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Analysis of Four Switch BLDC Motor Drive for Industrial applications

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Abstract

This paper presents the investigation of a practical sensor less control procedure for an ease four-switch, three-stage inverter brushless dc engine drive[1]. Sensor less strategy depends on the discovery of zero intersection purposes of three voltages. An immediate stage current control strategy[1] is utilized to control the stage flows in the four-switch inverter. In four switch brushless dc engine four switches were utilized and henceforth decrease of no of switches in the inverter which will diminish the expense and exchanging misfortunes. Rather than two switches, capacitors [2] utilized. The exhibition of the created sensor less strategy is shown by reproduction.

KEY WORDS— (BLDC) Motor, Inverter,Phase Shift, PWM Controller. Filters

I. INTRODUCTION

The essential purpose behind this paper is to depict an insignificant exertion brushless dc (BLDC) motor drive for business applications. For feasible utilization of the made structure, a newpwm plot is arranged and executed to convey the ideal static and dynamic power ascribes. A whole BLDC engine drive including power change unit, BLDC engine, voltage, speed control, voltage ripple and power drive is examined

Moreover, the attainability of the four-switch inverter is reached out four-stage BLDC engine drives and the four-switch inverter[2] for power factor rectification and speed control. Six replacement moments are given that agree to ZCPs of voltage capacities. Thus, there is no requirement for any 30 or 90 stage defer that is predominant in ordinary sensor less techniques.

In DPC (direct stage current control) strategy at any moment two current is estimated and other stage will be skimming and consequently by these current the control sign will be given to the four switches. Because of issues caused of disposing of two force switch, Direct stage Current (DPC) control technique[8,10] is conveyed out. Decrease in the amount of intensity switches, direct current power , exchanging driver circuits, misfortunes complete cost are the fundamental highlights of this geography. Nonetheless, in the four-switch geography, ordinary control plans are not compelling for current guideline.

Assembling cost of a BLDC engine drive can be diminished more by disposal of position sensors and by creating doable sensor less techniques. Moreover, sensor less control is the main decision for certain applications where these sensors can't work dependably as a result of the cruel condition.

In Six switchcontrolledBldc can be extremely hard to deliver six recompense moments ie troublesome. Thusly its favourable position to utilize four switches BLDC. DPC control method is utilized. The majority of the sensor less strategies for a six-switch inverter[11]BLDC engine drive isn't legitimately appropriate to the four-switch inverter. The fundamental explanation is that in the four-switch topology, some techniques distinguish fewer than six focuses, and different commutation instants must be interjected by means of programming. Up until now, there are few investigates the control strategy of sensor control of a three phase inverter operated with four switches and two legs controlled by capacitors for obtaining the sensor free brushless dc motor drive.In light of the exploratory outcomes, we examined to be two intersection focuses across the terminal voltage A and B concur to two substitution moments, and furthermore, the other four recompense in and accomplished through interjection and move defer programming

II.INVESTIGATION OF BLDC MOTOR.

The perpetual Permanent magnet brushless motor drive engines progressively are being utilized in PC were being utilized at PC, car, aviation, modern and family unit items on account of its powerful thickness, minimization, low upkeep and simplicity of control. It is essential to bring down the assembling cost of the BLDC engine drive for some applications. Cost decrease of BLDC engine is practiced by new control strategically method approach. From a geography perspective, least number of switches and dispensing with the mechanical sensors can be open for the inverter circuit.

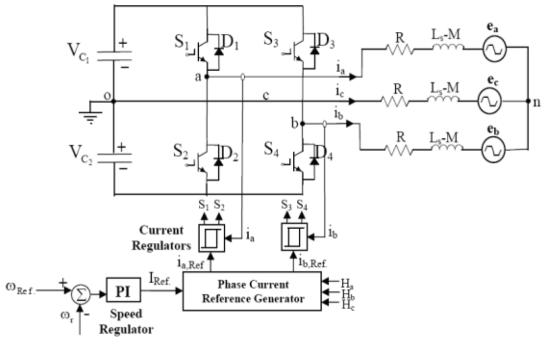

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Fig.1 – functional diagram of four switch operated inverter sensor less brushless dc motor drive.

