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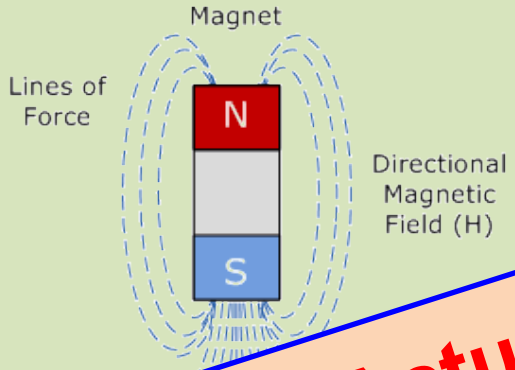
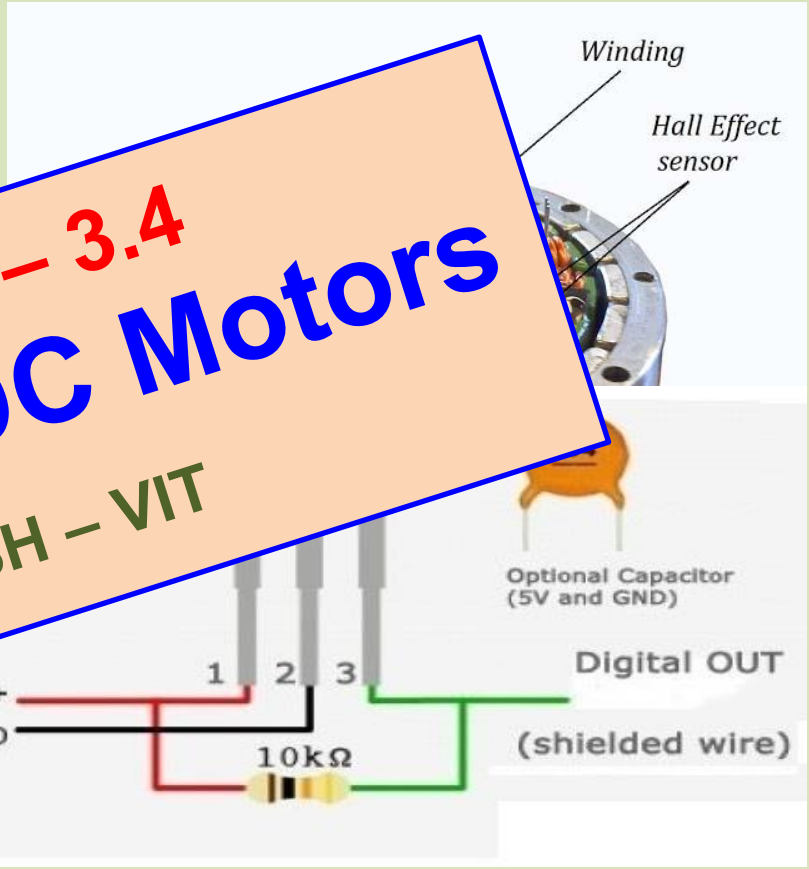


# Actuators – 3.4

# Brushless DC Motors

FY – DESH – VIT

# Merits of DC Brush motors –

1) Speed control over a wide range is possible.

2) Very high HP capacity motors are available.

3) Relatively ease of speed control.

4) Moderate technology power supply and starters are sufficient.

5) High expertise not required for maintenance.

6) Cheap and cost effective.

# Demerits of DC Brush motors –

1) At the Commutator, the brushes are continuously having friction. This causes wear and tear of the brushes as well as the commutator segments.
2) Maintenance cost increases.
3) Heat produces carbon particles at the brush contacts.
4) Frequent replacement of brushes is required.
5) Voltage drop takes place at the brush contacts.
6) To prevent high inrush of current at start, starter is a must.
7) A separate DC power supply is required.
8) Noisy operation.

# Problematic issues with Brush – Commutator

1) Brushes are soft in nature (made of carbon orgraphite) and commutator is hard (made up of copper).

2)Due to friction between brushes and commutator, brushes undergo wear and tear also, there is always a small sparking between them as a result, brushes are needed to be replaced more frequently.

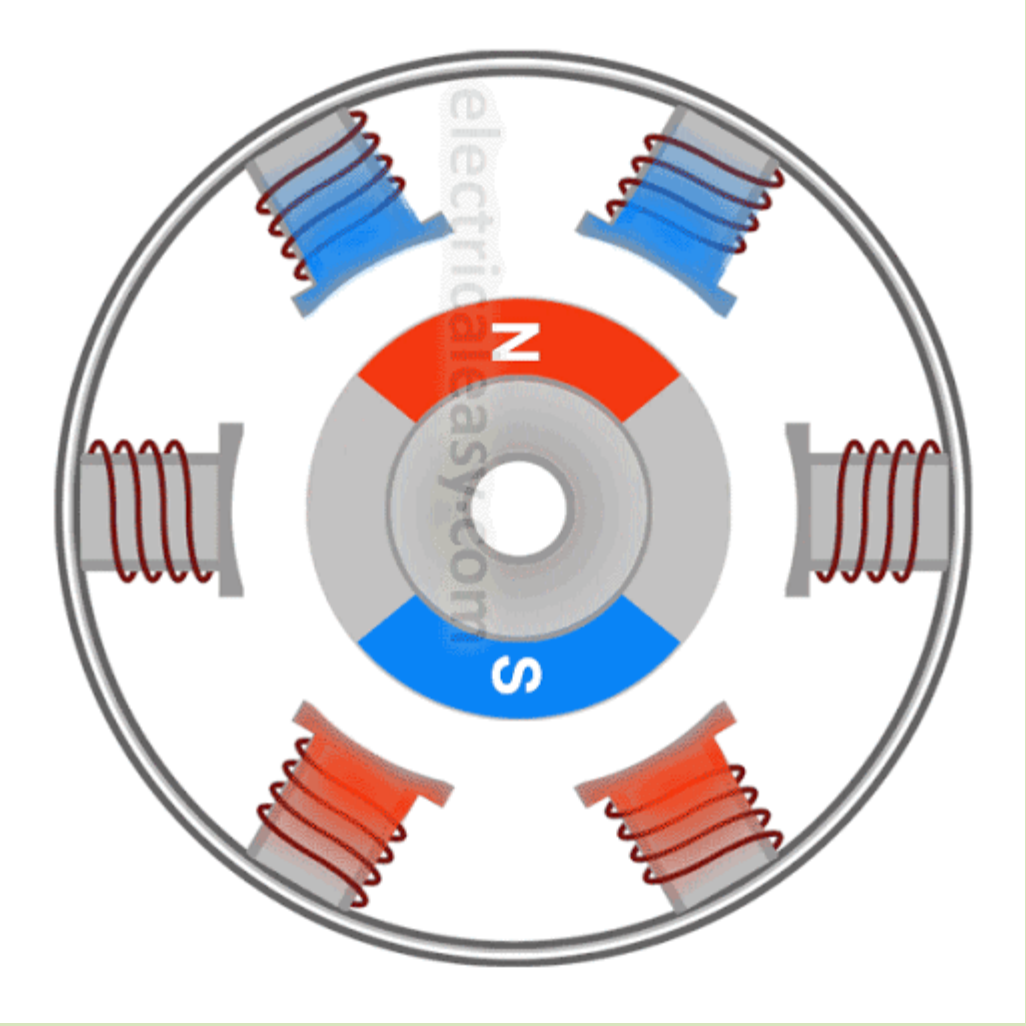
3)During friction, hot carbon dust particle always fall on the commutator and after a long time, we found pits on the surface of commutator.

