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# SIMULATION OF GRID CONNECTED PV SYSTEM USING MATLAB

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*Abstract:* Because they are pollution-free, simple to install, and inexhaustible, renewable energy sources like solar, wind, and hydropower are dependable substitutes for traditional energy sources like oil and natural gas. The effectiveness and functionality of these systems are continually being improved, though. Since they are compact, hygienic, and simple to install, photovoltaic systems are the ones that are most frequently employed. To achieve a high-quality electric power system, this system's connection to the grid necessitates particular circumstances. Three-phase grid-connected PV system interface is discussed in this work. To capture the most power from the sun and send it to the grid, a DC-DC boost converter with maximum power point tracking (MPPT) is utilized. The inverter is a crucial component crucial for controlling any PV-based system.

***Index Terms* - Renewable energy, PV modules, Photovoltaic system, boost converter, voltage source Inverter, MPPT control, Grid.**

## I. INTRODUCTION

Renewable energy sources are alternatives to our traditional energy sources, which are finite and will run out, as energy demand rises daily as a result of population growth, urbanization, and industrialisation. Because they don't emit any emissions and are endless, clean energy sources like solar, wind, and hydro are becoming more and more popular. Due to the abundance of solar radiant energy and sustainability, grid-connected photovoltaic systems are widely used. However, despite the fact that solar energy is abundant and cost-free, the price of photovoltaic cells is very high, making them an unaffordable option for most people. In light of this, the initial cost of solar energy will be very expensive. The solar cell is the fundamental component of a PV system

Elements Included in a System of Photovoltaic Conversion The basic schematic diagram of a grid connected PV system with voltage source inverter is shown below.

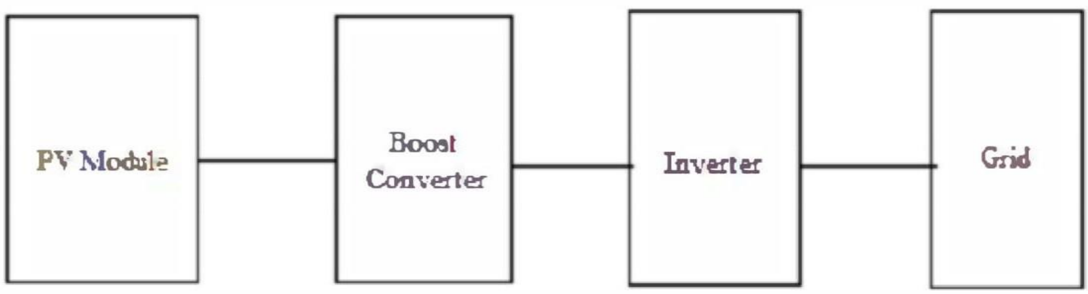



Fig 1: Grid connected PV system block Diagram

The main elements that can be included in a system of photovoltaic conversion are Photovoltaic modules, converters, utility grid, loads DC and AC, and Inverters. It is an arrangement used in PV standby power supply units, it's called grid connected system without a battery backup. Although systems with battery backup confront the issue of reliability of the grid supply but it is more complicated and more expensive.

**PV module:**

The power source for every photovoltaic installation is the solar panel. It is the end product of a collection of parallel and series photovoltaic cells. When sunlight interacts with semiconductor materials in the PV cells, the solar irradiance is directly converted into electricity in the form of dc. The equivalent circuit of a PV is shown in Figure 2, from which the non linear I-V characteristic may be inferred. In order to create an array with the desired voltage and power levels, the cells are connected in series and parallel combinations. Solar cells are then integrated to create'modules' to produce the desired voltage and current (and consequently, power).

