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EXPERIMENT NUMBER 4

TITLE: Verify Binary to Gray and Gray to Binary conversion using NAND gates only

• OBJECTIVE:

To analyse the truth table of binary to gray and gray to binary converter using combination of NAND gates and to understand the working of binary to gray and gray to binary converter with the help of LEDs display.

• APPARTUS REQUIRED:

- Power supply
- LED
- Resistance
- Switches
- NAND Gates

• THEORY:

Binary to Gray conversion :

1. The Most Significant Bit (MSB) of the gray code is always equal to the MSB of the given binary code.
2. Other bits of the output gray code can be obtained by Ex- ORing binary code bit at that index and previous index.
   There are four inputs and four outputs. The input variable are defined as B_3, B_2, B_1, B_0 and the output variables are defined as G_3, G_2, G_1, G_0. From the truth table, combinational circuit is designed .The logical expressions are defined as :
   $B_3 = G_3$

   $B_2 \oplus B_3 = G_2$

   $B_1 \oplus B_2 = G_1$

   $B_0 \oplus B_1 = G_0$

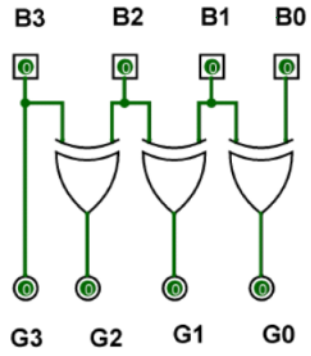


Figure : Binary to Gray Code Converter Circuit

Natural-binary code				Gray code			
B3	B2	B1	B0	G3	G2	G1	G0
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

Figure-2: Binary to Gray Code Converter Truth Table

➢ Gray to binary conversion :

1.The Most Significant Bit (MSB) of the binary code is always equal to the MSB of the given binary number.

2.Other bits of the output binary code can be obtained by checking gray code bit at that index. If current gray code bit is 0, then copy previous binary code bit, else copy invert of previous binary code bit.

There are four inputs and four outputs. The input variable are defined as G_3, G_2, G_1, G_0 and the output variables are defined as B_3, B_2, B_1, B_0. From the truth table, combinational circuit is designed .The logical expressions are defined as :

