LAB no. 3.

CODE CONVERTERS

Code converters are digital combinational circuits that realize the number conversion from one code to another.

1. Binary to Gray converter

The Gray code is a reflected code which has the property that two neighbor codes differs through the value of a single bit. The correspondence between the two codes is shown in the following table. It can be considered the converter truth table

Decimal no.	Gray code				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
1	0	0	0	1	0	0	0	1
2	0	0	1	1	0	0	1	0
3	0	0	1	0	0	0	1	1
4	0	1	1	0	0	1	0	0
5	0	1	1	1	0	1	0	1
6	0	1	0	1	0	1	1	0
7	0	1	0	0	0	1	1	1
8	1	1	0	0	1	0	0	0
9	1	1	0	1	1	0	0	1
10	1	1	1	1	1	0	1	0
11	1	1	1	0	1	0	1	1
12	1	0	1	0	1	1	0	0
13	1	0	1	1	1	1	0	1
14	1	0	0	1	1	1	1	0
15	1	0	0	0	1	1	1	1

From the above table we can build the Veitch-Karnaugh diagrams:

$B_1 B_0$ \ $B_3 B_2$	0 0	0 1	1 1	1 0
0 0	0	0	0	0
0 1	1	1	1	1
1 1	0	0	0	0
1 0	1	1	1	1

G_0

$B_1 B_0$ \ $B_3 B_2$	0 0	0 1	1 1	1 0
0 0	0	1	1	0
0 1	0	1	1	0
1 1	1	0	0	1
1 0	1	0	0	1

G_1

LAB no. 3.

B_3B_2 / B_1B_0	0 0	0 1	1 1	1 0
0 0	0	1	0	1
0 1	0	1	0	1
1 1	0	1	0	1
1 0	0	1	0	1

G_2

B_3B_2 / B_1B_0	0 0	0 1	1 1	1 0
0 0	0	0	1	1
0 1	0	0	1	1
1 1	0	0	1	1
1 0	0	0	1	1

G_3

By grouping the cells containing logic „1" and applying the VK method the boolean equations of the 4 outputs are obtained:

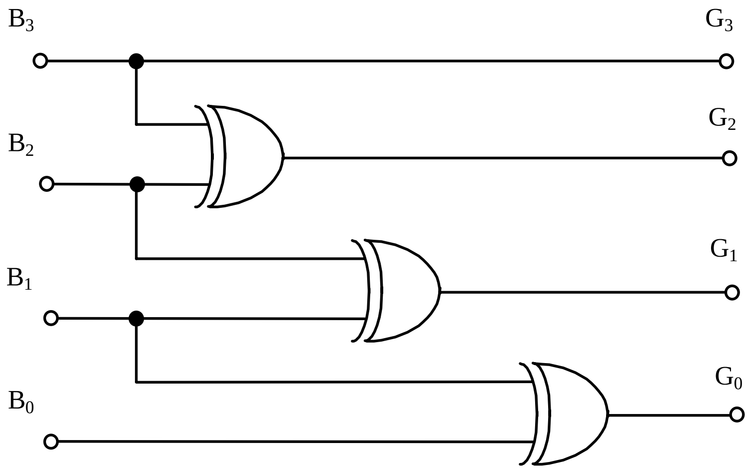
$$G_0 = B_0 \oplus B_1$$

$$G_1 = B_1 \oplus B_2$$

$$G_2 = B_2 \oplus B_3$$

$$G_3 = B_3$$

From these equations we can obtain immediately the circuit:

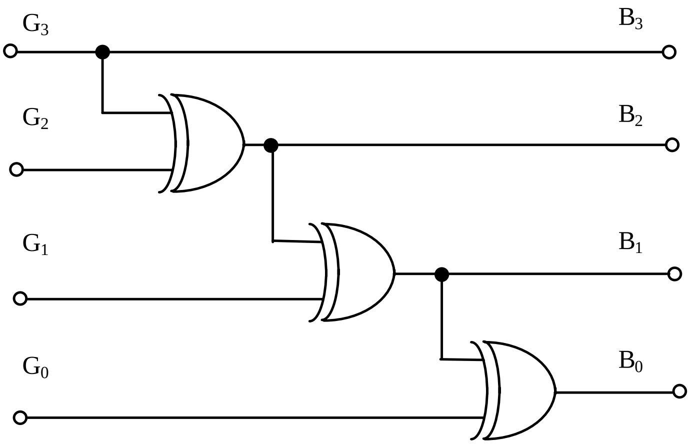


2. Gray to binary converter

Using the same algorithm as above, we can obtain the circuit for reverse conversion. But much simpler is to process the above equations:

