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LOW POWER ADJUSTABLE SPEED DRIVE FOR LIGHT ELECTRIC VEHICLES

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ABSTRACT

Electric Vehicles, Hybrid Electric Vehicles, Plug in Electric Vehicles are being researched actively to promote nonpolluting transportation system and in other allied fields. In this paper a low power adjustable drive system is proposed for the light electric vehicles. The proposed drive system has been simulated in TINA simulator and is validated by hardware. This proposed system is mainly developed for battery operated LEVs where, the power is the main concern.
Index Words— Electrical Vehicles, Adjustable Speed Drive, Motor Protection, Triangular wave generation

I. INTRODUCTION

Late 1960's theElectric Vehicles started gaining interest as conventional vehicles rely mainly on fossil fuels. The fossil fuels availability is one concern and the other major concern is the global warming due to fossil fuel use in various applications. The use of fossil fuel based vehicles, factories, industries and others emit Green House gases, which in turn causes environmental issues like global warming.

The fossil fuels sources are depleting very fast and hence there is a need for alternative resources. To achieve independency form these fast depleting fossil fuel resources, EV/HEV/PHEV are being actively researched. This vehicle mainly uses battery for their operation. The salient features of EV/HEV/PHEV have low emission, noise free, highly efficient. Global environment protection and energy preservation are the main reasons of the growing interest in electric vehicles (EV). Technological innovation to accelerate the deployment of clean vehicleshas to be encouraged to overtake the barriers to EV development.

The battery operated applications such as EV, UPS, etc needs a better energy management to achieve, high efficiency, greater reliability, long life. Battery management is relativelysimple in low-power applications and, thus, a great number of integrated solutions are available.

Electric motors impact almost every aspect of modern living. Refrigerators, vacuum cleaners, air conditioners, fans, computer hard drives, automatic car windows, and multitudes of other appliances and devices all use electric motors to convert electrical energy into useful mechanical energy. In addition to running the commonplace appliances that we use every day, electric motors are also responsible for a very large portion of industrial processes. Electric motors are used at some point in the manufacturing process of nearly every conceivable product that is produced in modern factories. Because of the nearly unlimited number of applications for electric motors, it is not hard to imagine that there are over 700 million motors of various sizes in operation across the world. This enormous number of motors and motor drives has a significant impact on the world because of the amount of power they consume. The systems that controlled electric motors in the past suffered from very poor performance and were very inefficient and expensive.

II. LITERATURE REVIEW

It has been recognized that hybrid electric vehicles are the only viable solution in order to reduce air pollution, in particular, in large urban areas. In a hybrid electric vehicle, the electric propulsion system is intended to provide advantages over conventional vehicles equipped with an internal combustion engine. With the help of the electric drive, the life of the internal combustion engine can be optimized, which often means low fuel consumption and low emissions [1].

Recently, Electric Vehicles (EVs) have been considered as new paradigm of transportation in order to resolve environmental concerns such as air pollution, sound pollution etc. However, EVs pose new challenges regarding their Battery Lifetime (BLT), energy consumption, and energy costs related to battery charging. The EV power consumption may be estimated by having the route information and the EV specifications. Also, by having the

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battery characteristics, the battery capacity consumption and the BLT may be estimated for each route. In this paper, a driving management which uses the above-mentioned information in order to optimize the driving route by being aware of the EV energy consumption, energy cost, and BLT. Our proposed driving managementextends the BLT and reduces the energy consumption and energy cost, by selecting the optimized route instead of the fastest route [2].

Haiying Wang et al [3] have highlighted the major constituents of modern electric vehicles such as vehicle technology, drive technology and energy management technology. They have also emphasized the importance of improving the distance to be covered, by way of system integrated technology.

In this paper a low power adjustable speed control for light electric vehicles has been proposed with all necessary protections such as, under voltage protection, over current protection, breaking etc.

