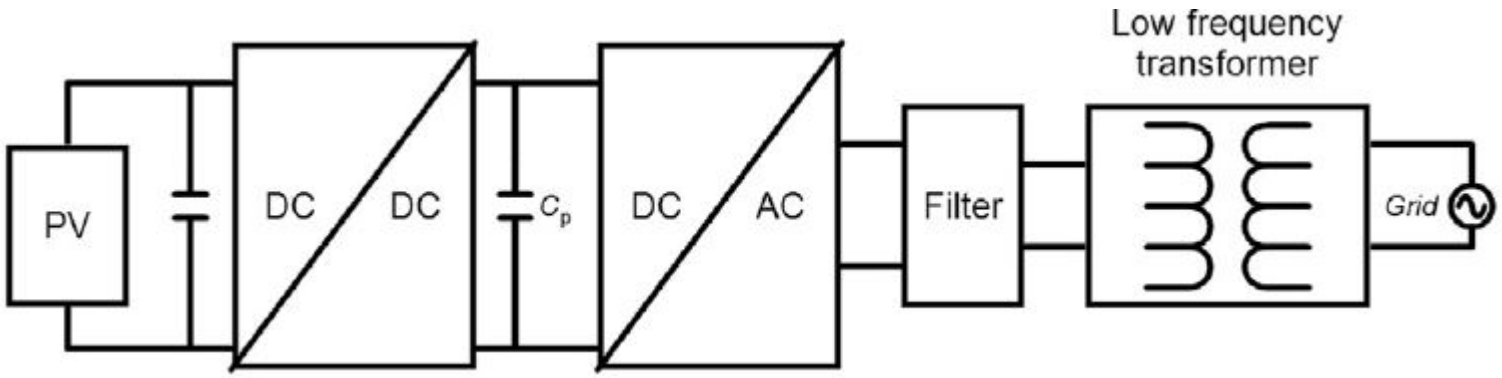
Development of a New Pseudo-DC Link Type DC-Decoupled Transformerless Inverter

Abstract

The PV renewable energy has become a very important electrical energy source within the entire energy market. The growing is mainly due to the fact that these systems have been constantly improving in terms of efficiency, power, reliability. Transformer less inverter is derived from conventional inverter. Where the transformer is removed after inverter and is directly connected to grid. Single stage Grid connected Transform less inverter can perform DC to AC conversion with boost operation in single stage. Transformer less inverters are extensively employed in grid connected photovoltaic (PV) generation systems due to its advantages of achieving low cost and high efficiency. Transformer less inverters are light, compact, and relatively inexpensive. Since transformer less inverters use electronic switching rather than mechanical switching the amount of heat and humidity produced by standard inverters is greatly reduced. Transformer less inverters do not have electrical isolation between DC and AC circuits. This may raise some grounding concerns because there is tendency to flow a current from load back to source called as leakage current. Thus, main motive is to decrease the Leakage current as much as possible.

CONVENTIONAL INVERTER



Advantage-

Suitable for Large capacity Power plant

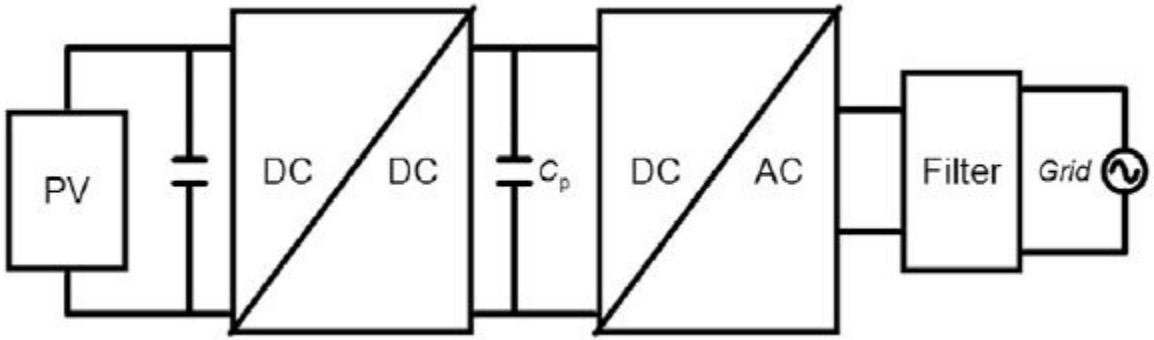
Disadvantage in Conventional inverter-

1.The overall efficiency gets reduced due to additional losses due to transformer.

2. Transformer less inverters are light, compact, and relatively inexpensive.

TRANSFORMERLESS INVERTER

1) TWO STAGE TRANSFORMERLESS INVERTER

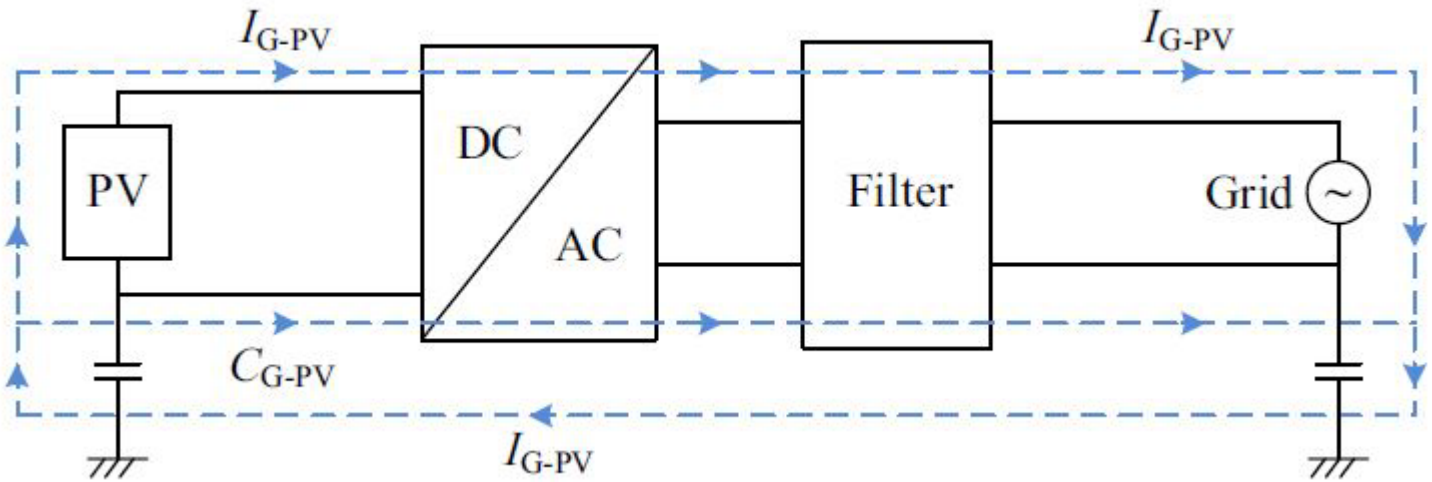


Advantage-
losses are present but lesser than Conventional inverter.

