Singaporean Journal of Scientific Research

Singaporean Journal of Scientific Research(SJSR)
Journal of Selected Areas in Microelectronics (JSAM)
Vol.8.No.2 2016 Pp.88-93
available at :www.iaaet.org/sjsr
Paper Received : 08-03-2016
Paper Accepted: 19-04-2016
Paper Reviewed by: 1.Prof. Cheng Yu 2. Dr.M. Akshay Kumar
Editor : Dr. Chu Lio

ANALYSIS OF WIND AND PV ENERGY SYSTEM WITH CUK AND SEPIC CONVERTERS USING FOINC MPPT TECHNIQUE

P.Panneer Selvam
PG Scholar,
Electrical and Electronics Engineering,
Government College of Engineering,
Salem, Tamil Nadu, India.

Dr.D.Murali[2]
Assistant Professor,
Electrical and Electronics Engineering,
Government College of Engineering,
Salem, Tamil Nadu, India.

ABSTRACT

This paper presents a new system configuration of the front-end rectifier stage for a combination of wind and photovoltaic energy system. As the power demand increases, power failure also increases. So, renewable energy sources can be used to supply constant loads. Hybridizing solar and wind power sources provide a realistic form of power generation. In this topology, the wind and solar energy sources are incorporated together using a combined with Cuk and SEPIC converters. This combination gives the two sources to supply the load separately or simultaneously which source is available. The fused multi-input rectifier stage also allows Maximum Power Point Tracking to be used for getting maximum power from the sun when it is available. A Fractional Order Incremental Conductance (FOINC) algorithm is used for the PV system. The average output voltage produced by the system is the adding the two inputs of these systems. The advantages of the proposed combination system make it highly efficient and reliable. Simulation results are given to highlight the merits of the proposed system.

Index Terms—*FOINC MPPT, Cuk converter, PV and wind source, SEPIC converter* .

I. INTRODUCTION

Solar energy and wind energy are the two renewable energy sources most common in use. Wind energy is one of the less expensive renewable energy technology in existence. Photovoltaic cells convert the energy from sunlight to DC supply voltage. PVs offer added advantages over offer renewable energy sources in that they give off no noise and practically require no maintenance. The Combined system of solar and wind power sources provide a realistic form of power generation. When a source is unavailable or insufficient in meeting the load demands, the alternative energy source can be meet the load demand difference. Huge hybrid wind/PV power systems with Maximum Power Point Tracking (MPPT) control system have been presented earlier. In the previous system is used an individual DC/DC buck and buck-boost converter connected in fusion in the rectifier stage to perform the MPPT control for each of the renewable energy power sources. This system requires some input filters to remove the high-frequency current harmonics injected into wind turbine generations. The harmonic content in the generation current decreases its lifespan and increases the power loss due to heating. In this system, two energy sources are incorporated together using a combination of Cuk and SEPIC converters and these converters are controlled by using (FOINC MPPT),If one of the source is unavailable, the another source can meet for the load demands. The combined converters had the capability to eliminate the HF current harmonics from wind generator. This eliminates the need for passive input filters in the system.

The two converters can perform both step up and step down operations for each renewable energy sources. They can also support individual and simultaneous operations. The Solar energy source is the input to the Cuk converter, wind energy source is the input to the SEPIC converter. The output voltage of the system will be the adding the two inputs of these systems.

II. DC-DC CONVERTERS

DC-DC converters is one of most common switching mode regulators to convert an unregulated magnitude dc voltage to a regulated magnitude dc output voltage. The voltage regulation is normally achieved by PWM at a fixed frequency and the switching components is generally MOSFET, IGBT,BJT

A. Cuk converter

This is one of the type of DC-DC converter and its output voltage is either greater than or less than the input voltage. It provides the negative output voltage. This converter always works in the continuous conduction mode. The Cuk converter operates when M1 is turned on, the diode D1 is reverse biased, the current in both L1 and L2 increases and the power is delivered to the load. When M1 is turned off, D1 becomes forward biased and the capacitor C1 is recharged.

