

BLDC MOTOR SPEED CONTROL USING CO-SIMULATION OF MULTISIM AND LABVIEW

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Abstract: Brushless dc motor is finding various applications in the present day scenario. They have improved efficiency, higher speed, better torque speed characteristics and faster dynamic response when compared with the traditional motors. In this paper, a controller is developed based on co-simulation of multi sim and lab view and is presented for low cost brushless dc motor drive with low-resolution hall sensors. The driver circuit is made using a low cost MOSFET gate driver IC in multi sim and the controller is developed in lab view. A hall sensor is usually used to commutate the BLDC motor and the hall sensor output is used as the gate pulse for the six pulse inverter. The effectiveness of the design was verified through co-simulation.

Keywords: BLDC, gate driver circuit, control circuit multi sim, lab view, co-simulation.

I. INTRODUCTION

Brushless dc motor (BLDC) are also known as synchronous motors, in which the rotor is a permanent magnet and the stator is the steel lamination stacked inside the stator slots [1]. In order to control the positioning of the rotor and the speed of the BLDC motor hall effect sensors are used. For obtaining a reliable speed, from the hall sensor signals control for time difference inverse is found. At lower speed the sampling time for speed regulation is still more. The sampling time is dependent to the motor speed and this makes it difficult to design the speed regulator for the model. For obtaining accurate speed control and to reduce any difficulty in designing speed regulator a low resolution encoders that works in low speed is used with the BLDC motor. A simple and easy implementation based on the reduced order disturbance torque at an instantaneous speed was explained by N.J Kim [2]. In [3] a new method was proposed to obtain the rotor speed and position with an out time delay known as dual observer. A low speed model with free enhancement differentiator was proposed for improving the velocity [4] [5.]. While considering the BLDC motor commonly used speed recognition method is using the back emf estimation. When the rotor speed is very less this method cannot be used to find the speed and position due to the inverter design and variation in parameters used. This paper presents study of controlling the speed of a brushless dc motor with the hall effect sensor using multisim and labview.

II. WORKING PRINCIPLE OF BLDC MOTOR

Fig.1 shows 3 phase bridge circuit for driving 3 phase BLDC motor. Each commutation sequence will have one of its windings energized to a positive power where the current enter will into the winding, the second winding is negative (current leaves the winding) and the third is in a non-energized condition from where the back emf is sensed.

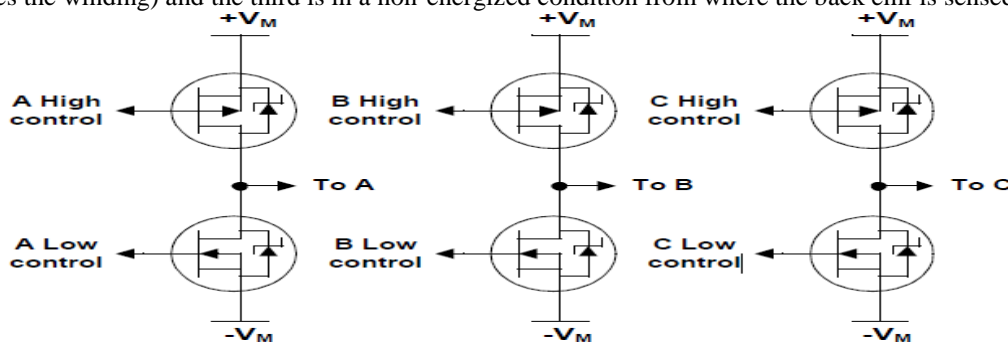


Fig.(1)

Phase voltages is shown in Fig.2. The torque is generated due the interaction between the stator magnetic field and the permanent magnets in the rotor [6]. The motor will continue running only when the rotor magnets catch up the magnetic field produced by the stator windings

