Analog Electronics II

555 Timer Project

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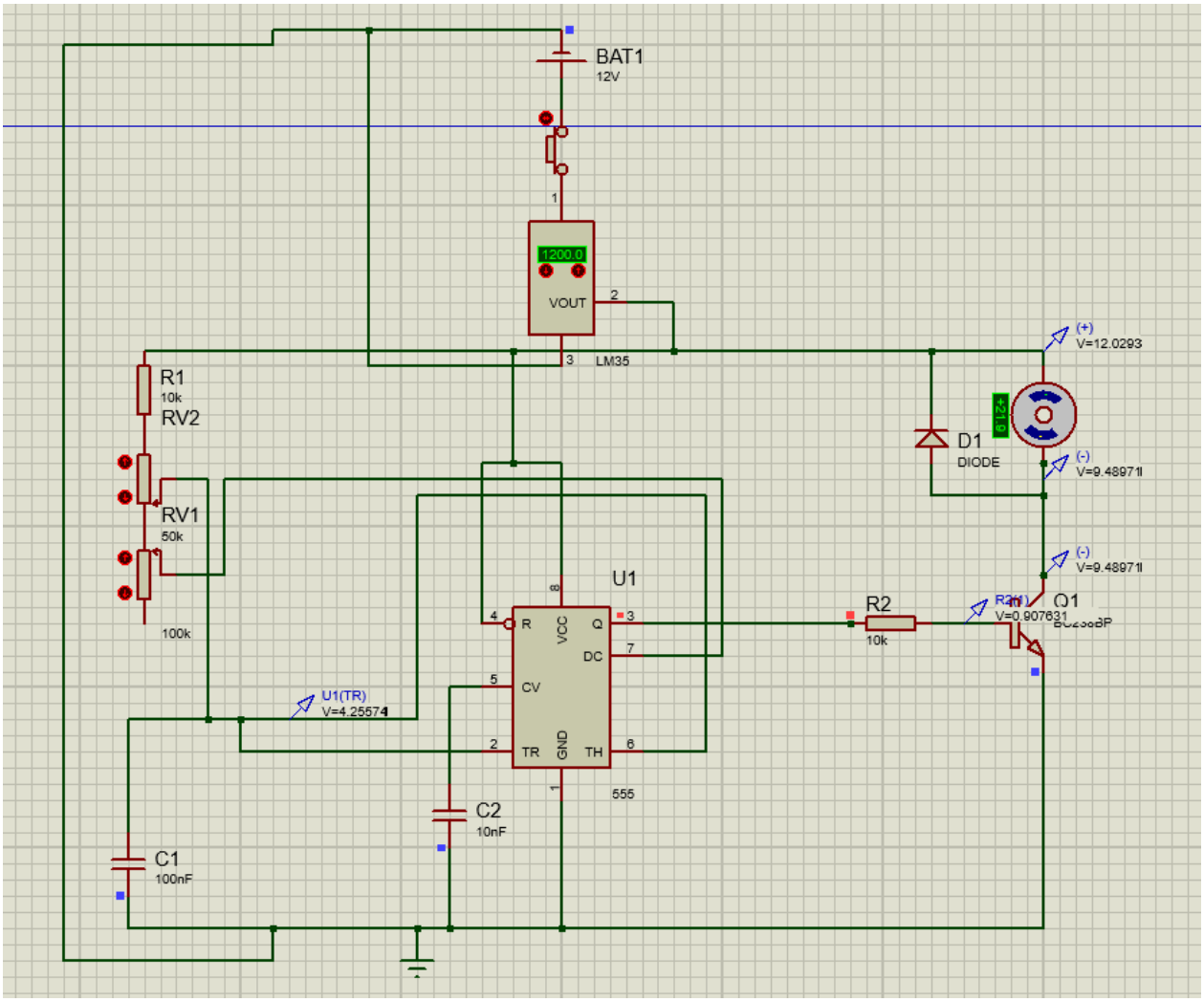
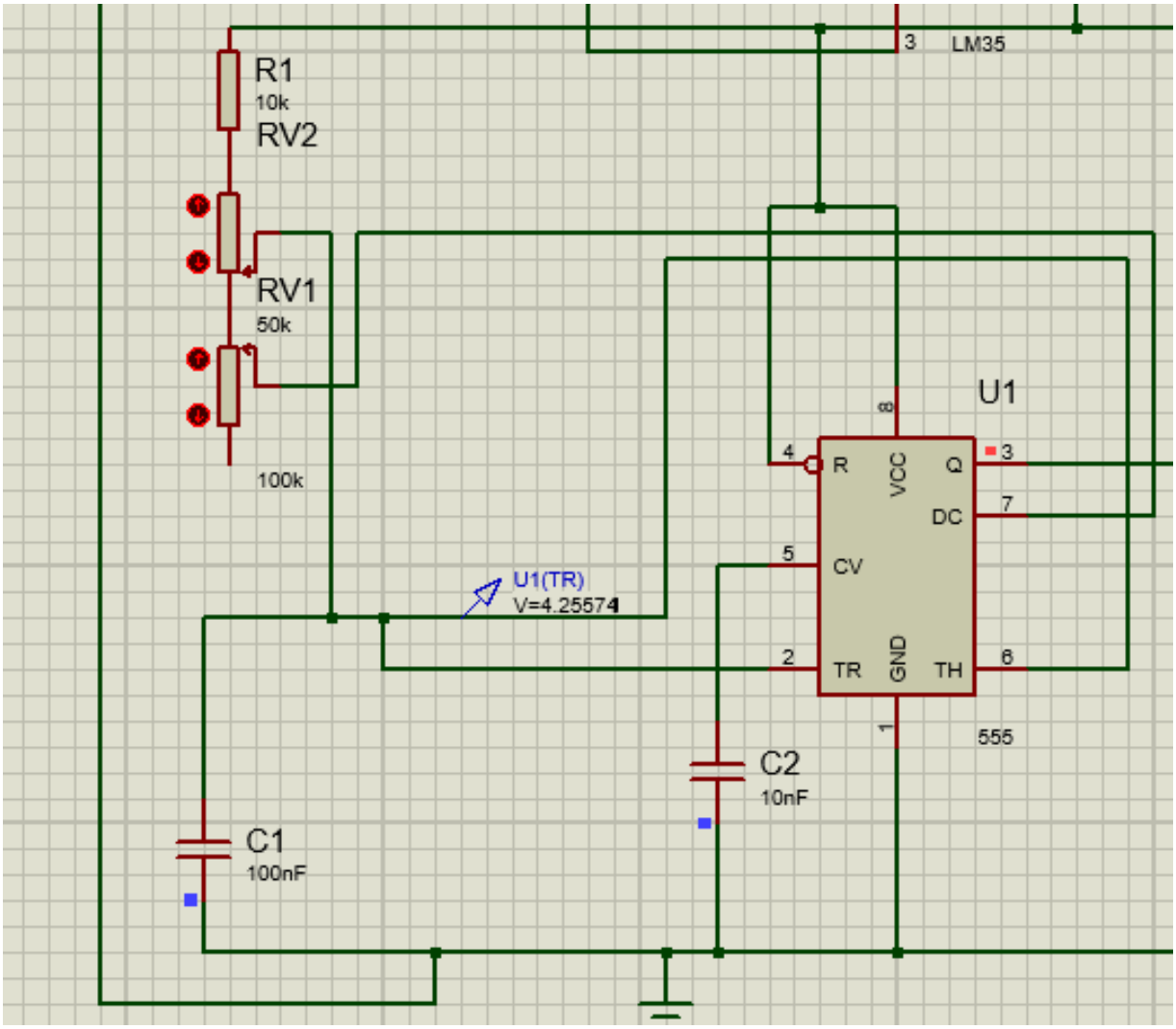
In this circuit we have established, we have set up a dc motor fan with the help of the 555 timer IC. In our circuit, we used 1 3.3k NTC temperature sensor, 2 potentiometers (50k and 100k), 2 10k resistors, 2 capacitors (100nf and 10nf), 1 BC237 transistor, 1 fan and 1 555 timer integrated.



