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IMPLEMENTATION OF CASCADED H-BRIDGE FIVE LEVEL INVETER WITH R LOAD

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Abstract - *The cascaded multilevel inverter (CMLI) has gained much attention in recent years due to its advantages in high voltage and high power with low harmonics applications. A standard cascaded multilevel inverter requires n DC sources for 2^n+1levels at the output, where n is the number of inverter stages. This paper presents a topology to control cascaded multilevel inverter that is implemented with multiple DC sources to get 2^n+1 levels. Without using Pulse Width Modulation (PWM) technique, the firing circuit can be implemented using Microcontroller which greatly reduces the Total Harmonic Distortion (THD) and switching losses. To develop the model of a cascaded hybrid multilevel inverter, a simulation is done based on MATLAB/SIMULINK software. Their integration makes the design and analysis of a hybrid multilevel inverter more complete and detailed.*

***Keywords'*: Microcontroller, voltage source converter, Bridge rectifier, Diode clamped inverter**

1. INTRODUCTION

This Power electronic converters, especially dc/ac PWM inverters have been extending their range of use in industry because they provide reduced energy consumption, better system efficiency, improved quality of product, good maintenance, and so on for a medium voltage grid, it is troublesome to connect only one power semiconductor switches directly. As a result, a multilevel power converter structure has been introduced as an alternative in high power and medium voltage situations such as laminators, mills, conveyors, pumps, fans, blowers, compressors, and so on. Many multilevel converter applications focus on industrial medium-voltage motor drives, utility interface for renewable energy systems, flexible AC transmission system (FACTS), and traction drive systems [8]. The inverters in such application areas as stated above should be able to handle high voltage and large power. [3] For this reason, two -level high-voltage and large power inverters have been designed with series connection of switching power devices such as gate -turn-off thyristors (GTOs), integrated gate commutated transistors (IGCTs), and integrated gate bipolar transistors (IGBTs), because the series connection allows reaching much higher voltages. However, the series connection of switching power devices has big problems, namely, non-equal distribution of applied device voltage across series-connected devices that may make the applied voltage of individual devices much higher than blocking voltage of the devices during transient and steady-state switching operation of devices. These multilevel inverters can extend rated inverter voltage and power by increasing the number of voltage levels [9]. They can also increase equivalent switching frequency without the increase of actual switching frequency, thus reducing ripple component of inverter output voltage and electromagnetic interference effects. A multilevel converter can be implemented in many different ways. The simplest techniques involve the parallel or series connection of conventional converters to form the multilevel waveforms [11]. More complex structures effectively insert converters within converters [2]. The voltage or current rating of the multilevel converter becomes a multiple of the individual switches, and so the power rating of the converter can exceed the limit imposed by the individual switching device problems, several circuit topologies of multilevel inverter and converter have been researched and utilized [10] The output voltage of the multilevel inverter has many levels synthesized from several DC voltage sources. The quality of the output voltage is improved as the number of voltage levels increases, so the quantity of output filters can be decreased [5]

2. EXSISTING SYSTEM

Recent advances in the power-handling capabilities of static switch devices such as IGBTs with voltage rating up to 4.5 kV

commercially available, has made the use of the voltage source inverters (VSI) feasible for high-power applications. The multilevel converters have drawn tremendous interest in the power - industry [7]. They present a new set of features that are well suited for use in reactive power compensation .It may be easier to produce a high-power, high-voltage inverter with the multilevel structure because of the way in which device voltage stresses are controlled in the structure[6]. Increasing the number of voltage levels in the inverter without requiring higher ratings on individual devices can increase the power rating.[9] The unique structure of multilevel voltage source inverter allows them to reach high voltages with low harmonics without the use of transformers or series-connected synchronized-switching devices [8]. As the number of voltage levels increases, the harmonic content of the output voltage waveform decrease significantly [9]. The multilevel inverters have drawn tremendous interest in the power - industry

