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Efficient High Step Up DC-DC Conversion using Fuzzy Logic Control and SEPIC Converter

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Abstract - *Renewables are steadily growing in popularity and are becoming incredibly valuable in the production and distribution of goods. As a result, a high voltage DC-DC converter with an active SEPIC network along with fuzzy logic control is proposed in this paper. This converter is used to boost the PV panel's output voltage to a higher level. With only one MOSFET, the active LC network is used to increase the voltage gain. Under continuous conduction mode, the high voltage gain is achieved by storing and discharging energy in inductor and capacitor. The current and voltage ripples are reduced. The high voltage gain is accomplished without using a duty cycle ratio that is too high.*

***Key Words*: SEPIC Converter, Fuzzy logic, High step-up DC-DC conversion, Photovoltaic, Micro-grids.**

1. INTRODUCTION

DC microgrids have rapidly become common in a variety of applications. For integrating photovoltaics (PVs) in such, DC microgrids, a variety of current structures are accessible. The most common PV integration topologies are centralized, multi-string, string, module, and sub module integration. Owing to the exploitation of traditional resources, the energy demand of daily life can only be met by renewable resources. Renewable energy sources such as solar panels and fuel cells have low output voltages that must be increased. Traditional boost converters require high-power rating switches, which causes conduction loss and limits the output voltage, even at very high duty cycles. According to the available boost converter's theoretical ideas, when the service cycle hits unification, the static gain would be infinite. High duty cycle values, on the other hand, result in lower voltage gain and performance. As a result, we've opted to use a high-step-up dc-dc converter to increase the output voltage. Coupled inductor and non-coupled inductor are two types of high-step-up DC-DC converters. High voltage gain can be achieved in coupled inductor forms by changing the coupled inductor turns ratio. However, voltage spikes may be caused by the leakage inductance. As a result, the topology's complexity is increased in this case.

The use of a boost converter with cascaded converters or voltage multipliers as switched inductor or switched capacitor is the basis for non-coupled inductor converters. While this type of converter may provide a high voltage gain, its performance can suffer due to a large number of components used. The active switched LC network with a high step-up dc-dc converter was chosen because of its high conversion ratio, high reliability, and low voltage stress on the active switches. Various high step-up DC-DC converters have been suggested to address these drawbacks. Furthermore, various techniques and circuits are given to increase the voltage gain and reduce the duty cycle values. Voltage-boosting methods, such as switched LC networks, are among them. To improve the boost ability, a switched inductor(L) technique is used. To increase the voltage gain, a switched capacitor (C) is used. The voltage stress on the semiconductor switches is reduced in these converters, which aids in the selection of MOSFET's with low static resistance to improve performance by lowering conduction loss. This form of soft switching, on the other hand, helps to remove voltage spikes. As a result, snubber circuits are needed to provide voltage stress safety to the output diodes. When compared to traditional converters, MOSFET switch on losses is also lower.[1]paper gave the idea to develop a DC-DC converter using SEPIC Converter as it is less complex compared to the OVR method(Output Voltage Regulation) used there.[2] helped in implementing the basic DC-DC converter in MATLAB.[3],[4],[5],[6] gave the idea about implementing converter using Fuzzy Logic Control.

2. EXISTING SYSTEM

2.1 Existing Model:

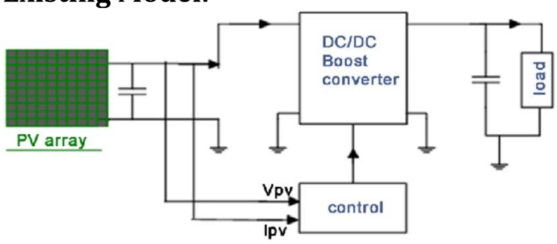

Fig -1: Existing System

Figure 1 depicts a general grid-connected SPV system. The system that binds the input to the inverter is paired with the first stage PV array or module. The 3-phase VSI transforms DC voltage to AC voltage and delivers it to the load and grid via an LC filter circuit. To obtain excellent power efficiency, the inverter must be attempted to acquire harmonic less voltage. The inverter circuitry is switched using several PWM techniques.

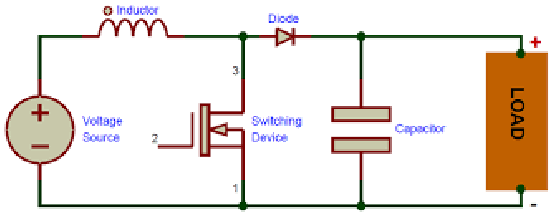

Fig -2: Existing System Circuit

Disadvantages of Existing System:

1. The boost converter's input to output ratio is 1:2, which is inefficient.
2. The magnetic is under a lot of voltage tension.
3. Current rises in an instant.

