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CIRCUIT SIMULATION PROJECT

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Project Guide: Dr.R.Maheswari

Title: Full Subtractor circuit Using Subcircuits (2 Half Subtractors)

THEORY/DESCRIPTION:

In this project, Output Waveforms of Full Subtractor circuit using 2 Half Subtractors in eSim is analysed. A full subtractor is a **combinational circuit** that performs subtraction of two bits, one is minuend and other is subtrahend, taking into account borrow of the previous adjacent lower minuend bit.

This circuit **has three inputs and two outputs**. The three inputs A, B and Bin, denote the minuend, subtrahend, and previous borrow, respectively. The two outputs, D and Bout represent the difference and output borrow, respectively.

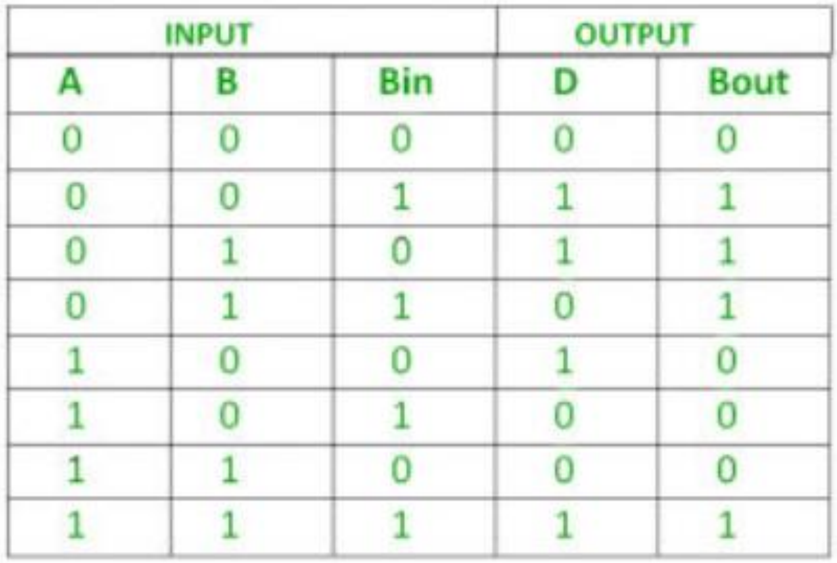
Bin is set when the previous digit is borrowed from A. Thus, Bin is also subtracted from A as well as the subtrahend B. Or in symbols: A-B-Bin.

Like the half subtractor, the full subtractor generates a borrow out when it needs to borrow from the next digit.

Since we are subtracting B and Bin from A, a borrow out needs to be generated when A<B+Bin.

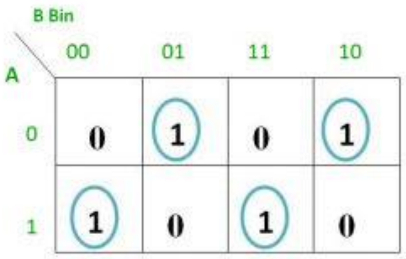
When a borrow out is generated, 2 is added in the current digit. (This is similar to the subtraction algorithm in decimal. Instead of adding 2, we add 10 when we borrow.) Therefore, D=A-B-Bin+2Bout.

TRUTH TABLE:



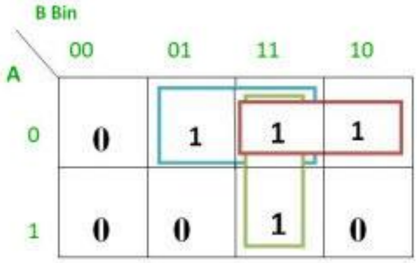
INPUT			OUTPUT	
A	B	Bin	D	Bout
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	0	1
1	0	0	1	0
1	0	1	0	0
1	1	0	0	0
1	1	1	1	1

From above table we can draw the K-Map as shown for "Difference" and "Borrow".



