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A Novel Reduced Common-Mode Current Using Single-Phase Multi Level Transformer Less Pv Inverter

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ABSTRACT: *The Multi-Level inverters are utilized in high power and medium voltage applications. These are acquiring much attention due to various advantages such as common mode voltage, operation at both fundamental and high switching frequency, drawing input current with low distortion, reduced harmonic distortions. A critical issues and challenges existed in this system are to suppress the ground leakage current, which is harmful to the human with additional ground currents flowing via resonant circuit parameters of the system. In this paper a novel topology is proposed with multilevel output voltage by utilizing modified sinusoidal multi-carrier based PWM technique for control the inverter. Moreover, consider a super junction MOSFETS as main power switches. The key features of the proposed topology are follows with no reverse recovery issues, operating with high efficiency, low ground current and current distortion is achieved. Hence, the proposed topology and its performance evaluation are demonstrated by the simulation results.*

Keywords: Transformer less pv inverters, ground leakage current, multilevel inverters, PWM technique, control strategy.

I.INTRODUCTION

This world demands more energy due to increased population and industries. A several renewable energy sources are available in nature such as coal, wind, solar energy etc. Photo-voltaic (PV) is also one of the energy which is popular and free source in nature. Now a day's PV industry is searching for low cost and efficient PV inverter topologies, which reduces the initial investment for PV generation system. According to PV inverters manufactures are improved their products without change in the system efficiency.

Therefore, transformer less PV inverters are introduced with reduced size, weight and higher efficiency comparing with conventional isolated inverters. Fig.1 shows the standard H-bridge topology which is not considered the transformer among converter and the utility grid such as either low frequency or high frequency. The ground current path includes the parasitic capacitor embedded between PV cells and grounded frame. These systems are evaluated in two types such as with transformer and without transformer**.**

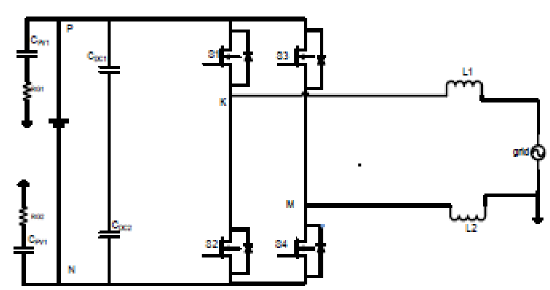

FIG.1. STANDARD H-BRIDGE TOPOLOGY

In general most of the grid connected systems are with transformer, provides the galvanic connection for the safety. These types of systems are complex in design, cost and low efficiency. The basic topology of the transformer less PV inverter which is not

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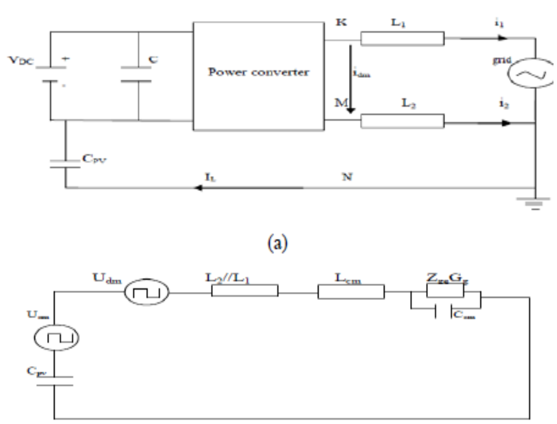
considered either low frequency or high frequency transformer in a system. The increase in the ground currents affects the systems parameters such as losses, reliability, grid current distractions and EMI issues. Therefore as per the VDE0126-1-1 standards the ground current is not exceed the 300mA, within 0.3s is required to disconnect the PV system. The magnitude of the ground leakage current is mainly based on the inverter topology and control strategy. As per literature various topologies are proposed based on the disconnection of PV array from the grid namely dc-decoupling and ac-decoupling methods.