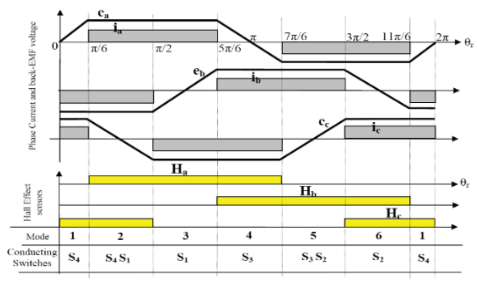

Fig.2 –back emf waveform, hall signal waveform, and current position signal waveform.

SWITCHING SEQUENCES OF THE FOUR-SWITCH CONVERTER

Modes	Active Phases	Silent Phases	Switching Devices
Mode I	Phase B and C	Phase A	S4
Mode II	Phase A and B	Phase C	S1 and S4
Mode III	Phase A and C	Phase B	S1
Mode IV	Phase B and C	Phase A	S3
Mode V	Phase A and B	Phase C	S2 and S3
Mode VI	Phase A and C	Phase B	S2

Table1

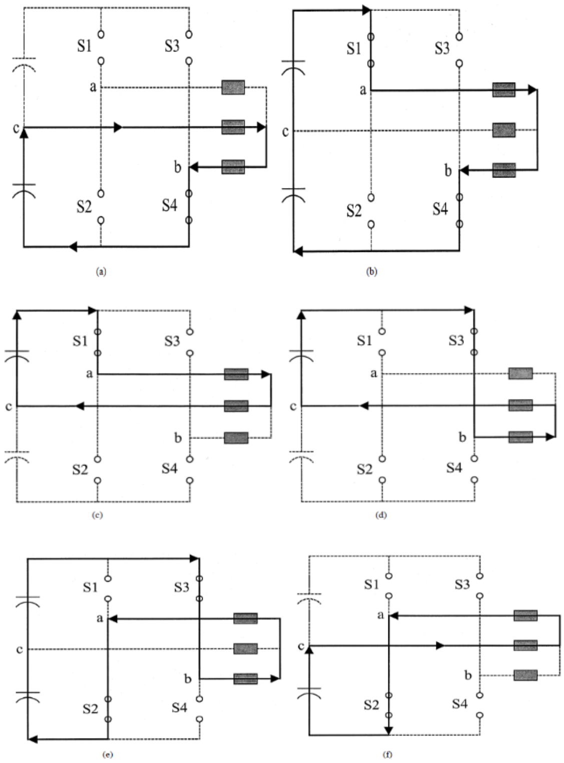

Fig 3 functional block diagram representation of three phase signals for a BLDC motor drive.

Modes	$di/dt > 0$	$di/dt < 0$
Mode I	$\frac{di_c}{dt} = -\frac{R}{L}i_c + \frac{1}{2L}(V_d - e_{cb})$	$\frac{di_c}{dt} = -\frac{R}{L}i_c - \frac{1}{2L}(V_d + e_{cb})$
Mode II	$\frac{di_a}{dt} = -\frac{R}{L}i_a + \frac{1}{2L}(2V_d - e_{ab})$	$\frac{di_a}{dt} = -\frac{R}{L}i_a - \frac{1}{2L}(2V_d + e_{ab})$
Mode III	$\frac{di_a}{dt} = -\frac{R}{L}i_a + \frac{1}{2L}(V_d - e_{ac})$	$\frac{di_a}{dt} = -\frac{R}{L}i_a - \frac{1}{2L}(V_d + e_{ac})$
Mode IV	$\frac{di_b}{dt} = -\frac{R}{L}i_b + \frac{1}{2L}(V_d - e_{bc})$	$\frac{di_b}{dt} = -\frac{R}{L}i_b - \frac{1}{2L}(V_d + e_{bc})$
Mode V	$\frac{di_b}{dt} = -\frac{R}{L}i_b + \frac{1}{2L}(2V_d - e_{ba})$	$\frac{di_b}{dt} = -\frac{R}{L}i_b - \frac{1}{2L}(2V_d + e_{ba})$
Mode VI	$\frac{di_c}{dt} = -\frac{R}{L}i_c + \frac{1}{2L}(V_d - e_{ca})$	$\frac{di_c}{dt} = -\frac{R}{L}i_c - \frac{1}{2L}(V_d + e_{ca})$

