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Fast Electric Vehicle Charging

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Abstract
E-vehicles took large time consumption for charge the batteries to full state. About 8 hoursto 10 hours are taken by normal chargers provided by e-vehicle companies in India. Sincetime is so valuable in everyone's life and e-vehicles are considered as the 'future vehicles' fastcharging of Electric Vehicle has become a prime need of the hour. We are using a DC-DC buckconverter circuits which can be isolated or non-isolated with a 500 VA step down transformerto charge an Electric Vehicle battery or any other sort of rechargeable battery up to 150 Ah.STM32F407 VET6 controller board is used to control the whole operation of the proposedsystem. 225 W charger is used and to reduce voltage ripple, filters made of capacitors are added in the output and input of the capacitors.

Keywords:*Fast Charging,Electric Vehicle, STM32F4,Buck converter,Green Revolution.*

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I. INTRODUCTION

Along with the ever-growing number of electric vehicles on the market and pressure fromgovernments to reduce vehicle emissions to zero latest by 2050, there is a strong need for moreefficient charging solutions.The first thing to know is that there are three different charginglevels. Level 1 chargers are the slowest, but they are also ubiquitous and work for some people'sneeds.Level 1 is the EV community's word for a regular 110 V to 120 V wall outlet. That'sthe same voltage you'd use to power most of the stuff in your house, from a floor lamp toa microwave to a phone charger. It would take about 40 hours to fully charge the batteryon our Bolt from empty at a Level 1 charger, at a rate of about 5 miles of added range perhour of charging. This is not ideal: we avoided using Level 1s and avoided letting our battery run close enough to empty that we would need one. But we've heard it can work in a pinch.

Level 2 chargers are much better at EV charging than a regular old wall outlet and, in our road tripexperience, they were easy to find at all our destinations and along many highways. They are 220 V to 240 V that's the same voltage as a standard-size electric clothes dryers that can be found in some homes. We found that public Level 2 chargers typically charge at a rate of about 6 kilowatts (kW). For our long-distance Bolt battery, that means a Level 2 charger can add about 25 miles of range per hour of charging. Filling up the whole battery from empty would take around 9 hours. Since cars are parked approximately 95 percent of the time, Level 2 charging is often the most suitable method of filling up an EV. Level 3 chargers are also referred to as fast chargers, DCFC chargers, and DC fast chargers. They are 400 V or more, and typically charge at a rate of 50 to 60 kW. This means our Bolt battery could fill up from empty in 1 hour and 20 minutes, at a rate of 150 miles of added range per hour of charging. Unfortunately, the increased charging speed goes hand-in-hand with increased prices.

Level 3 charging is the most expensive option. Depending on which car model you have, how big the battery is and how fast the charging point is, it can take anywhere from around 60 minutes to 8-9 hours for an electric car to charge up to 80 percent. However, with rapid chargers, you can reduce this time to 30-40 minutes. E-vehicles took large time consumption for charge the batteries to full state. About 8hrs to 10hrs are taken by normalchargers provided by e-vehicles companies in India.

II. METHEDOLOGY

2.1 Block diagram

The block diagram of the proposed model is shown in the figure below.The block diagram consists of SMPS(switched mode power supply),DC-DC Buck converter, IC Driver, current sensor, LCD display and STM 32F407VET6 microcontroller board. A 230 V AC supply is given to the SMPS the output from which is given the DC-DC buck converter.This is connected to a filter capacitor to avoid ripples which is then connected to a barrier resistor to limit the current flow to current sensor and provide protection. This output is given to current sensor and voltage sensor which is given as the input to the STM microcontroller. This output is given to the driver IC which is used to provide the power level for the buck converter. An LCD display is used to display the current and voltage level that is measured using the sensors. The battery load is connected to the voltage sensor.

