
BACK TO LEARN MATH
DOUBLE LETTER SCORE
DOUBLE WORD SCORE
TRIPLE LETTER SCORE

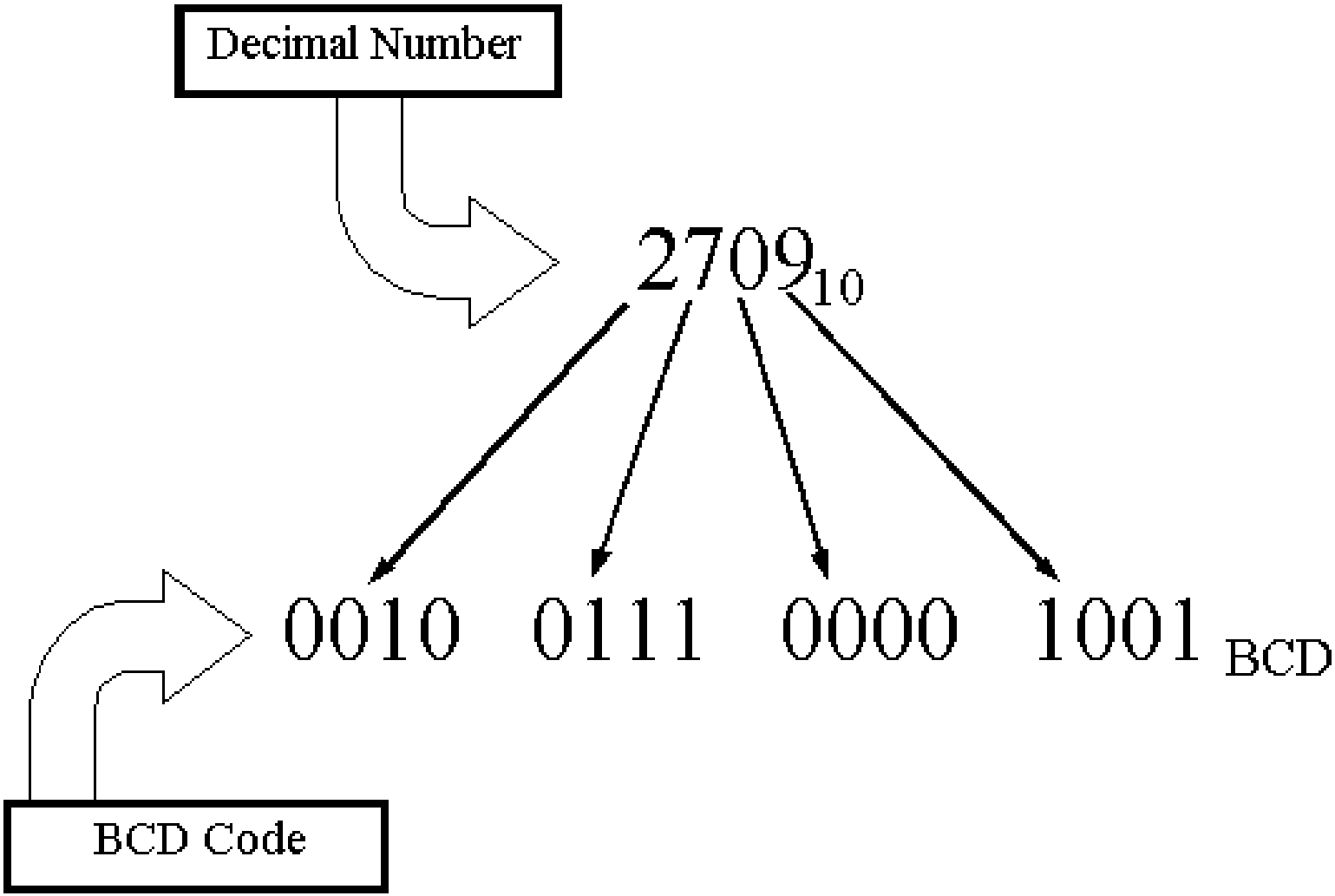
BCD

- **BCD** or **Binary Coded Decimal** is that number system or code which has the binary numbers or digits to represent a decimal nu mber.
- A decimal number contains 10 digits (0-9). Now the equivalent binary numbers can be found out of these 10 decimal numbers.
- In case of **BCD** the binary number formed by four binary digits, will be the equivalent code for the given decimal digits.
- In **BCD** we can use the binary number from 0000-1001 only, w hich are the decimal equivalent from 0-9 respectively.

