Circuit Simulation Project

https://esim.fossee.in/circuit-simulation-project

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Title of the circuit: Binary to Gray Code conversion

Theory/ Description:

The Gray code is a non-weighted code, and is not suitable for arithmetic operations. It is not a BCD code, it is a cyclic code because of successive code words in this code differ in 1 bit position only i.e., a unit distance code. It is also a reflective code.

Binary to Gray Code Conversion:

If n-bit number is represented by $B_n, B_{n-1}, \ldots, B_1$ and its Gray code equivalent by $G_n, G_{n-1}, \ldots, G_1$, where B_n and G_n are the MSBs. The Gray code bits are obtained from the binary code as follows:

$$G_n = B_n$$

$$G_{n-1} = B_n \oplus B_{n-1}$$

$$G_{n-2} = B_{n-1} \oplus B_{n-2}$$

$$: \; : \; :$$

$$G_1 = B_2 \oplus B_1$$

where $\oplus$ is the Exclusive OR (XOR) operation.

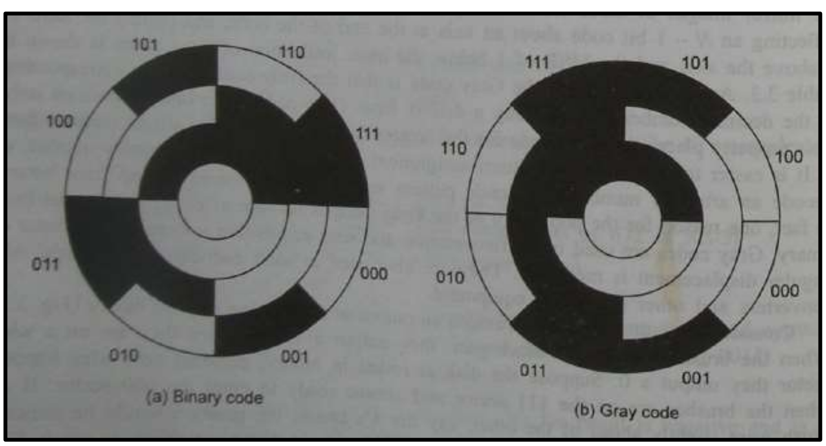


Fig 1 – Binary code and Gray Code Relation [2]

The truth table for the Binary to Gray Code conversion is:

Table 1 – Truth Table

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

The procedure to convert binary to Gray code is as follow:

1. Record the MSB of the binary as the MSB of the Gray code.
2. Add the MSB of the binary to the next bit in binary, recording the sum and ignoring the carry, if any, i.e., XOR the bits. This sum is the next bit of the Gray code.
3. Add the 2nd bit of the binary to the 3rd bit of the binary, the 3rd bit of the binary to the 4th bit and so on.
4. Record the successive sums as the successive bits of the Gray code until all the bits of the binary number are exhausted.

The Gray code is used in a few specific applications. The main applications include being used in analog to digital converters, as well as being used for error correction in digital communication. Gray code is used to minimize errors in converting analog signals to digital signals.

Circuit Diagram(s):

