **16** | **8** | **4** | **2** | **1** |
|  |  |  |  |  |  |  |  |

This chart is created by starting at the right hand side with the value "**1**" and then doubling that value as you go left (*2, then 4, then 8 and so on*).

Once you have created this chart, the next step is to fill in the 8 bit binary number (the byte) and add up all of the numbers above the 1's in that number. For example, the binary number **00110011** can be placed in the chart like this …

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **32 +** | **16 +** |  |  | **2 +** | **1** |
| **128** | **64** | **32** | **16** | **8** | **4** | **2** | **1** |
| 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 |

To get the answer **51** (this also can be expressed as 5110).

51 = 32 + 16 + 2 + 1.