

Switching Panels for complete Utilization of Diode Clamped Multi Level Inverter for PV Systems

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ABSTRACT: Now a days multi-level inverters mostly used for the PV systems because of it's good harmonic profile and minimum dv/dt. Along with these advantages it is also suffering from issues like power balance caused by uneven partial shading. This paper proposes a technique to minimize the difference in discharge levels of upper and lower battery banks, and also selection of isolated panels through optimization by considering irregularity of roof top and worst case conditions. In addition, a control strategy is developed for switching isolated panels depending on difference in discharge levels. This topology makes the system to run longtime by complete utilization of battery banks. The proposed topology using diode clamped bridge configuration accompanied MATLAB/SIMULINK model.

KEYWORDS: PV Panels, battery banks, isolated panels, diode clamped inverter

I. INTRODUCTION

As solar energy reduces interdependence on non-renewable sources of energy and also depreciate the Greenhouse gas emissions eventually contribute to energy security. And also per unit price of grid is increasing, solar power can be on par with traditional coal fuels [1]. The total amount of solar insolation absorbed by the PV module is not converted into electricity but the major part of it contributes to increase the temperature of the panel, thus the efficiency of the system is a major issue. The random variation in the output voltage and current of the solar PV panel is due to the fact that it depends on the solar radiation levels and the operating temperature conditions. The Maximum Power Point Tracking (MPPT) methods are required to fully utilize it with power devices incorporated with the system to improve the efficiency [2]. India being located in equatorial belt, clear sun is expected 250 to 350 days a year in most parts. The total irradiant energy varies from 1600 to 2200 kWh/m² [3]. The Ministry of New and Renewable Energy has planned to install 10 GW utility scale solar projects and 1 GW off-grid solar power projects by the end of 2017 [4].

For conversion of DC to AC is better choice for multilevel inverters why it is better it has good power quality and very small THD and minimum dv/dt ratio [5]. There are so many topologies were proposed to have multi-level profile in inverter output voltage [5]. In a five-level topology was proposed by cascading of two three-level diode clamped inverters with fore isolated voltage source is shown. Using above five-topology, fore PV arrays along with fore battery bank-ups one for each is place of DC buses. In two stage conversion, to collect the energy from PV panels MPPT followed by inverters are used [6]. Recent studies have shown that grid-connected PV power systems suffer from harmonic interactions [7], reliability problems [8] or even instabilities leading to unwanted on-off switching of the interfacing inverters [9]. Therefore, modeling will become an even more important tool in solving the observed problems in the future. To achieve required rating of voltage and current, PV modules in series and parallel are cascaded and modeling of PV array is done [11][10]. Mathematical modeling of PV module is shown in [12],[11] which inputs of the system temperature and irradiance. To use MPPT algorithm maximum output of PV array for giving temperature and irradiance inputs. To study the MPPT algorithm and compared starting form hill climb, OC method, SC method, algorithms based on ANN and FUZZY [13]. The PV panels are partial shading the output of PV panel are

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drastically changes [14]. In recent years to increase the PV panels and increases the level of inverter to reduce the total harmonic distortion (THD).

II. RELATED WORK

In recent years to increase the PV panels and increases the level of inverter to reduce the total harmonic distortion (THD). The main aim of this paper to reduce the total harmonic distortion (THD) to decrease the PV panels with partial shading with a proposed topology. As PV panel output drastically varies with partial shading, in recent years much study was done on partial shading and its effects. Use of by-pass diodes and parallel configuration improves the output in PV array under non-uniform partial shading conditions. many MPPT algorithms are studied and compared starting from OC method, SC method, hill climb (P&O), Incremental Conductance Method, and algorithms based on ANN and fuzzy. IN this paper hill and climb method is used

III. PV ARRAY MODELLING AND MPPT

The current source along with diode, series and parallel resistances are modeled as PV cell. The PV current is a function of irradiance, temperature, wind speed, coefficients of material. PV cells are grouped in larger units called PV modules, which are further interconnected in a series-parallel configuration to form PV arrays. A solar cell is basically a p-n junction fabricated in a thin wafer of semiconductor. The electromagnetic radiation of solar energy can be directly converted to electricity through photovoltaic effect. Being exposed to the sunlight, photons with energy greater than the band-gap energy of the semiconductor creates some electron-hole pair proportional to incident radiation [3]pv. In fig.1 it shows a single diode modeling of PV module along with Np and Ns number of parallel, series of PV cells respectively [10][12]. The equations (1)-(4) shows output current of PV module with Ns number of series connected PV cells and Np number of PV cells connected in parallel.

