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Design and Implementation of Supercharger for Lithium Ion Battery

Ms.K.M.Chougule[1], Ms. S. S. Sangave[2], Ms. P. S. Patil[3], Ms. S. S. Gayakwad[4], Ms. A. B. Pujari[5], Mr. V. S. Wadkar[6]

UG Student, Department of Electrical Engineering, Sharad Institute of Technology College of Engineering, Ichalkaranji, India[1,2,3,4,5]

Assistant Professor, Department of Electrical Engineering, Sharad Institute of Technology College of Engineering, Ichalkaranji, India[6]

ABSTRACT: There are various types of batteries available in market among them lithium ion battery is most widely used battery in electric vehicle. The basic problem associated with it is about its charging time and temperature. Normally, to charge 48 V, 39 AH lithium ion battery 6-8 hours are required by normal 230V supply. The drawback of conventional method is more time is required for charging, more power, heat & switching loss. The conventional circuit available for battery charging has more cost. Our aim is to reduce this charging time and improve the battery performance as well as its life. The control circuit used in our charging kit is capable to charge the battery in minimum time interval at the same time it will reduce the power loss and improve the life of battery. This charging kit uses the closed loop approach, so drawbacks available in conventional charging method are overcome. In this closed loop scheme, temperature is taken as a feedback signal and according to that charging is done, so it improves life of battery because temperature is most affecting parameter on battery life.

KEYWORDS: Closed loop approach, Charging method

I. INTRODUCTION

LITHIUM-ION batteries have high energy density, high specific energy, and good cycle life, low self-discharge and are environment friendly. Owing to these qualities, they have emerged as popular rechargeable battery chemistry with a wide variety of applications in portable electronics, electric vehicles (EVs), grid energy storage and renewable energy. For these secondary batteries, several charging techniques have been developed with varying implications on charging time, charging efficiency, cell temperature rise and cycle life.
Currently CC-CV,MCC this charging techniques are used in which at starting charging current is set to a very large value, because of this temperature of battery rises a lot.

The proposed charging technique for charging lithium ion cell is more advantageous than other techniques in following prospective.

1. In this technique charging is done by taking temperature as a feedback signal i.e. closed loop system so deterioration of battery can be avoided.
2. This charging technique charges the battery with minimum time as compared to other techniques available in now days.
3. It improves overall performance of battery as temperature which is most performance affecting parameter is controlled.

II. DRAWBACK OF CHARGING METHODS

1. CC-CV can lead to an appreciably higher cell temperature and hence a reduced cycle life.
2. Pulse current charging as well as SRC charging methods require much more complex charging setup with a high bandwidth current controller, compared to the simple set up required for CT-CV.
3. One of the major drawback is all methods have open loop approach
4. More concerned with safety and reliability issues.

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III. PROPOSED SCHEME WITH BLOCK DIAGRAM

The 230V AC supply is given to the transformer which converts 230V to 12V AC. Then 12V AC is given to the uncontrolled diode rectifier. The 12V AC is converted into 12V DC by the use of bridge rectifier. But the output is pulsating DC, by the use of filter circuit the ripples are removed and we get pure DC 12V output. The controller circuit and LCD require5V DC supply. Then two IC regulators 7805 are used which converts 12V DC into 5V DC. There are 3 types of protection is given to the whole circuit.

First the fuse is used in between the main supply and transformer. Second is the inductor of 330 µf, it controls the charging current of the circuit.

Third is the temperature sensor LM35DZ senses the surrounding temperature and give signal to the controller. The temperature 50°C is set in the controller. If there is sudden increase in temperature beyond 50°C, then charging of battery is stopped. The temperature and output voltage value is displaying on the LCD display. When the temperature goes below 40°C, then the charging of battery again starts. The 40°C value is set, because if we start charging of battery below 50°C, then temperature of the battery again increases and battery gets heated, which is harmful for the battery. Hence we give tolerance of 10°C for recovering the battery temperature.

