Analysis of CMOS Inverter

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Abstract

CMOS inverters (Complementary NOSFET Inverters) are some of the most widely used and adaptable MOSFET inverters used in chip design. They operate with very little power loss and at relatively high speed. Further, the CMOS inverter has good logic buffer characteristics, in that, its noise margins in both low and high states are large. This short description of CMOS inverters gives a basic understanding of the how a CMOS inverter works. It will cover input/output characteristics, MOSFET states at different input voltages, and power losses due to electrical current. CMOS inverters play a critical role in integrated circuits, including microprocessors, microcontrollers, data converters, and some types of transceivers.

1 Circuit Details

A CMOS inverter contains a PMOS and a NMOS transistor connected at the drain and gate terminals, a supply voltage Vdd at the PMOS source terminal, and a ground connected at the NMOS source terminal, were Vin is connected to the gate terminals and Vout is connected to the drain terminals. It is important to notice that the CMOS does not contain any resistors, which makes it more power efficient than a regular resistor-MOSFET inverter. As the voltage at the input of the CMOS device varies between 0 and 5 volts, the state of the NMOS and PMOS varies accordingly. When Vin is low, the NMOS is "off", while the PMOS stays "on": instantly charging Vout to logic high. When Vin is high, the NMOS is "on and the PMOS is "on: draining the voltage at Vout to logic low. Also, a input port is connected at Vin and a output port is connected at drain and gate terminals of PMOS and NMOS. And, plot V1 and plot V2 are connected to obtain the waveforms of input and output voltage respectively. For the ease of exposition, in both the cases the N channel MOS will be considered the driving transistor and the P channel MOS will be considered the load. (Note that the circuit is symmetric and if we reverse this assumption the results then obtained will still be identical). Now, with the help of the circuit will be able to simulate and do the analysis to get the input and output characteristics of the CMOS inverter.

2 Implemented Circuit

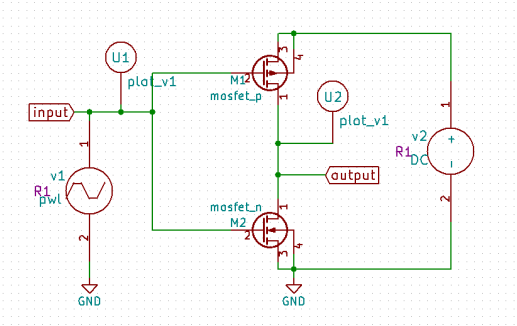

Figure 1: Implemented circuit diagram.

3 Implemented Waveforms

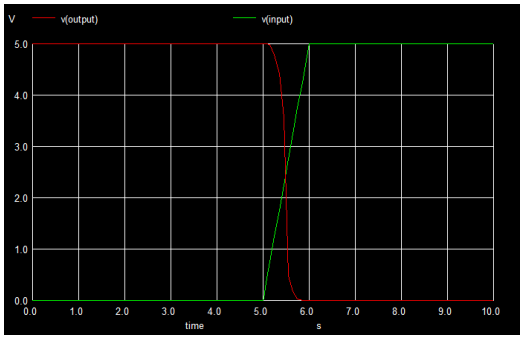

Figure 2: Implemented waveform.

References

[1] Elprocus. What is a cmos? https://www.elprocus.com/cmos-working-principle-and-applications.

[2] B. Sales. A simple description of the characteristics of cmos inverters. https://courseware.ee.calpoly.edu/ dbraun/courses/ee307/F02/02_Sale