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SPEED CONTROL METHODS FOR BLDC MOTOR

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Abstract— **In this topic we are discussing the method of speed control and speed control of BLDC motor in the closed loop and open loop techniques. It makes proper speed control of BLDC motor .In this paper we are taken the block diagrams and compare the advantages and disadvantages of the different control technique of BLDC motor The implementation includes both direction and open loop speed control. BLDC motors are widely used in various applications due to its efficiency, reliability and good performance**

I. INTRODUCTION

The use of Brushless DC (BLDC) motors is continuously increasing. The reason is obvious: BLDC motors have a good weight/size to power ratio and excellent acceleration performance, require little or no maintenance and generate less acoustic and electrical noise than universal (brushed) DC motors The BLDC (Brush Less Direct Current) motor is a commutator less motor .It is also known as electronically commutated motors .The commutation is done by using integrated inverter or power supply in BLDC motor dc electric source is converted to ac electric signals by using inverter or switching power supply .The brushless dc (BLDC) motor is very suitable for the places because of

- Increased Efficiency
- Good reliability
- Higher performance
- Easy to control the rotational speed

The BLDC motor is same as DC motor but the main difference is the use of brushes .As comparing with brush the BLDC motor has no brushes and it is electronically commutated. An electronic commutater changes the brush/commutator part of the BLDC motor. The commutation is proper changing of phase currents at a proper times to produce the rotational torque of motor. The electronics can either have position sensor inputs that provide information about when to commutate or use the Back Electromotive Force generated in the coils. Position sensors are most often used in applications where the starting torque varies greatly or where a high initial torque is required. Position sensors are also often used in applications where the motor is used for positioning. Sensor-less BLDC control is often used when the initial torque does not vary much and where position control is not in focus, e.g. in fans

In this topic we are discussing the existing technology of the speed control of BLDC motor mainly two type of speed control method which are sensored and sensor less control. Mainly OPEN LOOP SPEED CONTROL and CLOSED LOOP SPEED CONTROL are used in the BLDC motor .In open loop speed control there is no feedback signal and in closed loop speed control there is feedback signal from the output to the input

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II. PRINCIPLE OF OPERATION

The three phase BLDC motor is energized in two phase method. which means, the two phases which produce the highest torque are energized while the third phase is off. Which two phases are energized depends upon the rotor position. Every 60 electrical degrees of rotation, one of the Hall sensors changes the state. In synchronous, with every 60 electrical degrees, the phase current switching should be updated. The back EMF, required current waveforms and hall sensor signals. Back EMFs and currents are trapezoidal and rectangular in shape respectively. Three hall sensors are placed on the motor to get the position information. These sensors give high output when near to a phase and low output when away from that phase.

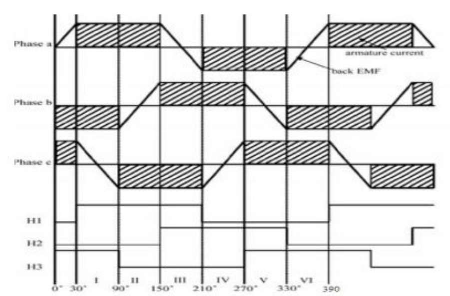


FIG 1 current and hall sensor signals of three phase

III. CONTROLLER IMPLIMENTATION

Because the controller must direct the rotor rotation, the controller requires some means of determining the rotor's orientation/position (relative to the stator coils.)Some designs use Hall effect sensors or a rotary encoder to directly measure the rotor's position. Others measure the back EMF in the undriven coils to infer the rotor position, eliminating the need for separate Hall effect sensors, and therefore are often called sensorless controllers.

A typical controller contains 3 bi-directional outputs (i.e. frequency controlled three phase output), which are controlled by a logic circuit. Simple controllers employ comparators to determine when the output phase should be advanced, while more advanced controllers employ a microcontroller to manage acceleration, control speed and fine-tune efficiency.

