Increasing Efficiency of Solar Panel using Grid Connected Micro Inverters and Orientation

R. Aarthi, S. Haritha, V.N. Ganesh, J. Ajay Daniel

Abstract--- The solar photovoltaic cell generated power is one of the major pollution free source of energy in the present times. Upon using a single inverter for the solar panel system, the overall efficiency of the solar panel gets affected. The cast of shadows on the solar panel is also a major concern for the reduction in efficiency. In order to rectify these this paper concentrates on increasing the efficiency of the solar panel by providing individual grid connected micro inverters and also orientation mechanism of the panel.

Keywords--- Solar Panel, Grid Connected Micro Inverters, Tilting Mechanism.

I. INTRODUCTION

The demand for energy is increasing day by day due to the high price of fuels. In order to fulfill this energy demand conventional energy sources can be replaced by renewable energy sources. Solar energy is one of the major non-polluting source of energy where there are no byproducts that can cause problems in the environment [10]. Solar energy can be used efficiently for major part of power supply if we can increaseits efficiency of the solar panel. The efficiency of a solar panel can be increased by connecting a micro inverter suitable for AC solar modules. It is based on the single-stage DC to AC conversion where it has a L-C series resonant converter, high frequency transformer and a line frequency unfolder.

Providing a common micro inverter for the overall solar panel assembly, can sometimes affect its efficiency by producing the least power generated from the set of solar panels. So individual grid connected micro inverters are connected to individual panels in order to increases the efficiency of each panel increasing the overall efficiency [4].

The efficiency of a solar panel will be affected if shade is falling on the surface of the panel.Now here the tilting mechanism comes to the play by adjusting the solar panel in such a way where it receives the maximum amount of solar energy thereby increasing its efficiency. Grid-connected solar inverters are one of the important elements in generation of power. In the first type, a single inverter is fixed to many of the solar panels connected to the same external circuit through the inverter [12]. The modules of micro-inverters attached to the solar panel andthis type of solar panel has various advantages over that of the power generation using integrated grid connected inverter system. The advantages are: easy upgrading, redundancy, maximum power tracking of individual panels; hence less shading.

Losses due to conduction with the active devices usage, while the losses due to switching is proportional to voltage and the changes in current for switching and frequency of switching [1].

II. SOLAR POWER GENERATION IN DOMESTIC HOUSES

In thischapter,we mention about the necessity of the proposed system and about the existing system in use for the generation of electricity using micro inverters. Solar panels made of PV semiconductor materials usually silicon is used for the generation of electricity where the sunlight is being converted into respective electricity [1].

This type of energy generation using PV cells is basically environment friendly and it is a renewable energy using this technology, when they are installed in individual houses they provide much cleaner environmental conditions and will become a one-time installation and does not have any kind of hazards or repetitive maintenance.

III. THE EXISTING GRID -CONNECTED SOLARPANEL STRING INVERTER CONNECTION IN THE SYSTEM

This existing system consists of individual solar panels cumulatively connected in a grid orientation to the main circuit through various diodes and IGBTs as given in the above orientation diagram of the MATLAB Simulink diagram. The grid connection is given to an inverter which is used for converting the solar panel output that is a direct current output to an alternating current input to the circuit to which the supply is to be given [1]. This system upon the domestic or at the larger level will result in the decreasing of the efficiency of the power generation using the solar panels [2].

The solar panel output from each of the solar panel being fixed and are connected to a single inverter will result in thedecrease in the efficiency because the output from the solar panel that has the least amount of power generation will be the same output that will be obtained from the rest of the solar panels that are connected to the same grid circuit [3].

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This supply upon being stepped up or stepped down due to commercial usages may also face other kinds of electrical losses that will result in the further reduction in the solar panel power generation efficiency.

In this type of mechanism there are primarily majorly two things are involved. Here there are individual micro-inverters that are being connected to each individual solar panel in such a manner that every output of the individual solar panel will provide their own respective output and thereby the efficiency will increase where there will be no power losses. The complete utilization of the solar energy will be put into use.

The output of every solar panel where every output of individual solar panel into their respective alternating current output will be cumulatively added and the resultant of the existing system to that of the proposed system will have a drastic difference that will eventually make the main purpose of solar as a renewable energy an utter waste.

IV. PROPOSED SYSTEM METHOD OF INCREASING EFFICIENCY OF SOLAR PANEL USING THE GRID CONNECTED MICRO INVERTERS

In this chapter we are proposing a system which involves the use of individual micro inverters for individual solar panels. This connection is a full bridge based gridconnection network as shown in the figure (1).

The solar panels upon the incidence of photons from the sun will convert it to respective DC current and this generated current is given to their respective micro inverter.

