e-ISSN:2582-7219

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH IN SCIENCE, ENGINEERING AND TECHNOLOGY

Volume 6, Issue 12, December 2023

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 7.54

6381 907 438 6381 907 438 ijmrset@gmail.com www.ijmrset.com

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.54| Monthly Peer Reviewed & Referred Journal |

| Volume 6, Issue 12, December 2023 |

| DOI:10.15680/IJMRSET.2023.0612019 |

Design and Analysis of Grid Connected PV System

Suraj Kanhu Raut [1], Prof. (Dr.) S.S Khule [2], S.S Hadpe [3]

Department of Electrical Engineering, Matoshri College of Engineering and Research Centre, Nashik, India

ABSTRACT: A grid-connected photovoltaic (PV) power system with high voltage gain is proposed, and the steady-state model analysis and the control strategy of the system are presented in this paper. For a typical PV array, the output voltage is relatively low, and a high voltage gain is obligatory to realize the grid-connected function. The proposed PV system employs a ZVT-interleaved boost converter with winding-coupled inductors and active-clamp circuits as the first power-processing stage, which can boost a low voltage of the PV array up to a high dc-bus voltage. Accordingly, an accurate steady-state model is obtained and verified by the simulation and experimental results, and a full-bridge inverter with bidirectional power flow is used as the second power-processing stage, which can stabilize the dc-bus voltage and shape the output current. Two compensation units are added to perform in the system control loops to achieve the low total harmonic distortion and fast dynamic response of the output current.

KEYWORDS: - Bidirectional power flow control, compensation units, direct current control, maximum-power-point-tracking (MPPT) method, photovoltaic (PV) system, steady-state model.

I.INTRODUCTION

In this new innovative world of growing technology and entrepreneurships the billion dollar term is Power. From manufacturing, transporting, building to lightening a small lamp requires one or different kind of power. And the problem is how to generate this Power? But however human beings managed an older legacy to generate power and paid whatever cost required to invent and generate it. But somehow the fantasy of clean generation was never achieved by the humans; instead every step was directly or indirectly harming the nature. To dominate this harm the solar power took a lead charge to jump towards the green generation. The following paper deals with such a way to produce green energy by using photovoltaic grid connected system inverters are needed to realize the power conversion, grid interconnection, and control optimization .Generally, gird-connected pulse width modulation (PWM) voltage source inverters (VSIs) are widely applied in PV systems, which have two functions at least because of the unique features of PV modules. First, the dc-bus voltage of the inverter should be stabilized to a specific value because the output voltage of the PV modules varies with temperature, second, the energy should be fed from the PV modules into the utility grid by inverting the dc current into a sinusoidal waveform synchronized with utility grid. Therefore, it is clear that for the inverter-based PV system, the conversion power quality including the low THD, high power factor, and fast dynamic response, largely depends on the control strategy adopted by the grid-connected inverters. Due to practical problems we are using battery in place of grid for demonstration purpose. The Main problem with PV System is to trap and store the solar energy, which may be solved by using a battery with a smart controlling circuit to automatically charge the battery when excess power is produced and to deliver the power as load is connected to the system. The system here uses a 12 V / 7A battery which can be used further for high voltage gain purpose using MPPT. The grid-connected PV power system can offer a high voltage gain and guarantee the used PV array voltage is less than 50 V. On the one hand, the required quantity of PV modules in series is greatly reduced. And the system power can be controlled in a wide range from several hundred to thousand watts only by changing the quantity of PV module branches in parallel. Therefore, the proposed system can not only be applied to the string or multistring inverter system, but also to the module-integrated inverter system in low power applications.

