

SPEED CONTROL OF DC MOTOR USING PULSE-WIDTH MODULATION

■ EFY LAB

Pulse-width modulation (PWM) or duty-cycle variation methods are commonly used in speed control of DC motors. The duty cycle is defined as the percentage of digital 'high' to digital 'low' plus digital 'high' pulse-width during a PWM period.

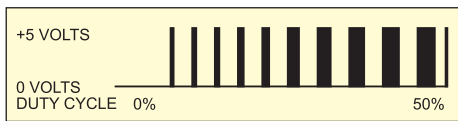


Fig. 1: 5V pulses with 0% through 50% duty cycle

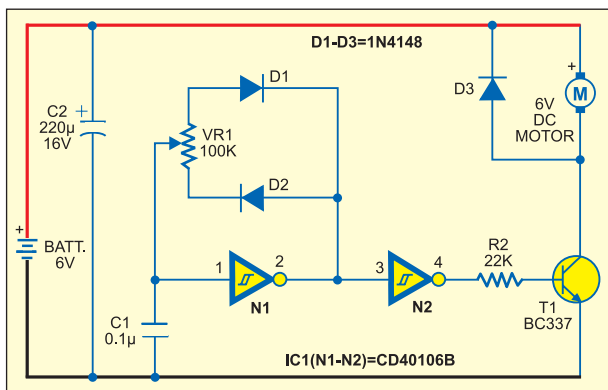


Fig. 2: DC motor speed control using PWM method

Fig. 1 shows the 5V pulses with 0% through 50% duty cycle.

The average DC voltage value for 0% duty cycle is zero; with 25% duty cycle the average value is 1.25V (25% of 5V). With 50% duty cycle the aver-

age value is 2.5V, and if the duty cycle is 75%, the average voltage is 3.75V and so on. The maximum duty cycle can be 100%, which is equivalent to a DC waveform. Thus by varying the pulse-width, we can vary the average voltage across a DC motor and hence its speed.

The circuit of a simple speed controller for a mini DC motor, such as that used in tape recorders and toys, is shown in Fig. 2.

Here N1 inverting Schmitt trigger is configured as an astable multivibrator with constant period

but variable duty cycle. Although the total in-circuit resistance of VR1 during a complete cycle is 100 kilo-ohms, the part used during positive and negative periods of each cycle can be varied by changing the position of its wiper contact to obtain variable pulse-width. Schmitt gate N2 simply acts as a buffer/driver to

drive transistor T1 during positive incursions at its base. Thus the average amplitude of DC drive pulses or the speed of motor M is proportional to the setting of the wiper position of VR1 potmeter. Capacitor C2 serves as a

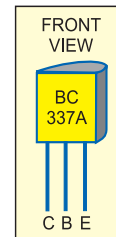


Fig. 3: Pin configuration of BC337A

storage capacitor to provide stable voltage to the circuit.

Thus, by varying VR1 the duty cycle can be changed from 0% to 100% and the speed of the motor from 'stopped' condition to 'full speed' in an even and continuous way. The diodes effectively provide different

timing resistor values during charging and discharging of timing capacitor C1.

The pulse or rest period is approximately given by the following equation:

Pulse or Rest period $\approx 0.4 \times C1$ (Farad) $\times VR1$ (ohm) seconds.

Here, use the in-circuit value of VR1 during pulse or rest period as applicable.

The frequency will remain constant and is given by the equation:

Frequency $\approx 2.466 / (VR1.C1) \approx 250$ Hz (for VR1=100 kilo-ohms and C1=0.1 µF)

The recommended value of in-circuit resistance should be greater than 50 kilo-ohms but less than 2 mega-ohms, while the capacitor value should be greater than 100 pF but less than 1 µF. ●