Dual PWM to Understand Performance of Multilevel Cascade Inverter for Medium and Low Power Application

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Abstract **- The direct current (DC) sources like batteries, solar panels, mini windmill or any source of direct current are currently in demand due to storage and availabilities as well as costing. This demand of energy can be covered using various energy sources which the consumer can own. Hence the devices which only runs on alternating current (AC) can also be operated using DC source by using the power electronic circuits known as inverter. Inverters are having various types according to working principles, designs, factors, efficiency and many more parameters. Here we proposed the multilevel cascade multilevel inverter which works on pulse with modulation (PWM) sequences provided to switch the MOSFET. The MOSFETs are used to convert this PWM steps to staircase signal as same of AC waveform shape. The analysis will be done in this paper will show the PWM sequences and inverter operating.**

Index Terms **- Alternating current, Batteries, Direct current, Efficiency, Inverter, MOSFET, Multilevel, Cascade multilevel inverter, Pulse with modulation, Solar panels.**

I.INTRODUCTION

Thea renewable energy sources are enhancing the system with greater precision and fewer power losses. Solar cells are a distributed energy source that may be mounted on any consumer location, such as the roof of a house. These photovoltaic cells convey the electricity using a converter to convert the dc voltage of the cells to ac voltage [1-3]. The power and harmonics of the two-level inverter are both high. A multi-level inverter is a power electronics circuit that can provide a desired alternating supply voltage at the output with variable voltage and frequency from a single dc voltage or multiple lower-level dc voltages as input, and it has been suggested as the best choice in several medium and high voltage applications [1]. Multilevel inverters have gained popularity in recent years.

A traditional inverter can operate at two voltage levels. Multilevel inverters have several voltage or current sources and can switch their outputs between voltage or current levels. A multilayer inverter can be built in a variety of topologies [6], each with its own set of benefits and drawbacks. To construct the inverter, the simplest way is to connect regular inverters in parallel or series. More complex structures involve, inserting inverter within inverter to form a multi-level inverter. A multilayer inverter's primary function is to generate a desired ac voltage level from dc voltage sources. This dc voltage source could be equal to or different from one another. The ac voltage that this dc voltage generates looks to be sinusoidal. One disadvantage of deploying a multi-layer inverter is that it approximates sinusoidal waveforms, which is problematic because of harmonics.

Sharp transitions can be found in the staircase waveform produced by a multilayer inverter. By converting power in small voltage steps and resulting in lesser harmonics, the multilayer inverter improves ac power quality. As a result, multilevel inverter research has gotten a lot of attention in recent years. Various classifications of multilevel inverters with diverse topologies, such as diode clamped, flying capacitor, cascaded H-bridge, hybrid H-bridge, and novel hybrid H-bridge multilevel inverters, have been created based on a significant number of research works [7]. The Electrical Engineer has been particularly interested in the cascaded H-bridge multilevel inverter among these topologies. The cascaded H-bridge multilevel inverter is a serially connected H-bridge with a separate dc supply. The voltage on each dc source in this setup is the same [1]. The multilayer inverter, on the other hand, has

disadvantages such as difficulty boosting voltage levels in power switching devices, switching losses, circuit complexity, and economic considerations.

II. MULTI LEVEL INVERTERS

Multilevel inverters have been widely used in many applications since the technology is advantageous to increase the converter capability as well as to improve the output voltage quality. Multilevel inverters are able to produce a staircase output waveform, that is more approaching sinusoidal and produce less number of harmonics compare to the conventional inverter output voltage. There are mainly three types of multilevel inverters, Diode clamped, Flying capacitor inverter and cascaded h- bridge multi-level inverter

Cascade Multilevel Inverter.

The structure of the cascaded H-bridge (CHB) may consist of two or more H-bridge inverters. The CHB inverter can be supplied by separated DC sources or a single DC source. The structure of the CHB inverter with separated DC-sources is shown in Figure. This type of inverter consists of two cells H-bridge inverter hence employs 8 power electronic switches. The modulation technique that applies to each cell of inverter may be the same or different. It varies from fundamental switching frequency PWM, carrier based PWM or combination of the two different PWM methods (known as mixed / hybrid PWM method).