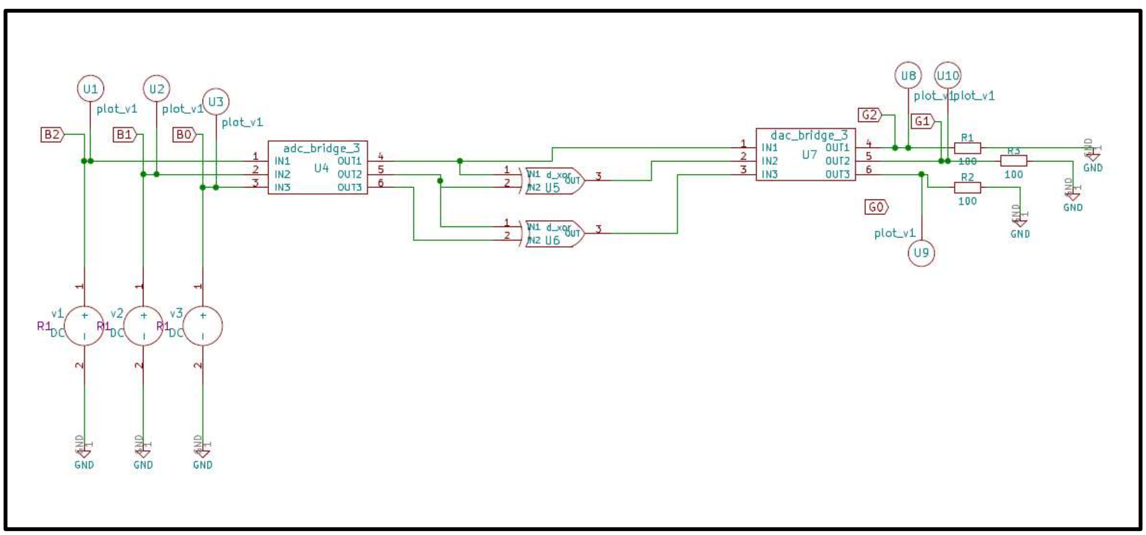


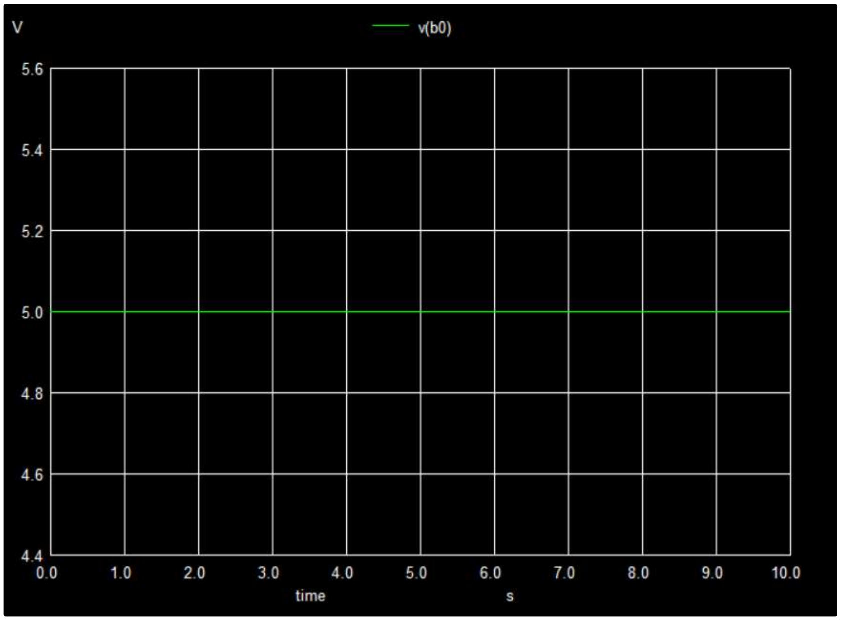
Fig. 2 – Circuit diagram of Binary to Gray code conversion

Results (Input, Output waveforms and/or Multimeter readings):

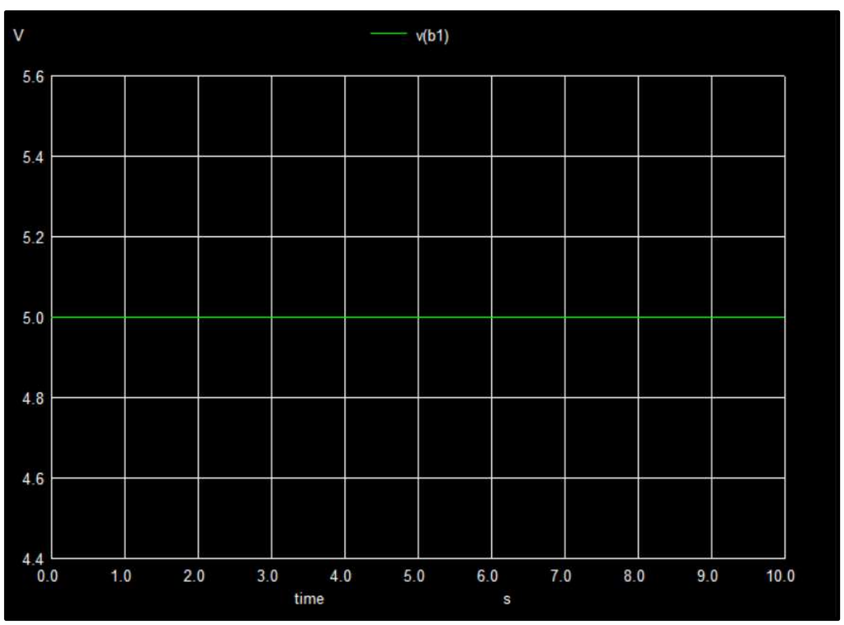
For input – 111 the output should be 100 which can be observed and verified from the following plots.