Controllers that sense rotor position based on back-EMF have extra challenges in initiating motion because no back-EMF is produced when the rotor is stationary. This is usually accomplished by beginning rotation from an arbitrary phase, and then skipping to the correct phase if it is found to be wrong. This can cause the motor to run briefly backwards, adding even more complexity to the startup sequence. Other sensor less controllers are capable of measuring winding saturation caused by the position of the magnets to infer the rotor position

IV. CONTROL METHODS OF BLDC MOTOR

BLDC motor can be controlled by using the position information as feedback. According to this, there are two types of control methods.

a)Sensored Control

Brushless DC motor is inherently electronically controlled and requires rotor position information for proper commutations of current. The sensored BLDC drive system consists of a BLDC motor, control circuit and hall sensor for position information as shown in figure Speed of motor can be calculated from the frequency of hall signals. Change in state will occur in every 60 electrical degrees. In conventional sensored control the speed of the motor is compared with its reference value and the speed error is processed in a proportional integral (PI) speed controller. By knowing the position information and speed error, the control circuit will generate the required PWM signals with suitable duty ratio. By using these PWM gate signals, inverter switches are turned on

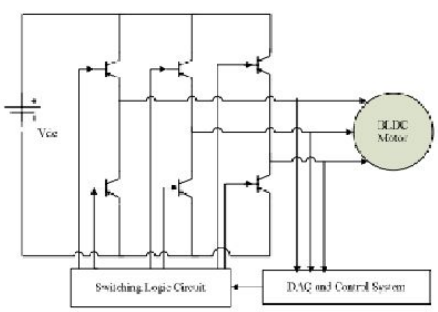


FIG 2

b)Sensor less Control Strategies

Draw backs of rotor position sensors in reliability and cost have motivated research in the area of position sensorless BLDC motor drives. Solving this problem effectively will open the way for full penetration of this motor drive into high reliability, large volume applications and low cost. However in sensorless control rotor position must be determined by means other than sensors. This research on sensorless control of BLDC motor can be divided into the following categories. They are,

(1) Back EMF detection techniques
(2) Flux estimation method
(3) Observers based control techniques
(4) Stator inductance variations method

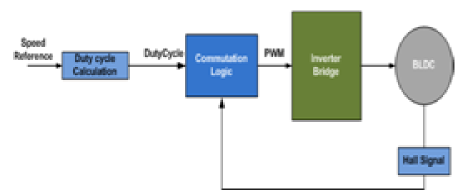
In the above methods, back EMF detection technique is the commonly used method and easier to implement. The various sensorless techniques are discussed in detail in the next chapter.

V. SPEED CONTROL OF BRUSHLESS DC MOTOR

The speed of the BLDC motor is directly proportional to the applied voltage. The commutation logic specifies the coils that need to be energized for every 60 degree of electrical revolution based on Hall inputs. The Pulse Width Modulation logic specifies the time intervals during which the switches should be ON and OFF to average the DC Bus voltage applied thereby controlling the Speed. If the switches are ON for the complete duration of the commutation period, then the DC bus rated voltage is directly fed to the phase windings of the motor. Hence the motor will run at the rated speed as specified in the motor datasheet. To operate at any speed below this level, the commutation pattern applied at either the High-side or Low-side switch should be pulse-width modulated with the PWM Pulses at a specified frequency, called the PWM Frequency.

a) OPEN LOOP SPEED CONTROL OF A BLDC MOTOR

In open loop speed control, the duty cycle is directly calculated from the set reference speed and there is no actual speed feedback for control purpose

