Orkun İbrahim Kök 22003656

EEE419 Lab 3 Experimental

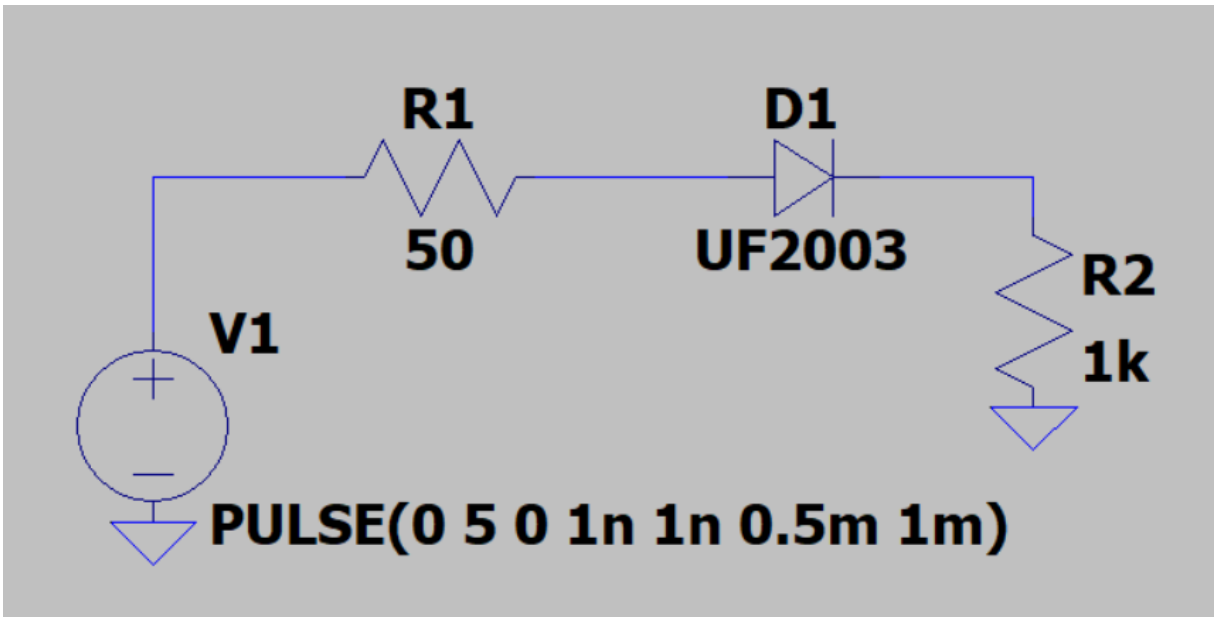


Fig. 1: Circuit for the 1st part

Analysis:

PART 1:

1.

Fig. 2 shows the output voltage with 1N4007 diode. The storage time is measured as 21µs.

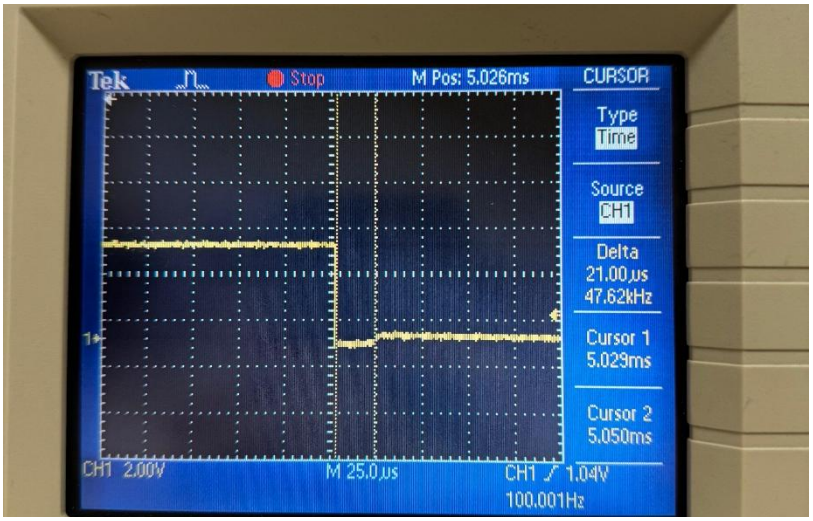


Fig. 2: Storage time (1N4007)

In the simulation, the storage time is measured as 11.22µs. The lifetime of the carriers are calculated using the formula below:

$$\tau_p = \frac{t_s}{\ln(1 + {I_R}/{I_F})}$$

The lifetime of carriers for 1N4007 diode is calculated as 280µs. Whereas in the simulation, the value is calculated as 82µs.

2.

Fig. 3 shows the output voltage graph when UF2003 diode is connected to the circuit. The storage time is measured as 820ns.