A \ B Bin	00	01	11	10
0	0	1	0	1
1	1	0	1	0

D=A'B'Bin + AB'Bin' + A'BBin' + ABBin



A \ B Bin	00	01	11	10
0	0	1	1	1
1	0	0	1	0

Bout=A'Bin + A'B + BBin

Logical expression for difference –

D = A'B'Bin + A'BBin' + AB'Bin' + ABBin

= Bin (A'B' + AB) + Bin' (AB' + A'B)

= Bin (A XNOR B) + Bin' (A XOR B)

= Bin (A XOR B)' + Bin' (A XOR B)

= Bin XOR (A XOR B)

= (A XOR B) XOR Bin

Logical expression for borrow –

Bout = A’B’Bin + A’BBin’ + A’BBin + ABBin

= A’B’Bin +A’BBin’ + A’BBin + A’BBin + A’BBin + ABBin

= A’Bin(B + B’) + A’B(Bin + Bin’) + BBin(A + A’)

= A’Bin + A’B + BBin

OR

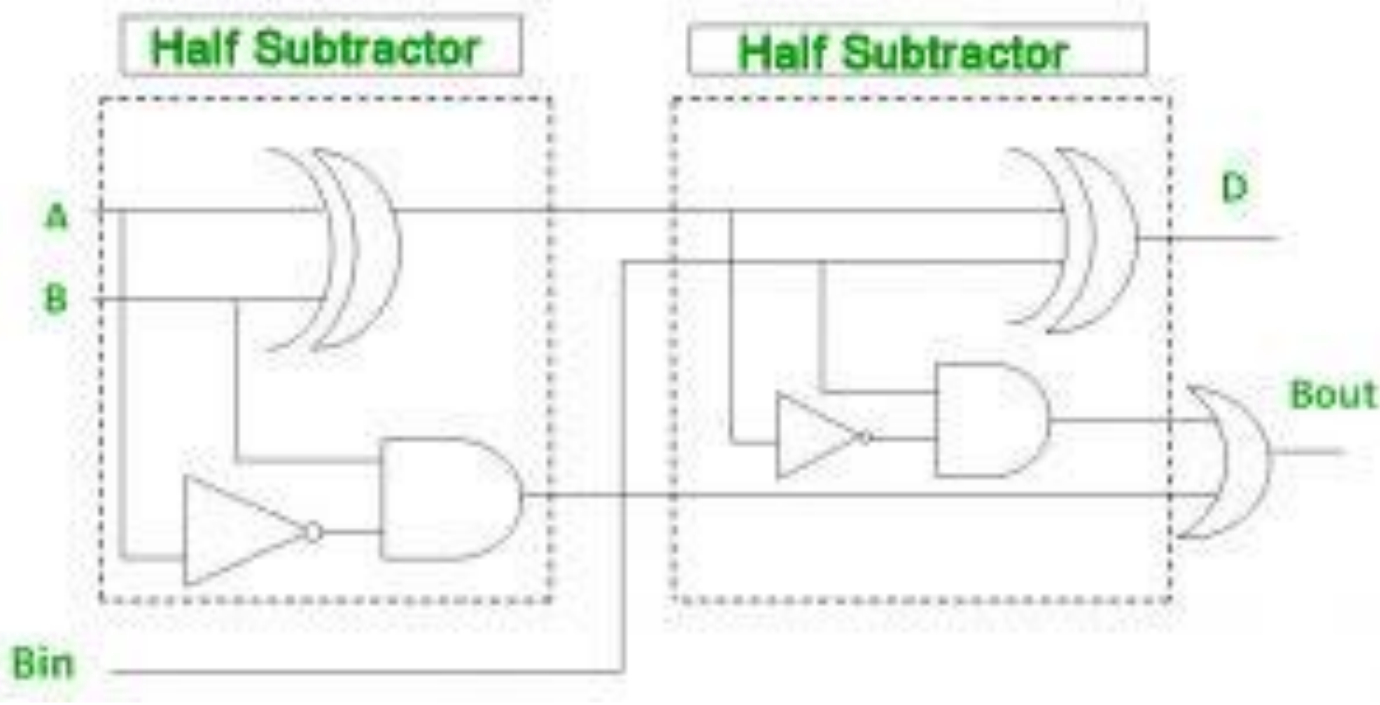
Bout = A’B’Bin + A’BBin’ + A’BBin + ABBin