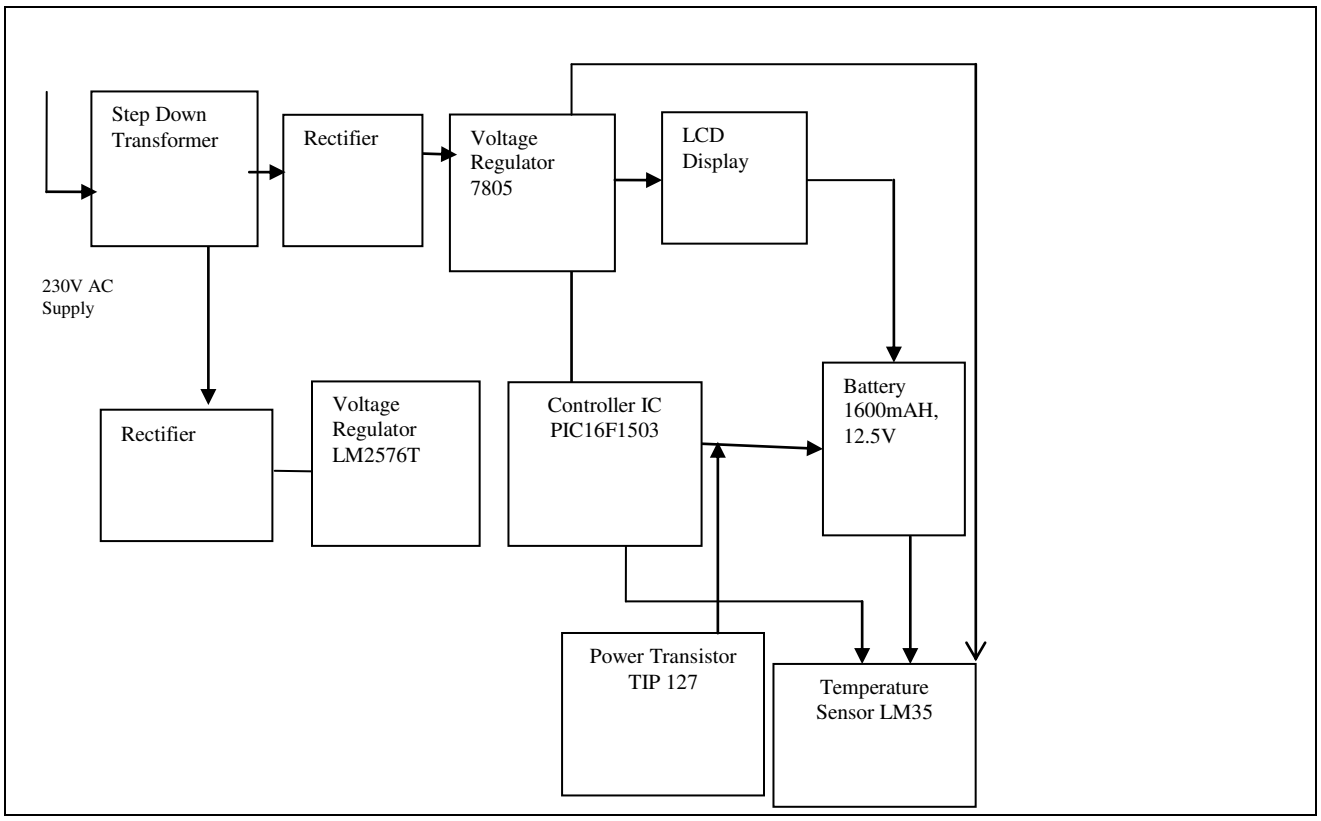

Fig 1: Block diagram of proposed scheme

Fourth protection is reverse current protection which avoids reverse power flow from battery to Circuit which is provided with help of battery.

Fifth protection is overvoltage protection which is provided with help of same IC used in circuit in which battery voltage is set to 12.5V after reaching to this voltage, battery automatically gets disconnected.