$$G_0 \oplus G_1 \oplus G_2 \oplus G_3 = B_0$$

$$G_1 \oplus G_2 \oplus G_3 = B_1$$

$$G_2 \oplus G_3 = B_2$$

$$G_3 = B_3$$

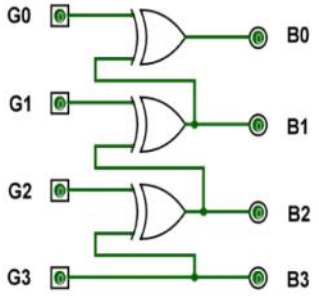


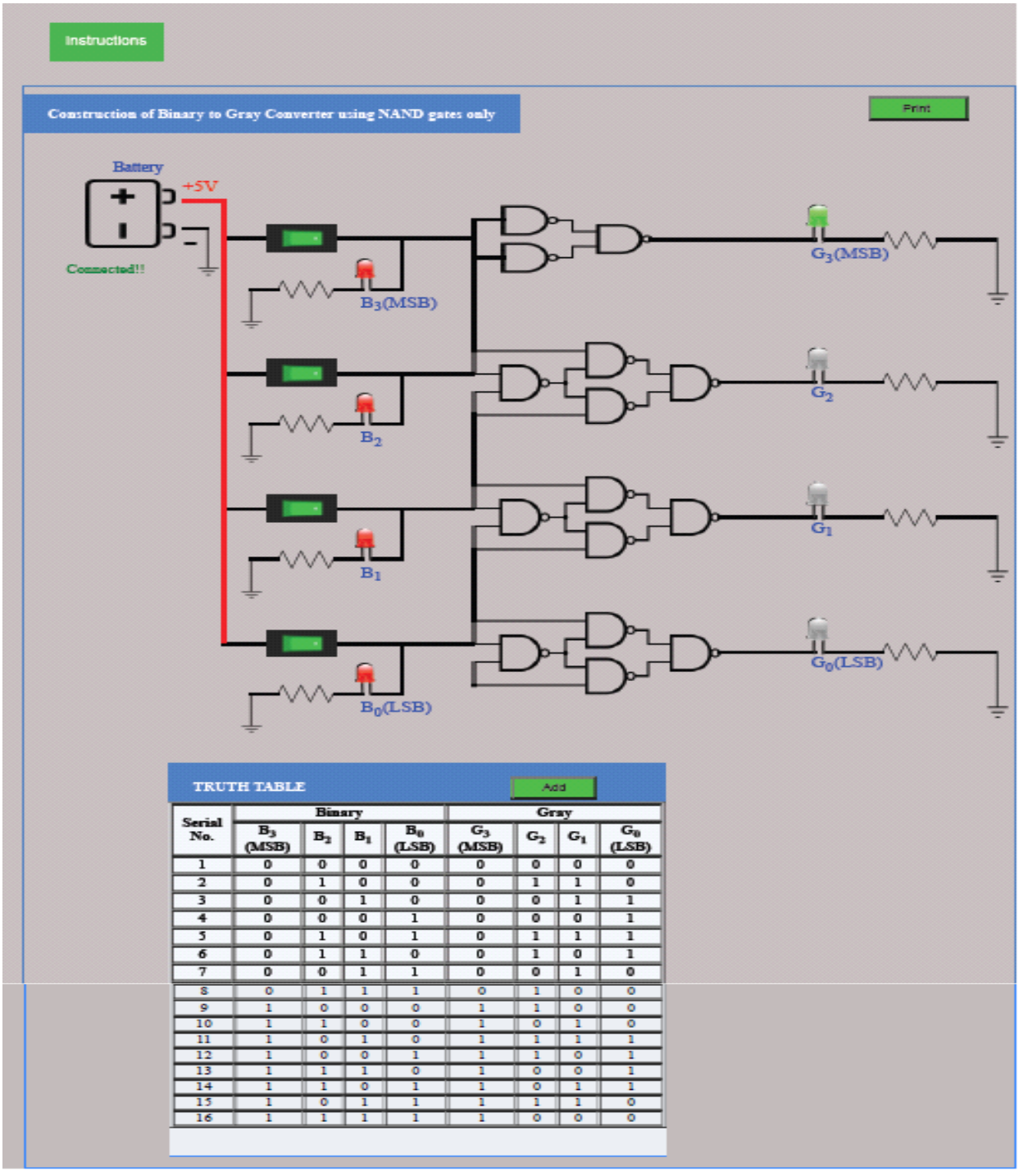
Figure-3: Gray to Binary Code Converter Circuit

Gray code				Natural-binary code			
G3	G2	G1	G0	B3	B2	B1	B0
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	1
0	1	0	1	0	1	1	0
0	1	1	0	0	1	0	0
0	1	1	1	0	1	0	1
1	0	0	0	1	1	1	1
1	0	0	1	1	1	1	0
1	0	1	0	1	1	0	0
1	0	1	1	1	1	0	1
1	1	0	0	1	0	0	0
1	1	0	1	1	0	0	1
1	1	1	0	1	0	1	1
1	1	1	1	1	0	1	0

Figure-4: Gray to Binary Code Converter Truth Table

- ***CIRCUIT DIAGRAM :***

➢ BINARY TO GRAY CODE CONVERTER :

