

THE μ A741 OPERATIONAL AMPLIFIER WITH DIFFERENT BIASES USING eSim

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ABSTRACT

Total dose dependence of bias current and offset voltage in the linear operational amplifier μ A741 with different bias is presented in this paper. The experimental results show that the bias current in the μ A741 with grounded bias is significantly affected by the degradation of the differential input transistors. In addition, the offset voltage is affected by the degradation of bipolar transistors of the current source in the differential input stage.

Keywords-operational amplifier; total dose; bias current; offset voltage; bipolar transistor.

INTRODUCTION

The impact of total dose radiation on linear ICs, specifically operational amplifiers (op-amps) using Bipolar Junction Transistors (BJTs). Previous studies have shown that total dose radiation can cause significant changes in parameters such as bias current and offset voltage. While prior research has focused on devices like the LM124 op-amp and LM111 voltage comparator, showing positive shifts in bias currents with increased total dose, there has been little examination of these effects on classic op-amps like the μ A741. The μ A741 op-amp under four different bias conditions at high dose rates.

- Section II: Description of the μ A741 circuit.
- Section III: Experimental procedure.
- Section IV: Results obtained with four bias conditions during irradiation.
- Section V: Discussion of the degradation mechanisms due to irradiation.

Circuit schematic

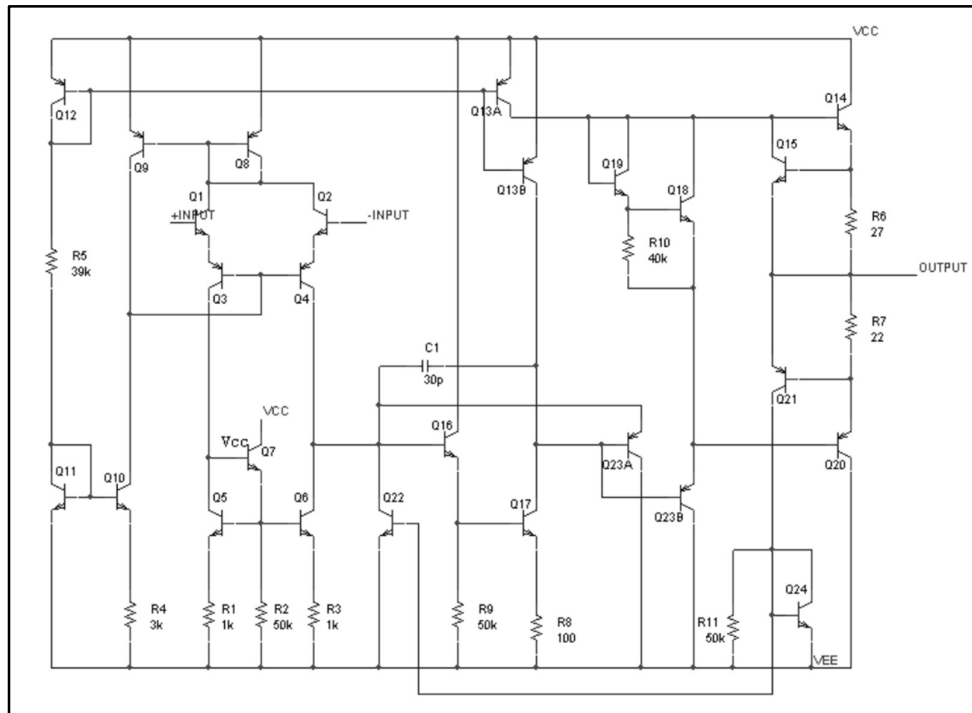


Figure 1: uA741 Op-amp circuit

eSim Schematic

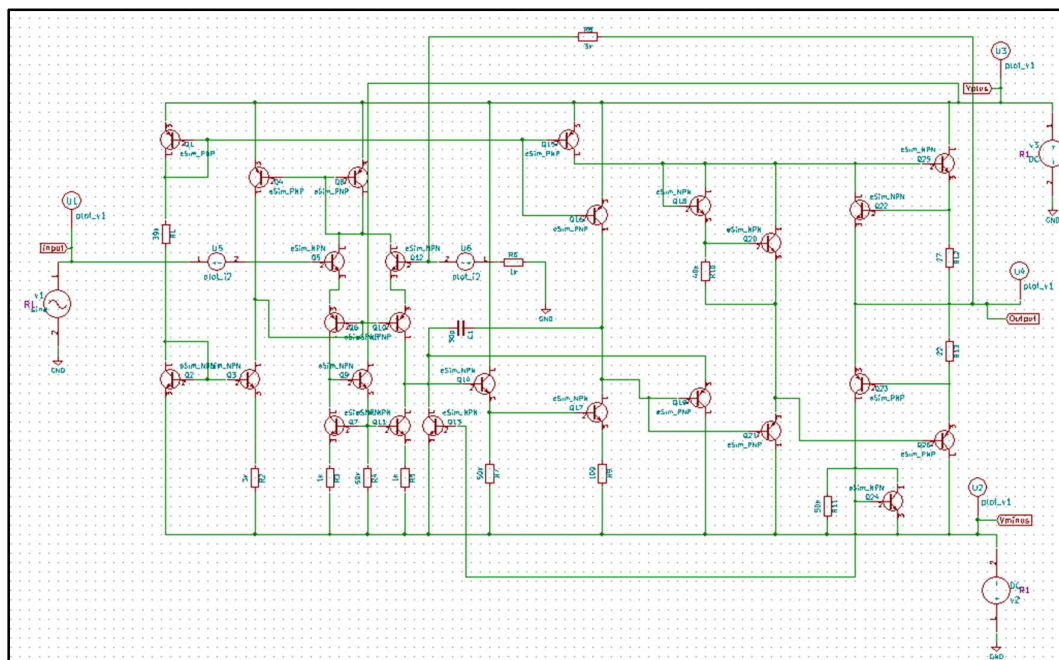
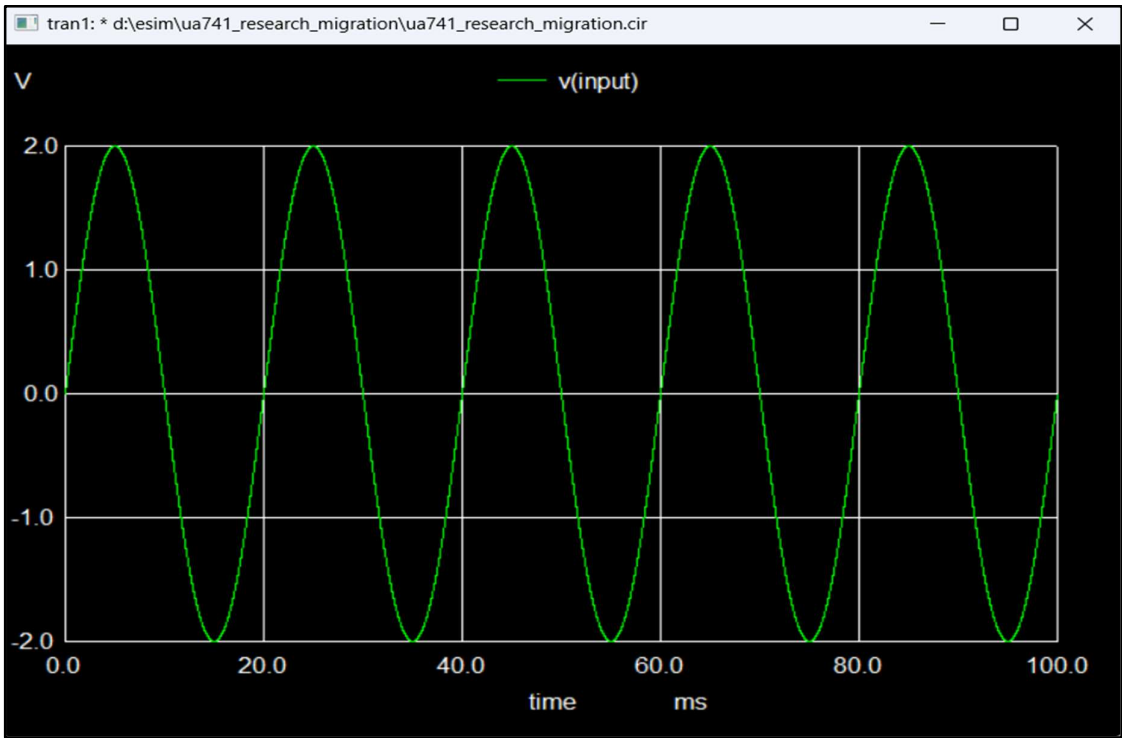
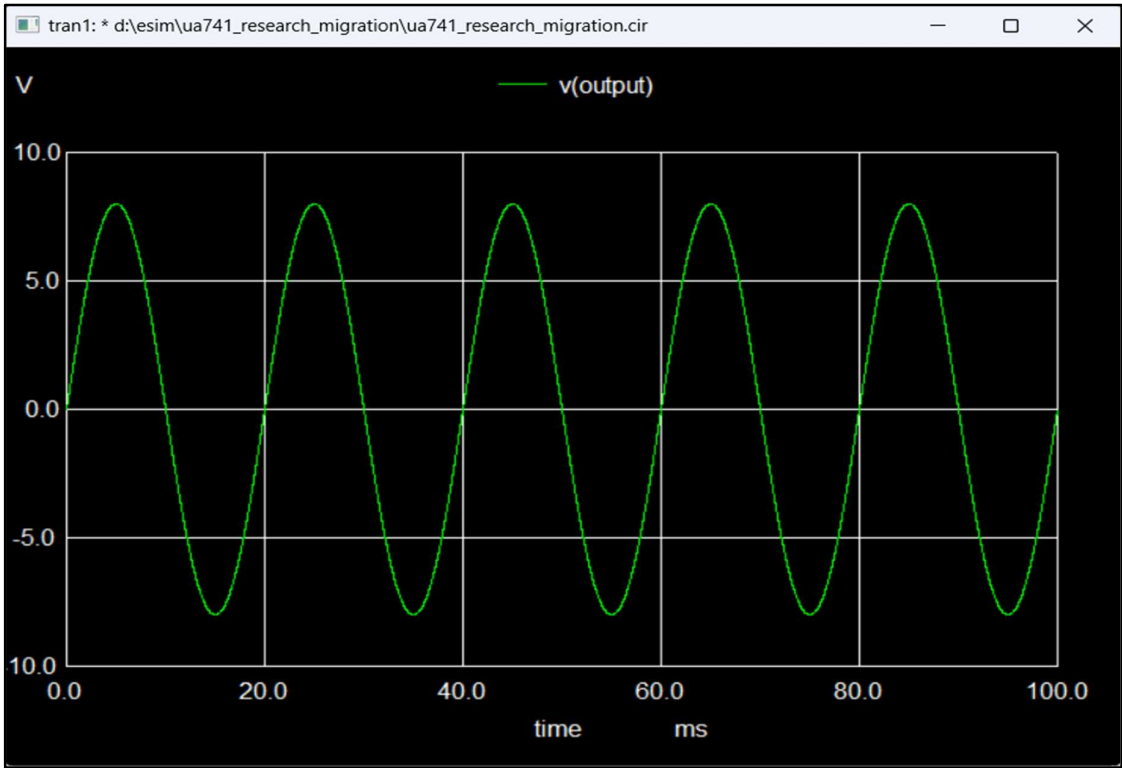