III. PRAPOSED SYSTEM AS CASCADE MULTILEVEL INVERTER

The N-level cascaded H-bridge, multilevel inverter comprises (N-1)/2 series connected single phase H-bridges per phase, for which each H-bridge has its own isolated dc source. Three output voltages are possible, ±Vs, and zero, giving a total number of states of 3(N−1)/2, where N is odd. Figure 1 shows one phase of a 5-level cascaded H-bridge inverter. Its main limitation lies in its need for isolated power sources for each level and for each phase, although for VA compensation, capacitors replace the dc supplies, and the necessary capacitor energy is only to replace losses due to inverter losses. Its modular structure of identical H-bridges is a positive feature.

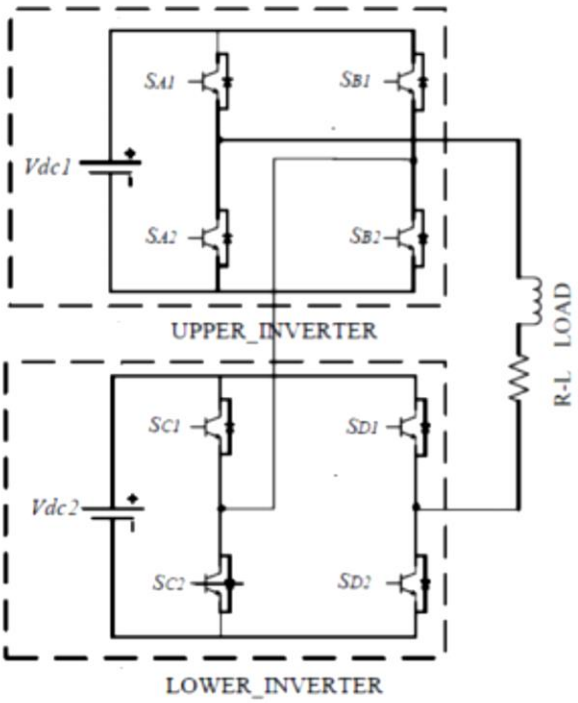

Fig.‖ A Five level cascaded H-bridge multilevel Inverter

1. The number of levels in the line-to-line voltage waveform will be k = 2N −1.
2. While the number of levels in the line to load neutral of a star (wye) load will be p = 2k −1.
3. The number of capacitors or isolated supplies required per phase is Ncap = (N −1)/2.
4. The number of possible required switch states is nstates=Nphases.
5. The number of switches in each leg is Sn= 2(N −1).

Due to the advantages, the cascaded inverter bridge has been widely applied to such applications as HVDC, SVC, stabilizer, high power motor drive and so on. This topology of inverter is suitable for high voltage and high power inversion because to its ability to synthesize waveforms with better harmonic spectrum and low switching frequency

A. Advantages

1. The number of possible output voltage levels is more than twice the number of dc sources (m = 2s + 1).
2. The series of H-bridges makes for modularized layout and packaging. This will enable the manufacturing process to be done more quickly and cheaply.

TABLE I Switching States of a 5 Level Inverter

s1	S2	S3	S4	S1	S2	S3	S4	OUTPUT
1	0	0	1	0	0	0	0	V
1	0	0	1	1	0	0	1	2V
0	0	0	0	1	0	0	1	V
0	0	0	0	0	0	0	0	0
0	1	1	0	0	0	0	0	N-V
0	1	1	0	0	1	1	0	N-2V
0	0	0	0	0	1	1	0	N-V
0	0	0	0	0	0	0	0	0

The 5 level inverter consists of two H-bridges shown in Fig.1, which are fed by Separate DC sources. There are four switches namely and S1, S2, S3, S4 in the first H-Bridge and there are four more switches namely S5, S6, S7, S8 in the second H-bridge. The load is associated between the terminals A and B.

