Shri Vile Parle Kelavani Mandal's
DWARKADAS J. SANGHVI COLLEGE OF ENGINEERING
(Autonomous College Affiliated to the University of Mumbai)
NAAC Accredited with "A" Grade (CGPA : 3.18)

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BRANCH: Computer Engineering
DIGITAL ELECTRONICS
Experiment No.: 04

AIM:
To realize binary to gray code converter and gray code to binary converter

APPARATUS REQUIRED:
• Breadboard
• Connecting Wires
• Resistors
• LEDs
• Power Supply (DC) • IC 7486 (XOR)

THEORY:
Binary Numbers is default way to store numbers, but in many applications binary numbers are difficult to use and a variation of binary numbers is needed. Gray code is an ordering of the binary numeral system such that two successive values differ in only one bit (binary digit). Gray codes are very useful in the normal sequence of binary numbers generated by the hardware that may cause an error or ambiguity during the transition from one number to the next. For example, the states of a system may change from 3(011) to 4(100) as- 011 — 001 — 101 — 100. Therefore, there is a high chance of a wrong state being read while the system changes from the initial state to the final state. This could have serious consequences for the machine using the information. So, the Gray code can eliminate this problem easily since only one bit changes its value during any transition between two numbers. Gray code has property that two successive numbers differ in only one bit because of this property gray code does the cycling through various states with minimal effort. It is used in K-maps, error correction, communication etc. In computer science many a times we need to convert binary code to gray code and vice versa. This conversion can be done by applying following rules:

Binary-to-Gray Code Conversion

The following rules explain how to convert from a binary number to a Gray code word:

1. The most significant bit (left-most) in the Gray code is the same as the corresponding MSB in the binary number.
2. Going from left to right, add each adjacent pair of binary code bits to get the next Gray code bit. Discard carries. (i.e. we are XOR-ing consecutive binary input bits

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.

Gray-to-Binary Code Conversion

To convert from Gray code to binary, use a similar method; however, there are some differences. The following rules apply:

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. (i.e. we are XOR-ing the previously generated binary bit with the next gray bit).

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

1	1	0	1	1	Gray
↓ ↗+	↓ ↗+	↓ ↗+	↓ ↗+	↓	
1	0	0	1	0	Binary

The binary number is 10010.

Procedure:

1. Assemble the circuits on the breadboard as per the circuit diagrams. The breadboard should also be grounded and connected to a power supply.
2. The ICs are to be connected properly to a power supply and ground following the schematics for the ICs.
3. Input combinations should be provided using the connecting wires by connecting to ground for a LOW value and power for HIGH value to be given to the IC input.
4. Turn on power of the experimental circuit. 5. Apply various combinations of inputs in the form of binary/gray numbers via the IC inputs. 6. Compare results

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Truth Table:

BINARY to GRAY $\boxed{60004220127}$

BINARY				GRAY			
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

* K-MAP for Binary to Gray

1) $G_0 \Rightarrow$

$b_3b_2 \backslash b_1b_0$	00	01	11	10
00	0	1	0	1
01	0	1	0	1
11	0	1	0	1
10	0	1	0	1

$$G_0 = b_1\overline{b_0} + \overline{b_1}b_0 = b_1 \oplus b_0$$

2) $G_1 \Rightarrow$

$b_3b_2 \backslash b_1b_0$	00	01	11	10
00	0	0	1	1
01	1	1	0	0
11	1	1	0	0
10	0	0	1	1

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$$G_1 = \overline{b_1}b_2 + b_1\overline{b_2} = b_1 \oplus b_2$$

3) $G_2 \Rightarrow$

$b_3b_2 \backslash b_1b_0$	00	01	11	10
00	0	0	0	0
01	1	1	1	1
11	0	0	0	0
10	1	1	1	1

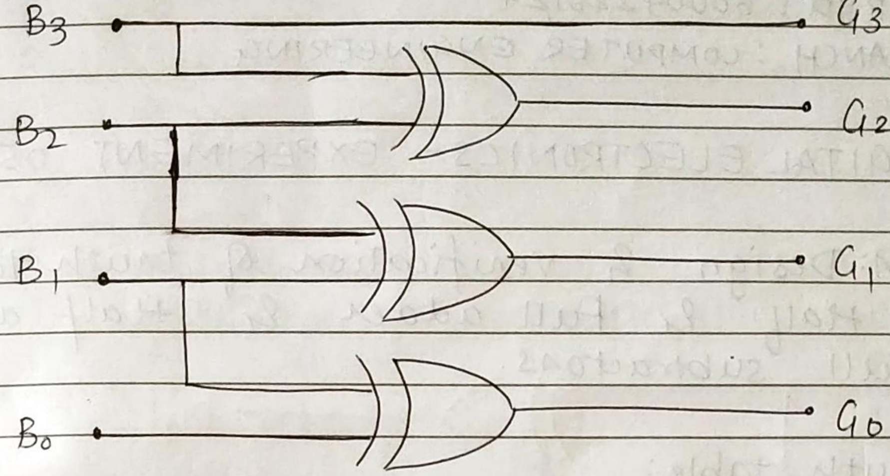
$$G_2 = \overline{b_3}b_2 + b_3\overline{b_2} = b_3 \oplus b_2$$

4) $G_3 \Rightarrow$

$b_3b_2 \backslash b_1b_0$	00	01	11	10
00	0	0	0	0
01	0	0	0	0
11	1	1	1	1
10	1	1	1	1

$$G_3 = b_3$$

Implementation for binary to Gray



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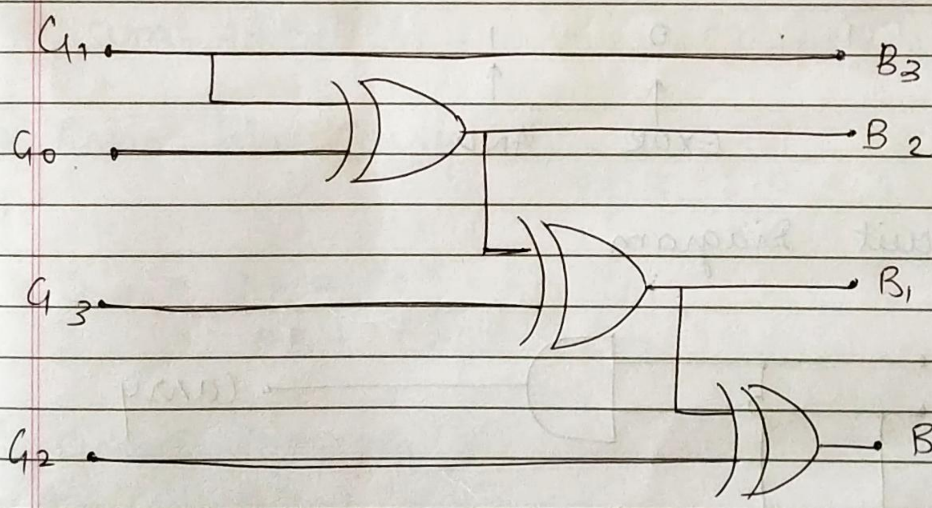
Implementation of gray to Binary



Conclusion:
Thus, we have designed a Binary to Gray converter & a Gray to Binary converter & verified the truth table