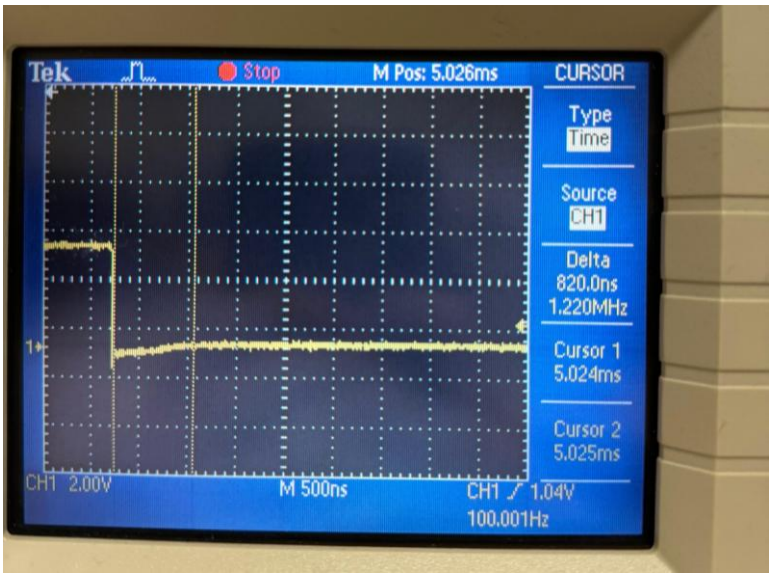


Fig. 3: Storage time (UF2003)

The storage time is measured as 426.25ns in the simulation. The lifetime of the carriers is calculated as 11.3µs, whereas in the simulation, it is calculated as 29µs.

PART 2:

3.

Fig. 4 shows the 3ms delay between gate pulse and input sine wave.

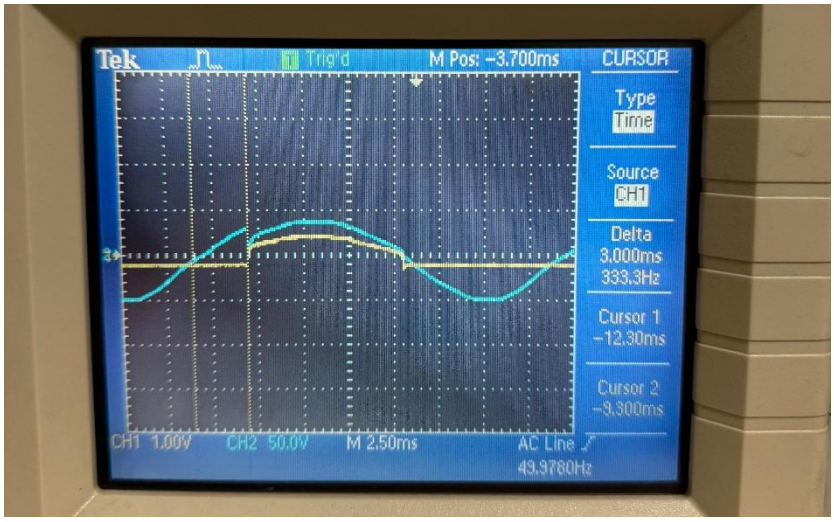


Fig. 4: 3ms delay

Fig. 5 shows the voltage V_T and following that, Fig. 6 shows the voltage V_A, anode voltage of the thyristor.

