ISSN: 2583-5637 (Online)
International Journal of Inventive Research in Science andTechnology Volume (3), Issue (1), Jan 2024

A Review of Modelling of DC-DC Converter for Solar Based ElectricVehicle

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Abstract

Presently a days we are searching for substitute sources like electric vehicles, to chop down the contamination from cars which are developing quickly. In electric vehicles, A DC-DC converter is used to boost the voltage from solar photo voltaic (PV) array and isolated bidirectional DC-DC converter (IBDC) is used to charge and discharge the battery. In this paper, the proposed utilization of quadratic twofold lift converter (QBC) instead of DC-DC converter, which has high increase when contrasted and ordinary converter. In disengaged bidirectional DC-DC converter, delicate exchanging is accommodated lessen the turning misfortunes and weights on switches. The proposed two DC-DC converters are demonstrated and mimicked utilizing MATLAB Simulink and results are appeared in this paper.

Keywords- Isolated Bidirectional DC-DC Converter, DC Motor, Boost converter, Battery.

1. INTRODUCTION

Petrol and oil assets across the world are exhausting at a high rate because of huge reliance on it, as it is an essential fuel for the cars. Delivering of ozone harming substances is influencing the climate. To decrease the contamination and to ration oil based commodities, we are searching for substitute strategies like electric vehicles (EVs), half and half electric vehicles (HEVs) and energy component vehicles (FCVs). As of now the exploration is going on DC-DC converter for electric vehicles [1] and crossover electric vehicles applications.

Fundamentally two sorts of DC-DC converters are utilized in electric vehicles for power hardware interfacing. The two DC-DC converters utilized in this plan are unidirectional converter (UQDC) and bidirectional DC-DC converter (BDC). The bidirectional converter used to interface the low voltage battery and high voltage DC bus, which are isolated and non-isolated. The different converter topologies for isolated bidirectional DC-DC converters are studied in literature [2] [3].

In this work Fig. 3 shows the separated bidirectional DC-DC converter circuit [4], which comprises of a high recurrence transformer, is utilized to give the galvanic segregation between the LV and HVDC transports and Ls is the prompt energy stockpiling component. The HF transformer has low volume, less weight and minimal expense contrasted with line transformer. The normal yield voltage and force move constrained by stage shift point. The distinctive stage shift control techniques are accessible, straightforward stage shift control is utilized generally for IBDC in light of its effortlessness. It permits power stream in both the ways from battery to DC connection and the other way around. This is used as battery charger (or) discharger. The zero voltage exchanging (ZVS) and zero current exchanging (ZCS) can be accomplished by delicate exchanging. We can get the delicate exchanging by outside snubber capacitor or parasitic capacitor [3], [5]. The quadratic twofold lift DC-DC converter [6] is utilized instead of sun based DC-DC converter [7]. The inexhaustible sources like photovoltaic (PV) framework and fuel cell have low yield voltage. When these are associated with high voltage DC transport which requires enormous boosting. The quadratic lift converter has high increase contrasted with traditional lift converter. In this the bidirectional DC-DC converter and quadratic boost converter are used to increasing the voltage level to feed the motor through propulsion.

Variable Frequency Drive is totally useful clear and insignificant exertion contraption which is realized effortlessly circuits and fragments and has control over engine up to the assessed speed.[8] Client requests for more prominent speed increase, execution, and vehicle range in unadulterated EVs in addition to ordered necessities to additionally lessen emanations in HEVs increment the interest for consolidated on-board energy stockpiling frameworks and generators. [9,10].

1.1 Bidirectional DC-DC Converter:

A disconnected bidirectional DC-DC converter (IBDC) are generally utilized in electric vehicle application. The bidirectional DC-DC converter are utilized where the battery charging and releasing and regenerative slowing down are required and which is utilized to associate the low voltage battery (12/24/48 V) to high voltage DC transport frameworks (200-900V). It permits the force in both the ways from source to load and the other way around. The distinctive IBDC geographies are concentrated in writing [2].

