

ABSTRACT

The development of electric vehicles requires a motor drive system that is efficient and energy-saving. One technology that can be applied is regenerative braking, which is the process of converting kinetic energy during braking into electrical energy stored back in the battery. This Final Project aims to design a Brushless Direct Current (BLDC) motor controller capable of performing regenerative braking. The study is limited to testing within a fixed braking duration of 5 seconds, focusing on the relationship between motor speed (RPM) and the amount of regenerated energy.

The system design is carried out through PWM signal control for the BLDC motor driver using trapezoidal control and the integration of a boost converter circuit to regulate the reverse energy flow into the battery. The testing is conducted by observing the PWM signals, back-EMF signals, and inductor current waveforms using an oscilloscope. The system is tested at various motor speeds to evaluate the performance of the regeneration process and the resulting energy efficiency. The experimental data are quantitatively analyzed based on the motor output power and the battery input power.

The results show that the system can effectively regenerate power with the highest energy efficiency reaching 53.47%. The higher the motor speed, the greater the power and current that can be returned to the battery. The system's success parameters are measured through the comparison of regenerative power to motor output power, as well as the stability of the resulting output voltage. This controller system has been proven to improve energy efficiency and can be implemented as a power-saving solution for BLDC motor-based electric drive systems.

Keywords: trapezoidal, BLDC Motor, Regenerative Braking, Boost Converter, Energy Efficiency, PWM.