3.5 POWER CONTROLLER FOR BLPM SQUARE WAVE DC MOTOR

POWER CIRCUIT

Power Circuit of BLPM dc motor is as shown fig3.5.1 consists of six power semiconductor switching device connected in bridge configuration across a dc supply. A suitable shunt resistance is connected in series to get the current feedback. Feedback diodes are connected across the device. The armature winding is assumed to be star connected. Rotor has a rotor position sensor and a tacho-generator is coupled to the shaft to get feedback signal.

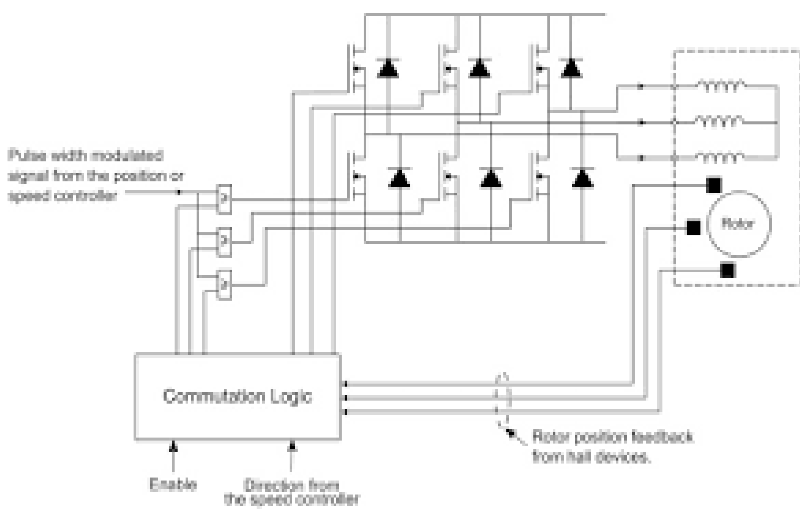

Figure 3.5.1 structure of controller for brushless PM DC Motor

[Source: "special electric machines" by R.Srinivasan page:4.11]

CONTROL CIRCUIT

The control circuits consist of a commutation logic unit. Which get the information about the rotor shaft position and decides which switching devices are to be turned on and which devices are to be turned off. This provides six output signals out of which three are used as the base drive for the upper leg devices. The other three output signal are logically AND with the high frequency pulses and the resultant signals are used to drive the lower leg devices.

A comparator compares the tachogenerator output with reference speed and the output signal is considered as the reference current signal for the current comparator which compares the reference current with the actual current and the error signal output is fed to the monostable multivibrator which is excited by high frequency pulses. The duty cycle of the output of monostable is controlled by error signal. This output signal influences the conduction period and duty cycle of lower leg devices.

ROTOR POSITION SENSORS FOR BLPM MOTOR

It converts the information of rotor shaft position into suitable electrical signal. This signal is utilized to switch ON and OFF the various semiconductor devices of electric switching and commutation circuitry of BLPM motor. Two popular rotor sensors are

Optical Position Sensor.

Hall Effect Position Sensor.

OPTICAL POSITION SENSOR

This makes use of six photo transistors. This device is turned into ON state when light rays fall on the devices. Otherwise the device is in OFF state the schematic representation is shown in fig.3.5.2

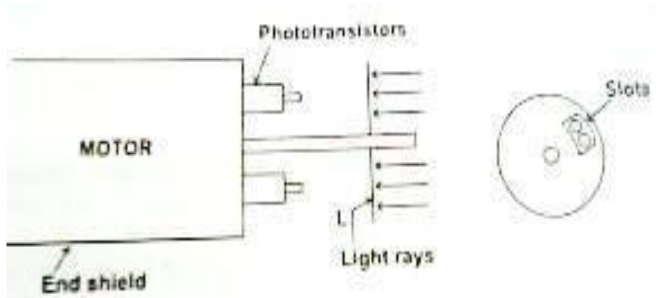

Figure 3.5.2 Optical position sensor
[Source: "special electric machines" by R.Srinivasan page:4.11]

The phototransistors are fixed at the end shield cover such that they are mutually displaced by 60 degree electrical by a suitable light source. The shaft carries a circular disc which rotates along the shaft. The disc prevents the light ray falling on the devices. Suitable slot are punched in the disc such turned into on state suitably turns the main switching devices of electronic commutation circuitry into on state. As the shaft rotates, the devices of electronic commutation which are turned into ON are successively changed.

