

Implementation of a New Charging feature in Electric Vehicles

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Abstract— *this paper presents a new charging feature in Electric Vehicles using PIC. Algorithm works utilizing the back electro motive force (BEMF) produced by the motor. The structure is a buck-boost converter chip, which transfers the energy stored in battery for driving motor, and can recycle the energy resulted from the back electromotive force (BEMF) to charge battery by changing the operation mode. A relay is employed for switching the buck-boost converter.*

Index Terms—Electric vehicle, BEMF, buck-boost converter, relay.

I. INTRODUCTION

Today, electric vehicles (EVs) have received much attention as an alternative to traditional vehicles powered by internal combustion engines with the advancement in battery technology and motor efficiency. The secondary batteries are the main energy sources of the EV. Thus, energy management is the most important key factor in EV or HEV design [1]-[2]. Moreover, the electric capacity of the battery will influence the endurance of electric vehicles. Generally, an energy management mechanism is very important for improving system efficiency and extending endurance. Therefore, well design charging strategies are key features in energy management of EV or HEV. Electric vehicles are charged at charging stations by directly connecting to the AC mains which is the conventional method of charging. Nowadays EVs are charged through regenerative braking in which the vehicle's momentum is captured and turned into electricity [3]. Recently various schemes are employed for converting the kinetic energy of the vehicle such as independent switching scheme, charging through ultra-capacitors, electronic throttle control system[4]-[5]. Many advanced techniques, research results or control strategy related to the bi-directional converter are explored in succession. In reference [6], the power management and circuit topologies of single-phase and multi-phase bidirectional converters including non-isolated type and isolated type are all detailed. The non-isolated converters can be categorized into: buck, boost, and buck-boost types, which are low cost, compact size, without transformer, and easy to control due to having common ground. However, a transformer is still essential based on safety considerations, e.g. the voltage ratio between the primary side and secondary side is high enough or these two sides cannot be grounded together. Moreover, flyback type bi-directional converter is commonly used in many related applications [7]. The buck-boost type bidirectional

converters not only possess step down and step up functions, but also can control the energy flow to achieve energy recovery, which is also suitable for many EV design [8]-[11]. This paper presents a new charging method making use of the BEMF produced by the main motor of the vehicle. PIC is used as a control core. BEMF is sensed and the buck-boost converter is switched accordingly using a relay. Generally, an energy management mechanism is very important for improving system efficiency and extending endurance. Therefore, the new charging strategy is proposed which ensures charging of the EVs while it is running by making use of the BEMF produced by the motor.

II. SYSTEM TOPOLOGY AND OPERATING MODES

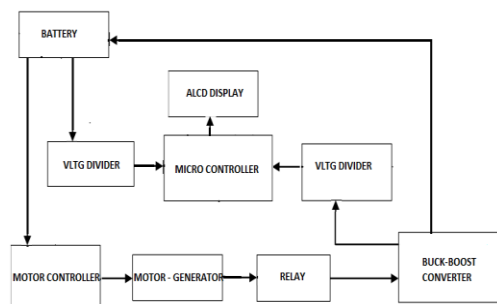


Fig. 1. Block schematic of the new system topology

Fig. 1 shows the system block diagram of the proposed charging feature. With this system, the battery can provide energy to motor through a motor driver. Variable speed is achieved by the motor controller circuitry. BEMF generated from motor is measured by the generator coupled with the motor and can be transferred to store in the battery. Besides, the bidirectional converter is switched into boost or buck mode depending on the charge of the battery. The battery voltage, back emf produced by the motor and boost voltage are displayed in the ALCD panel. A voltage divider is used to divide the voltage when fed to the microcontroller PIC16f877a. Motor is driven by the battery array which is the source of power in any Electric Vehicle. Thus the battery charge must be retained as long as possible in order to increase the legal limit of the vehicle. In the proposed system battery is charged by the BEMF produced by the motor of the vehicle during its run. When the back electromotive force (BEMF) generated by motor is higher than the battery voltage V_{bat} , then the buck-boost converter is switched through a relay. Relay is turned on switching the bidirectional converter into the boost mode. Thus battery is charged in this mode which increases the legal limit of the vehicle. When the battery voltage is sufficient i.e. between the required range to charge the battery then the relay is turned off. If the back emf

is greater than that required to charge the battery then the buck-boost converter switched into buck mode in order to limit the voltage.

III. CONTROL ALGORITHM

Control algorithm for entire system topology is as follows.

Step1: Ports are configured as input and output ports.

Step2: Initialize ALCD.

Step3: Initialize PWM by setting the CCPx pin of the microcontroller.

Step4: ADC is initialized.

Step6: Display the battery voltage .

