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ANALYSIS OF DC DISTRIBUTION SYSTEM USING COUPLED INDUCTOR AND SWITCHED CAPACITOR

Dr T. Jangid Sareen

ABSTRACT

This paper proposes a high step-up solar power optimizer (SPO) that efficiently harvests maximum energy from a photovoltaic (PV) panel then outputs energy to a dc-microgrid. Its structure switched inductor and switched capacitor technologies to realize high step-up voltage gain. The leakage inductance energy of the coupled inductor can be recycled to re- duce voltage stress and power losses. A low voltage rating and low-conduction resistance switch improves system efficiency by employing the incremental conductance method for the maximum power point tracking (MPPT) algorithm. Because of its high tracking accuracy, the method is widely used in the energy harvesting of PV systems. laboratory prototypes of the proposed SPO that have an input voltage range of 40 to 60V and a maximum PV output power of 400 V/300 W are applied. This paper proposes use of a high step up solar power optimizer (SPO) that efficiently reaps maximum energy taken from photo voltaic (PV) panel fed to a DC-micro-grid. The proposed converter employs a switched capacitor and coupled inductor, by varying duty ratio and turns ratios generally we want for the coupled inductor to achieve high step up voltage conversion; The leakage inductance energy of the coupled inductor is efficiently to the load and reduce voltage stress. A rating of low voltage and low-conduction resistance switch makes the system efficiency by employing the perturb and observe (P and O) method for the maximum power point tracking the operating principles and continuous and discontinuous modes , as well as the voltage and current stress of the active switch componentsareinvestigatedindetai

1. INTRODUCTION

Generally a photovoltaic power generation system is used as a renewable resource; it has been used in emergency facilities and generating electricity. This PV power generation system needs to be high efficiency and high reliability. A conventional photovoltaic generation system is either a single or a PV array is connected to one or few central PV inverters. The PV modules are connected in series with the PV array to obtain the Dc link voltage that is high enough to electricity connected fed to the DC-ac inverter.However the reduction of power is caused by effect of the shadow. That is problem of centralized photo voltaic system. The micro-grid or AC modules are using in recent days for separate PV panels [1], [2]. Although this PV power generation of shadow problem solution may partially eliminate, the structure of the micro inverter constrains the system energy's reaping efficiency and cost is high.

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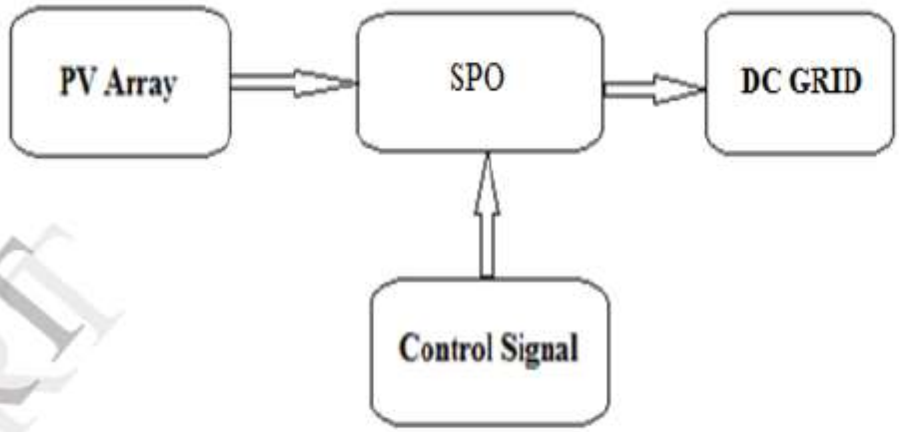

Fig. 1 General block diagram of the proposed system

An alternative proposed solar power optimizer is developed to reap maximize energy taken from separate
photovoltaic modules. A DC-DC convertor is used in solar power optimizer with maximum power point tracking. The PV panel voltage increases rapidly to optimum voltage levels and a DC micro-grid connection for the electricity of DC-AC inverter [3]-[6]. A single PV panel's energy is shown in Fig. 1. This power passes through an SPO to a DC micro-grid system. The 40V input voltage fed to SPO. This SPO will produce high step up voltage of 400V DC using boost converter, this output of micro-grid distribution for data centre systems and telecommunication facility [7]. These are the attempts of SPO to improve the overall system of renewable resources and system cost is lower, has an antishadow effect of PV system can be monitored and improve the efficiency [8].