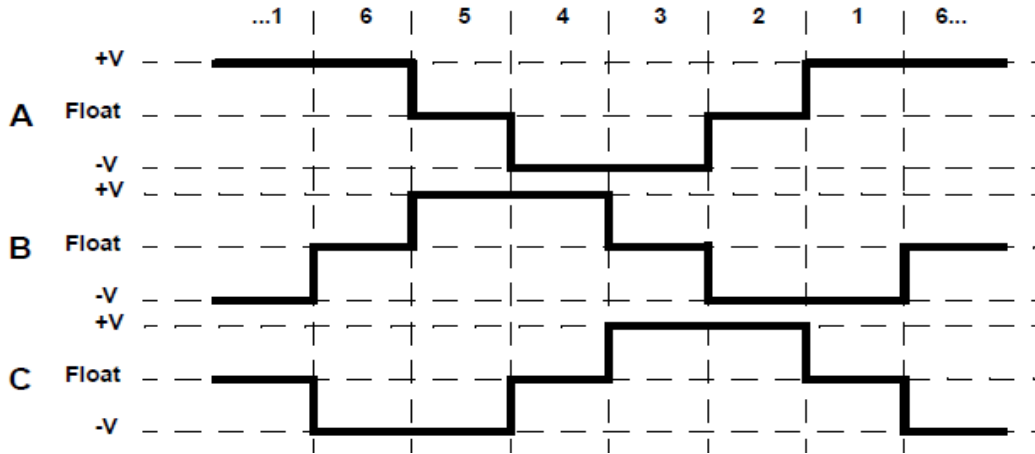


Fig.(2)

The relationship between the Hall sensors and back EMF [7] is shown in Fig.3. Hall sensor mounted motors can be controlled easily as its initial position is known. Here we are considering the hall sensors for controlling the speed of the motor been used

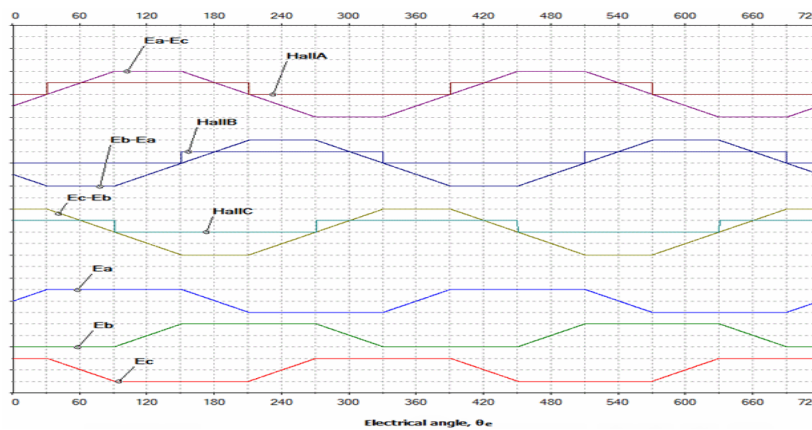


Fig.(3)

Fig.4 shows the block diagram of overall functioning of the project. The speed obtained by Hall sensors is used as the feedback. And the feedback is given to the control circuit which is designed using labview and the corresponding pulse necessary to turn on the driver circuit is generated. The speed of the motor is controlled by varying the pwm duty cycle.

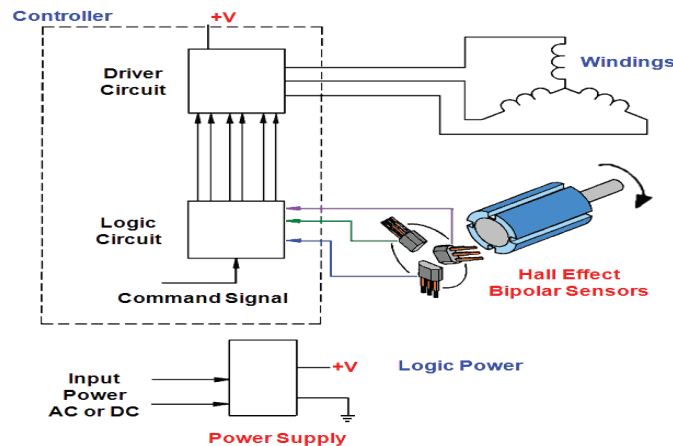


Fig.(4)

The relation ship between the electrical angle and the mechanical angle is given by the equation

- $e = m * P$

where

- $e =$ electrical angle
- $m =$ mechanical angle
- $P =$ number of rotor pole pairs