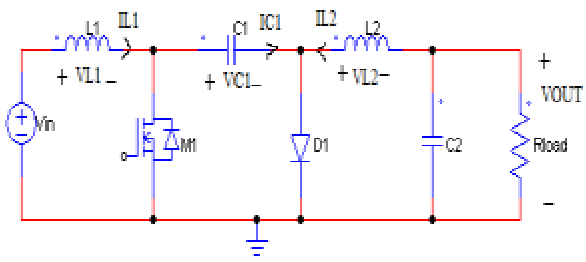

Figure1: Cuk converter

B. SEPIC converter

SEPIC converter is a type of DC-DC converter allowing the voltage at its output to be a higher than the input or lower than the input, or equal to that at its input. It is similar to a buck- boost converter. It has the capability for both steps up and step down operation. The output polarity of the converter is positive with respect to the common terminal.

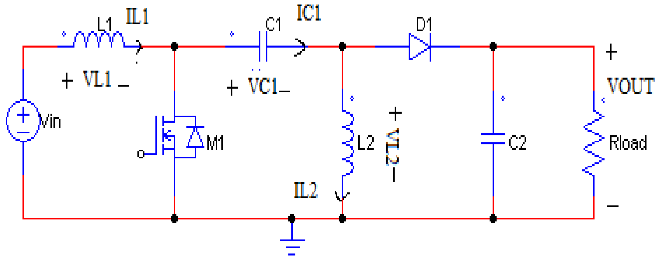

Figure 2: SEPIC Converter

The capacitor C1 blocks any DC current path between the input and the output. The anode of the diode D1 is connected to a defined potential. When the switch M1 is turned on, the input voltage, Vin appears across the inductor L1 and the current IL1 increases. Energy is also stored in the inductor L2 as soon as the voltage across the capacitor C1 appears across L2. The diode D1 is reverse biased during this period. But when M1 turns off, D1 conducts. The energy stored in L1 and L2 is delivered to the output, and C1 is recharged by L1 for the next period.

III. A.MPPT CONTROL TECHNIQUE

Maximum power point tracking method is good accuracy system for getting more efficiency of power from hybrid analysis method of wind and solar power generating schemes.

In the previous years, the traditional methods of MPPT Control techniques are used and they are having some drawbacks like complexity, taking more converging time, poor efficiency etc. The proposed method of fractional order incremental conductance method gives more efficiency of power extracted from the wind and solar generating schemes. In this method of algorithm, the fractional-order differentiator is used for signal processing, adaptive control, linear and nonlinear feedback control, active control active control. The fractional order incremental conductance as expressed as the follows:

$$\frac{d^{\alpha}I}{dV^{\alpha}} = \frac{I-\alpha I_0}{(V-V_0)^{\alpha}} \quad (1)$$

Where Vo and Io are the voltage and current captured at present and previous point in time, V and I are the variation of voltage and current in unit time, $0 < \alpha < 1$ presents the form of fractional-order derivative. However, when the method processes MPPT, the offset V_0 determines the output voltage reaching the MPP and the perturbation after the MPP is reached.

$$\frac{d^{\alpha}}{dV^{\alpha}}\left(-\frac{I_O}{V_O}\right) = \left(-\frac{1}{V_O}\right)\frac{d^{\alpha}I_O}{dV^{\alpha}} + (-I_O)\frac{d^{\alpha}V_O}{dV^{\alpha}} \quad (2)$$

The above equations give maximum voltage and current signals captured by using FONIC algorithm.the voltage and current signals are used for doing repeated iterations for the system.Duty cycle of the converters are calculated by the repeated sequence of the FOINC algorithm. The proposed algorithm is able to track the GMPP accurately and thus reduces the power losses faced by the conventional algorithm.

