Power generation for remote area using PV based Stand Alone Scheme with minimum converter stages

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Abstract: Electrical power is generated by using Renewable sources and Non Renewable sources as fuel. In Conventional Methods Coal , Crude Oil where used as raw materials. Pollution and availability were the major drawback , Nowadays greater importance is given to renewable resources ,among which keen interest is shown in solar based Power generation projects. Enumerous topologies are developed in literature but the important constraint is, most of the models are developed with many converter power stages. Which increase the cost and size thereby the efficiency decreases. In this work Transformer coupled dual input Converter is proposed to rectify this deficiency. Maximum Output Power is utilized by using MPPT Control method. Thus the proposed topology confers with less components and high performance and it is validated using Mat lab simulation software

Keywords: PV source, high voltage gain, voltage doubler and ripple voltage

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Introduction

The power is generated using various resources, varyingly renewable and nonrenewable. The need of the work is to produce consistent and healthy power economically by using renewable energy resources. The best candidate to suit under this category is Solar and wind base of generation system to conclude a pollution free environment. The primary requirement for the PV based power generation is battery storage to give constant voltage and dc-dc converter for boosting the solar output voltage [1]-[2].

Domestic instruments are required 230V 50 Hz ac power supply. High dc link voltage (300V) is required to achieve this output voltage. The PV cells can be connected in series or parallel to obtain high dc link voltage. The disadvantages of Series connected PV are more power loss and complex mechanism [3]-[4]. The serial connections of 12v batteries increase the cost and size. The PV output is converted into ac with the help of inverter and stepped up by a step up transformer. The major drawback is increase in size and cost due to low frequency. In another advanced topology the voltage gain is increased by interfacing a dc-dc converter between PV and inverter [5]. To overcome power loss and poor efficiency due to more converter stages [6]. Multi winding transformer based converter is also developed for high voltage gain [7]. But this method sufFer from Excessive switching loss . For specific applications single stage Dc-Dc converter is developed [8]-[11]. But this method has some limitations such as duty cycle control and less voltage gain. To solve the above problem transformer coupled dual input converter is proposed in this paper. The proposed system has MPPT technique to achieve maximum voltage gain and high efficiency with less components count.

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II. Circuit description:

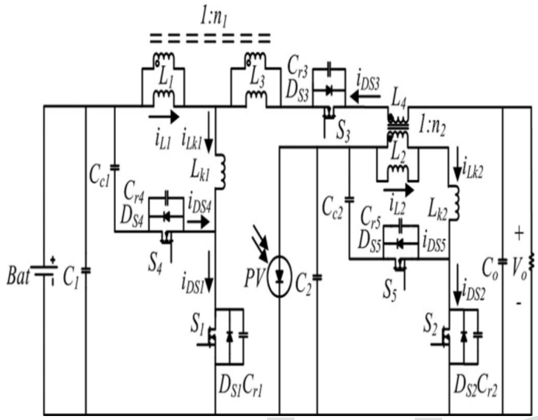

Figure 1.Conventional circuit diagram

Figure.1 shows the conventional three port converter it consist two input port and one output port. Battery and PV cells are used as an input. This circuit consist five switches and two coupled inductors. The circuit operation is explained detailed in [10]. Figure.2 shows the proposed transformer coupled dual input dc-dc converter. It consist two input port and one output port. The proposed system has less number of switching devices compare than conventional circuit diagram. It is shown that from Figure.1. The proposed circuit operation is explained in the next section.

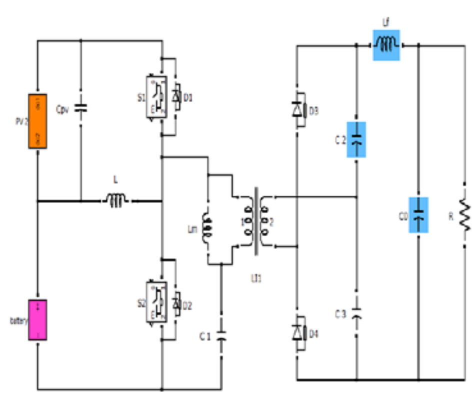

Figure 2.Proposed Circuit diagram

a. Operating principles:

Mode I:

During this mode switch s1 is turned on and PV voltage is applied to inductor. Inductor and capacitor c1 gets charging. The PV and battery voltage is present across the primary side of the transformer. In secondary side D3 becomes forward bias and capacitor C2 gets charged. The voltage across C2 is given by, Vc2 = n (Vpv + Vb - Vc1), where in n is the turns ratio of the transformer. Fig 3 shows the mode-1 operation.

