ROCO222: Intro to sensors and actuators

Lecture 3

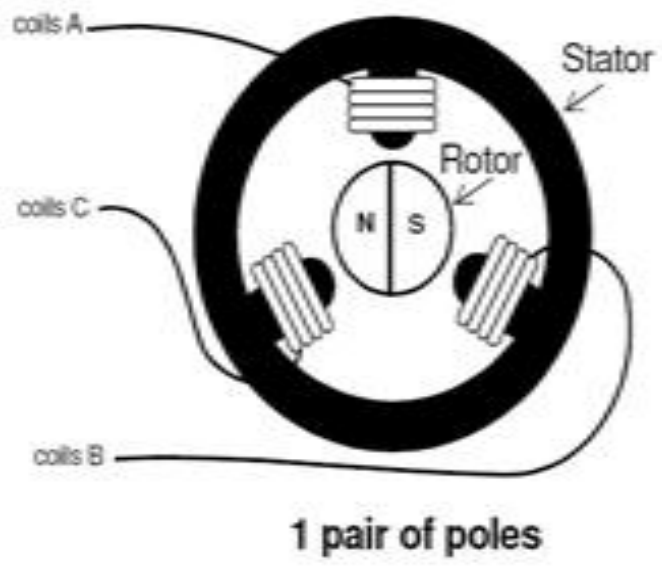
Brushless DC motors

Problems of mechanical commutation

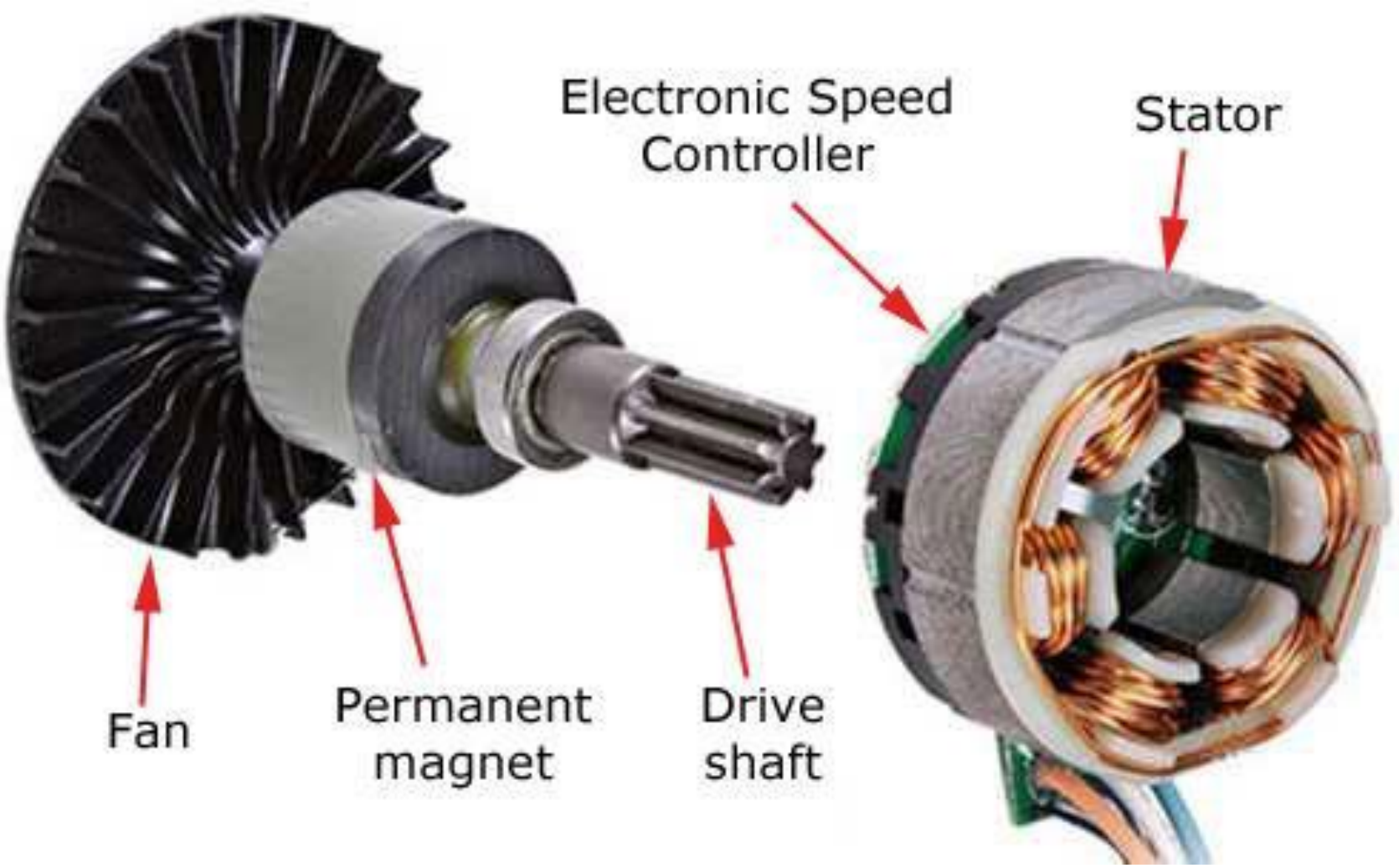
- Can get potential difference across commutator segments
- Commutation shorts out the commutator segments
- Arcing and sparkling at the brushes
- Brushless electronic switching solves this issue

