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Design of Charge Controller for Electric Vehicle

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Abstract -Electric vehicles are a recent technology which has a zero emission duringits use and is looking for an important role in the technology and market. Electricvehicles have several advantages. The main concern of this project is to analyse and design a charge controller to charge electric vehicles using single phase AC supply and also to prevent over chargingofthebattery. Various energy management waysfor a powered Electric vehicles has been studied and a suitable method has been selected.An Electric vehicle can be charged by using AC supply which is taken from the grid or by using solar panels.This proposed system can be installed and used in any public places.

Keywords - Bridge rectifier, Floating method,Switched mode power supply,PWM based charge controller.

I. INTRODUCTION

The air quality in many major cities of India is no longer healthy and the pollution related to automobiles has been one of the main cause.So nowadays,the research and developmental activities related to automobile sector have been playing an important role in the development of high efficient and an emission methods of transport.Electric vehicles appears to be the best alternative for replacing the engine powered vehicles. And also the high energy demand and the constant reduction in the amount of fossil fuels due to increase in population led us to shift our focus to electric vehicles and renewable energy sources which is the future of India.Because electric vehicles not only reduce the emissions,it also improves the Indian economy and growth.It is eco-friendly and unharmable to the environment.The Indian government started Faster Adoption and Manufacturing of Hybrid and Electric vehicles (FAME) scheme that provides incentives for those who purchases electric vehicle such as announcing tax cuts for the manufacture of an electric vehicle to penetrate its use in India.

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For now the Indian government has planned to shift to charging electric vehicles by the year 2030. Tamilnadu government is offering total road tax exception for electric two wheelers which are used for commercial transport purposes.However, there are certain factors that needs to be looked upon in order to make electric vehicle.Way of charging an electric vehicle is the most important factor.

Therefore, in order to make sure the lifespan and guarantee of the batteries present in the vehicle and to improve the energy conversion during the battery charging process,it is necessary to establish the charging method. Electric vehicle employs the use of some of the power electronics controllers that connect the electric vehicle power system to the source for charging.

These converters can either be a diode bridge rectifier that converts an AC supply into DC voltage supply or a switch mode converter that controls the charging of the battery.Thispaper proposes the method to charge the electric vehicle.

In this paper,a model is proposed to charge the electric vehicle.Issues related to overcharging of the batteries are dealt with the implementation of charge controller is used for solving the over charging problem.Section2 demonstrates about the literature surveys that have been studied.Section 3gives a brief about the proposed system andsection 4 implies the results.

II. LITERATURE REVIEW

Electric vehicles plays as an important element in the urban transport development and offers many advantages such as

- Reduced air pollutions and it improves air quality.
- Reduction in the carbon-di-oxide emission.
- Dependency on crude oil is decreased.

In a country like India,there is an increasing need for an electric vehicle.Therefore,more electric vehicles are needed in the future and a proper way to charge the electric vehicles needs to be known.So in order to select the appropriate technique to charge the electric vehicles,three systems have been studied.

A model with PV array includes 310 panels,buck converter and PI controller.A control algorithm is used to check the presence of sunlight and also to check whether the PV generated power is greater than the EV power or not[1][2].

A system uses solar energy to charge the electric vehicle during the day when the solar energy produced from the photovoltaic panels is greater than the load and is discharged when it is lower than the load demand[3].

A system with photovoltaic source consists of 21 PV panels,managing unit,inverter and charging station storage battery.A managing unit is used to make sure that the voltage supplied to the inverter is in between the range of 41V to 57V.

A control algorithm is used.A binary variable VP indicates the presence of e-bike when VP is equal to 1.When VP equal is to 0,novehicle is connected to station[4][5].