A single PV panel voltage range of 20V-40V and capacities of power about 100W-300W are used [9]. A high step up SPO using boost converter, that increases low voltage to required voltage level. The step-up DC-DC converter with various topologies consists of a boost and fly back converters switched capacitor and coupled inductor converters and boost type that are investigated with coupled inductor.

The floating switch used in SPO because of its increasing voltage gain, the leakage inductance energy of the coupled inductor can be recycled and the voltage stress on the active switch.

A power optimizer is a DC to DC converter technology developed to maximize the energy harvest from solar photovoltaic or wind turbine systems. They do this by individually tuning the performance of the panel or wind turbine through maximum power point tracking, and optionally tuning the output to match the performance of the string inverter. Power optimizers are especially useful when the performance of the power generating components in a distributed system will vary widely, differences in equipment, shading of light or wind, or being installed facing different directions or widely separated locations. Power optimizers for solar applications, can be similar to micro inverters, in that both systems attempt to isolate individual panels in order to improve overall system performance. A microinverter essentially combines a power optimizer with a small inverter in a single case that is used on every panel, while the power optimizer leaves the inverter in a separate box and uses only one inverter for the entire array. The claimed advantage to this "hybrid" approach is lower overall system costs, avoiding the distribution of electronics [2].

2 PROPOSED CIRCUIT

Circuit diagram of the proposed SPO is as shown in fig. 2 below.

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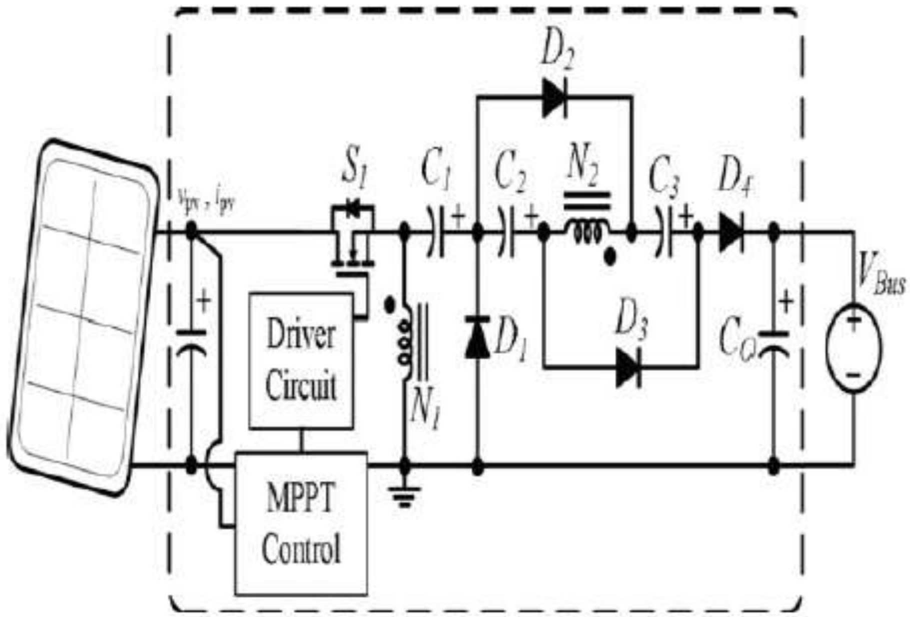

Fig. 2 circuit diagram of the proposed system

This proposed SPO is based on a high step up dc-dc converter with an MPPT control circuit. The converter consists of a drifting active switch S and a coupled inductor T1 with primary winding N1, which is comparing to the conventional boost converter capacitor c1 and diode D1 used to recycle the leakage inductance energy from N1. Secondary winding N2 is series connected to the capacitor C2 and C3 and diodes D1 and D2 are parallel connected. The output capacitor connected from rectifier diode D4 and load R. The duty ratios are adjusted by the MPPT algorithm. Which uses perturb and observe method in the proposed SPO. Therefore, the MPPT can be gained by representing a similar instantaneous conductance I/V and perturb and observe dI/dV.

The main three features in proposed converter are as follows:

(1) The voltage transmutation ratio is increased due to coupled inductor and switched capacitor techniques.

(2) Its increase efficiency due to leakage inductance energy of the coupled inductor can be recycle and active switch restrained

(3) During co-operating conditions, the drifting active switch isolates the PV panel's energy.