Table IICurrent equation and voltage equation for six different modes (Mode I to Mode VI)

Back Emfis controlled and monitored using pulse width modulation technique.Exceptional consideration ought to be monitored at two different modes mode V and mode II .during the mode of operation, the stage A and B are controlled and the current at the stage three will be unexcited.so it is normal that there is no current in the stage C. Nonetheless, the induced EMF of step D can cause an extra unforeseen current, bringing about current mutilation in the stages An and B. Thusly, in the immediate current controlled pulse width modulation technique will be used, the back induced EMF remuneration issue ought to be

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thought of. This wonder can be clarified with the guide of the streamlined comparable circuit in Fig5. To act at the illustration at the modeIII, at the observed case, just a phase at the stage A and the stage B) should be detected and exchanging signs of s1 and s4 are indistinguishable.

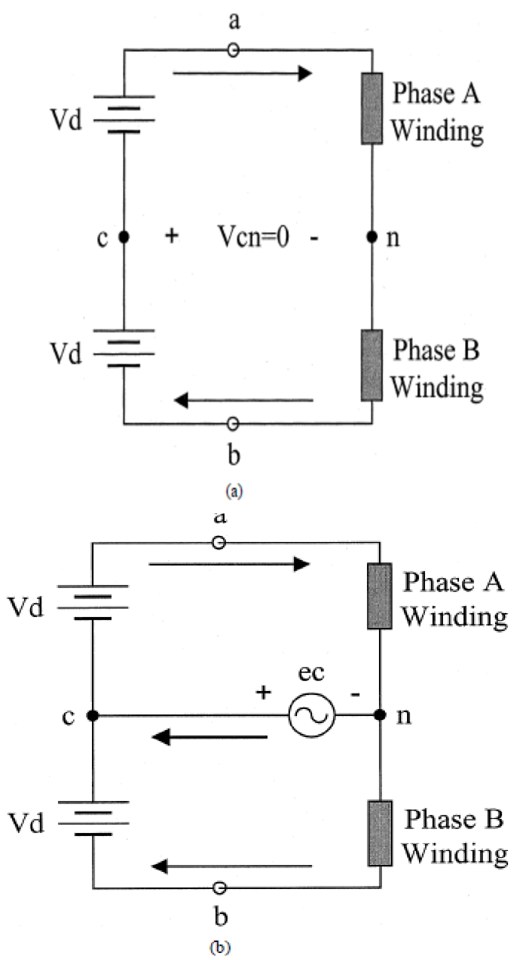

Fig 4 .circuit functional diagram for mode II and mode (a) Ideal case.(b) Genuine situation when the EMF causes current in stage C