B. FLOW CHART FOR FRACTIONAL ORDER INCREMENTAL CONDUCTANCE ALGORITHM

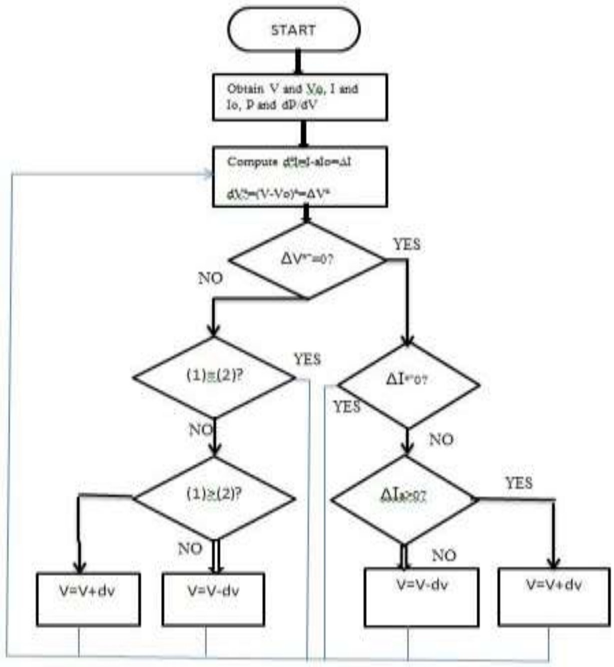

Figure 3: flow chart for FOINC

IV. PROPOSED SYSTEM

In order to eliminate the problems of stand-alone PV and wind system and meeting the load demand.so the compensation technique is to combine one or more renewable energy sources are connected as a parrell schemes to meet the load demand and the new combined system has input side converter topology with maximum power point tracking technique to meet the load. This is very opt for grid connected loads and also commercial loads. The new combined converter topology will eliminate the lower order harmonics present in the combination system.

A. Block diagram

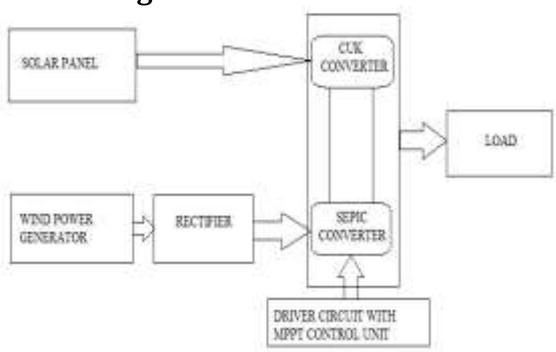

Figure 4: Block diagram of PV/Wind system

B. Circuit diagram

The solar PV system is the input to the Cuk converter and wind source is the input to the

SEPIC converter. The converters are connected together by reconfiguring the two existing diodes from each converter and the sharing the Cuk converter output inductor by means of SEPIC converter. This system allows each converter to operate individually in the system when the source is available. If the wind source is available, the combined system operates only SEPIC converter. When only the PV source is available, the circuit operates only a Cuk converter.

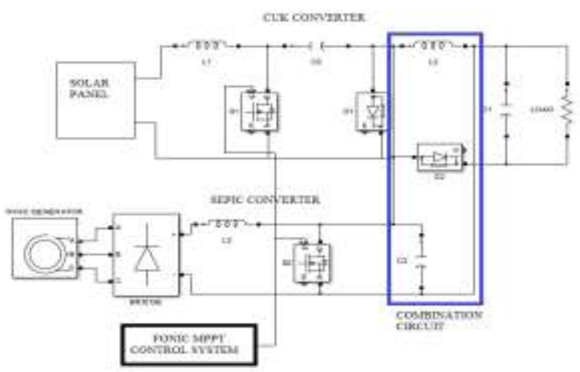

Figure 5: Combined System with MPPT Controller System

C. MODES OF OPERATION OF THE CONVERTER TOPOLOGY

a. MODE 1: WHEN M2 IS ON AND M1 IS OFF (SEPIC OPERATION)

When M2 is on condition, in the combined system, Wind source energy will compensate the load by a SEPIC converter operation. The wind energy will produce the Ac power, Then this Ac power converted to dc power by using the rectifier. The rectified dc power will be stored in battery, and feed to the load. Normally the SEPIC converter will be triggered at 50% of the duty cycle.

