Circuit Simulation Project

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

Design of 4-Bit Braun Multiplier using Kogge-Stone Adder

by

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THEORY/DESCRIPTION :

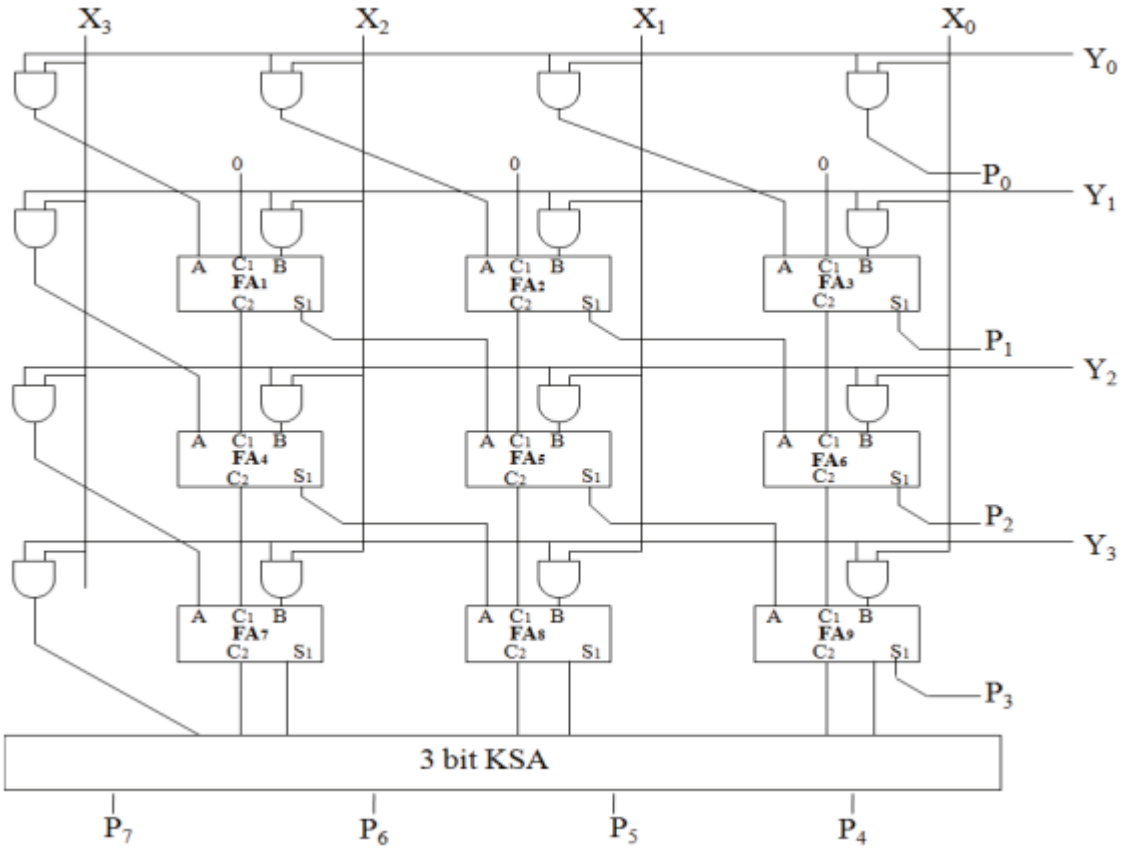
Multiplication is an important fundamental arithmetic operation. It is commonly used in digital signal processing applications and contributes to significant amount of delay. A multiplier is a basic block of any processor that achieves multiplication and a huge boost in performance can be achieved by enhancing the performance of a multiplier.

Over time, computational needs have increased and hence the demand for a parallel array multiplier that can achieve high speed and meet the performance demands has also increased.

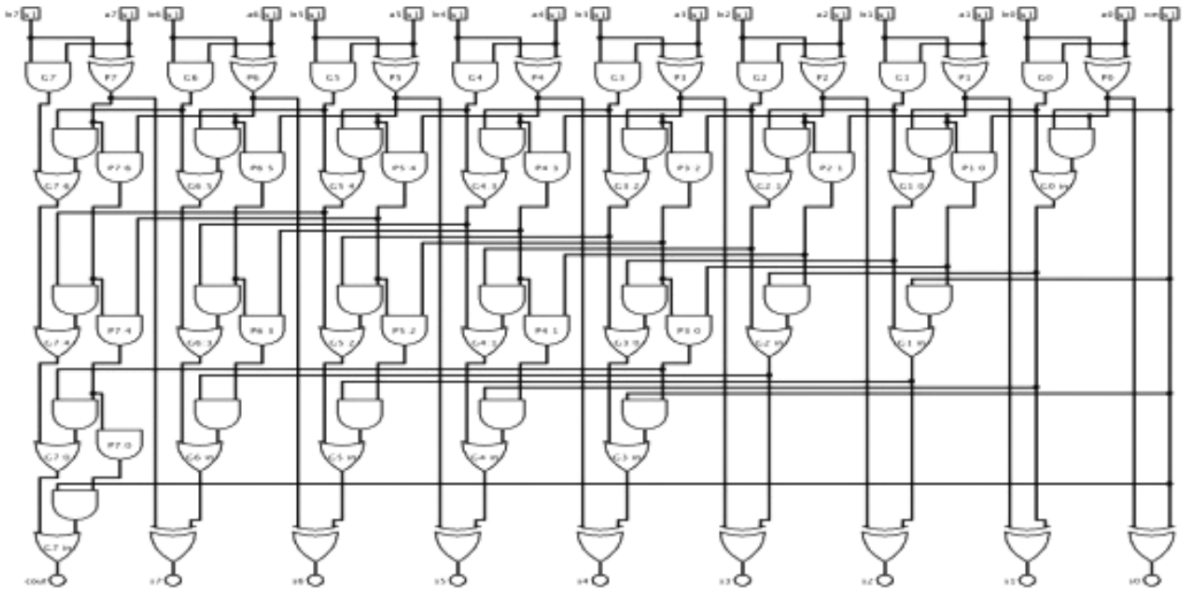
Braun multiplier is a type of parallel array multiplier that meets the above mentioned needs. This architecture can be further enhanced by using a very fast parallel prefix adder like Kogge-Stone instead of a ripple carry adder. This enables reduced delay and faster performance. Kogge-Stone adder belongs to the family of parallel prefix adders.

An n bit Braun multiplier requires $(n-1)^2$ full adders, n^2 AND gates and (n-1) bit Kogge Stone Adder. Each partial product is added to the sum of previous partial product.