HALL EFFECT POSITION SENSOR

Consider a small pellet of n-type semiconducting material as shown in fig 4.36.

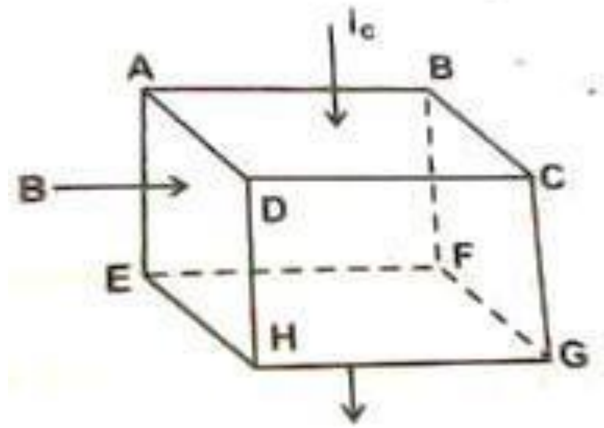

Figure 3.5.3 Hall Effect sensor

[Source: "special electric machines" by R.Srinivasan page:4.11]

A current is allowed to pass from the surface ABCD to the surface EFGH. Let the surface ABEF be subjected to a North pole magnetic field of flux density B tesla. As per Fleming left hand rule, the positive charge in the pellet get concentrated near surface ADHE and negative charges near the surface BCFG. Since type material has free negative charges, there electrons gets concentrated near the surface BCGF.This charge in distribution makes the surface ADHE more positive than the surface BCGF. This potential known as Hall emf or emf due to Hall Effect.

It has been experimentally shown that Emf due to Hall Effect is V_H is given by

$V_H = R_H(i_c / d)$ volts

Where i_c current through the pellet in amps

B- Flux density in tesla

d- Thickness of the pellet in m.

R_H – Constant which depends upon the physical dimensions or physical properties of the pellet. If the polarity of B is changed from North Pole to South Pole the polarity of the emf due to Hall Effect also get changed.

HALL EFFECT POSITION SENSOR

Hall effect position sensor can be advantageously used in a BLPM motor. Consider a 2 pole BLPM motor with two winding w1 and w2 as shown in fig.

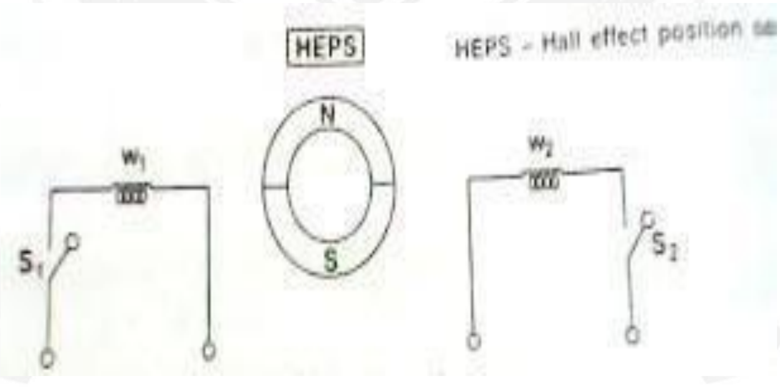

Figure 3.5.4 2 pole BLPM motor

[Source: "special electric machines" by R.Srinivasan page:4.11]

When w1 carries a current on closing S1 it set up a North Pole flux in the air gap. Similarly when s2 is closed w2 is energized and sets up a North Pole flux.w1 and w2 are located in the stator such that their axes are 180 degree apart. A Hall Effect position sensor is kept in an axis of the winding.

When Hall Effect position sensor is influenced by North Pole flux the hall Emf is made to operate the switch S1. Then w1 sets up North Pole flux. The rotor experiences a torque and South Pole of the rotor tends to align with the axis of w1.because of interia.it overshoot the rotor hence rotates in clockwise direction. Now HEPS is under the influence of S pole flux of the rotor. Then the polarity of hall emf gets changed. This make the switch S1 in off state and S2 is closed. Now w2 sets up N pole flux in the air gap, the rotor rotates in clockwise direction. So that the s pole gets aligned with w2 axis. Then this process continuous. The rotor rotates continuously.