DESIGN AND DEVELOPMENT OF MOTOR CONTROLLER (PMBLDC MOTOR CONTROLLER FOR RADIATOR FAN APPLICATION)

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ABSTRACT

A brushless DC (BLDC) motor control based on rotor position sensing scheme is discussed in this paper. A PIC microcontroller is employed to generate pulse width modulation (PWM) signals for driving the power inverter bridge. Parameters required for power PWM generations have been programmed, which provide flexible and online source code modifications in accordance with the motor and circuit requirements. Hardware implementation and simulation results show the effectiveness of the developed motor drive. The flexibility offered by the developed motor control and drive enables the implementation of difference control algorithms for improving the output characteristics of the BLDC motor.

***Keywords*: BLDC, Motor Drive, Microcontroller, PWM.**

I. INTRODUCTION

Electric motors have played a crucial role in the evolution of the automotive industry. Existing trends in more electrification of automobiles indicate a further increase in contribution of electromechanical energy devices in upcoming years. Therefore hybrid and electric vehicles are going to be popular due to their sustainability, energy saving and zero emission. Hybrid electric vehicle is a type of electrical vehicle which combines a conventional internal combustion engine (ICE) propulsion system with an electric propulsion system because of vehicle achieves better fuel economy than a conventional vehicle and better performance. The recent development of Permanent magnet materials, solid state devices contributing high performance electric drives. Nowadays as BLDC electric motor play significant role in EVs and It also gaining attention from various industries such as Automotive, Aerospace, Consumer, Medical, Industrial Automation Equipment, and household appliance manufacturers, because of its high efficiency, high power density and low maintenance cost. After many research and developments in the fields of magnetic materials and power electronics, their applications to electric drives have increased to a significant extent.

II. HEADINGS

2.1 Working Principle

The base drive to the MOSFETS in the Inverter circuit is given by the T1320F28335 Texas DSP. Hall signals from the motor are fed as inputs to the PIC16Fseries device and based on the Hall position and the direction of rotation of the motor specified by the manufacturer the corresponding gate drive is made active by the microcontroller and fed to the stator of the BLDC motor. The commutation sequence for rotating the motor in clock wise direction when viewed from the non driving end. Based on the Hall sensor input to the microcontroller, the corresponding transistors are made active and current flows through two windings and the other winding is inactive and hence commutation is done electronically with the use of a microcontroller. The commutation sequence for rotating the motor in counter clock wise direction when viewed from the non driving end .Thus by properly exciting the corresponding winding based on the hall signal, the motor is commutated and is made to run at the desired speed. Initially irrespective of the rotor position, the windings are excited in the given sequence and once the motor starts rotating, rotor position is sensed by the Hall sensor and then the motor is excited based on the Hall signal and according to the direction of rotation of the motor. The speed can be controlled in a closed loop by measuring the actual speed of the motor. If the speed is greater than the desired rated speed, then all the transistors are turned off for a short duration and then again excited based on the Hall position and accordingly speed can be adjusted to get constant speed.

The ADC of the microcontroller is used to convert the analog signal corresponding to the speed of the motor to a digital value and comparison is done with the calculated digital value which is proportional to the rated speed

2.2 Hall Effect

A Hall Effect sensor is a transducer that varies its output voltage in response to a magnetic field. Application: proximity switching Positioning, Speed detection, Current sensing. Design characteristics: Sensitivity, Repeatability, Stability-over-temperature, and Response time.

2.3 Pulse Width Modulation (PWM) Mode

The supply voltage is chopped at a fixed frequency with a duty cycle depending on the current error. Therefore both the current and the rate of change of current can be controlled. The two phase supply duration is limited by the two phase commutation angles. The main advantage of the PWM strategy is that the chopping frequency is a fixed parameter; hence, acoustic and electromagnetic noises are relatively easy to filter.

