

PV Fed UPS System with SEPIC

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Abstract: The project proposed is to feed the back-up battery of UPS system from PV panel with a modified Single Ended Primary Inductance Converter (SEPIC). In this project, utilization of a modified SEPIC for control of photovoltaic power is adopted for charging the back-up battery of UPS system. The power will be directly fed from solar panel whenever enough power is generated from the PV system. So the supply from the mains is needed only when the power from the PV panel is not adequate. Hence this project mainly focused on reduction of power drawn from the grid by the use renewable energy.

Keywords - PV System, SEPIC, UPS.

I. INTRODUCTION

As we stress mother earth to the breaking point by burning fossil fuel, concerned folks are gravitating towards using renewable energy. The sun provides peak power of about 1,000 watts per square meter (93W/sq.ft.) and a solar panel transforms this power into roughly 130W per square meter (12W/sq.ft.). These conditions correspond to a clear day with the solar panel facing the sun that is 42° or better. Surface dust on the solar panels and high heat reduce the overall efficiency.

A solar charging system is not complete without a charge controller. The charge controller takes the energy from the solar panels or wind turbine and converts the voltage to a level that is suitable to charge the battery. For a 12V battery bank, the supply voltage is about 15V.

An advanced charge controller tracks the power by continually measuring the voltage to dynamically adjust the current. It enables maximum power transfer with available light conditions, and this is made possible with maximum power point tracking (MPPT). Figure 1 illustrates the voltage and current source from a solar cell with varying sunlight. The optimal power is available at the voltage knee where the dropping voltage line meets the vertical power line. MPPT determines this point. MPPT finds the best power point where the vertical power line meets the dropping voltage curves. ($V \times A = W$). It should be noted that not all charge controllers with MPPT function equally well.

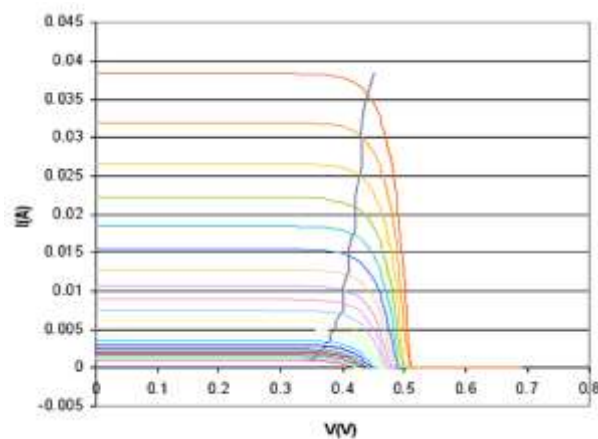


Fig 1: Voltage and current from source a solar cell at varying sunlight.

Many topologies have been used since now for providing a high step-up output voltage, which include the boost converter, buck-boost converter, Ćuk converter etc. Another option is to use a SEPIC, which proved to be much better than above mentioned converters. Boost converter is a classical DC-DC converter which can operate with adequate static gain but, need to have high value for duty cycle. When using these converters the component size as well as their conduction losses will be very high. In a classical SEPIC the components used are less and thus minimum will be their conduction losses. The switch used is a single one in the proposed topology which makes a way to low switching and conduction losses. There are some modifications made to the

classical SEPIC by adding a secondary winding which acts as a flyback transformer and the supply is fed from a solar panel. Also a voltage multiplier is added at the output section providing a low voltage less than the output voltage across the output diode. Thus the drawback of producing a high voltage across the output diode in classical SEPIC can be eliminated.

II. PROPOSED SYSTEM

Solar-electric-energy system has grown consistently over the years. The core of solar power generation system is a solar cell. Utilization of a modified SEPIC for control of photovoltaic power using Maximum Power Point Tracking (MPPT) control mechanism have to be adopted in this project. The SEPIC is designed to make the power flow from PV module to load effectively and maintain constant output voltage. The model is developed using basic circuit equations of the photovoltaic (PV) solar cells including the effects of solar irradiation and temperature changes. The preferred topology presents low switch voltage with high efficiency for low input and high output voltage applications. The Maximum Power Point tracking make it possible to track the maximum power out of a solar cell. When the power increases the voltage also increases. This technique can be fulfilled by using several algorithms. Common among the algorithms are Perturb and Observe and incremental conductance method. By using the proposed topology the static gain can be increased effectively.

