AN OFF BOARD SOLAR EV CHARGER USING HIGH GAIN BDC AND SEPIC CONVERTER

A PROJECT REPORT

Submitted by

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TKM20EEPS02

to

the **APJ Abdul Kalam Technological University**

in partial fulfillment of the requirements for the award of the Degree

of

MASTER OF TECHNOLOGY

in

POWER SYSTEMS

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

T.K.M COLLEGE OF ENGINEERING

KOLLAM-5

2022

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

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CERTIFICATE

This is to certify that the Project report entitled '**AN OFF BOARD SOLAR EV CHARGER USING HIGH GAIN BDC AND SEPIC CONVERTER'** submitted by **'AMINA B'** to the APJ Abdul Kalam Technological University in partial fulfillment of the requirement for the award of the Degree of Master of Technology in Power Systems, Electrical & Electronics Engineering is a bonafide record of the project work carried out by her under our guidance and supervision. This report in any form has not been submitted to any other University or Institute for any purpose.

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ACKNOWLEDGEMENT

I am obediently thankful to **God Almighty,** praise and glory is to Him, for all His uncountable bounties and guidance, without which, this project would have never been a reality.

It is my privilege and pleasure to express my gratitude and indebtedness to **Dr. T Shahul Hameed,** Principal of TKM College of Engineering, and **Dr. Sabeena Beevi K**, Head of the Department, Dept. of EEE, for providing all the required resources for the completion of my project work.

My heartfelt gratitude to **Prof. Shanavas T N**, Associate Professor, PG Coordinator and Internal Supervisor **Prof. Jibi P Mathew**, Asst. Professor , Department of Electrical and Electronics Engineering, for his valuable suggestions and guidance in designing and implementing this project.

I express my thanks to **Prof. Jibi P Mathew**, Asst. Professor, Project Coordinator, Department of Electrical and Electronics Engineering for all help and coordination in completing this project successfully and on time.

I will be failing in duty if I do not acknowledge the authors of the references and other pieces of literature referred to in this project.

I show my extreme gratitude to all Faculty member and Technical staffs in Electrical and Electronics Dept, for providing all the help and necessary facilities to complete the project work and my deep hearted cheers to my parents and all my friends who extended their supportand co-operation towards the successful completion of the project.

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ABSTRACT

The urge for sustainable transportation is increasing the demand for electric vehicles progressively. The main concern related to the usage of electric vehicles is that it may drastically increase the load demand on the grid. The erratic demand and the use of grid connected converters cause various power quality problems in the grid. A sustainable solution to override the various issue is renewable energy, especially solar photo voltaic based EV charging stations. This project introduces a novel photovoltaic integrated off-board electric vehicle battery charger. It is a system capable of operating in both sunshine and non-sunshine hours. It can be realised with the help of a SEPIC converter, a High Gain Bidirectional Buck-Boost converter and a Backup Battery bank. Also, to extract maximum power from the available station area and thereby improve the PV conversion efficiency, it uses integrated MPPT. A realistic model of the proposed system is designed and simulated in MATLAB SIMULINK in this project. And various proposed modes of operations for different irradiance conditions are verified for the system. The results show that the proposed charging system is capable of powering up EVs irrespective of the availability of sunshine. Finally, a comparative performance analysis of the proposed EV battery charging system using P & O and INC-MPPT techniques is verified.

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ABBREVIATIONS

PV	:	Photovoltaic
EV	:	Electric vehicle
MPC	:	Multiport converter
SEPIC	:	Single Ended Primary Inductor
BDC	:	Bidirectional DC–DC converter
MPPT	:	Maximum power point tracking
P&O	:	Perturb and observe
INC	:	Incremental conductance
PWM	:	Pulse Width Modulation
ESR	:	External Series Resistances
FSCC	:	Fractional short circuit current

CHAPTER 1
INTRODUCTION

1.1 GENERAL BACKGROUND

The economic development of our nation will dependence on the transportation sector. The main sources of air pollution is from the pollutant released from the vehicles. This pollutant create major problems like global warming, severe lung diseases and so on. The internal combustion engine vehicles are the major sources of this type of pollutant. To solve this problem the whole world suggest new transportation that is the electric vehicle. Electric vehicles are producing zero emission to environment because they are operating based on battery inside the vehicle. The main attraction of this type of vehicles are it can use DC sources to charge the EV battery. Hence use renewable energy sources that can be very ecofriendly and reusable forms of energy . The renewable energy is highly used as a power source in electric vehicle due to their environment friendly characteristics. Solar is one of the efficient energy source for electric vehicle battery charging . So we can use the solar power that will help the operation of charging the electric vehicle battery. The main drawbacks of this energy sources are their availability is dependent on nature. To overcome this disadvantage can employ various converters according the usage.

In a large group of power converters, multiport converters (MPCs) are commonly used in hybrid electric vehicles (HEVs) because it have the high potential to connect between source and storage system. In the case of MPC used as isolated one in the core a transformer so it high the implementation cost. Non-isolated MPCs are less complex than the isolated converter type. EV battery chargers are broadly classified as on-board and offboard chargers. An off-board charger is installed only at the fixed location, whereas on-board charger is found inside the vehicle. Size, weight, space and value are a number of the constraints associated with the onboard charger.

From this SEPIC converter is used for this battery charging system. Because SEPIC converter have lots of advantages such that operates on both buck boost mode, non-inverted output, low input current ripple and higher efficiency, stable operation. Next to consider the storage element for battery charging system. In the case of low solar irradiation and non-sunshine hours, there is a need for an additional storage battery bank to charge the EV battery. This backup battery bank has to be charged and discharged depending on the solar irradiation.

Hence, a bidirectional converter with power flow in either direction is required. Here using a high gain bidirectional buck boost converter due to it will reducing the switching losses by increasing the gain. The bidirectional dc-dc converter proposed here having a coupled inductor, 4 switches, a clamp capacitor and an intermediate capacitor. The clamped capacitor recovers the leakage energy, therefore enhancing the performance of the converter. The excessive voltage conversion ratio is executed via the use of coupled inductor and an intermediate capacitor. For buck operation, the intermediate capacitor is charged in collection to the secondary of the coupled inductor and discharged in parallel to it. For rais**e** mode, that **is** vice versa. All switches of the proposed configuration are anticipated to have inherent soft switching functionality in the course of flip on.To extract the maximum power from the panel we can use different MPPT techniques. In this project uses mainly two MPPT that is P and O and INC. Due to its simplicity, P and O is one of the most widely used algorithms for power point tracking. This algorithm, which tracks MPP, is based on voltage and current sensing. To track MPP, this controller needs to calculate power and voltage. If power continues to increase continuously, the algorithm will continue to perturb the voltage in the same way. If the new power is smaller than the old power, the perturbation will be in the other direction. There is oscillation around the MPP point when the module power reaches that level. The principle of operation of this method is that increasing or decreasing the value of perturbation. According to the flowchart initially sense the PV voltage and current. Then compute the power. Then calculate the instantaneous value of power and voltage is determined. Apply conditions to reach the maximum power point. The first condition is that change in power is greater than zero and change in voltage is less than zero then increase the duty cycle. The second condition is that change in power is greater than zero and change in voltage is greater than zero then decrease the duty cycle. The third condition is that change in power is less than zero and change in voltage is greater than zero then increase the duty cycle. The fourth condition is that change in power is less than zero and change in voltage is greater than zero then decrease the duty cycle.

INC,One of the simplest method of maximum power point tracking. We know that their will be a one maximum power point in the power verses voltage characteristics of the solar panel. From the concept of maximum power point the graph of P-V characteristics of solar panel is divides in to three region.one is the MPP region and left hand and right-hand side of maximum power point. The change in power to change in voltage is greater than zero in left hand side of maximum power point and this ratio is less than zero on right hand side of the MPP. In this MPPT technique we check the I/V ratio of the PV panel. That is the conductance value. If no temperature change, irradiance is not changing the duty is same as the previous value it does not need to change. If any change in temperature variation the add or subtract duty to reach MP

1.2 MOTIVATIONS

We know that usage of Internal combustion engine-based transportation will highly produce environmental impacts. In order to reduce this impacts the electric vehicle-based transportation is come in to action. The main thing related to EV is that its battery charging. So we need a solution for EV battery charging. Lots of methods used for this problem. Battery charging of EV takes the power from the grid. Which will increase the power demand on grid, harmonics problems and reliability issues on grid. In order to solve the grid issues we can charge the EV battery using DC Power. Which can be obtained from the PV panel. It is necessary to store the power .So their will a storage system that help to charge the battery. The conventional methods of EV battery charging do not have storage devices and not operate absence of solar power.it is necessary implement a EV battery charging system to charge battery without affecting low or medium irradiance condition.

1.3 THESIS MAIN OBJECTIVES

- To study the Photo voltaic (PV) array based electric vehicle charger
- To study the behavior of EV battery charger in three different modes of operation and check the efficiency of the system by changing the Irradiance condition

1.4 ORGANIZATION OF THESIS

The entire thesis organization is as follows:

It consists of 7 chapters. Chapter 1 includes brief introduction, motivation and objective of the problem. Chapter 2 deals with the literature review on the condition assessment renewable energy basis EV battery charging and Converters used in this type charging and its types. Chapter 3 focuses on the basic introduction of Methodology used in this work. It consist of conventional OFF board EV battery operations and its drawbacks. Due to the demerits of this system PV based OFF board EV battery charger is proposing. It works on 3 Modes of operation. According to all modes the proposing system charge the EV battery without any interruption. Chapter 4 deals with detailed descriptions of Maximum power point tracking methods. It is very important to adopt MPP tracking method to extract maximum power in the PV panel. Chapter 5 deals with Modelling of converters and design parameters used for the simulation purpose. Chapter 6 deals with simulation diagram and Results of Conventional and proposed EV battery charging system. Chapter 7 gives a condition assessment PV based OFF board EV battery charging and brings out the main conclusion of the work

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CHAPTER 2

LITERATURE SURVEY

2.1 INTRODUCTION

This chapter deals with the literature review of various converters used for EV charging, Various grid issues due to take grid power for EV charging and different MPPT techniques that can be used to extract maximum power from the PV panel.

[1] M. S. ElNozahy and M. M. Salama, "A comprehensive study of the impacts of PHEVs on residential distribution networks," IEEE Trans. Sustainable Energy, vol. 5, no. 1, pp. 332–342, Jan. 2020.

In this paper describes the battery charging of Electric vehicle in two modes of operation. That is when PV power available or not. If PV is present charging of EV otherwise DC load help to recharge the battery. The main drawback of this type of EV battery charging is that it only work on sunshine hours. In the non sunshine hour the EV battery is cannot be charged. The other drawback is the power loss. If the power generated by the PV panel is excess then no storage element in this system.

[2] S. M. P., M. Das and V. Agarwal, " Design and Development of a Novel High Voltage Gain, High-Efficiency Bidirectional DC–DC Converter for Storage Interface", ***IEEE Transactions on Industrial Electronics,*** **vol. 66, no. 6, pp. 4490-4501, June 2019**.

It describe the new mode of bidirectional converter with large gain and more efficiency is proposed. The efficiency is about 94% is produced, irrespective with conventional converters. BDC improve the system efficiency, a less inductance value, and eliminating the input ripple to a very small value. The bidirectional dc-dc converter proposed here having a coupled inductor, 4 switches, a clamp capacitor and an intermediate capacitor. The clamped capacitor recovers the leakage energy, therefore enhancing the performance of the converter.

[3] H. Li, Z. Zhang, S. Wang, J. Tang, X. Ren, and Q. Chen, "A 300-kHz 6.6-kW SiC Bidirectional LLC On-Board Charger," IEEE Trans. Ind. Electron., Early Access 2019

This paper discusses about the renewable energy based electric vehicle battery charging. We know that the renewable sources of energy is very ecofriendly and create pollution free environment. The main problem associated with the electric vehicle transportation is its battery charging's are so many batteries available for charging of EV battery. Among this the lithium ion batteries are very usable because it has higher energy desnity.Enegy density means that how much energy stored in this battery. So its charging requires the grid power.it will increase the load demand. in order to reduce this here detailed about different renewable energy based transportation.

[4] B. Axelrod, Y. Beck, and Y. Berkovich, "High step-up dc–dc converter based on the switched-coupled-inductor boost converter and diode capacitor multiplier: steady state and dynamics," IET Power Electron., vol. 8, no. 8, pp. 1420–1428, Aug. 2017

An on board charger with three phase connection and its control is described. This charger is placed between the vehicle and the energy source. This type of charger consists of three phase connection between the source and vehicle. This type the converter is in interleaved operation to increase the efficiency of the system. It is derived from the conventional buck boost charger.so in the conventional system has the motor winding which is connected to this charger. A two stage charger with double control is proposed.

[5] Chiang, S.J., Shieh, H., Chen, M.: 'Modeling and control of PV charger system with SEPIC converter', IEEE Trans. Ind. Electron., 2018, 56, (11), pp. 4344–4353

In order to built a electric vehicle charger it necessary to model the PV array and the SEPIC converter. This paper tells about the description of PV array integrated with SEPIC converter based on current mode control. The merits of this converter is less input current ripple, higher efficiency ,and large gain to reduce the switching loss. This converter can operate both CCM and DCM modes of operation. The behavior of this converter in CCM modes is detailed in this paper also its advantage over other conventional converters is discussed.

[6] M. R. Banaei and H. A. F. Bonab, "A Novel Structure for Single-Switch Nonisolated Transformerless Buck–Boost DC–DC Converter," in IEEE Transactions on Industrial Electronics, vol. 64, no. 1, pp. 198-205, Jan. 2017.

The bidirectional converter play an important role in different application such as EV battery charging, Telecommunication industries, mobile battery charging and so on. Which is act as barrier between the source and energy storage devices. So it is more popular in research view. This converter can used in electric vehicle battery charging because of bidirectional flow is required there. In the case of isolated converter which requires the transformer core for operation that increase the complexity of the system and cost is increasing. It is necessary to charge the battery of the electric vehicle through the bidirectional converter because it uses renewable energy sources like photovoltaic system. solar is the one of the promising energy resources to charge the EV battery.

[7] Farzin, H., Fotuhi-Firuzabad, M., Moeini-Aghtaie, M.: 'A practical scheme to involve degradation cost of lithium-ion batteries in vehicle-to-grid applications', IEEE Trans. Sustain. Energy, 2016, 7, pp. 1730–1738

This research focuses on EV lithium-ion battery degradation in vehicle-to-grid (V2G) programmed and presents a viable wear cost model for EV charge scheduling applications. As a first step, consider all of the things that influence the cycle life of lithium-ion batteries are found and their consequences on deterioration process are explored. Following that, a general A model for battery cycle life loss is developed, integrating all of the data. In V2G applications, there are a number of important considerations to consider when charging and discharging. Modeling the expense of battery wear as a series of numbers a mechanism for calculating equal-payments over the cycle life the cost that EV users incur as a result of participating in V2G programmed is being created. The EV charge scheduling problem is explored using the proposed battery degradation cost model.

[8] B. Wu, S. Li, Y. Liu, and K. Ma Smedley, "A new hybrid boosting converter for renewable energy applications," IEEE Trans. Power Electron., vol. 31, no. 2, pp. 1203–1215, Feb. 2016.

The multiport converter is fed from full bridge bidirectional DC DC converter is introduced in this paper. The switching pulses are generated using bidirectional DC DC converter and it is from the group of full bridge converters. this converters are used to connect large amount of bidirectional converters and load. It has a higher efficiency to achieve one stage power transfer between two ports and ZVS between the switches. It increasing the gain and efficiency of converters. Pulse width modulation process is used to control the port voltage in the desired limit.it also uses phase shift control techniques to achieve the result. It is have a advantage is that producing more efficiency compared with conventional isolated converters. It also reduces the switching losses in the circuit.

[9] J. Ahmad, "A fractional open circuit voltage based maximum power point tracker for photovoltaic arrays," 2010 2nd International Conference on Software Technology and Engineering, 2015, pp. V1-247-V1-250

The fractional open circuit MPPT is based on the concept that it uses PV voltage at maximum power and create linear relationship between the open circuit voltage of the panel. It is a simple form of MPPT techniques. The main drawbacks of this system is that it requires to disconnect the solar PV with regular intervals of time. The another drawback is it causes to power loss of the whole system .It also leads to increase the sampling period between two adjacent array voltage.

