Chapter-4

Sensorless BLDC Motor Drive for Automotive Applications

[1]K. Alfoni Jose, [2]Chikkala Sai Sirisha, [3]A. Konda babu, [4]K. Ganesh, [5]R. Kurma Kapoor
[1]Faculty, [2,3,4,5,6]Student, Dadi Institute of Engineering & Technology, Anakapalle
alfonibipin@diet.edu.in, 20U45A0210@diet.edu.in

Sensorless BLDC (brushless DC) motor drives have become increasingly popular in automotive applications due to their high efficiency, reliability, and low maintenance requirements. In a sensorless BLDC motor drive, the position of the rotor is estimated using information obtained from the motor's back EMF (electromotive force) waveform, eliminating the need for a physical sensor to detect the rotor position. The sensorless control algorithm typically uses a model of the motor and the associated electronics to estimate the rotor position and control the motor's speed and torque. This approach can be implemented using a variety of techniques, including software-based algorithms, observer-based techniques, and sensorless field-oriented control (FOC). The block diagram of Sensorless BLDC Motor drive as shown in Fig.1.

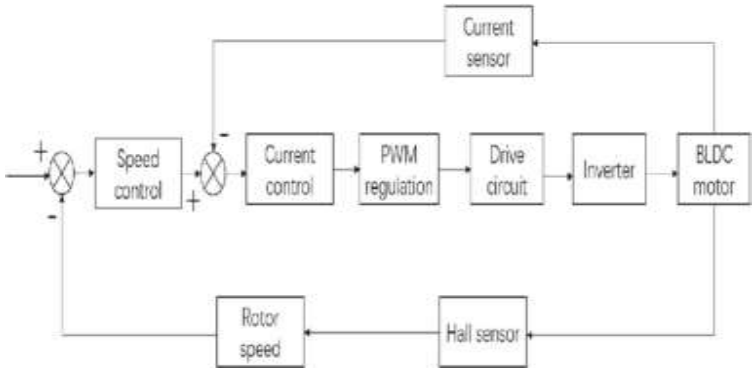

Fig.1: Block Diagram

The direct back-electromotive force (EMF) detection method in a sensor less brushless dc (BLDC) motor-drive system synchronously samples the motor back EMF during the pulse width modulation (PWM) off time without the need to sensorles. Since this direct back-EMF-sensing scheme requires a minimum PWM off time to sample the back EMF signal, the duty cycle is limited to something less than 100%. In this Chapter, an improved direct back-EMF detection scheme that samples the motor back EMF synchronously during either the PWM on time or the PWM off time is proposed to overcome the problem. In this Chapter, some techniques for automotive applications, such as motor-rotation detection, and current sensing are proposed as well.

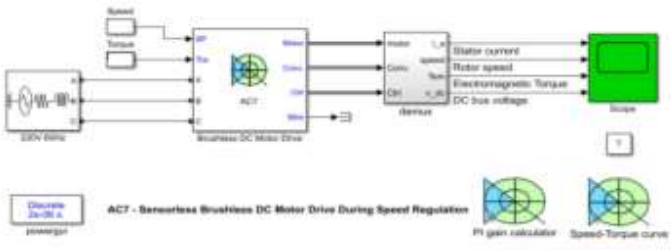
Fig 2: Circuit diagram in Simulink

The original direct back-EMF-sensing scheme has a maximum duty-cycle limitation, since there is a required high side-switch minimum PWM off time to do the detection and the speed will

be constant when the torque is decrease and if current will decrease then the torque is constant speed is increase. The improved direct back-EMF-sensing scheme eliminates this duty-cycle limitation by adding the option of sensing the back EMF during the high-side-switch PWM on time. An optimized system uses both sensing schemes where during motor startup and low speed, when back EMF is low, it is preferred to use the original scheme, since there is no signal attenuation. Experimental results are presented in Fig.3.

In this Project The use of electric motors in automotive applications has increased significantly due to their efficiency, reliability, and low emissions. One of the most common types of electric motors used in automotive applications is the brushless DC (BLDC) motor, which offers higher efficiency and reliability compared to brushed DC motors. However, traditional BLDC motor drives require sensors to detect the position and speed of the rotor, which increases the complexity and cost of the system. In addition, the sensors can be prone to failure due to harsh operating conditions and vibrations.

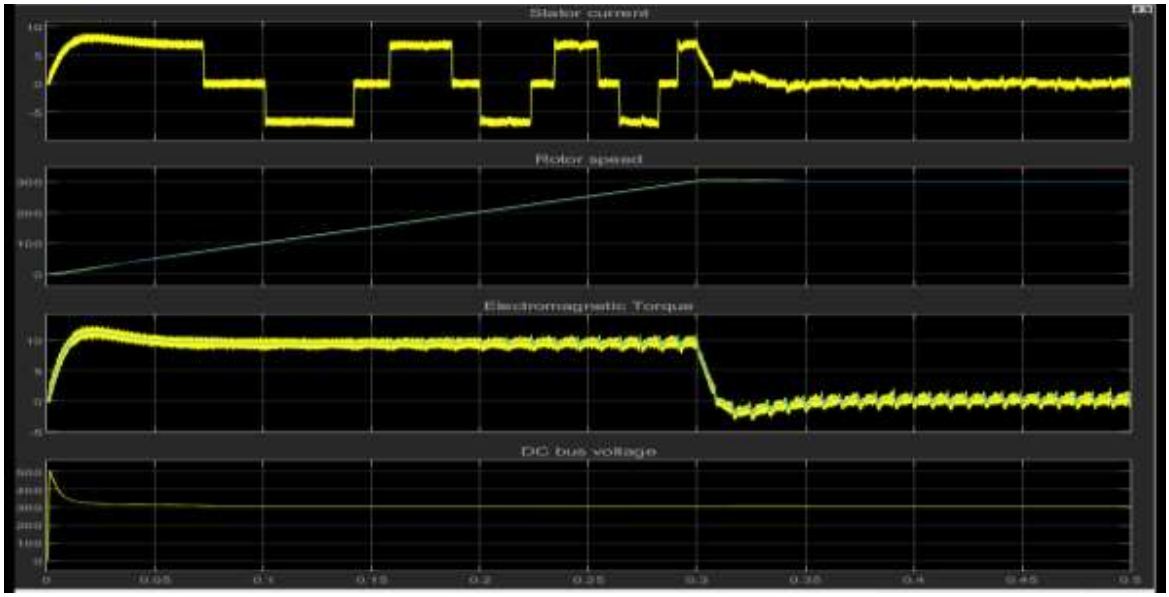

Fig 3: Simulink Results

At higher speeds, where the back EMF is much easier to detect, the system can switch to the alternative back-EMF-sensing scheme introducing some attenuation to the back-EMF signal and allowing for the high side switch to be full on. With the combination of two detection schemes in one system, the motor commutation detection can be optimized over the entire speed range. The experimental results verify this concept and show a good performance. For automotive applications, the algorithm to detect motor rotation caused by the windmilling effect is very useful. Also, the method of measuring voltage drop on MOSFET can provide over-current protection for the circuit but without current sensing resistor. The Sensorless BLDC motor drives are used in several applications which include Electric power steering, HVAC systems, Engine cooling fans, Electrical vehicles and Bicycles etc.

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