<u>**Digital Electronics**</u>

Combinational Logic Functions

Code Converters, Parity Generators & Checkers

Code Converters:

A code converter is a combinational logic circuit that changes data presented in one type of binary code to another type of binary code.

Binary to Gray Code Converter:

4 bit Binary to Gray code converter is a logic circuit which converts 4 bit Binary code to corresponding Gray code.

B_3	B_2	B_1	B_0	G_3	G_2	G_1	G_0
0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	1
0	0	1	0	0	0	1	1
0	0	1	1	0	0	1	0
0	1	0	0	0	1	1	0
0	1	0	1	0	1	1	1
0	1	1	0	0	1	0	1
0	1	1	1	0	1	0	0
1	0	0	0	1	1	0	0
1	0	0	1	1	1	0	1
1	0	1	0	1	1	1	1
1	0	1	1	1	1	1	0
1	1	0	0	1	0	1	0
1	1	0	1	1	0	1	1
1	1	1	0	1	0	0	1
1	1	1	1	1	0	0	0

$G_3 = \Sigma\,(8, 9, 10, 11, 12, 13, 14, 15)$, $G_2 = \Sigma\,(4, 5, 6, 7, 8, 9, 10, 11)$

$G_1 = \Sigma\,(2, 3, 4, 5, 10, 11, 12, 13)$, $G_0 = \Sigma\,(1, 2, 5, 6, 9, 10, 13, 14)$

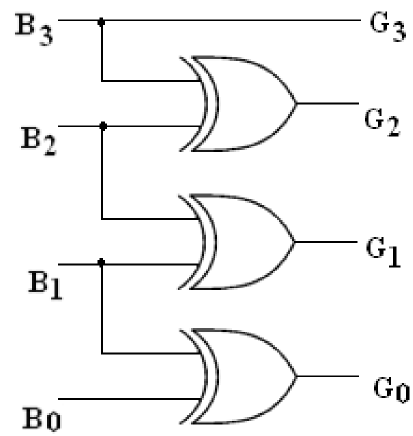
By simplifying the above expressions using K maps, we get

$$G_3 = B_3$$

$$G_2 = B_3'B_2 + B_3B_2' = B_3 \oplus \mathrm{B}_2$$

$$G_1 = B_2B_1' + B_2'B_1 = B_2 \oplus \mathrm{B}_1$$

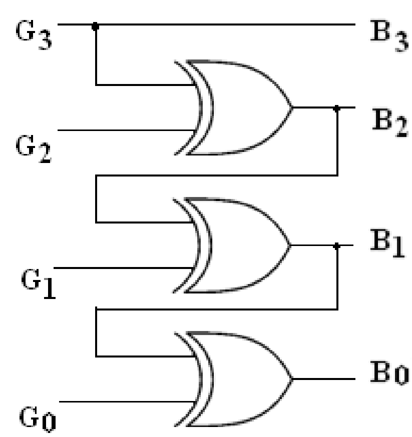
$$G_0 = B_1'B_0 + B_1B_0' = B_1 \oplus \mathrm{B}_0$$



Gray to Binary Code Converter:

4 bit Gray to Binary code converter is a logic circuit which converts 4 bit Gray code to corresponding Binary code.

G_3	G_2	G_1	G_0	B_3	B_2	B_1	B_0
0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	1
0	0	1	1	0	0	1	0
0	0	1	0	0	0	1	1
0	1	1	0	0	1	0	0
0	1	1	1	0	1	0	1
0	1	0	1	0	1	1	0
0	1	0	0	0	1	1	1
1	1	0	0	1	0	0	0
1	1	0	1	1	0	0	1
1	1	1	1	1	0	1	0
1	1	1	0	1	0	1	1
1	0	1	0	1	1	0	0
1	0	1	1	1	1	0	1
1	0	0	1	1	1	1	0
1	0	0	0	1	1	1	1



$B_3 = G_{3,}\ B_2 = G_3 \oplus \mathrm{G}_2$

$B_1 = G_3 \oplus \mathrm{G}_2 \oplus \mathrm{G}_1$

$B_0 = G_3 \oplus \mathrm{G}_2 \oplus \mathrm{G}_1 \oplus \mathrm{G}_0$

BCD to Excess-3 Code Converter:

Input BCD				Output Excess-3 Code			
A	*B*	*C*	*D*	*w*	*x*	*y*	*z*
0	0	0	0	0	0	1	1
0	0	0	1	0	1	0	0
0	0	1	0	0	1	0	1
0	0	1	1	0	1	1	0
0	1	0	0	0	1	1	1
0	1	0	1	1	0	0	0
0	1	1	0	1	0	0	1
0	1	1	1	1	0	1	0
1	0	0	0	1	0	1	1
1	0	0	1	1	1	0	0

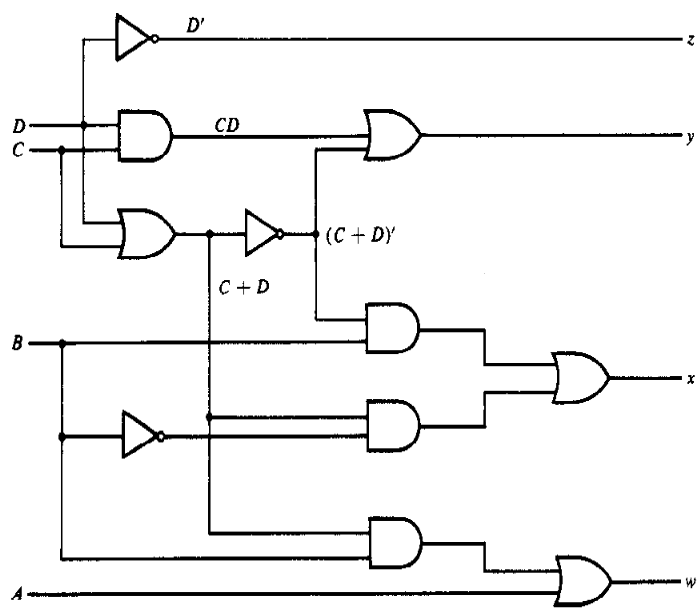
$$z = D'$$

$$y = CD + C'D' = CD + (C + D)'$$

$$x = B'C + B'D + BC'D' = B'(C + D) + BC'D'$$

$$= B'(C + D) + B(C + D)'$$

$$w = A + BC + BD = A + B(C + D)$$



Parity Generator and Checker:

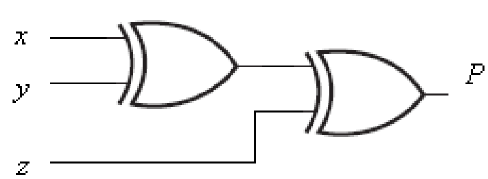
When digital data is transmitted from one location to another, it is necessary to know at the receiving end, whether the received data is free of error. To help make the transmission accurate, special error detection methods are used. To detect errors, we must keep a constant check on the data being transmitted. To check accuracy we can generate and transmit an extra bit along with the message (data). This extra bit is known as the parity bit and it decides whether the data transmitted is error free or not. There are two types of parity bits, namely, even parity and odd parity.

The circuit that generates the parity bit in the transmitter is called a parity generator. The circuit that checks the parity in the receiver is called a parity checker.

Even Parity Generator:

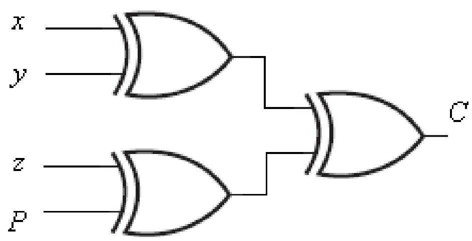
X	Y	Z	P
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	1

$$P = X'Y'Z + X'YZ' + XY'Z' + XYZ = X \oplus Y \oplus Z$$



Even Parity Checker:

$C = x \oplus y \oplus z \oplus P$



Four Bits Received				Parity Error Check
x	y	z	P	C
0	0	0	0	0
0	0	0	1	1
0	0	1	0	1
0	0	1	1	0
0	1	0	0	1
0	1	0	1	0
0	1	1	0	0
0	1	1	1	1
1	0	0	0	1
1	0	0	1	0
1	0	1	0	0
1	0	1	1	1
1	1	0	0	0
1	1	0	1	1
1	1	1	0	1
1	1	1	1	0