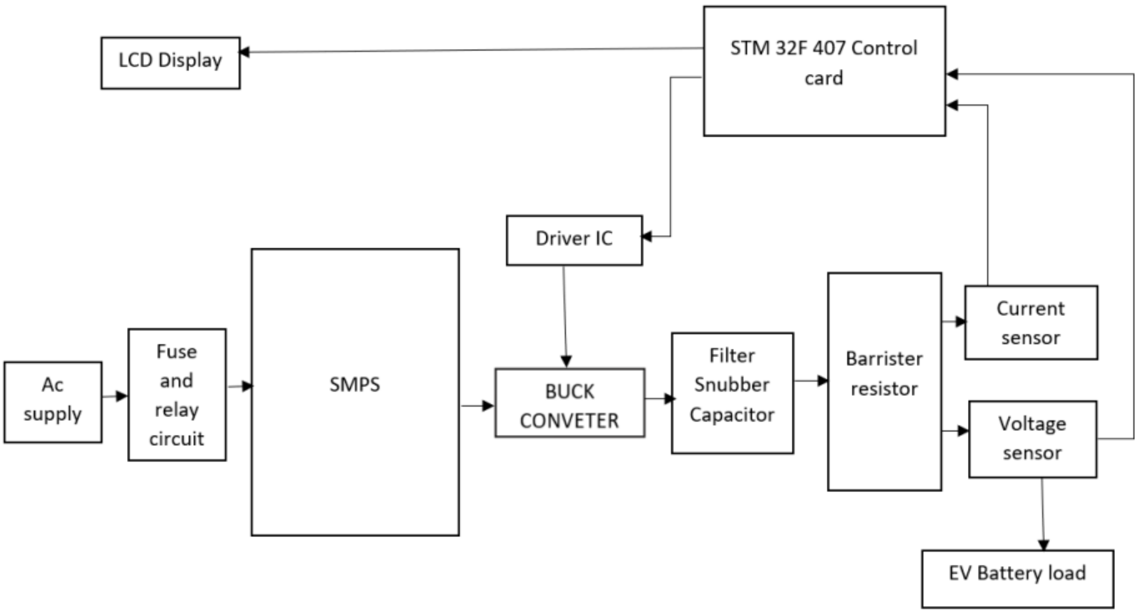

Figure 1: Block diagram of the proposed fast EV charger

2.2 Circuit Diagram

The circuit diagram consists of microcontroller board, STM32F407VET06. A 230 V supply is given as input.A DC-DC buck converter maintain the voltage at 12 V.The battery that we used in the project is 12 Ah Lithium-Ion battery.Figure shows the complete diagram of the proposed system.The main designing of circuit included in the proposed system is the design of the dc-dc buck converter. Figure 3.3 shows the basic configuration of a buck converter where the switch is integrated in the selected integrated circuit (IC). Some converters have the diode replaced by a second switch integrated into the converter (synchronous converters). If this is the case, all equations in this document apply besides the power dissipation equation of the diode.