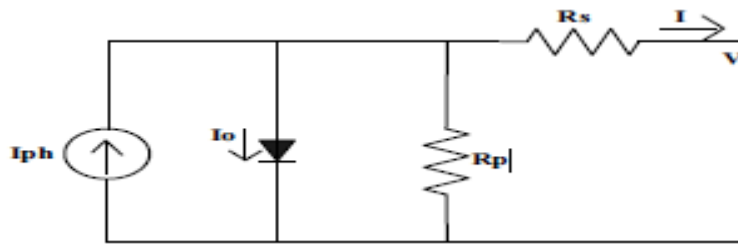


Fig.1 PV Module

Equations of a PV Module:

The basic equations from the theory of semiconductors and PVs that mathematically describe the I-V characteristic of the photovoltaic cell and module are given further in this section. The module photocurrent I_{ph} of the photovoltaic module depends linearly on the solar irradiation and is also influenced by the temperature according to the following equation (1)

$$I_{ph} = [I_{scr} + K_i (T - T_{ref})] * \lambda / 1000 \quad (1)$$

I_{pv} =PV array output current

T_{ref} =Cell's reference temperature

T=working temperature

K_i = short circuit temperature coefficient

λ =irradiation in W/m^2

Module reverse saturation current is given by (2)

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$$I_{rs} = \frac{I_{Scr}}{[\exp(QV_{oc} / N_s KAT) - 1]} \quad (2)$$

I_{rs} =reverses saturation current

K=Boltzmann constant

A=Ideal factor

V_{oc} =open cricket voltage

Module saturation Current is given by (3) and this current varies with the cell temperature and which is given by

$$I_0 = I_{rs} \left[\frac{T}{T_r} \right]^3 \exp \left[\frac{q * E_{go}}{AK} \left\{ \frac{1}{T_r} - \frac{1}{T} \right\} \right] \quad (3)$$

I_0 =saturation Current

T_r =Reference Temperature

E_{go} =Band gap for silicon

Module output current I_{pv} is given by (4)

$$I_{pv} = N_p * I_{ph} - N_p * I_0 \left[\exp \left\{ \frac{q * (V_{pv} + I_{pv} R_s)}{N_s AKT} \right\} - 1 \right] - \frac{1}{R_p} \left(\frac{V_{pv}}{N_s} + \frac{I_{pv} R_s}{N_p} \right) \quad (4)$$