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IV. CIRCUIT DIAGRAM

The 230V power supply is given to the two stepped transformer from that two outputs are taken. One is of 22-24V which has the less current capability this voltage is applied to the bridge circuit which converts it into the DC voltage. For this rectification process diodes of high current ratings (6 Amperes) are used. Output of this bridge rectifier is given to LM2576T.LM 2576T is adjustable voltage regulator and has 3Amp maximum capability (input 16 -48 volts& output 0 -33 volts); it can also act as a protective device for battery. It gives the output voltage as per the current value. Inductor L1, L2 is used to produce smooth dc voltage. The filtered supply obtained is given to battery through TIP127 transistor. The operation of transistor is controlled by controlling base current through main controller PIC16F1503.

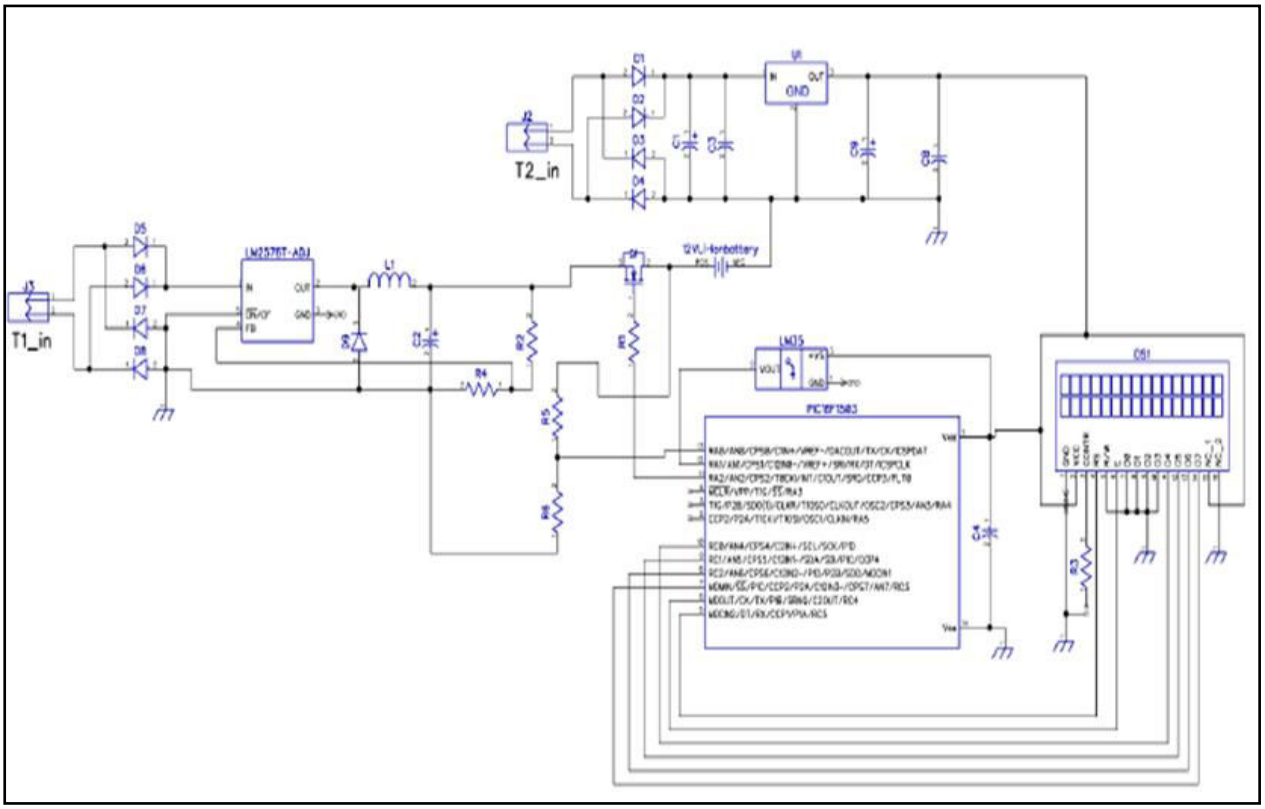

Fig2: Circuit diagram

