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EEE419 Lab 1 Preliminary

Analysis:

a) When only the NE555 circuit is on the breadboard with the BC308 pnp transistor and applied V_d from the power supply (12V), waveforöm at the node V_p can be seen in Fig. 1. The voltage varies between $-V_d$ (-12V) and -200mV. The specifications says it should vary between $-V_d$ and zero.

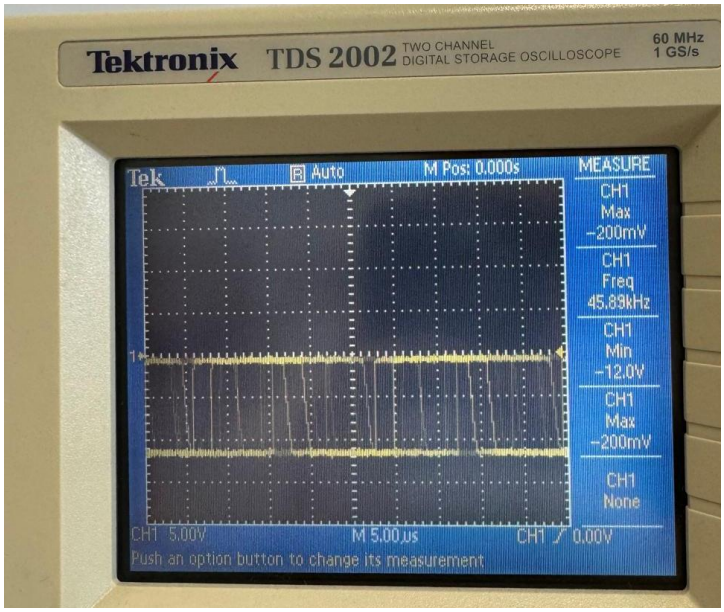

Fig. 1: Voltage at V_p

b) Now, the whole board is set up on the breadboard. For this questioni R_L=560Ω. Fig. 2 shows the voltage waveform at node V_X from the LTspice simulation. Fig. 3 shows the voltage at V_X measured on oscilloscope. The waveforms resemble to each other. Also, V_X varies between -13V to 800mV. Per the specification indicates, the voltage should vary between $-V_d$ (-12V) and 0.6V. The values are near with a slight error included.