Disadvantage-

1. More components are present so conversion gets completed in two stage

2)Single stage transformer less inverter



1.Efficiency is increased due to lesser components.
2.DC to AC conversion with boost application.

LITERATURE SURVEY

TITLE	AUTHUR	JOURNAL	YEAR	ABSTRACT
• **Topology Review and Derivation Methodology of Single-Phase Transformer less Photovoltaic Inverters for Leakage Current Suppression**	Wuhua Li, Yunjie Gu, Haoze Luo, Wenfeng Cui, Xiangning He, and Changliang Xia,	IEEE	2015	1)Firstly generation mechanism of leakage current is investigated to divide the transformer less inverters into asymmetrical inductor-based and symmetrical inductor-based groups. 2) For advance inverter, the concepts of dc-based and ac-based decoupling networks are proposed
• **A Single-Phase Asymmetrical T-Type Five-Level Transformer less PV Inverter**	Gerardo Escobar Valderrama,Gerardo Vazquez Guzman,,Erick I. Pool-Mazún, Panfilo Raymundo Martinez-Rodriguez,	IEEE	2018	This paper presents a transformer less single-phase inverter topology based on a modified H-bridge-based multilevel converter.

• **Derivation, Analysis, and Implementation of a Boost–Buck Converter-Based High-Efficiency PV Inverter**	Zheng Zhao, Ming Xu,, Qiaoliang Chen,	IEEE	2012	In this paper, a single-phase grid-connected transformer less photovoltaic inverter for residential application is presented.
• **An Improved H5 Topology with Low Common- Mode Current for Transformer less PV Grid-Connected Inverter**	Hong Li, Yangbin Zeng, Bo Zhang,	IEEE	2012	However, common-mode current in the transformer less photovoltaic inverters can result in serious electromagnetic interference and insecurity
• **A Multilevel Transformer less Inverter Employing Ground Connection Between PV Negative Terminal and Grid Neutral Point**	Abhijit Kadam and Anshuman Shukla		2013	In this paper, a novel multilevel transformer less inverter topology is proposed

• **A Zero-Voltage-Transition HERIC-Type Transformer less Photovoltaic Grid Connected Inverter**	Hua F. Xiao, Li Zhang, and Yanqing Li	IEEE	2017	(ZVT-HERIC) in transformer less photovoltaic grid-connected applications is derived from proposed basic resonant cells.
• **An Optimized Transformer less Photovoltaic Grid-Connected Inverter**	Huafeng Xiao,Shaojun Xie, Yang Chen, and Ruhai Huang	IEEE	2011	Unipolar sinusoidal pulse width modulation (SPWM) full-bridge inverter brings high-frequency common-mode voltage, which restricts its application in transformer less photovoltaic grid-connected inverters
• **Optimal Design of Modern Transformer less PV Inverter Topologies**	Stefanos Saridakis, Eftichios Koutroulis,, and Frede Blaabjerg,	IEEE	2013	The design optimization of H5, H6, neutral point clamped, active-neutral point clamped, and Conergy-NPC transformer less photovoltaic (PV) inverters is presented in this paper

• **A New Soft-Switching Configuration and Its Application in Transformer less Photovoltaic Grid-Connected Inverters**	Huafeng Xiao , Li Zhang, Zheng Wang	IEEE	2015	Soft-switching techniques of transformer less photovoltaic grid-connected inverters (TLIs) can significantly reduce switching losses, as well as soften switching processes
• **Improved Transformer less Inverter With Common-Mode Leakage Current Elimination for a Photovoltaic Grid-Connected Power System**	Bo Yang, Wuhua Li, Yunjie Gu, Wenfeng Cui, and Xiangning He	IEEE	2018	To eliminate the common-mode leakage current in the transformer less photovoltaic grid-connected system, an improved single-phase inverter topology is presented

Objectives of the project

1) TO Reduce the flow of current (Leakage current) from load side back to PV panel.

2) TO Make Grid-Tie inverter more efficient.

3) TO Minimize the losses.

4)To make an inverter which can do a boost operation also.

5) Chopper circuit and inverter circuit are present within single stage.

