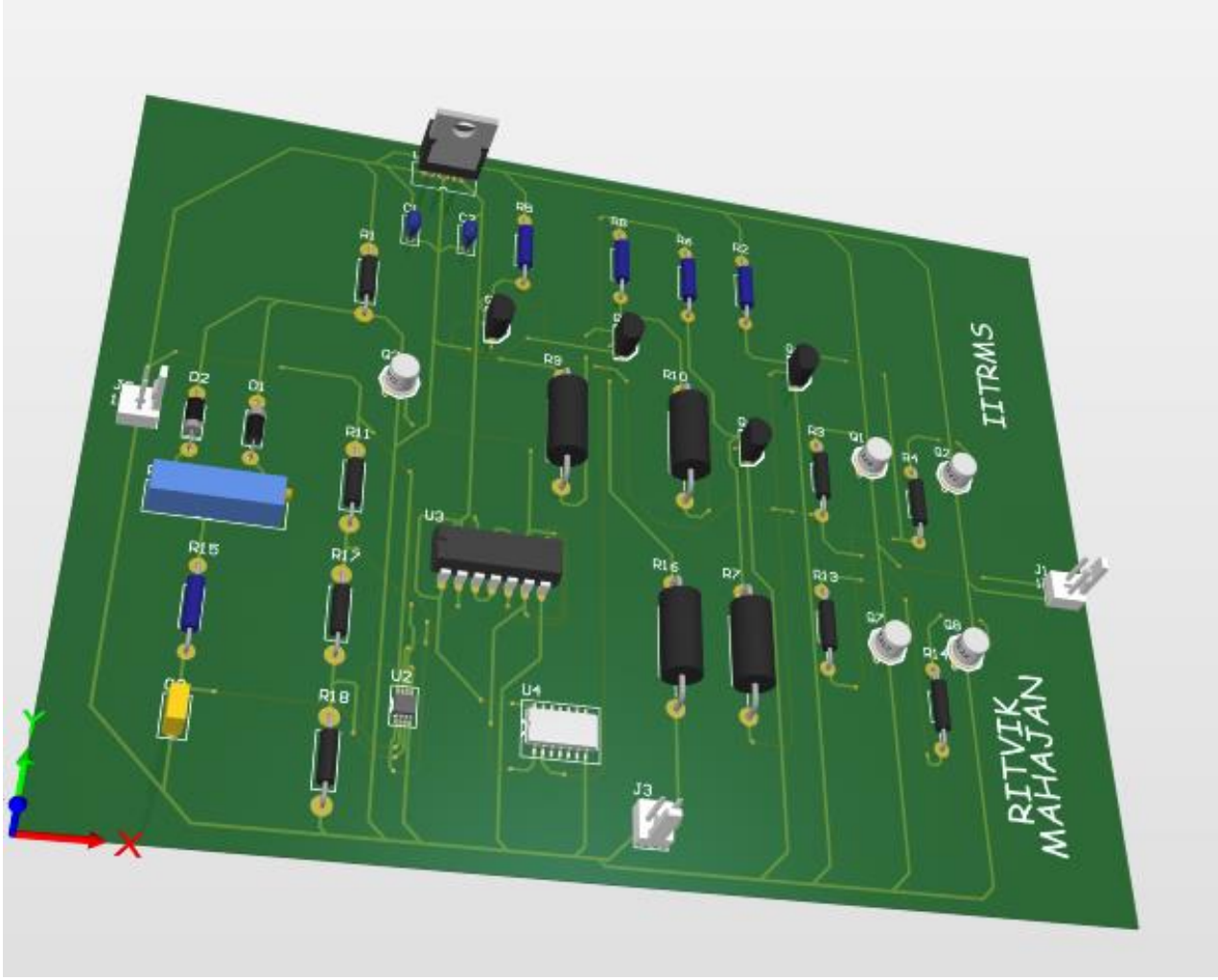
Project Report

Open Loop DC Motor Control

Ritvik Mahajan



Motivation

~~Getting the certificate which, we later realized we wouldn't get~~. One of the most important things one wants to control in his / her vehicle, after the AC temperature, is vehicle speed. Since our car doesn't have an AC, we concentrated in this project on the latter i.e., the motor speed. Although the task accomplished in this project is much simpler in the sense that the motor is a simple DC motor, and the control strategy is open loop, nevertheless the project proved to be a great enabler for learning various concepts with immense practical applications.