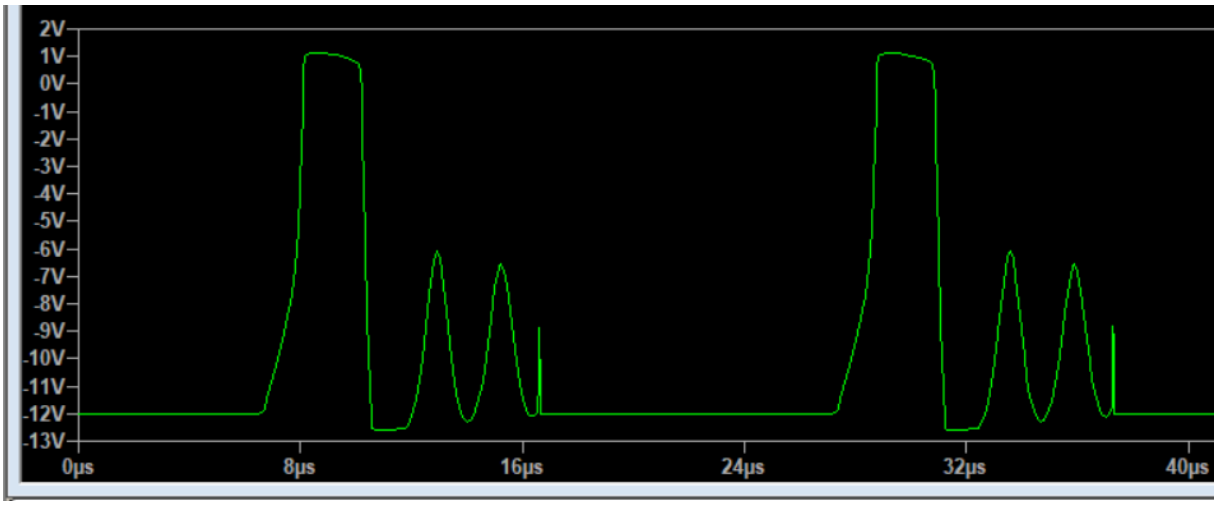

Fig. 2: Voltage at V_X

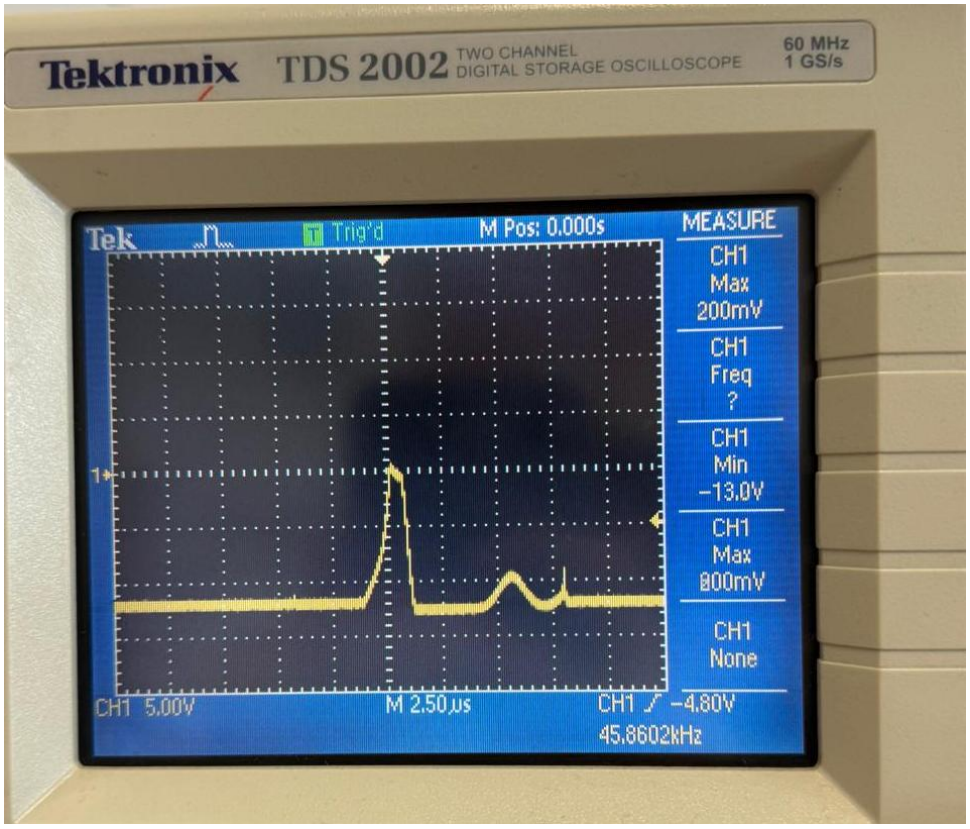

Fig. 3: Voltage at V_x measured from oscilloscope

c) The R_{L1} value is changed to 10Ω and asked values are recorded (Table 1).