The electromagnetic torque, T_e , is:

$$T_e = I_a * K_1 * \frac{K_t}{K_e} + I_b * K_2 * \frac{K_t}{K_e} + I_c * K_3 * \frac{K_t}{K_e}$$

$K_t =$ torque constant

$K_e =$ speed constant

III. CO-SIMULATION USING MULTISIM AND LABVIEW

In co-simulation the circuit designed in multisim is integrated with the labview program. The combination of the three components, the BLDC motor, 3 Phase inverter and a digital control system makes the BLDC motor driver system, here co simulation is done between inverter circuit designed using multisim and control circuit generated in labview. The three phases of BLDC motor is connected to the inverter and is designed in multisim. In the motor, energization is done by sensing the rotor position. And for the same reason the Hall sensor based BLDC motor is generally used as the position feedback.

A multisim modelled 3 phase rectifier circuit of driver is shown in Fig. 5 below.

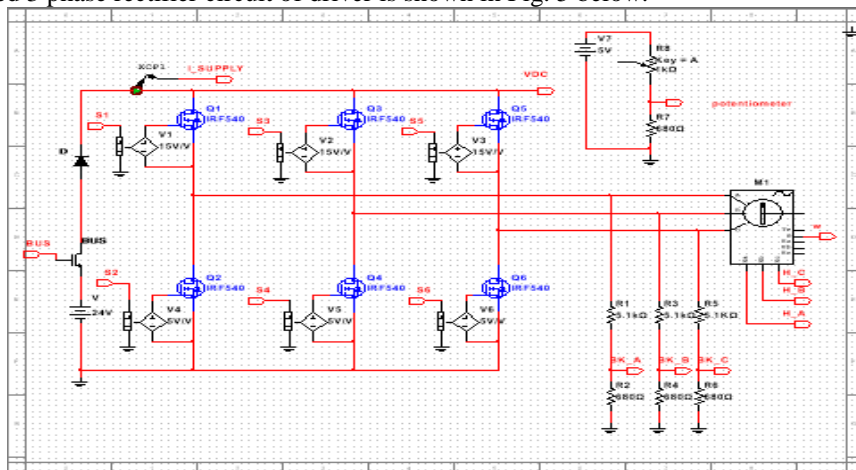


Fig.(5)

While working with co-simulation toolbox, inverter designed in multisim and the three hall sensor output from the motor is made to communicate with the labview. The control circuit is designed in labview and the output data from the multisim is the input of the labview. These are then processed and the switching pulse is generated which is then send to the inverter circuit designed in multisim. The speed of the dc motor is adjusted by varying the pwm duty cycle which controls the average dc bus voltage. The labview design is shown in Fig 6.

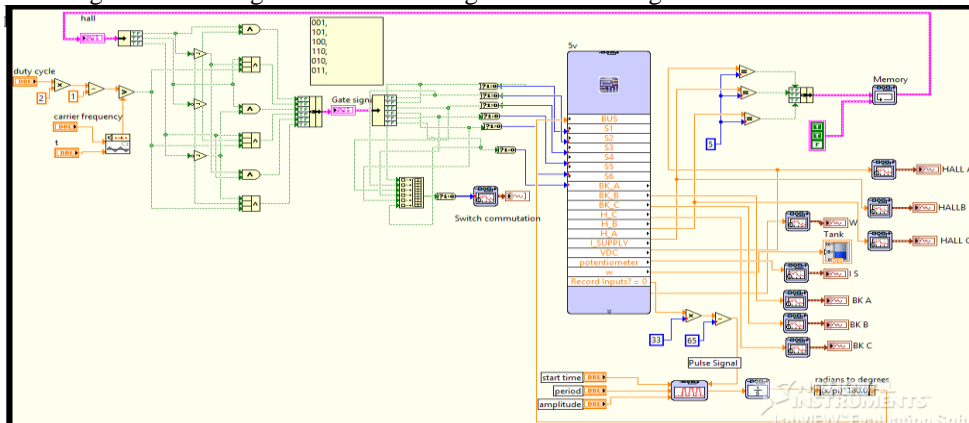


Fig.(6)

IV. SIMULATION RESULT

The co simulation result of the simulation being carried in labview for the BLDC motor controller .The simulation is performed for different speed, a potentiometer is provided to vary the pwm duty cycle there by the speed of the brushless dc motor. The switching pulse wave form for the motor driver designed in labview when the pwm frequency was set at 80 % and is shown in Fig 7.The corresponding back emf waveform is shown in the Fig 8.

