ELEMENTS OF ELECTRICAL ENGINEERING
Course Code : UE25EE141A/B

PES UNIVERSITY

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ELEMENTS OF ELECTRICAL ENGINEERING

Brushless DC Motor – Principle of Operation & Applications

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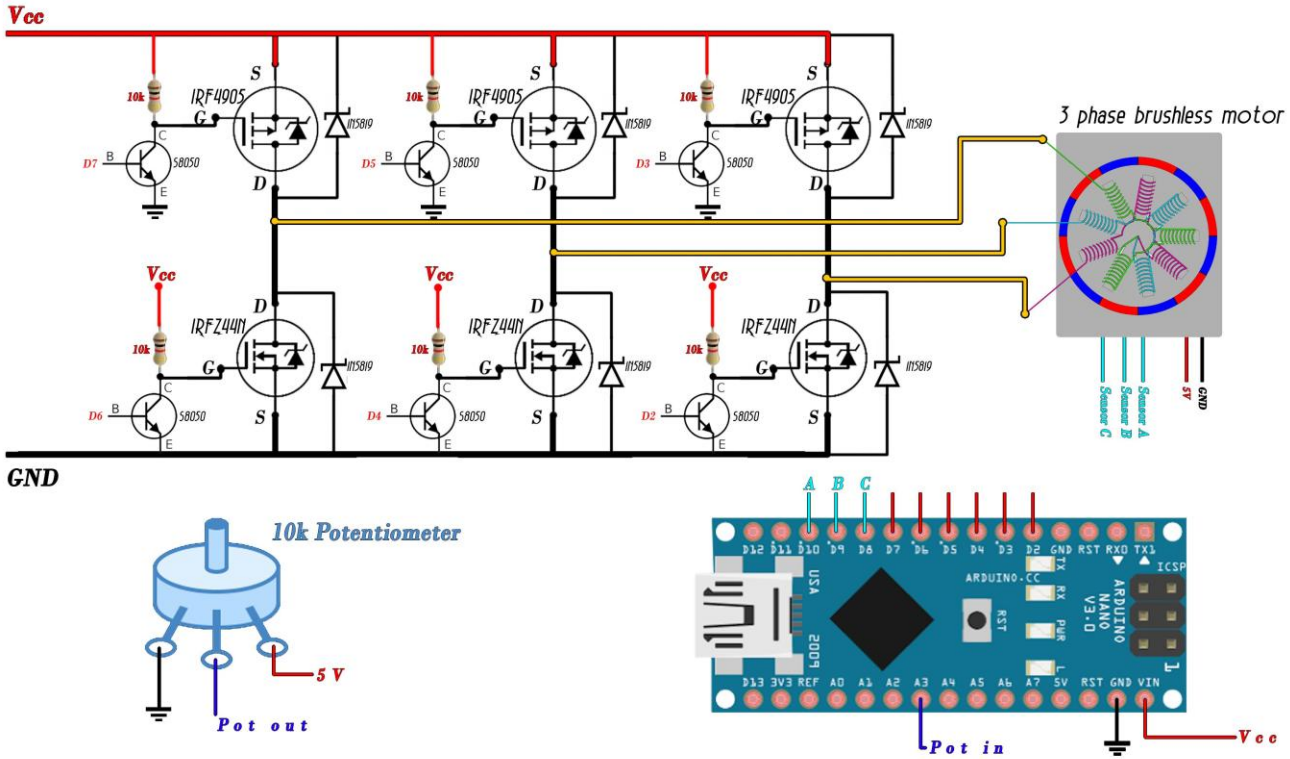
ELEMENTS OF ELECTRICAL ENGINEERING