- An 8421 code is a binary-coded-decimal (BCD) code consistin g of four binary digits.
- The 8421 designation refers to the binary weight of the 4 bits.

Power of 2:	2^3	2^2	2^1	2^0
Binary weight:	8	4	2	1

DECIMAL TO BCD CODE



BCD TO DECIMAL

Example:

Convert 0110100000111001 (BCD) to its decimal equivalent.

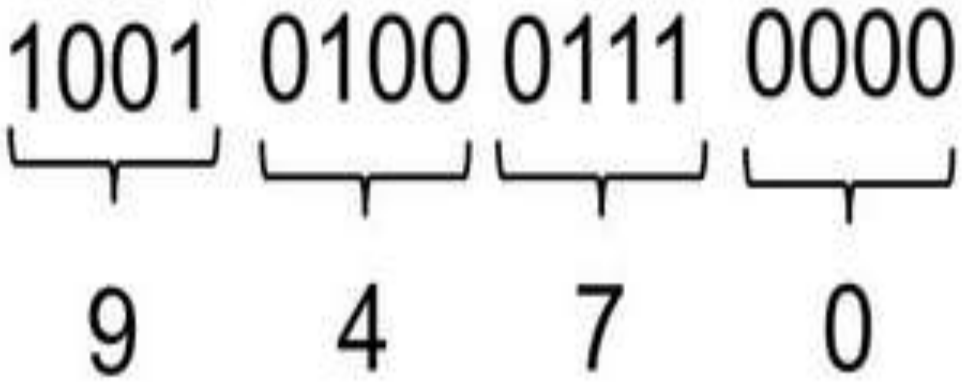
Solution:

Divide the BCD number into 4-bit groups and convert each to decimal.

0110	1000	0011	1001
6	8	3	9

BCD-to-Decimal Conversion

Convert BCD code 1001 0100 0111 0000 to decimal



BCD Addition

- Like other number system in BCD arithmetical operation may be required.
- BCD is a numerical code which has several rules for addition. The rules are given below in three steps with an example to make the idea of **BCD Addition** clear.

1. At first the given number are to be added using the rule of binary. For example,

Case 1:

$$\begin{array}{r} 1010 \\ +\ 0101 \\ \hline 1111 \end{array}$$

Case 2:

$$\begin{array}{r} 0001 \\ +\ 0101 \\ \hline 0110 \end{array}$$

2. In second step we have to judge the result of addition. Here two cases are shown to describe the rules of **BCD Addition**. In case 1 the result of additior of two binary number is greater than 9, which is not valid for BCD number. But the result of addition in case 2 is less than 9, which is valid for BCD numbers.

3. If the four bit result of addition is greater than 9 and if a carry bit is present in the result then it is invalid and we have to add 6 whose binary equivalent is $(0110)_2$ to the result of addition. Then the resultant that we would get will be a valid binary coded number. In case 1 the result was $(1111)_2$, which is greater than 9 so we have to add 6 or $(0110)_2$ to it.

$$(1111)_2 + (0110)_2 = 0001\ 0101 = 15$$

Example:1

Let, 0101 is added with 0110.

$$\begin{array}{rl} & 0101 \\ + & 0110 \\ \hline & 1011 \rightarrow \text{Invalid BCD number} \\ + & 0110 \rightarrow \text{Add 6} \\ \hline 0001 & 0001 \rightarrow \text{Valid BCD number} \end{array}$$

Check your self. $(0101)_2 \rightarrow (5)_{10}$ & $(0110)_2 \rightarrow (6)_{10}$

(5) (6) (11)

Example:2

Now let 0001 0011 is added to 0010 0110.

