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BLDC MOTOR for ELECTRIC VEHICLE REGENERATIVE BRAKING POWERED

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Abstract— Because fossil fuels are becoming extinct in the near future, it is now imperative to conserve them. These cars could be replaced by EVs. EVs are more inexpensive and ecologically friendlier than internal combustion engines. These cars have a restricted driving range because to their poor quality batteries and the lack of charging stations.
Regenerative braking is a technique used by BLDCM, which allows it to function when braking. The regenerative braking system manoeuvre for BLDCM is explained in this work. MATLAB is used to model the motor and regeneration aspects of the proposed scheme's performance.

Key words: EV, IC, PM, RBS, BLDCM, IM

I. INTRODUCTION

Even though cars have a significant social influence, ICE is a notable advancement in modern technology that has received praise in its field. The massive global expansion of the automotive sector, however, poses a major danger to the environment and fossil fuel supplies [1].

Fossil fuels are utilised to feed energy needed for haulage. These are awful for environment and can run out, but mostly because they release greenhouse gases [2]. The usage of EVs has lately been stressed in terms of satisfying its requirement for transportation, and endeavour to construct more effectual cars in this segment are speedy advancing [3].

One of these experiments focuses on regenerative braking, which replaces energy lost when the car brakes. It was called energy regeneration by researchers. [4] Making energy ready for reuse is the process of regeneration. By minimising wasted energy as greatly as possible, it improves energy effectiveness. Regeneration schemes are typically utilised to do this. [5]

Fuel costs for EVs are cheaper than for conventional automobiles since they are more fuel-efficient than ICEs. Unfortunately, the obtained distances are limited because of the inadequate batteries utilised in EVs. [6] There are very few electric vehicle charging facilities.

II. CONVERTER ANALYSIS

Block schematic for suggested circuitry is shown in Fig. 1. It has control circuits and a battery source feeding inverter.

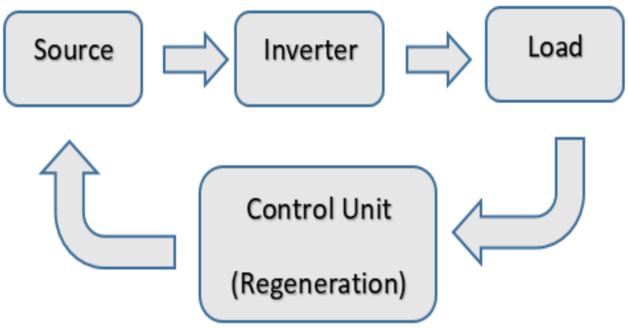


Fig.1. Typical Regenerating Scheme Block Diagram

In this circuit, the inverter that transforms DC into AC is fed a DC source. The appropriate BLDCM is provided this AC voltage. The inverter switch is given with PWM pulses by using the required control technique. It is a good idea to have a backup plan in case something goes wrong. The AC load will then be fed with it. Regenerative braking is worn to produce electricity to charge battery.

