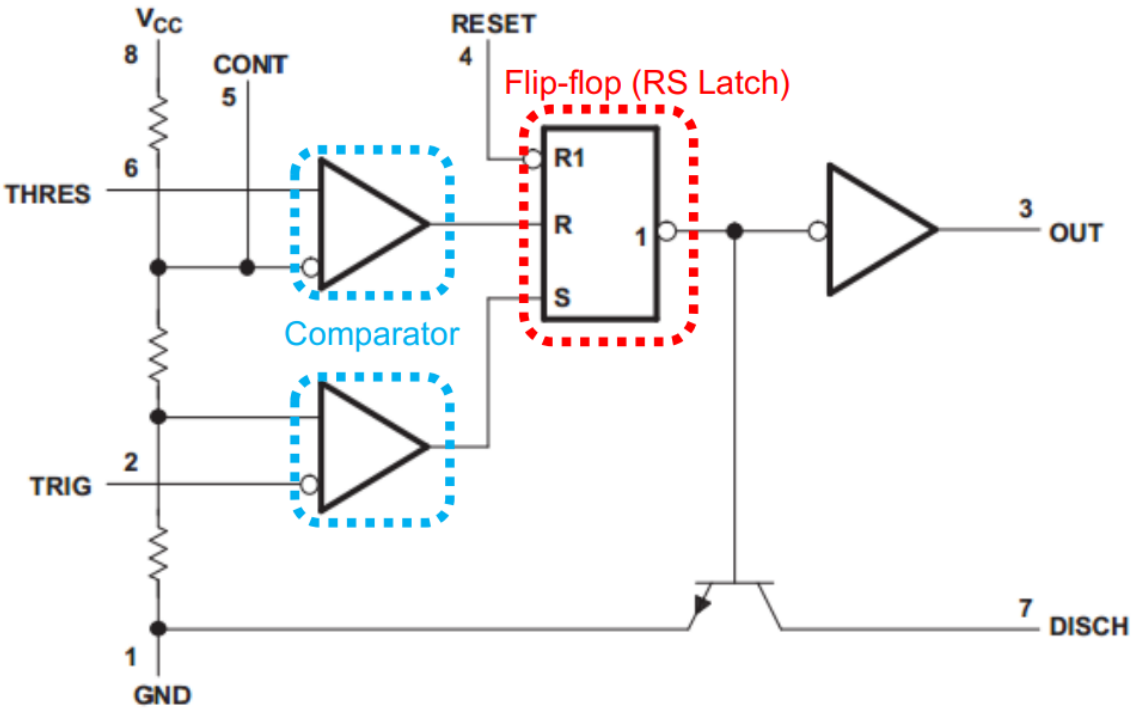
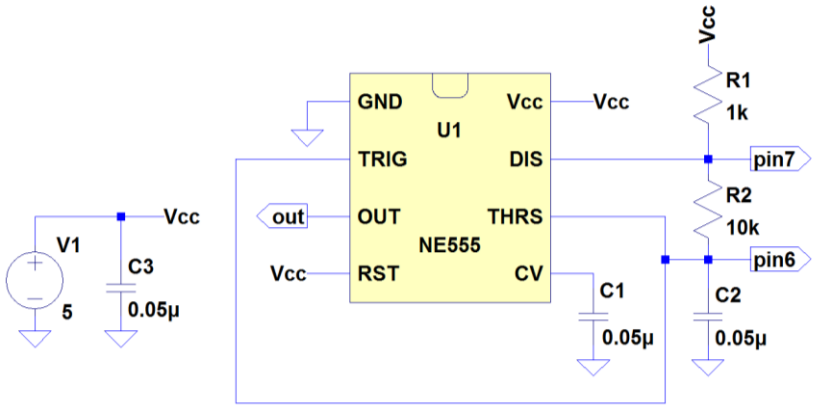
REPORT

The Pins of an NE555:



- ✧ Ground (GND - Pin 1): This pin is connected to the ground or 0V reference of the circuit.
- ✧ Trigger (TRIG - Pin 2): When the voltage at this pin falls below $\frac{1}{3}$ of the supply voltage, the timer starts. It initiates the timing cycle when it receives a low voltage or a voltage less than $\frac{1}{3}$ VCC.
- ✧ Output (OUT - Pin 3): This pin produces the square wave output based on the timing set by the internal circuitry.
- ✧ Reset (RESET - Pin 4): This pin, when connected to a voltage lower than $\frac{1}{3}$ VCC, resets the timing cycle and stops the output.
- ✧ Control Voltage (CONT - Pin 5): This pin allows voltage control of the timing threshold. By applying an external voltage here, you can adjust the timing characteristics of the NE555.
- ✧ Threshold (THRS - Pin 6): This pin is the threshold for the timing cycle. When the voltage at this pin exceeds $\frac{2}{3}$ of the supply voltage, it ends the timing cycle.
- ✧ Discharge (DISCH - Pin 7): This pin is used to discharge the external capacitor to ground. It's connected internally to the open collector of the discharge transistor.
- ✧ Supply Voltage (VCC - Pin 8): This pin connects to the positive supply voltage.

