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Transformer Less Grid Connected Inverter Circuits Used In Solar Photovoltaic Systems Using Different Filters

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***Abstract*— Transformer less grid-connected inverter circuits is popular in solar PV systems owing to their efficiency and small size. By reducing the amount of power that would be lost inside the inverter circuit, the approach that has been offered guarantees an increase in efficiency. The technology decreases switching losses and conduction losses, which ultimately results in an increase in the overall efficiency of the photovoltaic (PV) system. This is accomplished by carefully managing the switching angles and various modulation patterns. Within the Maximum Power Point, the MPPT is able to successfully acquire the desired voltage. The system makes use of CSI, which is then driven by carrier-based pulse width modulation (PWM). By using a twofold tuned resonant filter, it is possible to reduce the high value inductor, denoted by L. Using the resonant filter, harmonics were also eliminated from the sound. The total harmonic distortion (THD) is 1.36 when using a double-tuned filter and 1.86 when using an inductor. MATLAB/SIMULINK is capable of simulating any conceivable outcome. This study examines transformer less inverter topologies using different filters to improve performance. LCL (inductor-capacitor-inductor) and RL (resistor-inductor) filters and their combinations are researched to reduce EMI and leakage currents. Inverter efficiency, grid synchronization, and international standards are also examined in relation to filter type design. Comparative assessments of different designs show their pros and cons, revealing the best filter types for transformer less grid-connected inverters in solar PV applications.**

***Keywords*— LCL (inductor-capacitor-inductor) , Photo-voltaic (PV) Total Harmonic Distortion (THD) , MATLAB/SIMULINK, and RL (resistor-inductor) filters .**

I. INTRODUCTION

E Grid-connected reactors are essential to PV systems. These devices convert solar panel-generated DC power into AC current for households and businesses. Grid-connected inverters without transformers to split DC and AC components are becoming increasingly popular due to their smaller size, cheaper cost, and improved efficiency. Transformer-less grid-connected inverters depend on the modulation technique that synthesizes the AC output waveform. Modulation to convert the DC input voltage into an AC waveform of the right frequency and amplitude is crucial. Transformer less grid-connected inverters employ advanced modulation technology high-frequency injection (HFI). A high-energy voltage component is added to the DC connection and superimposed over the PV array's DC voltage. This high-frequency injection aims to take power from the PV array with little leakage current. Transformer-less grid-connected inverters may cause leakage current from the PV array to the ground. Parasitic capacitances may cause harmful leakage current if the inverter is connected to the grid via long wires. Leakage current causes EMI and efficiency loss. To address these concerns, HFI injects a high-frequency voltage to actively cancel leakage current. The HFI technique injects a voltage at a frequency higher than the grid frequency, thus the injected current always flows opposing the leakage current. This cancelation makes transformer-less grid-connected inverters safer and more efficient. The HFI approach also allows smaller filter components, like as capacitors, to attenuate the high-frequency injected current, making the design compact and cost-effective. HFI-based transformer less grid-connected inverters efficiently harvest electricity from PV arrays using a modulation technique that controls injected voltage. Solar photovoltaic (PV) systems have gained popularity as a sustainable energy source. These devices convert solar energy into usable electricity using solar cells. Grid-connected inverters integrate generated power into the grid. Historically, transformer-based inverters were used. Due to their size, weight, and cost, transformer-less grid-connected inverters are an intriguing option. Designing a grid-connected inverter requires considering its modulation strategy. Modulation technique affects output voltage waveform quality and inverter efficiency. The chosen modulation method should minimize output voltage total harmonic distortion (THD) without losing efficiency. It must offer galvanic separation between the DC and AC sides of the inverter for safety and grid compliance.

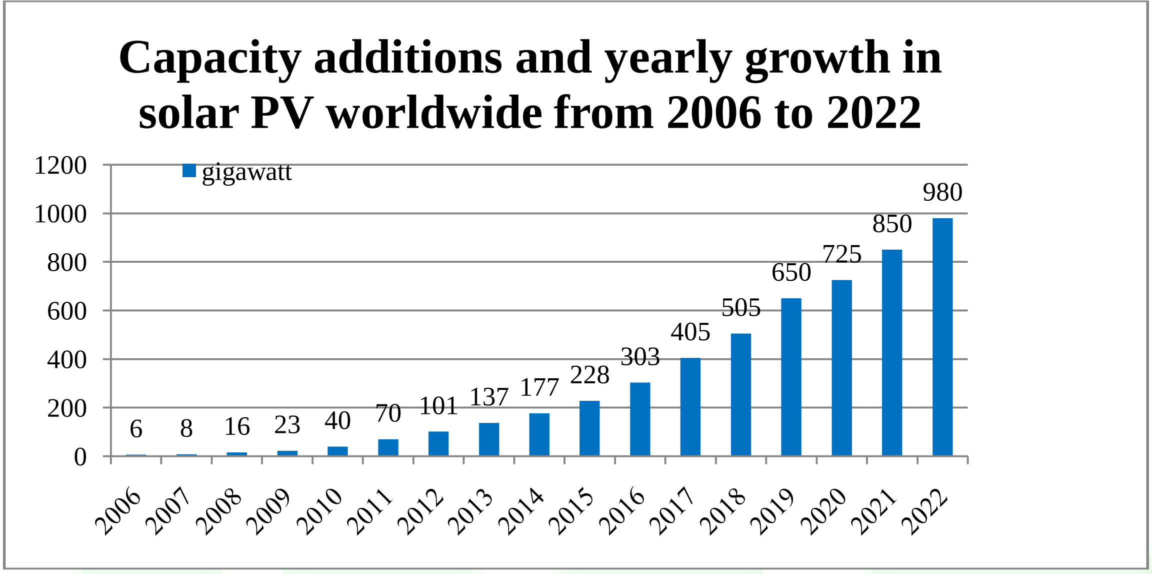

Fig.1. Solar PV Growth Worldwide

An Overview of Grid-Connected PV Inverter System: A photovoltaic (PV) power system that is linked to the electrical grid is called a grid-connected PV inverter system. It transforms solar-generated direct current (DC) power into alternating current (AC) electricity that may be used inside the house or exported to the power grid.

