

8x4 right Barrel Shifter using NMOS pass transistor logic

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July 1, 2021

Abstract

Barrel shifter is a digital circuit that can shift a data word block by a specified number of bits either in right, left or both directions in a single clock cycle, without the use of any sequential logic. The input bit shift is dependent on control shift bits and the direction of shift is dependent on arrangement of transistors. In this paper, a 8x4 right barrel shifter circuit using NMOS pass transistor logic is implemented in eSim with skywater 130nm technology. The shifter circuit takes 8 inputs bits and shifts them according to 5 control shift bits and generates 4 output bits. Limited high output voltage level due to threshold voltage drop of NMOS can be overcome by using transmission gates.

1 Circuit Details

An 8x4 right barrel shifter using NMOS pass transistors with skywater 130nm technology is designed using an integrated tool, 'eSim' with circuit schematics on KiCAD. The transistors are positioned to give right shift operation. The 8 inputs bits of shifter are In0, In1, In2, In3, In4, In5, In6, In7, the five control shift bits are S0, S1, S2, S3, S4 and output bits are Out0, Out1, Out2, Out3 respectively. The gate terminal of each NMOS transistor in a column is connected to one control shift signal as input. At a time only one control signals (from S0-S4) are enabled high while others are low. When control shift bit S0 is enabled, then the output bits are at Out0 = In0, Out1 = In1, Out2 = In2, Out3 = In3. For the next clock cycle, when S1 is enabled then the inputs bits are shifted right by one bit position. For the input bit pattern In0 = 0, In1 = 1, In2 = 1, In3 = 0, In4 = 0, In5 = 0, In6 = 1, In7 = 1 and control bits as S0 = 0, S1 = 0, S2 = 1, S3 = 0, S4 = 0, output becomes Out0 = 1, Out1 = 0, Out2 = 0, Out3 = 0. For simulation purpose, the control bit S4 is enabled, the inputs bits are shifted right by 4 bit position and the output bits are at Out0 = In4, Out1 = In5, Out2 = In6, Out3 = In7. From the NgSpice output plots, the output shifted bits are observed and these are cross-validated to confirm the functionality of the circuit. The output bits suffer from threshold voltage (V_{Tn}) drop i.e. maximum output voltage level is limited to $V_{DD} - V_{Tn}$ which can be overcome by using transmission gates instead of pass transistors.

2 Implemented Circuit

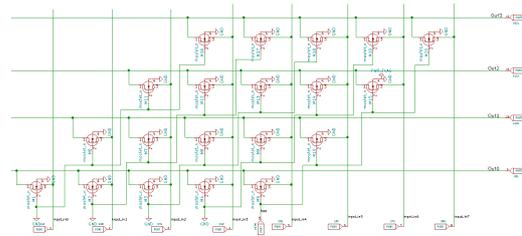


Figure 1: Implemented circuit diagram.

3 Implemented Waveforms

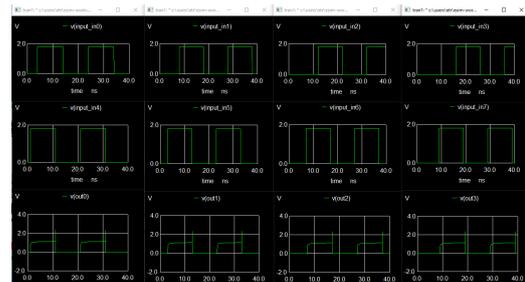


Figure 2: Implemented waveform.

References

- [1] R. M. R. R. V. Ashok Babu, V. Siva Nagaraju. Realization of 8 x 4 barrel shifter with 4-bit binary to gray converter using finfet for low power digital applications. <https://iopscience.iop.org/article/10.1088/1742-6596/1714/1/012028/meta>.