Design of SEPIC Converter Fed Brushless DC Motor CUM Solar PV Array

K. Sundararaju*, P. Ranjani
Department of EEE, M. Kumarasamy College of engineering, Karur, Tamil Nadu, India
***Corresponding author: E-Mail: sunkrr@gmail.com**

ABSTRACT

This paper deals with the design of the SEPIC converter (single ended primary inductance converter) is connected to Brushless Direct Current motor through VSI (voltage source inverter). The SEPIC converter values have been designed based upon the transfer function and the input is get from the Renewable Energy Source as Solar PV cells. The Maximum power should be extracting by using perturb and observe technique. The ripples should be reduced by the low pass filter. The result should be obtained from the MATLAB/ SIMULINK software.

KEY WORDS: Maximum Power Point Tracking (MPPT), Single Ended Primary Inductance Converter (SEPIC), Photo Voltaic cells (PV cells), Voltage Source Inverter (VSI), Perturb & Observe (P&O).

1. INTRODUCTION

The invention of combustion engine initiated to use the petroleum based products to fulfil our power demands. The use of energy plays a important role in one's life. Since the usage of energy had become more important in our life, its source and supply will be safe and sustainable. It should be economically, natural eco-friendly & generally acceptable one. The recent trends in power consuming methods are not suitable and not sustainable. The increasing usage of fuel products from fossils and respective prices, it tends to increase in ozone layer depletion, lurks our energy demands. Therefore for the clean environment, safety, sustainable, renewable energy sources should be the main objective of our century.

To get the maximum power the tracking is important in a PV array and it is vital part of a PV system. Now many Maximum power point techniques had been implemented and executed. The techniques had been vary in design, availability of sensors, cost, high speed, popularity, the length of effectiveness, and hardware implementation on real time application and in other expects. The range of the panel should be the most resourceful. The number of methods had been implemented in that more methods are become tough to apply for getting maximum power, the proposed system will be is more suitable for the PV module (Lian, 2014). The paper based on solar Photo Voltaic cell with MPPT has grown significantly of the last decades and remains strong.

The SEPIC converter is used to produce output voltage either increase or decrease in input voltage without inverting the polarity (Paz, 2014; Sera, 2013). The VSI which is used to convert the direct current to alternating current will produce either two or three level based on the modes of operation. The output of voltage source inverter has high harmonics distortion. Increasing the voltage levels will decrease the harmonics.

However a DC motor is not preferred because the frequent maintenance is required for commutation and brushes are used. Now-a-days Brushless DC motor becomes more popular by the advantages of high efficiency, high power density, compact size, high ruggedness, low maintenance requirements, brushless direct current motor can able to run at high asynchronous speed. The electronically commutated brushless dc motor is supplied by voltage source inverter is operated in fundamental frequency used to reduce the switching losses. It has a three phase winding on the stator which are excited by a voltage source inverter and it is electronically commutated the power electronic switches are used in the stator part which get pulses from hall sensor, the main purpose of sensor to sense the rotor rotating position. By using these the problems are sparking, electro- magnetic interference, noise interference can be eliminated.

2. PROPOSED SYSTEM CONFIGURATION

Solar PV Cell: The Photo voltaic modules have the irregular current- voltage flow characteristics, and the maximum power (i.e the conducting point for the Photo Voltaic generation) will differ under a particular time period. The Solar Panel consist of number of cells and is basically a p-n junction semiconductor is fabricated in a thin wafer or in thin layer in can be designed. By the photo voltaic effect the current (electricity) can be directly converted it from the solar radiation. The radiation occurs the electrons in silicon wafer or layer it can scattered in different places by changing the places of electrons (i.e the movement of electrons from one place to another the current can be produced) (Brito, 2013). The electric field of the p-n junction is create the electric current and is directly proportional to the insolation. The Photo Voltaic system is normally will produce the different P-V and I-V characteristics because of the different temperature and climatic conditions will differ in regular interval.

