DTL Logic Example

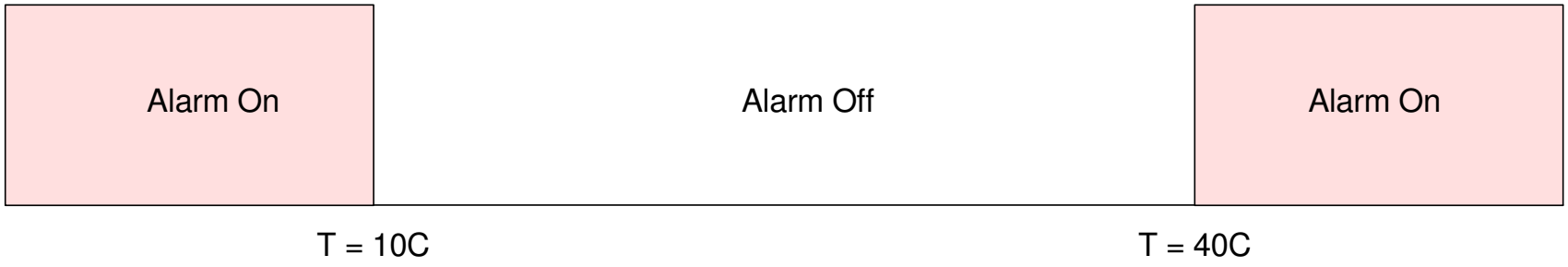
ECE 320 Electronics I

Jake Glower - Lecture #20b

Objective:

Create a temperature alarm

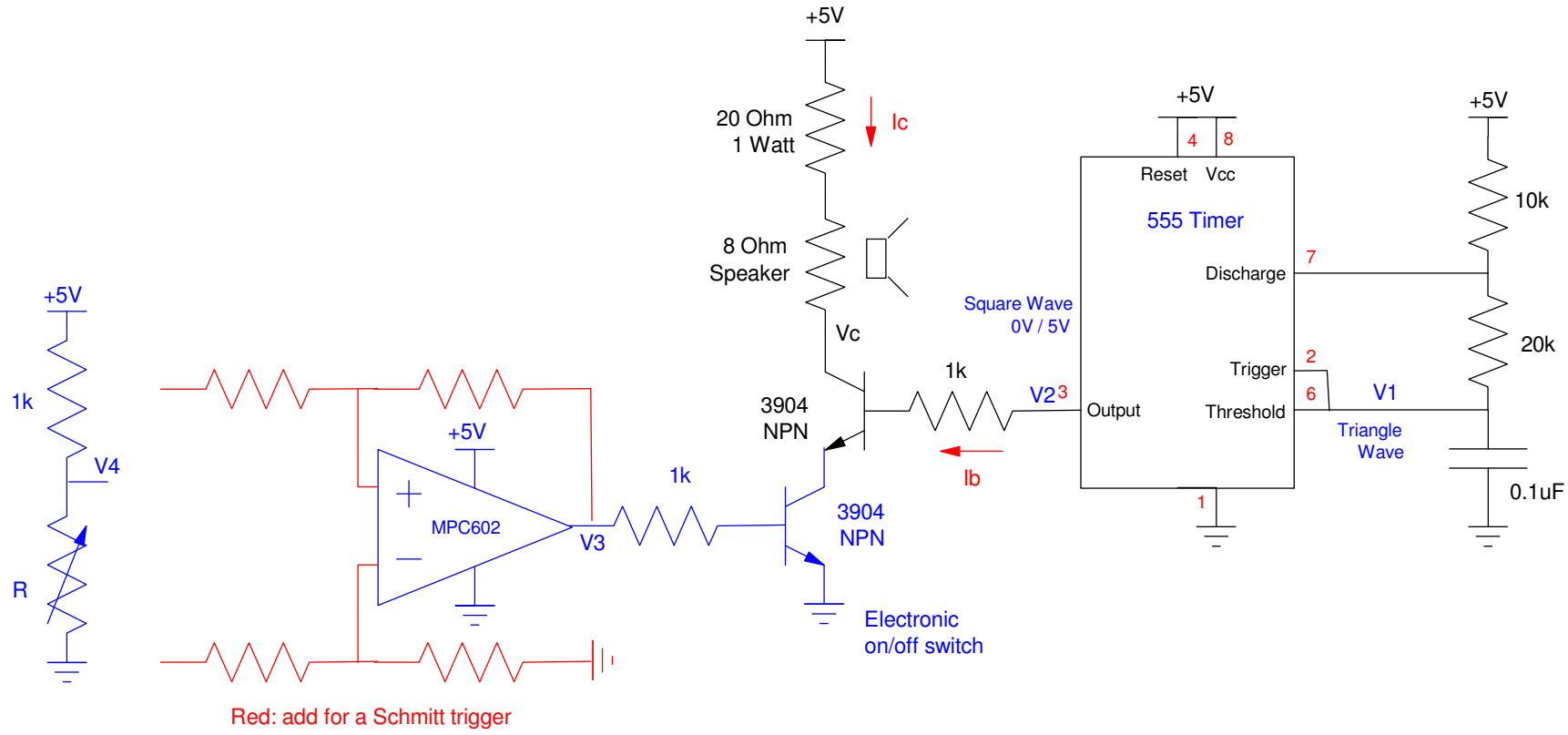
- When T > 40C, the alarm goes on (heat warning)
- When T < 10C, the alarm goes on (frost warning)
- Alarm = 1kHz, 50% duty cycle square wave



