Speed Control of a DC motor by Armature Voltage Control

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Contents

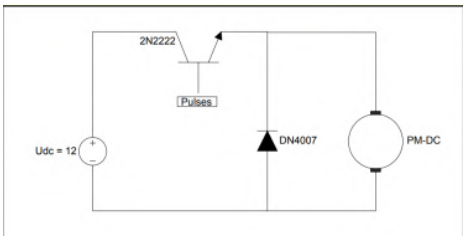
1 Aim

Control the speed of the motor using armature voltage control method. Demonstrate motor running at, (i) the rated speed, (ii) half the rated speed.

2 Apparatus Required

1. 555 Timer and variable resistance
2. Capacitors and diodes
3. DSO,wires and power supply
4. BJT Transistor
5. DC Motor

3 Theory



PWM (Pulse Width Modulation) is a method through which we can generate variable voltage by turning on and off the power that's going to the electronic device at a fast rate. The average voltage depends on the duty cycle of the signal, or the amount of time the signal is ON versus the amount of time the signal is OFF in a single period of time.

The 555 Timer is capable of generating PWM signal when set up in an astable mode. When the output is HIGH when the capacitor C_1 is charging through the resistors R_1 and R_2. On the other hand, the output of the IC is LOW when the capacitor C_1 is discharging but only through the resistor R_2. So we can notice that if we change the values of any of these three components we will get different ON and OFF times, or different duty cycle of the square wave output signal. The control pin of the 555 Timer is not used but it's connected to a 10nF capacitor in order to eliminate any external noise from that terminal. The reset, pin number 4, is active low so therefore it is connected to VCC in order to prevent any unwanted reset of the output. The output of the 555 timer can sink or source a current of 200mA to the load. So if the motor that we want to control exceeds this rating we need to use a transistor or a MOSFET for driving the motor. We used a (TIP122) Darlington transistor which can handle a current up to 5A. For preventing any voltage spikes produced by the motor we need to use a freewheeling diode which is connected in parallel with the motor.

