

Digital technology

Numbering systems

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Numbering systems

Calculation with binary numbers, subtraction of two numbers

- In computers the information is always presented in binary format
- For positive and negative numbers it has been agreed
 - For negative numbers one is used
 - For positive numbers zero is used
 - Sign bit is separated by a comma from the actual number
- E.g.: numbers +12 and -12 with 6-bit grade of accuracy could be presented in format
- +12 = 0,01100 -12 = 1,01100

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Calculation with binary numbers, subtraction of two numbers

- This presentation is relatively rarely used, among others
 - Because of the two presentation of zero $0 = 1,000$ or $0,000$ <- **one cannot use two different presentations simultaneously!**
 - Because of Boolean algebra
 - Is used for calculation inside the processor
 - **Does not use subtraction operation**
- With a negative number the presentation is implemented with so-called **complement of two**

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Complement of two

- **Presentation of complement of two** is obtained by **converting** the original number's ones to zeroes and vice versa and by adding one to the number
- E-g-: complement presentation of number -12 with grade of accuracy of 2 bits

- $+12 = 0,01100$
- **Conversion** $1,10011$
- $+1 \qquad \qquad \qquad 1$
- -----
- $-12 = 1,10100$ <-**presentation of complement of two**

- The same number -12 presented with eight bits is 1,1110100.
- This kind of number can be used for addition $X+(-Y)$.

Numbering systems

Calculations with binary numbers, subtraction with two numbers, example

- E.g.: subtraction $13-12 = 13 + (-12)$ with six bits

$$\begin{array}{rcl} & & 1\ 11 \\ +13 & = & 0,01101 \\ +(-12) & = & 1,10100 \end{array}$$

$$+1 = \textcolor{red}{1}0,00001 = 0,00001$$

- In the number **the sign bit** is the first bit on the left side of the comma i.e. 0=+ and the following to the left i.e. **one is overflow** (six-bit presentation)
- The overflow cannot be avoided with this type of calculations.

Numbering systems

Calculation with binary numbers, substraction with two numbers, example

- E.g.: -19-6 with 6-bit presentation
- -19 = 1,01101
- - 6 = 1,11010
- -----
- -25 = 11,00111 i.e. the number -25 is 1,00111
- The reserved number of bits should be as big as the number of significant bits plus **sign bit** in the biggest number.

Exercises

5. Calculate with binary numbers

a) $18-3$

b) $11-14$

c) $2-1$