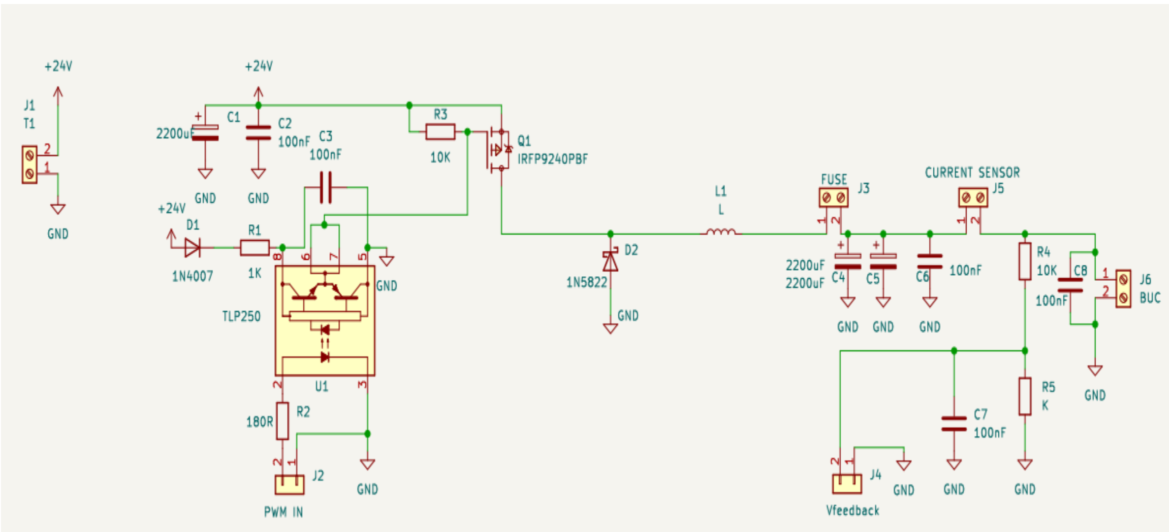

Figure 2:Circuit Schematics of the Proposed System

2.3 PCB Model

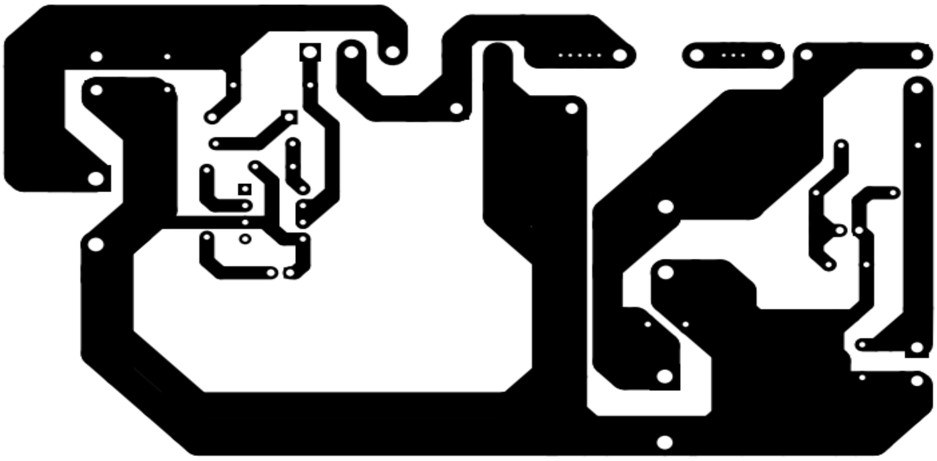

Figure 3: PCB Design

III. THE SIMULATION

Software simulation of the proposed system is done in Proteus Software. Since STM32F407 which is used to build the prototype is not available in it so instead we used STMF103C6 for the purpose of simulation. STM103C6 has almost the same configuration as of STM32F407 it can obtain a similar output result in the Proteus. Set point is at RV1, it can be adjusted to maintain the value of voltage. We have a dummy load and a variable load. The variable load adjustment will result in current variation in ammeter but voltage will remain constant. Presently the voltage feedback system is used, wecan also use a current-feedback so that the current will remain constant. Basic topology of buck converter is represented by transistor switching element, input capacitor, diode, inductor and output capacitor. Entire circuit and feedback control is maintained by STM,that is feedback input from analog pin and PWM output from digital pin.