(b)

FIG.2. (A) BASIC TRANSFORMER LESS PV INVERTER (B) SIMPLIFIED COMMON MODE VOLTAGE

The major issues are come across the common mode current flowing through parasitic capacitor to the ground, by means of galvanic isolation problems. The comprehensive analysis of the ground leakage current with respective to the common mode voltage and differential mode voltage is discussed as shown in fig.2 (a),(b). Fig.2 (a) shows the schematic of the transformerless PV inverter with actual stray elements and ground leakage current. Similarly fig.2 (b) shows the equivalent circuits of the basic full bridge PV inverter in terms of common mode voltage and differential mode voltage, which are useful notations for ground leakage current. Where positive phase K and the reference ground N terminal voltage is UKN, negative phase M to ground N voltage is UMN. Defined common mode voltage is

$$U_{cm\text{-}KM} = \frac{U_{KN}+U_{MN}}{2} \quad (1)$$

Differential voltage is defined as

$$U_{dm} = U_{KN}-U_{MN}=U_{KM} \quad (2)$$

From the above relation explains, how capacitive leakage current depend on the common mode voltage and it concludes that reduced common mode current is possible while the CMV is constant such as exactly half of the input dc voltage.

II. PROPOSED TOPOLOGY

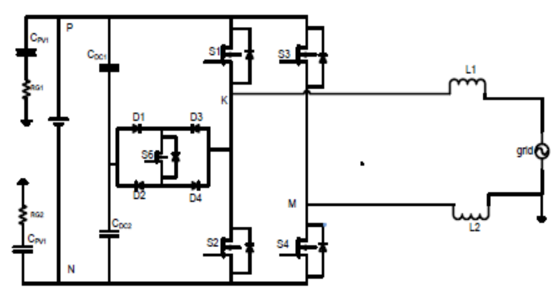


FIG 3. PROPOSED TOPOLOGY

The proposed PV multilevel inverter is shown in fig.3, which consist of a basic H-

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bridge inverter and multilevel output voltage is obtained through bidirectional switch such as active clamping method configured. Fig.3 shows the single phase multilevel transformerless PV inverter with six super junction MOSFET such as main switches S1-S4 and novel clamping branch is adopted between the midpoint of the dc-link capacitors such as S5 and D1-D4.

In multilevel inverters when number of levels is increased, zero voltage states are reduced. In this paper novel improved sinusoidal Modulation technique called third harmonic injection method with multicarrier phase shift (THI-PSMPWM) method is presented. A third harmonic injection method is analyzed by utilizing multilevel transformer less PV inverter. Therefore various multicarrier techniques are proposed based on the carrier signal.

OPERATING PRINCIPLES OF PROPOSED TOPOLOGY:

The operating principles of the proposed topology in various voltage levels are explored in Fig.4 As per the operating principle of the proposed inverter is illustrate the various output voltage levels which is shown in figs.4 (a)-(f).In positive half semi cycle the voltages levels are Vpv, Vpv/2 are generated using switching configuration as shown in fig.4 (a)-(b) called mode1 and mode2. From the fig.4 (a) shows similar in conventional operating principle of full bridge such as S1, S4 are turn on while S3, S5, D1 and D2 turn off.

The current flows via S1, load, S4 & dc voltage source. In this case it generates the positive output voltage Vpv. From the fig.4 (b) shows the freewheeling case which is generate the half of the input dc voltage Vpv/2.The current flows via D1,S5,D4 ,inductor,S4 and comeback grid lines and remains are off. It noticed that proper dead time is required to avoid the short circuit between switching signals at dc-link capacitor. Similar way of procedure is followed in negative semi cycle which is shown in fig.4 (d)-(f) called mode4 to mode6.

The switches S2, S3 are turned on while remain off, it generate the output voltage –Vpv, where Current flows via load, S2, dc-link, S3 and comeback to grid line. While it generate the -Vpv/2 output voltage the switches S3,S5, diode D2,D3 is ON and other is turned OFF. The current flows via load, D3, S5, D2, CDC1 and S3. However to avoid the short circuit the dead time must be inserted between the S2 and S5.In addition there are two zero states are possible in discussed topology such as S1,S3 are ON at one time period or S2, S4.Which is shown in fig.4 (c) & (f).