Maximum Power Point Tracking:

Perturb & Observe: The maximum power will be get by the MPPT technique in that the hill climbing method is more useful and easy compare to the fuzzy logic and neural network. In that the more methods are used in the hill climbing method such as the constant current method, perturb and observe method and the incremental conductance. The Perturb is nothing but the disturbance and observe is nothing but the observation by varying the voltage the

changes have done in the PV panel that should be observed and make calculation and these algorithm involves a disturbance in the voltage and the duty ratio of the power will be recorded and calculated based upon the present value and previous value, so that we are getting the power. If we getting the power value we can make the PV curve and the IV curve and we can check the slope for the representing curve or the conducting region will be carried out and if the changes happen in D (duty ratio) it will affect the direction, so that the conducting region (maximum power point) will get clear PV characteristics.

If the system oscillates the maximum power point also will get oscillate (Mojiri, 2013; Kwon, 2006). These oscillations can be reduced by controlling the step size of disturbance (i.e. perturbation). Thus the small disturbance will shows the process of Maximum power point tracking technique, by using modified Perturb and the Observe algorithm will reduce the drift size compared to the normal Perturb and the Observe algorithm because it will sense the power, voltage, current on every duty cycle.

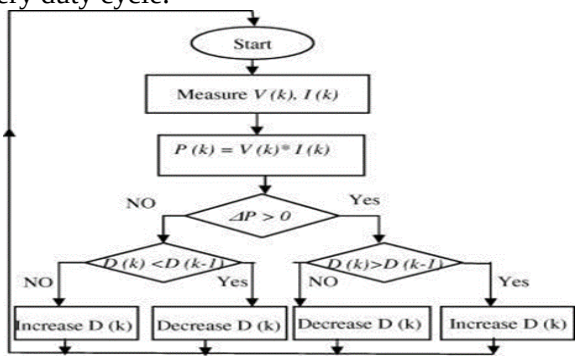

Figure.1. Flowchart for P&O MPPT Algorithm

Circuit operation:

SEPIC converter: The buck converter and boost converter are the basic DC-DC Converter in which the single-ended primary-inductance converter (SEPIC) is one of the DC-DC converter the special function in these converter is in normal converter either we can reduce or increase the input but in single ended primary inductance converter we can do both functions (Kjaer, 2005). The pulse is given to the power semiconductor switch in order to control the output of the SEPIC converter. The SEPIC converter is basically derived from the boost type converter in which inductance is placed in the input side and it shows similar to the olden days BUCK- BOOST converter, the another advantage of using the SEPIC converter is having same polarity at the output side so the output will be get from the positive side. And if the power semiconductor switch is turned off the voltage will be drop to Zero volt, the circuit diagram for the circuit diagram shown in Figure.2.

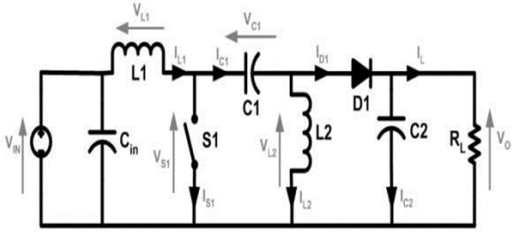

Figure.2. Circuit Diagram of SEPIC Converter

Mode-1: The Metal Oxide Semiconductor field Effect Transistor switch S1 is turned on, the current will get absorb by the inductance L1 and the L2 will be more negative. The inductance L1 will get more power because of in input side. The switch S1 is a partially closed, the polarity must be same because of same voltage that is input voltage as same as Vin in L1, then the voltage from the inductance in L2 will be opposite polarity –VL2 (Bist, 2015). Then the capacitor C2 will store the energy and if supplies if the switch is turn off to increase the magnitude of the current of inductance L2.

