ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 8, Issue 3, March 2019

Design and Development of Controller for BLDC Fan

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ABSTRACT: With the evolution of various technologies in power electronics, the DC appliances have acquired higher efficiency and better power-to-size characteristics. Gradually, homes and offices are moving towards DC appliances because of the energy efficient performance it offers. In India, the predominant technology for electricity transmission is alternating current (AC) technology. This project aims to show that the traditionally available AC voltage can be used to run BLDC fan using various controllers. It deals with the designing of a controller for a BLDC fan which has increased efficiency at a low cost and reduced size. The purpose of the controllers is to convert the available AC voltage to the DC voltage and produce variations in the output voltage in terms of 8V, 10V, 12V which will in turn control the speed of the fan accordingly. The performance of different controllers are analysed and compared. The efficiency benefits arising from the different controllers and drawbacks are outlined.

KEY WORDS: BLDC,MOSFET,PIC.

I.INTRODUCTION

Electrical end uses have dramatically changed since the days when the benefits of AC and DC were debated during the war of the currents. Although, AC is the dominant power distribution technology, today's appliances actually favour DC, with the proliferation of light emitting diode (LED) lighting, photovoltaics (PV), and consumer electronics.
It is estimated that within the next 20 years, we could definitely see as much as 50 percent of our total loads be made up of DC. As there is a growing number of appliances using direct current, there comes a big opportunity to save energy. According to a 2011 study, converting all appliances to high efficiency DC is not only technically feasible but could save about 30 percent of residential electrical use. Increasing demand for higher efficiency through the use of brushless permanent magnet DC motors (BLDC) has encouraged the households to move towards an environment dominated by DC appliances.
The energy efficiency of AC and DC appliances are compared in this Fig.

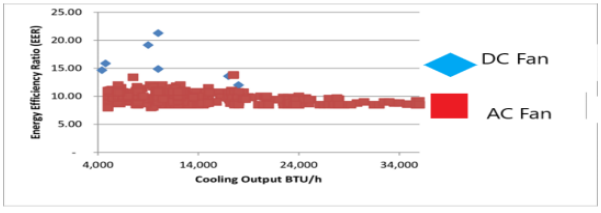

Figure 1: Efficiency comparison of AC and DC appliances.

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II.COMPONENTS REQUIRED

Potentiometer, microcontroller, inverter, MOSFET, crystal oscillator, TLP250 driver, DC power supply, BLDC motor, MATLAB software.

III.SIMULATION FOR BLDC FAN USING CONTROLLED RECTIFIER

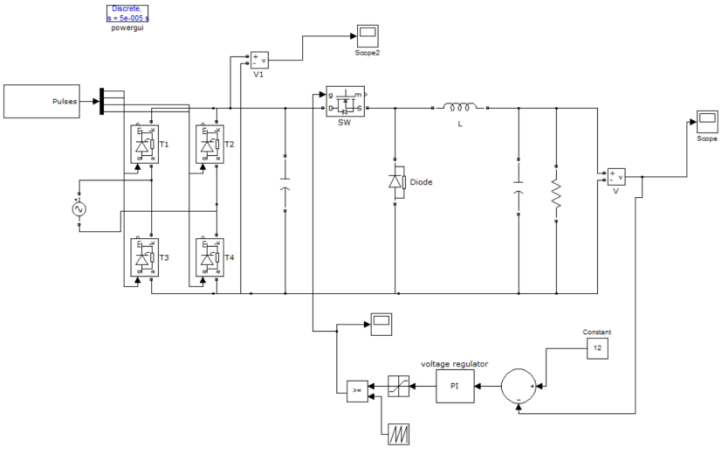

Figure 2: Simulation for BLDC fan using controlled rectifier.

The simulation of controller for BLDC fan using controlled rectifier. The rectifier circuit consists of SCR to convert the AC voltage into a fixed DC voltage. The fixed DC voltage is converted to variable DC voltages of 8V, 10V, 12V using a chopper. The voltage obtained from the chopper is given to the BLDC fan from which we will achieve the different speeds

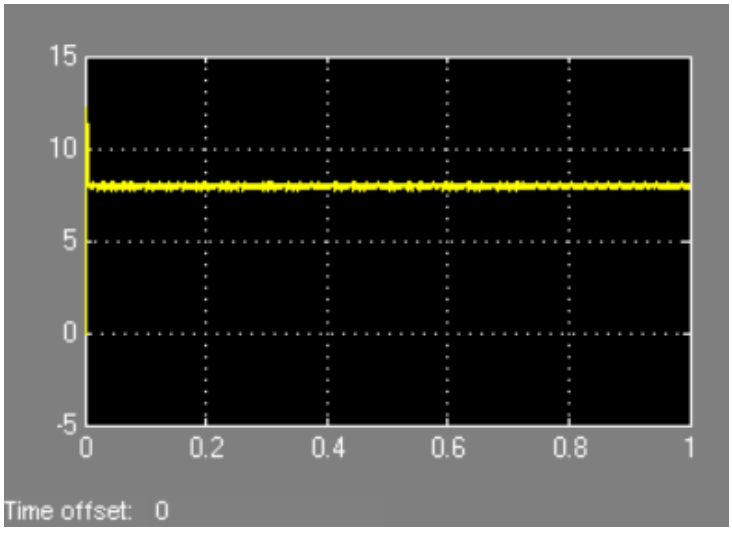

Figure 3: Output of 8V.