2.4 Microcontroller Section

This section is the heart of the whole hardware system of BLDC motor controller. This section consists PIC18F4431 micro-controller which is very helpful for automotive applications. Along with this controller ic it having a digital multiplexer ic which is used for signal switching or we can also do on the way switching by writing a program itself and LIN ic used for device or signal communication purpose Here the output of voltage regulator ic i.e. 5V is given to the PIC18f4431 to turn on and also in this section some pins are left for digital input and output along with over-voltage protection circuitry because as we know the PIC ic is working on the 5V supply so if any pin get more than 5V or 25mA supply that pin will be damage or may be whole ic will also get damaged so to prevent from this it is used. Three Hall sensors are connected to the capture module of PIC through capture pins to detect the position or rotor and then according to the position of hall states the six PWM pulses will get generated by using Power PWM module of the PIC controller The generated six pwm pulses will get across six pwm pins of micro-controller and these pulses are then apply to the driver circuitry. The RJ-11 is a programming connector is also placed in this section for flashing the program in controller. The output of zero-cross detector circuit is also given to the capture module parallel with the hall sensors signals, this additional provision makes for if we want to switch to sensor-less control of BLDC motor. The SN65HVDA195 is the Local Interconnect Network (LIN) physical interface with I/O pin is the single-wire LIN bus transmitter and receiver. It has been designed for operation in the harsh automotive environment. The device can handle LIN bus voltage swings from 40 V down to ground and survive 40 V. This LIN bus is used to make communication between various electronic devices of vehicle. Which also integrates the serial transceiver with wake-up and protection features and the bus is a single-wire bidirectional bus typically used for low-speed in vehicle networks using data rates to 20 kbps. It also features under-voltage, over-temperature, and loss-of-ground protection. In the event of a fault condition, the output is immediately switched off and remains off until the fault condition is removed. The 74ALS257 is a quad 2-input multiplexer 14 pin ic which can draw 10ma current and it also selects 4 bits of data from one of two sources under the control of a common select input (S). The outputs are forced to a High impedance state (3-State) regardless of all other input conditions. Moving data from two registers to a common output bus is a typical use of the 74ALS257. The state of the select input determines the particular register from which data comes. The device is the logic implementation of 4-pole, 2-position switch where the position of the switch is determined by the logic levels supplied to the select input.

III. INDENTATIONS AND EQUATIONS

To get 5V regulated output we use LM7805.Output voltage of LM7805 regulator is 5V. Dropout Voltage of LM7805 is 2V, so minimum input voltage required at input of regulator to get 5V output is

Minimum input voltage = Output of LM7805 + Dropout voltage

= 5 +2 = 7V

So minimum input voltage is 7V and maximum input voltage is 35V (Ref. Datasheet) for which LM7805 gives 5V regulated output.

Vdc = Regulator output + drop across diode and IC

= 5+4 = 9V

As we increase Vin for LM7805 Power Dissipation also increases. For LM7805 maximum Power Dissipation is 15W

In our Design,

Power Dissipation is = Vdc * Io = 9* 0.3 =2.7W

2.7W<15W so it does not need heat sink.

Rectifier Design:

Diode Selection

I (f) average =Io/2=300mA/2=150mA

Now Im = 300mA

PIV rating= Vm= pi*Vc (DC)/2

= 3.14*9/2

= 15V

So, diode with PIV rating greater then 15V is suitable.

IN4007 is more than sufficient as it has PIV=1000V;

Transformer Design:

RMS secondary output voltage of transformer is

Vs= (Vm+n*1)/1.42

n=1 for FWR or HWR

n=2 for BWR.

But Vm = Vdc* pi /2=14.13

= 15(aprox.)

So,

Vs= (15+2)/1.42

Vs=12V

RMS current on secondary side is

Irms=2*Im/pi

=0.191A

Irms=0.191A

Rating of transformer = Vs*Irms;

= 12*0.191

=3.25VA

V1/V2=I2/I1

230/12=0.191/I1

I1=0.01A;

Turn Ration is

I2/I1=N1/N2;

OR

N1/N2=0.191/.01

=19

So Turn ratio is 19:1

Size of Core is given by,

Size of Core = Sqrt (wp/0.87)

= Sqrt (230*0.01/0.87)

=1.625sp.cm

Power ON Indication:

We know voltage drop across LED when it is in ON state is 1.8 to 2.5v

We should put a series resistor to control If .Value of Resistor should be selected such that forward current shall not exceed

If (max) = 50mA (Ref. Datasheet).