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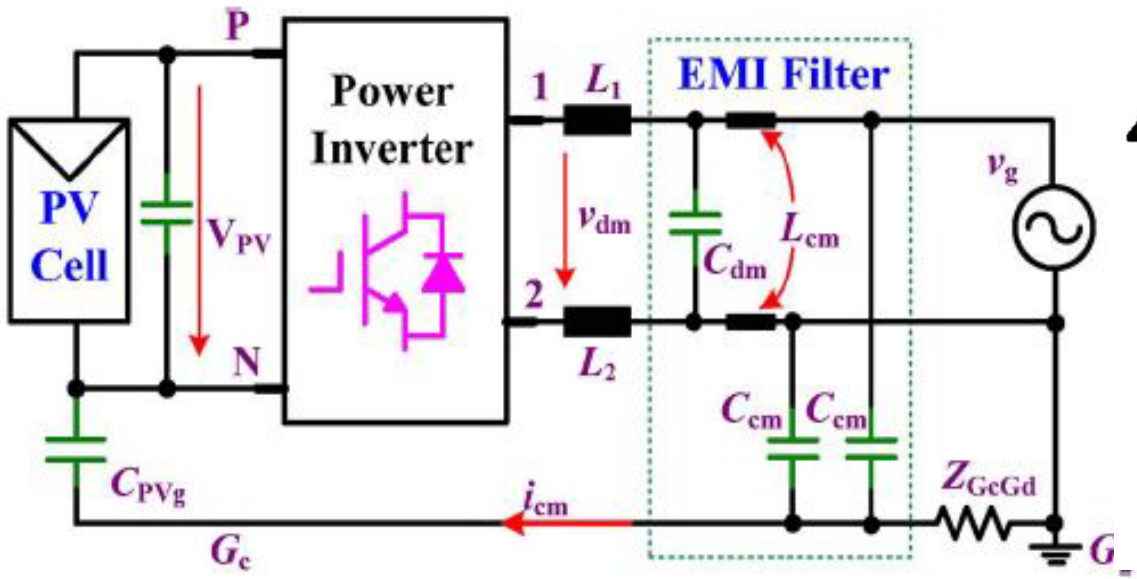
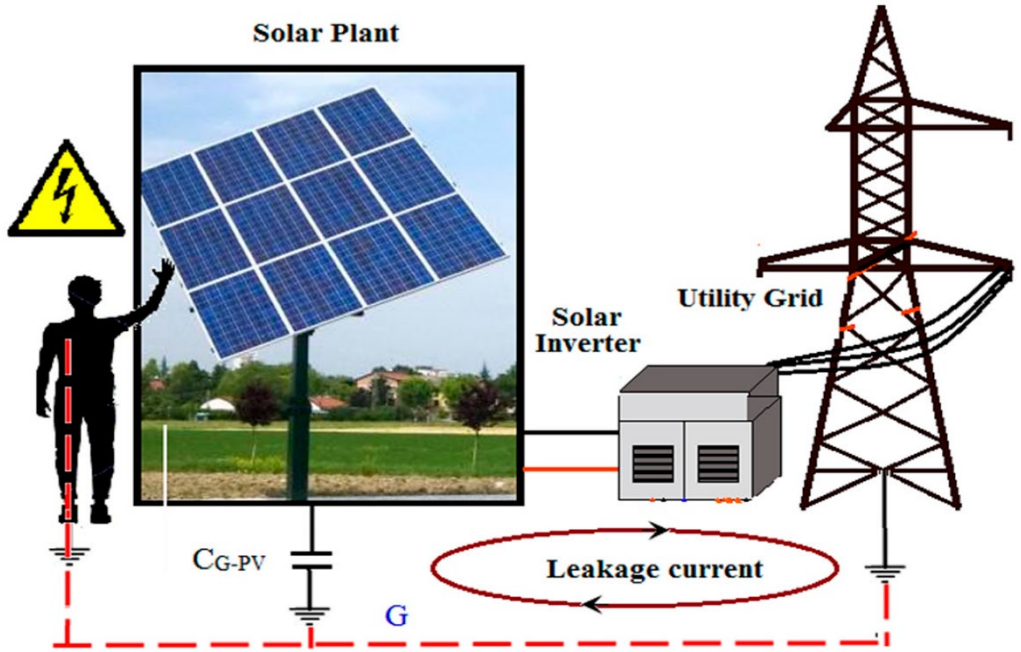
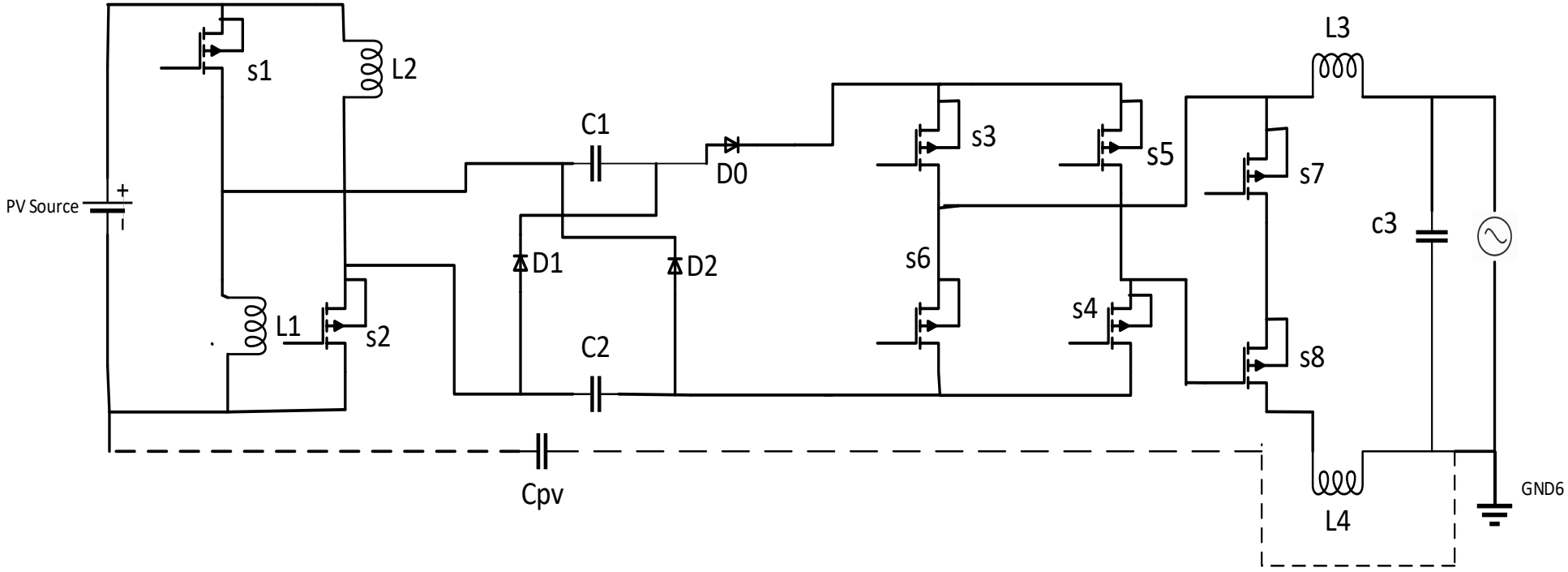
Block diagram