4)Hence, a servicing of motor is needed for every 03 to 04 months.

# Brushless DC Motors (BLDC )

# Features of BLDC motors –

1) To overcome the problems arising of brush contact issues, BLDC motors are developed.
2) No Left Hand Rule….! Rather, working is based on just a simple Attraction – Repulsion principle between N and S poles.
3) BLDC motors with or without Hall effect sensors are available.
4) A specialised motor driver circuit is required.
5) Quiet operation.
6) Moderate and small capacity motors.
7) High power to weight ratio.
8) Good electronic and software control.
9) Low maintenance.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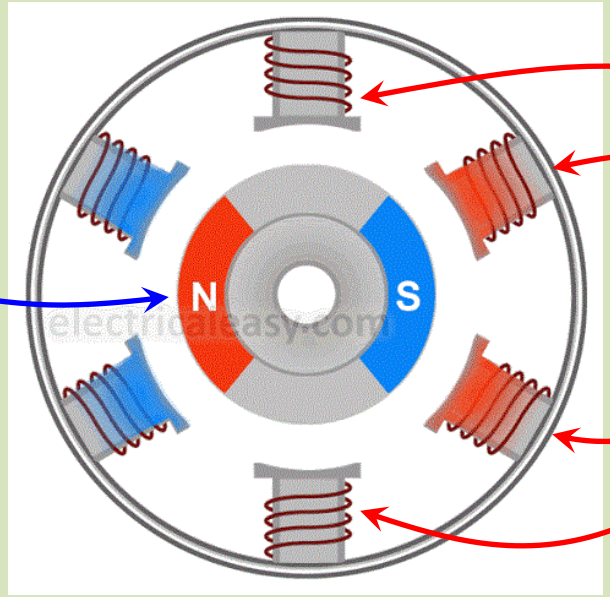
2 Rotor poles
(N and S)
(Permanent)

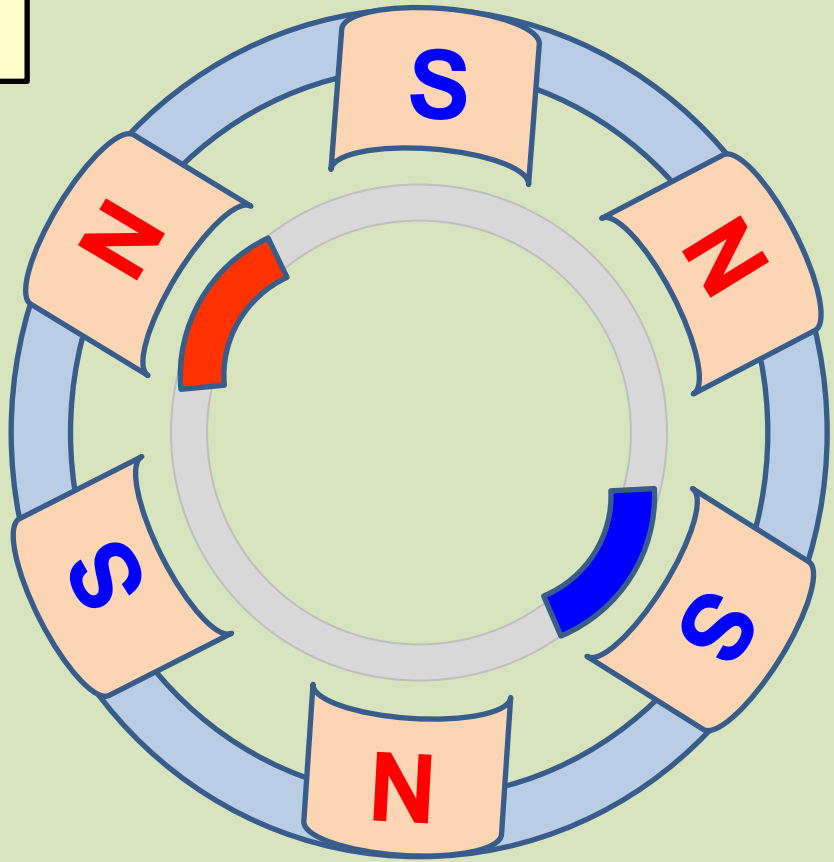



6 Stator poles (Temporary)

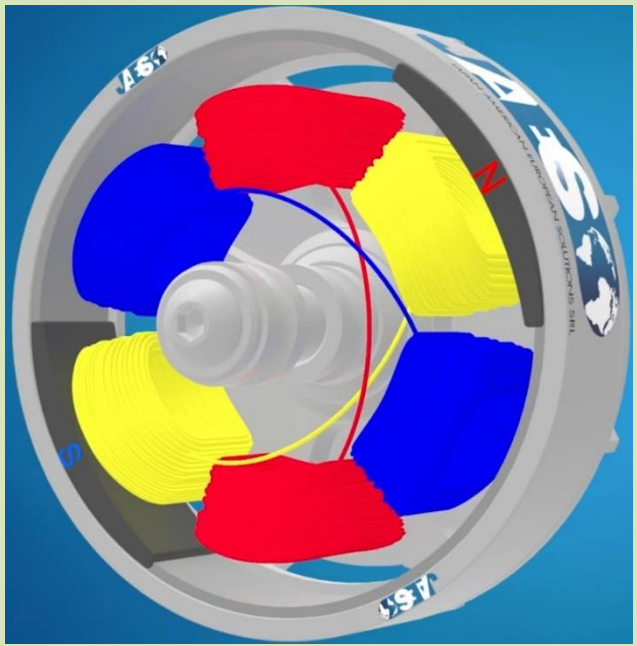
**Working Principle –**

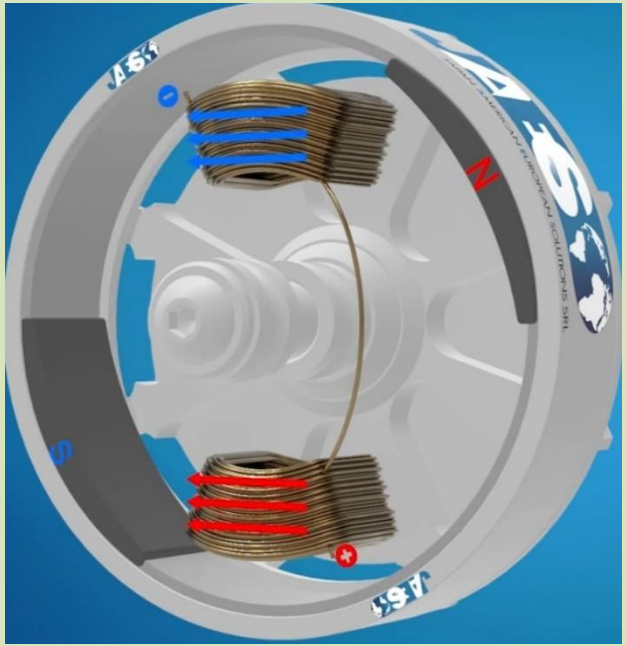
- When the stator poles are excited, attraction takes place between opposite poles of stator and rotor, which gives rise to rotation.
- When the rotor pole approaches an opposite pole of stator, that stator pole is switched off and next stator pole is excited.
- Thus the rotor pole keeps on chasing stator pole but never successful ….!

