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Simulation of Transformerless Single Phase Inverter Using Solar System

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ABSTRACT

Solar energy is the major source of power. Its potential is 178 billion MW, which is about 20,000 times the world's demand. Solar energy, received in the form of radiation (electromagnetic waves), can be converted directly or indirectly into other forms of energy, such as heat and electricity which can be utilized by man .Inverters are the devices usually solid state which change the array DC output to AC suitable voltage, frequency and phase to feed photo voltaic ally generated power into the power grid or local load. Solar energy is time dependent and intermittent energy resources. Inverter may also contain a suitable output step up transformer perhaps some filtering and power factor correction circuits and some power conditioning circuitry to initiate the battery charging and to prevent overcharging .Inverters of PV system based distributed generation (DG) are subjected to wide changes in the inverter input voltage, thus demanding a buck-boost operation of inverters . Further the inverter size, weight and cost is increased. It is designed transformer less inverter that can be operated over a wide dc input voltage range making it suitable for distributed generation applications. Depending on the reference signal, the inverter output voltage can be either boosted or bucked with respect input voltage.

Keywords: Solar Panel, Buck-Boost Converter, Reference Signal, Transformer-Less Inverters, PWM

I. INTRODUCTION

Renewable energy substitutes conventional fuels or distinct areas air and water heating and cooling, motor fuels, electricity generation. Photovoltaic systems (PV) that supply power directly to the grid are becoming more popular due to the cost reduction achieved from the lack of a battery subsystem. This design can be used in high power ranges providing high system flexibility.

Energy conversion devices which are used to convert sun light to electricity by the use of the photo voltaic effect are called "Solar cells". Inverters are the devices usually solid state which change the array DC output to AC suitable voltage, frequency and phase to feed photo voltaic ally generated power into the power grid or local load. Inverter may also contain a suitable output step up transformer for some filtering and power factor correction circuit.

Distributed generation (DG) systems are usually small modular devices which are nearly to electricity consumers. These include wind turbines, solar energy systems, fuel cells, micro gas turbines, and small hydro systems, as well as relevant control and energy storage systems. These systems normally need inverters as interfaces between their single phase loads and source.

The functions of inverters for small DG systems can be summarized as follows:

1. It converts power conversion from variable dc voltage into fixed ac voltage for stand-alone applications and ac output in synchronism with the grid voltage and frequency for grid-connected applications.
2. Variable dc voltage can be higher or lower than the ac voltage in a system, which is observed normally in a solar energy and wind turbine systems. Thus, there is a need to buck boost the inverter voltage.

Based on the electrical isolation between the output and input, inverters can be classified as isolated or non-isolated. Electrical isolation is normally achieved using either line frequency or high-frequency transformers. Inverters are used for many applications, as in situations where low voltage DC sources such as batteries, solar panels or fuel cells should be converted so that devices can run off of AC power.

II. LITERATURE SURVEY

When no transformer is used in a grid connected pv system, a galvanic connection between grid and a pv array exists. In this condition, dangerous leakage current can appear through thr stray capacitance between the pv array and the ground. In order to avoid these leakage currents, different inverter topologies that generate no varying common mode voltages, such as half bridge and the bipolar pulse width modulation(PWM) full bridge topologies have been proposed".

The elimination of the output transformer from grid connected photovoltaic (pv)systems not only reduces the cost, size ,and weight of the conversion stage but also increases the system overall efficiency . However, if the transformer is removed, the galvanic isolation between the pv generator and the grid is lost .This may cause safety hazards in the event of ground faults. In addition, the circulation of leackage currents (common –mode currents) through the stray capacitance between the PV array and the ground would be enabled.

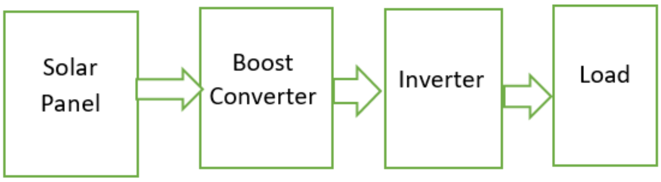

Figure 1: Block Diagram DC to AC

The boost converter is best if a significant and much step up is required, such as with a short string of 12-PV panels. A cascaded multilevel inverter consists of a series of Hbridge inverter devices. The work of multilevel inverter is to synthesize a desired voltage from Several Separate DC Source. The main disadvantage of this system is that each single H-bridge cascaded inverter modules needs a separate DC supply source.

Traditional full-bridge inverters do not have flexibility of handling a wide range of dc input voltages. Especially when the DC voltage is lower than the AC voltage, heavy line frequency step-up transformers are required. Although these inverters show robust performance and high reliability, they demand higher volume, weight and cost for DG system applications.