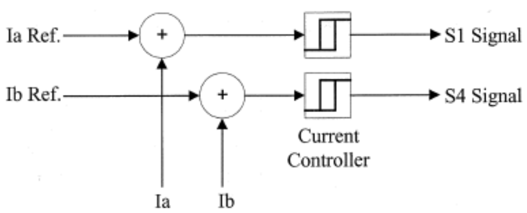

Fig 5 PWM technique for back emf generation

III SIMULATION DIAGRAM

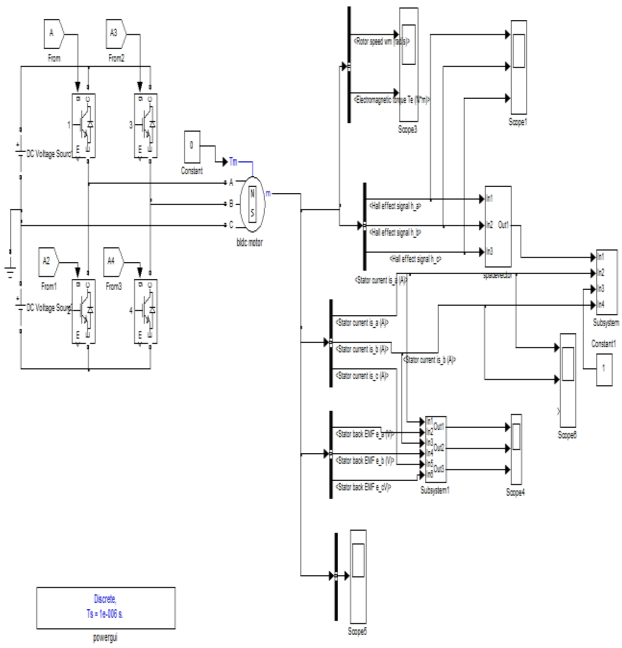

Fig 6 Mat lab simulation diagram of four switch Bldc Motor drive using hall effect signals

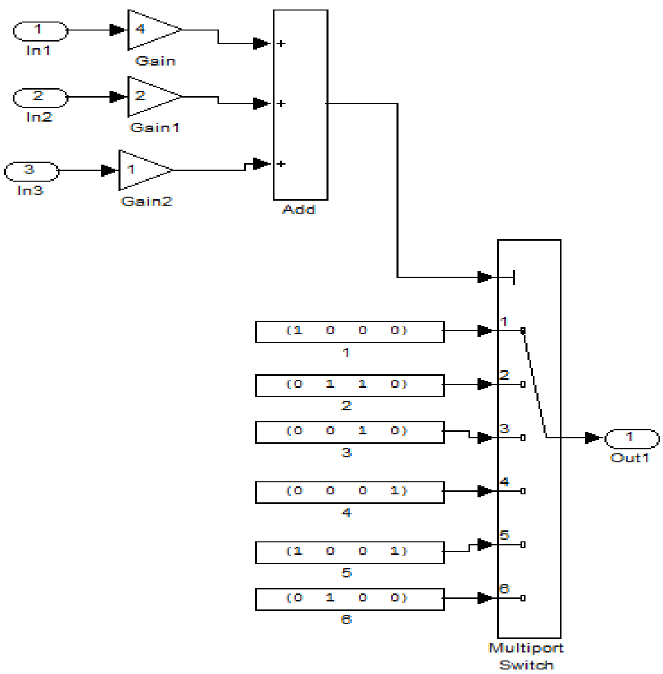

Fig 7 PWM Technique ForBldc Motor Drive.

IV SIMULATION RESULTS

when current constant = 1

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Supply voltage = 300V

Motor speed = 815 rpm

Torque = 20 N-m

Power factor =0.9

When current constant =2

Supply voltage=300v

Motor speed=850rpm

Torque=21 N-m

Power factor=0.9

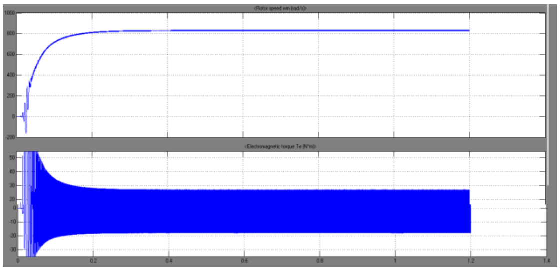

Fig1 shows the electromagnetic torque and speed

The above figure shows the electromagnetic torque developed by a four switch BLDC motor which shows the torque value is 50Nm and machine produces steady state torque with uniform flux density and it depends on the permanent magnets. The flux on the machine also depends on the length of the armature conductors.

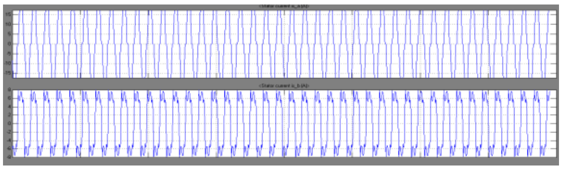

Fig2 shows stator currents Ia and Ib

The above figure depicts the current in two phases and its shows that the current in the circuit is uniform and hence maintains the electromagnetic torque constant.