I_{pv} =Module output current

N_p =Parallel number of cells for a PV array

N_s =Series number of cells for a PV array

R_s =Series Resistance

R_p =Shunt Resistance

q = charge of electron

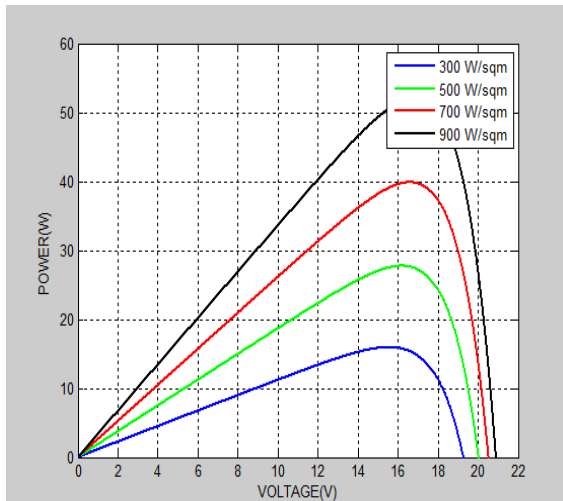


Fig. 2 Pvs V Characteristics of PV module

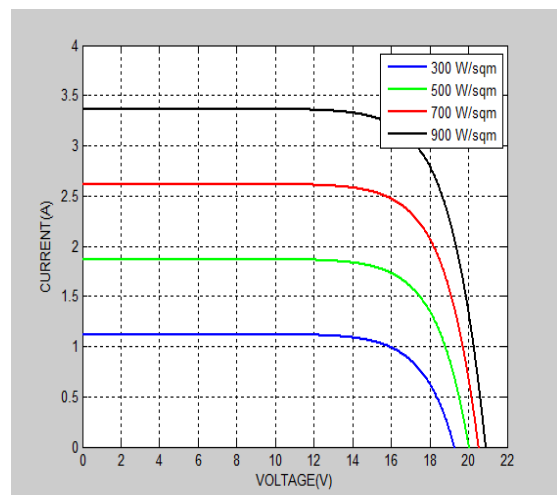


Fig.3 I vs V Characteristics of PV module

Solar energy is a clean and renewable energy resource for power generation. The power output from a solar photovoltaic system mainly depends on the nature of the connected load because of non-linear

I-V characteristics. The PV systems connected directly to the load result in overall poor efficiency as such MPPT is to be introduced in PV systems to increase the efficiency of the system [3]. Solar radiation, load impedance and module temperature are the three factors which affect the maximum power extraction from solar PV module. I-V curve of PV

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module is a function of insolation and temperature which affects output current and voltage. The increased temperature decreases the open circuit voltage (V_{oc}) while increased intensity of solar radiation increases short circuit current (I_{sc}). Therefore I-V and P-V curve changes according to the operating conditions which alters maximum power point accordingly as shown in Fig 4

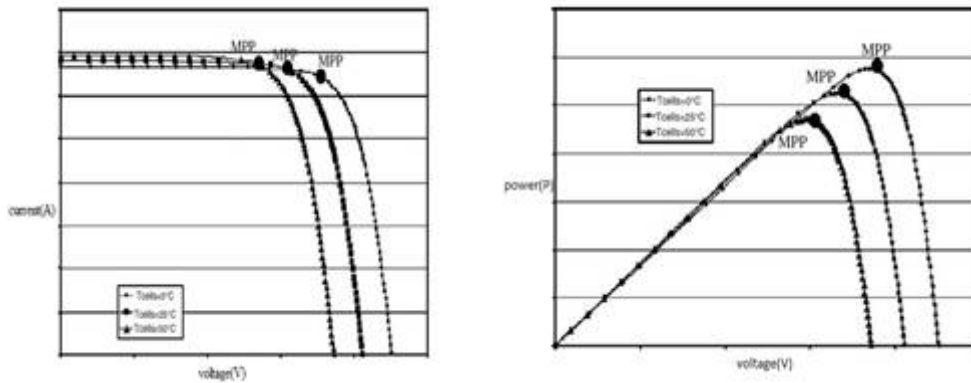


Fig 4 different characteristics of I Vs V and P Vs V of PV module

Steady state oscillations can be minimized by selecting very small perturbation in duty ratio. As show in below figure 5 hill climbing achieves MPP under different irradiances.