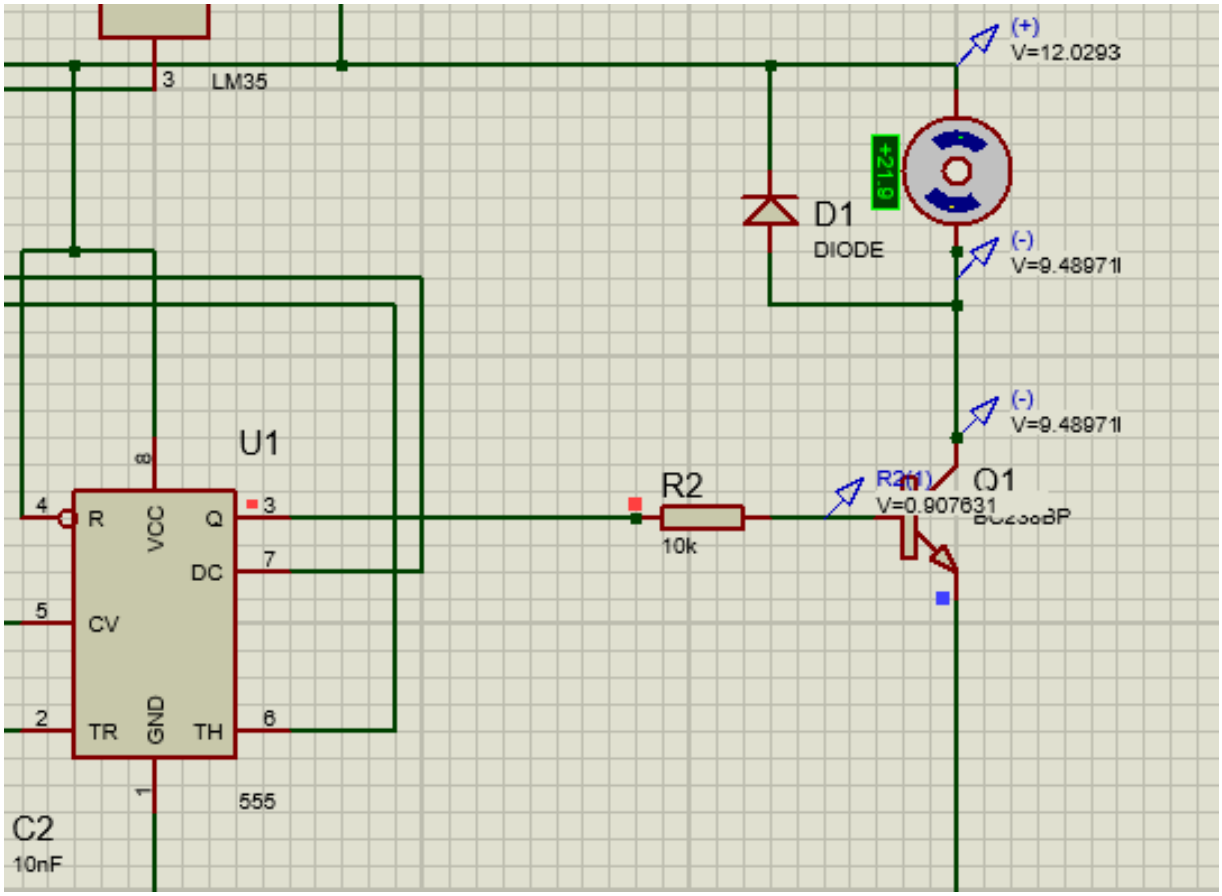
While we were building this circuit, we aimed to establish a dc fan circuit with 2-stage speed control activated by the temperature sensor. The purpose of using two potentiometers is both to make a more precise speed control functionally and to adjust the VC voltage and discharge voltage technically going to the threshold.

We used 3.3k NTC as heat sensor in our circuit. However, we used the LM35 temperature sensor as a representative because we could not obtain accurate results in the simulation.