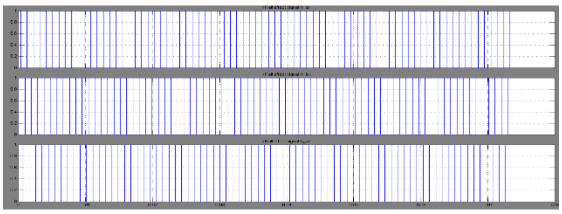

Fig 3 shoes the three Hall Effect signal

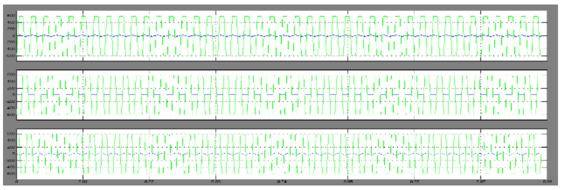

Fig 4 shows stator currents and back emf

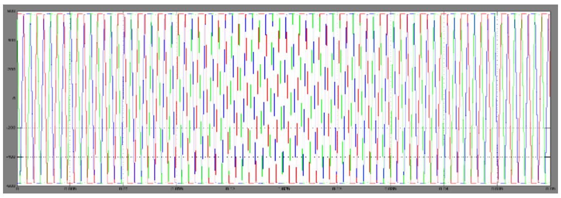

Fig 5 shows electromotive force signals

From fig 6 Control of the motor speed when the speed constant is varied and hence the motor speed varied from 815rpm to 150 rpm and speed can be varied up to any value by varying the speed constant hence by direct phase current method is employed

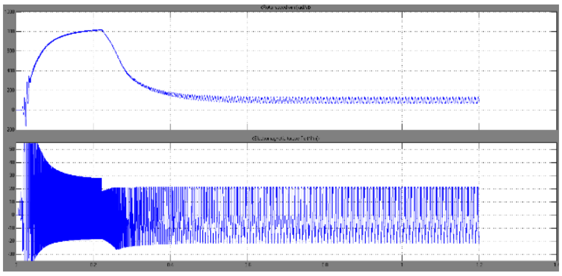

Fig 6 shows the electromagnetic torque and speed

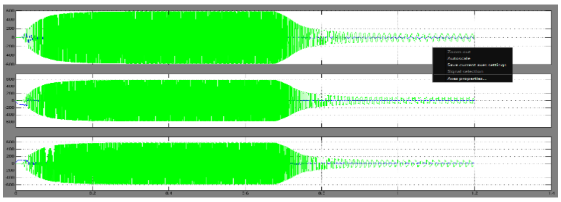

Figure 7Emf and stator current

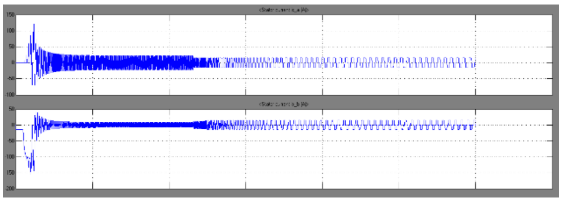

Fig 8 shows stator currents Ia and Ib

VCONCLUSION

A minimal and cost efficient BLDC motor is presented in the examination. Cost sparing is accomplished in decreasing quantity of converter power switches and furthermore by disposal of the position impact sensors. sensor less technique utilizing line-to-line voltages that are determined from the deliberate terminal voltages. Reproduction and trial results check the legitimacy of the proposed sensor less strategy. The proposed blunder examination shows that the voltage drop on the stator impedance is the fundamental. The bldc motor are used in transport in electrical battery operated vehicles and hybrid transportation, heating tools, ventilating tools, refrigeration, position actuation systems, and industrial operations . thestarting and running torque is increased with constant output .bldc motors runs with good efficiency.

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