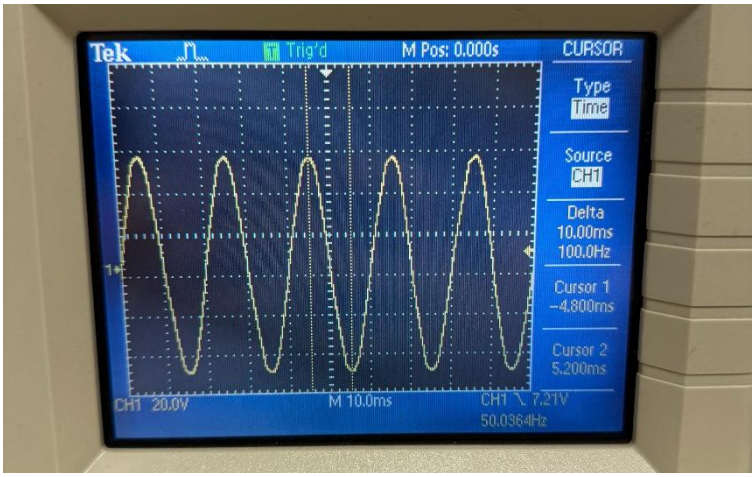


Fig. 5: V_T voltage

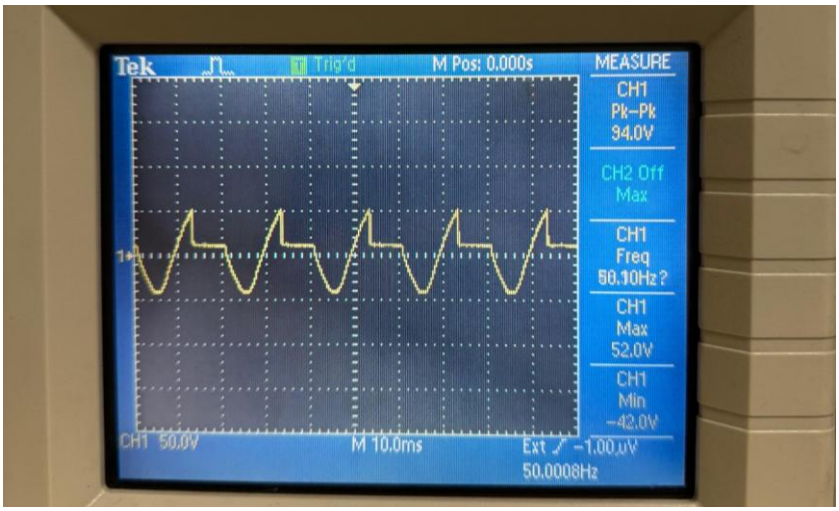


Fig. 6: V_A voltage

Fig. 7 shows the difference of these two voltages, i.e., voltage across the 68Ω load resistor.

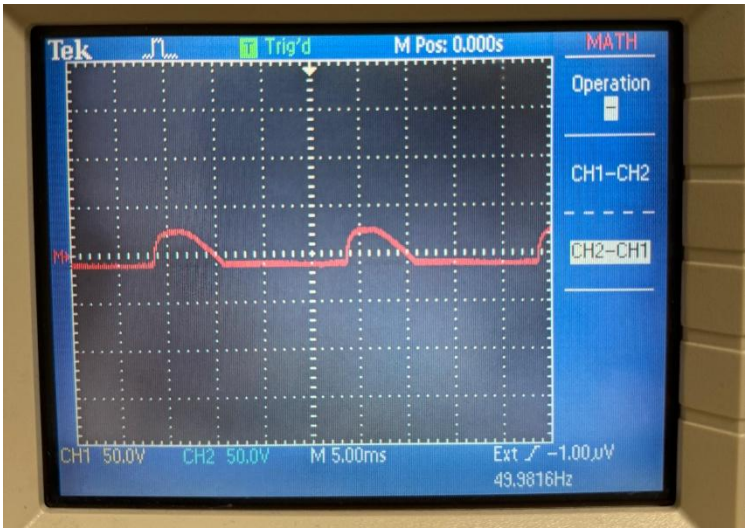


Fig. 7: Voltage across load resistor

The voltage across R_L is measured with a DC voltmeter, the measured voltage is 8.54V DC. Also, the voltage across R_L is also measured with an AC voltmeter, the measured value is 12.87V AC. The average value measured in the simulation is 12.28V AC.

Fig. 8: DC voltage across R_L

Fig. 9: AC voltage across R_L

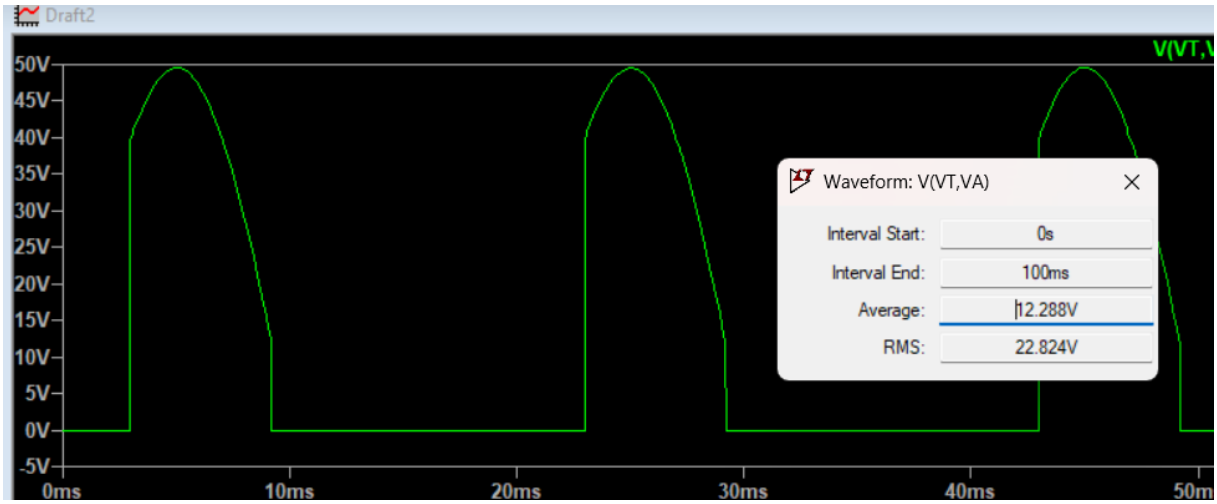


Fig. 10: Average value of voltage across R_L

4.

The triggering voltage of the triggering voltage of the thyristor is measured as 52V in the lab, whereas in the simulation, this value is measured as 40.92V. The difference is more than expected.

