# AN ISOLATED BIDIRECTIONAL BUCK-BOOST CONVERTER WITH A PHOTOVOLTAIC ENERGY SOURCE

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**Abstract**— This paper deals with the power conditioned source for an electric vehicle, the renewable resource Photo Voltaic PV system is connected to the power conditioning unit (DC-DC). Here, a Power Conditioning (PC) unit is designed. The voltage to the vehicle is stepped up and then the battery can be charged by the same PC unit but with reversal of flow, where at this time it steps down the power to the battery level. The simulation reports based on MATLAB/Simulink are discussed in detatil to support the different modes present in this paper.

**Index Terms**— Bidirectional converter, Power Conditioner (PC) unit, Photo Voltaic system (PV), electric vehicle.

## I. INTRODUCTION

Now-a-days, with the increasing amount of pollution due to the usage of conventional energy such as fossil fuels and nuclear fuels, there is a strong growth in the field of sustainable energy. Due to the abundant in the nature, the sustainable energy or renewable energy can be utilized efficiently. Somme of the sustainable energy are PV, wind, hydro, tidal, geothermal etc. Among them PV resource has an impact in the research areas. PV systems has an economical aspects like 20 years of maintenance free and very less installation cost compared to the other sustainable energy systems. The output of the PV can be easily modulated with the corresponding power electronic devices.

The little particles present in the sun light of the solar energy called photons. As a PV cell is exposed to this sunlight, many of the photons are reflected, pass right through, or absorbed by the solar cell.

The DC output of the PV can be regulated with the aid of DC-DC converter (Chopper). There are different kinds of topologies existing in the DC-Dc converter. The basic types of the converter are buck, boost and buck-boost chopper.

The converter also involves a major classification regarding the switching which has a tremendous scope in the research field.

The switching involves hard switching and soft switching. Soft switching deals with ZCS and ZVS which is presented in detail In this paper.
The paper proposed a PV system which supplies power to the load through the PC unit (DC-DC). The PC unit designed in this project is a bidirectional soft switching buck-boost converter [1-2]. The converter is proposed without auxiliary switches and reduced turn off switching loss.

## II. PHOTOVOLTAIC SYSTEM WITH A BATTERY

In the year 1950's, researches incorporate the development of PV [3]. The equivalent circuit of the PV system as shown in the Fig 1 represents a elementary circuit [3]. The PV system sometimes referred as hybrid system due to the capability of photovoltaic/ thermal (PV/T) energy system [3-4].

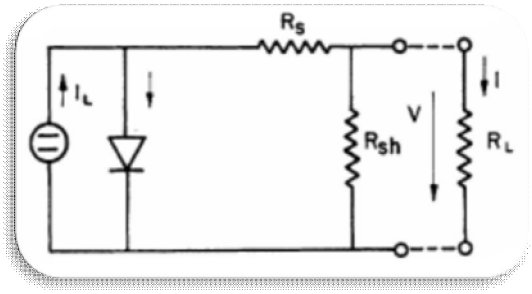


**Fig 1: Equivalent circuit of PV**

The MPPT techniques are majorly followed by seven different algorithms. Mostly utilized techniques are Incremental Conductance (Incond) method and Perturb & Observe (P&O) method Different techniques for maximum power point tracking of photovoltaic (PV) arrays were discussed in [5].

The MPPT is to track the Maximum Power Point, so that the DC-DC converter always exerts same and maximum power from the PV. The characteristics of MPPT [5] is represented in Fig. 2.

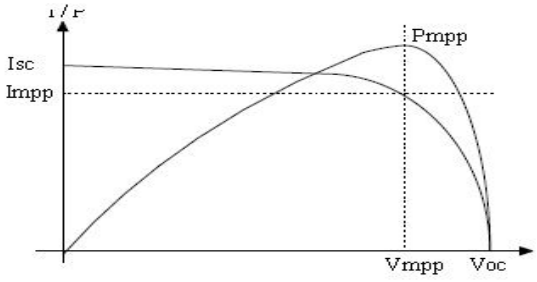


**Fig 2 : current VS Voltage and Current VS Power characteristics for a solar cell.**

The photovoltaic system used in this paper deals with lower voltage, where the converter's work is to step up five times the voltage to reach desired level.

## III. PROPOSED ISOLATED CONVERTER WITHOUT TURN OFF LOSSES

### *A. Proposed Bidirectional Converter:*

The proposed bidirectional converter (DC-DC) consists of eight switches, which is separated by an isolated transformer. The separations of switches are taken place by four switches at the primary of the isolated transformer and remaining four switches are connected to the secondary of the isolated transformer. Here the IGBT is preferred as a switch due to the advantage of lower conduction loss, high power density and lower cost. But usage of IGBT also poses a major disadvantage such as higher switching loss, which can be reduced by utilizing the large external capacitor. Thus the accomplishment of ZVS operation is also carried over due to the snubber element.