Here is a rundown of what goes into a PV inverter system and how it works when linked to the grid:

- Solar Panels: First, solar panels, often referred to as PV modules, transform sunlight into direct current (DC) power. To maximize exposure to sunlight, the panels are often placed in a field or on the top of a building.
- PV Array Combiner: For larger installations, many solar panels are frequently connected in series or parallel to form a PV array. All of these solar panels' electricity is gathered by the PV array combiner box and sent into a single inverter connection.
- PV Inverter: The brains of the system are the solar inverter. The solar panels' DC electricity is transformed into AC power, which may then be used by the building's appliances or sent back into the grid. Additionally, the inverter modifies the frequency and voltage of the output to match the grid.
- Grid Connection: The grid-connected inverter system is connected to the municipal electricity grid via a unique connection point. This enables the import of grid electricity during times of insufficient solar output or the export of excess PV system production to the grid. Support for bidirectional power flow is an essential feature of grid inverters that are linked. The excess energy produced by the PV system is returned to the utility company whenever it exceeds its needs. On the other hand, grid power is used when electrical consumption surpasses PV production.
- Net Metering: Net Metering or feed-in rates are available in several countries for PV systems that are linked to the grid. Both the amount of power used from the grid and the amount of electricity generated and given back into it may be tracked with net metering. Net energy usage is used to determine whether or not a customer receives a bill.
- Monitoring and Control: Monitoring and control features are common in PV inverter systems that are connected into the grid. Users may monitor the system's output, consumption, and efficiency with the use of web-based dashboards and mobile applications. Adjusting system parameters and controlling certain inverters remotely is also possible.

Reduced power costs, environmental sustainability, and the possibility of earning cash from surplus electricity production are just a few of the many benefits of grid-connected PV inverter systems. These technologies make it possible to connect renewable energy sources to the grid, paving the way for a shift to more environmentally friendly forms of power production.

Fig.2 Serpa Solar Park built in Portugal in 2006

Over time, improvements in efficiency, reliability, and productivity of transformer less grid-connected inverting circuits utilised in solar photovoltaic (PV) systems have resulted from the use of more sophisticated modulation methods. Learn about the origins of these methods here:

- **Traditional Inverter Topologies:** In the past, standard inverter topologies like the pulse-width modulation (PWM) method were often utilized in solar PV systems. These techniques employed a transformer for galvanic isolation and grid synchronization. However, transformers added cost, size, and weight to the system, limiting their efficiency and reliability.
- **Transformer less Inverter Topologies:** Transformer less alternatives for grid-connected PV inverters have been studied as a means of overcoming the shortcomings of conventional inverter topologies. Because they don't have a power supply, transformer less inverters are smaller, lighter, and cheaper. However, without a transformer, it was difficult to achieve galvanic separation and maintain grid synchronization.
- **High-Frequency Isolation Techniques:** High-frequency isolation methods were among the first developments in transformer less grid-connected inverters circuits. To provide galvanic isolation among the PV system and the grid, these methods made use of high-frequency transformers or inductors. Miniaturization and efficiency gains were made possible by high-frequency isolation, but this came with drawbacks in the form of loss and electromagnetic interference.
- **Capacitive Coupling Techniques:** Instead of using high-frequency isolation, engineers have begun to experiment with capacious coupling approaches. These methods included the use of capacitors to isolate the PV system from the grid's electrical current. When compared to high-frequency isolation, capacitive coupling provides lower losses and EMI. Voltage balancing, leakage currents, and safety issues were only some of the obstacles that needed to be overcome.
- **Advanced Modulation Techniques:** Improved performance of transformer less grid-connected inverter circuits has been achieved via the development of advanced modulation methods. These methods are geared at optimizing the efficiency with which energy is converted, increasing power quality, decreasing THD, and synchronizing the grid. Modulation methods that have come a long way in recent years:
- The Phase-Shifted Carrier Pulse-Width Modulation (PSCPWM)
- secondly, methods of predicative control
- The MPC Model for Predictive Control
- SVM (SVM) - Space Vector Modification
- Lastly, we have SHE (Selective Harmonic Elimination).
- Modulation Methods Using Artificial Intelligence

In order to precisely manage the inverter's switching components, these cutting-edge modulation methods use sophisticated methods for digital signal processing and control algorithms. They maximize system efficiency, reduce harmonic distortion, and improve power quality while maintaining grid conformity.

II. LITERATURE SURVEY

Sudipto Monda et.al (2023) – The recommend a transformer-free inverter based on a single phase, five-level SC architecture for grid-connected PV installations. One SC is all that's needed to ensure five distinct levels of output voltage in the proposed transformer-less inverter. Since the suggested transformer-less inverters are found to have a generally steady standard mode voltage, the leakage current is calculated to be 15.33mA in simulation and 17.1mA in hardware validation. It is also shown that the overall power loss and heat distribution in the proposed transformer-less inverter are both satisfactory. Total power loss is around 6.42W, which is lower than in other transformer-less inverter topologies, and efficiency is about 98.3 percent, which is higher. The suggested transformer-less inverter keeps power quality good while feeding PV electricity into the grid, with a THD of only 1.03% for a switched capacitor (SC) of 3300F [01].