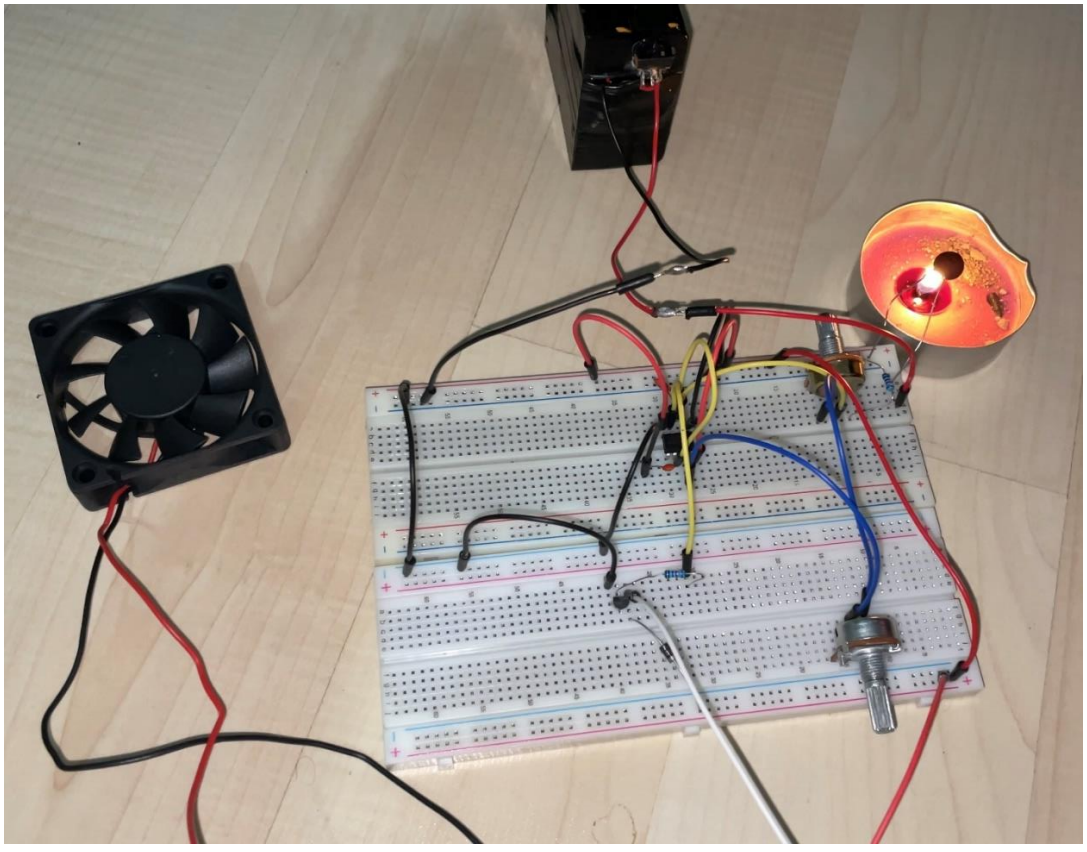
If we explain how the circuit works, we first connected our 12V VCC source to the temperature sensor and from there to the other supplies of the circuit.



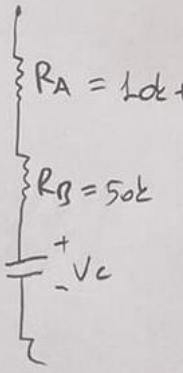
The reason we added a 10k resistor before adding the potentiometers is to prevent the voltage from VCC from being short circuited when we reset the pots. Then we added the 50k pot and connected the middle pin with the threshold, trigger and 100nf capacitor. We connected a 100k pot to the other end of this pot. We connected the middle pin of this pot to the discharge end. But we left the last pin of this pot exposed. Thanks to the 50k pot, we were able to adjust the VC voltage to the threshold and trigger inputs. So, thanks to this pot, we were able to make precise speed adjustments. With the other 100k pot, we adjusted the discharge voltage. In this way, we made a gradual switching. When we reset this pot, we can stop our motor independently of the other pot. We connected the 100nF capacitor with trigger, threshold and 50k connected to ground. This capacitor is charged by feeding with VCC when our discharge tip is not active. When our Discharge tip is activated, because a short circuit occurs, it is separated from the VCC supply and discharged very quickly. While the 555 Timer is running, thanks to this capacitor, the trigger is activated when the VC value exceeds VCC/3=4V, when it exceeds 2VCC/3=8V, the threshold is activated and the discharge part we mentioned above starts to work. That's why the capacitor discharges quickly. We connected our other 10nF capacitor, which we added, between the control voltage and ground. The purpose of this capacitor is to act as a regulator by protecting our 555-timer integrated from external influences.