Previous Solution

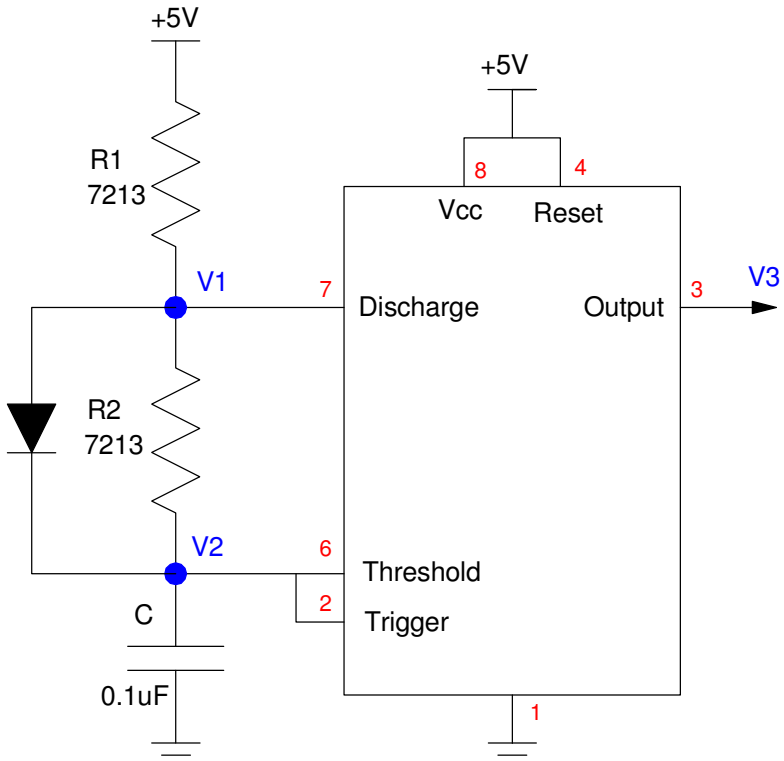
- 555 Timer to create a square wave
- BJT Switch to drive a speaker
- Second BJT Switch for on/off with temperature

New Solution: Repeat but using DTL logic



Step 1: 555 Timer Redesign

- 1kHz, 50% duty cycle square wave
- $T_{on} \approx R_1 \cdot C \cdot \ln(2) = 500\mu s$
- $T_{off} \approx R_2 \cdot C \cdot \ln(2) = 500\mu s$

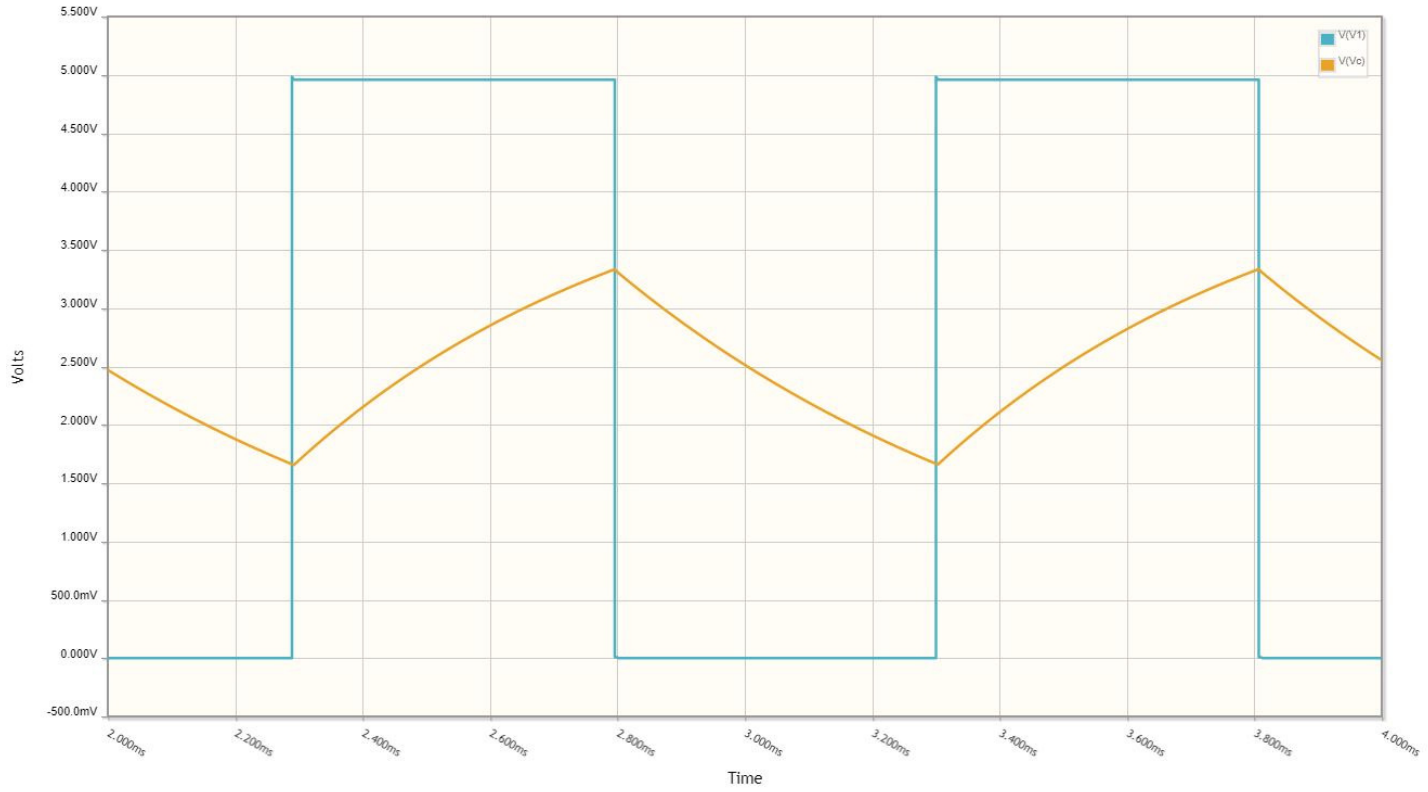


Check in CircuitLab

- On time = 660us (vs 500)
- Off time = 498us (vs 500)

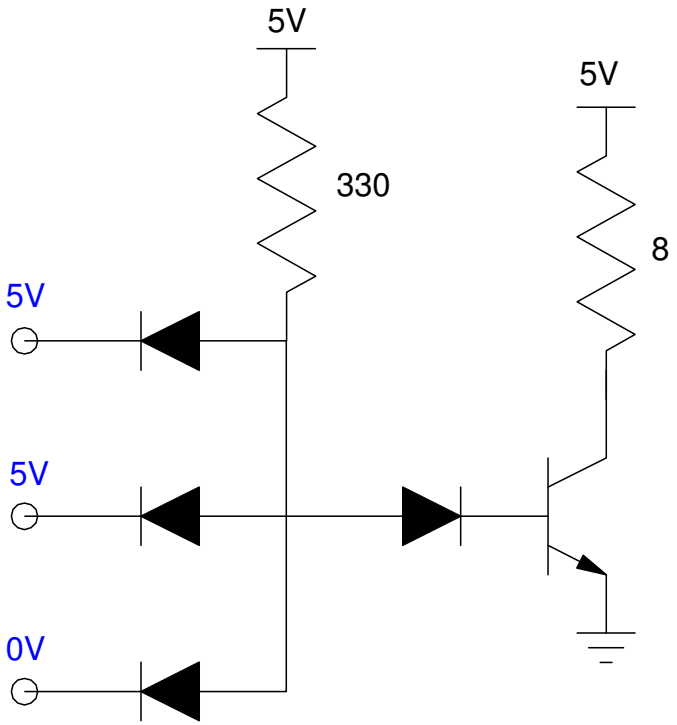
On time is a little off due to the 0.7V drop across the diode