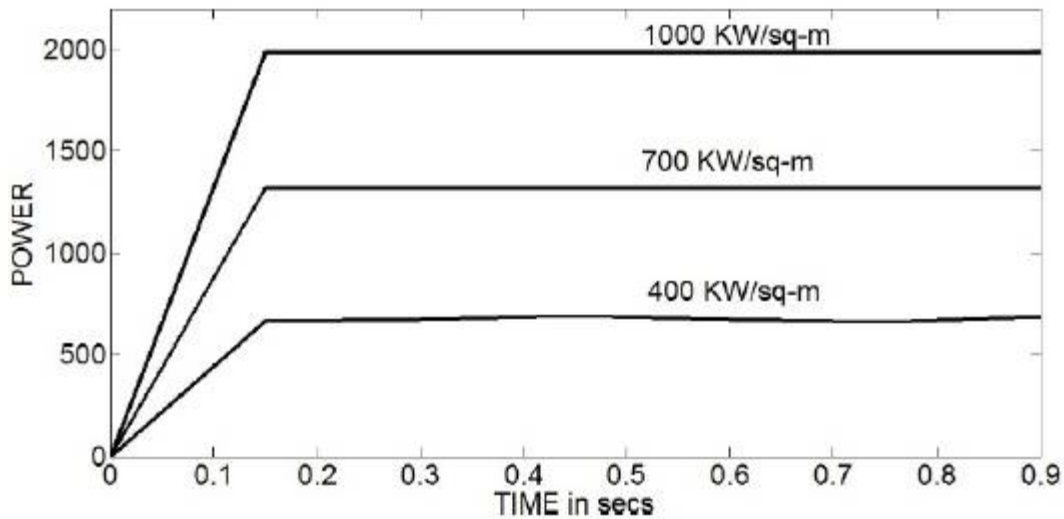


Fig 5 Maximum power point tracking under different irradiances

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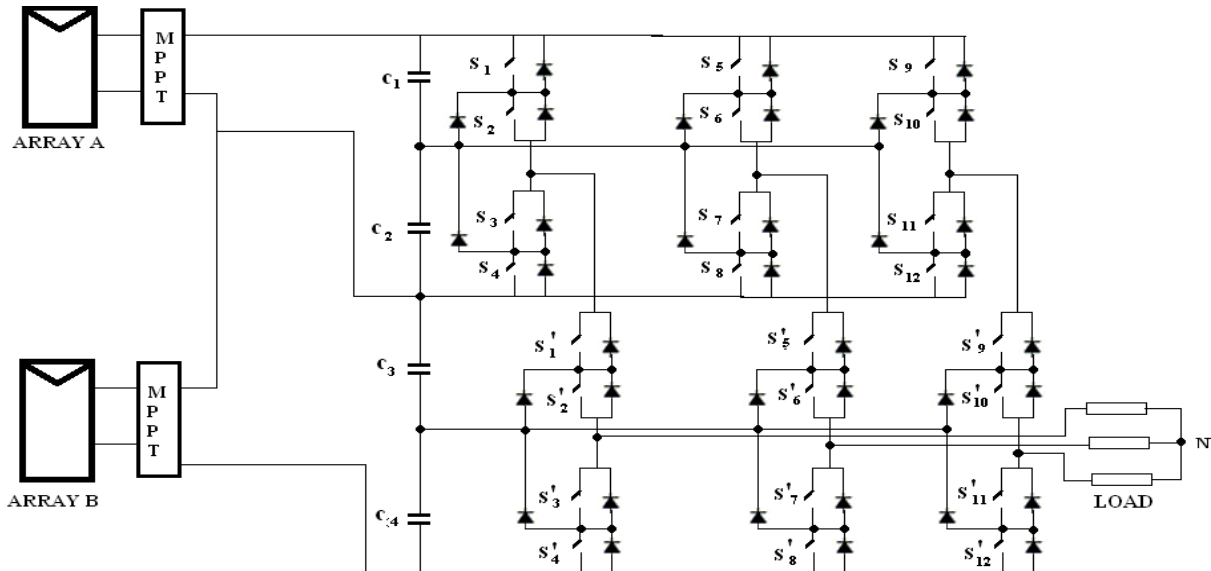


Fig.5. Two isolated PV arrays supplying to three-level diode clamped multi-level inverter

In urban roof tops where tradeoff between clearance space and inclination as show in fig. the effect of shading of panels results in start/more discharge in batteries. In case of uneven roof tops where one of possible cases shown in fig. as show in fig partial shading of one panel on other is different in array-A to array-B. In case the two PV panels are used the THD value is. To increase the PV panels and increase the level of inverter to reduce the THD value. The main aim of this paper to reduce the THD value.