= Bin (AB + A’B’) + A’B (Bin + Bin’)

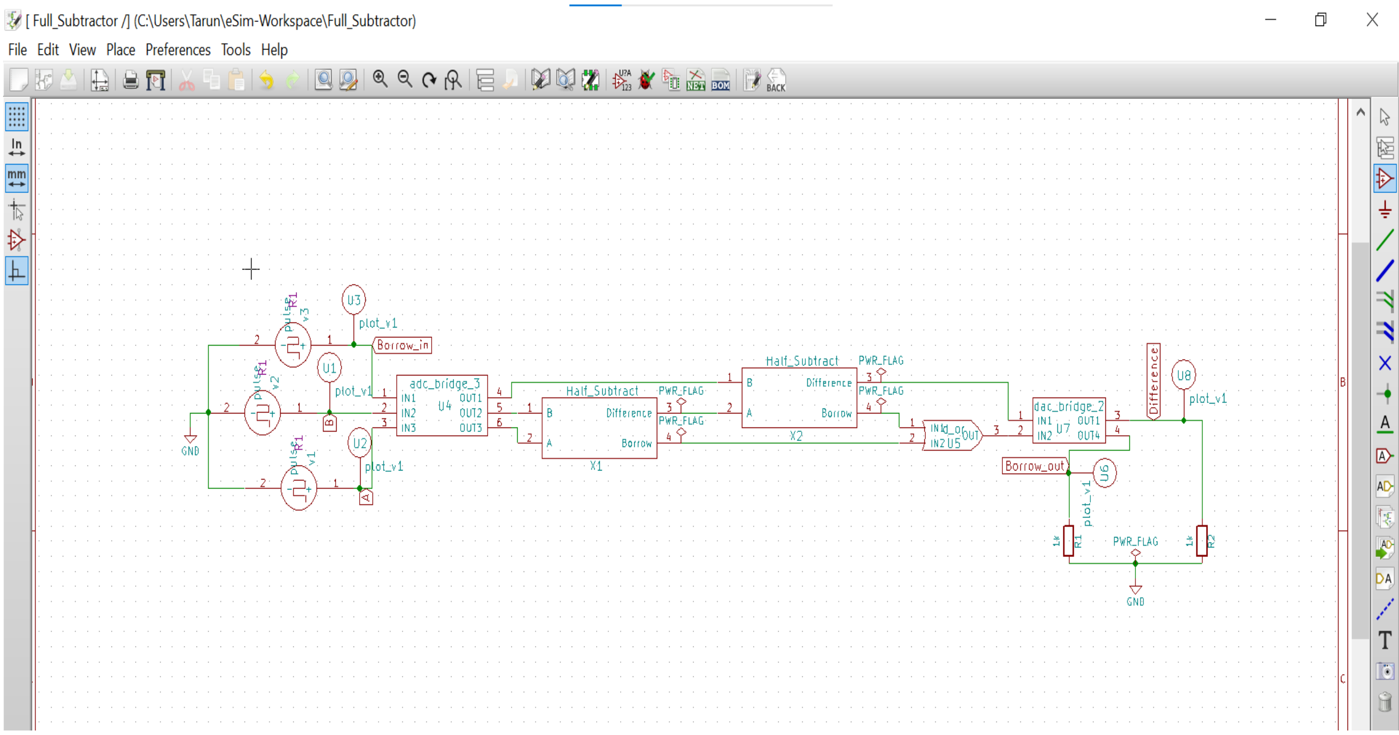
= Bin (A XNOR B) + A’B

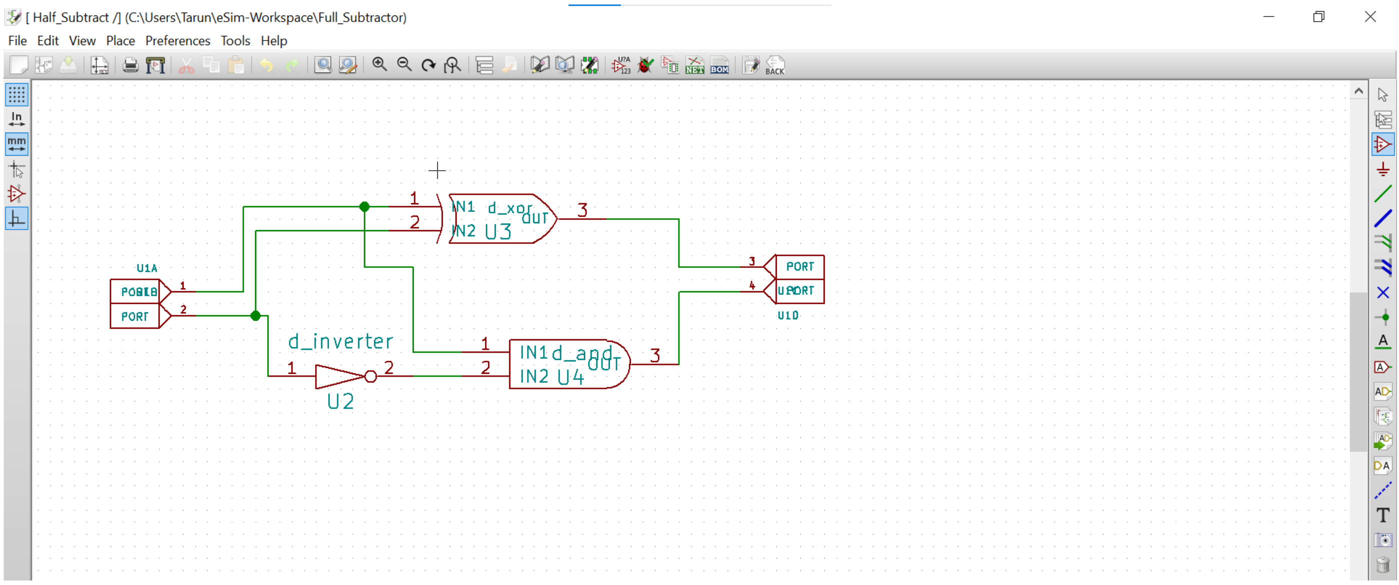