3. PROPOSED SYSTEM

A DC to DC converter is the SEPIC converter. The DC to DC converter's output voltage has been either less than or greater than the input voltage. The duty cycle affects the magnitude's output voltage. These converters are often referred to as step up and step down transformers, after the similar step up and step down transformer.

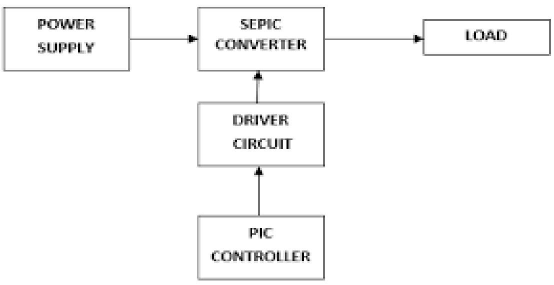

Fig -3: Block diagram of the proposed system

The input voltages are scaled up or down to a higher or lower level than the input voltage. The input power is equal to the output power because of the low conversion energy. The low of conversion is defined by the following expression. The input voltage is less than the output voltage (Vin < Vout) in the step-up mode. The output current is less than the input current, as shown. As a result, the buck booster acts as a step-up mode.

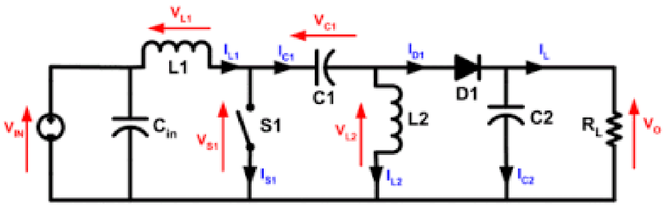

Fig -4: Mode of operation

The buck converter's process is depicted in the diagram. Due to the increased square wave frequency, the first transistor in the buck converter is turned on and the second transistor is shut off. If the current that passes through the magnetic field is stronger than the gate terminal of the first transistor, the current passes through the magnetic field, charging C, and supplies the load. The Schottky diode D1 is switched off by the positive voltage applied to the cathode. The initial current source is the inductor L. The current flow in the buck operation is stopped if the first transistor is turned off with the control unit. The inductor's magnetic field falls, triggering back e.m.f. The collapsing field spins the polarity of the voltage around the inductor. The current will pass through diode D2, the load, and also the D1 diode.

With the support of the current, the discharge of the inductor L decreases. The charge of the accumulator in the capacitor is maintained when the first transistor is in one position. During the off-time, the current flows through the load, holding Vout at a reasonable level. As a result, the ripple amplitude is kept to a minimum, and Vout is kept close to Vs.

3.1 Controller for Fuzzy Logic MPPT:

In the monitoring of the MPP in PV systems, fuzzy logic controllers have recently been added. They have the advantage of being durable and relatively easy to build because they do not need exact model information. In the other hand, they do necessitate the designer's full understanding of the PV system's function.

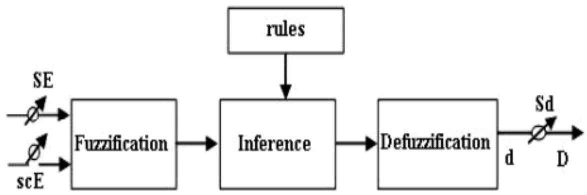

Fig -5: Fuzzy logic controller

Figure 5 depicts the proposed FL MPPT Controller, which has two inputs and one output. The error E and change of error CE at sampled times k are the two FLC input variables, as defined by figure 6.

$$E(k) = \frac{P_{ph}(k) - P_{ph}(k-1)}{V_{ph}(k) - V_{ph}(k-1)}$$

$$CE(k) = E(k) - E(k-1)$$

Fig -6: Error E and Change of Error CE

The input E(k) indicates whether the load service point at the instant k is to the left or right of the PV characteristic's maximum power point, while the input CE(k) indicates the point's moving direction. The fuzzy inference is performed using Madani's process, and the defuzzification is performed using the center of gravity to calculate the service cycle performance of this FLC:

$$D = \frac{\sum_{j=1}^{n} \mu(D_j) - D_j}{\sum_{j=1}^{n} \mu(D_j)}$$

Fig -7: Defuzzification D

4. MODELING AND SIMULATION ANALYSIS

4.1 Hardware Model:

Initially, the Solar radiation will fall on the PV array. The PV cells within the array will convert the solar radiation into electric energy. The electric energy from the PV panel will be fed into Step up transformer of a 500mA rating in order to boost the input and feeds it into the Control Unit. The bridge rectifier in the Control unit will rectify the incoming signal of 12 V into pure DC voltage and again feeds it into the Voltage regulator (7805). The 7805 regulators will feed only positive voltage of Amplitude 5V to power the Crystal Oscillator. The crystal oscillator will generate the required Clock pulses. The clock pulses will trigger the micro-controller(dsPIC30F4011/4012) through its Pulse width Modulation Pins. This process is denoted by the LED indicators on the board. Now the 5V in the Micro controller will be considered as a weak signal. In order to boost the weak signal to a strong signal, the optocoupler amplifier circuit is used to convert the 5V back to 12 V. Now the converted 12v will be used to power the SEPIC converter to produce the required boost output. The input to output ratio will be of order 1:4.