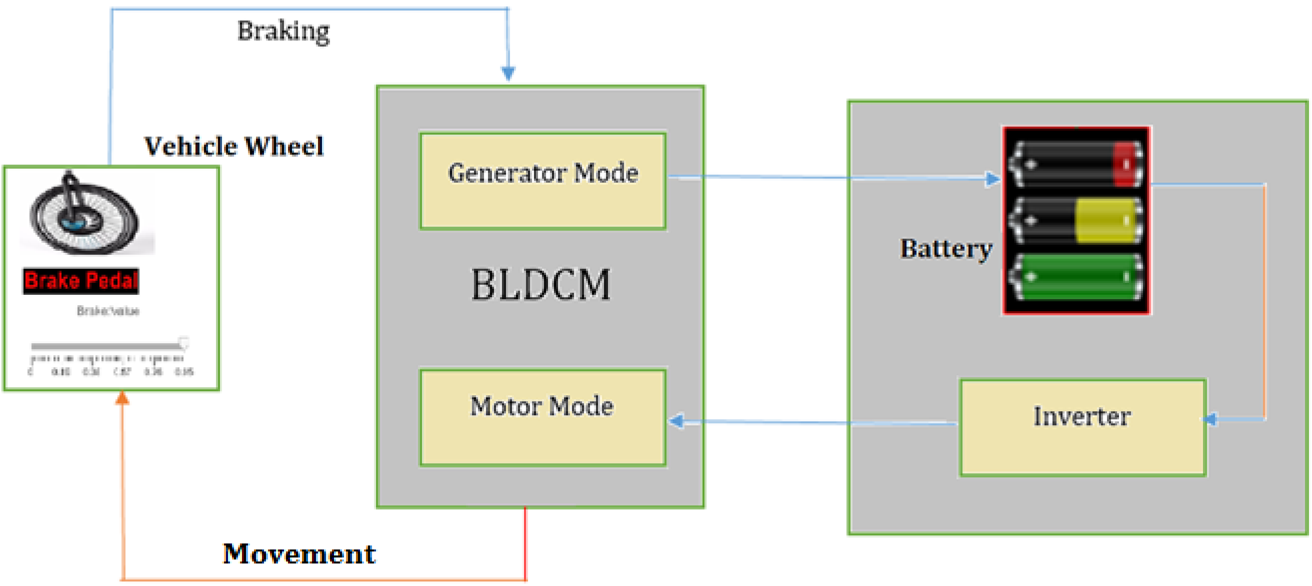


Fig. (2). Suggested Method for Supplying an Induction Motor with an Isolated SEPIC Converter

III. PROPOSED SCHEME

The suggested BLDCM drive system is shown in Fig. 2 along with a regeneration strategy.

A greater switching frequency used by inverter switches allowed for effectual control through lower component ratings, such as Ims. Nonetheless, MOSFETs are used in inverters to operate at lower frequencies.

Motor speed N s is equated with N s* to provide error signals, or deviation of N s* together with N s, which is supplied to PI block to obtain output in a controlled way. The regulated output must finally be compared to a higher frequency triangle wave that produces pulses (PWM) for switching the relevant inverter.

The properties of the brake pedal, which is used to control the motor's speed, also show how much power is recovered when braking.

IV. BLDCM OPERATION

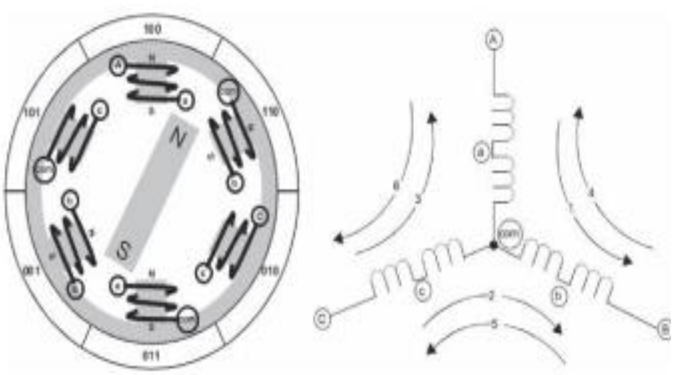


Fig.3: Rotor position circuitry

As its higher power densities, favorable speed-torque attributes, astounding efficiency, wider range for speed, and lower maintenance supplies, BLDCM are perfect for EVs. Exceptional subset for synchronous motors are BLDCMs. The following are the results of the survey. Induction motors frequently display "slip," while BLDCM does not. Yet to control it, rather intricate circuitry is needed. In BLDCM, PMs are inserted at rotor, and armature windings are attached to stator with laminated steel core. Form phases are pairs of energy-opposing pole windings that consecutively initiate and maintain rotation. It is essential to determine the rotor orientation to keep the windings flowing.