= Bin (A XOR B)’ + A’B

Model Circuit Diagram:



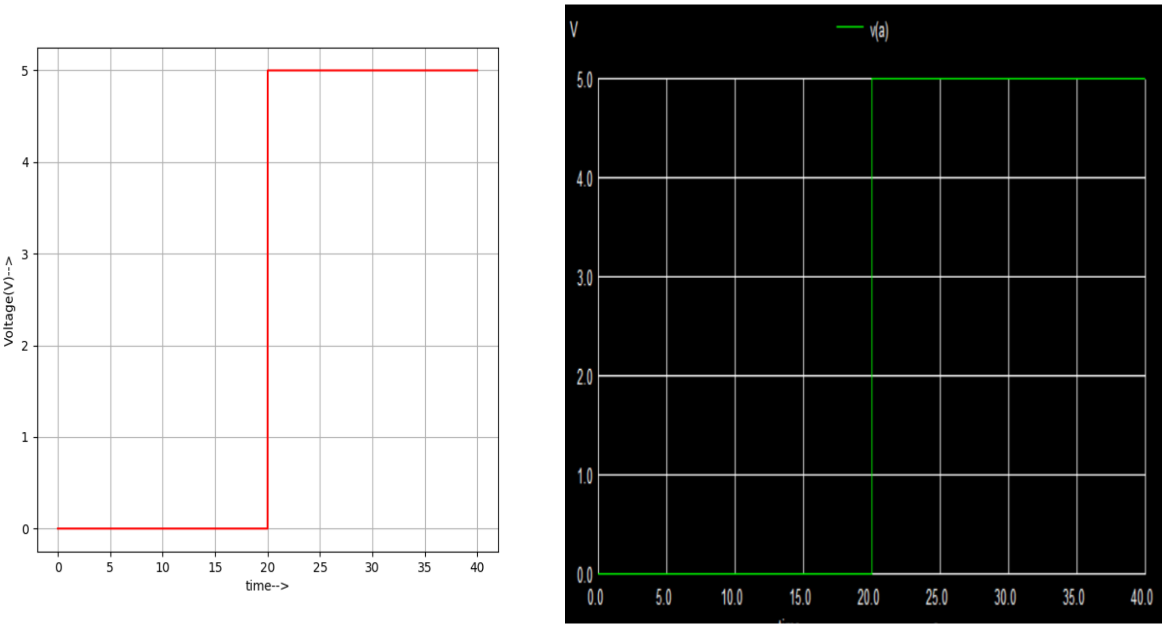
eSim Circuit Diagram:



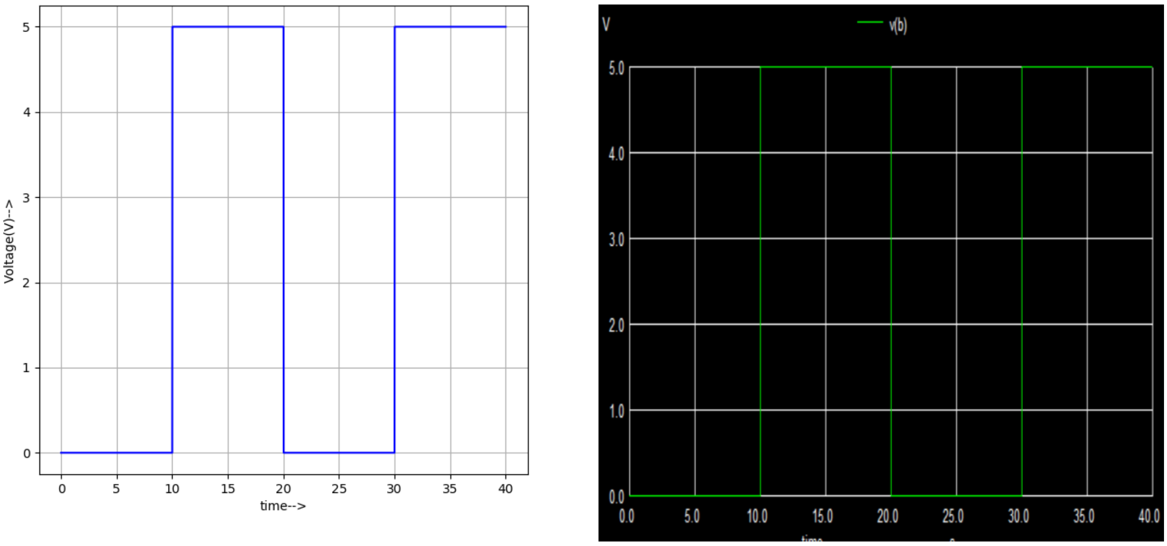

[Half_Subtract /] (C:\Users\Tarun\eSim-Workspace\Full_Subtractor)
File Edit View Place Preferences Tools Help
U1A
PORT
PORT
IN1 d_xor
IN2 U3
OUT
d_inverter
U2
IN1 d_and
IN2 U4
OUT
PORT
PORT
U1D

(Half Subtractor SubCircuit)