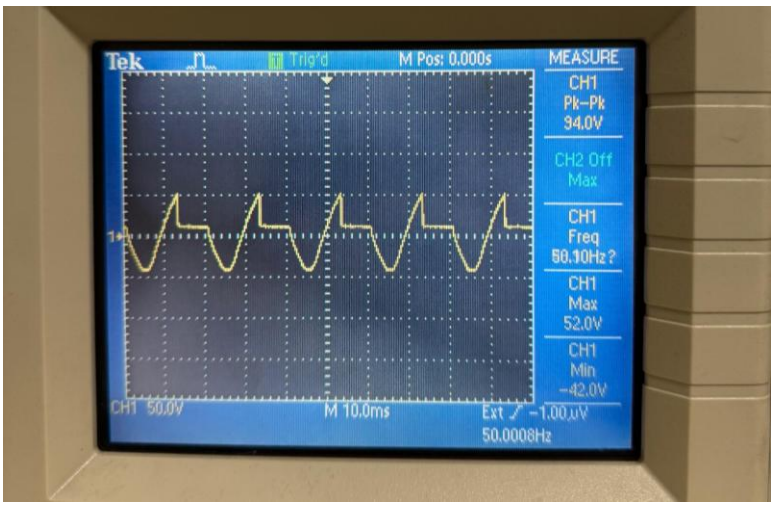


Fig. 11: Anode voltage

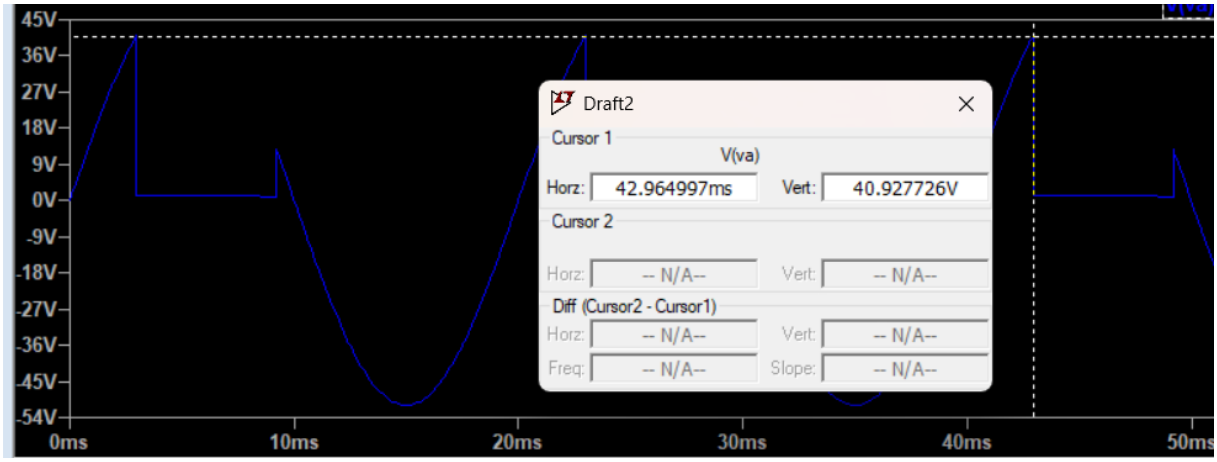
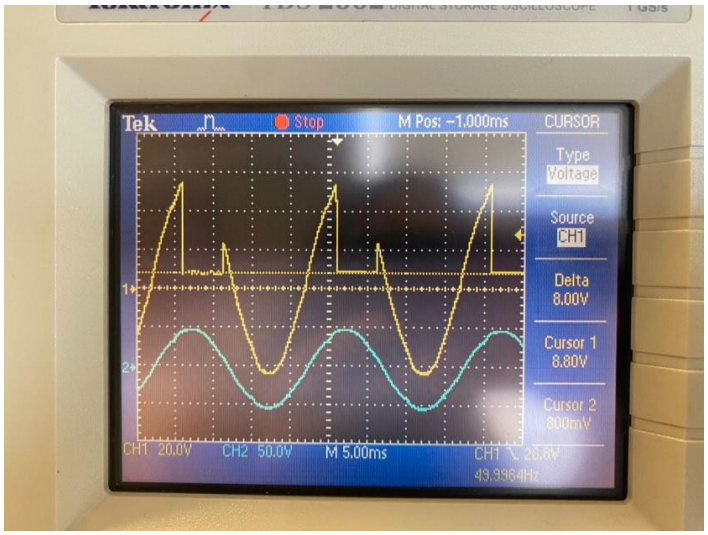


Fig. 12: Triggering voltage of the anode voltage



Above figure shows the forward ON state voltage V_{TM} voltage. The measured value is 800mV.

5.

The voltage waveform at the gate of the thyristor resembles to pulse. Fig. 13 shows the corresponding waveform.

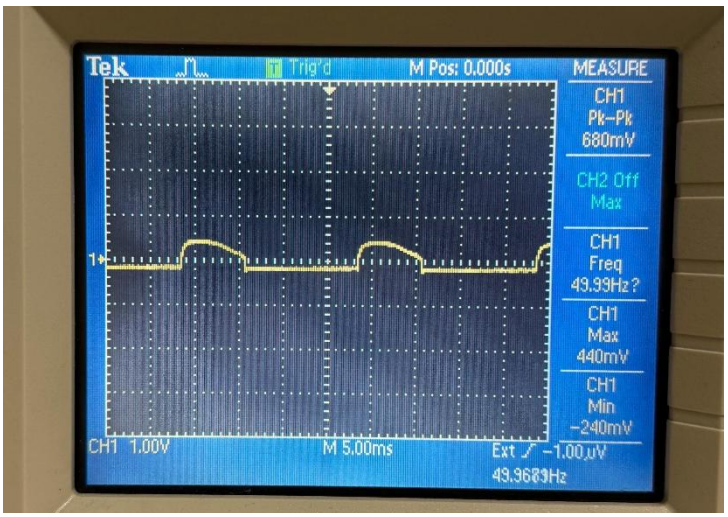


Fig. 13: Gate voltage

6.

