Design and Implementation of Solar Based Heric Inverter Performance for Standalone System

[1]Digesh D. Shah, [2]Amarpal kanogia

Department of Electrical Engineering
Dr. Jivraj Mehta Institute of Technology, Anand, Gujarat

Abstract— **Transformerless inverters are widely used in grid-tied Photovoltaic (PV) generation systems, due to the benefits of achieving high efficiency and low cost. Various transformerless inverter topologies have been proposed to meet the safety requirement of leakage currents, such as specified in the VDE 4105 standard. In this paper, leakage currents is proposed highly efficient and reliable inverter concept (HERIC) topology has been discussed with Matlab simulation & also hardware implementation [1].**

Index Terms—**Common-mode voltage, grid-tied inverter, leakage
Current, photovoltaic (PV) generation system, transformerless inverter.**

I. INTRODUCTION

THE applications of distributed photovoltaic (PV) generation systems in both commercial and residential structures have rapidly increased during recent years. Although the price of PV panel has been declined largely, the overall cost of both the investment and generation of PV grid-tied system are still too high, comparing with other renewable energy sources. Therefore, the grid-tied inverters need to be carefully designed for achieving the purposes of high efficiency, low cost, small size, and low weight, especially in the low-power single-phase systems (less than 5 kW). From the safety point of view, most of the PV grid-tied inverters employ line-frequency transformers to provide galvanic isolation in commercial structures in the past. However, line-frequency transformers are large and heavy, making the whole system bulky and hard to install. Compared with line-frequency isolation, inverters with high-frequency isolation transformers have lower cost, smaller size and weight. However, the inverters with high-frequency transformers have several power stages, which increase the system complexity and reduce the system efficiency [1]–[6]. As a result, the transformerless PV grid-tied inverters are widely
Installed in the low-power distributed PV generation systems. Unfortunately, when the transformer is removed, the common mode (CM) leakage currents (*l*eakage) may appear in the system and flow through the parasitic capacitances between the PV panels and the ground [7], [8]. Moreover, the leakage currents lead to serious safety and radiated interference issues [9]. Therefore, they must be limited within a reasonable range [10].

II. BASIC BLOCK DIAGRAM OF PV SYSTEM

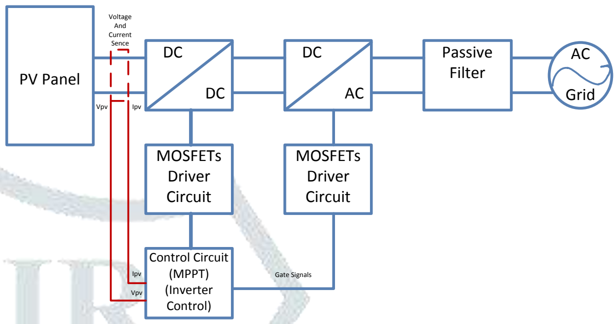


Fig.1. Basic Block Diagram (1)

III. HERIC INVERTER TOPOLOGIES

The HERIC topology shown in Fig. 2 employs two extra switches on the ac side of inverter, so the leakage current path is cut off as well.[1]

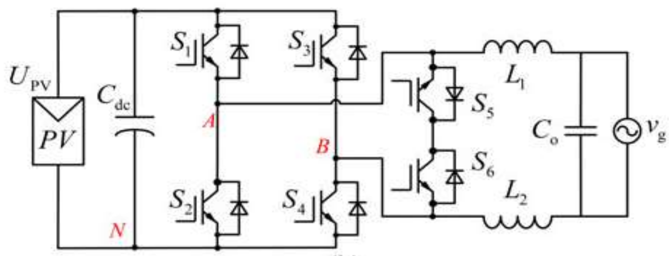


Fig.2. HERIC Topology (2)

IV. CONDUCTION MODE OF INVERTER TOPOLOGY

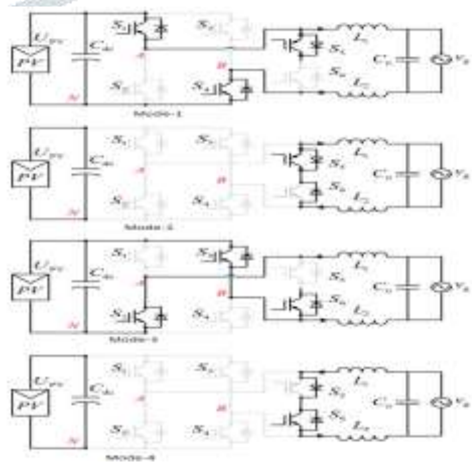
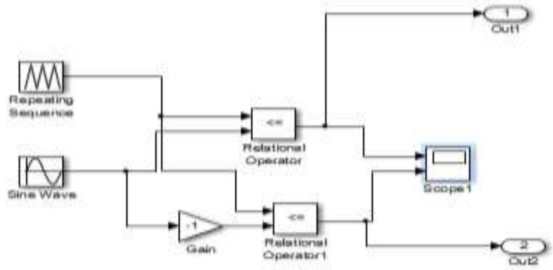