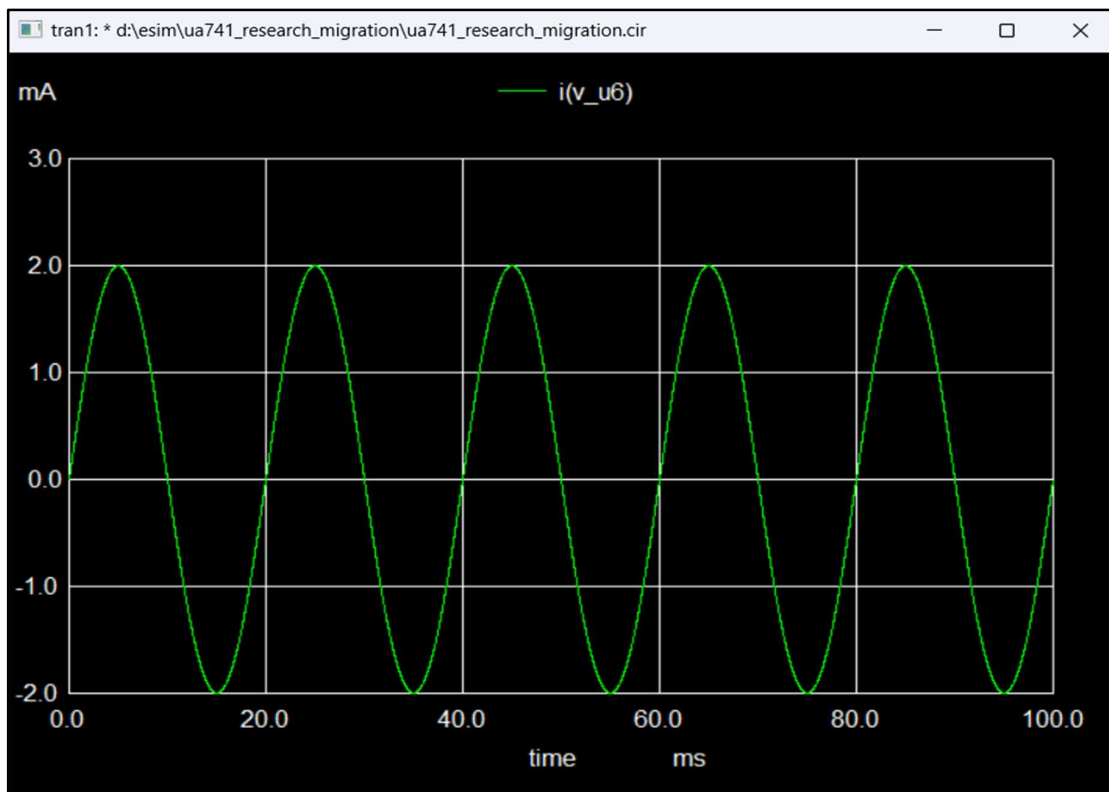
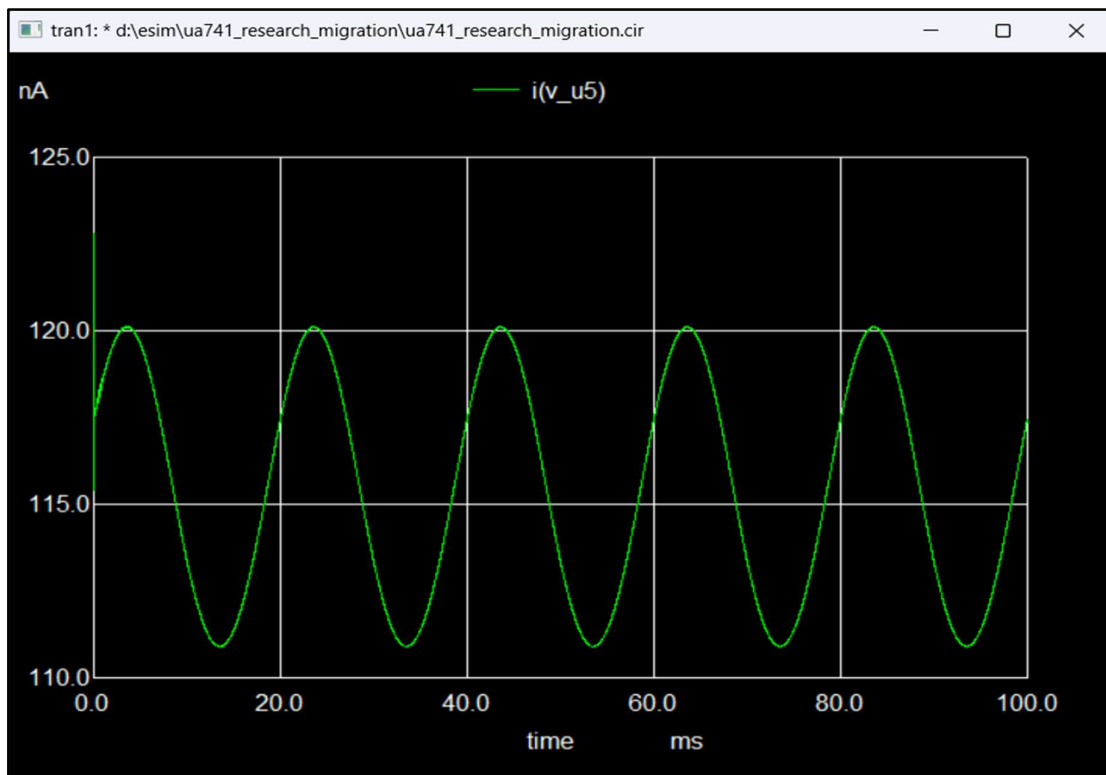
Figure 2: uA741 Op-amp schematic

