PERMANENT MAGNET BRUSHLESS DC MOTOR

The conventional DC motors are highly efficient and their characteristics make them suitable for use as servomotors. But the only drawback is that they need a commutator and brushes which are subjected to wear and requires maintenance. In a conventional DC motor, commutation is undertaken by brushes and commutator but in brushlesses DC motor, it is done by using semiconductor devices such as transistors. The commutation refers to the process which coverts the input direct current to an alternating current and properly distributes it to each winding in the armature.

4.1 CONSTRUCTION

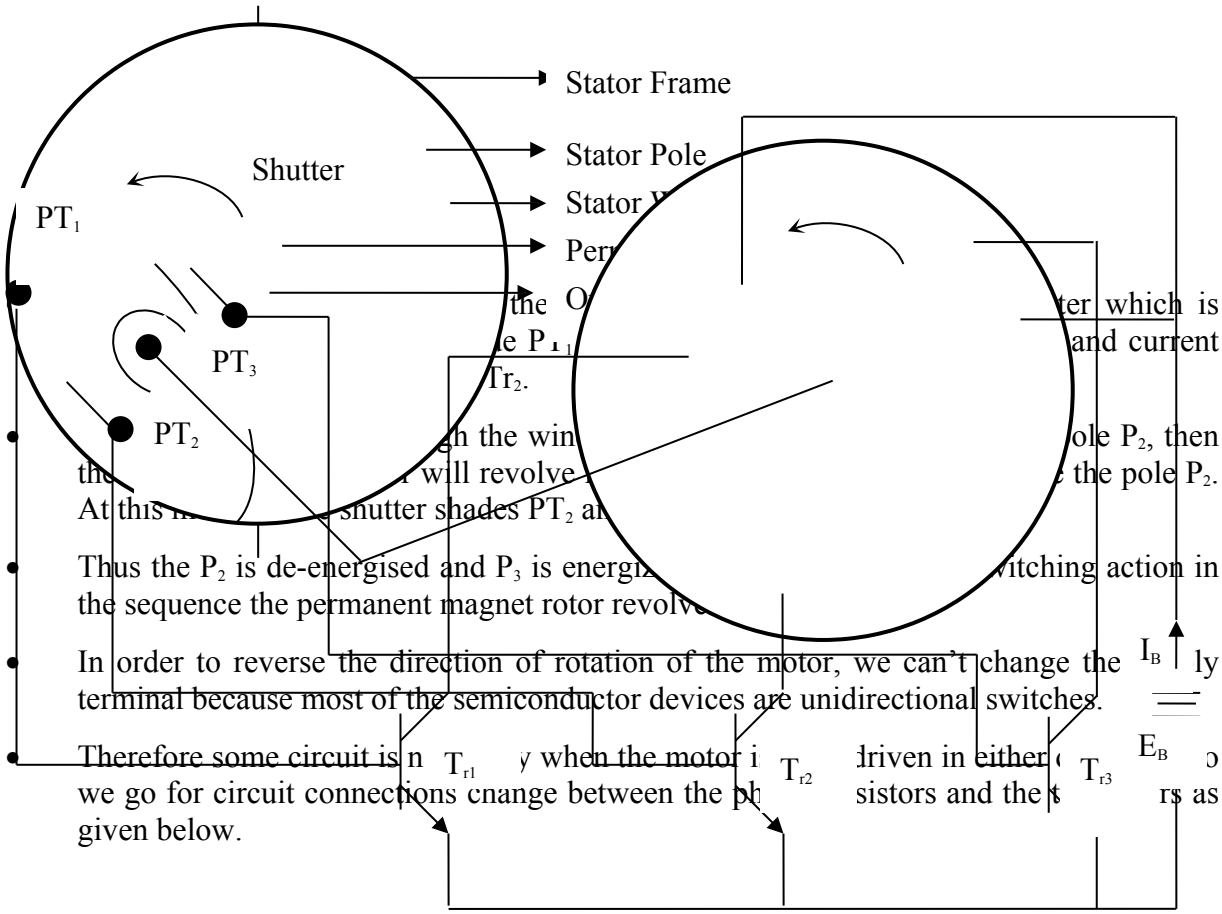
- The construction of modern brushless DC motor is very similar to the AC motor. It consists of two important main parts (ie) stator and rotor.
- The stator which is the stationary parts has got stator frame which encloses the internal parts of the motor and protects it and it is made up of cast iron (or) steel.
- Beneath the stator frame, stator poles are fixed which are of projective type which may be laminated or solid piece and it is mostly made of silicon steel material.
- The stator windings are placed on the stator poles .They may be copper windings and may be single (or) Double layer winding.
- The stator windings are excited by the DC supply through the controllable switches.
- The rotor construction is very simple (ie) it has permanent magnets of one (or) two number with their poles, which may be projecting pole type.
- The rotor doesn't carry any winding, brushes (or) commutator segments. The maintenance is less and inertia is low.
- The rotor positions are sensed by position sensors such as Hall elements (or) optical encoders which are fixed on the shaft of the motor.
- The constructional details are shown in the figure 4.1

4.1.1 Basic Principle of operation of PMBLDC Motor

- The basic principle of operation of motor can be easily understand by considering simple three phase unipolar motor as shown in the figure 4.2
- It uses optical sensors (photo transistors) as position detectors. Three photo transistors

PT_1, PT_2, and PT_3 are placed on the end plates at 120° interval and they are exposed to light in sequence through a revolving shutter coupled to the motor shaft.

- As shown in the figure 4.2, the south pole of the rotor now faces the salient pole P_2 of the stator, and the phototransistor PT_1 detects the light and turns transistor Tr_1 ON.
- In this state, the south pole which is created by the salient pole P_1 by the electrical current flowing through the winding w_1 is attracting the north pole of the rotor to move it in the direction of the arrow (CCW).



- Thus the P_2 is de-energised and P_3 is energi… …witching action in the sequence the permanent magnet rotor revolve…
- In order to reverse the direction of rotation of the motor, we can't change the …ly terminal because most of the semiconductor devices are unidirectional switches.
- Therefore some circuit is n… …y when the motor i… …driven in either … we go for circuit connections change between the ph… …sistors and the t… …rs as given below.

For CCW rotation

PT1 → TR1

PT2 → TR2

PT3 → TR3

For CW rotation

PT1 → TR3

PT2 → TR2

PT3 → TR1

The switching sequence for CCW & CW is given below.

	CCW				CW			
PT_1	1	0	0	1	1	0	0	1
PT_2	0	1	0	0	0	1	0	0
PT_3	0	0	1	0	0	0	1	0
TR_1	1	0	0	1	0	0	1	0
TR_2	0	1	0	0	0	1	0	0
TR_3	0	0	1	0	1	0	0	1

The above switching sequences between the phototransistors and the transistors can be implemented by using integrated logic gate circuits. The rotation of stator magnetic field with respect to the excitation of the winding and the respective photo transistor waveforms are shown in the figure 4.3 for CCW rotational direction.