Brushless DC Motor – Principle of Operation

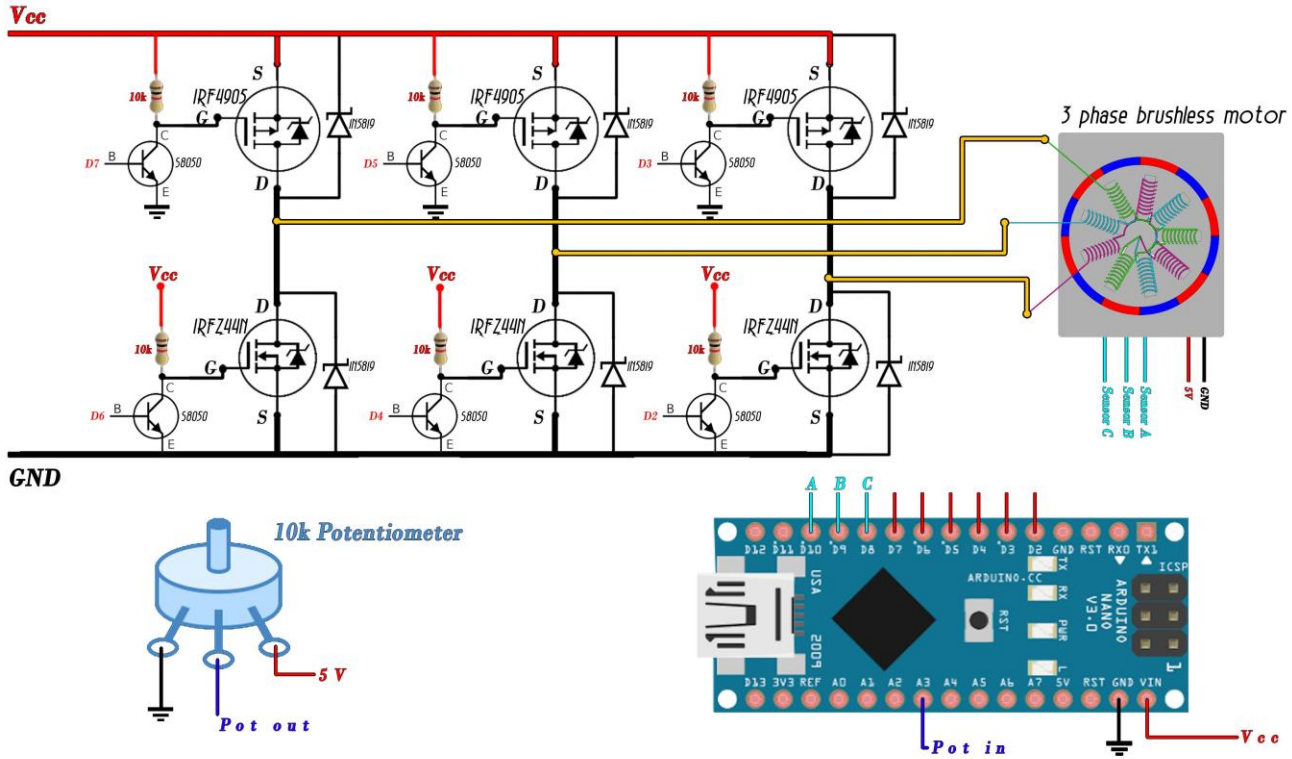
The operation of a BLDC Motor is based on a sequence of events which are performed repeatedly by ESC. The events are as follows:

i) **Rotor position sensing** : Done using Hall Effect sensors which send the rotor position information in the form of digitally encoded data to microcontroller.