It is feasible for BLDCM to drive thanks to the inverter. Using semiconductor technology, the switches. Quick switching is possible with this type of switch. Each phase of stator employs the use of two switches. The battery is a critical part of an electric vehicle. The system's total energy supply is maintained constant even when electrical energy is being stored in this way. Again, for battery to store energy, a voltage must be provided that is greater than the battery's capacity. Boost converters are required for low-voltage systems such as this in order to attain essential voltage for battery

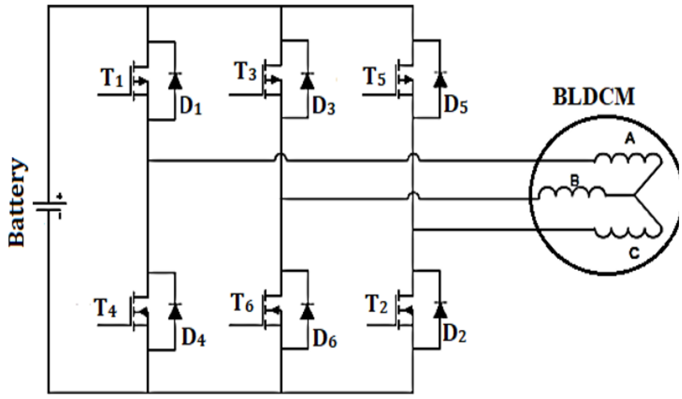


Fig.4: BLDCM Inverter Circuitry

Inverter and electronic switching are used together. The flow of current through the three-phase inverter circuit during normal driving and regenerative braking is seen in the diagram below.

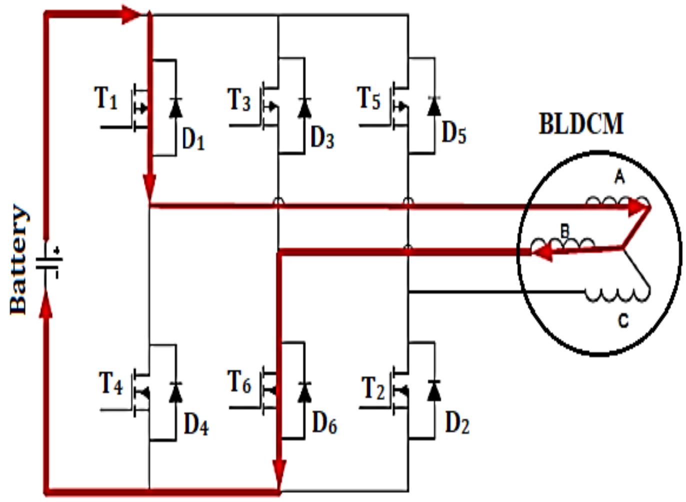


Fig. 5. Flow of current during Motoring

The current in switches has to flow in opposed direction furthermore it is supplied back to battery throughout the regenerative braking approach. Current flows through battery, D1, and T6 even while all switches are off. Nevertheless, PWM enables braking intensity to be changed. The greatest amount of regeneration is possible when all low-side switches are off.

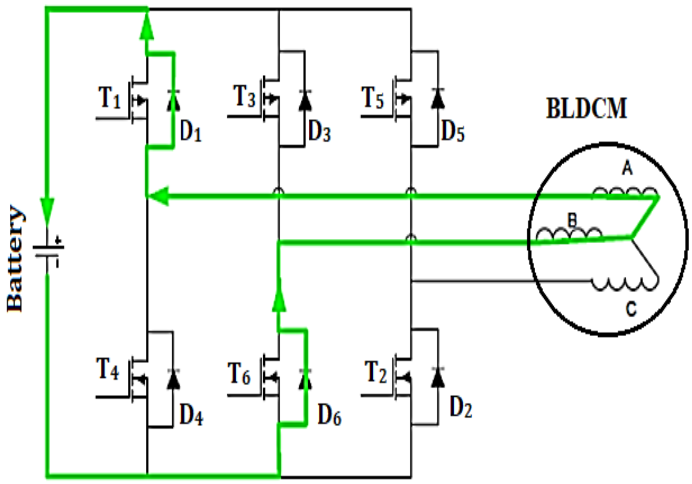


Fig. 6. Flow of current during regenerative braking

V. Control Schemes for Scheme

A. PWM GENERATOR

The PWM generator receives the output from the PI in order to produce a steady frequency PWM signal with a configurable duty ratio. Triangular waveform is used to equalize the outcome of PI, and PWM is produced.

