Single Phase, Single-stage Current Source Inverter-based photovoltaic system for grid Connection

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ABSTRACT

In this paper, a single, single phase current photovoltaic source for inverter-based for grid connection grid is proposed. The highest power point is maintained by the Perturb & Observe Method, which is as simple as the operating concept. To connect PV system with grid a transformer is mandatory. To eliminate transformer to make system light and simple a high values inductor is mandatory. To improve power quality, system efficiency and reduce inductor size double compatible double filter filter is recommended. This also eliminates the harmonics of the second and fourth sides of the inverter dc. The current switch-based network switch system is proposed to magnetize the dc-link installer by reducing one leg of the bridge converter after every active switch cycle.

Key words- Photovoltaic (PV), Maximum Power Point Tracking(MPPT)

1. INTRODUCTION

Based on semiconductor technology, the basic principle of solar cells is given, that electricity will flow between two semiconductors when they are connected to each other and exposed to light (photons). This process, known as photovoltaic technology Photovoltaic (PV) technology converts one form of energy (sunlight) into another form of energy (electricity) that does not use moving parts, does not consume ordinary fuels, creates pollution, and lasts for decades. The use of a widely available and reasonably reliable oil source, SUN.

1.1 PHOTOVOLTAIC CELL

PV cells are basically a semiconductor diode. The term photovoltaic is derived from the effect of photovoltaic. This semiconductor diode creates a p-n junction exposed to light. When illuminated by sunlight it produces electrical energy. PV cell is made of various semiconductor materials. Such as micro-crystalline, mono-crystalline silicon, poly-crystalline silicon, amorphous silicon, cadmium telluride and copper indium gallium selenide / sulfide. But mono-crystalline silicon and poly-crystalline silicon are used for commercial use. The electromagnetic effect can be defined as the occurrence in which an electron is released from a conductor band as a result of the absorption of sunlight of a certain wavelength by matter (solid or non-metallic solids, liquids or gases). A photovoltaic cell, whenever the sunlight strikes, part of the sun's energy is absorbed into the semiconductor material. When the absorption capacity is greater than the semiconductor band gap, the electron from the valence band jumps towards the conductor band. With this, hole-electron pairs are created in the illuminated area of the semiconductor. So the electrons created in the steering band are now free to move. So these free electrons are forced to move in a certain direction by the action of the electric field present in the PV cells. These flowing electrons emit current and can be attracted to proper use by attaching a metal plate to the top and bottom of a PV cell. This current and voltage (created due to its built-in electrical outlets) produce the required power. Figure 1 shows the internal photovoltaic cell structure.

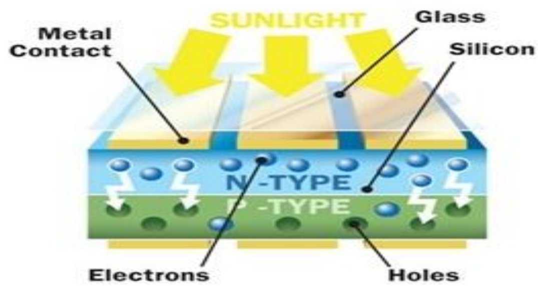

Fig. 1 Photovoltaic Cell Structure

1.2 CHARACTERISTICS OF A PV CELL

The Photovoltaic Characteristics is very important parameter. Its indicates performance of photovoltaic Module. The parameters includes Irradiance, Open Circuit Voltage(I_{oc}), Short Circuit Current(I_{sc}), Maximum Voltage(V_{MPP}), Maximum Current(I_{MPP}), Power, Maximum System Voltage, Tolerance etc. These all are electrical parameters and consider under Standard Test Condition(STC). Standard Test Conditions (STC) considered as irradiance of 1000W/m2, spectrum AM 1.5 and cell temperature of 25°C.

There is also Mechanical Parameters including Weight, Cell arrangement, Junction Box(size), Back side Cover Front Cover(Glass) size, Encapsulate Material (Ethylene vinyl acetate- EVA) size etc.