Table 1: R_L=10Ω measurements

	V_d	I_d	R_L= R_{L1}	D	V_o	η(%)	V_{ripple}
Preliminary	12V	355mA	10Ω	0.458	5.5V	72%	52mV
Experimental	12V	388mA	10Ω	0.418	0.551	66%	100mV

Fig. 4 shows the V_d and I_d. Fig. 5 shows the T_s=22µs and Fig. 6 shows the t_{on}=9.2µs waveforms (Inductor current waveforms). The waveform is a bit distorted because of the breadboard's insensitivity. When I connected the GND of the oscilloscope probe near the load resistor, the waveform changed and be as expected, a triangle. D is calculated as 0.418. The efficiency is calculated as 66% in the experiment, where it is measured as 72% in the simulation. The difference may caused by the inductor windings and its series resistance, breadboard's insensitiveness. The output voltage ripple V_{ripple} is measured as 100mV (Fig. 7). However, as Prof. Atalar said, 100mV is a reasonable value for output voltage ripple. Therefore, with a slight error included, all of the value measured and calculated in the experiment are near to values measured and calculated in the LTspice simulation.

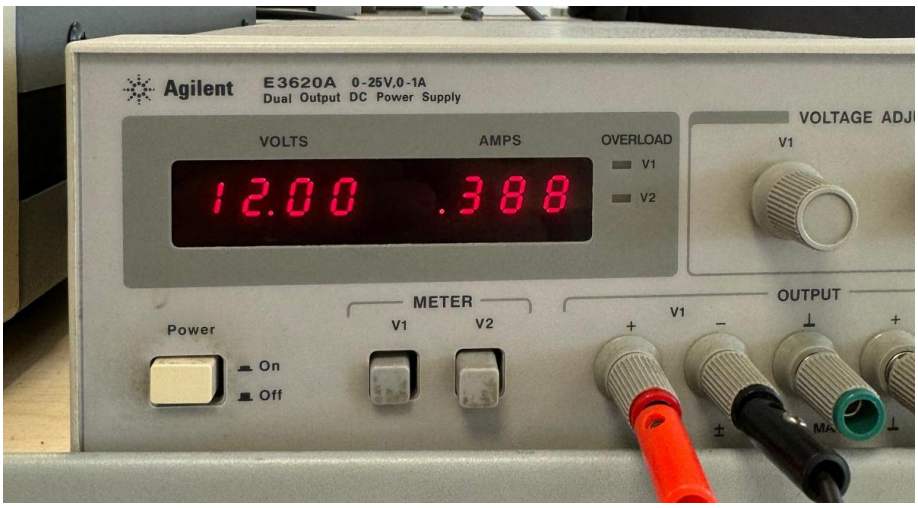

Fig. 4: Input voltage and current

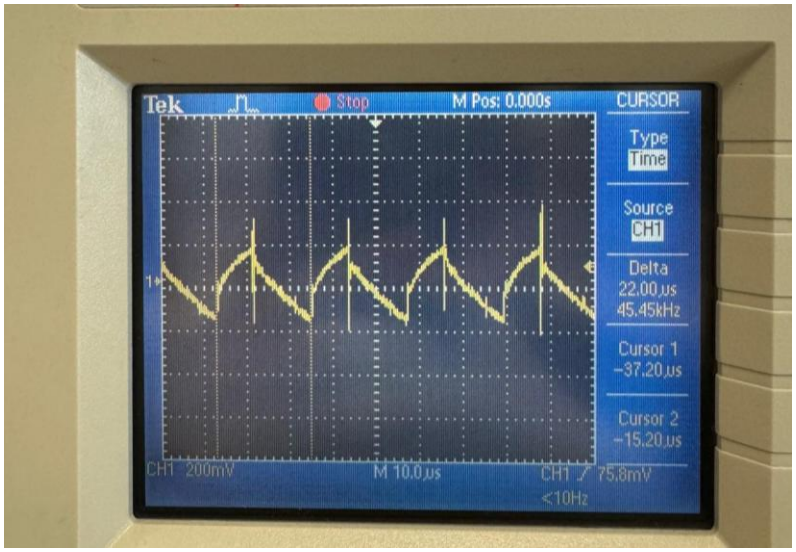

Fig. 5: T_s value from inductor current

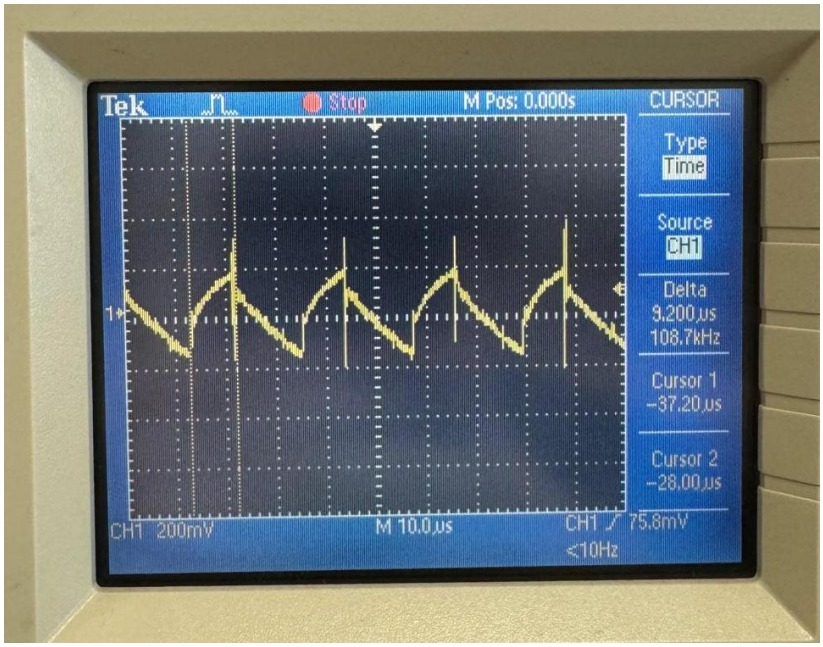

Fig. 6: t_{ON} value from inductor current

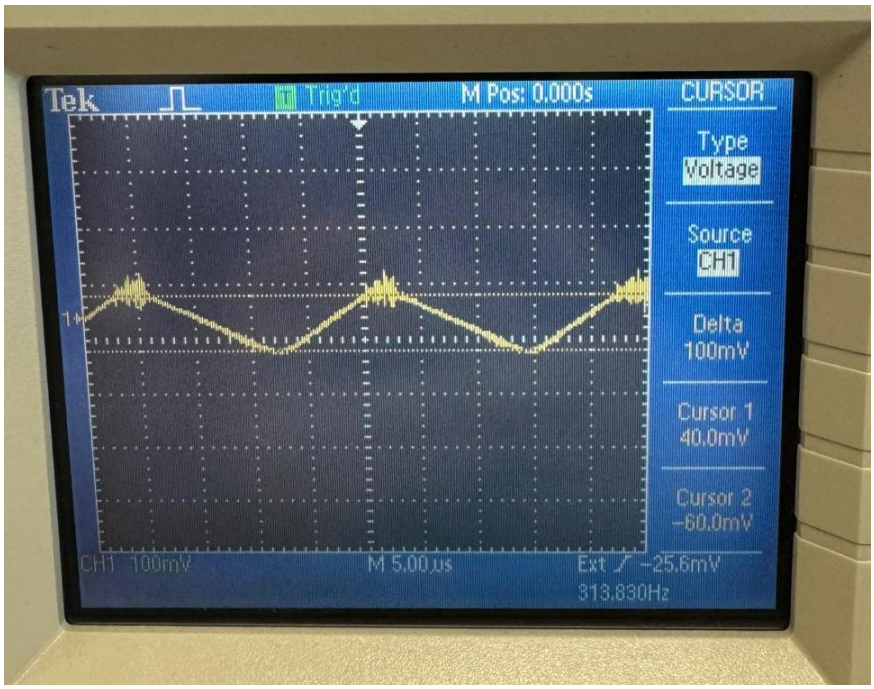

Fig. 7: Output voltage ripple V_{ripple}

d) $V_x(t)$ is the diode voltage. Fig. 8 shows the V_x voltage in LTspice and Fig. 9 shows the V_x voltage measured from oscilloscope.