III.

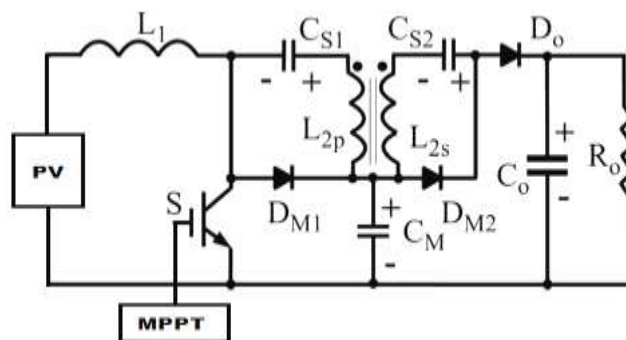


Figure 2: PV Fed Modified SEPIC Converter

(a) First Stage $[t_0-t_1]$: The power switch S is conducting and the input inductor L_1 stores energy. The capacitor C_{S2} is charged by the secondary winding L_{2S} and diode D_{M2} . The leakage inductance limits the current and the energy transference occurs in a resonant way. The output diode is blocked, and the maximum diode voltage is equal to $(V_o - V_{CM})$. At the instant t_1 , the energy transference to the capacitor C_{S2} is finished and the diode D_{M2} is blocked as shown in figure 3.

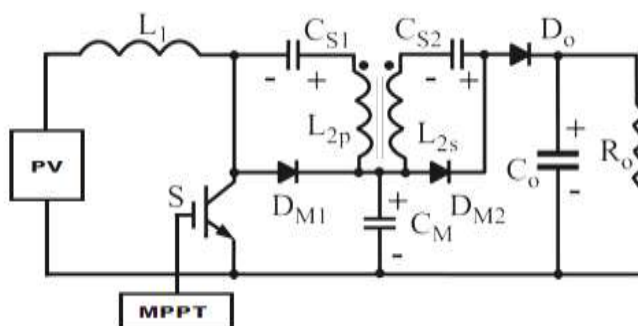


Figure 3: First Stage Operation

(b) Second Stage $[t_1-t_2]$: From the instant t_1 , when the diode D_{M2} is blocked, to the instant t_2 when the power switch is turned OFF, the inductors L_1 and L_2 store energy and the currents linearly increase. Mode 2 is shown in figure 4

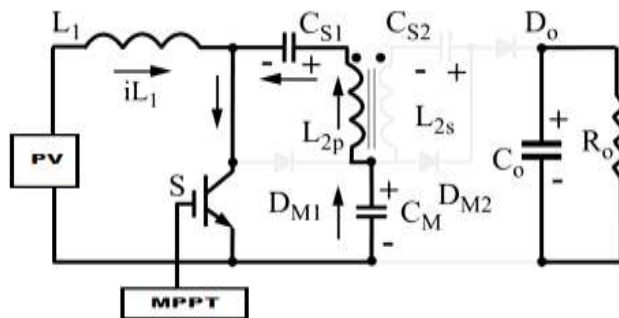


Figure 4: Second Stage Operation

(c)Third Stage $[t_2-t_3]$: At the instant t_2 the power switch S is turned OFF. The energy stored in the L_1 inductor is transferred to the C_M capacitor. Also, there is the energy transference to the output through the capacitors C_{S1} , C_{S2} inductor L_2 and output diode D_o .

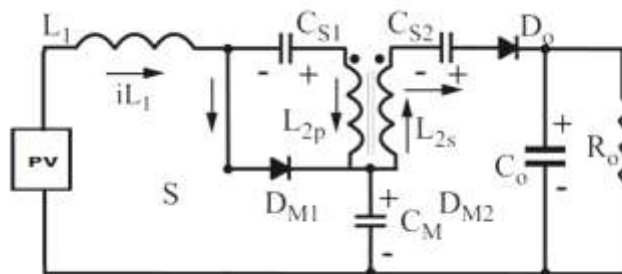


Figure 5: Third Stage Operation

(d)Fourth Stage $[t_3-t_4]$: At the instant t_3 , the energy transference to the capacitor C_M is finished and the diode D_{M1} is blocked. The energy transference to the output is maintained until the instant t_4 , when the power switch is turned ON.