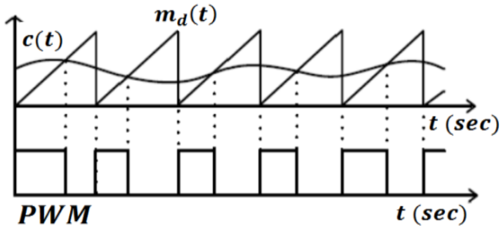


Fig.7. Pulse generation in PWM

B . CONTROL FOR PI

Motors often employ PI control, sometimes known as control systems. A single sensor controls the motor. The reference speed is then contrasted with the motor speed. To calculate error speed, N s* is chosen as the reference and compared to motor speed N (s).

The slip error at all instant [11],

$$N_e(k) = N_s{*}(k) - N_s(k)$$

Error in speed is supplied to PI for generating controlled speed. The controlled outcome from PI controller is $N_c(k)$

$$N_c(k) = k_i N_e(k) + N_c(k-1) + k_p\{N_e(k) - N_e(k-1)\}$$

Where Kp as well as Ki are equivalent constants for proportional with integral gain. A higher frequency Triangular signal is equivalent to an output that starts the controller's production of PWM pulses for the inverter switch's switching.

VI. Simulations And Results

A. MODEL OF THE PROPOSED SCHEME IN SIMULINK

MATLAB simulates the predicted system. Figure 8 depicts a Simulink model of a regenerative system with a BLDCM that changes speed using PI Control and an external brake pedal.

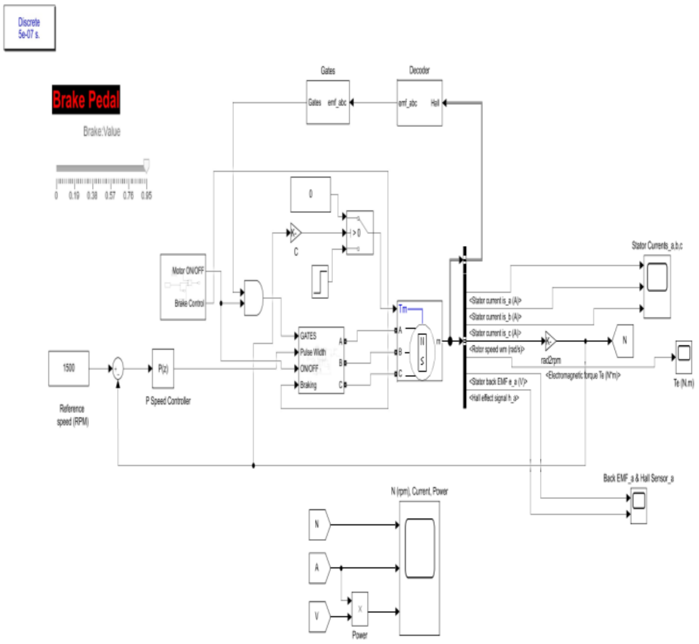


Fig.8. Model of the Proposed Scheme in Simulink

B. RESULTS FOR PROPOSED SYSTEM

At starting, no brake is applied, vehicle is moving with reference speed. At this stage, brake is applied from the values on brake pedal from 0% to 95%. Again, brake pedal is released to zero, speed increases and tries to settle at reference speed. At this stage, full brake is applied, speed decreases suddenly and comes to zero. While a full brake creates an abrupt, significant reduction in speed, a moderate brake just marginally slows down motion.

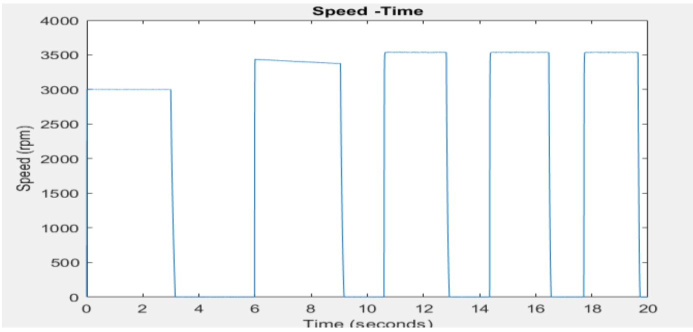


Fig.9.Speed Waveform

The speed deviation depicts the relevance of pedal at respective fluctuation in speed. While applying gentle brake, speed decrease slightly whereas full brake yields an abrupt decline in speed.