Input Waveform



Output Waveform





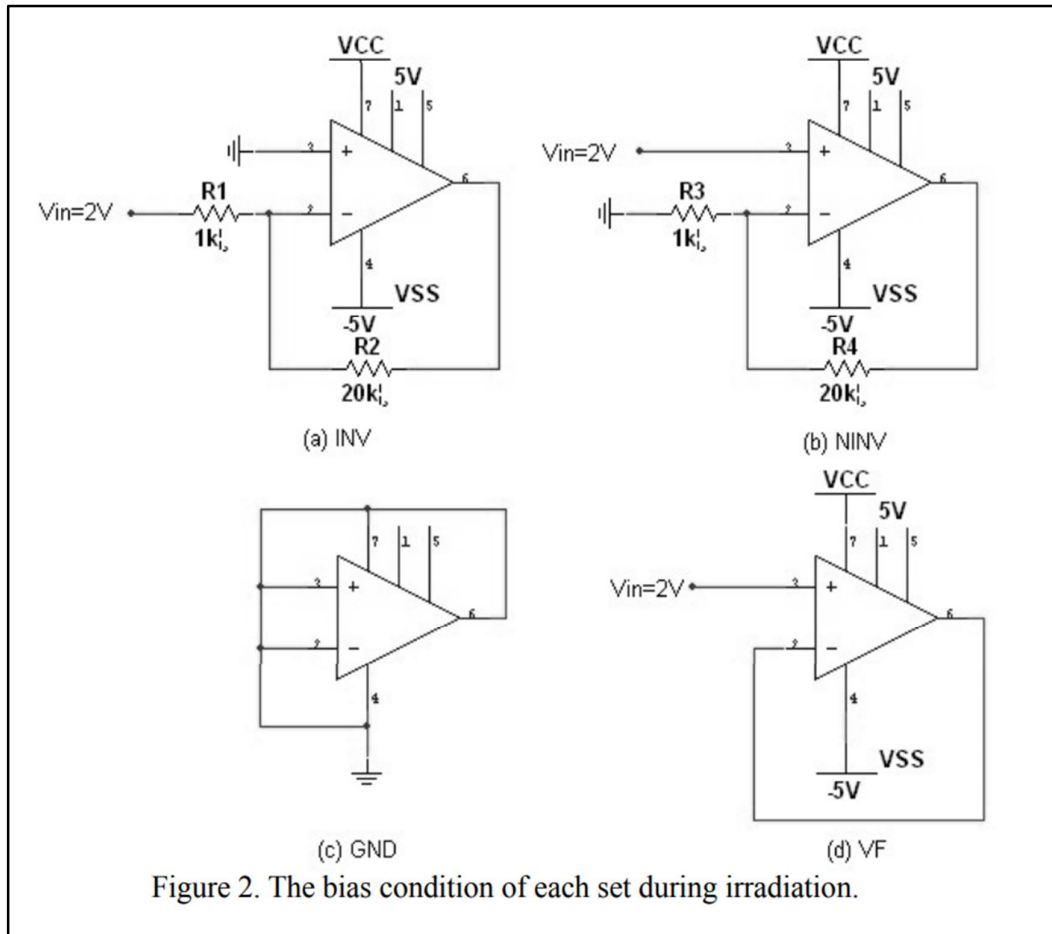


Figure 3

The bias condition

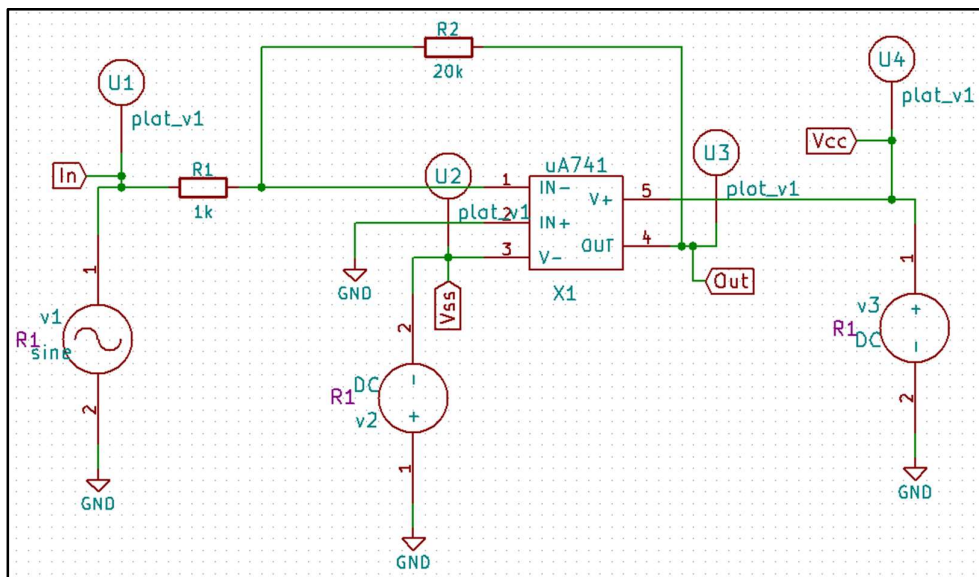
