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Soft Switched Interleaved Boost Converter with MPPT Controller for Photovoltaic System

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Abstract: *A large number of solar photovoltaic system has been increasing day by day because of its vast size in the level of production .This will focus as a challenge in the operation at the current time and it needs a new pv system which have the greater voltage land the current level .PV system design with highest voltage gain soft switched interleaved boost converter has been focused by this paper . By allowing for the voltage and the current rating the interleaved characteristics will increase the flexibility of the converter . Due to its high gain the SSIB converter is connected directly to the dc bus and will make easy for the direct connection of the PV system to the load. To analyze the operation of SSIB converter various simulation has been performed by the modeling of Photovoltaic topology with MPPT technique.*

I. Introduction

As renewable energy sources plays a vital role in everyday life and are capable of using widely in power houses and small business . Compared to other renewable energy sources, solar energy is highly efficient and is available everywhere .Researches are undergoing in the field of extracting the maximum amount of power from the solar energy .The power generated from the PV system is not equal everywhere in the operating period of time. A method called the Maximum Power Point (MPP) which will produce the maximum power generation. Temperature and the intensity of light may vary with PV electrical characteristics , which will cause changes in the MPP. For tracking the maximum power, there various methods available depending upon the method adopted. Perturb and observe method has been proposed in this paper to track the maximum power .

Based on the varying surrounding conditions such as irradiation ,temperature and the power conditioning system, the solar cell output power has been changed and the power will transmit from the PV array to the load This changes may bring low efficiency . The dc/dc converter absorbs the maximum power coming from the PV array and under low irradiance it will perform the dc-link voltage.

The fundamental power conversion unit of a PV generator system is represented by the PV module. Depends on the solar insulation the output characteristics of the PV module may bring difference in the cell temperature and output voltage of PV module. When the characteristics of the PV module is nonlinear, it is necessary to model for the designing and the simulation process of maximum power point tracking (MPPT) for the applications of the PV system The output characteristics mainly affected by the solar insulation, cell temperature, and load voltage should be used to describe most of the PV models.

For high power applications boost converters are mainly connected in parallel for increasing the output current and also for reducing the output current ripple . Since, the main drawback of this converter is that the voltage across the switch very high during the resonance mode . Depending upon the voltage across the switch the resonant components and the resonant inductor current parameters will select. The designing process of the resonant components and the multiphasing method is developed for the reduction in the resonant current in this paper. Disturbance in the input current may occur during the interleaved method . This may reduce the input current ripple, output voltage ripple, and size of the passive components [1]-[3]. Hence , with the generation of larger efficiency the output power of the PV array can be boosted.

II. Large Scale PV System

A diagramatic view of the SSIB converters which mainly depending on the MV dc-bus PV system is shown in Fig. 1. The PV system designing consists of three similar PV arrays, one step-up transformer and two power conversion stages: the using of SSIB converters may develop dc–dc stage and a dc–ac stage by the using of voltage source converter (VSC). A VSC with sinusoidal pulse width modulation (PWM) and a transformer is subjected will constitute the conventional inverter in this paper. Each PV array is get connected to a high gain DC/DC converter of the VSC which then connects to a common DC bus. The DC bus voltage is controlled by the VSC and the maximum power point of the PV array is get tracked by the high gain DC/DC converter . The SSIB converter will transfer all the power generated which is generated by each PV array to the common dc bus of the VSC and during this time, the SSIB converter of each PV array may controls the output voltage. The voltage which is get generated by the dc bus is controlled by the inverter and it transfers the power to the load via transformer.