CIRCUIT DIAGRAM(S) :



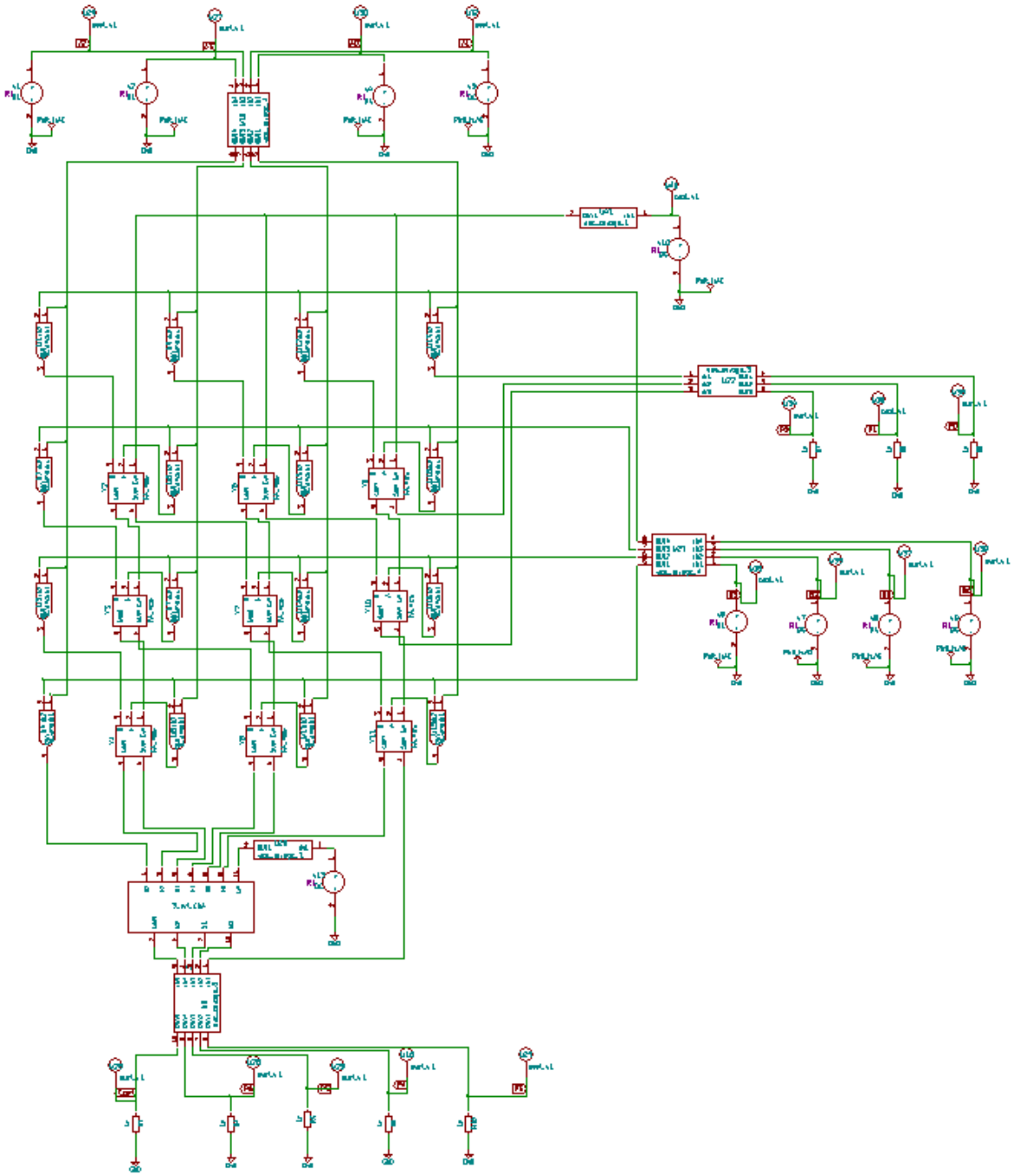
Braun multiplier with KSA



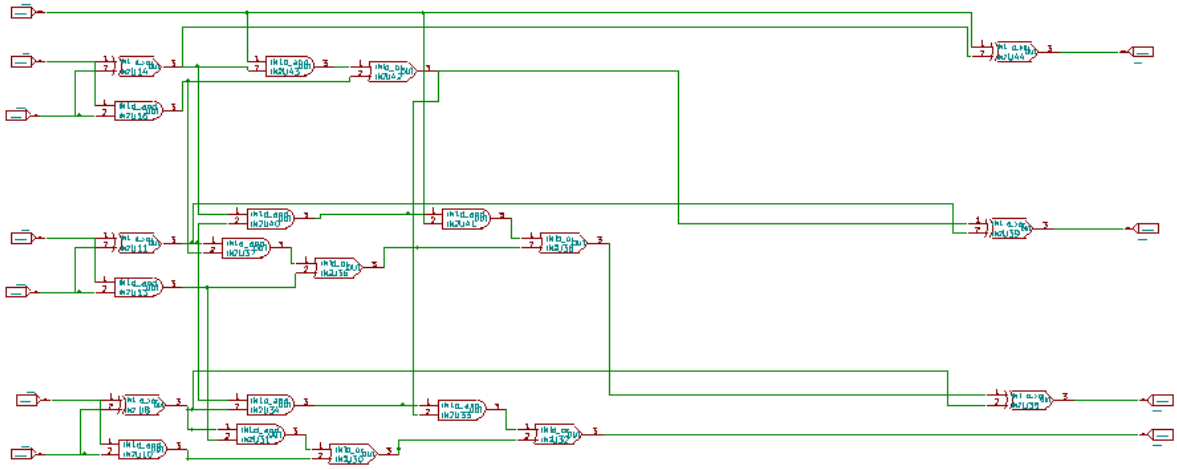
8 bit Kogge-Stone Adder

SCHEMATIC:

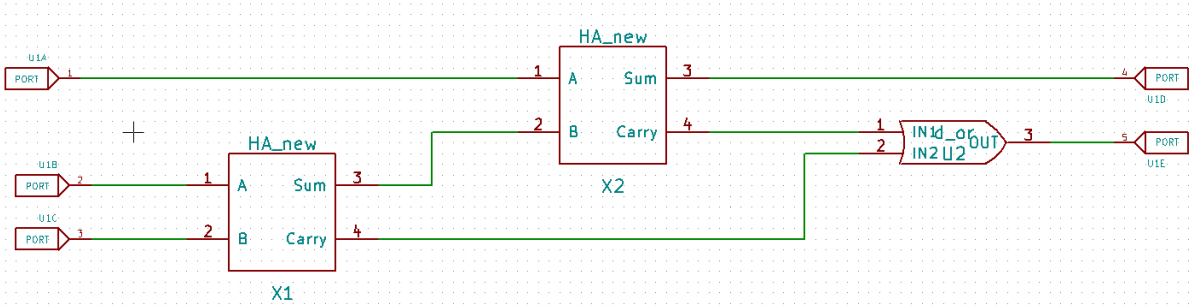
4 bit Braun multiplier using Kogge-Stone adder



