ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 8, Issue 4, April 2019

Battery and Inverter System for V2G Based Solar Electric Vehicle

Yadhu Mukundhan[1] , Firdhousy P E[2] , Sandeep Anil[3] , Minu Mary Joy[4] , Basil Kumar[5] , Arun Eldho Alias[6]

Assistant Professor, Dept. of EEE, Mar Baselios Institute of Technology and Science, Nellimattom, Kerala, India[4,5,6],

UG Students, Dept. of EEE, Mar Baselios Institute of Technology and Science, Nellimattom, Kerala, India[1,2,3,4]

ABSTRACT: Electric Vehicle (EV) is anticipated to play an important role in urban transport in near future. The passion in the minds of many researchers for an eco-friendly transport medium with reduced dependency on fossil fuels have sparked a large-scale research shift towards EV and its promotion. This paper focus on selection of battery for electric vehicle and also the design of inverter which is used to provide supply to household loads during peak hours (V2G concept). The charge control system provides protection for battery during charging and discharging conditions.It also maintains the battery voltage level at the particular level for protection of battery.

KEYWORDS: Electric Vehicle, Battery, Charge controller, Vehicle to Grid (V2G).

I.INTRODUCTION

The increase in vehicle use had lead to depletion of fossil fuels and several environmental issues. The use of electric vehicles instead of internal combustion engine can eliminate green house gas emission and can also increase the efficiency of vehicle. A BLDC motor drive and controller can be designed as per required torque and weight specification on existing conventional vehicle. The motor gets the power from a lead acid battery source. A single stage PWM inverter which is powered from the battery source can be used as an external source of energy when vehicle is in stand by condition.

Lead acid batteries have been used for automotive applications because they are robust construction, low cost reliability and availability in wide sizes and capacities. They can deliver high currents and are tolerant to overcharging. They are the world’s most recycled product.

An Inverter is an electronic device used to convert direct current to alternating current at desired frequency and voltage. The inverter gets its input supply from the battery source and it provides protections for automatic shutdown for DC over voltage, over load, over temperature and AC over frequency. Inverter is an electronic device used to convert direct current to alternating current at desired frequency and voltage. The inverter gets its input supply from the battery source and it provides protections for automatic shutdown for DC over voltage, over load, over temperature and AC over frequency.

The potential for alternative technologies in automobiles such as Electric Vehicles (EV) in India as in the case of many other comparable markets depends on improved battery technologies, driving ranges, government funding incentives and better charging infrastructure.

Electric vehicle are pollution free as it does not emit pollution gases. They are 100% eco friendly as they run on electrically powered motors. It does not emit toxic gas or smoke in the environment as it run on clean energy sources. In other words, EV is greener than their average petrol or diesel equivalent, even when taking the electricity

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 8, Issue 4, April 2019

generation into account. EV gets their power from rechargeable batteries and not only used to power the vehicle but also for the functioning of lights.

II. PROPOSED SYSTEM

This project aims to design an electric golf cart which is driven with one KW BLDC motor with the help of batteries. The battery can be charged by manual plugging or by solar panel. The inverter in the vehicle can be used to supply household loads. The inverter used is a single stage PWM inverter of 300 VA capacity which converts 48 Volt DC to 240 Volt AC.A battery charger is used to put energy into a secondary cell or rechargeable battery by forcing an electric current through it. The charge controller helps to control the battery voltage in a safe limit during charging. If the battery voltage increases above the rated voltage, the charge controller automatically senses and cut of the supply from the charger output. Also the charge controller controls the current flow to theloads.

A.BLOCK DIAGRAM

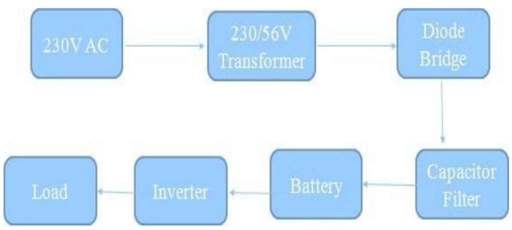

Fig 1.Block Diagram of plugged charging

Figure 1 shows the block diagram of plugged charging. The 230 Volt from mains supply is stepped down using a transformer. The diode bridge is used to convert alternating current in to pulsating direct current. It provides full wave rectification from a two wire ac input. The capacitor filter is to provide steady dc output and the ac ripples are eliminated. The battery consist of four 12 V 60 Ah lead acid battery. Inverter used in circuit is to convert DC to AC at desired voltage and frequency. The inverter can be used to feed household loads. The battery drives the BLDC motor and also provides input DC supply for inverter.