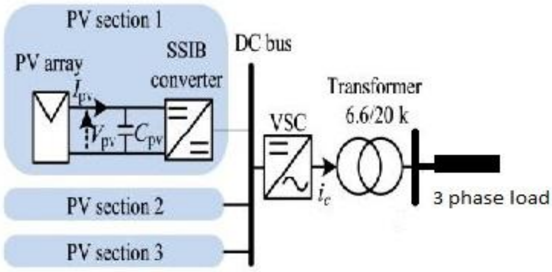

Fig 1: Large scale PV system

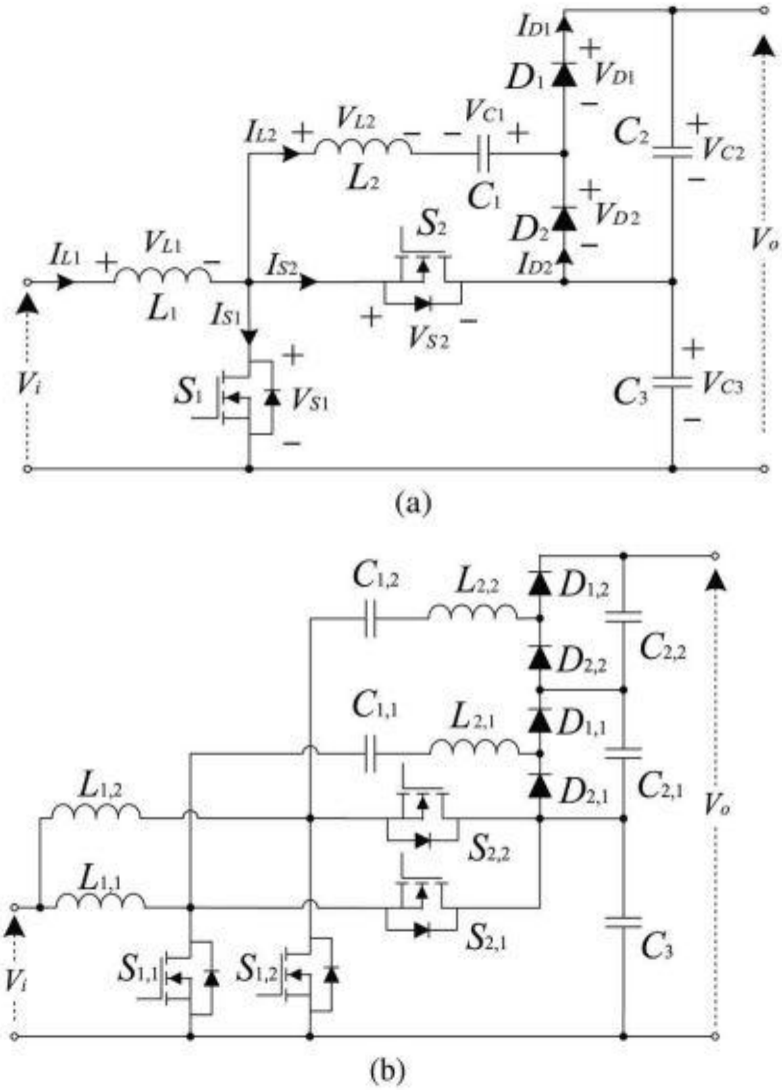

Fig.2. Converter topology. (a) SSB converter. (b) SSIB converter (N=2, P=1).

A. SSIB Converter

The SSB converter topology and its configuration has been illustrated in [4]. The circuit diagram of the SSB converter has been shown in Fig. 2(a). By the rectifier diode of the conventional boost converter, the SSB converter may get take the place of with a switch (S2) and introduces an auxiliary circuit, which constitutes an inductor (L2), a capacitor (C1), and a voltage-doubler circuit. The voltage-doubler circuit consists of two diodes (D1and D2) and a capacitor (C2). The auxiliary circuit allows the converter to attain large gain in voltage than that of the conventional boost converter, and it allows zero voltage switching (ZVS) for both the lower switch (S1) and the upper switch (S2). Zero current switching (ZCS) of the diodes of voltage-doublers (D1andD2) is achieved by the inductor L2 by the discontinuous conduction mode (DCM) operation.