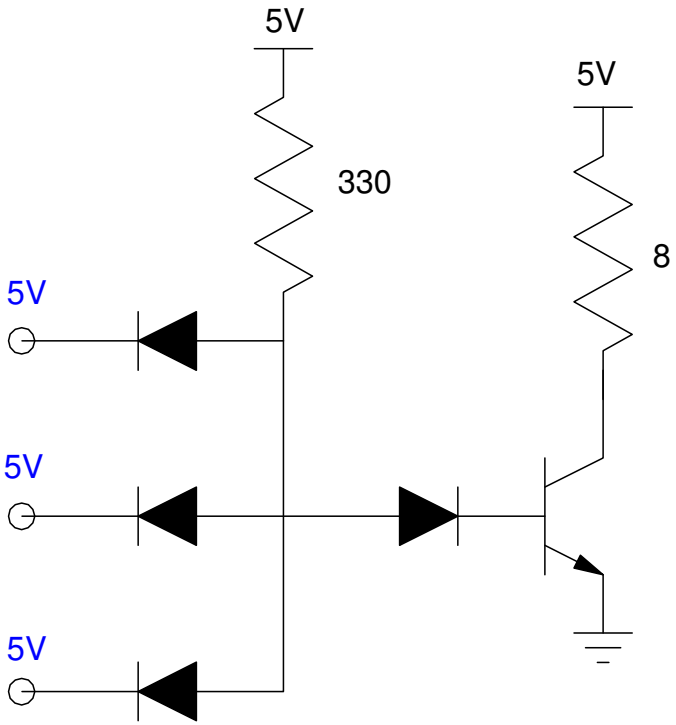
- Fix by adjusting R1 to $\left(\frac{500\mu s}{660\mu s}\right)7213\Omega = 5464\Omega$



Step 2: DTL Logic (review)

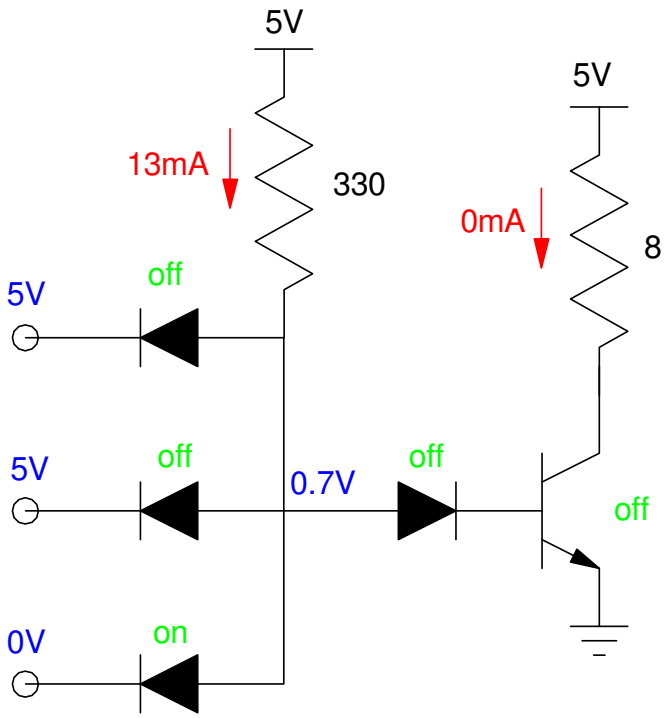
Determine the voltages and currents for the following DTL AND gate

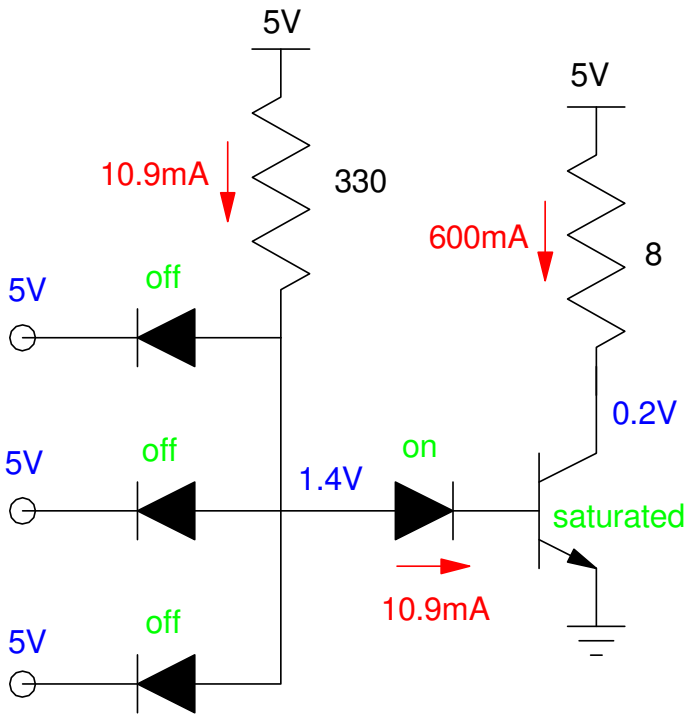




Solution:

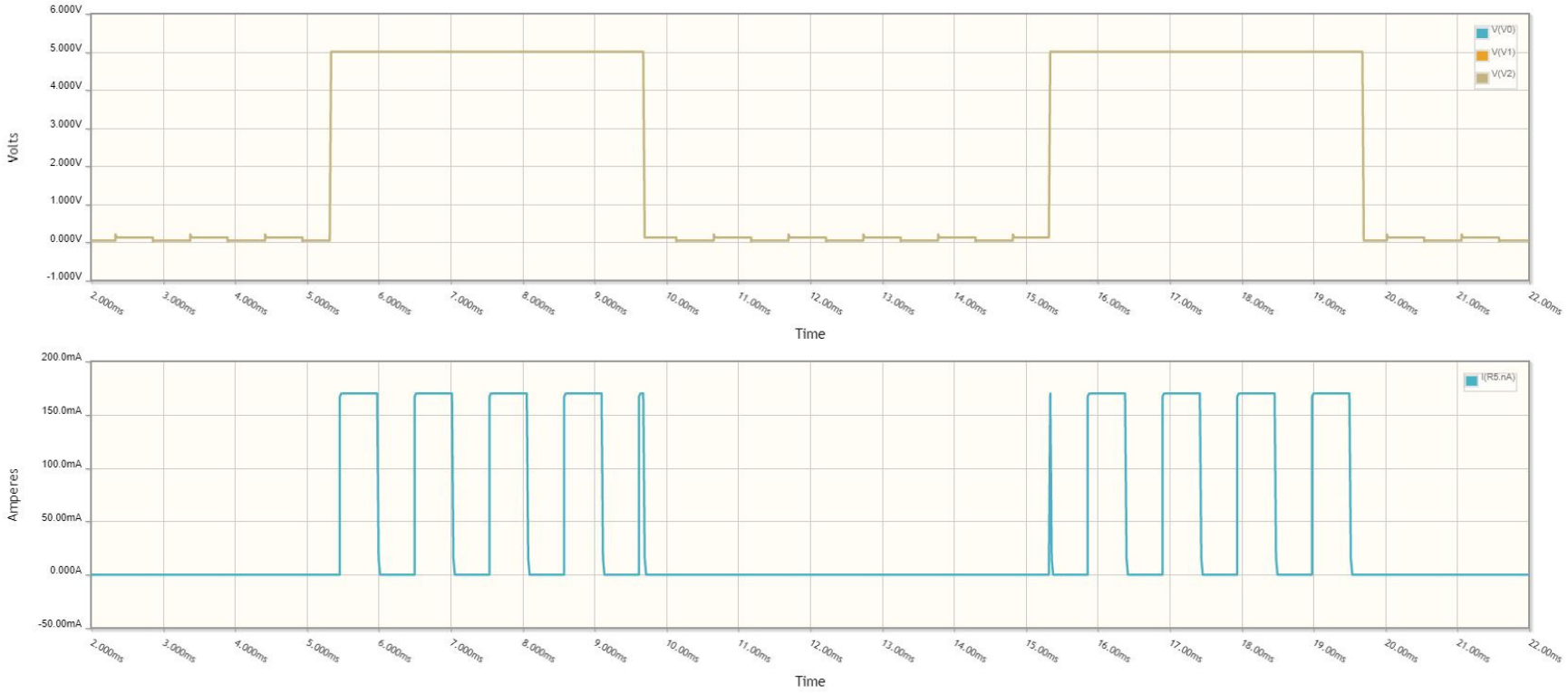
- The speaker is off (current = 0) if any input is 0V





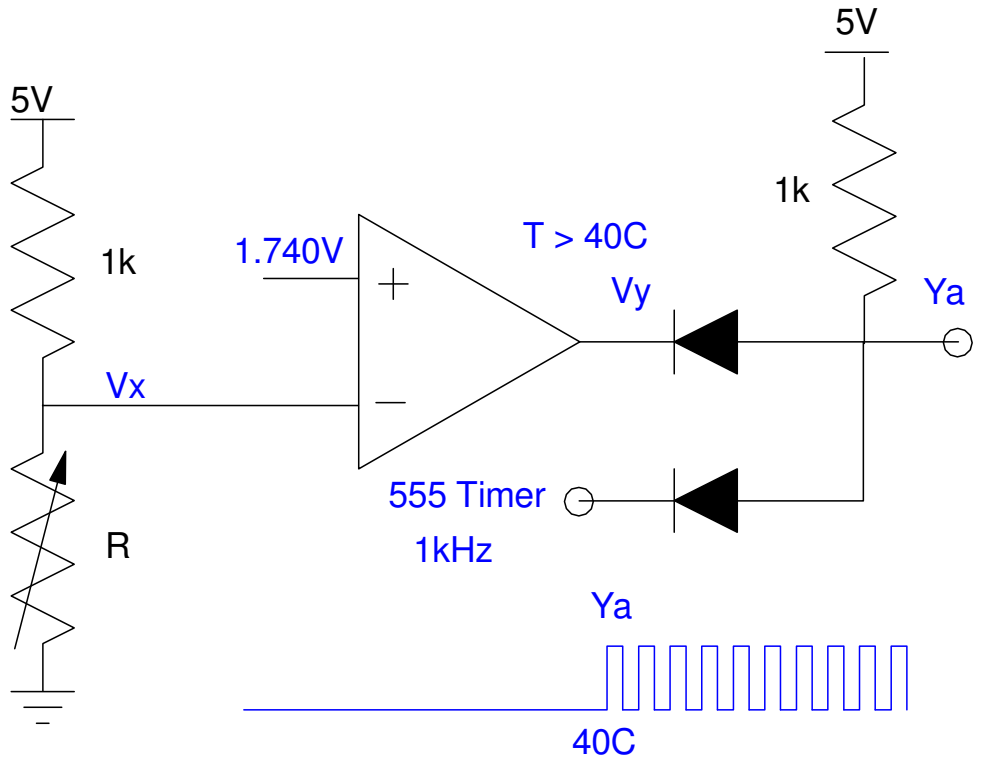
CircuitLab Simulation

- Current to the speaker only when all inputs are 5V
- When any input goes to 0V, the speaker turns off



