PCB Report – Board 1

555 Timer as Astable Vibrator

Objective:

A 555 timer can be used in modes such as Monostable, Bistable, and Astable Multivibrator. Here in this lab, the 555 timer is used as an Astable Multivibrator to output a signal with a certain frequency and duty cycle. Also, comparing the rise time, fall time, and amplitude of voltage output from a slow 555 timer NE555 used.

Plan of Record:

Features of board:

- 5V power input rating.
- Slow 555 timer IC(NE555).
- Designed for Duty cycle of 66% and 500Hz.
- Different loads attached 50, 300,1k and 10k to limit current.

Risk Reduction:

- Added LEDs to indicate power supply is working fine.
- Separated the modules as power, 555timer and load using headers/switches.
- Proper labelling for each input and outputs
- Added decoupling capacitor to avoid switching noise in power rail.
- Plane is poured with copper to make it GND to avoid mutual loop inductance due to large loop area.

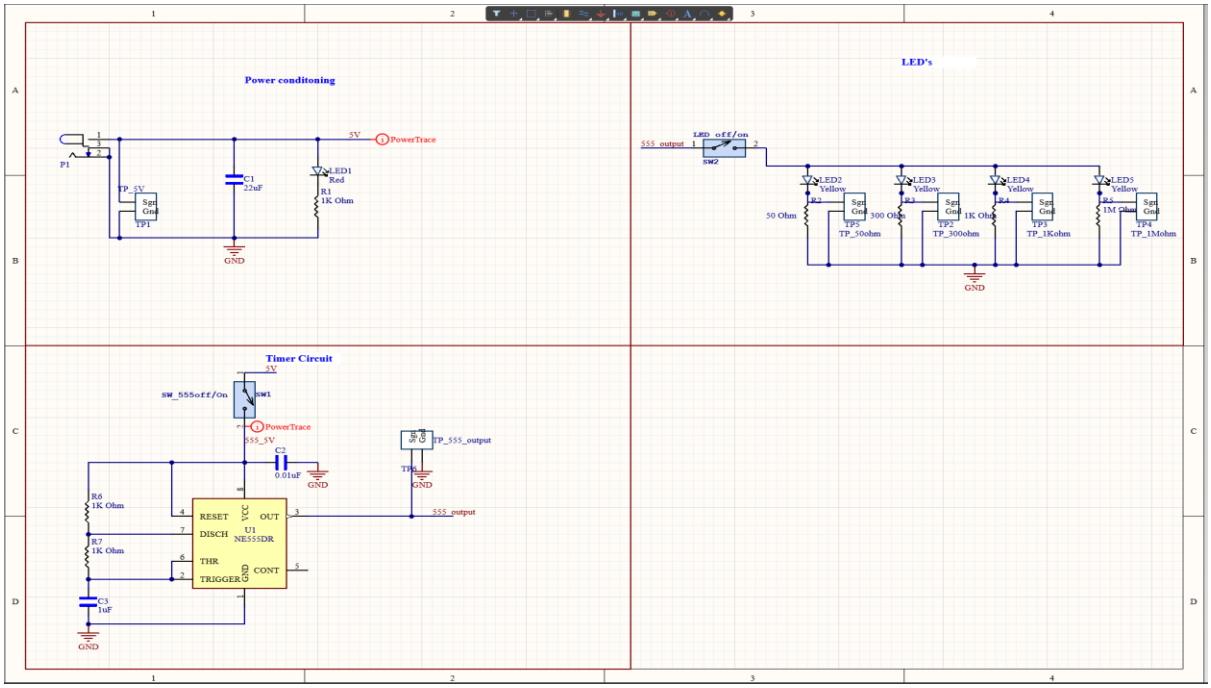
What does it mean to work?

- Read 5V from power input test point.
- Read 555 timer output signal with nearly 66% duty cycle and 500Hz frequency.
- Observe dimness in load LEDs according to increase in load resistor values.
- Draw current less than 200mA that NE555 supports.
- Rist time and fall time closest to that mentioned in Datasheet.