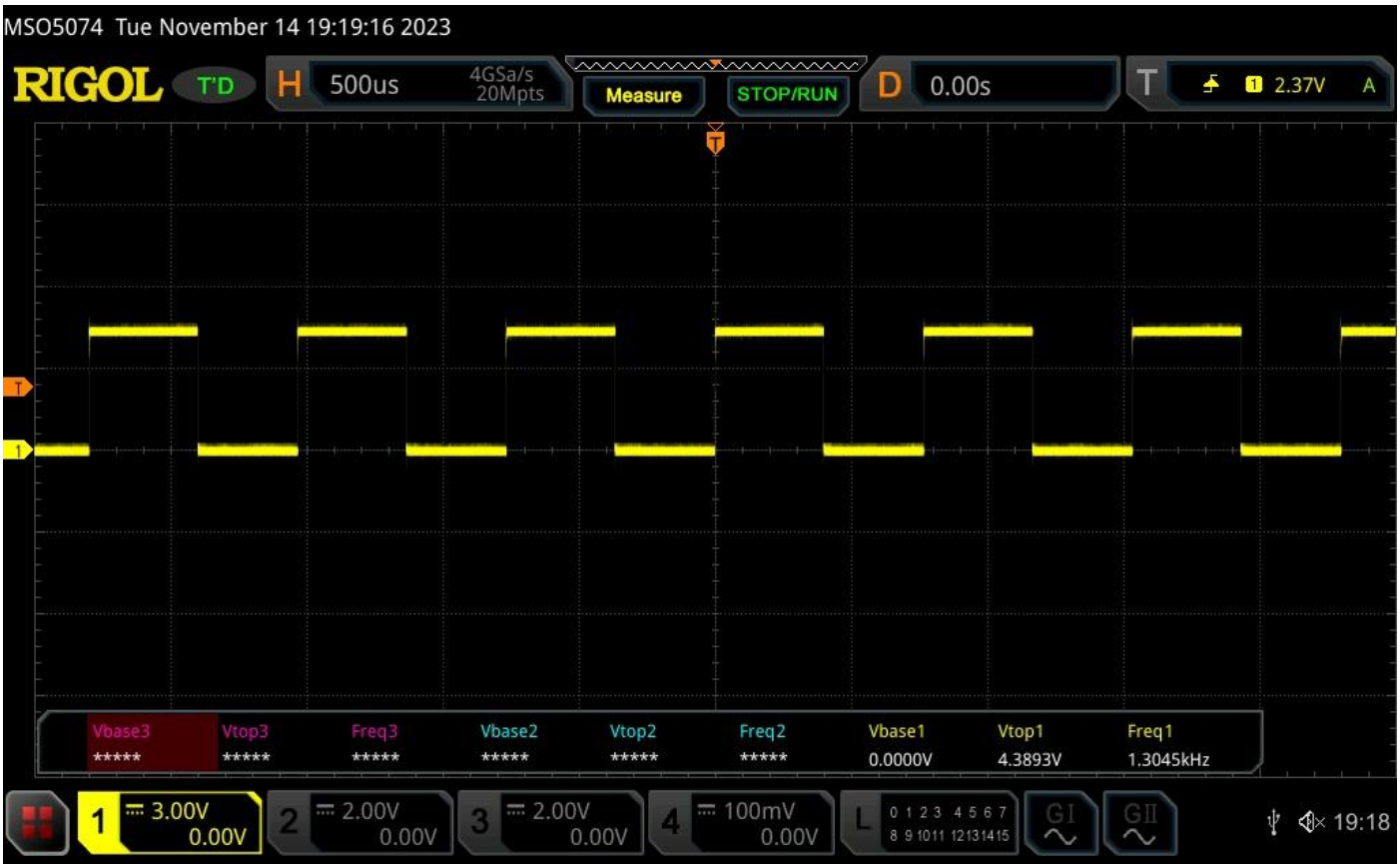
Experiment 1: Astable Multivibrator



	pin1	pin4	pin5	pin8
theoretical (V)	0	5	3.33	5
measured (V)	3m	4.99	3.32	4.99

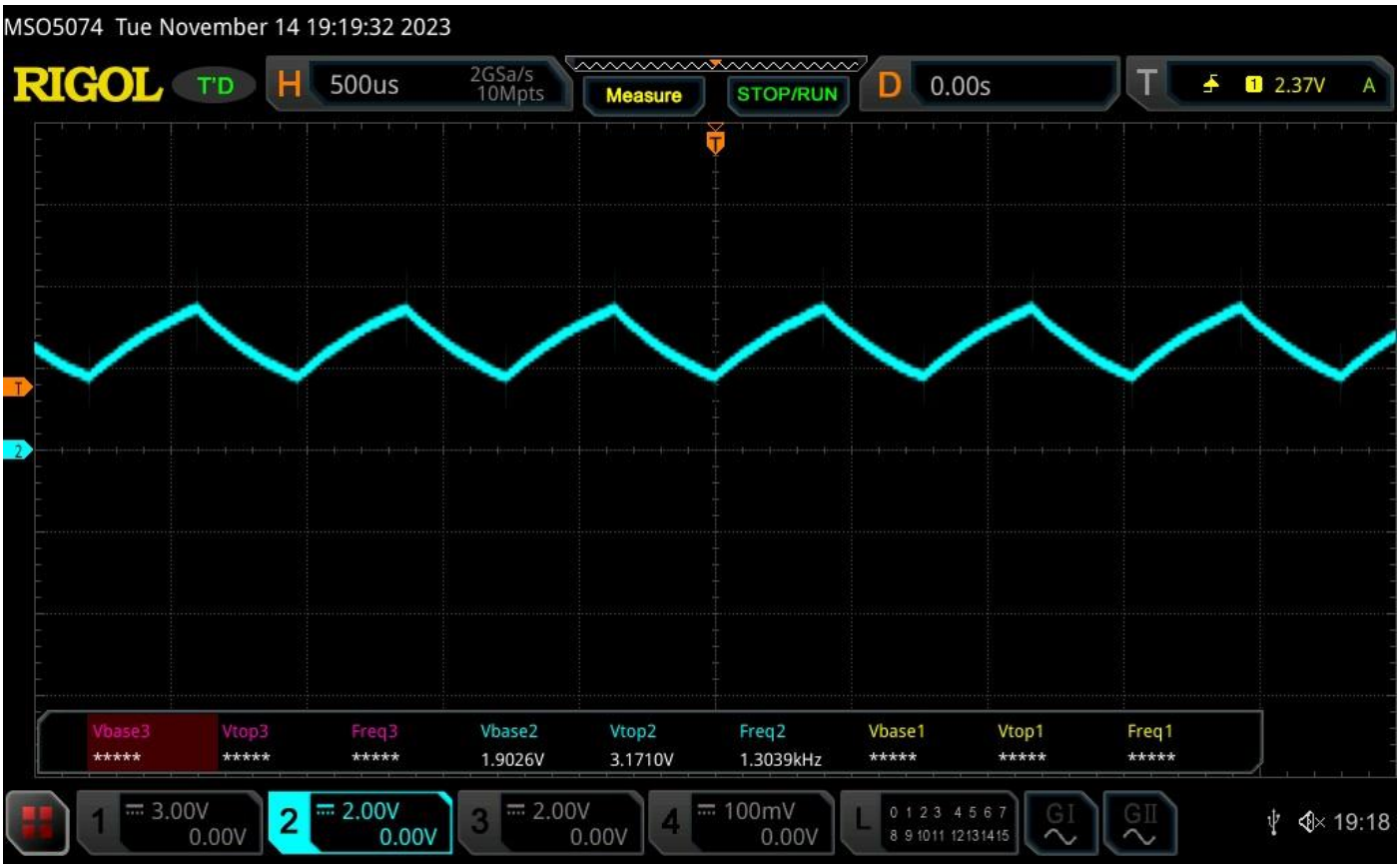
	pin3(OUT)	pin6(THRS)	pin7(DIS)
frequency (Hz)	1.3057k	1.3054k	1.3052k
V_{high} (V)	4.5265	3.1710	
V_{low} (V)	274.33m	1.8120	

Waveform in pin3(OUT)

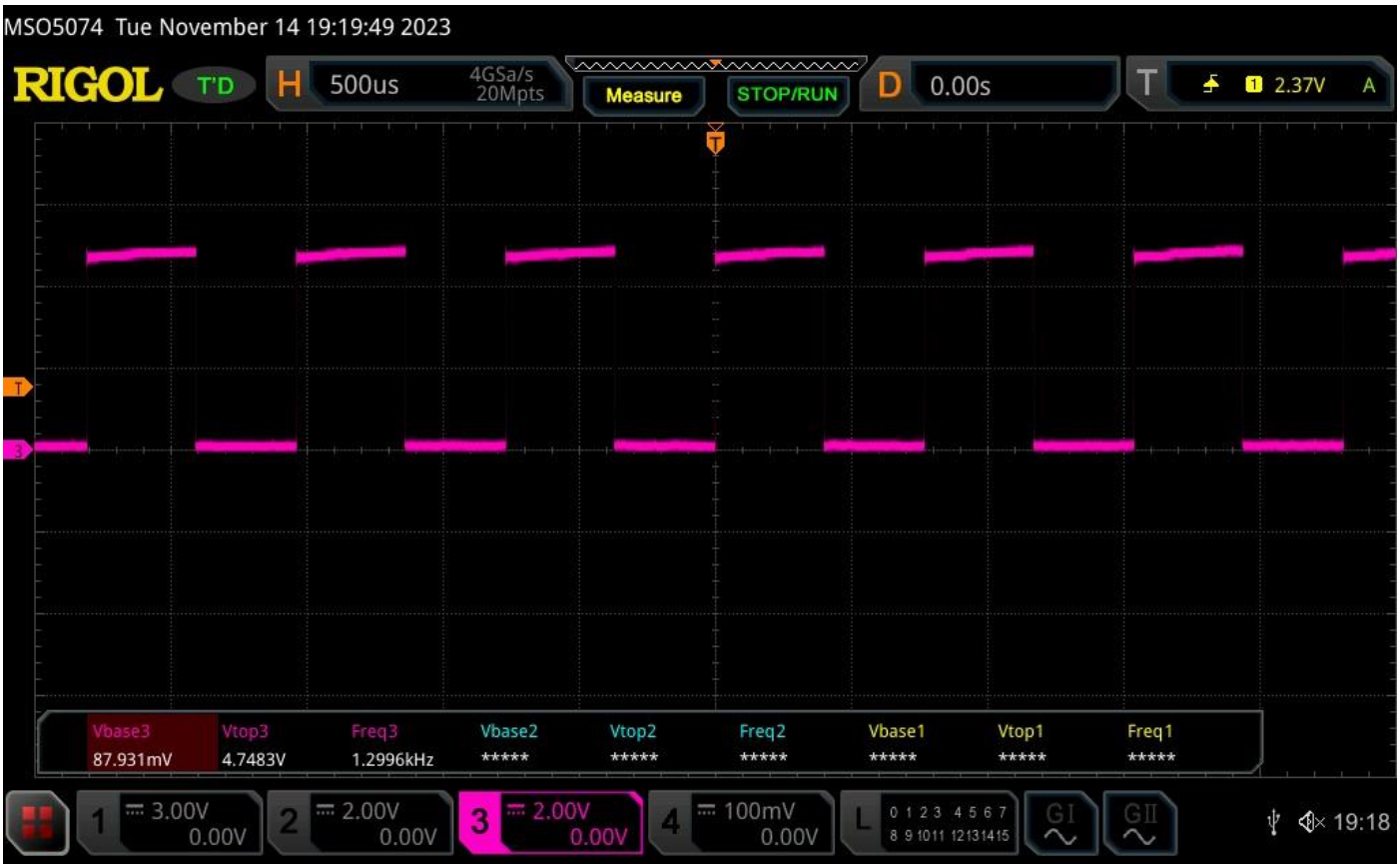


Multivibrator

Waveform in pin6(THRS)



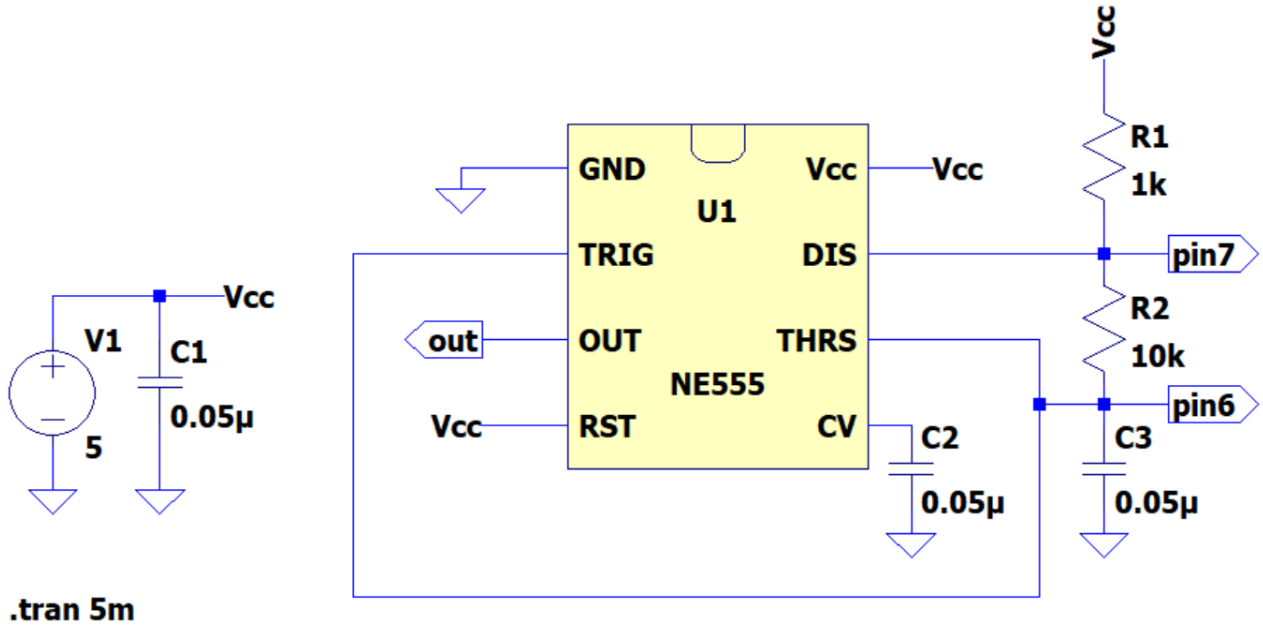
Waveform in pin7(DIS)