If = (5V-2.5)/470

If = 5.31mA

For greater brightness value of resistor should be increased.

IV. FIGURES AND TABLES

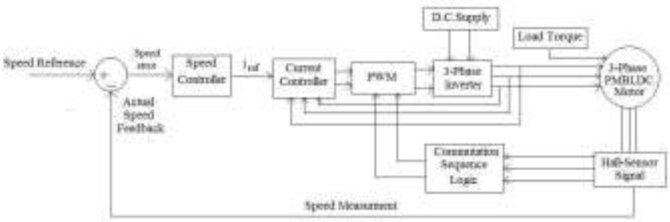

FIG.1 BASIC BLOCK DIAGRAM

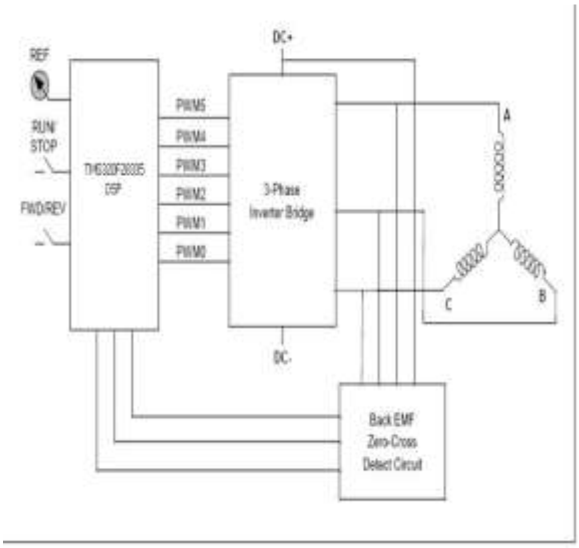

FIG.2 SENSOR LESS CONTROL OF BLDC

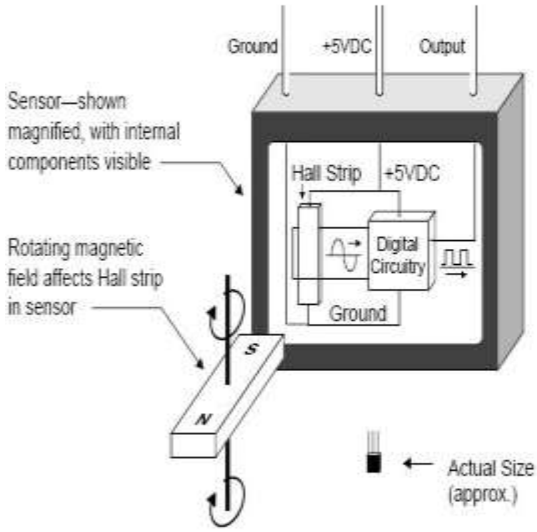

FIG.3 HALLSENSOR

TABLE : HALL EFFECT SIGNALS

ELECTRIC DEGREE	HALL 1	HALL 2	HALL 3
0-60	1	0	1
60-120	0	0	1
120-180	0	1	1
180-240	0	1	0
240-300	1	1	0
300-360	1	1	0

V. CONCLUSION

This work is an exercise to develop the motor drive along with speed controller and 3-phase inverter for Permanent magnet brushless dc motor.Themodeling and simulation of the complete drive system of bldc motor is described in this thesis. The closed loop speed control of BLDC motor is implemented in Matlab Simulink with specially designed motor parameters for desired automotive application. To control the speed of motor conventional Proportional-Integral (PI) controller is used because it is ease for practical implementation. Here to injecting the current into the voltage source inverter as per commutation sequence two current controller methods are applied; first one is hysteresis current controller and another one is PWM current controller. The simulation results are verified by using this both methods and from the results it is conclude that hysteresis controller performance is good as compare to pwm current controller but switching frequency variation is drawback of this method. In this thesis, Design and fabrication of 3-phase inverter a well as controller is done. As per particular automotive application of BLDC motor i.e. Radiator cooling fan.

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