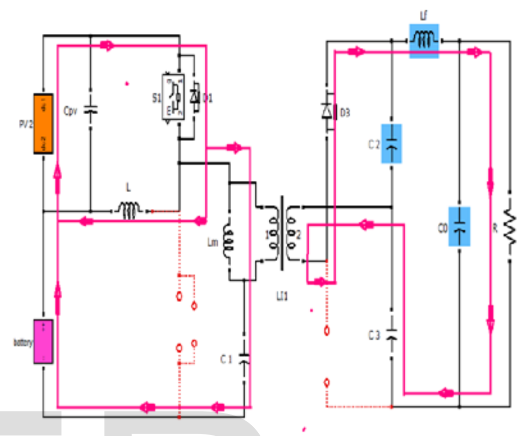

Figure3 modes of operation 1

Mode II :

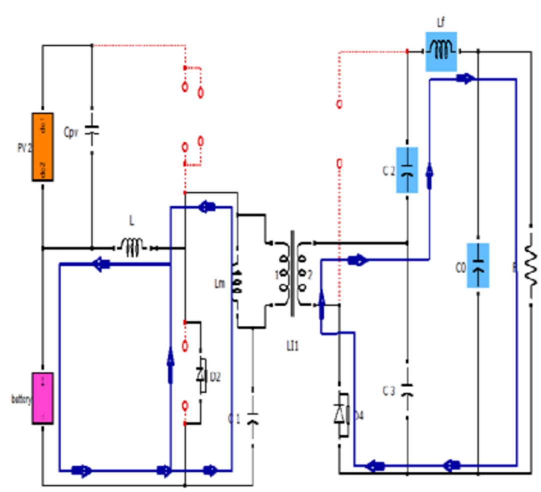

Figure 4 modes of operation 2

During this mode s1 is off and s2 is on. Inductor gets charging continually. When VL reach –Vb at that time inductor starts to discharge the energy. The primary side

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voltage is equal to Vc1 voltage. In secondary side D4 becomes forward bias and capacitor C3 gets charged. The voltage across C2 is given by, Vc3 = n (Vc1), where in n is the turns ratio of the transformer. Fig 4 shows the mode-2 operation.

Mode III :

When iL becomes smaller than (-Ipri) the diode D2 is reverse biased
and the switch, S2 starts conducting. The rest of the operation remains the same as that of mode II.

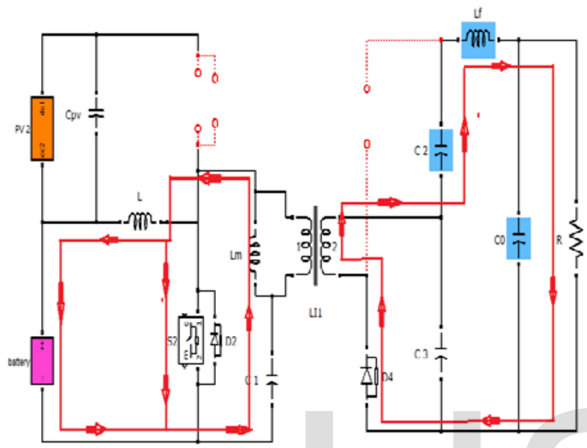

Figure 5 modes of operation 3

III.Simulation results

Figure.6 shows the simulink model of the proposed circuit. It consist PV cells,battery, coupled inductor, voltage doubler circuit and mppt controller. Figure.7 and 8 shows the PV and battery voltages. Figure.9 shows the MPPT control block. Figure 10 and 11 shows the gate pulse, current through and voltage across switch S1and S2. The Power switches are switched on and off at zero voltage switching condition.It is proven from Figure 10 and 11. Figure 12 shows the gate pulse, current through inductor L and Lm