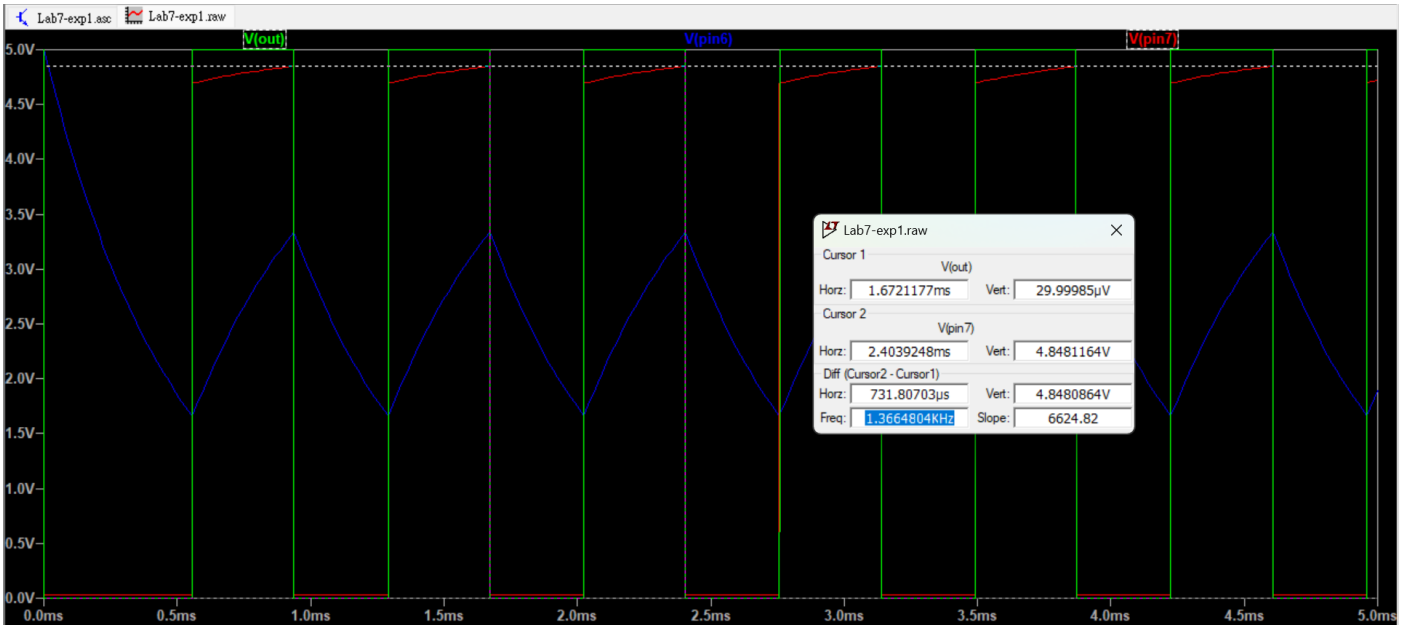


Multivibrator

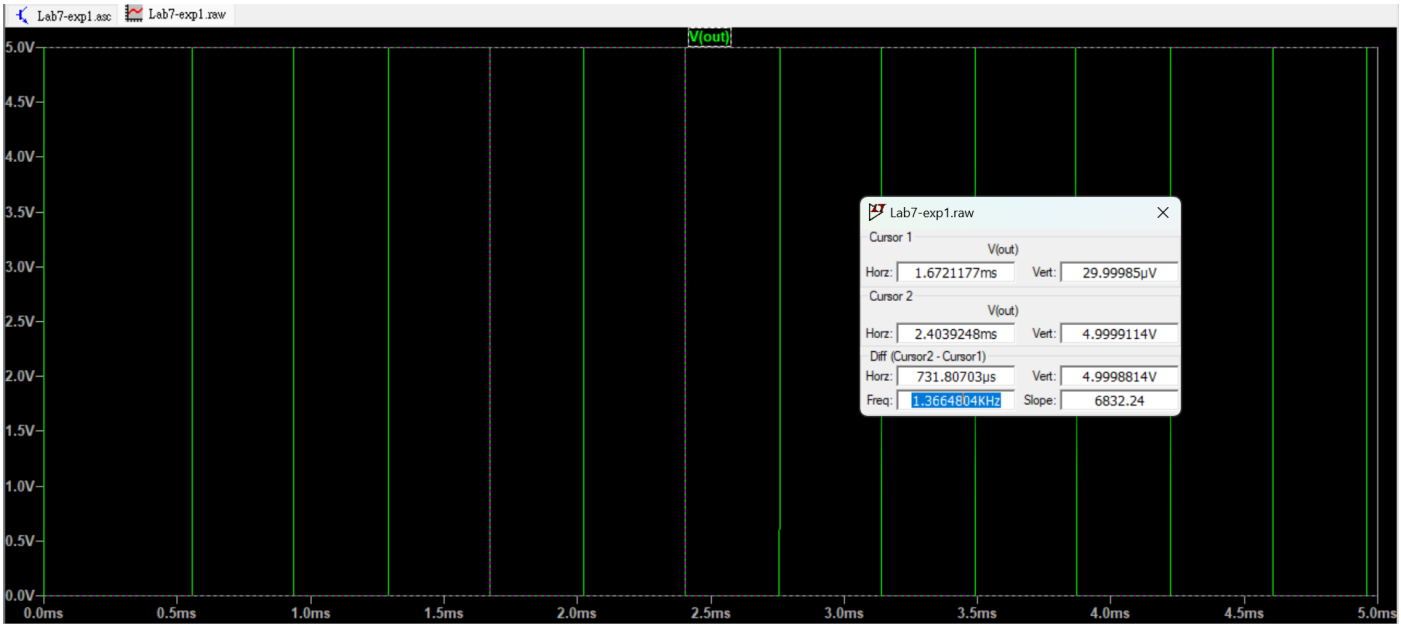
Question:

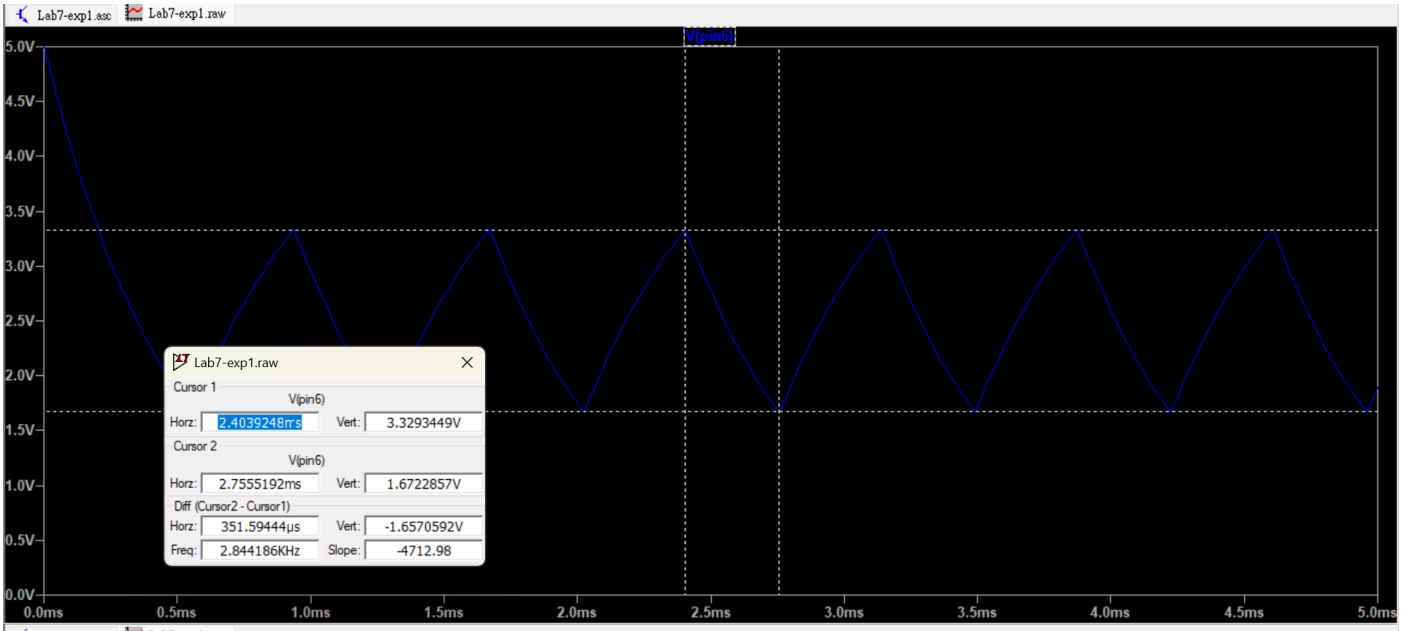
LTSPICE simulation result: (both schematic and waveform)