Inputs: B0|B1|B2 = 111 (each 5V)

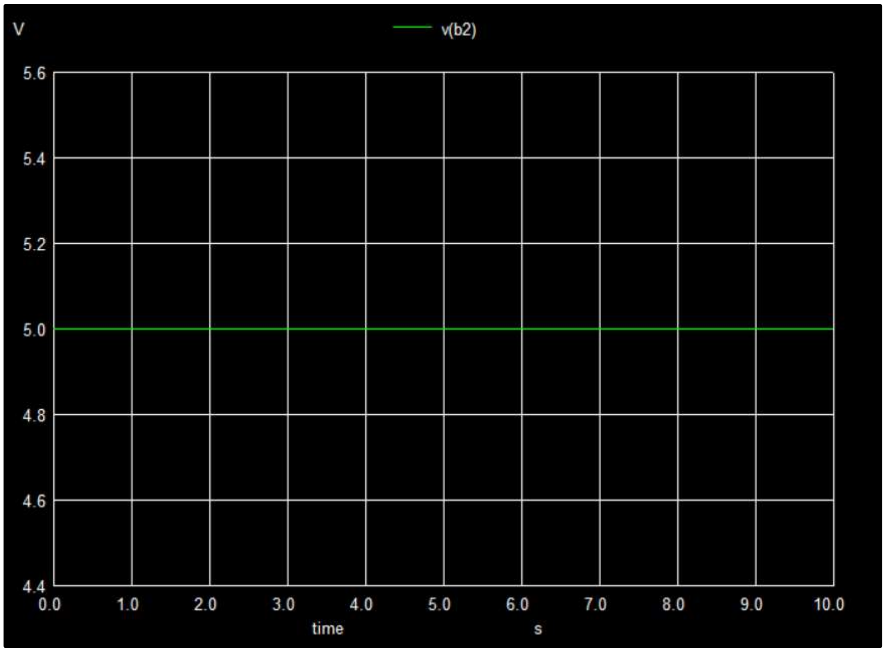
1. B0 bit input



2. B1 bit input

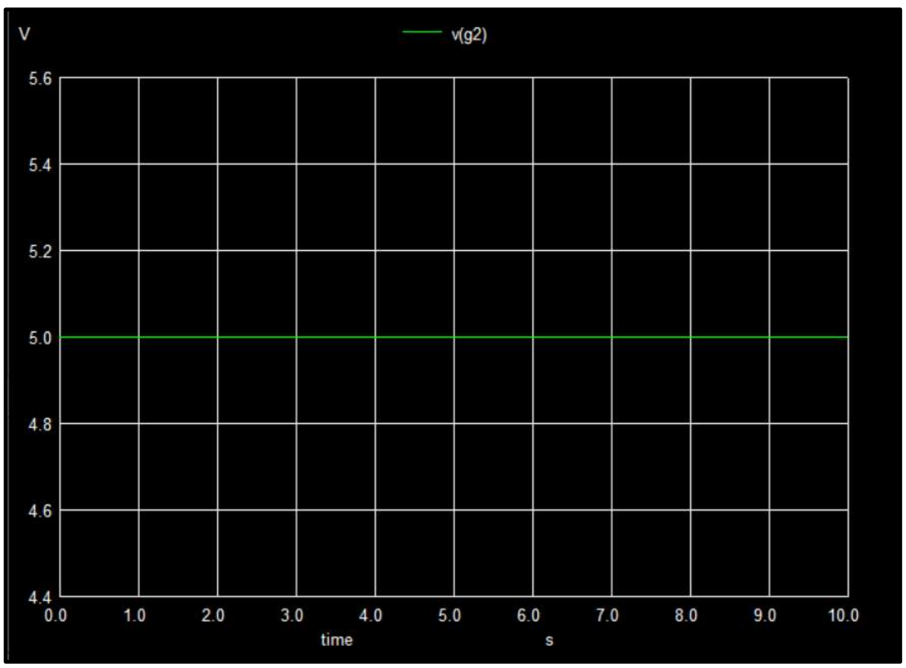


3. B2 bit input

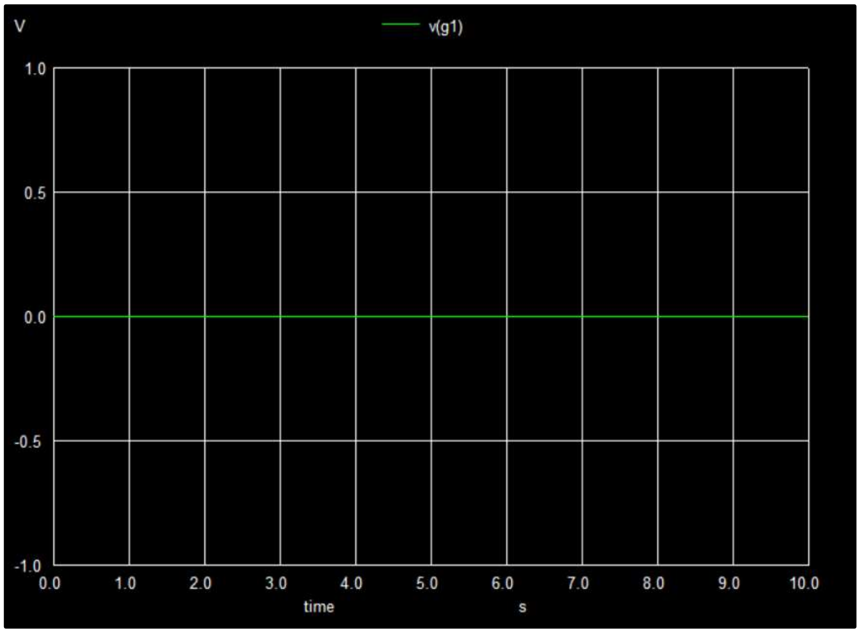


Outputs: G2|G1|G0 = 100

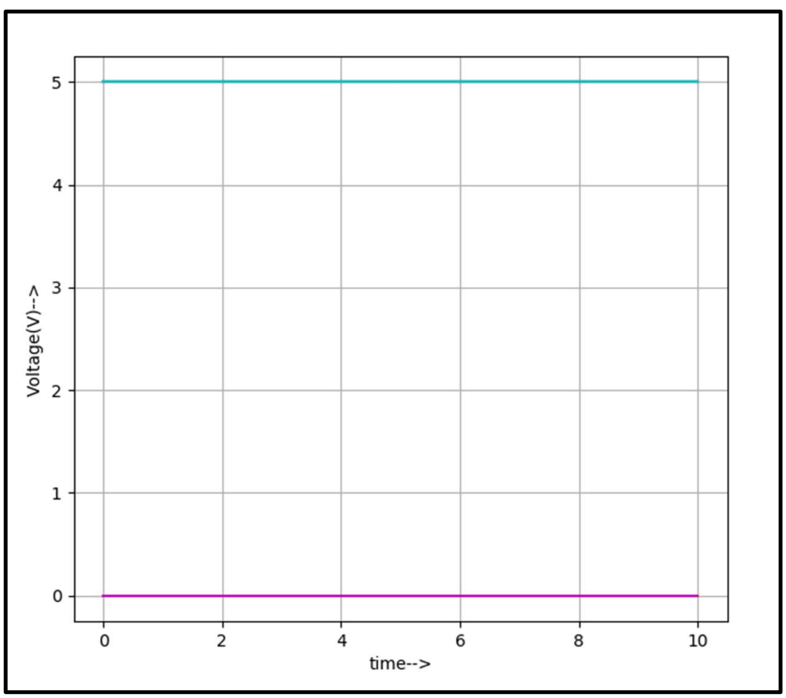
1. G2 bit output (G1 and G0 bits are 0)



2. Output G1 and G0



Python Plot:



Source/Reference(s):

1. https://www.electrical4u.com/binary-to-gray-code-converter-and-grey-to-binary-code-converter/
2. Book - Digital Circuits by Anand Kumar