

# Lecture №1.3. Calculation systems.

## Binary calculation system.

- ***Item calculation systems***

Automatic digital computers work with the information set by numbers, presented in the form of special codes in the calculation system accepted for the given machine.

***The calculation system*** is a set of receptions of the name and a designation of numbers.

***Not item*** and ***item*** calculation systems differ.

In ***not item calculation system*** signs with which central numbers enter the name are allocated. Nevertheless other numbers turn out by addition or subtraction of one central numbers from others. As an example of such calculation system can serve Roman.

In ***item calculation systems*** any number is represented in the form of sequence of figures and signs which quantitative value depends on what place (position) is borrowed with everyone from them among.

Quantity of the various figures used for the image of numbers in an item calculation system, name its ***basis***.

I.e. if in a calculation system for the image of numbers it is used  $r$  various among themselves the figures designating integers the basis of this system will be number  $r$ , being by the whole positive number.

Let's consider the sequence of figures representing some number in which the whole and fractional parts are divided by a comma:

$$\pm a_{n-1} a_{n-2} \dots a_j \dots a_1 a_0$$

If in the set number to renumber the positions borrowed in figures, an index  $i$  we shall see, that it runs the sequence of values laying within the limits of  $-m = <i = <n-1$ , where  $n$  - quantity of the figures representing the whole part of number;  $m$  - quantity of the figures representing a fractional part of number. The positions renumbered thus, name categories of number (in the set number quantity of categories to equally sum  $n$ ). Further, if to consider, that the sequence resulted above represents number in a calculation system with the basis  $r$  each of figures of this sequence can accept one of values of a range  $r - 1 \geq a_i \geq 0$ .

For an estimation of quantitative value of each category of number the basis of a calculation system which specifies is used, in how many times unit  $i+1$  the category is more than unit  $i$  the younger category.

Considering above told, set number it is possible to present so:

$$\pm (a_{n-1} * r^{n-1} + a_{n-2} * r^{n-2} + \dots + a_0 * r^0)$$

## ○ *A binary calculation system*

Base element in the COMPUTER is the ***trigger***. The trigger is an electric element which can be in two steady conditions: it is included or switched off, it is similar to the switch.

The COMPUTER is constructed on a binary calculation system, each of conditions of the trigger can compare 0 or 1. In both conditions the trigger is stable, that gives to the binary information stored it very high reliability. There are also other advantages of a binary calculation system. Transfer of the information to a computer is carried out by means of transfer of electric impulses. Characteristics of an electric signal are force of a current and a pressure. On electric signals the big influence is rendered with the handicapes created by external electromagnetic fields. Electric signals in a computer as are subject to handicapes and importance of these handicapes much more, than at radio or a telecast where because of flickering strips on the screen, nevertheless it is possible to make out the image. How this problem is solved in a computer? Due to a binary calculation system

Let's consider principles of storage of the information on the magnetic carrier. The basic properties of a magnet are polarity and a level of magnetization. There are two conditions of magnetization of magnet SN and NS. So, conditions two, therefore it is possible to compare with polarity of magnet SN with 0, and NS with 1. Thus, have received system of storage of the binary information. The magnet has one more easily changeable property which can bear the helpful information. We shall admit, we shall compare with the certain levels of magnetization to figures of a decimal calculation system. Thus, it is possible to write down numbers in decimal system by means of sequence of magnets. A level of magnetization very stable characteristic subject to influence of external magnetic fields (an example the deteriorated record on an old magnetic tape can serve). For change of polarity of a magnet much stronger magnetic field is required. The information from a diskette not

always can be erased, even having put it on a strong magnet. It is caused by use on floppy disks as a data carrier property of a magnet - magnetization. The size "1" so strongly differs from "0", that spontaneous change of magnetization (or under action of external magnetic fields) is so insignificant (concerning a level "1"), that the probability of loss of the information is close to 0. On compact discs as the binary system of record-storage is used. As zero (0) deepenings, burned on a smooth surface of a disk there act. The nature represents us advantages of use of binary system of calculation where reliability of storage is very high.