III. PROPOSED SYSTEM

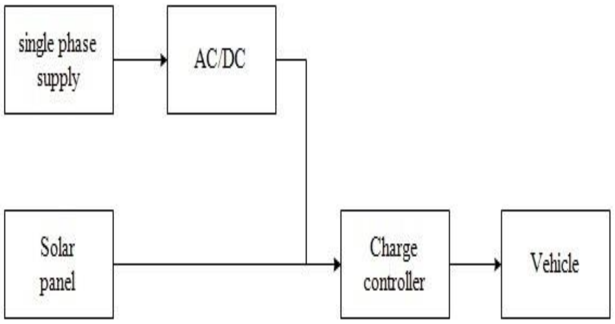

Fig.1 Block diagram of proposed system

In the proposed system ,two methods are used to charge the electric vehicle. The first method is solar panel to vehicle technology. The second method is grid to vehicle technology. Fig 1 shows that the electric vehicle can be charged by using single phase supply taken from the grid or by using renewable source i.e. from solar panels. During the first method, electric vehicle is charged by the electricity that has been generated by the solar panels. Whileduring the grid to vehicle mode, the single phase supply taken from the grid is used to charge electric vehicle.

A. Array – Vehicle Method

The direct voltage of 48V generated from a PV array is given to the charge controller and then the battery.

The array specifications are given below.

Model	:	HST60F 250P
Pmax	:	250W
Voc	:	37V
Isc	:	8.80A
Vmp	:	30.23V
Imp	:	8.27A

B. Grid – Vehicle Method

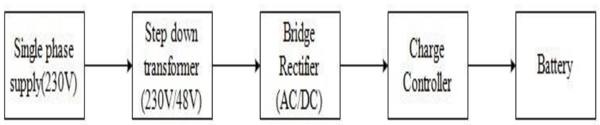

Fig 2. Block diagram of grid to vehicle method

The single phase supply of 230V is taken out from the grid .The step down transformer is used to step down the 230V to 48V and the transformer is designed to produce 4A in its secondary since the capacity of the electric vehicle battery is 20Ah 48V.Then the converter converts the single phase AC supply into DC. The converter used here is a full wave diode bridge rectifier because its efficiency is higher than the other types of rectifiers.The efficiency of full wave rectifier is about 81.2%.The process of coversion of AC to DC is known as rectification because it straightens the direction of current.The full wave diode rectifier consists of four power diodes.The four diodes are connected in series pairs in such a way that only two diodes conducts during each half cycle. The 48V DC is then connected to the battery via charge controller.

C. Charge Controller

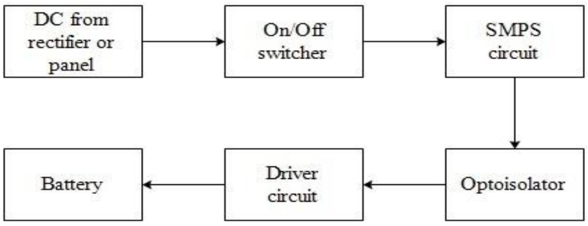

Fig 3.Block diagram of charge controller

Charge controller is the one which limits the rate at which the current is added to the battery of the vehicle.The charge controller prevents the overcharging of the battery and also protects the battery against over voltages.The PWM(Pulse Width Modulation) based charge controller is used here.PWM charge controllers are a standard type of controllers that are simpler than MPPT controllers.PWM controllers basically work by slowly reducing the amount of power going into the battery when the battery approaches its full capacity.

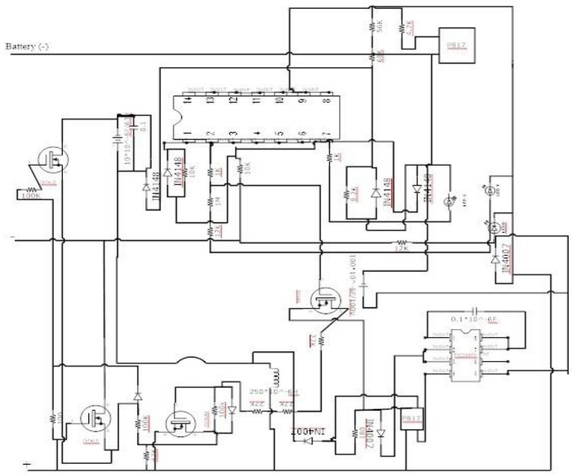

Fig 4. Schematic diagram of charge controller.