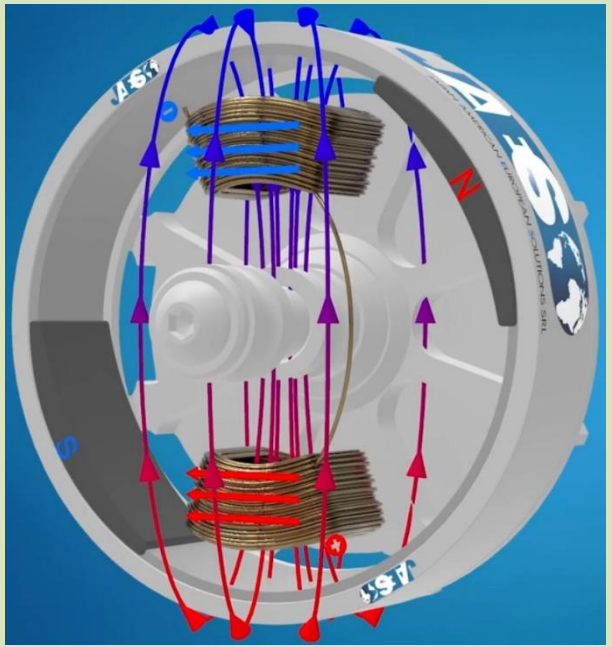
# BLDC Motor

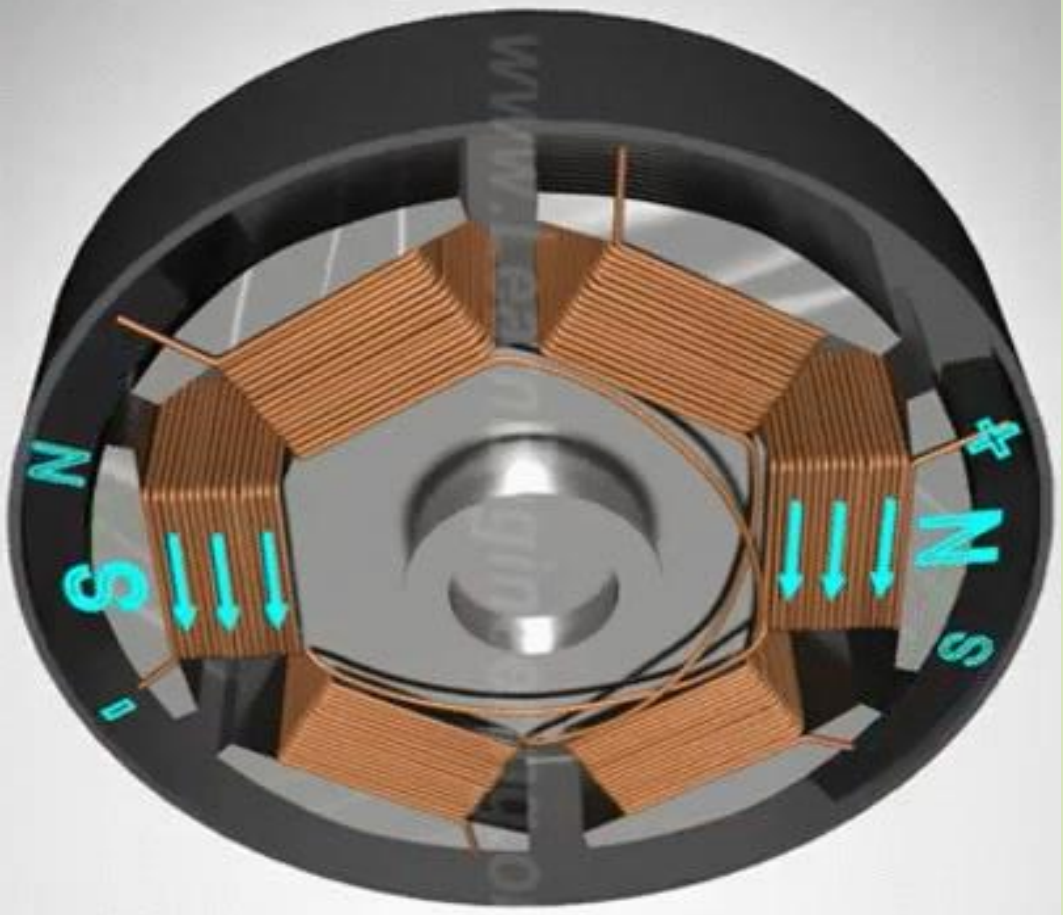


# Working Principle





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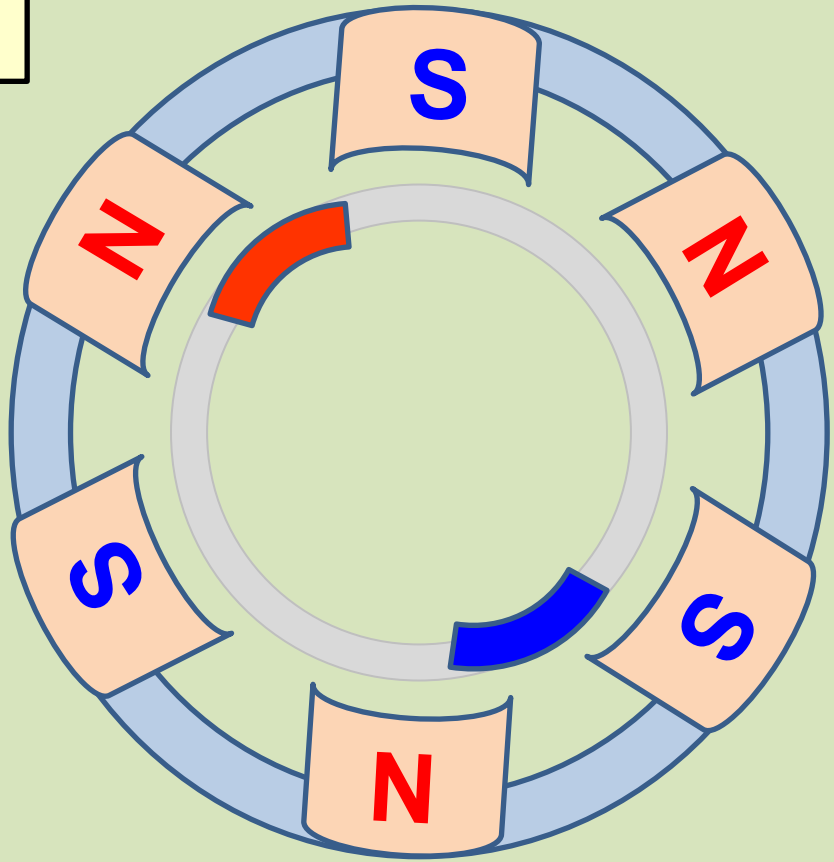
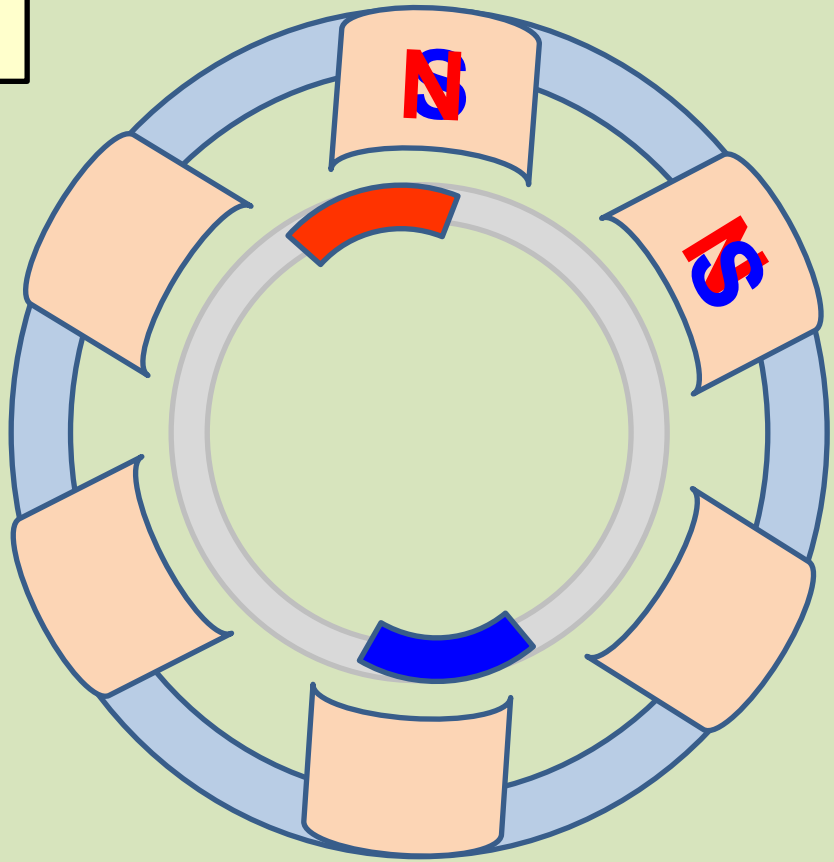
# BLDC Motor