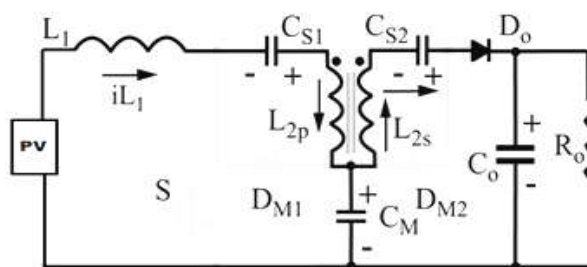


Figure 6: Fourth Stage Operation

(e)Fifth Stage $[t_4-t_5]$: When the power switch is turned ON at the instant t_4 , the current at the output diode D_o linearly decreases and the di/dt is limited by the transformer leakage inductance, reducing the diode reverse recovery current problems. When the output diode is blocked, the converter returns to the first operation stage.

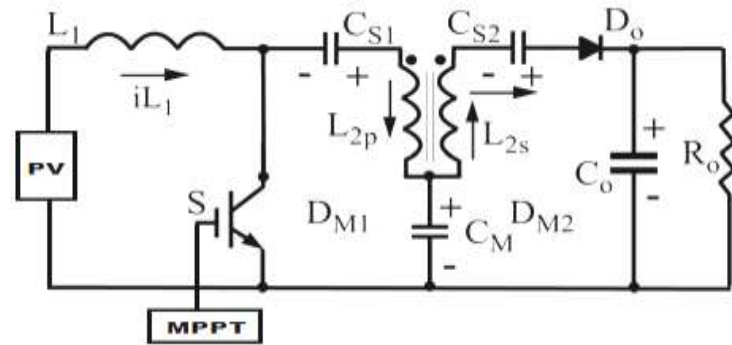
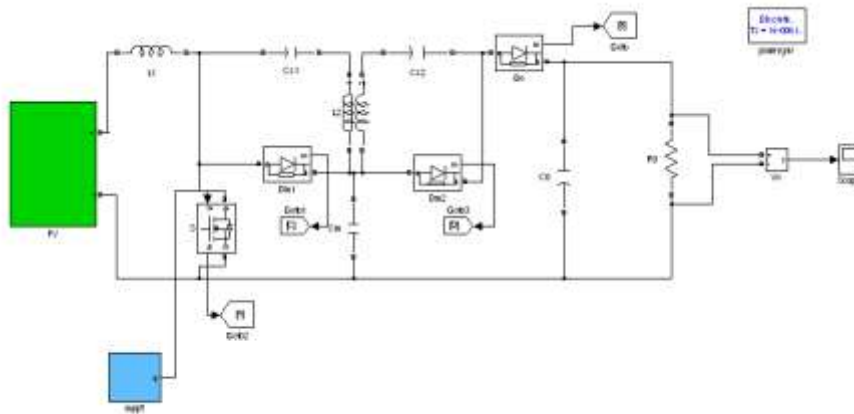


Figure 7: Fifth Stage Operation

IV. Simulation Model And Result

The simulation model is developed in the SIMULINK platform.



The simulation results of basic SEPIC converter are obtained for an input of 15V and the output of 14V, at 50 percent duty cycle with switching frequency of 50 KHz is shown in figure 8.

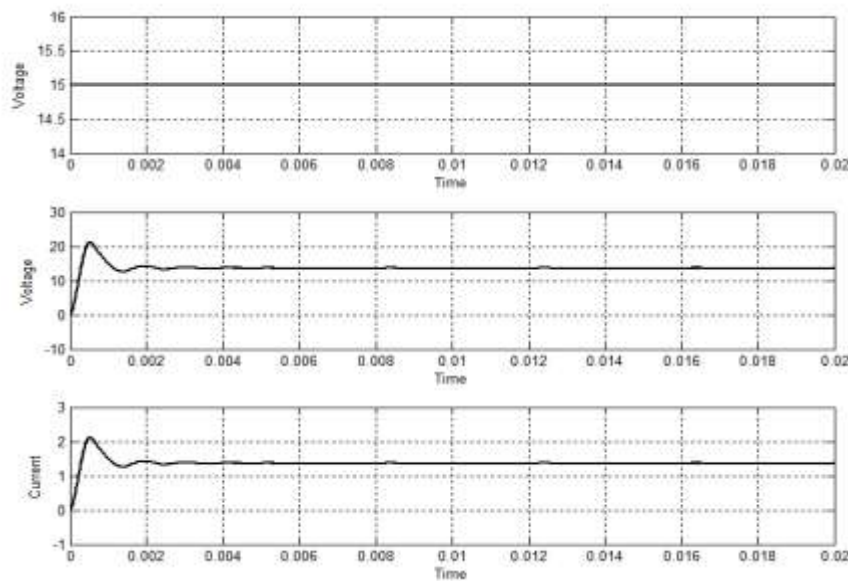


Figure 8: Simulation waveforms of basic SEPIC converter.

