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Perturb and Observe Based Photovoltaic Power Generation System for Off-Grid Using SEPIC Converter

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Abstract

This paper proposed of a DC-DC Converter single ended primary inductor converter (SEPIC) converter and an inverter with PV as a source This paper has a two phase, one is it has a DC-DC converter and an inverter as interface circuits. Keeping in mind the end goal to coordinate with the heap to the photovoltaic modules and to enhance the proficiency of the work, the DC-DC converter with Maximum power point tracking (MPPT) is important. For boosting up of the output voltage of the PV module, Perturb and Observe calculation is utilized as a part of the DC-DC converter. The output voltage is changed over to AC voltage by utilizing the inverter. The Simulation works of the SEPIC converter and the inverter have been completed utilizing the MATLAB programming. A DSP controller is utilized to create the PWM beats for the SEPIC converter circuit. The negative terminal of the solar based cell can be specifically associated with the ground so that transparent conducting oxide corrosion and the leakage current can be reduced. Thus efficiency can be improved.

Key Words: Photovoltaic array, maximum power point tracking (MPPT) Algorithms, P & O, INC, boost converter and SEPIC.

I. Introduction

Sustainable power source is the energy which originates from normal assets, for example, daylight, wind, rain, tides and geothermal warmth. These assets are inexhaustible and can be normally recharged. Accordingly, for all pragmatic purposes, these assets can be thought to be endless, not at all like diminishing ordinary petroleum derivatives. The worldwide energy crunch has given a re-established driving force to the development and advancement of Clean and Renewable Energy sources. Clean Development Mechanisms (CDMs) [2] are being received by associations the whole way across the globe. Aside from the quickly diminishing stores of petroleum derivatives on the planet, another main consideration conflicting with non-renewable energy sources is the contamination related with their burning. Contrastingly, sustainable power sources are known to be much cleaner and deliver energy without the unsafe impacts of contamination dissimilar to their regular partners. As referred by various irradiations, the output power of a Photovoltaic module has a significant change. All in all, PV modules have a nonlinear current-voltage-attribute, and there is just a single interesting working point for a PV era context with a greatest output control under a specific ecological condition. Nonetheless, the P&O strategy, which measures the varieties of energy and voltage to decide the passing district and change the reference value of voltage for working near the most extreme power point, is regularly utilized in light of its basic structure and less measured value of parameters point shifts with illumination and temperature, so that maximum power point tracking (MPPT) at all barometrical circumstances is a testing issue. By and large, an earth parasitic capacitance will be produced between sun oriented modules and their ground. This capacitance is around 50-150nF/KW for a glass-confronted sun oriented cell array. This capacitance is expanded to 1 µF/KW,if a thin film cell array is utilized. Along these lines genuine spillage current happens if a high recurrence throbbing voltage is connected between the modules and the ground. On the off chance that the voltage of the negative terminal is lower than that of the ground, transparent conducting oxide corrosion happens which harms the thin film modules. In this way to keep the corrosion impact negative terminal of the module is transparently associated with the ground.[4] The single-ended primary-inductor converter (SEPIC) is capable of regulating output voltage greater than operating input voltage. Both Boost and Buck operations are possible in SEPIC converter. Also it has less active components, a nominal converter and waveforms with lesser noise operation. Two magnetic windings is placed on a common core, but it in a dual winding inductor they separate windings of two uncoupled inductors specifies SEPIC converter. [7-10]

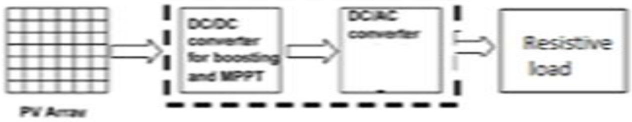

Fig. 1: Photovoltaic generation system

II. System Configuration

The proposed photovoltaic generation system consists of a DC-DC power converter, inverter and the resistive load.