Parimalasundar Ezhilvannan et.al (2023) - After meticulous planning and fine-tuning to optimum energy output, a PV network has been connected to the grid. Maximum power point tracking, when applied to an accurate PV model, has the ability to boost the system's efficiency. A controller connected between the appliance and the power source is necessary for both power regulation and grid synchronisation. The MPPT technique and PV grid are modelled in MATLAB/Simulink. An MPPT approach is simulated in this study, and the results show it may enhance the dynamic and steady-state properties of a photovoltaic system. Computer simulations suggest that MPP tracking is possible with a well-designed system. This study also demonstrates that the suggested control system provides a straightforward method for gauging the efficacy of programmes dependent on service interfaces [02].

Shaik Nyamathulla et.al. (2023) - This review research focuses on grid-connected PV systems and covers topics such as motivation, characteristics, assessment criteria, topologies, modulation techniques of the multilevel inverter, performance metrics, and the selection process for specific applications. The purpose of this article is to assess the reliability of three distinct kinds of basic multilevel converters based on the findings of a comprehensive reliability investigation. This literature review compared two methods (exact and approximate) for evaluating the reliability of multilevel inverters [03].

A. M. Mahfuz-Ur-Rahman et.al. (2022) - A unique current peaking point tracking third harmonics injected bus clamped pulse width modulating (CPPTTHBCPWM) technique has been developed for effective reactive and active power regulation in a transformer-less H5 solar photovoltaic inverter. The proposed approach reduces switching loss in contrast to the standard method via the use of a new reference signal and the elimination of unneeded gate pulses. The suggested CPPTTHBCPWM method maximizes the use of dc bus voltage, minimizes overall harmonic distortion, and reduces traditional modulation approaches. converter loss. The proposed modulation strategy also reduces thermal stress on the switching device and extends the power converter's lifetime. After modelling in MATLAB/Simulink, the proposed modulation technique is put through its paces in the lab on a miniature prototype test platform [04].

Safa Haq et.al. (2021) - As a global response to climate change and the depletion of fossil fuel supplies, solar photovoltaic (PV) systems that link to existing power grids are gaining traction. Modular multilevel cascaded (MMC) inverters are the best option for connecting solar photovoltaic (PV) systems to the grid directly at low to medium voltages without the need for a step-up transformer and line filter. However, power dependability and loss become key problems when connecting a PV system to a medium voltage grid using an MMC inverter. Using the right modulation strategy, it is possible to reduce the produced power's total harmonic distortion (THD), as well as its switching and conduction losses. In this research, we recommend employing triangle saturation shared mode pulse width variation (TSCMPWM) control for a three-phase, five-level Modular Multilevel Converter (MMC) in a connected to the grid PV system. When compared to more traditional modulation techniques, the power losses and voltage THD caused by inverters are minimised by the proposed TSCMPWM control [05].

Phani Kumar Chamarthi et.al.(2021) - Cascading H-bridge (CHB) MLIs may accept input dc voltages below their rated value, reducing voltage stress between devices. numerous PV sources are needed for the CHB MLI because the dc-link voltage must come from numerous sources. This increases the potential for leakage currents. Leakage currents provide a significant challenge when dealing with CHB MLIs. This article describes a novel architecture for grid-connected solar PV inverters that eliminates the requirement for a transformer. The six-switch-per-phase inverter design detailed here incorporates the advantages of dc-bypass and ac-bypass designs.. A novel modulating methodology based on the sine-triangle pulse-width modulation method and utilizing specialized logic functions is created for the suggested architecture. These particular logic operations generate the gate pulses for every switch [06].

III. PROPOSED METHODOLOGY

Discuss the suggested approach in this area for a PV system without a transformer. Previous research and issues with transformer-free PV systems are discussed in detail in the preceding chapter. In this section, we'll compare and contrast two approaches to the suggested answer. The simulation results and analysis of the first model's suggested Double Tuned Resonant Filter and the second method's usage of a digital filter with adjustable parameters are presented in the next chapter.