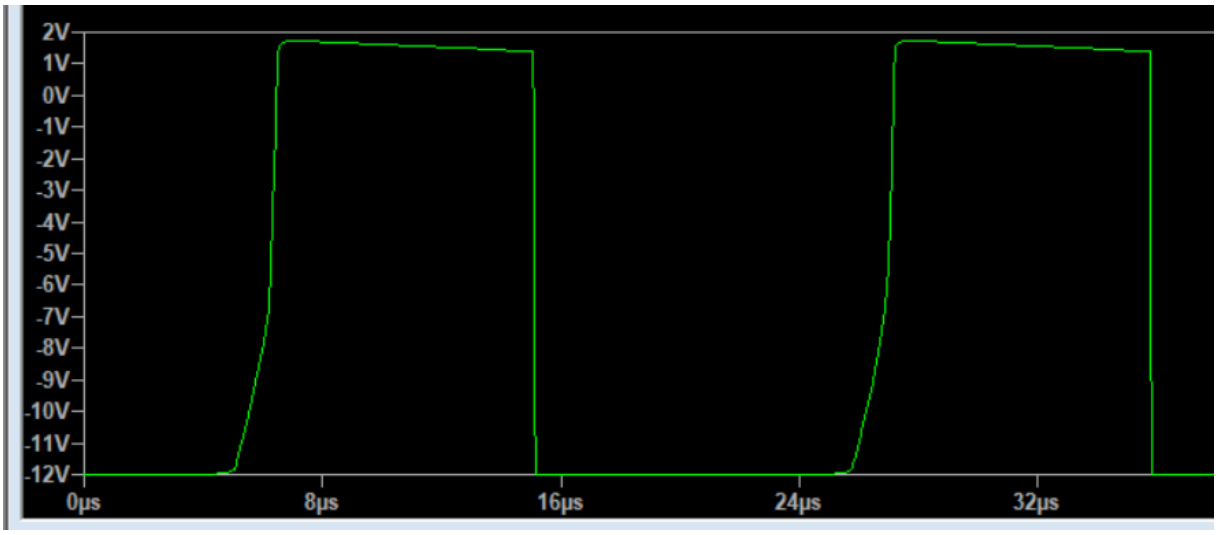

Fig. 8: V_x voltage

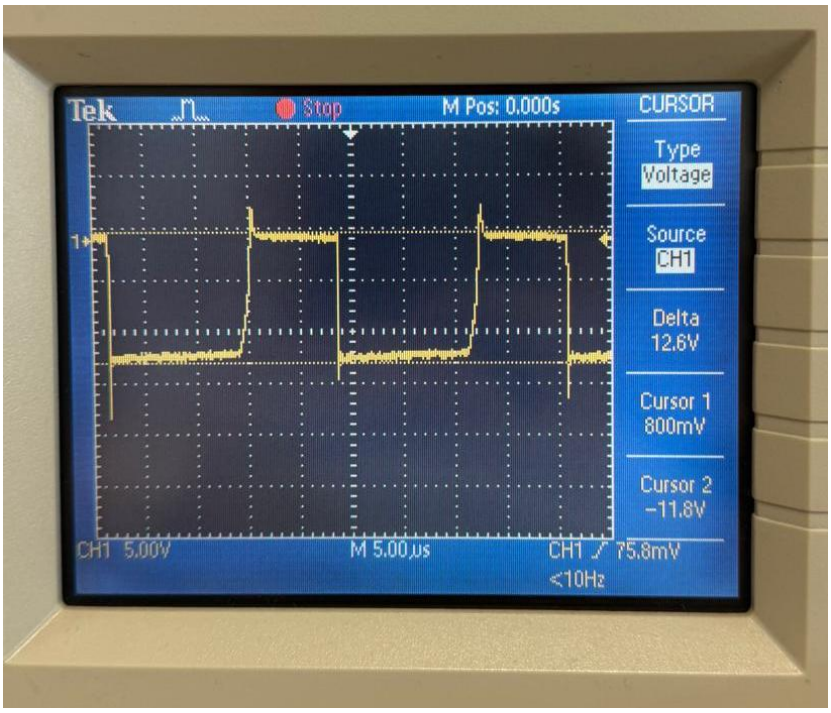

Fig. 9: Voltage V_x measured frım oscilloscope

In the simulation, V_x varies between $-V_d$ (-12V) to 1.7V. In the experiment, voltage varies between -11.8V and 800mV. The waveforms are exactly the same.

For $i_D(t)$, I measured $v_R(t)$ and multiplied it with 2 because of the two parallel connected 1Ω resistors. Fig. 10 shows the $i_D(t)$ measured from LTspice and Fig. 11 shows the $v_R(t)$ waveform measured from oscilloscope. The result will be multiplied by 2.