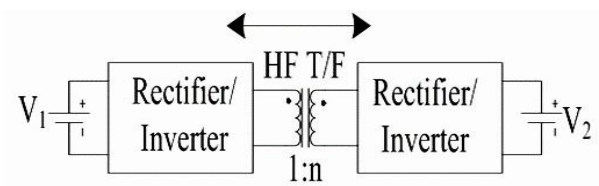

Fig.1.Basic Structure of BDC

The Bidirectional converter is utilized to change over unregulated DC contribution to high controlled DC yield with high voltage acquire. Fundamentally, the BDC are utilized in electric vehicle for battery charging and releasing. The confined bidirectional DC-DC converter (IBDC) fundamentally works in two modes, for example,

A. Boost mode:

In this mode, the converter is step up the low voltage to high voltage from battery to load. The operating states of IBDC in boost mode are described below.

State (1) : (to-t1)

The switches (S1, S4) and (S5, S8) of the primary and secondary side are turned on respectively at same instant. The positive square wave voltage shows up across the transformer essential and auxiliary. The positive secondary current will flows to load through S5 and S8 At the end of this state the series inductor current reaches to zero.

State (2): (t1-t2)

The switches (S2, S3) and (S6, S7) of the primary and secondary side are turned on respectively at same instant. The negative secondary current will flows through S6 and S7 to load. The equivalent circuits for above two states in boost mode is given below.

B. Buck mode:

In this mode, the voltage is venture down and current streams from load side to energy stockpiling gadget (battery) side then battery get charged. In this, the correct side extension goes about as inverter and left side scaffold goes about as rectifier. The converter works in two conditions of activity like lift mode however the thing that matters is power streams from auxiliary scaffold to essential extension.

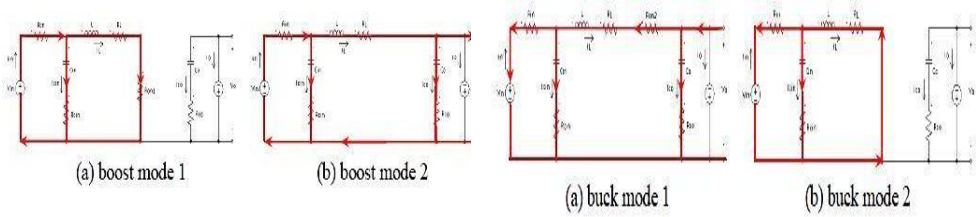

Fig.2 boost mode / buck mode

1.2 PV Array Characteristics

The utilization of single diode comparable electric circuit makes it conceivable to display the qualities of a PV cell. The mathematical model of a photovoltaic cell can be created utilizing MATLAB simulink tool compartment. The basic equation from the theory of semiconductors that mathematically describes the I-V characteristic of the Ideal photovoltaic cell is given by [4]

$$I = I_{pvcell} - I_d \quad (1)$$

Where,

$$I_d = I_{0cell}[\exp(qv/\alpha kT)-1] \quad (2)$$

Therefore

$$I = I_{pvcell} - I_{0cell}[\exp(qv/\alpha kT)-1] \quad (3)$$

Where,

I_{PVCell} = current generated by the incident light (it is directly proportional to the Sun irradiation), I_d is the diode equation,

Iocell = reverse saturation or leakage current of the diode.q = electron charge [1.60217646* 10−19C],
k = Boltzmann constant [1.3806503 *10−23J/K].T = temperature of the p-n junction,
α = diode ideality constant.

Fig.3 shows the equivalent circuit of ideal PV cell.