III. BATTERY

Usually secondary or rechargeable batteries are used to power propulsion of electric vehicles. Electric vehicle batteries differ from Starting, Lighting and Ignition (SLI) batteries because they are designed to give power over sustained periods of time. Batteries for electric vehicles are characterized by their relatively high power-to-weight ratio, specific energy and energy density; smaller, lighter batteries reduce the weight of the vehicle and improve its performance.

A. LEAD ACID BATTERY

Lead acid batteries are inexpensive compared to newer technologies; lead–acid batteries are widely used even when surge current is not important. Lead-acid batteries use a chemical reaction to do work on charge and produce a voltage between their output terminals. The reaction of lead and lead oxide with the sulphuric acid electrolyte produces a voltage. The supplying of energy to and external resistance discharges the battery. To charge the lead-acid battery a voltage from a charging source is applied to reverse the discharge reaction. These batteries are reliable over 140 years of development. They are robust and tolerant to overcharging. The world's most recycled product is lead-acid battery and they have an attractive advantage of being cheap.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 8, Issue 4, April 2019

Overcharging with high charging voltages generates oxygen and hydrogen gas by electrolysis of water, which is lost to the cell. The design of some types of lead-acid battery allows the electrolyte level to be inspected and topped up with any water that has been lost. Batteries are used to store the excess charge developed during the day time electricity generation by using solar module. In rainy season or if the solar panel is not working, the battery can be charged using plugged charging.

It has two plates;

1. Lead (pb)-negative plate or Cathode
2. Lead Oxide(pbo_2)-positive plate or Anode.

Electrolyte used is sulphuric acid which ionizes as H+ and HSO_4 – ions.

- Reaction of negative electrode;

$PbO_2+HSO_4^- =PbSO_4 +H^+ +2e^-$

- Reaction on positive electrode;

$PbO_2+HSO_4^- + 3H^+ +2e^- =PbSO_4 +2H_2O$

A. MATHEMATICAL MODEL OF LEAD ACID BATTERY

In systems, where the low power load is present, the power supply battery may often be treated as an ideal or real voltage source. Figure 2 shows the mathematical model of lead acid battery, which comprises an ideal voltage source or a voltage source with serially connected resistor that represents the internal resistance of the battery. One of the most accurate mathematical models used to analyze the battery performance is the electric circuit consisting of the voltage source Em and the pairs of capacitors and resistors joined in parallel $RnCn$.The electric charge losses caused by the self-discharge of the battery are represented by the occurrence of the P-N branch, through which the parasitic current Ip flows. Depending on the expected model accuracy, the appropriate number of pairs of RC dynamic branches must be selected. The number as such also depends on the dynamics of changes in the load of the analyzed battery.

The value of the majority of parameters of the cell's equivalent circuit depends, above all, on the battery state of charge *SOC*, the load and the electrolyte temperature Te. The parameters, which affect the operational properties of the battery can be determined by following equations.

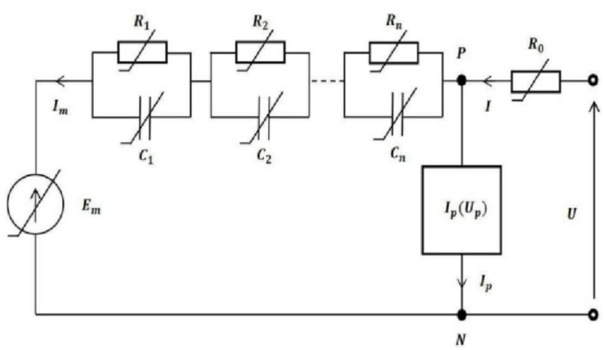

Fig. 2. Electric diagram of the lead-acid battery cell

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 8, Issue 4, April 2019

$E_m = E_{m0} - K_E\,(1 - SOC)(273.15 + T_e)$ $SOC = 1 - Q/C(0,T)$ $R_0 = R_{00}\,(1 + A_0\,(1 - R_{10}\ln(DOC)$
$C1 = Q1/R1$

Where; E_m is electromotive force of the cell, E_{m0} is open-circuit voltage of fully charged battery at 0 degree C, SOC = battery state of charge, T_e =electrolyte temperature, Q is electric charge drawn from the battery, C(0,T) is unloaded battery capacity at T, R_0, R_1, R_2 etc., are main branch resistances.DOC is battery depth of charge.

C.BATTERY CALCULATIONS AND SPECIFICATIONS

Power = Voltage *Current

Four batteries are connected in series to get 48Volt.Since the motor capacity is 1 KW (BLDC Motor) with 48V With (12V*4 battery) .Rating current, I =1000/48 =20.83 Ampere.

