Course Code - EEE-401
Course Title – Energy Conversion and Special Machine
Lecture- Brushless DC Motor

Brushless DC Motor

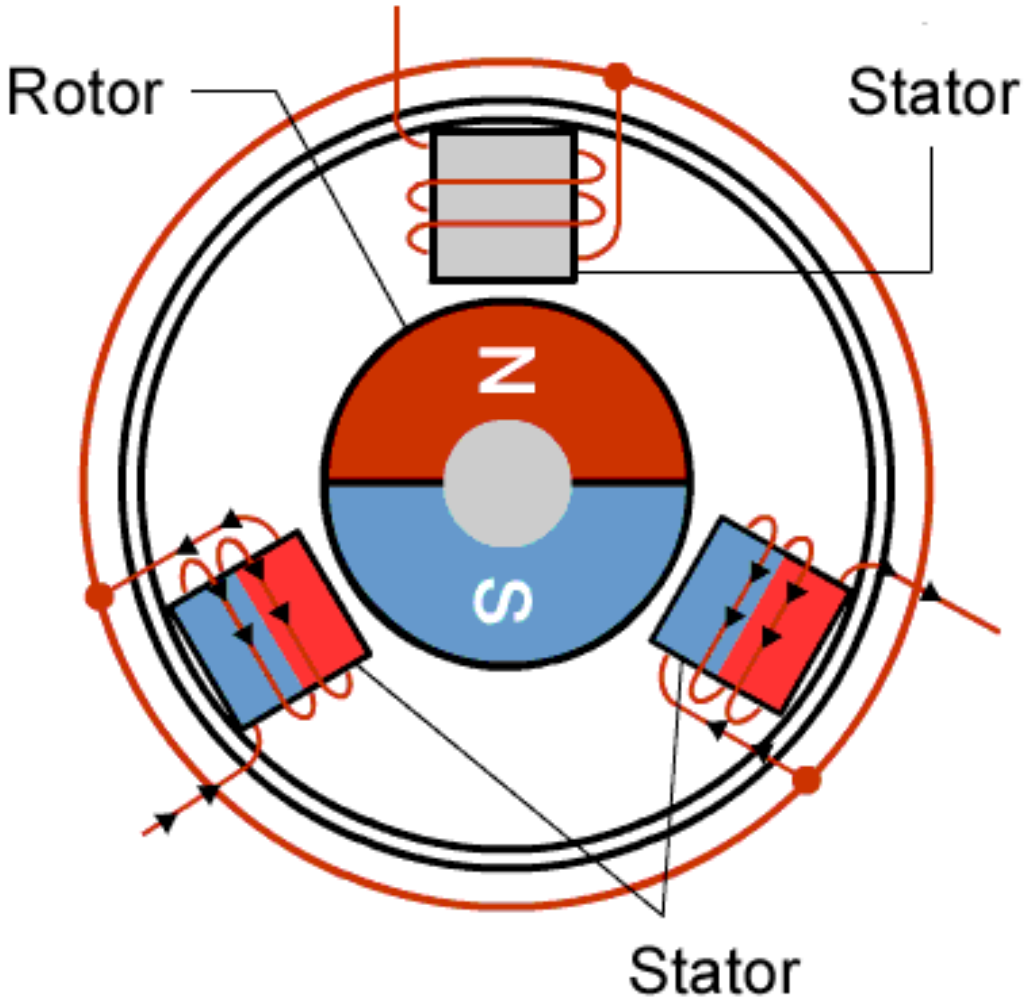
Brushless DC Motor

- A brushless DC electric motor (BLDC) also known as an electronically commutated motor (ECM) or synchronous DC motor, using a direct current (DC) electric power supply.
- It uses an electronic closed loop controller to switch DC currents to the motor windings.
- Brushless DC motors (BLDC) has high efficiency and excellent controllability
- The BLDC motor has power-saving advantages relative to other motor types.

Brushless DC Motor

Brushless DC Motor Working

- BLDC motor works on the principle similar to that of a Brushed DC motor.
- In the BLDC motor, the current carrying conductor(Stator) is stationary and the permanent magnet(Rotor) is moving.
- When the stator coils get a supply from source(DC), it becomes electromagnet and starts producing the uniform field in the air gap.
- Due to the force of interaction between electromagnet stator and permanent magnet rotor, the rotor continues to rotate.
- With the switching of windings as High and Low signals, corresponding winding energized as North and South poles.
- The permanent magnet rotor with North and South poles align with stator poles which causes the motor to rotate.



Brushless DC Motor

Advantages

- Since there are no brushes or slip- rings, there is no sparking.
- High efficiency and high output power to size ratio due to the use of permanent magnet rotor
- High speed of operation even in loaded and unloaded conditions due to the absence of brushes that limits the speed
- Also, brush maintenance is eliminated.
- Such motors can pull into synchronism with inertia loads of many times their rotor inertia.
- Less electromagnetic interference
- Low noise due to absence of brushes.