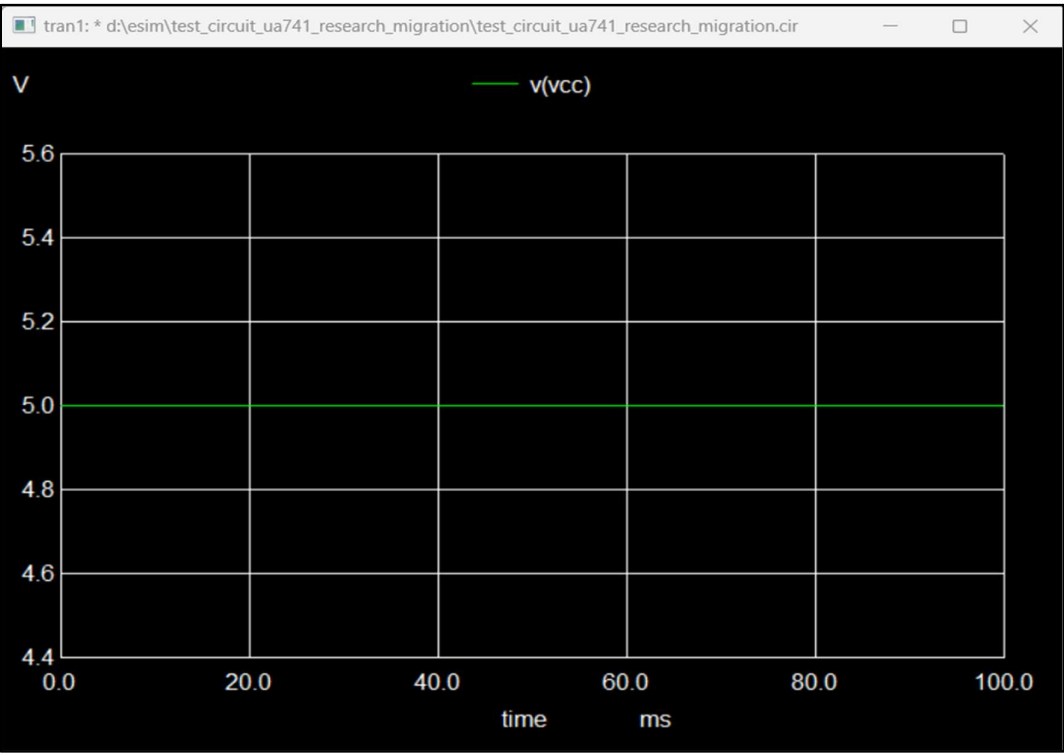
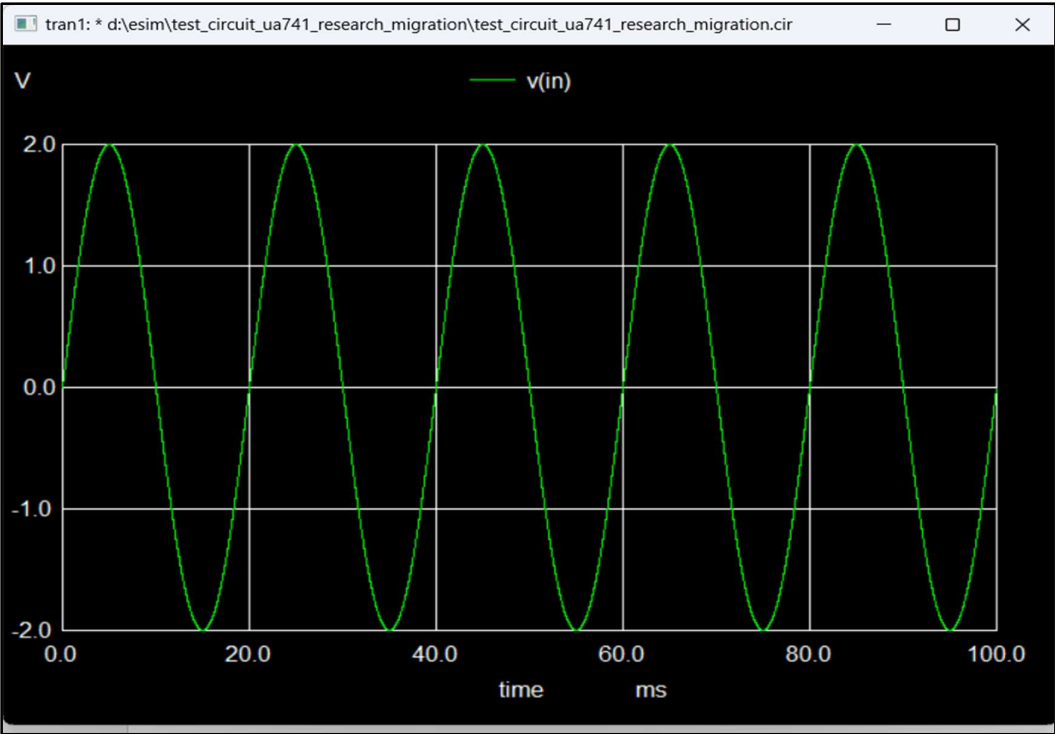
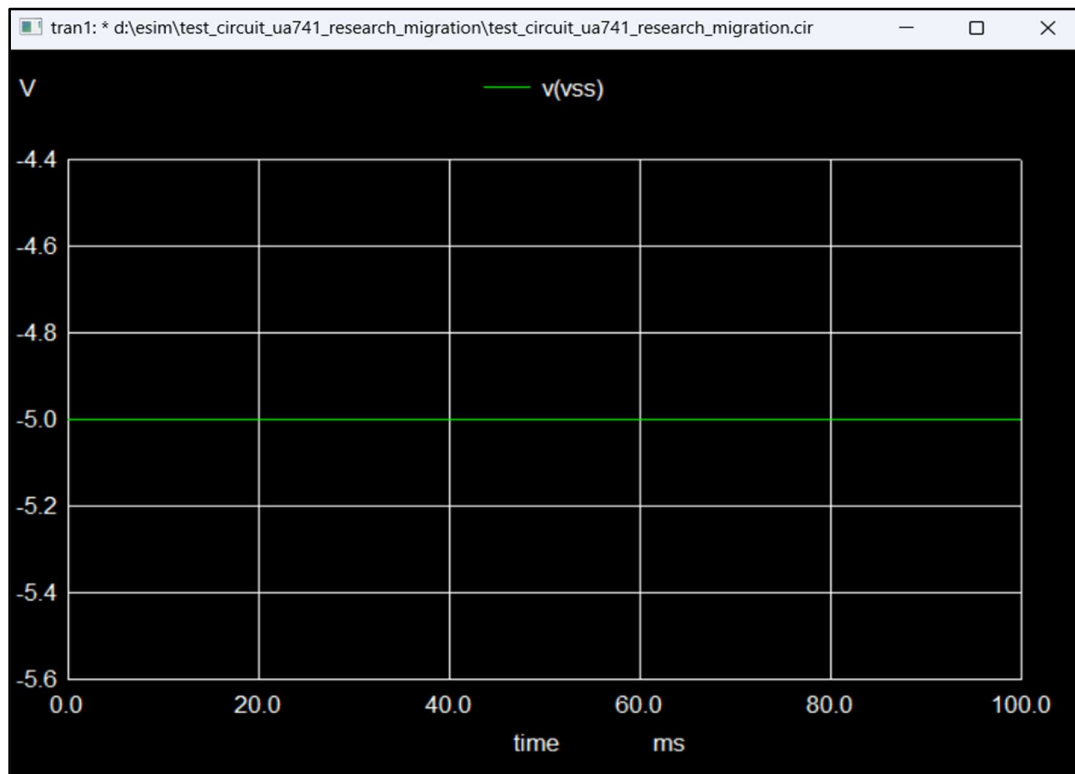