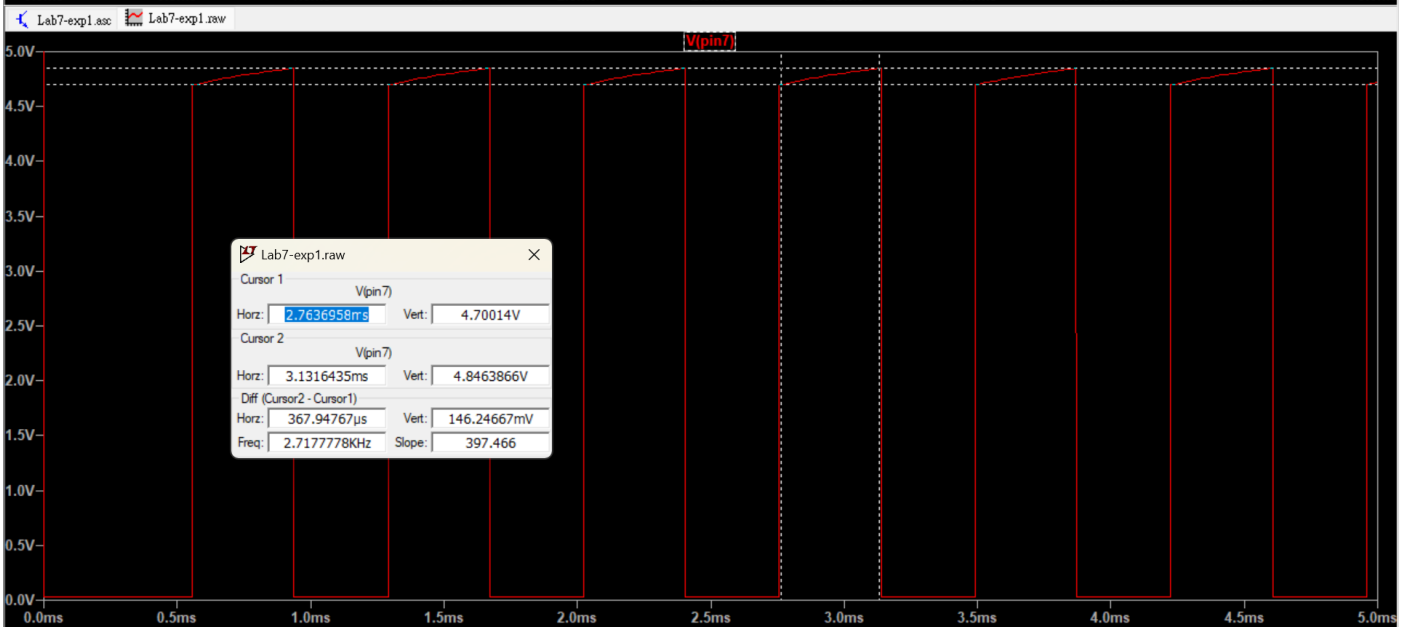




Multivibrator



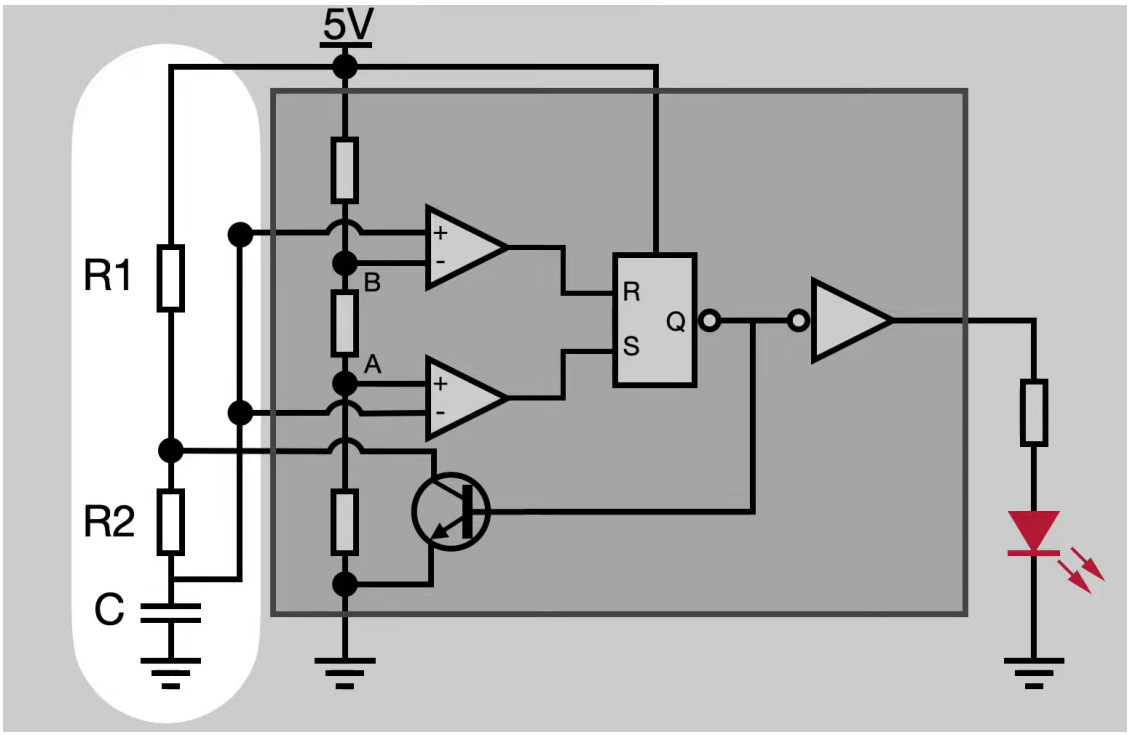




Multivibrator

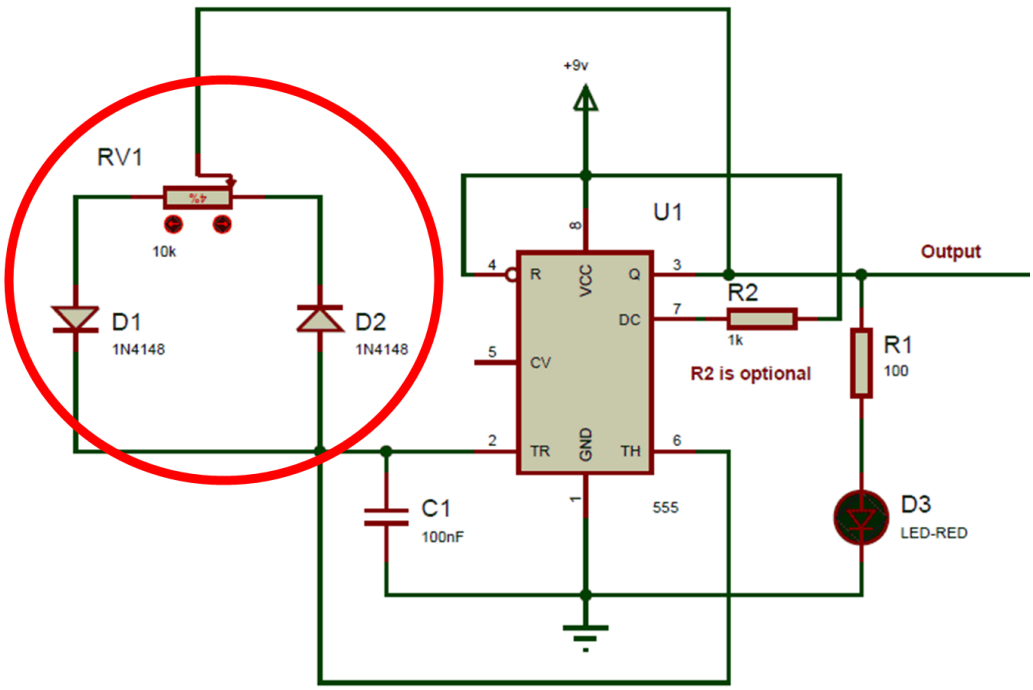
In the astable(“a” means “away from” in latin, so “astable” means “not stable”) mode configuration, the NE555 continues to switch between on and off nonstop. The capacitor C3 (in my LTspice schematic) continues to charge and discharge, which can be observed at pin 6. The ramp at the top of pin 7’s waveform is also caused by the capacitor’s discharge.

Duty Cycle of an NE555



The duty cycle of an NE555 is governed by its 2 external connected resistors.