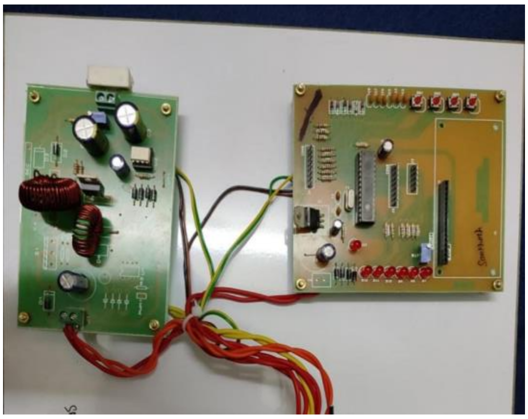

Fig -8: Hardware Circuit Kit

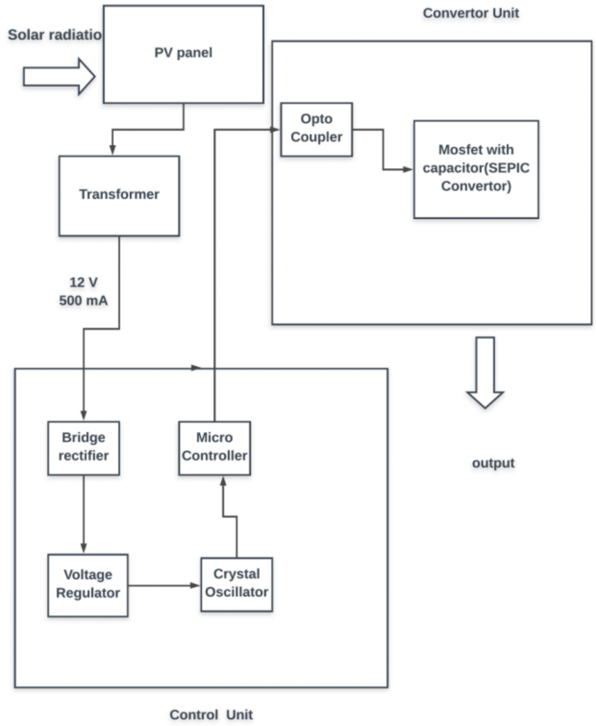

Fig -9: Block Diagram

4.2 Simulation Output:

In Boost converter using SEPIC Converter the input to output ratio using pulse generator is of order 1:4.5.

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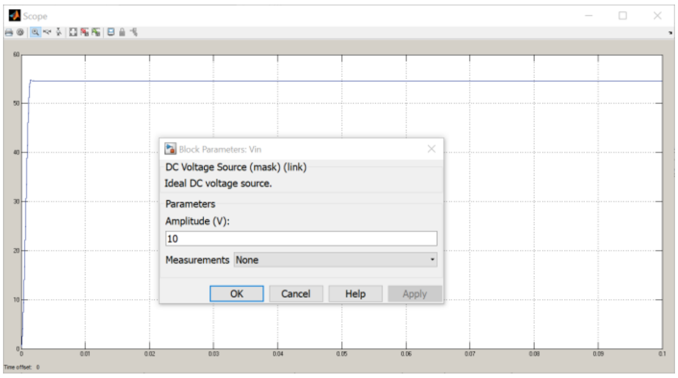

Fig -10: Input Voltage of Boost Converter

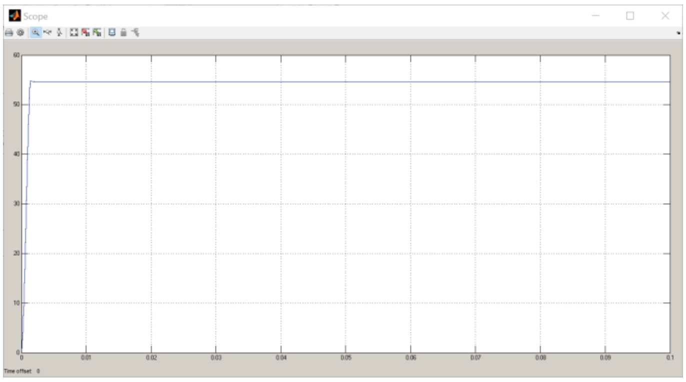

Fig -11. Output Voltage of Boost Converter

To implement the Fuzzy logic in the simulation we developed a Buck converter as it is used in normal solar applications. The ratio will be 4:1