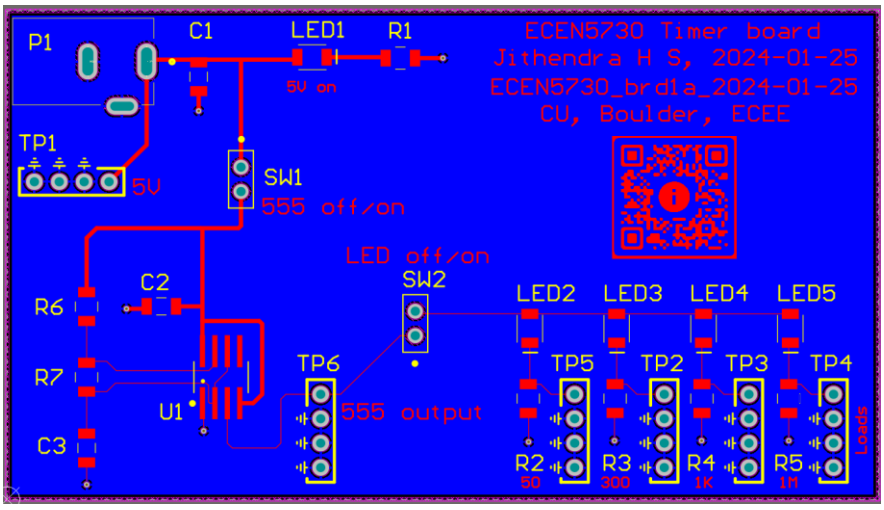
Components listing:

- Resistors: 1K, 50, 500,10K
- Capacitors: 22uF, 1uF
- Power jack
- Headers
- LEDS

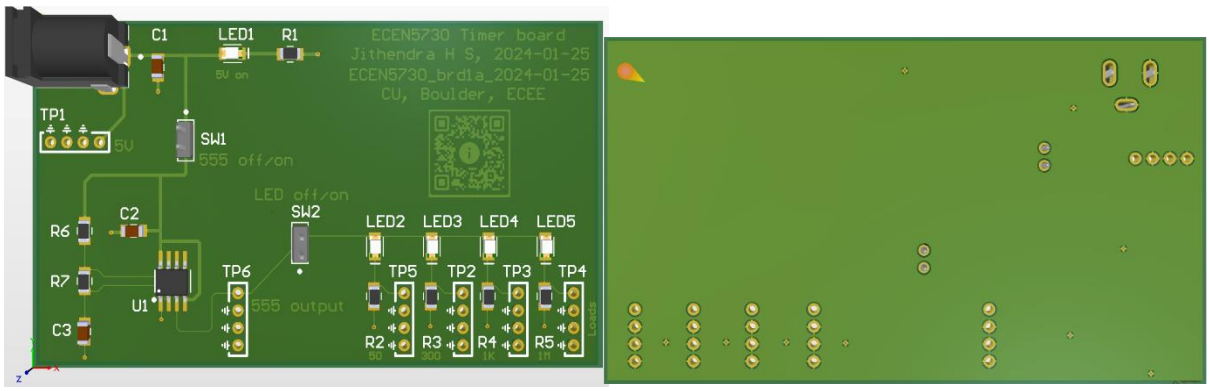
Schematic:

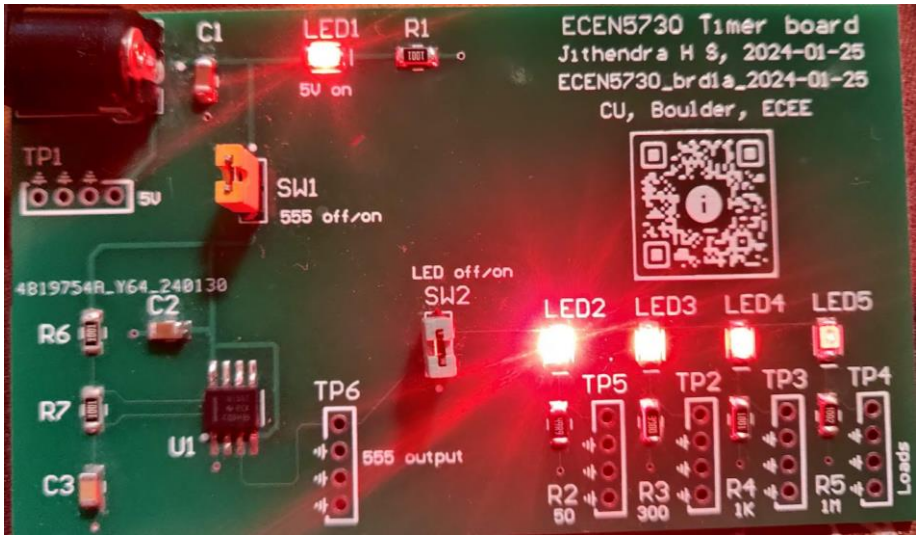


Layout:



Board:





Assembled board with LEDS lit up.

