HYBRID MULTICARRIER MODULATION BASED TRANSFORMERLESS CASCADED MULTILEVEL INVERTER FOR PV SYSTEMS

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Abstract - Due to the decade of fossil fuel at present renewable energy plays an important role to produce the energy. The transformerless photovoltaic (PV) inverter topology has the advantages of simple structure, low weight and provides higher efficiency. However, the topology makes a path for leakage current to flow through parasitic capacitance formed between the photovoltaic (PV) module and the ground. A modulation technique has significant impact to reduce the leakage current without adding any extra component. This project proposes a hybrid multicarrier pulse width modulation (H-MCPWM) technique to reduce leakage current in a transformerless cascaded multilevel inverter for photovoltaic (PV) systems. The proposed hybrid multicarrier pulse width modulation technique ensures low leakage current in the transformerless photovoltaic inverter system with simplicity in implementation of the modulation technique using lesser number of carriers.

Key Words: Hybrid Multi carrier Pulse Width Modulation (H-MCPWM), leakage current reduction, transformer less photovoltaic (PV) system.

1. INTRODUCTION

The total power generation from the photo voltaic (PV) system is relatively small as compared to other common energy resources due to its high installation cost. Reducing the system cost and increasing system efficiency. One of the solutions to remove transformer required in the output of the photovoltaic (PV) inverter. , the use of transformers increases, size, weight and cost of the Photo voltaic system, and also reduces the power conversion efficiency.

To overcome the effects of transformers in inverter, transformer less photovoltaic systems are used. However, removal of the transformer introduces leakage current to flow through the parasitic capacitance which exists between the photo voltaic (PV) module and the ground. This leakage current may increase the system losses, total harmonic distortion in the grid current, electromagnetic inferences, and safety concerns. Traditional two- and three-level inverters are unable to provide high efficiency and grid code requirements for higher power and voltage ratings.

The switching sequence and modulation can be decided by the users, but it requires regress effort for Implementation. We can use the space vector modulation technique to reduce the leakage current in transformer less photo voltaic inverter topology by placing zero active vectors at appropriate switching instants. However, selection of switching states is not easy for practical implementation. The multi carrier pulse width modulation technique eliminates the problem of common mode voltage applied in the neutral clamped multilevel inverter, which in which increases the computational burden due to more number of carrier signals. So in proposed system hybrid multi carrier modulation technique is used to reduce the leakage current in transformer less inverter.

The cascaded H-bridge multilevel inverter has the advantages of less leakage current as compared to the conventional single H-bridge inverter due to reduced value of dc-link voltage per bridge. The common multicarrier modulation techniques used in the transformerless cascaded H-bridge multilevel PV inverter topologies introduce common mode voltage.

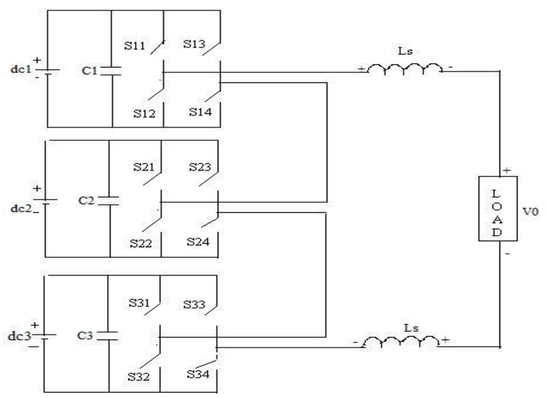

Fig. 1. PV –supported transformerless single phase seven level cascaded multilevel inverter

This letter proposes a hybrid multicarrier pulse width modulation (H-MCPWM) technique to reduce leakage current in transformerless cascaded H-bridge multilevel inverter for PV systems. When the common mode voltage changes in a large step value, it induces high leakage current in the PV system through the parasitic capacitance between the PV module and the ground. The reduced voltage transition in the common mode voltage reduces the leakage current. It is easy to implement the proposed modulation technique without much complexity and require half the number of carriers as required in the conventional MCPWM techniques.