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This shows the output voltages of 8V obtained from the chopper. When the voltage of 10V and 12V are given to the BLDC fan, variations in the speed is achieved accordingly. This simulation shows that the speed of a BLDC fan can be varied using the variable voltages obtained from the chopper.

IV.SIMULATION FOR BLDC FAN USING MICROCONTROLLER

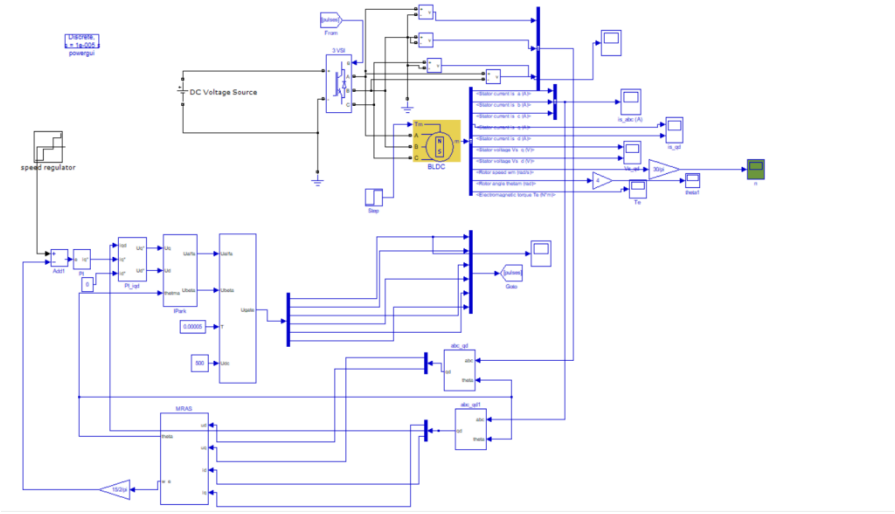

Figure 4: Simulation for BLDC fan using microcontroller.

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This shows the circuit diagram simulation of controller for BLDC fan where a PI controller is used to generate reference current. The following are the set points of the speed regulator: 500, 1000, 1500,1700 rpm. The actual current sensed from the rotor position sensing is compared with the reference current to give the quadrature axis and direct axis currents. The suitable pulses are generated using space vector pulse width modulation technique. The pulses are given to the inverter circuit which produces the required voltage to run the BLDC motor.

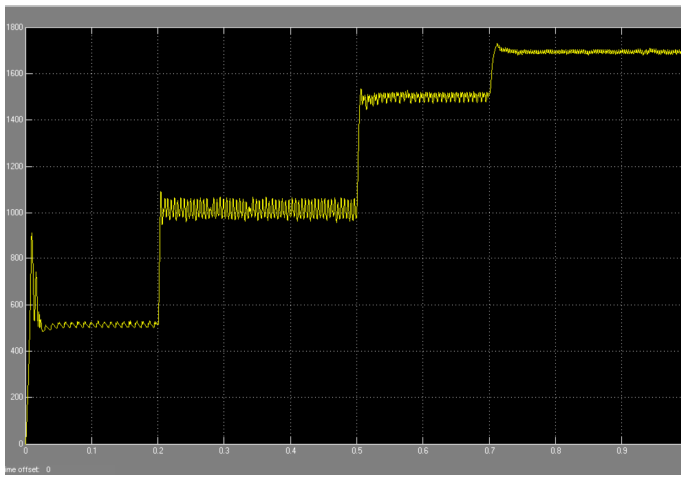

Figure 5: Speed variation waveform of the fan.

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This shows the variation of speed in the fan in accordance with the feedback from the speed regulator. This simulation shows that an AC voltage can be converted to DC voltage and regulate them to change the speed of BLDC fan. A hardware model for the simulation using microcontroller is implemented and the hardware is explained .

