surface because of their high speed. It's referred as sputtering. Over a long time, sputtering can damage a spacecraft's thermal coating and sensors [2, 5].

Single charged particles penetrating deeply into spacecraft electronics systems may cause a single event phenomenon. One type of is a single event upset or "bitflip" [1]. This occurs when the impact of a high-energy particle resets one part of a computer' memory from 1 to 0, or vice versa. This can cause subtle but significant changes to spacecraft functions. For example, setting a bit from 1 to 0 may cause the spacecraft to turn off or forget which direction to point its antenna [2].

Total dose effects are long-term damage to the crystal structure of semiconductors within a spacecraft's computer caused by electrons and protons in the solar wind and the Van Allen belts. Over time, the cumulative damage lowers the efficiency of the material, causing computer problems.

Conclusion

In this paper the influence of cosmic factors on spacecraft was considered. It can be noted that, for optimum efficiency and effectiveness, definition of the flight environment is of great importance at the beginning of spacecraft design cycle.

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Brushless Direct Current Motor and its Control

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Introduction

BLDC motors have a wide variety of applications. The BLDC motor loads a commutator, so it is more reliable than the direct current (DC) motor. The BLDC motor also has advantages in comparison with an alternating current (AC) induction motor. With the ability to generate rotor achieve magnetic flux with rotor magnets, BLDC motors are more efficient and therefore are used in high-end goods (refrigerators, washing machines, dishwashers, etc.), high-end pumps, fans and other appliances which require high reliability and efficiency (satellite, aerospace equipment, etc.). There are some more advantages of BLDC motor, such as [1]: long service life due to a lack of electrical and friction losses; reduced noise because of the elimination of ionizing spikes from brushes; virtually maintenance-free due to a lack of brushes and mechanical commutators; more suitable for hazardous environments when BLDC motor can be completely sealed.

Main operational characteristics of BLDC motor are: high speed, short index moves; heavy load, high torque control; short duty cycle moves; high acceleration/deceleration capability; high productivity; compact size and small weight.

Besides the mentioned advantages, there are also disadvantages of brushless direct current motor: high cost because of permanent magnet rotor; system control and hall sensor are very expensive and properties of magnets decrease with increasing environment temperature.

Machine construction [2]

BLDC motors have many similarities to AC induction motors and brushed DC motors in terms of construction and working principles respectively. Like all other motors, BLDC motors also have a rotor and a stator.

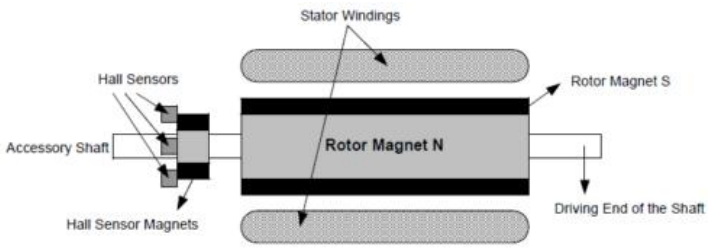
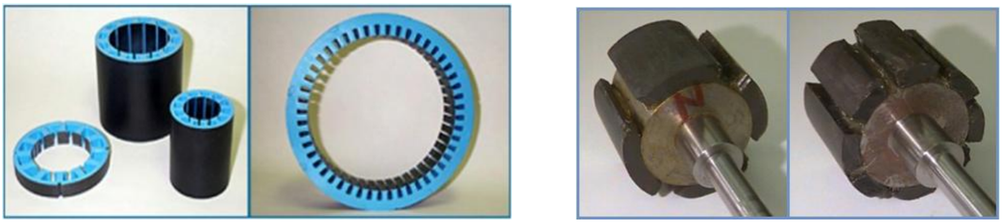


Figure 1 – Construction of Micrichip's BLDC

Similar to an Induction AC motor, the BLDC motor stator is made out of laminated steel stacked up to carry the windings. Windings in the stator can be arranged in two patterns: a star pattern (Y) or delta pattern (Δ).The major difference between the two patterns is that the Y pattern gives high torque at low RPM and the Δ pattern gives low torque at low RPM. This is because in the Δ configuration, half of the voltage is applied across the winding that is not driven, thus increasing losses and, in turn, efficiency and torque.



a) b)

Figure 2 – Laminated steel stampings – stator (a); 4 poles and 8 poles – permanent magnet rotor (b)

The rotor of a typical BLDC motor is made out of permanent magnets. Depending upon the application requirements, the number of poles in the rotor may vary. Increasing the number of poles gives better torque but it reduces the maximum of possible speed.

The BLDC motor control methods

The features of controller [3]

Like permanent magnet synchronous motors (PMSM), BLDC motor also uses 3-phase power to create a rotating magnetic field. However BLDC motor using DC current is controlled by the power key to DC voltage 3 phase lag of 120 to operate.