In the previous step, gate voltage is measured as 440mV in its peak. Using the formula, the minimum gate current was calculated.

$$I_{GT} = \frac{V_S - V_{GT}}{1.2K} = \frac{15 - 0.44}{1.2K} = 12.1mA$$

Whereas, in the simulation, the minimum gate current I_{GT} require for triggering is measured as 11.5mA.

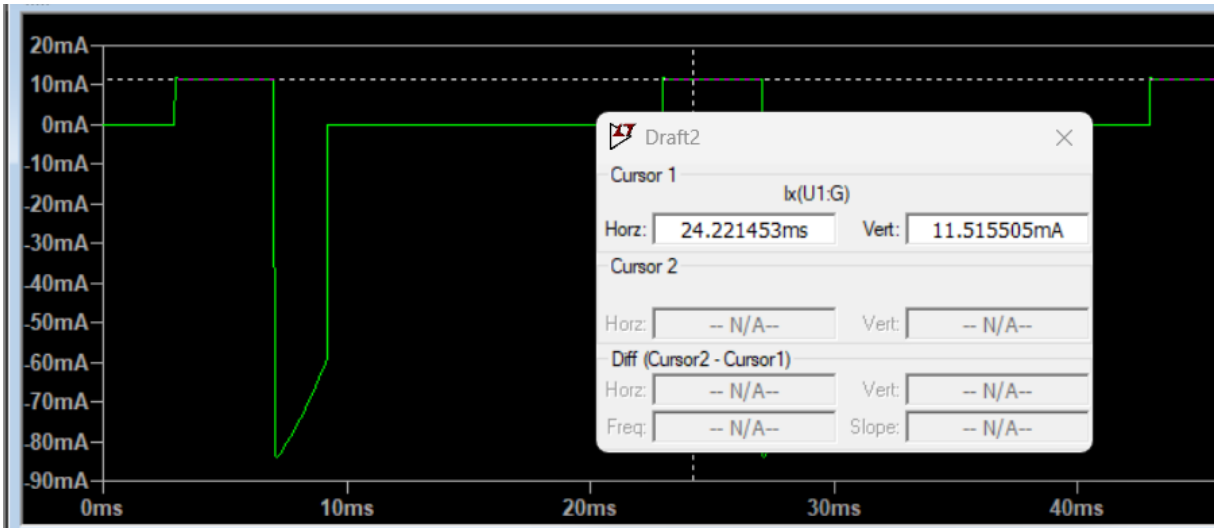


Fig. 14: Minimum gate current required for triggering

7.

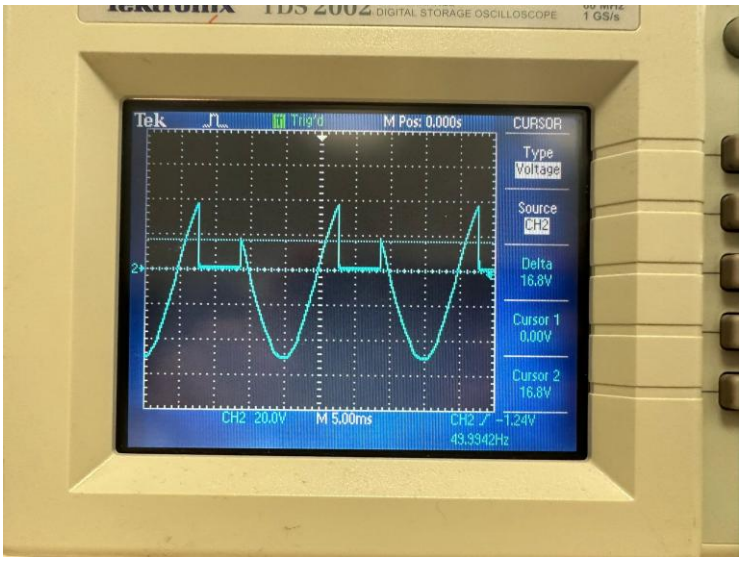


Fig. 15: Thyristor turn off voltage

V_T voltage is measured as 16.8V as seen from Fig. 15. Also, in step 4., V_{TM} voltage is measured as 800mV. Plugging in these values into the following equation will give the holding current.

$$I_H = \frac{V_T - V_{TM}}{1K} = 16mA$$

The value measured in the simulation can be seen in below figure. The values in the simulation and experiment are close values with a slight error included.