Calculation:

Here, I have calculated the resistor and capacitor values for a frequency of 500Hz and a duty cycle of Ton as 66.67%.

T = Ton + Toff

Ton = 0.693(R1+R2) C

Toff = 0.693(R2) C

T = 0.693(R1 + 2R2) C

F = 1/T = 1.44/ (R1 + 2R2) C

The components provided are 1K and 1uF so, considering R1=R2= 1K and C = 1uF

F= 1.44/(3K) 1uF = 480Hz

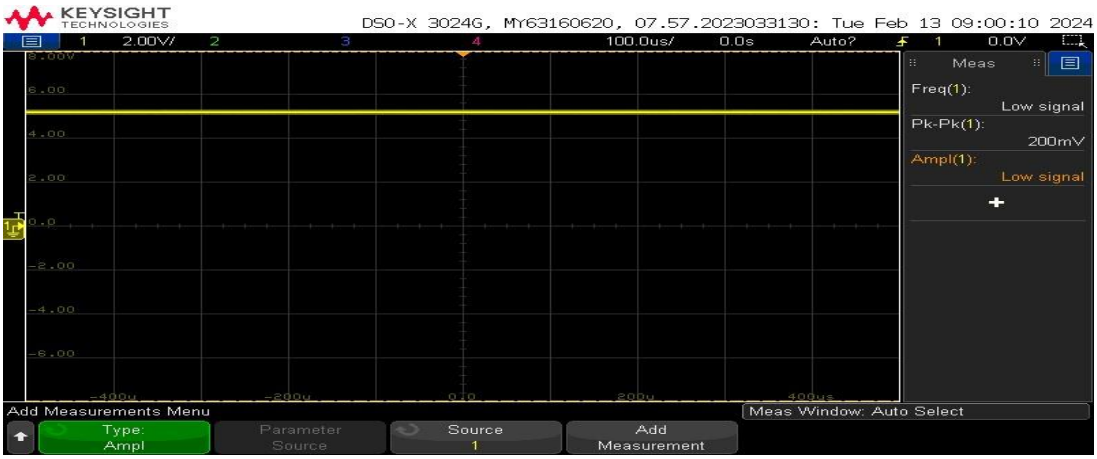
T= 1/480 = 2.08ms

Ton = 0.693(1K + 1K) 1uF = 1.386ms

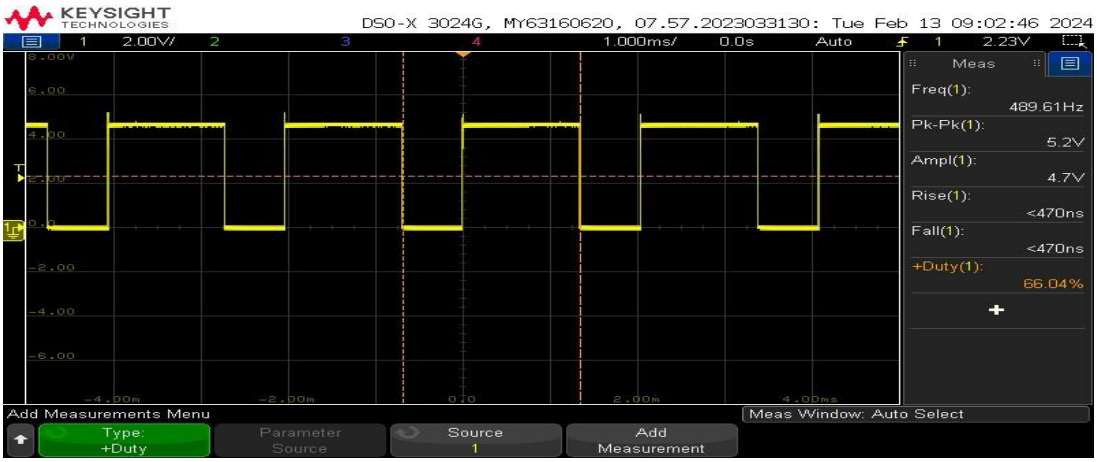
Duty cycle = Ton/T = 66.6%

Scope output:

1. 5V from power supply

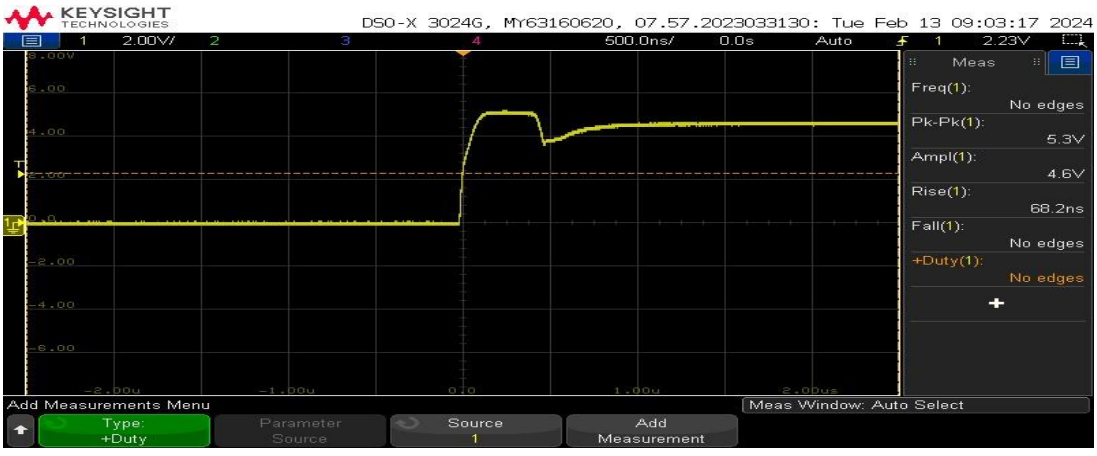


2. Figure of merits from 555 timer output



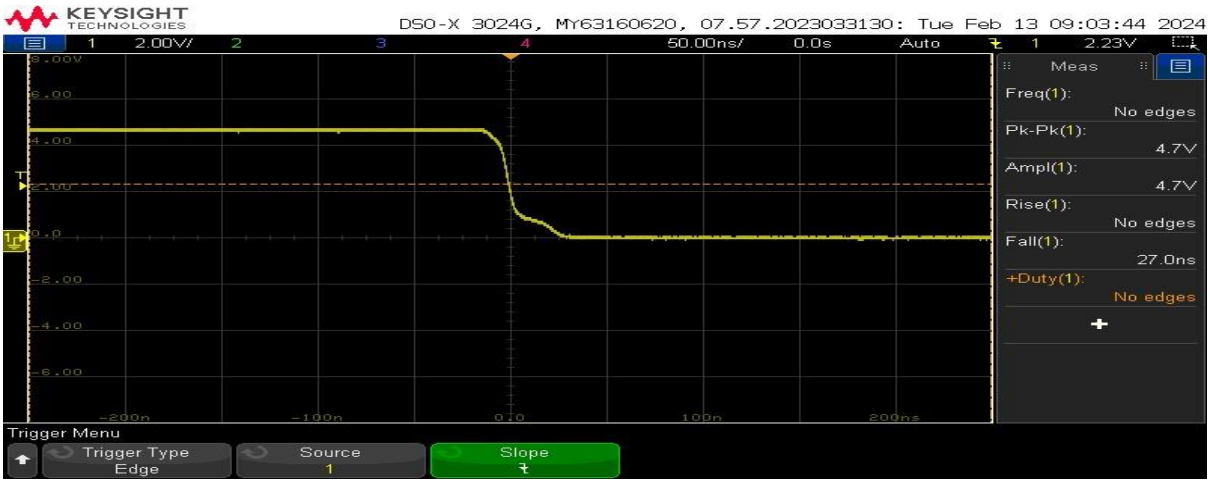
Noted signal output with amplitude 4.7V, frequency of 489.61Hz and 66.04% duty cycle which is nearest to the design.