B. Principle of operation

Let us consider names of the switches of each bridge as S11, S12, S13, and S14 for first bridge, S21, S22, S23, S24 for second bridge switches. Consider the three voltage sources are equal as V1=V2=V.

IV. IMPELEMENTATION AND WORKING OF PROPOSED MODEL

A. HARDWARE IMPLEMENTATION

The figure represents the system we developed for multilevel cascaded inverter. The microcontroller is used to control the PWM. The controlled sequential signal then transferred to MOSFET connected in H-Bridge format. The isolation will be provided by using Opto-isolator which in terms isolate the microcontroller from high current drain into it. The H-Bridge will convert this PWM sequences into levels of voltages to form a sinusoidal waveform. This waveform will be having same parameters as pure sine wave but instead of linear it will be in staircase type waveform.

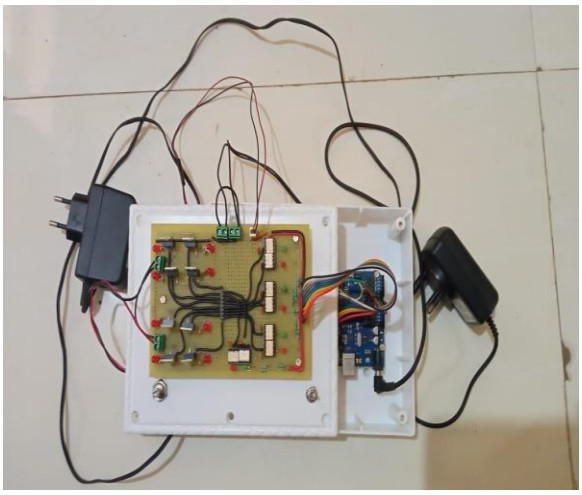

Fig.2 A Five level cascaded H-bridge multilevel Inverter Implemented

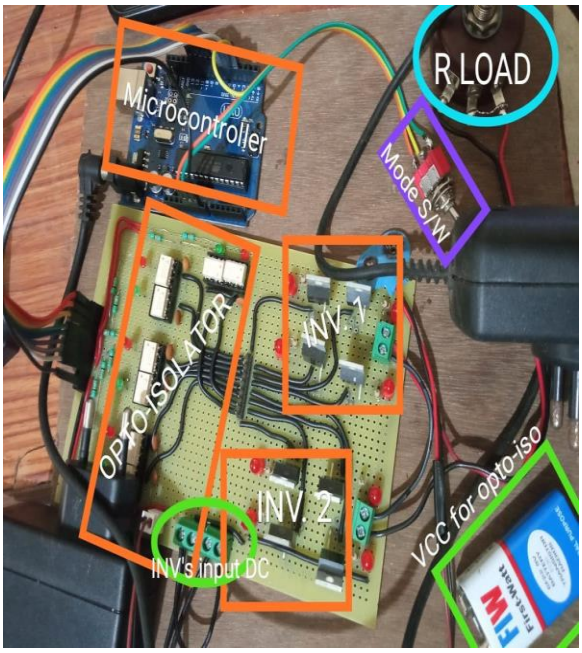

Fig.3 A Five level cascaded H-bridge multilevel Inverter Implemented with components

B. SOFTWARE IMPLEMENTATION

The table one shows the sequential sequences need to be applied. the microcontroller provides sequences with respect to logic and the switching frequency which is nothing but the driving signals for MOSFET. The figure with having flowchart for the program execution.