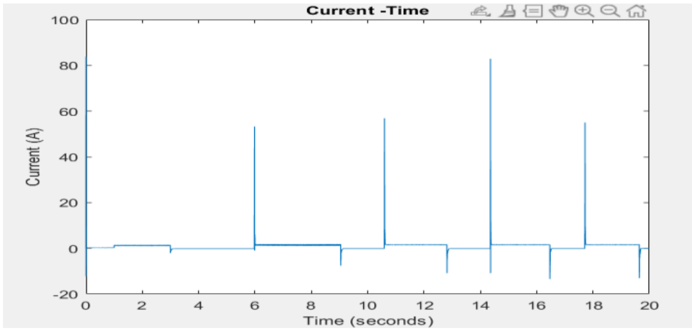


Fig.10. Current Waveform

The current waveform is expressed in Fig 10.It depicts the waveform for motor current. First peak in motor current waveform is starting current, initially motor speed increases and tries to settles at reference speed from its standstill. After few seconds motor speed became constant and stator current also. Current varies in accordance with speed changes. When the brake pedal is pressed, the speed decreases while the current starts to increase in a negative direction, which triggers the regenerative function that charges the battery. Firstly, mild brake i.e., small value of brake is applied therefore regeneration is also mild and when full brake is applied, we get more regeneration, which can be clearly seen in waveform fig. 10

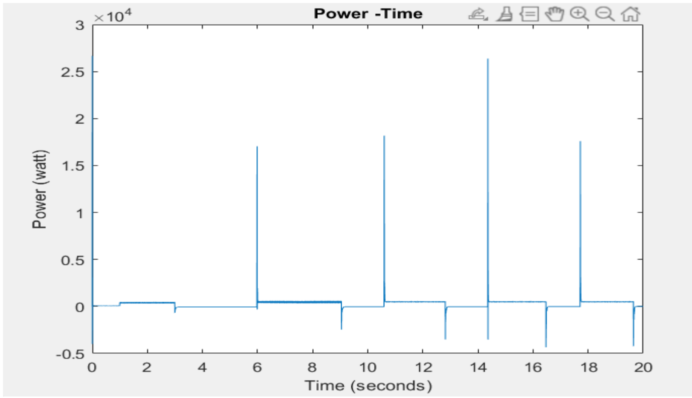


Fig.11.Power Waveform

Fig. 11 displays the power waveform. It serves to both store and supply the regenerated energy that results from braking. As the speed decreases, the power begins to rise in the negative direction, indicating that the battery is being charged.