PV Module Characteristics

The practical equivalent circuit of a PV module is shown in the fig 2and the typical output characteristics is shown in fig 3

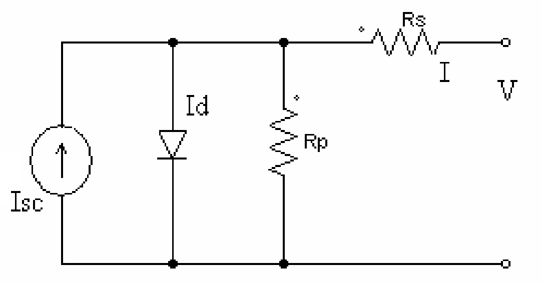

Fig. 2: Equivalent circuit of a PV module

A photovoltaic cell or photoelectric cell is a semiconductor gadget that converts light to electrical energy by photovoltaic impact. On the off chance that the energy of photon of light is more prominent than the band hole then the electron is discharged and the stream of electrons makes current. However a photovoltaic cell is not quite the same as a photodiode. In a photodiode light falls on n channel of the semiconductor intersection and gets changed over into current or voltage flag however a photovoltaic cell is constantly forward one-sided. Typically various PV modules are organized in arrangement and parallel to meet the energy necessities. [6]

In a solitary diode show, there is a present source parallel to a diode. The present source speaks to light-produced current, which differs directly with sun powered illumination. This is the easiest and most generally utilized model as it offers a decent trade off amongst straightforwardness and precision. [1][13]

The characteristic equation for the solar cell is given by ,

$$I = I_{ph} - I_s \exp\left[q\left(\frac{V + IR_S}{KT_cA}\right) - 1\right] - \frac{V + IR_s}{R_{sh}}$$

Where

Iph = light-generated current or photocurrent,
Is = cell saturation of dark current,
q = 1.6 x10-9C is an electron charge,
k = 1.38x10-23J/K is a Boltzmann’s constant,
Tc= cell’s working temperature,
A = An ideal factor,
Rsh= shunt resistance, and

Rs = series resistance.

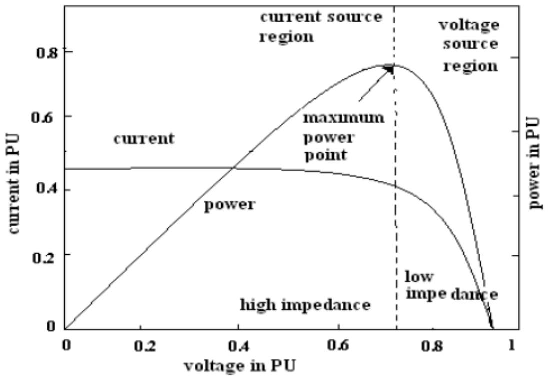

Fig. 3: PV Module IV and PV characteristics

As found in the voltage Vs power curve of the module there is a single maximum of power. That is there exists a peak power corresponding to relating to a specific voltage and current. Since the module productivity is low it is attractive to work the module at the pinnacle control point so that the most extreme power can be conveyed to the heap under changing temperature and insolation conditions. Thus augmentation of energy enhances the usage of the sunlight based PV module. A most maximum power point tracking (MPPT) is utilized for removing the greatest power from the sun powered PV module and exchanges it to the load.[11]

DC-DC Converter with MPPT Technique

The fundamental need of any DC–DC converter used as a parts of the MPPT plan is that it should have a low data current ripple. Buck converters will make ripples on the PV module side streams and in this way require a greater value of data capacitance on the module side. Of course, enable converters to will show low ripple on the PV module side, yet the stack current shows more ripple and gives a voltage higher than the group voltage to the stores. The buck– bolster converters can be used where the need of load voltage, either low or higher than the bunch voltage. In any case, with this converter the data and load streams are throbbing in nature. Furthermore, the stack voltage will be adjusted with buck–boost or CUK converters. Under these conditions, the SEPIC converter, give the buck–boost change work without furthest point reversal, despite the low ripple current on the source and load sides.[15][19]

