

Binary numbers

When we count and do everyday calculations such as adding and multiplying, we use the **decimal** number system. When computers count, calculate and process words, they use the **binary number system**.

What is the difference between these two number systems?

In 'decimal' arithmetic, which is based on the number 10, the positions of the digits in a number, reading from the right, mean 'units', 'tens', 'hundreds', 'thousands', and so on. (The value of each position goes up by a factor of 10.) The decimal system uses 10 numerals (0,1,2,3,4,5,6,7,8,9) and the number 453 means 3 units, 5 tens and 4 hundreds.

In the binary representation of a number, the position of the digits, reading from the right mean 'units', 'twos', 'fours', 'eights', 'sixteens', and so on. (The value of each position goes up by a factor of 2.) The binary number system uses two numerals (0,1) and 1101 means 1 unit, no twos, 1 four and 1 eight, or $1 + 4 + 8$, which equals 13. (A binary digit (a 1 or a 0) is called a **bit**.)

Here are some other examples:

Decimal Number	2	3	5	6	15	56	100
Binary representation	10	11	101	110	1111	111000	1100100

Binary numbers and computers

The binary number system is ideal for use in computer programs because the two digits can be represented by the two states of an electronic circuit (off = 0 and on = 1).

Although computers are based on the binary number system, we don't have to use binary numbers when using a computer or calculator. Instead, we enter decimal numbers which computer programs translate into binary representations before manipulating them.

Representing letters with a binary code

Binary codes can represent the letters of the alphabet, numerals, common symbols, and commands such as 'space' or 'enter'. These are not represented by single bits, but rather by eight-bit assemblages called **bytes**.

Using groupings of eight means that it is possible to generate 2^8 or 256 different combinations, each of which can be assigned a different meaning. A byte can represent an individual letter, numeral, symbol or command in a text document, in which case every character in the document uses a byte. (The computer memory required to store the 8 bits is also called a byte.)

There are 47 keys on an ordinary computer keyboard, and each can be used with or without the 'Shift' key, making 94 basic symbols to be encoded for numbers, small letters, capitals, and common punctuation. (The 'Space' bar and the 'Return' key add two more to this.) The [ASCII](#) code for computers

uses a 7-bit code which can represent 128 symbols – more than enough to encode all 'ordinary' keyboard symbols.

If grouping of eight are used (256 possible combinations), there are a large number of 'spare' codes for other symbols which are used in an extended ASCII system. These symbols are encoded using either the 'Control' or the 'Alternate' keys together with one of the 47 ordinary keys (making an extra 94 symbols). Finally there are codes for the 12 'Function' keys and for the other special keys (eg, arrow keys) at the right of the keyboard. Once the keystrokes are encoded in binary form, the computer can recognise the difference between numbers and other symbols and can process them accordingly.

Digital communications

Computing is not the only area of technology that uses the binary number system. 'Digital' representations based on binary numbers are used for CDs, mobile phones as well as for fibre optic and satellite communications. In these examples, the system detects the difference between a 1 and a 0 in the signal, just as a computer does. **We now live in a digital world, and the most important digits are 1 and 0!**

Related sites

- [On binary numbers](#) (Telstra Classroom, Australia)
- [How bytes and bits work](#) (How Stuff Works, USA)

Binary numbers. (n.d.).
<http://www.science.org.au/nova/021/021print.htm#box%203> Retrieved Oct. 13, 2005, from <http://citationmachine.net/>.