Electronics II
Power Control by IR Remote Control – Spring 2025

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1 Introduction

This project, developed as part of the Electronics II course at the German International University, focuses on the wireless control of an electrical load by varying the firing angle of a Silicon-Controlled Rectifier (SCR). The main objective is to regulate the duty cycle of an appliance remotely using analog signal transmission and reception components.

The system is designed to simulate and analyze how a wireless analog signal can effectively adjust the firing angle, thereby controlling the power delivered to a load. The project includes designing the analog transmission circuit, simulating the system in LTspice, building the hardware on a breadboard, and comparing simulation results with real-world measurements.

2 Circuit Schematic (Not from LTspice)

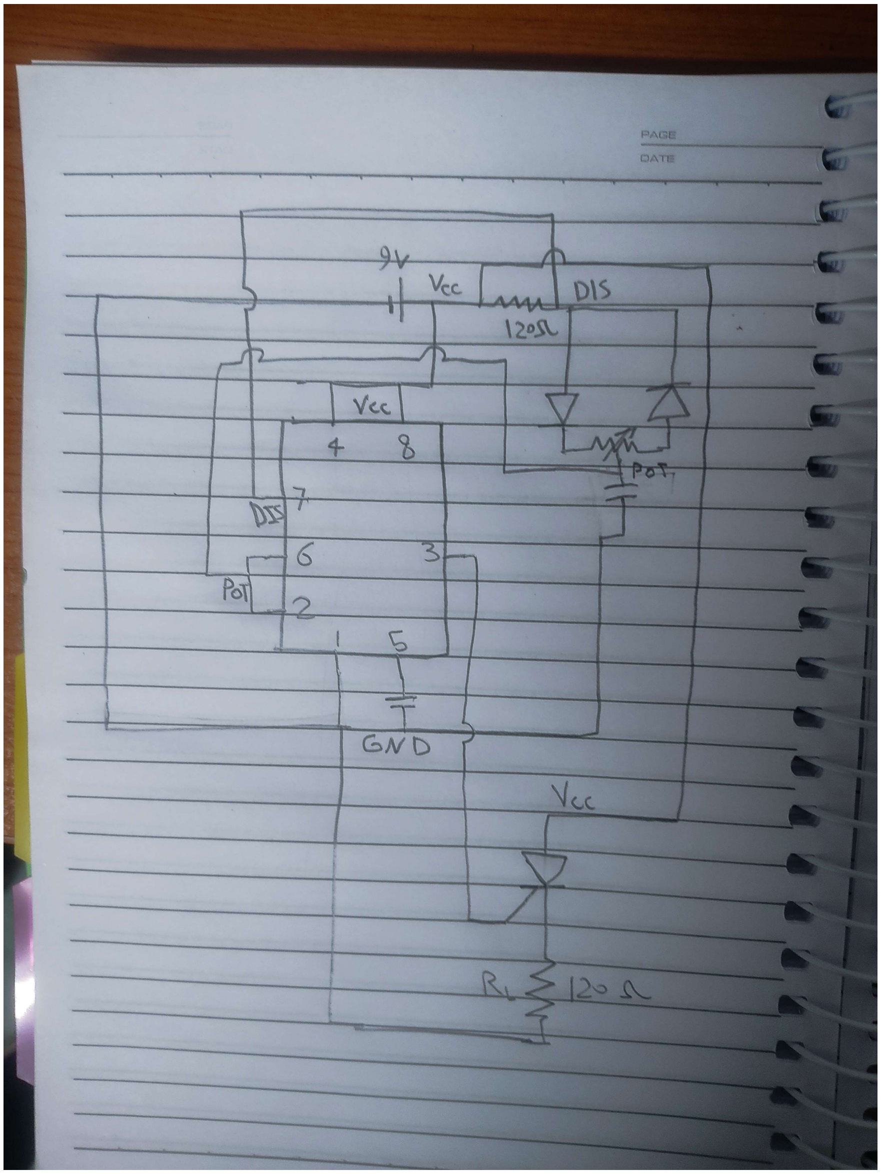

Figure 1: Hand-drawn circuit schematic (not LTspice)

3 Circuit Operation

The operation of the circuit is based on controlling the firing angle of a Silicon-Controlled Rectifier (SCR) using an analog signal that simulates IR transmission.