Brushless DC Motor

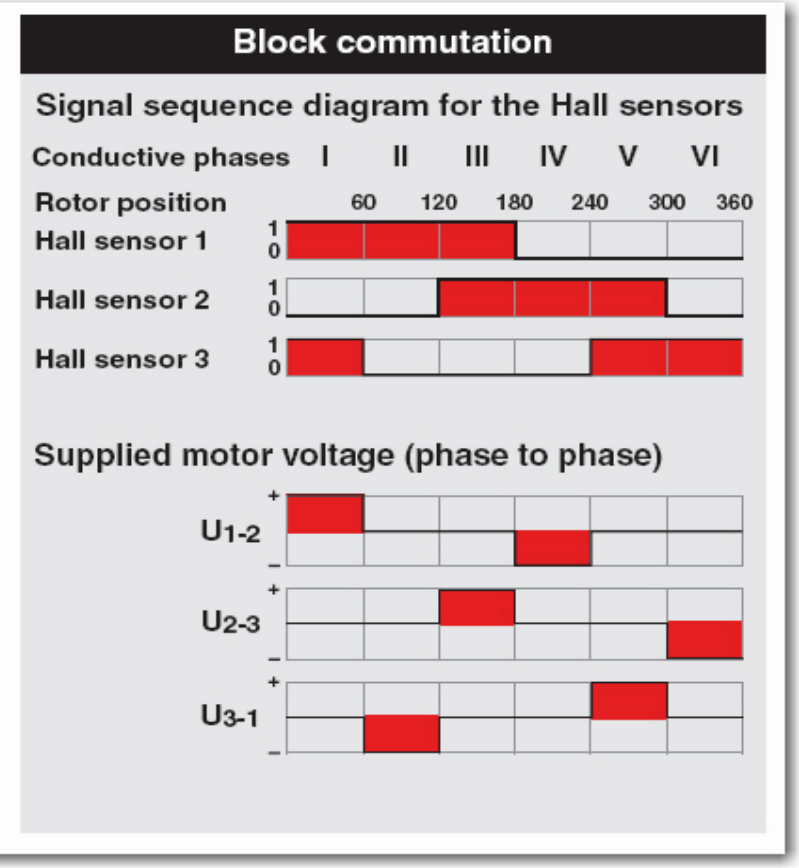
- This motor type looks like DC brushed motor turned inside out!
- In an EC (brushless) motor, commutation is performed electronically to eliminate brushes
- The stator generally consists of several coils
- Current flow in the stator coils creates magnetic field
- This forces the permanent magnet rotor turn
- The rotor can be forced to rotate continuously by switching on current in the stator coils in the appreciate sequence thereby generating a sequenced magnetic field
- All brushless motors require a controller to work that must perform the commutation operation

