Design Of Fredkin CSWAP Quantum Gate

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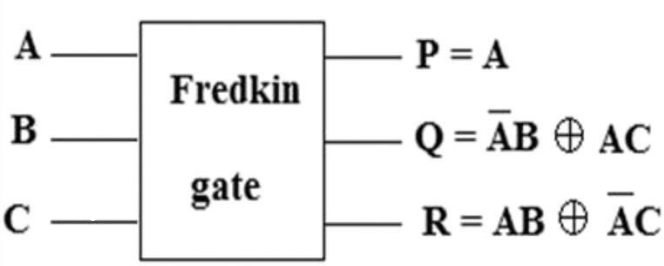
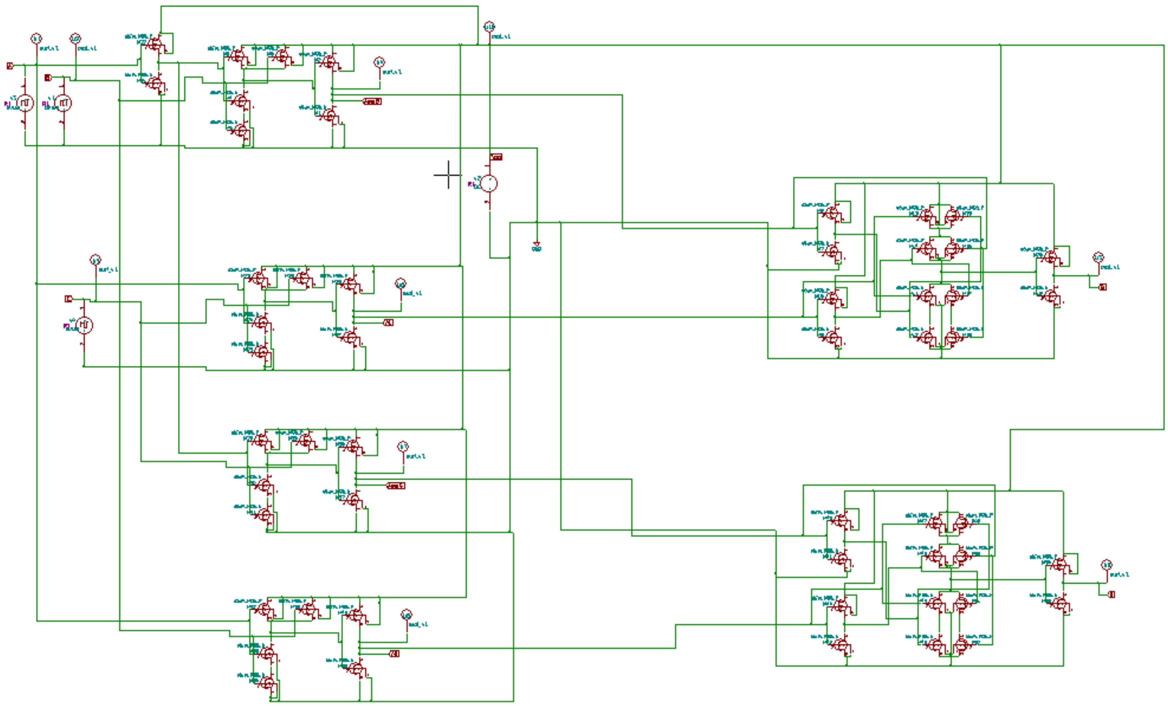
Abstract:

The Fredkin gate is named after physicist Edward Fredkin, who introduced the concept of reversible computing and contributed to the development of reversible logic gates. Reversible gates are important in quantum computing because they preserve information, making them useful for constructing quantum circuits where information must not be lost .Fredkin gate, also known as the Controlled SWAP (CSWAP) gate, is a three-bit reversible gate in quantum computing and reversible computing. It performs a controlled swap operation on three bits. The Fredkin gate swaps the second and third bits if the first bit (control bit) is set to 1 and leaves the bits unchanged if the control bit is 0. Reversible logic is also called information lossless logic, since the information embedded in the circuits can be recovered, if lost. A number of reversible gates were designed and invented. As examples like- the Fredkin gate, the Toffoli gate, the Peres gate, and the Feynman gate. Reversible logic has extensive applications and is considered as one of the futuristic technologies. But the logic circuit designing is based on logic gates, which are non-reversible. These logic gates help in future implementation of higher end circuits. In this paper an attempt is made to design logic gates using reversible gates and some of the higher end circuits are also designed such as Binary-to-Grey, grey-to-Binary, Adder, Subtractor etc.



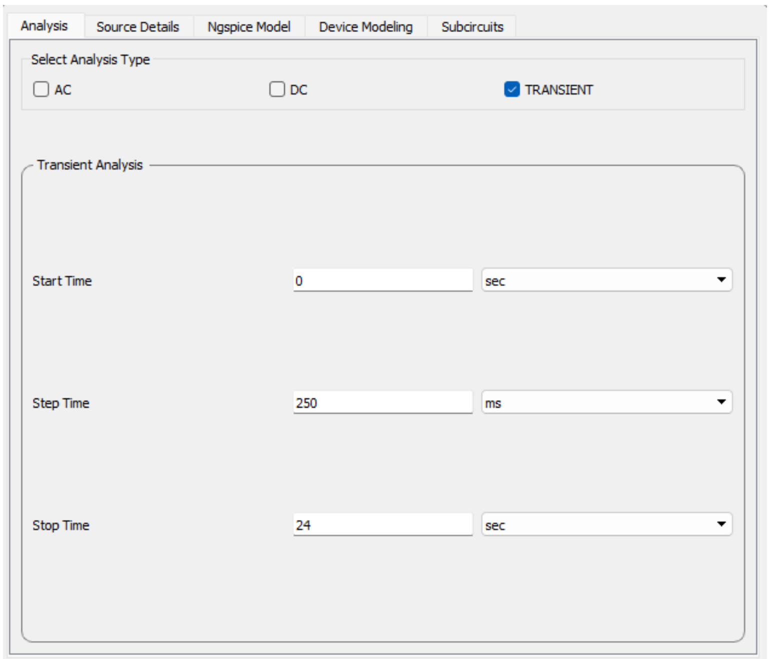
A	B	C	P	Q	R
0	0	0	0	0	0
0	0	1	0	0	1
0	1	0	0	1	0
0	1	1	0	1	1
1	0	0	1	0	0
1	0	1	1	1	0
1	1	0	1	0	1
1	1	1	1	1	1



