디지털 PI 컨트롤을 사용한 단상 7레벨 연계형 인버터

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Single-Phase Seven-Level Grid-Connected Inverter Employing Digital PI Controller

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ABSTRACT

This paper proposes a new single phase seven level grid connected inverter. Operational principle with switching function are analyzed. A digital proportional integral current control algorithm was implemented in a TMS320F28335 DSP to keep the current injected into the grid sinusoidal. To verify the performance of the proposed inverter, PSIM simulation and experimental results are also shown in this paper.

1. Introduction

Nowadays, due to the energy shortage, the integration of renewable energy sources to the grid becomes an interesting research topic. Among various types of renewable energy sources, solar energy and wind energy have become very popular and demanding due to advancement in power electronics techniques. Photovoltaic (PV) sources are used today in many applications as they have the advantages of being maintenance and pollution free. PV inverter, which is the heart of a PV system, is used to convert dc power obtained from PV modules into ac power to be fed into the grid. Improving the output waveform of the inverter reduces its respective harmonic content and, hence, the size of the filter used and the level of electromagnetic interference (EMI) generated by switching operation of the inverter.

In recent years, multilevel inverters have become more attractive for researchers and manufacturer due to their advantages over conventional three level PWM inverter. They offer improved output waveform smaller filter size, lower EMI, lower total harmonic distortion (THD). Various topologies for multilevel inverters have been proposed over the years. Common ones are dioded clamped, capacitor clamped and cascaded full bridge. This paper proposes a seven level PWM inverter whose output voltage can be represented in the following seven levels: zero, Vc, 2Vc, 3Vc, Vc, 2Vc, and 3Vc. As the number of output levels increases, the harmonic content can be reduced.

2. Contents

2.1 Description of the proposed inverter

Fig. 1 shows a configuration of the proposed single phase seven level inverter. The power supply is connected to the inverter via two dc dc buck boost converters. The output capacitors of the converters are cascaded with the input capacitors to make dc link voltage for the inverter. At the output voltage of the inverter, switches S1, SA1 SA2, S2 can generate 1/4, 2/2, 3/4 of dc link voltage, switch S3 for the negative and switch S4 for the positive of the output voltage VAB. And switch SB3 SB4 is controlled to make the zero level of output voltage.

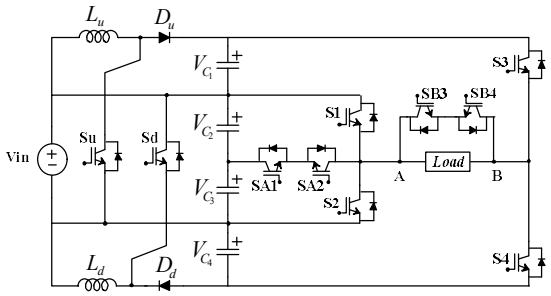


Fig. 1. Configuration of the proposed single phase seven level inverter

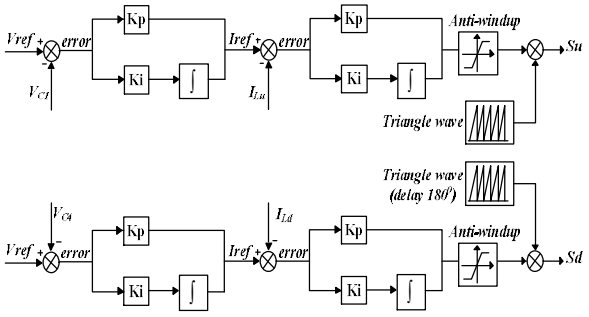


Fig. 2. PI control algorithm for dc dc buck boost converter

The current and voltage PI controllers are implemented to keep the output voltage of two dc dc buck boost converters being stable are shown in Fig. 2. The phase difference of

PWM signals for Su, Sd is 180 degree to reduce ripple of input current.

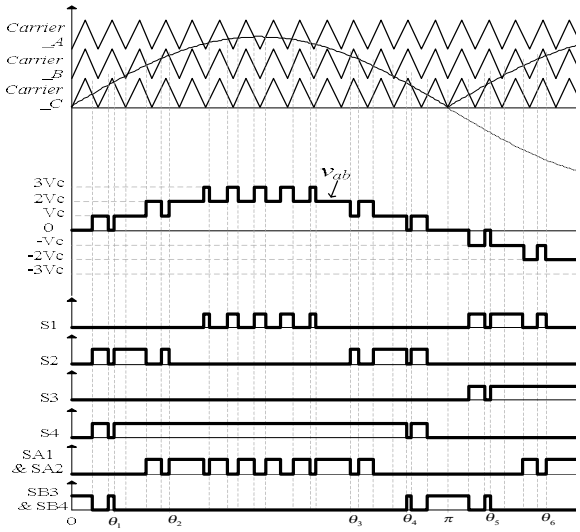


Fig. 3. Switching pattern of the proposed inverter

Fig. 3 shows the switching pattern of the proposed inverter. Basic principle of the proposed switching strategy is to generate gate signals by comparing the reference signal with three carrier waves having same frequency and in phase, but different offset voltages.

