Single phase Cascaded multi level Inverter Using PIC Microcontroller

M.Sabarinath, Dr.S.PRABAKARAN
[1]PG Scholar, Power Systems, Department of EEE, SCSVMV University, Enathur, Tamilnadu
[2]Associate Professor, Power Systems, Department of EEE, SCSVMV University, Enathur, Tamilnadu

Abstract-- Multilevel inverters have recently found its way in to the high power applications in both domestic and industrial fields with its ability of low switching frequency. Out of all the topologies of a multilevel inverter, the cascaded H-bridge inverter is most commonly used due to its modular topology. This inverter is called the developed cascaded multilevel inverter. In order to generate all voltage levels (even and odd) at the output, four different algorithms are proposed to determine the magnitude of dc voltage sources. The ability of the proposed inverter to generate all voltage levels (even and odd) is reconfirmed by using the experimental results of a 5-level inverter. The switching is done by PIC microcontroller. Topology is designed with minimum size, weight & reduced power losses.

Index terms - cascaded H-bridge, multilevel inverters

1. INTRODUCTION

Multilevel inverters have gained widespread interest recently. The normal CSIs and VSIs are two-level inverters because the power switches are connected to either the positive or the negative DC bus. Though this method is effective, it creates harmonic distortions in the output voltage, EMI and high dv/dt. This may not always be a problem, but for some applications there may be a need for low distortion in the output voltage.

If more than two voltage levels were available to the inverter output terminals, the output which is obtained can be approximated as a sine wave. The concept of multilevel inverters (MLI) does not depend on just two levels of voltage to create an AC signal. Instead several voltage levels are added to each other to create a smoother stepped waveform with lower dv/dt, lesser distortions in harmonics, smaller common-mode voltage and lower switching frequency thereby making it available for high power applications [1].

With more voltage levels in the inverter, the waveform finally obtained becomes smoother. There are different kinds of topologies of multilevel inverters which is obtained by designing the multilevel circuits in different ways that can generate a stepped voltage waveform and that are suitable for different applications.

The available topologies include neutral point clamped, flying capacitor and cascaded H-bridge converters [2]. Diode-clamped multilevel converters are used in conventional high-power ac motor drive applications like in mills, conveyors, fans, etc. They are also utilized in gas, power, mining, water, chemical industries, etc. Flying capacitor multilevel converters have been used in high-bandwidth high-switching frequency applications such as medium-voltage traction drives. Finally, a cascaded H-bridge multilevel converter have been applied where high power and power quality are essential, for example, active filter, reactive power compensation, static synchronous compensator applications, photovoltaic power conversions, UPS, etc. Besides, one of the growing applications for multilevel motor drives is in the electric and hybrid power trains [3].

This paper presents a five-level cascaded H-bridge multilevel inverter in which each of the level is fed by a solar panel. The simulation is done with the help of MATLAB and hardware implementation details are also included. The first part explains about the cascaded H-bridge inverter. The second part deals with the model and its result.

2. H-BRIDGE MULTILEVEL INVERTER

A cascaded H-bridge multilevel inverter differs in several ways from the other multilevel inverters in how it achieves the voltage waveform using separate DC sources, in a modular setup, to create the stepped waveform. The cascaded H-bridges multilevel inverter introduces the idea of using Separate DC Sources (SDCSs) to produce an AC voltage waveform. Each of the H-bridge inverter is connected to separate DC source's Vdc. The AC output of each H-bridge inverter is cascaded and an AC voltage waveform is produced. The number of levels in a cascaded inverter is defined by $m = 2s + 1$ (1) where s is the number of dc sources.

