An Overview of Different Types of 1-Phase Transformerless Inverter Topology

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***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, a family of H5 transformerless inverter topologies with low leakage currents is proposed highly efficient and reliable inverter concept (HERIC) topology has been discussed with Matlab simulation [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. PRAPOSED INVERTER TOPOLOGIES

1. H5 Topology

It employs an extra switch on the dc side of inverter. As a result, the PV array is disconnected from the utility grid when the inverter output voltage is at zero Voltage level, and the leakage current path is cut off.[1] Shown in Fig.1

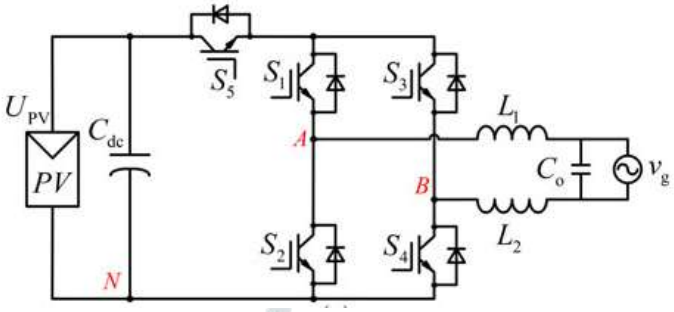


Fig.1. H5 Topology (1)

2. HERIC Topology

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]

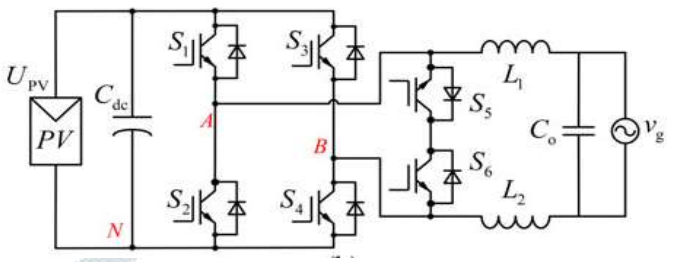


Fig.2. HERIC Topology (2)

III. CONDUCTION MODE OF INVERTER TOPOLOGY

- **Conduction Mode of H5 Topology**

There are four operation modes. Fig.3 shows that, in mode (1), S5, S1, S4 Switches conduct. In Mode (2) S1 & freewheeling diode conduct for dissipating energy.Same as in Mode (3) S5, S2, S3 Switches conduct. And In Mode (4) S3 & Freewheeling diode conduct.