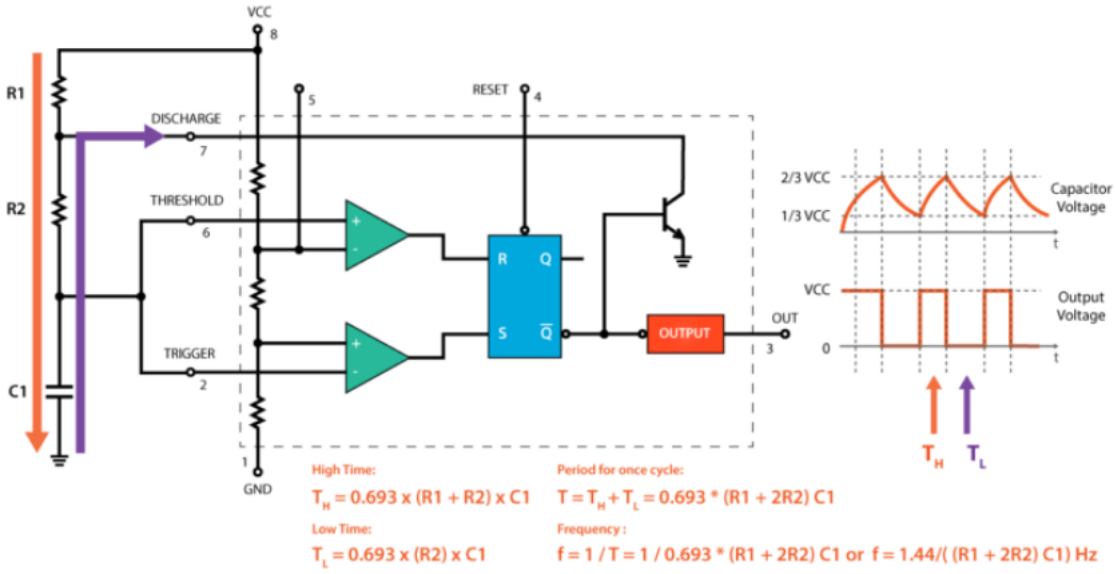
Objective

To design and implement an Open Loop Speed Control Strategy of a 24V (Low Voltage Brushed DC Motor.

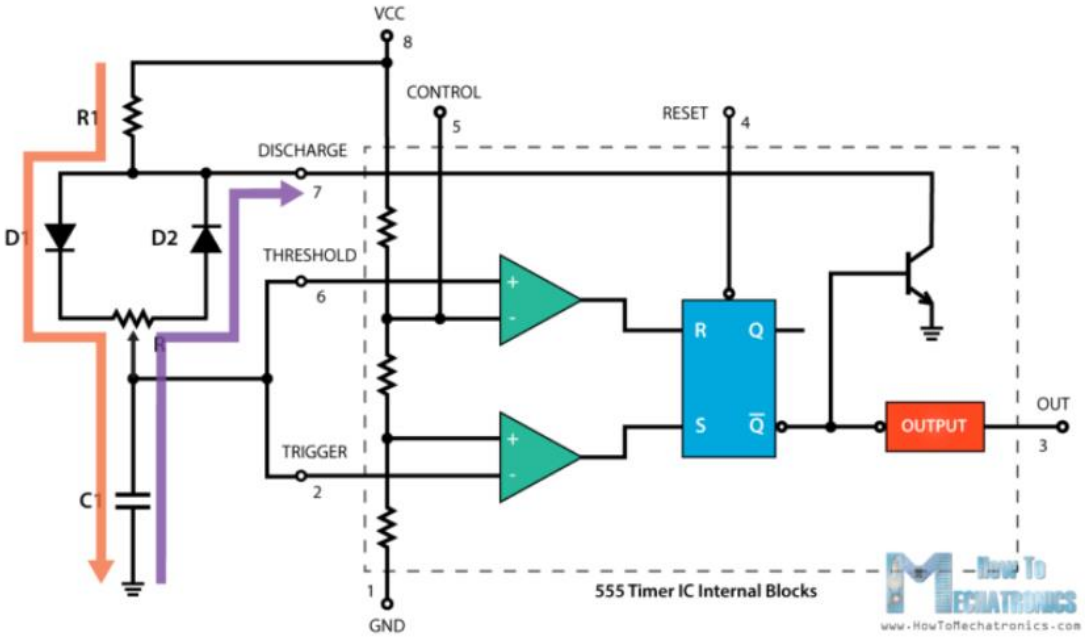
Literature / Theory

- To make the motor rotate at variable speed, variable input voltage is required. Since it is not feasible to convert a constant supply voltage to an analog (varying continuously), we resorted to PWM signals with variable duty cycles. For more information about PWM: https://www.youtube.com/watch?v=2XjqS1clY_E

- 555 Timer IC can be used in Astable Multivibrator to accomplish the above task. More about the topic: https://www.youtube.com/watch?v=iJYm_BGqa1A



- In the above shown circuit, a constant duty cycle of T_H/T can be achieved. To achieve variable duty cycle, R2 needs to be replaced by a variable resistance (Potentiometer). However, this would mean different frequencies for different duty cycle values. To overcome this, the following modifications were made in the circuit.