[10] J. Mroczka and M. Ostrowski, "A low cost maximum power point tracker with the hybrid algorithm that uses temperature measurement," 2019 8th International Conference on Renewable Energy Research and Applications (ICRERA), ***2019, pp. 445-449*****.**

This paper describes the minimum cost power point tracker is simulated and tested with hardware. It consist of DC DC converter,Microcntrolleer with MPPT algorithm. It uses temperature as well as maximum power to track the speed and partial shading condition. It is very adequate method for tracking power point of any PV array.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This chapter deals with the conventional off board EV charger and its disadvantage. Also describes the Proposed EV charger, converters and controllers used in it.The main converters used in this are SEPIC converter and High gain bidirectional DC DC converter.

3.2 CONVENTIONAL OFF BOARD EV BATTERY CHARGER

This system is used to charge the EV battery. It operates on two modes. Initially the solar is available to charge the battery. Second condition is when the solar power is not present then EV is charged help of DC load on this system. It mainly include Photovoltaic panel, two switches, Bidirectional converter and Battery. The gate pulses is applied to switches S_1 and S_2 which is used to disconnect the PV array and load in the charging system. This system operates on two modes namely forwarded and reverse mode.

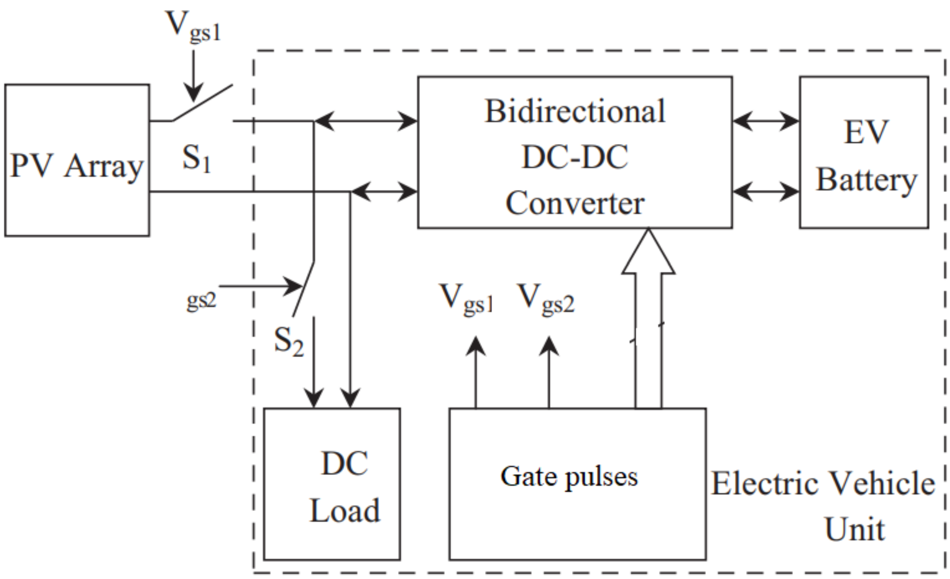

Fig.3.1 Block diagram of the PV based off board EV charger

3.2.1 Working of System

- Forward mode

In this mode initially switch 1 is on condition ,as a result power is flowing from PV panel to the EV battery through the bidirectional converter. Here PV is sufficient to charge the EV battery. The pulses for BDC and switch 1 is given. In this condition DC load is disconnect from this sytem.so the switch is off condition. The current across the load is zero. Then the voltage become high and reaches open circuit voltage.

- Reverse mode

In this mode, the BDC functions in buck mode. Switch S1 is also off in this state, but switch S2 is constantly on. As a result, the EV unit is separated from the PV array, as well as the DC load is coupled to the BDC. The battery discharges through to the BDC in this mode, giving power to the DC load. The EV is in this mode while it is not connected to the charging station and is running. The DC load, which could be the DC motor and or DC loads inside the EV, is driven by the discharging battery system in the running condition. Battery-discharging mode is another name for this mode.

3.2.2 Drawbacks of conventional system

- It is only available on solar power is present and during non-sunshine hour it fails to operate
- Another disadvantage is the power loss because of no storage devices

3.3 PROPOSED PV BASED OFF BOARD EV BATERY CHARGER

The limitation of conventional system is corrected by a new system, mainly consist of two batteries, power source is the PV panel, to flow the power in both direction using bidirectional DC -DC converter and three auxiliary switches for controlling 3 modes and controller. The main operation of this system is divided into three. Initially the PV panel power is greater then both battery get charged. Second condition is that PV not available the EV battery get charged using the secondary battery. Third condition is that less PV power is available only to charge the EV battery. The first condition all auxiliary switches on. In the second condition switch connected to PV is off others are off. In third condition switch connected to secondary battery is closed.it operate based on irradiances conditions. irradiances is the main output of PV panel. If irradiance is very low and PV is the primary source to charge the EV battery the system may fail to operate. In order to get the best results to extract maximum power from the PV panel. Here using 2 MPPT techniques. The MPPT techniques are P and O &INC Method of tracking maximum power. Then compare results to obtain maximum output.

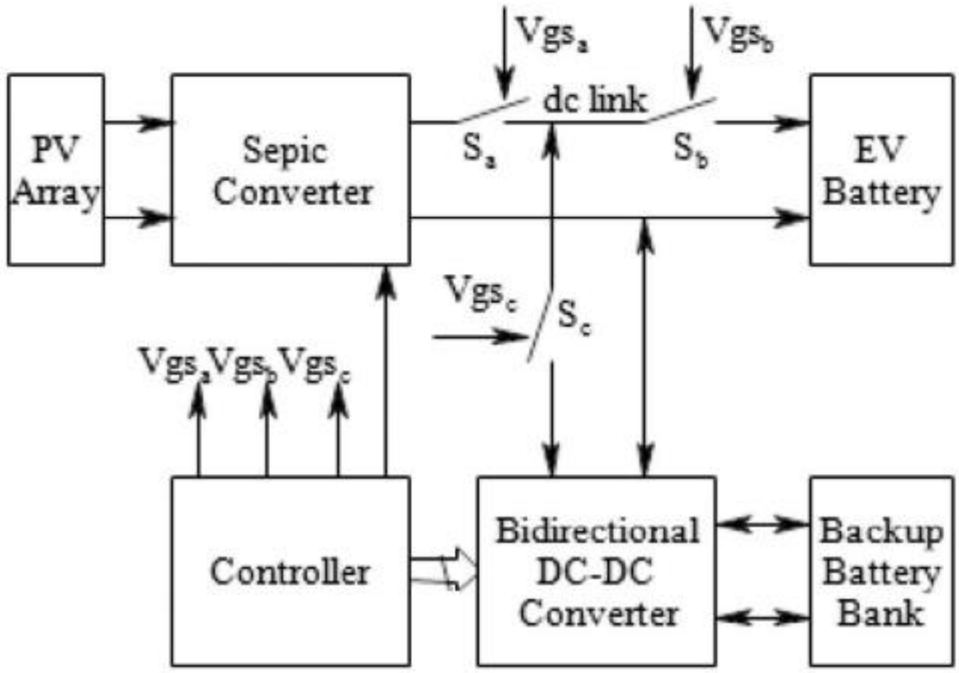

Fig.3.2 Block diagram of Proposed the PV based off board EV charger

3.3.1 Working of proposed system

Mode 1:

In this mode all switches are on because of high irradiance condition. During this period the power from panel is so high and enough to charge both batteries .The controller help to generate pulses to auxiliary switches and BDC.Here the converter is work on boost operation based on irriandince.This condition MPPT will help to produce maximum output from the panel.

Mode 2:

This condition the PV power is very less to charge the battery in electric vehicle. In order to run the vehicle their will be an secondary battery.so the system will drive by the backup battery and charging the battery of the electric vehicle. BDC act on buck mode for the charging the battery.

Then first auxiliary switch off and another two are on this condition, PV is disconnected from the system.

Mode 3: 3rd mode Switches Sa and Sb are turned on and switch Sc is turned off when the PV array generates enough power to charge only the EV battery. This disconnects the BDC and backup battery bank from the dc link.

3.3.2 Operation of converters

- **SEPIC Converter**

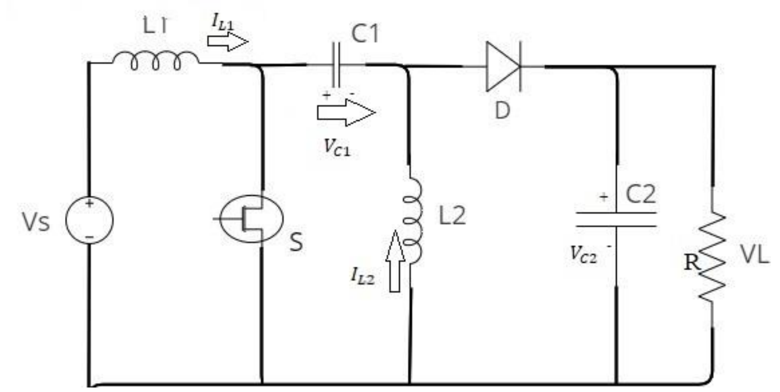

Fig.3.3 Schematic of SEPIC converter

It consist of a coupling capacitor and output capacitor respectively C_1& C_2, inductors l_1, and l_2, and diode. It produce an output voltage that is either greater or less than the input voltage. On inverting polarity of output. Easy to drive switch and low input current for high precise MPPT.

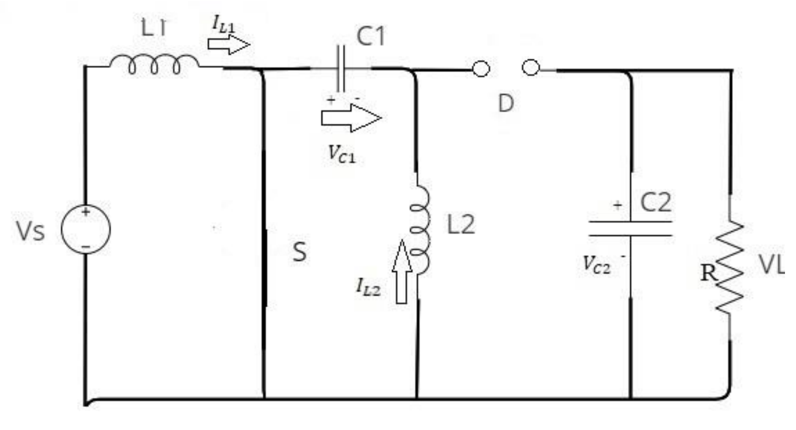

Fig.3.4 SEPIC converter ON state

When the switch is ON condition, During this time the inductor L_1, get charged by input voltage source. When state of power switch is ON with appropriate polarities. During this time the inductor L_1, get charged by input voltage source When state of power switch is OFF. The capacitor C_1, charged by inductor L_1, and also current to the load is provided

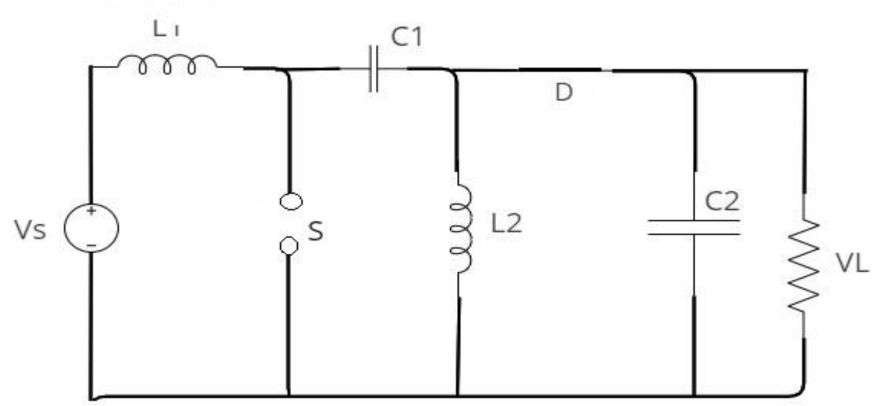

Fig.3.5 SEPIC converter off state

Single Ended Primary Inductor Converter is one of the DC -DC converter which producing an voltage either greater or lesser than the input voltage. The output of this converter is mainly controlled by adjusting the duty of switches present on it.The main difference between the buck boost converter, C_1 is that it does not change in polarity in the output. SEPIC have non inverting output. When switch 1 is turned on its operation on continuous conduction mode. In this mode the current in two inductors are remains zero. In steady state operation the average voltage passing through the capacitor is same as the input voltage. Because the capacitor restrict the dc and average current become zero.it will create the inductor L_2 act as a source of DC load. As result the average current across the L_2 is same as the current passing through the load. Which will not effect by the input voltage.

The average voltage can be written as the sum of voltage across L_1, C_1 and L_2.Since the voltage magnitude is same the mutual inductance between L_1 and L_2 become zero. In this condition assume the polarity of the winding is correct. The main need of this type of converter to obtain a steady state value output with respect the input is given from the circuit. It is necessary to controlling the output according to the design. we know that the conversion of AC to AC is done using a transformer and process is simple. But the conversion of DC DC is not much simple. We can desire some desired output by changing the input voltage. This time we can use the SEPIC Converter. The main advantage of this type converter is that it is cheaper, higher efficiency less amount of input ripple and best filtering inside the circuit processing. The basic operation of all converters are same. That is the pulses are generated from the DC

DC PWM generator is driven to the switch of the converter which will used to controlling the output desired level. now the advantages of SEPIC converter is come into action. we know that the pulse is given from the PWM generator is given to switch that time the first inductor get charged from the inductor voltage and second inductor is charged from the capacitor one. In this time diode is in close position and output controlled by capacitor two. The second condition is that the switch 2 is on that time the current is flowing into inductor through diode and into the capacitor get charged. The output is low means that increasing the duty cycle of the converter. But it very high the system may fail to operate in the design requirement.

- **High Bidirectional DC- DC Converter**

The figure below shows the schematic of High gain bidirectional DC- DC converter.

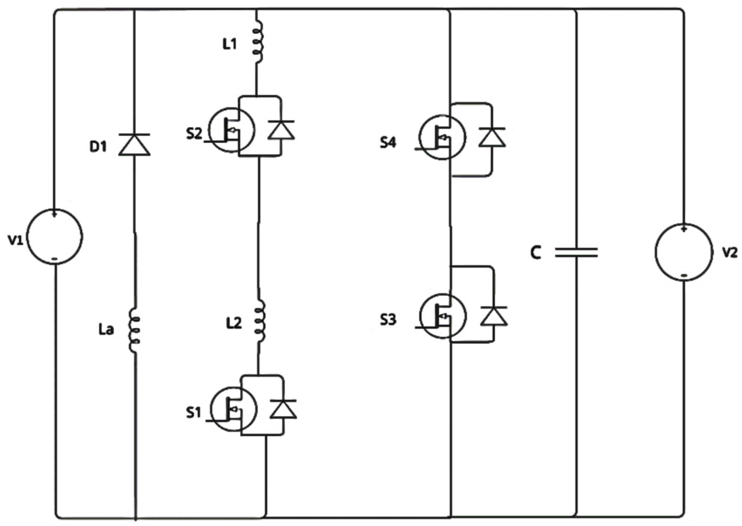

Fig.3.6 Schematic of high gain bidirectional DC- DC converter

In comparison to other non-isolated BDCs, the suggested converter gives a proper functioning. Auxiliary circuit with ZVS state provides soft switching operation. As a result, this architecture is well suited for EV charging and discharging, UPS systems, industrial networks, renewable power, battery storage systems, and other applications. Fig.3.6 depicts the suggested high gain BDC with coupled-inductor. The recommended converter has two modes of operation. (1) Buck mode: it works as a zero-voltage switching Buck converter, during switch S_1 and diode $S_4$are on. (2) Boost mode: it works as a Zero voltage switching Boost converter, during switch S_2 and diode $S_3$are on. The soft switching condition of proposed converter is achieved by four switches , Capacitor (C_1), coupled inductors (L_a, L_1, L_2) and one diode (D_1)

3.3.3 Controller used in proposed system

The proposed charger's controller creates duty for High gain bidirectional DC -DC converter, and three auxiliary switches. Figure 4 depicts the algorithm for turning on and off the auxiliary switches. The Photovoltaic system current and voltage are sensed by the controller, and the PV array power is computed. If the PV array power is more than the EV battery's rated power, PR, the controller generates gate pulses to switch on all of the auxiliary switches, charging both the EV and backup battery banks from the PV array at the same time.