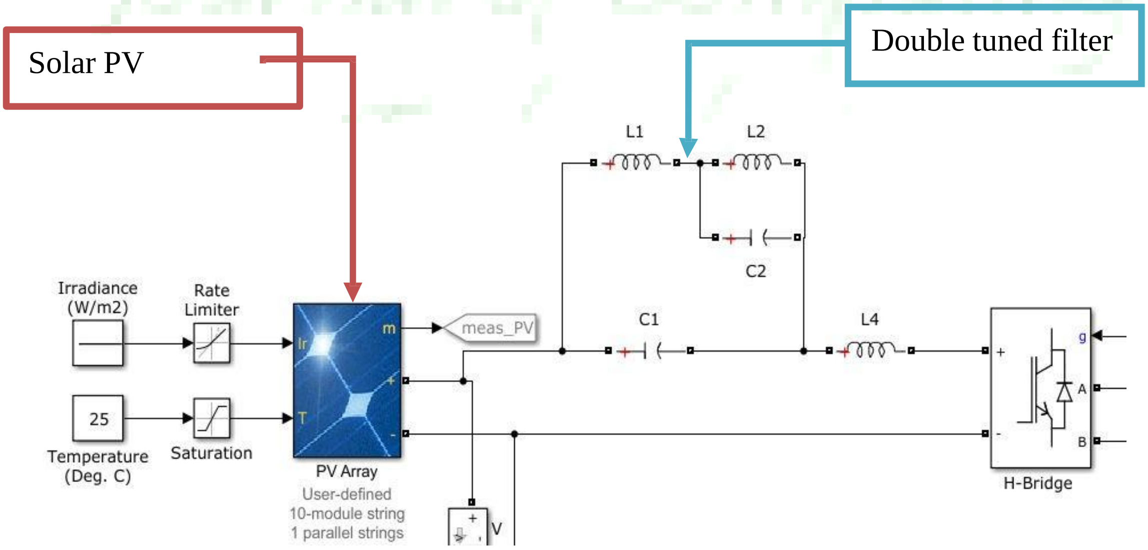

Fig.3 Building Block diagram of Solar PV system

Double Tuned Resonant Filter Introduction

The current and voltage produced by a single-phase Current Source Inverter (CSI) are not perfectly sinusoidal. To put it simply, it's full of life. In the dc-link current, it produces even harmonics. There are two significant effects of these even harmonics. One may be found on the ac side as current and voltage odd harmonics of low order. As a second point, these even harmonics have an effect on the PV side's Maximum Power Point Tracker (MPPT). This might shorten the lifespan of photovoltaic panels. The negative impact of these dc-side harmonics on the AC side and the PV system may be mitigated by.

A double-tuned parallel resonant filter is presented as a solution to the problem of the big inductor's cost. Typically, a low-value inductor is connected in series with this double-tuned resonant filter. Using just a tiny inductor, this filter may effectively smooth out the current in the dc connection. Despite the fact that the second-order harmonic has a considerable effect on

The dc-link current might be impacted by the fourth-order harmonic, particularly when the Current Source Inverter (CSI) is operating at high modulation indices. The basic of Double Tuned Resonant Filter is shown in figure 4.2

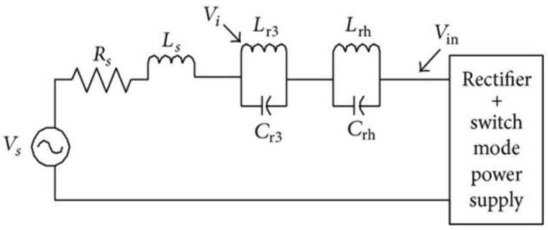

Fig. 4 Double Tuned RF with Rectifier and Power Supply

Because of their simple design and excellent dependability, filters are often used to mitigate power system harmonics. In a power grid, harmonic recurrences may take several forms. This kind of filtering consumes a great deal of signal and comes at a high price. Both a double-tuned filter and two parallel single-tuned filters may perform the same task of filtering out two harmonics of a given frequency. When compared to using two parallel single-tuned filters, the cost of a double-tuned filter is much less.

Design of Double Tuned Resonant Filter

The filter's design parameters have been covered here. First, to get rid of the desired harmonics, make sure that C1's impedance and the sum of L1, L2, and C2 are both zero. Assume the resistances of the components are modest and hence unimportant for the calculation's sake.

Now,

$$Z_{c1} + Z_t = 0 \qquad (1)$$

Capacitances are given by,

$$C_1 = \frac{L_2C_2 - 1/\omega^2}{\omega^2 L_1 L_2 C_2 - L_1 - L_2} \qquad (2)$$

$$C_2 = \frac{-L_2}{{L_2}/{C_1} - \omega^2 L_1 L_2} + \frac{1}{\omega^2 L_2} \qquad (3)$$

To clarify, C1 and C2 represent the resonant filter capacitances, L1 and L2 represent the resonant filter inductances, ZC1 represents the impedance of C1, and Zt represents the impedance of L1, L2, and C2. The second- or fourth-order harmonic angular frequency is denoted by.(in any case, that's what we think).Capacitance values are found by balancing Equations (2) and (3). The filter can get rid of harmonics of both the second and fourth orders.

Here's how we can calculate L1 and L2 inductances:

$$L2 \leq 1.778L1 \qquad (4)$$

To eliminate the no. of harmonics from system, the Capacitances C1, C2.....Cn given as

$$C_1 = L_1\omega_1 + \frac{1}{\omega_1 C_1} + Z_t = 0 \qquad (5)$$

$$C_2 = L_2\omega_2 + \frac{1}{\omega_2 C_2} + Z_t = 0 \qquad (6)$$

$$C_n = L_1\omega_n + \frac{1}{\omega_n C_1} + Z_t = 0 \qquad (7)$$

Hence we can solve it for nth harmonic order.

Proposed Simulink Model

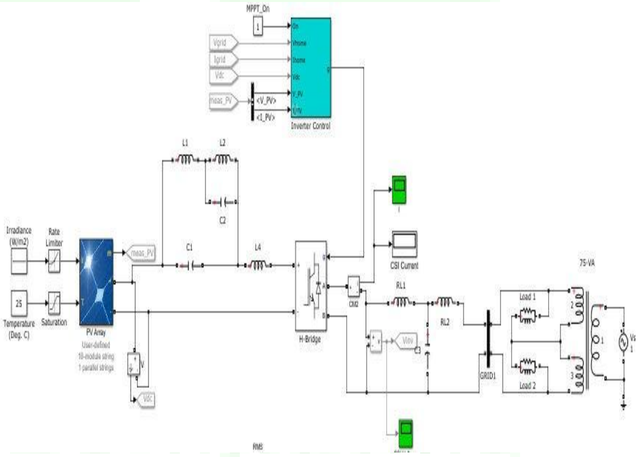

Fig.5 Shows the Proposed Double Tuned Resonant Filter Model

A simulink model of the suggested design is shown in Figure 4.3. The concept behind it is a double-tuned resonant filter. Figure 4 shows the many components of the proposed system 4.3.