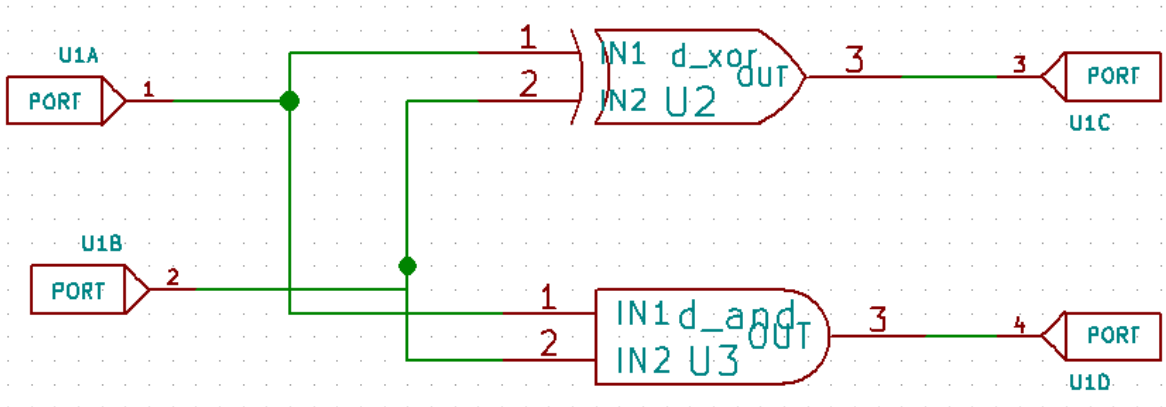
3 bit Kogge-Stone Adder



Full Adder



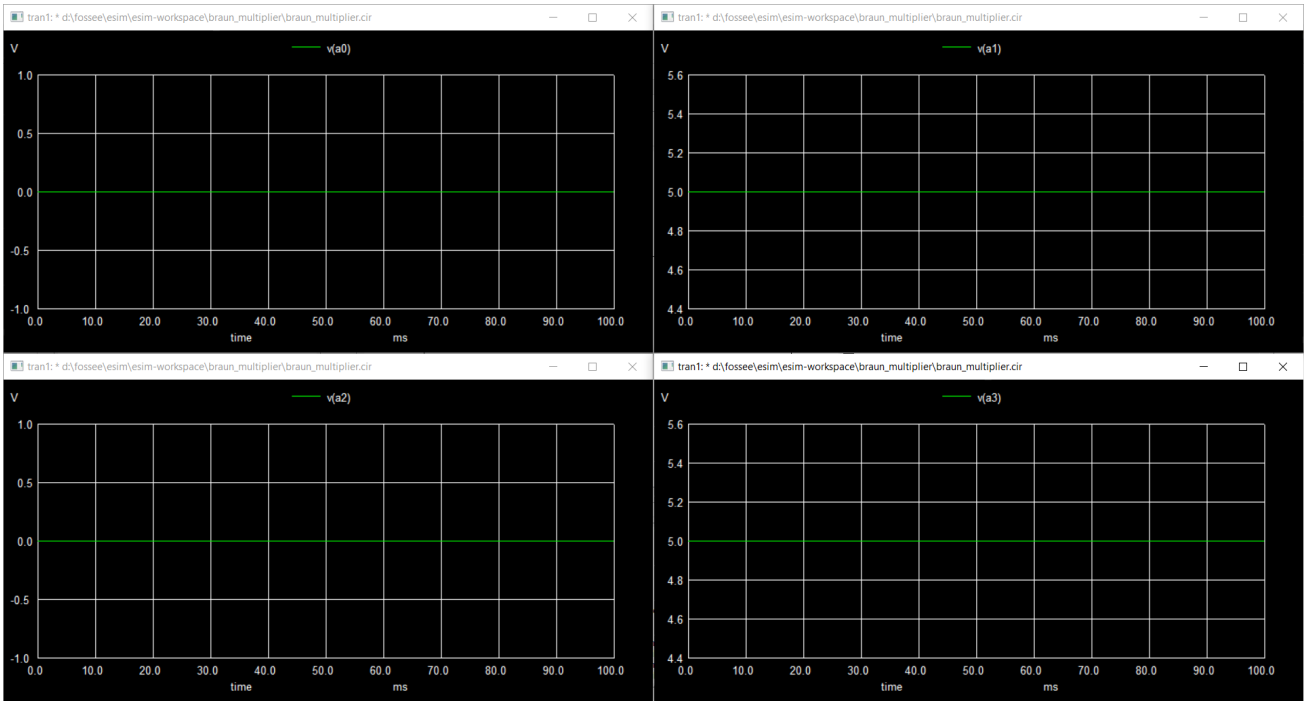
Half Adder



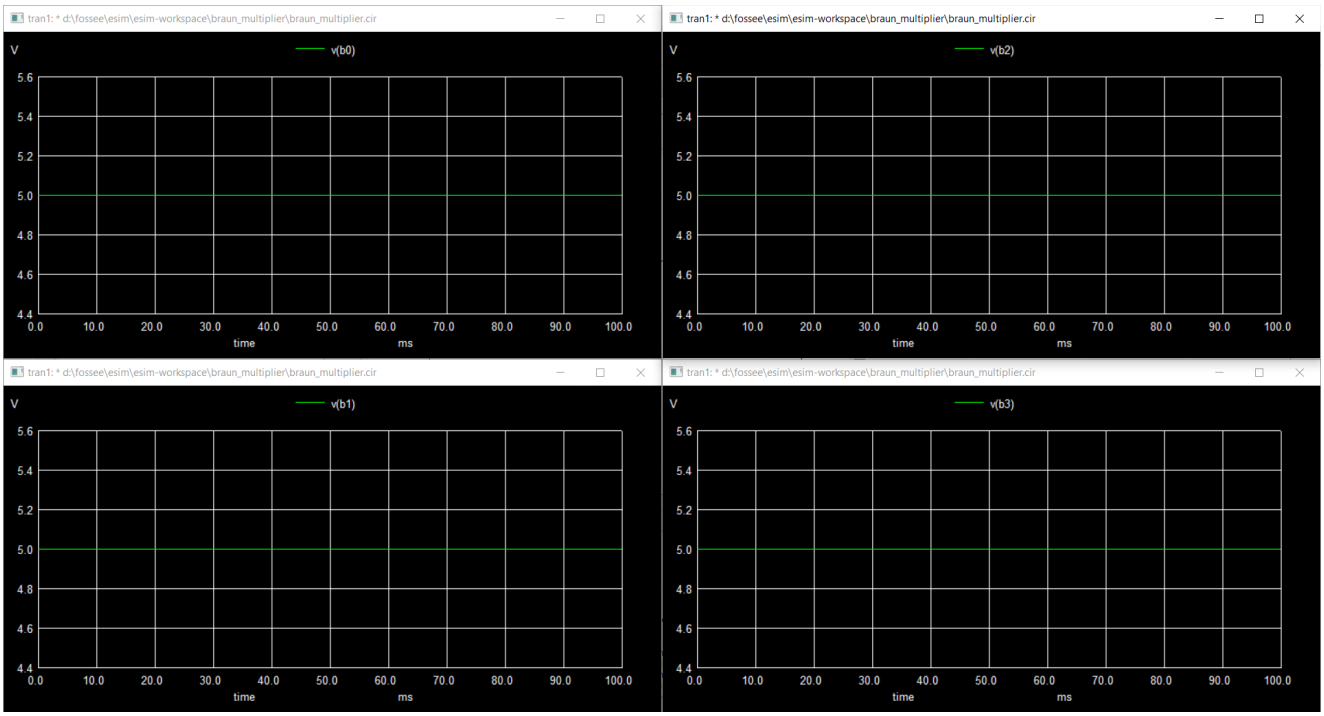
RESULTS:

Ngspice plots

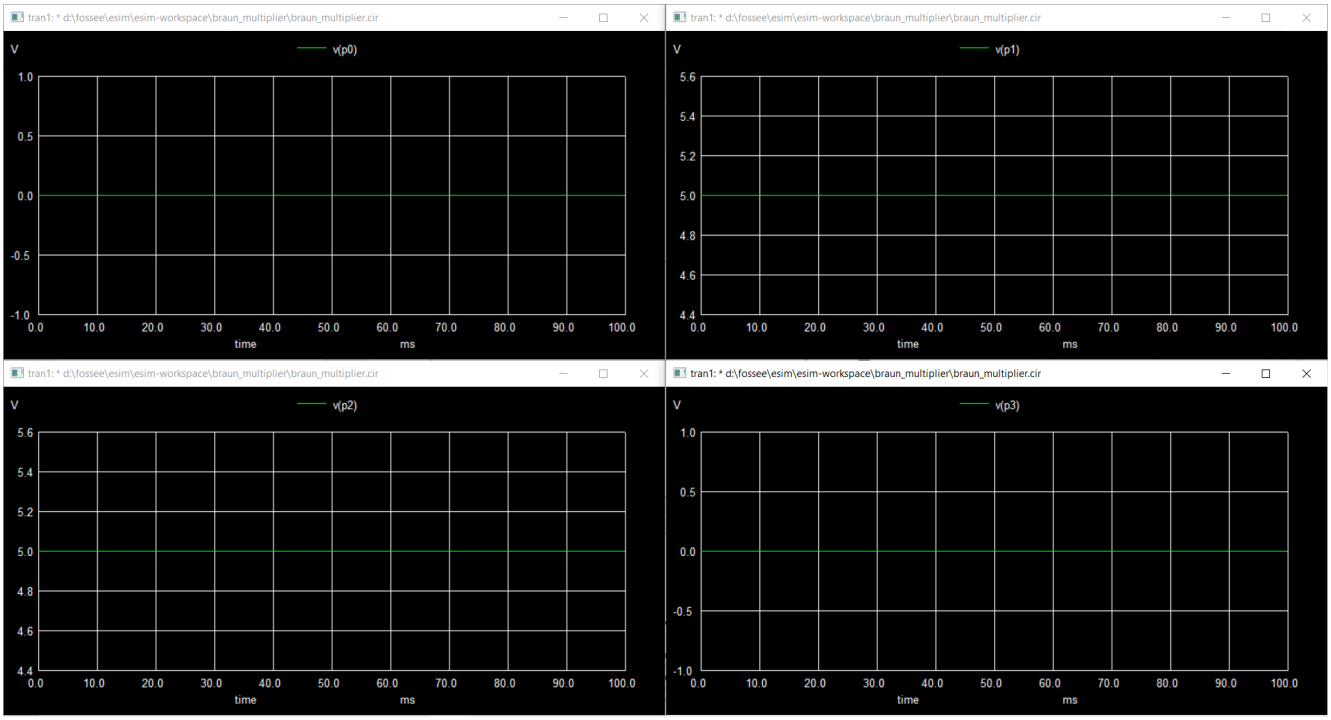
For inputs A = 1010 & B = 1111



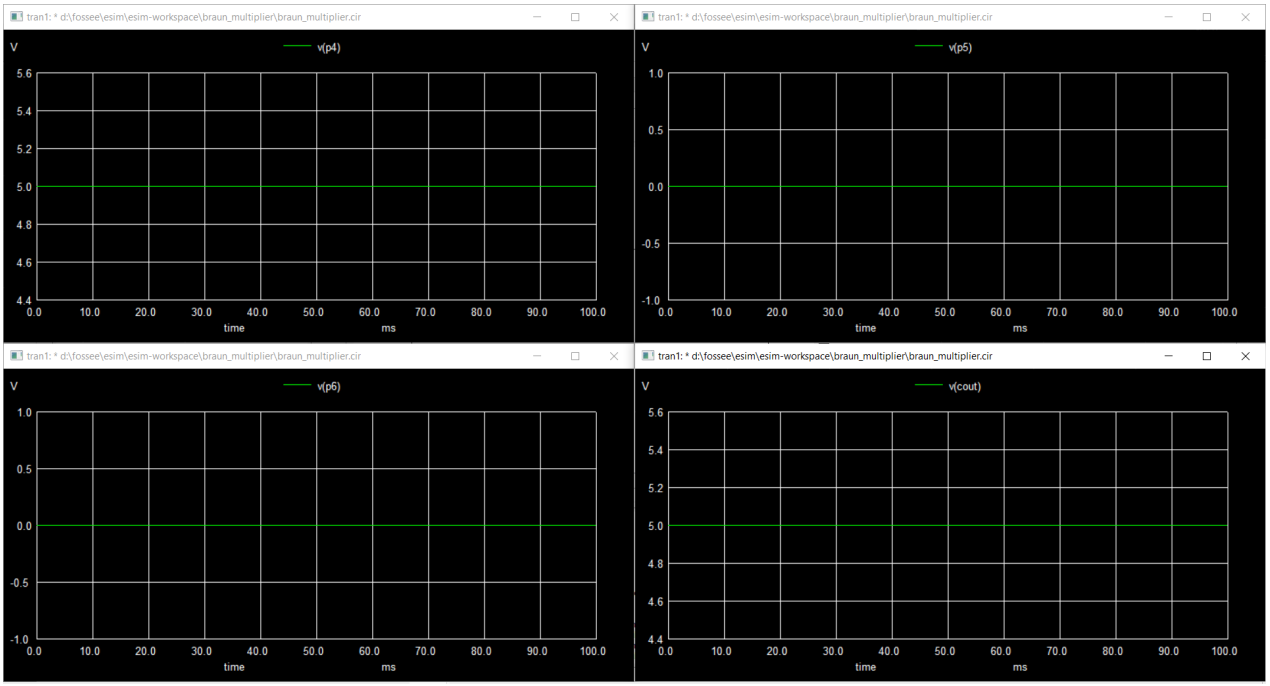
Inputs A (A0, A1, A2, A3)



Inputs B (B0, B1, B2, B3)

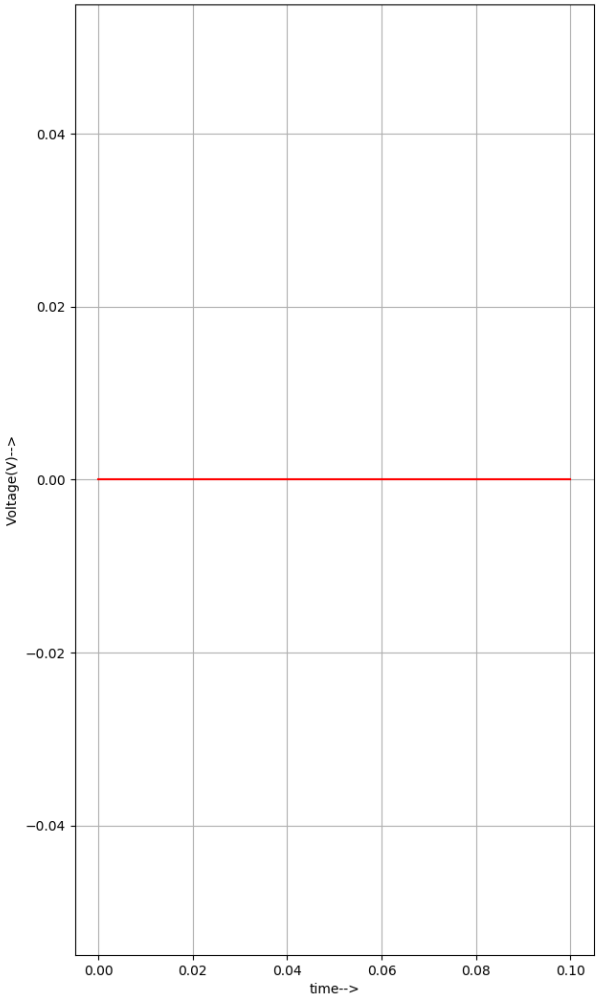


Outputs (P0, P1, P2, P3)