T > 40C Circuit

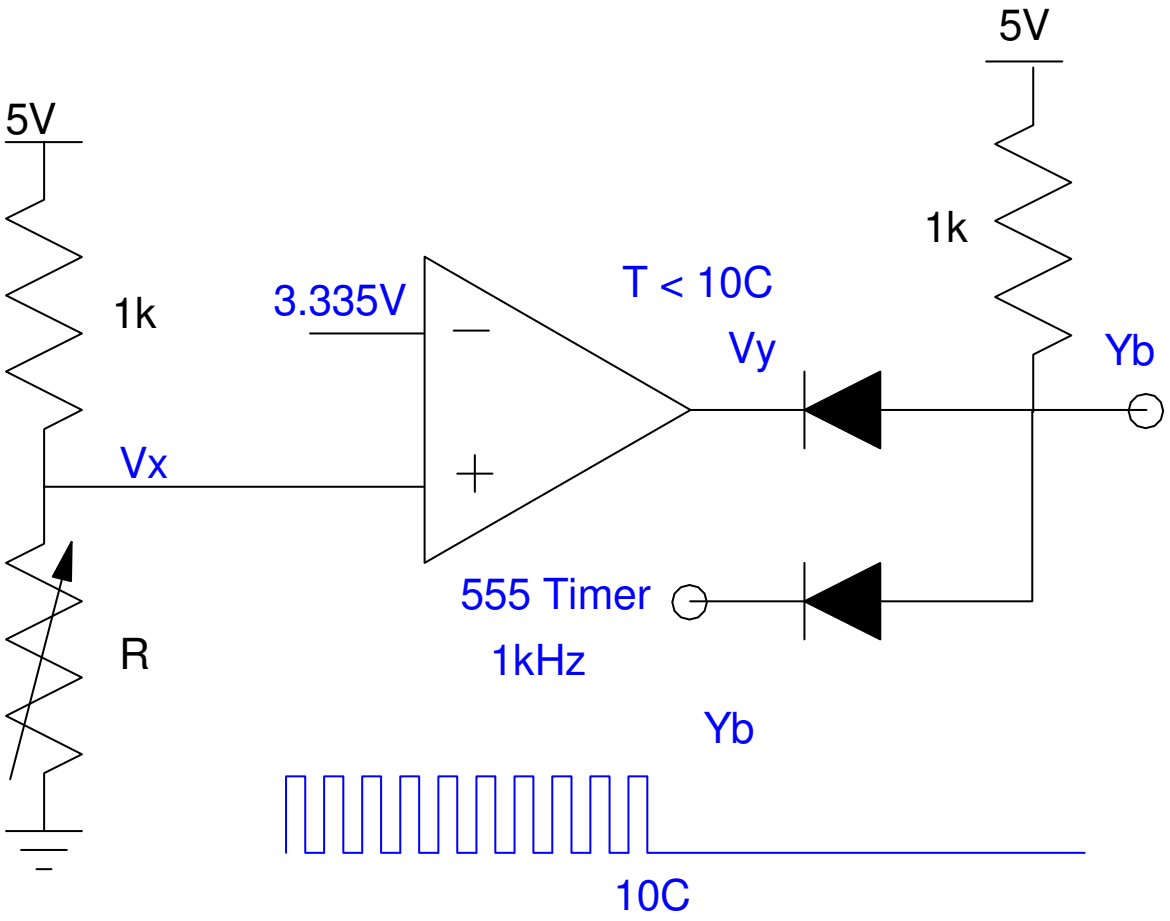
- Play an alarm when T > 40C
- Use a thermistor & voltage divider
  - $R = 1000 \cdot \exp\left(\frac{3905}{T+273} - \frac{3905}{298}\right)\Omega \qquad R(40C) = 533.7\Omega \qquad V_x = 1.740V$
- Use a comparitor
- Use a min() function (square wave when T > 40C)