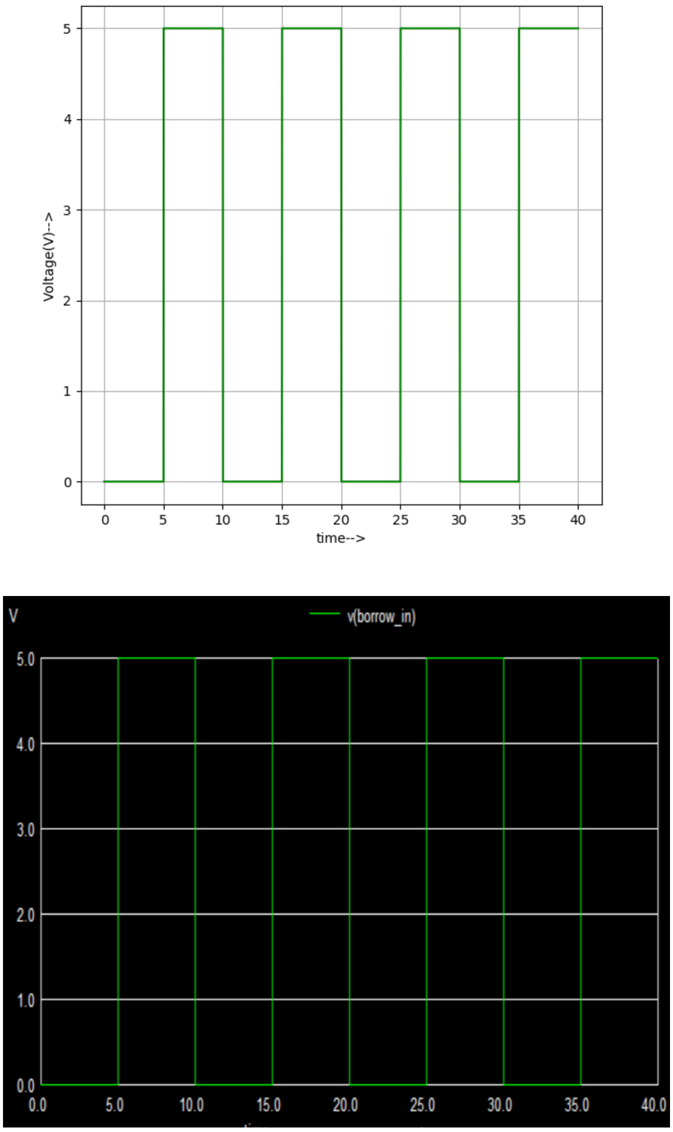
Waveforms (INPUT):