Fig.3. Conduction Modes of HERIC Topology

V. TRIGGERING TECHNIQUE FOR INVERTER TOPOLOGIES

- SPWM Technique

The gating signal generated by sinusoidal reference signal with triangular carrier wave of frequency f_c. This sinusoidal modulation is commonly used in industrial application. The frequency of reference f_r signal is determine the inverter output frequency f_o and its peak amplitude A_r controls the modulation index M and turns the RMS output voltage V_o. comparing the bidirectional carrier signal V_{cr} with two sinusoidal reference signal v_r and $-v_r$. [11],[12]
The output voltage is $V_o = V_1 (g_1 - g_4)$



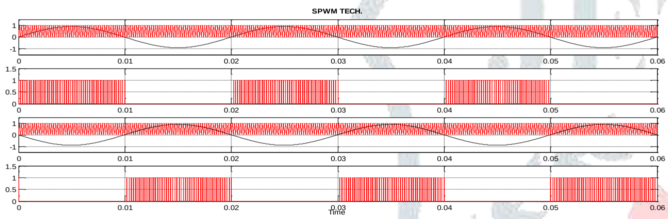


Fig.4. Simulation of SPWM Technique [11]-[12]

VI. SIMULATION OF DC-DC BOOST CONVERTER

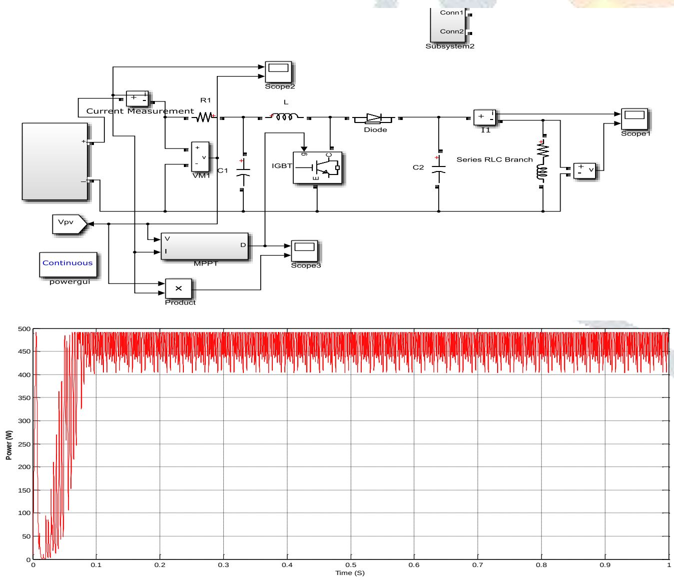


Fig.5. Simulation & O/P Result of Boost converter with MPPT

VII. SIMULATION OF INVERTER TOPOLOGIES WITH PV SYSTEM

A. Simulation and Output Result of HERIC Topology with SPWM Technique

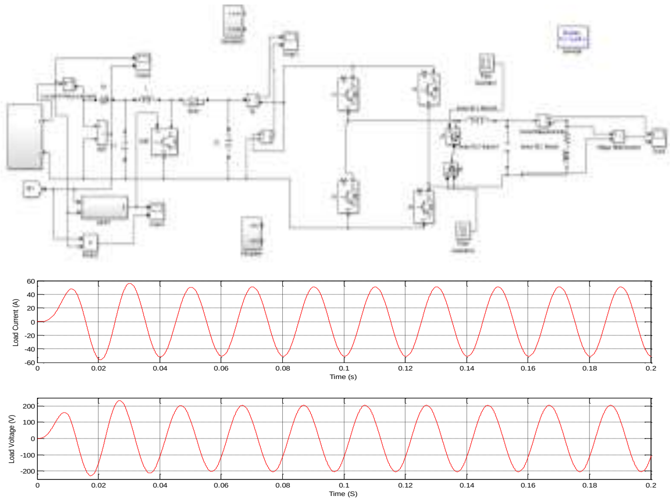


Fig.6. Simulation O/P Result of HERIC Topology

Fig.6. shows that simulation and output results of HERIC Topology

VIII. HARDWARE RESULTS

- Output Results of Boost Converter with Different Duty Cycle

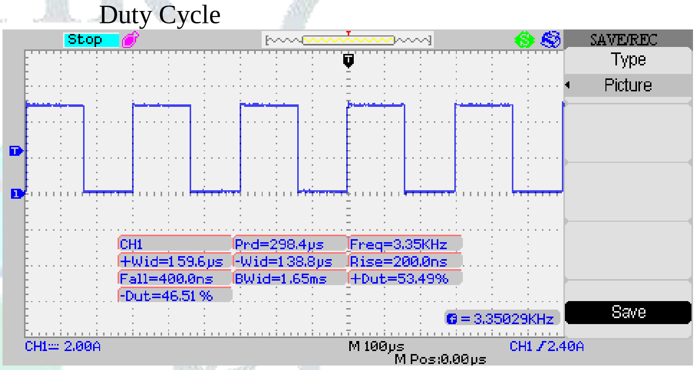


Figure 7. Output of boost converter with 50% Duty cycle

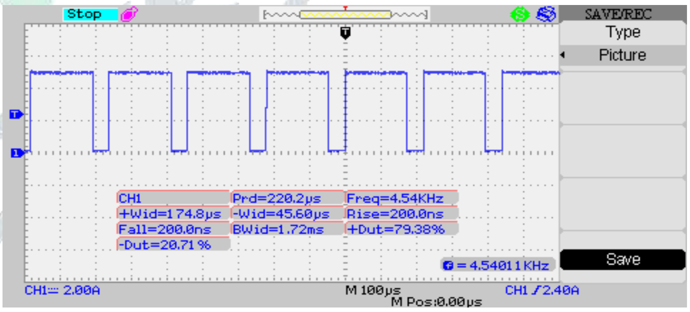


Figure .8. Output of boost converter with 79.39% Duty cycle

