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REVIEW ON DESIGN AND SIMULATION OF GRID CONNECTED SOLAR INVERTER USING MPPT TOPOLOGY

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ABSTRACT: Increasing fossil fuel prices with continuous increasing demand has made use of renewable energy sources a necessity then a luxury. This project focuses on development of a photovoltaic inverter which can be used to supply the generated photovoltaic energy to grid. Interfacing a solar inverter module with the power grid involves three major tasks. One is to ensure that the solar inverter module is operated at the Maximum Power Point (MPP), the second is to inject a sinusoidal current into the grid and the third is the efficiency. Since the inverter is connected to the grid, the standards given by the utility companies must be obeyed. These standards deal with issues like power quality, detection of islanding operation, grounding, and so on. A rigorous design and simulation verification process of different photovoltaic inverter topologies through PSIM will be carried out and after having analyzed results which also comply with IEC norms of grid connection the proposed topology will be implemented.

I. INTRODUCTION

The PV inverter is the key element of grid-connected PV power systems. The main function is to convert the DC power generated by PV panels into grid-synchronized AC power.

Depending on the PV power plant configuration, the PV inverters can be categorized
As:

- Module integrated inverters, typically in the 50 to 400 W range for very small PV plants (one panel).
- String inverters, typically in the 0.4 to 2 kW range for small roof-top plants With panels connected in one string.
- Multi string inverters, typically in the 1.5 to 6 kW range for medium large
- Roof-top plants with panels configured in one to two strings.
- Mini central inverters, typically 6 kW with three-phase topology and modular

Design for larger roof-tops or smaller power plants in the range of 100 kW and Typical unit sizes of 6, 8, 10 and 15 kW. Grid-connected PV systems are being developed very fast and systems from a few kW to tenths of a MW are now in operation. As an important source of distributed generation (DS) the PV systems need to comply with a series of standard requirements in order to ensure the safety and the seamless transfer of the electrical energy to the grid.

A. Topology Selection

The Photovoltaic (PV) inverters can be classified as follows:

On the basis of Power Processing Stage
1. Two Stage
2. Single Stage

On the basis of Galvanic isolation to Grid
1. with Galvanic Isolation
2. without Galvanic Isolation

B. Selected Topology

Commonly, the output voltage of the PV array is not high enough to connect to the grid. Moreover, the voltage source inverter (VSI) usually has a voltage-down property, which causes the "PV array + Inverter" topology to output a lower voltage, thus two stages topology is suggested. This topology adds a voltage-up link part, usually Configured as Fig. (1).The DC/DC part often adopts a Boost circuit or some other derived versions, like Buck-boost, isolated Boost, etc. Besides voltage-up function, the Boost circuit can also offer a more stable input voltage for the inverter. The main advantage of the two stages topology is the flexibility of designing its control scheme since it has a higher freedom degree, i.e. more controllable variables, which means multiple control objectives (MPPT, grid connecting, VAR compensating, active filter, etc.) can share by two stages respectively simultaneously.

II. POWER SCHEMATIC

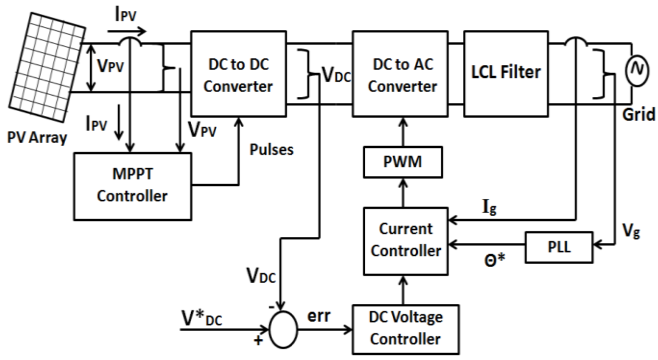

Fig-1

The Fig-1 shows the power schematic of the developed system. Output voltage of PV panel is very low and it is not cost effective to keep large number of panels and that creates a requirement of a DC to DC boost converter in the system. For low power system a single phase full bridge inverter is employed. Output of the inverter is not sinusoidal so it cannot be directly connected with the grid and hence a filter stage is required before the grid connection.