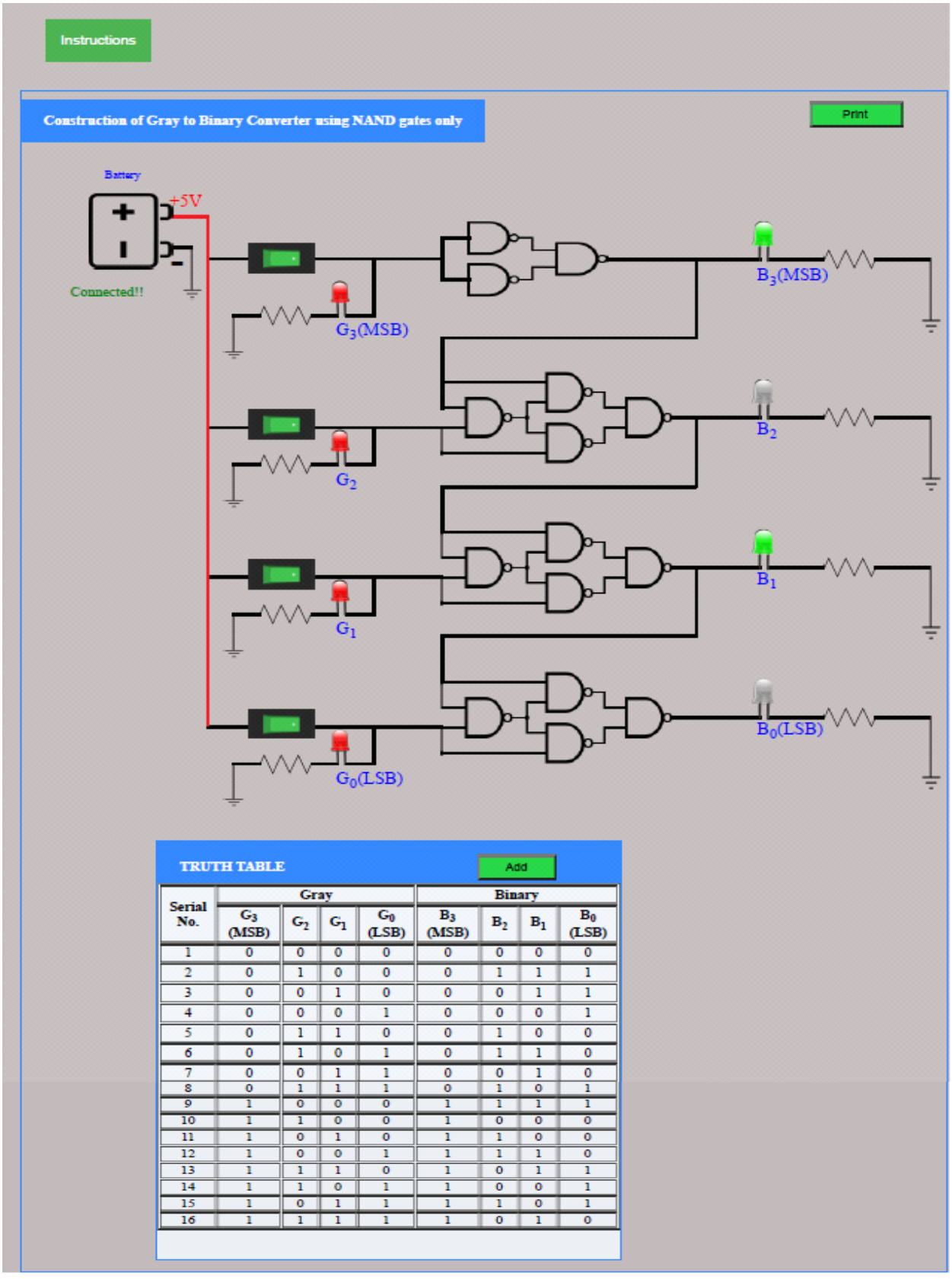


TRUTH TABLE

Add

Serial No.	Binary				Gray			
	B_3 (MSB)	B_2	B_1	B_0 (LSB)	G_3 (MSB)	G_2	G_1	G_0 (LSB)
1	0	0	0	0	0	0	0	0
2	0	1	0	0	0	1	1	0
3	0	0	1	0	0	0	1	1
4	0	0	0	1	0	0	0	1
5	0	1	0	1	0	1	1	1
6	0	1	1	0	0	1	0	1
7	0	0	1	1	0	0	1	0
8	0	1	1	1	0	1	0	0
9	1	0	0	0	1	1	0	0
10	1	1	0	0	1	0	1	0
11	1	0	1	0	1	1	1	1
12	1	0	0	1	1	1	0	1
13	1	1	1	0	1	0	0	1
14	1	1	0	1	1	0	1	1
15	1	0	1	1	1	1	1	0
16	1	1	1	1	1	0	0	0