There are different parts available in the above model -

- Inverter Control
- Photo Voltaic cell (P.V.)
- Double Tunned Filter
- H Bridger Inverter

Inverter Control

The maximum power point controller, the variable direct current (VDC) regulator, the variable current (current) Maximum Power Point Tracking Controller Maximum Power Point Tracking makes use of the 'Perturb and Observe' method as the basis for its controller. In order to acquire a DC voltage that produces maximum power from the photovoltaic system, this optimal power point tracking system automatically adjusts the direct current voltage reference signal of the inverter VDC regulator.

Regulator, the phase loop lock, and the pulse width modulation (PWM) generator are the five primary components of the inverter control system. Maximum power point tracking, or MPPT for short, is a sensor-based method for improving system efficiency.

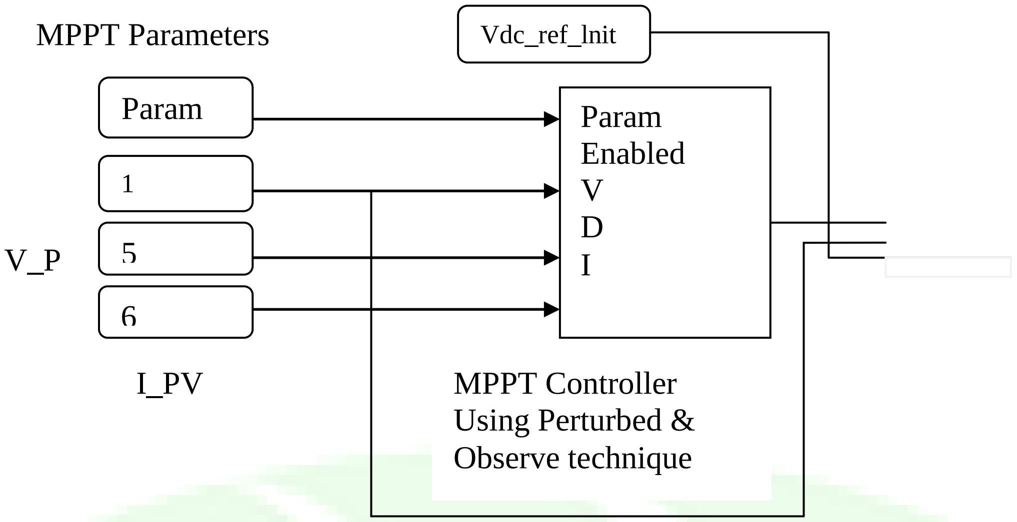

Fig.6 Shows the Maximum Power Point Tracking Controller

VDC Regulator

Find out what the current regulator's active current reference should be. An electrical gadget with voltage controller software is one that keeps the voltage steady. A voltage controller might use either a simple feed-forward strategy or integrate feedback in the form of criticism. An electrical or electromechanical system might be used. It might be used to regulate voltages from alternating current (AC) to direct current (DC), depending on the design.

Current Regulator

The regulator figures out what the inverter's reference voltages need to be based on current sources Id and reactive current. Here, we use a reference value of 0 for the reactive current (Iq).

Phase Loop Lock

A phase-locked loop is a kind of control system that synchronises its output with the timing of an incoming input. Several distinct varieties exist;

The simplest example is an electrical circuit for a critique circle, which consists of a variable recurrence oscillator and a stage identifier. The oscillator generates a periodic signal, which is compared by the stage locator to the period of the information periodic signal; the oscillator is then adjusted to maintain synchronous oscillation between the two periodic signals.

PWM Generator

To trigger the IGBTs, use a PWM bipolar modulation technique. The PWM the carrier frequency in this case is 3780 Hz (63 * 50).

Photo Voltaic Array (P.V.)

The solar photovoltaic system is seen in Figure 4.7 below. This model is used to simulate the effect of sunlight in a system by using a string array of ten lessons and a parallel string of 1 module.

Double Tunned Filter

A double-tuned inductor is used to decrease the cost of a big inductor. It is proposed to use a parallel resonant filter. Typically, a low-value inductor is connected in series with this double-tuned resonant filter. Using just a tiny inductor, this filter may effectively smooth out the current in the dc connection. Fourth-order harmonics may have an effect on the dc-link current, particularly when the Current Source Inverter (CSI) is operating at high modulation indices, even though the influence of the second-order harmonic is more substantial.

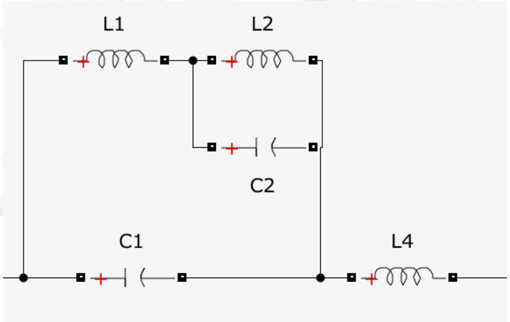

Fig.7 Shows the LLC filter

The parameters of a double-tuned filter are shown in Table 4.1 below. There is a 5 mH inductor (L1) in series, and a 10 mH inductor (L2) and a 250 F capacitor (C2) in a tuned filter LC circuit. Other parameters are also displayed and explained in table I below.

S.No.	Parameters	Value
01	L1 Series	5e-3
02	L2 (L parallel C)	10e-3

03	C2 Series	250e-6
04	C1	125e-6
05	L4	300e-3

H. Bridger Inverter

An inverter is a crucial component in transformer-free PV systems. H bridge inverters are used in this suggested setup. Multi-step or H-bridge inverter. A multistep converter's output voltage is often more sinusoidal than that of a simple square-wave switching inverter. It also has a benefit over the PWM inverter in that its control signals are simpler. However, unlike the PWM switching scheme inverter, the sinusoidal output voltage produced by the multistep inverter is not of very good quality.