The SSB converter configuration can be expanded to an interleaved converter, by using number of converters connected in parallel or in series (N is the number of series connected voltage doublers P is the number of parallel connected diode legs in voltage - doubler). A higher voltage gain can be developed by increasing N, while a decrease in the rating of current can be attained by increasing P. At that time, the input current ripple starts reducing due to the increase in the value of N and P. In this paper, an N=2, P=1 SSIB converter is considered for connecting a PV array to the load. The circuit diagram is shown in Fig. 2(b).The relation between the voltage gain and duty ratio of the conventional boost converter and N=2, P=1 SSIB converter is shown below in Fig. 3. The voltage gain of the SSIB converter is always higher than that of the conventional boost converter and it may be approximately three times higher.

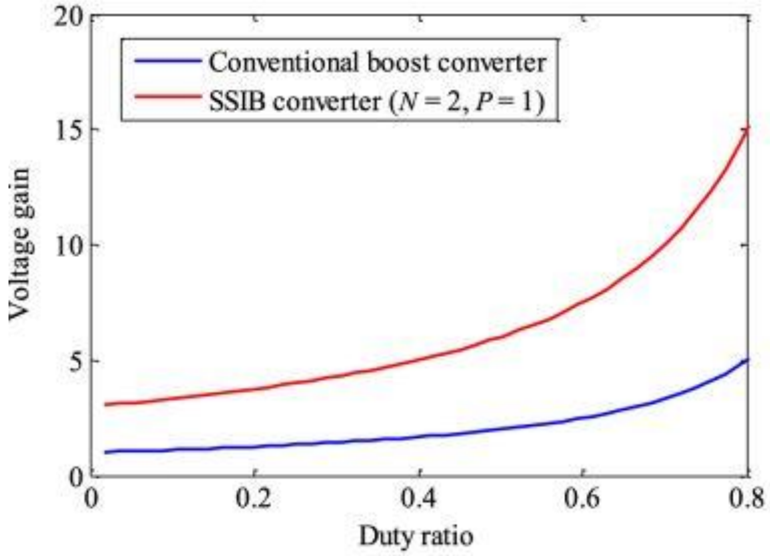

Fig. 3. Voltage gain attained by the SSIB converter (N=2, P=1) and conventional boost converter.

1) Configuration of the converter: To operate the converter with a lower duty cycle, greater values of N should be needed . The input current ripple is reduced 1/N, and also can be reduced by depending on the duty cycle. Therefore reduced input current ripple results in better MPPT performance. However, the voltage rating of the uppermost auxiliary capacitor increases with increasing value of N. So the value of N should depend on operating duty cycle of the converter, input current ripple, and voltage rating of the auxiliary capacitor.
When using the SSIB converter for PV system applications important factor is to choose proper value of P . The current rating of the converter is increased by a factor of P, thus increasing the power rating of the converter. The input current ripple is decreased by 1/P, which will result in increasing the efficiency of the MPPT. By increasing the value of P may provides increased circuit complexity and higher component number.
2) Designing Process: The SSIB converter is designed for PV application. By the characteristics of the PV system the input voltage and the required output voltage of the SSIB converter are determined
3) Control Process: When applying the converter to PV application, the control of an SSIB converter based on an MPPT algorithm is an important issue . The SSIB converter maintains the PV array voltage at the MPP based on P and O method.