Brushless DC Motor – Principle of Operation

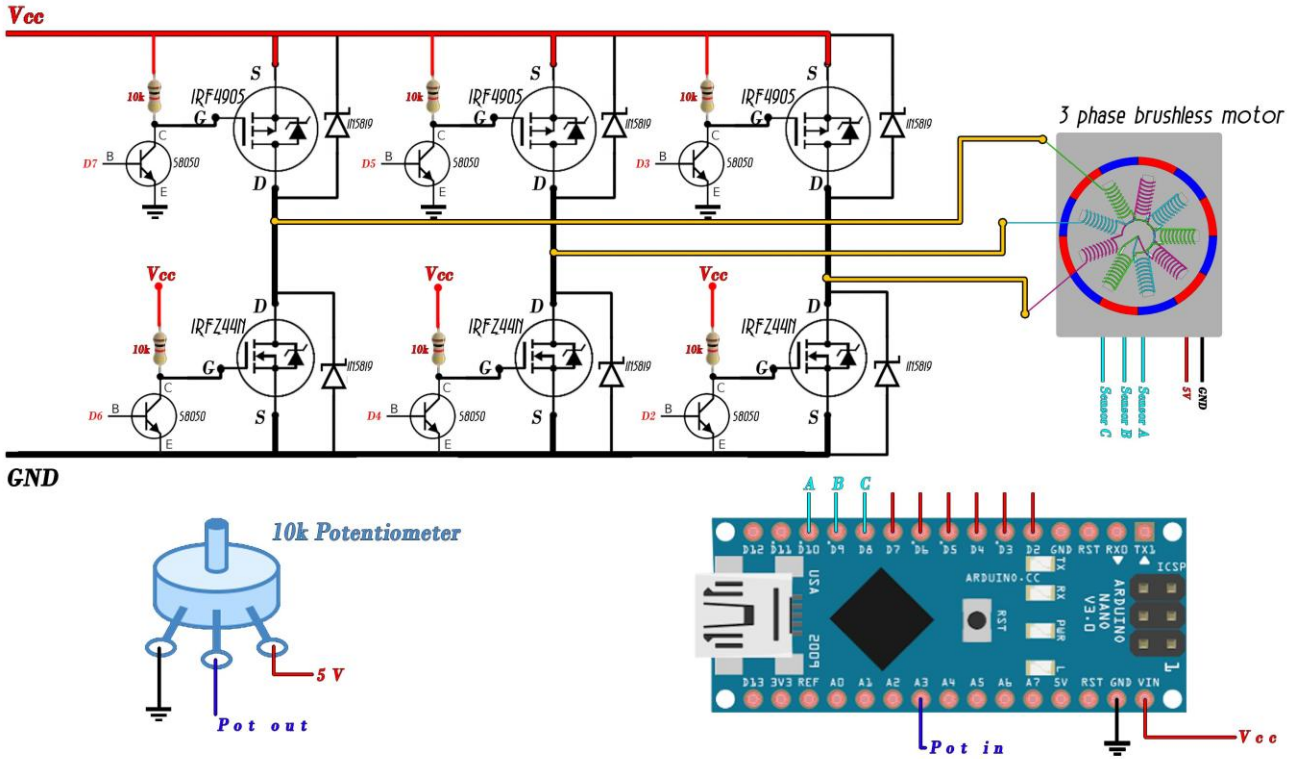
ii) **Electronic Commutation** :
Based on Hall sensor data processed by the microcontroller, gate driver circuit turns ON/OFF relevant switches in the Bridge Inverter so that at any point in time two out of three stator coils are energized.



Brushless DC Motor – Principle of Operation (contd..)

iii) **Torque production & Rotation of the Rotor** :

The newly created stator poles (due to new phase being turned ON) creates torque which forces rotor magnets to align to a new position in the direction of rotation.
ESC continues to perform this sequence of events repeatedly, which continuously rotates the rotor in the desired direction.



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Comparison between Conventional (Brushed) DC Motor & BLDC Motor

Feature	Brushed DC Motor (BDC)	BLDC Motor (Brushless DC)
Efficiency	Moderate (Typically 50-80%). Energy is lost as heat/friction at the brushes.	**High** (Typically 80-90%). No friction or resistance losses from brushes.
Maintenance	**High/Regular**. Brushes and commutator wear out, requiring inspection, cleaning, and replacement.	**Low/Minimal**. Lifetime is limited mainly by the bearings.
Lifespan	Shorter (Limited by brush and commutator wear).	**Longer** (Due to no mechanical wear parts).
Speed	Lower Max Speed (Limited by brush arcing/contact at high speeds).	**Higher Max Speed** (No mechanical limitations).
Noise	Noisier (Acoustic noise from brush friction and electrical noise from sparking).	Quieter (No brush friction or electrical arcing).
Control	Simple (Direct control by varying voltage).	Complex (Requires an electronic controller/driver for commutation).
Initial Cost	**Lower** (Simpler construction).	**Higher** (Due to the required electronic controller).

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Brushless DC Motor – Applications

BLDC Motors are ideal for applications requiring **high efficiency, long life, precise speed control, quiet operation, and higher power density** (more power for a smaller size).

Examples include Electric vehicles, Drones, Modern home appliances (like BLDC fans), Robotics, and Medical devices.

https://robu.in/difference-between-brushed-and-brushless-dc-motor/#:~:text=Home%20appliances%2C%20kid%20toys%2C%20in,Fans%2C%20pumps%20and%20blowers%20etc

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Text Book & References

Text Book:

1. "Basic Electrical Engineering" S.K Bhattacharya, 1st Edition Pearson India Education Services Pvt. Ltd., 2017
2. "Basic Electrical Engineering", D. C. Kulshreshta, 2nd Edition, McGraw-Hill. 2019
3. "Special Electrical Machines" E G Janardanan, PHI Learning Pvt. Ltd., 2014

Reference Books:

1. "Engineering Circuit Analysis" William Hayt, Jack Kemmerly, Jamie Phillips and Steven Durbin, 10th Edition McGraw Hill, 2023

2. "Electrical and Electronic Technology" E. Hughes (Revised by J. Hiley, K. Brown & I.M Smith), 12th Edition, Pearson Education, 2016.

THANK YOU

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