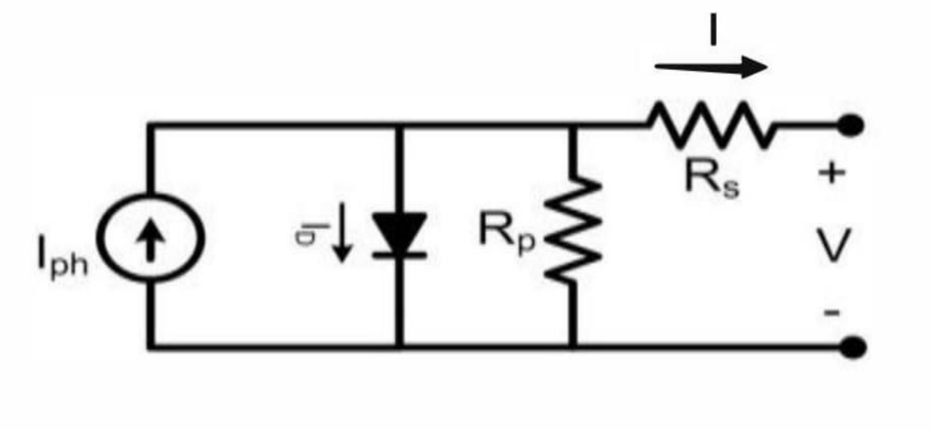



Fig. 2. Equivalent circuit of photovoltaic cell

***2)* DC-DC Boost Converter :**

The placement of the boost converter will enhance the entire photovoltaic installation and enable various system controls. The panels will contribute to either the maximum energy supplied to the system or the optimal energy for their functioning, depending on the applied regulation. From a solar panel to a grid-tied inverter, energy is absorbed and injected through a power transfer medium called a boost converter. An electrical switch, a diode, an output capacitor, and an inductor work together to conduct the processes of energy injection and absorption [3]. Figure (3) depicts the connecting of a boostconverter.

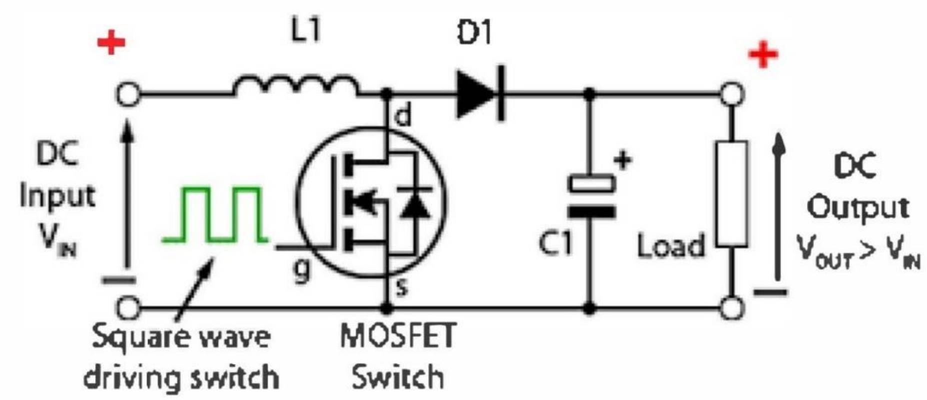



Fig.3. Basic Boost Converter Circuit

When switch is closed for time tl, the inductor current rises and energy is stored in inductor L. If the switch is open for time t2, the energy stored in the inductor is translated through diode D and inductor current falls, the switching duty cycle a is defined as the ratio of the on duration to the switching time period so the output voltage is greater than the input voltage and is expressed as in eq. (1) Vout/Vin = 1/ (1 - a)

**3) Inverter :**

The controller that produces the proper switching pulses to drive the inverter is the key component of the system, which comprises of semiconductor switches. In order to meet the utility grid's requirements for voltage and power quality, it converts the DC power generated by the PV array into AC electricity.
The voltage source inverter (VSI) is the inverter topology chosen for this design. A three phase VSI is schematically depicted in Figure (4). It consists of six switches, SI through S6, with the middle of each "inverter leg" being connected to the output of each phase. In each phase, one leg is built using two switches. The inverter's AC output voltage is obtained by turning the semiconductor switches on and off.