# BLDC Motor



# BLDC Motor

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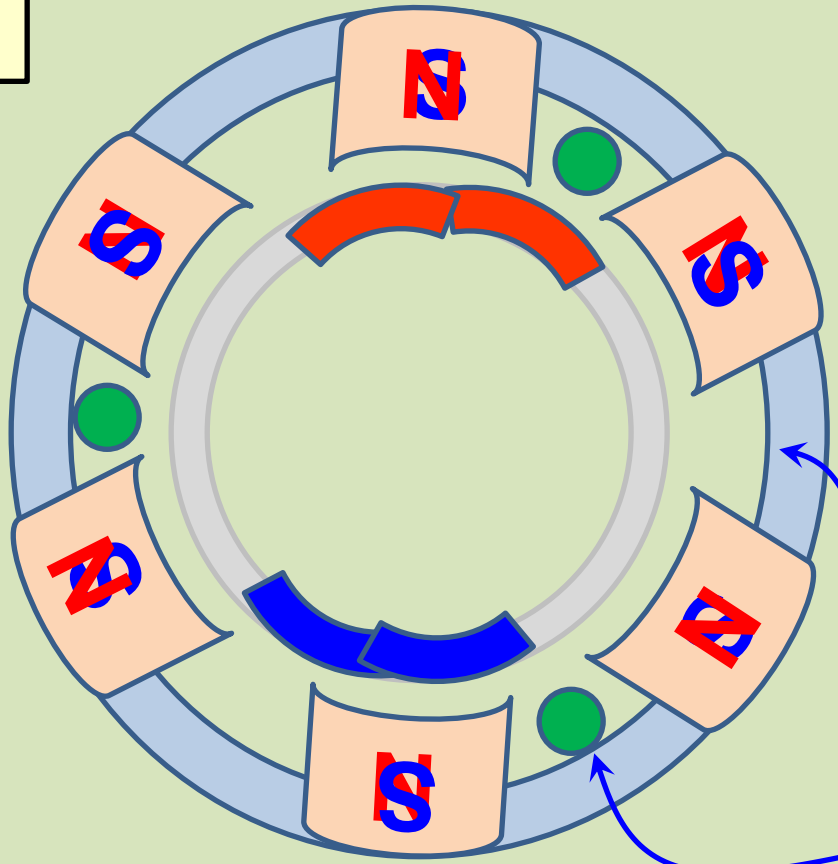
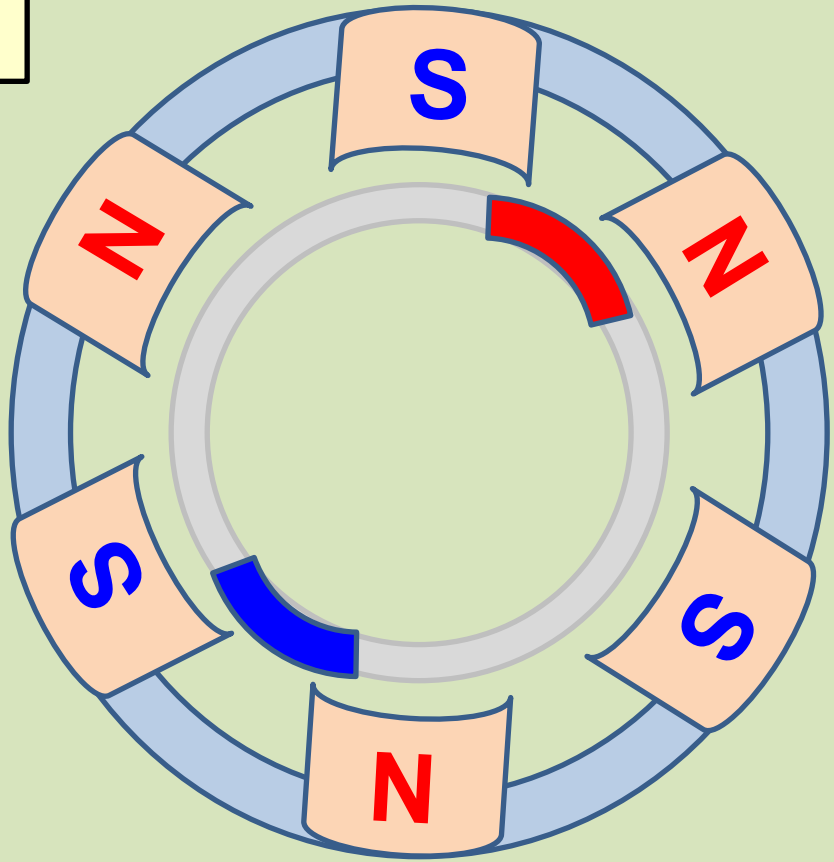


