Brushless DC – A Practical Guide to Implementation

Brushless DC (BLDC) motors have the performance advantages of DC permanent magnet motors without the need for motor brush maintenance. BLDC motors have the additional advantages of very high base speed (20,000 RPM and higher), quiet operation and energy efficiency. In years past these advantages came with an initial investment premium. Today that premium over traditional DCPM motors has been reduced to the point where BLDC motors and drives may be seriously considered.

The following is provided to help designers and users have a better understanding of the practical aspects of implementing BLDC motors and drives in their variable speed applications.

Drive & Motor Connection - The market for BLDC drives and motors is fragmented – evidenced by the number of companies who list themselves as Motor Manufacturers (133) and Brushless DC Drive Manufacturers (50)\(^1\). There is little standardization in terms of motor wire color coding, terminology or orientation – with 8 or more wires to connect from the motor it is very easy to misconnect to the drive causing erratic performance or damage. It is not unusual that the drive and motor will come from separate suppliers to meet the users’ requirements.

The recommendation when sampling a BLDC system is to request the motor, motor timing diagram and performance curve data all be sent to the drive manufacturer (or drive to the motor manufacturer). This will allow the suppliers involved to establish the correct connection and send the tested motor and drive to the user ready for evaluation.

Drive & Motor Voltage - There are defacto standard BLDC motor armature voltages on the market, with the most common being 24V. Experience finds the designer/user has already selected the motor prior to investigating drive options. When selecting a drive, there seems to be an expectation to apply (example) 120VAC source power and get 0-24VDC out of the drive. While this is possible, it is not advisable. Source voltage should be considered when selecting motor armature voltage – wide discrepancies between them mean energy is needlessly dumped across the drive, and the drive is forced to operate inefficiently. Speed range is restricted and speed regulation is compromised. Energy savings are sacrificed.

Line voltage BLDC drives (120VAC / 240VAC, single phase) typically produce 160 / 320 armature voltages as designed for optimum performance. BLDC motors can be wound for these voltages and a growing number of BLDC motor manufacturers are offering these options.

In some cases the best option for the user is a low voltage motor. In the absence of a low voltage power supply, the recommendation is to buy one. There are many makes and models of power supplies on the market with all the necessary electrical
certifications and voltage in / out combinations needed. Economy of scale makes the power supply manufacturer the best source for line voltage to DC voltage conversion, as opposed to a drive manufacturer incorporating this function into their product.

**Drive & Motor Speed Regulation** – The majority of BLDC drives are sensored (closed-loop) design. This means the drive is expecting some sort of feedback from the motor to verify its speed / rotor to phase position relationship to maintain electrical commutation by the drive. This feedback is accomplished using (typically) hall-effect transistors in the motor; or an encoder. Some drives and motors are being designed as ‘sensor-less’. The key here is a sensored drive is designed for use with a sensored motor. There are applications for both sensored and sensor-less designs. The recommendation to equipment designers / industrial users who wish to regulate the speed of their motors under varying conditions use a sensored design.

**Conclusion**

BLDC technology is gaining momentum as equipment designers and users consider size, weight, performance and long-term maintenance in their selection process for motor / drive packages.

In the 1/2HP and below market, BLDC is a viable alternative to brushed DC and AC motor / drive packages in terms of overall cost. Some applications (pumps and fans) see distinct advantages in BLDC through the unique ability to run at higher speeds to produce equal throughput, at a smaller size / weight / cost.

\(^{1}\text{Source - ThomasNet®}\)

Mark Lewis is Vice President – Marketing and Sales for Dart Controls, Inc. Dart designs and produces SCR, Digital and BLDC drives for the OEM and user markets from its factory in Zionsville, Indiana USA. Dart will celebrate 50 Years of Speed Control Innovation in 2013.

Mark Lewis  
VP-Marketing & Sales  
Dart Controls, Inc.  
5000 W. 106th Street  
Zionsville, IN 46077  
317.873.5211  
www.DartControls.com