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Single Phase Grid Connected PV System Using Landsman Converter with MPPT Algorithm

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Abstract- As the increase in population and industrialization, the energy generated is not sufficient enough to meet the energy demand by using non-renewable energy resources such as fuel and coal. It also polluted the environment and they are also responsible for increasing carbon emission, global warming, acid rain and other health hazardous issues. They are now on the path of extinction. So, to meet the energy demand we have to move towards renewable energy resources such as wind and solar which are freely available, less maintenance cost and pollution free. The use of renewable resources is very convenient and efficient as they can be used in large as well as the small-scale production of energy. The balance between non-renewable as well as renewable resources will bring a drastic change in future in the production of energy. The DC-DC converters are widely used in renewable energy system as well as industrial drives applications. It's necessary to maintain constant output voltage. The buck-boost and have inverse polarity voltage and output current while SEPIC converter and Zeta Converter current and voltage had the same polarity as the input but its current is discontinuous. The Smallest ripple current and voltage at output side occurred in Zeta converter. To overcome the above mention disadvantages the Landsman converter is recommended for variable torque and Power Factor Correction purpose. The Landsman Converter performs power factor correction and DC voltage control in single stage utilizing just a single controller. It is controlled using single sensed entity to achieve the robust regulation of DC-link voltage as well as to ensure the unity power factor operation. Another technique used in this project is MPPT technique which could improve the efficiency of the system.

I. INTRODUCTION

In this project, an advance DC- DC Landsman Converter is used for a photovoltaic (PV) power-generation system. The topology used raises the efficiency for the dc/dc converter of the PV power conditioning system (PVPCS), and it minimizes switching losses by adopting INC MPPT. The load characteristics can give the highest power transfer efficiency changes, as the amount of sunlight varies. The efficiency of the system is optimized to keep the power at a high efficiency. The process of finding this point is known as MPPT.

The proposed controller scheme utilizes PWM techniques to regulate the output power of dc-dc converter at its maximum possible value. This converter is able to turn on both the active power switches at zero voltage to reduce their switching losses and evidently raise the conversion efficiency. Output of DC-DC converter is given to Single Phase inverter which maintain sinusoidal output with less harmonic distortion and it is injected in the PCC. The resulting system has high-efficiency, lower-cost, very fast-tracking speed. The circuit will be simulated using MATLAB Simulink and hardware is developed with DSPIC30F4011 controller.

II. MATERIALS AND METHODS

A solar panel is connected as an input source. Voltage and Current sensors are connected to the solar panel and the corresponding values are given to MPPT controller. The MPPT works on Incremental conductance Algorithm method. There were also available of several type of Algorithm methods and are widely used. The landsman converter is connected with MPPT controller and the switching operation is performed by the gate driver circuit. The single-phase inverter is connected along with landman converter and a load resistor is given across. The PWM generator is used to produce signals and to adjust the duty cycle so that the corresponding values can be taken for graphical representation.

- INTERFACING PV PANNEL AND MPPT

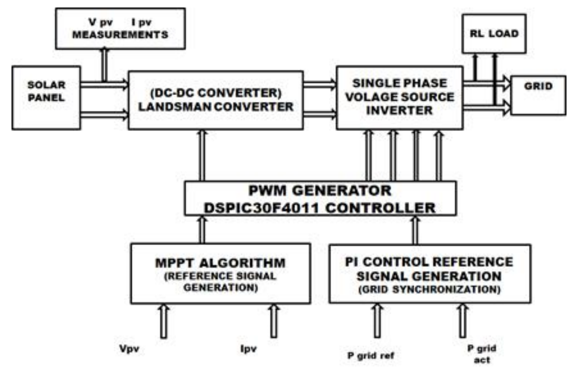
The current and voltage sensors are connected with the solar panel and corresponding values are given to MPPT controller. The MPPT works on Incremental conductance Algorithm Method. The MPP is tracked by searching the peak of the P-V curve. This algorithm uses the instantaneous conductance I/V and dI/dV for MPPT. Using these two values, the algorithm determines the location of the operating point of the PV module in the P-V curve. Incremental Conductance method determines the radiation direction to do voltage changing under rapidly changing condition; in addition, it also calculates the MPP. Thus, oscillation problem of P&O algorithm around MPP would have been eliminated.

Incremental Conductance method was determined to operate with more efficiency under randomly generated conditions. However, the cost of INC method is high due to requirements of high sampling compliance and speed control as a result of complex structure.

- INTERFACING MPPT WITH LANDSMAN CONVERTER

The MPPT controller is connected with Landsman converter. The Landsman converter, acting as an interface is operated by the execution of INC-MPPT algorithm in order to extract the maximum power available from the PV array. A converter acts as an interface between the SPV array and Voltage Source Inverter (VSI). The Landsman converter is designed to operate in CCM irrespective of the variation in irradiance level.