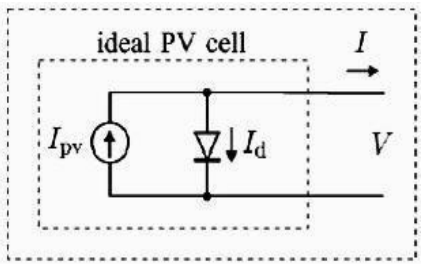

Fig.3 Equivalent circuit of ideal PV cell

Practical arrays are composed of several connected PV cells and the observation of the characteristics at the terminals of the PV array requires the inclusion of additional parameters (as shown in Fig.3) to the basic equation: [4]

$$I = I_{pv} - I_o[\exp(V+IR_s/Vt\alpha)-1]-(V+IR_s/R_p) \quad (4)$$

For a decent sunlight based cell, the series resistance (Rs), ought to be exceptionally little and the shunt (equal) obstruction (Rp), ought to be enormous. For business sun oriented cells (Rp) is a lot more prominent than the forward opposition of a diode. The I-V bend has three significant boundaries to be specific open circuit voltage (Voc), short circuit current (Isc) and greatest force point (MPP). In this model single diode identical circuit is thought of. The I-V characteristic of the photovoltaic device depends on the internal characteristics of the device and on external influences such as irradiation level and the temperature.[4]

2. FUNCTIONAL BLOCK DIAGRAM

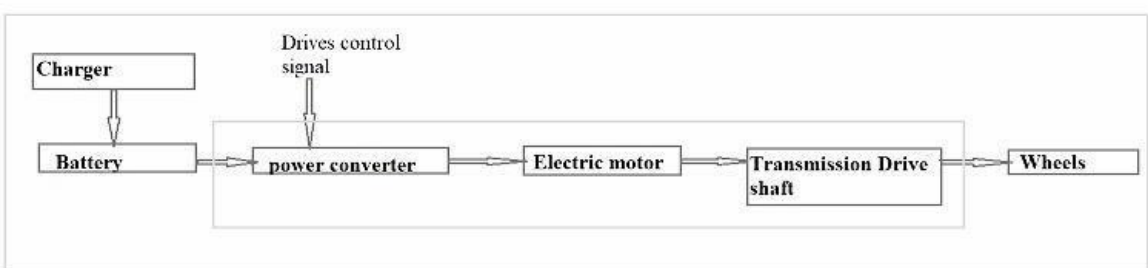

Fig.4 Functional block diagram

Solar cars are powered by Sun's energy .Solar panel is most important part of the solar car .Solar panel is used to collect the solar energy in the form of dc .Then it is given to solar charger . It is basically a voltage regulator or current regulator device which stops batteries from overcharging .The battery stores the energy in the form of dc energy .Then gives to the boost converter which also known as power converter. It is DC-DC power converter that step up the voltage then give to the DC motor. Which converts electrical energy into mechanical energy then this mechanical energy is given to the drive shaft which rotate the wheels.

3. RESULTS AND DISCUSSION

The proposed solar panel,charger,battery and dc-dc converter (boost converter) are modeled and simulated using MATLAB simulink and result are shown below.

The simulation circuits of the system and results are shown in the following figures