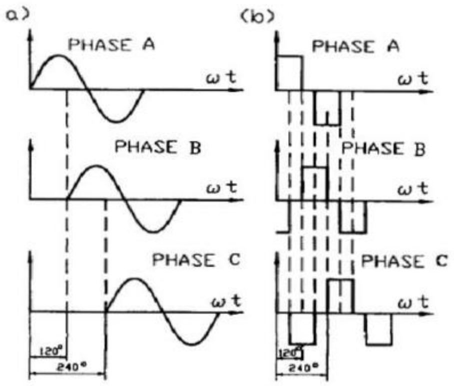


Figure 3 – Schematic comparison of three-phase sine wave and three-phase DC
a – sine wave; b – DC wave

The underlying principles for the working of a BLDC motor are the same as for a brushed DC motor. In case of a brushed DC motor, feedback is implemented using a mechanical commutator and brushes. With BLDC motor, it is achieved using multiple feedback sensors. The most commonly used sensors are hall sensors and optical encoders. In a commutation system is based on the position of the motor that is identified by using feedback sensors – two of the three electrical windings are energized in time.

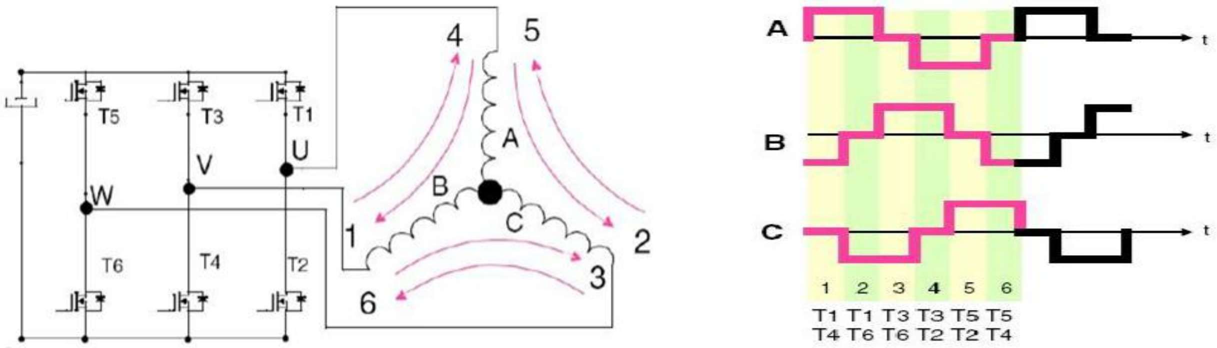


Figure 4 – The process of switching electronic keys to control BLCD and currents in the stator windings

The BLDC motor control methods

There are two main BLDC motor control methods: using sensor (Hall sensor or encoder) and without sensor.

Hall sensor – based commutation [4, 5]

In the Hall sensor technique, three Hall sensors are placed inside the motor, spaced 120 degrees apart. Each Hall sensor provides either a High or Low output based on the polarity of magnetic pole close to it. Rotor position is determined by analyzing the outputs of all three Hall sensors. Based on the output from hall sensors, the voltages to the motor's three phases are switched. The advantage of Hall sensor-based commutation is that the control algorithm is simple and easy to understand. Hall sensor-based commutation can also be used to run the motor at very low speeds.

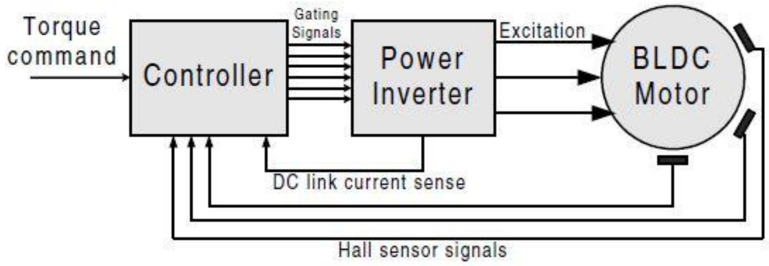


Figure 7 – The control method using Hall sensors

Sensorless commutation [6]

In the sensorless commutation technique, the back-EMF induced in the idle phase is used to determine the moment of commutation. When the induced idle-phase back-EMF equals one-half of the DC bus voltage, commutation is complete. The advantage of sensorless commutation is that it makes the hardware design simpler. Sensors or associated interface circuitry are not required in this method. The disadvantages are that this method requires a relatively complex control algorithm and, when the magnitude of induced back-EMF is low, it does not support low motor speeds. When a BLDC motor application requires high torque, or when the motor is moving from a standstill, the Hall sensor commutation technique is an appropriate choice.

Conclusion

In this paper engine construction and its control methods and in the future should be selected from the considered optimal method that can be used in space environment were examined. On the basis of the chosen method will be design a control system of BLDC manufacture experimental model.

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