4 Circuit Diagram

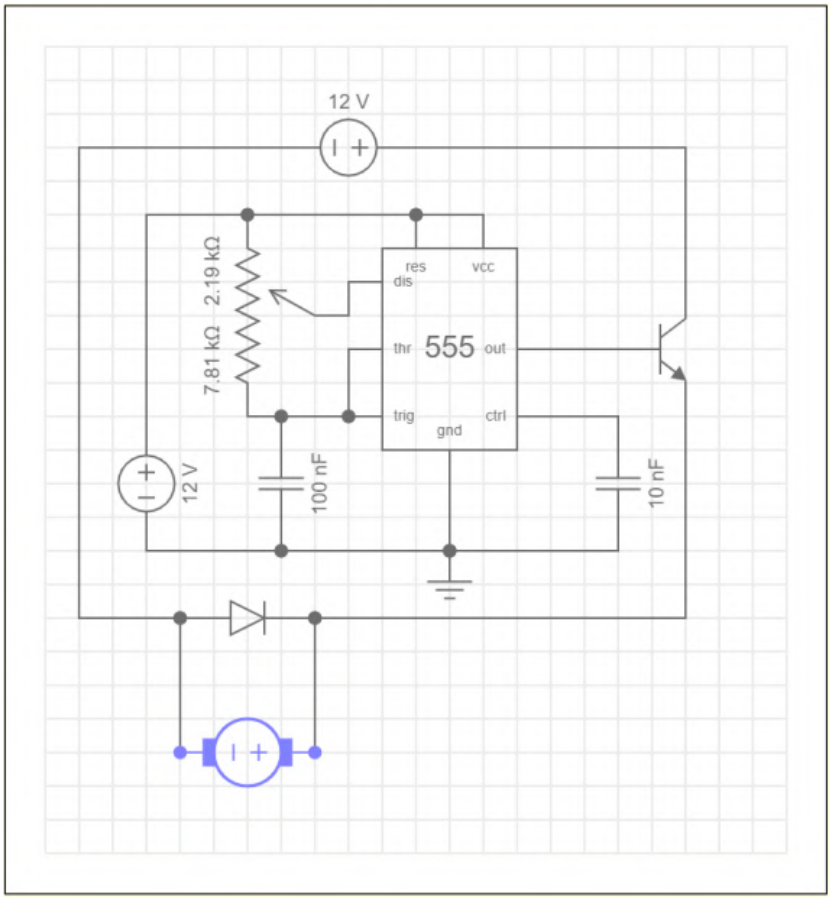


Figure 1: Circuit Diagram

5 Breadboard Setup

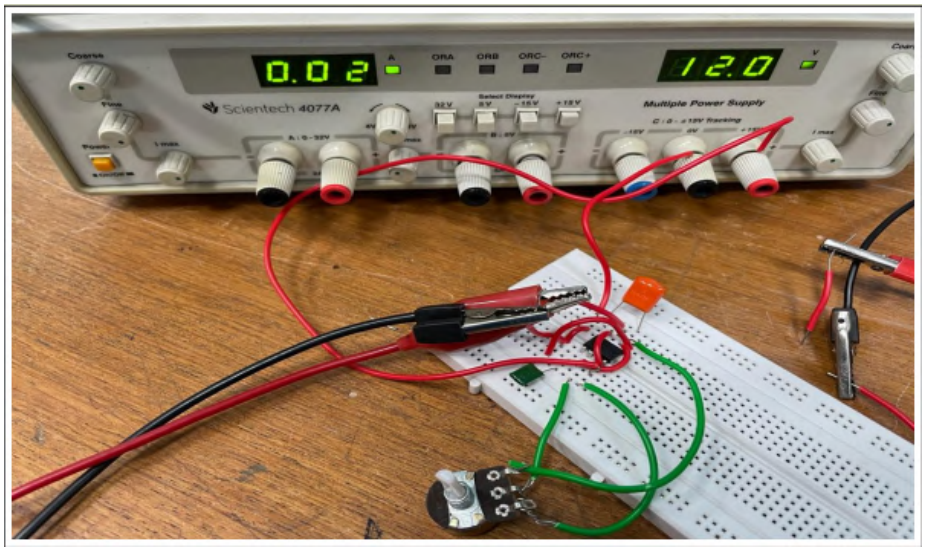


Figure 2: Control Circuit

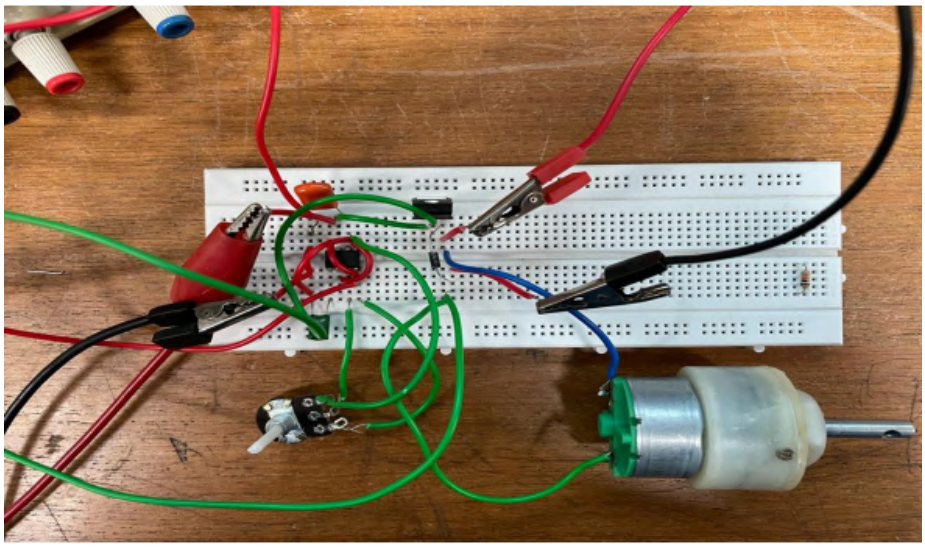
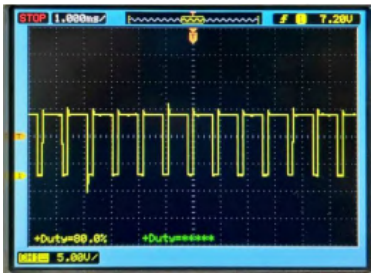


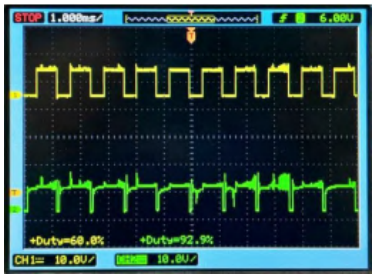
Figure 3: Power Circuit

6 DSO Images

6.1 Control Circuit



6.2 Power Circuit



7 Sources Of Error

- Scale of DSO not appropriate for measurements.
- Resistance of wires not taken into account, and also giving rise to inconsistency due to increase in resistance due to heating.
- Loose Connections.
- Change in the connections while circuit is closed.

8 Precautions

- Make the connections neat and tight.
- Wear proper shoes and use insulated tools.
- Don't leave the switch on for long continuous periods of time.

9 Concluding Remarks

On the DSO, the output waveform for different values of R_1 and R_2 can be examined by connecting a potentiometer. We notice the following:

1. The value of R_1 should not tend to 0 Ω. The circuit malfunctions if the value is close to 0 Ω. Thus, in ideal case, we should keep R_1 constant and vary R_2. Value of R_1 should be kept as low as 1kΩ while R_2 should have a potentiometer of value 100kΩ.

2. We verified that the waveform across the motor and output terminal of IC 555 Timer is same.

3. When we decrease R_2, the speed of motor increases and when R_2 is 0 Ω, then motor runs at maximum speed.

4. The Darlington transistor (TIP122) is a NPN Transistor. It acts as a switch in our case. When the output waveform is 0V, the transistor is in OFF State.

5. A Freewheeling Diode is connected across the motor. When the Transistor is in OFF State, it helps the inductive load to freewheel the energy.

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