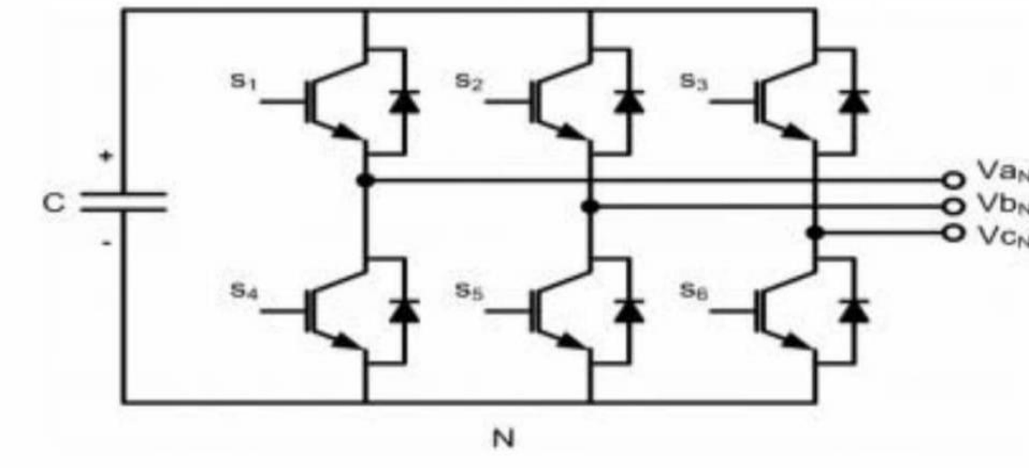



Fig.4. Topology of Three Phase Inverter

The way the conduction intervals of the switches are adjusted has a direct impact on the shape and quality of the AC output waveforms. Sinusoidal pulse width modulation (SPWM), which enables modification of the resultant AC waveform's phase, amplitude, and frequency, was the method selected for this application. A high frequency triangular waveform known as the carrier signal and three reference sinusoidal waveforms (for three phase operation) at the same frequency as the desired output waveform are needed. The method involves comparing the sinusoidal and triangular waveforms' magnitudes. The upper switch in the corresponding phase leg of figure (4) is engaged when the modulating signal's amplitude exceeds that of the carrier signal. The output voltage results from this.

**4) Other Devices**

like filter can also be used for a better performance, a meter could be used to account for the energy being drawn from or fed into the local supply network.

**5) Load**

It is the component responsible for absorbing this energy and transforming it into work.

**6) Grid modeling**

The unit formed by the energy transport line and all the connection transformers between the various voltage levels, will be indicated by network in figure 5

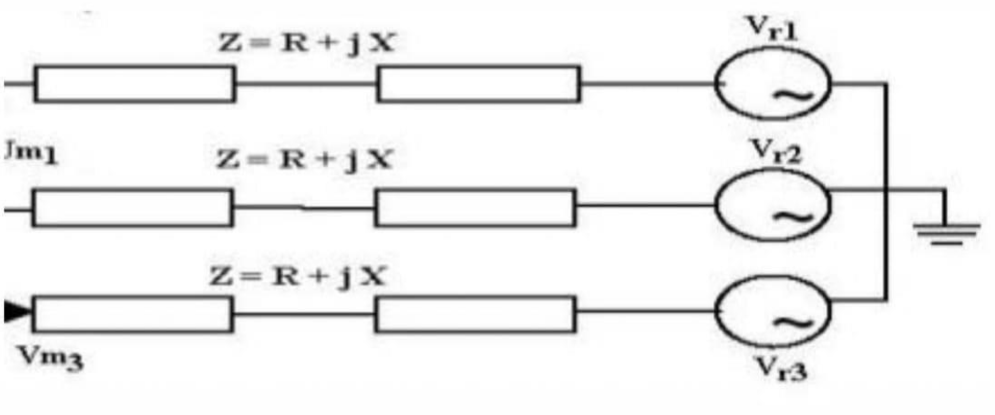



Fig.5. Grid Equivalent Circuit

The conditions for proper interfacing between the two systems are discussed below:

• Phase sequence for the solar system and grid should be matched otherwise synchronization is not possible. The three phases should be 120 digphase apart for both systems.

