

# A Smart Transformer-Less PV System Based on Filter Method

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**Abstract-** In this era, a utilization of renewable energy is more important like solar energy, wind energy, bio-gas energy to match the current requirement of power by the market. In this paper discusses the PV module which generate the power and transferred that without use of transformer system. This is a smart grid PV module system which boosting the voltage at maximum point by applying MPPT algorithmic rule. The smart grid system that utilize CSI which further drive by the modulation techniques like PWM and SVPWM and also use the filtration mechanism such as LLC filter to reduce the harmonics and also calculate the parameter like active and reactive power which shows the system stability, at last a comparison with existing mechanism has been shown at these parameters.

**Keywords:** PV, MATLAB, PWM, SVPWM, LLC, CSI

## I. INTRODUCTION

This In the past century, the burning of fossil fuel has revolutionized the world with rapid industrial development, while there are unavoidable consequences that are seriously affecting public health and the environment. Apart from the obvious issues arising in the fossil fuel supply chain, the most serious risk in terms of universality and irreversibility is global warming associated with the combustion of fossil fuel. It has been reported that over 70% of total greenhouse gas emission is carbon dioxide (CO<sub>2</sub>), whilst over 60% of the CO<sub>2</sub> is emitted from the use of fossil fuels. Although there is a notable slowdown in the growth of global greenhouse gas emission, as long as CO<sub>2</sub> is emitted it will continue to build up in the atmosphere. In order to stabilize, or even reduce the effect of global warming, the use of fossil fuel needs to be significantly reduced; and this has led to an increasing demand for clean and sustainable renewable energy resources. [1]

As one of the most effective ways to fight against these environmental concerns, photovoltaic (PV) technology has experienced significant development and huge cost improvements over the past decade. Particularly in recent years, driven by the rising demand for electricity and the increasing competitiveness of solar PV energy, PV capacity has expanded exponentially in some regions. According to data from the Renewable 2017 Global Status Report, additions to the worldwide PV capacity during 2016 reached 75 GW with an increase of 48% compare to 2015, which is greater than the cumulative world capacity five years earlier. Among this amount over 34 GW were contributed from China, representing nearly half of the global additions. Meanwhile the top five markets have been reported to be China, the United States, Japan, India and the United

Kingdom, accounting for approximately 85% of additions. By the end of 2016, the total solar PV capacity reached 303 GW. Figure 1 shows the global cumulative solar PV capacity and annual additions between 2006 and 2016. Furthermore, due to the substantial demand from China, IHS Market predicts another record-breaking year for global photo voltaic in 2018, forecasting new installations to hit 108 GW by the year's end. Given a continued strong growth of PV deployment through to 2022, the global cumulative PV capacity is forecast to expand by over 920 GW.

The International Energy Agency (IEA) envisions a contribution of 16% of global electricity from PV generation by 2050; this, in turn will lead to an annual reduction in carbon dioxide emission of 4 Gt in the process. While demand for off-grid (stand-alone) PV is growing rapidly, the capacity of grid-connected PV applications is expanding at a faster pace and continues to comprise the vast majority of global solar PV installations. Even though centralized large-scale grid-connected projects have accounted for a rising share of the annual addition compared to other renewable energy sources, one of the advantages of grid-connected PV generation is its wide-ranging power scale. This makes it possible for individuals to implement PV plants, for example, in residential and industrial rooftop systems.

Both consumers and power utilities can benefit from the widespread deployment of distributed PV applications which reduce capital expenditure, improve power quality and increase generation and transmission efficiency. In 2016, a capacity of at least 20 GW grid-connected distributed PV systems have been installed worldwide. Supported by new policies established by some countries, there tends to be an increasing demand for small-scale residential PV systems.