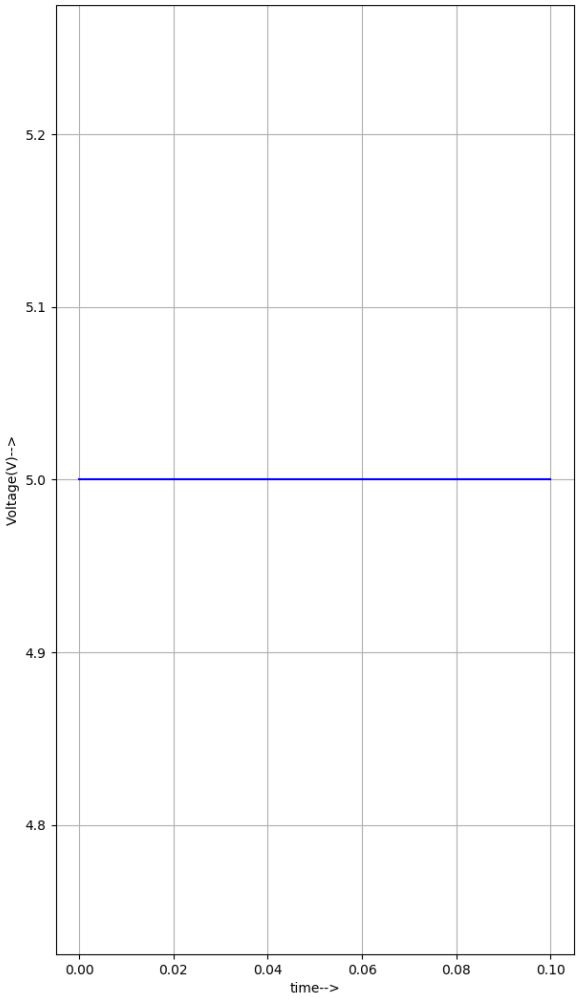


Outputs (P4, P5, P6, Cout)