Second output of two tapped transformer having 17 -18V which is given to the bridge circuit which consist diodes of lower current rating. It produces DC 17-18V which is given to 7805 IC. 5Volt supply obtained from 7805 IC is given to the display unit, Temperature sensor & controller IC. Capacitors C1 and C2 are used to remove the extra ripple or peak voltage and they are act as a filter. Duty cycle is set to the 500mA.Temperature sensor LM35 is connected to pin no 12 of IC which controls the operation of transistor switch as per programming made in battery. It disconnects the battery if temperature exceeds the set value. Also once the battery is completely charges it is disconnected from the supply as the program made.

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V. HARDWARE RESULTS

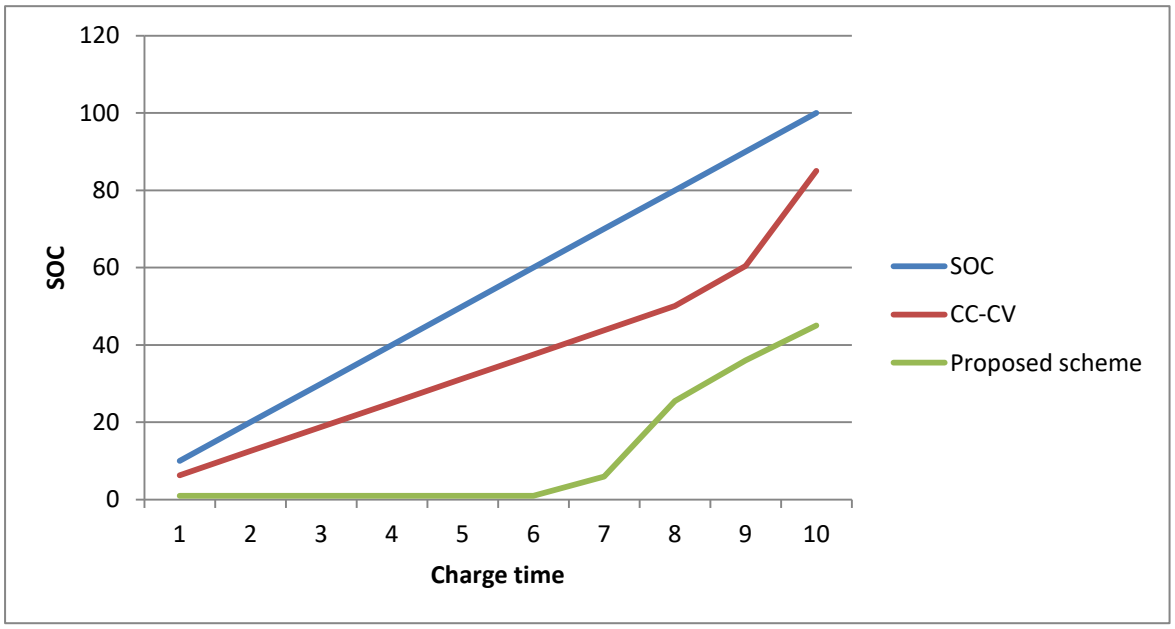

Fig3. Graph of SOC vs. charging time

VI. SIMULATION RESULT

The Proteus Design Suite is a Windows application for schematic capture, simulation, and PCB (Printed Circuit Board) layout design. The micro-controller simulation in Proteus works by applying either a hex file or a debug file to the controller part on the schematic.