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.54| Monthly Peer Reviewed & Referred Journal |

| Volume 6, Issue 12, December 2023 |

| DOI:10.15680/IJMRSET.2023.0612019 |

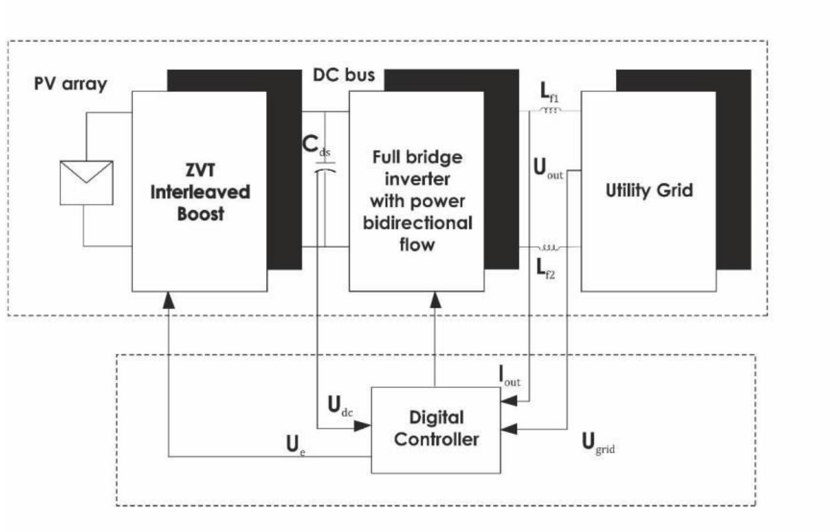


Figure 1: Control block of two-stage grid-connected PV system

II.LITERATURE REVIEW

It is important to state that the amount of literature on World's energy, the solar energy system and PV grid connected systems is enormous. So much study is needed to design a grid connected PV system with battery backup accurately from first principles. The author of this thesis has attended courses on the subject, read over a hundred books, journals and papers. This chapter will cover just a little portion of that enormous amount of literature. In simple terms, solar energy is energy from the sun. It is a semiconductor - based technology that converts light energy from the sun to electrical energy. It is the only source of electrical energy where there are no moving parts, noise or emissions.

In 1921, Albert Einstein won the Noble Peace Prize for Physics for his paper on the photoelectric effect (The paper was published in 1904). Until about 1973, the only market for photovoltaic systems was its use in powering space vehicles. In 1973, the energy disruptions caused by the oil embargo caused governments around the world to 19 begin looking for alternative energy sources. The most common form of photovoltaic device has been the crystalline and amorphous silicon. Other technologies like Copper indium dieseline (CIS), Cadium-telluride (CdTe) and organic solar cells (using titanium oxides and organic dyes) are still under research. Telecommunications, water pumping, residential and commercial activities and mainly utility grid support. When the sun shines on a PV panel, the PV panel produces Direct Current but solar Systems vary in complexity from its use in water pumping which requires only a PV module to be connected to a load to a solar home system.

Off-grid PV systems, as the name implies, are systems that are not connected to the public electricity grid. These systems require an energy storage system for the energy generated because the energy generated is not usually required at the same time as it is generated (DGS, 2008). In other words, solar energy is available during the day, but the lights in a stand-alone solar lighting system are used at night so the solar energy generated during the day must be stored for use in the night. They are mostly used in areas where it is not possible to install an electricity supply from the mains utility grid, or where this is not cost-effective or desirable. They are therefore preferable for developing countries where vast areas are still frequently not supplied by an electrical grid. Off-grid systems are usually employed in the following applications; consumer applications such as watches and scientific calculators, industrial applications such as telecommunications and traffic signs and remote habitations such assolar home systems and water pumping applications.

Grid-connected systems are systems connected to a large independent grid usually the public electricity grid and feed power directly into the grid. These systems are usually employed in decentralized grid-connected PV applications and

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.54| Monthly Peer Reviewed & Referred Journal |

| Volume 6, Issue 12, December 2023 |

| DOI:10.15680/IJMRSET.2023.0612019 |

centralized grid-connected PV applications (DGS, 2008). Decentralized grid-connected PV applications include rooftop PV generators, where the PV systems are mounted on rooftops of buildings and incorporated into the building's integrated system (DGS, 2008).