A

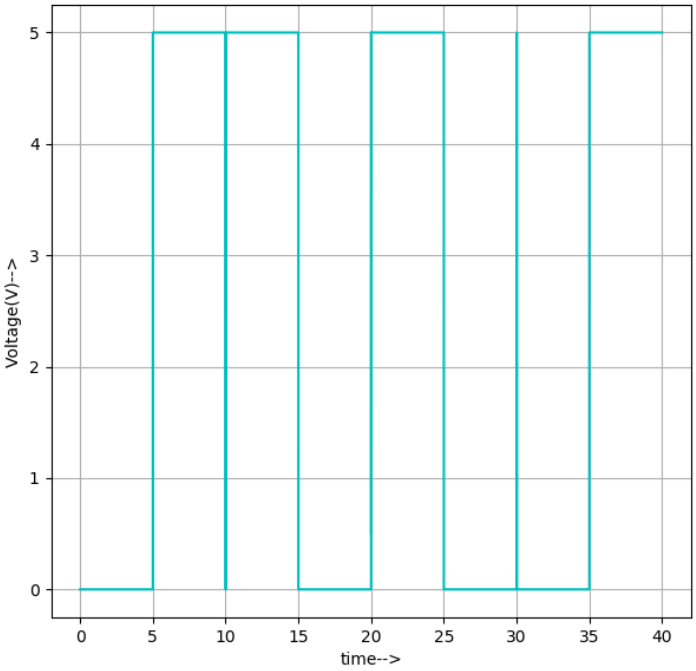


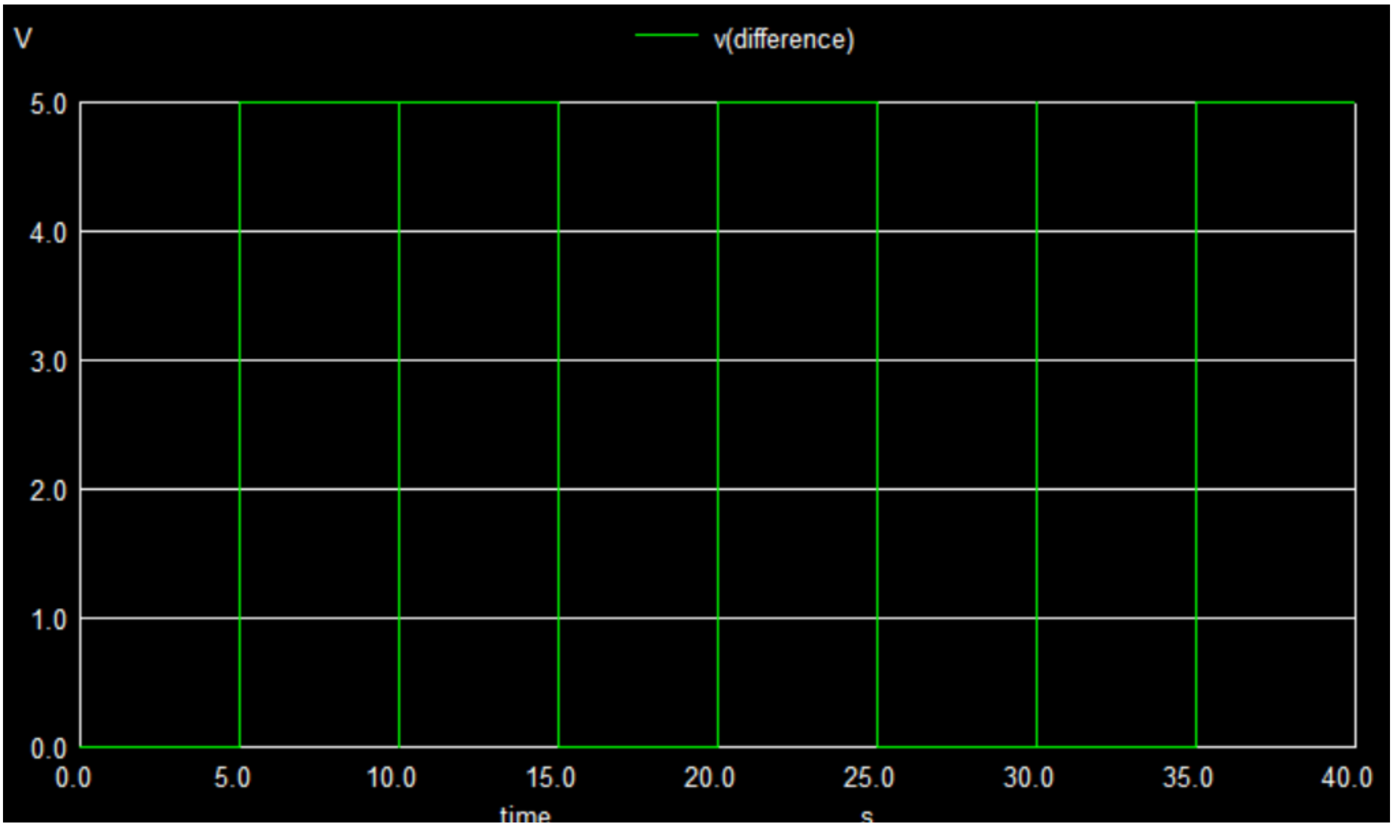
B



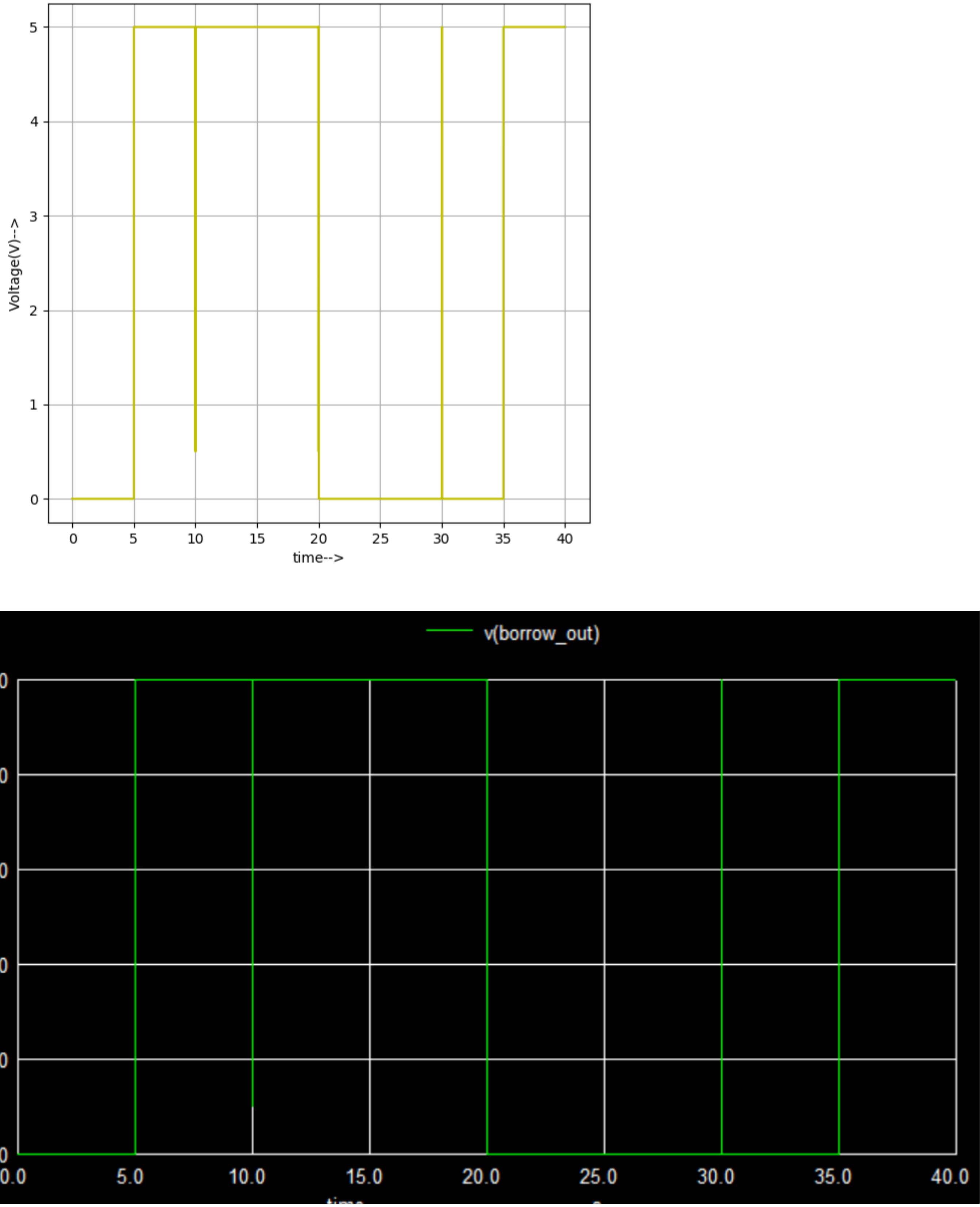
Borrow_in (Bin)

OUTPUT Waveforms:





Difference, D



Borrow_out (Bout)

Conclusion:

Hence, the analysis of Fall Subtractor using 2 Half Subtractors in eSim is studied and verified with the waveforms and truth table.

References:

https://en.wikipedia.org/wiki/Subtractor

https://www.geeksforgeeks.org/full-subtractor-in-digital-logic/