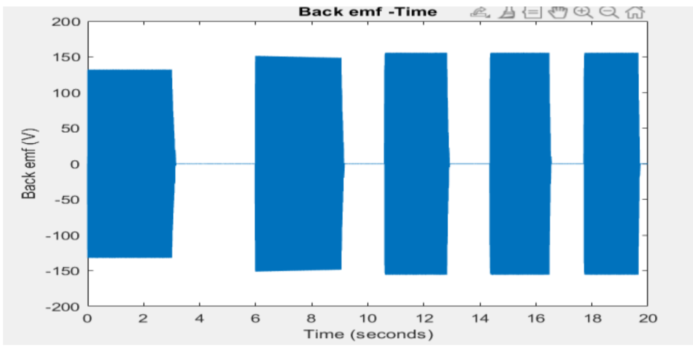


Fig.12: Back emf waveform

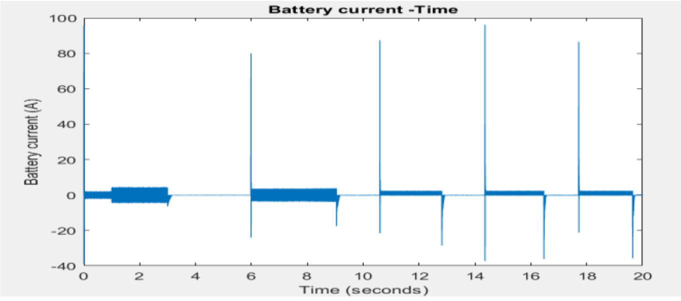


Fig.13: Battery Current Waveform

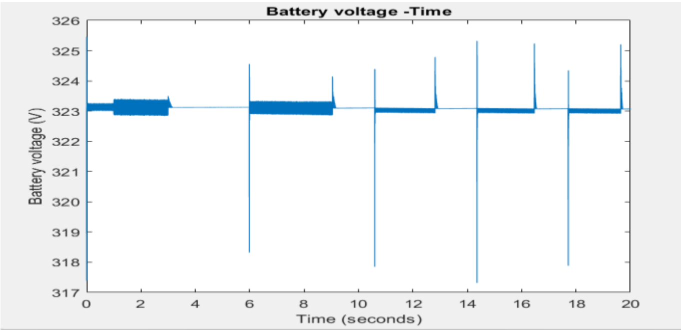


Fig.14: Battery Voltage Waveform

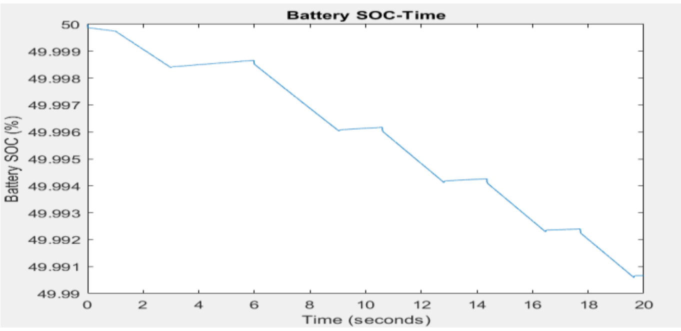
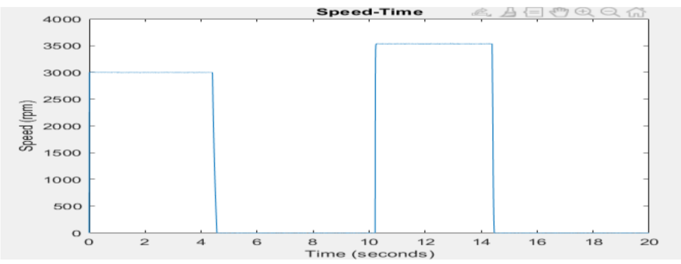


Fig. 15: Battery SOC (%) Waveform

C. COMPARATIVE WAVEFORMS OF SPEED AND BATTERY SOC

Fig. 16 shows comparative waveforms of speed and battery SOC. At starting battery SOC drastically decreases. When motor attains constant reference speed, battery SOC decreases slightly. At this stage, brake is applied, battery SOC increases. By making use of regenerative braking, power can be conserved with the help of batteries. The EV running process consumes more energy and the corresponding battery SOC declines faster. In stages of braking, the SOC curve rises, which demonstrates that regenerative braking is working.



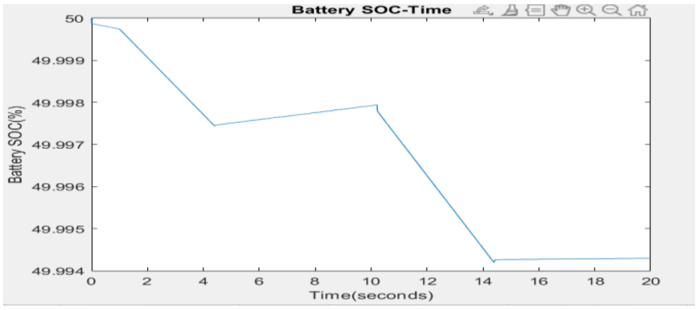


Fig.16: Speed and corresponding battery SOC %

VII. CONCLUSION

This literature describes a thorough simulation for BLDCM regenerative braking that should be used with electric vehicles. During regenerative braking, BLDCM spins underneath. Furthermore, when the battery is charged to its full voltage, the back electromagnetic field is enhanced. All electric vehicles are equipped with regenerative braking.

Based on research conducted for this dissertation, we can say that electricity can be saved using batteries by using regenerative braking. More energy is needed for EV operation, and as a result, battery SOC drops more quickly. When braking, the SOC curve slightly increases, indicating the effectiveness of regenerative braking. The battery's state of charge (SOC) diminishes little at slower speeds and significantly at faster speeds.

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