III. Configuration for Low Power Adjustable Speed Drive

The configuration of the proposed Low Power Adjustable Speed Drive is shown in figure-1.The major concentration is to have a better variable speed regulation system. The proposed system has a part of battery power management implementation and speed regulation part. The speed of the motor is regulated by a Pulse Width Modulation (PWM) technique. The power management has protections such as under voltage to avoid deep discharge of battery. If the motor develops any fault and draws more current, it may impact power source, and other ECU parts. In such cases, the Over current protection becomes active and stops the motor by switching off the power.

The proposed design has few blocks such as triangular wave generation, comparator block, break block, under voltage protection block, over current protection block, and accelerator control called Thumb Throttle. All these blocks have been simulated using TINA software and the proposed work is validated in hardware.

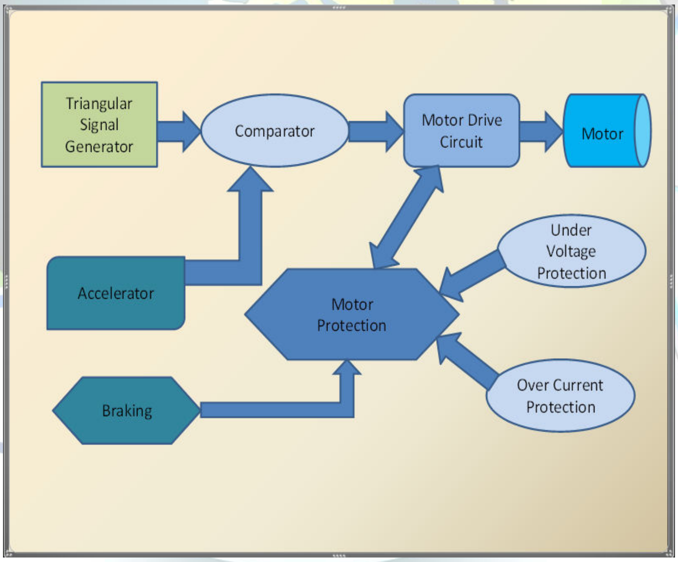

Fig.1 Block Diagram of low power Adjustable Speed Drive

IV. Simulation

The simulation model was built in TINA (Toolkit for Interactive Network Analysis) environment; it is a SPICE based electronics design and training software. The simulation model is shown in figure-2. The different blocks of the proposed work simulated in TINA are indicated by numbs. The block -1 represents the thumb throttle, which varies the reference voltage to vary the width of the PWM control signal. The reference signal from this throttle is fed to the comparator block which in turn produces the PWM signals.

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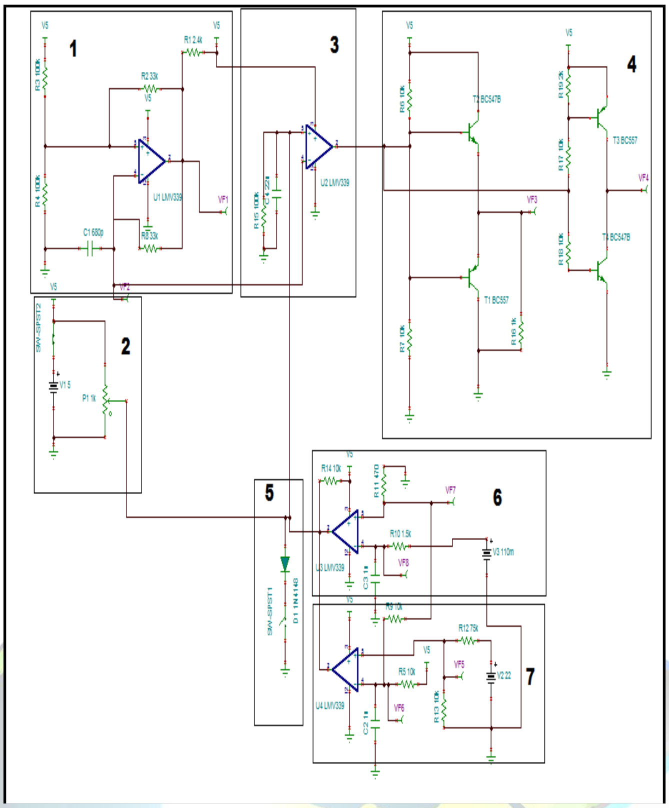

Fig.2Simulation Model -TINA.