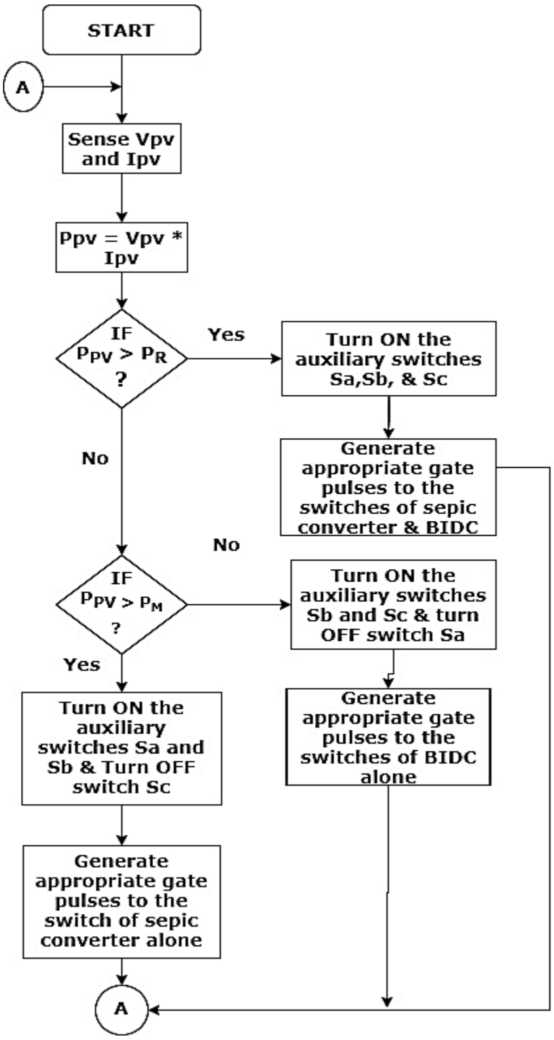

Fig.3.7 Flowchart of controller

If the Photovoltaic array power is less than the EV battery's power rating but greater than the minimum needed power, PM, the switch Sc, is turned off, isolating the backup battery from the charging system, and switches Sa and Sb are switched on, recharging the EV battery alone from the PV array. When the PV array power falls below the minimum needed power, PM, the switch, Sa, is switched off, isolating the PV array and SEPIC converter from the charging system. The Sb and Sc switches are both switched on, allowing the backup battery to charge the EV battery. The proposed battery charging system consist of voltage control PI controller to maintain voltage output of SEPIC converter irrespective of irradiations

CHAPTER 4

MAXIMUM POWER POINT TRACKING

4.1 INTRODUCTION

This chapter deals with the different MPPT techniques .For the efficient working of the proposed system ,It must be incorporated with MPPT controller to extract maximum power from the solar panel.In this chapter mainly discuss Fractional open circuit and short circuit MPPT,P and O,INC MPPT.

4.2 MPP TRACKING

Solar modules have a low power conversion efficiency, as we all know. To improve the efficiency of a solar module, correct impedance matching is required. In the last year, researchers have created a variety of MPPT methods. Every method has its own set of benefits and drawbacks. Because of their simplicity, efficiency, tracking speed, sensor requirements, and cost, MPPT algorithms differ. It can be shown that the solar module's V-I characteristics are nonlinear and highly influenced by solar irradiation and temperature. To maximize the solar module's output power, it must be operated at a set load resistance. This necessitates a separate MPPT power converter circuit. In our design, a SEPIC converter is utilized to extract the maximum power from solar array. Following algorithms for maximum power point tracking are listed below

4.3 MPPT METHOD

Method used for MPPT are listed below:-

- Fractional open circuit voltage MPPT
- Fractional short circuit current MPPT
- Perturb and observe (P&O) MPPT
- Incremental conductance (INC) MPPT

4.3.1 Fractional open circuit voltage MPPT

MPPT tracking using fractional open circuit (FOCV) is a quick and easy method. This approach is incapable of detecting the exact maximum power point. The reason for this is that when the module's irradiation level and temperature change, the MPP point changes as well, but this algorithm only works when the module's irradiation level and temperature remain constant. At MPP, the voltage is fixed. This approach is based on the idea that the voltage at MPP is almost constant. N times the open circuit voltage of the module($v_{mpp=N*V_{OC}}$)Where N is constant and its value is taken from the PV module's data sheet. Basically, the value of N is Braying ranges from.68 to.80, depending on the type of module utilized. Open circuit voltage fractional Only the panel voltage must be sensed, which may be done with a simple voltage divider. a circuit running across the panel

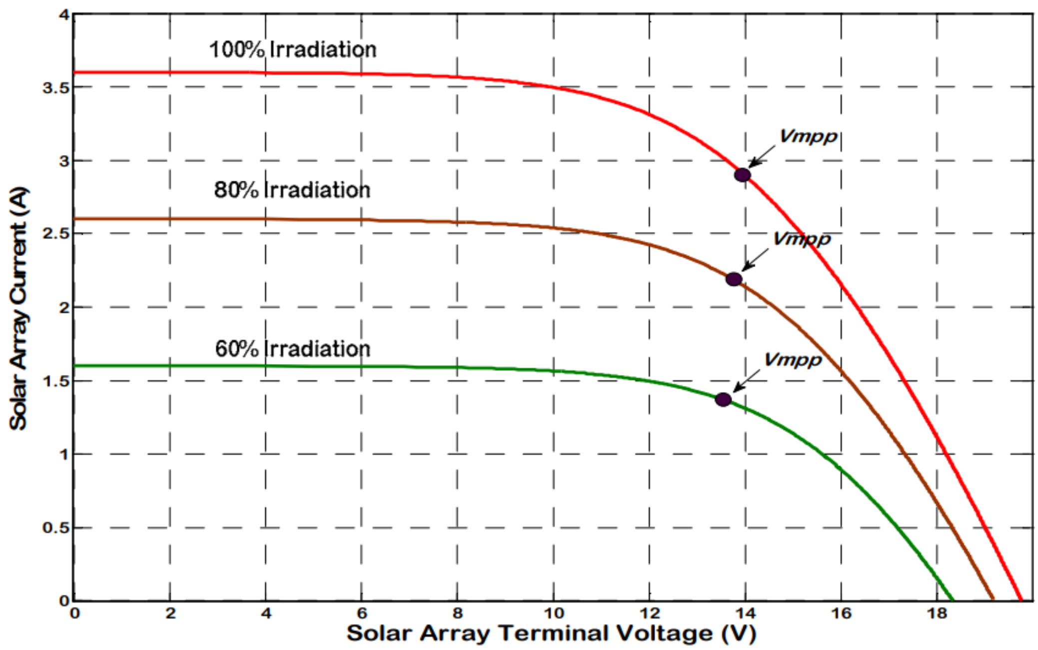

Fig.4.1 Nonlinear VI charactristics with different irriadiations

This is general V I characteristics of solar PV module. It is observed that the characteristics is nonlinear with different irradiation. We know that there is only one point that is called maximum power point at maximum voltage and current to operate the panel with maximum efficiency. Here there is variation in MPP due the irradiance variation. To achieve MPP we can use various MPPT techniques. This proposed MPPT have lots of advantage is that it reduces the level of sampling interval and not using microprocessor based controller ,so that the overall cost can be be reduced.

4.3.2 Fractional short circuit current MPPT

This technique likewise operates on the fractional open circuit voltage idea (FOCV). Due to the fact that it uses a fixed value of current, like (FOCV), it is likewise unable to track an exact MPPT. Temperature and irradiance fluctuations have no effect on the imp. $Imp \cong N * Isc$ where N is derived using the panel's data sheet. Depending on the type of panel used, the value of N typically ranges from 0.82 to 0.94. Sensing of panel current is necessary for fractional short circuit current (FSCC). We need a current sensor to sense panel current because we can't feel current straight across the panel. Hall effect-based current sensors are typically employed for MPP monitoring because of their precision and transient response, which improve system performance.

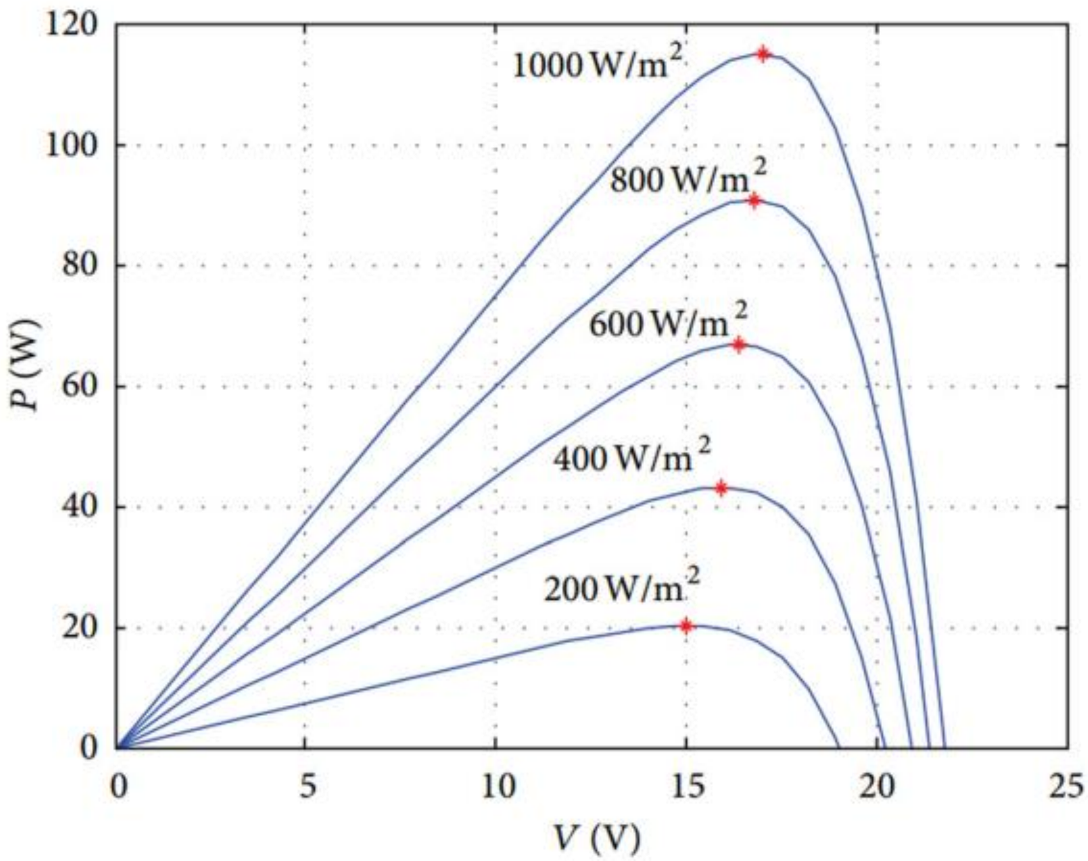

Fig.4.2 validation result of P-V Curve of PV module under changing irradiance

Fig.4.2 shows the P-V characteristics of fractional short circuit current MPPT. In FSCC is a swift technique to track MPP. It is done by finding the value of short circuit current by isolating the PV array. This system is simulated for 115W PV panel with irradiance level of 1000.From this graph it can see that the system is reaching about same power .For changing the irradiance levelto800,600,400,200,the corresponding power 97.8W,68.53W,50W,39.9W Respectively.

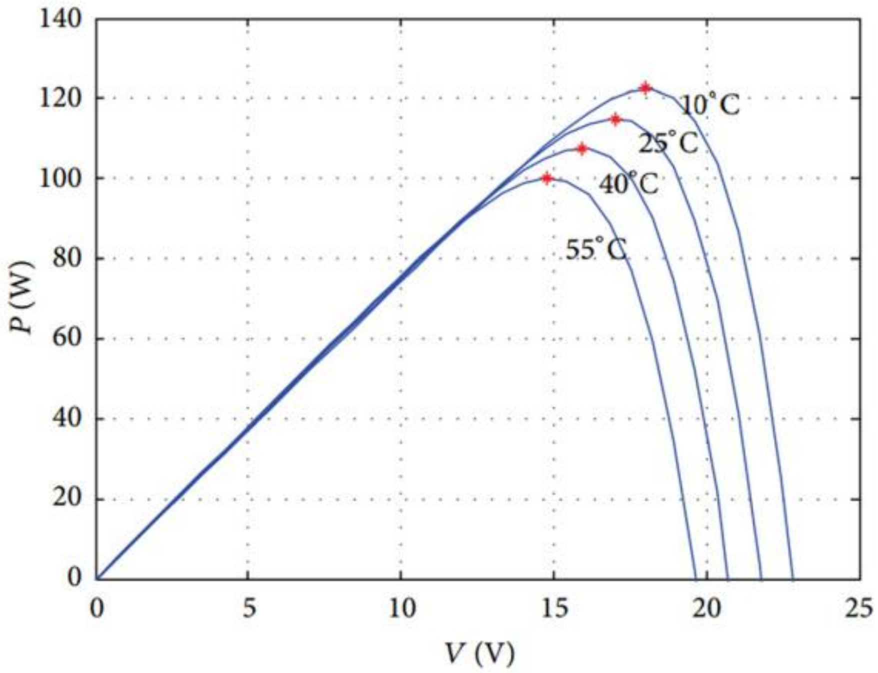

Fig.4.3 Validation result of PV curve of PV panel

Fig.4.3 shows that for changing the temperature rate is less as reference with the irradiance level. Also it can see that the variation of temperature reduces the value of short circuit current.so we can say that the impact of temperature is very less as compared with other MPPT techniques. The main disadvantage of this system is that it increase the power loss because it measure the short circuit current continuously.

4.3.3 Perturb and observe (P&O)

Due to its simplicity, it is one of the most widely used algorithms for power point tracking. This algorithm, which tracks MPP, is based on voltage and current sensing. To track MPP, this controller needs to calculate power and voltage. If power continues to increase continuously, the algorithm will continue to perturb the voltage in the same way. If the new power is smaller than the old power, the perturbation will be in the other direction. There is oscillation around the MPP point when the module power reaches that level. The P&O algorithm flow chart is shown below. It is the conventional and commonly used method for tracking maximum power of solar Panel. The principle of operation of this method is that increasing or decreasing the value of perturbation. According to the flowchart initially sense the PV voltage and current. Then compute the power. Then calculate the instantaneous value of power and voltage is determined. Apply conditions to reach the maximum power point. The first condition is that change in power is greater than zero and change in voltage is less than zero then increase the duty cycle. The second condition is that change in power is greater than zero and change in voltage is greater than zero then decrease the duty cycle. The third condition is that change in power is less than zero and change in voltage is greater than zero then increase the duty cycle. The fourth condition is that change in power is less than zero and change in voltage is greater than zero then decrease the duty cycle