III. Simulation Results

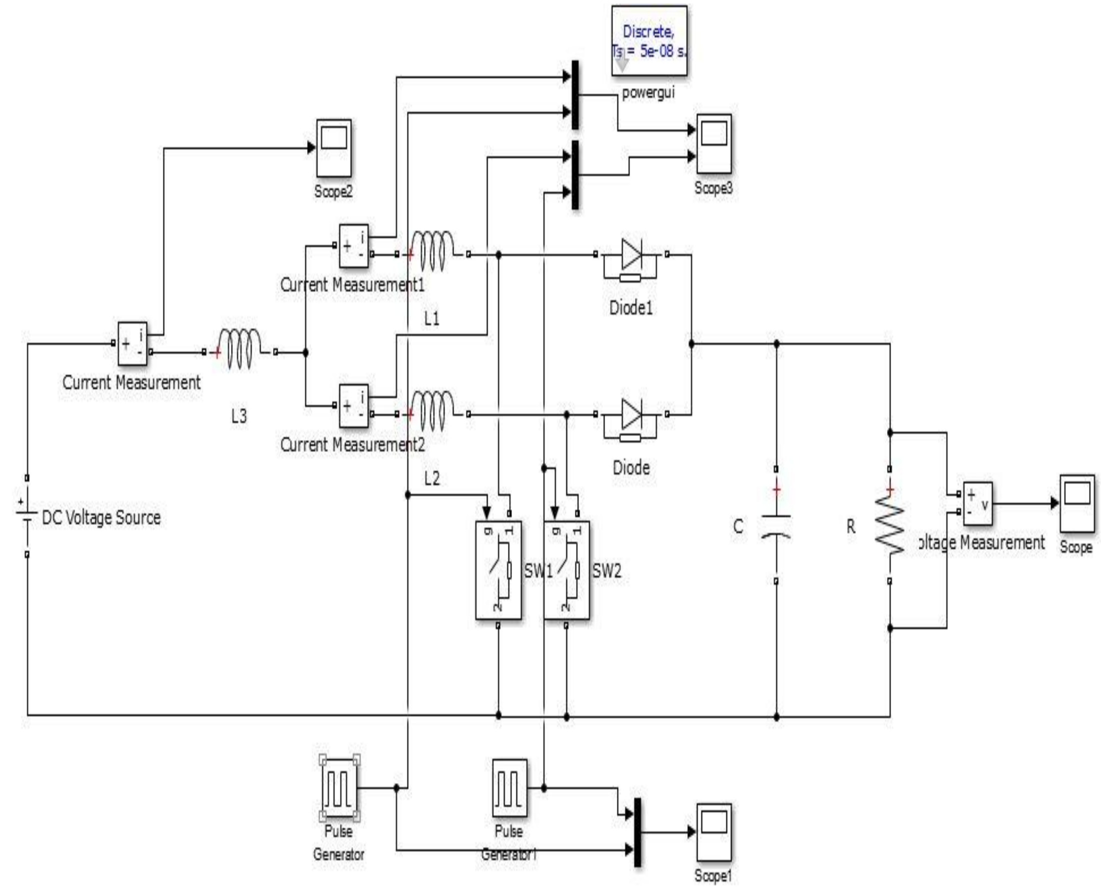

Fig. 4. Simulation model interleaved boost converter

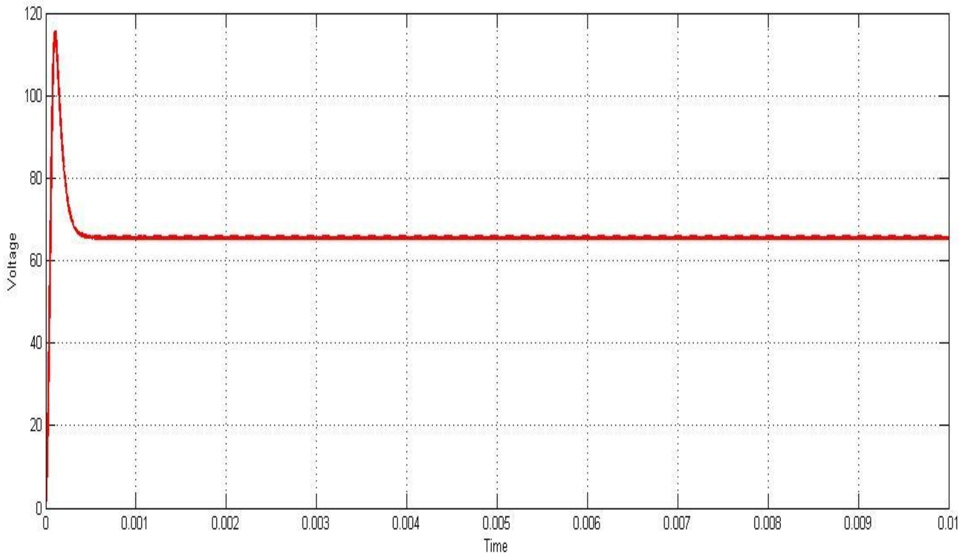