The MPPT algorithm is widely used in the energy reaping of PV system. Hence it exhibits high tracking efficiency.

3. OPERATING PRINCIPLES

The operating principles for continuous conduction mode (CCM) and discontinuous conduction mode (DCM) are presented in detail. Fig. 3 illustrates a typical waveform of several major components in CCM operation during one switching period.

To simplify the circuit analysis of the proposed converter, the following assumptions are made:

1) All components are ideal, except for the leakage inductance of coupled inductor T1 , which is taken into account. On-state resistance RDS (ON) and all the parasitic capacitances of main switch S are disregarded, as are the forward voltage drops of diodes D1 to D4 ;

2) Capacitors C1 to C3 and Co are sufficiently large that the voltages across them are considered constant;

3) The equivalent series resistance (ESR) of capacitors C1 to C3 and Co , as well as the parasitic resistance of coupled inductor T1 is Neglected;

4) Turns ratio n of coupled inductor T1 windings is equal to N2 /N1.

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The CCM operating modes are described as follows.

A. CCM Operation

Mode I [t0, t1]: During this interval, switch S and diodes D2 and D3 are conducted; diodes D1 and D4 are turned OFF. The current flow path is shown in Fig. 4(a). Magnetizing inductor Lm continues to release energy to capacitors C2 and C3 through secondary windingN2 of coupled inductor T1. Leakage inductance Lk 1 denotes the stored energy from source energy Vin . The energy that is stored in capacitor Co is constantly discharged to load R. This mode ends when increasing iLk1 is equal to decreasing iLm at t = t1

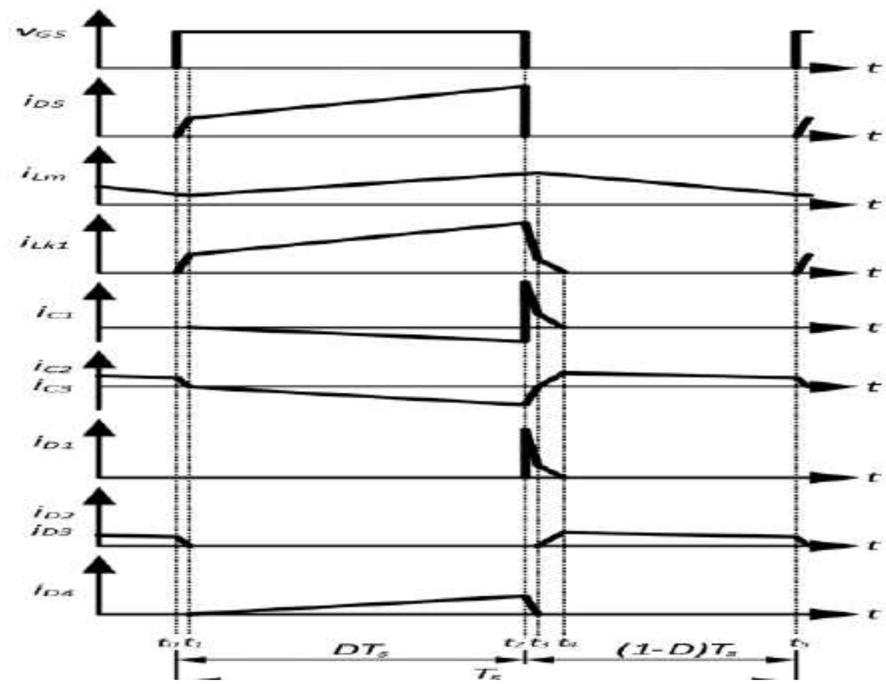

Fig. 3. Typical waveforms of the proposed converter in CCM operation.

$$v_{Lm} = V_{in} \quad (1)$$

$$\Delta i_{Lm} = V_{in}/L_m(t_1 - t_0) \quad (2)$$

Mode II [t1 , t2]: During this interval, switch S and diode D4 are conducted. Source energy Vin is serially connected to C1, C2 , and C3 , and secondary winding N2 ; Lk2 discharges the energy that is stored in charge output capacitor Co and loads R. Meanwhile, magnetizing inductor Lm also receives energy from Vin. The current flow path is shown in Fig. 4(b). This mode ends when switch S is turned OFF at t = t2

$$v_{Lm} = \frac{V_o - V_{in} - V_{c1} - V_{c2} - V_{c3}}{n} \quad (3)$$

$$n = \frac{N_2}{N_1} \quad (4)$$

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$$\Delta i_{Lm} = \frac{V_o - V_{in} - V_{c1} - V_{c2} - V_{c3} \cdot (t_2 - t_1)}{n \cdot L_m} \quad (5)$$