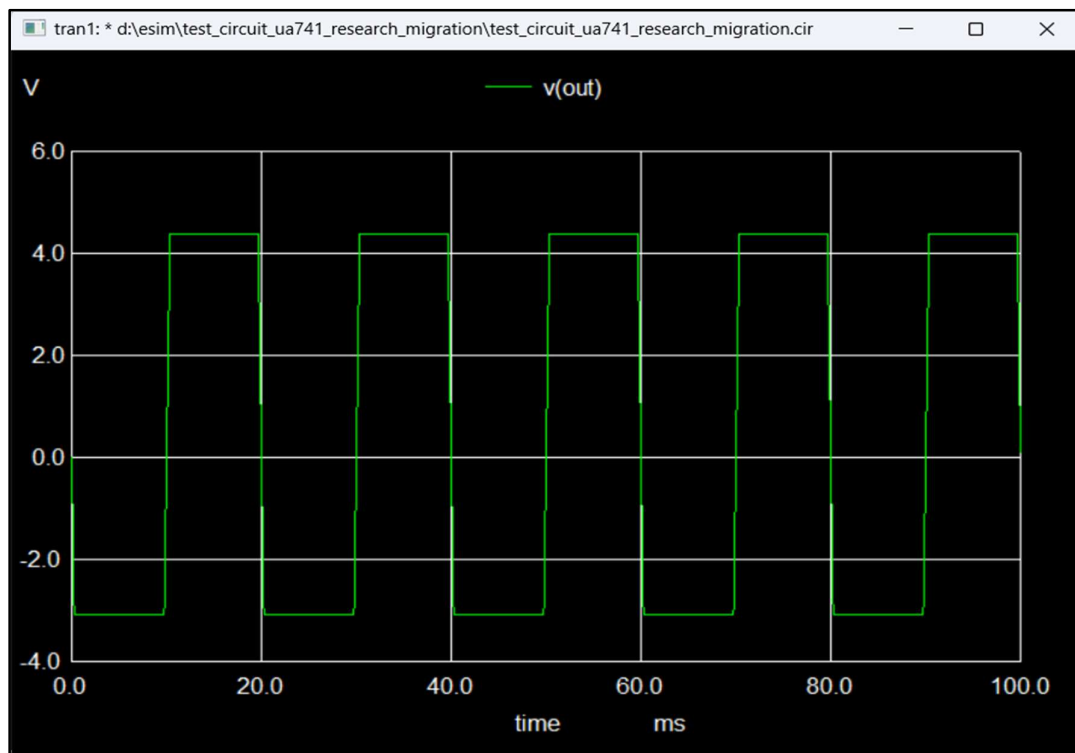
Figure 4: INV

Input Waveform





Output Waveform



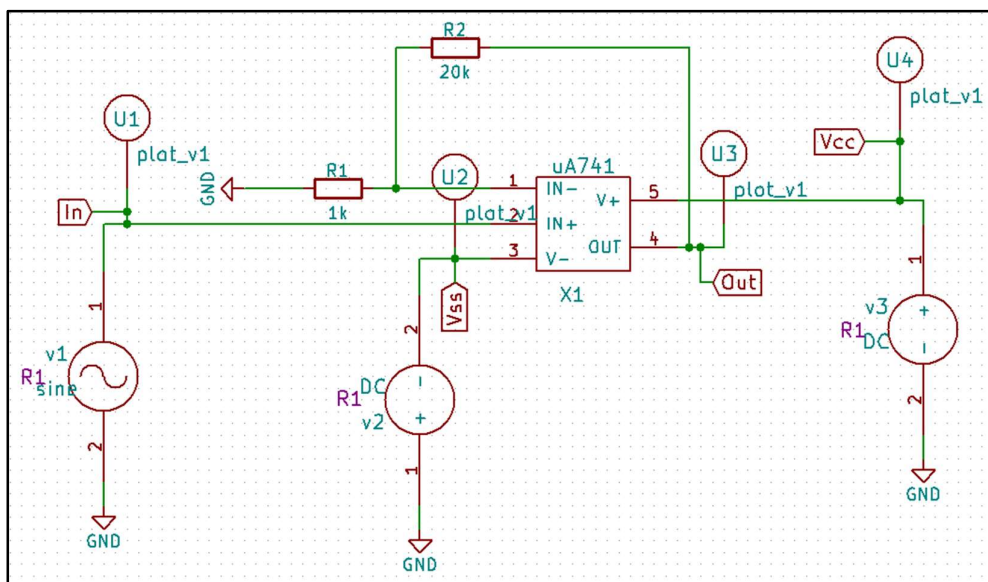
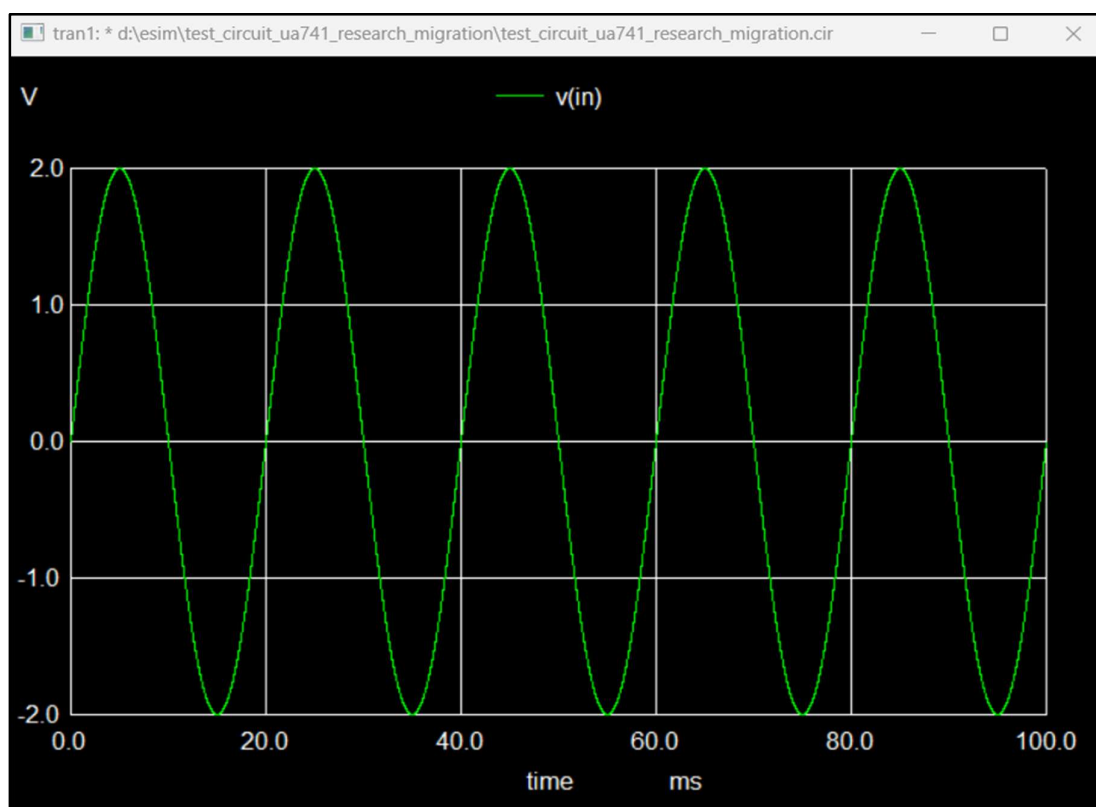
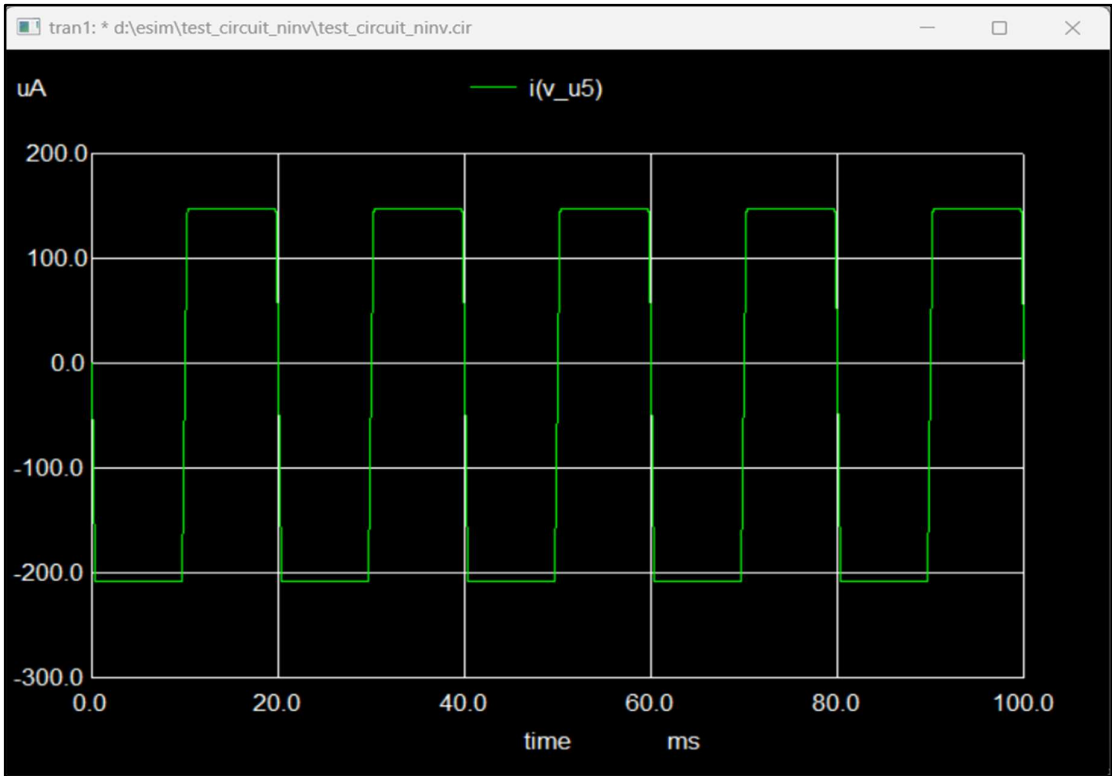
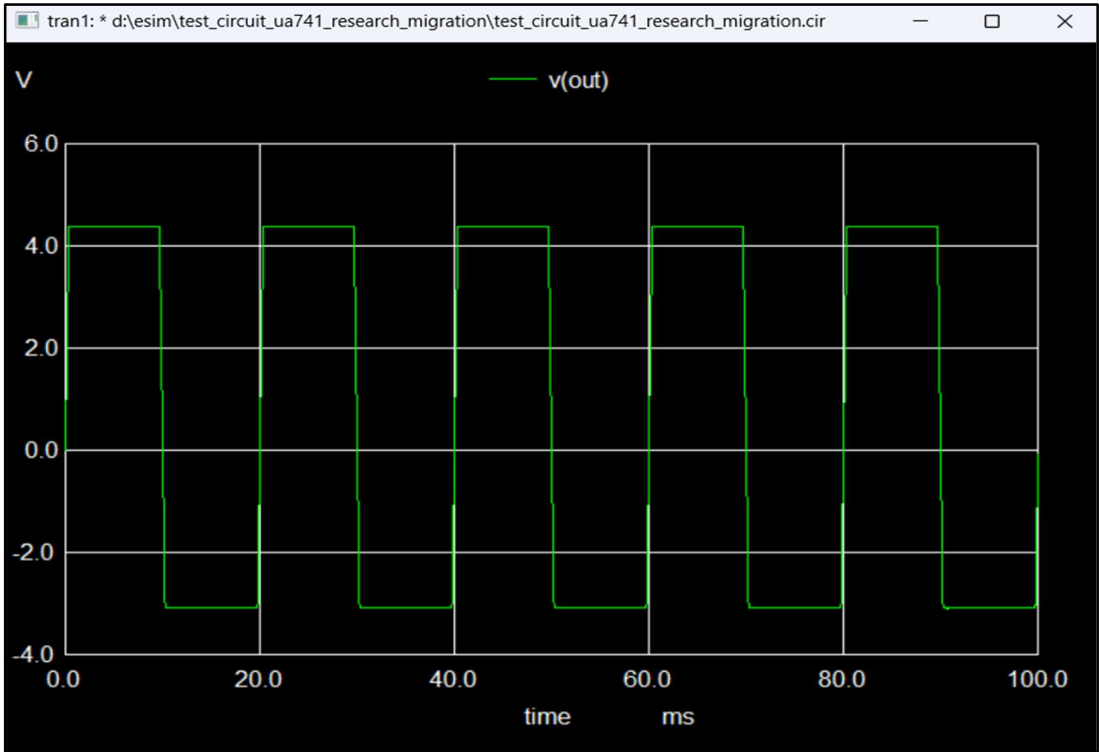