Mode-2: Then the MOSFET switch will turn off the current of C1 will be same as the input. And also the inductance will not allow the changes of current regularly. The reverse current will flow so that it moves in reverse direction because of the conducting flow by the diagram we can see the flow of current. By the Kirchoff's current law we can prove that *I*D1 = *I*C1 - *I*L2. Thus we can conclude that switch S1 is turned off (Saranya, 2016), the power will be go to load by the discharge of inductance L1 and L2.

BLDC Motor: A brush less and commutator less dc motor is defined as the permanent magnet synchronous motor with the feedback which is get from the rotor position. The brushless direct current motors are mainly controlled by using the three phase full bridge converter. The motor requires the initial speed and the rotor will get rotate the sensor used to sense the rotor position for starting and it provides the proper commutation order to make turn on the converter devices in the circuit. Based on the position of the rotating part, for every sixty degree the switches are commutated regularly. In case of using the brushes for commutating the armature current it will need the regular maintenance, now-a-days the electronically commutation method is used to avoid the regular

maintenance. The problems that raised based on the brushes and the communication, for example, the spark and short circuit will happen in the brush arrangement, so that the making of Brush less direct current motor is more useful than the DC motor.

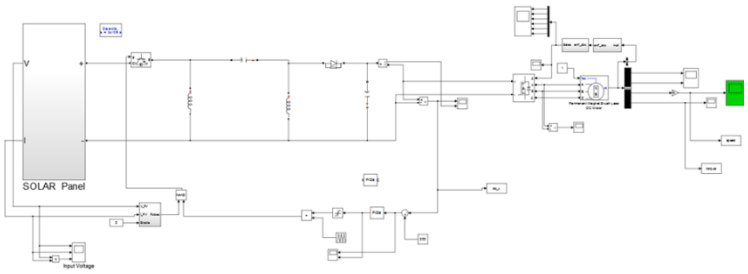

Figure.3. Simulation Diagram

3. RESULT

Panel Output:

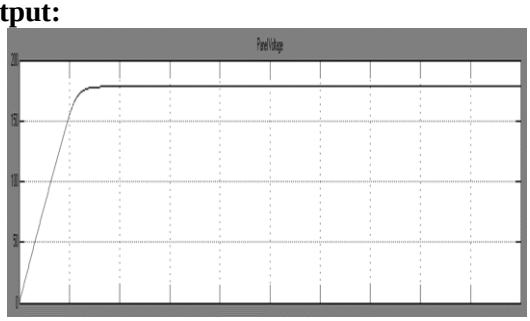

Figure.4. Panel Voltage

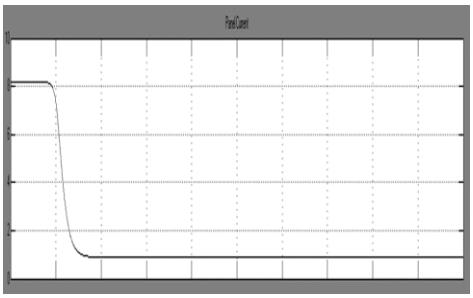

Figure.5. Panel Current

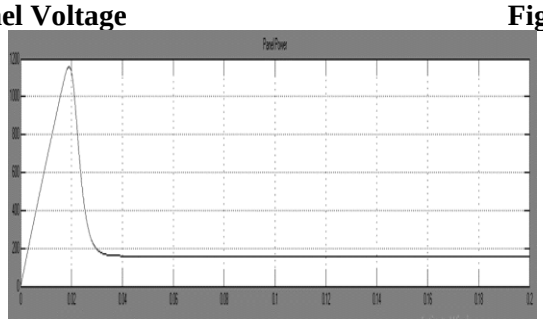

Figure.6. Panel Power

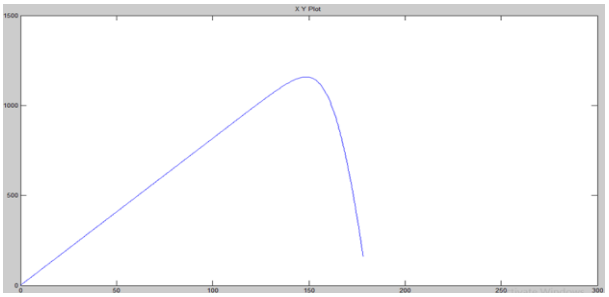

Figure.7. Panel PV characteristics

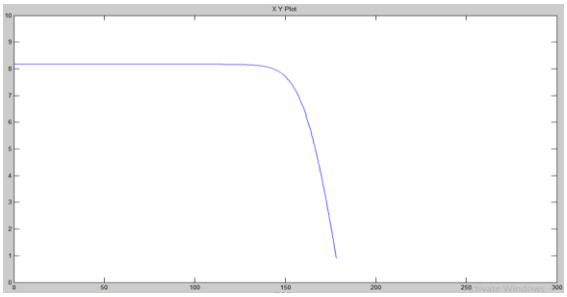

Figure.8. Panel VI characteristics

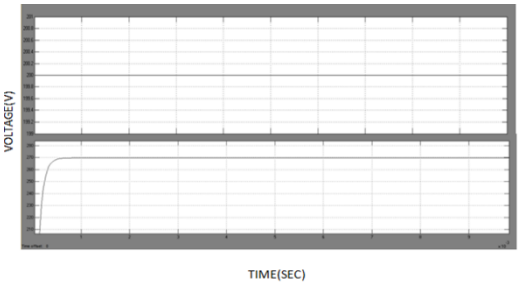

Figure.9. Input and Output of SEPIC converter

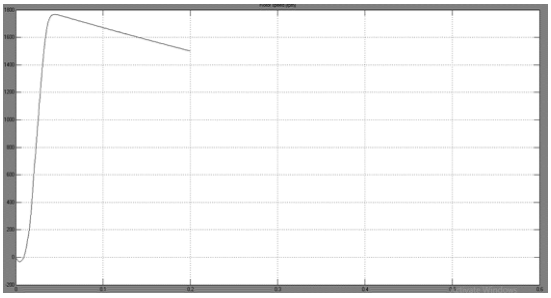

Figure.10. output of speed vs time

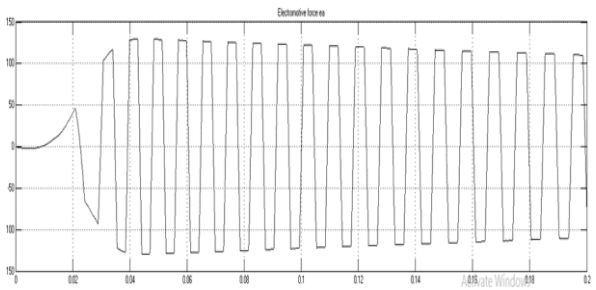

Figure.11. output of Back Emf vs Time

4. CONCLUSION

The Single Ended Primary Inductance Converter has been designed based upon the rating of the load i.e. BLDC motor. The output parameters such as panel output voltage, panel output current, SEPIC output voltage, speed, torque, back Emf taken by using MATLAB/SIMULINK software. Thus the value of SEPIC is identified by using the transfer function. The output should be get either from buck or boost mode it should be under the rated value.

REFERENCE

Banumathi S, Chandrasekar S, Aging effect on Partial Discharge Characteristics of Olive oil as an Alternative Liquid Insulating Medium, Research Journal of Applied Sciences, Engineering and Technology, 9 (9), 2015, 745-754.

Banumathi S, Chandrasekar S, Analysis of Breakdown Strength and Physical Characteristics of Vegetable Oils for High Voltage Insulation Applications, Journal of Advances in Chemistry, 12 (16), 2016, 4902-4912.

Banumathi S, Chandrasekar S, Analysis of Partial Discharge Characteristics of Olive and Castor Oil as Dielectric Medium for HV Applications, International Review of Electrical Engineering, 8 (8), 2013, 1882-1889.