Each such set of zero and units refers to as ***a binary code***. The quantity of the information coded in binary figure - 0 or 1 - refers to bat. By means of a bats set, it is possible to present any number and any sign. Signs are represented by eight-digit bats combinations – by bytes (i.e. 1 byte = 8 bats). For example, the Russian letter A – 10000000 byte. Any bats combination can be interpreted as number. For example, 110 means number 6, and 01101100 - number 108. The number

The basis of a binary calculation system is the number two. Any numbers in this system are represented by sequence of figures 0 and 1. Thus each senior category more next younger twice.

For example, binary number 10101 in the developed kind can be written down so:

$$1*2^4+0*2^3+1*2^2+0*2^1+1*2^0$$

For reception of value of binary number 10101 in a binary calculation system it is enough to calculate the written expression:

$$1*2^4+0*2^3+1*2^2+0*2^1+1*2^0=16+0+4+0+1=21$$

The fractional binary number in the developed kind enters the name with use of positions with negative numbers.

For example, 101 in the developed kind will enter the name:

$$1*2^2+0*2^1+1*2^0=4+0+1=5$$

In the further the basis of a calculation system we shall specify as the bottom index at the most right figure of number, for example:  $125_{10}$  - a decimal calculation system;  $1011_2$  - a binary calculation system.

In a binary calculation system the whole decimal numbers from zero up to nine are accordingly represented so:

Decimal record	Binary record	Decimal record	Binary record
0	0	5	101
1	1	6	110
2	10	7	111
3	11	8	1000
4	100	9	1001



## Arithmetic actions above integers in binary calculation system:

1. Operation of addition is carried out with use of the table of binary addition in one category:

$$\begin{array}{r} 1001_2 \\ + \underline{1010}_2 \\ \hline 10011_2 \end{array}$$

$$\begin{array}{r} 1101_2 \\ + \underline{1011}_2 \\ \hline 11000_2 \end{array}$$

$$\begin{array}{r} 11111_2 \\ + \underline{\phantom{11111}1}_2 \\ \hline 100000_2 \end{array}$$

2. Operation of subtraction is carried out with use of the table of subtraction in which 1 the loan in the senior category is designated.

$$\begin{array}{r} 101110011_2 \\ - \underline{100011011}_2 \\ \hline 001011000_2 \end{array}$$

$$\begin{array}{r} 110101101_2 \\ - \underline{101011111}_2 \\ \hline 001001110_2 \end{array}$$

3. Operation of multiplication is carried out under the usual scheme applied in decimal calculation system with consecutive multiplication of the 1-st multiplier on the next figure of the 2-nd multiplier.

$$\begin{array}{r}
 \phantom{x} 11001_2 \\
 \times 1101_2 \\
 \hline
 11001 \\
 11001 \\
 11001 \\
 \hline
 101000101_2
 \end{array}$$

$$\begin{array}{r}
 \phantom{x} 101_2 \\
 \times 11_2 \\
 \hline
 101 \\
 101 \\
 \hline
 1111_2
 \end{array}$$

4. Operation of division is carried out on the algorithm similar to algorithm of operation of division in decimal calculation system.

$$\begin{array}{r}
 - 101000101_2 \quad \underline{1101}_2 \\
 \underline{1101} \phantom{000000000} \\
 - 1110 \phantom{000000000} \\
 \underline{1101} \phantom{000000000} \\
 - 1101 \phantom{000000000} \\
 \underline{1101} \phantom{000000000} \\
 0
 \end{array}$$

$$\begin{array}{r}
 - 100011000_2 \quad \underline{1111}_2 \\
 \underline{1111} \phantom{000000000} \\
 - 0010100 \phantom{000000000} \\
 \underline{1111} \phantom{000000000} \\
 1010_2 - \text{a remainder}
 \end{array}$$

division

of

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Thank you for your attention