Disadvantages

- These motors are costly
- Electronic controller required control this motor is expensive
- Requires complex drive circuitry
- Need of additional sensors

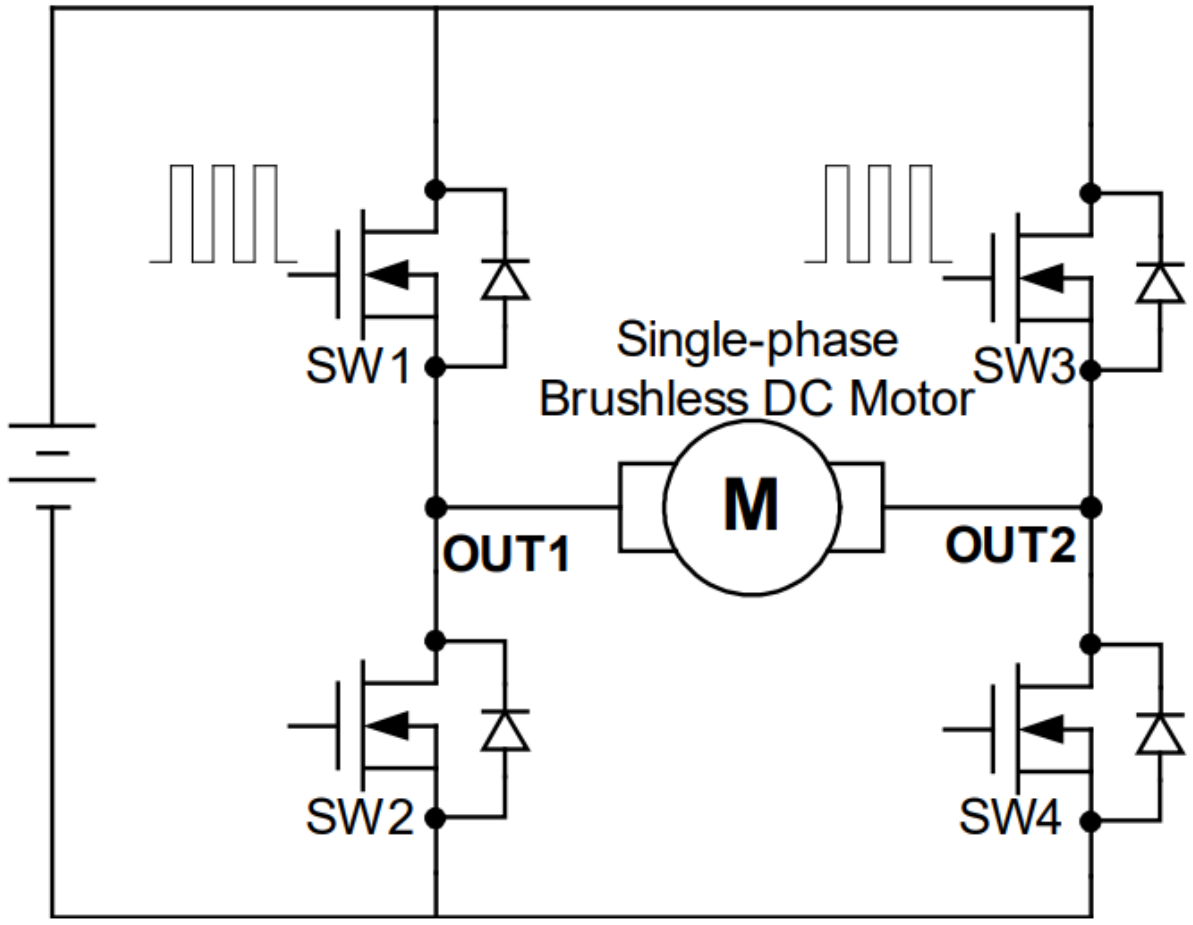
Application

- These motors are used where precise speed must be maintained to ensure a consistent product.
- With a constant load, the motor maintains a constant speed.
- These motors are used for syntheticfibre drawing where constant speeds are absolutely essential.

Brushless DC Motor

Brushless DC Motor Control

- Brushless DC motors use electric switches to realize current commutation, and thus continuously rotate the motor.
- These electric switches are usually connected in an H-bridge structure for a single-phase BLDC motor, and a three-phase bridge structure for a three-phase BLDC motor shown in Figures.
- Usually the high-side switches are controlled using pulse-width modulation (PWM), which converts a DC voltage into a modulated voltage, which easily and efficiently limits the startup current, control speed and torque.
- Generally, raising the switching frequency increases PWM losses, through lowering the switching frequency limits the system's bandwidth and can raise the ripple current pulses to the points where they become destructive or shut down the BLDC motor driver.