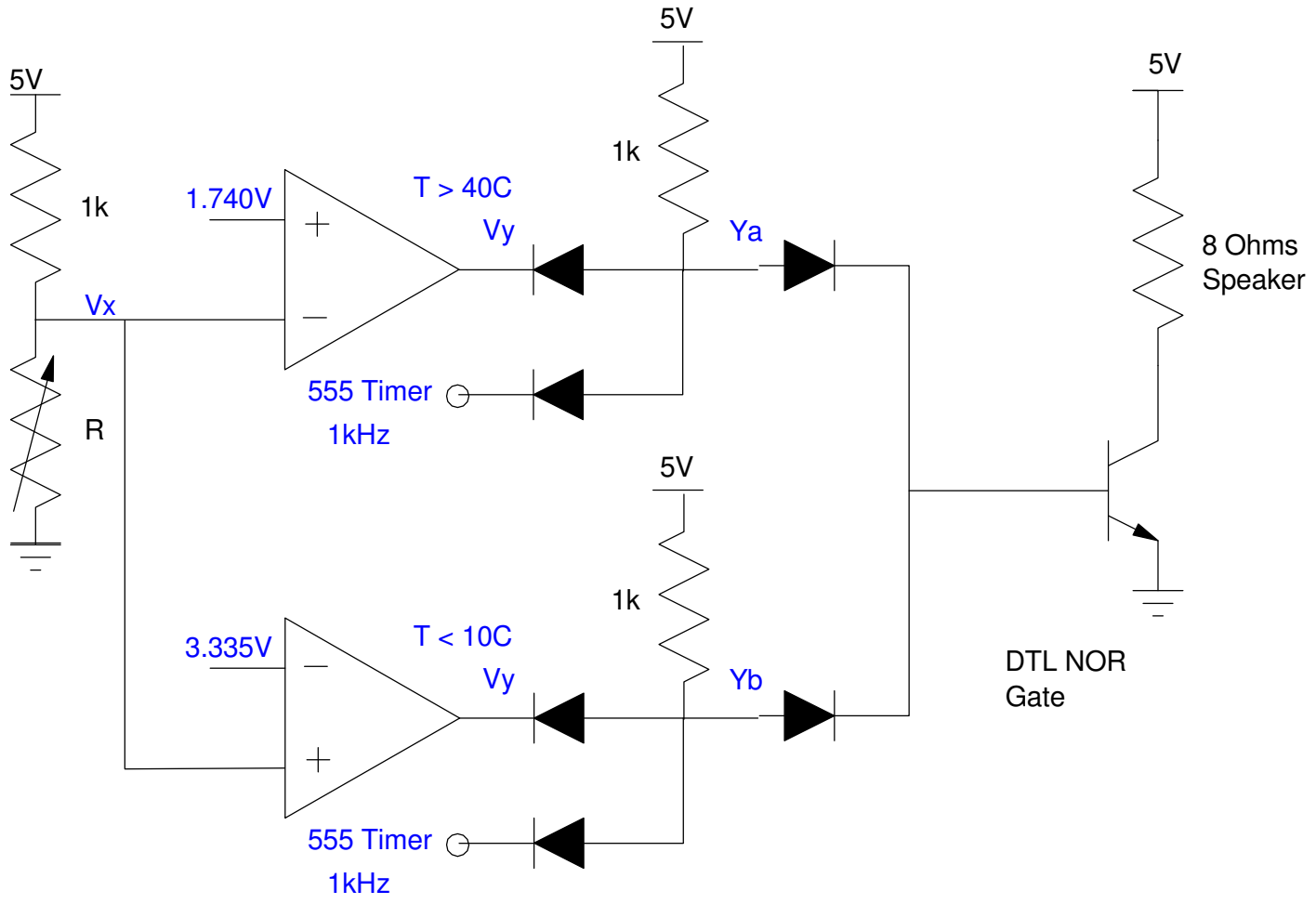
T < 10C Circuit

$$R(10C) = 2003\Omega$$

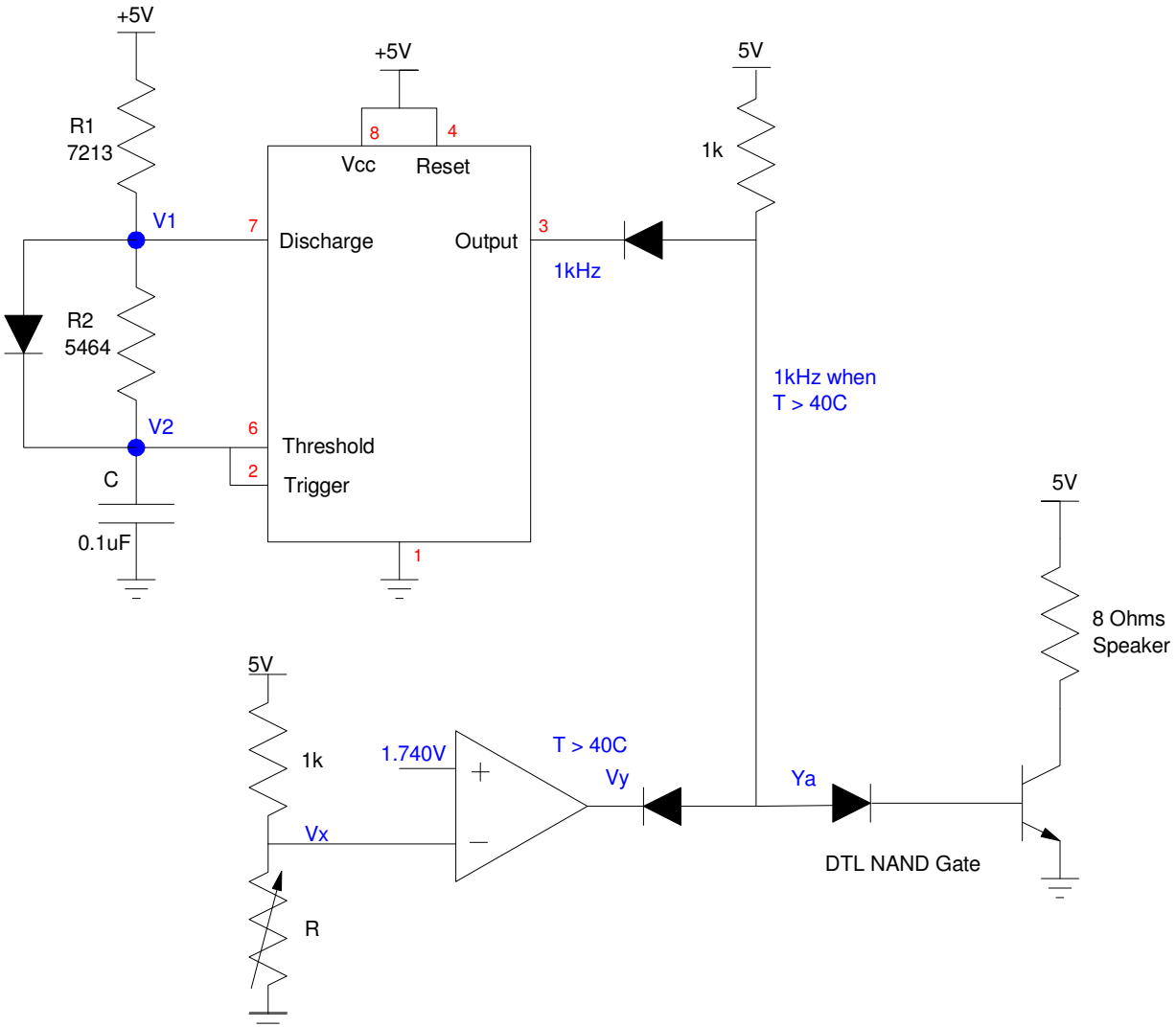
$$V_x = 3.335V$$



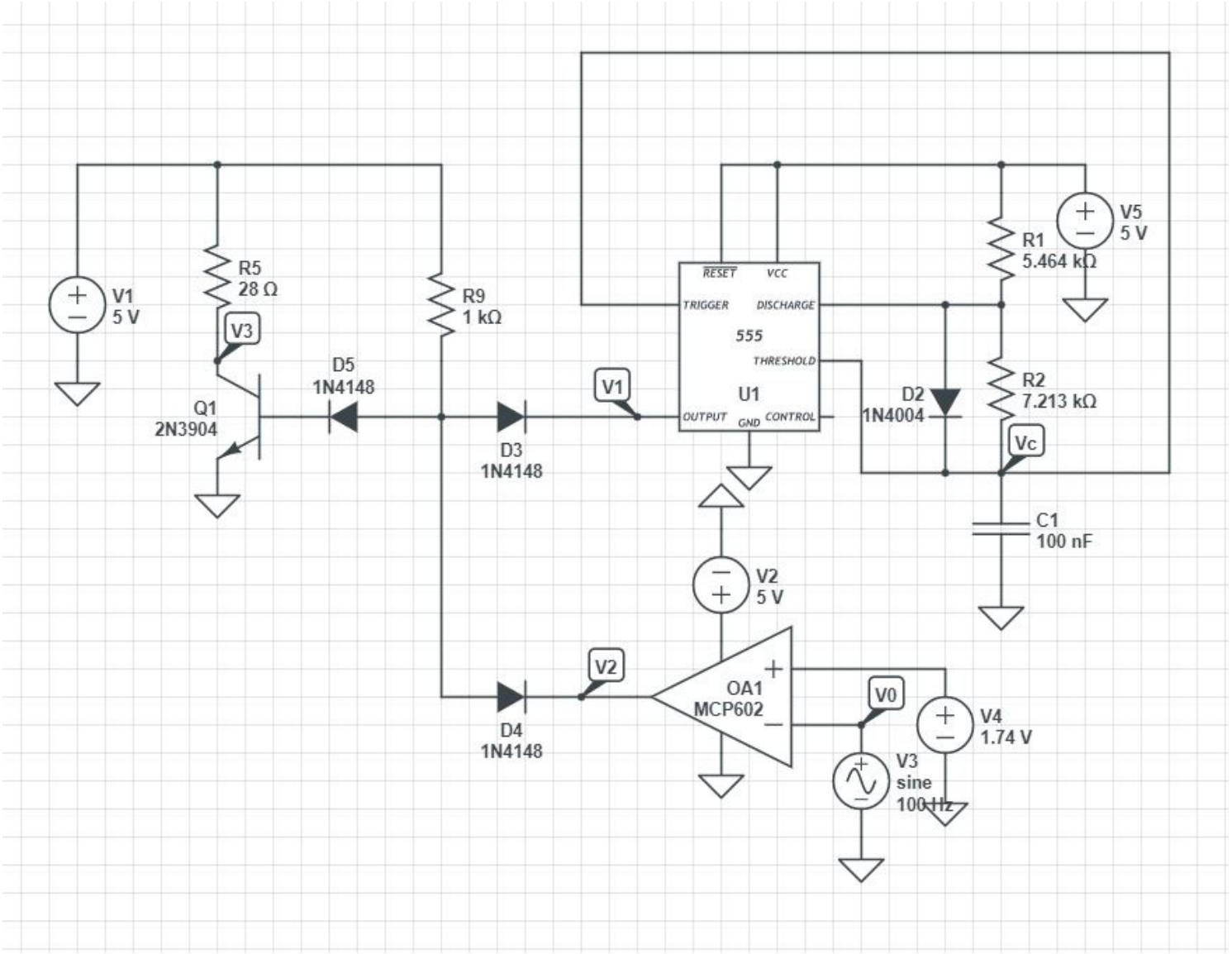