Figure 5: NINV

Input waveform



Output Waveform



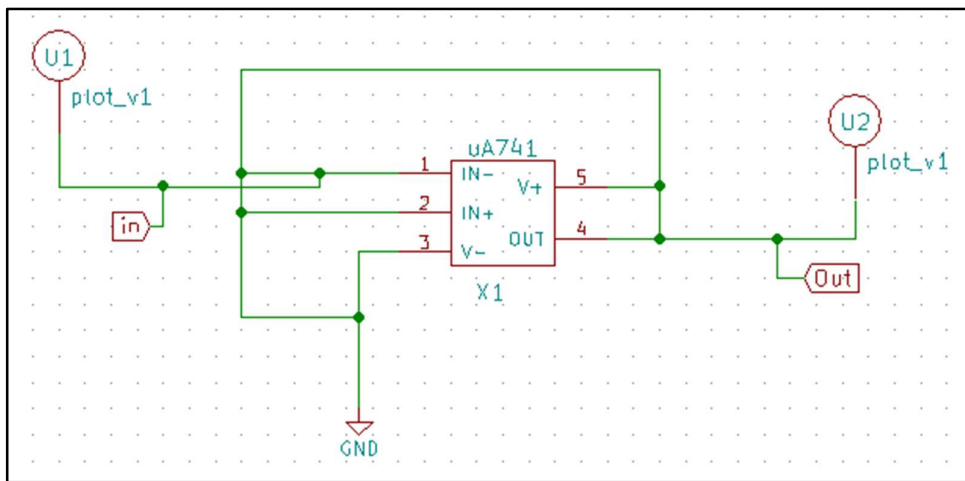
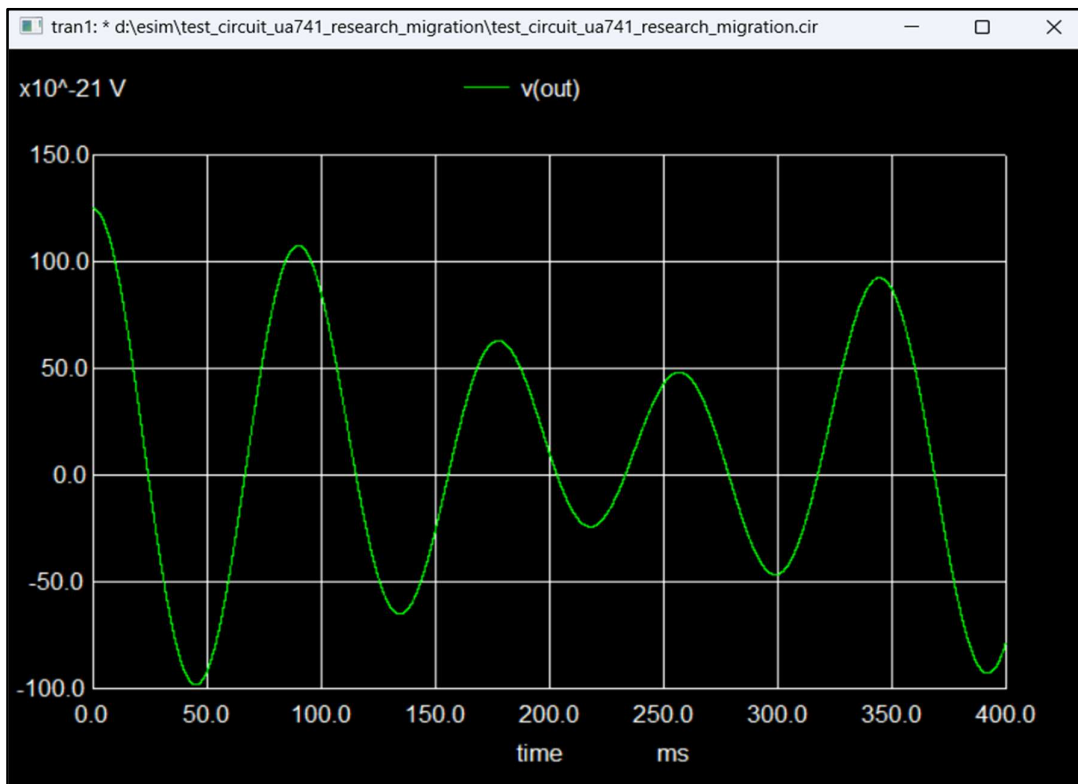