To produce a staircase output voltage, let us consider only one leg of the five-level inverter as shown Figure1. The steps to synthesize the five-level voltages are as follows: 1. For an output voltage level *v*ao = Vdc, turn on all upper-half switches *S*1 2. For an output voltage level *v*ao = 3Vdc /4, turn on three upper switches *S*2 through *S*4 and one lower switch $S1^1$. 3. For an output voltage level *v*ao = Vdc /4, turn on one upper switch *S*4 and three lower switches $S1^1$ through $S3^1$. 4. For an output voltage level *v*ao = 0, turn on all lower half switches $S1^1$ through $S4^1$. It should be noticed that each switch is turned on only once per cycle and there are four complementary switch pairs in each phase The phase voltage waveform of the five-level inverter .The line voltage consists of the positive phase –leg voltage of terminal *a'* and the negative phase-leg voltage of terminal *b'*. Each phase-leg voltage tracks one-half of the sinusoidal waves. The resulting line voltage is nine-level staircase wave. This implies that an *m*-level converter has an *m*-level output phase –leg voltage and a (2*m*-1)-level output line voltage.

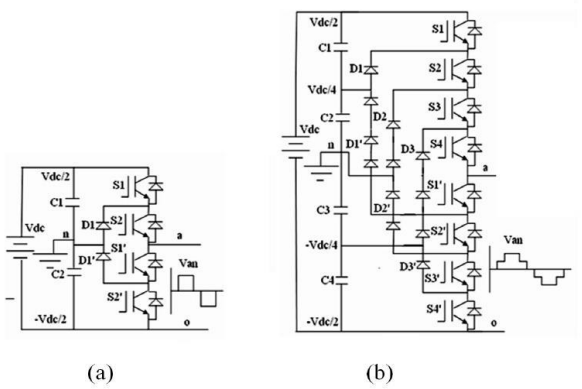

Fig.1: Topology of the diode-clamped inverter

(a) three-level inverter, (b) five -level inverter

PROBLEM:

The only disadvantage of the multilevel converter is that it required a huge amount of semiconductors switches. It should be pointed out that lower voltage rated switches can be used in the multilevel converter and as a result the active semiconductor cost is not considerably increased when compared with the two level cases. On the other hand, each active semiconductor added requires associated gate drive circuitry and adds further complication to the converter mechanical layout.

3. PROPOSED SYSTEM

Cascaded H-Bridge multilevel Inverter:

The cascaded H-bridge multilevel Inverter uses separate dc sources (SDCSs). The multilevel inverter using cascaded-inverter with SDCSs synthesizes a desired voltage from several independent sources of dc voltages, which may be obtained from either batteries, fuel cells, or solar cells[7].

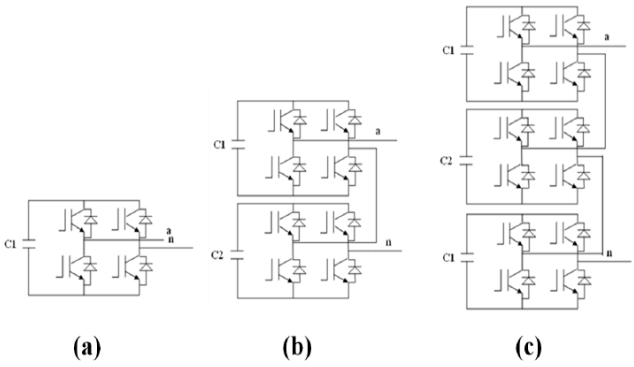

Fig .2: Single phase structures of Cascaded inverter
(a) 3- level (b) 5-level, (c) 7-level

Features of cascade inverter: The main features are as follows:

1. For real power conversions from dc to ac the cascaded inverters need separate dc sources. The structure of separate dc sources is well suited for various renewable energy sources such as fuel cell, photovoltaic, and biomass.
2. Connecting dc sources between two converters in a back-to-back fashion is not possible because a short circuit can be introduced when back- to- back converters are not switching synchronously.
3. Compared with the diode-clamped and flying-capacitors inverters, it requires the least number of components to achieve the same number of voltage levels.