We used the transistor connected to the motor and diode to create a voltage difference between VCC and output Q. In this way, our motor worked properly. Thanks to the resistor between the transistor and Q, we have controlled the base current. In addition, we have prevented the overheating of the transistor by choosing a high resistance. We used the diode connected in parallel to the motor to prevent the excess voltage from the motor. So, we protected the motor.



when discharge is off; Assumming Pots' values 50k



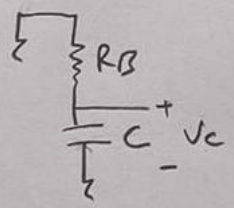
$$V_c(t) = V_{cc} - V_{cc}\, e^{-t/\tau}$$

$$\tau = C(R_A + R_B)$$
$$= 100nf\,(60k + 50k)$$
$$= 100.10^{-9}.\,110.10^{3}$$
$$\tau = 0{,}011$$

* At time $t=0$, $V_c = 0$. As t increases, our V_c value also increases.

* When our V_c volve exceeds $V_{cc}/3 = 4V$, the trigger is activated and we get 1 signal from the output. Our capacitor continues to fill.

* Threshold is activated when our V_c value exceeds $2V_{cc}/3 = 8V$. Our output will be 0. Discharge is activated. So our capacitor discharge quickly.



$$V_c(t) = V_{c\,initial} \cdot e^{-t/\tau}$$

$$\tau = R_B.C \Rightarrow 50k.\,100nf$$
$$= 50.10^{3}.\,100.10^{-9}$$
$$\tau = 5.10^{-3}$$

Our capacitor discharges up to $V_{CC}/3 = 4V$. Then it starts charging again up to $2V_{CC}/3 = 8V$. To find the rise time "tr" and the fall time "tf", a calculation can be made as follows.

$$V_c(t) = V_{c\infty} - (V_{c\infty} - V_{c\,initial})\, e^{-t/\tau}$$

Rise Time (tr)

$$t = t_r \Rightarrow V_c(t)\Big|_{t=t_r} = \frac{2V_{CC}}{3} = V_{CC} - \left(V_{CC} - \frac{V_{CC}}{3}\right) e^{\frac{-t_r}{C(R_A+R_B)}}$$

$$-\frac{V_{CC}}{3} = -\frac{2V_{CC}}{3}\, e^{\frac{-t_r}{C(R_A+R_B)}}$$

$$\ln\frac{1}{2} = \frac{-t_r}{C(R_A+R_B)} \Rightarrow t_r = \ln(2)\,(C\cdot(R_A+R_B))$$

$$\ln(2) \approx 0{,}69$$

$$t_r = 0{,}69\,(100\cdot10^{-9}\,(110\cdot10^{3}))$$

$$t_r = 0{,}0075\,s$$

fall time (tf)

$$V_c(t) = V_{c\,initial}\, e^{-t/\tau} = \frac{2V_{CC}}{3}\, e^{\frac{t}{R_B C}}$$

$$t = t_f \Rightarrow \frac{V_{CC}}{3} = \frac{2V_{CC}}{3}\, e^{\frac{-t_f}{R_B C}}$$

$$t_f = \ln(2)\, R_B C \Rightarrow 0{,}69\,(50k\cdot 100nf) = 0{,}69\,(50\cdot10^{3}\cdot100\cdot10^{-9})$$

$$= 3{,}45\cdot10^{-3}$$

As a result, we created DC signals in our output with the 555 Timer integration by applying temperature to the heat sensor in our circuit. We started our engine. We adjusted the speed of our motor when we changed the resistors using the pots.

We took a video about our circuit when its working and we uploaded on YouTube. You can reach it with this QR code.