Putting it All Together



Schematic (T < 40C portion)

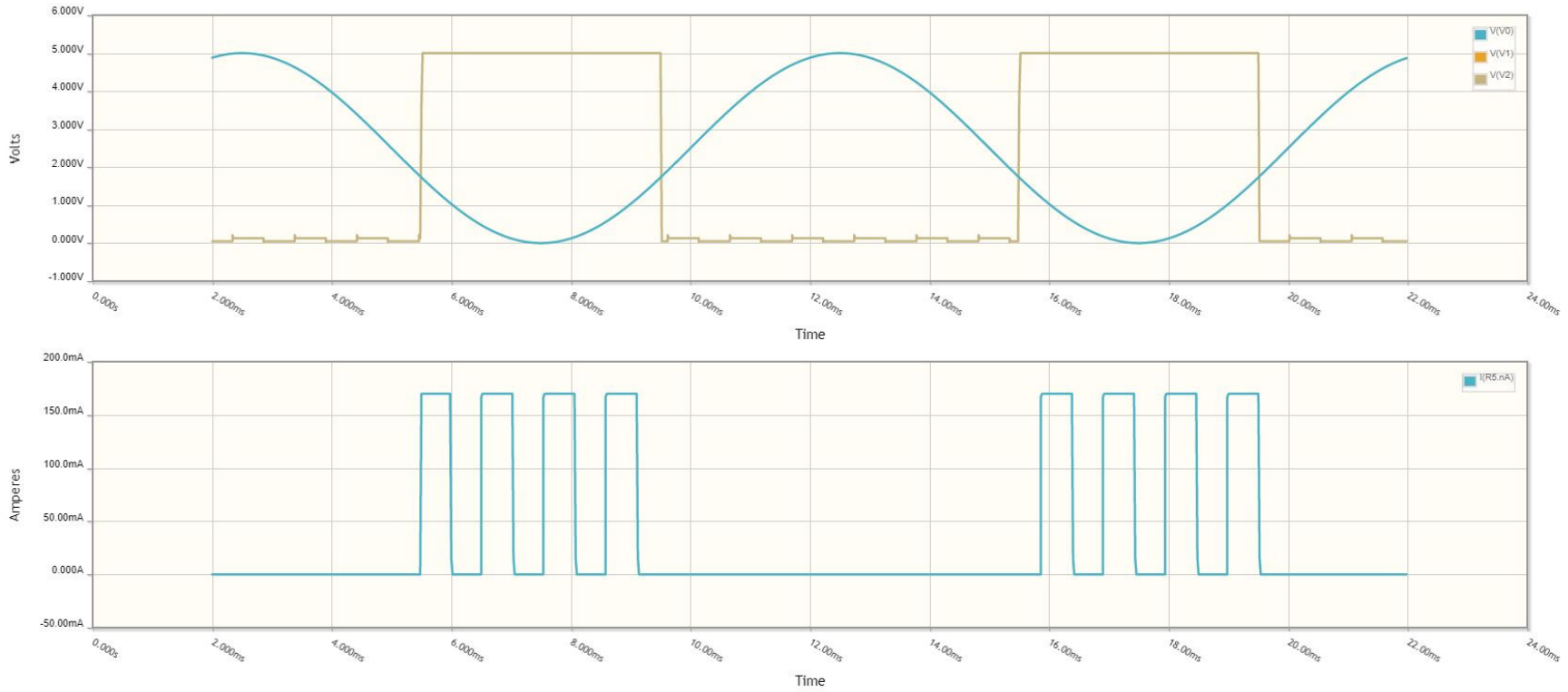


CircuitLab Simulation (V3 simulates the voltage divider)