➢ GRAY TO BINARY CODE CONVERTER :



Serial No.	Gray				Binary			
	G_3 (MSB)	G_2	G_1	G_0 (LSB)	B_3 (MSB)	B_2	B_1	B_0 (LSB)
1	0	0	0	0	0	0	0	0
2	0	1	0	0	0	1	1	1
3	0	0	1	0	0	0	1	1
4	0	0	0	1	0	0	0	1
5	0	1	1	0	0	1	0	0
6	0	1	0	1	0	1	1	0
7	0	0	1	1	0	0	1	0
8	0	1	1	1	0	1	0	1
9	1	0	0	0	1	1	1	1
10	1	1	0	0	1	0	0	0
11	1	0	1	0	1	1	0	0
12	1	0	0	1	1	1	1	0
13	1	1	1	0	1	0	1	1
14	1	1	0	1	1	0	0	1
15	1	0	1	1	1	1	0	1
16	1	1	1	1	1	0	1	0

- ***CALCULATIONS :***

➢ Verification of Truth Table of conversion from Binary to Gray using NAND Gates

TRUTH TABLE

Serial No.	Binary				Gray			
	B_3 (MSB)	B_2	B_1	B_0 (LSB)	G_3 (MSB)	G_2	G_1	G_0 (LSB)
1	0	0	0	0	0	0	0	0
2	0	1	0	0	0	1	1	0
3	0	0	1	0	0	0	1	1
4	0	0	0	1	0	0	0	1
5	0	1	1	0	0	1	0	1
6	0	1	0	1	0	1	1	1
7	0	0	1	1	0	0	1	0
8	0	1	1	1	0	1	0	0
9	1	0	0	0	1	1	0	0
10	1	0	0	1	1	1	0	1
11	1	0	1	0	1	1	1	1
12	1	1	0	0	1	0	1	0
13	1	1	1	0	1	0	0	1
14	1	1	0	1	1	0	1	1
15	1	0	1	1	1	1	1	0
16	1	1	1	1	1	0	0	0

- Verification of Truth Table of conversion from Gray to Binary using NAND Gates.

TRUTH TABLE

Serial No.	Gray				Binary			
	G_3 (MSB)	G_2	G_1	G_0 (LSB)	B_3 (MSB)	B_2	B_1	B_0 (LSB)
1	0	0	0	0	0	0	0	0
2	0	1	0	0	0	1	1	1
3	0	0	1	0	0	0	1	1
4	0	0	0	1	0	0	0	1
5	0	0	1	1	0	0	1	0
6	0	1	0	1	0	1	1	0
7	0	1	1	0	0	1	0	0
8	0	1	1	1	0	1	0	1
9	1	0	0	0	1	1	1	1
10	1	0	0	1	1	1	1	0
11	1	0	1	0	1	1	0	0
12	1	1	0	0	1	0	0	0
13	1	1	1	0	1	0	1	1
14	1	1	0	1	1	0	0	1
15	1	0	1	1	1	1	0	1
16	1	1	1	1	1	0	1	0

• ***RESULT AND CONCLUSION:***

- Verified the Truth Table of Conversion of Binary to Gray using NAND Gates.
- Verified the Truth Table of Conversion of Gray to Binary using NAND Gates.

• ***PRECAUTIONS:***

- All the connections should be made properly as per the circuit diagram.
- Connections should be tight and easy to inspect.
- Power supply should be 5v.
- Keep the switch turned off while making connections.