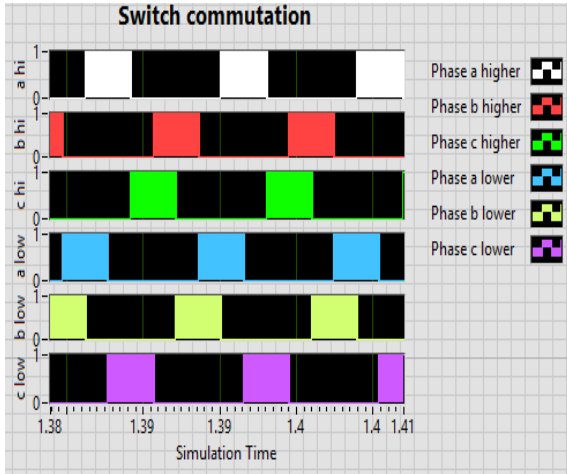


Fig.(7)

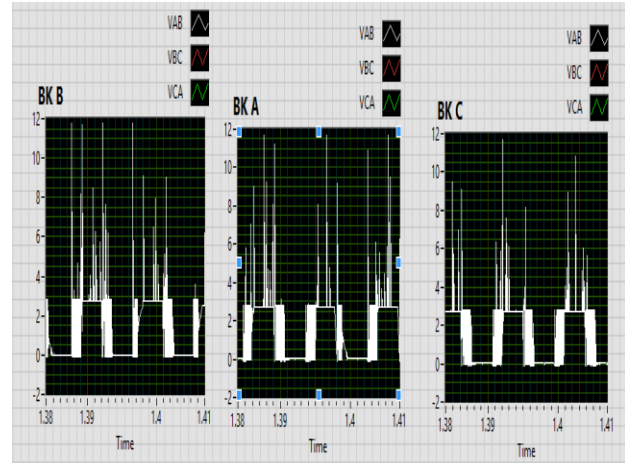


Fig.(8)

When the pwm duty cycle is set to 20%,the wave form for hall sensor output,speed and the supply current is shown in Fig 9, Fig 10 and Fig 11.

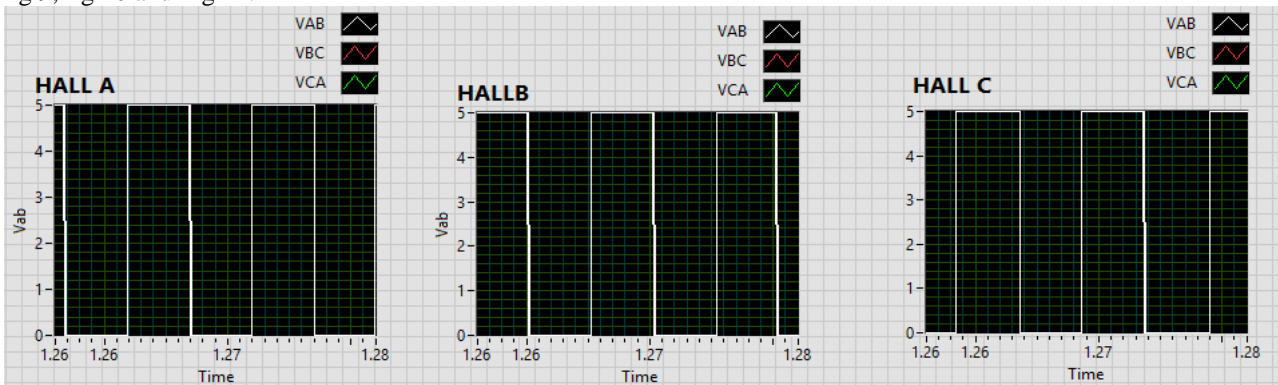


Fig.(9)