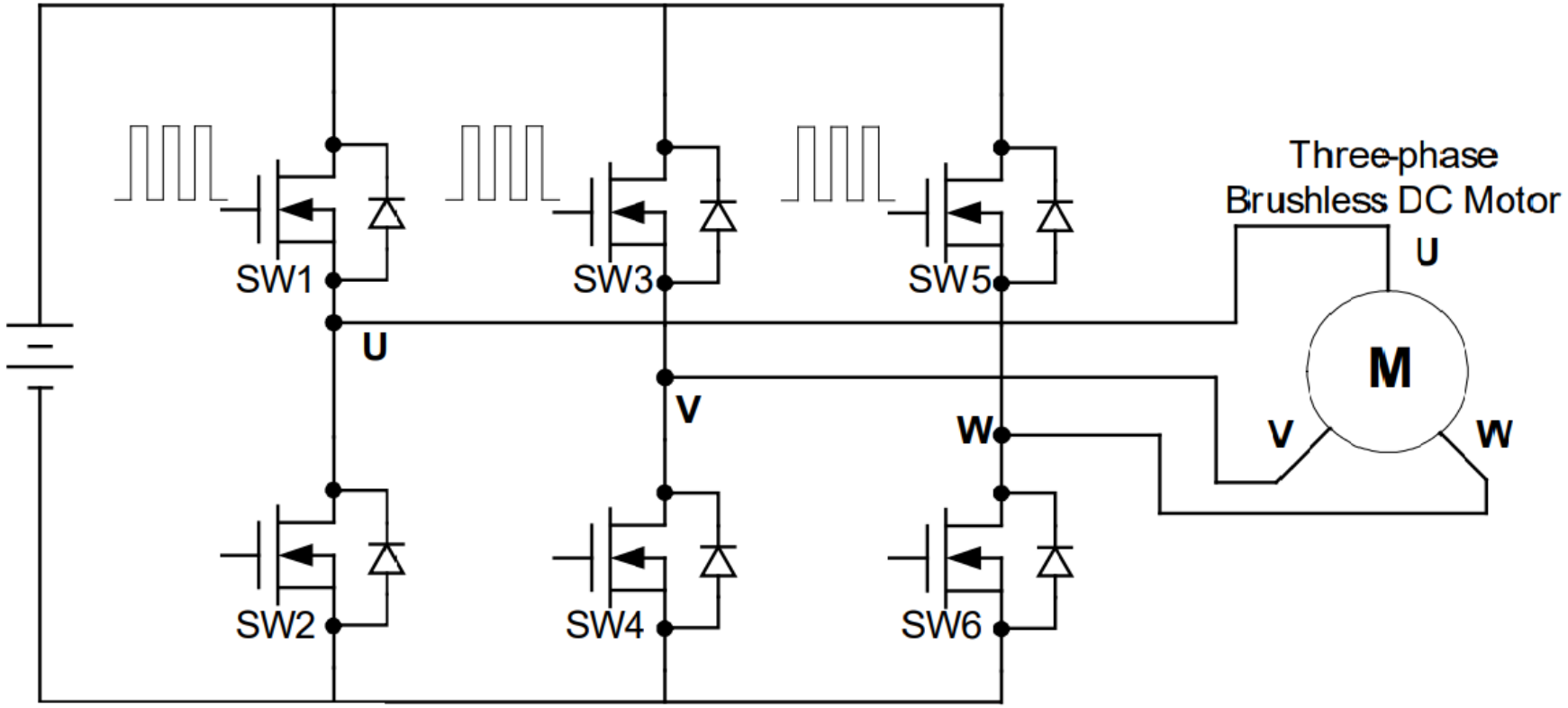


(a) H-bridge

Brushless DC Motor

Brushless DC Motor Control

Three-phase bridge structure for a three-phase BLDC motor



(b) Three-phase bridge

Brushless DC Motor

Comparison between BLDC motor and brushed DC motor

Features	Brushed DC motor	BLDC motor
1. Commutation	Mechanical brushes and commutator	Electronic commutation based on rotor position information
2. Efficiency	Moderate	High
3. Maintenance	Periodic	Little
4. Thermal performance	Poor	Better
5. Output Power/Frame Size (Ratio)	Moderate/Low	High
6. Speed/Torque Characteristics	Moderately flat	Flat
7. Dynamic Response	Slow	Fast
8. Speed Range	Low	High
9. Electric Noise	High	Low
10. Lifetime	Short	Long

Brushless DC Motor

Comparison between BLDC Motor and AC Induction Motor

Features	AC Induction Motor	BLDC motor
1.Speed/Torque Characteristics	Nonlinear — lower torque at lower speed	Flat
2. Output Power/ Frame Size (Ratio)	Moderate	High
3. Dynamic Response	Low	Fast
4. Slip Between Stator And Rotor Frequency	Yes; rotor runs at a lower frequency than stator by slip frequency and slip increases with load on the motor.	No