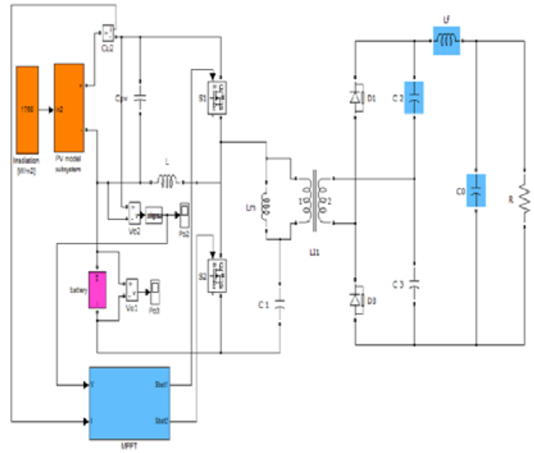

Figure 6 proposed simu-link circuit

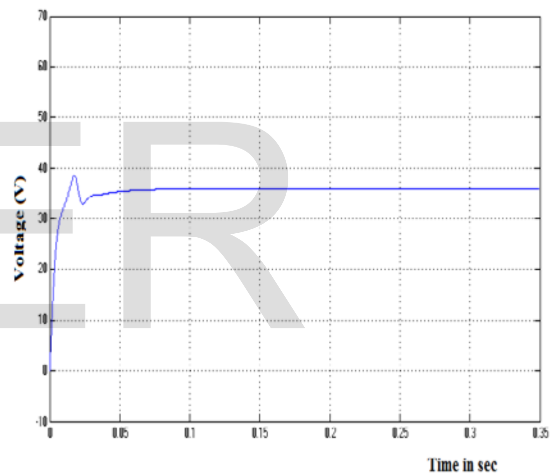

Figure 7 PV output voltages

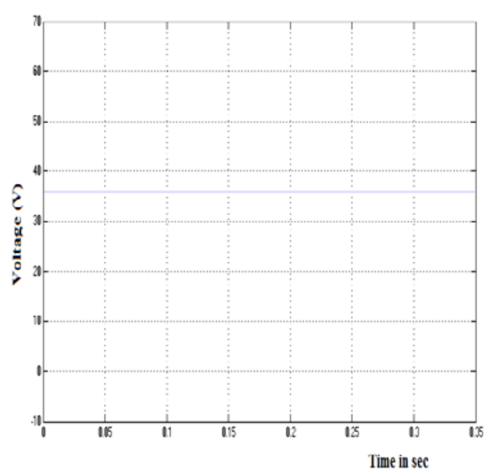

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Figure 8 Battery output voltage

