Response of an Inverting Operational Amplifier

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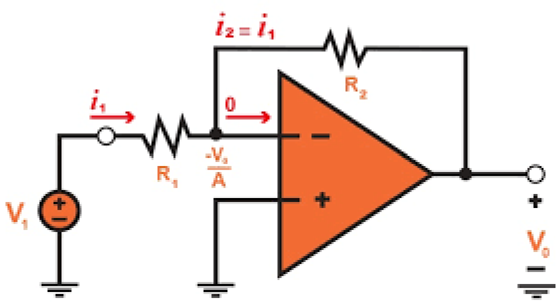
1. Introduction

Operational amplifiers are designed to have high input impedance, low output impedance and high gain. Inverting OPAMP provides 180^0 phase shift between input and output voltage. The input voltage is applied at negative input terminal of the operational amplifier and the positive input terminal is grounded. In this work, we have designed, simulated and studied the response of an Inverting operational amplifier (OPAMP) using eSim EDA software.

2. Theory



From the above circuit, by applying KCL

$i_1= (V_1-0)/R_1$

$i_2= (0-V_0)/R_2$

$i_1= i_2$

$V_1/R_1= -V_0/R_2$

$V_0/ V_1= -R_2/ R_1$

Hence, we can see that output voltage has 180° phase shift with input.

Applications:

- Used as amplifier for converting small signal (e.g. output of a sensor) to much larger signal

3. Approach

Following steps were performed using eSim software

- Generating schematic of inverting amplifier
- Annotating the schematic
- Electric Rule Check for the schematic
- Generating Netlist for simulation(.cir)
- Circuit Simulatio

4. Results

Schematic of the inverting OPAMP is drawn using eSim simulator which is shown in figure 1. The peak voltage of sinusoidal input signal is 2 V. The resistor R_1 and R_2 are 1kΩ and 10kΩ, respectively. The koad resistor R_3 is taken as 1kΩ.

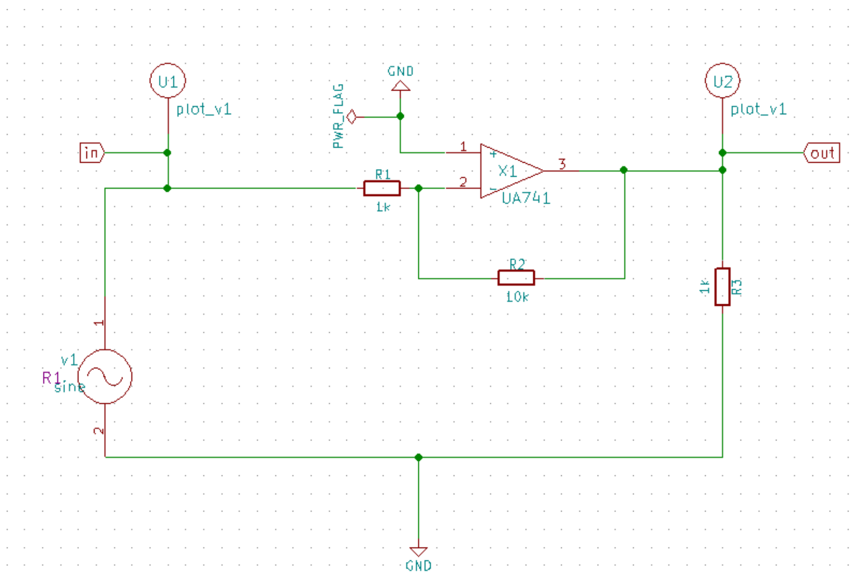
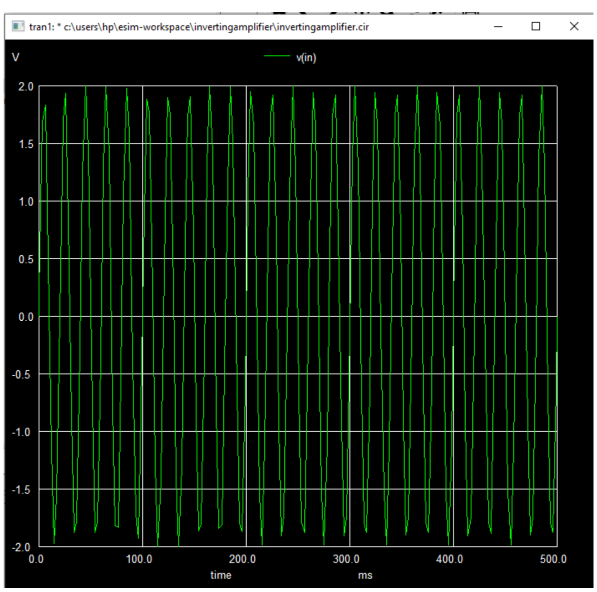


Figure 1 : Schematic of inverting OPAMP designed using eSim

The waveform of input and output signal is shown in figure 2(a) and (b), respectively.