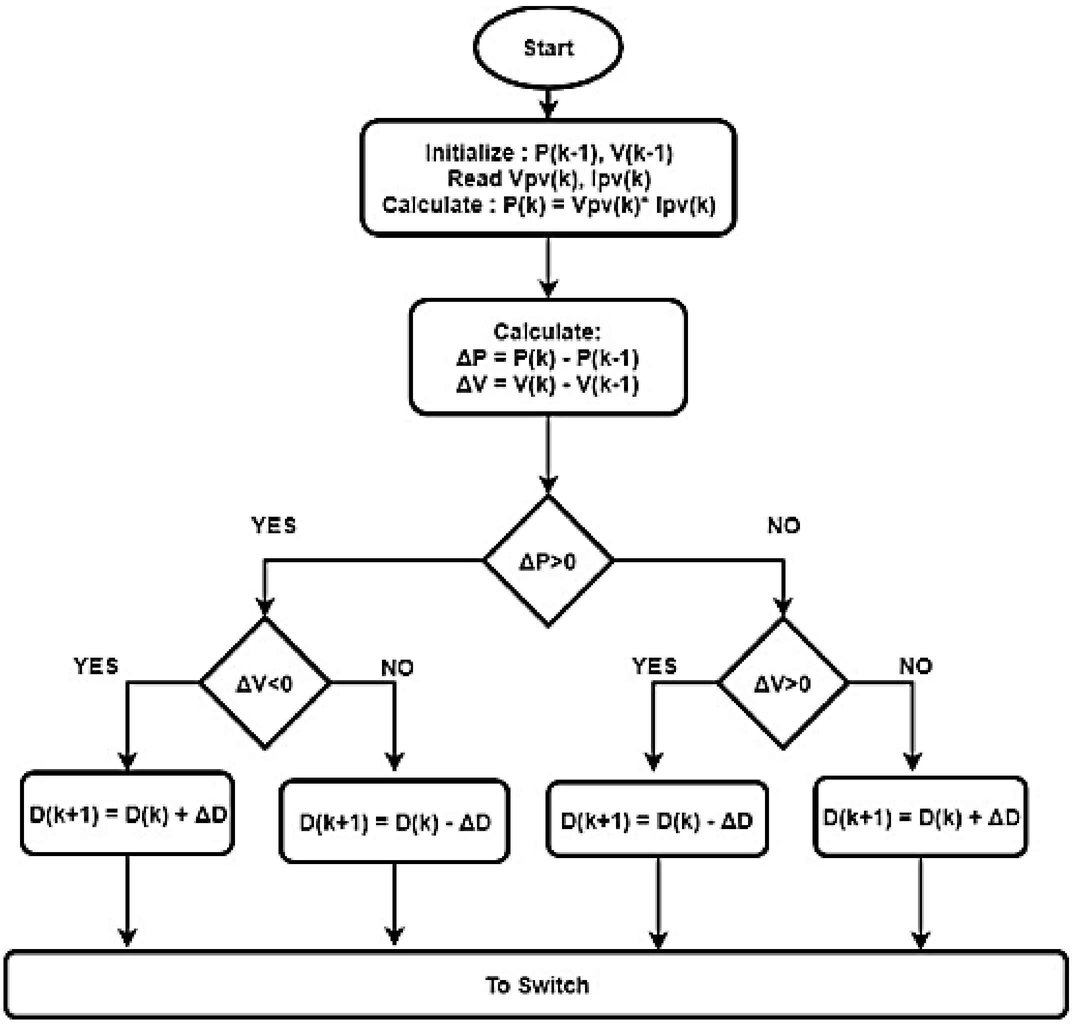

Fig.4.4 Flowchart of P and O algorithm

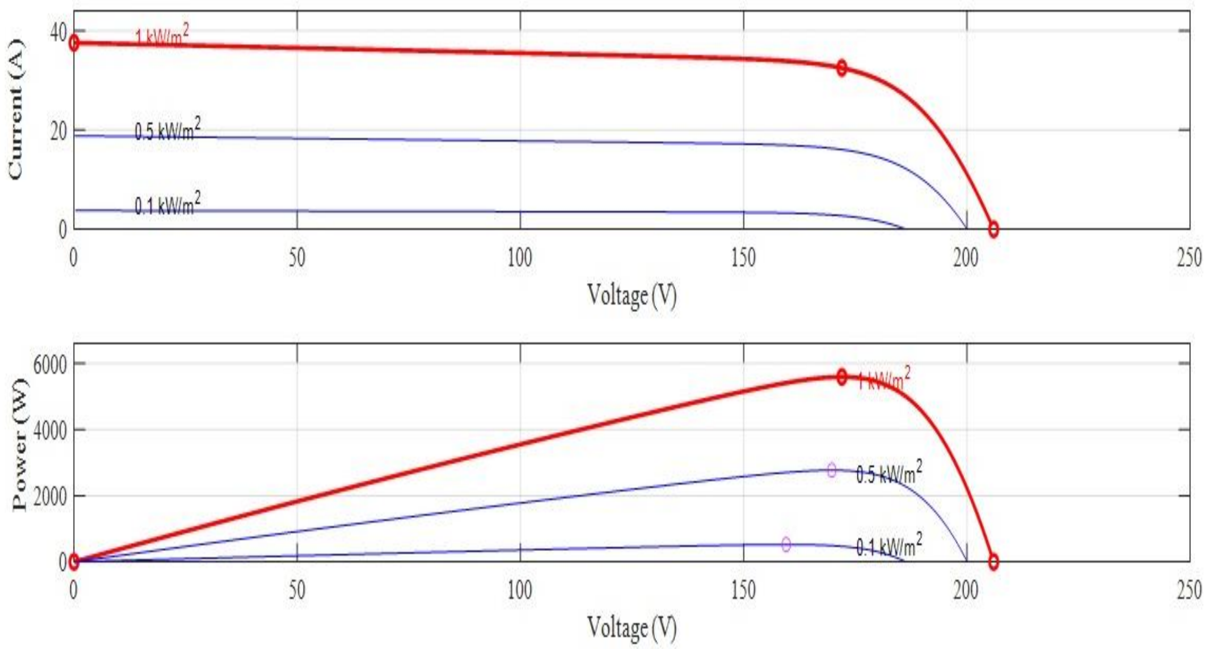

Fig.4.5 Simulated PV and IV characteristics of PV panel

Fig.4.5 shows the simulated PV and IV characteristic of PV array used in the proposed system. Here using a 350W with 4 series string and 4 parallel string for required design of maximum power with open circuit voltage is about 206V and short circuit current of 37.6A.From this figure for 1000 irradiance condition maximum power point voltage is about 172V and corresponding maximum current is about

4.3.4 Incremental Conductance (INC) MPPT

One of the simplest method of maximum power point tracking. We know that their will be a one maximum power point in the power verses voltage characteristics of the solar panel. From the concept of maximum power point the graph of P-V characteristics of solar panel is divides in to three region.one is the MPP region and left hand and right-hand side of maximum power point. The change in power to change in voltage is greater than zero in left hand side of maximum power point and this ratio is less than zero on right hand side of the MPP. In this MPPT technique we check the I/V ratio of the PV panel. That is the conductance value. If no temperature change, irradiance is not changing the duty is same as the previous value it does not need to change. If any change in temperature variation the add or subtract duty to reach MPP.

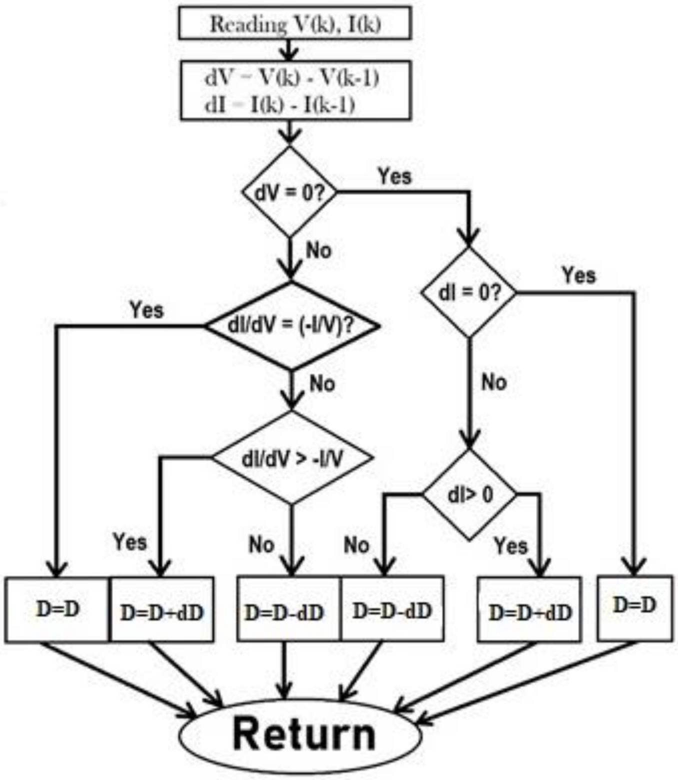

Fig.4.6 Flowchart of INC algorithm

From the flowchart initially found V(k) and I(k) .Then find the change in voltage and change in current by subtracting present value and previous value of voltage and current. first check the value of change in voltage if it is zero then found the incremental conductance value. Next condition is that is the incremental conductance equal to the negative of the conductance add the present point. If this condition satisfy it does not add reference voltage. Otherwise check this value greater or lesser. Checking this condition add or subtract the change in duty cycle to reach the maximum power point. If change in current and voltage is zero then no need to add the duty cycle it also in MPP. If change in voltage is zero and change in current not equal to zero subtract the duty cycle. The second condition is change in current is greater than zero then add the change in duty cycle. Then take the condition of change in current to voltage is zero then add duty. vice versa the change in current to voltage is lesser and the final duty value to be added with the duty cycle value. This is method of obtaining the maximum power from the solar panel and less oscillation and ripple. In compared with conventional P and O method it is more accurate and less complexity to achieve the maximum power point from the solar.

In INC method, the output PV power is,

Ppv=Vpv Ipv (4.1)

$$\frac{dP_{pv}}{dV_{pv}} = I_{PV} + V_{PV} * \frac{dI_{pv}}{dV_{pv}} \quad (4.2)$$

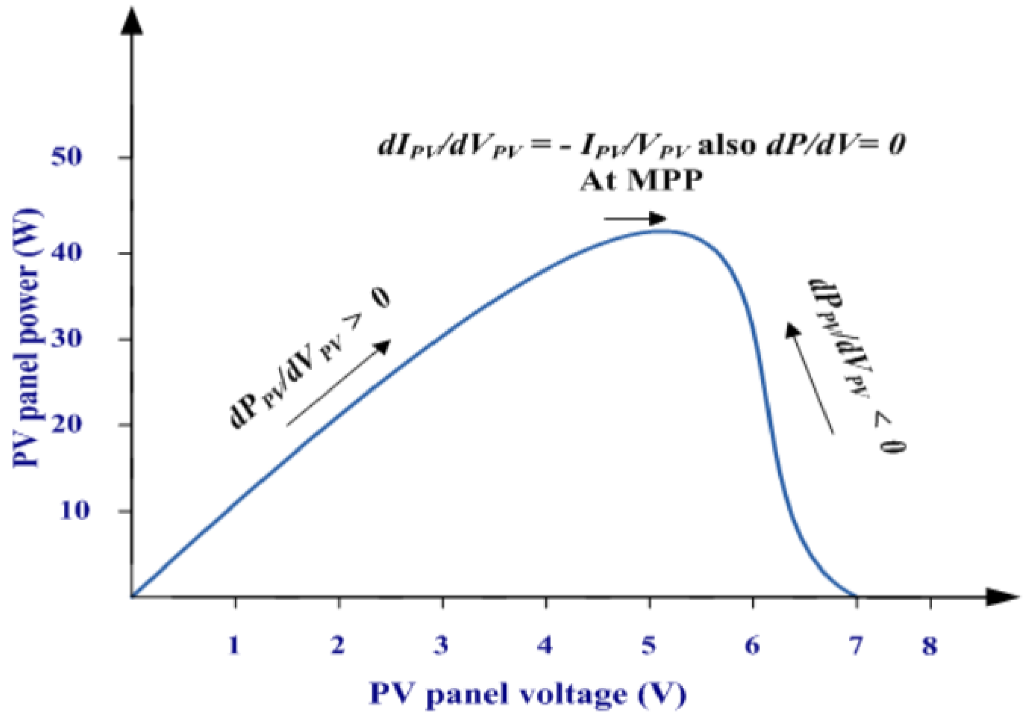

Fig.4.7. PV curve for INC MPPT

From the PV curve at MPP

$$\frac{dP_{pv}}{dV_{pv}} = 0 \quad (4.3)$$

$$\frac{dI_{pv}}{dV_{pv}} = -\frac{I_{PV}}{V_{PV}} \quad (4.4)$$

If the operating point n right of MPP then,

$$\frac{dP_{pv}}{dV_{pv}} < 0 \quad (4.5)$$

If the operating point on left of MPP the equation become,

$$\frac{dP_{pv}}{dV_{pv}} > 0 \quad (4.6)$$

In INC method present and past value of PV voltage and current is used to find the value of dIpv and dVpv.From the algorithm it can say that,

If $\frac{dI_{pv}}{dV_{pv}} > -\frac{I_{PV}}{V_{PV}}$, then $\frac{dp_{pv}}{dV_{pv}} > 0$

This the condition where the PV operating point is left of MPP so we need to increase the voltage to reach the MPP.Viceversa the next condition is that, If $\frac{dI_{pv}}{dV_{pv}} < -\frac{I_{PV}}{V_{PV}}$, then $\frac{dp_{pv}}{dV_{pv}} < 0$ to reach MPP by decreasing the voltage of PV panel.To reach the the MPP,the duty of DC DC converter is increased or decreased based on the operating point is left or right of the maximum power point.

CHAPTER 5

MODELLING OF CONVERTERS

5.1 INTRODUCTION

This chapter deals with the modelling of converters. It consist of SEPIC converter and High Gain Bidirectional DC- DC converter. Also describes the PV array parameters choices and EV battery specification.

5.2 DESIGN OF SEPIC CONVERTER

To design the SEPIC converter the parameters which is known are,

Supply voltage = 172V

Output voltage = 48V

Output power = 5.6KW

Frequency = 20kHz

SEPIC converter duty is given by,

Duty ratio $= \frac{Vo}{Vo+Vs} = \frac{48}{172+48} = 0.2181$ (5.1)

Output current = 116.4A

$I_{L2} = I_0 = 116.4A$

$I_{L1} = \frac{V0*I0}{Vs} = \frac{48*116.6}{172} = 32.53A$ (5.2)

Assume 40% of ripple current,

$\Delta I_{L1} = 0.4*I_{L1}$ (5.3)

$= 0.4* 32.53 = 7.38A$

$\Delta I_{L2} = 0.4*I_{L2}$ (5.4)

$= 0.4*116.6 = 46.65A$

$L_1 = \frac{Vs*D}{\Delta IL1*Fs} = \frac{172*0.2181}{32.53*20*103} = 144.148\ \mu H$ (5.5)

$L_2 = \frac{Vs*D}{\Delta IL2*Fs} = \frac{172*0.2404}{46.65*20*103} = 40.28\ \mu H$ (5.6)

Assume 2% voltage ripple

$C_1 = C_2 = \frac{D}{R*Fs*\Delta V0} = \frac{0.2181}{0.4114*0.02*20*103} = 961.62\mu F$ (5.7)

This the design of SEPIC converter is shown above above. Here SEPIC play an important role for maintain the voltage without affecting the changing irradiation condition. The input this converter is the PV voltage that is 172 V here. According to design the pv having a maximum power point voltage at 43V and using 4 series string in order to meet energy requirements. we know that the SEPIC can work on both buck and boost modes. Here for charging the battery of an electric vehicle it is operate on buck mode. The duty cycle is about 20.01% and output of this SEPIC converter is connected to the EV battery. In order to select the passive component like inductor must known the inductor ripple current. according the rule it uses 20% to 40% of the input current. Here using 40% ripple .Next we have to consider the capacitance value. To find this value the must consider the capacitor voltage ripple as is compared with load current.so that the output capacitance value having low equivalent series resistances(ESR) according to our design requirements.

The design of high Gain bidirectional converter is below. The battery charging operation requires a bidirectional converter. Because it must work on both SunPower and non sunpower condition.in order to get this the power must use a bidirectional converter in either direction dependence on the application. From this design the converter must operate both buck and boost mode dependence on duty cycle. Their will be isolated converters for the same purpose. But it requires more cost for implementation and circuit become bulky. Here we are using high gain bidirectional converter with non isolated type. During buck operation the input voltage of 360V is converted to 48V and the duty is about 0.133.The flow of current in this condition is that initially switch 1 and switch 4 is on.so the inductor 1 & 2 get charged. The load is driven by the capacitor. In the second condition switch 2 and 3 in operation and boost action is takes place.

5.3 DESIGN OF HIGH GAIN BIDIRECTIONAL DC DC CONVERTER

- Buck mode

  Input voltage=360V

  Output voltage=48V

  Power rating=100W

  Switching frequency=50kHz

Duty ratio = 0.133

Inductor, L_1 =250 μH

Capacitator , C_f =27.36 μF

- Boost mode

Input voltage=48V

Output voltage=360V

Power rating=100W

Switching frequency=100kHz

Duty ratio = 0.89

Inductor, L_2 =125 μH

Capacitator ,C_f = 445 μF

Table.5.1 EV battery specifications

Characteristics	**values**
Nominal Voltage	48.1 V
Upper Voltage Cut off	54.6V
Lower Voltage Cut off	39 – 40 V
Capacity	50Ah
No of. Life Cycles	1000

Table.5.2 PV array specifications

Characteristics	**values**
Maximum power point voltage(V_{mpp})	43V
Maximum power point Current(I_{mpp})	8.13A
Open circuit voltage(v_{oc})	51.5V
Short circuit current(I_{SC})	9.4A
Maximum Power(p_{pv})	350W

CHAPTER 6

SIMULATION AND RESULTS

6.1 INTRODUCTION

This chapter deals with the simulation of conventional system and proposed system and its results. The drawbacks of conventional system is overcome by the proposed EV battery charging system. Also the results of these system is included in this chapter.