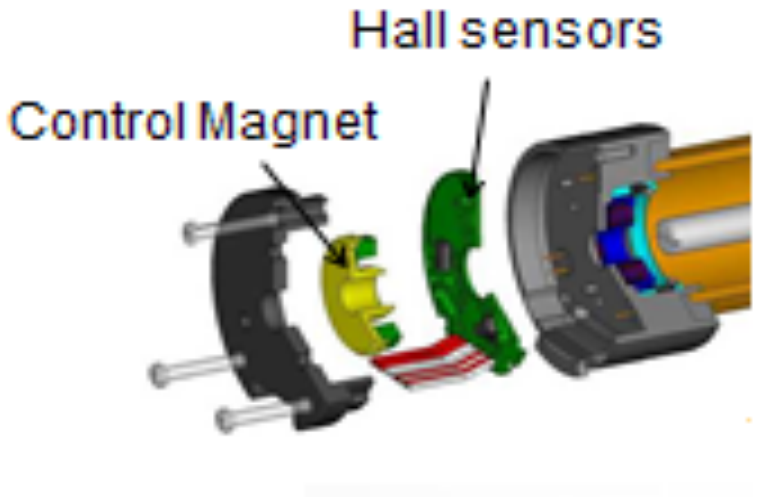


Typical brushless motor



How do brushless motors work?