- **Triggering Signal Output**

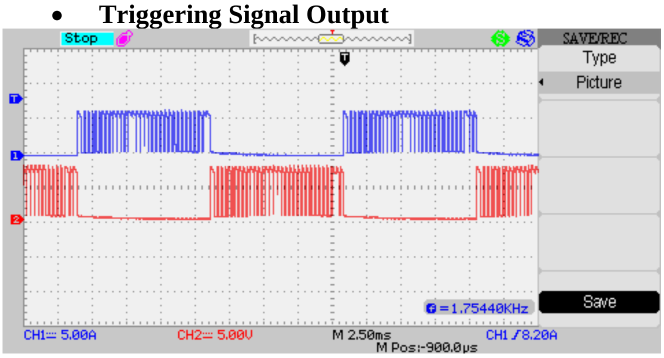


Figure 9. Triggering for switch T1 & T4 and T2 & T3

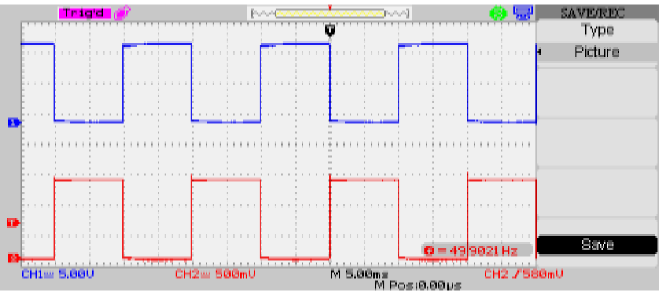


Figure. 10.Triggering for AC Coupling switch

- **HERIC Inverter Output**

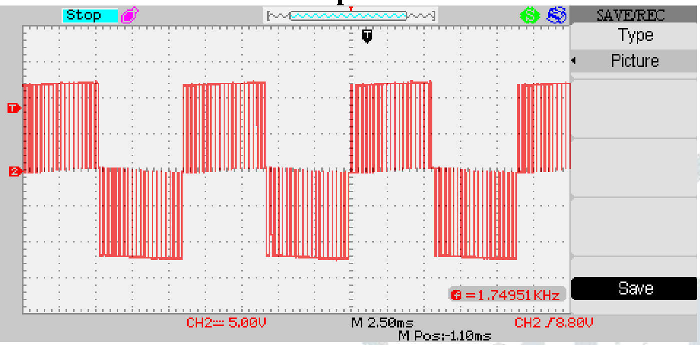


Figure .11. Load Voltage of HERIC Inverter with RL Load without Filter

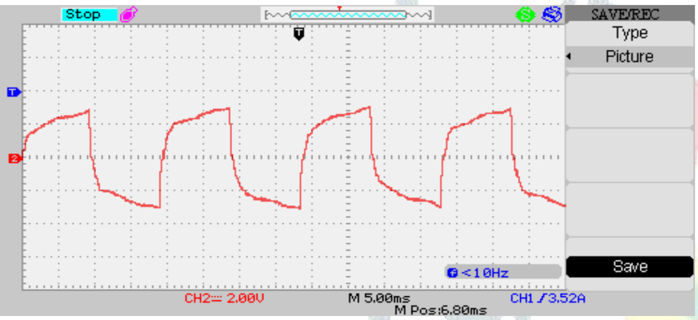


Figure .12. Load Voltage of HERIC Inverter with RL Load with Filter

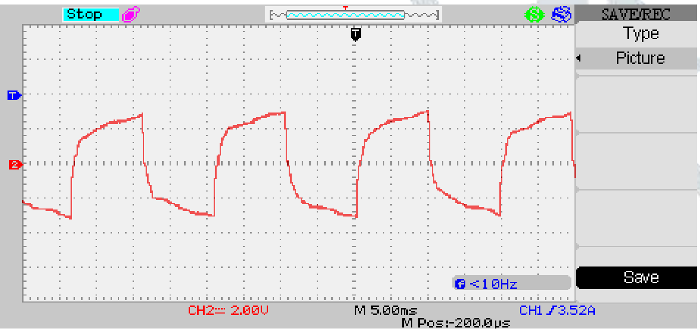


Figure .13. Load Current of HERIC Inverter with RL Load with Filter

IX. CONCLUSION

A novel single-phase transformerless grid-connected PV Inverter, which generates no ground leakage current, is proposed in this paper. The efficiency of the proposed Inverter is high. Finally, the simulated results both verify the theoretical analysis.

REFERENCE

Paper:-

1. I ZHANG, MEMBER, IEEE, KAI SUN, MEMBER, IEEE, YAN XING, MEMBER, IEEE, AND MU XING, "**H6 TRANSFORMER LESS FULL-BRIDGE PV GRID-TIED INVERTERS**" IEEE.
2. TAMES KER EKES, REMUS TEODORESCU, PEDRO RODRIGUEZ, GERARDO VAZQUEZ, EMILIANO, "**A NEW HIGH-EFFICIENCY SINGLE –PHASE TRANSFORMER LESS PV INVERTER TOPOLOGY**", IEEE (JAN 2011)
3. W. CUI, B. YANG, Y. ZHAO, W. LI, AND X. HE,"**A NOVEL SINGLE-PHASE TRANSFORMER LESS GRID-CONNECTED INVERTER**," IN *PROC. IEEE IECON*, 2011,PP. 1067–1071.