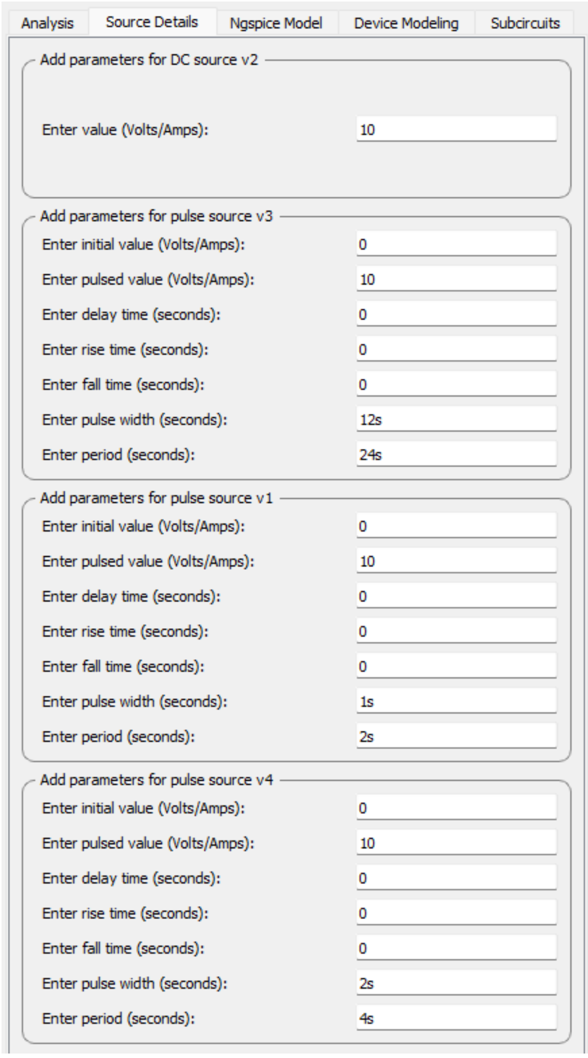
CIRCUIT DIAGRAM OF FREDKIN GATE

Given Inputs:

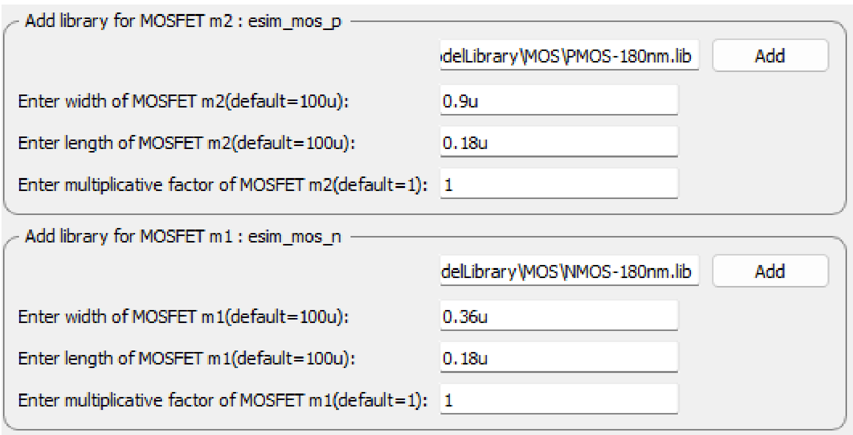
i) Transient analysis



ii) Source Details

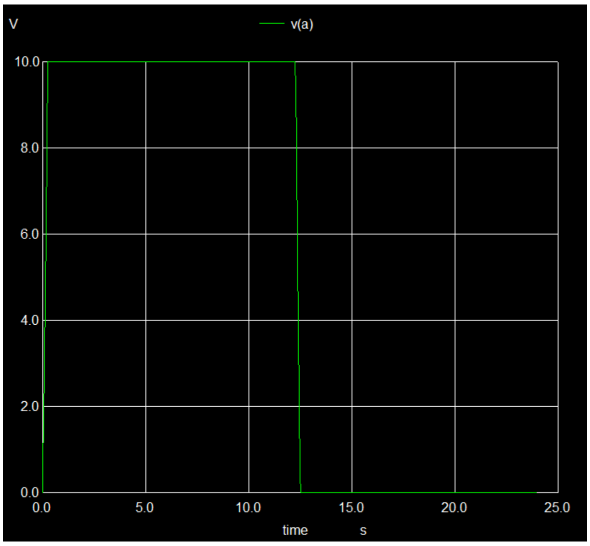


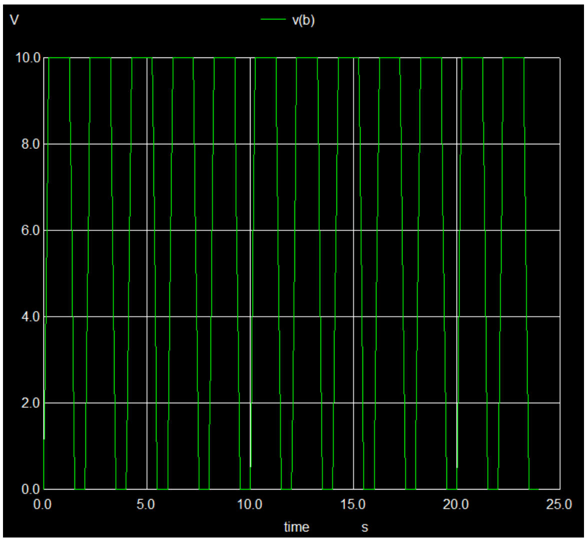
iii) Mosfet Parameters-



Verified Results (According to truth table):