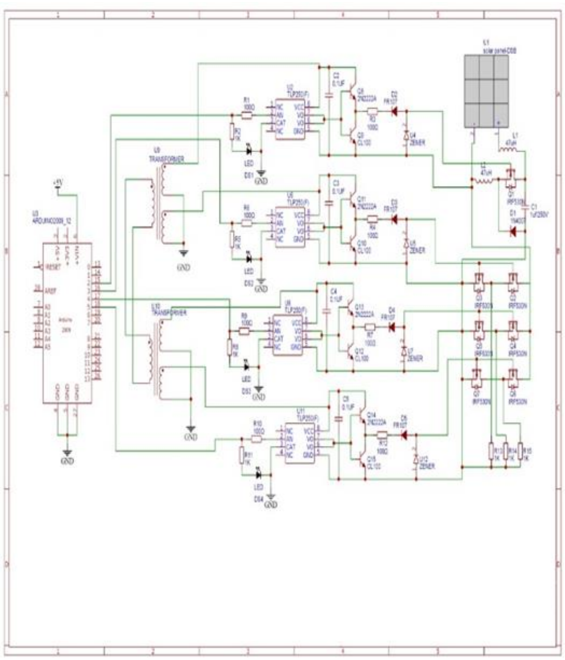
The input DBR is eliminated by two Landsman converters, which operates in parallel during the positive half line and negative half line, separately. Therefore, the conduction losses are reduced to half due to reduced number of components conducting in one switching cycle. For improved performance-based switching, two converters, in synchronization, are switched at 20 kHz. The currents in output inductor Lop and Lon are designed to become discontinuous over one switching cycle, during the positive half line and negative half line operation. Therefore, the simplicity in control is achieved due to single sensor used to sense the intermediate output voltage.



III. WORKING

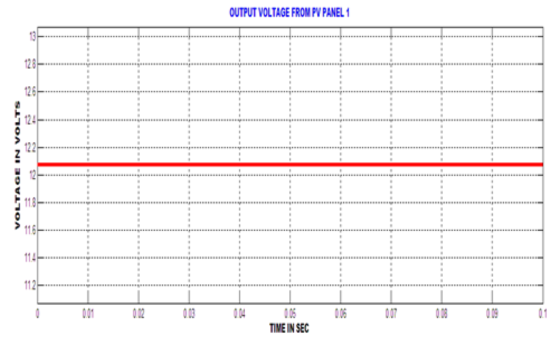
The Solar input is connected to MPPT controller. The MPPT controller tracks and extract the maximum power output. The proposed Landsman converter, at the first stage, is slightly modified than that reported in by rearranging the input and output side inductors. The proposed modification offers the advantage of low input current ripple, due to continuous conduction (CCM) of input inductors Lip, n as well as the benefit of low output current ripple with the conventional Landsman topology is retained in proposed topology. Two parallel converters operate in synchronization, and, in discontinuous region (DCM mode) in the respective half cycles of mains voltage to improve the power factor to unity. The DCM operation, offers the inherent benefits of low cost and simplicity in the circuit owing to the use of single sensor at the output stage.

A voltage follower based proportional and integral (PI) controller is used, effectively, to regulate the intermediate DC link voltage of the charger. However, the flyback converter at the second stage, designed based on, is controlled using dual loop PI controller. The battery current is regulated corresponding to 60% state of charge (SOC) to 100% SOC with the simple PI control during the conditions of constant current and constant voltage mode charging. A small input inductor of the Landsman converter acts as an input-ripple filter, eliminating the external ripple filtering. This inductor also damps the oscillation occurred, due to the snubbed elements of insulated gate bipolar transistor (IGBT) module, in the current through the module. The Landsman converter is designed to operate always in continuous conduction mode (CCM) irrespective of the variation in irradiance level, resulting in a reduced stress on its power devices and components. The switching operation of MOSFET is controlled by Gate driver circuit. The gate driver circuit Operates ON and OFF signal based on timer. The function of the gate driver is controlled by PI controller. Resistors are connected as load across the landsman converter so that the output value can be verified using multi-meter.



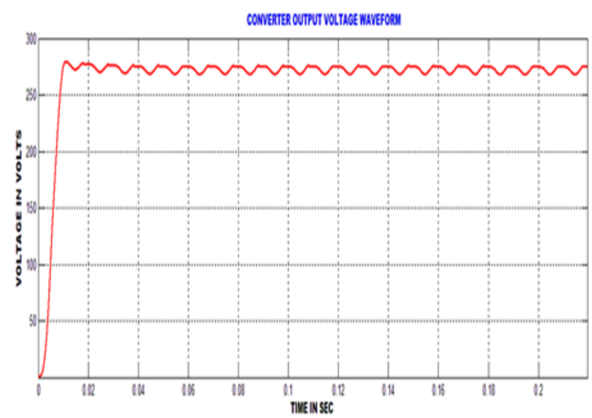
i. PV PANEL OUTPUT VOLTAGE WAVEFORM

The Voltage from the 12 V PV panel is measured using voltage sensor and corresponding stimulation is performed and output wave form is shown.