$$\begin{array}{r} 0001\ 0001 \\ +\ 0010\ 0110 \\ \hline 0011\ 0111 \end{array} \longrightarrow \text{Valid BCD number}$$

$$(0001\ 0001)_{BCD} \rightarrow (11)_{10},\ (0010\ 0110)_{BCD} \rightarrow (26)_{10}\ and\ (0011\ 0111)_{BCD}$$
$$\rightarrow (37)_{10}(11)_{10} + (26)_{10} = (37)_{10}$$

Excess-3

- **Excess-3** is a digital code related to BCD that is derived by adding 3 to each decimal digit

Decimal	Binary	Excess-3
0	0000	0011
1	0001	0100
2	0010	0101
3	0011	0110
4	0100	0111
5	0101	1000
6	0110	1001
7	0111	1010
8	1000	1011
9	1001	1100

Binary to Gray code

The most significant bit (left-most) in the Gray code is the same as the corresponding MSB in the binary number.

Going from left to right, add each adjacent pair of binary code bits to get the next Gray code bit. Discard carries.

For example, the conversion of the binary number 10110 to Gray code is as follows:

1	0	1	1	0	Binary
↓	↓	↓	↓	↓	
1	1	1	0	1	Gray

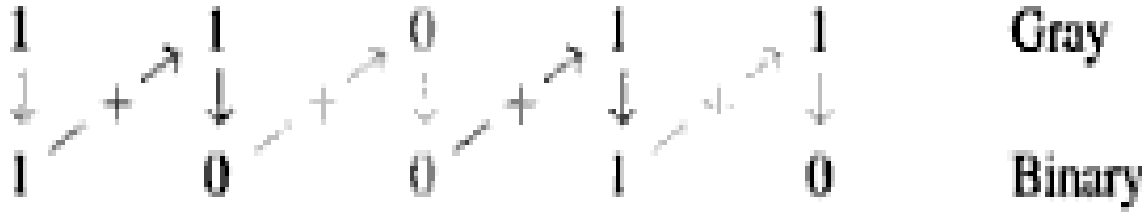
The Gray code is 11101.

Decimal Number	4 bit Binary Number ABCD	4 bit Gray Code $G_1G_2G_3G_4$
0	0 0 0 0	0 0 0 0
1	0 0 0 1	0 0 0 1
2	0 0 1 0	0 0 1 1
3	0 0 1 1	0 0 1 0
4	0 1 0 0	0 1 1 0
5	0 1 0 1	0 1 1 1
6	0 1 1 0	0 1 0 1
7	0 1 1 1	0 1 0 0
8	1 0 0 0	1 1 0 0
9	1 0 0 1	1 1 0 1
10	1 0 1 0	1 1 1 1
11	1 0 1 1	1 1 1 0
12	1 1 0 0	1 0 1 0
13	1 1 0 1	1 0 1 1
14	1 1 1 0	1 0 0 1
15	1 1 1 1	1 0 0 0

Gray to Binary Code

1. The most significant bit (left-most) in the binary code is the same as the corresponding bit in the Gray code.
2. Add each binary code bit generated to the Gray code bit in the next adjacent position. Discard carries.

For example, the conversion of the Gray code word 11011 to binary is as follows:



The binary number is 10010.

4 bit Gray Code

A	B	C	D
0	0	0	0
0	0	0	1
0	0	1	1
0	0	1	0
0	1	1	0
0	1	1	1
0	1	0	1
0	1	0	0
1	1	0	0
1	1	0	1
1	1	1	1
1	1	1	0
1	0	1	0
1	0	1	1
1	0	0	1
1	0	0	0

4 bit Binary Code

B_4	B_3	B_2	B_1
0	0	0	0
0	0	0	1
0	0	1	0
0	0	1	1
0	1	0	0
0	1	0	1
0	1	1	0
0	1	1	1
1	0	0	0
1	0	0	1
1	0	1	0
1	0	1	1
1	1	0	0
1	1	0	1
1	1	1	0
1	1	1	1

Quick Quiz (Poll 1)

- A code converter is a logic circuit that ___ _____

  a) Inverts the given input
  b) Converts into decimal number
  c) Converts data of one type into another type
  d) Converts to octal

Quick Quiz (Poll 2)

- Convert binary number into gray code: 100101.

a) 101101
b) 001110
c) 110111
d) 111001