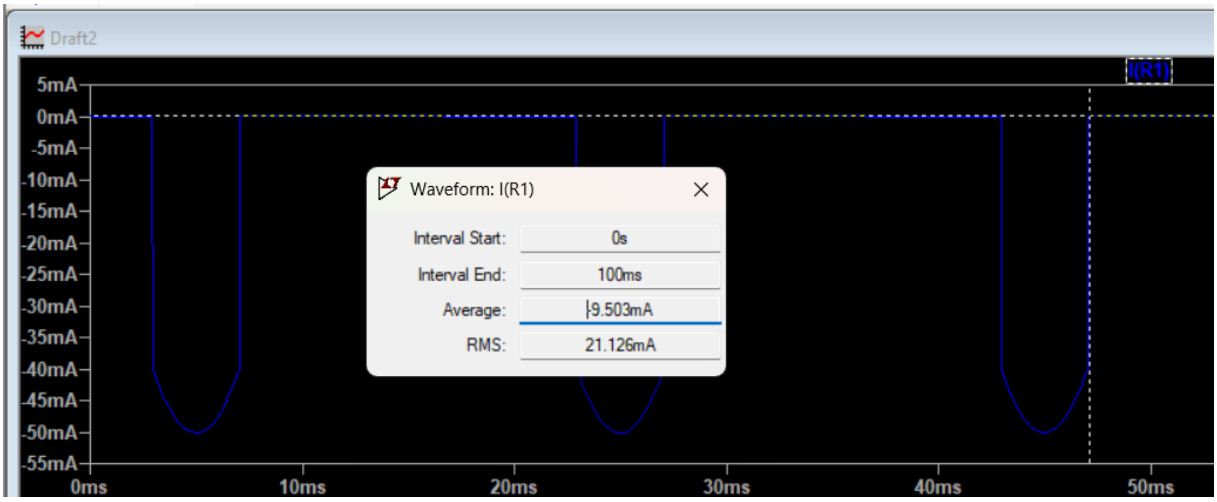


Fig. 16: Holding current in simulation

8.

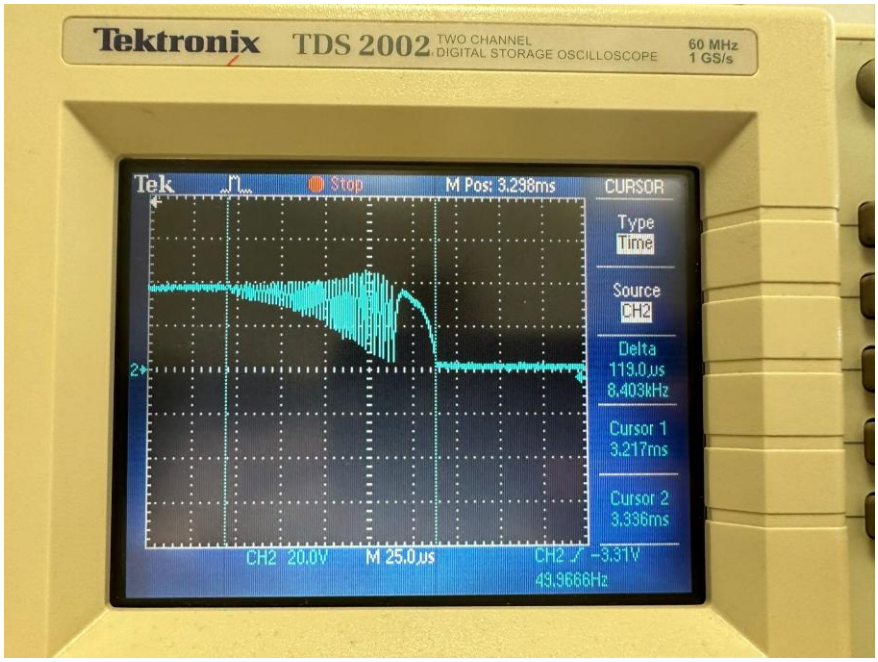


Fig. 17: Turn on transient

Fig. 17 shows the turn on transient with R_L=68Ω. The measured fall-time value is 119µs.

9.

The LM339 OPAMP is replaced with DB3 diac and anode voltage V_A is measured with no capacitor, C=0.1µF, and C=0.22µF. Then the breakover voltage, V_{BO} is measured. The anode voltage V_A turned out to be same for cases C=0.1µF and C=0.22µF as seen in the below figure.