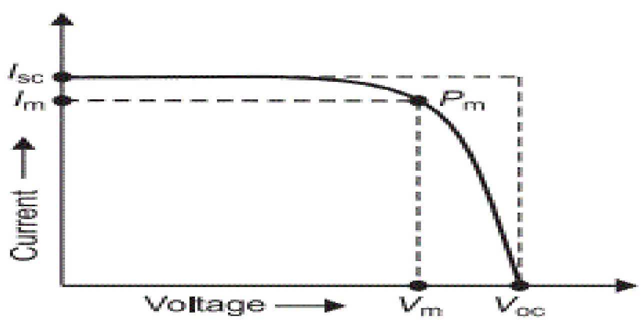

Fig. 2 P-V Characteristics of PV Cell

1.3 PHOTOVOLTAIC EFFECT

The effect due to which light energy is converted to electric energy in certain semiconductor materials is known as **photovoltaic effect**. This directly converts light energy to electricity without any intermediate process. To understand the effect of photovoltaic let's consider a silicon crystal block. The upper part of the block is lined with donor dirt and the lower part is lined with acceptance or dirt. As a result the interaction of free electrons is much higher in the n-zone compared to the p-zone region and the concentration of the hole is much higher in the p-area compared to the n-block region. There will be a high focus gradient for charging carriers across the block assembly line. Free electrons from the n-zone try to propagate in the p-type area and the pits in the p-type area try to propagate in the n-n-crystal area. This is because charging carriers naturally tend to vary from high focus area to low focus area. Each free electron of the n-zone when it reaches the p-type area due to dispersion, leaves the donor ion directly behind it in the n-n zone. This is because each free electron in the n-zone is given one atom of a neutral donor. Similarly when a hole is distributed from type p to type n, it leaves a negative reception or ion behind it in the p-type area.

2. INVERTER

2.1 VOLTAGE SOURCE INVERTER (VSI)

The inverter where the input voltage remains unchanged is called the Voltage Source Inverter.Fig.3 and 4 show schematic diagrams of one phase and three phase voltage sources respectively.These topologies require only a single dc source and for medium output power applications the preferred devices are n-channel IGBTs. EDC and VS are the dc input supply and a large dc link capacitor (CDC) is installed in all supply areas. Capacitors and switches connected to the dc bus using short cables to reduce the inductance lost between the capacitor and the inverter switch. Needless to say, the physical composition of the right and wrong bus lines is also important to limit the missing inductances. S1, S2, S3 etc. fast and controllable switches. D1, D2, D3 etc. instant recovery diodes are connected to anti-parallel switches. ‘A’, ‘B’ and ‘C’ outlet terminals of the inverter are connected to an ac. A three-phase inverter has three load-phase terminals whereas a single-phase inverter has only one pair of load terminals.

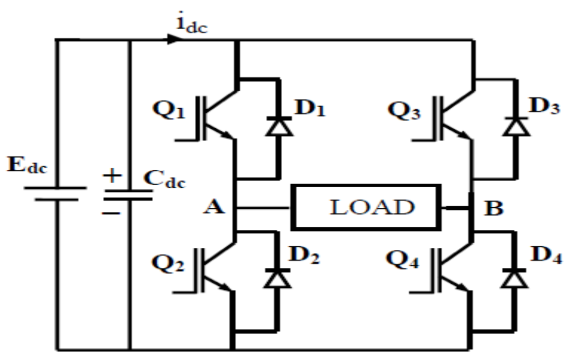

Fig. 3 Single Phase Voltage Source Inverter

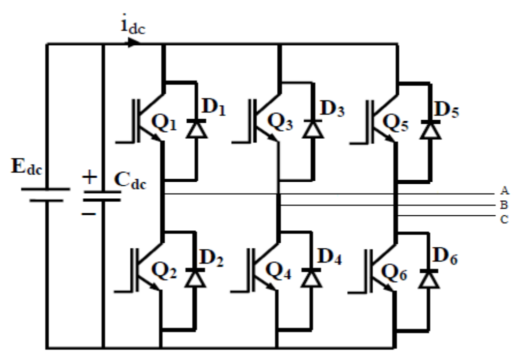

Fig. 4 Three Phase Voltage Source Inverter

2.2 CURRENT SOURCE INVERTER (CSI)

The inverter in which the input current remains constant is termed as Current Source Inverter. In other words the input behaves as current source. The output current is maintained constant irrespective of load on the inverter and output voltage is forced to change. Figure 5 and 6 shows the single phase and three phased Current Source Inverter configuration respectively.