The block-2 is the generation of the triangular wave of 13.6 KHz signal. This signal is fed to the comparator as one of the input. The block-3 is the comparator block which accepts the signals from both block-1 and block-2 to produce PWM signal. The block-4 is the driver circuit for MOSFET which eventually drives the motor. Block -5 is the circuit used to stop PWM pulses when break is applied. Block 6 is the over current protection circuit, whenever there is a fault in the motor it tends to consume more current which represents a short circuit, this condition will be detected by this block. Therefore whenever the current exceeds the rated currentthe pulse generation will be stopped and protects the Motor as well other components in the circuit. Similarly block -7 represents the under voltage protection, this block can be referred to Battery Management the moment battery reaches its lower limit this block will get activated and stops the gate pulses protecting the battery from deep discharge. According to the specifications selected the under voltage limit is set to 11v and the over current is set to 8.5A.

V. EXPERIMENTAL VERIFICATION

Experimental setup is shown in figure.3. The device LM-339 is a low power comparator, BC-557, BC-547 is used to drive a POWER MOSFET IRF-9540 which in turn drives the DC MOTOR. Therefore all these devices are used to realize the various blocks of the proposed work. The circuit simulated in TINA simulator is implemented in hardware. All the blocks are realized in hardware by using various devices, LM-339, LM-7805, BC-557, BC-547, IRF-9540, diodes and other electronic, active and passive components. Lm 7805 is used to derive the operating voltage of 5V for the electronics to function. The input to this regulator is supplied from the battery.

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Fig.3 Complete Experimental Setup.

VI. SIMULATION AND EXPERIMENT RESULTS

The PWM pulses generated during simulation are shown infigure.4, figure.5 and figure-6 for different duty ratio.