$$G_3 = B_3$$
$$\Rightarrow B_3 = G_3$$
$$G_2 = B_2 \oplus B_3 \Rightarrow G_2 \oplus G_3 = B_2 \oplus B_3 \oplus B_3 = B_2$$
$$\Rightarrow B_2 = G_2 \oplus G_3$$
$$G_1 = B_2 \oplus B_1 \Rightarrow G_1 \oplus G_2 \oplus G_3 = B_2 \oplus B_2 \oplus B_1 = B_1$$
$$\Rightarrow B_1 = G_1 \oplus G_2 \oplus G_3$$
$$G_0 = B_0 \oplus B_1 \Rightarrow G_0 \oplus G_1 \oplus G_2 \oplus G_3 = B_0 \oplus B_1 \oplus B_1 = B_0$$
$$\Rightarrow B_0 = G_0 \oplus G_1 \oplus G_2 \oplus G_3$$

Following these equations the circuit looks like the one below:



3. Other interesting codes

Decimal code	***8421*** code	***2421*** code	***Exces 3*** code	***2*** *from* ***5*** code
0	0000	0000	0011	00011
1	0001	0001	0100	00101
2	0010	0010	0101	00110
3	0011	0011	0110	01001
4	0100	0100	0111	01010
5	0101	1011	1000	01100
6	0110	1100	1001	10001
7	0111	1101	1010	10010
8	1000	1110	1011	10100
9	1001	1111	1100	11000

4. Works to do in the lab

Complete the following sheet according to the indications.

LAB no. 3.

LAB SHEET

1. Starting from VK diagrams, minimize and extract the logic equations for the binary-Gray converter:

B_3B_2 \ B_1B_0	00	01	11	10
0 0	0	0	0	0
0 1	1	1	1	1
1 1	0	0	0	0
1 0	1	1	1	1

G_0=

B_3B_2 \ B_1B_0	00	01	11	10
0 0	0	1	1	0
0 1	0	1	1	0
1 1	1	0	0	1
1 0	1	0	0	1

G_1=

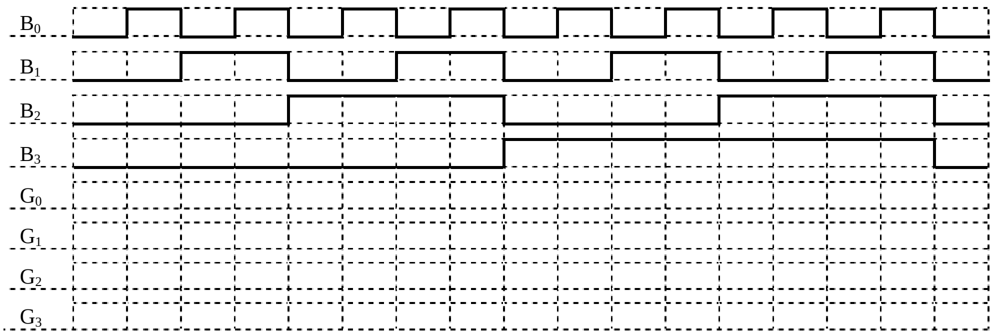
B_3B_2 \ B_1B_0	00	01	11	10
0 0	0	1	0	1
0 1	0	1	0	1
1 1	0	1	0	1
1 0	0	1	0	1

G_2=

B_3B_2 \ B_1B_0	00	01	11	10
0 0	0	0	1	1
0 1	0	0	1	1
1 1	0	0	1	1
1 0	0	0	1	1

G_3=

2. Verify the operation of the binary to Gray converter (first figure) in MaxPlus II. Use the input waveforms as shown below.



2. Verify the operation of the Gray to binary converter (second figure) in Maxplus II. Use the input waveforms as shown below.