CIRCUIT DIAGRAM



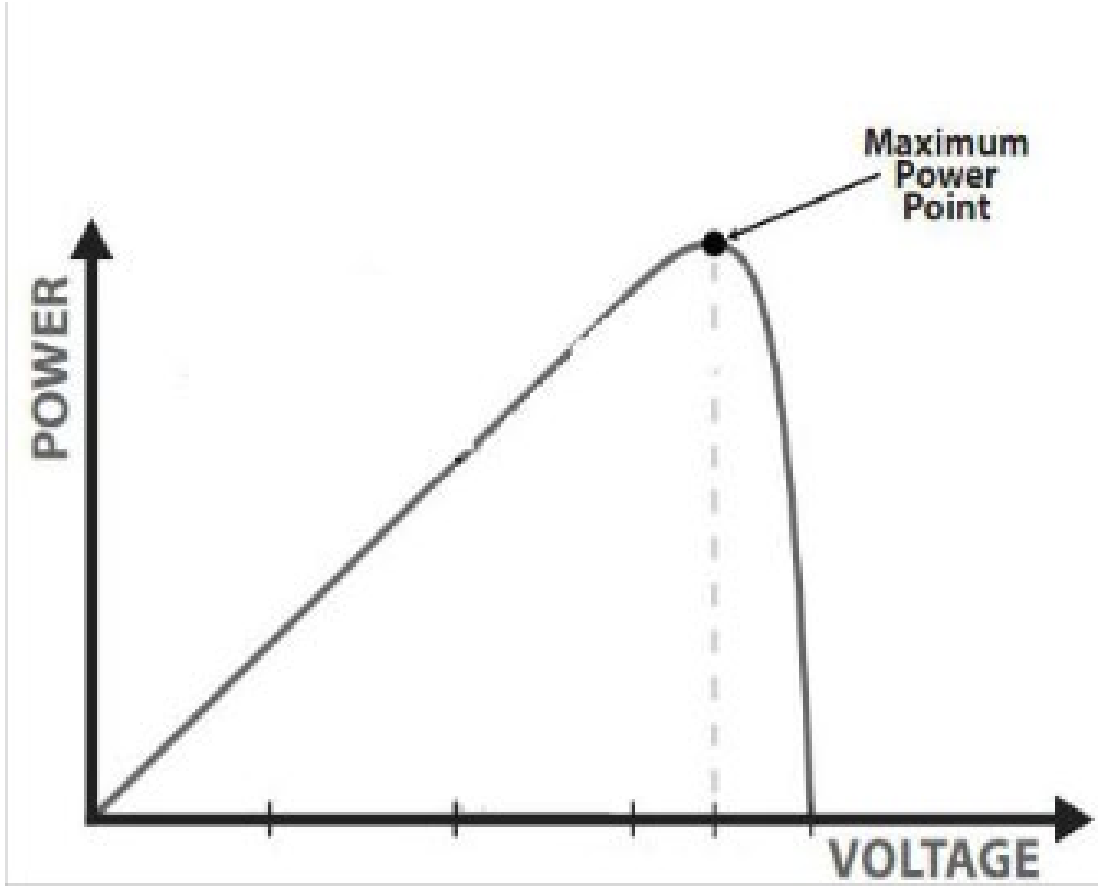
MAXIMUM POWER POINT TRACKING(MPPT)

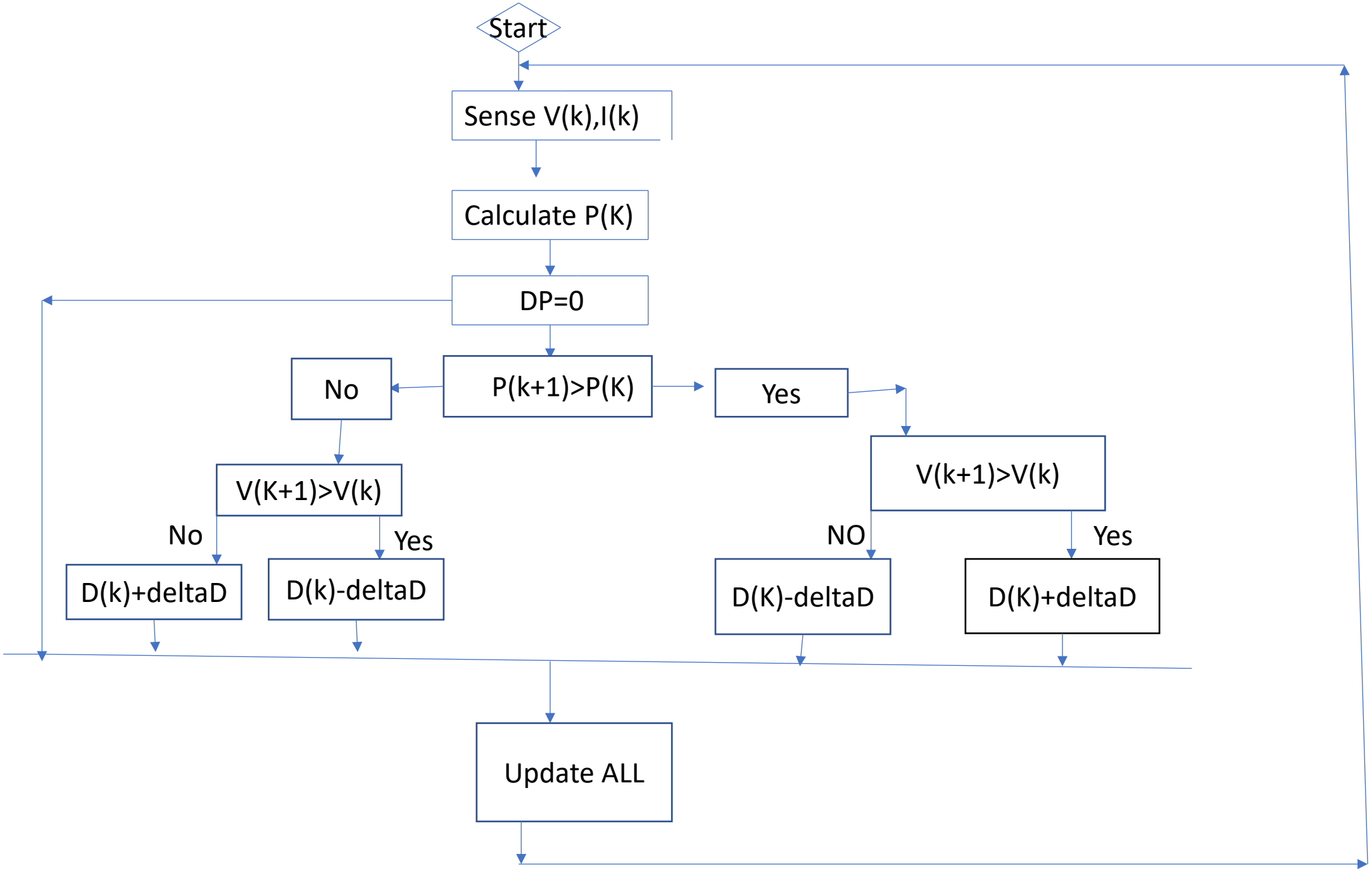
- Maximum Power Point(MPPT) is a algorithm that is included in charge controllers used for extracting maximum available power from PV module under given conditions.
- MPPT increases the output efficiency of the solar PV module System.
- Maximum voltage and current are tracked using different Algorithms such as P & O, incremental Conductance method.