3. Rise time of 555 timer output without load



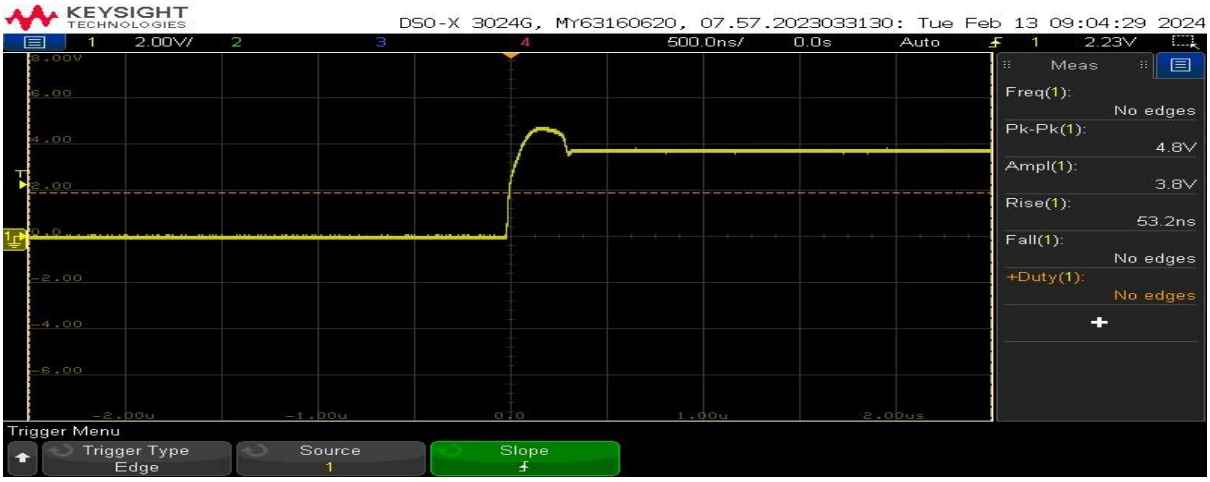
Rise time of 68.2ns observed due to use of slow 555 timer output.

4. Fall time of 555 timer output without load



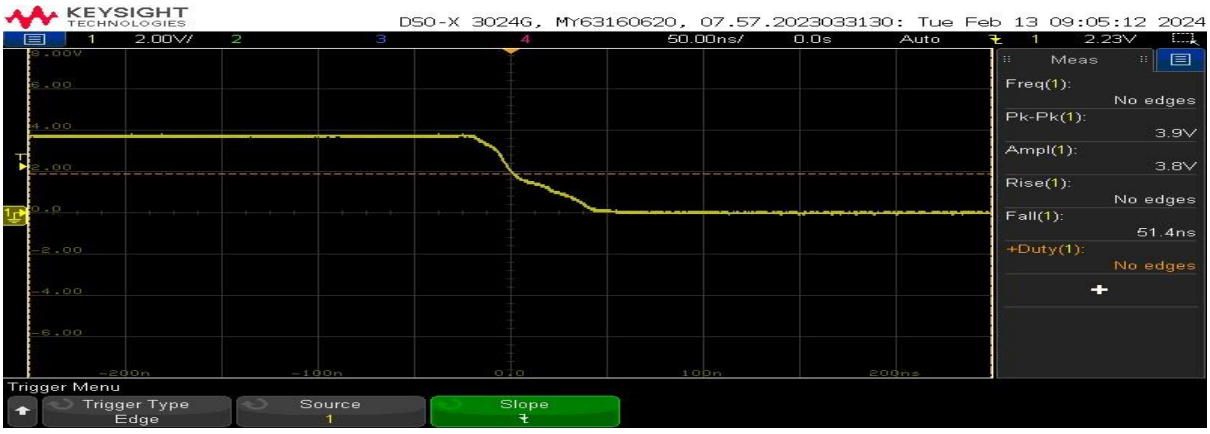
Fall time of 27ns indicates the fast turning on of the NPN transistor.