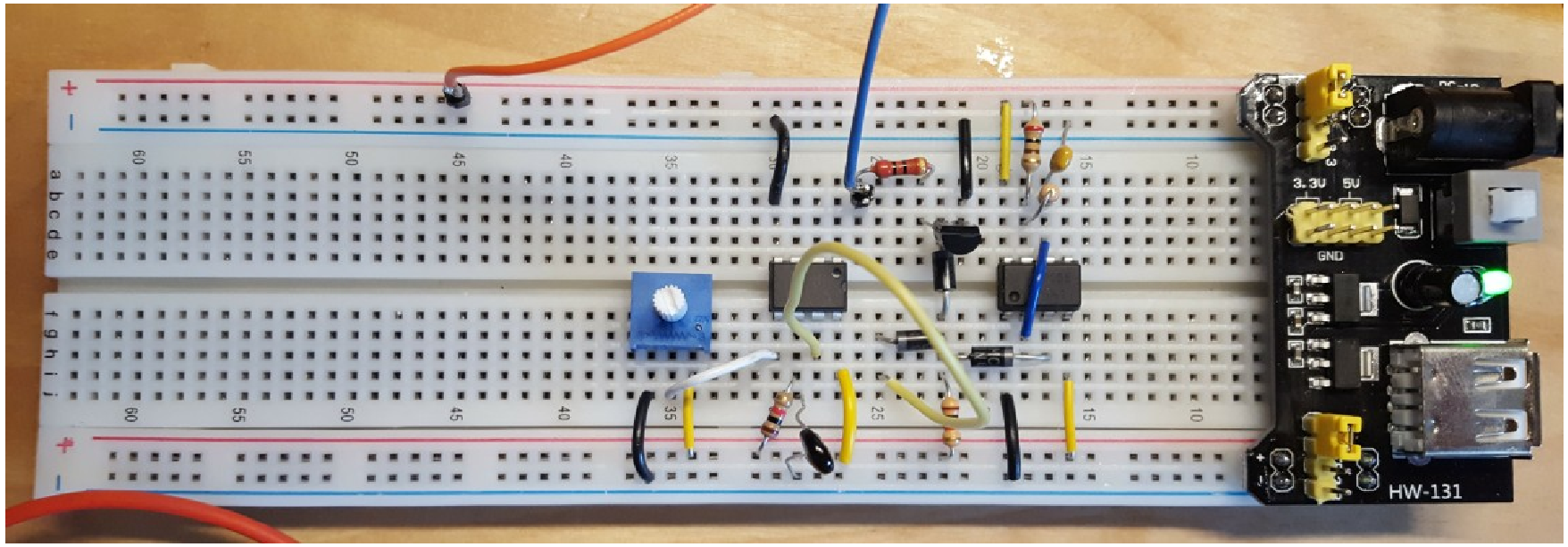
CircuitLab Simulation

- Alarm sounds when V < 1.74V (T > 40C)



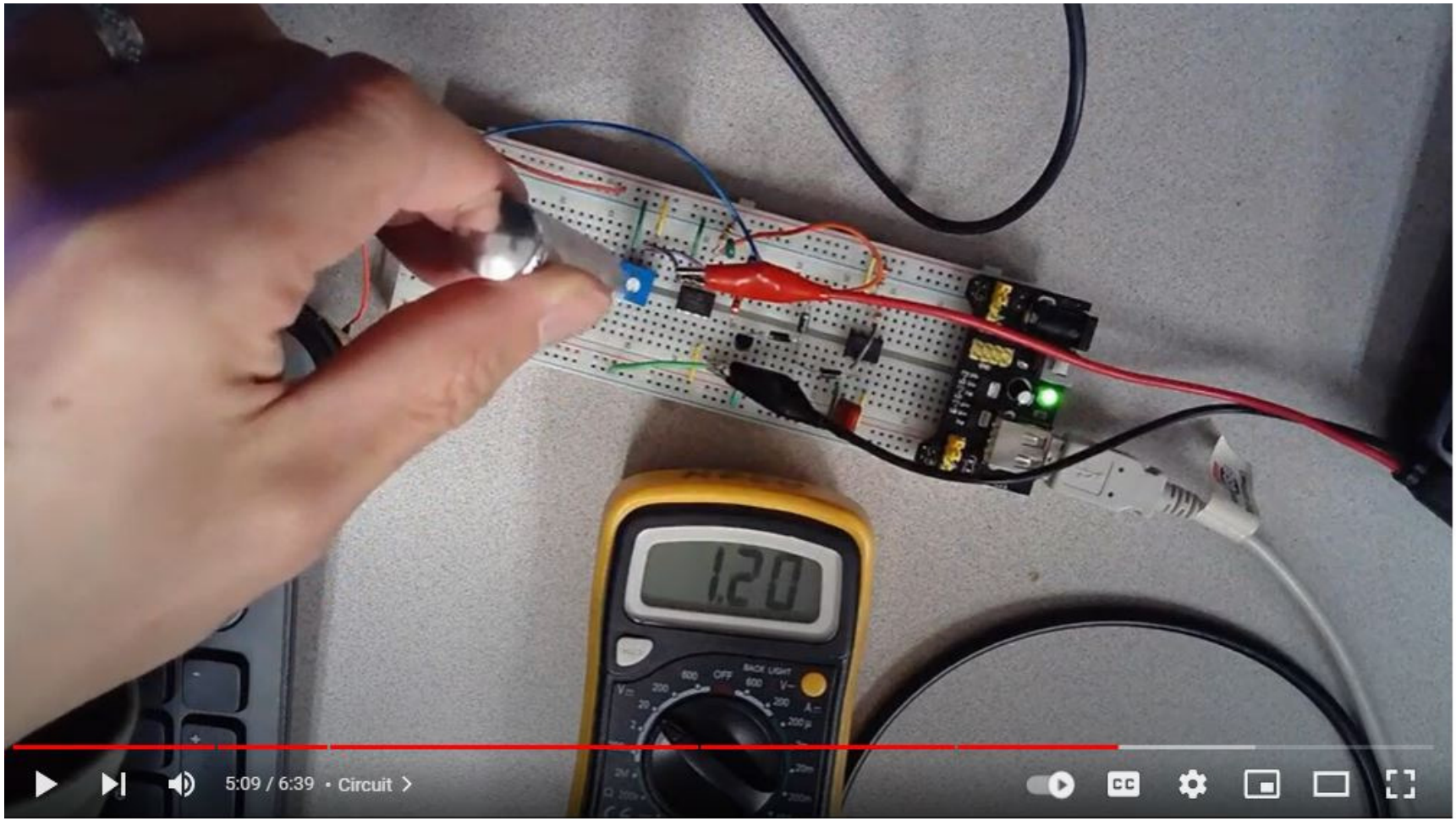
Hardware

- Verify your design in hardware (build and test the circuit with your lab kit).



Hardware Demo

- https://youtu.be/hymtdTzBCQc (5:09 mark)



Summary

DTL logic is one way to turn on and off a speaker

Instead of using multiple BJT transistors

- It uses a single BJT transistor, and
- Several diodes to implement max & min functions