P&O Algorithm

- This Algorithm works on a simple feedback arrangement.
- In this Approach Module Voltage is Periodically given a Perturbation and Corresponding Output Power is Compared with at the previous P&O Cycle.
- If Power increases due to the Perturbation then Perturbation is continued in the same direction .
- If Power decreases due to the Perturbation then direction of Perturbation is reversed .

Maximum Power Point Graph

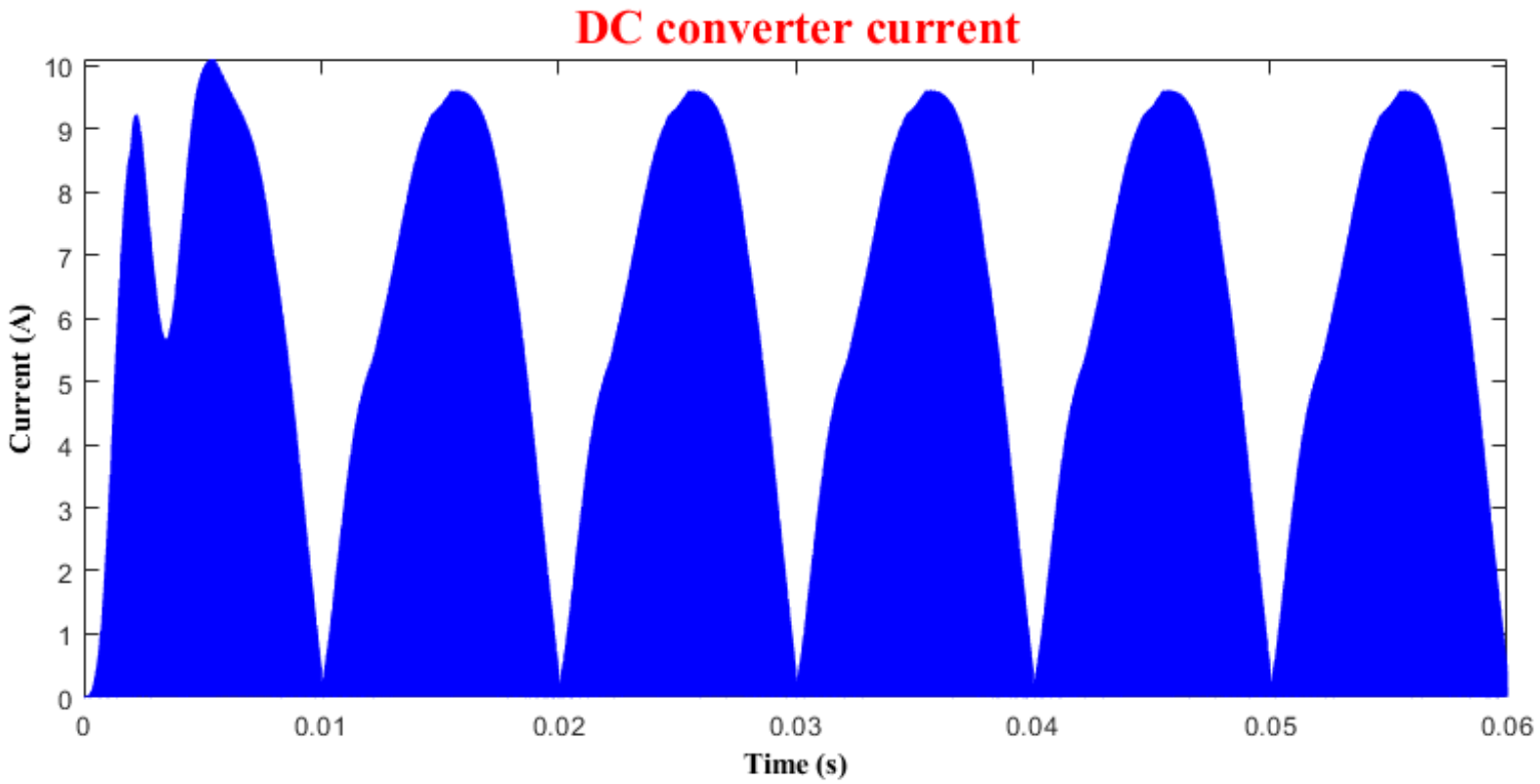



Start
Sense V(k),I(k)
Calculate P(K)
DP=0
P(k+1)>P(K)
No
Yes
V(K+1)>V(k)
No
Yes
D(k)+deltaD
D(k)-deltaD
V(k+1)>V(k)
NO
Yes
D(K)-deltaD
D(K)+deltaD
Update ALL