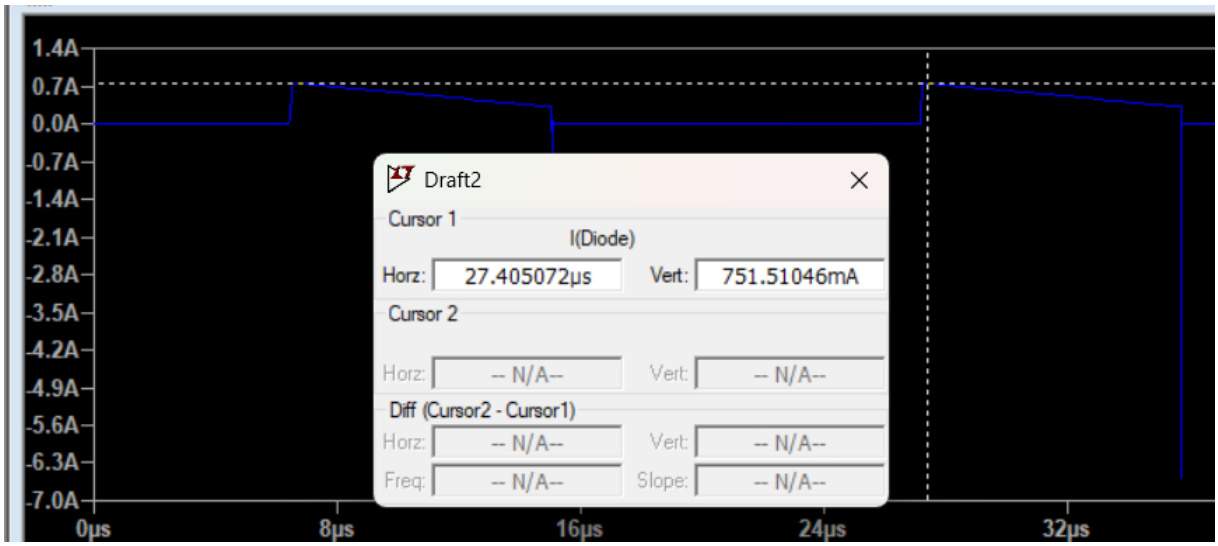

Fig. 10: $i_D(t)$ diode current waveform

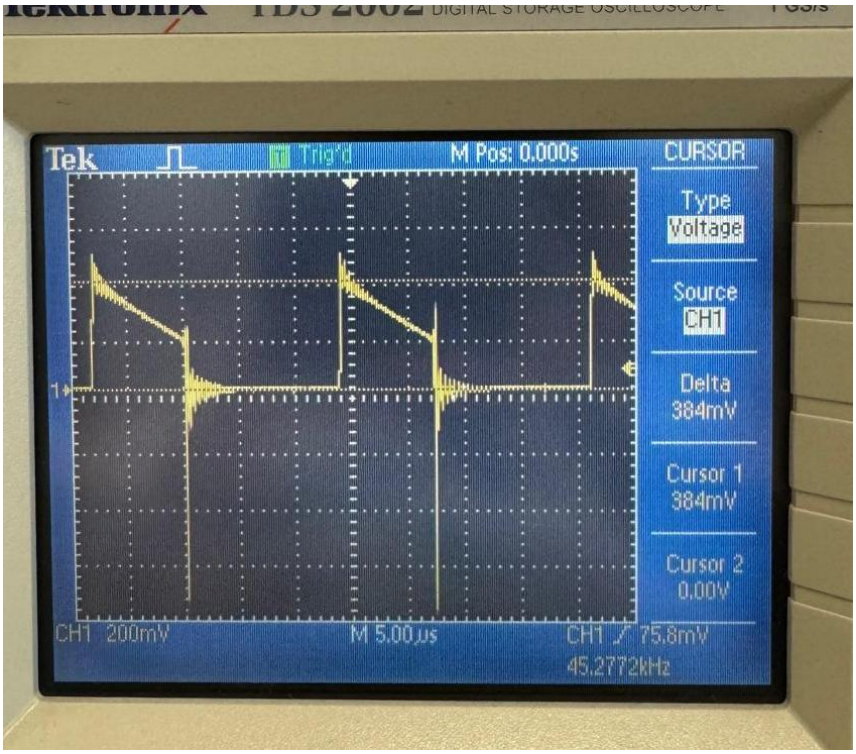

Fig. 11: Diode voltage $v_R(t)$ measured from oscilloscope

As seen from Fig. 11, the peak value is 384, multiplying by 2 gives 768mA. Whereas in the simulation, max diode current value is 751mA. The values are exactly the same as expected.

e) Now, the load resistance R_{L2}=47Ω. In order to get the desired output voltage V_o=5.5V, I swapped the