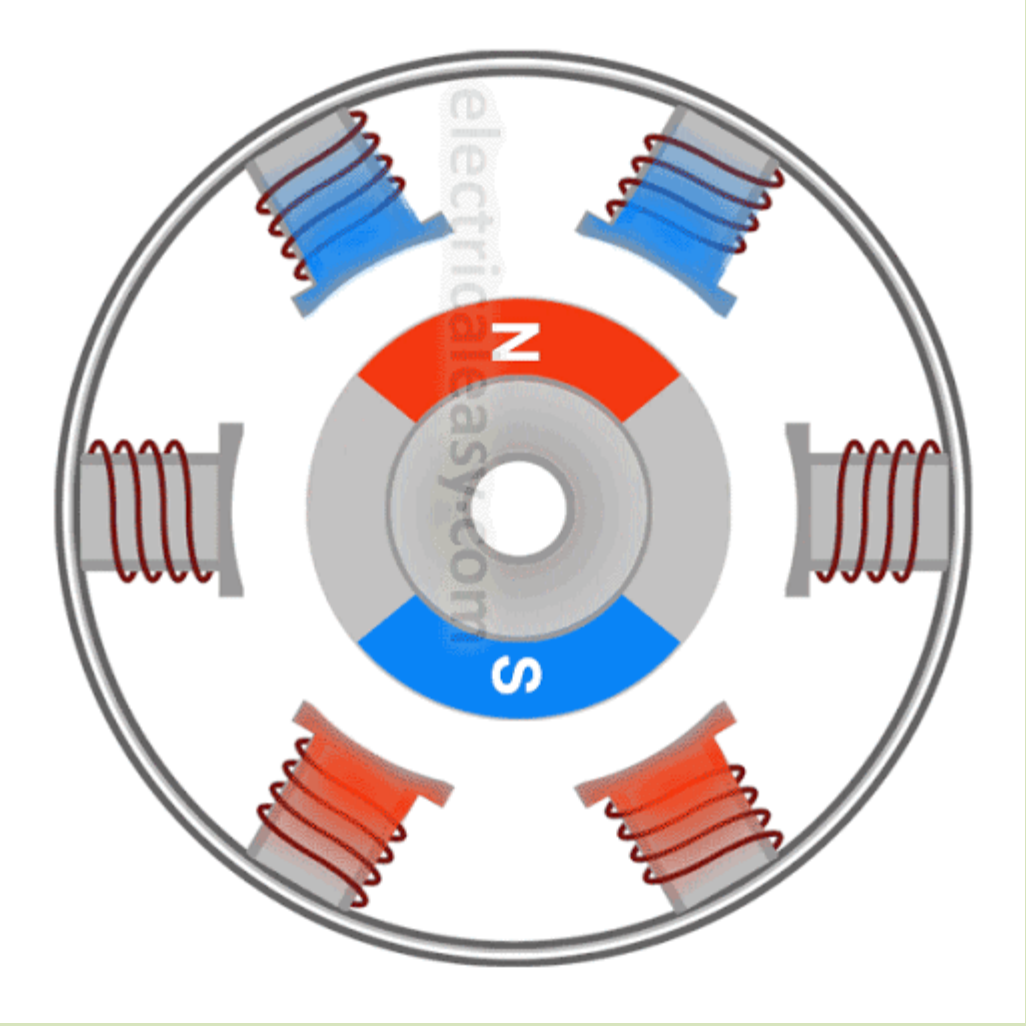

The Rotor pole keeps chasing the opposite pole of the Stator

The motor Driver circuit changes the stator polarity at correct moment.

Thus, to know exact location of the rotor pole, Hall effect sensor is required.

# BLDC Motor

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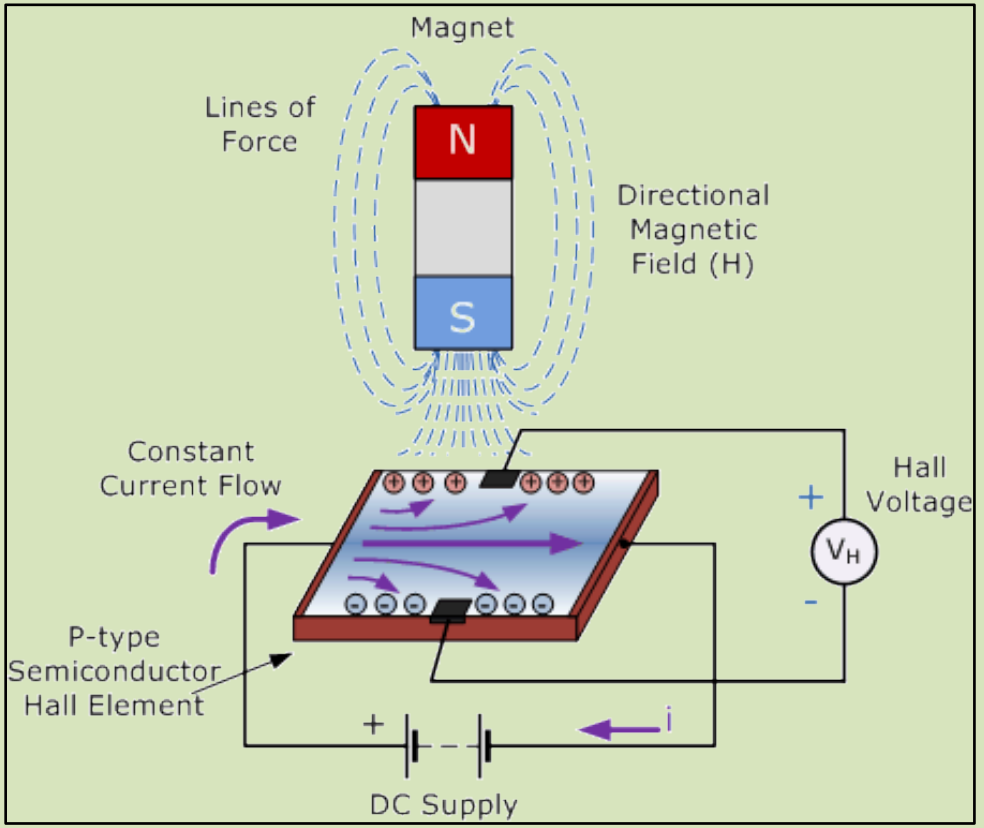
# Features of Hall effect sensor –

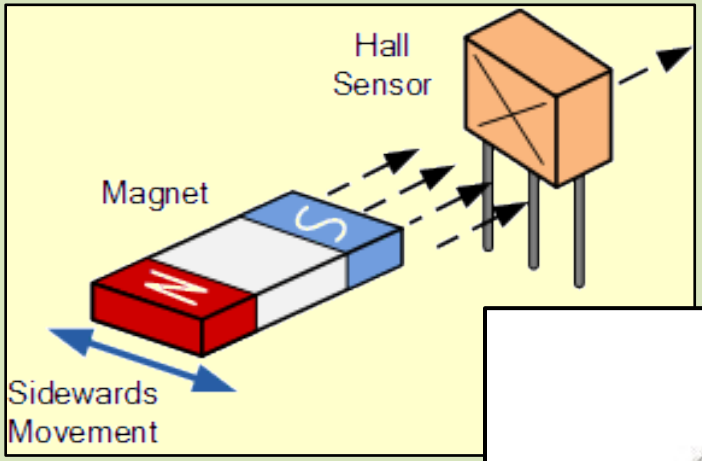
## Working –

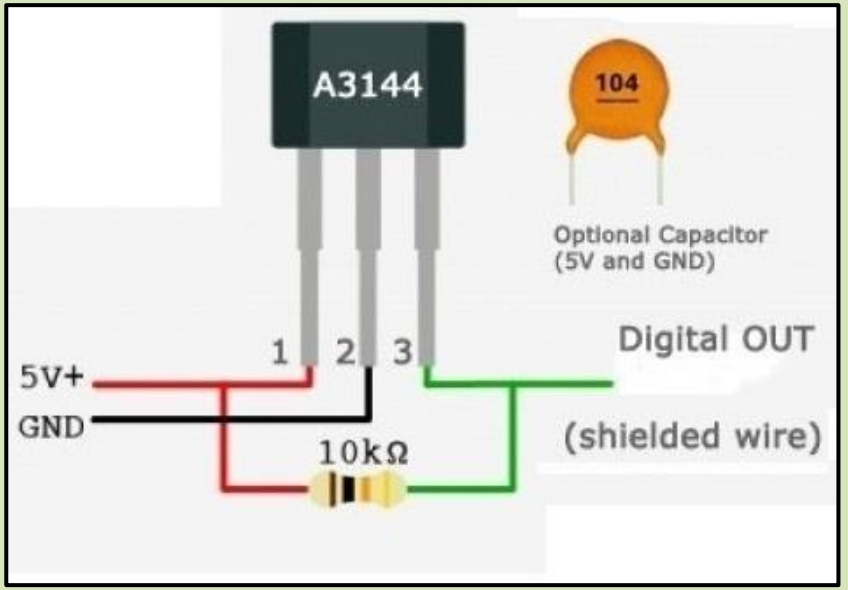
Hall effect – When a current carrying conductor is subjected to a magnetic field which is perpendicular to the flow of electric current, an EMF, which is at right angle to the path of the flow of current, changes.