III. PROPOSED DC TO AC CONVERTER

The block diagram of boost inverter used for the proposed system is shown in Fig 3. DC voltage obtained from the photo voltaic cells is given as input to dc- dc converter.

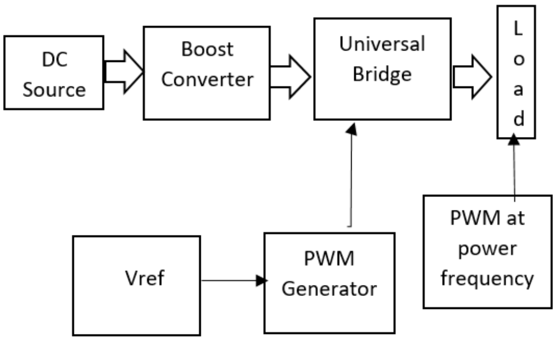

Figure 2. Block Diagram of AC to DC Convert

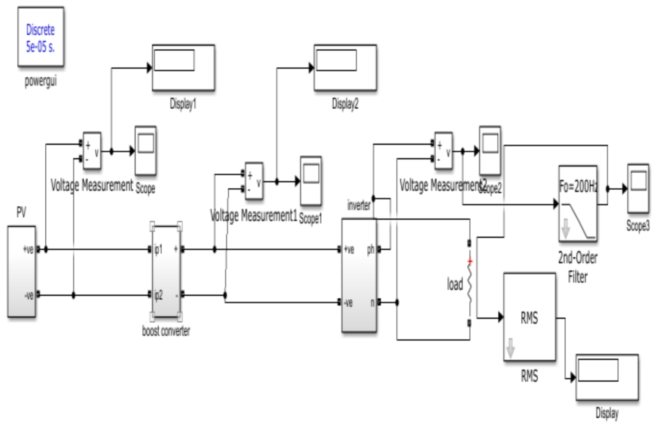

Figure 3. Proposed Dc to Ac converter

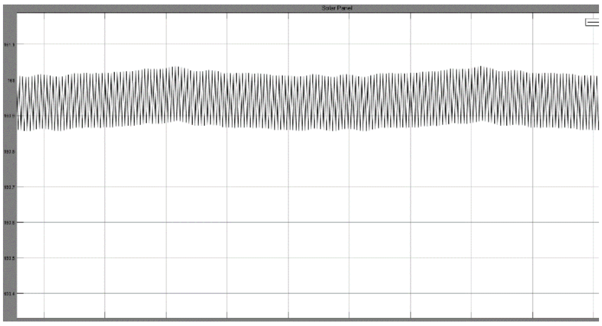

Figure 4. Output from Solar Panel

IV. WORKING PRINCIPLE

Normally the Pulse Width Technique (PWM) uses the sine wave reference but it is proposed that triangular wave is taken as reference .When the Switch 1 is closed .then inductor coil stores the energy from the source, When the switch is opened, inductor coil is releases the energy in the form of voltage, so that it is added to the source voltage thus boosts the output voltage.

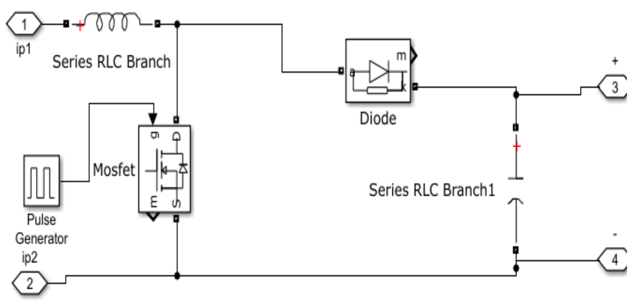

Figure 5. Inductor storing energy

The output from the dc-to-dc converter is as shown in Fig (7) is approximate pulsated dc wave.