5. Rise time with load connected.



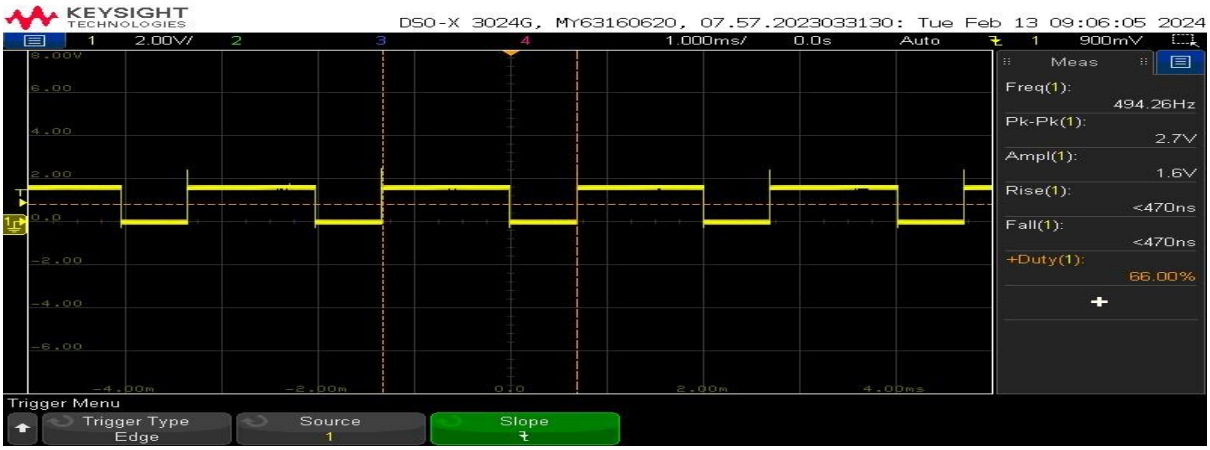
Noted rise time of 53.2 which is less compared to without load due to reduce in amplitude of output due to load.

6. Fall time with the load connected.



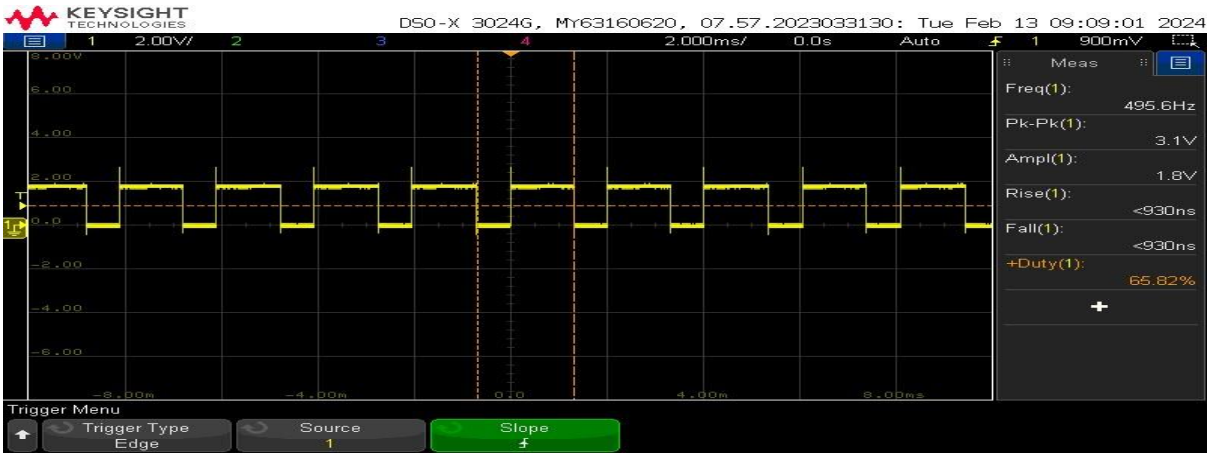
Observed fall time of 51.4ns which is higher than without load due to slow turning of NPN transistor.