2.2 Simulation results

PSIM simulated the proposed configuration before it was physically implemented in a prototype. Input voltage is 250Vdc, output voltages of two buck boost converters is 125Vdc and the output ac voltage of the inverter is controlled to make a sine wave with 60Hz and 220 Vrm. Fig. 4 shows the simulation results when the inverter is connected to the load, with filter inductor L = 2mH, filter capacitor C = 10uF. And Fig. 5 shows the results when the inverter is connected to the grid with L = 4mH, C = 2uF.

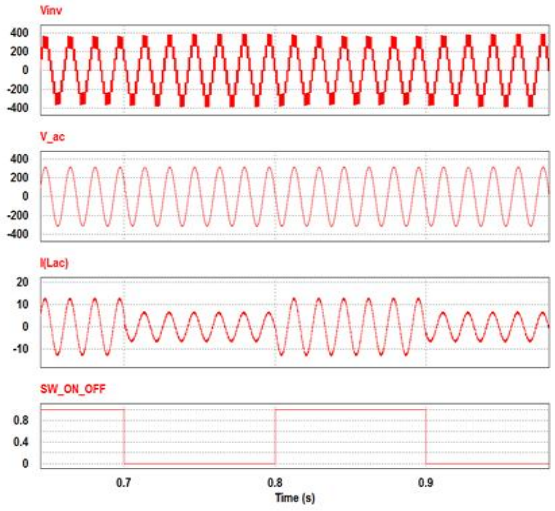


Fig. 4. Voltage and current waves when the load is changed 25 50 25 (ohm)

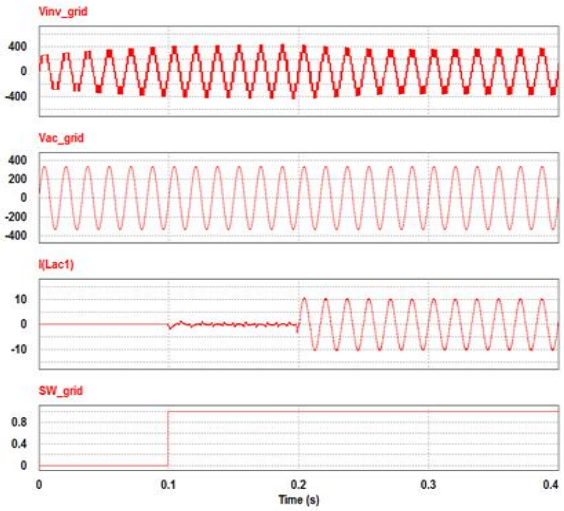
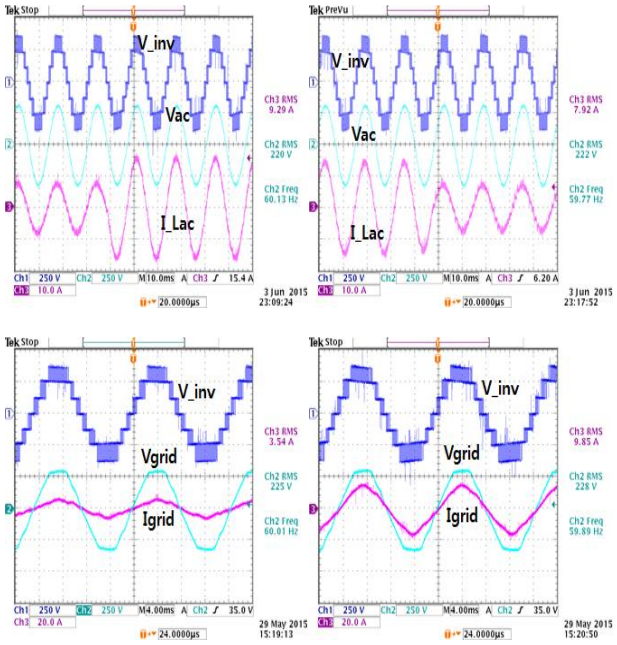


Fig. 5. Voltage and current waves when the inverter connected to the grid.

2.3 Experimental results



3. Conclusion

This paper presented a new single phase seven level grid connected inverter. Simulation and experimental results are shown to verify that the proposed inverter can generate the ac voltage with seven levels.

참 고 문 헌

[1] S. J. Park, F. S. Kang, M. H. Lee, C. U. Kim, "A new single phase five level PWM employing a deadbeat control scheme", IEEE Trans. Power Electron., vol. 18, pp.831 843, May 2003.