resistors R_A and R_B. By changing their values, the desired output voltage is achieved (Fig. 12).

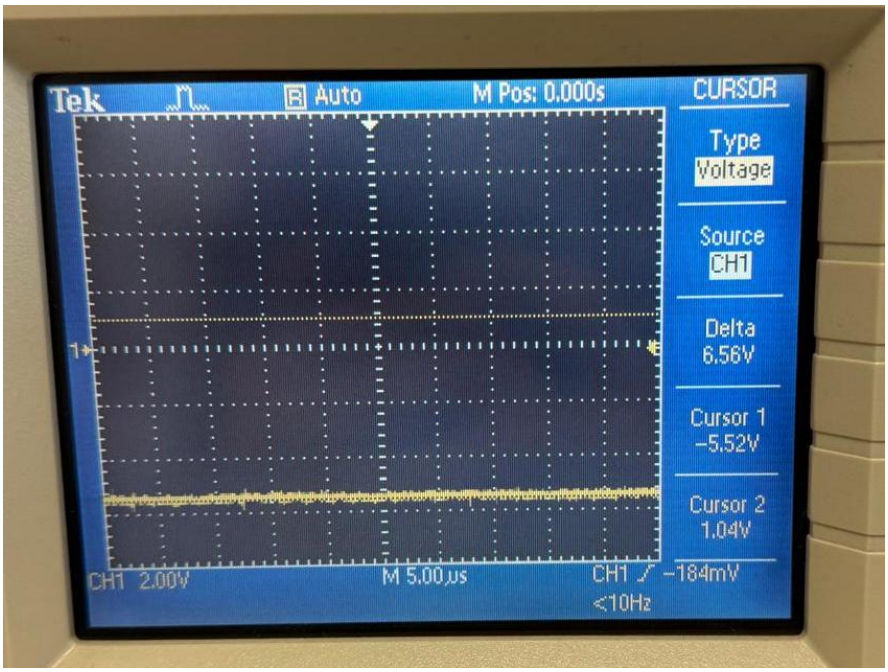

Fig. 12: Output voltage when R_{L2}=47Ω

Table 2: R_L=47 measurements

	V_d	$R_{L2}=R_L$	D	V_o
Preliminary	12V	47Ω	0.462	5.5V
Experimental	12V	47Ω	0.488	5.52V

In LTspice simulation, the duty cycle is measured as 0.462 from the inductor current graph. In the experiment, Fig. 13 and Fig. 14 shows the T_s and t_{ON} values respectively.