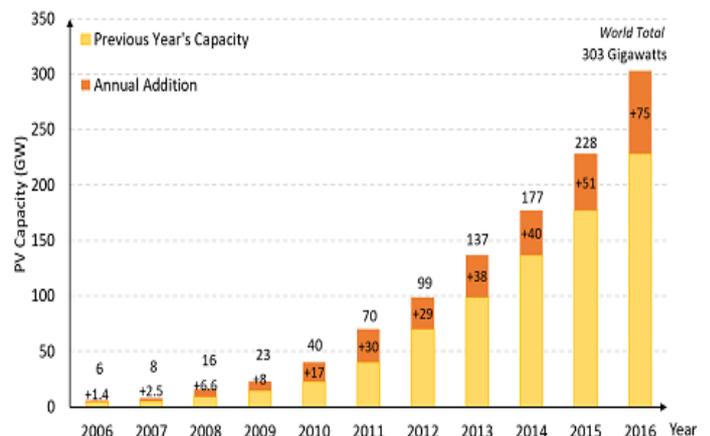


Fig 1. World solar PV capacity and annual additions between 2006 and 2016 [2]

**II. OVERVIEW OF GRID-CONNECTED PV INVERTER SYSTEM**

As stated earlier, PV systems broadly fall into stand-alone and grid-connected systems. The energy generated in stand-alone systems is consumed by local loads in the same place without the need for interaction with the grid. Therefore, no grid-connected VSI is presented in such systems, and they are outside the scope of this work. Different PV inverter topologies in grid-connected systems are generally categorized based on the number of power processing stages, power scale, and the interconnection of the isolation transformer. The control functions are implemented to ensure the grid-connected PV inverter system injects a sinusoidal current to the grid at the highest possible conversion efficiency.

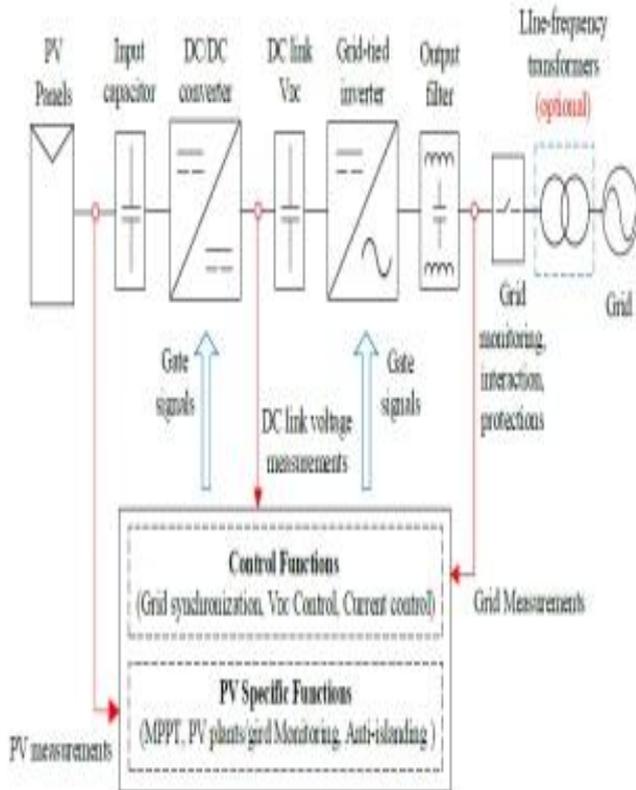


Fig 2: An overview of generic two-stage grid-connected PV inverter system [2]

In the above figure 2 shows the two stage grid connected PV inverter system. More specifically, the outer loop, for DC voltage control, balances the active power between the DC side and the grid side by maintaining the voltage across the DC link capacitor at a specific reference level. Meanwhile the current controller and grid synchronization work together as an inner loop to regulate the output sinusoidal current, allowing for the PV inverter and the grid to work in unison. These control functions including output current control and grid synchronization techniques, are discussed in detail in this proposed work.

**III. PROPOSED METHODOLOGY**

In the work proposed a transformer less PV system, in the below figure 3 shows the block diagram of proposed method.

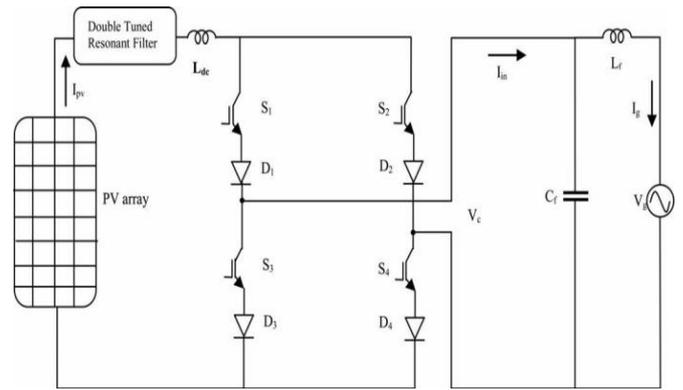


Fig. 3 Block Diagram transformer less PV system [8]