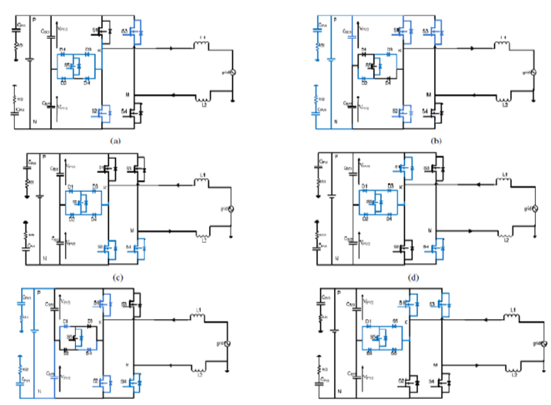

FIG.4 (A)-(F).MODES OF OPERATION

CONCEPT OF THIRD HARMONIC INJECTION PWM: In modulation techniques

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SPWM is suitable method for analysis but it is not fully utilize the available dc bus voltage. To eliminate these issues and improve the system performance via third harmonic injection pulse width modulation (THI-PSPWM) technique was employed in converters. From the reference waveform include it fundamental component and third frequency term, which is presented as follows: From above Ɵ=wt and A represents the parameter with optimize while the maximum peak amplitude.

In third harmonic injection method, low frequency 50Hz signal is added to the third harmonic signal, which is 1/6 of the Fundamental component magnitude. Therefore modified modulating signal is rectified and compared to the high frequency signal with phase shift of 180 degrees t/2 time interval. The following equations' are required to develop the THI-PSMPWM (Third harmonic injection using phase shifted Multi carrier pulse width modulation). Primary reference signals is given by

$$Y=\sin\Theta+A\sin3\Theta \quad (3)$$

$$V_{ref}=A\sin\Theta \quad (4)$$

If third harmonic signal is added to the primary reference signal

$$V_{3rd}=B\sin(3\Theta) \quad (5)$$

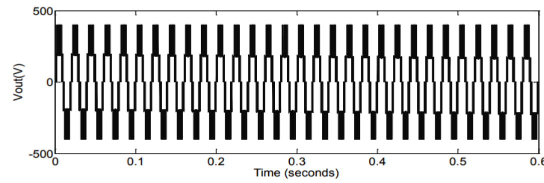
As a result modified signal is obtained by

$$V_{mod}=V_{ref}+V_{3rd} \quad (6)$$

Let B=A/6 Finally the modified new reference signal will be presented as

$$V_{mod}=A\left(\sin\Theta+\frac{1}{6}\sin3\Theta\right) \quad (7)$$

III.RESULT



(a)

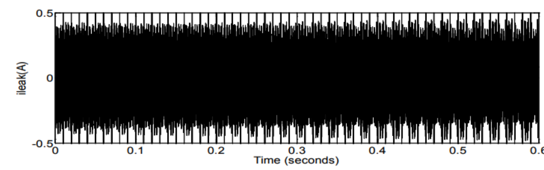


FIG. 5 Performance parameters of the proposed multilevel inverter (a) Output voltage (b) leakage current

IV.CONCLUSION

In this paper a novel multilevel transformerless PV inverter is proposed with modified third harmonic injection multicarrier phase shift pulse width modulation technique (THI-PSMPWM) with reduced capacitive leakage current. It is configured based on the standard H-bridge topology with an auxiliary circuit. Proposed topology consisted in bidirectional switch formed by one MOSFET and four diodes. The bidirectional switch was connected between the midpoint of the first leg in the H-bridge and second terminal connected to the mid-point of the spilt capacitor. According to other commercial single phase topologies, proposed inverter provided with five output voltage levels. Besides, this control strategy was proposed based on the multicarrier modulation technique, which

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controlled the power flowing from DC source. The proposed topology and PWM were aimed to suppress the ground leakage current issue in low power transformerless PV applications. The proposed inverter and its PWM strategy are validated through numerical simulations, which confirmed that common mode current is follows as per the German standard. From analysis and simulation results, it is concluded that the proposed topology and modulation technique is extremely suitable for grid connected PV applications.

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