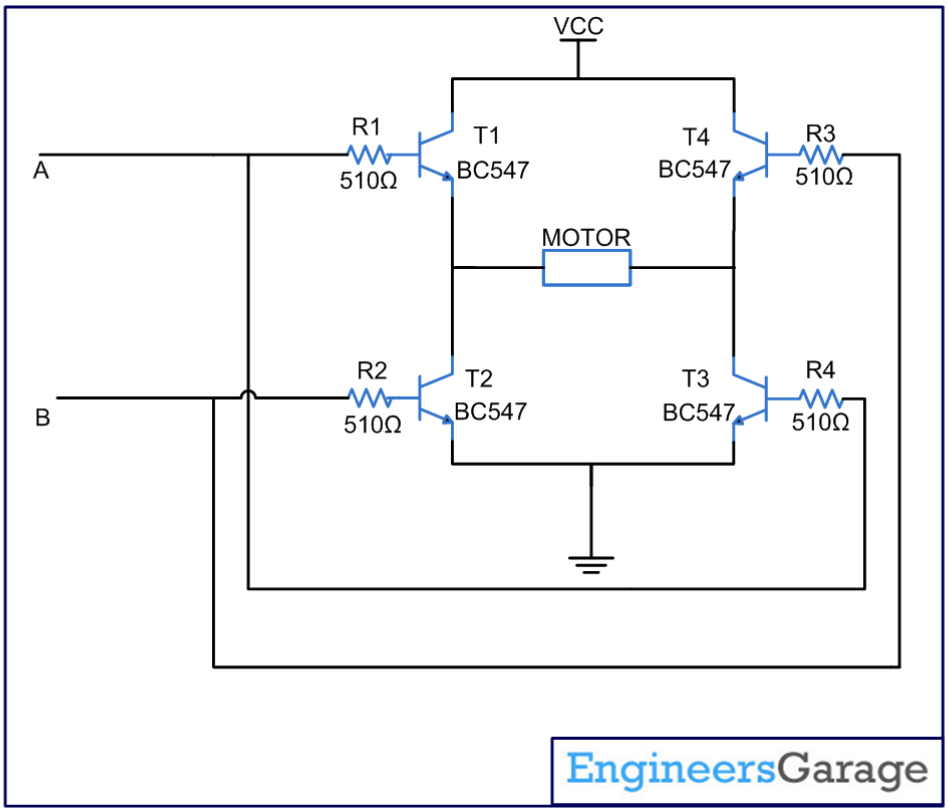


- More about the above circuit can be read here: https://howtomechatronics.com/how-it-works/electronics/how-to-make-pwm-dc-motor-speed-controller-using-555-timer-ic/

- Substituting the values of resistances, we have taken (The circuit is shown under "Simulation"), we are able to achieve duty cycle values in the range of about 0.05 % - 99 %.