Solar system when compared to grid supply and even fuel generators on purely initial cost is seen to have a higher cost. IEA PVPS task 1 report of 2000 states that in IEA countries PV electricity can now be generated at less than 0.6 USD per kWh, which is cost competitive in many off-grid applications. However, PV is locked in a critical "Chicken and egg" situation between price and economy of volume. A bigger market is needed to generate economy of scale

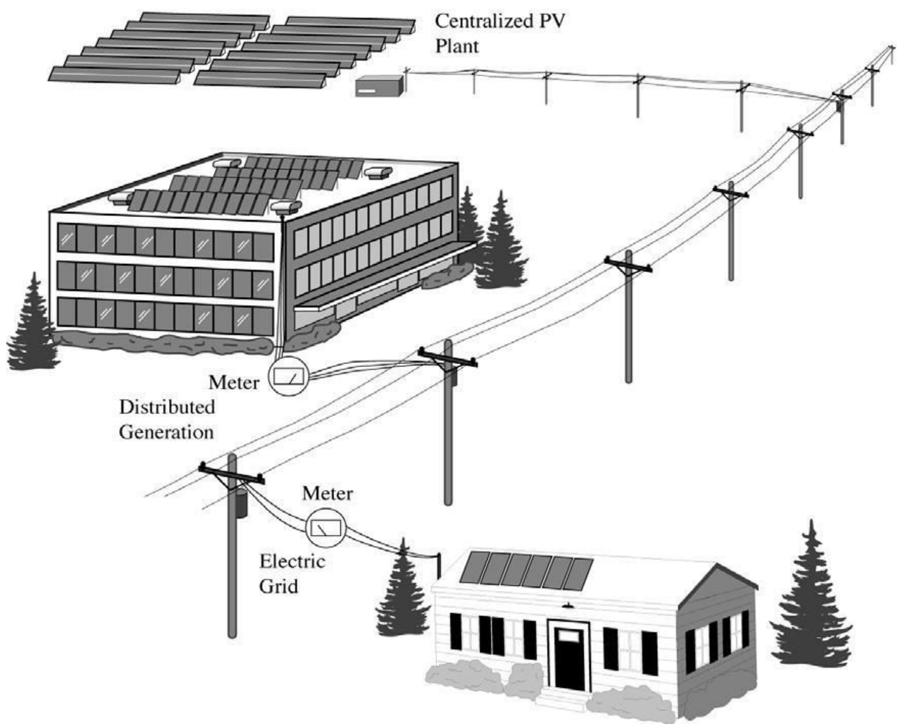


Figure 2: Schematic diagram of different grid- connected photovoltaic systems.

III.METHODOLOGY OF PROPOSED SURVEY

Let us consider what happens in the vicinity of a *p–n* junction when it is exposed to sunlight. As photons are absorbed, hole-electron pairs may be formed. If these mobile charge carriers reach the vicinity of the junction, the electric field in the depletion region will push the holes into the *p*-side and push the electrons into the *n*-side. The *p*-side accumulates holes and the *n*-side accumulates electrons, which creates a voltage that can be used to deliver current to a load. If electrical contacts are attached to the top and bottom of the cell, electrons will flow out of the *n*- slide into the connecting wire, through the load and back to the *p*-side. Since wire cannot conduct holes, it is only the electrons that actually move around the circuit. When they reach the *p*-side, they recombine with holes completing the circuit. By convention, positive current flows in the direction opposite to electron flow, so the current arrow current going from the *p*-side to the load and back into the *n*-side. Electrons flow from the n-side contact, through the load, and back to the p-side where they recombine with holes.