A brief description about individual power processing stage is as follows:

A. PV Panel:-
The optimal choice and rating of PV panel array depends on system power rating. According to systems voltage and current requirement different number of PV panels are connected in series and parallel combination. If system demands for more voltage more number of PV panels will be connected in series and if current demand is more number of panels in parallel will increase. When performing this task it must be taken care that panel Voc should not increase maximum system voltage and same with the current rating that it must be taken care that panel Isc should not increase the maximum current.

B. DC to DC Converter:-
Generally output voltage of PV panel is low and continuously varying with the change in atmospheric conditions. So in two stage topology to overcome this issue a DC to DC conversion stage is kept which can boost as well as keep the output DC voltage constant. By designing a proper value of inductor and analysis of voltage variation throughout the day this task can be accomplished. Boost converter also serves the purpose of providing a constant DC link voltage for the inverter stage.

C. DC to AC Converter:-
Any grid connected system must have sinusoidal voltage and current as an output stage. So to convert the DC voltage into AC an inverter stage is required. For low power system a single phase H-bridge inverter topology can be used.

D. Output Filter:-
Output of the inverter stage is not pure sinusoidal in wave shape so it cannot be directly connected with the grid. Hence a filter stage is required to convert the inverter output waveform into sine wave. While designing this stage inductor voltage drop must be taken into consideration so to avoid excessive voltage drop.

III. SIMULATION VERIFICATION OF BOOST INVERTER

For the compatibility testing of the selected components simulation analysis has been carried out and different operating conditions taken into consideration. Below Fig shows the circuit connection in the simulation.
As shown in Fig-2 input current has been sensed which is compared by the given input reference. As it is already mentioned that input voltage variation will be between 190 V to 290 V and irrespective of the change in the input voltage DC link voltage will remain constant to 380 V. While testing the system with constant voltage and current source (3- Phase variac), a current controlled system is developed, which controls the input dc current, DC link voltage while testing with resistive (R) load depends on IR drop in resistors and when it is integrated with inverter system it is maintained by the inverter system.

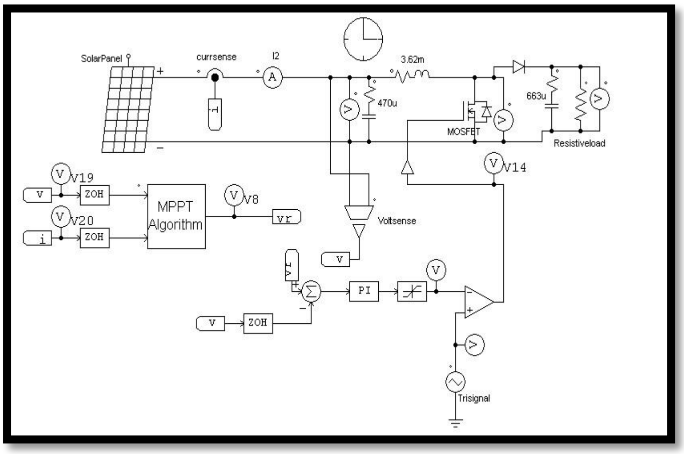

FIG – 2

Simulation Results

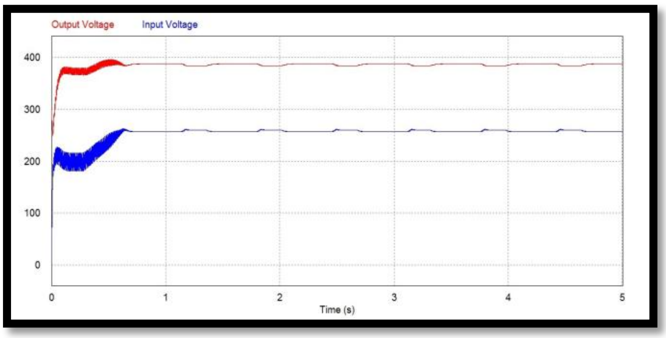

FIG – 3

As shown in Fig-3 the applied input voltage is 190 V and given current reference is 100%. Resistive load across the resistor is 48 and the value of the DC link capacitance is 1.88 μF. Same way, the results at the time of input voltage is 290 V and current reference is 100% are shown in Fig.3. In both the cases above duty cycle is kept at 50% constant. It is clear that whenever value of resistor or current reference or both increases, drop across resistor increases and hence more boost voltage appears across the DC link. When the system will be integrated with the inverter system DC link voltage (VDC) will be maintained by the close loop control through inverter. Now seeing the output in terms of ripple content in output voltage and current, at the time of minimum input voltage 190 V the ripple content in output voltage and current are shown in Fig.4