Fig.5. Output voltage of interleaved boost converter

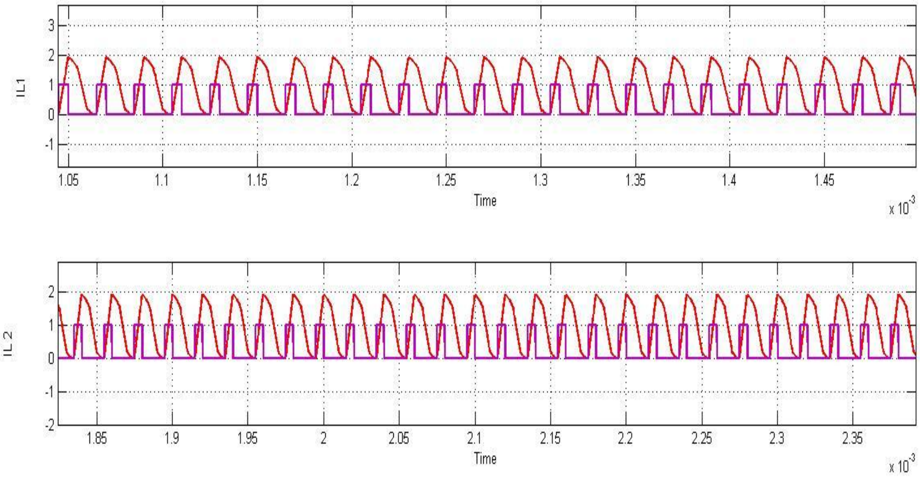

Fig. 6. Inductor current IL1 and IL2

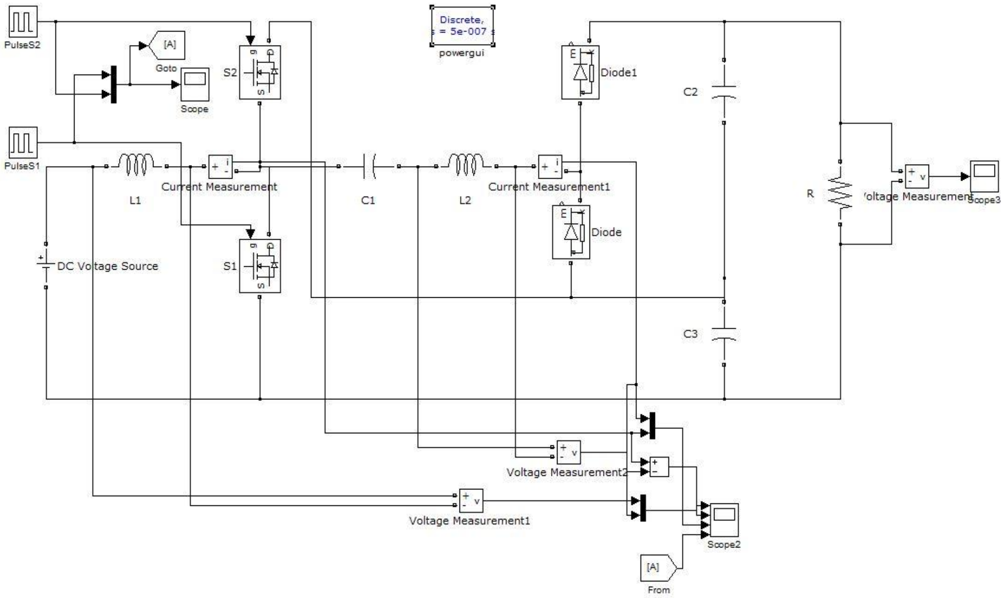

Fig. 7. Simulation model of SSB converter