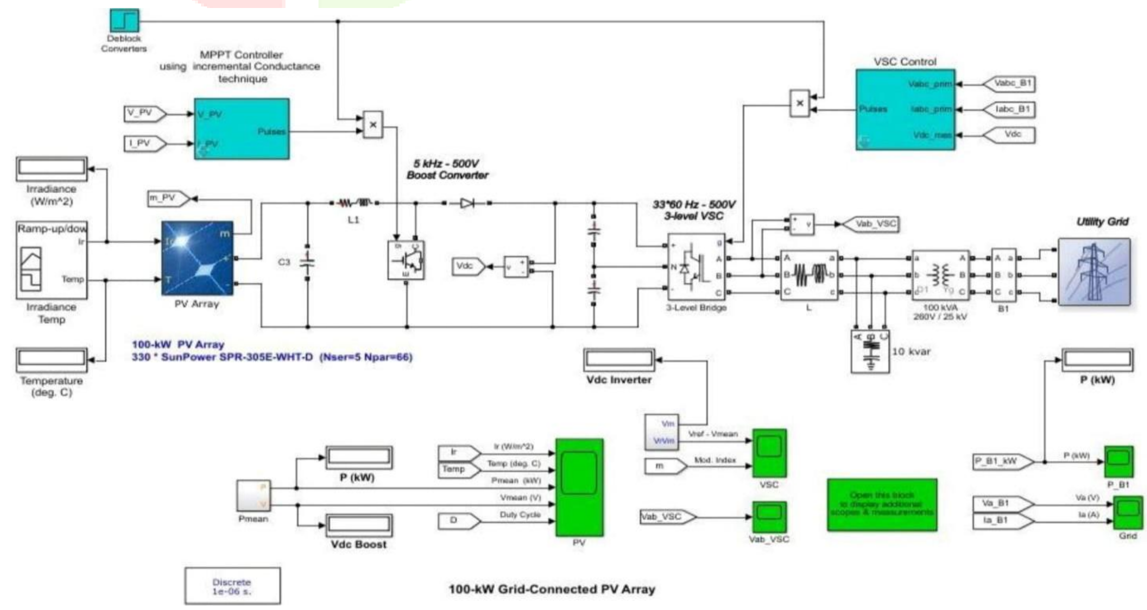
• Frequency matching: generally, grid is of 50 Hz frequency, now if the solar system's frequency is slightly higher than grid frequency (0.1 to 0.5) synchronization is possible but it should not be less than grid frequency.

• Voltage matching: one of the vital points is the voltage matching. The voltage level of both systems should be the same [5].

As the capacity of PV systems is growing significantly, the impact of PV modules on utility grids cannot be ignored. Grid-connected PV systems can cause problems on the grid, such as injecting more harmonics or reducing the stability. This problem can be severe when a large-scale PV module is connected to the grid. Current harmonics produce voltage distortions, current distortions, and cause unsatisfactory operation of power systems [6].

**METHODOLOGY:**

The following components make up the system in most cases: When the sun's irradiance is converted into dc voltage and current by a photovoltaic array, the DC-DC boost converter is controlled by maximum power point tracking using the (P&O) algorithm to track the maximum power point of the array. A three-phase inverter then converts the dc voltage to AC for grid interfacing or to supply a local load. The inverter output is cleaned of harmonics by the band pass filter, and the output voltage is increased and zero sequences are circulated by the delta star transformer before connecting to the utility grid. Switching, synchronization, and MPPT controlare accomplished by the control circuits.




6. MATLAB MODEL OF GRID CONNECTED PV SYSTEM

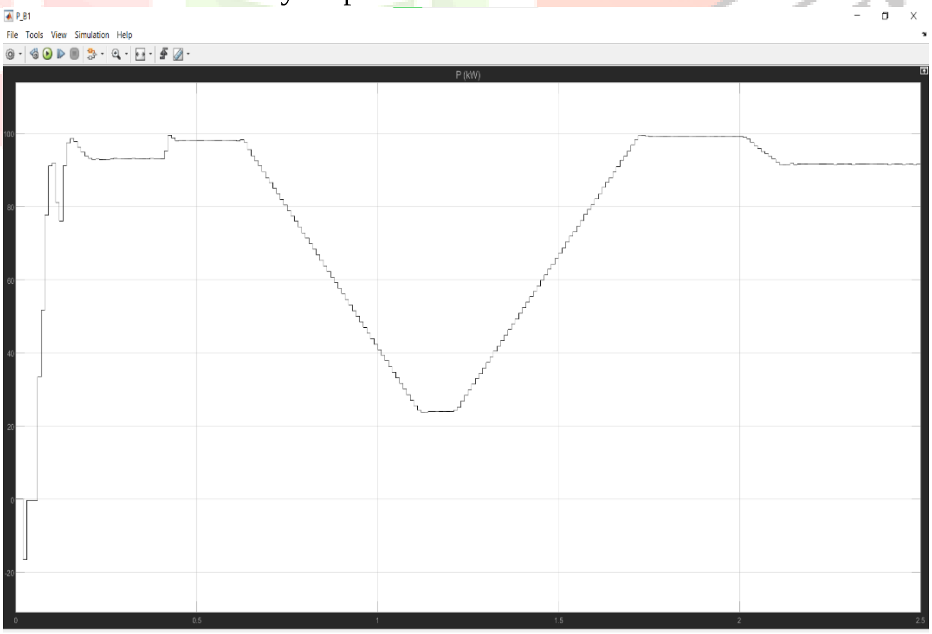
## OBSERVATIONS:

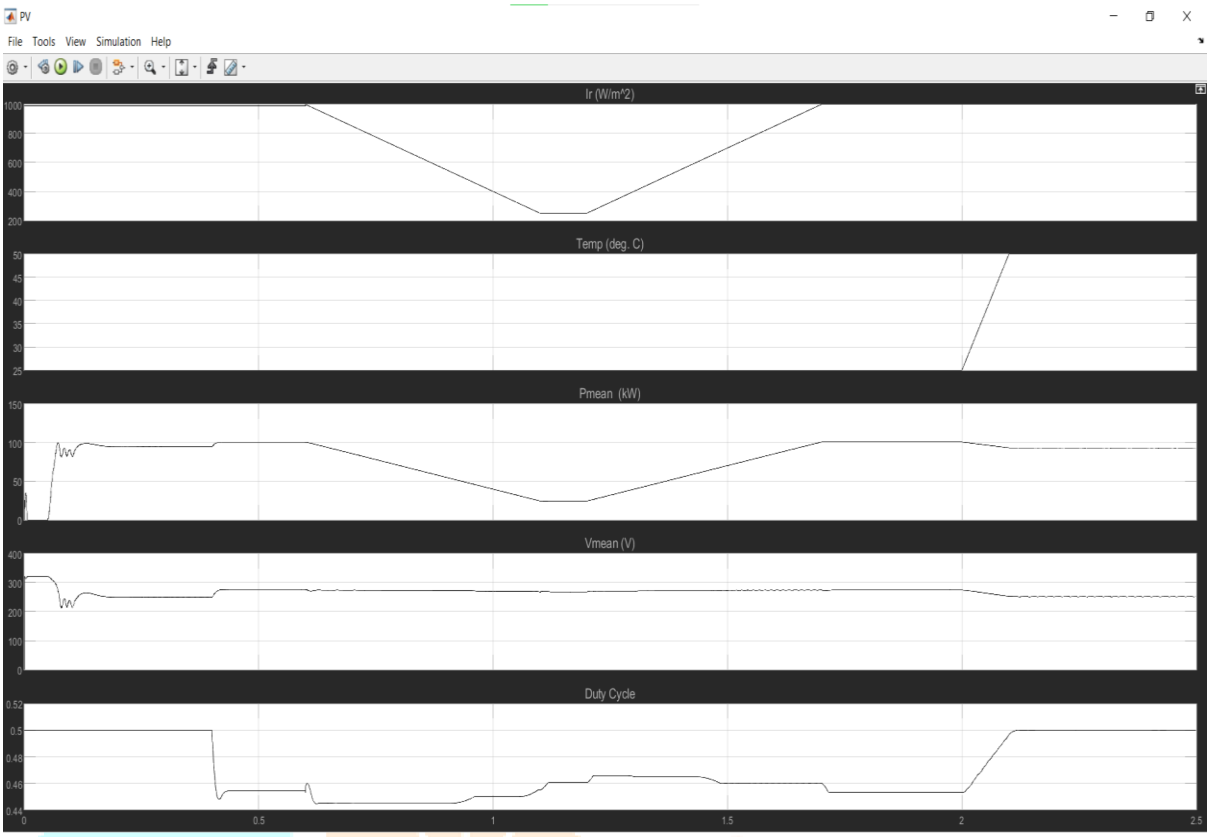
We have recorded utility grid voltage and power readings for the supplied inputs of sun irradiation and temperature from the PV array. The voltage and current waveforms of the PV array's output, the duty cycle of the boost converter, the voltage of the converter's output, the voltage and current waveforms at the grid, and the grid's power are all visible in scope. There is a 2.5 second simulation. Below are readings for phase to ground voltage, current, and power for varying sun irradiation and temperature.