Step7: Check if BEMF occurs or not

If BEMF occurs then goto step 8 else goto step7.

Step8: If the battery voltage V_{bat} is less than that required for charging then the relay is turned on.

Step8: Buck-boost converter is switched into boost mode providing sufficient voltage to charge the battery.

Step9: Else if the battery voltage is sufficient as per requirement then the relay is turned off.

Step10: Buck-boost converter is switched into the buck mode if the back emf is much greater than that required for charging.

Thus the back emf provides a battery backup and the battery charge is maintained which ensures increased legal limit for the vehicle sudden variation in the speed of vehicle is also avoided.

Mode 1: Motor driving mode:

In this mode, motor is driven by a battery array through a motor driver which in turn regulates the motor speed. The bi-directional converter will enter Mode I when the handle signal is detected, i.e., the battery offers energy for driving motor. Conversely, the system will detect whether BEMF occurs or not. If not, it represents system idle, and the program will return to initial state. On the other hand, the electric bike may be decelerated or in descent state as the BEMF occurs. And then, the system will automatically select Mode II to recycle energy to battery according to whether the BEMF higher than battery voltage or not.

Mode 2: Battery charging mode:

Initial battery voltage is displayed and if the battery voltage falls below a particular value that is the critical value required to drive the motor then the relay is turned on thereby switching the buck-boost converter into boost mode. The BEMF voltage is thus boosted and used for charging the battery. If the BEMF voltage is much greater than that required for charging the battery then the bidirectional converter is switched into buck mode maintaining the voltage within a range.

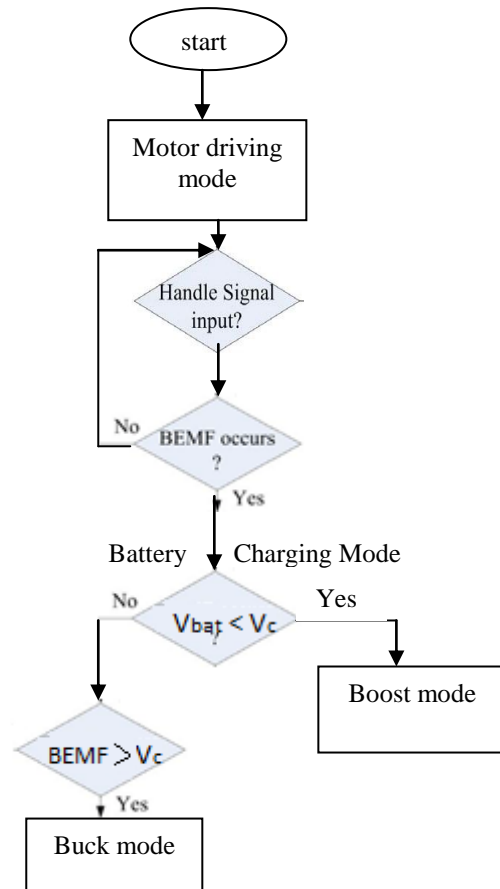


Fig.2. Flow chart of system topology

IV. EXPERIMENTAL PROTOTYPE

PIC16f877a microcontroller is used as the control core. A 12V, 100 RPM NR-DC-ECO permanent magnet dc motor is used which is coupled to a generator to measure the BEMF of the motor. Speed of the motor can be varied by means of a motor driver. Motor driver used is L239D which is a dual driver and the rating is limited to 600mA. IL34063A is a bidirectional dc-dc converter used to operate in boost and buck mode according to the battery voltage and BEMF produced.

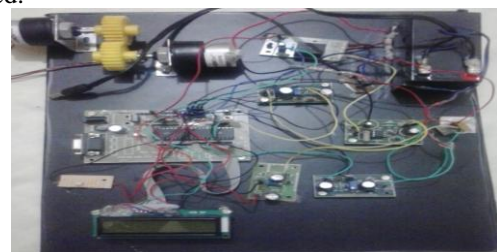


Fig.3. Hardware Prototype of the System

V. CONCLUSION

The paper thus presents a new charging feature making use of the back emf produced by the motor which increases the legal limit of the vehicle and ensures its smooth run. Motor is driven by the battery array and simultaneously charged by the BEMF produced by the motor. Thus the disadvantages of

conventional method of charging and charging during regenerative braking can be mitigated by employing the new charging feature.

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Shamna P V received the B-tech. degree in Electrical and Electronics Engineering from Mar Athanasius College of Engineering (under Mahatma Gandhi University), Kothamangalam, Ernakulam, Kerala, India in 2011. She is currently working towards the M-tech. degree in Power Electronics at the same college. Her research interests include battery management systems and automotive electronics.