System Parameters

Discuss the many input parameters utilized by the simulionk model in the table below. Table 2 below displays the various parameters of the obtained results.

Table 2 System Parameters

PV Open Circuit Voltage	80 V
PV Short Circuit Current	8 A
PV Array Rated Power	500 W
LDC (With Filter)	5 mH
LDC (Without Filter)	300 mH
Carrier Frequency	3.5 KHz
L1	5 mH
L2	10 mH
C1	125 µ F
C2	250µF
AC Side Inductor L1	50 mH
AC Side Inductor L2	50 mH
AC Side Capacitor	250µF

IV. SIMULATION AND RESULT

The simulation and result of proposed Double Tuned Resonant Filter. There are different result parameters and parameters value observed in this presented work that is shown in below.

System Parameters and Model

The input parameters were necessary for the outcome computation. The values of the parameters used in the system that is suggested based model are shown in table 3.

Table 3 Model Input Values

PV Open Circuit Voltage	80 V
PV Short Circuit Current	8 A
PV Array Rated Power	500 W
LDC (With Filter)	5 mH
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Carrier Frequency	3.5 KHz
L1	5 mH
L2	10 mH
C1	125 µ F
C2	250 µ F
AC Side Inductor L1	50 mH
AC Side Inductor L2	50 mH
AC Side Capacitor	250 µ F

Result Parameters

Active Power (P) - is a function of the current, voltage, and a cosine of their tangent Reactive Power (Q) - In contrast, voltage, current, and the sine of the angle between them all result in reactive power.

P= (V/2)2× (I/G)2×cos(φ)
Q = (V/2)2× (I/G)2×sin(φ)
φ=∠V−∠I

It also displays the contrast all result and distinctive MLI, as well as the absolute symphonic interruption profile and implementation of the circuit using performance assessment techniques. The lowest THD profile is seen in a fallen staggered inverter.

$$THD = \frac{\sqrt{V_2 + V_3 + V_4 + V_5 \ldots\ldots . V_N}}{V_2}$$

Where Vn is the root-mean-square voltage of the nth harmonics and n = 1 is the frequency of the basic voltage.

Result Analysis

Various outcome parameters may be used to evaluate the effectiveness of the offered effort. Grid current, grid voltage, current source inverter current, solar power, solar current, grid active reactive power, total harmonics distortion, and so on are the major characteristics given and explored. Examine the differences between the model with and without the filter in the work offered here. In the research effort the key objective is decrease the harmonics and losses of provided system. The examination of grid attributes and performance relies heavily on grid current, therefore we'll start there.

Grid Current

At 1.5s, 4.7A is the maximum output and the lowest value -4.6A.

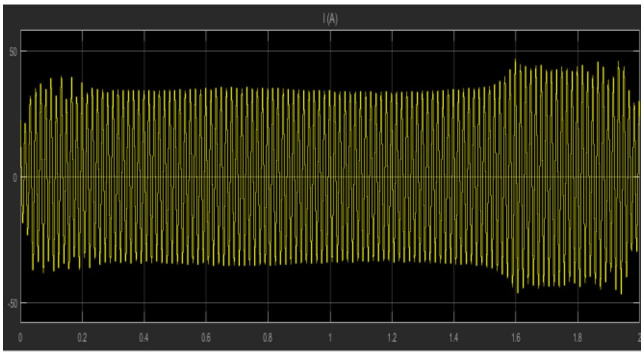
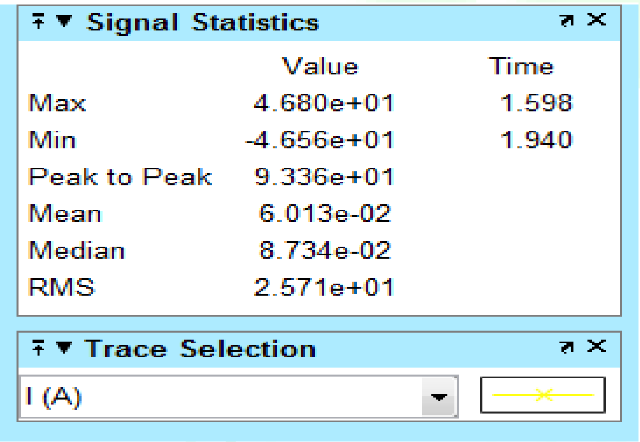


Fig. 9 Grid Current



Signal Statistics

	Value	Time
Max	4.680e+01	1.598
Min	-4.656e+01	1.940
Peak to Peak	9.336e+01	
Mean	6.013e-02	
Median	8.734e-02	
RMS	2.571e+01	

Trace Selection

I (A)

Fig.10 Obtain Grid Results

Figure 10 displays the relative values of the remaining parameters. Displayed metrics include peak-to-peak, mean-median, and root-mean-square levels. The table 9 also has information about the parameters.