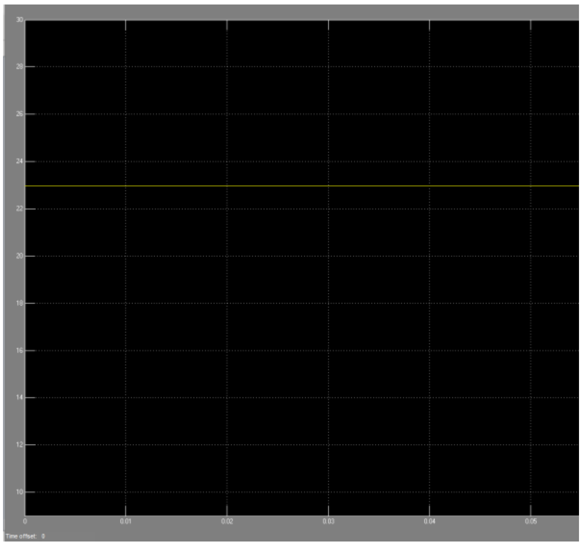

Fig -12: Input voltage of Buck converter

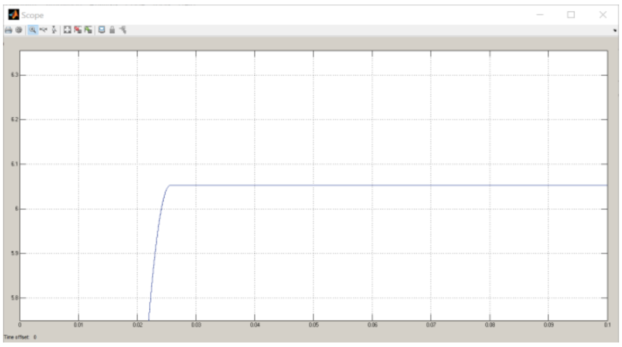

Fig -13: Output voltage of Buck converter

5. RESULTS AND DISCUSSION

Table -1: Comparison of Efficiency of various systems

SN.	System Type	Input Voltage	Output Voltage	Efficiency ratio
1	Existing Boost system	10V	20V	1:2
2	Proposed Boost system	9.9V	41.8V	1:4
3	Proposed Boost system (simulation)	10V	45V	1:4.5
4	Proposed Buck system (simulation)	24V	6V	4:1

Fig -14: Input Voltage of Hardware Unit

Fig -15: Output Voltage of Hardware Unit

6. CONCLUSION

Since the existing system's efficiency ratio is 1:2, it is used to get the most energy out of this circuit rather than boost transformed circuits. We improved the performance by using a high-step-up DC-DC conversion with a single-transistor boost converter, which generates performance in the ratio of 1:4 in hardware and 1:4.5 in simulation. It decreases the number of transistors used in a traditional boost converter. And also compared with the Buck converter with the set up to verify the 4:1 ratio.

ACKNOWLEDGEMENT

This project and paper is inspired from the works of Moustafa Adly and Kai Strunz who proposed a paper based on the title “Efficient Digital Control for MPP Tracking and Output Voltage regulation of Partially-Shaded PV Modules in DC Bus and DC Micro-grid Systems.“

REFERENCES

[1] “Efficient Digital Control for MPP Tracking and Output Voltage regulation of Partially-Shaded PV Modules in DC Bus and DC Micro-grid Systems. “ by Moustafa Adly and Kai Strunz.

[2] “A Study on Recent DC-DC Converters” by Mousumi Biswal and Sidharth Sabyasachi from Visvesvaraya National Institute of Technology

[3] “Research on DC-DC converter with high voltage and high power” by Rong Wang; Heng Chen; Tengfei Lei; Yun Shi published in 2014 IEEE International Conference on Information and Automation (ICIA).

[4] “Design and Implementation of a Single Input Fuzzy Logic Controller for Boost Converters" by Zainal Salam , Fazel Taeed , Shahrin Md in Journal of Power Electronics in July 2011.

[5] “A Comparative Study of PI and Fuzzy Controllers for Solar Powered DC-DC Boost Converter” by Babita Panda; Akashdeep Sarkar; Bhagabat Panda; P.K. Hota in 2015 International Conference on Computational Intelligence and Networks.

[6] “Performance Analysis of Boost Converter Using Fuzzy Logic and PID Controller” by S. Shinde, S. Sankeshwari published in IOSR journals in 2016.