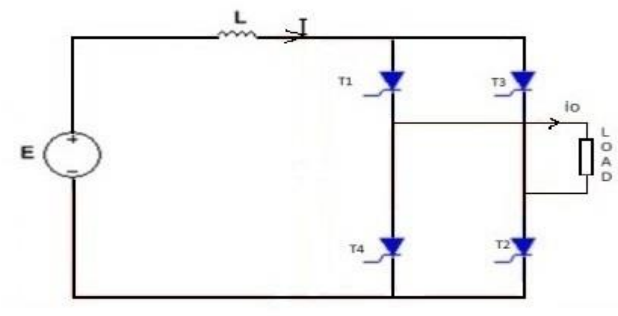

Fig. 5 Single Phase Current Source Inverter

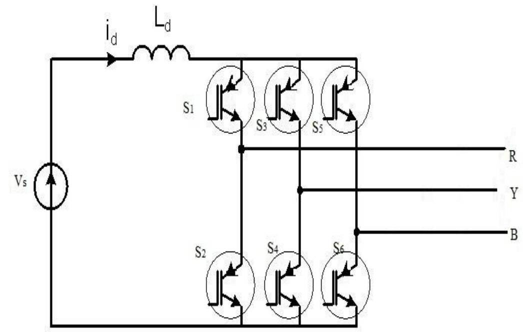

Fig. 6 Three Phase Current Source Inverter

2. *DOUBLE TUNED RESONANT FILTER*

In one phase of the Current Source Inverter (CSI), the output is not pure sinusoidal. Pulsating. It even produces harmonics right now for dc-link. These even harmonics have two major effects. The other side of the ac as the abnormal harmonics of low current and voltage. Secondly even these harmonics affect the Maximum Power Point Tracker (MPPT) on the PV side. This may shorten Photovoltaic (PV) life. To reduce the effect of these dc-side harmonics on the ac and PV side. There are two proposed solutions.

One is to use a large amount of inductance to be used. These large value inductances are able to reduce the current dc-link ripple produced by these harmonics. Here we used an inductor with a value of 300mH. But in reality this installation is not possible. Because it adds cost, size, weight and may be a loss. Another major impact is that the outpatient response of MPPT is slow. To overcome this, a second solution might be helpful. Second In order to reduce the amount of large inductor, a dual compatible resonant filter is introduced. This is a Double-Sided Resonant Filter, usually placed in a series with a low value mound. This filter is capable of smoothing dc-link current with a small inductor. Even if the harmonic effect of the second order is important to the current dc-link, the harmonic of the fourth order may also affect the current dc-link, especially if the Current Source Inverter (CSI) works with high flexibility indicators. The basic of Double Tuned Resonant Filter is shown in figure 7.