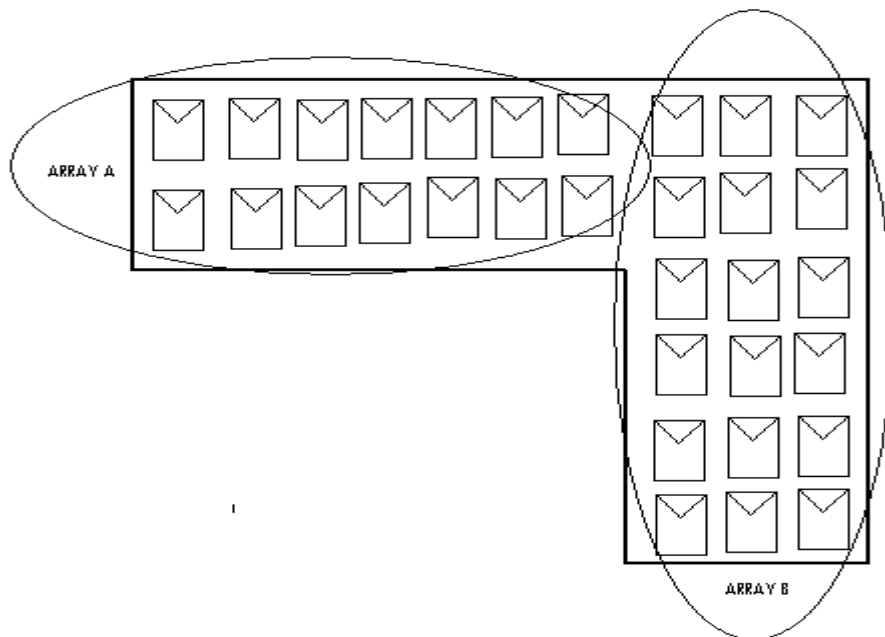


Fig.6 One of possible case of irregular roof top

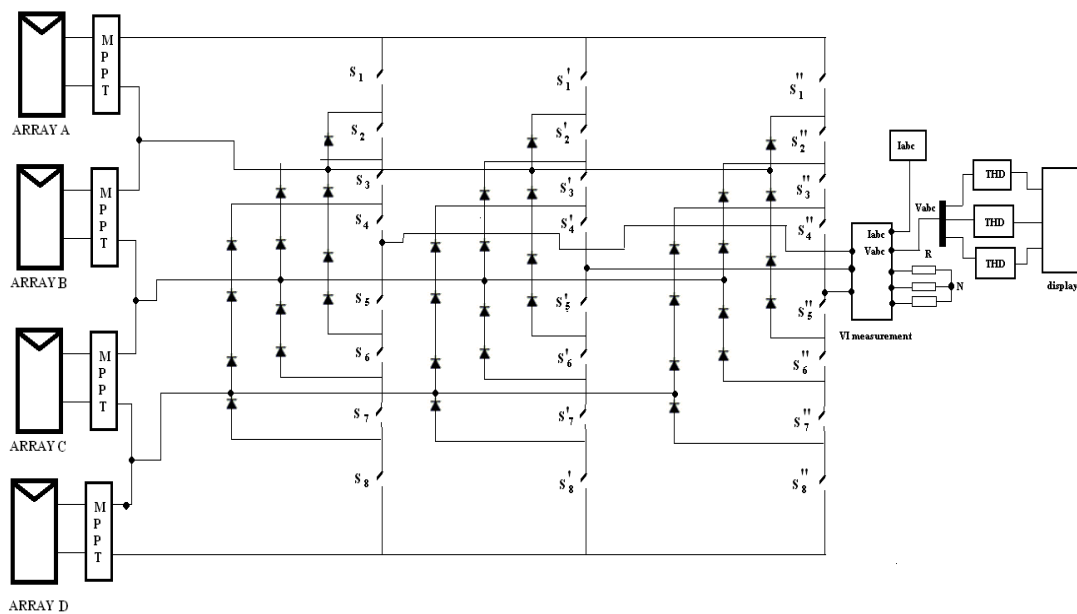
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As show in above figure 6 one of possible case of irregular roof top. The effect of shading of panels results in start /more discharge in batteries. In case of uneven roof tops where one possible case as show in above fig6.To increase the level and PV panels of the system. Fore PV panels are fed to the five level diode clamped inverter.