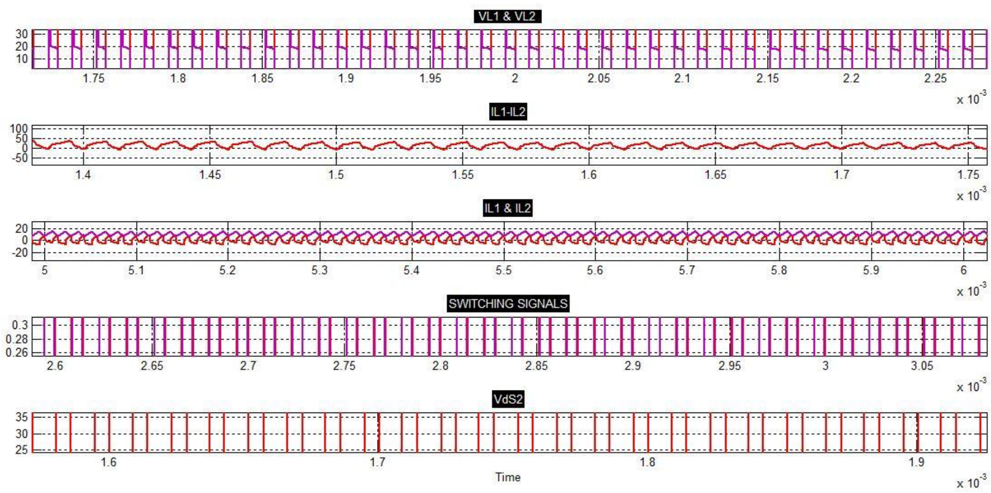

Fig. 8. Key waveforms of SSB converter

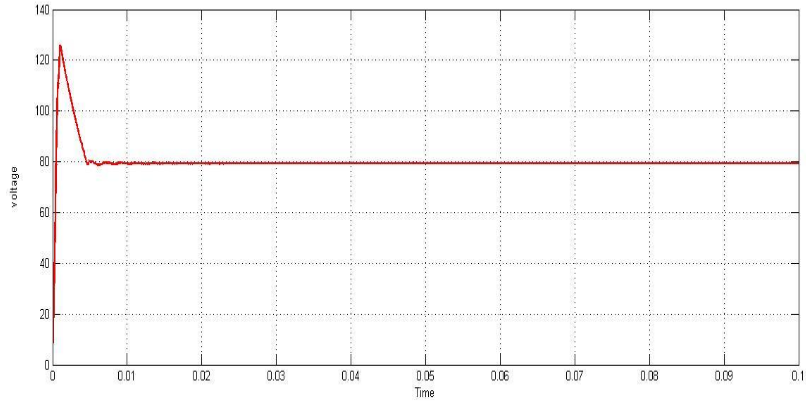

Fig. 9. Output voltage of SSB converter.