4. Optimized circuit lay out and packaging is possible because each level has the same structure and there are no extra clamping diodes or voltage-balancing capacitors. □ □
5. Soft-switching techniques can be used to reduce switching losses and device □ stresses
6. They are able to generate output voltages with very low distortion and lower dv/dt.
7. They are able to bring in input current with very low input distortion
8. They can be functioned with a much lower switching frequency
9. They are able to produce smaller common mode (CM) voltage, therefore, reducing the stress in the motoring bearings. In addition, using complicated modulation methods, CM voltages can be eliminated.

APPLICATIONS:

1. DC power source utilization
2. Uninterruptible power supplies
3. HVDC power transmission\
4. Variable-frequency drives

BLOCK DIAGRAM :

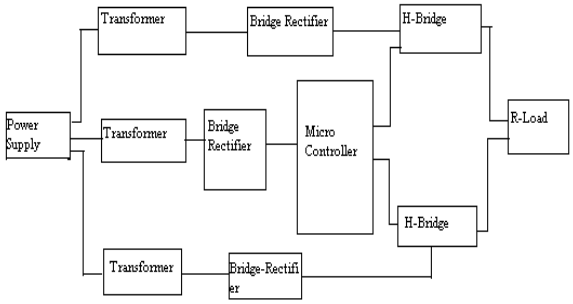

Fig.3: Block diagram of cascaded five level H-Bridge inverter

In this 230v power supply is given to three step down transformers. Rating of these transformers is 12v. It can be given to bridge rectifier which consists of rectifier, filter and a voltage regulator. Rectifier converts the ac into dc and filter gives the pure dc signal by blocking ripples. Voltage regulator regulates the voltage to the amount required by the H-Bridge. Two of the three transformers are used to give supply to the two HBridges and another transformer is used to give supply to the micro controller. Micro controller has a switch. We can ON or OFF that switch whenever we want. It also consists of rectifier, filter, voltage regulator and Opt coupler. Opt coupler is used to isolate the current and by using these components micro controller takes dc input and gives the output as commands to the H-Bridges. Each bridge consists of four switches. Thus, by taking the signal pulse from micro controller triggering process is completed. We have to give power supply to the each switch so, each switch is connected to a pulse transformer.

DESIGN OF FIVE LEVEL INVERTER PROJECT KIT

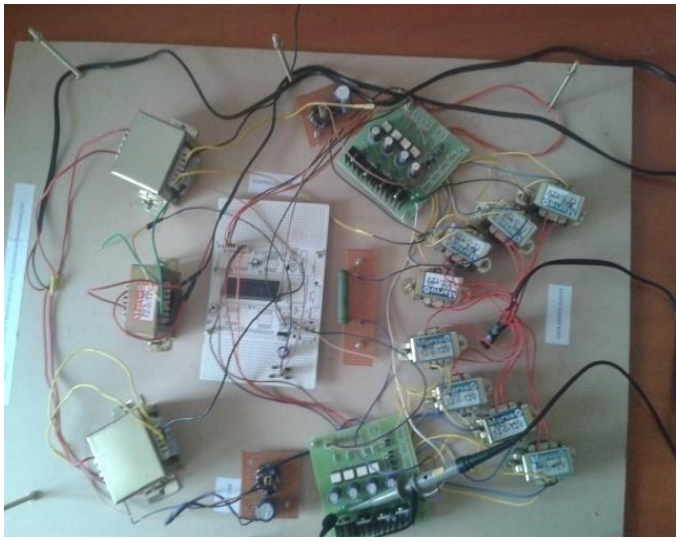

Fig.3.1: Implementation of cascaded five level H-Bridge

Figure shows the block diagram of cascaded five level H-Bridge inverter Whenever we switch on the supply transformers, these transformers step down the 230v to 12 volts and supply it to the rectifier bridge. That rectifier bridge converts ac to required amount of dc by using filters and voltage regulators and fed it to the H-Bridge. Another transformer gives supply to micro controller. Micro controller takes input by the help of Rectifier Bridge and Opto coupler and when we switch on the controller it sends signals to the H-Bridges. Switches present in the bridge come into action and by triggering process we get the output wave with less amount of total harmonic distortion.