Duty Cycle Formula: $\frac{R_1+R_2}{R_1+2R_2} \times 100\%$

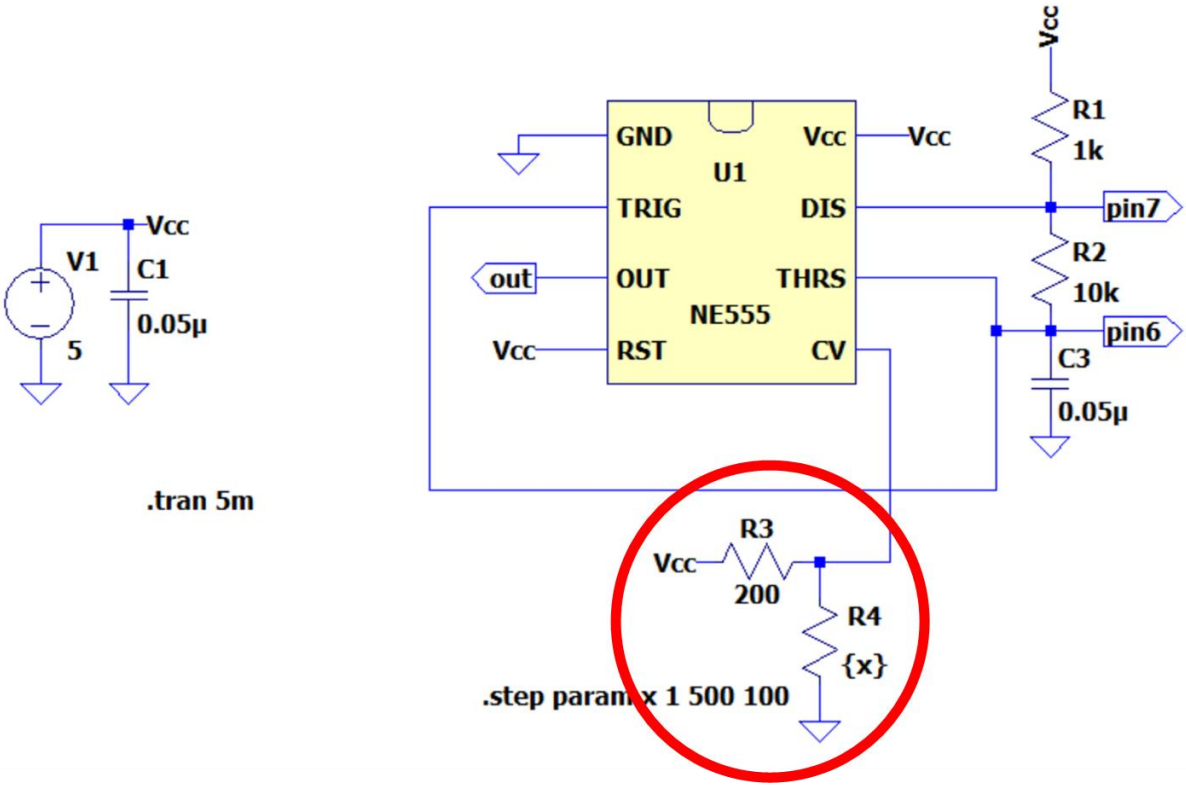


Using 2 diodes and a potentiometer, we can achieve PWM(Pulse Width Modulation) (Basically just modifying the duty cycle).

Applications:

1. Change the brightness of an LED (like we tested in Lab06)
2. Change the speed of a motor.

Frequency of an NE555

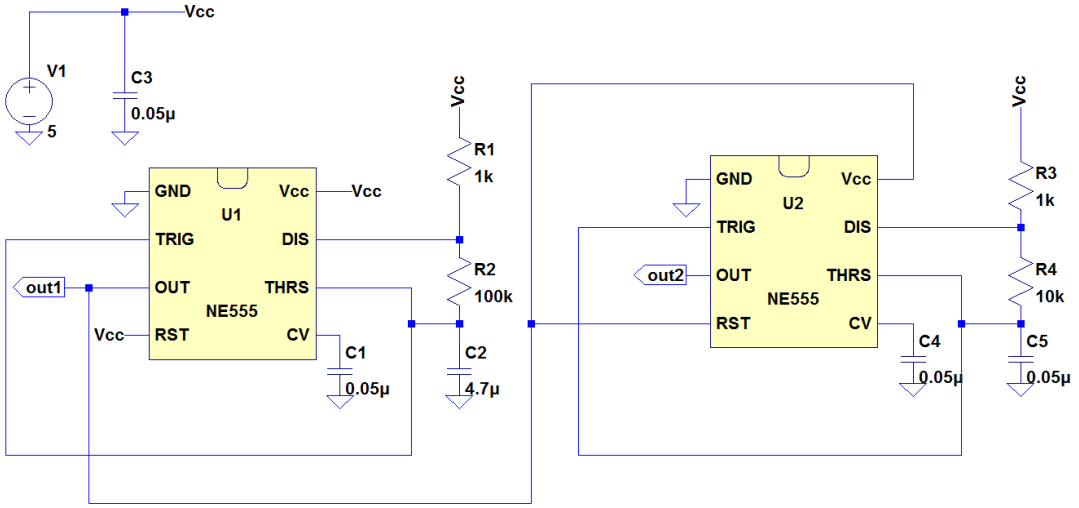


By changing the voltage at Pin 5(Control Voltage), we can modify the frequency of the output. To make the frequency easily adjustable, we can connect a potentiometer as R4. However, the duty cycle will not remain constant. To maintain a constant duty cycle across different frequencies, we may need a varactor(varicap).

Applications:

1. Flash LEDs
2. Generate clock signal
3. Create 8-bit music

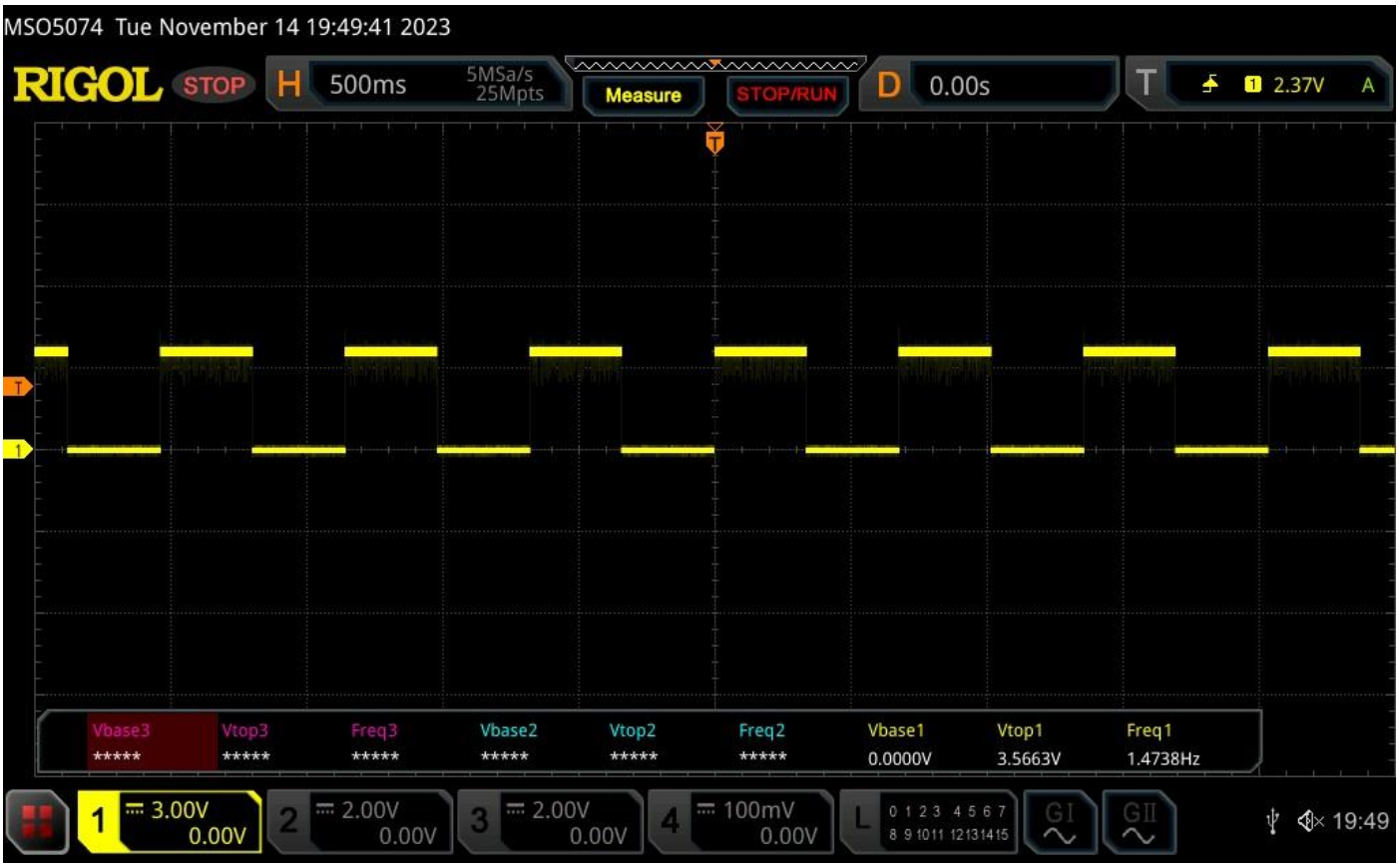
Experiment 2: Double Astable Multivibrator