The peak current is less than 50 A, So we can choose 60 Ah batteries. Therefore from 60 Ah batteries, the vehicle can run for 60/20.83=2.88 hr. Considering temperature and heat loss, the vehicle can run for 2 hours. Operating temperature is ambient. The battery has 50%-95% charging and discharging efficiency. The total time taken for recharge time is 5 hours .It has large power to weight ratio. The self- discharge rate of lead acid is 3-20% per month. The battery has life cycle up to 800.An auxillary battery is used to provide power supply for internal lighting of the vehicle.

Table 1 shows the specification of battery used in the vehicle.

Name	Specification	Quantity	Cost
SF Sonic	12V,60 Ah	4	4000 each

Table 1

IV.INVERTER

Figure 3 shows the block diagram of PWM inverter. The DC source from battery is fed to clock pulse generator which produces clock signal. The MOSFETS serve as electrical switches to deliver DC at one polarity. This is then fed to transformer and AC output is obtained.

In this project we are using a 12 Volt DC/240 Volt AC, 300VA inverter. The inverter we are using is single stage inverter for the house hold applications. It provides an external source of energy when the vehicle is in standby condition and protections for automatic shutdown for DC over voltage, overload, over temperature and AC over frequency.

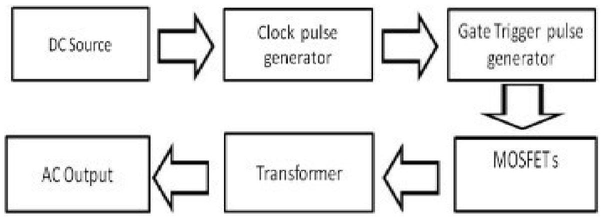

Fig.3 Block Diagram

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 8, Issue 4, April 2019

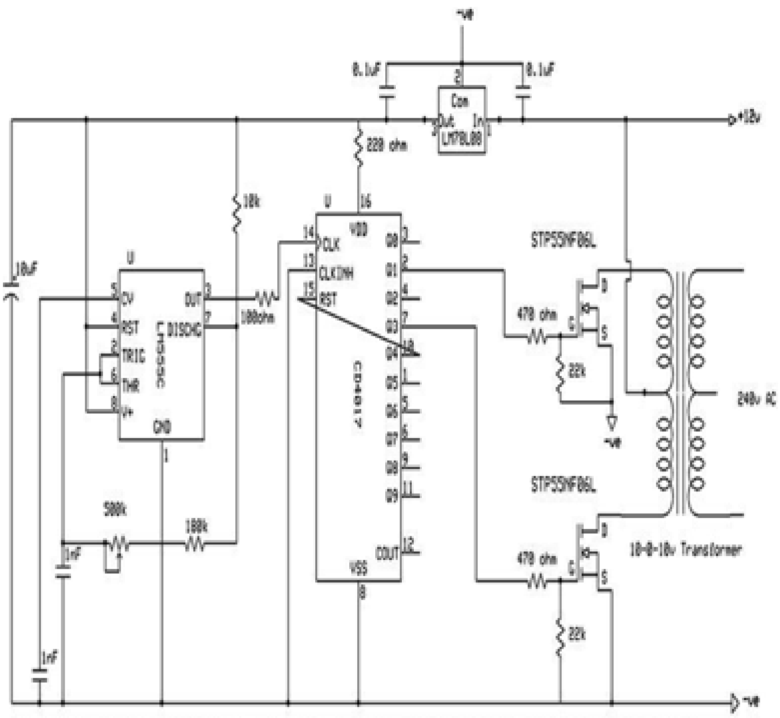

Fig.4 circuit diagram

Figure 4 shows the circuit diagram of single stage PWM inverter.IC CD4017 is a Decade Counter that gives 10 consecutive output from Q0 to Q9 when clockpulses are available on it's pin14. Clock pulses are provided from IC 555 Timer. If we want 50Hz output, then timer output frequency must be equal to 4*50=200Hz whichis obtained byvarying 50k variable pot.

Output from 555 timer (pin3) is connected to pin14 (clk) of CD4017. Now output from Q1 and Q3 of CD4017 is used to trigger MOSFETs STP55NF06L alternately. If we see output waveform from Q1 and Q3 of CD4017 in DSO ,it will appear as a modified sine wave with peak of 5V. Hence output obtained from step-up transformer (centre tapped) 10-0-10to240Vis a sine wave.

