

# Variable Frequency Drive Using DC Motor with PWM Technique

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**Abstract:**-The variable frequency drive (VFD) is an electronic device to change utility power source to variable frequency to control DC motor in variable speed operation. The load of a DC is constant. But it can be varied as per the load requirement. So, speed must be changed as per increasing or decreasing the load. If supply voltage decreases, motor torque is also decreased. Motor speed is directly proportional to supply frequency. Hence, to maintain the speed, supply voltage and frequency must be varied accordingly. There are several ways to define Variable Frequency Drive (VFD). This project is intended to provide a basic understanding of Variable Frequency Drive (VFD) terms, Variable Frequency Drive (VFD) operation. The VFD is used in DC motor with PWM (pulse width modulation) techniques to control the speed of DC motor with the help of potentiometer. The most important operation is dependent on SG3525 IC, and additional protection purpose LM339 IC is used. It protects the motor under short circuit, over current, low voltage and also high voltage protection. This VFD is used to motor smoothly starts, energy saving, protection of motor, and low torque will be provided at starting. The additional two-switch is used to change the direction of rotation of motor.

**Keywords:** - DC Motor, PWM, Duty Cycle, LM339 Protection IC.

## I. INTRODUCTION

In this paper, the speed of the motor is controlled by using the SG3525 (PWM) IC, LM339 protection IC. The SG3525 IC is PWM (Pulse-Width Modulation) modulator IC, it generates 10 KHz-40 KHz square wave PWM signal. This IC is 1 AMP current maximum. The SG3525 IC pulse width modulator control circuit offers improved performance and lower external parts count when implemented for controlling all types of switching power supplies. With the help of potentiometer to adjust duty cycle 50%-90% of PWM signal generated. LM339 is protection purpose IC. This IC is used to protect circuit under faulty condition.

Such as over current, short circuit, low voltage and high voltage etc. The MOSFET is used to increase the current of circuit. Because the voltage is constant. And we can need the power for circuit.

$$\text{Power} = \text{current} * \text{voltage}$$

## II. LITERATURE REVIEW

### Scope of Work:-

The variable frequency drive is to design the control the speed of DC motor in SG3525 IC and PWM methods. The speed control by using the potentiometer. It is easy to handle. In case DC motor is used in traction system, conveyor, lifts and elevators, cranes and hoist etc. In this applications this techniques are used to control the speed of DC motor. And to protect the motor under over current, over voltage, short circuit and low voltage etc., with the help of LM339 protection IC.

The two-way switch is used to motor rotates in clockwise and anticlockwise direction. The Pulse Width Modulation (PWM) technique is modern technology in solid state field and it provides smooth starting of motor. Now a days PWM techniques are used in fuzzy logic control system, so PWM technique is efficient and reliable to control the speed of DC motor and smooth starting etc. In case of fault occurs in circuit, the additional point of this circuit is used to automatically start the circuit after clearing the fault.

**Background Study:-**

**Problem Definition:**

In this background study, the variable frequency drive is used in DC motor is very difficult, but by using PWM technique it is possible to use. This VFD is useful in modern industry, traction system and lifts, cranes etc. So many problem occurs in industry, such as overcurrent, high voltage and overheating the circuit, electronics components. In case speed of motor is high.

IC is measure the normal values of current and voltage, so no output signal can be generate. But the current and voltage values are abnormal so LM339 IC is generate signal and send back to SG3525 PWM IC to SHUTDOWN PIN (10). Then to stop the operation of system. After few seconds to normal the values of current and voltage, to clear the fault and to start the operation of system.

**III. METHODOLOGY OF PROPOSED WORK**

**EXPERIMENTAL/ WORKING DIAGRAM:-**



Fig.2



Fig.3

Actual Working Diagram shows in above Fig. (2) and (3)

**IV. RESULTS**

The speed of DC motor is change by using potentiometer. The speed of motor is always depends on frequency. The SG3525 PWM IC is generates the Frequency/ Signal = 10 KHz to 40 KHz.

By using potentiometer to changes the speed of motor.