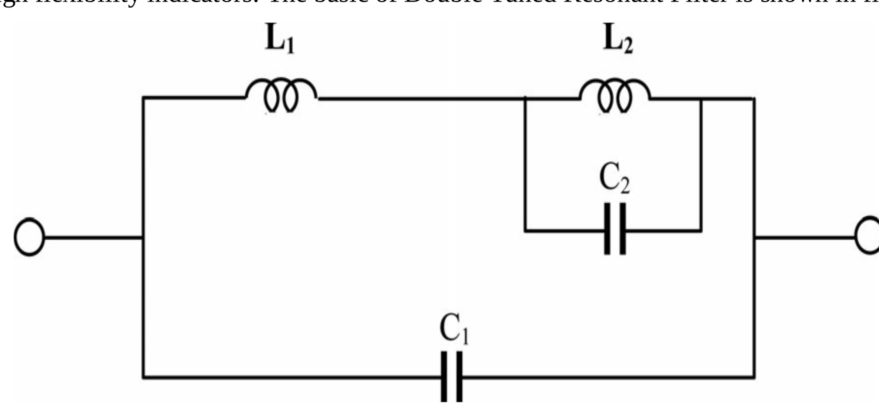

Fig. 7 Double Tuned Resonant Filter

3. RESULTS

4.1 WITHOUT USE OF DOUBLE TUNED RESONANT FILTER

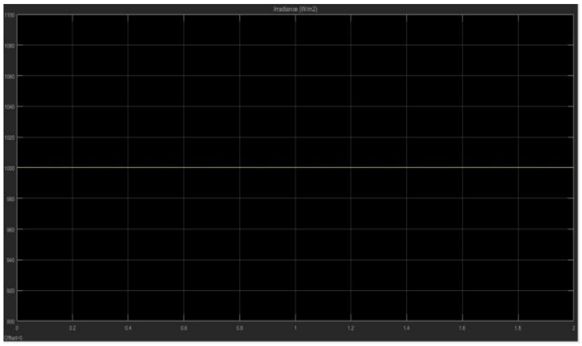

Fig. 8 Irradiance

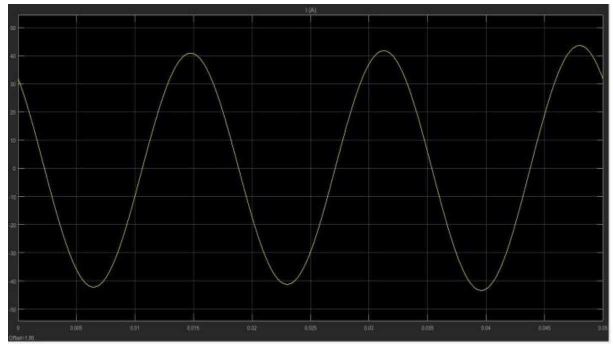

Fig. 9 Grid Current

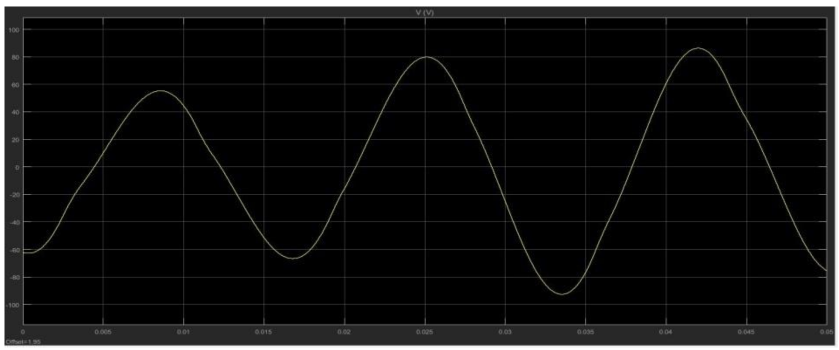

Fig. 10 Grid Voltage

3.2 WITH USE OF DOUBLE TUNED RESONANT FILTER

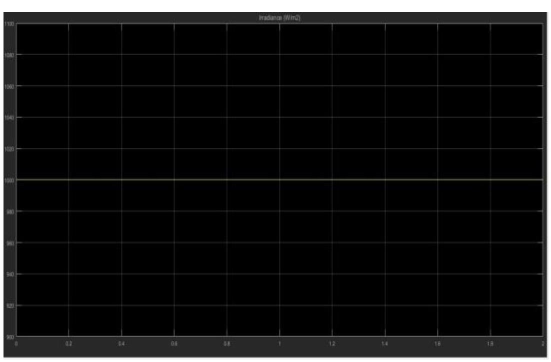

Fig. 11 Irradiance

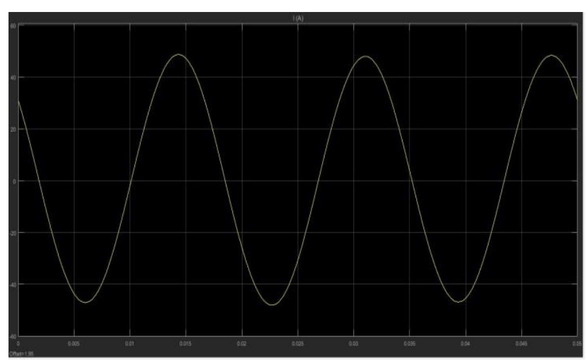

Fig. 12 Grid Current

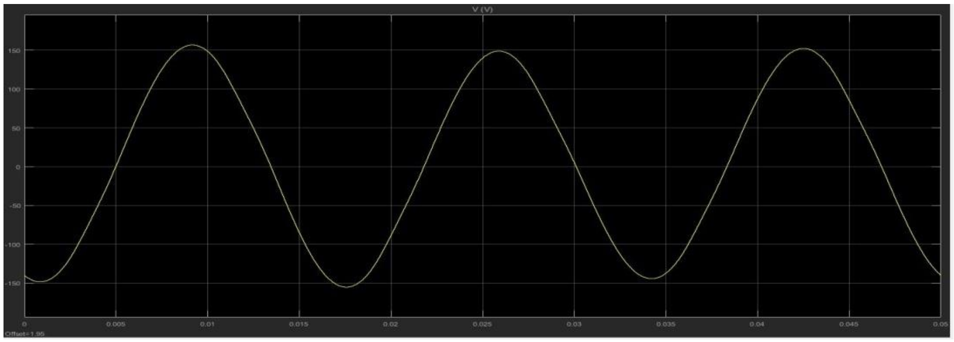

Fig. 13 Grid Voltage

4. *REFERENCES*

1.PV cell basic A Thesis titled "Modeling of Photovoltaic array" in Department of Electrical Engineering In National Institute of Technology, Rourkela

2.A Necessity of Hybrid AC/DC Micro grids in Indian Electricity Sector, Dr. Mrs G A Vaidya, Prof. Mrs Kalyani M Kurundkar, Electrical India Magazine Volume 56 No 1 January 2016

3. A Thesis Title "Maximum Power Point Tracking Algorithm and Software Development" Delft University of Technology Faculty of EEMCS June 27, 2012, Stefan Moring, Anton Pols, Dr. J. Popovic

4.A Literature titled "Moving Toward A Cleaner Future" by Dinesh Dhut, Electrical India Magazine Volume 55 No 11 November 2015

5.electrical4u.com

6. A reconsider learn of photovoltaic array most power track algorithms by Hala J. El-Khozondar , Rifa J. El-Khozondar, Khaled Matter and Teuvo Suntio in Renewable : storm, Water & Solar in Springer unlock periodical

7.A Paper generous "A novel most Power direct Tracking for Photovoltaic system" accessible in global Journal of Electrical & Electronics Engineering by Mohamed Azab date 3:11 2009

8. Utmost Power aim track for Photovoltaic Optimization by Ripple-Based Extremum looking for Control Steven in IEEE Transactions on authority Electronics, , Vol. 25, No. 10, OCTOBER 2010 by Steven L. Brunton1, Clarence W. Rowley, Sanjeev R. Kulkarni, and Charles Clarkson page no. 253 to 254