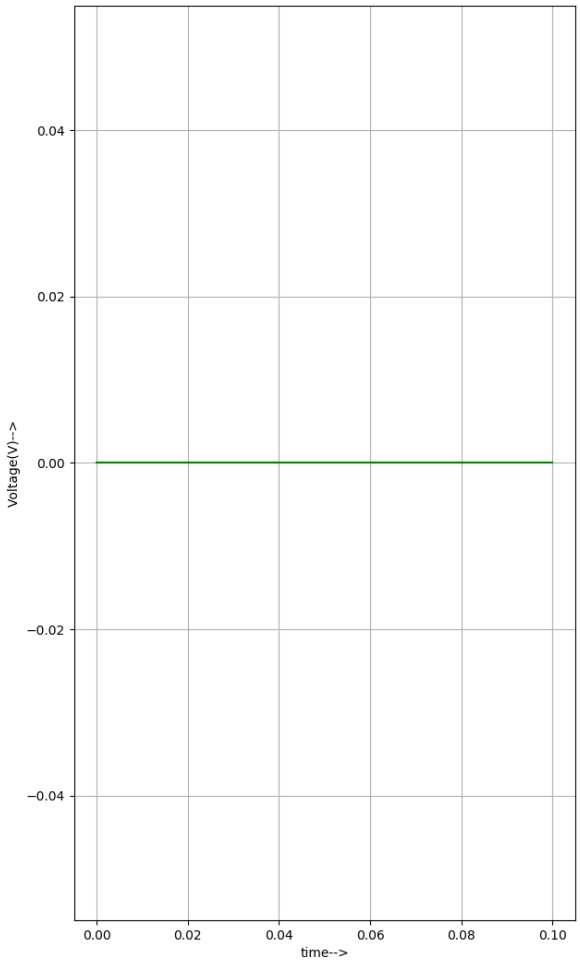
Python plots



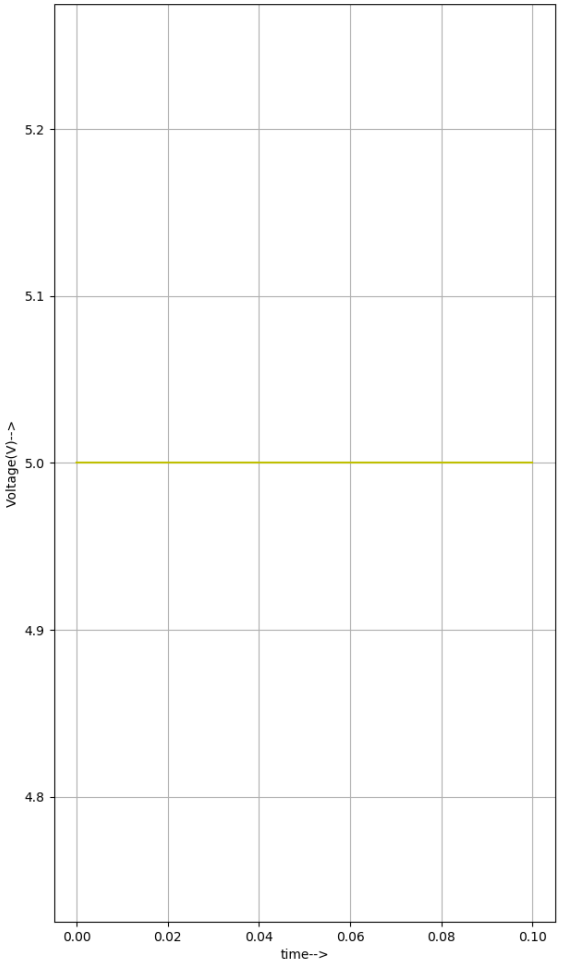
A0



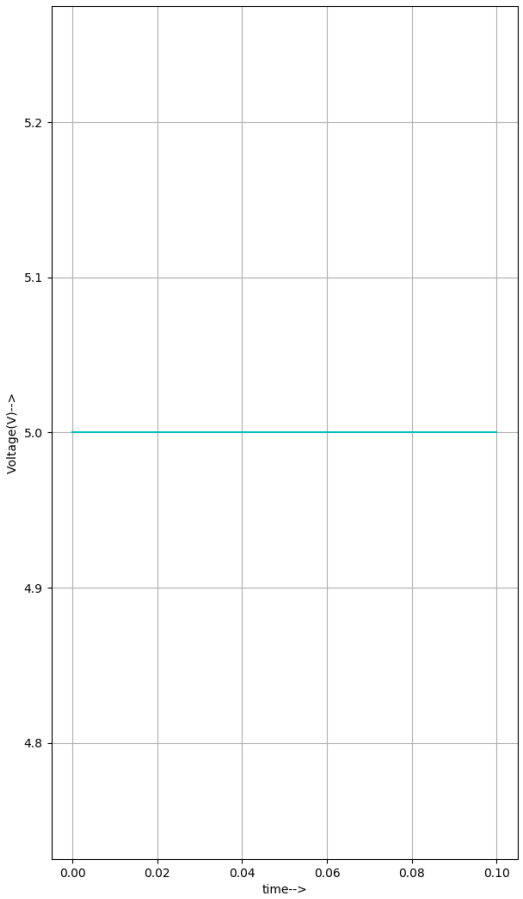
A1


0.04
0.02
0.00
−0.02
−0.04
Voltage(V)-->
0.00
0.02
0.04
0.06
0.08
0.10
time-->

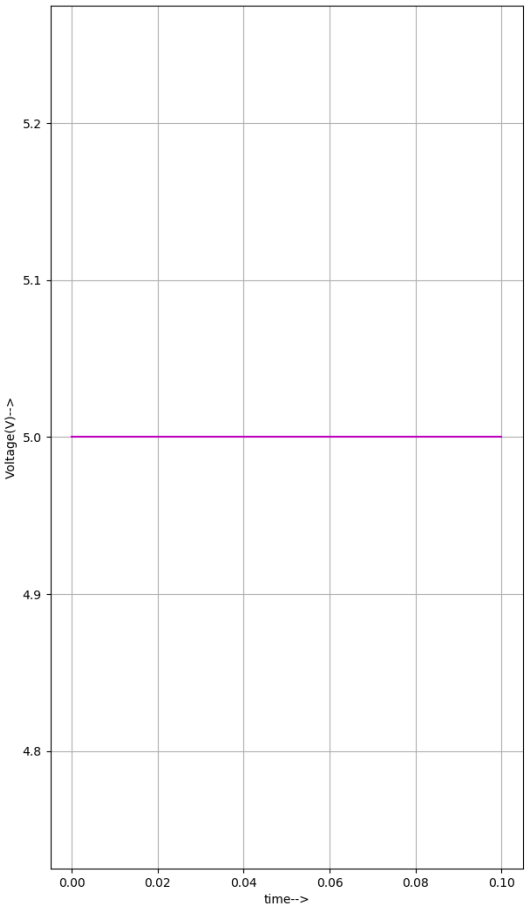
A2


5.2
5.1
5.0
4.9
4.8
Voltage(V)-->
0.00
0.02
0.04
0.06
0.08
0.10
time-->

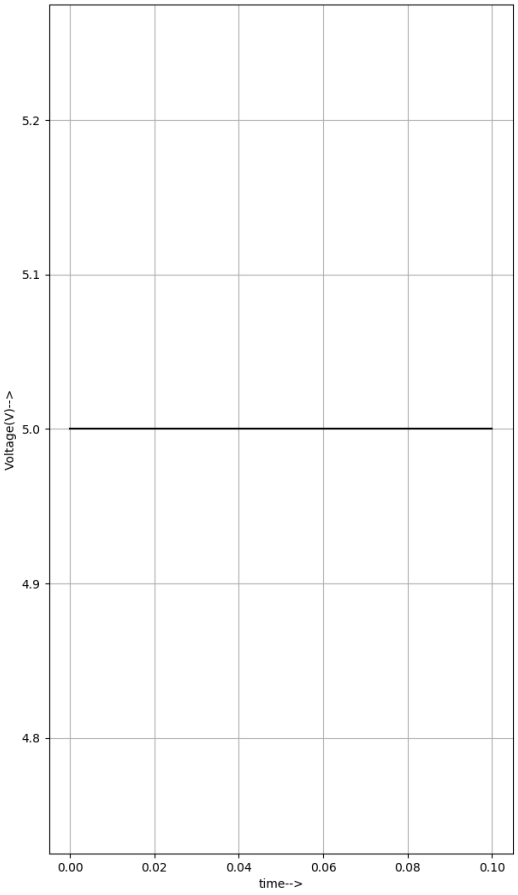
A3


5.2
5.1
5.0
4.9
4.8
Voltage(V)-->
0.00
0.02
0.04
0.06
0.08
0.10
time-->

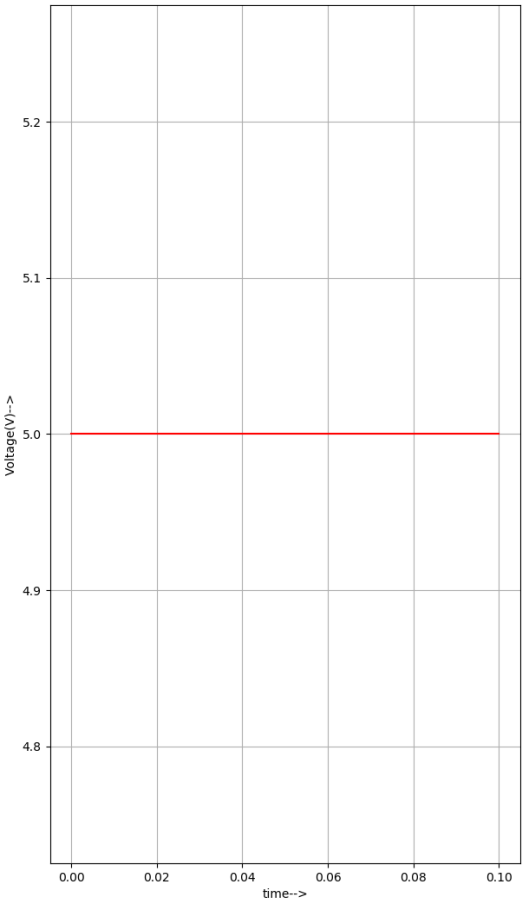
B0


5.2
5.1
5.0
4.9
4.8
Voltage(V)-->
0.00
0.02
0.04
0.06
0.08
0.10
time-->

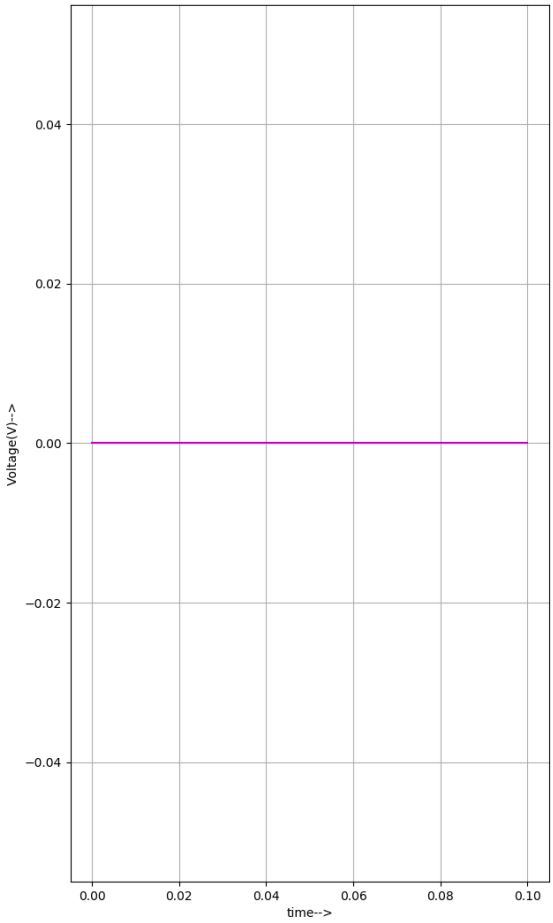
B1


5.2
5.1
5.0
4.9
4.8
Voltage(V)-->
0.00
0.02
0.04
0.06
0.08
0.10
time-->

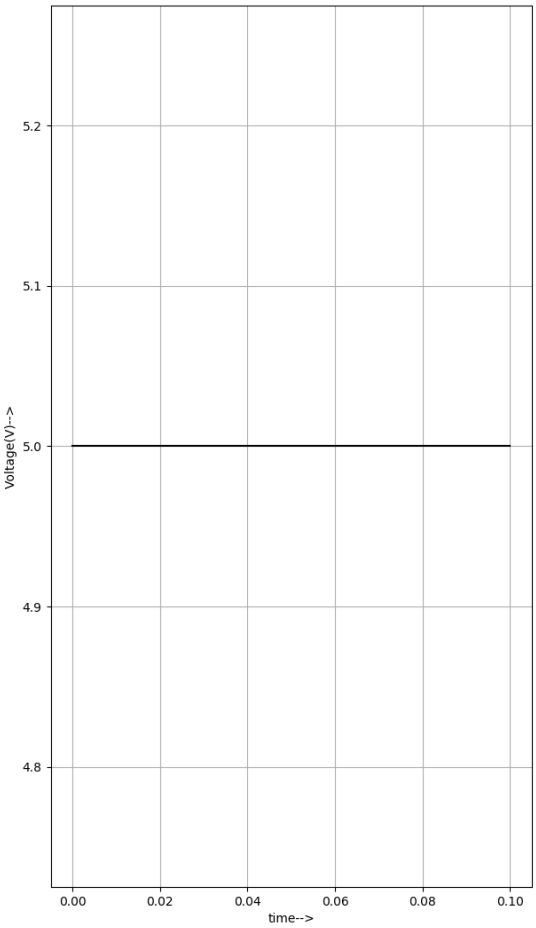
B2


5.2
5.1
5.0
4.9
4.8
Voltage(V)-->
0.00
0.02
0.04
0.06
0.08
0.10
time-->

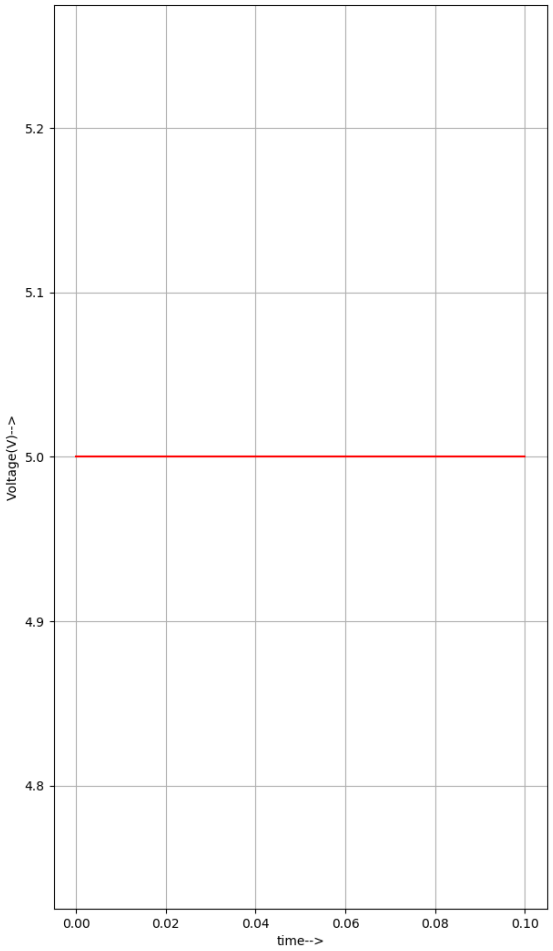
B3


0.04
0.02
0.00
−0.02
−0.04
Voltage(V)-->
0.00
0.02
0.04
0.06
0.08
0.10