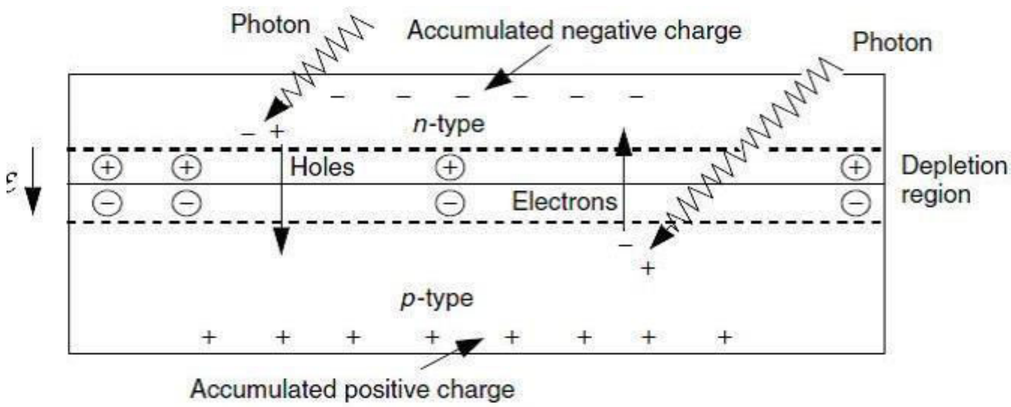
After solar panels, inverters represent the single largest hardware cost in any solar project. While most commercial and utility-scale solar projects in the United States have traditionally employed central inverters, there is increasing interest in the use of string inverters for certain applications. Solar cells produce electricity as direct current (DC). Inverters convert DC power to alternating current (AC) power that is used by businesses and homes. Individual solar panels are connected in series

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.54| Monthly Peer Reviewed & Referred Journal |

| Volume 6, Issue 12, December 2023 |

| DOI:10.15680/IJMRSET.2023.0612019 |

to form strings. When using a central inverter, the DC power produced from each string runs along wires to combiner boxes where they are connected in parallel with other strings.



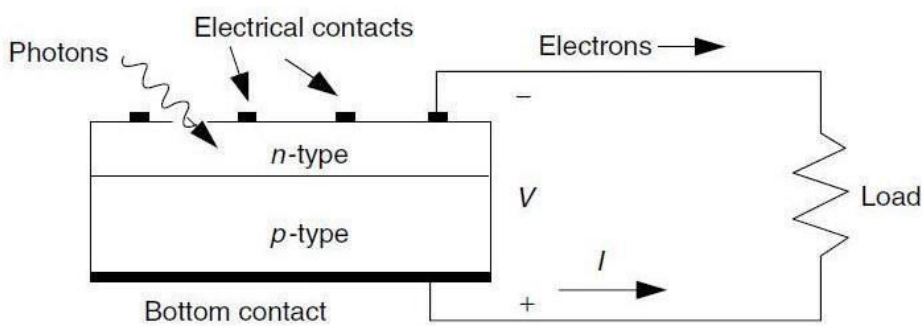


Figure 3: Photons create hole–electron pairs near the junction

Figure 4: Connecting wires to P-layer and n-layer for conduction.

A relatively new term and misleading term in the world of alternative energy, it applies primarily to solar electric generating equipment. Grid Tie or Non grid Tie or Grid Interactive is a better term. Generically, an inverter is a device which changes electricity from DC (direct current) to AC (alternating current). Prior to the popularization of system which interact with the utility grid, most photovoltaic (PV) electricity-generating systems were based on one or more solar panels which produced 12, 24 or 48 volts nominal DC power. In situations where more power (more panels) were used, the panels would be connected in parallel, to increase the available current flow while keeping the voltage output at 12, 24 or 48 volts, depending on the nominal panel output voltage. In Grid Tie system the panels are wired in series which increases the voltage and keeps the current low so that wiring is simpler and wire size can be smaller. When panels are wired in series it is a STRING of panels. Hence the term String Inverter. However you can have string of panels on systems where the controller changes the voltage to battery voltages and the inverter is not a "String Inverter" or Inverters which are Grid Tie and work off Battery voltage.