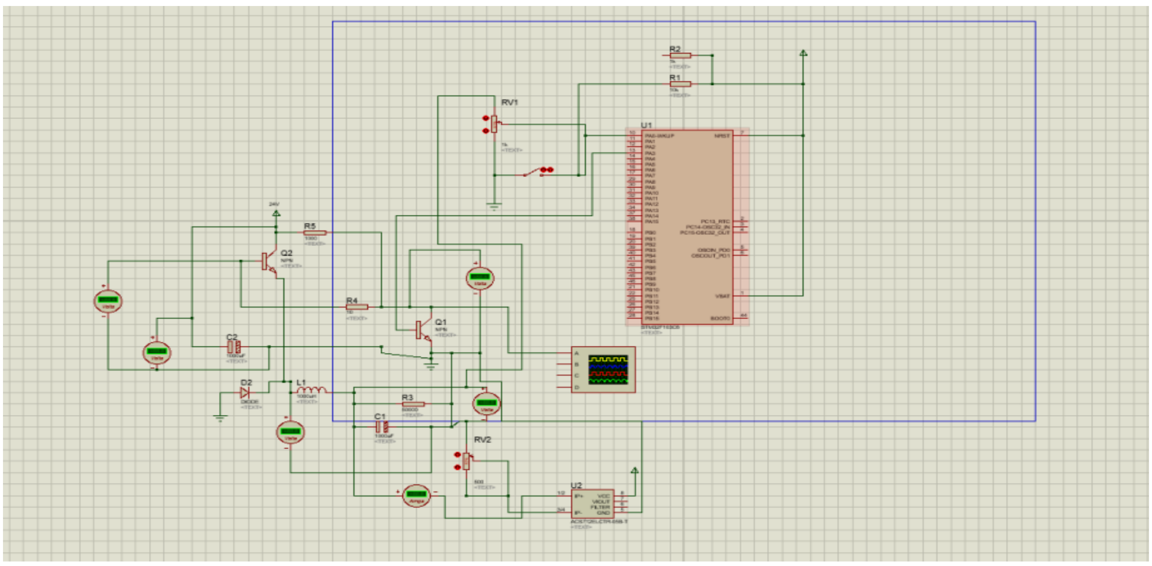

Figure 4:Simulation of the proposed system

IV. HARDWARE IMPLEMENTATION

A DC-DC buck converter is the heart of EV CHARGEX(fast and efficient charger for electric vehicles). The buck converter (step-down converter) is a DC-to-DC power converter which steps down voltage (while stepping up current) from its input (supply) to its output (load). It is a class of switched-mode power supply (SMPS) typically containing at least two semiconductors (a diode and a transistor, although modern buck converters frequently replace the diode with a second transistor used for synchronous rectification) and at least one energy storage element, a capacitor, inductor, or the two in combination. To reduce voltage ripple, filters made of capacitors (sometimes in combination with inductors) are normally added to such a converter's output (load-side filter) and input (supply-side filter). The switch used in the converter is IRFP9240 which has a maximum current capacity of 42 A, and inductor of 240 micro-Hendry and a fast recovery diode is designed for our converter.

The switch is controlled by gate pulses which is produced as per preplanned program by the STM32F407 VET6 controller board and TLP 350 driver IC (TLP 350 can use alternately) with as switching frequency of 20 kHz. It is a no isolated converter system but we isolate it with 230/24 V 500 VA step down transformer. By using ACS712 current sensor and potential divider for voltage sensor feedback current and voltage signals are taken to controller card. The charging method used in the system is constant current constant voltage method. Which is a fast-charging technique. Almost all company's use constant current method for fast charging by setting a high value constant current which is harm full to battery. But we are charging battery with constant current mode up to 80% current setting is based on battery's 'C'-rating and AH rating of battery remaining 20% is charged by constant voltage mode which is normal speed charging. We choose this method on the demand of fast charging at the same time battery should be safe and healthy (charging should not affect the specified cycle rating by company of battery). In shot charging should not affect battery life harmfully. Switching converters (such as buck converters) provide much greater power efficiency as DC-to-DC converters than linear regulators, which are simpler circuits that lower voltages by dissipating power as heat, but do not step-up output current.