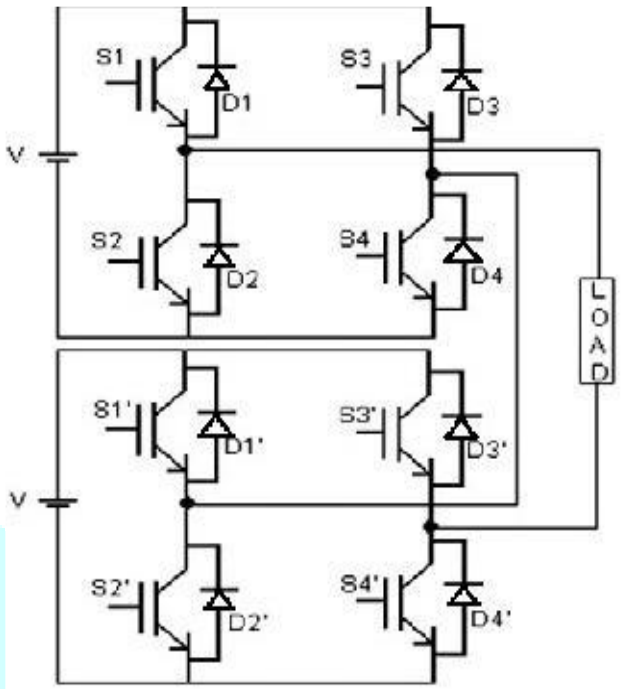

Fig.1 Five Level Cascaded Multilevel Inverter

Fig.1 shows a five-level cascaded multilevel Inverter. The ac output of each of the different level H-bridge cells is connected in series to synthesis a multilevel waveform. The so obtained voltage waveform is hence the sum of the inverter outputs.

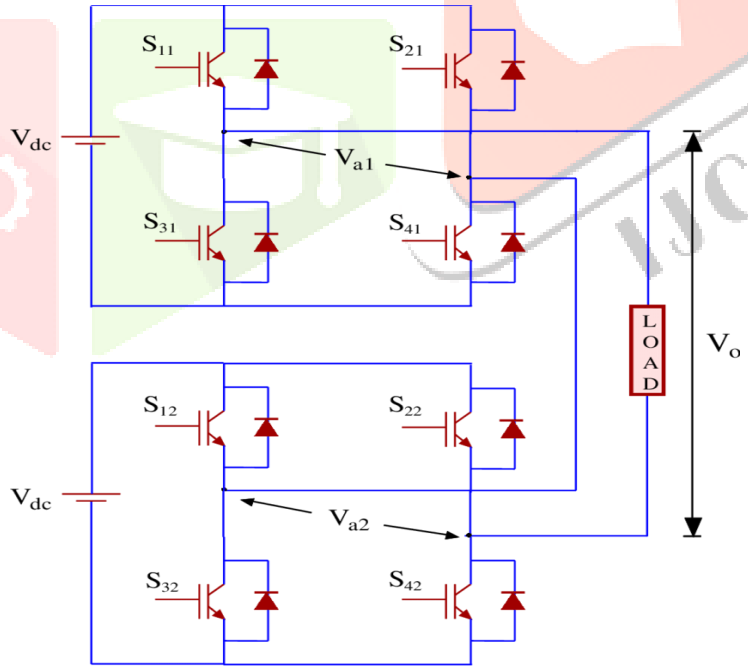

Fig.2 One phase of a cascaded H-bridge multilevel inverter

The H-bridge topology can be seen as being made of modules. Every module added in cascade to the already existing levels extends the inverter with two voltage levels. The total output voltage is the sum of the outputs of all the full-bridge modules in the inverter and every full-bridge can create the three voltages +V1, 0 and –V1. It should be noted that the cascaded multilevel inverter is capable of putting out the total voltage magnitude in both positive and negative direction while many other topologies can only put out half the total DC-bus voltage source magnitude. If the inverter is being implemented in active power transfer applications, the

voltage sources need to be isolated since there is no common DC-bus to recharge the sources energy content. Renewable energy sources can hence be used to charge each of the DC source. A drawback for the energy / fuel cell applications is however that the sources must be charged individually or through the inverter.