YOU MAY NEED TO USE "STOP" FUNCTION TO CAPTURE THE WAVEFORMS

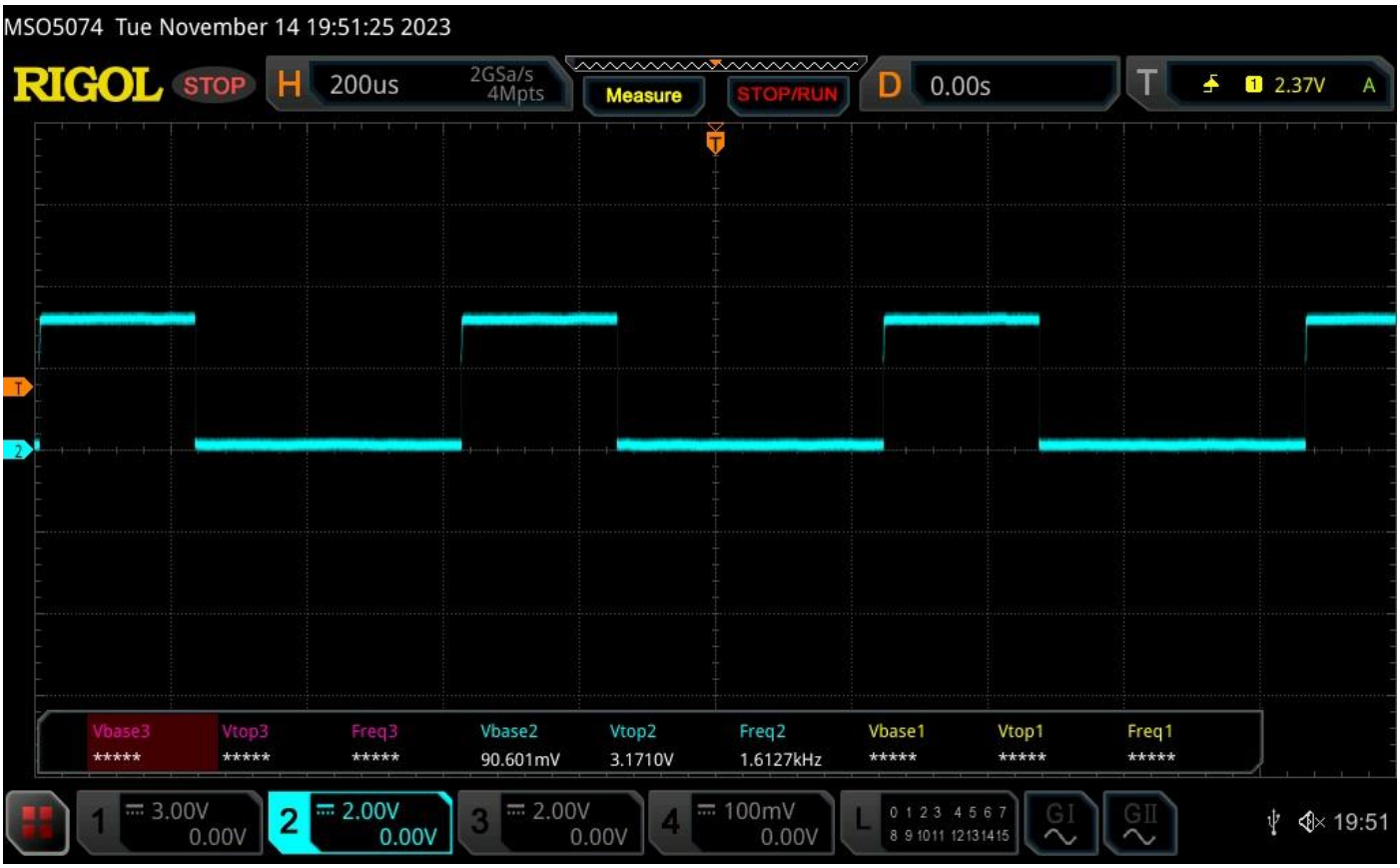
	U1 pin3	U2 pin3
Frequency (Hz)	1.4738	1.6127k