9. Appraisal editorial on psychiatry of a Three Phase Grid-Connected PV control scheme using a Modified Dual-Stage Inverter by Denizar Cruz Martins ISRN Renewable Energy amount 2013, Article ID 40312,18 pages http://dx.doi.org/10.115/2013/406312, Hidawi Publishing business

10. Solitary Phase single stage transformer fewer Grid linked PV scheme by G.M.Kulkarni, Prof.S.S.Khule Matoshri academy of Engineering & investigate Centre in Spvryan's global Journal of Engineering Sciences & knowledge (SEST) ISSN : 2394-0905

11. Bader N. Alajmi, Khaled H. Ahmed, Grain Philip Adam, and Barry W. Williams," Single-Phase Single-Stage Transformer less Grid-Connected PV System", IEEE Transactions On Power Electronics, Vol. 28, No. 6, June 2013

12. M. G. Villalva, J. R. Gazoli, and E. R. Filho, "Comprehensive approach to modeling and simulation of photovoltaic arrays," IEEE Transaction on Power Electronics, vol. 24, no. 5, pp. 1198–1208, May 2009.

13. S. Dasgupta, S. K. Sahoo, S. K. Panda, and G. A. J. Amaratunga, "Single phase inverter-control techniques for interfacing renewable energy sources with microgrid—Part II: Series-connected inverter topology to mitigate voltage-related problems along with active power flow control," IEEE Transaction on Power Electronics, vol. 26, no. 3, pp. 732–746, Mar. 2011.

14. B. N. Alajmi, K. H. Ahmed, S. J. Finney, and B. W. Williams, "Fuzzy logic control approach of a modified hill-climbing method for maximum power point in microgrid standalone photovoltaic system," IEEE Transaction on Power Electronics, vol. 26, no. 4, pp. 1022–1030, Apr. 2011.

15. Y. Bo, L.Wuhua, Z. Yi, and H. Xiangning, "Design and analysis of a grid connected photovoltaic power system," IEEE Transaction on Power Electronics, vol. 25, no. 4, pp. 992–1000, Apr. 2010.