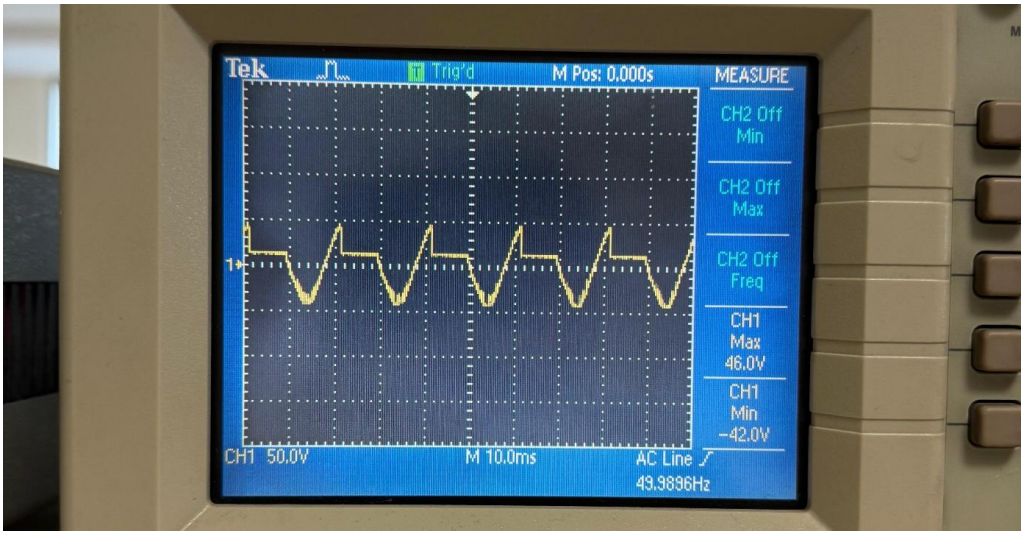


Fig. 18: Anode voltage V_A for C=0.1µF and C=0.22µF

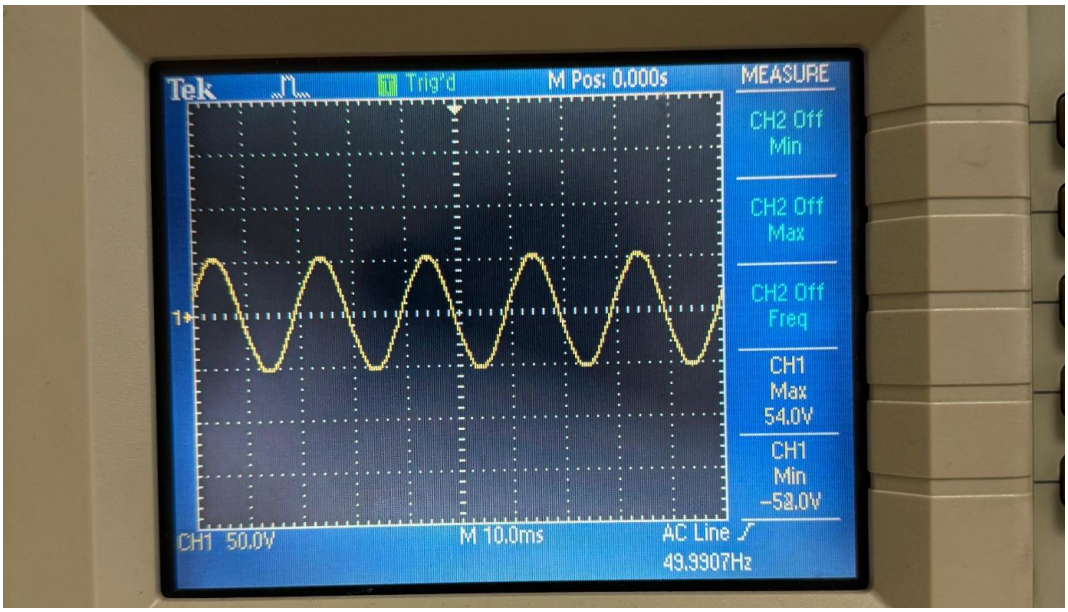


Fig. 19: Anode voltage V_A with no capacitor

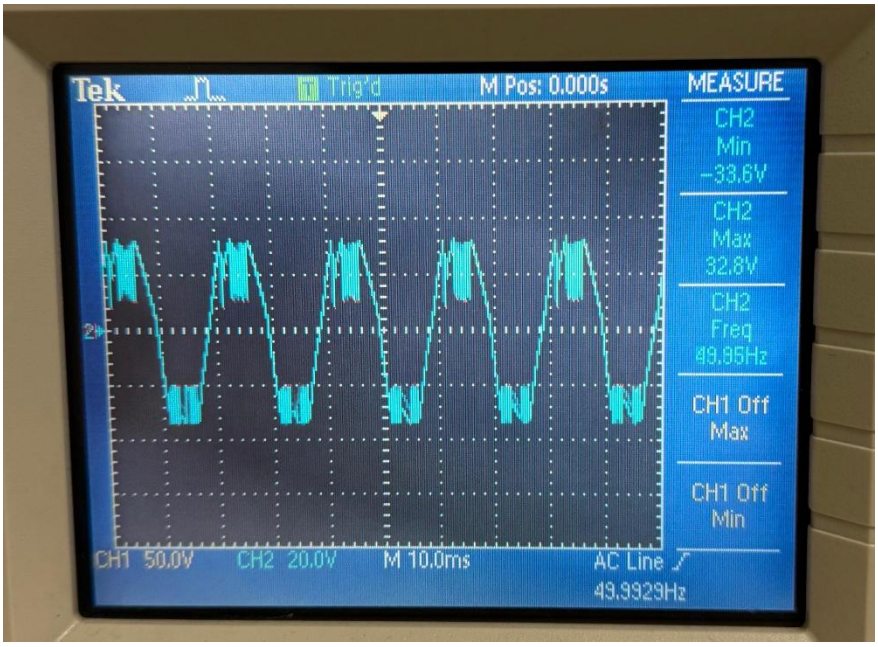


Fig. 20: Voltage across capacitor

The breakover voltage is where the oscillation starts, which is the value 32.8V.