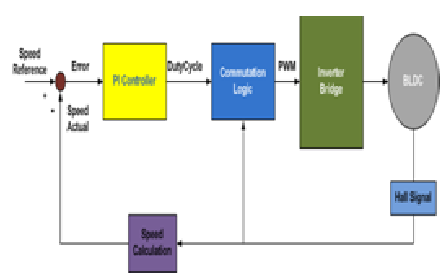


open loop speed control

In the case of a motor the desired operating equilibrium may be the motor speed or its angular position. The controlling parameters such as the supply voltage or the load on the motor may or may not be under the control of the operator. If any of the parameters such as the load or the supply voltage are changed then the motor will find a new equilibrium state, in this case it will settle at a different speed. The actual equilibrium state can be changed by forcing a change in the parameters over which the operator has control

b) CLOSED LOOP SPEED CONTROL OF BLDC MOTOR

In closed loop speed control, the set speed and the actual speed are compared and the error is fed to the PI controller, which finally outputs the required duty cycle in order to achieve the required speed operation of the motor

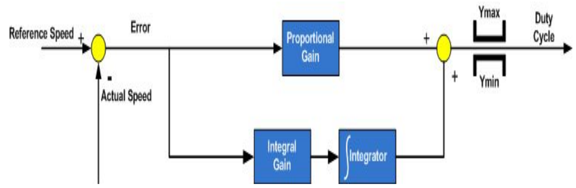


closed loop speed control

For continual monitoring and control over the operating state of a system without operator intervention, for more precision or faster response, automatic control systems are needed.

VI. Proportional-Integral Controller (PI Controller)

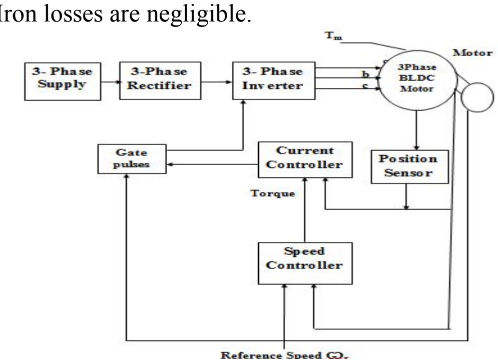
The regulation of speed is done with the PI controller. The error difference between the actual speed and reference speed is calculated at every PWM cycle and is given as an input to the PI controller. The proportional and integral gains of the controller are configurable using UART commands



VII. ANALYSIS OF BLDC MOTOR DRIVE SYSTEM

Figure shows the overall system configuration of the three-phase BLDC motor drive. The three phase inverter topology is a six-switch voltage-source configuration with constant dc-link voltage (Vdc), which is identical with the induction motor drives and the permanent magnet ac motor drives. The analysis is based on the following assumption for simplification:

1. The motor is not saturated.
2. Stator resistances of all the windings are equal, and self- and mutual inductances are constant.
3. Power semiconductor devices in the inverter are ideal.
4. Iron losses are negligible.



VIII. PROBLEM RELATED TO SPEED CONTROL OF BRUSHLESS D.C. MOTOR DRIVE USING SENSORS

1. Low-cost Hall-effect sensors are usually used
2. Electromagnetic variable reluctance (VR) sensors
3. Accelerometers have been extensively applied to measure motor position and speed

APPLICATION

These speed control is applied in transportation such as hybrid vehicles, electric bicycles etc. These is applied in the area of heating and ventilation these field the speed control is a important factor

CONCLUSION

In this topic we are discussing the speed control of the BLDC motor in the sensor and sensor less method and given the closed loop and open loop control strategies and compare the advantages. The various application of BLDC motor control strategies also discussed

REFERANCE

[1] Frank Julian Sprague#Joining the emerging electrical industry
[2] Electric motor#The first electric motors
[3]BLDC Closed-Loop Speed Control Based on CY8C24x33, Bill Jiang, Jeremy Huang and XiaoPing Weng, AN42102, Cypress
[4]T.G. Wilson, P.H. Trickey, "D.C. Machine. With Solid State Commutation", AIEE paper I. CP62-1372, October 7, 1962
[5]M. Gopal. Control systems: principles and design. 2nd ed. Tata McGraw-Hill, 2002. Page 165