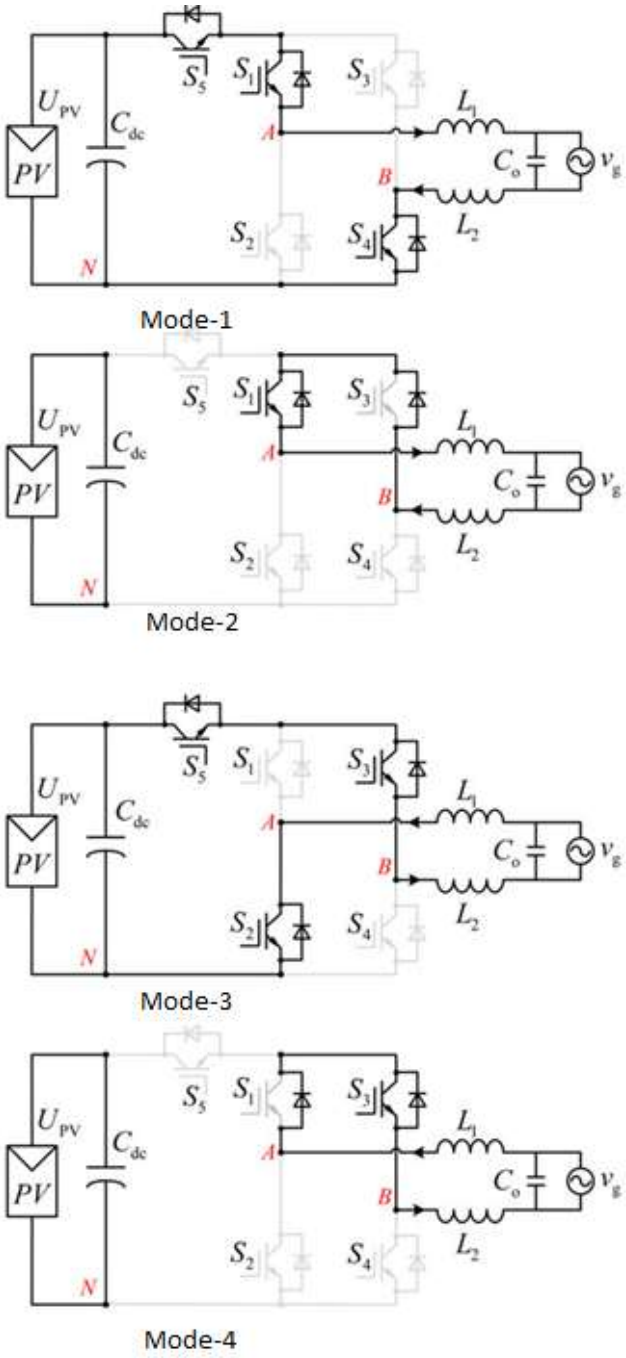


Fig. 3. Conduction Modes of H5 Topology

- **Conduction Mode of HERIC Topology**

There are four operation modes. Fig.4 Shows that, In mode (1) S1, S4 Switches conduct. In Mode (2) S5, S6 Switches conduct. Same as in Mode (3) S2, S3 Switches conduct..
And In Mode (4) S5, S6 Switches conduct.