Thus, the sensor senses this EMF and can detect existence of a magnetic field in the vicinity if it.



# Hall effect sensor in BLDC motor –

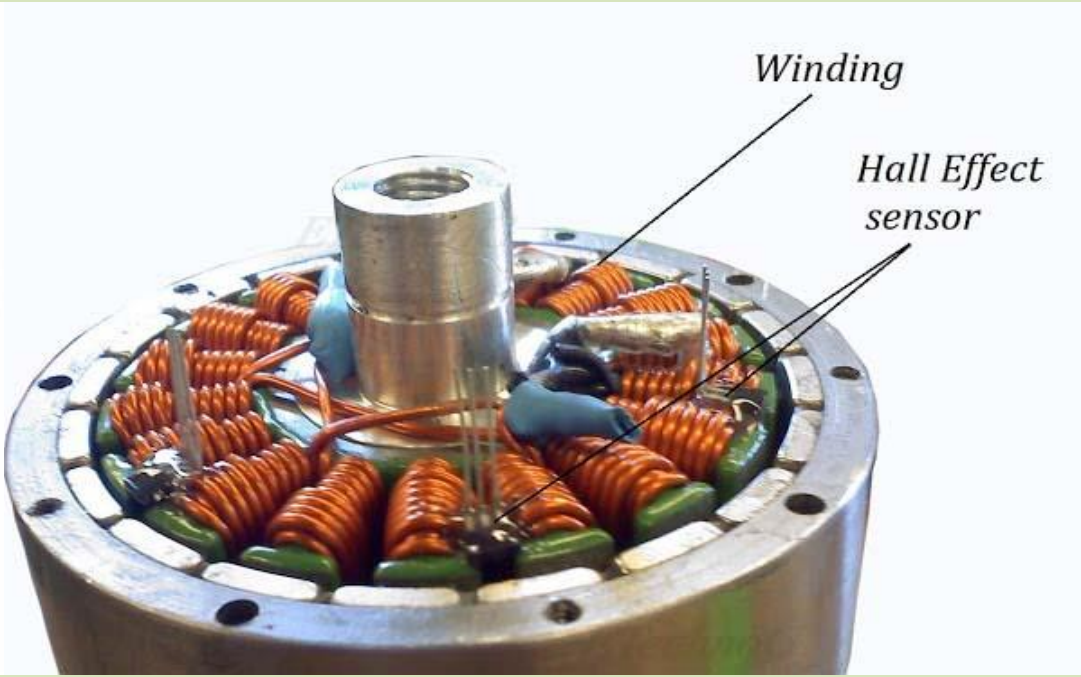





**Pin configuration and terminals of Hall effect sensor (3144)**

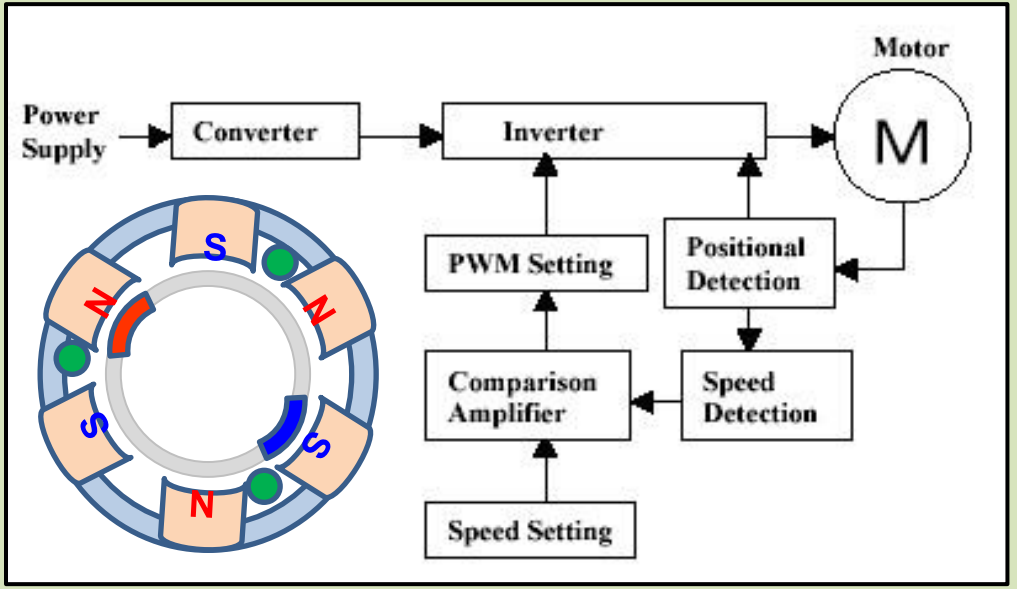
Digital out - This pin goes high, if magnet detected. Output voltage is equal to Operating voltage.

BLDC Motor



# Driver for BLDC motor –

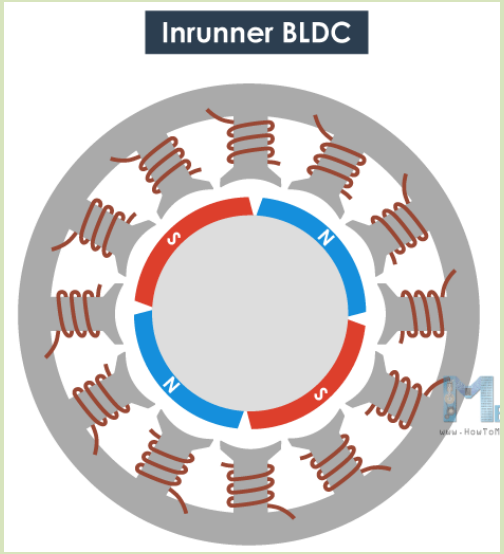
**What is a driver circuit ? – As the rotor approaches the stator pole, it is necessary to change the polarity of the stator pole at right time. So that the rotor will advance further and chase the stator pole. Thus, the position of the rotor should be known.**




**This is done by the Hall effect sensor and accordingly the stator pole is changed. The electronic circuit switching the stator poles is called as the driver circuit.**

# Types of BLDC motors –

1) Inrunner motor – The rotor carries the permanent magnet poles on it and it is surrounded by the stator with wound pole winding on it.