6.2 Simulation of conventional OFF board EV battery charger

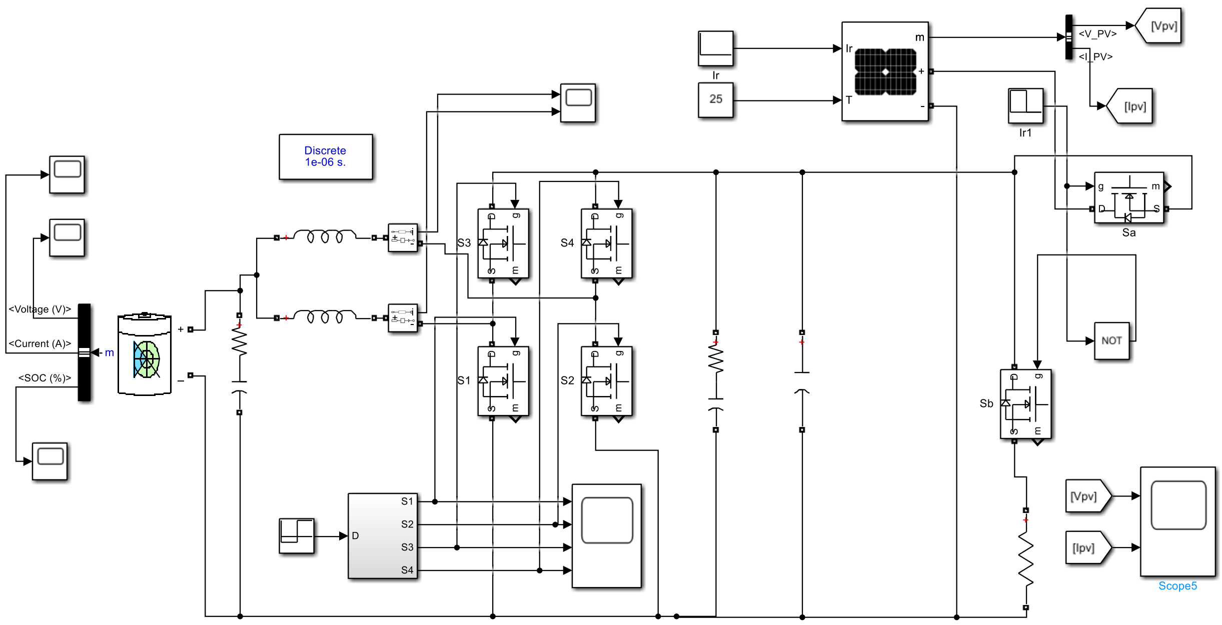

Fig.6.1 Simulation diagram of conventional EV battery charger

Fig.6.1 This system is used to charge the EV battery. It operates on two modes. Initially the solar is available to charge the battery. Second condition is when the solar power is not present then EV is charged help of DC load on this system. It mainly include Photovoltaic panel, two switches ,Bidirectional converter and Battery. The gate pulses is applied to switches S_1 and S_2 which is used to disconnect the PV array and load in the charging system. This system operates on two modes namely forwarded and reverse mode

This is done by using MATLAB/SIMULINK software. In SIMULINK we can directly take the model of PV array. Then put the values of PV parameters according to design. Then the BDC can arranged using mosfet,resistors,capacitors and inductors in the library. Then logic can applied using repeating sequences. During boost mode the PV power is available so it will operate upper switches. Another condition is provided using the not gate so the dc load is used to recharge the battery. Simulation results showing the dynamic response of the system are depicted in Fig.6.1. In boost mode, switch S1 is ON and switch S2 is OFF.

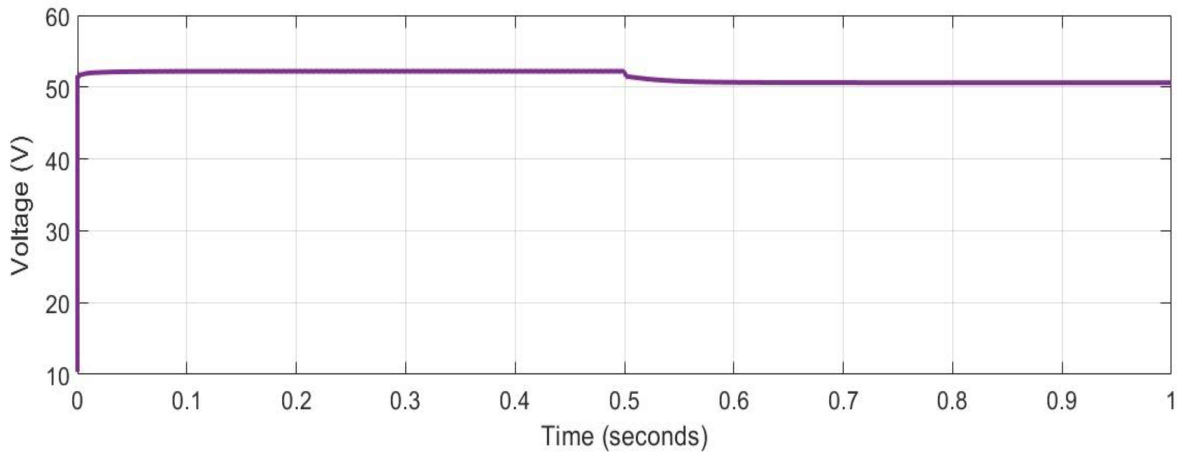

Fig.6.2 Output voltage across the EV battery

Fig.6.2 shows the output voltage of EV battery. During boost mode about 0.5 S the battery get charged and reaches 52V.The PV array is connected to the converter and battery get charged. After 0.5 S it get discharged through dc load present in the system. That time battery voltage also reduced.

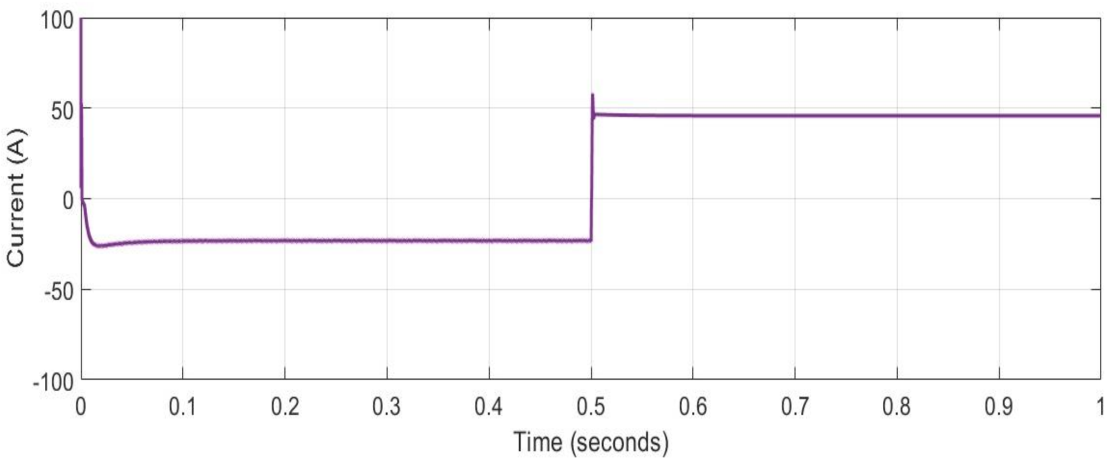

Fig.6.3 Output EV battery current

Fig.6.3 shows the current of EV battery during boost and buck mode. During boost mode its value is negative during charging and buck mode value become positive during the discharging condition.

Fig.6.4 shows the output PV voltage of the conventional off board EV Battery charger. Solar is the only source of energy in this sytem.it does not contain any storage devices.so their will loss of energy.

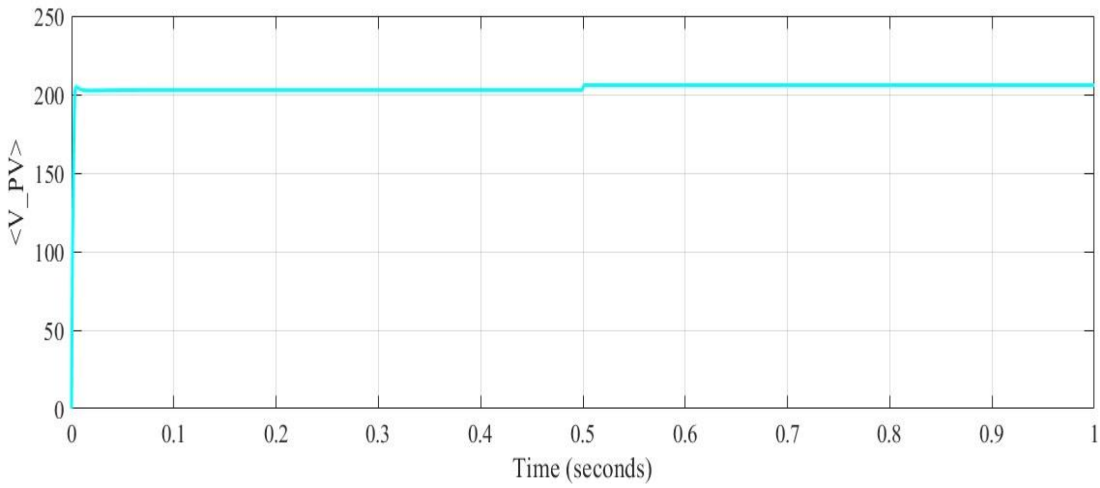

Fig..6.4 Output PV Voltage

Fig.6.4 shows that up to 0.5s the voltage is raising and that is not reaches the appropriate maximum power point voltage because it does not have any MPPT techniques. After 0.5 s it is operate on buck mode increasing the PV voltage because the system now run based on discharging of load.So PV is disconnected. In this figure we can find that the voltage is about 200V which is greater than the maximum power point voltage.Beacause it does not include any MPPT techniques.

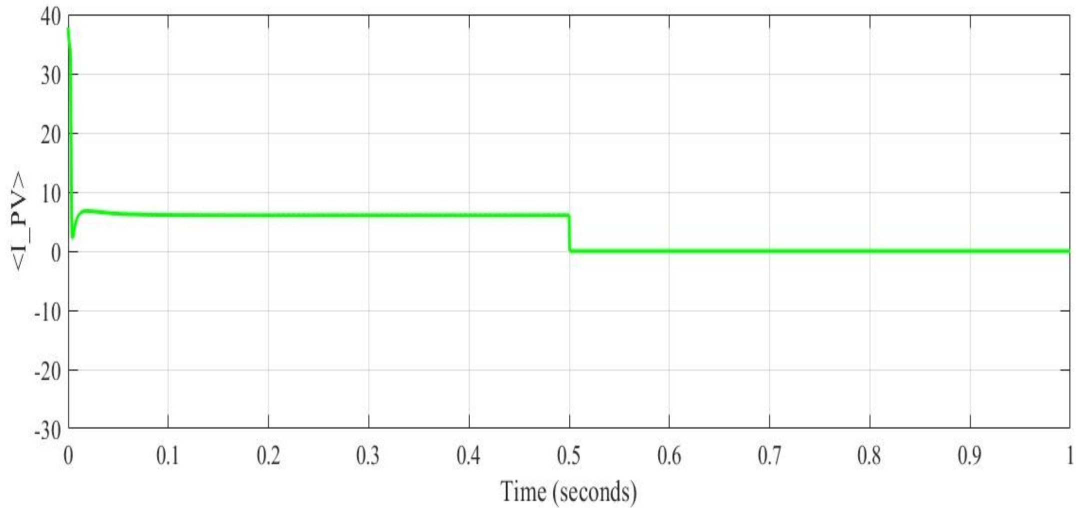

Fig.6.5 Output PV current

Fig.6.5 shows that up to 0.5s the current is raising and steady to about 5A..After 0.5 s it is operate on buck mode reaches zero PV current because the system now run based on discharging of load.so PV is disconnected. This time the battery current become positive as shown the above figure.

6.3 Simulation of Proposed PV based OFF board EV battery charger

6.3.1 Simulink Model of SEPIC Converter

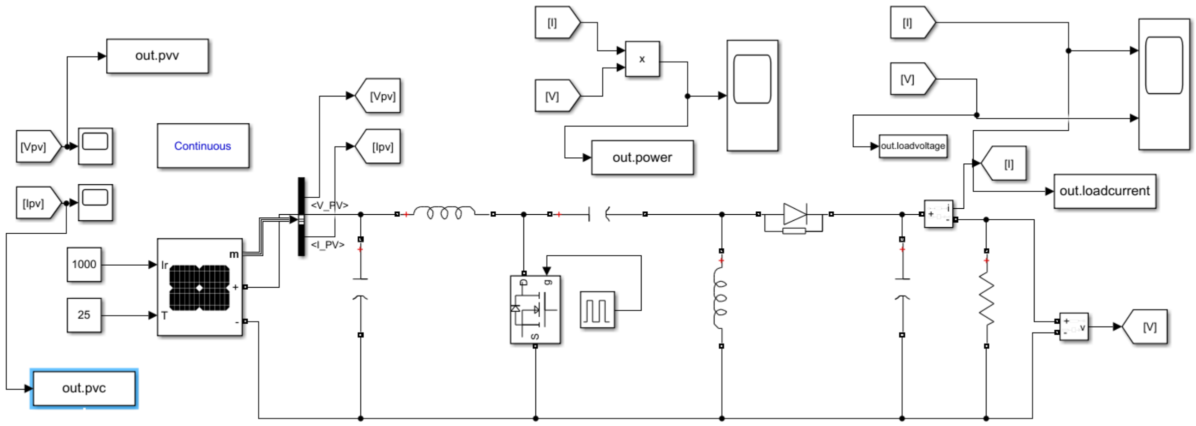

Fig.6.6 Simulation SEPIC converter with PV array

SEPIC converter is designed using mat lab Simulink shown above. The design of this converter is detailed in previous chapter. The input of SEPIC converter is 172 V and output is 48 V with a power of 5. 6kW.The output voltage, current and power is below

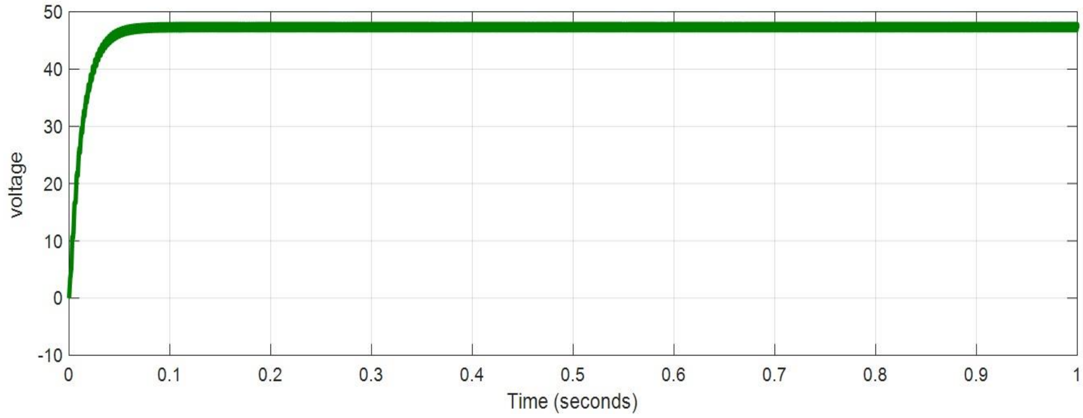

Fig.6.7 Output voltage of SEPIC converter

In Fig.6.7 According to design the output voltage of SEPIC converter is about 48V.getting almost same value here.SEPIC is act as both buck and boost mode. From the design it is found that it operate on buck modes.