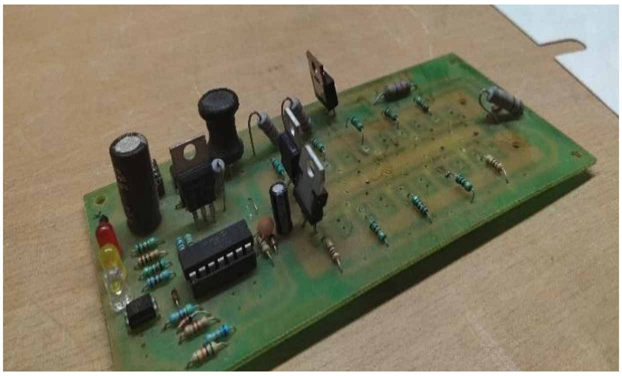

Fig 5.Charge Controller

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The above figure shows the hardware of charge controller.
Here,float charging method is used where the battery voltage is maintained at 14.5V for a 12V battery.The average time takes to charge the electric vehicle is about 6 to 8 hours.
The main components in charge controller are an on/off switcher,switched mode power supply,optocoupler,PIC and mosfets that are used as a switch in driver circuit.
The DC from the rectifier is given to the ON/OFF switcher.TNY268PN is used here.It is an energy efficient off line switcher which belongs to tinyswitch family.This IC familyuses an on/off control scheme.In the event of a fault condition such as short circuit or an open circuit condition,this switcher enters into auto restart operation.The auto restart alternatively enables and disables the switching of the power MOSFET until the fault condition is removed.
If the ON/OFF switcher detects no faults then the voltage is regulated using SMPS circuit.

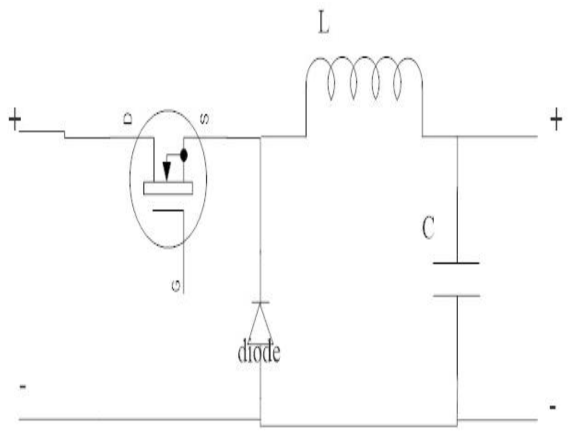

Fig 6. SMPS circuit

A SMPS buck converter is used here since the voltage needs to be stepped down or regulated before it is given diode and transistor and an inductor.To reduce the to the PIC.It consists of two semiconductors namely voltage ripples,filters such as capacitors are normally included in a converter circuit.The inductor – capacitor arrangement provides a very good filtering.Optoisolator is used in between the citcuit.The main purpose of an optoisolator is to isolate the input from output completely in order to protect the either side of the circuit when fault occurs in other side.

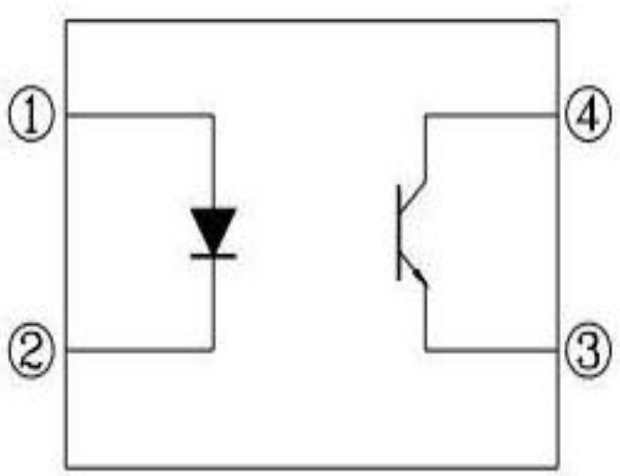

Fig 7. Optoisolator

PC817 optocoupler is used here.It is a four pin package consists of an internal LED optically coupled to the photo transistor.It separates the SMPS circuit from driver circuit.The driver circuit consists of a PIC and MOSFETs.The regulated voltage from the SMPS buck circuit is given to the PIC.Since the pulse width modulation controller is used,voltage sense is used here.Two MOSFETs are used in the driver circuit.The number of MOSFETs used depends upon the current range.The gate pulse to the MOSFET is given according to the voltage sensed by the voltage sense.The source of the two MOSFETs are connected such that the voltage flows from one to another and the battery gets charged.