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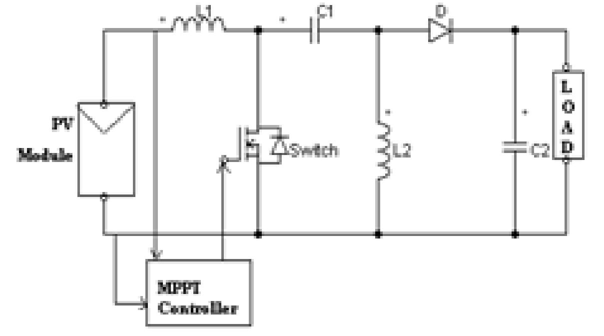

Fig. 4: SEPIC converter topology with PV and MPPT

L_1 is the source side inductance, L_2 is the output side inductance, C_1 is the energy exchange capacitor, C_2 is the output side capacitor, Vin is the input voltage, V_o is the output voltage, VC_1 is the voltage crosswise over capacitor C_1, IL_1 is the current however L_1 and IL_2 is the current through L_2.

MPPT Control Algorithm

Maximum Power Point Tracking, as frequently as conceivable insinuated as MPPT, is an electronic setting that works the Photovoltaic (PV) modules in a way that empowers the modules to make all the power they can do. MPPT is not a mechanical after setting that "physically moves" the modules to make them point more direct at the sun. MPPT is a totally electronic setting that moves the electrical working motivation behind the modules so that the modules can pass on most outrageous open power. Additional power gathered from the modules is then made open as extended battery charge current. MPPT can be used as a piece of conjunction with a mechanical after setting, yet the two settings are entirely unexpected. The MPPT computation used as a piece of this proposed setting is the Perturb and Observe method. The most for the most part used MPPT figuring is the P&O because of its ease of use. Fig. 5 shows the value of P&O. [4][7]

P&O calculation depends on the count of the PV array output control and the power change by detecting both the PV current and voltage. The controller works occasionally by comparing the present value of the power output with the past incentive to decide the change on the sun oriented array voltage or current.[2][16] The calculation peruses the value of current and voltage at the output sun oriented PV module. Power is ascertained from the deliberate voltage and current. The extent of voltage and power at kth moment are put away. At that point the extent of energy and voltage at (k+1)th moment are measured again and power is computed from the deliberate esteems

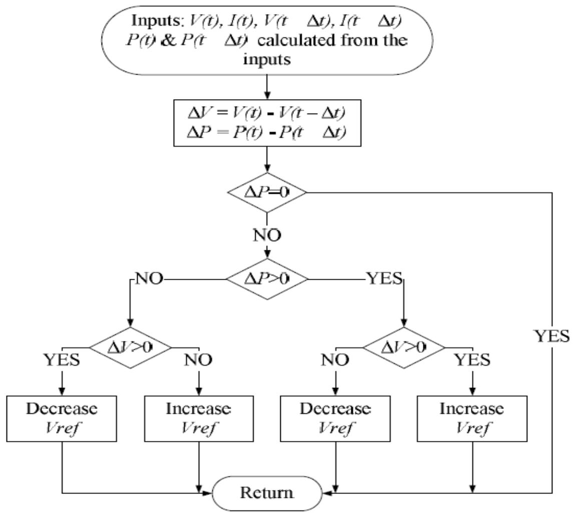

Fig. 5: Algorithm for P & O method

On the off chance that the greatness of energy is expanding, the bother will proceed in a similar bearing in the following cycle, generally the irritation heading is turned around. At the point when the MPPT is achieved, the context then sways around the MPPT. With a specific end goal to limit the swaying, the irritation step size ought to be decreased to such an extent that when the working point is far from the MPPT, the progression change in obligation cycle ought to be vast, when it nears the MPPT, the progression change in'α' ought to diminish.[2]

This algorithm has the drawback that after reaching the maximum power point its starts deviating on the maximum power point continuously all the time results in the substantial amount of power loss at maximum power point. Although this algorithm is quite simple to implement and it requires only one voltage sensor so, the cost of implementation of this algorithm is low [6].

