Data	Parity bit	data
10110	0	10110
10001	1	10001
10101	0	10101
00010	0	00010
11000	1	11000
00000	1	00000
11010	0	11010

Error –Correcting Codes:

A code is said to be an error –correcting code, if the code word can always be deduced from an erroneous word. For a code to be a single bit error correcting code, the minimum distance of that code must be three. The minimum distance of that code is the smallest no. of bits by which any two code words must differ. A code with minimum distance of 3 can't only correct single bit errors but also detect (can't correct) two bit errors, The key to error correction is that it must be possible to detect & locate erroneous that it must be possible to detect & locate erroneous digits. If the location of an error has been determined. Then by complementing the erroneous digit, the message can be corrected , error correcting , code is the Hamming code , In this , to each group of m information or message or data bits, K parity checking bits denoted by P1,P2,----------pk located at positions 2^{k-1} from left are added to form an (m+k) bit code word. To correct the error, k parity checks are performed on selected digits of each code word, & the position of the error bit is located by forming an error word, & the error bit is then complemented. The k bit error word is generated by putting a 0 or a 1 in the 2^{k-1}th position depending upon whether the check for parity involving the parity bit P_k is satisfied or not.Error positions & their corresponding values :

Error Position	For 15 bit code $C_4\,C_3\,C_2\,C_1$	For 12 bit code $C_4\,C_3\,C_2\,C_1$	For 7 bit code $C_3\,C_2\,C_1$
0	0 0 0 0	0 0 0 0	0 0 0
1	0 0 0 1	0 0 0 1	0 0 1
2	0 0 1 0	0 0 1 0	0 1 0
3	0 0 1 1	0 0 1 1	0 1 1
4	0 1 0 0	0 1 0 0	1 0 0
5	0 1 0 1	0 1 0 1	1 0 1
6	0 1 1 0	0 1 1 0	1 1 0
7	0 1 1 1	0 1 1 1	1 1 1
8	1 0 0 0	1 0 0 0	
9	1 0 0 1	1 0 0 1	
10	1 0 1 0	1 0 1 0	
11	1 0 1 1	1 0 1 1	
12	1 1 0 0	1 1 0 0	
13	1 1 0 1		
14	1 1 1 0		
15	1 1 1 1		

7-bit Hamming code:

To transmit four data bits, 3 parity bits located at positions $2^0\,2^1\,\&\,2^2$ from left are added to make a 7 bit codeword which is then transmitted.

The word format

P_1	P_2	D_3	P_4	D_5	D_6	D_7

D—Data bits P-
Parity bits

Decimal Digit	For BCD $P_1P_2D_3P_4D_5D_6D_7$							For Excess-3 $P_1P_2D_3P_4D_5D_6D_7$						
0	0	0	0	0	0	0		1	0	0	0	0	1	1
1	1	1	0	1	0	0	1	1	0	0	1	1	0	0
2	0	1	0	1	0	1	1	0	1	0	0	1	0	1
3	1	0	0	0	0	1	1	1	1	0	0	1	1	0
4	1	0	0	1	1	0	0	0	0	0	1	1	1	1
5	0	1	0	0	1	0	1	1	1	1	0	0	0	0
6	1	1	0	0	1	1	0	0	0	1	1	0	0	1
7	0	0	0	1	1	1	1	1	0	1	1	0	1	0
8	1	1	1	0	0	0	0	0	1	1	0	0	1	1
9	0	0	1	1	0	0	1	0	1	1	1	1	0	0

Ex: Encode the data bits 1101 into the 7 bit even parity Hamming Code

The bit pattern is

$P_1P_2D_3P_4D_5D_6D_7$

1   1   0   1

Bits 1,3,5,7 (P_1 111) must have even parity, so $P_1 = 1$

Bits 2, 3, 6, 7(P_2 101) must have even parity, so $P_2 = 0$

Bits 4,5,6,7 (P_4 101)must have even parity, so $P_4 = 0$

The final code is 1010101

EX: Code word is 1001001

Bits 1,3,5,7 (C_1 1001) →no error →put a 0 in the 1's position→C1=0

Bits 2, 3, 6, 7(C_2 0001)) → error →put a 1 in the 2's position→C2=1

Bits 4,5,6,7 (C_4 1001)) →no error →put a 0 in the 4's position→C3=0

15-bit Hamming Code: It transmit 11 data bits, 4 parity bits located $2^0\, 2^1\, 2^2\, 2^3$

Word format is

P_1	P_2	D_3	P_4	D_5	D_6	D_7	P_8	D_9	D_{10}	D_{11}	D_{12}	D_{13}	D_{14}	D_{15}

12-Bit Hamming Code: It transmit 8 data bits, 4 parity bits located at position $2^0\, 2^1\, 2^2\, 2^3$

Word format is

P_1	P_2	D_3	P_4	D_5	D_6	D_7	P_8	D_9	D_{10}	D_{11}	D_{12}

Alphanumeric Codes:

These codes are used to encode the characteristics of alphabet in addition to the decimal digits. It is used for transmitting data between computers & its I/O device such as printers, keyboards & video display terminals.Popular modern alphanumeric codes are ASCII code & EBCDIC code.