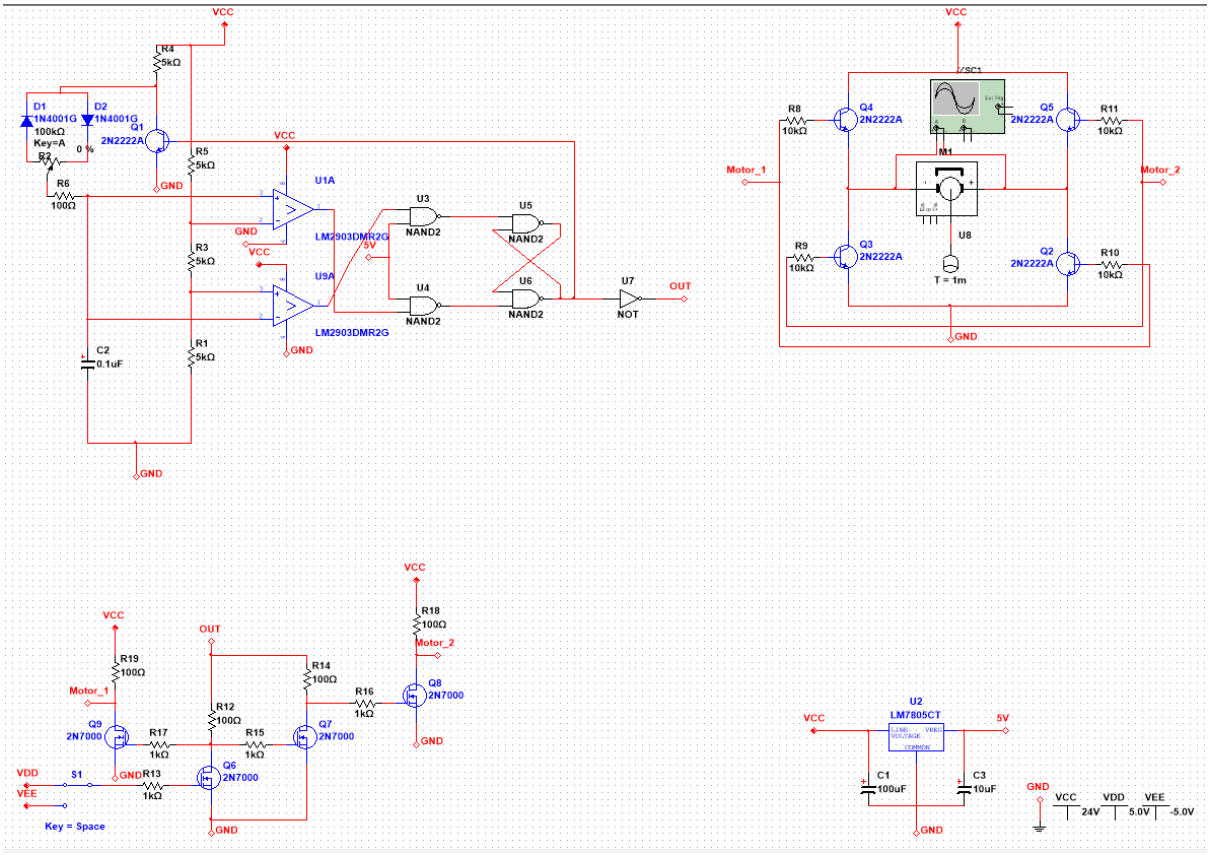
- To change the direction of motor without using a physical switch, MOSFETS were used as switches. More about the topic: https://www.youtube.com/watch?v=UJkHL-6mn8s

- A H-Bridge circuit was used to control the DC motor (The circuit shown below doesn't have the same models as used in the project, but it explains the idea well enough).



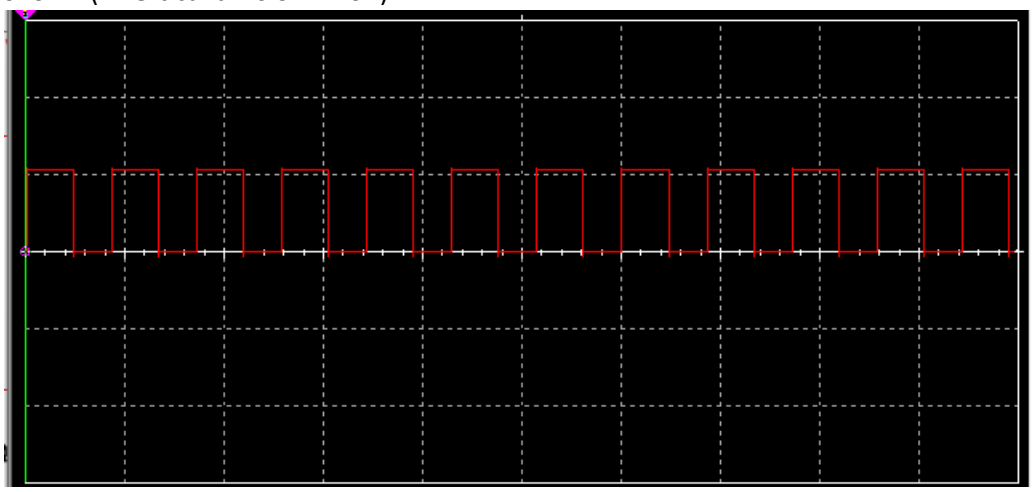
- For a better understanding of the complete concept, watch: https://www.youtube.com/watch?v=dQw4w9WgXcQ