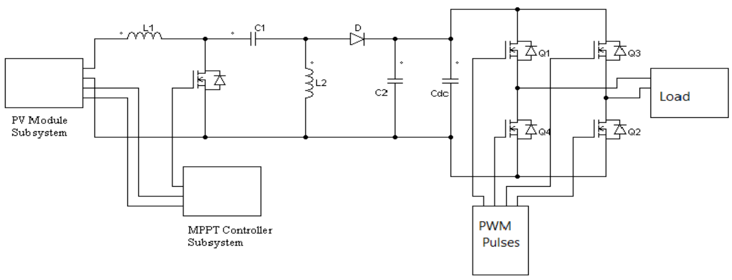

Fig. 6: Simulation model of SEPIC converter and inverter

Table 1: Sepic converter design Specification

Parameter	Value
Input Voltage	60V
Output Voltage	230V
Duty Ratio	0.8
Switching Frequency	20KHz

The simulation model of the proposed context is done in MATLAB/ SIMULINK programming. The reproduction is finished by considering consistent irradiance and temperature for the PV module. The figure 7 demonstrates the recreation waveforms for the SEPIC converter by considering the resistive load. The info voltage of context is 60V.It is supported up to 230V settled DC output voltage utilizing the SEPIC converter. The figure 8 demonstrates the simulation consequences of the inverter by considering the resistive load. The inverter converters the balanced out DC output voltage to the AC voltage of 230V which is required for the heap.[3]

Table 2: Showing output corresponding to irradiation

Iterations (i)	Irradiation (W/m^2)	MPP At Iteration	Output Power (W)
		P&O	P&O
1-20	800	**20**	41.41
21-40	500	**40**	48.08
41-55	300	**55**	38.44
56-75	400	**61**	70.09
76-88	600	**79**	120.44
89-100	700	**95**	145.63

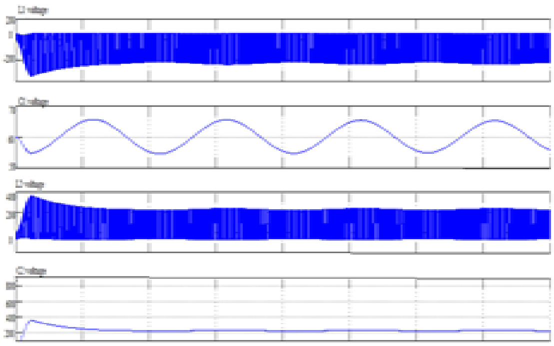

Fig. 7: Simulation results of SEPIC converter

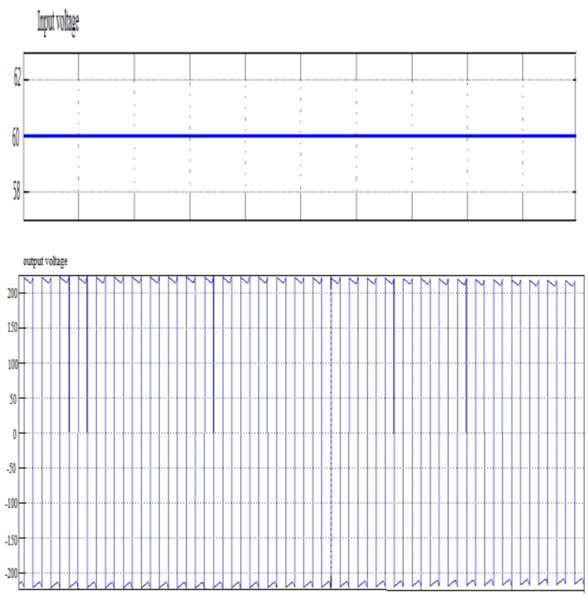

Fig. 8: Simulation result of combined SEPIC converter and inverter

III. Conclusion and Future Scope

The paper proposes the off grid photo voltaic era system in which the boost converter is replaced with the SEPIC converter for which the DC voltage from PV panel can be boost or buck up to the 230V which is then inverted and are connected to the load. This uses the MPPT system for the maximum power tracking. This system can be produced in future to enhance and to increase the system performance and over all efficiency of the system

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