**DUTY CYCLE:-**

$$D = \frac{PW}{T}$$

Lets;

The LM339

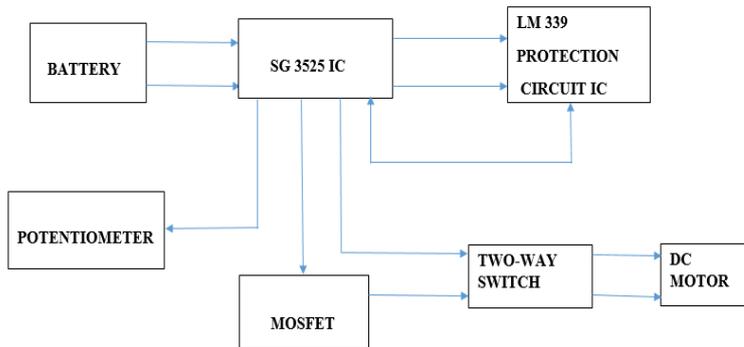


Fig.1 Block Diagram

The above block diagram (Fig.1) shows, Variable Frequency Drive using DC motor. The input supply of battery is connect to SG3525 PWM (Pulse Width Modulation) IC. This IC is generate 10 KHz square wave PWM signal. To use the 10 k preset (Potentiometer) for adjust the duty cycle (50%-90%) of PWM signal, in case the duty cycle is lower down to burn the MOSFET, because of to maintain the position of duty cycle and to not enough dead time to switch MOSFET safely. The speed control of DC motor by using the potentiometer, so effects of speed control are;

1. Lower duty cycle means lower motor speed
2. Higher duty cycle means higher motor speed

The most important component is MOSFET (Metal Oxide Semiconductor field – effect transistor), its use to increase the current of system. Normally the SG3525 PWM IC is 1 AMP current maximum. But motor needs higher current to increase the power of system.

$$\text{Power} = \text{Voltage} * \text{Current}$$

The LM339 IC is protection purpose IC. The LM339 IC is work for protection of circuit under low voltage, overcurrent, short circuit current and high voltage etc. this LM339 IC circuit 4 presets are used to adjust the values of current and voltage. So main working principle is depends on this IC. The LM339

D- Duty Cycle  
 PW- Pulse Width  
 T- Time Period

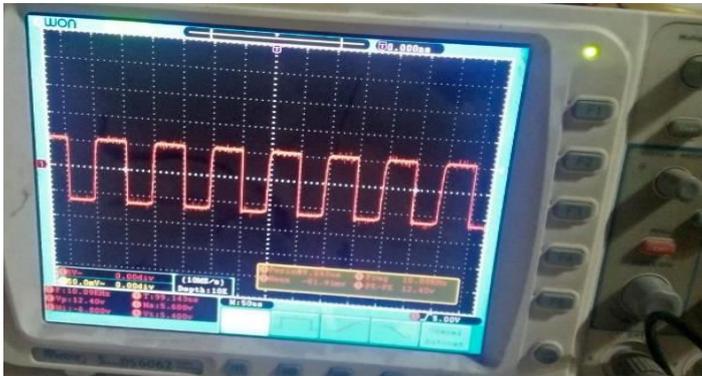


Fig.4 shows;

Frequency (F) = 10.10 KHz  
 Peak Voltage (Vp) = 13.20 v  
 Time Period (T) = 99.000 uS  
 Duty Cycle =70.7 %  
 Pulse Width (TON) =70.000 us  
 Depth = 10 K  
 Mean = -62.63 mV

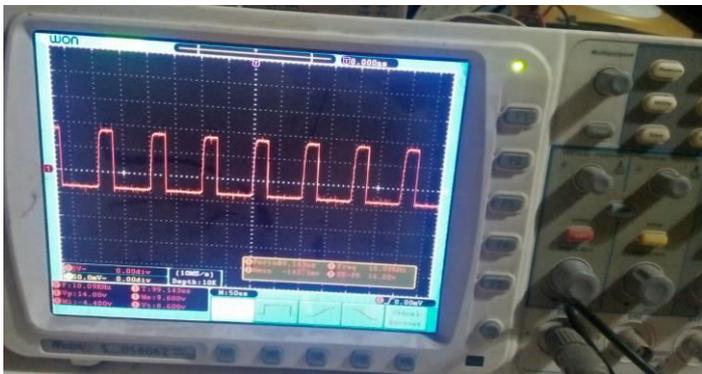
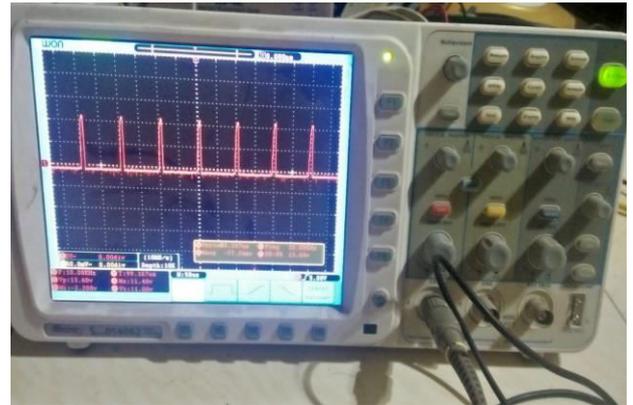


Fig.5 shows;