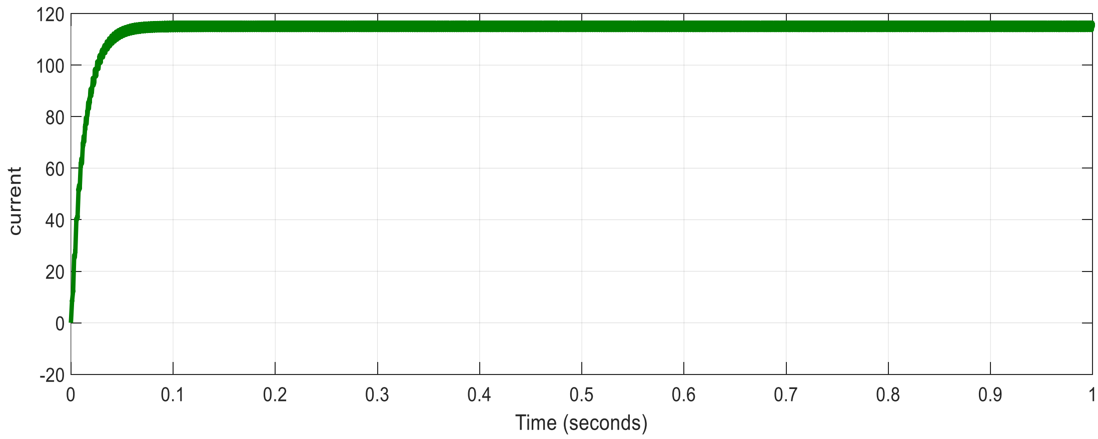

Fig.6.8 Output current of SEPIC converter

In Fig.6.8 According to design the output current of SEPIC converter is about 116.6A.getting almost same value here.SEPIC is act as both buck and boost mode. From the design it is found that it operate on buck modes.

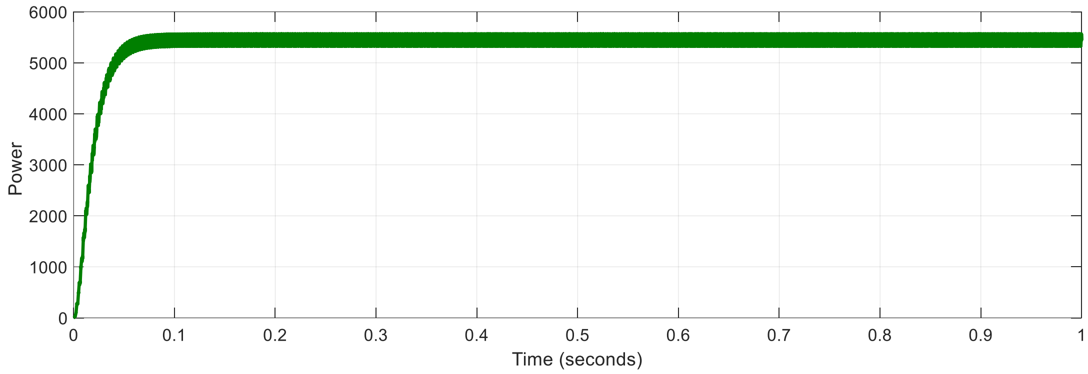

Fig.6.9 Output current of SEPIC converter

From Fig.6.9 it seems the output power of SEPIC converter.it is conclude that power become 5.6kW.

6.3.2 Simulink Model of HIGH GAIN BIDIRECTIONAL DC DC Converter

The suggested high gain BDC with coupled-inductor. The recommended converter has two modes of operation.(1) Buck mode: it works as a ZVS Buck converter, during switch S_1 and diode $S_4$are on. (2) Boost mode: it works as a ZVS Boost converter, during switch S_2 and diode $S_3$are on.The simulation result in buck and boost mode are given below. In buck mode the voltage conversion is from 48V to 360V.Similarly in boost mode it is about 360V to 48V.So the gain become 7.5 as per voltage ratio.The Simulink diagram is below.Initially doing the simulation of HIGH GAIN BDC on buck and boost mode with open loop.During the buck mode of operation switches 1 and 4 are closed.so the duty is given to this switch only.The other switches are off condition.In the second mode of operation the duty is given to switch 2 and 3.The remaining switches are off this condition.According to design the input voltage of about 360V inn buck mode to get an output of 48V.Similary in the second mode it get reversed.The main advantage of this type of converter is reduces the switching losses.As a result the overall efficiency of the system is increased.The system is integrated with the backup battery.which is connected to the high voltage side of the converter.This converter is also help in simple switching compared with other complex converters like transformer integrated converters.

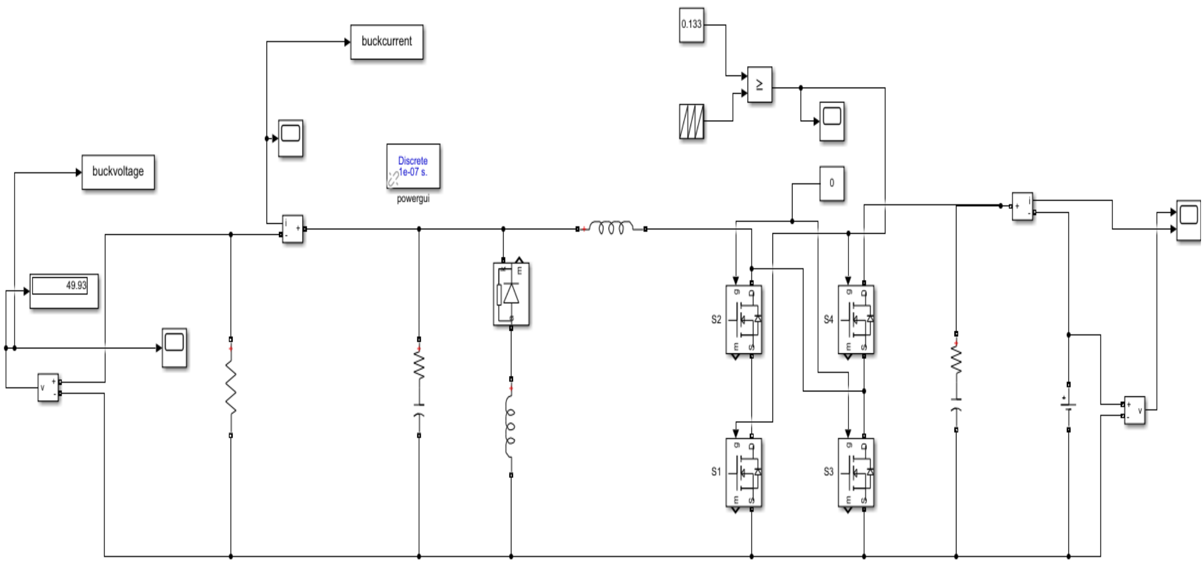

Fig.6.10 Simulink diagram of High gain BDC on buck mode

Fig.6.10 shows the simulation diagram of high gain BDC on buck mode. During this mode switch 1 &4 are on others are ZVS condition.

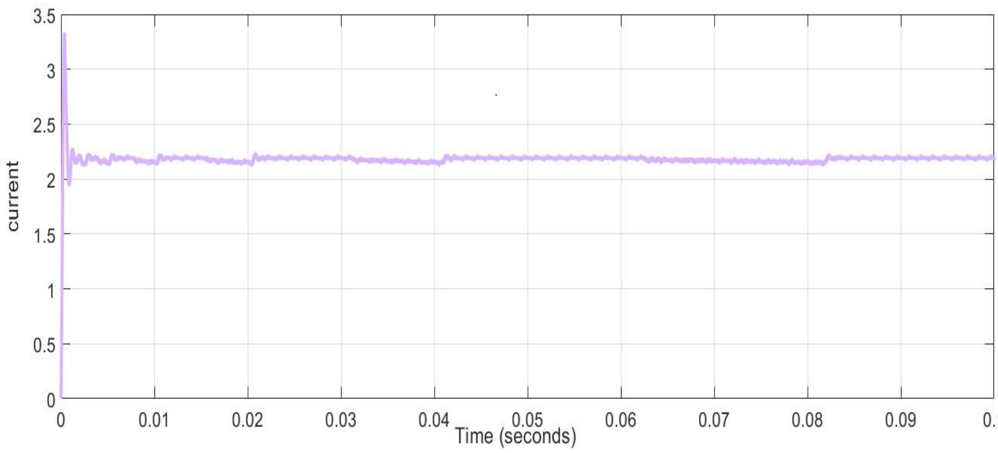

Fig.6.11 Output current of High gain BDC on buck mode

Fig.6.11shows the output current of 2.3A during the buck operation. It has initial peak of 3.5 A then settled to 2.3A.

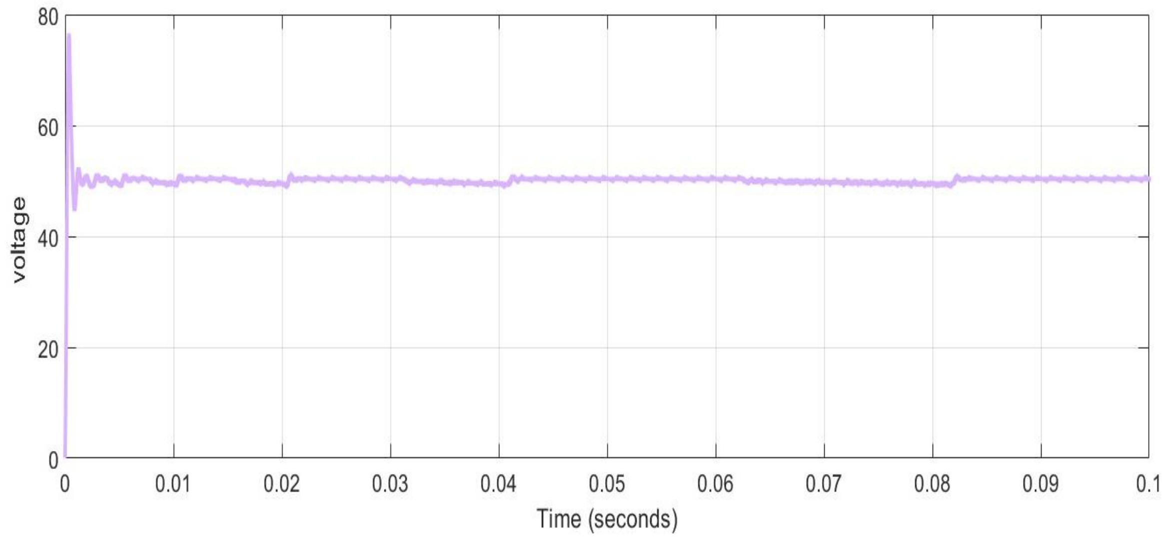

Fig.6.12 Output Voltage of High gain BDC on buck mode

Fig.6.12 shows the output voltage of 48V during the buck operation. It has initial peak of 70V A then settled to 48V.

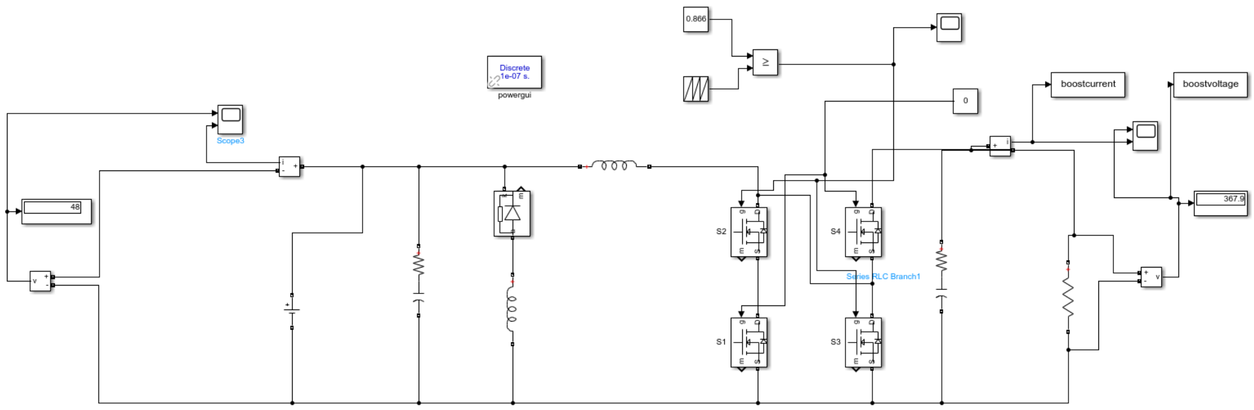

Fig.6.13 Simulink diagram of High gain BDC on boost mode

Fig.6.13 shows the simulation diagram of high gain BDC on buck mode. During this mode switch 2 &3 are on others are ZVS condition.

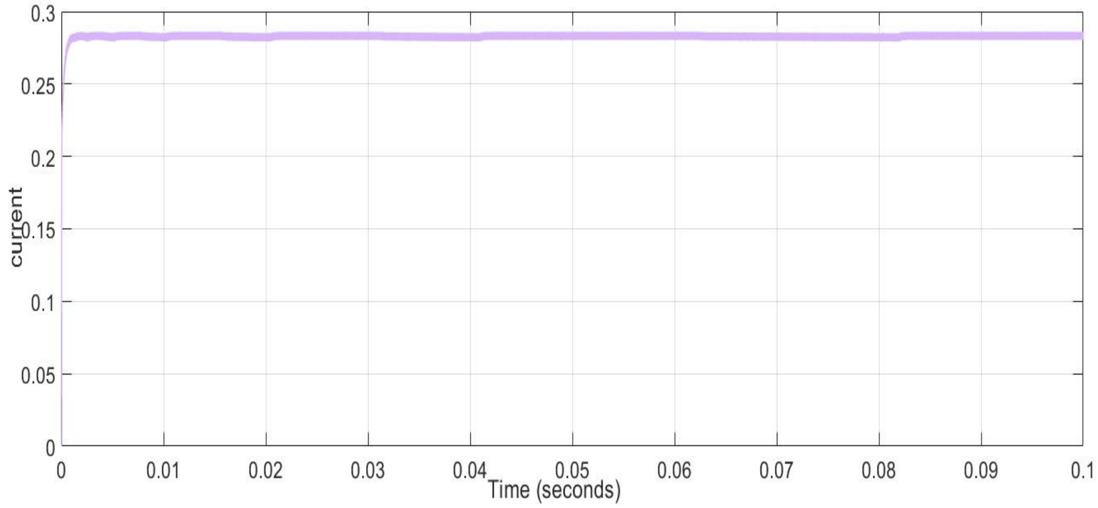

Fig.6.14 Output current of High gain BDC on boost mode

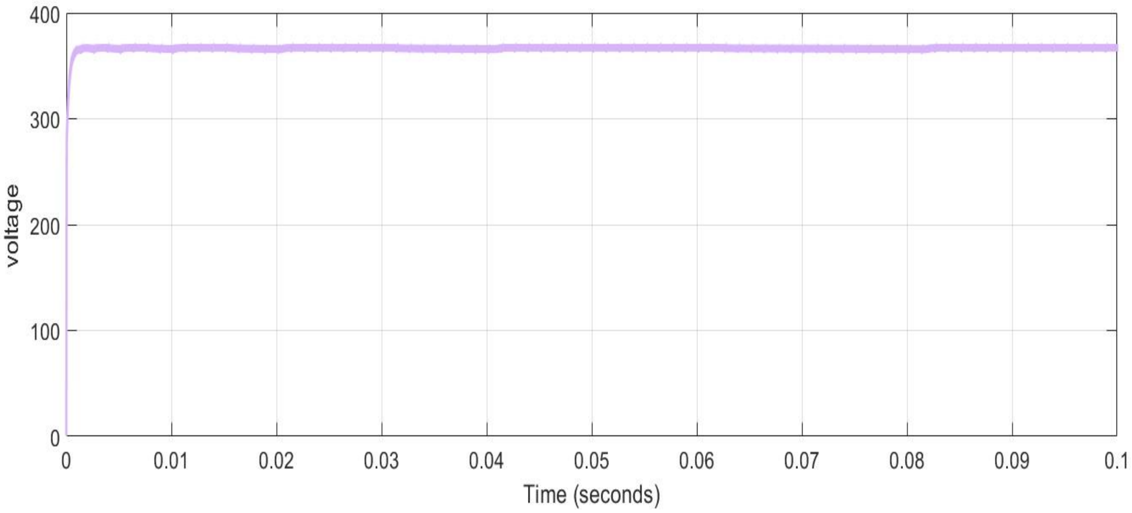

Fig.6.15 Output voltage of High gain BDC on boost mode

6.3.3 OFF Board EV battery charging in 3 modes of operation

The proposed EV battery charger in 3 modes of operation with different irradiance condition is shown in Fig.6.16.Initially PV is connected to the SEPIC converter,the controller generate pulses to the auxillary switches and buck and boost mode of operation of High Gain BDC.