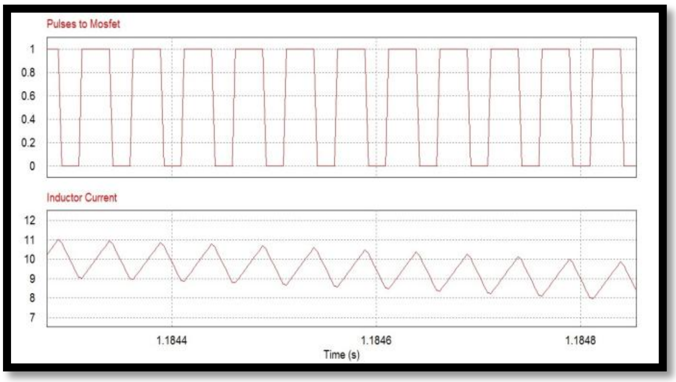

FIG – 4

From the above Fig it can be seen that ripple in DC link voltage VDC is not more than 1% of the total DC link voltage and same way the ripple in the output Current is also not more than 10% of the output rated current.

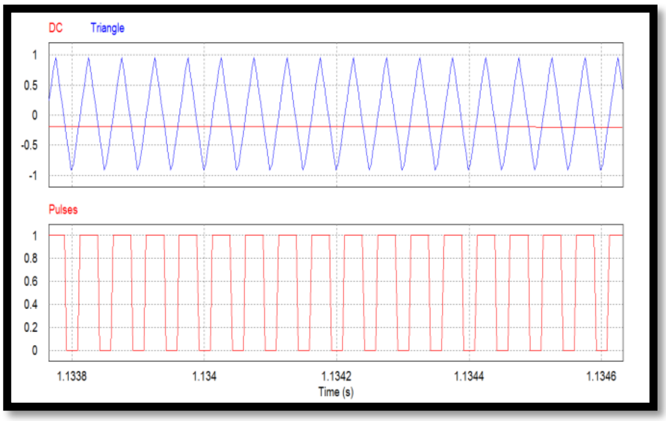

Fig- 5

From the above Fig we can saw that here compare the DC and Triangle wave and we get the pulses. In which the comparison of the dc and triangle wave when the magnitude of triangle is more then to dc the Pulse will be generate and when the magnitude of the triangle wave is less the pulse is zero.

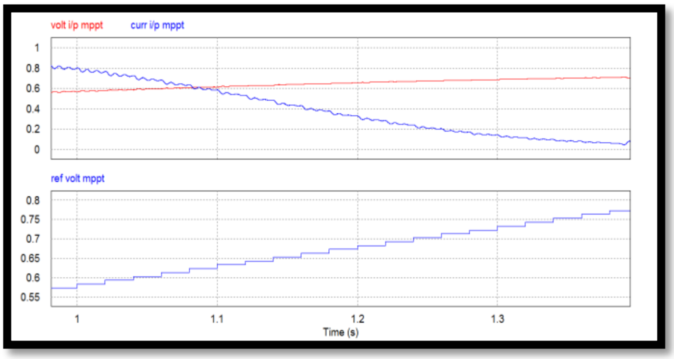

Fig- 6

From the above fig we can see that the input current and the input voltage is variable when we apply the load. Here we have use the mppt algorithm for the constant output. In which the input voltage and input current apply the mppt sense the maximum input value for the reference voltage and then mppt compare the input value and set the maximum value with the reference value and get the constant output at the inverter side.

IV. DC TO AC CONVERTER

Introduction

For the feeding of sinusoidal current and voltage into the grid and for the conversion of DC voltage at the DC link into AC, effective DC-AC conversion stage (Inverter) has been kept into the system. As the system is in low power category single phase full bridge inverter is employed. Output of the inverter cannot be directly feed in to the grid, so an output low pass filter stage has been designed to maintain sinusoidal voltage and current at the output. In the converter there is four IGBT's work in this inverter and at that time only two IGBT work simultaneously, in which we apply the sine and triangle wave the first 1and 4 no of IGBT work and then the second 2 and 3 no of IGBT work but in second cycle there are negative polarity so we get the pulse at that time.

