

Manipulating numbers - Binary

Numbers which are to be used in calculations are stored and manipulated as sequences of binary digits - **Binary numbers**.

Consider first our ordinary **Decimal, Denary** or **Base 10** system. As we move from right to left each digit is worth ten times as much as the previous one

Consider the Denary number 134:-

100	10	1
1	3	4

i.e.: $100 + 30 + 4 = 134$

Ten symbols are used in - 0, 1, 2, 3, 4, 5, 6, 7, 8, 9 .

In binary two symbols are used – 0 and 1.

Sample Binary numbers could look like: 10101010
1110011010101
10101
000001101010

Converting from Base 2 to Base 10:-

As we move from right to left each digit is worth twice as much as the previous one. Thus the binary number 10000110 could be set out under the following column headings:

128	64	32	16	8	4	2	1
1	0	0	0	0	1	1	0

A '1' indicates that the number is used in the calculation ... so:

10000110 is $128 + 4 + 2 = 134$.

Converting from Base 10 to Base 2:-

Place '1's in the table until the required number is arrived at. Consider converting 102 into Base 2 -

We will obviously require a 64 in the number:

128	64	32	16	8	4	2	1
	1						

64 + 32 would make 96, which is close to the number we require:

128	64	32	16	8	4	2	1
	1	1					

We are 6 short from our number (102 - 96) - this can be obtained by using 4 and 2 :

128	64	32	16	8	4	2	1
	1	1			1	1	

Fill out the rest of the cells with zeros:

128	64	32	16	8	4	2	1
0	1	1	0	0	1	1	0

Giving our final binary number - 102 is 1100110.

Notation

Sometimes there can be confusion about the Base that a number is actually in. Consider 1001, which could be a binary number, or the decimal number one thousand and one. To make the base of a number clear, always use the following notation when writing answers:

134_{10} is the same as 10000110_2

Exercise: What is the largest binary number that can be held in 8-bits ?

Obviously, using only one byte to hold a number places a severe restriction on the size of number the computer can hold. Two or Four consecutive bytes are commonly used to store numbers.

When representing binary numbers held in bytes of main memory, you should insert leading 0s as required to make the number of digits upto a multiple of 8. The base can also be left off:

The number 11001 held in 8-bits would be: 00011001

What is the largest number that could be held in two bytes of memory? Express this number in Binary and Denary.

Exercise:

Convert the following binary numbers to decimal:-

0011_2 0110_2
 1010_2 01000010_2
 01000101_2

Convert the following numbers to binary:-

5_{10} 7_{10}
 1_{10} 26_{10}
 68_{10} 137_{10}