Waveform in U1 pin3



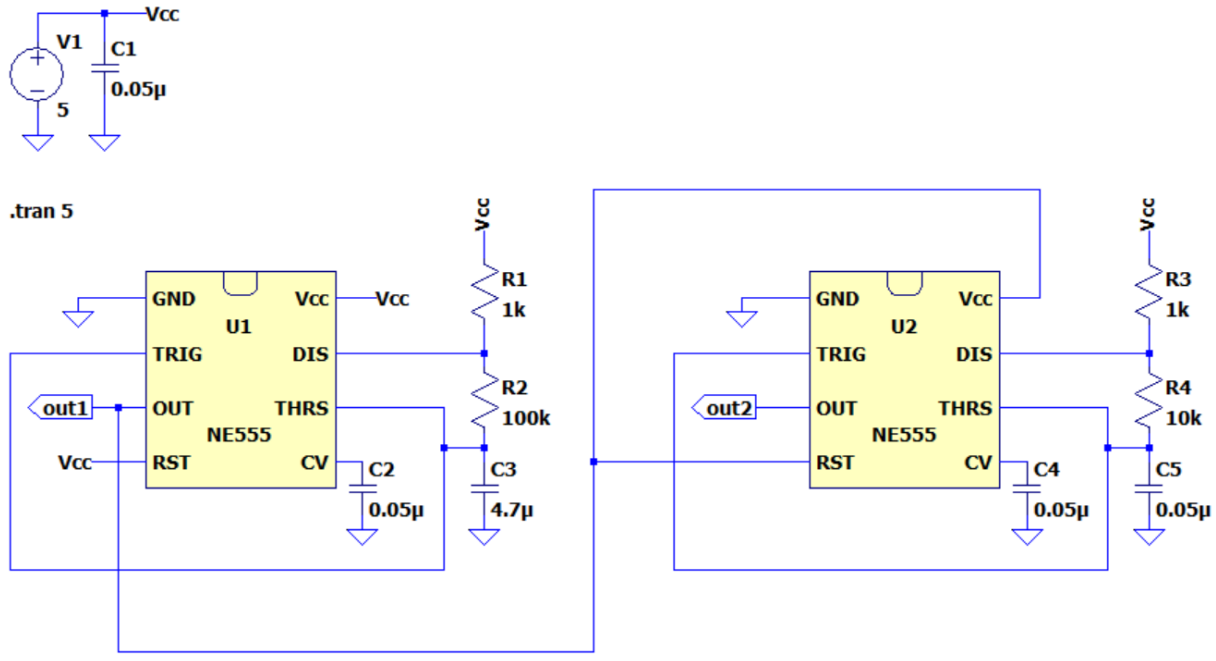
Multivibrator

Waveform in U2 pin3

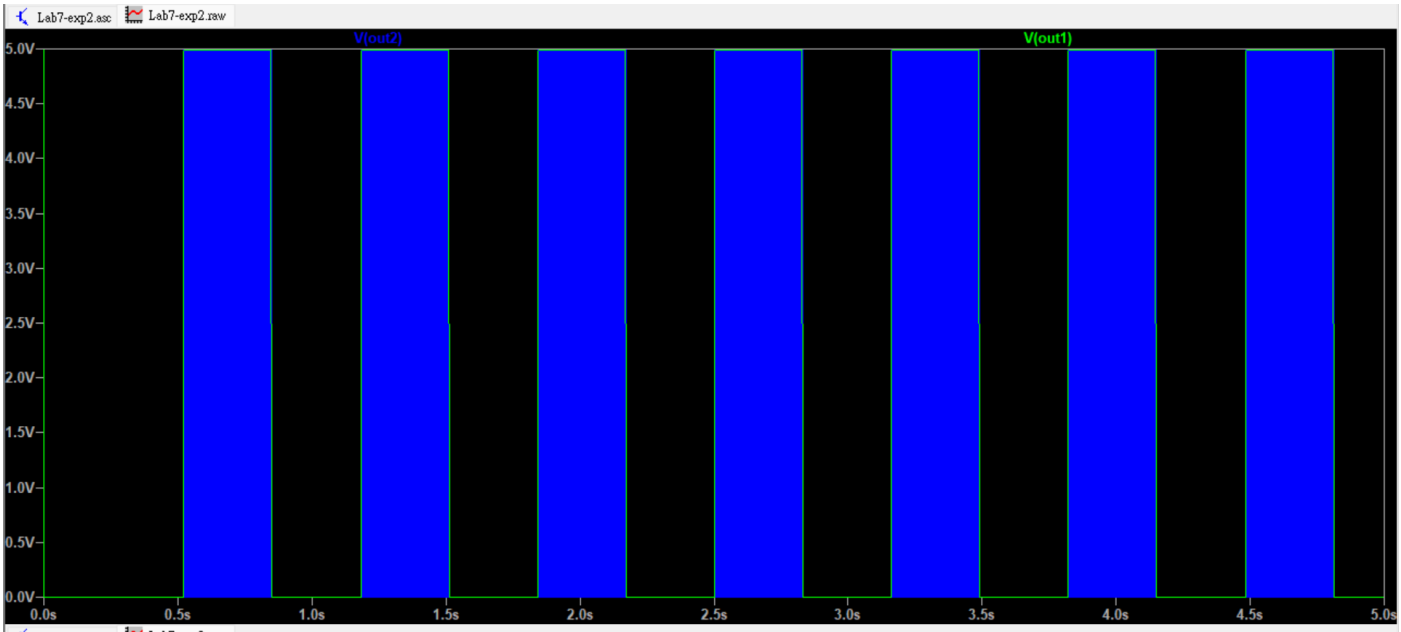


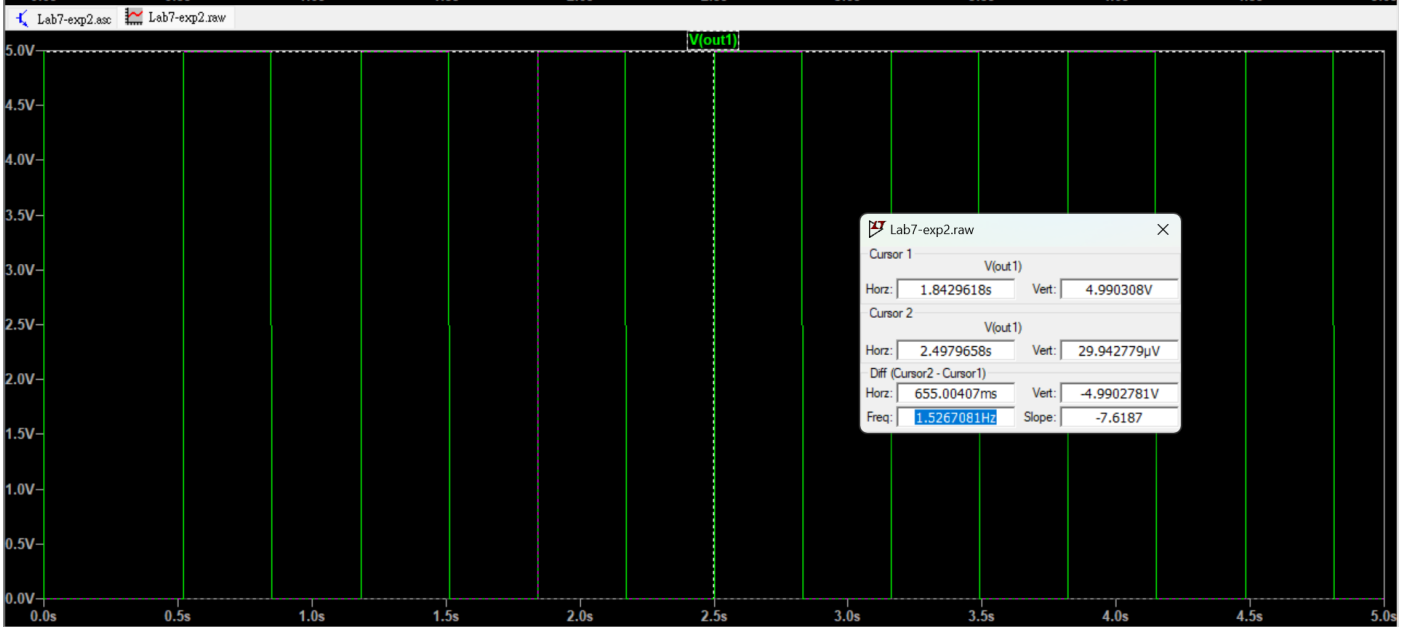
Question:

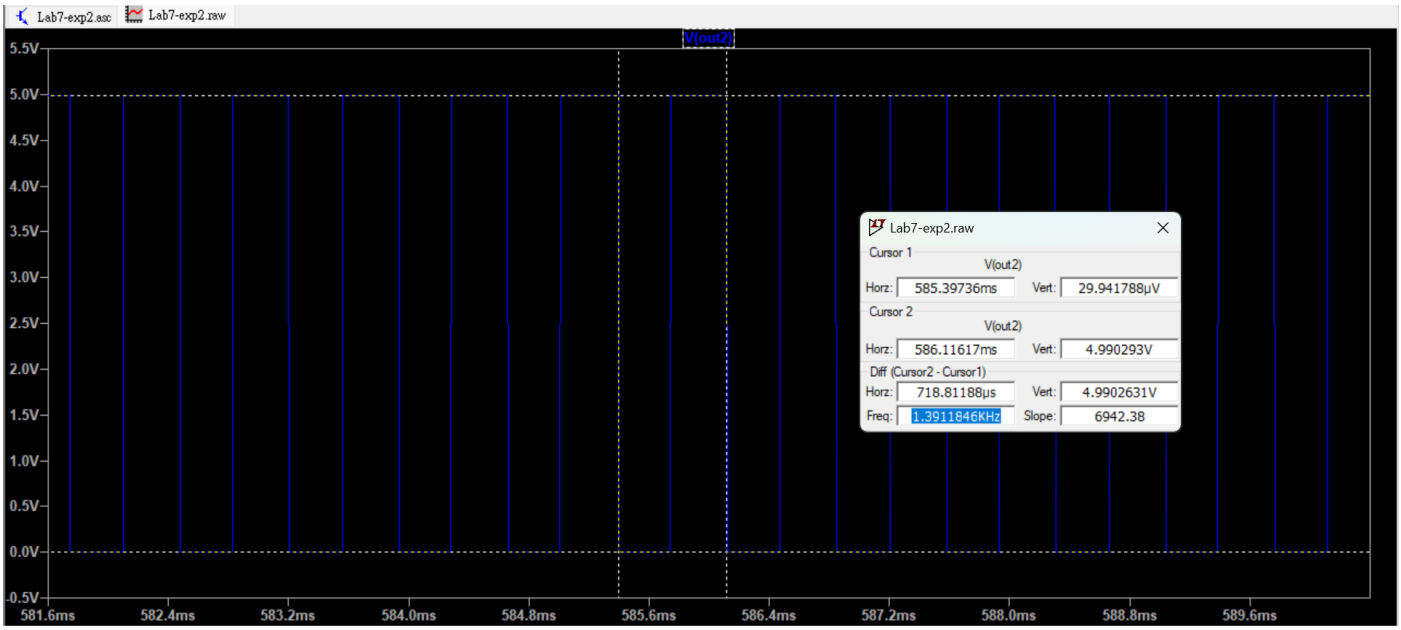
LTSPICE simulation result: (both schematic and waveform)



Multivibrator



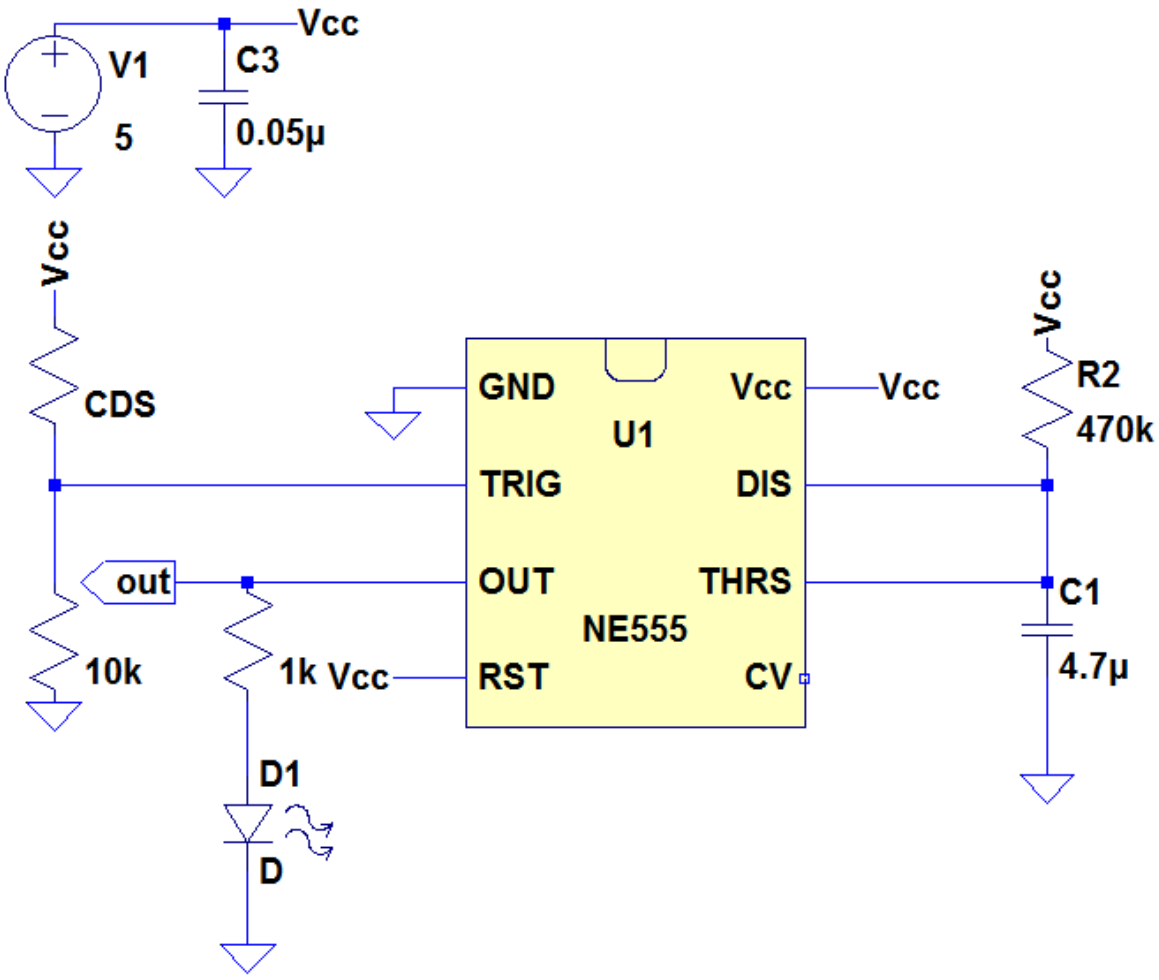




Multivibrator

This configuration puts the two NE555s in a master-slave relationship. The NE555 on the right is governed by the output of the one on the left. It only starts operating when “out1” is high. This is essentially how a flip-flop is made. This configuration allows the storage of information through logic levels (high/low).