time-->

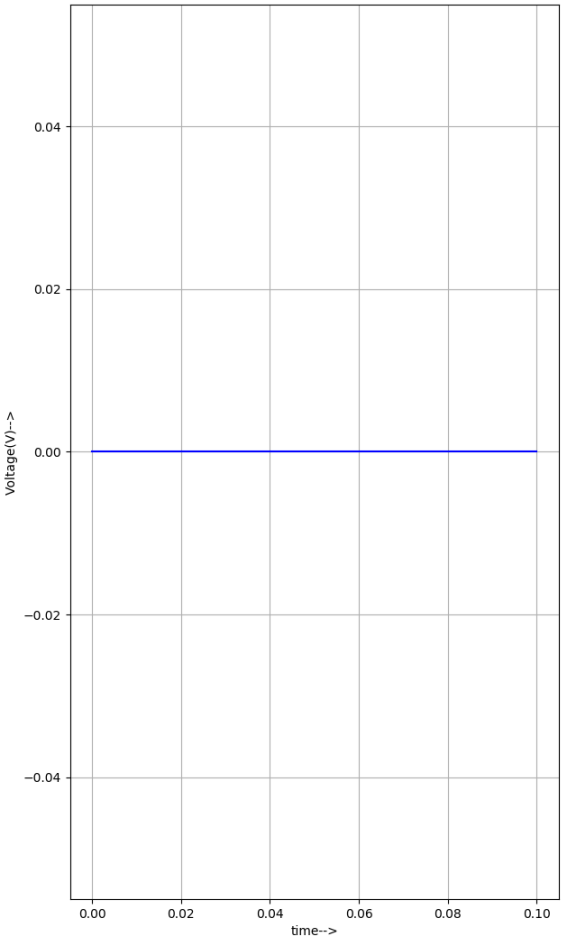
P0


5.2
5.1
5.0
4.9
4.8
Voltage(V)-->
0.00
0.02
0.04
0.06
0.08
0.10
time-->

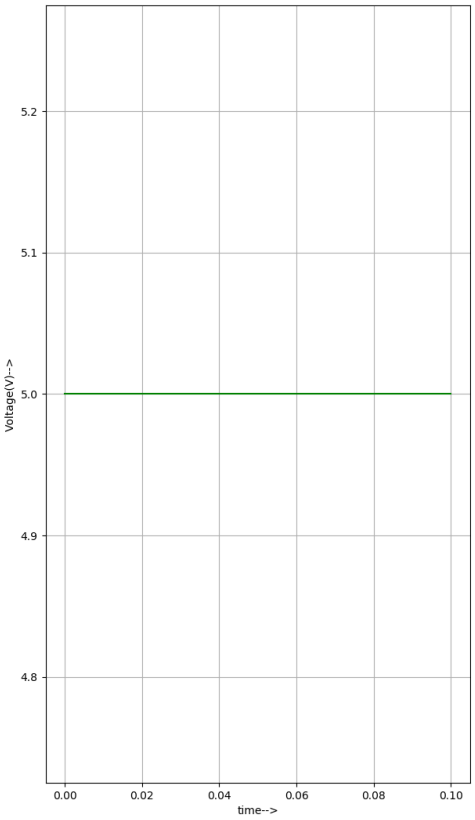
P1


5.2
5.1
5.0
4.9
4.8
Voltage(V)-->
0.00
0.02
0.04
0.06
0.08
0.10
time-->

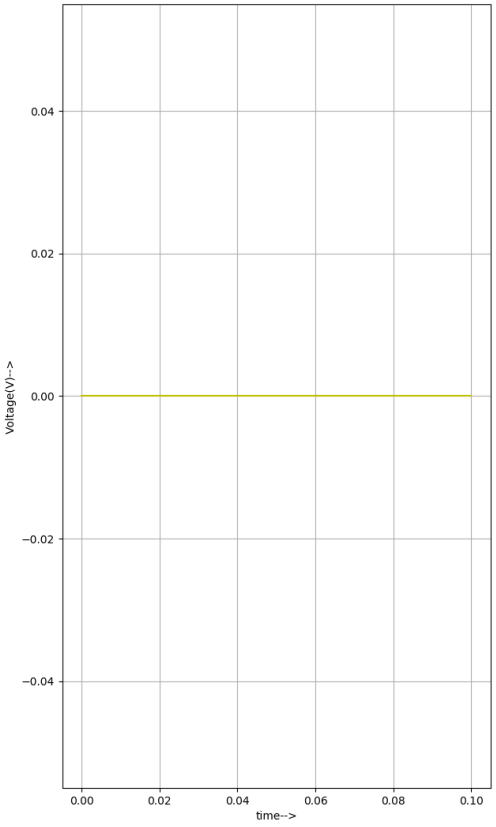
P2


0.04
0.02
0.00
−0.02
−0.04
Voltage(V)-->
0.00
0.02
0.04
0.06
0.08
0.10
time-->

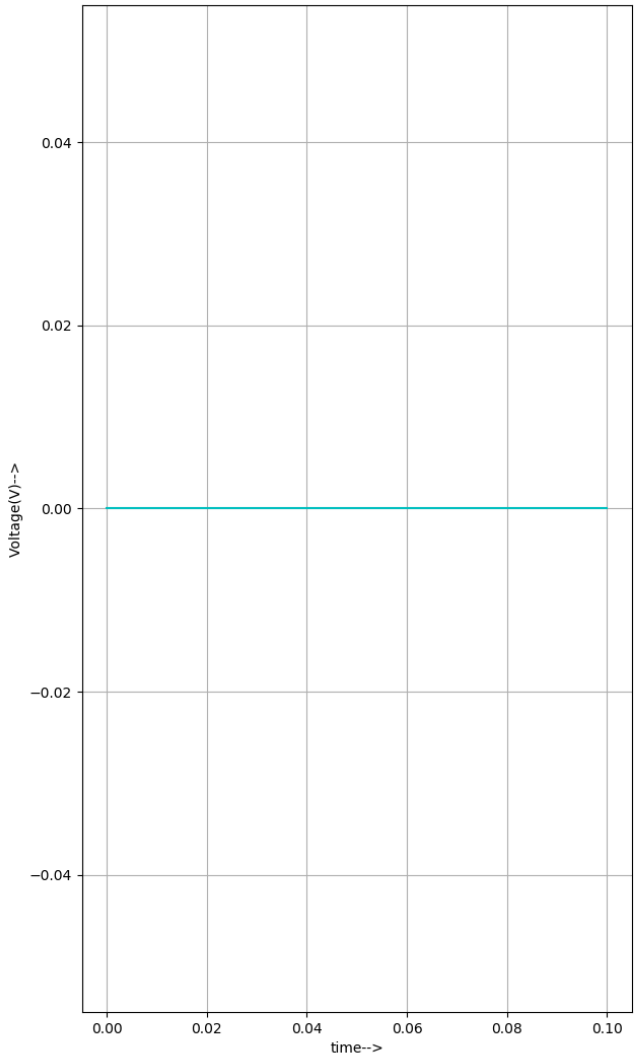
P3


5.2
5.1
5.0
4.9
4.8
Voltage(V)-->
0.00
0.02
0.04
0.06
0.08
0.10
time-->

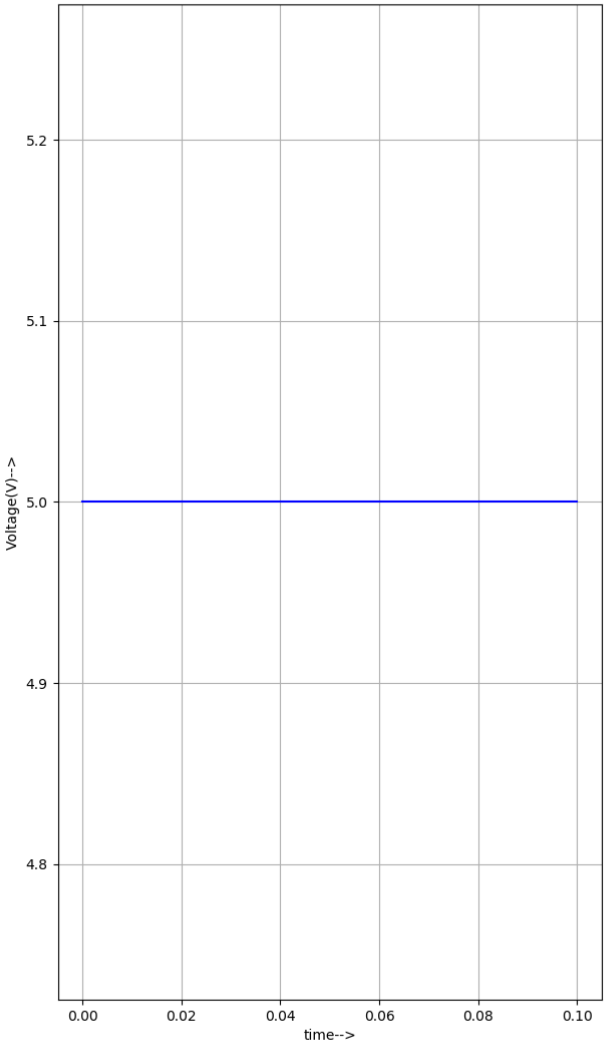
P4


0.04
0.02
0.00
−0.02
−0.04
Voltage(V)-->
0.00
0.02
0.04
0.06
0.08
0.10
time-->

P5


0.04
0.02
0.00
−0.02
−0.04
Voltage(V)-->
0.00
0.02
0.04
0.06
0.08
0.10
time-->

P6


5.2
5.1
5.0
4.9
4.8
Voltage(V)-->
0.00
0.02
0.04
0.06
0.08
0.10
time-->

Cout

The following table displays a list of some of the possible inputs along with the obtained outputs.

B				A				Product							