Mode III [t2 , t3]: During this transition interval, switch S and diodes D2 and D3 are turned OFF, and diodes D1 and D4 are conducted. The current flow path is shown in Fig. 4(c). The energy stored in leakage inductance Lk 1 instantly flows through the diode D1 to charge capacitor C1 . The energy is released to magnetizing inductor Lm through coupled inductor T1 , which is serially connected to C1, C2 , and C3 , and secondary winding N2 ; Lk2 discharges the energy that is stored in charge output capacitor Co and loads R. This mode ends when decreasing iLk1 is equal to increasing iLm at t = t3

$$vLm = -Vc1 \quad (6)$$

CONCLUSION

The high step-up SPO uses the coupled inductor with an appropriate turn's ratio design and switched-capacitor technology to achieve a high-voltage gain higher than the input voltage. Because the leakage inductance energy of a coupled inductor is recycled and the voltage stress across the active switch S is constrained, the low RDS (ON) of active switch can be selected to improve maximum efficiency. A 300 W SPO with a high step-up voltage gain and MPPT functions are implemented and verified using MATLAB Simulink model design.

Future Scope

The system can be extended for more voltage range. Increase in more voltage range will increases the voltage gain and efficiency of the converter system. The output DC voltage can be inverted and we can use the AC loads also

REFERENCES

1. W. Yu, J.-S. Lai, H. Qian, and C. Hutchens, \High-efficiency MOSFET inverter with H6-type configuration for photovoltaic nonisolated ac-module applications,. IEEE Trans. Power Electron., vol. 26, no. 4, pp. 1253.1260, Apr. 2011.

2. L. Gao, R. A. Dougal, S. Liu, and A. P. Iotova, \Parallelconnected solarPV system to address partial and rapidly fluctuating shadow conditions,. IEEE Trans. Ind. Electron., vol. 56, no. 5, pp. 1548.1556, May 2009.

3. R. Gules, J. De Pellegrin Pacheco, H. L. Hey, and J. Imhoff, \A maximum power point tracking system with parallel connection for PV stand-alone applications,. IEEE Trans. Ind. Electron., vol. 55, no. 7, pp. 2674.2683, Jul. 2008.

4. B. Liu, S. Duan, and T. Cai, \Photovoltaic dc-building-modulebased BIPV system: Concept and design considerations,. IEEE Trans. Power Electron., vol. 26, no. 5, pp. 1418.1429, May 2011.

5. W. Xiao, N. Ozog, and W. G. Dunford, \Topology study of photovoltaic interface for maximum power point tracking,. IEEE Trans. Ind. Electron., vol. 54, no. 3, pp. 1696.1704, Jun. 2007.

6. L. Zhang, K. Sun,Y. Xing, L. Feng, andH.Ge, \A modular gridconnected photovoltaic generation system based on DC bus,. IEEE Trans. Power Electron., vol. 26, no. 2, pp. 523.531, Feb. 2011.

7. S. M. Chen, K. R. Hu, T. J. Liang, L. S. Yang, and Y. H. Hsieh, \Implementation of high step-up solar power optimizer for DC micro grid application,.inProc. IEEE Appl. Power Electron Conf., Feb. 2012, pp. 28.32.

8. A. Pratt, P. Kumar, and T. V. Aldridge, \Evaluation of 400 V DC distribution telcom and data centers to improve energy efficiency,. in Proc. IEEEInt. Telecomm. Energy Conf., Sep./Oct. 2007, pp. 32.39.

9. L. Zhang, K. Sun,Y. Xing, L. Feng, andH.Ge, \A modular gridconnected photovoltaic generation system based on DC bus,. IEEE

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ISSN : 2799-18

Trans. Power Electron., vol. 26, no. 2, pp. 523.531, Feb. 2011.

10. S.M. Chen, T. J. Liang, L. S. Yang, and J. F. Chen, \A boost converter with capacitor multiplier and coupled inductor for AC module applications,.IEEE Trans. Ind. Electron., Early Access Articles, vol. PP, no. 99, p. 1.