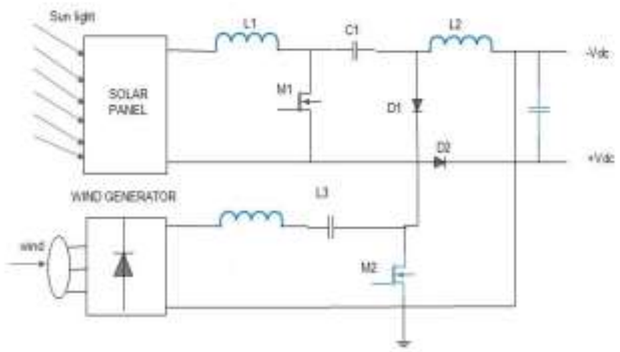

Figure 6: SEPIC operation

b. MODE 2: WHEN M1 IS ON AND M2 IS OFF (CUK OPERATION)

When the switch M1 is turn on condition the combined system of solar energy will meet the load by a Cuk converter operation. The solar energy will produce the dc power; the dc power will stored the battery, and directly feed to the load. Normally the CUK converter will be triggered at 50% of the duty cycle by using the maximum power point tracking controller to meet the load demand.

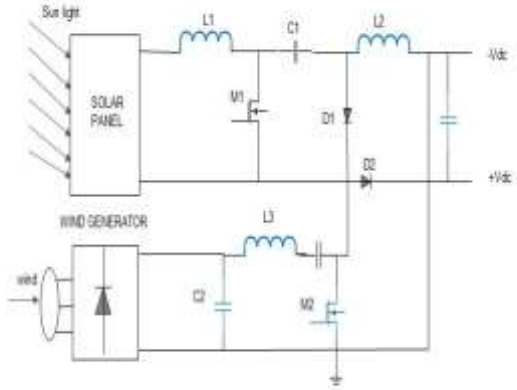

Figure 7: Cuk operation

C. Both Wind and PV Sources

If the turn-on a duration of M1 is longer than M2, then the converter operates in state I, III and IV and if the turn-on the duration of M2 is longer than M1, then the converter operates in state I, II and IV. To provide a better explanation, the inductor current waveforms of each switching state are assumed that the d2 > d1; so,here only states I, III, IV are discussed in this example. In the following, Ii is the RMS input current after the rectifier (wind case); and Idc is the output current of the system. The output waveforms are illustrated by the switching states in this example are shown in Figure 7. The input voltage of Cuk converter is 12V, and the output voltage is 34 V. The SEPIC converter input voltage is 12 V and the output voltage is 37 V. while combining the Cuk and SEPIC converter, the input voltage is 24 V and the output voltage is 42 V.