2. HYBRID PULSE WIDTH MODULATION TECHNIQUE

A hybrid multicarrier pulse width modulation (H-MCPWM) technique to reduce leakage current in multilevel inverter for photovoltaic systems. When the common mode voltage changes in a large step value, it induces high leakage current in the photovoltaic system through the parasitic capacitance between the photovoltaic module and the ground. The reduced voltage transition in the common mode voltage reduces the leakage current. It is easy to implement the proposed modulation technique without much complexity and require half the number of carriers as required in the conventional multicarrier pulse width modulation techniques.

The proposed hybrid multicarrier pulse width modulation is the modified version of the phase opposite disposition (POD) pulse width modulation technique, where the number of carriers required is half of that required in phase opposite disposition (POD) pulse width modulation technique, and therefore computational burden is reduced. In this modulation method, the carrier signals used are in-phase with each other. The phase of all the carriers is shifted by 180° after each half-cycle. There is no voltage transition in zero common mode voltage. The common mode voltage may take the values depending upon the inverter switch states selected since the voltage-source inverter cannot provide pure sinusoidal voltages and has discrete output voltage levels synthesized from the output voltage of the photovoltaic.

In case of alternate phase opposition disposition (APOD) modulation, every carrier waveform is in out of phase with its neighbor carrier by 180 degree. Since alternate phase opposition disposition and phase opposition disposition schemes in case of three- level inverter are the same, a five level inverter is considered to discuss about the alternate phase opposition disposition scheme.

MODES OF OPERATION

Mode 1(0-T/3)

1) The reference signal *V*ref is smaller than the carrier signals *Vc*1 and *Vc*2, then the switches *S*11, *S*14, *S*23, and *S*22 are turned ON and the complimentary switches, *S13*, *S*12, *S*21, S24, S31, S32, S33 and S34 are turned OFF.

2) Reference signal *V*ref is greater the carrier signal *Vc*2 , and lesser than the carrier signal *Vc*1 , then the switches *S*14, *S*12, *S*23, and *S*22 are turned ON and the Switches,*S*11,*S*13,*S*21,S31,S32,S33,S34,and *S*24 are turned OFF.

3) When both the carrier signals, *Vc*1 and *Vc*2, are smaller than the reference signal *V*ref, then the switches, *S*13, *S12*, *S*23, and *S*22, are turned ON and the complimentary switches, *S*11, *S*14, *S*21, and *S*24, are turned OFF.

Mode-2 (T/3 to 2T/3)

1) When the reference signal *V*ref is greater than the carrier signals *Vc*2 and vref is lesser than *Vc*2, then the switches, *S*11, *S*14, *S*23, S33, S34and *S*22, are turned ON and the complimentary switches, *S13*, *S*12, *S*21, S31, S32 and *S*24, are turned OFF.

2) Reference signal *V*ref is greater the carrier signals *Vc*2 , and *Vc*3 , then the switches, *S*11, *S*14, *S*21, S31,S34and *S*23, are turned ON and the complimentary switches, *S*13, *S*12, *S*22, S32,S33and*S*24, are turned OFF.

3) The carrier signals, *Vc2*, are smaller than the reference signal *V*ref and vc3is greater than vref, then the switches, *S*11, *S14*, *S*21, S31, S34and *S*24, are turned ON and the complimentary switches, *S*13, *S*12, *S*23, S32, S33and *S*22, are turned OFF.

Mode-3 (2T/3 to T)

1) The reference signal *V*ref is smaller than the carrier signals *Vc*1 and *V*ref is greater than the carrier signal *Vc*2 , then the switches, *S*11, *S*14,S21, *S*23,S33,S34 and *S*22, are turned OFF and the complimentary switches,*S*13, *S*12, *S*21, and *S*24, are turned ON.