The Multistring inverter concept has been developed to combine the advantage of higher energy yield of a string inverter with the lower costs of a central inverter, Lower power DC/DC converters are connected to individual PV strings. Each PV string has its own MPP tracker, which independently optimizes the energy output from each PV string. To expand the system within a certain power range only a new string with a DC-DC converter has to be included. All DCDC converters are connected via a DC bus through a central inverter to the grid. The central inverter is a PWM inverter based on the well-known and cheap GIFT technology already used in drive systems and includes all supervisory and protection functions. Depending on the size of the string the input voltage ranges between 125-750 V. Module inverters are more likely to operate with systems using 12, 24 or 48 volt batteries. The panels may be 12V or 24V, possibly 48V panels, and these are

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.54| Monthly Peer Reviewed & Referred Journal |

| Volume 6, Issue 12, December 2023 |

| DOI:10.15680/IJMRSET.2023.0612019 |

called modules. The drawback is that at lower voltages the currents become ridiculous for a few kW, and the cables are huge. They are more suited to simple low power operation, with batteries. A 12 V system is practically limited to a few hundred Watts. The output of a PV module can be reduced dramatically when even a small portion of it is shaded. Unless special efforts are made to compensate for shade problems, even a single shaded cell in a long string of cells can easily cut output power by more than half. External diodes, purposely added by the PV manufacturer or by the system designer, can help preserve the performance of PV modules. The main purpose for such diodes is to mitigate the impacts of shading on PV I –V curves. Such diodes are usually added in parallel with modules or blocks of cells within a module.

IV.CONCLUSION AND FUTURE WORK

We have presented a prototype for grid-connected PV power system with high voltage gain. The proposed PV system employs a high step-up ZVT-interleaved boost converter with winding-coupled inductors and active-clamp circuits as the first power-processing stage, and high voltage gain is obtained by the turn's ratio selection of winding-coupled inductors. A full bridge inverter is used as the second power-processing stage, to stabilize the dc-bus voltage and shape the output current. The main achievement of this project is obtaining direct power form PV panels when sunlight is available and excess power is stored in the battery while the stored power can be utilized any time later. Also as per the load condition we can increase or decrease the number of Solar panels with changing the battery and the transformed of appropriate rating.

REFERENCES

[1] "Design and Analysis of a Grid-Connected Photovoltaic Power System" Bo Yang, Wuhua Li, Member, IEEE, Yi Zhao, and Xiangning He, Fellow, IEEE

[2] Frank Yeboah Dadzie (BSc. Electrical Engineering (Hons)) " Design of a grid connected photovoltaic system for knust and economic and environmental analysis of the designed system"

[3] B. A. Miwa, D. M. Otten, M. F. Schlecht, "High efficiency power factor correction using interleaving techniques", IEEE Applied Power Elec. Conf. Proc., Mar. 1992, pp. 557–568.

[4] National Centre for Photovoltaic, www.nrel.gov/ncpv 2003.

[5] S. B. Kjaer, J. K. Pedersen, and F. Blaabjerg, "A review of single-phase grid-connected inverters for photovoltaic modules," IEEE Trans. Ind. Appl., vol. 41, no. 5, pp. 1292– 1306, Sep./Oct. 2005.

[6] The Solar Report by Cenergy power http://cenergypower.com/blog/string-vs-central- inverters-choosing-right-inverter/

[7] A. Bellini, S. Bifaretti, and V. Iacovone, "Resonant DC–DC converters for photovoltaic energy generation systems," in Proc. IEEE SPEEDAM Conf., 2008, pp. 815–820.

[8] "Design and Analysis of a Grid-Connected Photovoltaic Power System" Bo Yang, Wuhua Li, Member, IEEE, Yi Zhao, and Xiangning He, Fellow, IEEE

[9] D. Fu, F. C. Lee, Y. Liu, and M. Xu, "Novel multi-element resonant converters for front-end dc/dc converters," in Proc. IEEE PESC Conf.,2008, pp. 250–256.

[10] Naci Genc, Ires Iskender "An improved zero-voltage-transition interleaved boost converter with high power factor", Gazi University, Faculty of Engineering and Architecture, Department of Electrical & Electronics Engineering, 06570, Maltepe, Ankara, Turkey

Impact Factor
7.54

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH IN SCIENCE, ENGINEERING AND TECHNOLOGY

| Mobile No: +91-6381907438 | Whatsapp: +91-6381907438 | ijmrset@gmail.com |

www.ijmrset.com