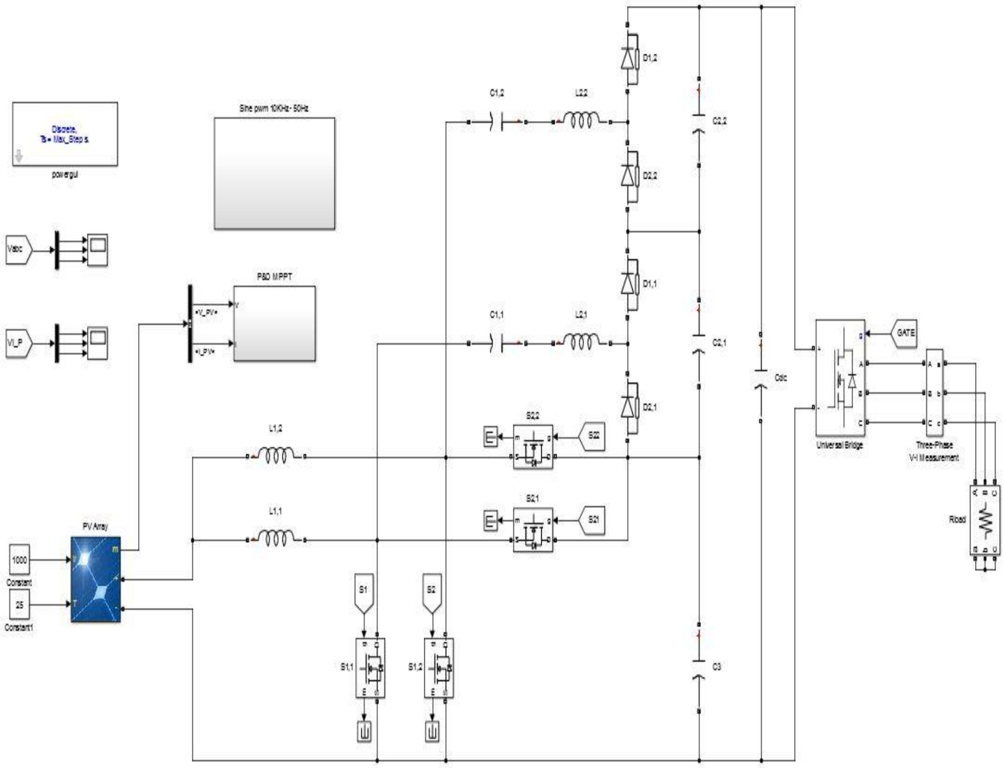

Fig:10. Simulation model of SSIB converter with MPPT controller

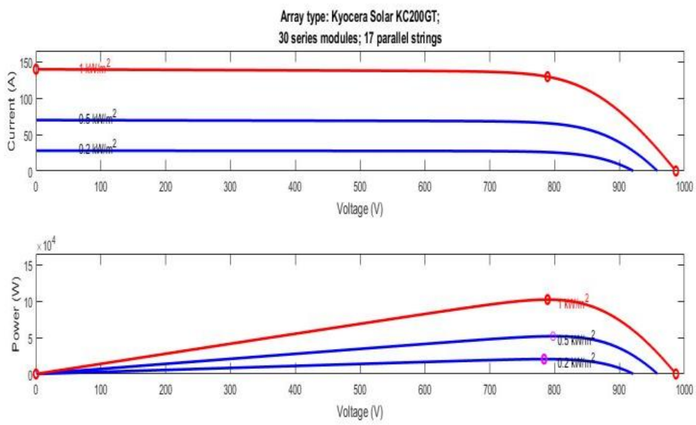

Fig 11: PV curve with varying irradiance

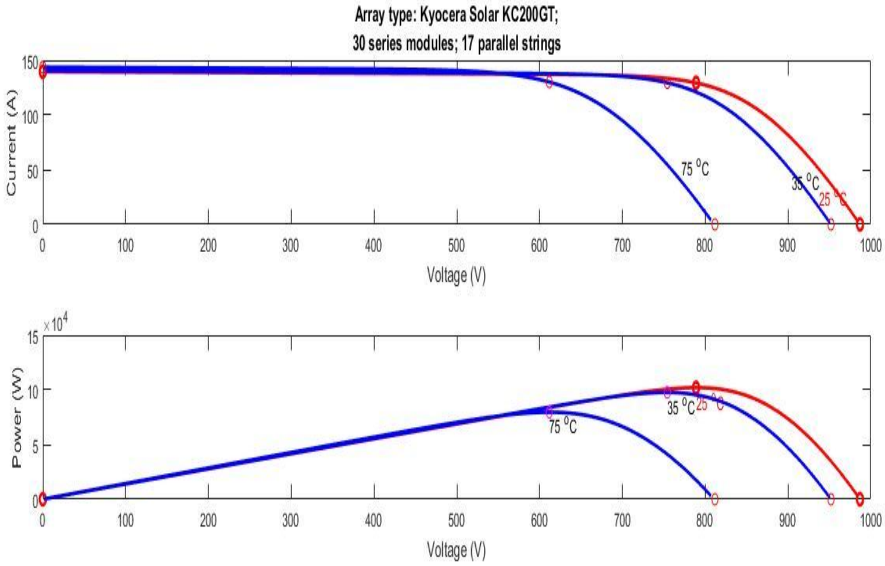

Fig 12: PV curve with varying irradiance

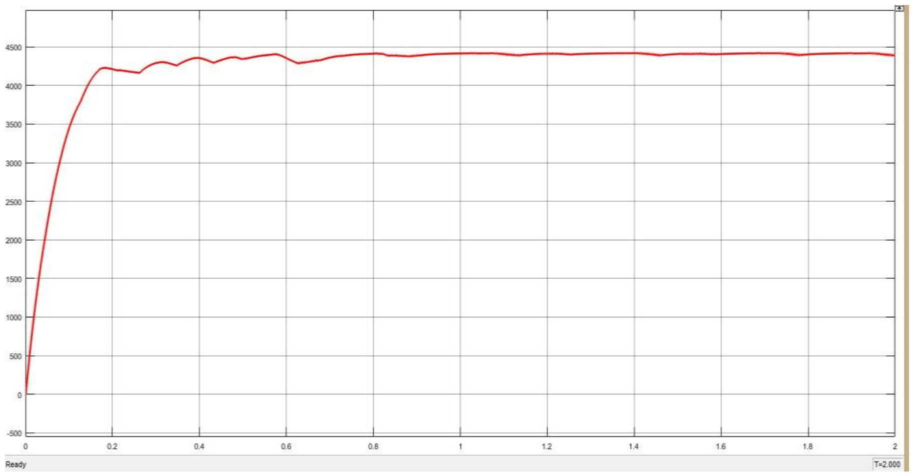

Fig:13. Output voltage of SSIB converter with MPPT controller

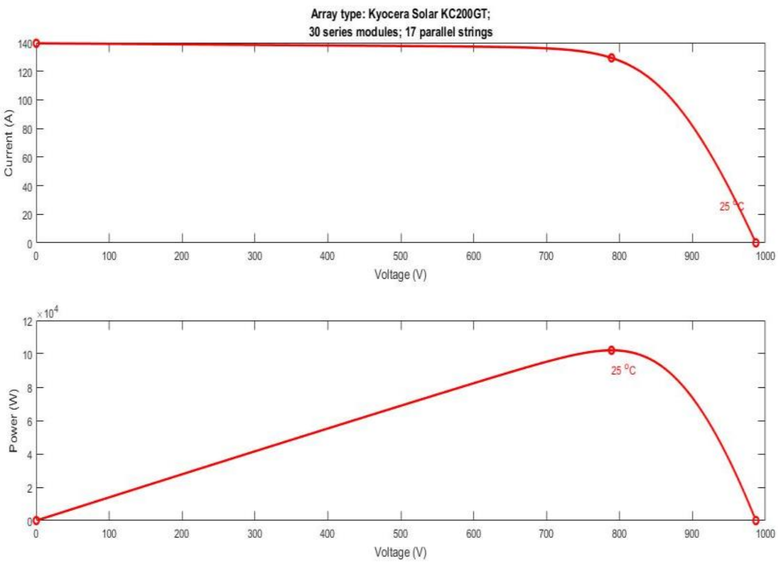

Fig 14: V-I curve and V-P curve of PV array and operating point of SSIB converter

IV. Conclusion

In this paper a new soft switched interleaved boost converter with MPPT controller were proposed which is suitable for high voltage and high power applications . The computer simulation of the converter has been done using MATLAB. From the simulation results ,the performance of the MPPT controller under changing solar radiation and the resonant components design has been verified. The output voltage and current waveforms of the proposed SSIB with MPPT controller are shown. From the simulation results, the SSIB converter is working well with PV system architecture has been observed.

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