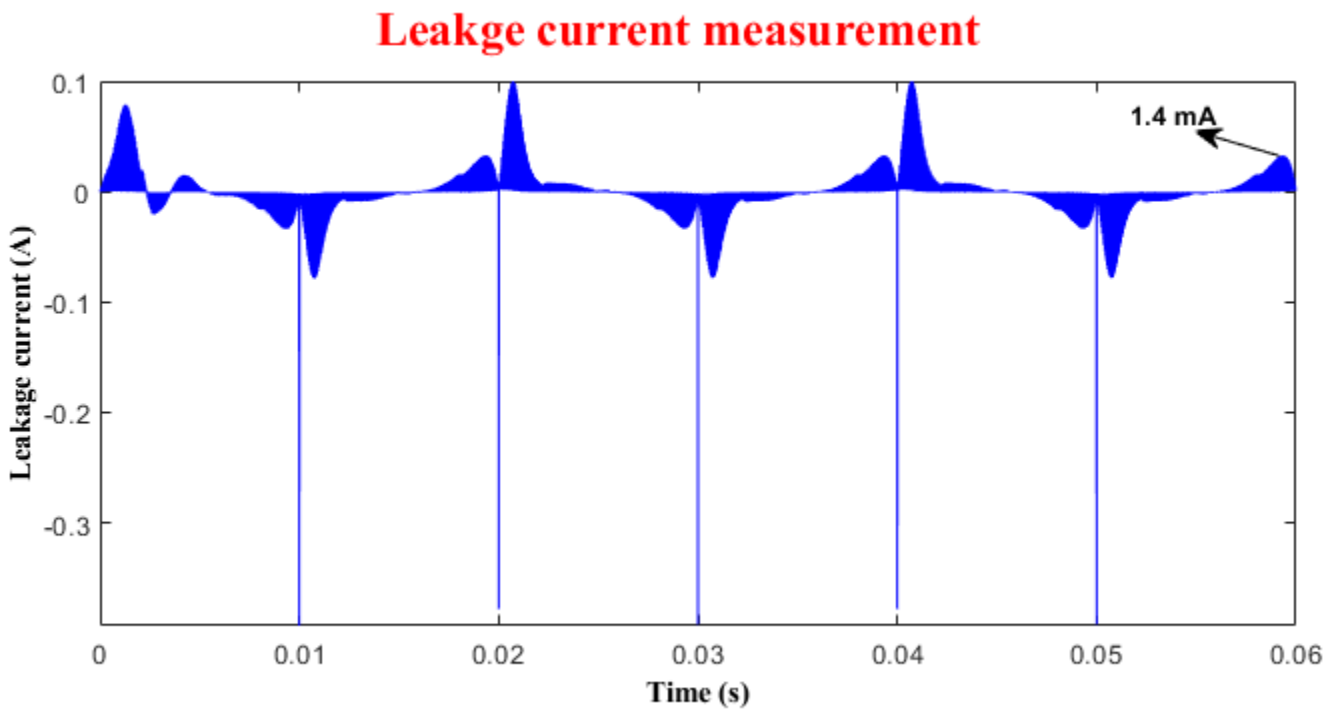
SPWM Generation

- In normal PWM the harmonics are high so Sinusoidal pulse width modulation (SPWM) is used here to obtain low harmonics.
- In this method, a sinusoidal waveform called reference waveform is compared with a triangular waveform with a higher frequency called the carrier wave.
- The obtained signals can trigger the inverter switches for every half-cycle with varying pulse width in order to get a quasi-sine wave.