4. W. YU, J. LAI, H. QI AN, AND C. HUTCHENS,"**HIGH-EFFICIENCY MOSFET INVERTER WITH H6-TYPE CONFIGURATION FOR PHOTOVOLTAIC NONISOLATED AC-MODULE APPLICATIONS**," *IEEE TRANS. POWER ELECTRON.*, VOL. 26, NO. 4, PP. 1253–1260, APR. 2011
5. R. GONZALEZ, J. LOPEZ, P. SANCHIS, AND L. MARROYO, "**TRANSFORMERLESS INVERTER FOR SINGLE-PHASE PHOTOVOLTAIC SYSTEMS**" IEEE TRANS. POWER ELECTRON, VOL. 22, NO. 2, PP. 693–697, MAR. 2007.
6. S. V. ARAUJO, P. ZACHARIAS, AND R. MALLWITZ, "**HIGHLY EFFICIENT SINGLE-PHASE TRANSFORMERLESS INVERTERS FOR GRID-CONNECTED PHOTOVOLTAIC SYSTEMS**," IEEE TRANS. IND. ELECTRON., VOL. 57, NO. 9, PP. 3118–3128, SEP. 2010.
7. RAJESH SINGH FARSWAN AND B.G. FERNANDEZ, IIT BOMBAY, "**LOW COST HIGH RELIABLE HYBRID SWITCH SINGLE PHASE GRID-TIED INVERTER**"*IEEE TRANS.* 2014
8. BUDI YANTO HUSODO, SHAHRIN MD. AYOB, MAKBUL ANWARI, TAUFIK, "**SIMULATION OF MODIFIED SIMPLE BOOST CONTROL FOR Z-SOURCE INVERTER**" INTERNATIONAL JOURNAL OF AUTOMATION AND POWER ENGINEERING (IJAPE) VOLUME 2 ISSUE 4, MAY 2013
9. XIN WANG, SUBBARAYA YUVARAJAN, "**MPPT CONTROL FOR A PMSG-BASED GRID-TIED WIND GENERATION SYSTEM**" IEEE.
10. HABBATI BELLIA, RAMDANI YOUCEF, MOULAY FATIMA, "**A DETAILED MODELING OF PHOTOVOLTAIC MODULE USING MATLAB**" NRIAG JOURNAL OF ASTRONOMY AND GEOPHYSICS, VOL. 3, ISSUE 1, JUNE 2014.

BOOKS:-

11. MUHAMMAD H. RASHID
3RD EDITION – POWER ELECTRONICS: CIRCUITS, DEVICES AND APPLICATION, PEARSON
12. K. B. KHANCHANDANI
POWER ELECTROCS-ELECTRICAL & ELECTRONICS SERIES, MCGRAW- HILL