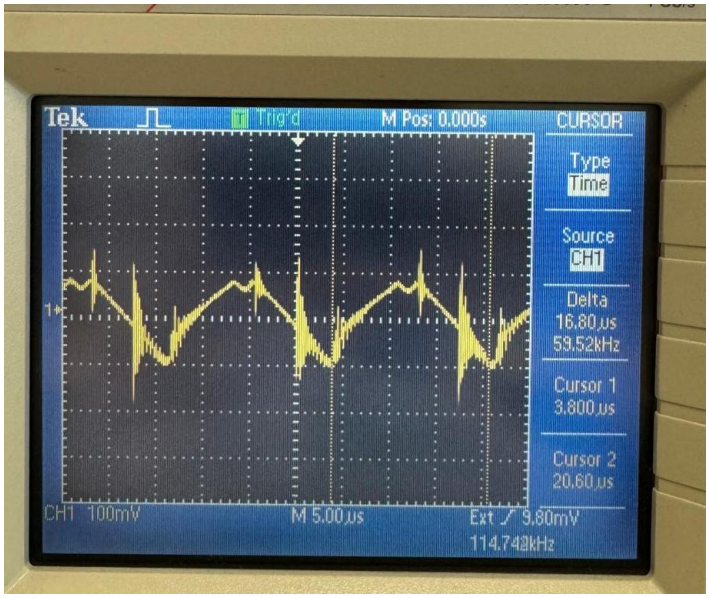

Fig. 13: T_s when R_L=47Ω

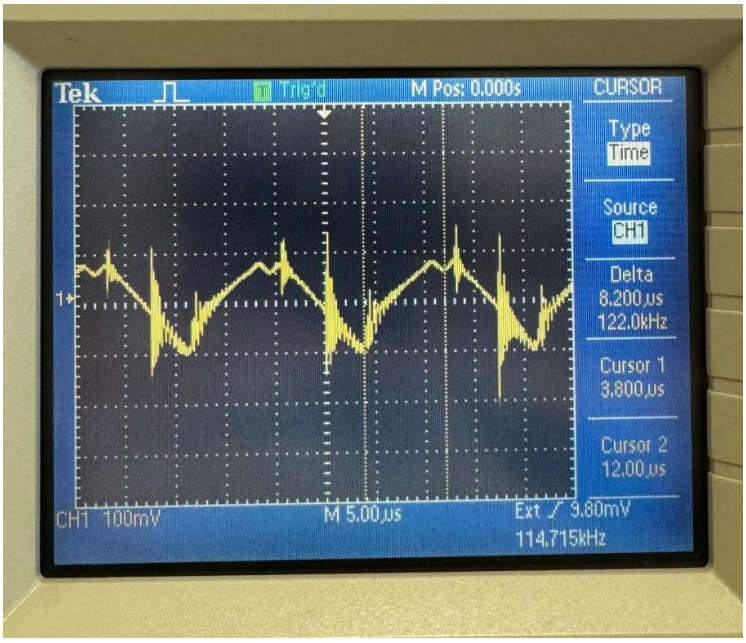

Fig. 14: t_{ON} value when R_L=47Ω

T_s value is measured as 16.8µs and t_{ON} value is measured as 8.2µs. Whereas in the LTspice simulation, T_s=16.36µs and t_{ON}=7.54µs. The values are near to each other. As stated in Table 2, D=0.462 for simulation and D=0.488 for experiment. The values are reasonable.