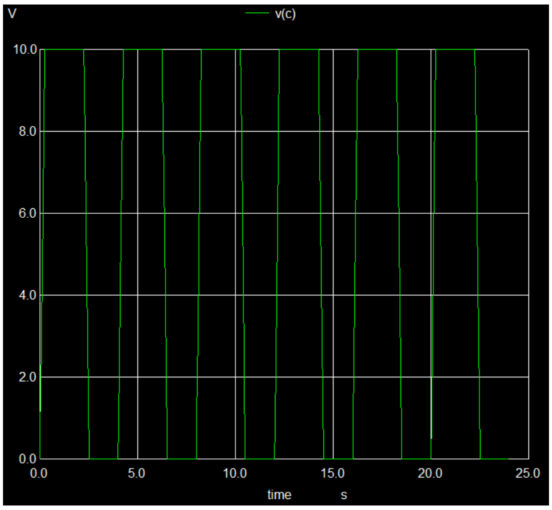
Inputs-





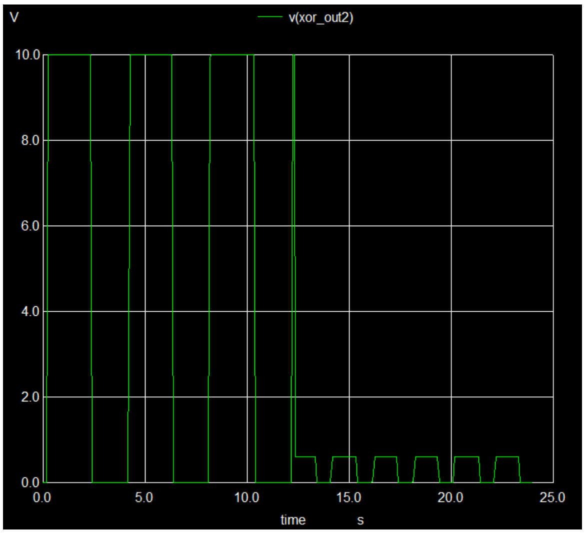
Output P=Input A

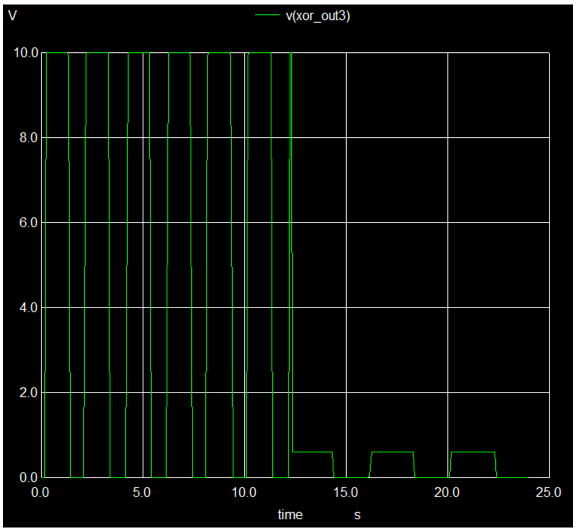
Input B



Input C

Outputs-





Output Q

Output R

Observation:

Thus from the given graphs we can observe that, whenever the input A is high the output bit Q and R are getting reversed else the output remains same as the input bits.

References:

https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=9125070

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

https://www.researchgate.net/publication/320243483_A_Survey_on_Synchronous_and_Asynchronous_Counters_using_Reversible_Logic_Gates/figures?lo=1