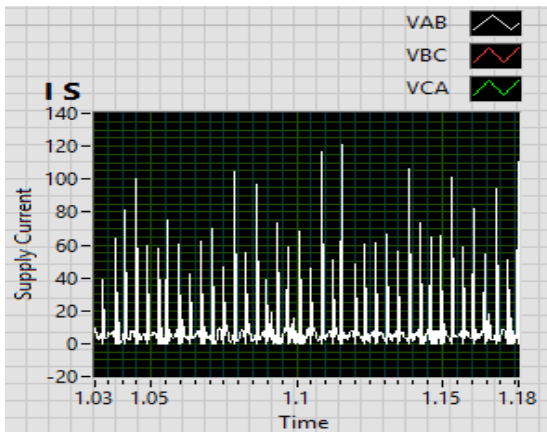


Fig.(10)

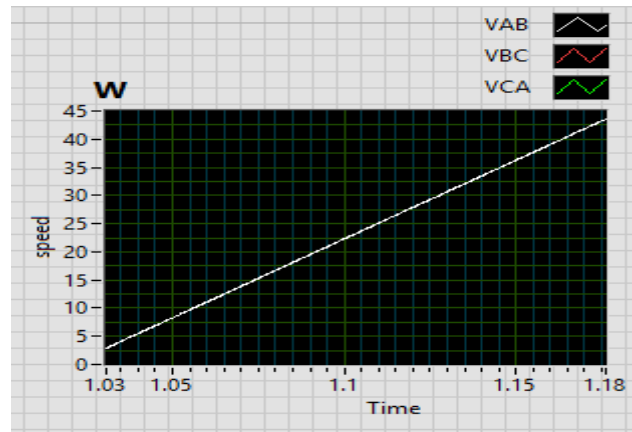


Fig.(11)

When the pwm duty cycle set to 80%,the wave form of the hall sensor output, the supply current and speed is shown in Fig 12, Fig 13 and Fig 14.

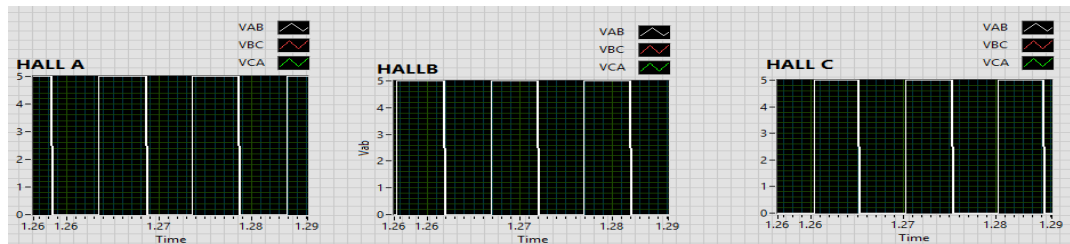


Fig.(12)

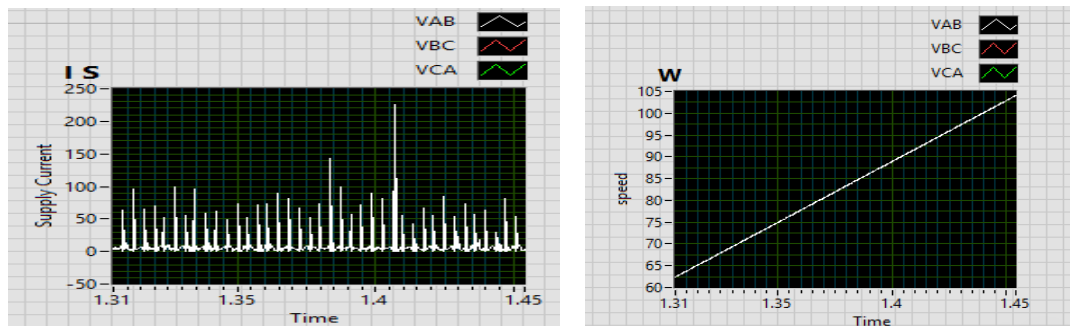


Fig.(13)

Fig.(14)

The comparison was carried out by varying the pwm duty cycle. Simulation was carried out for pwm duty cycle 20% and 80% shown in Fig 10,11&Fig 13,15 respectively..