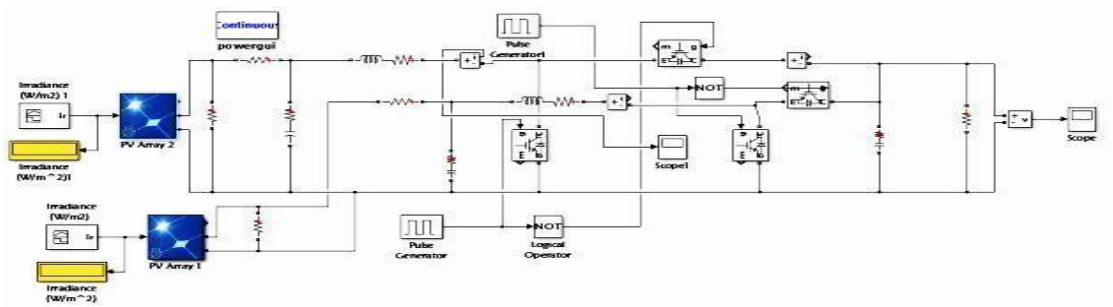

Fig.5 Simulation of DC-DC converter with solar input

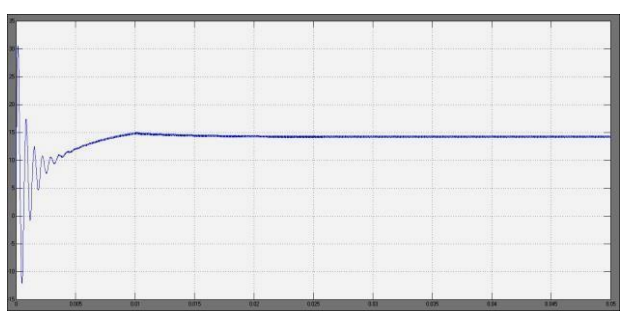

Fig.6 Solar cell input voltage (12v-15v)

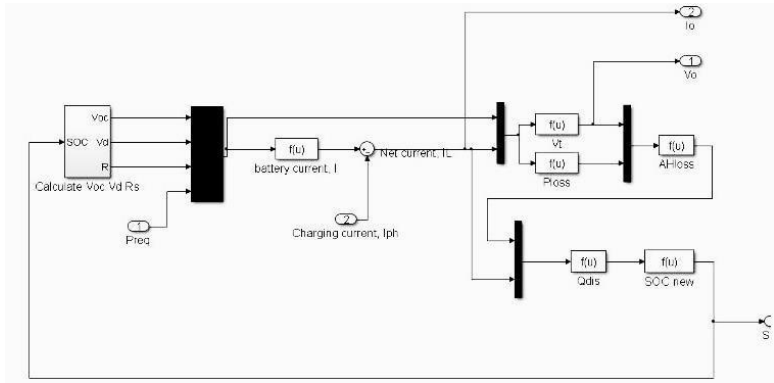

Fig.7 Simulink model of battery

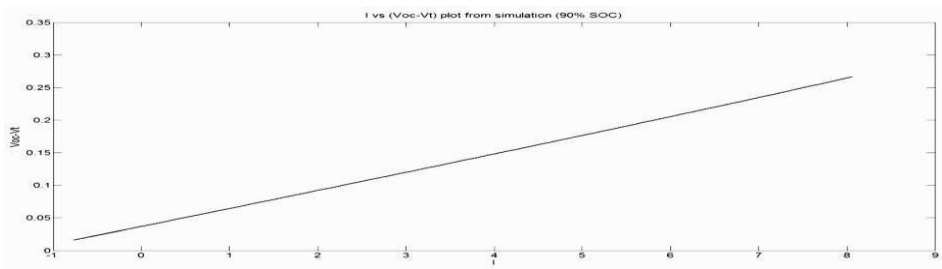

Fig.8 I vs (Voc-Vt) plot (90% SOC)

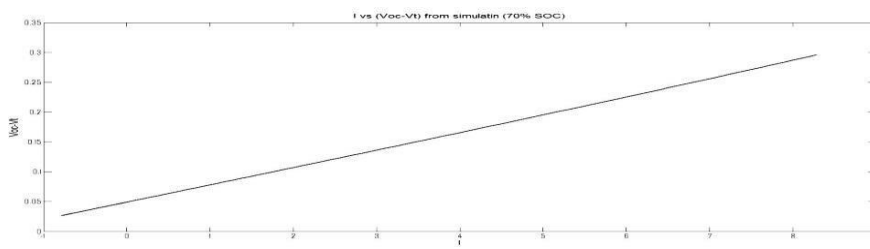

Fig.9. I vs (Voc-Vt) plot (70 % SOC)

Fig. 8 and Fig 9 shows plot of I Vs Voc-Vt at 70% and 90% of SOC.