The micro inverter includes a set of diodes connected to the RLC circuit as shown in the solar panel setup will not be the same like the existing system where the output of individual solar panels is not considered and the least output from any of the solar panels will be the output for the rest of the panels which will reduce the overall output and efficiency of the solar output [6].

Whereas in this type of grid connection the individual outputs are considered from the individual panels and there is reduced loss. Along with the micro inverters the orientation mechanism as shown in figure(4) will also help in increasing the efficiency by aligning the respective solar panel on which the shadow is cast upon towards the sun direction which will result in higher power generation. The suitable waveform is obtained as shown in figure (3).

In solar type of inverters basically there are two main types, they are called the string inverters and the micro inverters.

The first type of inverters be the existing type of inverters called as the string inverters that are connected to a group or also an array assembly of the solar panels that are into use of power generation whereas in the second type of the inverters, they are connected in the format where one inverter is connected to another individual solar panel [15].

This type of inverters are connected exclusively on the back of the solar panel as a design and space management development. The output from each of the individual solar panel output from the inverter is obtained in an AC power. Here the solar DC output now gets individually converted into the alternating current output.

As per the inverter characteristics in both the cases. The second type of inverter where the individual use of inverters to each panel is used, this type is also called the micro inverter [16]. This type of inverter is said to be much more efficient and has several advantages over the other inverter called as the string inverter.

V. ABOUT SOLAR MICROINVERTER

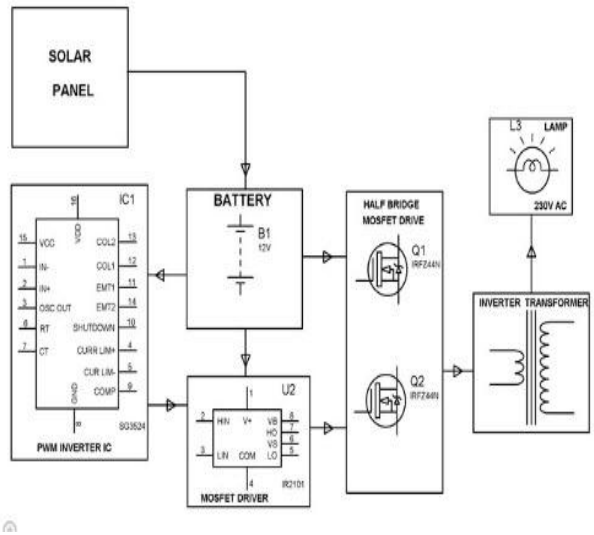

Figure 1:Design of micro inverters

A micro inverter is a photovoltaic device that converts the energy obtained from the solar panel into alternating current. A single micro inverter can be connected to multiple solar panel to obtain the output which is then fed to the micro grid. The micro inverters have got more advantageswhen compared to the conventional inverters. Small amount of shading or dust will not affect the output of the entire array of panels. The design is very simple and also has many added features to it. The life span of a micro inverter is much longer when compared to an ordinary conventional inverter [4]. A boost converter for the conversion of DC/DC is being introduced in order to provide better conversion ratio and also to provide a better output [4].

As grid tie panels are rated upto 275 W, the micro inverters are usually rated between 190 to 220 W. Since micro inverters are attached to individual panels, the overall efficiency of the grid is improved by 5% than if connected to an array of all the panels. The panel that gives less output will not affect the overall efficiency of the grid as individual micro inverters are connected to every panel [7].

Though these micro inverters have a lower efficiency when compared to an individual inverter the overall efficiency is still higher because each panel has individual micro inverters and can act independently. Monitoring and maintenance is very easy as these micro inverters are provided with monitoring systems like apps to check their output production [5].

The hard ware requirements of a micro inverter may include bridge MOSFET drive, step up transformer, voltage regulator MOSFET drive, PWM inverter IC, solar panel and battery.

Figure 2: Proposed system using grid connected micro inverters

VI. PROPOSED SYSTEM USING GRID CONNECTED MICRO INVERTERS AND OUTPUT WAVEFORM& RESULT

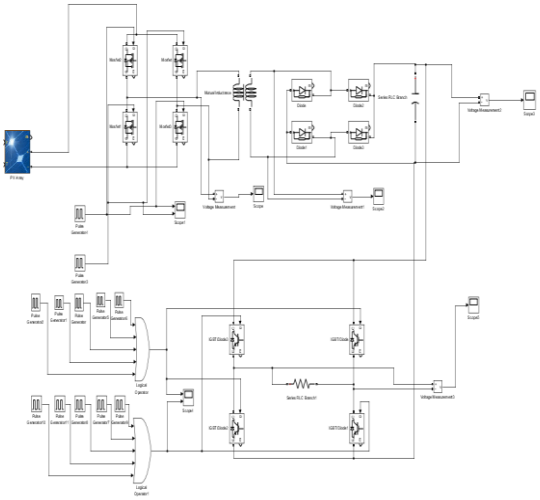

Figure 3: Output waveform of scope 1 (amplified MOS drive signal)