Figure 6: GND

Input & Output Waveform



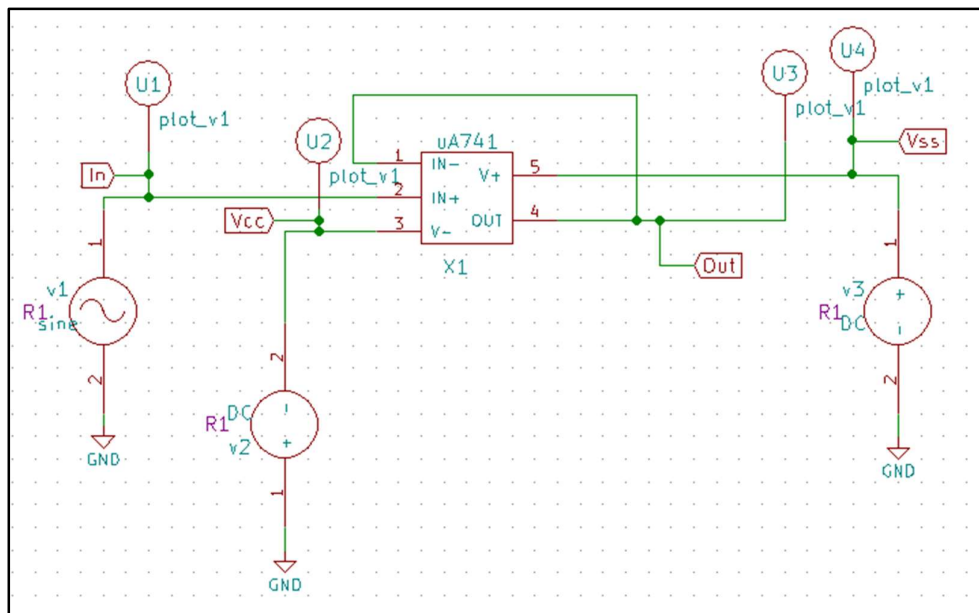
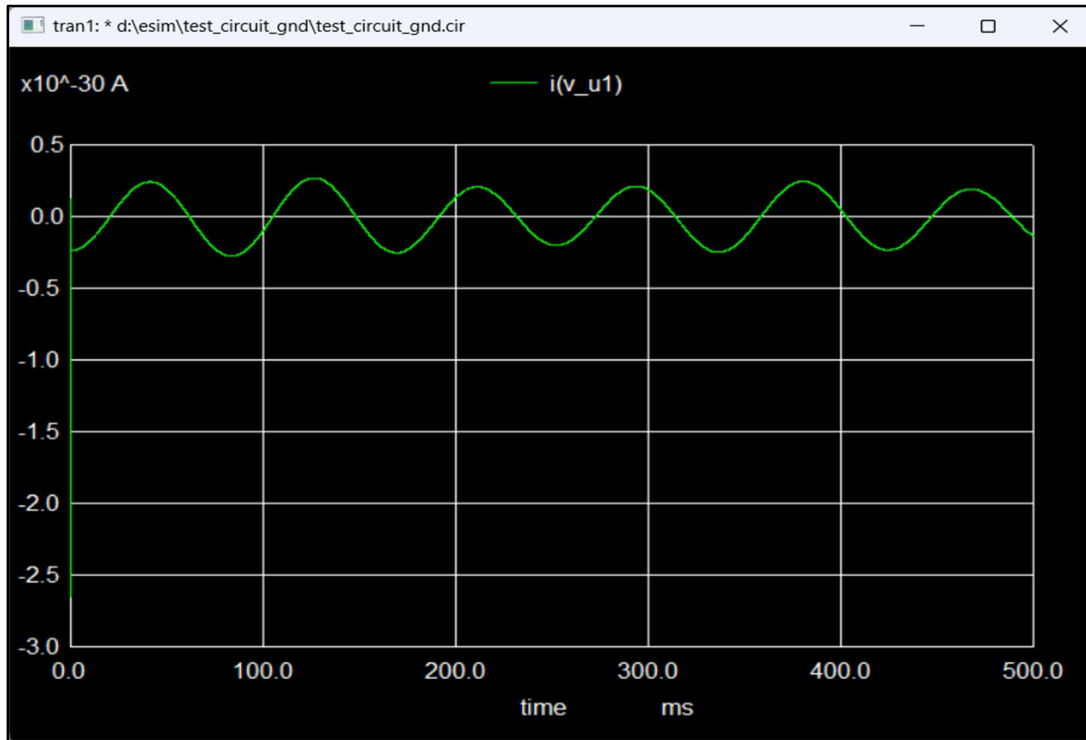
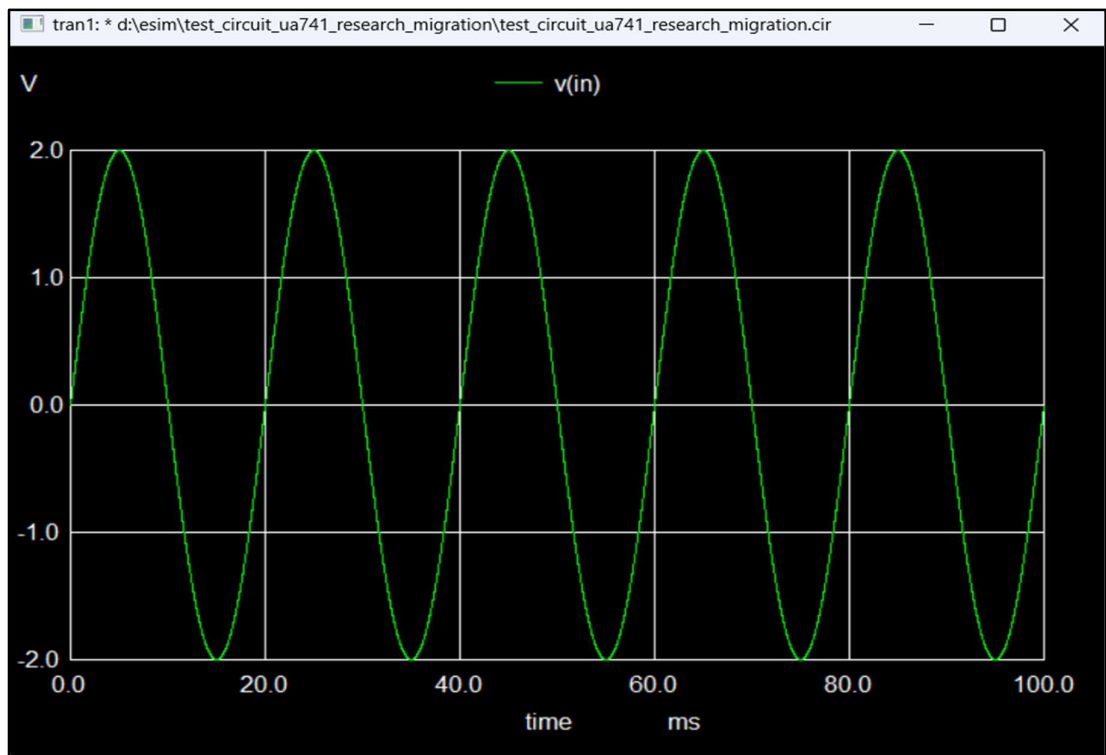
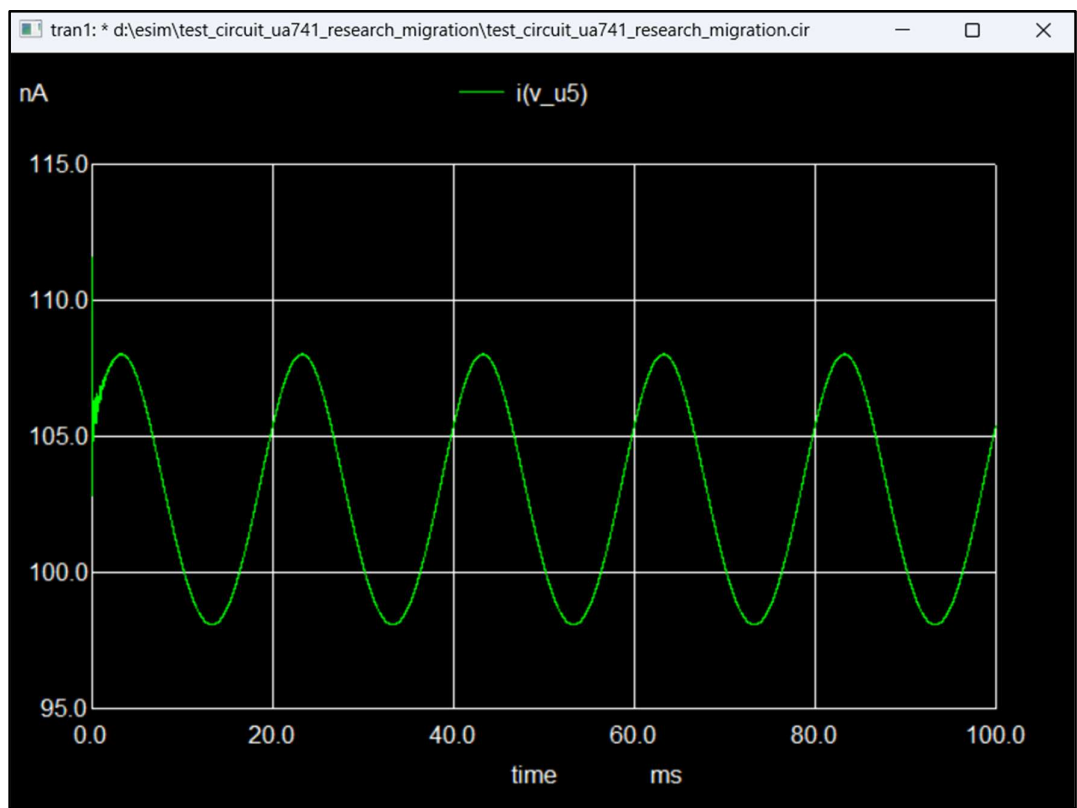


