

Regenerative Braking System For An Electric Vehicle And Method Of Maximizing Regenerative Braking Energy Recovery

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ABSTRACT

A regenerative braking system (100) for an electric vehicle and method (900) of maximizing regenerative braking energy recovery is disclosed. The system (100) includes a controller (102) configured to detect a braking command from a driver during braking of the electric vehicle. A back-electromotive force (back-emf) of a permanent magnet synchronous motor (PMSM) (110) is estimated during the braking. A voltage source inverter (VSI) (106) that interfaces the PMSM (110) with a battery system (108) is controlled. The VSI (106) includes a set of upper switches and a set of lower switches. A set of pulse-width modulation (PWM) signals with varying duty cycles are generated for selectively switching the set of lower switches to the VSI (106) to manage braking force based on the estimated back-emf. A duty cycle of the PWM signals is regulated in response to the braking command and a speed error of the PMSM (110).

KEY APPLICATION AREAS

1. Electric Vehicles (EVs).
2. Regenerative Braking Systems.
3. Motor Drives & Power Electronics.
4. Battery Management Systems (BMS).
5. Automotive Energy Management.
6. Smart Mobility & Electric Transportation.

POTENTIAL USE

- 1.High-efficiency regenerative braking to recover braking energy and extend EV driving range.
- 2.Adaptive braking control for both fast and slow deceleration using dynamic PWM duty-cycle regulation.
- 3.Low-speed regenerative braking without drawing power from the battery, improving efficiency.
- 4.Battery life enhancement by maximizing energy recovery and reducing battery discharge.
- 5.Energy-efficient PMSM motor drive control through optimized Voltage Source Inverter (VSI) switching.
- 6.Electric passenger cars, buses, and commercial EVs, especially for hilly terrain and urban stop-and-go traffic.
7. Next-generation EV powertrains with improved energy efficiency, reduced energy consumption, and longer driving range.