IV. RESULT

This paper represents the way of solving the effects on environment by the use of fossil fuels for transportation and its constant depletion.The study of the different types of rectifiers demonstrate the effectiveness of full wave bridge rectifier. Atlast the proposed system consists of a charge controller to prevents the overcharging of the battery and also the voltage drop across the charge controller circuit is zero.The proposed system is designed to charge an electric vehicle having a capacity of 48V 20Ah battery.Electric vehicle uses lithium ion battery.

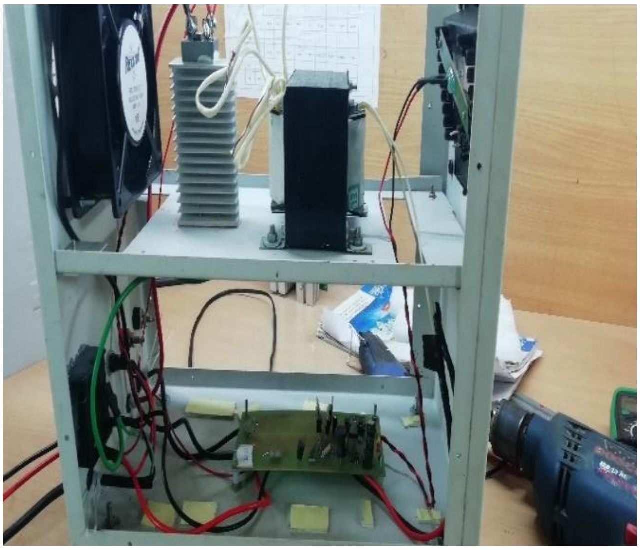

Fig 8.Hardware assembly

The input of 233V is given when supply is taken from the grid and after converting AC to DC 53V is obtained from the rectifier because the voltage is being set to the battery full voltage.While charging from solar panel 49V is given as an input.Therefore ,the result shows that the vehicle battery is charged at 04.10 to 04.40A with a voltage range of 46V to 48V.The Fig 9.shows the output charging current when battery is nearest to empty. Fig 10.shows the charging current and voltage when the battery is at half charged.

Fig 9.Charging current

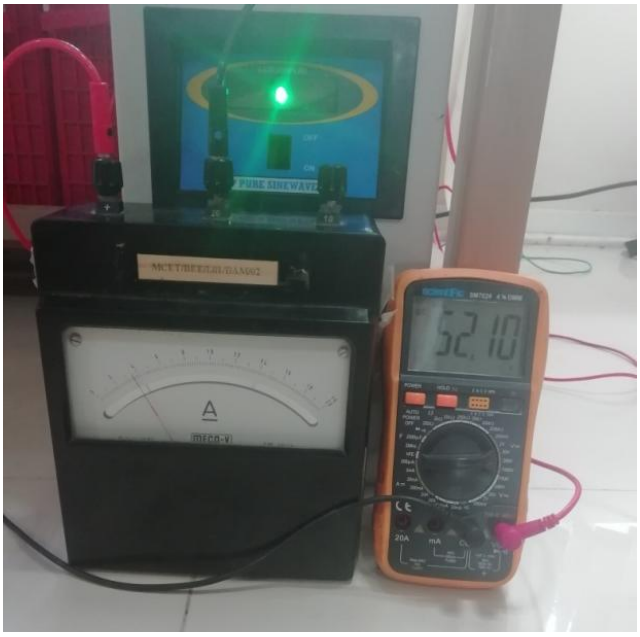

Fig 10.Charging current and voltage

Battery condition	Input voltage(AC)	Charging voltage(DC)	Charging current(DC)
Empty	233V	53.5V	4.34A
At 25%	232V	52.10V	3.9A
At 50%	232V	51.1V	3.1A
At 75%	232V	49.2V	2.5A

The above table shows the charging voltage and charging current when battery is at different conditions.

V. CONCLUSION

This paper presents the design of charge controller for electric vehicle applications. The proposed system is verified with the simulation and also the prototype is designed to charge an electric vehicle having a capacity of 48V 20Ah battery. The prototype is tested for different charging conditions and the results are tabulated.

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