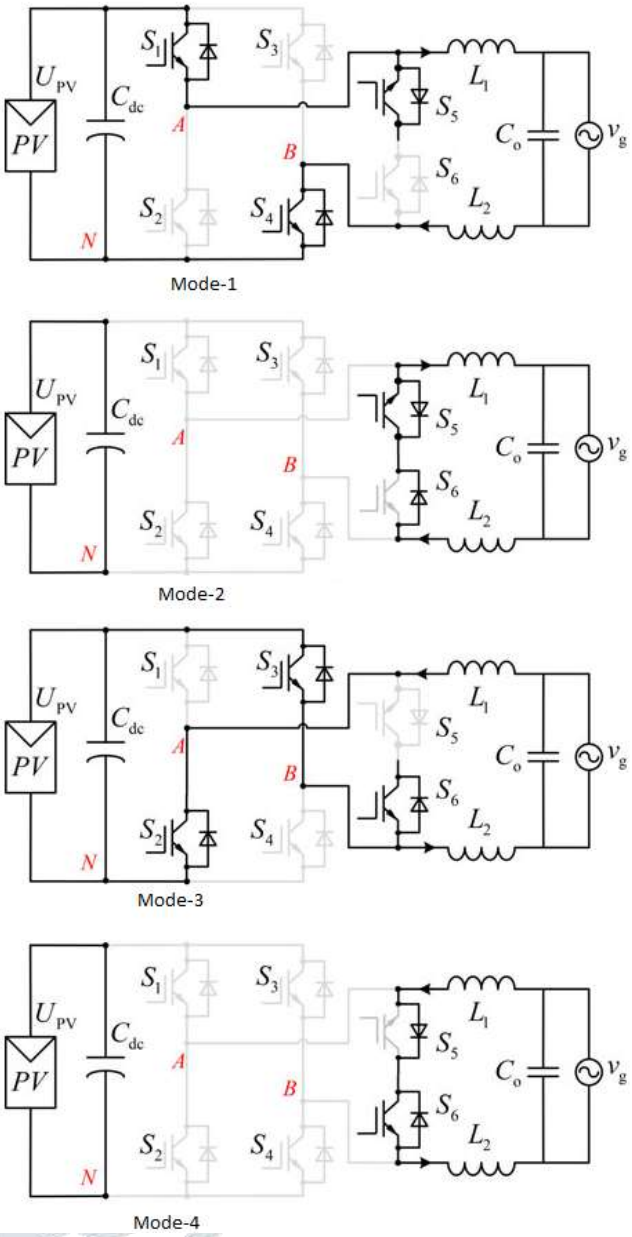


Fig.4. Conduction Modes of HERIC Topology

IV. 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 $V_o = V_1 (g_1 - g_4)$

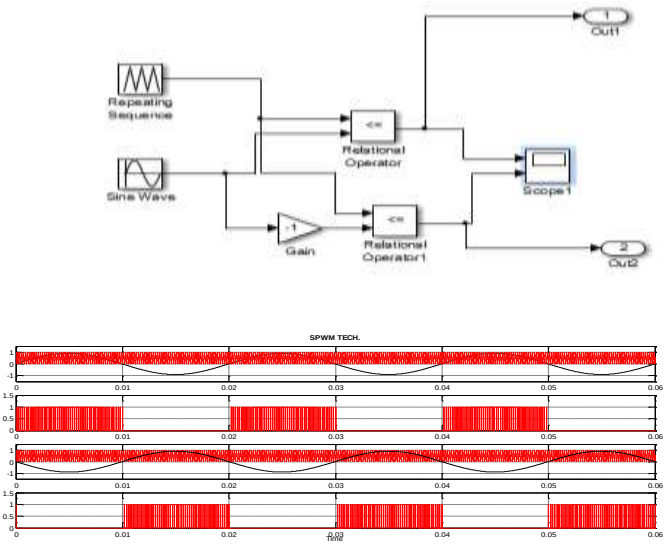


Fig.5. Simulation of SPWM Technique [11]-[12]

V. SIMULATION OF INVERTER TOPOLOGIES WITH MATLAB

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

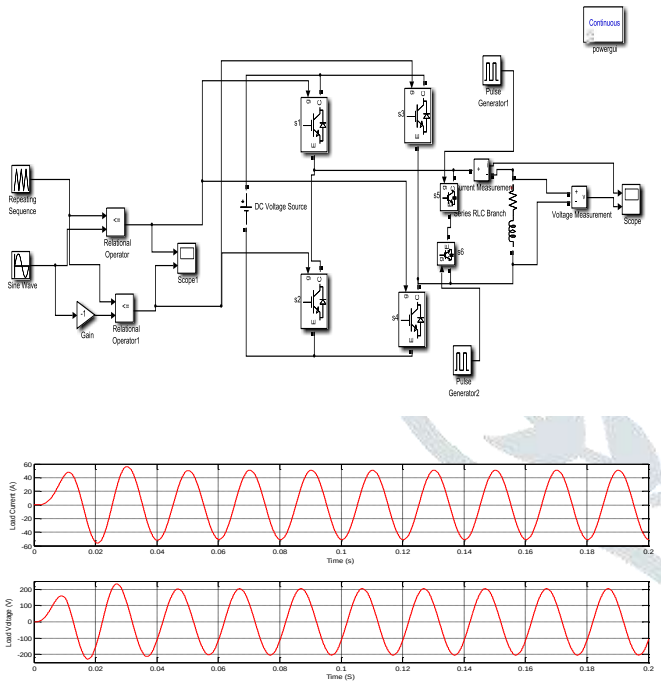
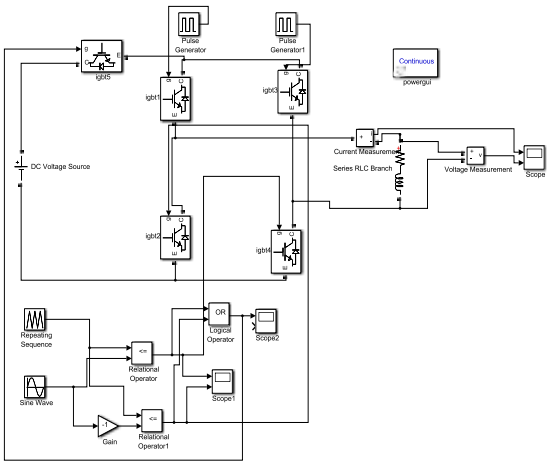


Fig.6. Simulation O/P Result of HERIC Topology

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

B. Simulation and Output Result of H5 Topology with SPWM Technique



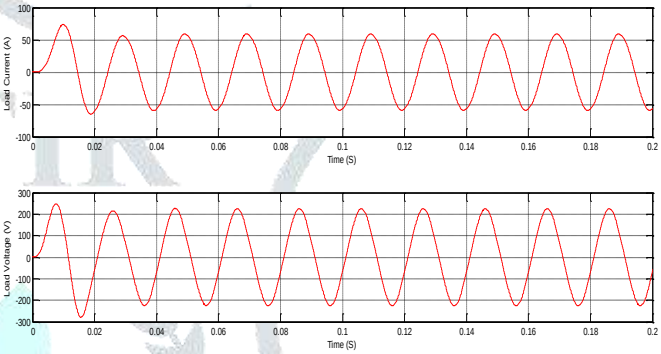


Fig. 7. Simulation & O/P Result of H5 Topology

Fig.7. shows that simulation and output results of H5 Topology

VI. 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.

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