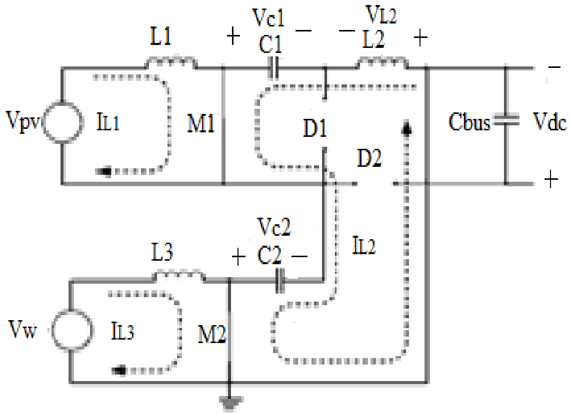

Figure 7(a): M1 ON, M2 ON

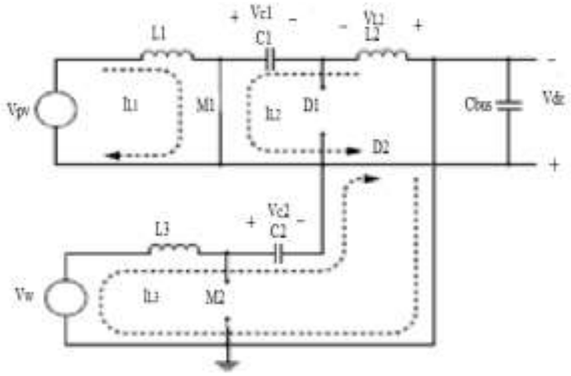

Figure 7(b): M1 ON, M2 OFF

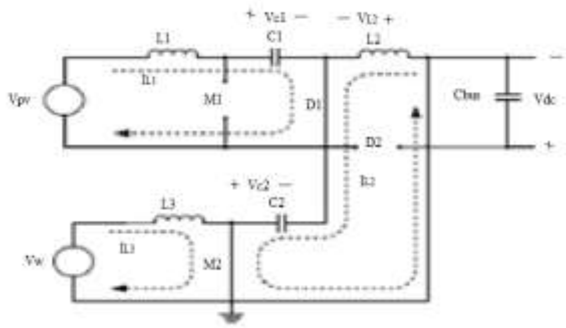

Figure 7(c): M1 OFF, M2 ON

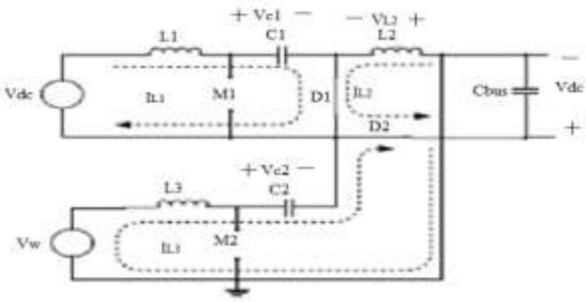

Figure 7(d): M1 OFF, M2 OFF

V. SIMULATION RESULTS

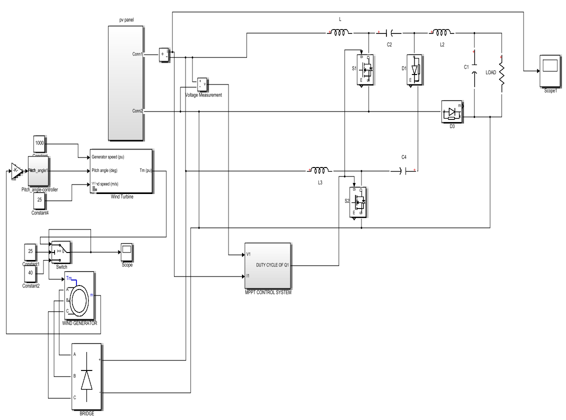

Figure 8: Matlab simulation for wind/PV system

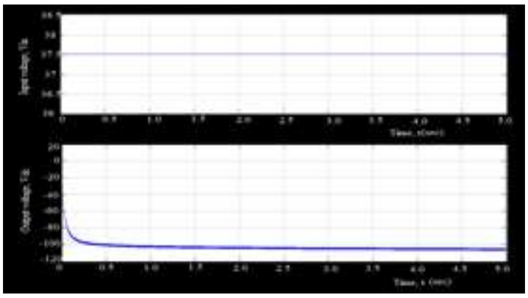

Figure 9: DC Output Voltage Waveform of Solar Energy System in Boost mode

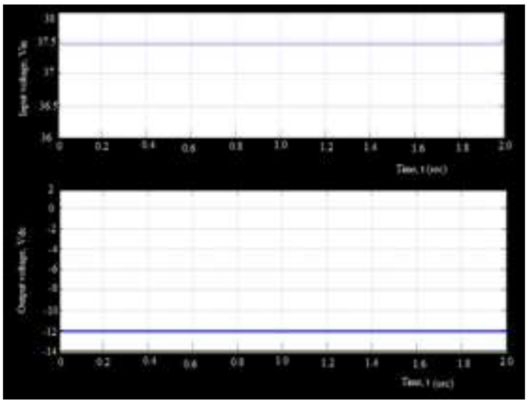

Figure 10: DC Output Voltage Waveform of Solar Energy System in Boost mode

VI. CONCLUSION

In this paper, a new multi-input Cuk-SEPIC rectifier stage for hybrid wind/solar energy system has been presented. The simulation of both Cuk and SEPIC converters are carried out in Matlab/Simulink platform. The time domain analysis output results demonstrate that the SEPIC converter shows improved dynamic performance compared to Cuk converter in terms of increased output voltage. It can support step up/step down operations for each renewable source. Both converters are efficiently used to improve the system efficiency and voltage profile and no need to add the input filters to filter out high order frequency harmonics. Here FOINC MPPT has been realized for each source and also Individual and simultaneous operations are supported.

REFERENCES

[1] Divya Teja Reddy Challa, Raghavender Inguva (2012), "An Inverter Fed with Combined Wind-Solar Energy System Cuk-SEPIC Converter," International Journal of Engineering Research and Technology Vol.1, No. 9.

[2] Arun, Teena Jacob (2012), "Modelling of Hybrid wind and Photovoltaic Energy System using New Converter Topology," Electrical and Electronics Engineering: An International Journal Vol.1, No.2.pp.