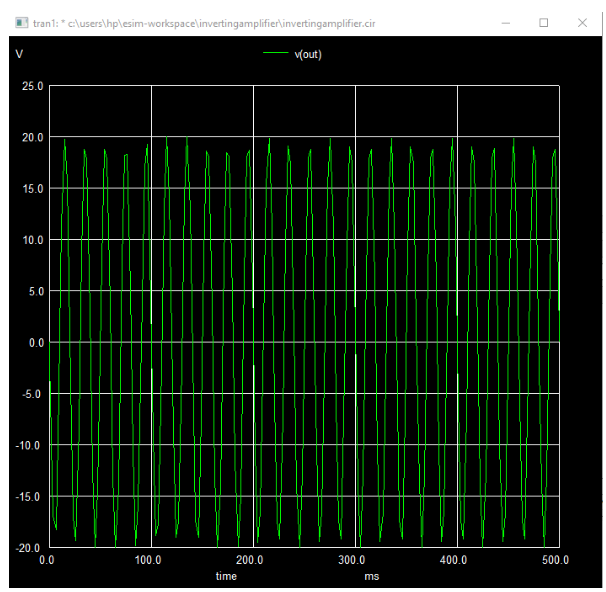


Figure 2(a) Figure 2(b)

Figure: 2(a) Plot of input voltage to inverting OPAMP; 2(b) Plot of output voltage

The voltage waveform of input and output signal with respect to time is plotted using Python is shown in figure 3. Here, the figure shows that the output voltage is 10 times amplified and has 180° phase shift with respect to input which justifies the proper working of inverting opamp.

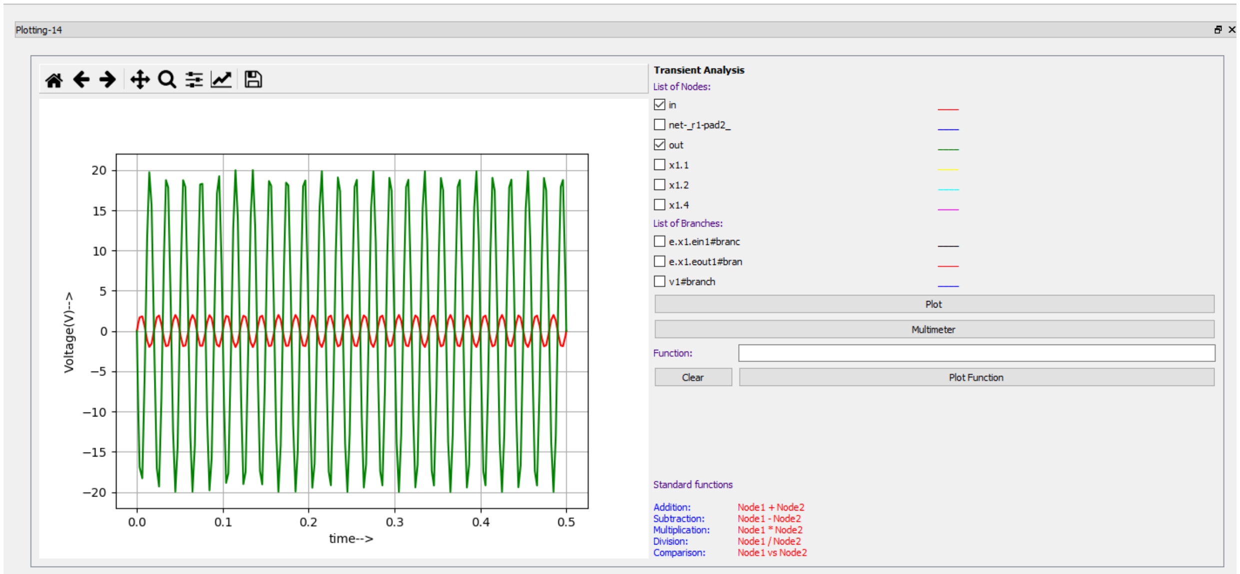


Figure 3 : Python plot of input and output of inverting amplifier

The RMS reading of input and output voltages are calculated using the multimeter function which is shown in figure 4.

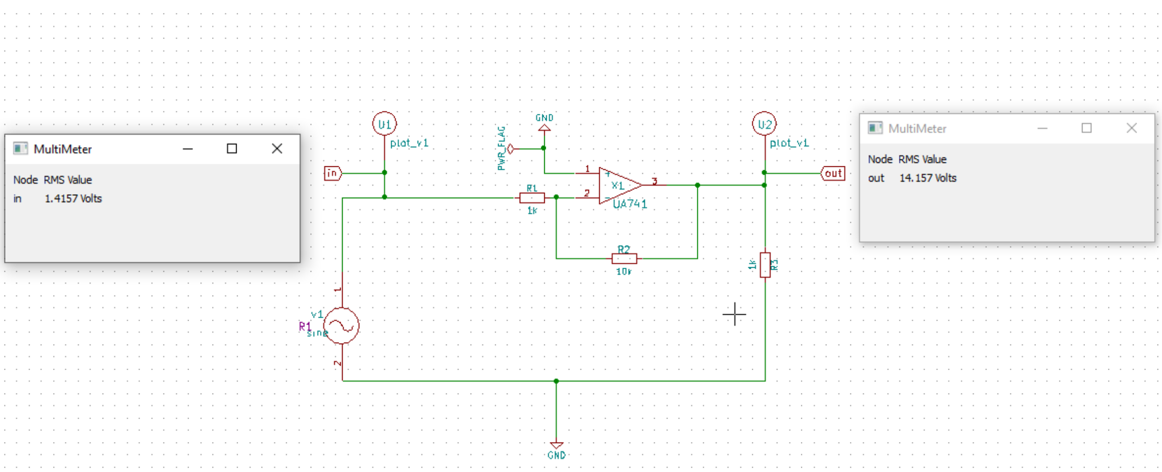


Figure 4 : RMS readings of input and output voltage using multimeter function

5. Conclusion

In summary, we have successfully, designed and simulated the response of an inverting operational amplifier. The response shows a 180° phase shift between input and output voltage. The output voltage is an amplified replica of input signal. Hence, the overall result substantiates the proper design and working of inverting OPAMP.

References:

Microelectronics Circuits, Adel S. Sedra & Kenneth C. Smith, Oxford University Press