**1. Double Tuned Resonant Filter**

In a single-phase Current Source Inverter the output is not pure sinusoidal. It is Pulsating. It generates even harmonics in the dc-link current. These even harmonics has two major effect. One is on the ac side as low-order odd harmonics in the current and voltage. Second these even harmonics affect Maximum Power Point Tracker (MPPT) on PV side. This may be reduce Photovoltaic (PV) life. In order to reduce the effect of these dc-side harmonics on the ac side and on the PV. In the use of large value inductance must use. These large value inductance is capable reduce the dc-link the dc-link current ripple produced by these harmonics. Here we used the inductor of value 300mH. But practically this large value inductance is not possible.

Because it added cost, size, weight & may be losses also. Another major effect is that is slow the MPPT output response. To overcome this, the second solution may be useful. Second To reduce the value of large inductor, a double tuned parallel resonant filter is introduced. This Double Tuned Resonant Filter, generally placed in series with the inductor of low value. The basic of Double Tuned Resonant Filter is shown in figure 4.

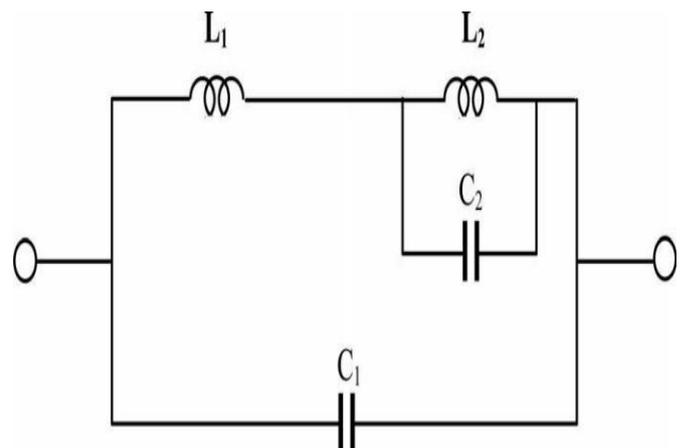


Fig.4 Double Tuned Resonant Filter

**IV. SIMULINK MODEL AND RESULT**

For the simulation of proposed model use MATLAB SIMULINK version R2017B. There are different result parameters are discussed in the work. Peak to peak signal value [9] [10], root mean square value [11], THD [12], grid voltage and current. Simulation is done in two modes. One is with use of Double Tuned Resonant Filter and second is without use of Double Tuned Resonant Filter.

In the above figure 5 shows the block diagram of proposed transformer less PV system. In discuss the different result parameters calculated in this presented research work. In the below figure 6 show the obtain grid current that is denoted by I (A). It's measure in ampere. In the figure x axis denoted the timing and y axis denoted the current. Maximum output obtain at 1.5s 4.7 Amp as well as minimum value -4.6Amp

In the below figure discuss the result outcome of proposed method in both form tabular form as well as graphical representation of presented work. In the above comparison clearly shows that the with double filter proposed method shows better result and low losses as compare to without filter method that is previously represented.