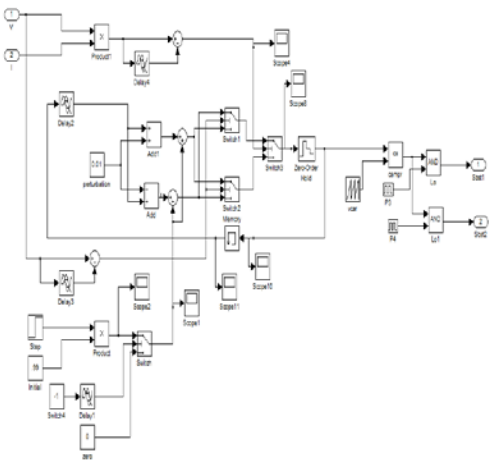

Figure 9 MPPT controller

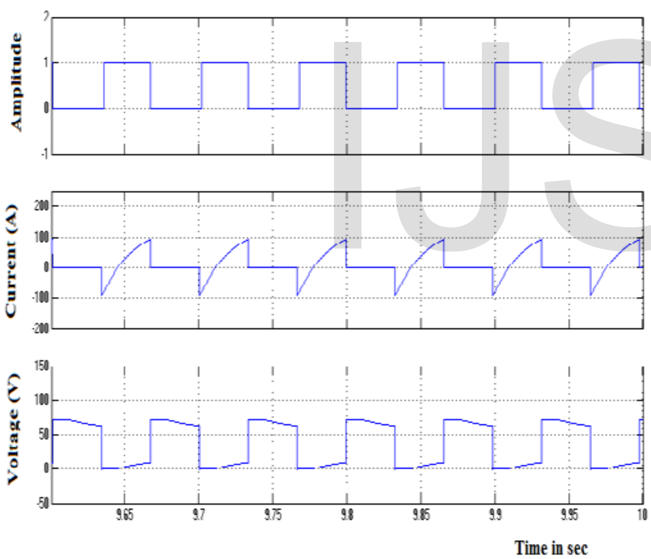

Figure 10 Gate pulse current through and voltage across switch S1

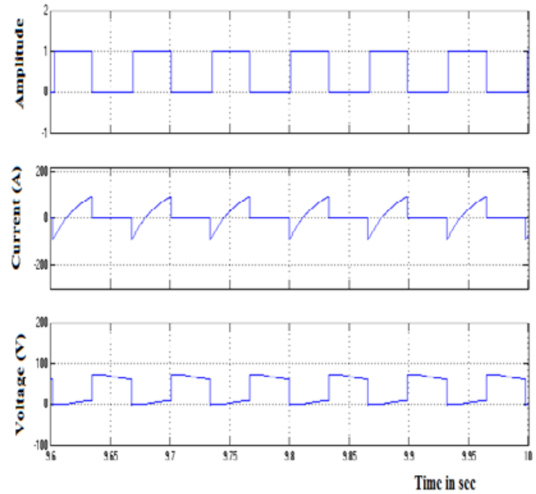

Figure 11 Gate pulse current through and voltage across switch S2

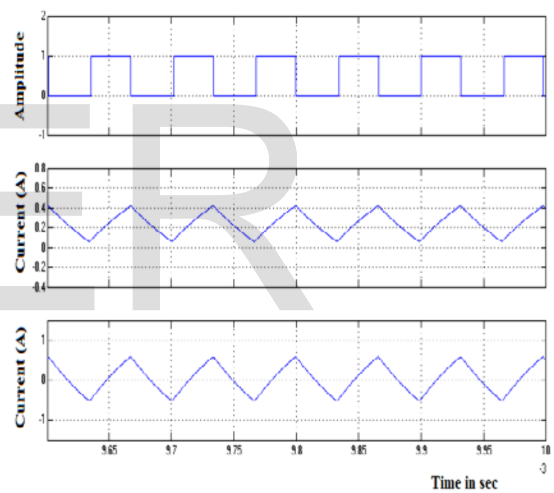

Figure 12 Gate pulse and current through inductor L, Lm

IV. Comparative analysis

The proposed system has less components count compare than conventional system. The MPPT technique is used to maintain PV output voltage is constant. Power optimization algorithm is used in the proposed system. The proposed system output side has voltage doubler circuit with C-filter. The voltage doubler circuit and coupled transformer are used to increase the voltage gain of the transformer. When we included PI filter in the output side the system has less output ripple current and ripple voltage. It is proven that from figure 13 and 14. The proposed system input and output parameters as shown in Table-1

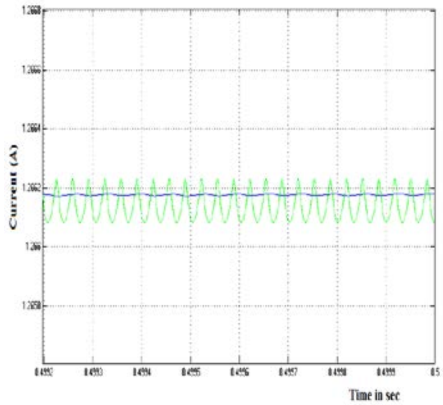

Figure 13 Output current

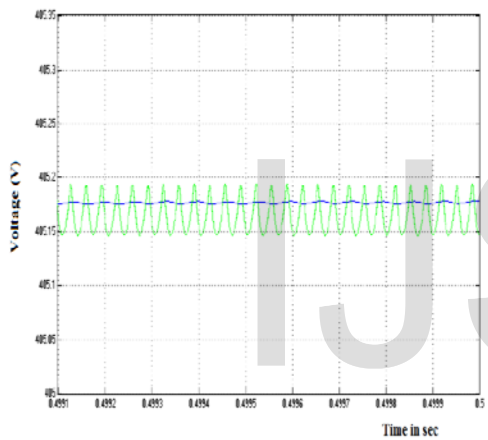

Figure 14 Output voltage

Table-1

Parameters	PI-filter
PV voltage	36V
Battery voltage	36V
Output current	1.25A
Output voltage	400V
Output power	500W
Ripple voltage	0.002V

V.Conclusion

The transformer coupled dual input dc-dc converter is presented in this paper. The proposed circuit has MPPT technique to achieve the maximum power from solar cells and maintain constant PV output voltage. The Pi filter is used to reduce the output ripple. The proposed system has less converter stage compare than conventional system. Thus the proposed circuit has less device count and high performance compare than conventional circuit. The circuit performance is verified with simulation results.

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