In this design, the IR signal was modeled using a potentiometer. By adjusting the potentiometer, the threshold and trigger voltages of a 555 timer (configured in astable mode) are modified. This 555 timer represents the microcontroller that, in a real-world scenario, would receive an IR signal and convert it into a Pulse Width Modulation (PWM) output.

The PWM signal generated by the timer is fed into the gate of the SCR. As the duty cycle of the PWM changes (depending on the potentiometer setting), the effective firing angle of the SCR is adjusted. This results in control over the power delivered to the load, while keeping the frequency near constant.

4 Simulation Schematic (From LTspice)

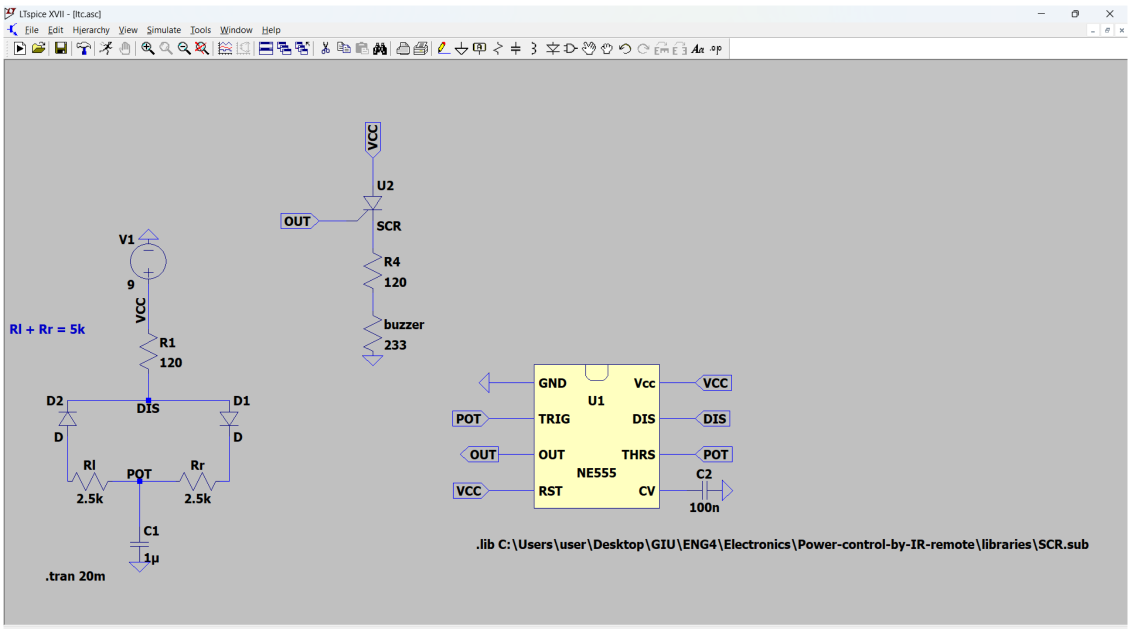

Figure 2: LTspice simulation schematic

5 Simulation Results (Screenshots)

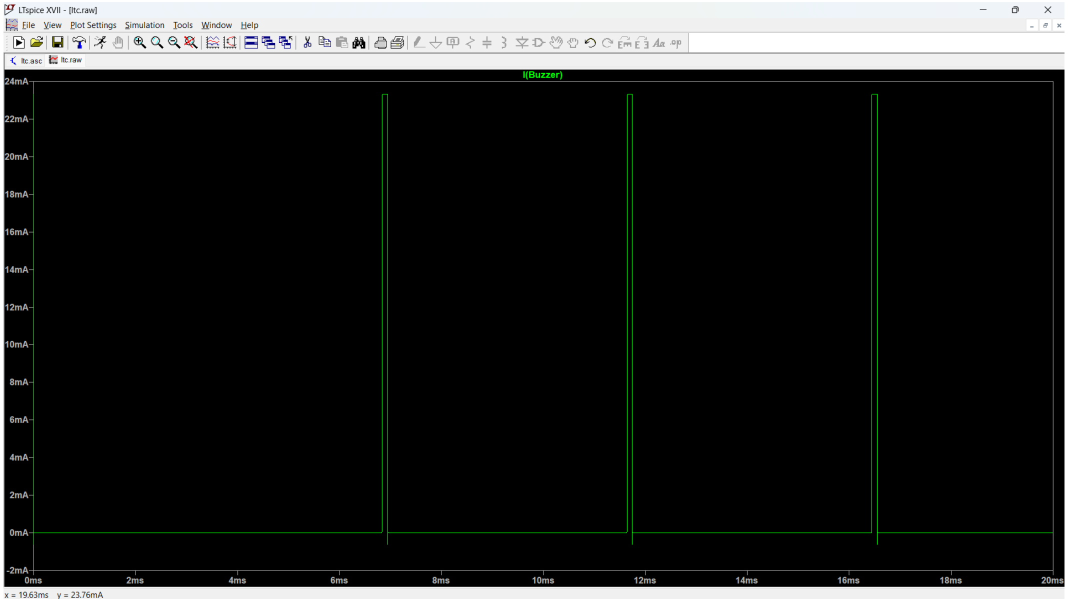

Figure 3: Simulation Result – Maximum R_l

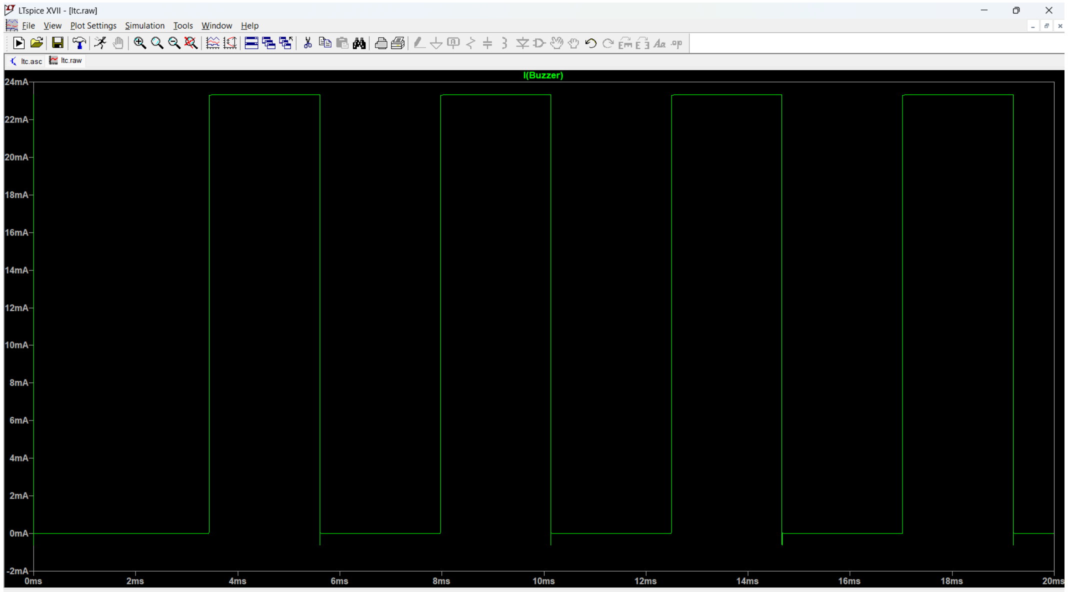

Figure 4: Simulation Result – $R_l = R_r$

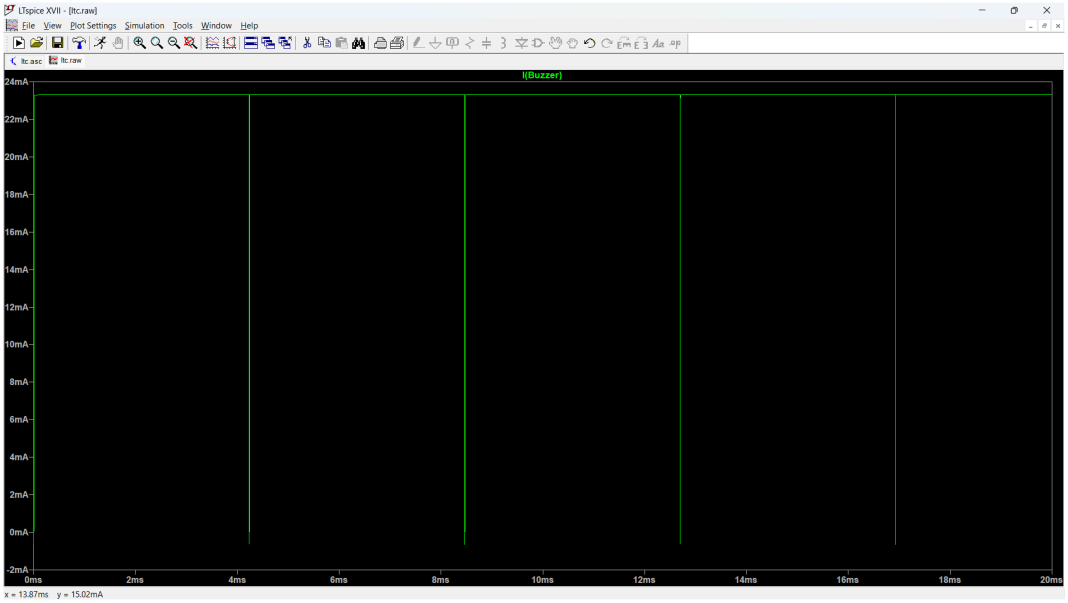

Figure 5: Simulation Result – Maximum R_r

6 Simulation Results Table

R_l (Ω)	R_r (Ω)	T_{on} (ms)	T_{off} (ms)	Load Current (mA)	Max Current (mA)
5k	1	0.108	4.9	0.502	23.3
2.5k	2.5k	2.18	2.36	11.2	23.3
1	5k	4.2	0.03	23.1	23.3

Table 1: Simulation output values

7 Hardware Components and Descriptions

Component	**Description**	**Price (EGP)**
Battery (9V)	Supplies power to the circuit	50
TIC126D SCR	Limits load current depending on firing angle	10
NE555 Timer	Produces PWM signal to feed the SCR's gate	4
Buzzer (12V)	Provides sonic illustration on the duty cycle	8
Resistor (120 Ω)	Limits current to protect buzzer	0.2
Resistor (120 Ω)	Needed for NE555 operation in astable mode	0.2
Capacitor (100nF)	Filters high-frequency noise for CV pin	0.25
Capacitor (1μF)	Needed for NE555 operation in astable mode	1
Potentiometer (5k Ω)	Adjusts SCR firing angle	5
Diode (2 Pieces)	Separate the charging and discharging paths of the capacitor	1