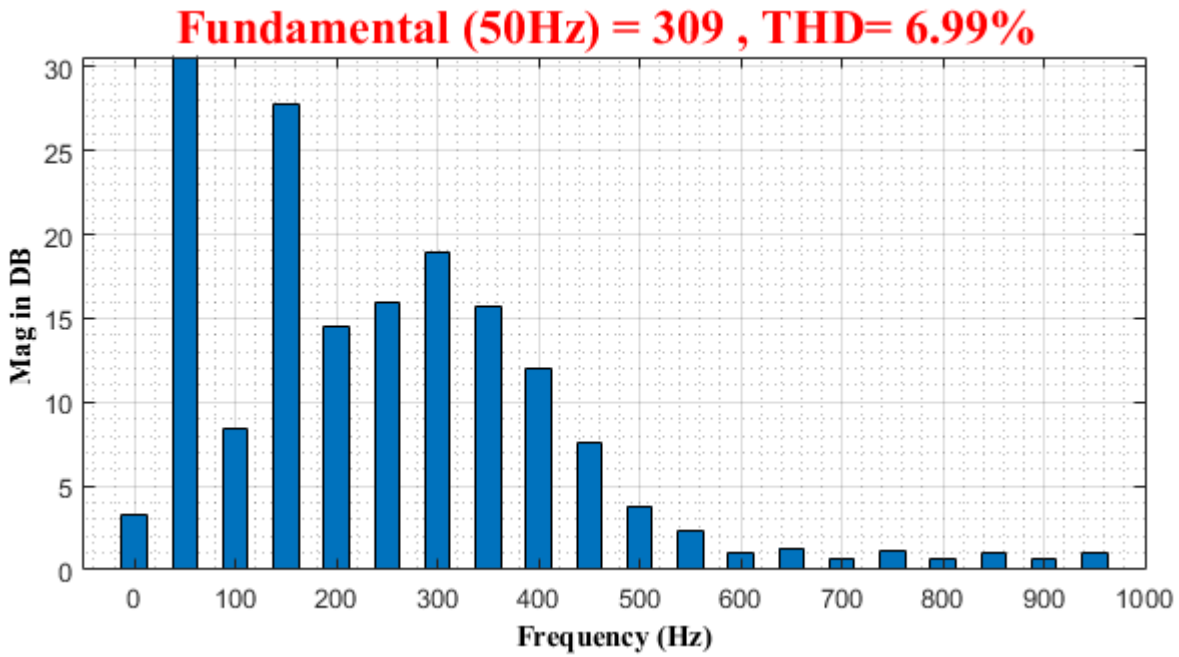
Dc output current



LEAKAGE CURRENT

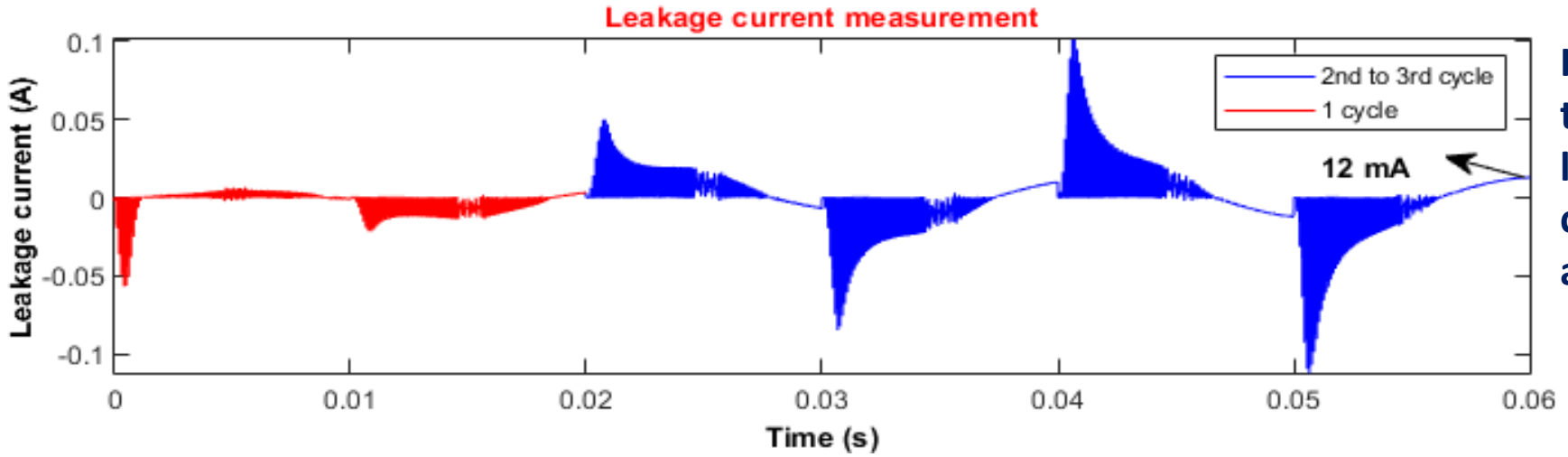


TOTAL HARMONIC DISTORTION

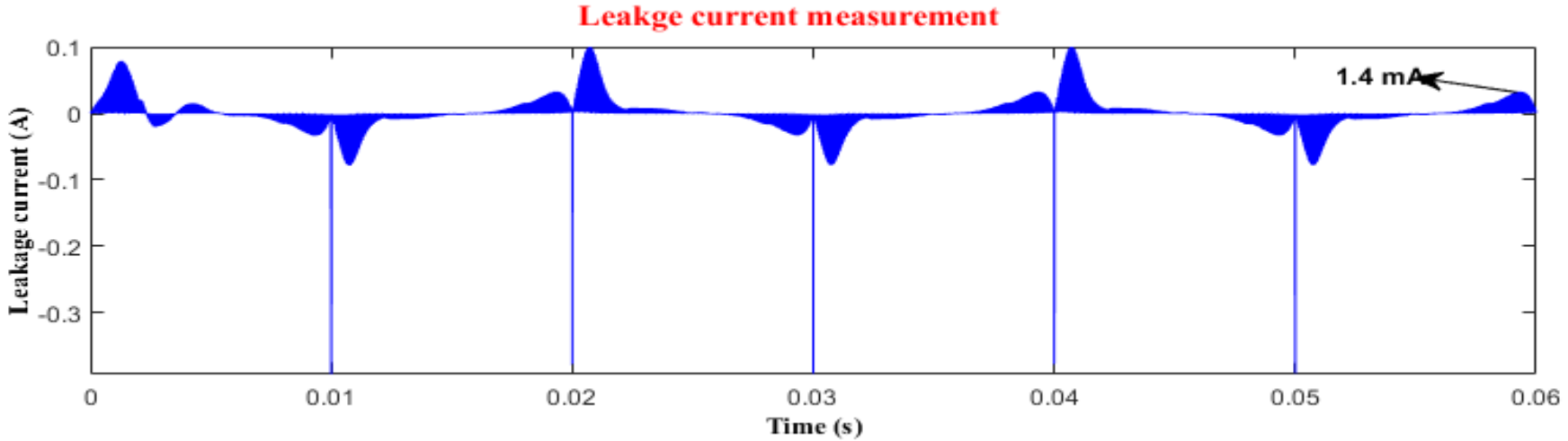


COMPARISON BETWEEN H5 TOPOLOGY AND OUR MODIFIED CIRCUIT

Leakage current

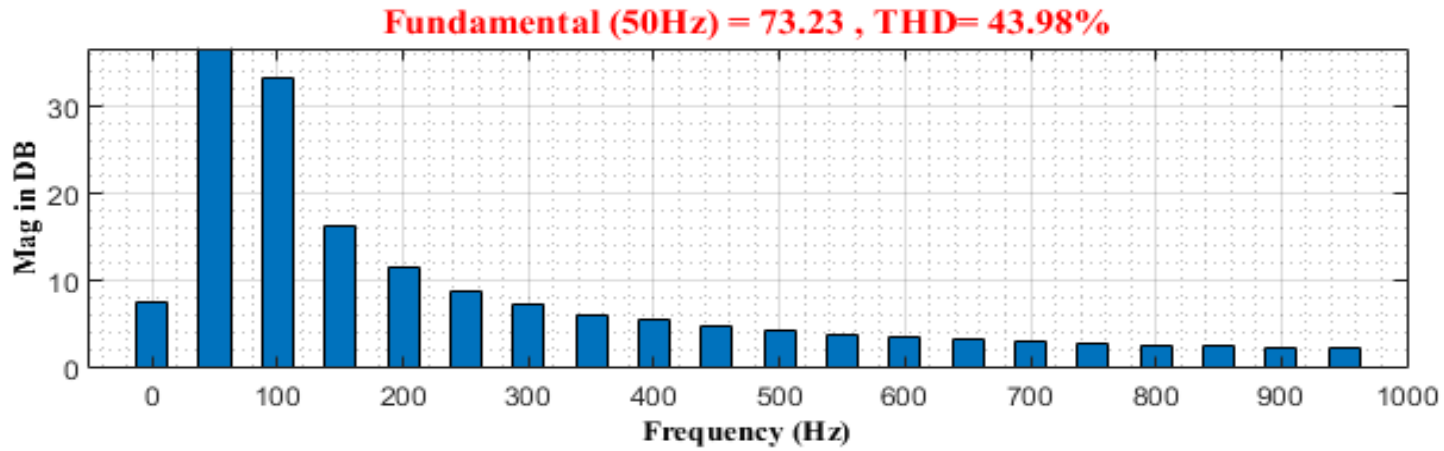


In H5 topology, the leakage current comes around 12 mA

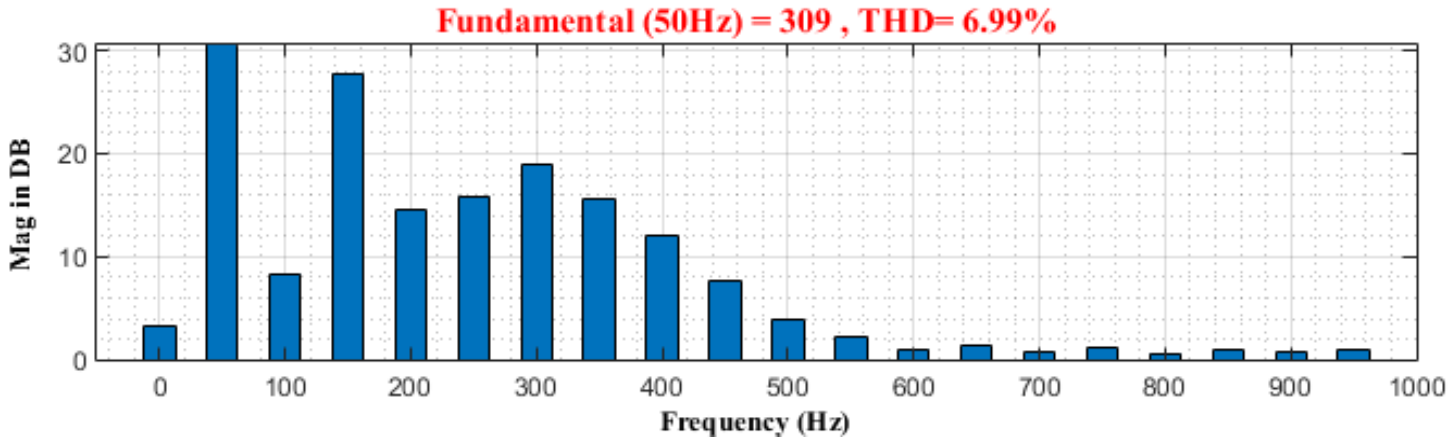


In our proposed circuit the leakage current is 1.4 mA

Total harmonics distortion

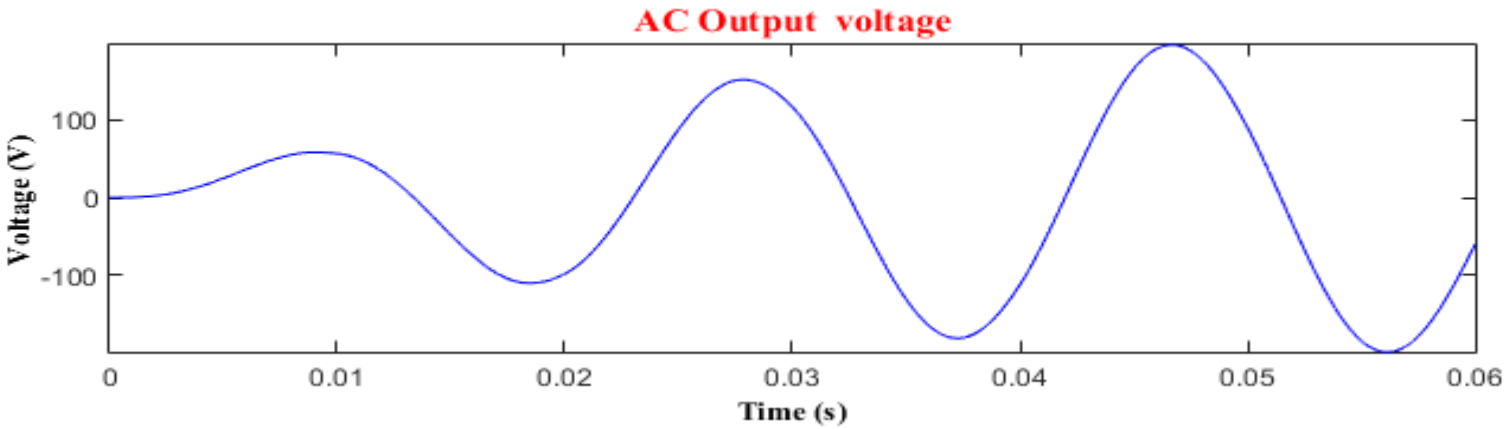


In H5 topology the Total harmonics distortion is 43.98 %

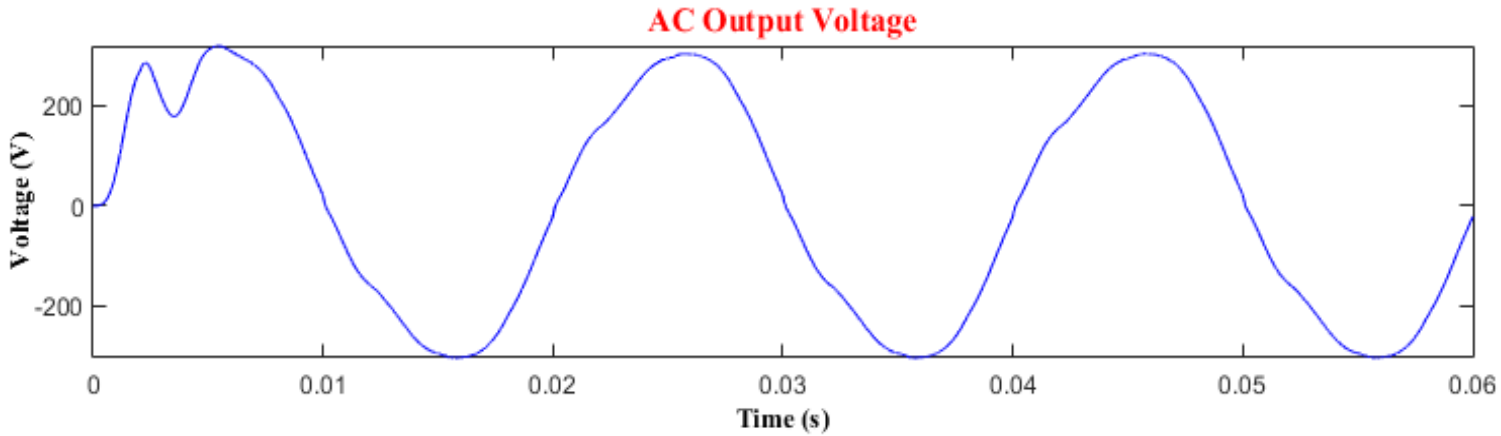


In our proposed circuit the Total harmonics distortion is 06.99 %

AC output voltage



In H5 topology the peak amplitude is 200 V



In Proposed circuit the peak amplitude is 306 V

Conclusion-

- The main idea of the circuit is to reduce leakage current. It should be less than 3mA for lesser losses.Hence,in the above simulated circuit the leakage current is coming as 1.4mA.
- The AC output voltage is coming nearly 9 times more than input voltage.
- Total harmonics distortion comes around 6.99 percent.

References.

1. **Topology Review and Derivation Methodology of Single-Phase Transformer less Photovoltaic Inverters for Leakage Current Suppression**

   Wuhua Li, Yunjie Gu, Haoze Luo, Wenfeng Cui, Xiangning He, and Changliang Xia

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4. **An Improved H5 Topology with Low Common- Mode Current for Transformer less PV Grid- Connected Inverter**

   Hong Li,, Yangbin Zeng, Bo Zhang,**.**

5. **An Optimized Transformer less Photovoltaic Grid-Connected Inverter**

   Huafeng Xiao, *Student Member, IEEE*, Shaojun Xie, *Member, IEEE*, Yang Chen, and Ruhai Huang

- Originality

-After going through so many different variety of ieee papers we have

Came up with a new topology. This topology contains DC converter and inverter both unlike any other.

Innovation

-This one is our proposed circuit of inverter which can convert

Low DC voltage into 8 times higher AC voltage and leakage current is

Very less (1.4 mA) with improved distortion (< 10 %).

- Highlight the originality of the project

-This one is our proposed circuit of inverter which can convert Low DC voltage into 8 times higher AC voltage and leakage current is Very less (1.4 mA) with improved distortion (< 10 %).