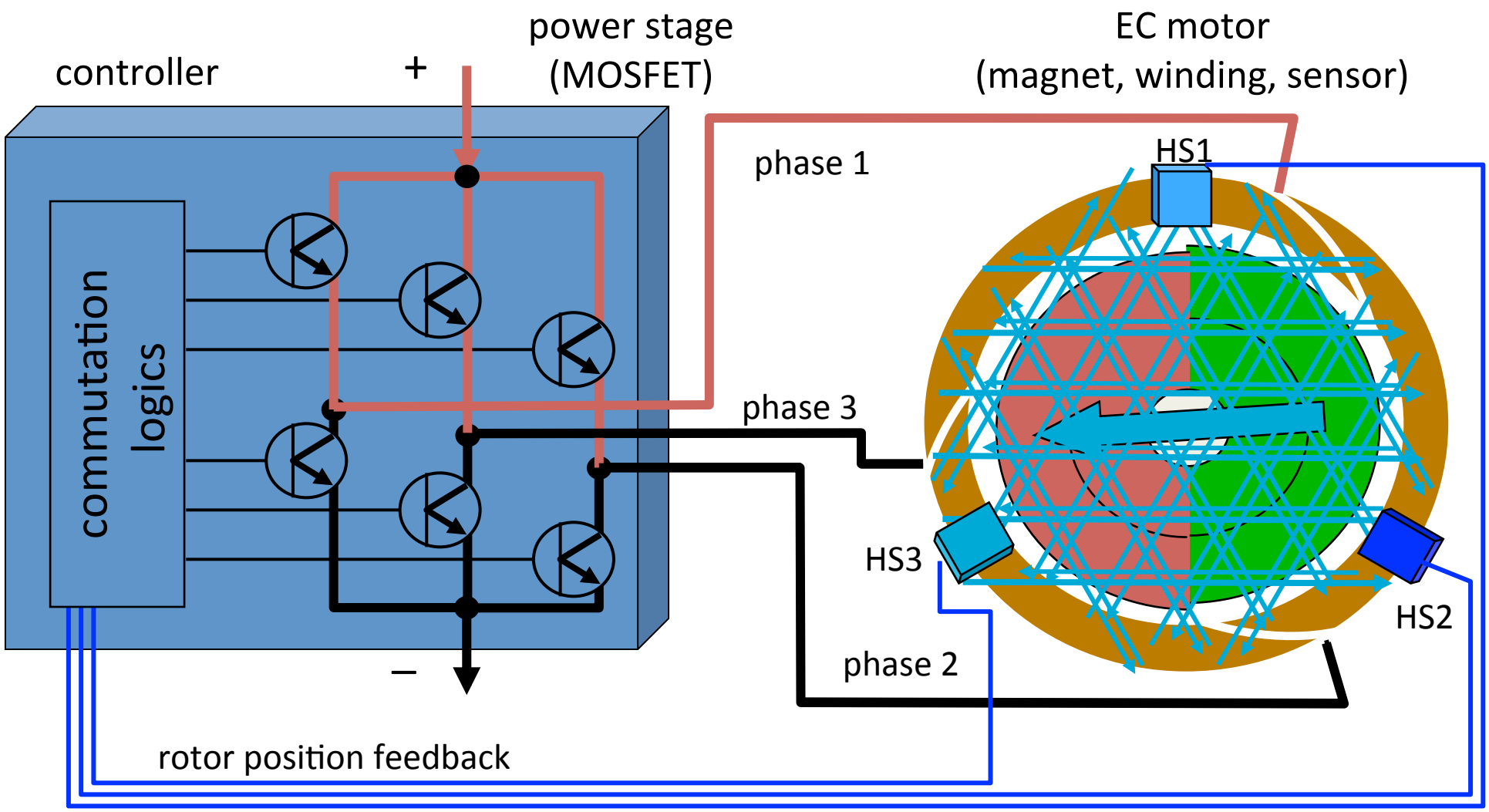




- Electronic commutation is used to switch current in the stator could so that the rotor is forced to rotate

- There is often a control magnet is in line with the poles of the large magnet in the motor to identify rotor angle so that the controller can switch current into the appropriate coils
- As it turns Hall sensors are stimulated by the magnetic flux.
- The Hall sensors are used to tell the controller what the orientation is of the magnet with respect to the three winding phases.
- Current in the stator coils is turned on and off in sequence creating motion from pole to pole.