2) When the reference signal *V*ref is greater the carrier signals*Vc*1 , and lesser than the carrier signal *Vc*3 , then the switches, *S*11, *S*13, *S*31, and *S*32, are turned ON and the complimentary switches, *S*14, *S*12,S21, *S*24,S23,S33 and*S*34, are turned OFF.

3) The carrier signals, *Vc*1 is greater than vref and *Vc*3 are smaller than the reference signal *V*ref , then the switches, *S*11,*S*14, *S*31, and *S*32, are turned ON and the complimentary switches, *S*13, *S*12, S21,S24,*S*23,S33 and *S*34, are turned OFF.

3. RESULT AND DISCUSSION

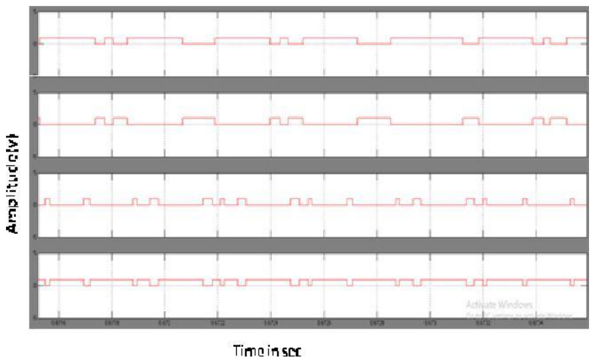

Fig .2. Switching pattern for proposed controller

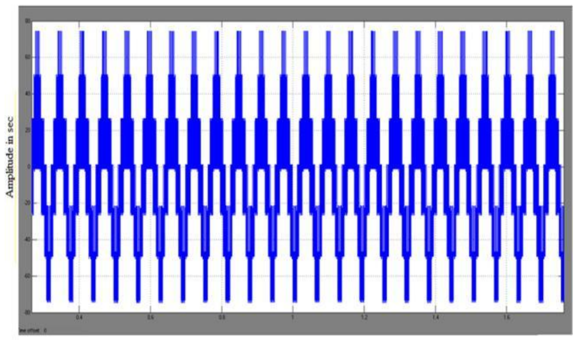

Fig.3. Inverter output voltage of proposed system

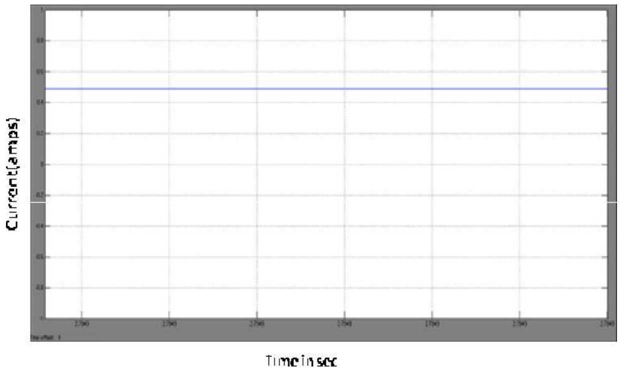

Fig.4. Reduced leakage current of proposed system

4. CONCLUSION

Compare to the existing system in proposed system has seven level cascaded inverter is used so the amount of voltage boosting is high. Due to the seven level inverter leakage current which is produced due to parasitic capacitance also get reduced and amount of total harmonic distortion also gets reduced. For future scope we can increase the level of the inverter which further to reduce the leakage current and total harmonic distortion in transformerless photovoltaic inverter. The proposed system can also implement in hardware to demonstrate the simulated model.

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BIOGRAPHIES

M.Ranjani was born in Namakkal, India 1993.She received the B.E degree in Electrical and Electronics Engineering in United Institute of Engineering and Technology from Anna University in the year of 2014.Now, she is doing post graduation in the field of Power Electronics & Drives in Sri Shakthi Institute of Engineering and Technology in the year of 2016.Here my area of interests are power electronics, control system& electrical drives.

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