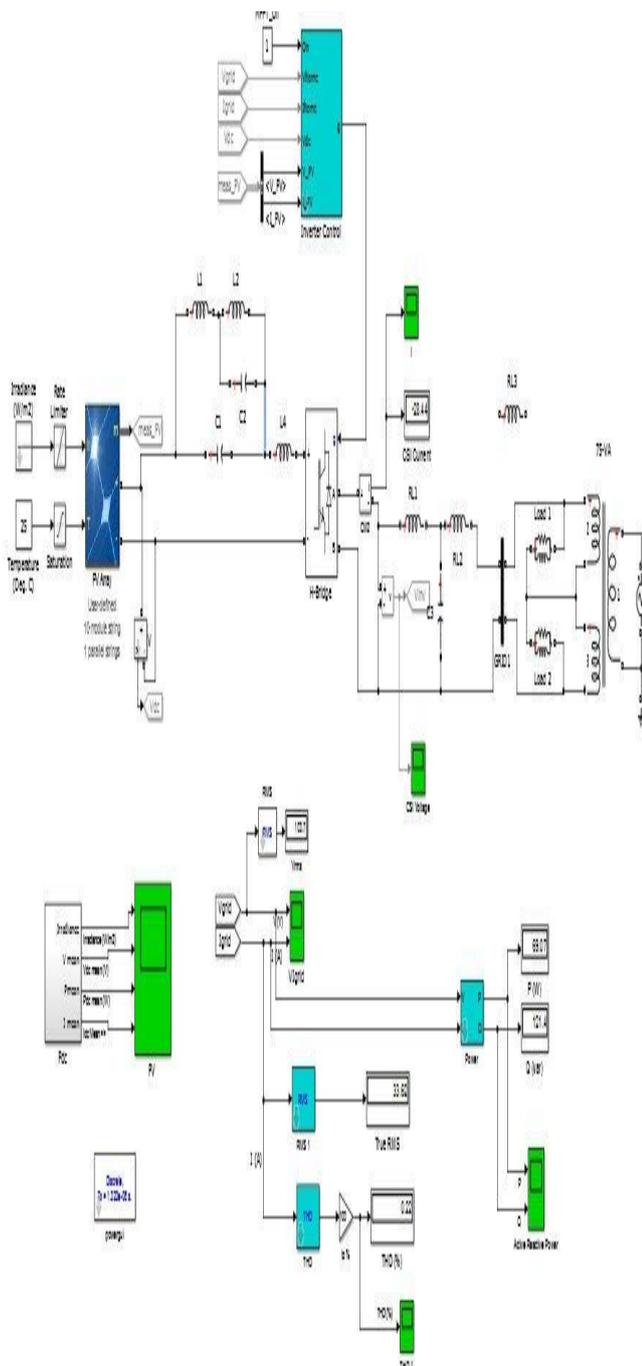


Fig. 5 Main Diagram With use of Filter

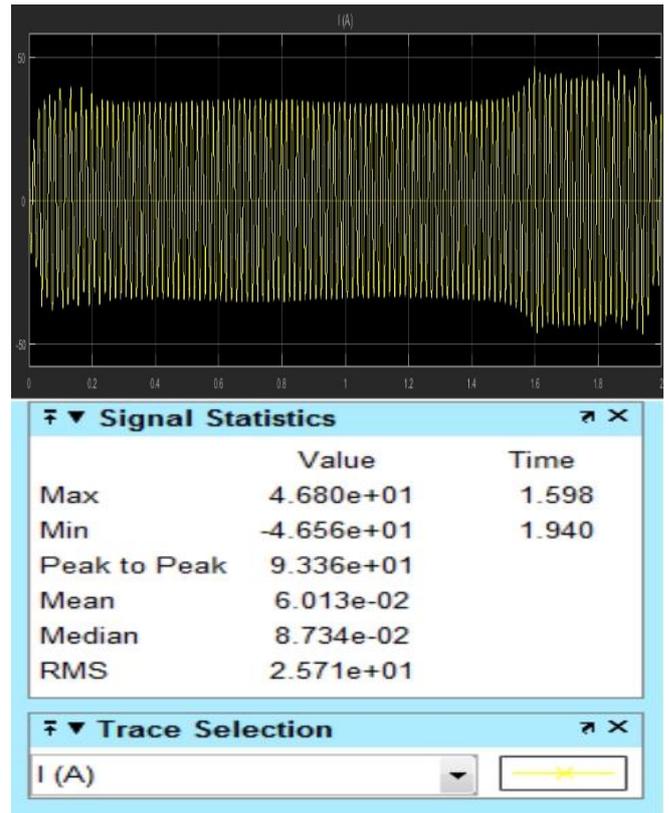


Fig. 6 Grid Current and Obtain Grid Results

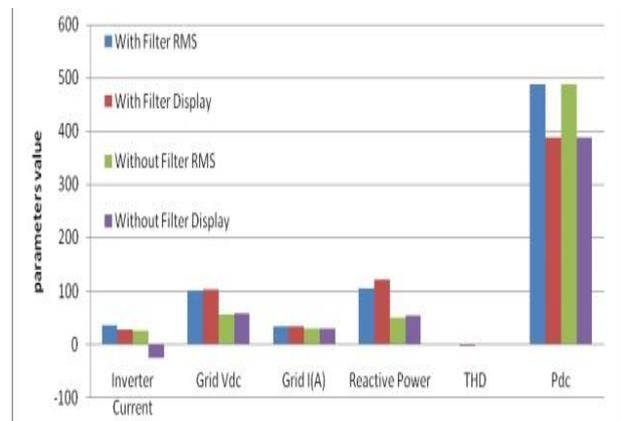


Fig. 7 Graphical Comparison of Results

**V. CONCLUSION**

This presented work focus on feed forward Cascade-This thesis present a grid connected PV system without use of transformer. The required power for grid is achieved and can be send to grid without use of transformer. The MPPT successfully locks desired voltage at Maximum Power Point. The system uses current source inverter which is further drive by carrier based pulse width modulation. The High value inductor can be reduced by double tuned resonant filter. Resonant filter also eliminated harmonics. The Total Harmonic Distortion with Inductor is 1.86 and with Double tuned resonant filter 1.73. All results are simulated in MATLAB/SIMULINK.

## REFERENCES

- [1] Guo, Xiaoqiang, Na Wang, Baocheng Wang, Zhigang Lu, and Frede Blaabjerg. "Evaluation of Three-Phase Transformerless DC-Bypass PV Inverters for Leakage Current Reduction." *IEEE Transactions on Power Electronics* 35, no. 6 (2019): 5918-5927.
- [2] Sabry, Ahmad H., Zeina Mueen Mohammed, Farah Hani Nordin, NH Nik Ali, and Ali Saadon Al-Ogaili. "Single-phase grid-tied transformerless inverter of zero leakage current for PV system." *IEEE Access* 8 (2019): 4361-4371.
- [3] Li, Xiaoyan, Xiangyang Xing, Chenghui Zhang, Alian Chen, Changwei Qin, and Guangxian Zhang. "Simultaneous common-mode resonance circulating current and leakage current suppression for transformerless three-level T-type PV inverter system." *IEEE Transactions on Industrial Electronics* 66, no. 6 (2018): 4457-4467.
- [4] Rajeev, Mini, and Vivek Agarwal. "Analysis and control of a novel transformer-less microinverter for PV-grid interface." *IEEE Journal of Photovoltaics* 8, no. 4 (2018): 1110-1118.