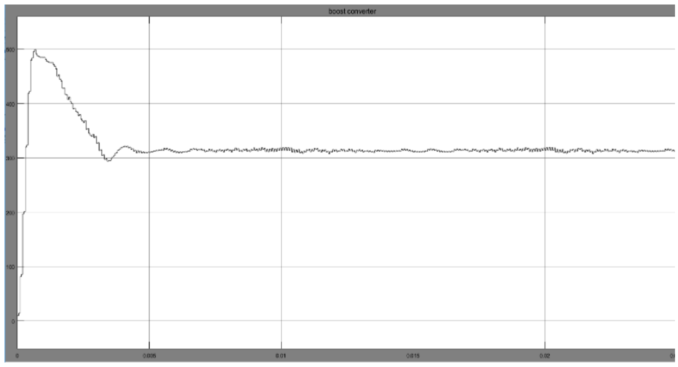

Figure 6. Output from DC to DC Converter

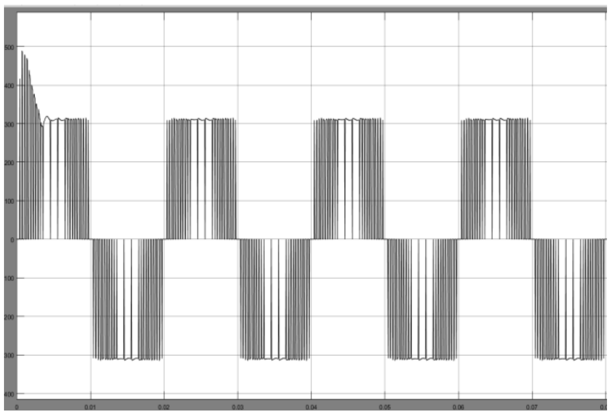

Figure 7. Output wave from H-Bridge

This pulsated dc wave is given to the H Bridge inverter as shown in the Fig (8). The output from the DC-to-DC converter is fed to the H Bridge, which is cosists of four Mosfets.

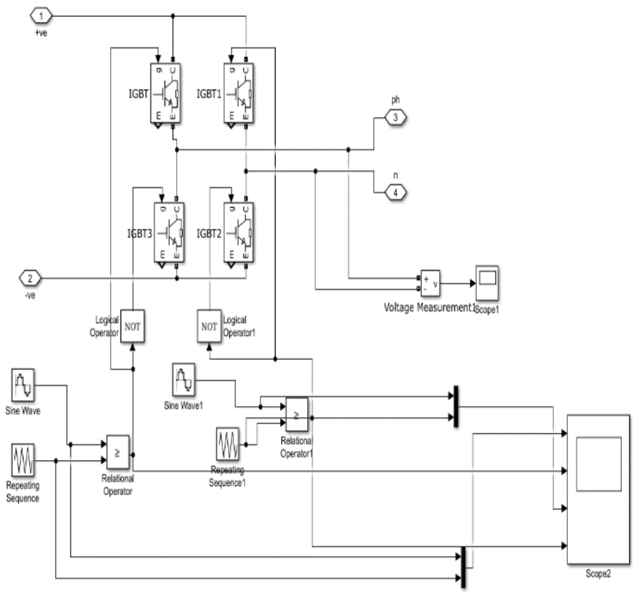

Figure 8. H-Bridge Schematic Diagram

The implementation of this circuit is done. The system Parameters of the circuit to generate triangular wave from integrated circuit logic inverter 74hc14 are in table (1).

Table 1: System Parameters

Power frequency	Resistance
50HZ	50 ohm

The proposed design of the inverter is implemented using boost converter and PWM generator .The input voltage is varied from 1Vto 30V. The output voltage is varied from 85 to 105V (lower rated devices used for implementation, XL6009 voltage regulator) with corresponding input voltage. The circuit working is examined are in table (2).

V. RESULTS

It is implemented and validated the proposed design of circuit .The summary of results are given in table (2).

Table 2: Summary of Results

S.NO	V in(V)	V out(V)
1.	1	0
2.	2	45
3.	3	67
4.	4	96
5.	5	105
6.	6	105
7.	12	105

In this case the proposed design of the inverter circuits acts as a boost inverter since the reference triangular wave is set to maximum, so that voltage is constant. The implemented inverter acts as boost inverter converting 10 volts to 105 volts. It is observed that the output voltage is remains same when further increase in input voltage from 5V.

VI. CONCLUSION

From the results it is seen that designed boost single phase voltage inverter works well producing an ac wave outputs depending upon the reference signal. From the summary table it can be summarized that proposed design of the inverter circuit operates for wide voltage range of the dc input voltage producing a sinusoidal ac voltage 50Hz.

The proposed design uses only five switches, the low switching frequency of the output H-bridge reduces the inverter switching losses and cost compared to multilevel inverters.

The drawbacks of the inverter, compared to traditional H Bridge inverters are relatively high cost (switches) and relatively high switching losses in one of the five switches.

VII. SCOPE OF FUTURE WORK

The present trend of research, the cost of photovoltaic cells is expected to go down in future. This design of inverter under consideration is capable of minimizing the no of components and design portable, thus occupying less space reducing the size of the equipment. This design can be extended by using suitable inductor coils and switching circuitry.

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