### *B. Operational Modes and Switching Patterns:*

The switching pattern of the proposed converter is explained below. The switches process alternately according to the pattern, in order to fulfill the different modes of functions.

(i) Interval [to,t1]:

When interval of To S1-S3 are turned on. Inductor Lf is charged by Vi, inductor current iL increases. S6 turned on after interval to.

(ii) Interval [t1,t2]:

The four switches turned off . At the interval of t2 that time the incoming switch of S5.

(iii) Interval [t2,t3]

At t=t2, the S1,S2,S5 switches conduct and S5 is incoming switches. When t=t3, S1,S2,S5 are the three switches turn on

(iv) Interval[t3,t4]

This interval starts at t=t3, when S7 is turned off. The transformer secondary current is charges up the output capacitance and raises the Vo At t=t4, S1,S2 turns on .

(v) Interval [t4,t5]

When t=t4 , S1,S3,S4,S6 are turned on , The primary current ip, along with secondary current.

(vi) Interval[t5,t6]

All four switches, S1-S4 are turned on. Inductor lf stores energy from Vi as it does in interval [t0,t1].

(vii) Interval[t6,t7]

At t=t6, S3,S4,S8 are turned on and S1,S2,S5,S6 are turned off. When S7 is incoming switch at t=t6. At t=t7, S3,S4,S7 are conducting switches.

(viii) Interval[t7,t8]

When t=t7 the incoming switches are S1,S2.At t=t8 all four switches S1-S4 and S7 are turned on and S6 is incoming switch.

The operation of the converter involves in both the direction, from source to load and from load to source. The switches operate according to the switching pattern as shown in Fig. 4, thus the complete operation of the system is executed.

During the system's source to load operation, the converter operates in boost mode and serves the load.

## IV. SIMULATION CIRCUITS AND RESULTS

The circuit of the DC-DC converter is depicted in the Fig. 3 where it explains about the conventional circuit of the DC-DC converter with isolated transformer. The presence of snubber element in the secondary side located switches reduces the switching loss which is created due to the switches.

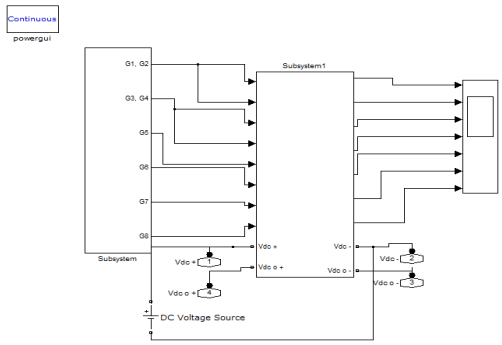


**Fig. 3 : Proposed DC-DC Converter**

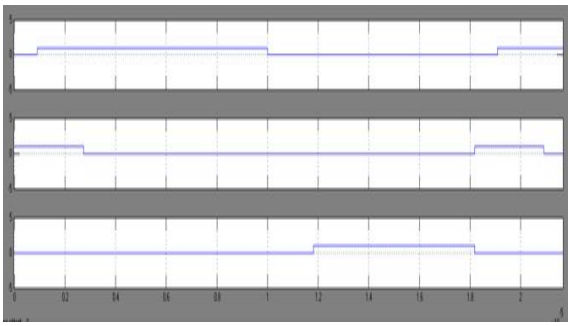

**Fig 4 : Switching Pattern of the eight DC-DC converter switches**

The load utilized in this system is a vehicle, where it represents RLE load. The reverse flow of current from load to source is due to the presence of E in the system. The energy from the load passes to the source whenever it is not in usage or whenever it is over exited.

Thus the source PV is connected to the battery, so that the battery charges whenever there is a reverse flow of current in the system. The voltage is increased times of five in the system during step up and reduced during step down operation.

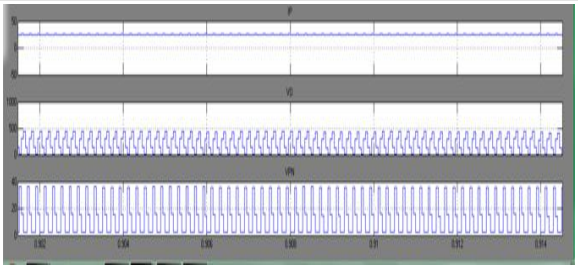

**Fig. 5 : Output Waveform parameters of DC-DC converter**

All the necessary parameters of the DC-DC converter is depicted above in Fig. 5. The major concentration was entirely covered on the output voltage of the system.

The ratio of the duty cycle is designed, so that the conducting voltage of the load meets the requirement.

## CONCLUSION

The different mode of operations of the vehicle is operated with the switching patterns designed for the proposed converter. The eight switches of the converter operates in both the direction, boosts from source to load and steps down from load to source. The efficiency of the converter can be increased in future by comparing the MPPT techniques in the system.

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