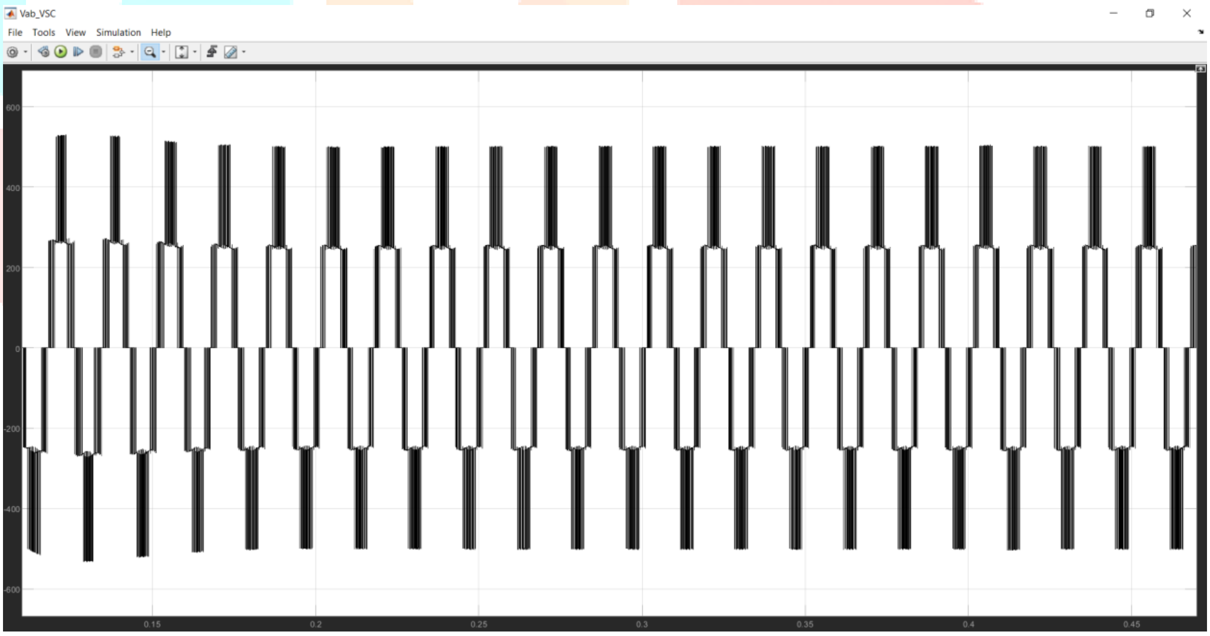
| Irradiance W/M2 | Temperature Deg.C | Pmean (KW) | Pa-B1 (KW) | Vdc inverter(V) | Vdc Booster(V) | Va-B1 (V) | Ia-B1 (A) |
|---|---|---|---|---|---|---|---|
| 10000 | 25 | 100.36 | 98.71 | 499.98 | 274.43 | 1.913*10 | 32.19 |
| 284.5 | 25 | 85.18 | 81.89 | 500.91 | 274.48 | 1.82*10 | 2.703 |
| 627.04 | 25 | 70.46 | 71.53 | 499.03 | 273.02 | 7.9*10 | 0.8099 |
| 375.44 | 25 | 40.39 | 41.52 | 499.903 | 269.94 | 1.986*10 | 1.997 |
| 320.5 | 25 | 24.34 | 23.92 | 499.99 | 268.91 | -1.97*10 | -0.9993 |
| 1000 | 35 | 100.36 | 98.70 | 499.99 | 274.44 | 1.34*10 | 2.084 |
| 1000 | 50 | 92.91 | 91.39 | 499.98 | 251.04 | -4.9*10 | -0.8237 |

**Graph:**

The scopes are shown below for every output in the simulation.




PV
File Tools View Simulation Help
Ir (W/m^2)
Temp (deg. C)
Pmean (kW)
Vmean (V)
Duty Cycle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**CONCLUSION:**

The grid-connected PV system of the future was proposed to be modeled in this study.The complex modeling of the system's parts has been extensively discussed. The incremental conductance method was used with a DC DC boost converter to raise the PV array's output power. A DC to AC PV inverter and an LC filter were created to convert DC voltage and current to AC values. Using controlled SPWM modulation, it has been utilized to produce reference signals for inverter IGBT switches. It was demonstrated that sun irradiance had a bigger impact on the system's output power than temperature did during testing of the system under varied temperature and solar irradiance values. The proposed model can be used to examine the system's

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