The simulation results of PV fed SEPIC converter using MPPT technique are obtained for an input of 15V and the output of 118V, at 80 percent duty cycle with switching frequency of 24 KHz. The basic SEPIC converter is fed from a PV module and to track maximum power out of it MPPT technique is used. The algorithm used for this purpose is P & O algorithm, which is simple to implement

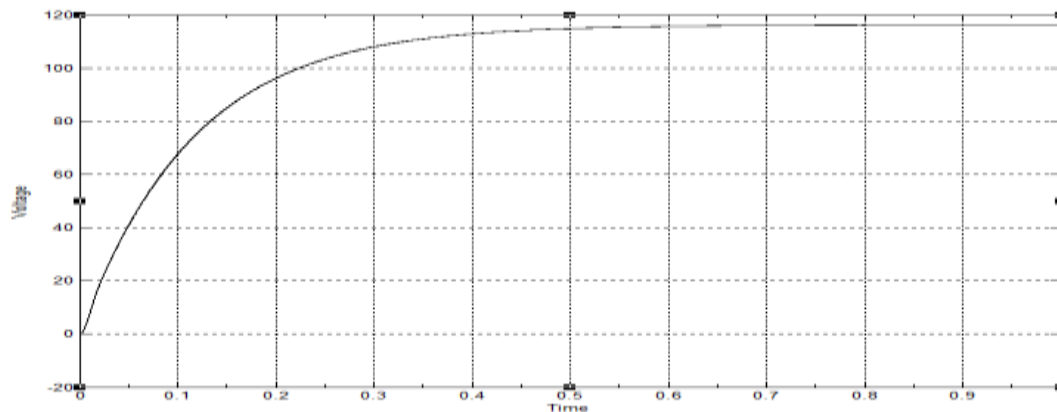


Figure 9: Simulation waveform of output voltage

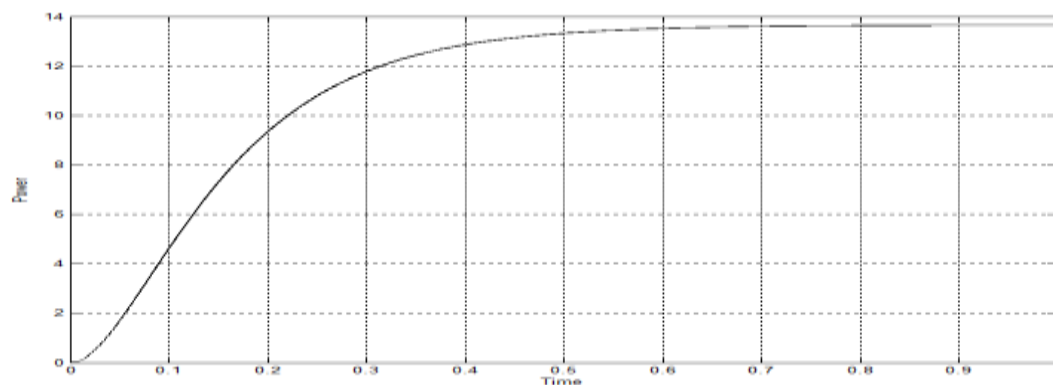


Figure 10: Simulation waveform of output power

IV. Conclusion

A simulation model of SEPIC converter using low cost control circuit has been designed for PV system. The converter maintains constant output voltage even though the output voltage from PV system changes. The simulation is done using MATLAB Simulink. Modified SEPIC converter with magnetic coupling is the most advanced scheme in order to achieve a very high static gain for low input voltage and high output voltage applications. Inclusion of voltage multiplier cell at the secondary side will not affect the complexity of converter. Furthermore, it increases the converter static gain. The commutation losses of the suggested converter with magnetic coupling are reduced due to the existence of the transformer leakage inductance. The main advantage of modified SEPIC converter circuit is that it has a standard gain for a given duty cycle.

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