PLTW Engineering

10-12/Counting in Binary Numbers

4/15/2020

10-12/DE

Lesson: **4/15/2020**

Objective/Learning Target: Students will be able to convert binary numbers to their common decimal equivalent and convert common decimal numbers to their binary equivalent.

Convert Decimal Numbers to Binary Numbers

The decimal numbering system refers to the common everyday number system we use.

Examples would be 12, 23, 266, 43, 19, or 6.

When we write these numbers in electronics we use a base 10 (subscript)

Examples: 12_{10}, 23_{10}, 266_{10}, 43_{10}, etc..

Convert Decimal Numbers to Binary Numbers

To convert decimal numbers (base 10) to binary numbers (base 2) we use a process called Successive Division. To do successive division follow the steps below:

a) **Divide the *Decimal Number* by 2; the remainder is the LSB of *Binary Number*.**

b) **If the quotation is zero, the conversion is complete; else repeat step (a) using the quotation as the Decimal Number. The new remainder is the next most significant bit of the *Binary Number***

Convert Decimal Numbers to Binary Numbers

Lets do an example:

a) **Divide the *Decimal Number* by 2; the remainder is the LSB of *Binary Number*.**

b) **If the quotation is zero, the conversion is complete; else repeat step (a) using the quotation as the Decimal Number. The new remainder is the next most significant bit of the *Binary Number***

Example: Convert 6_{10} to the binary equivalent.

$$2\overline{)6} \quad \text{quotient } 3,\ r = 0 \leftarrow \text{Least Significant Bit}$$

$$2\overline{)3} \quad \text{quotient } 1,\ r = 1$$

$$2\overline{)1} \quad \text{quotient } 0,\ r = 1 \leftarrow \text{Most Significant Bit}$$

$$6_{10} = 110_2$$

Convert Decimal Numbers to Binary Numbers

Example: Convert 6_{10} to the binary equivalent:

$$6_{10} = 110_2$$

$$2\overline{)6} \quad r = 0 \leftarrow \text{Least Significant Bit}$$

$$2\overline{)3} \quad r = 1$$

$$2\overline{)1} \quad r = 1 \leftarrow \text{Most Significant Bit}$$

Convert Binary Numbers to Decimal Numbers

To convert binary numbers (base 2) to decimal numbers (base 10) we use a process called Weighted Multiplication. To do weighted multiplication follow the steps below

a) **Multiply each bit of the *Binary Number* by it corresponding bit-weighting factor (i.e. Bit-0$\rightarrow 2^0=1$; Bit-1$\rightarrow 2^1=2$; Bit-2$\rightarrow 2^2=4$; etc).**

b) **Sum up all the products in step (a) to get the *Decimal Number*.**

Convert Binary Numbers to Decimal Numbers

Example: Convert the Binary number 0110_2 to its decimal equivalent:

a) **Multiply each bit of the *Binary Number* by it corresponding bit-weighting factor (i.e. Bit-0→2^0=1; Bit-1→2^1=2; Bit-2→2^2=4; etc).**

b) **Sum up all the products in step (a) to get the *Decimal Number*.**

0	1	1	0
2^3	2^2	2^1	2^0
8	4	2	1

0 + 4 + 2 + 0 = 6_{10}

$0110_2 = 6_{10}$

Convert Decimal to Binary Practice

a) 13_{10} = ?

b) 22_{10} = ?

c) 43_{10} = ?

d) 158_{10} = ?

Convert Binary to Decimal Practice

a) $0110_2 = ?$

b) $11010_2 = ?$

c) $0110101_2 = ?$

d) $11010011_2 = ?$

Helpful Links

Binary Number Systems

Conversion calculator