V. CONCLUSION

The paper presented co-simulation analysis of low cost BLDC motor speed controller. Initially a three phase inverter system with a BLDC motor was developed in multisim, and later the commutation technique was developed along with position based controller in labview. Labview is a powerful simulation tool and has various advantages like better efficiency ,higher expandability when compared with the other simulating options available. From the above result it can be concluded that as the pwm duty cycle vary the speed of the BLDC motor varies. And in the proposed method duty cycle was smoothly varied from 20% to 80% which indicates with the proposed technique simulation can carried out for low and high speed. As the future work a real time control operation for a brushless dc motor integrating labview tool such as my RIO or my DAQ can be developed. And comparison can be carried out between the co-simulation application and the real time test.

REFERENCES

- [1]. Jose carlos Gamazo-Real*,Ernesto Vazquez-Sanchez and
- [2]. Jaime Gomez-Gil "Position and speed control of Brushless DC motors using sensorless techniques and application trends" sensors 2010,10,6901- 6947, www.mdpi.com/journal/sensors. 2N. J. Kim, H. S. Moon, and D. S. Hyun, "Inertia identification for the speed control of induction machines," IEEE Trans. Ind. Appl., vol. 32, no. 6, pp. 1371–1379, 1996
- [3]. A. Yoo, S. K. Sul, D. C. Lee, and C. S. Jun, "Novel speed and rotor position estimation strategy using a dual observer for low resolution position sensors," IEEE Trans. Power Electron., vol. 24, no. 12, pp. 2897–2906, Dec. 2009.
- [4]. Y. X. Su, C. H. Zheng, S. Dong, and B. Y. Duan, "A simple nonlinear velocity estimator for high-performance motion control," IEEE Trans. Ind. Electron., vol. 52, no. 4, pp. 1161–1169, Aug. 2005.
- [5]. Y. X. Su, C. H. Zheng, P. C. Mueller, and B. Y. Duan, "A simple improved velocity estimation for low-speed regions based on position measurements only," IEEE Trans. Control Syst. Technol., vol. 14, no. 5, pp. 937–942, Sep. 2006.
- [6]. Muhammad Mubeen, "Brushless DC Motor Primer," Motion Tech Trends, July, 2008.
- [7]. Brushless DC motor fundamental application note; AN047, MPS, www.monolithicpower.com.
- [8]. Yen-Shin Lai "Novel back-emf detection technique of brushless dc motor drives for wide range control without using current and position sensors" Trans. Power Electron., vol. 23, no. 2, Mar. 2008
- [9]. A. Hemant Mehar, "MATLAB Simulation Techniques in Power Electronics", IEEE Technology and Engineering Education (ITEE), VOL.7, NO.4 p. 62-66, December, 2012.
- [10]. Tekin, R., "MATLAB and LabVIEW in modelling, analysis and real time control of a motion control system Control and Automation (ICCA), 2010 8th IEEE International Conference on.,p. 2077-2081, 9-11 June 2010.
- [11]. Vikas S. Wadnerkar, Dr. G. Tulasi Ram Das and Dr. A.D.Rajkumar, "Performance Analysis Of Switched Reluctance Motor; Design, Modeling And Simulation Of 8/6 Switched Reluctance Motor", Journal of Theoretical and Applied Information Technology, pp 1118-1124, 2008.
- [12]. Sameer Khader, Alan Hadad and Akram A. Abu-aisheh, "The Application Of Psim & Matlab/ 2011 IEEE Global Engineering Education Conference (EDUCON) – "Learning Environments and Ecosystems in Engineering Education", pp 118-121.
- [13]. K. Vinoth Kumar, Prawin Angel Michael, Joseph P. John and Dr. S. Suresh Kumar, "Simulation And Comparison Of Spwm And Svpwm Control For Three Phase Inverter", ARPN Journal of Engineering and Applied Sciences, Vol. 5, No. 7, July 2010, pp 61-74.
- [14]. G. Lipovszki and P. Aradi, "Simulating Complex Systems and Processes in LabVIEW", Journal of Mathematical Sciences 2-2006, Volume 132, Issue 5, pp 629-636.