Buck converters can be highly efficient (often higher than 90%), making them useful fortasks such as converting a computer's main (bulk) supply voltage (often 12 V) down to lower voltages needed by USB, DRAM and the CPU (1.8 V or less). The converted 12v dc is filtered using capacitor filters and given to battery as per polarity for charging. The current setting can be changed by making alterations in program or by setting a preprogrammed rotary switch. The observed result is that the proposed system charges the battery of 12 Ah around 1 hour time. Usually, the battery takes 3-4 hours to get fully charged. The LCD display will give the values of current and voltage. When the display shows the value of voltage to be around 12 V the battery will be fully charged.

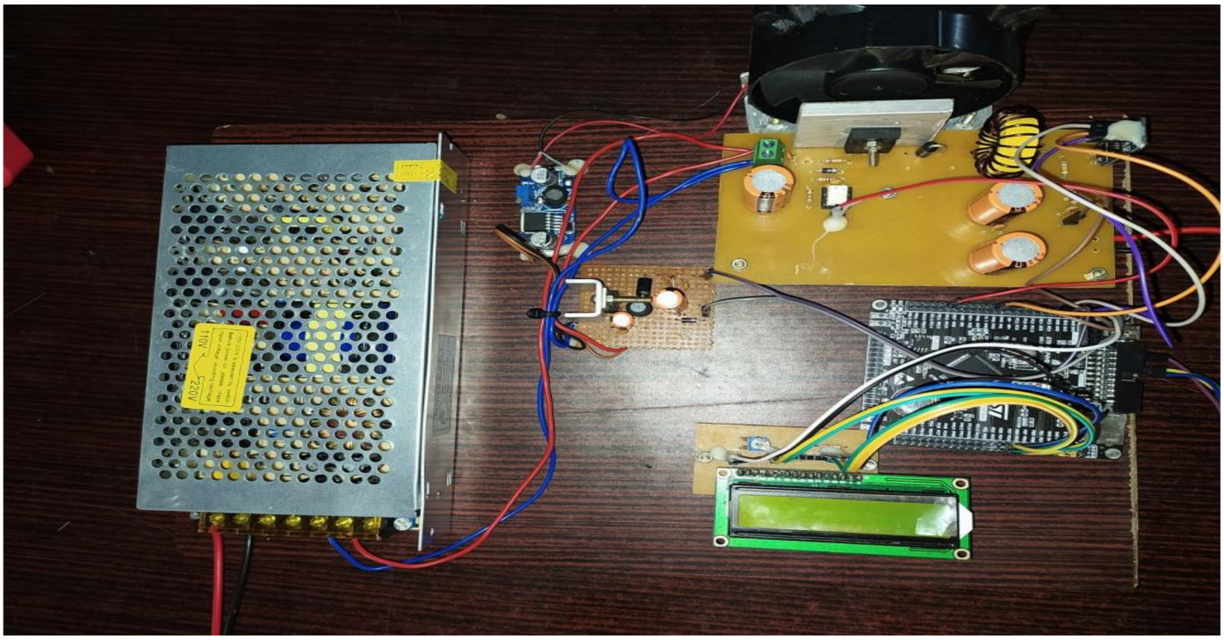

Figure 5: Hardware Model

V. CONCLUSION

As we know the crude oil products such as petroleum, diesel etc. are non-renewable energy sources so it should be conserved for future for sustainable development and also cost of crude oil is increasing day by day. So, the time to switch towards electric vehicles comes up. Electric vehicles are eco- friendly and do not cause any pollution to environment comparatively. In all way electric vehicles are better but the only dis advantage is its charging time. It is the main factor which common people hesitate to buy electric vehicle. By our proposed system were implementing aremedy to that problem by innovating fast and safe charging station. The future scope of the work incorporates expansion of the efficiency of the system and we are trying to modify the same system to a pocket size by isolated topology like full bridge or forward charger then it will be portable and can handle easily by individual user at home itself. It will be more user friendly and convenient to use then. In 2020 most of the moto companies going to launch their new models of electric vehicles. It will be "GREEN REVOLOTION IN VEHICLES "so this generation is demanding new innovations in this field and the proposed fast charger will be a great contribution to this generation.

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