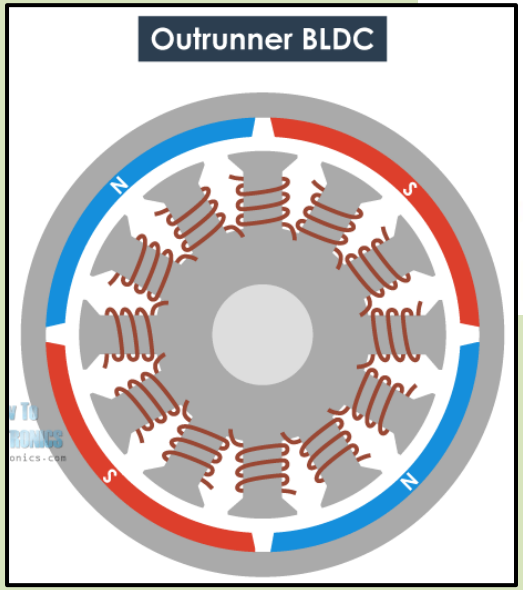


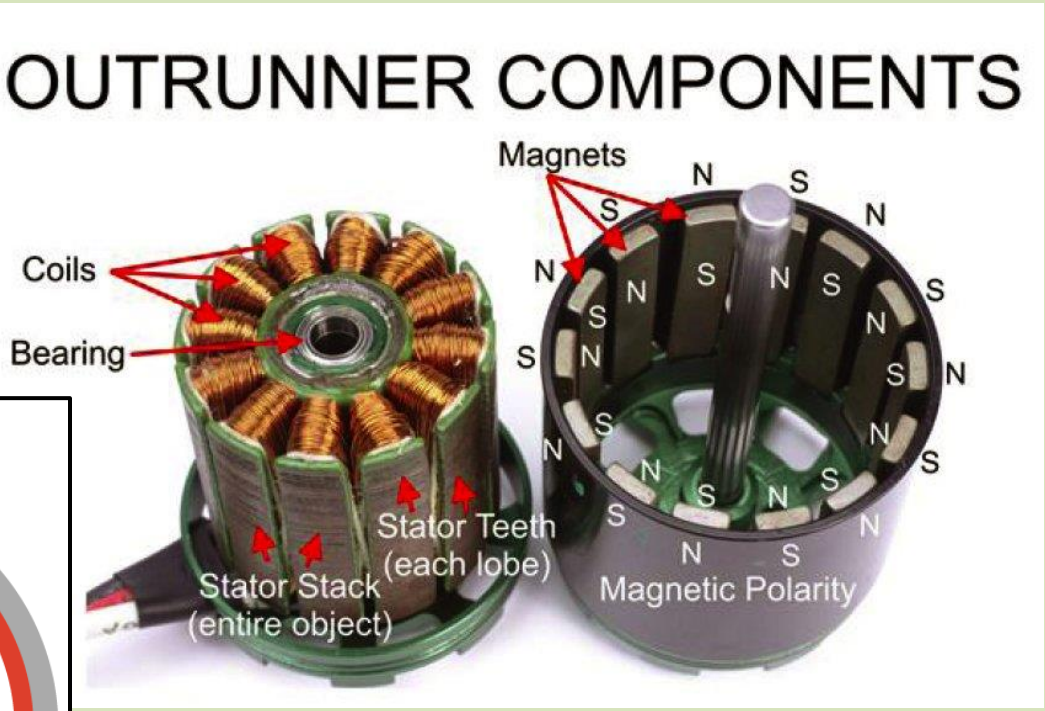
Outer stator with wound poles

Inner rotor with permanent poles

# Types of BLDC motors –

2) Outrunner type – The rotor with permanent magnet poles is outside and surrounds the stator with coils in it mounted on the shaft.