10.

In this step, thyristor is replaced with a TRIAC. Again, V_A is measured for no capacitor, C=0.1µF, and C=0.22µF cases. Below figures show the corresponding voltage waveforms.

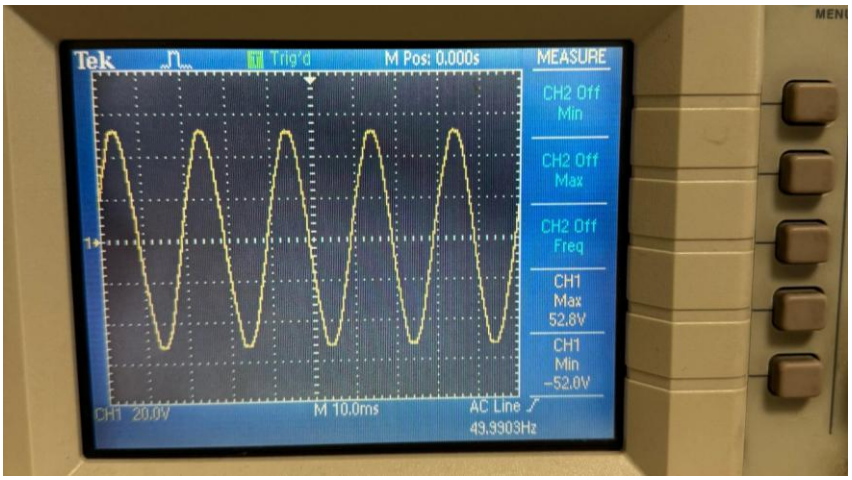


Fig. 21: Anode voltage V_A with no capacitor

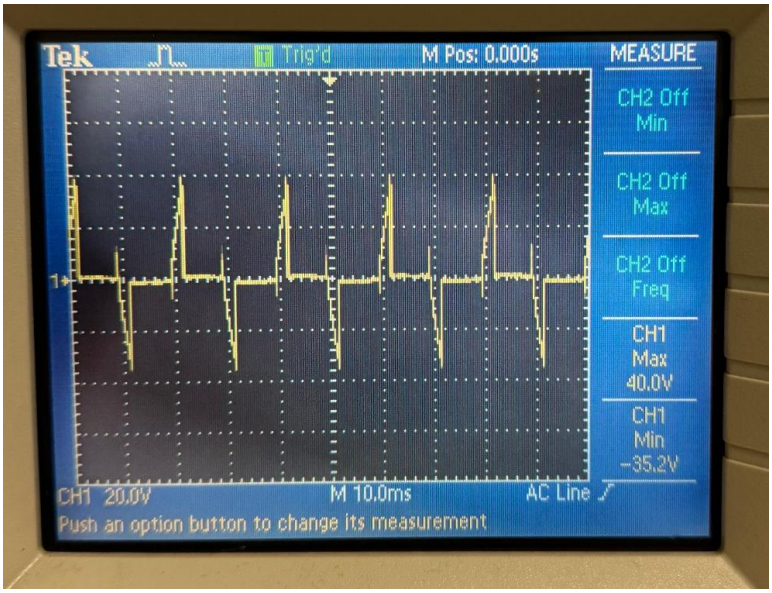


Fig. 22: : Anode voltage V_A for C=0.1µF

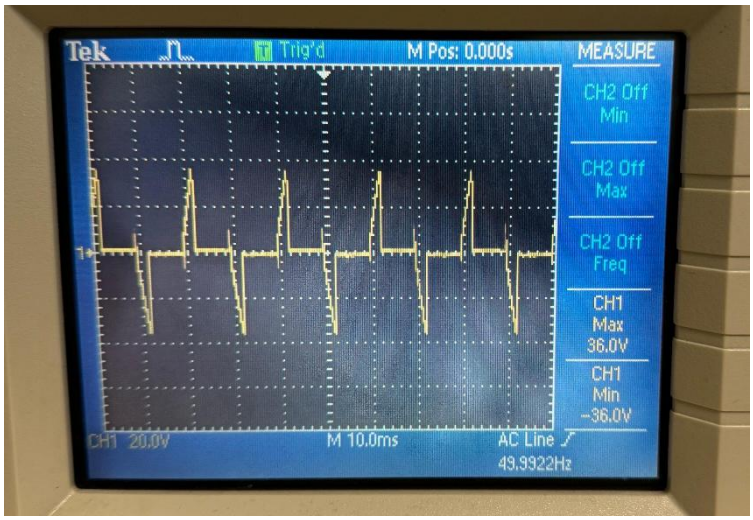


Fig. 23: Anode voltage V_A for C=0.22µF

For the case C=0.1µF, the voltage across the load resistor R_L is measured with a true-RMS AC voltmeter. Figure below shows the result.

Fig. 24: Voltage across load resistor