Inverting amplifier and CMOS inverter

Dr Savita Gaur Kumar, DRDO

June 30, 2021

Abstract

The phase180inverse circuit in eSIM was built to amplify and invert sine wave and then use mirror inversion for noise cancellation application in future. In the common source MOS amplifier circuit both current and voltage gain can be described as medium, but the output is the inverse of the input, i.e. 180deg phase change .A single stage inverting MOSFET amplifier was successfully built using n-MOSFET in enhancement mode. The output of the amplifier drove CMOS inverter to get wave exactly 180 out of phase. The CMOS does not contain any resistors, which makes it more power efficient that a regular resistor-MOSFET inverter.

1 Circuit Details

The phase180inverse circuit in eSIM had primarily two circuit design : (a) single stage n-MOSFET inverting amplifier and (b) CMOS inverter (a) MOSFET inverting amplifier A single stage NMOS amplifier was constructed usingnp-MOSFET in enhancement mode. The threshold voltage, VTH of the MOSFET is 2.5 volts, and the DC supply voltage, is +15 volts. This simple enhancement-mode common source n-MOSFET amplifier configuration used a single 15 volt DC supply at the drain with load resistor RD=500 Ohms and generated the required gate voltage, VG using a resistor divider. Voltage divider network with Resistors R1 and R2 was built to set gate voltage, where R1 and R2 were set as R1 = 200kΩ and R2 = 100kΩ. (xM1 Phase180 Net-_C1-Pad1_ Phase180 Phase180 sky130_fd_pr_nfet_01v8 w=.42 l=.5) The inverted and amplified output of the nMOS inverter serves as input to CMOS inverter (b) CMOS inverter: A CMOS inverter was constructed in eSIM from a PMOS and a NMOS FETs connected at the drain and gate terminals. The input is connected to the gate terminal of both the transistors such that both can be driven directly with input voltages. VOUT is connected to the drain terminals. The output of the single stage MOSFET amplifier serves as gate voltage to both MOSFETS.

(xM3 Net-_M3-Pad1_ Phase180 OUT Net-_M3-Pad1_ sky130_fd_pr_pfet_01v8 w=1 l=0.5 xM2 OUT Phase180 GND GND sky130_fd_pr_nfet_01v8 w=.42 l=.5)

2 Implemented Circuit

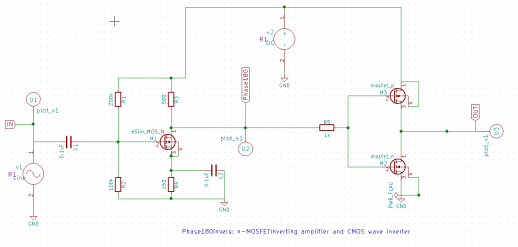

Figure 1: Implemented circuit diagram.

3 Implemented Waveforms

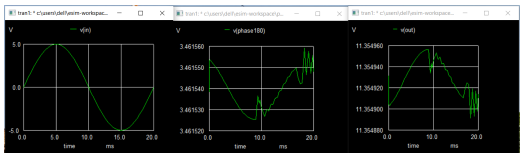

Figure 2: Implemented waveform.

References

[1] E. S. K. Er Kunal Ghosh. https://www.udemy.com/course/vsd-intern-10-bit-dac-design-using-esim-and-sky130/learn/lecture/27028946#overview. https://www.udemy.com/course/vlsi-academy-circuit-design/.

[2] https://www.udemy.com/course/vsd-intern-10-bit-dac-design-using-esim-and sky130/learn/lecture/27028946#overview. Mosfet amplifier. https://www.electronics-tutorials.ws/amplifier/mosfet-amplifier.html.