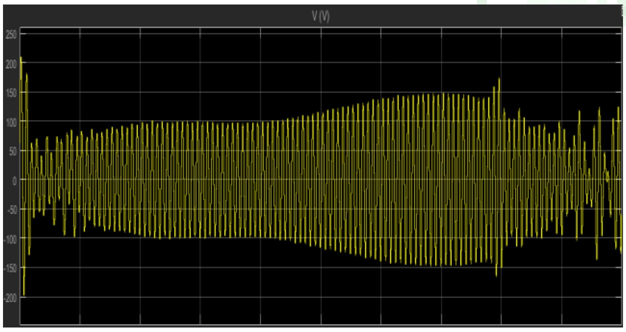
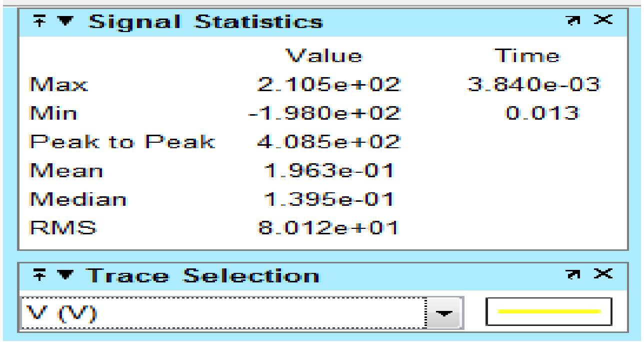


Fig.11 Grid Voltage

Direct current is transformed into alternating current by the current source inverter. The excellent CSI value of the proposed model compared to the CSI value without filter is clearly seen in the image. In the below figure 15 as well as 16 shows the PV output of proposed work.



Signal Statistics

	Value	Time
Max	2.105e+02	3.840e-03
Min	-1.980e+02	0.013
Peak to Peak	4.085e+02	
Mean	1.963e-01	
Median	1.395e-01	
RMS	8.012e+01	

Trace Selection

V (V)

Fig.12 Outcome Grid Voltage Parameters

The grid voltage and its associated characteristics may be seen in Figure 12 the time was represented by the x axis and voltage by the y axis in the diagram. Figure 12 depicts the greatest and least peak values of gird voltage that may be obtained

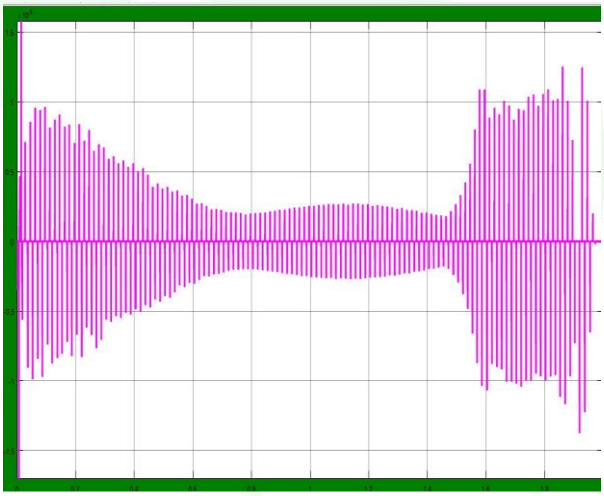
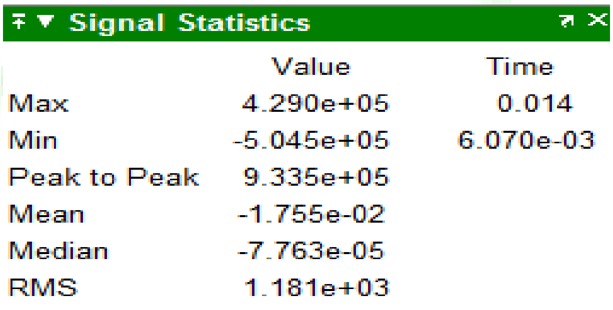


Fig. 13 CSI Output Current



Signal Statistics

	Value	Time
Max	4.290e+05	0.014
Min	-5.045e+05	6.070e-03
Peak to Peak	9.335e+05	
Mean	-1.755e-02	
Median	-7.763e-05	
RMS	1.181e+03	