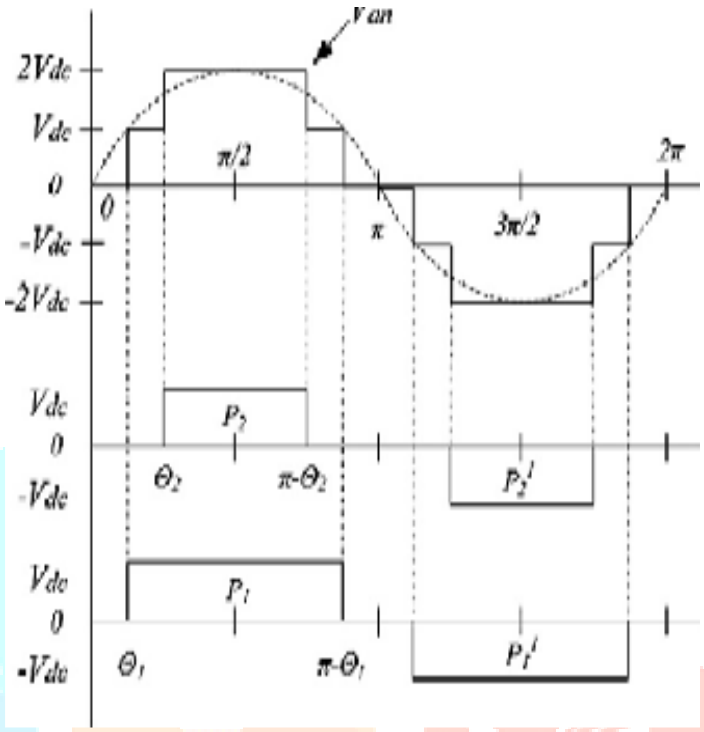

Fig.3 Output Voltage Waveform Of The 5 Level Inverter

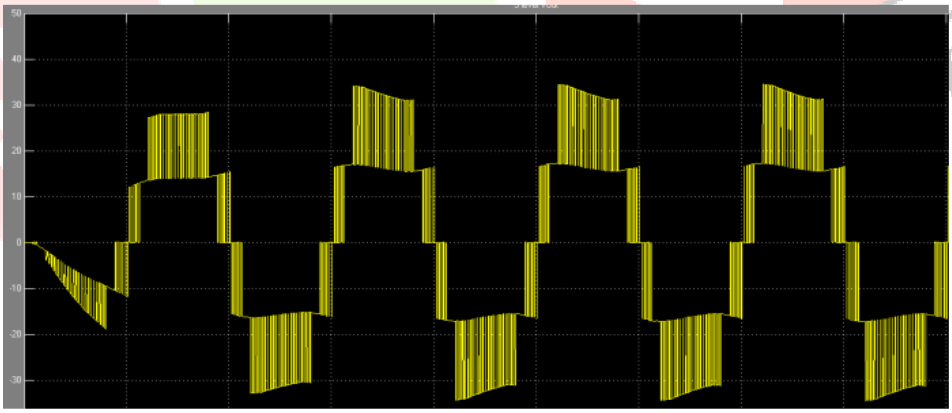

Fig. 4 Output Result

4. CONCLUSION

The proposed cascaded H-bridge multilevel inverter using the DC sources was developed. The fundamental switching scheme is employed using the PIC microcontroller. The main advantage of using cascaded H –bridge is that:

- It requires a low number of components per level
- It has modularized structure without clamping components
- There is a possibility to implement soft-switching
- It has simple voltage balancing modulation

The output obtained from the MLI can be utilized for charging batteries, in UPS and other household appliances. By increasing the input voltage source, this inverter can also be used in HEV/EV.

REFERENCES

1] S. Kouro, M. Malinowski, K. Gopakumar, J. Pou, L. G. Franquelo, B.Wu, J. Rodriguez, M. A. Perez, and J. I. Leon, ―Recent advances and industrial applications of multilevel converters,‖ *IEEE Trans. Ind. Electron.*, vol. 57, no. 8, pp. 2553–2580, Aug. 2010.

[2] J. Rodriguez, L. G. Franquelo, S. Kouro, J. I. Leon, R. C. Portillo, M. A. M. Prats, and M. A. Perez, ―Multilevel converters: An enabling technology for high-power applications,‖ *Proc. IEEE*, vol. 97, no. 11, pp. 1786–1817, Nov. 2009.

[3] Pooja Jose ― Cascaded H-BRIDGE Converter for Domestic Applications ― International journal for trends in engineering & technology volume 5 Issue 2 May 2015

[4]. Teodorescu, R., Blaabjerg, F., Pedersen, J.K., Cengelci, E., Enjeti, P.N.: „Multilevel inverter by cascading industrial VSI", IEEE Trans. Ind. Electron., 2002, 49, pp. 832–838

[5]. J. Dixon and L. Moran, "Multilevel inverter, based on multi-stage connection of three-level converters scaled in

[6] K.Gopinath, S. Mahendran, I. Gnanambal, ― New Cascaded H-bridge Multilevel inverter with improved efficiency,‖ *International Journal Of Advanced Research In Electrical, Electronics & Instrumentation Engineering*, vol. 2, Issue 4, April 2013.

[7] T. Salami, M. Bouzguenda, A. Gastli & A. Masmoudi, ―Matlab/ Simulink based modeling of solar photovoltaic cell,‖ *International Journal of Renewable Energy Research* 2012, vol. 2, No. 2, pp. 213-218.

[8] N. Pandiarajan, and R. Muthu, ―Mathematical modeling of photovoltaic module with simulink,‖ 1st International Conference on Electrical Energy Systems ICEES'11, 2011; pp. 258–263.

[9] Javier Napoles, Alan J. Watson, Jose J. Padilla, Jose I. Leon, Leopoldo G. Franquelo, Patrick W. Wheeler and Miguel A. Aguirre, "Selective Harmonic Mitigation Technique for Cascaded H-Bridge Converters With Nonequal DC Link Voltages,‖ *IEEE Transactions On Industrial Electronics*, Vol. 60, No. 5, May 2013.