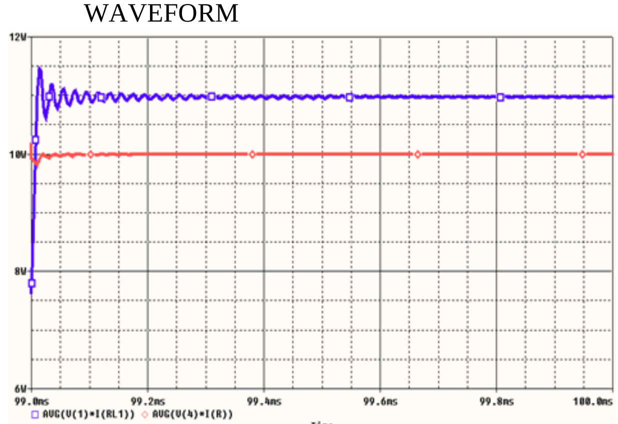


ii. PROPOSED CONVERTER OUTPUT VOLTAGE WAVEFORM

The resultant Output voltage from the landsman converter is shown below. By comparing the output voltage wave form of Landsman converter and SEPIC converter we can clearly understand that the landsman converter is much efficient and maximum output voltage is drawn.



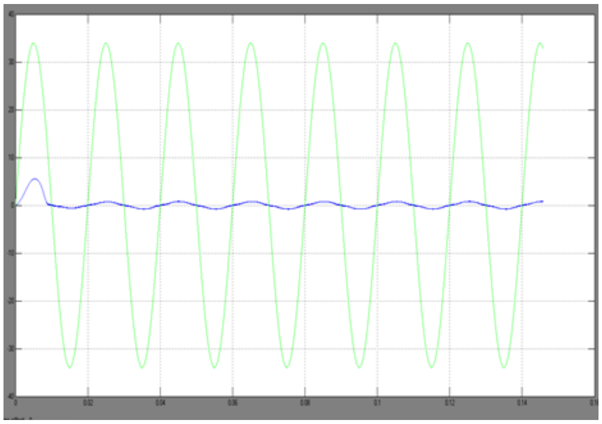
iii. SEPIC CONVERTER OUTPUTVOLTAGE WAVEFORM



This clearly shows the elimination of ripples and provides the output with much better efficiency.

iv. GRID VOLTAGE AND CURRENT WAVEFORM

The output AC that is measured across the resistor is shown. It will be further taken into account for the purpose of Grid connection in future.



IV. ADVANTAGE OF PROPOSED SYSTEM

The proposed Landsman converter, at the first stage, is slightly modified than that reported in by rearranging the input and output side inductors.

- The proposed modification offers the advantage of low input current ripple, due to continuous conduction (CCM) of input inductors Lip, n as well as the benefit of low output current ripple with the conventional Landsman topology is retained in proposed topology.
- The proposed converter is controlled using single sensed entity to achieve the robust regulation of DC-link voltage as well as to ensure the unity power factor operation.
- Two parallel converters operate in synchronization, and, in discontinuous region (DCM mode).
- The DCM operation, offers the inherent benefits of low cost and simplicity in the circuit owing to the use of single sensor at the output stage.
- A voltage follower based proportional and integral (PI) controller is used, effectively, to regulate the intermediate DC link voltage.
- The MPPT is based on INC algorithm which is entirely based on the Instantaneous and Incremental conductance to generate an error signal which is the made zero at the MPP point.
- One of the main advantages of the system was the filter size is reduced and so that it eliminates the need Of Separate input filters for PFC
- This system has high static gain at low line voltage and also shows soft commutation with simple regenerative snubber circuit

CONCLUSION

An improved DC-DC converter with Landsman converter has been proposed, analysed, and validated in this work with inherent PF Correction. The design and control of the proposed converter in CCM mode have offered the advantage of reduced number of sensors at the output. Moreover, the proposed converter has reduced the input and output current ripples due to inductors both in input and output of the converter

A prototype has been developed and operation of the converter has been verified by the experimental results under steady state input voltage. The results from the hardware validation show that the performance of proposed charger is found satisfactory for improved power-quality based charging of EV battery. Moreover, the input current THD is reduced. to meet the recommended IEC standard guidelines for power quality. Therefore, proposed converter fed charger aims at cost effective, reliable and suitable option to replace the conventional lossy and inefficient DC-DC converter.

FUTURESCOPE

In future, the maximum power extracted by this converter is planned to be synched with grid or a rectifier can be added in the circuit and the power can be stored as DC in batteries. These batteries can be later used in EV vehicles as EV batteries.

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