- [5] Valderrama, Gerardo Escobar, Gerardo Vazquez Guzman, Erick I. Pool-Mazún, Panfilo Raymundo Martinez-Rodriguez, Manuel JLopez-Sanchez, and Jose Miguel Sosa Zuñiga. "A single-phase asymmetrical T-type five-level transformerless PV inverter." *IEEE Journal of Emerging and Selected Topics in Power Electronics* 6, no. 1 (2017): 140-150.
- [6] Kafle, Yuba Raj, et al. "Performance comparison of single-phase transformerless PV inverter systems." 2017 IEEE Applied Power Electronics Conference and Exposition (APEC). IEEE, 2017.
- [7] Guo, Xiaoqiang, and Xiaoyu Jia. "Hardware-based cascaded topology and modulation strategy with leakage current reduction for transformerless PV systems." *IEEE Transactions on Industrial Electronics* 63.12 (2016): 7823-7832.
- [8] Mollah, Almas Hossain, P. G. K. Panda, and P. P. K Saha. "Single phase grid-connected inverter for photovoltaic system with maximum power point tracking." *International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering* 4, no. 2 (2015): 648-655.
- [9] Yadav Pranay, "Color image noise removal by modified adaptive threshold median filter for RVIN." In *2015 International Conference on Electronic Design, Computer Networks & Automated Verification (EDCAV)*, pp. 175-180. IEEE, 2015
- [10] Sharma, Shachi, and Pranay Yadav, "Removal of fixed valued impulse noise by improved Trimmed Mean Median filter." In *2014 IEEE International Conference on Computational Intelligence and Computing Research*, pp. 1-8. IEEE, 2014.
- [11] Yadav, Pranay, and Parool Singh, "Color impulse noise removal by modified alpha trimmed median mean filter for FVIN." In *2014 IEEE International Conference on Computational Intelligence and Computing Research*, pp. 1-8. IEEE, 2014.
- [12] [www.mathworks.com](http://www.mathworks.com)