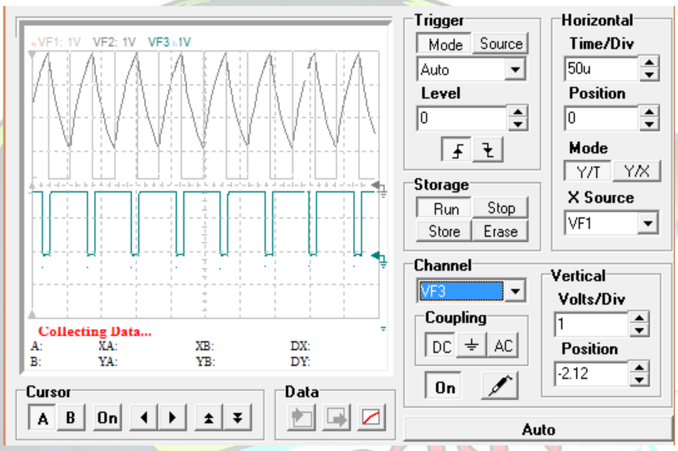

Fig.4 Gate pulse generated- 80%. Duty ratio

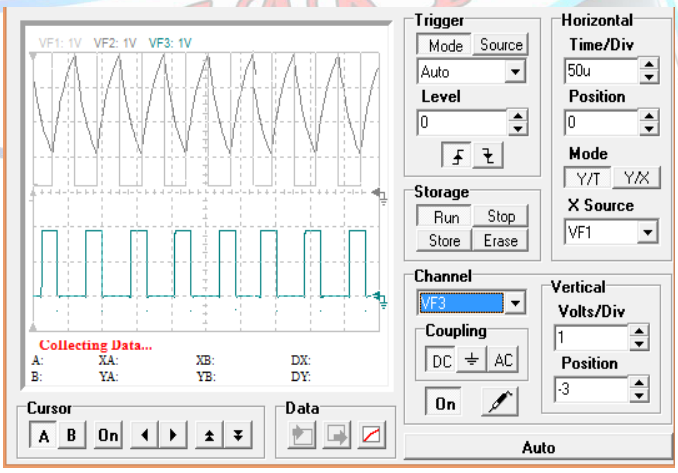

Fig.5 Gate pulse generated -40%. Duty ratio

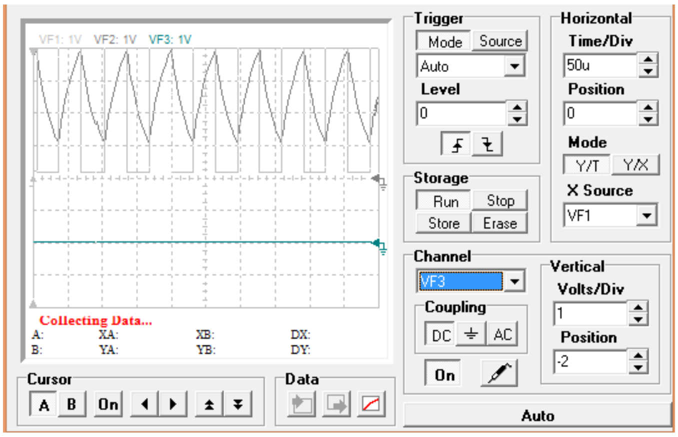

Fig.6 Gate pulse becomes zero when the break is applied

The results of the hardware model are shown in figure.7 and figure.8. Electrical Bike throttle has been used in the experiment to vary the duty cycle i.e. width of the PWM signal so as to vary the speed of the motor. The variations in speed of the motor has been observed according to the changes in the throttle.

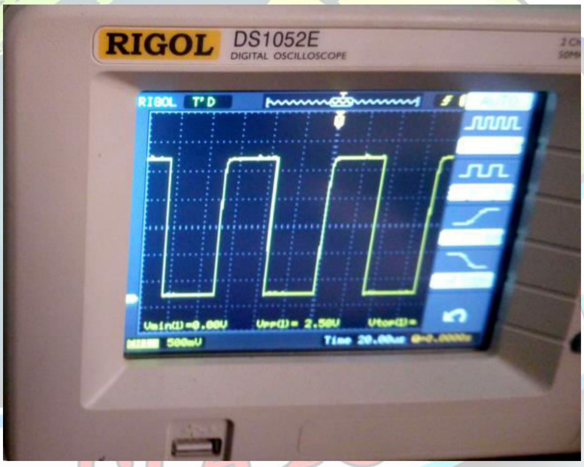

Fig.7 Gate pulse generated half throttle is applied

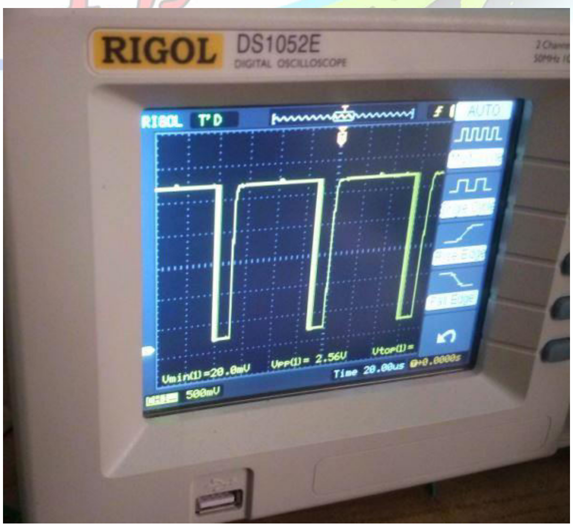

Fig.8 Gate pulse generated when almost full throttle is applied.

VII. CONCLUSION

The proposed work on the Low Power Adjustable Speed Drive for Light Electric Vehicles is simulated and also realized in hardware. The whole speed controller electronics works on 5V @ 200mA only. The total power consumed by the speed controller is about 1W only. Simulation results and the hardware results are in par with each other.

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