V.BLOCK DIAGRAM OF THE PROPOSED SYSTEM

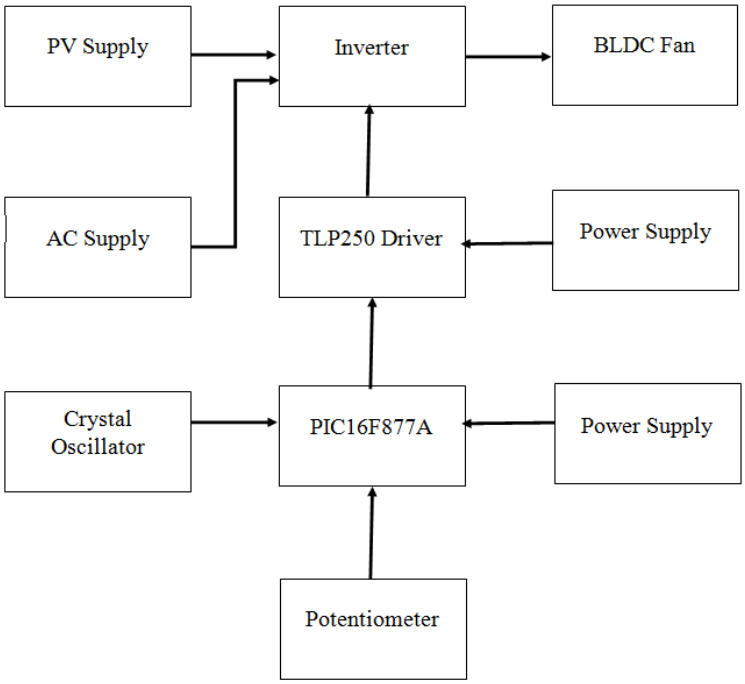

Figure 6: Block diagram.

VI.PIC16F877A

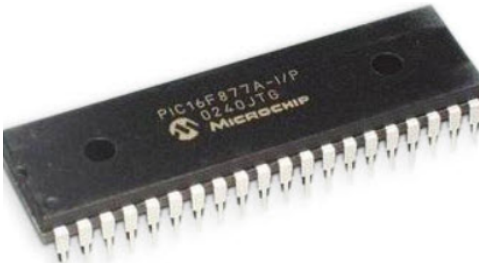

Figure 7: PIC16F877A.

PIC microcontroller was developed in the year 1993 by microchip technology. The term PIC stands for Peripheral Interface Controller. Initially this was developed for supporting computers to control its peripheral devices, and therefore, named as a peripheral interface device. These microcontrollers are very fast and easy to execute a program compared with other microcontrollers. PIC microcontroller is based on Harvard architecture. PIC microcontrollers are

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very popular due to their ease of programming, wide availability, easy to interfacing with other peripherals, low cost, large user base and serial programming capability (reprogramming with flash memory).

VII.TLP250 DRIVER

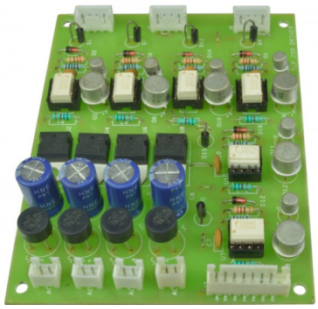

Figure 8: TLP250 Driver.

Mosfet driver TLP250 like other MOSFET drivers have input stage and output stage. It also has power supply configuration. TLP250 is more suitable for MOSFET and IGBT. The main difference betweenTLP250 and other MOSFET drivers is that TLP250 MOSFET driver is optically isolated. It means input and output of TLP250 mosfet driver is isolated from each other. Its works like an optocoupler. Input stage have a light emitting diode and output stage have photo diode. Whenever the input stage LED light falls on output stage photo detector diode, output becomes high.

VIII.CRYSTAL OSCILLATOR

Figure 9: Crystal Oscillator.

A crystal oscillator is an electronic circuit that uses the mechanical resonance of a vibrating crystal of piezoelectric material to create an electrical signal with a very precise frequency.The PIC16F87XA can be operated in four different oscillator modes. The user can program two configuration bits (FOSC1 and FOSC0) to select one of these four modes LP Low-Power Crystal, XT Crystal/Resonator, HS High-Speed Crystal/Resonator, RC Resistor/Capacitor.

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IX.BLDC MOTOR

Figure 10: BLDC Motor.

Electrical motors have been developed in various special types, such as stepper motors, servo motors, permanent magnet motors etc. A Brushless DC motor or BLDC motor is the type which is most suitable for applications that require high reliability, high efficiency, more torque per weight etc. Just like any other electric motor, a BLDC motor also has a stator and a rotor. Permanent magnets are mounted on the rotor of a BLDC motor, and stator is wound with specific number of poles. This is the basic constructional difference between a brushless motor and a typical dc motor. There can be two types of BLDC motor on the basis of construction: (i) inner rotor design (ii) outer rotor design. Stator windings of a BLDC motor are connected to a control circuit (an integrated switching circuit). The control circuit energizes proper winding at proper time, in a pattern which rotates around the stator. The rotor magnet tries to align with the energized electromagnet of the stator, and as soon as it aligns, the next electromagnet is energized. Thus, the rotor keeps running.

X.CONCLUSION

The design and development of controller for BLDC fan was done and the results of the simulation was analysed.
Simulation results of controller designed using controlled rectifier shows that although the SCR needs to be turned on for each cycle, the triggering circuit for SCR is simple and easy to turn on. It is also evident that when hardware is implemented, the DC chopper device will have light weight and small size thereby reducing the entire size of the hardware and the cost.
Simulation results of controller designed using a microcontroller shows that MOSFET switches used in the inverters have high switching speeds and low power loss compared to the thyristors but they are highly temperature sensitive and of high cost. The hardware model also implies that the microcontroller which operates at a low voltage of 5V is not sufficient to drive the MOSFET switches. So, an optocoupler is used for each MOSFET which increases the size of the circuit thereby increasing the cost.
From these observations, a comparative study was made between the controllers and their advantages and disadvantages are outlined.

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