Output Waveform

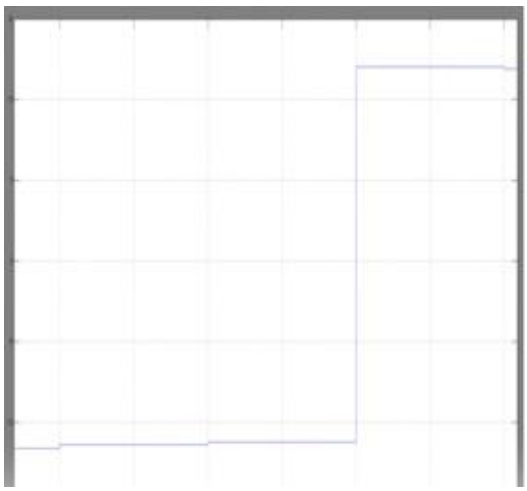

Figure 4: Output waveform of scope 2 (signal from diode combination inverters)

The output signal from the panel through a MOSFET combination circuit is connected in the manner as shown in the figure (1) and the respective output of MOS drive signal is obtained through the scope 1 as in the figure (1). It shows the level of inverter efficiency signal as shown in figure (2). The output signal from the panel through the diode combination after the transformer circuit combination circuit is connected in the manner as shown in the figure (1) and the respective output of boosted efficiency signal is obtained through the scope 1 as in the figure (1). It shows the level of inverter efficiency signal as shown in figure (3). [2].

VII. THE ORIENTATION MECHANISM OF THE PANEL

Depending upon the sunlight and the direction of the sun, the power generation through the solar panel occurs. It is majorly depending upon these factors.

Thus the solar panel micro grid connected inverters are also connected with a tilting mechanism technique where the individual solar panels are monitored individually and if there is a decrease in the power generation than others then if the factor of the hindrance is mainly because of the solar panel attaining shade due to the rotation of the earth around the sun and thus upon the detection of the variation the solar panel upon the shadow will automatically orient itself in the direction of that of the sun thereby increasing the efficiency farther [3].

This simulation is performed in MATLAB Simulink and is shown in figure (5).

VIII. THE SIMULINK DIAGRAM FOR THE TILTING MECHANISM

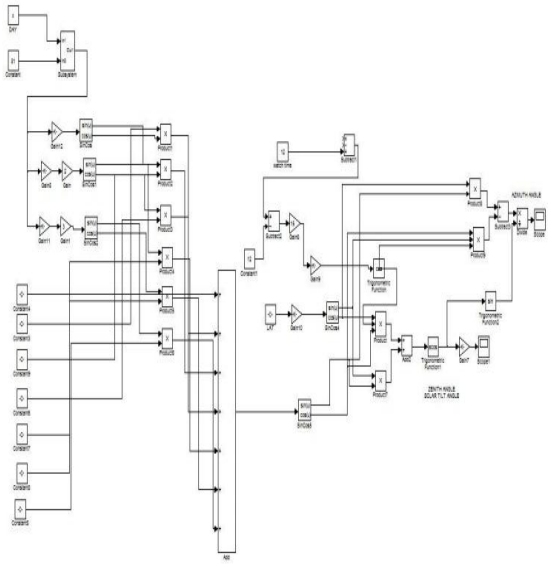

Figure 5: the tilting mechanism of the solar panel

The tilting mechanism is used to orient the solar panel in the direction of the sun. Here this mechanism is primarily put in use to prevent the occurrence of shade on the PV solar panels such that there is no problem in the generation of the power and a highly efficient output is obtained [12].

This mechanism is connected along with the grid connected micro inverter assembly and thus a much efficient output of the renewable energy supply is obtained.

It involves connection of various panels with source products where each detects individually the sun direction and moves itself to orient along the direction.
The major advantage of this type of system is the orientation will majorly affect the amount of solar energy being generated [12].

Even though the initial setup becomes quite expensive, when considered on the long run they immensely have a positive impact on the cost wise where on comparison with the existing system the daily amount of generation is greater and thus when calculating on a longer period the cost becomes much less.

IX. CONCLUSION

This paper concentrates on increasing the efficiency of solar panel using grid connected micro inverters and tilting mechanism. The simulation studies prove that there is a increase in the efficiency of the solar panel while using individual micro inverters for individual panels and given tilting mechanism for the individual panels [2].

A suitable orientation of the tilting mechanism on every solar panel will have an ample effect of efficiency increase on every output of the solar panel which cumulatively increases the efficiency when it is being combined with that of the micro inverter grid connection of the solar panel system with the main circuit system.

This promotes renewable energy harvesting in every domestic household efficiently and also green earth motion which is important criteria to be considered at an alarming rate in current times [13].

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