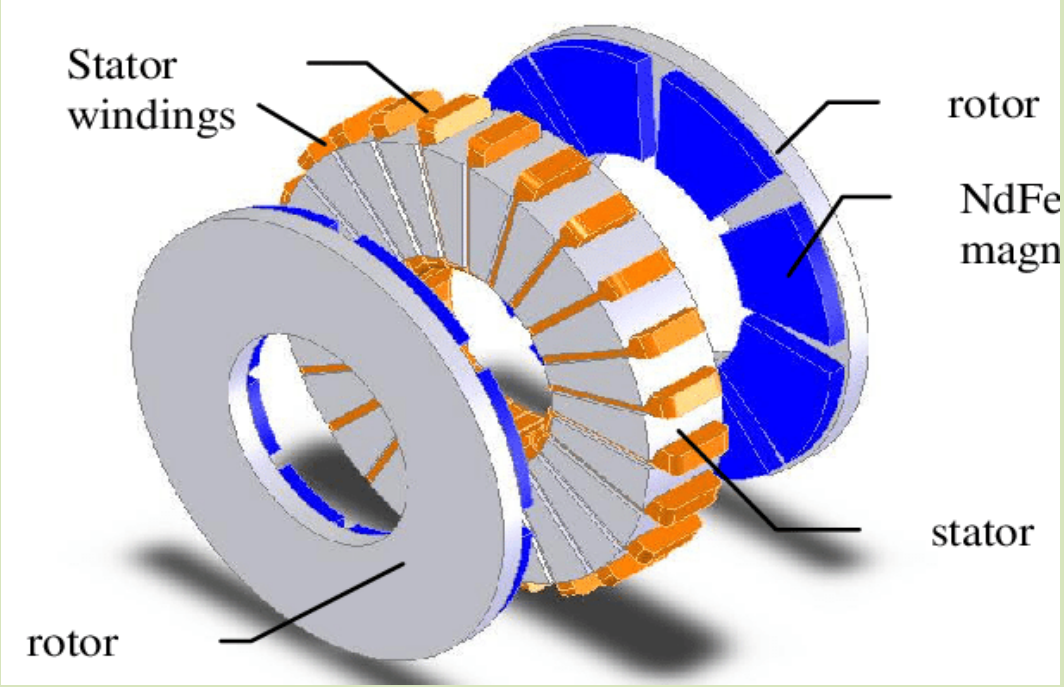



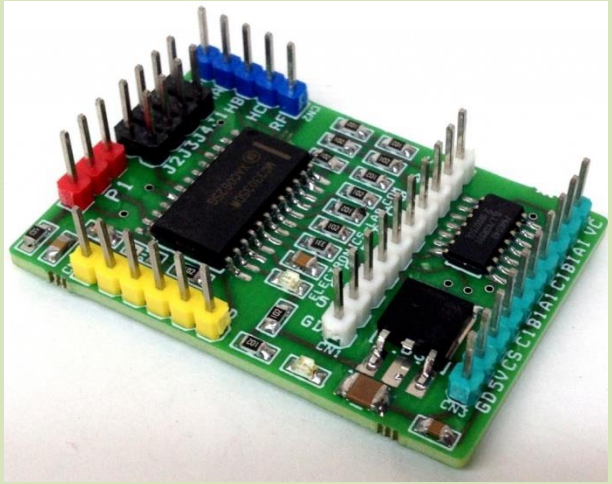
# Types of BLDC motors –

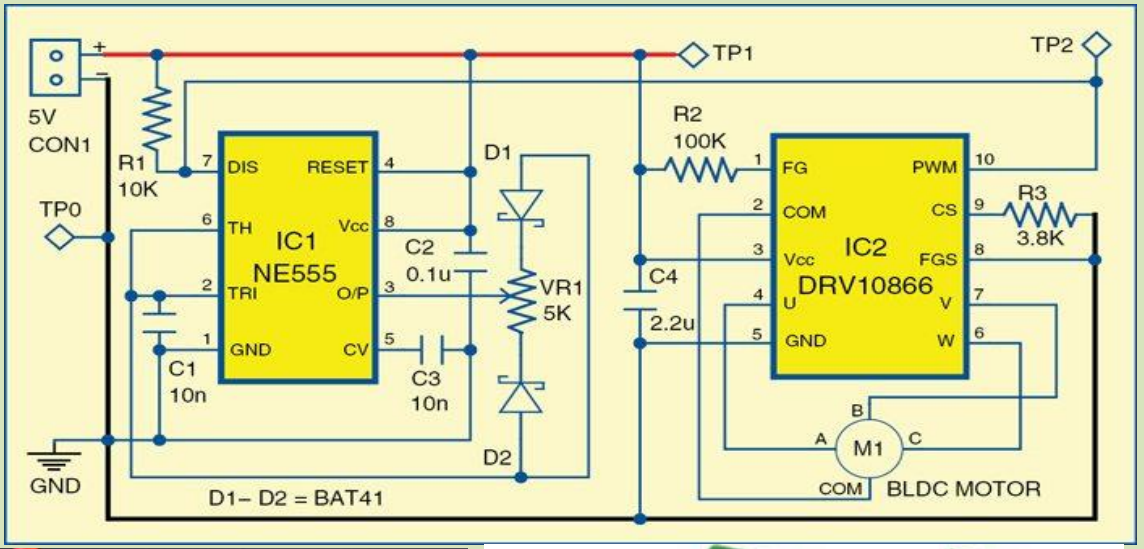
**3) Axial flux or Flat motor – The stator and rotor are mounted parallel to each other and face to face. Generally used where there are space constraints. These motors are also called as "Pan Cake" motors.**

**Stator coils are always stationary in all the 3 types.**

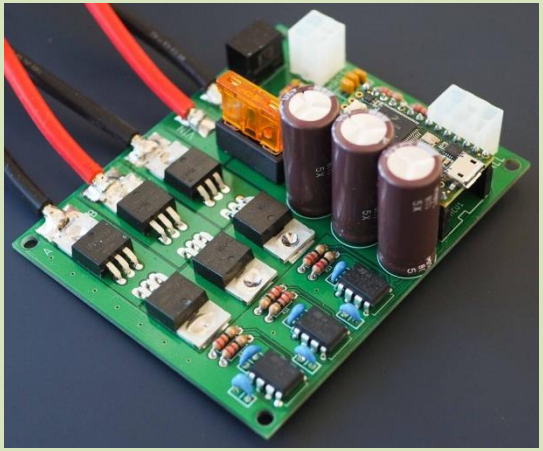
## Axial flux BLDC motor or Flat motor








**Driver circuits of BLDC motor …..**



# Applications of BLDC motor

- CNC machines
- Robotics
- Position control systems
- Electric vehicles
- Washing machines
- Hard drives of PC
- DVD drives
- Ceiling fans
- Blowers
- Air conditioners
- Refrigeration systems
- Aeromodelling
- Drones …… and many more ….

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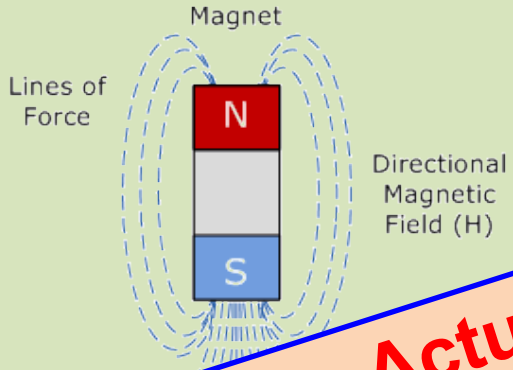
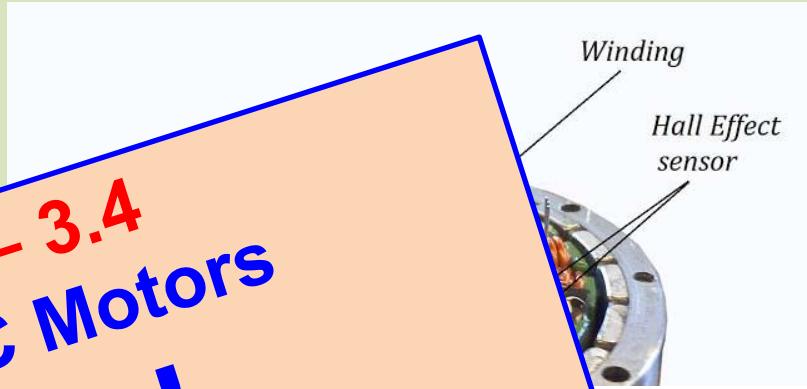
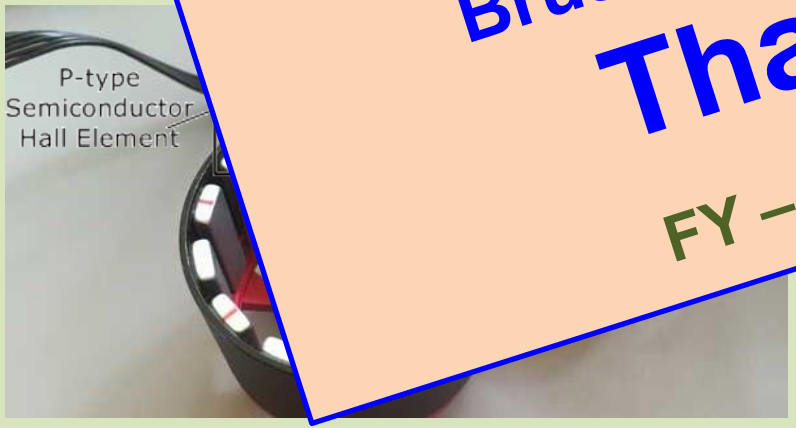
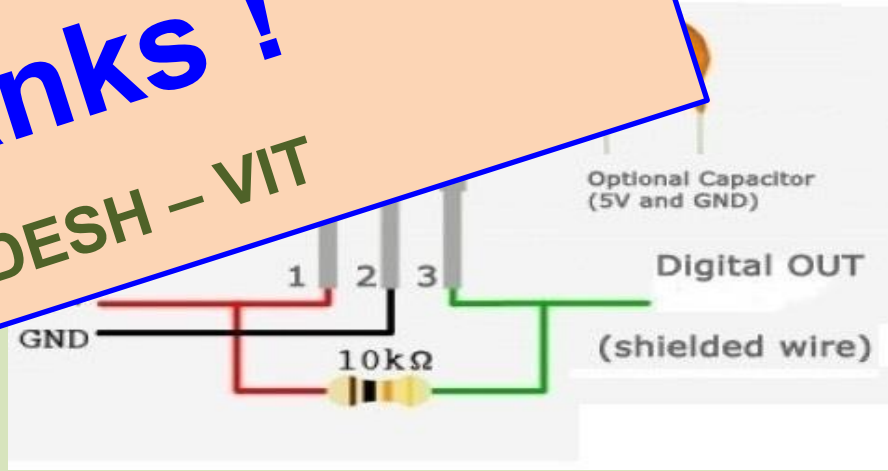



Constant Current Fl




# Actuators – 3.4

# Brushless DC Motors

# Thanks !

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