7. Voltage across 50ohm resistor



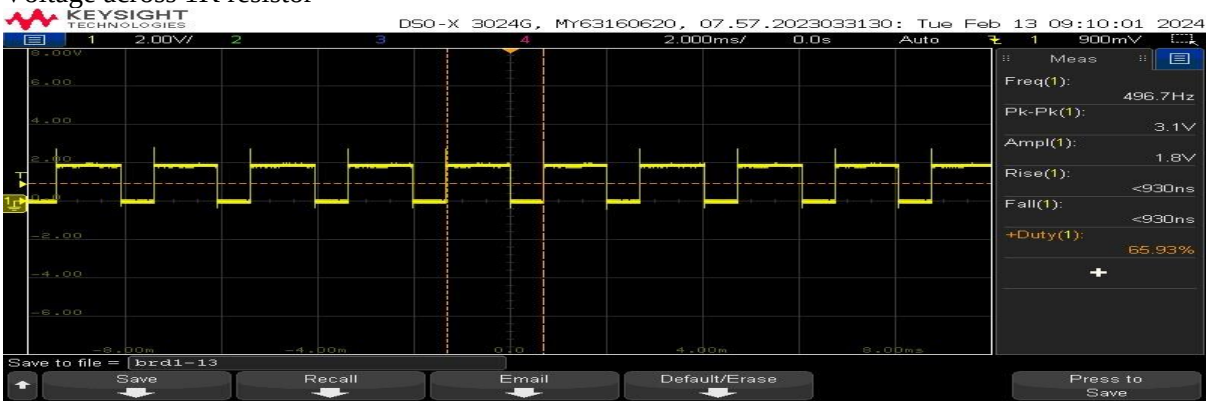
Voltage Amplitude of 1.6V read across 50ohm resistor and current drawn = V/R = 1.6/50 = 32mA.

8. Voltage across 300ohm resistor



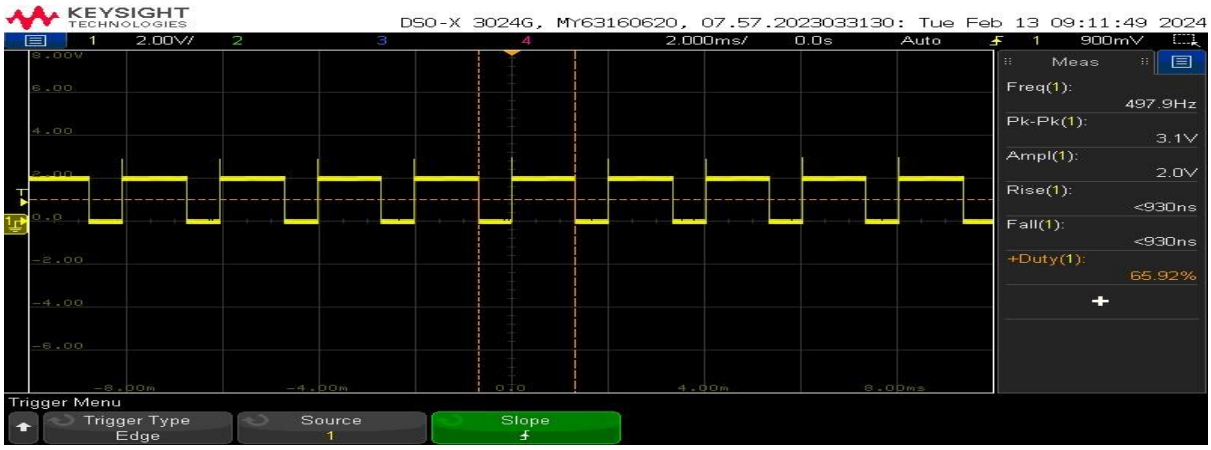
Voltage Amplitude of 1.8V read across 300ohm resistor and current drawn = V/R = 1.8/300 = 6mA

9. Voltage across 1K resistor



Voltage Amplitude of 1.8V read across 300ohm resistor and current drawn = V/R = 1.8/1K = 1.8mA.

10. Voltage across 10K resistor



Voltage Amplitude of 2V read across 10K resistor and current drawn = V/R = 2/10K = 0.2mA.

11. Thevenin Voltage

The voltage measured without load is 4.7V which is equal to Thevenin voltage, and the load voltage can be 3.8V from point 5. The Thevenin resistance $R_L = R_{th}\ (V_{th} - V_L)/V_L$ = 40.9(4.7-3.8)/3.8 = **9.7ohm.**

What all worked:

Parameters	Result	Remarks
Read 5V from power input test point.	Worked	
Read 555 timer output signal with nearly 66% duty cycle and 500Hz frequency.	Worked	
Observe dimness in load LEDs according to increase in load resistor values.	Worked	
Draw current less than 200mA that NE555 supports.	Worked	
Rist time and fall time closest to that mentioned in Datasheet.	Worked	

Mistakes:
No errors seen in the board.

Key learnings:

- Switching noise depends on how fast IC switches.
- Benefit of adding decoupling capacitor to compensate sudden surge in current and avoid switching noise.
- How to use Altium software to create schematics, layout and BoM.
- Design board in modules so that can help in bring up and debugging.
- Importance of risk reduction in project development.