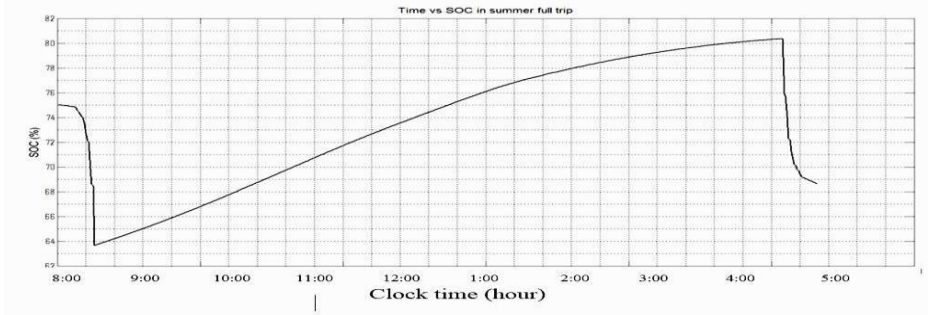

Fig.10. Time vs SOC in summer day

Above graph shows time versus change in SOC.

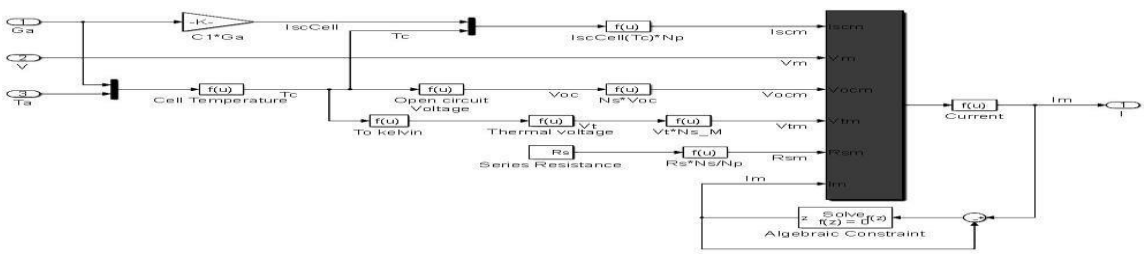

Fig.11. PV module SIMULINK block diagram

In Fig. 12 first graph shows that Voc Vs Temperature, second graph shows that Isc Vs temperature and third graph shows that Pmax Vs Temperature. The open circuit voltage falls as temperature increases, but the short circuit current is less in high temperature. The maximum power point is also inversely proportional to the

temperature.

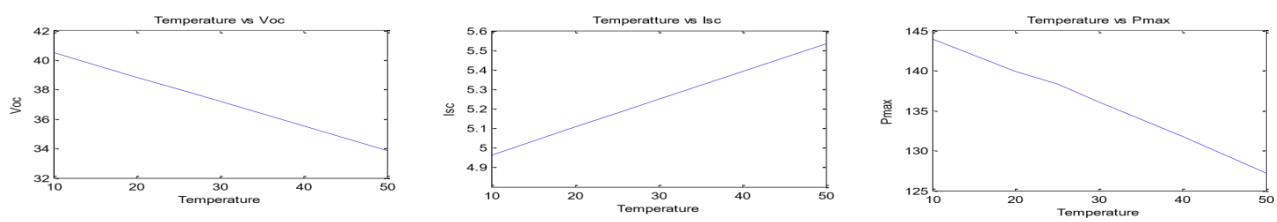

Fig.12. Effect of change in temperature

Conclusions

Facing the ongoing energy crisis in the world, it is important that we harvest all the energy available to us and implementing them such a way that will bring us in taking a step ahead towards doing so. Solar energy more specifically solar cars would be an amazing advancement in future car technology because it is infinite, efficient, cheap and of course eco-friendly. It also makes good sense to develop a green car technology that car manufactures will be able to save energy without cutting down on the luxuries that they provide to their customers. Since we develop a dynamic model of a solar car, we hope that it will help examine the technical aspects of the solar car technology. This model provides a clear understanding about the temperature effects on the model as well as we come to know the charging/discharging rate (SOC) changes the capacity and all other functions of it are very much related with it. Also it will be used for research work and educational purpose. In future we will try to research on the C-rate or deep cycle of the battery through this model to figure out the battery's longevity which will be very much helpful for the user.

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