Frequency (F) = 10.09 KHz  
 Peak Voltage (Vp) = 14.00 v  
 Time Period (T) = 99.143 us  
 Duty Cycle=22.2 %  
 Pulse Width=22.000 us  
 Depth = 10 k  
 Mean = -141.1 mV



6 shows;

Frequency (F) = 10.08 KHz  
 Peak Voltage (Vp) = 13.60 v  
 Time Period (T) = 99.167 us  
 Duty Cycle=7.9 %  
 Pulse Width=7.000 us  
 Depth = 10 k  
 Mean = -77.04 m

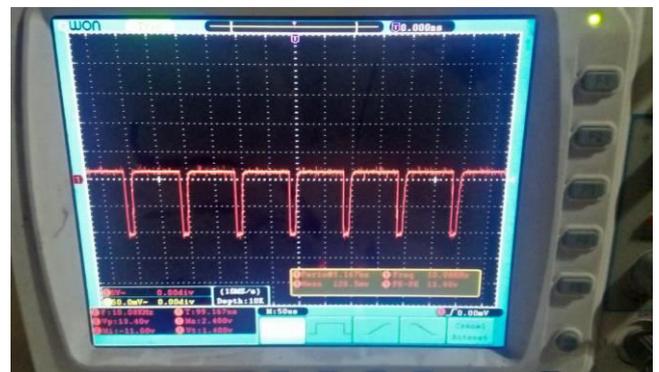


Fig.7 shows;

Frequency (F) = 10.08 KHz  
 Peak Voltage (Vp) = 13.40 v  
 Time Period (T) = 99.167 us  
 Duty Cycle=88.9 %  
 Pulse Width=88.000 us  
 Depth = 10 k  
 Mean = 126.5 mV

## V.CONCLUSION

The DC motor speed is controlled by using power electronic devices, and also PWM is used which to control the speed of DC motor. To design the circuit of SG3525 PWM IC and LM339 protection IC. The SG3525 IC is generate the 10 KHz to 40 KHz. The protection purpose LM339 IC is protect the circuit under abnormal condition. In case the voltage and current values are abnormal so this LM339 IC is generate output signal. Then SG3525 IC is trip the circuit. After few seconds the voltage and current values are normal to start the operation of circuit.

The output (PWM square wave) waveform is seen to connect the CRO (Cathode Ray Oscilloscope) in MOSFET to GATE terminal and ground connection in SG3525 IC.

## REFERENCES

- [1] Muhammad H. Rashid, "Power electronics circuits, devices, and applications," *prentice hall, 3<sup>rd</sup> edition, 2003.*
- [2] Hao JIANG, Du Peng-ying and REN Guo-hai, "PWM velocity modulation experiment system using modularization brushless DC motor," *Experimental Technology and Management*, no.9, pp.53-56, 2007.
- [3] Molekutty George, "Speed control of separately excited DC motor," *American journal of applied sciences*, vol.5, 2008.
- [4] G.R.Slemon "Electrical machines for variable-frequency drives", *proceeding of the IEEE*, vol.82, no. 8, pp.1123-1139, 1994.
- [5] S.Thakur, D.Fredrickson, "adjustable-speed drives motor protection applications and issues", *IEEE march 2014.*
- [6] Vinod Kr S P and AK Pandey May-Jun 2013 *Modeling and simulation of Brushless DC motor using PWM control technique*, Department of Electrical Engineering MMM Engineering College Gorakhpur (UP) int. Journal of Engineering Research and Applications (IJERA), vol.3 issue 3.
- [7] Bansal, U. K. & Narvey, R. "Speed control of DC motor using fuzzy PID controller", *Advance in Electronic and Electric Engineering*. vol. 3 no.9, pp. 1209-1220, 2013.
- [8] B. J. Baliga, "Power semiconductor devices for variable-frequency drives," *proceeding of the IEEE*, vol.82, no.8, pp.1112-1122, 1994.
- [9] Becerra RC, Ehsani M. high-speed torque control of brushless permanent magnet motors. *IEEE Trans. Ind. Electron.* 1988; **35**:402-406. [[Google Scholar](#)]
- [10] Valluru Hemanth Kumar, M.V. Ramesh. "Over current and over voltage protection of permanent magnet brushless DC motor using wavelet analysis" *IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE)*, vol.9, pp. 79-86, set.-oct.2014.
- [11] Barr, Michael (1September 2001). "[Introduction to Pulse Width Modulation \(PWM\)](#)". Barr Group.
- [12] J. Huang, K. Padmanabhan, and O.M. Collins, "The sampling theorem with constant amplitude variable width pulses", *IEEE transactions on Circuits and Systems*, vol. 58, pp. 1178-1190, June 2011.
- [13] To measure the pulse width and Duty cycle this link; <https://www.oscium.com>.

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