8 Hardware Photos from Breadboard

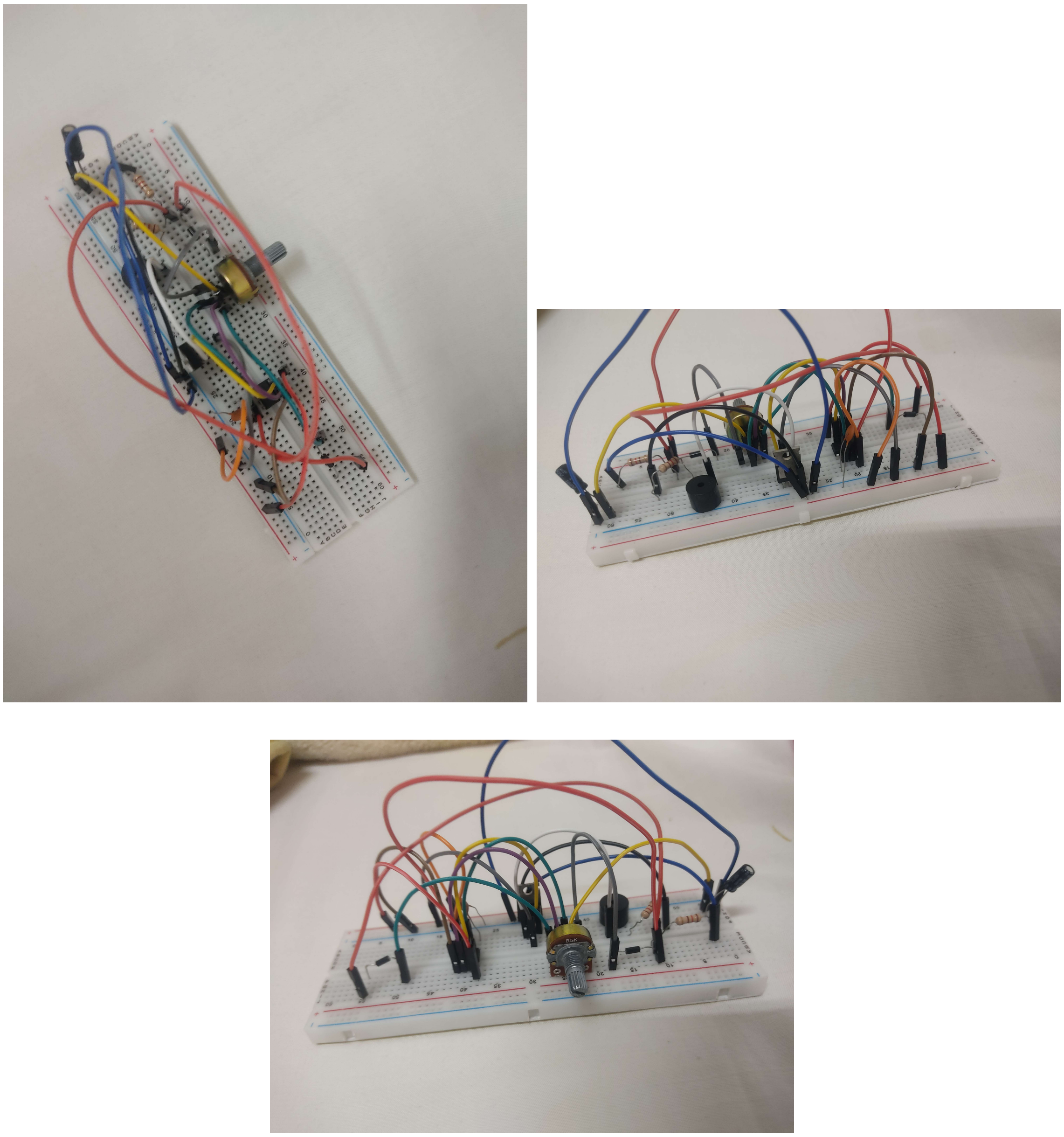

Figure 6: Breadboard implementation of the circuit from multiple angles

9 Hardware Results Table

R_l (Ω)	R_r (Ω)	Observation
5k	0	Buzzer sound was dim and pulsed
Decrease	Increase	Sound gradually changed from pulses to a steady DC-like tone
0	5k	Buzzer sound was clear and continuous

Table 3: Qualitative hardware observations based on R_l and R_r (Potentiometer) values

10 Conclusion

The combined simulation and hardware measurements demonstrate that varying the potentiometer effectively adjusts the duty cycle of the NE555-based PWM, and hence the SCR firing angle, without significantly altering oscillation frequency. In LTspice, as R_l decreased from 5kΩ to 1kΩ, T_{on} increased from 0.108ms to 4.2ms and T_{off} decreased from 4.9ms to 0.03ms, yielding a load current change from 0.502mA up to 23.1mA while the peak current remained at 23.3mA. These results were mirrored in hardware: with $R_l = 5\text{k}\Omega$ the buzzer emitted faint, pulsed tones, transitioning to a steady tone as R_l decreased, and becoming continuous at $R_l = 0$. The close qualitative agreement between simulation and experiment validates our analog IR-signal model and the use of dual diodes to decouple charge/discharge paths for independent duty-cycle control. Minor discrepancies in timing and sound clarity were attributed to component tolerances and breadboard parasitics. Future work could include replacing the potentiometer/diodes with a microcontroller-driven PWM for finer resolution and exploring closed-loop feedback to stabilize the load output under varying supply or load conditions.