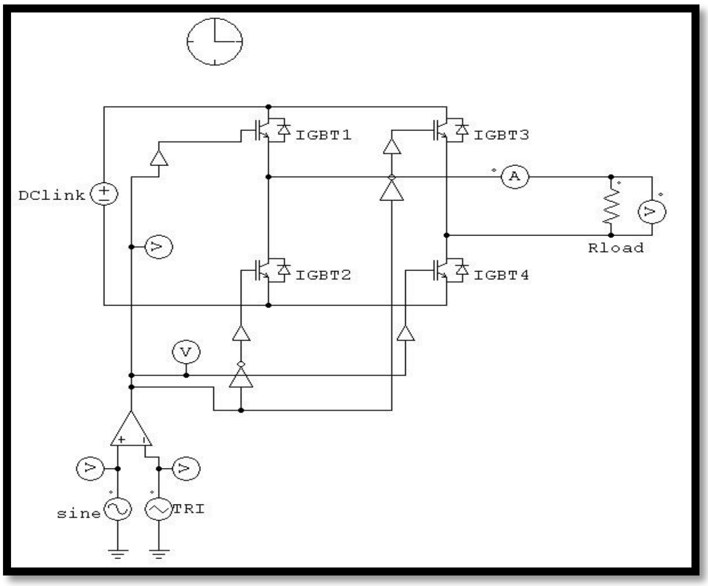

Fig – 7

Simulation Results

In this Fig we can see that the output voltage of inverter and output current of inverter

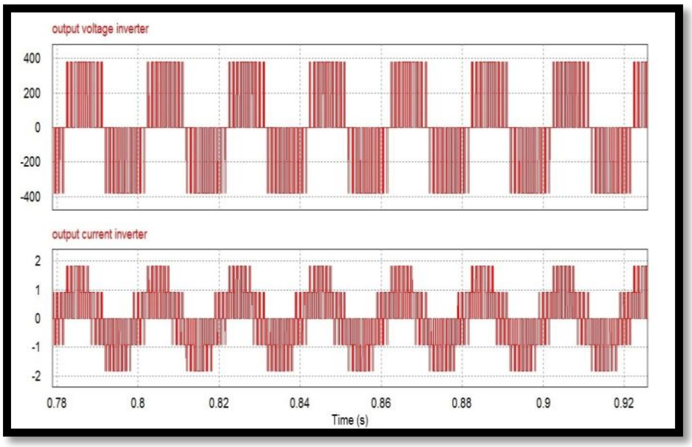

Fig – 8

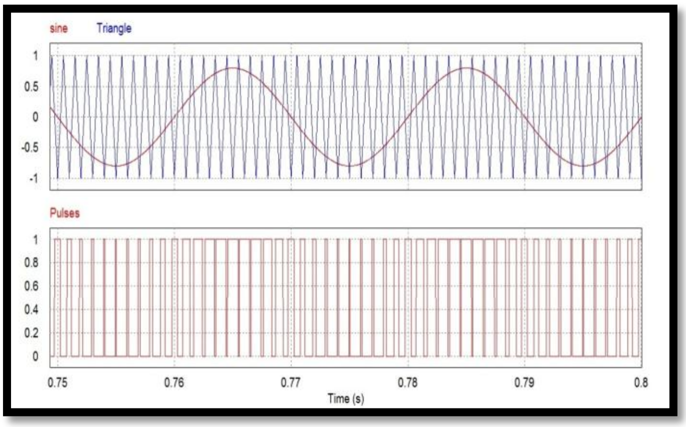

Fig – 9

From the above fig compare the sine and triangle wave form and in this also when the magnitude of triangle wave form high from the sine we get the pulse and when the magnitude is less than the sine wave the pulse is zero.

V. CONCLUSION

Close loop of Boost converter along with MPPT algorithm is been completed as per requirement and is been verified with simulation results. Simulation of Single phase inverter is carried out and is verified with simulation results

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