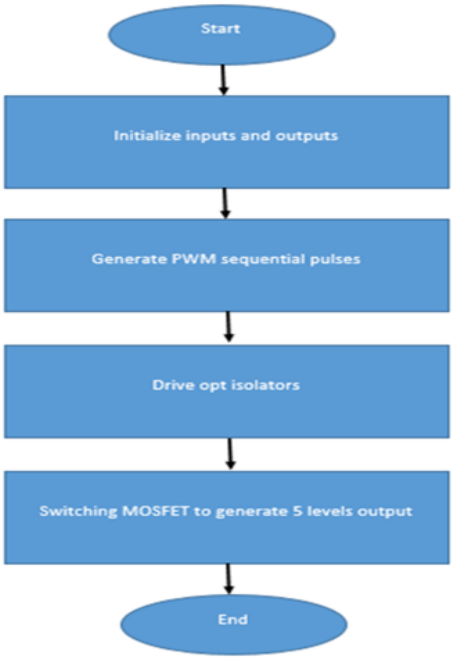

Fig.4 A Five level cascaded H-bridge multilevel Inverter flowchart

IV. RESULTS AND DISCUSSION

In this paper, experimental implementation of 5 level inverter with single phase resistive load has been proposed and the hardware prototype of 5 level inverter with resistive load using microcontroller ARDUINO UNO is implemented. Future work will be towards the implementation of 7, 9 and 11 level inverters. As the levels of output increases, nearly sinusoidal waveform will be obtained, this results in reduced THD. So the benefits of multilevel inverter include, lower transient power loss due to low frequency switching, less THD, reduced ac filters, and possibility to replace MOSFETs with IGBTs, and thereby providing compact power conversion. it is necessary to replace the conventional drives with 2 level inverters by multilevel inverters. In order to reveal the performance of the proposed PWM schemes, the THD and the content of the low-order harmonics is noted and compared with numerous PWM methods as presented in Figure. It is shown that the mixed frequency PWM with equal dc-link voltage presents The lowest low-order harmonics among the other PWM methods while the mixed frequency PWM with unequal dc-link voltage shows the lowest THD among the other PWM methods.

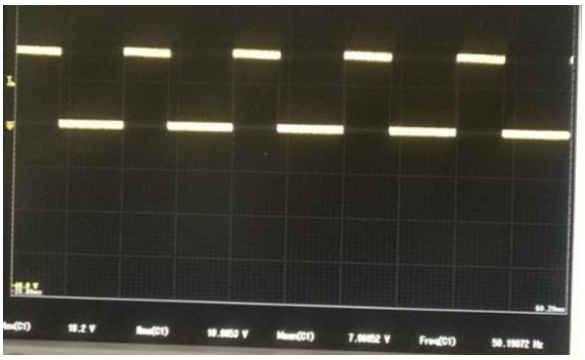

Fig.5 A Five level cascaded H-bridge multilevel Inverter PWM from microcontroller

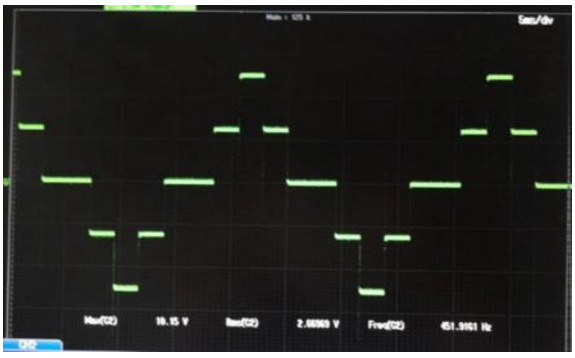

Fig.6 A Five level cascaded H-bridge multilevel Inverter output waveform

V. CONCLUSION

In this paper, experimental implementation of 5 level inverter with single phase resistive load has been proposed and the hardware prototype of 5 level inverter with resistive load using microcontroller ARDUINO UNO is implemented. Future work will be towards the implementation of 7, 9 and 11 level inverters. As the levels of output increases, nearly sinusoidal waveform will be obtained, this results in reduced THD. So the benefits of multilevel inverter include, lower transient power loss due to low frequency switching, less THD, reduced ac filters, and possibility to replace MOSFETs with IGBTs, and thereby providing compact power conversion. it is necessary to replace the conventional drives with 2 level inverters by multilevel inverters.

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