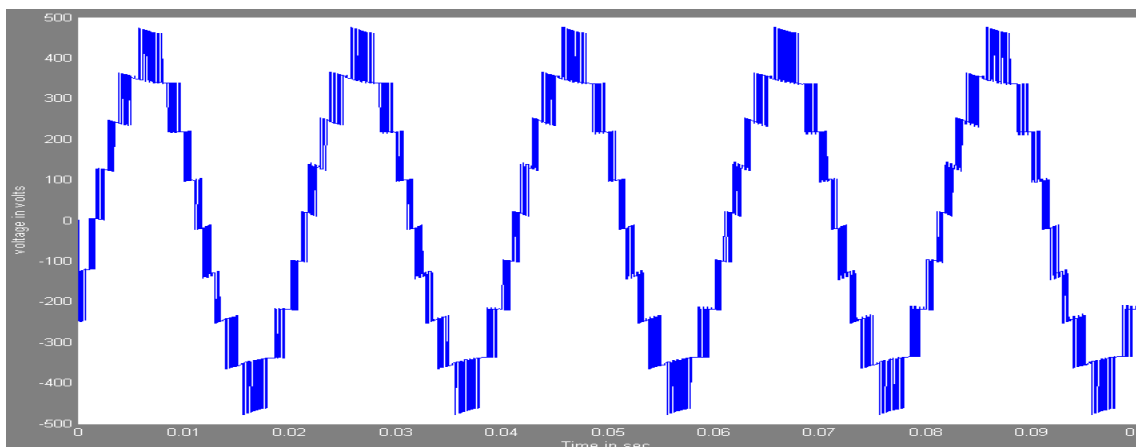
IV. PROPOSED TOPOLOGY



The figure shows the proposed topology using five level diode clamped inverter faded by four arrays and this topology find out the very low THD value to show in display.

V.SIMULATION RESULTS

The proposed topology shown in this paper has been simulated in MATLAB/SIMULINK software. The following figure shows the simulation results of the proposed system.

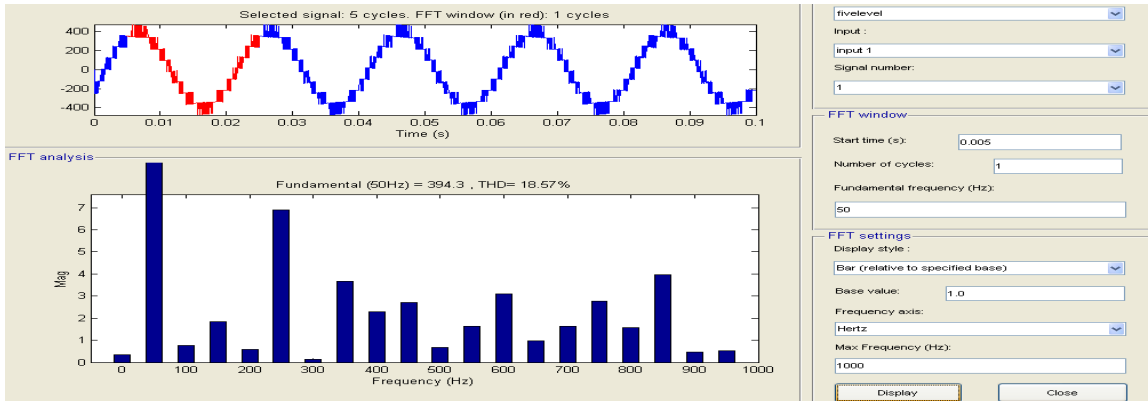


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The case study, to increase the level of system in three level to five level as show in above fig. tacking x-axis time in sec(0-0.1) and y axis voltage in volts(-500-500). In this fig it is a voltage Vabc.



To increase the level of the system to reduce the THD value of the system the FFT analysis of the voltage Vabc as show in above fig. as show in below fig the selected signals five to tack one cycles in FFT analysis to show the FFT analysis of 50Hz fundamental frequency is 18.57% of THD.



The voltage Vabc signal are connected to THD block the different voltages are produces that voltages as show in below fig. to show the fig there are three waveforms every waveform x axis in time in sec and y axis voltage in volts.

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The different voltage to apply the FFT analysis of the system to give the different THD values. As shown in the below three figures, the FFT analysis of the three signals is shown. Three signals with a 50 Hz fundamental frequency: the first signal has a THD value of 131.15%, the second signal has a THD value of 77.68%, and the third signal has a THD value of 56.72%.

VI. CONCLUSION

For improving the energy efficiency and power quality issues with increasing demand, grid-connected solar PV systems are taking a good place. In this paper, modeling and simulation of a grid-connected solar PV system using a five-level diode-clamped multi-level inverter. First, a mathematical model of a PV cell is given, and P-V and I-V characteristics are obtained for different irradiation levels. Then, a 3-inverter has been modeled using a d-q reference frame. The feed forward grid voltage compensation can effectively eliminate the grid harmonics disturbance, and both fast dynamic response and high quality current output with very low THD can be achieved for a grid-connected solar PV system.

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BIOGRAPHY



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