V. CHARGER

The electric golf cart is fully powered by a 48V, 60 Ah rechargeable Lead-acid battery pack. This battery pack is recharged by an auxiliary charger. The current output of the charger is adjustable from 0A to 12 A. The output of the auxiliary charger is directly connected to the battery pack through a charge controller. 230 V ac supply is converted to 48 V dc supply for the battery pack. The charger includes features like short circuit protection, over voltage protection and charge controller.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 8, Issue 4, April 2019

VI. CHARGE CONTROLLER

The charge controller controls the battery voltage in a safe limit during charging. While charging sometimes the battery charges above the rated voltage. This will reduce the battery efficiency and reduces the life span of the battery pack. Thus while charging the charge controller in the charger monitors the live voltage level of the battery. If the battery voltage increases above the rated voltage, the charge controller automatically senses and cur of the supply from the charger output. Also the charge controller controls the current flow to the loads.

VII. FUTURE SCOPE

Even with low oil prices, future of electric vehicle is bright due to lowering of battery prices. They are cleaner and more efficient than conventional vehicles. Automobile industries are investing billions of dollars to bring electric vehicles models to market. Electric vehicles are also gaining importance as the world looks for ways to reduce carbon pollution. The energy crisis and pollution problems in the long term continue to worry vehicle manufacturers. In order to resolve the negative problems caused by automobiles, researching and applying new alternative energy in the field of automobile are attracting people's attention.

VIII. CONCLUSION

The project deals with inverter and battery for solar based electric vehicle. We are designing inverter and selecting battery for a vehicle weighing 150 Kg. The electrical energy supplied by four 12 V, 60 Ah batteries connected in series to attain a maximum speed of 50 km/hr. The inverter converts the 12 volt DC to 230 Volt AC for providing supply to household loads.
This work aims at contributing towards the application of electric vehicle to grid (V2G) concept to support the grid during different requirements. By using this concept, we can reduce the peak time load on grid. So in short, we aims at a pollution less transportation and utilization of non conventional energy.

REFERENCES

1. Danish Hameed, Saad Hamayoon, Asad Ali Malik, *Solar Grid-Tied* of Electrical Engineering and ComputerSciences National University of *Inverter,with Battery Back-up, for Efficient Solar Energy Harvesting"*, School Sciences and Technology Islamabad, Pakistan, 2016 the 4th IEEE International Conference on Smart Energy Grid Engineering,pp 95-99,2016.
2. Suresh H. Kala, Pushpak B. Patel,Ashish N. Patel," *designing & analysis of micro inverter for pv grid*",PG Scholar, EE Dept., LDRP-ITR, Gandhinagar, Gujarat, India,Assistant Professor, EE Dept., LDRP-ITR, Gandhinagar, Gujarat, India,pp 428431,2018.
3. Hicham Chaoui, Guven Alcicek, "*Experimental Investigation of Calendar Aging o Lithium-ion Batteries for Vehicular Applications*", IRES research group, Department Electronics, Carleton University, Ottawa, ON, Canada,pp 455-460,2016.
4. H. Bai, X. Zheng, "Evaluationof the impact of the different charging algorithms on the lead-acid batteries lifetime", *Conf. and Expo. IEEE Transportation Electrification*, pp. 1-4, 2012.
5.]C. C. Hua, M. Y. Lin, "A study of charging control of lead-acid battery for electric vehicles", *IEEE International Symp. on Proceedings of the Industrial Electronics*, vol. 1, pp. 135-140, 2013.
6. K. S. Ng, C. S. Moo, Y. P. Chen, Y. C. Hsieh, "State-of-charge estimation for leadacid batteries based on dynamic open-circuit voltage", *Power and Energy Conf.*, pp. 972-976, 2012.
7. C M Dini□,G N Popa and A Iagăr "Study on sources of charging lead acid batteries". Politehnica University of Timisoara, Department of Electrical Engineering and Industrial Informatics, International Conference on Applied Sciences 2014 (ICAS2014).
8. Damith B. Wickramasinghe Abeywardana, Pablo Acuna, Ricardo P. Aguilera "Single-Phase Boost Inverter-Based

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 8, Issue 4, April 2019

9. Electric Vehicle Charger With Integrated Vehicle to Grid Reactive Power Compensation" IEEE Transactions on Power electronicsVolume: 33 , Issue: 4 , April 2018.
10. Vladimir Valdimirov Dimtrov, Peter Trifonov Goranov, Dimcho Stanche Hvarchilkov "Methods and power converters for charging/formation of VRLA batteries" 2017 XXVI International Scientifi Conference Electronics (ET) 01 December 2017.
11. Alvin Hua,B.Zong-Wei Syue"Charge and discharge characteristics of lead-acid battery and LiFePO4 battery." Published 2010 in the 2010 International Power Electronics.