Banumathi S, Chandrasekar S, Montanari GC, Investigations on PD Characteristics of Vegetable Oils for High Voltage Applications, Proceedings of IEEE 1st International Conference on Condition Assessment Techniques in Electrical Systems (CATCON 2013), IEEE Explorer, 2013, 191-195.

Bist V and Singh B, A Unity Power Factor Bridgeless Isolated Cuk Converter fed Brushless DC Motor Drive, IEEE Transaction on Industrial Electronics, 62 (7), 2015, 4118-4129.

Brito M.A.G, Galotto L, Sampaio L.P, Melo G.A and Canesin C.A, Evaluation of the main MPPT techniques for photovoltaic applications, IEEE Transactions on Industrial Electronics, 60 (3), 2013, 1156–1167.

Gouthaman J, Bharathwajanprabhu R, Srikanth A, Automated urban drinking water supply control and water theft identification system, Students Technology Symposium (Tech Sym), IEEE, 2011, 87-91.

Karthikeyan R, Chenthur Pandian S, A Novel 3-D Space Vector Modulation Algorithm for Cascaded Multilevel Inverter, International Review of Electrical Engineering, 6 (7), 2011.

Karthikeyan R, Chenthur Pandian S, Generalized space vector PWM algorithm for minimizing THD in hybrid multilevel inverters, International Review of Electrical Engineering, 6 (5), 2011, 2094-2099.

Karthikeyan R, Pandian SC, An efficient multilevel inverter system for reducing THD with Space Vector Modulation, International Journal of Computer Applications (0975-8887) , 23 (2), 2011.

Kjaer S, Pedersen J, Blaabjerg F, A review of single-phase grid connected inverters for photovoltaic modules, IEEE Transactions on Industry Applications, 41 (5), 2005.

Kwon M, Nam K.H, and Kwon B.H, Photovoltaic power conditioning system with line connection, IEEE Transactions on Industrial Electronics, 53 (4), 2006, 1048 – 1054.

Lian K.L, Jhang J.H and Tian I.S, A maximum power point tracking method based on perturb-and-observe combined with particle swarm optimization, IEEE Journal of Photovoltaic, 4 (2), 2014, 626–633.

Mojiri M, Safaee A, Walseth J.A, Khajehoddin S.A, Jain P, Bakhshai, A New Phase-Locked Loop System for Three-Phase Applications, IEEE Transactions on Power Electronics, 28 (3), 2013.

Paz F and Ordonez M, Zero oscillation and irradiance slope tracking for photovoltaic MPPT, IEEE Transaction Industrial Electronics, 61 (11), 2014, 6138–6147.

Saranya S.K, Gowtham Raj T, Ranjani P, THD Analysis in Three Phase-Three Level VSI with MPPT Tracker and SEPIC Converter for Solar PV Array, Journal of Advanced Chemistry, 12 (16), 2016, 4895-4901.

Sera D, Mathe L, Kerekes T, Spataru S.V and Teodorescu R, On the perturb-and-observe and incremental conductance MPPT methods for PV systems, IEEE Journal of Photovoltaics, 3 (3), 2013, 1070–1078.

Sundararaju K, Nirmal Kumar A, European, Control analysis of STATCOM, with enhanced methods for compensation of load variation, Journal of Scientific Research, 53 (4), 2011, 590-597.

Udhayashankar R, Rani T, Gowthamraj T, comparative analysis of cuk and luo converter fed bldc motor, International journl of applied engineering research, 10 (88), 2015, 68-72.

Uma J, Jeevanandham A, Conventional Controller Design for Switched Reluctance Motor Drives, International Journal of Computer Applications, 134 (7), 2016, 38-42.

Uma J, Jeevanandham A, Indirect Position Estimation of Switched Reluctance Motor based on Flux Sensing Method, International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, 4 (12), 2015.

Uma J, Jeevanandham A, Investigations of Fuzzy Logic Controller for Sensorless Switched Reluctance Motor Drive, IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE), 11 (1), 2016, 30-35.