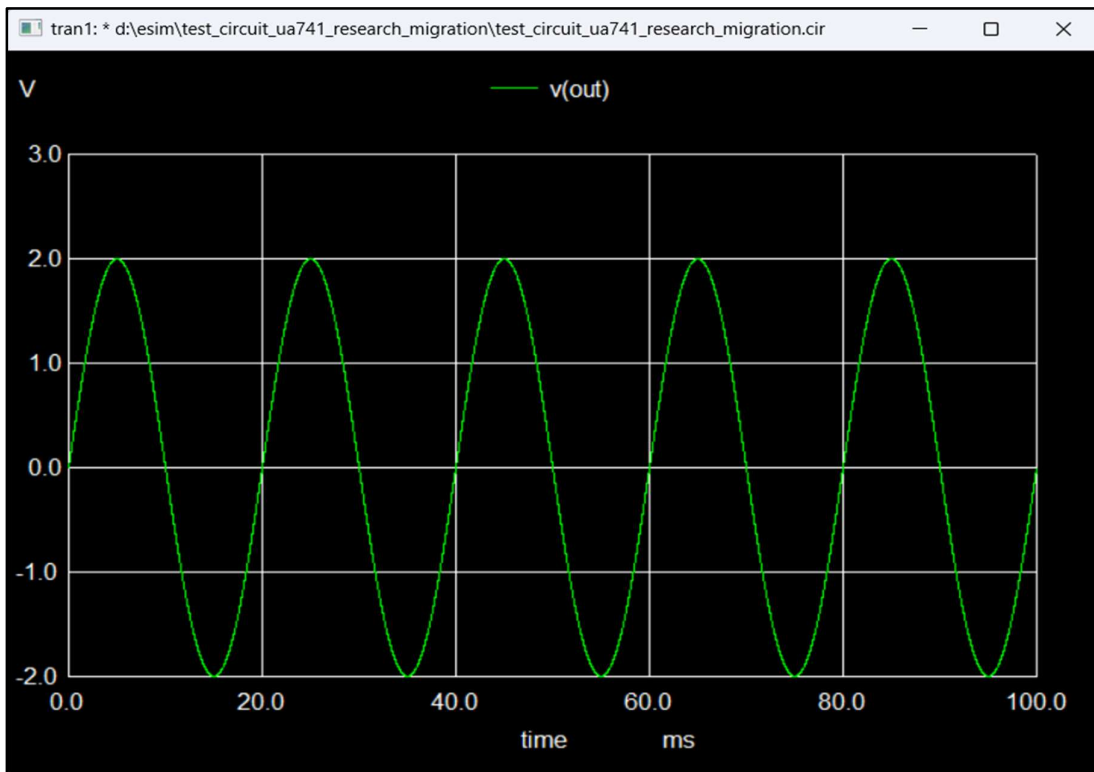
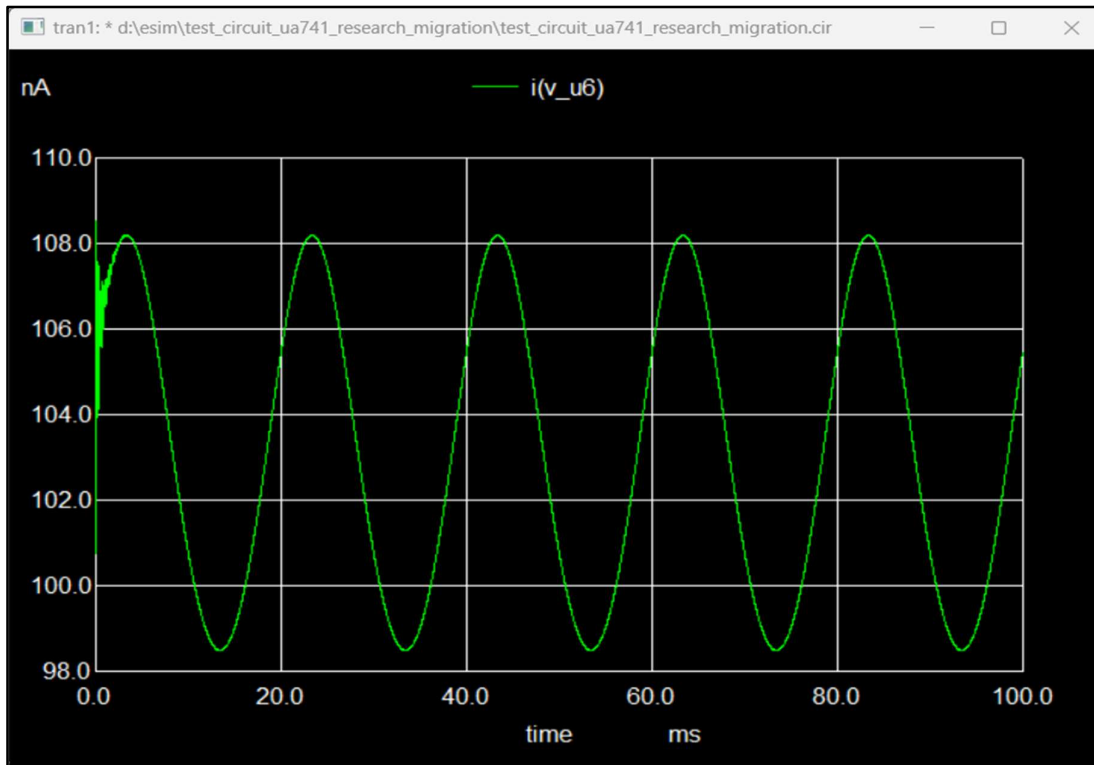
Figure 7: VF

Input Waveform



Output Waveform





Conclusion

The bias currents and offset voltage in the μ A741 operational amplifiers with different bias conditions at high dose rate was investigated. The experimental results show that the grounded bias is the worst case bias condition of μ A741 operational amplifiers during irradiation. The increment of bias current as the increasing total dose irradiation is due to the degradation of the transistors in the input differential stage.

Reference :

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2. H. Johnston and R. E. Plaag, "Models for total dose degradation of unear integrated circuits," IEEE Transactions on Nuclear Science, vol. 34, no. 6, pp. 1474-1480, 1987.