Fig. 14 CSI outcome value

(a) PV Power

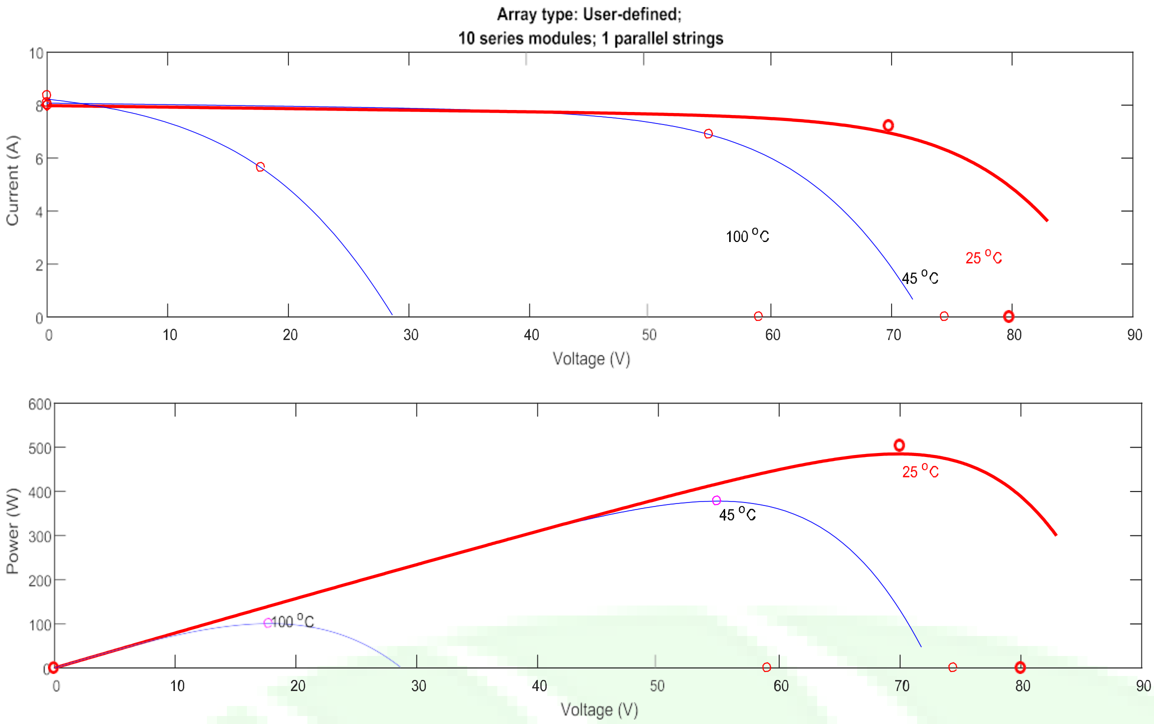


Fig. 15 PV Power

(b) PV Current

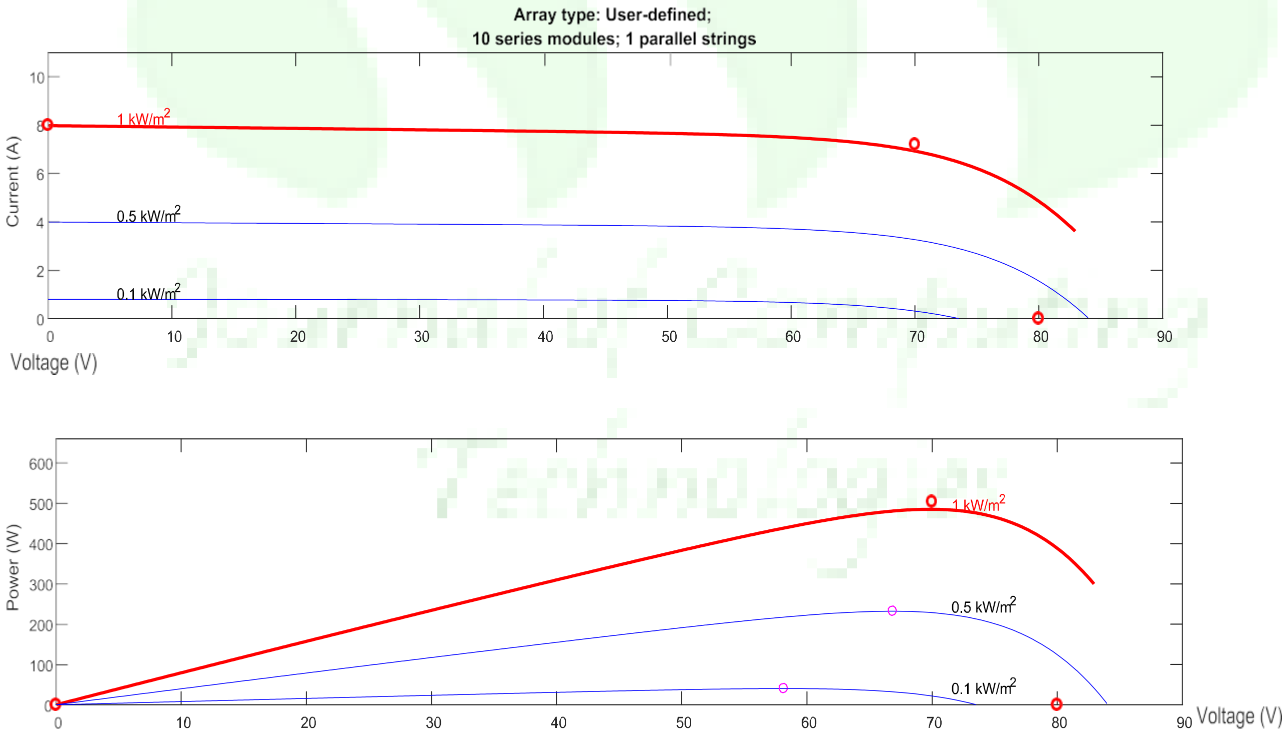


Fig. 16 PV Current

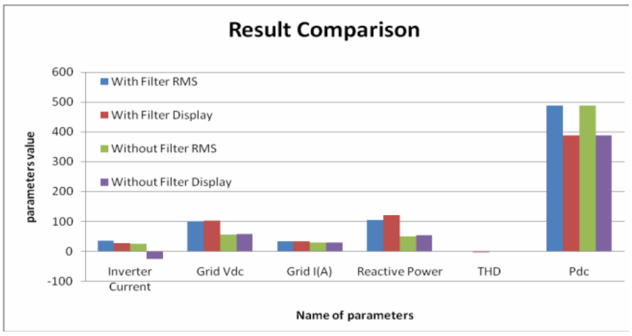


Fig. 19 Graphical Comparison of Results

The outcomes of the suggested approach are discussed in tabular and graphical formats in the figure and table up top. The results and loss percentages of the suggested approach with two filters are clearly superior to those of the non-filtered method, as shown in the table above.

V. CONCLUSION

In comparison to more traditional modulation methods, this technology has a number of additional benefits, which makes it an attractive option for contemporary photovoltaic (PV) systems. By reducing the amount of power that would be lost inside the inverter circuit, the approach that has been offered guarantees an increase in efficiency. The technology decreases switching losses and conduction losses, which ultimately results in an increase in the overall efficiency of the photovoltaic (PV) system. This is accomplished by carefully managing the switching angles and various modulation patterns. Within the Maximum Power Point, the MPPT is able to successfully acquire the desired voltage. The system makes use of CSI, which is then driven by carrier-based pulse width modulation (PWM). By using a twofold tuned resonant filter, it is possible to reduce the high value inductor, denoted by L. Using the resonant filter, harmonics were also eliminated from the sound. The total harmonic distortion (THD) is 1.36 when using a double-tuned filter and 1.86 when using an inductor. MATLAB/SIMULINK is capable of simulating any conceivable outcome.

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