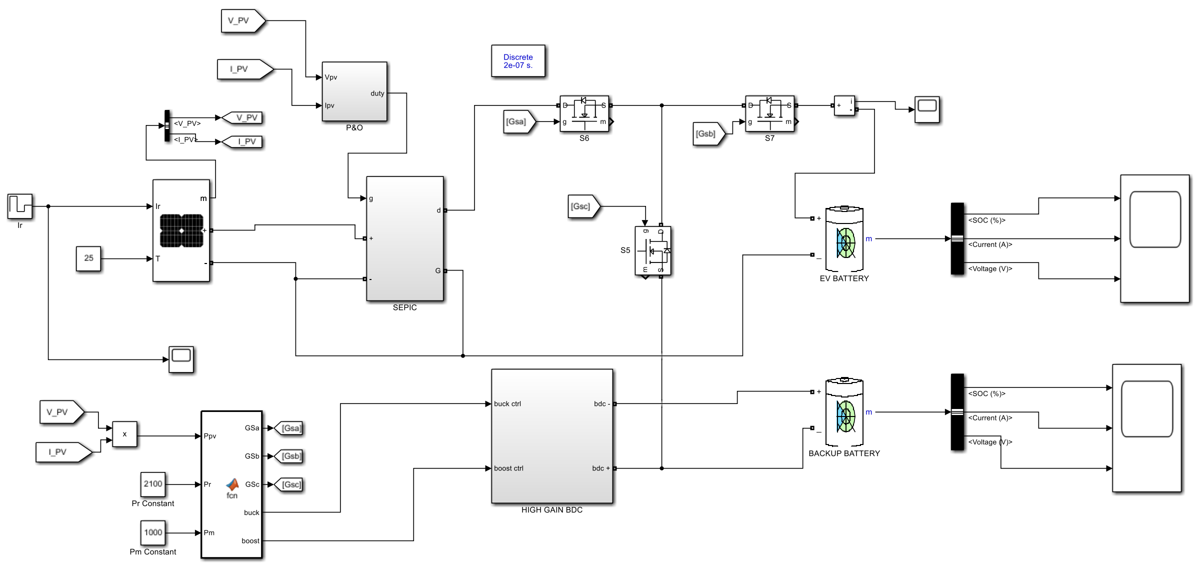

Fig.6.16 Overall Simulink diagram of OFF Board EV battery charger

The overall Simulink model is shown above. It is evaluated in 3 modes of operation with different irradiance conditions. The 3 modes of operation done using 3 auxiliary switches.

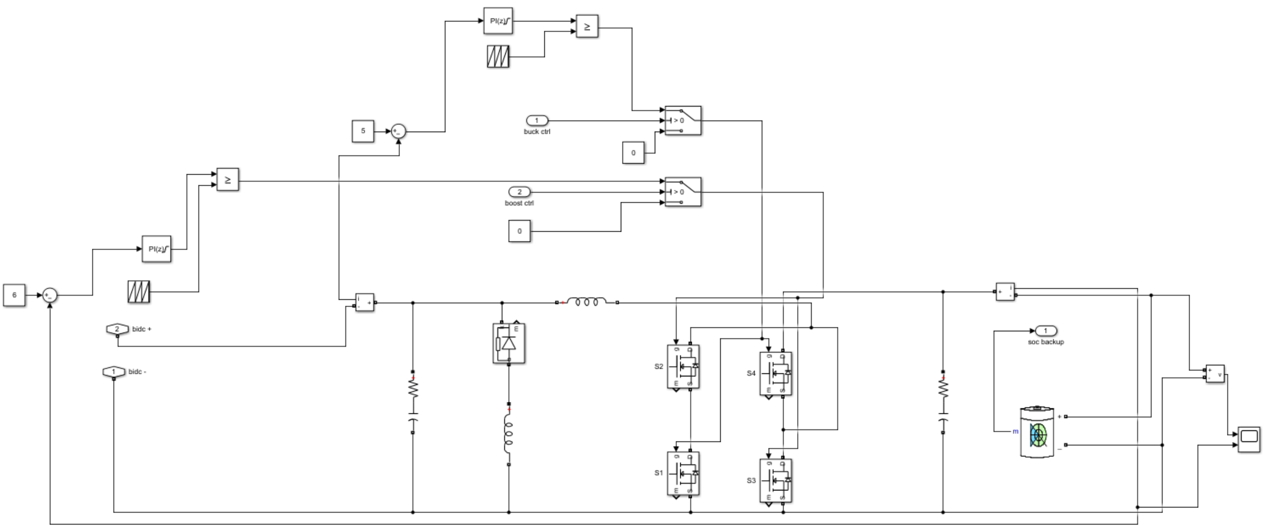

Fig.6.17 Sub system 1 of OFF Board EV battery charger

Fig.6.17 shows the High gain BDC operate on both buck and boost mode. It is controlled by using two PI controller. This shows the input irradiations. It is 1000,100 and 500 respectively

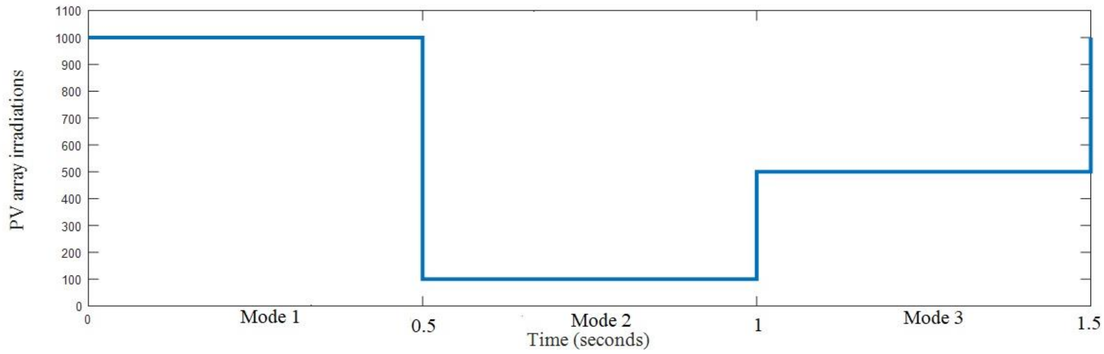

Fig.6.18 Input irradiation OFF Board EV battery charger

Fig.6.18 gives the input irriadiation for 3 modes. In the mode 1it is about high that is 1000,In second mode is 100 and third mode is 500.

Initially it is implemented using P and O mppt.it have drawback of large oscilation.to overcome this INC are used. Both the methods are used to achieve maximum power from the solar panel.

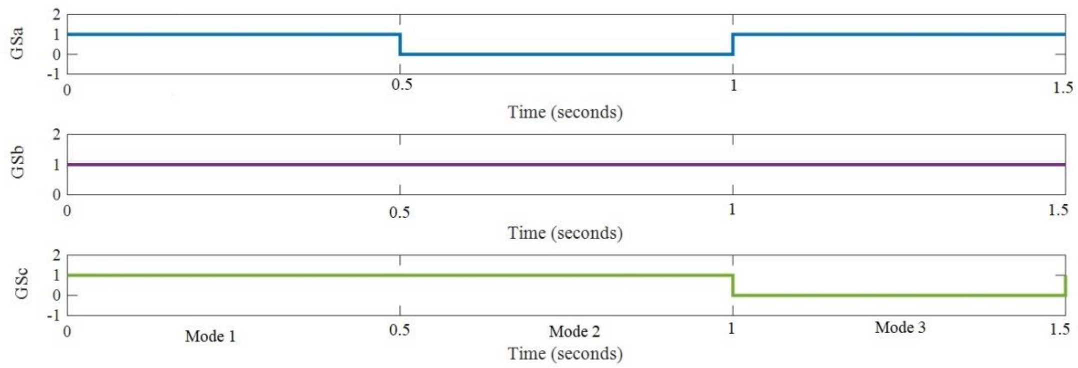

Fig.6.19 Gate pulses in different modes of OFF Board EV battery charger

From the Fig.6.19 it is found that initially the all switches are on condition. Then the signal gives 1 as output. In the second condition first switch is off all others are on condition. In third condition the backup battery is disconnected from the system so the last switch become turned off and which will give zero signal as output.

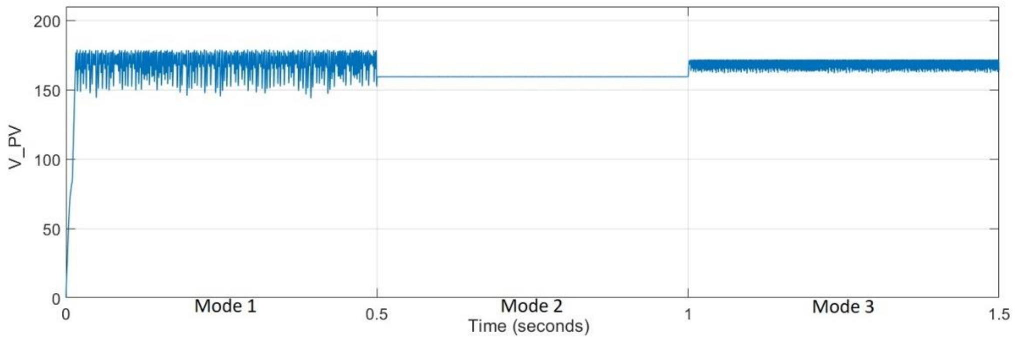

Fig.6.20 PV voltage in 3 modes using P&O MPPT

To obtain the better result the whole system is simulated with 2 MPPT methods that is P and O and INC methods. From the figure 6.20 ,it is clear that the PV voltage in P an O MPPT is having large oscillation and high ripple content. But in the case of INC MPPT it is found that better accuracy than the P and O .

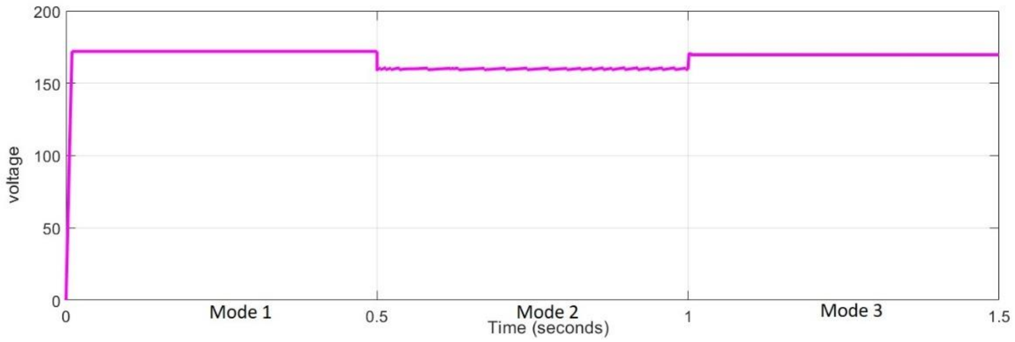

Fig.6.21 PV voltage in 3 modes using INC MPPT

To obtain the better result the whole system is simulated with 2 MPPT methods that is P and O and INC methods. From the fig. 6.21 it is clear that the PV voltage in P an O MPPT is having large oscillation and high ripple content. But in the case of INC MPPT it is found that better accuracy than the P and O .From these two figures it Can see that the P and voltage is about 170V and INC voltage is about 171.5 it is much closer to the PV designed voltage.

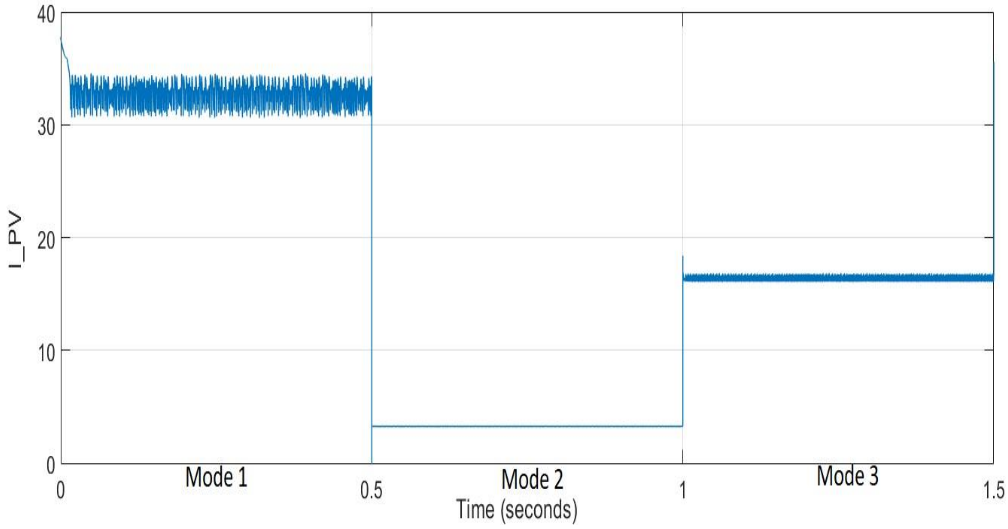

Fig.6.22 PV Current in 3 modes using P&O MPPT

To obtain the better result the whole system is simulated with 2 MPPT methods that is P and O and INC methods. From the fig. 6.22 it is clear that the PV Current in P and O MPPT is having large oscillation and high ripple content and its value is less. But in the case of INC MPPT it is found that better accuracy than the P and O

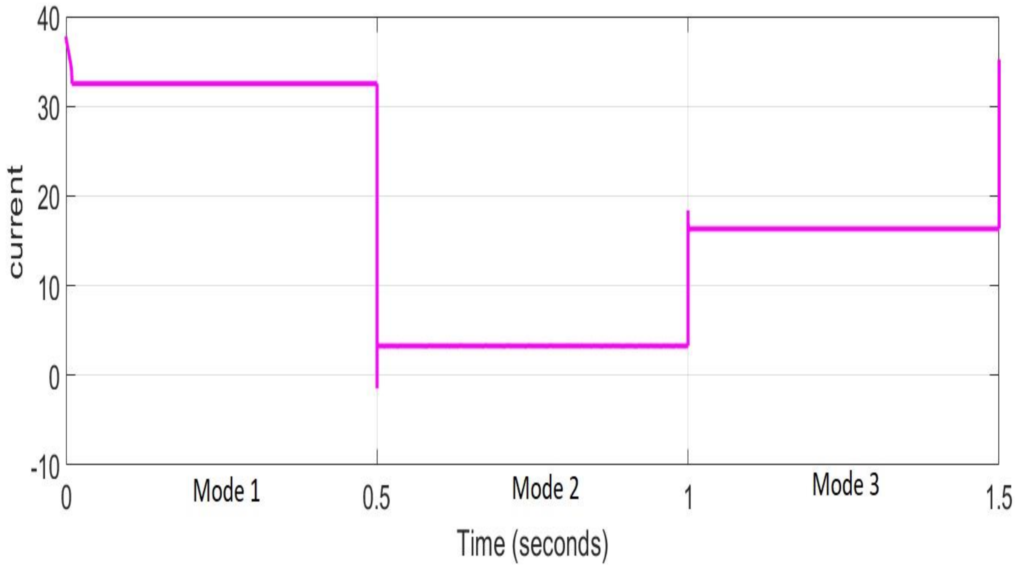

Fig.6.23 PV Current in 3 modes using INC MPPT

From the fig.6.23 it is clear that the PV Current in P and O MPPT is having large oscillation and high ripple content and its value is less. But in the case of INC MPPT, it is found that better accuracy than the P and O .