[3] P. Chidambaram, N. Subramani (2012) Modelling and Simulation of Hybrid Wind-Solar energy system using CUK-SEPIC Fused Converter," International Journal of Communications and Engineering Vol 03, No. 3.pp.378-383.

[4] Rlos A. Canesin, Senior Member, Leonardo P. Sampaio, Luigi G. Jr., Guilherme A. e Melo and Moacyr A. G. de Brito (2012) "Evaluation of the Main MPPT Techniques for Photovoltaic Applications", International Electrical and Electronics Engineering .pp.10505-10511

[5] D. Das and S. K. Pradhan (2011), "Modelling and Simulation of PV Array with Boost Converter: An Open Loop Study", National Institute Of Technology, Rourkela.

[6] A. Bakhshai et al. (2010) , "A Hybrid Wind – Solar Energy System: A New Rectifier Stage Topology", IEEE Magazine.

[7] Chiang.S.J, Hsin-JangShieh, Member, IEEE, and Ming- Chen: (2009) "Modelling and Control of PV Charger System with SEPIC Converter", IEEE Transactions on Industrial Electronics, Vol.56, No.11.

[8] G. Adrian and D. C. Drago (2009) , "Modelling of renewable hybrid energy sources", Scientific Bulletin of the Petru Maior University of Tirgu Mures, Vol. 6.pp.1146-1150.

[9] E. Koutroulis and K. Kalaitzakis (2006), "Design of a Maximum Power Tracking System for wind energy Conversion Applications", IEEE Transactions on Industrial Electronics, Vol. 53.pp.486-494.

[10] D. Das, R. Esmaili, D. Nichols, L. Xu (2005) , " An Optimal Design of a Grid Connected Hybrid Wind/Photovoltaic/Fuel Cell System for Distributed Energy Production," in Proc. IEEE Industrial Electronics Conference, pp. 2499-2504.

[11] R. Billinton and R. Karki (2001) "Capacity Expansion of Small Isolated Power Systems Using PV and Wind Energy", IEEE Transactions on Power Systems, Vol. 16.pp.6702-6709.