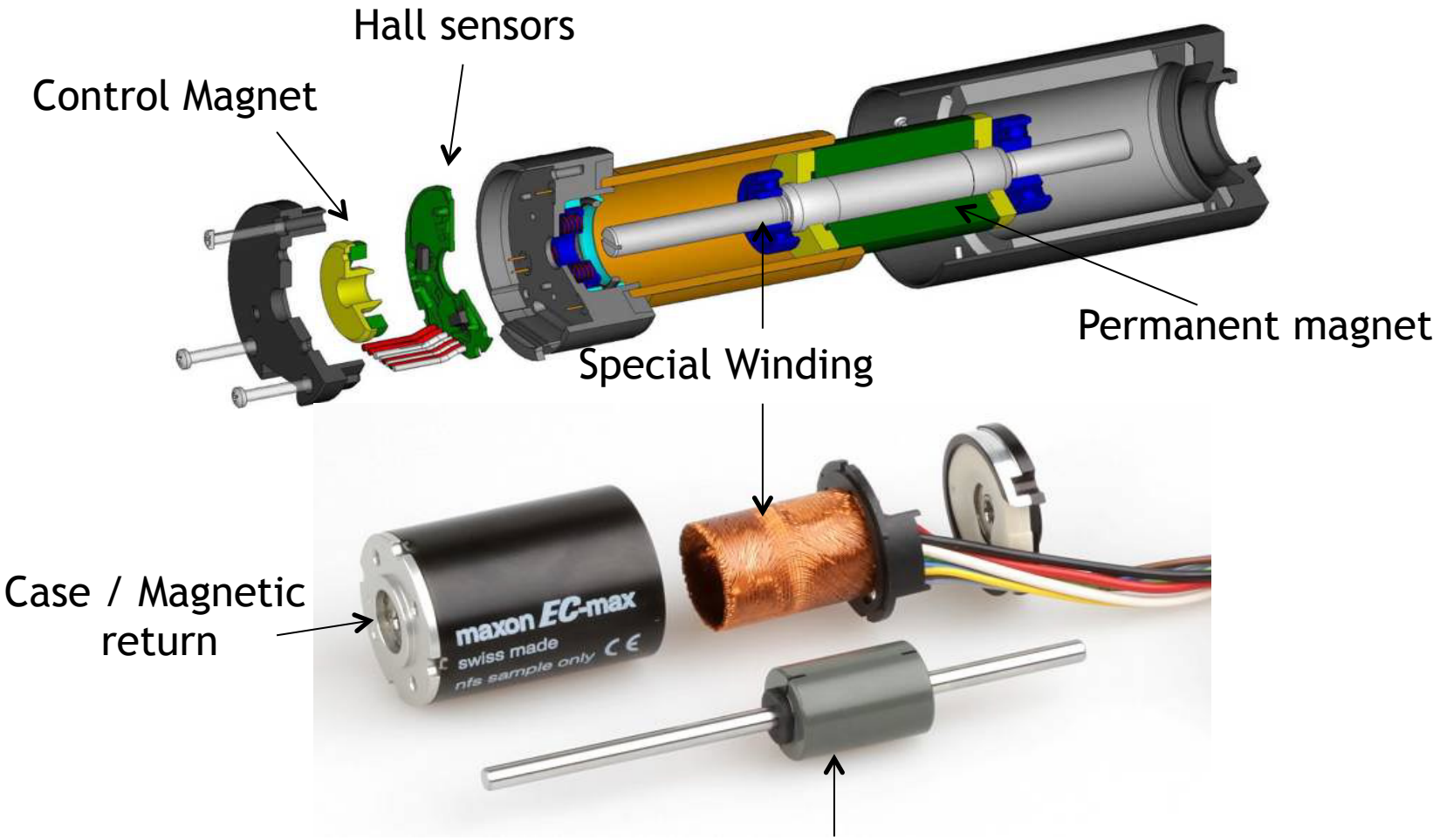
Block commutation



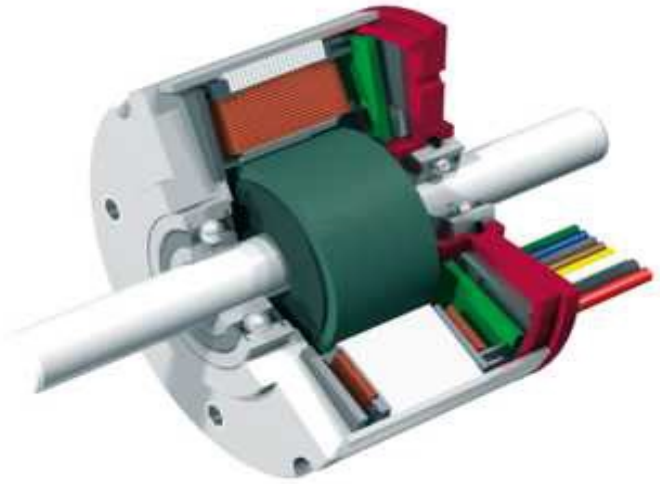
Brushless motor for RC aircraft

- Product Name : Brushless Motor;Model : A2212-6;KV : 2200RPM/V
- Fit for Battery : 2-3 Li-Poly;Fit for ESC : 30A;Shaft Size : 3 x 12mm/ 0.1" x 0.5"(D*L)
- Motor Part Size : 25 x 28mm/ 1" x 1.1"(L*D);Mounted Screw Hole Diameter : 2.5mm/0.1";Screw Hole Centre Distance : 13 x 13mm/0.5" x 0.5"(L*W)
- Cable Length : 55mm / 2.2";Material : Metal, Electronic Parts;Color : Silver Tone, Brass Tone
- Weight : 59g;Package Content : 1 x Brushless Motor w Prop Adapter

Maxon EC brushless motor



Maxon EC flat brushless motor



Multi pole motor

Flat design gives more torque as the flux is acting further from the centre of rotation

Advantages and disadvantages of EC

Brushed DC motors

- Mechanical commutation
- Need periodic brush maintenance
- Power losses in brushes
- Sparking
- Can have noisy operation
- Linear torque characteristic at lower speeds
- Change direction by changing voltage polarity
- Controller not always needed

EC motors

- Electronic commutation
- Low or no maintenance
- Less power loss
- No sparking
- Quieter operation
- More linear torque characteristic
- Change direction by changing switching sequence
- Always needs drive controller circuitry
- Requires sensors
- Higher reliability & efficiency
- Stator on outside – better for heat dissipation
- Longer life
- More expensive