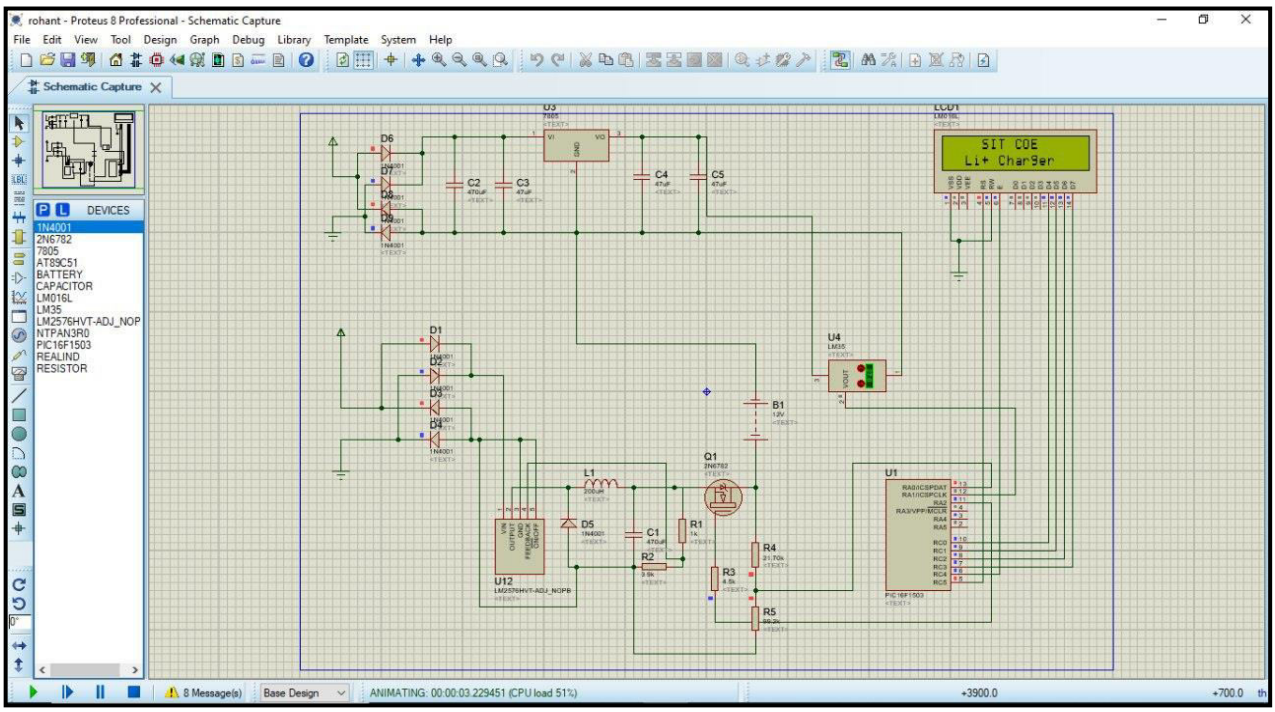

Fig4: Simulation result

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We will get all devices by searching on 'P'. We will take all the devices on the screen. The component which are not available from proteus library that we have taken from library files & internet when we run the simulation the LCD displays "SITCOE Li+ charger" & also display the charging voltage and so on.

VII. ADVANTAGES OF PROPOSED SCHEME

1) Closed-loop charging scheme.
2) Faster charging time for given amount of degradation, specified by given temperature rise.
3) It improves the life of battery by controlling temperature.

VIII. APPLICATIONS

1) Electric vehicle
2) Electronic devices
3) Mobile phones, Laptops, DSLR camera

IX. SETUP OF PROPOSED SCHEM

Fig5: Setup of proposed scheme

X. CONCLUSION

Lithium-ion batteries are widely used in consumer electronics, including cell phones, laptops, electric vehicles (EVs), and military and aerospace electronics.The supercharger kit designed by us can charge the battery in less time as compared to present chargers available in market this time interval can be changed by changing the duty cycle. By our kit we can improve the life of battery by controlling most life affecting parameter i.e. temperature so this kit is most affordable charger kit instead purchasing charger, battery management system & temperature compensation kit separately. This charging kit use can be extended to charge lithium ion cells. This charged cells can be used in various types of utilities such as laptop batteries, DSLR cameras, mobile phones, Electronic devices and ultimately the lithium ion battery itself.

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