B3	**B2**	**B1**	**B0**	**A3**	**A2**	**A1**	**A0**	**Cout**	**P6**	**P5**	**P4**	**P3**	**P2**	**P1**	**P0**
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	1	0	0	0	0	0	0	1	0
0	0	1	0	0	0	1	0	0	0	0	0	0	1	0	0
0	0	1	1	0	0	1	1	0	0	0	0	0	1	1	0
0	1	0	0	0	1	0	0	0	0	0	0	1	0	0	0
0	1	0	1	0	1	0	1	0	0	0	0	1	0	1	0
0	1	1	0	0	1	1	0	0	0	0	0	1	1	0	0
0	1	1	1	0	1	1	1	0	0	0	0	1	1	1	0
1	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0
1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	1

REFERENCES:

- Design and performance analysis of multipliers using Kogge Stone Adder : https://ieeexplore.ieee.org/document/8389113
- Modeling, Design and Performance Analysis of Various 8-bit Adders for Embedded Applications - Kunjan D. Shinde and Jayashree C. Nidagundi : https://www.researchgate.net/publication/303997659_Modeling_Design_and_Performance_Analysis_of_Various_8-bit_Adders_for_Embedded_Applications
- Kogge-Stone Adder : https://en.wikipedia.org/wiki/Kogge%E2%80%93Stone_adder