1.3 BINARY CODES

Binary codes are codes which are represented in binary system with modification from the original ones. There are two types of binary codes: Weighted codes and Non-Weighted codes. BCD and the 2421 code are examples of weighted codes. In a weighted code, each bit position is assigned a weighting factor in such a way that each digit ca n be evaluated by adding the weight of all the 1's the in coded combination.

8421 code/BCD code

The BCD (Binary Coded Decimal) is a straight assignment of the binary equivalent. It is possible to assign weights to the binary bits according to their positions. The weights in the BCD code are 8,4,2,1.

Example: The bit assignment 1001, can be seen by its weights to represent the decimal 9 because 1x8+0x4+0x2+1x1 = 9

Weighted Code

– 8421 code

- Most common
- Default
- The corresponding decimal digit is determined by adding the weights associated with t code group.

– 62310 = 0110 0010 0011

– 2421, 5421,7536, etc… codes

• The weights associated with the bits in each code group are given by the name of the code

Nonweighted Codes

Non Weighted codes are codes that are not positionally weighted. That is, each position within the binary number is not assigned a fixed value.

- Actually weighted 74210 except for the digit 0
- Used by the post office for scanning bar codes for zip codes
- Has error detection properties

2421 code

This is a weighted code; its weights are 2, 4, 2 and 1. A decimal number is represented in 4-bit form and the total four bits weight is 2 + 4 + 2 + 1 = 9. Hence the 2421 code represents the decimal numbers from 0 to 9.

5211 code

This is a weighted code; its weights are 5, 2, 1 and 1. A decimal number is represented in 4-bit form and the total four bits weight is 5 + 2 + 1 + 1 = 9. Hence the 5211 code represents the decimal numbers from 0 to 9.

Reflective code

A code is said to be reflective when code for 9 is complement for the code for 0, and so is for 8 and 1 codes, 7 and 2, 6 and 3, 5 and 4. Codes 2421, 5211, and excess-3 are reflective, whereas the 8421 code is not.

Sequential code

The BCD (Binary Coded Decimal) is a straight assignment of the binary equivalent. It is possible to assign weights to the binary bits according to their positions. The weights in the BCD code are 8,4,2,1.

Excess- 3 code

Excess-3 is a non weighted code used to express decimal numbers. The code derives its name from the fact that each binary code is the corresponding 8421 code plus 0011(3).

Example: 1000 of 8421 = 1011 in Excess-3

Gray code

The gray code belongs to a class of codes called minimum change codes, in which only one bit in the code changes when moving from one code to the next. The Gray code is non-weighted code, as the position of bit does not contain any weight. In digital Gray code has got a special place.

Decimal Number	Binary Code	Gray Code
0	0000	0000
1	0001	0001
2	0010	0011
3	0011	0010
4	0100	0110
5	0101	0111
6	0110	0101
7	0111	0100
8	1000	1100
9	1001	1101
10	1010	1111
11	1011	1110
12	1100	1010
13	1101	1011
14	1110	1001
15	1111	1000

The gray code is a reflective digital code which has the special property that any two subsequent numbers codes differ by only one bit. This is also called a unit-distance code. Important when an analog quantity must be converted to a digital representation. Only one bit changes between two successive integers which are being coded.

Error Detecting and Correction Codes

Error detecting codes

When data is transmitted from one point to another, like in wireless transmission, or it is just stored, like in hard disks and memories, there are chances that data may

get corrupted. To detect these data errors, we use special codes, which are error detection codes.

Error correcting code

Error-correcting codes not only detect errors, but also correct them. This is used normally in Satellite communication, where turn-around delay is very high as is the probability of data getting corrupt.

Hamming codes

Hamming code adds a minimum number of bits to the data transmitted in a noisy channel, to be able to correct every possible one-bit error. It can detect (not correct) two-bit errors and cannot distinguish between 1-bit and 2-bits inconsistencies. It can't - in general - detect 3(or more)-bits errors.

Parity codes

A parity bit is an extra bit included with a message to make the total number of 1's either parity codes, every data byte, or nibble (according to how user wants to use it) is checked if they have even number of ones or even number of zeros. Based on this information an additional bit is appended to the original data. Thus if we consider 8-bit data, adding the parity bit will make it 9 bit long.

At the receiver side, once again parity is calculated and matched with the received parity (bit 9), and if they match, data is ok, otherwise data is corrupt.

Two types of parity

-Even parity: Checks if there is an even number of ones; if so, parity bit is zero. When the number of one'sis odd then parity bit is set to 1.

-Odd Parity: Checks if there is an odd number of ones; if so, parity bit is zero. When the number of one'sis even then parity bit is set to 1.

Alphanumeric codes

The binary codes that can be used to represent all the letters of the alphabet, numbers and mathematical symbols, punctuation marks, are known as alphanumeric codes or character codes. These codes enable us to interface the input-output devices like the keyboard, printers, video displays with the computer.

ASCII codes

Codes to handle alphabetic and numeric information, special symbols, punctuation marks, and control characters.

• ASCII (American Standard Code Information Interchange) is the best known.

• Unicode –a 16-bit coding system provides for foreign languages, mathematical symbols, geometrical shapes, dingbats, etc. It has become a world standard alphanumeric code for microcomputers and computers. It is a 7-bit code representing $2^7 = 128$ different characters. These characters represent 26 upper case letters (A to Z), 26 lowercase letters (a to z), 10 numbers (0 to 9), 33 special characters and symbols and 33 control characters.

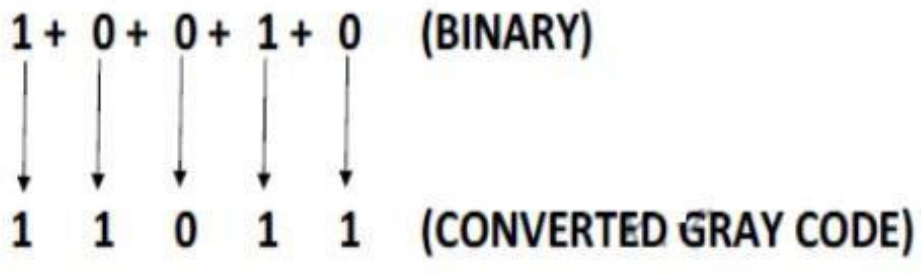
EBCDIC codes

EBCDIC stands for Extended Binary Coded Decimal Interchange. It is mainly used with large computer systems like mainframes. EBCDIC is an 8-bit code and thus accommodates up to 256 characters. An EBCDIC code is divided into two portions: 4 zone bits (on the left) and 4 numeric bits (on the right).

Example 1: Give the binary, BCD, Excess-3, gray code representations of numbers: 5,8,14.

Decimal Number	Binary code	BCD code	Excess-3 code	Gray code
5	0101	0101	1000	0111
8	1000	1000	1011	1100
14	1110	0001 0100	0100 0111	1001

Example 2: Binary To Gray Code Conversion



Example 3: Gray Code To Binary Code Conversion