Experiment 3: Monostable Multivibrator



YOU MAY NEED TO USE “STOP” FUNCTION TO CAPTURE THE WAVEFORMS

T(theoretical) = ln3 * R*C = 2.4268 S

$\ln(3) \times 470k \times 4.7\mu = 2.4268$

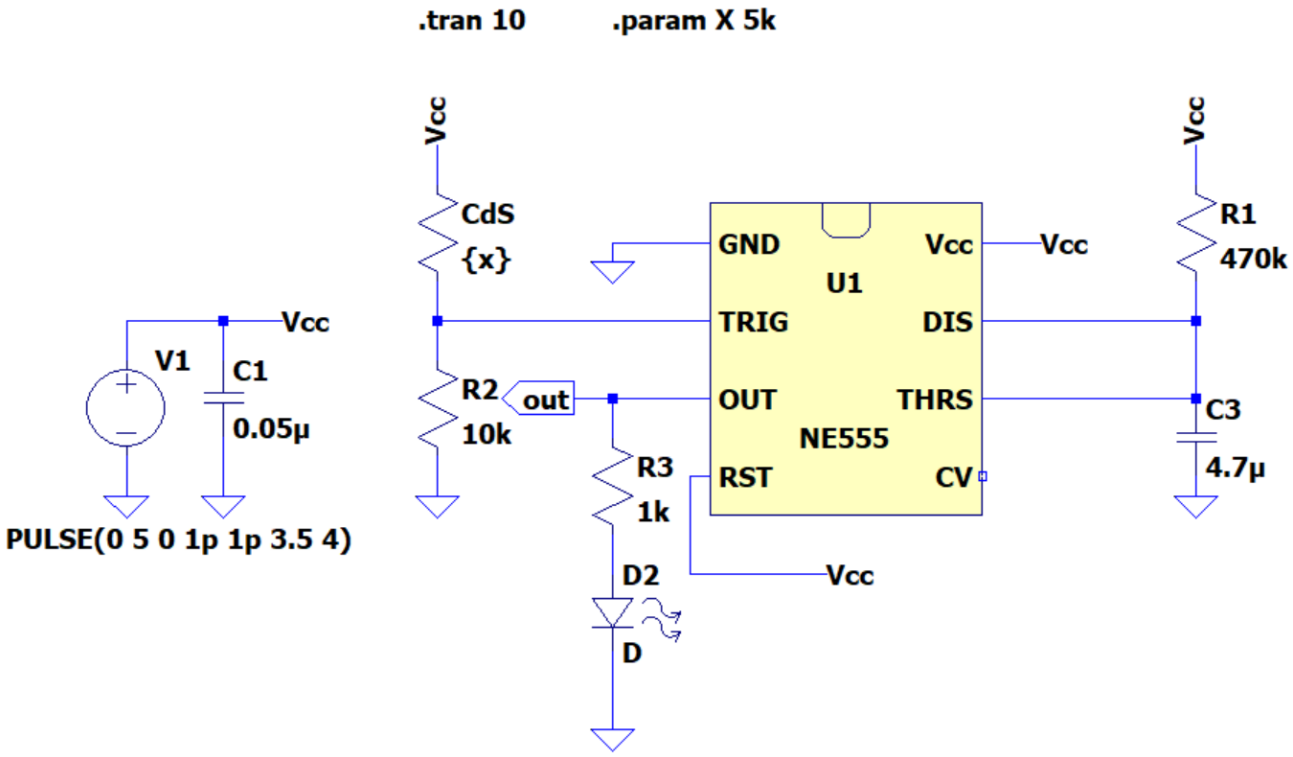
T(measured) = 2.72 S

Multivibrator

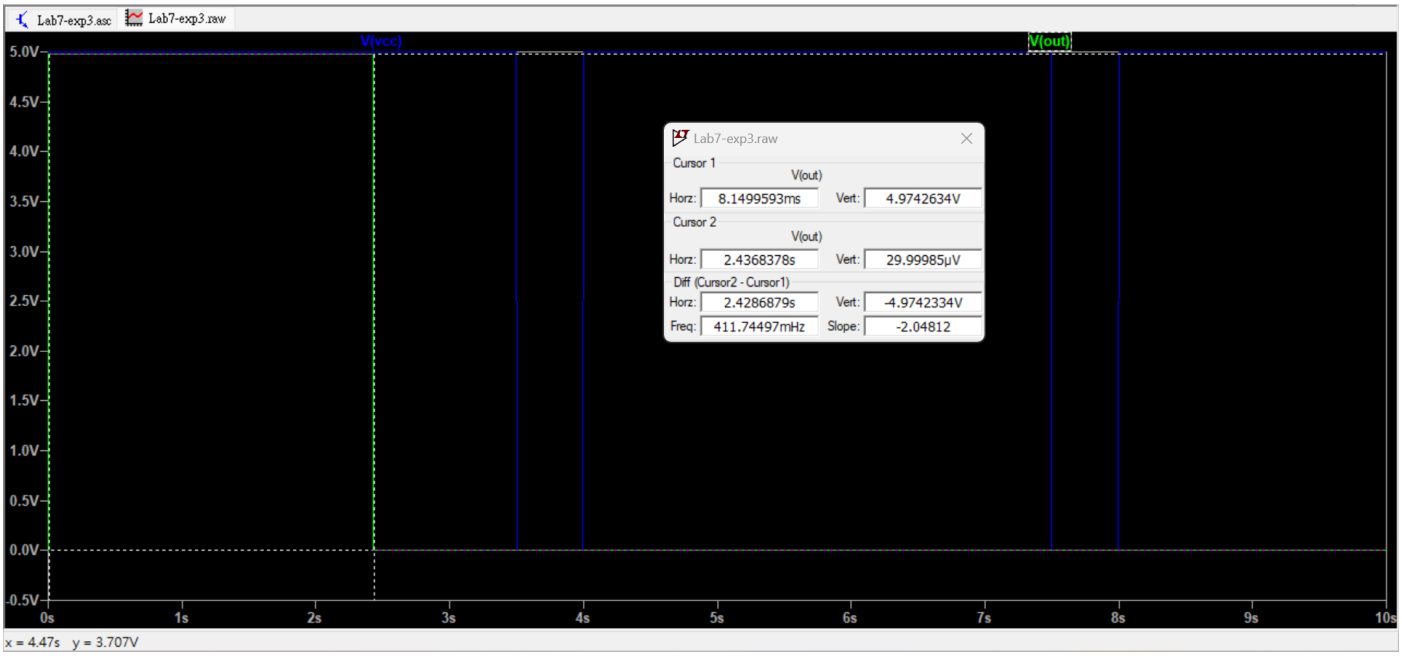
Waveform in pin3 (OUT)\

Question:

LTSPICE simulation result: (both schematic and waveform)



Multivibrator



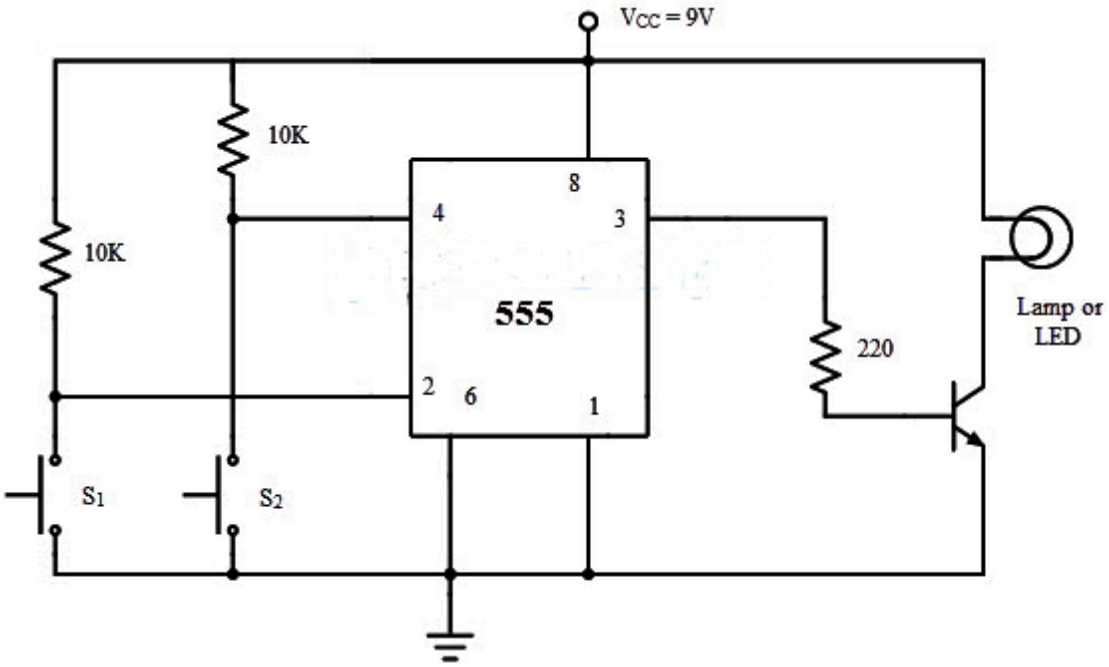
Since it is not possible to simulate a CdS resistor in LTspice, I opted to use a pulse signal to mimic the voltage change at the trigger pin. We can see that the simulated RC time constant (2.4287) is comparable to the theoretical time constant we calculated (2.4268).

In the monostable(“mono” means “one” in latin) state, the NE555 is remains in the off state until a “turn on” mechanism is triggered (button press, switch flip, photosensitive resistor). Then, the RC circuit connected to pin 6 and pin 7 takes control and generates a “high” output for the duration of the RC time constant given by $1.1 \times R \times C$.

Bistable Mode:

The NE555 has one more simple configuration that we didn’t use in this week’s lab, the bistable (“bi” means “two” in latin) mode. Observe that there is an SR flip-flop in the NE555’s internal circuit. For this configuration, we do not use the 555 as an oscillator or timer. We simply want to use the flip-flop inside.

Multivibrator



Connect one button to pin 2 (trigger), one to pin 4 (reset). When we press the pin 2 button, the output will be set to “high” and retain that state. Press the pin 4 button, and the output will be reset to “low”.