Simulation / Design



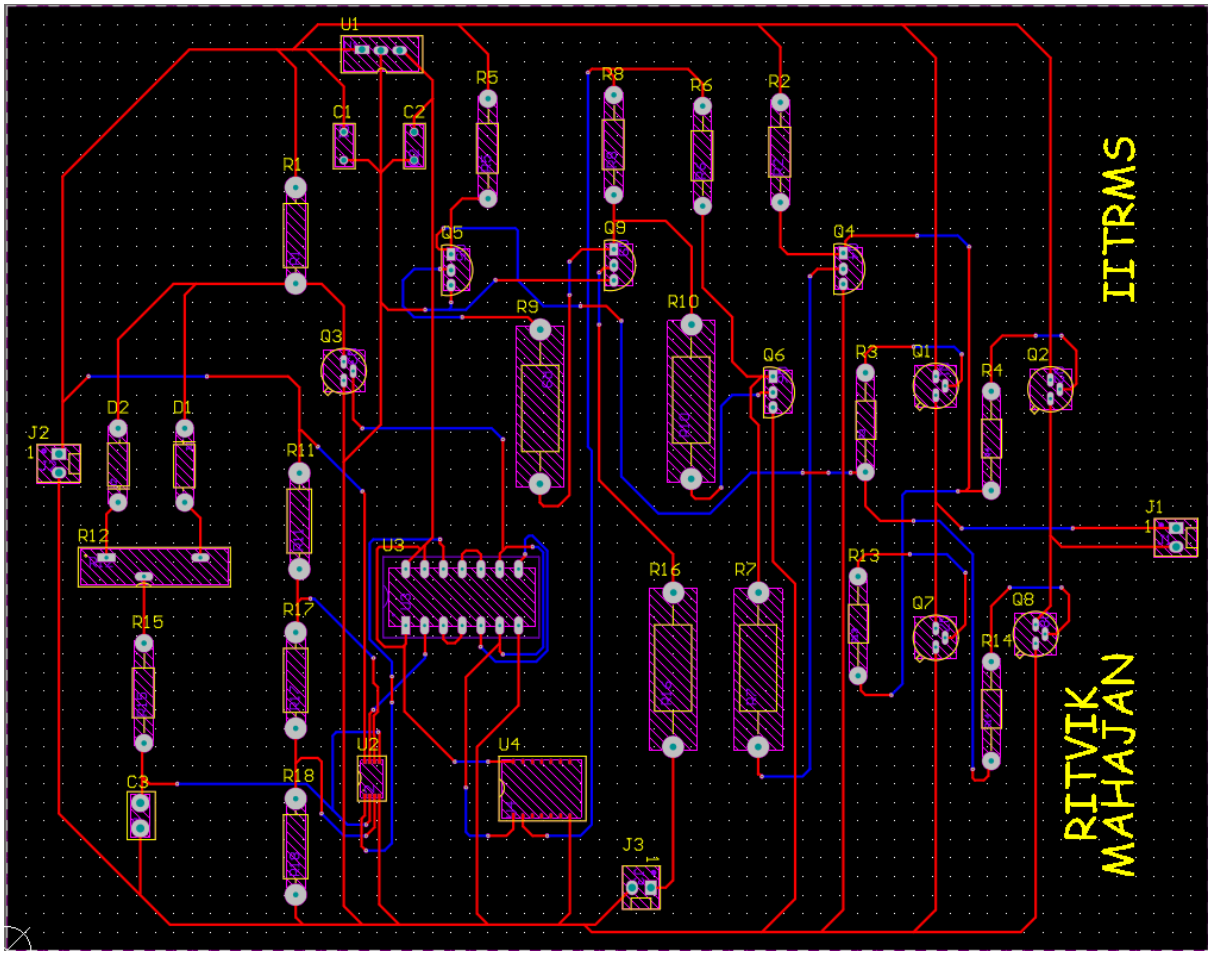
- All the components have been selected after considering the rated voltages / currents.

- A sample output (Voltage across the motor) for Potentiometer value = 60 % (60k ohm) is shown (1 vertical division = 20V):



PCB Output

- PCB Layout:



- No flex, but Design Rule Check was passed on 1st attempt!

- The process followed was studied from here: https://www.youtube.com/playlist?list=PLXvLToQzgzdfKKQn2wmpuSXz6sROQmO6R

Problems

- No major issues were faced during the project

References

- All the component datasheets, simulation file, PCB files and outputs can be accessed here: https://drive.google.com/drive/folders/1qra9_DHklYXDNjC7D-qFC03tHZpz9qVs?usp=sharing