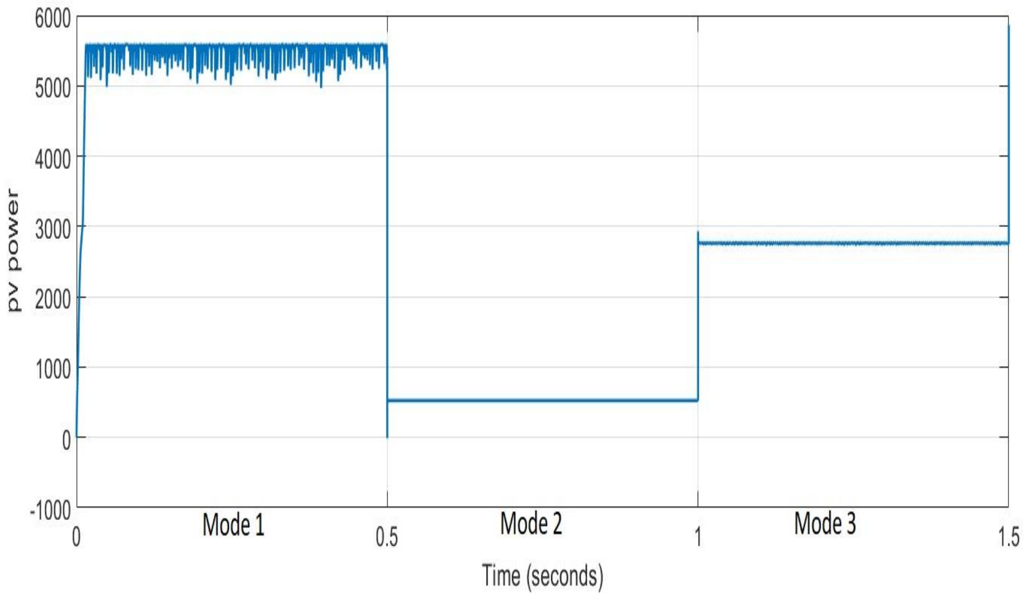

Fig.6.24 PV power in 3 modes using P and O MPPT

From the Fig.6.23 it is clear that the PV Current in P and O MPPT is having large oscillation and high ripple content and its value is less. But in the case of INC MPPT, it is found that better accuracy than the P and O is having large oscillation and high ripple content and its value is less. But in the case of INC MPPT, it is found that better accuracy than the P and O .From the figure it is found that in P and O based system the power is obtained about 5.52kw for 1000 irradiance condition. It is closer to the maximum power point power but lesser than power get in the INC based system. For INC based proposed charger getting the power output as about 5.59 kW which is very closer to the maximum power. So the efficiency of P and O based system is less compared to the INC based system.

In Fig.6.24 shws the PV power in 3 modes of operation.In mode 1 it about reaching the maximum power of 5.52Kw in this P and O MPPT.During MODE 2 the PV get disconnected but there is some voltage and current dueto the mathematical modelling of the solar panel.Thei will be small powe about 500W.In mode 3 the irriadance again increasing so the power is about 2500W.For checking the efficiency of the system it is found that P and O based system is less efficient than the INC based system.

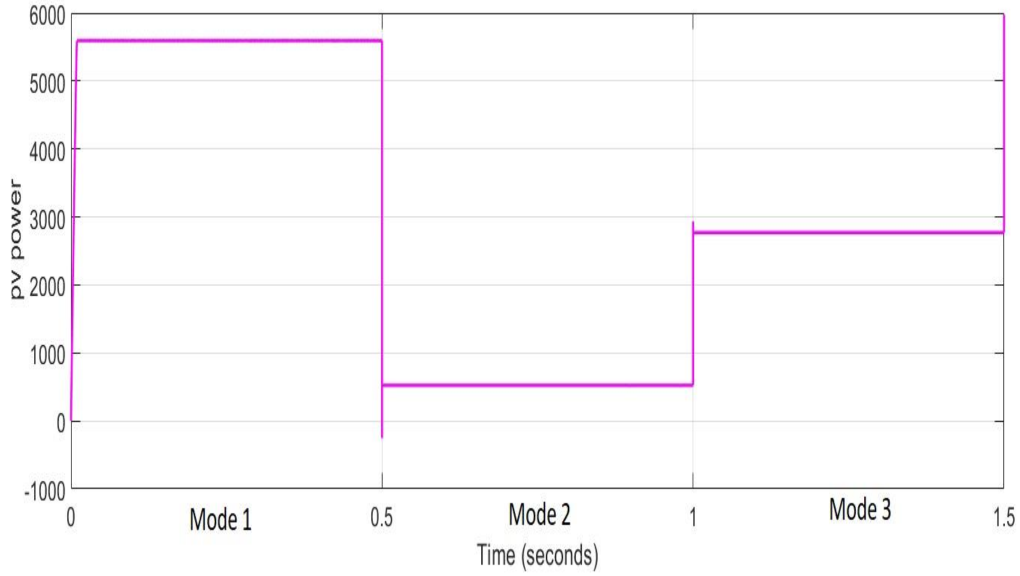

Fig.6.25 PV power in 3 modes using INC MPPT

From the Fig.6.25 it is clear that the power in P and O MPPT is having large oscillation and high ripple content and its value is less. But in the case of INC MPPT, it is found that better accuracy than the P and O is having large oscillation and high ripple content and its value is less. But in the case of INC MPPT, it is found that better accuracy than the P and O .

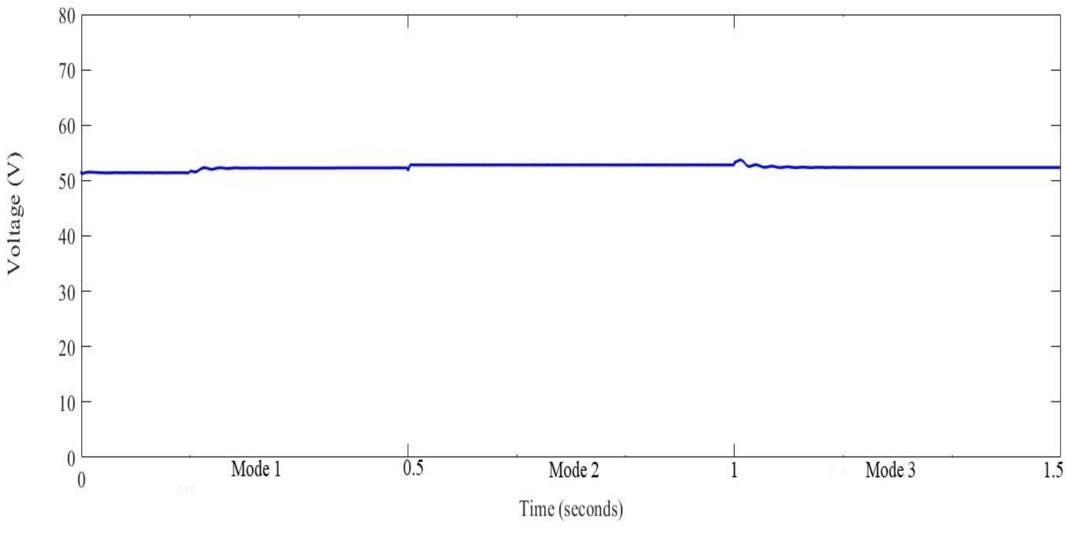

Fig.6.26 EV battery voltage in 3 modes

Fig.6.26 shows the EV battery voltage in 3 modes of operation. All 3 modes include irradiance level of 1000,100&500 respectively. The charging voltage of EV battery is about 51.5 V in all the condition. This is we need to charging the EV battery irrespective of irradiance condition.

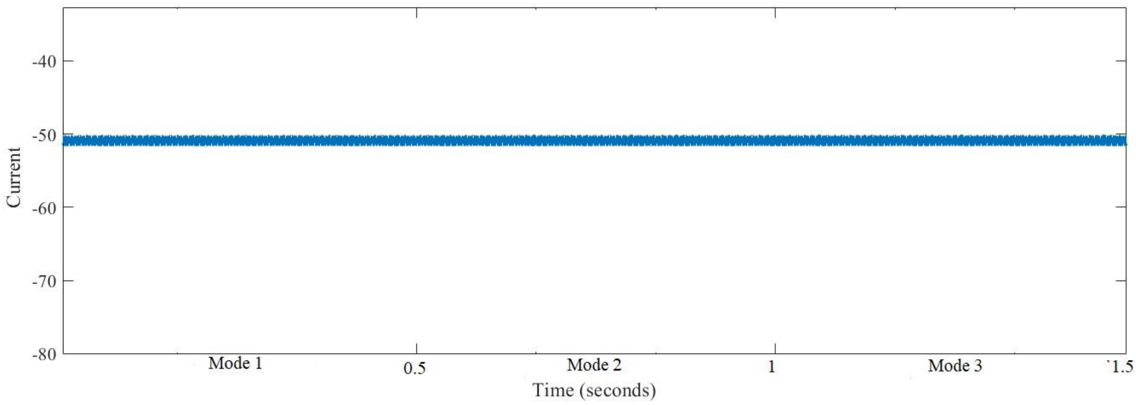

Fig.6.27 EV battery current in 3 modes

Fig.6.27 shows the EV battery current in 3 modes of operation. All 3 modes the charging current become negative.so it is conclude that all condition battery get charged.

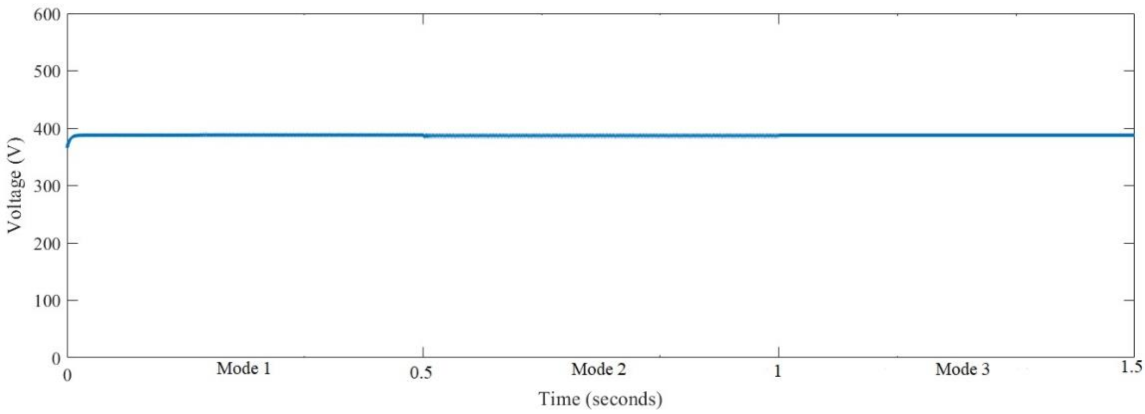

Fig.6.28 Backup battery voltage in 3 modes

Fig. 6.28 shows the backup battery current in 3 modes .during mode1 the voltage is about 365.5 V. Then all other modes it will again reaches this value. Their will be small change in mode 2 because it get discharged during this mode. In mode 3 again reaches it nominal value of voltage.

Fig.6.29 shows the back up battery current in 3 modes. during mode 1it is negative due to charging. In mode 2 it value is positive because of discharging. In mode 3 it is reaches to zero. because the battery is disconnected from the system.

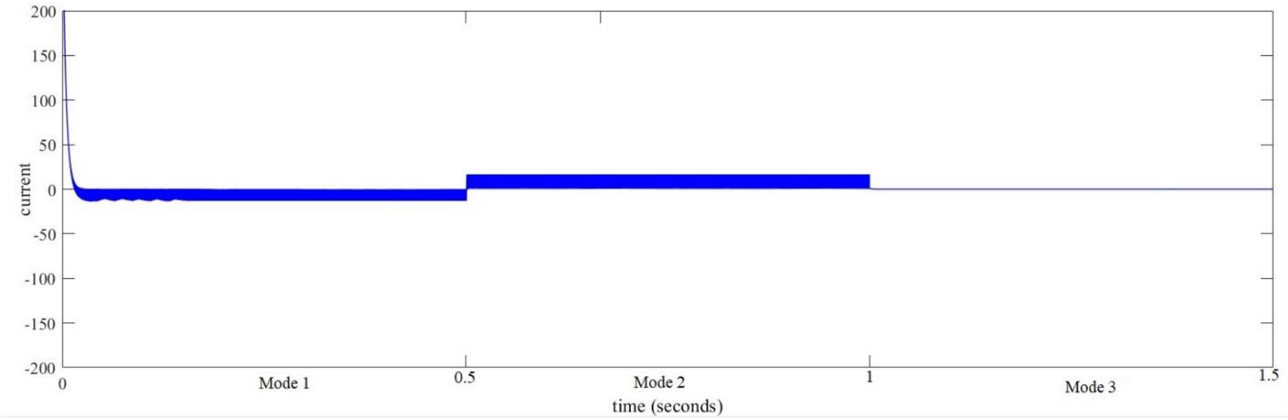

Fig.6.29 Backup battery current in 3 modes

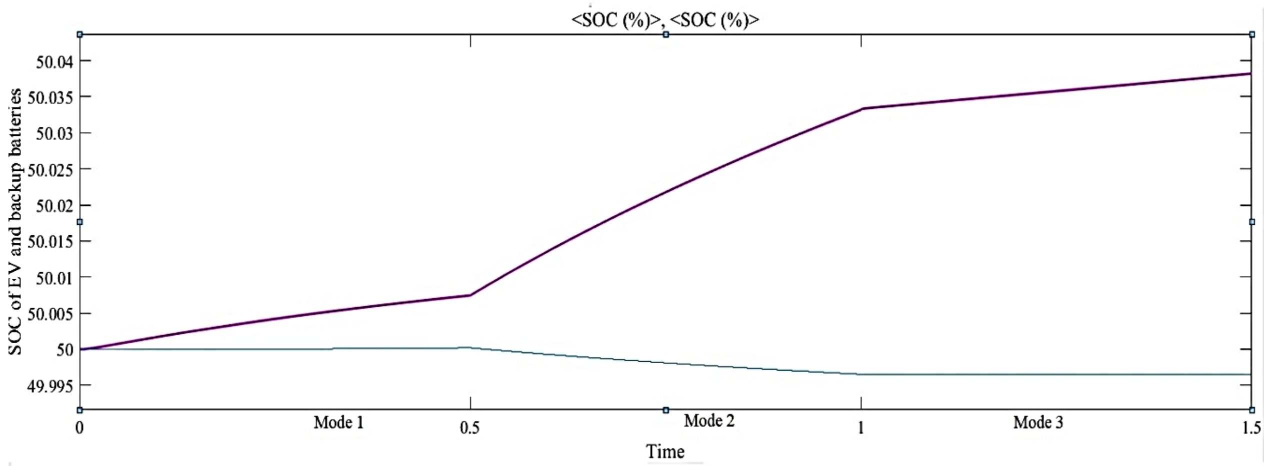

Fig.6.30 SOC of 2 Batteries in 3 modes

Fig.6.30 shows the SOC of two batteries.The purple line shows the SOC of EV battery and the blueline shows the SOC of backup battery. It can see that ,All 3 modes soc of EV battery is increasing due to charging. In the case of backup battery in mode1 it is increasing ,Mode 2 it starts to decreasing because of discharging and mode 3 it reaches to zero.

6.3.4 Comparison

The comparison of the proposed EV battery charger is using P and O and INC MPPT.Then check the efficiency of the system in three different modes of operation. The three modes of operation will dependence of three different irradiance conditions

Table.6.1 Comparison of OFF Board EV battery charging using P&O &INC MPPT

Parameters	P&O based Proposed system	INC based Proposed system
Output power	5.52kW	5.59kW
Outputvoltage	170V	171.4V
Time response	0.006s	0.004s
Accuracy	Less	more
Output ripple	high	low
Efficiency	98%	99.1%

From Table.6.1 it is found that P and O based system is less accurate than INC based system. Because in conventional P and O methods having large oscillations and ripple content.so their will be an oscillation in the peak point also. In the first column see that the voltage is reaching to MPP voltage but is lesser than the INC based MPPT system. As a result the power output is less so the accuracy is also reduced.

CHAPTER 7

CONCLUSION

To provide a continuous charging of EV battery irrespective of irradiance condition of PV array integrated with a electric vehicle battery charger is proposing . It check the flexibility of the system to charge the EV battery constantly irrespective of the irradiation conditions. The system is designed and simulated in Simulink environment of the MATLAB software. To charge the EV battery of capacity 48V,50Ah,the PV is selected as 350W with 4 series and 4 parallel string module. It is designed to operate in different modes with varying the irradiance condition. The irradiance is selected here as 1000W/m^2,200 W/$m^2$and 500 W/m^2respectively. The proposed EV battery charger is working in 3 modes of operation with the help of power converter topologies. In these 3 modes based on different irradiance condition the EV get charged and ccorresponding EV battery voltage,current ,Backup battery voltage, Backup battery current and SOC of these two batteries are obtained in these three modes of operations. The proposed EV battery charging system is implemented using two MPPT algorithms. P&O and INC MPPT are implemented in the proposed system. comparative study of this results are obtained for 3 modes. By the comparison it is found that it is found that P&O based system is less accurate than INC based system. Because in conventional P&O methods having large oscillations and ripple content.so their will be an oscillation in the peak point also. In t result it can see that the voltage is reaching to MPP voltages is 170 V for P&O but is lesser than the INC based MPPT system that in this it is about 171.5 V that is very close the PV specification maximum power point voltage. As a result the power output is less so the efficiency is also reduced in P&O based proposed system. PV off board EV battery charger is used with P&O mppt is less accurate than the INC based system.

PUBLICATIONS

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