4. HARDWARE RESULTS:

The input for the DC bus for upper H Bridge is given by 230/24V transformer through a diode bridge followed by capacitive filter. The DC voltage obtained is around 40V.The input for the lower H Bridge is given by 230/12V transformer through a diode bridge followed by capacitive filter. The DC voltage obtained is around 20V.The voltage steps in the outputs are therefore 0V, 20V, 40V, 60V,-20V,-40V and-60V.The voltage output obtained is as follows.

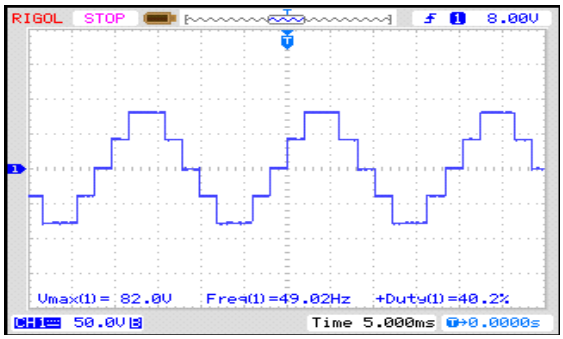

Fig 4: output of the inverter.

The gating pulses are generated by AT89S52 micro controller:

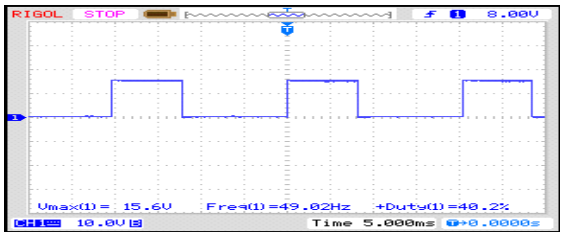

Fig 4.1: Gating pulse of switch1

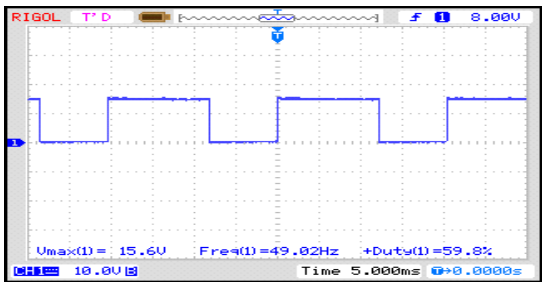

Fig 4.2: Gating pulse of switch2

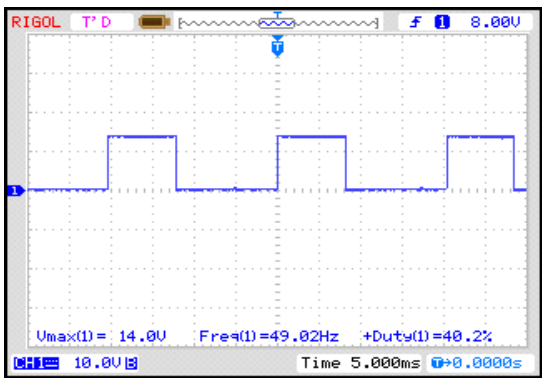

Fig 4.3: Gating pulse of switch3

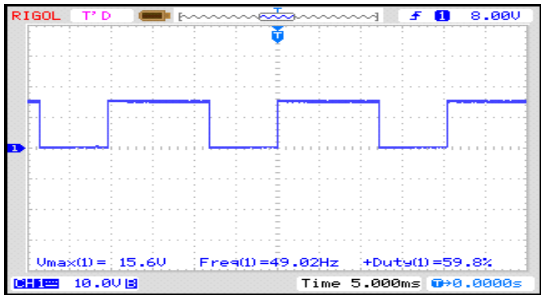

Fig 4.4: Gating pulse of switch4

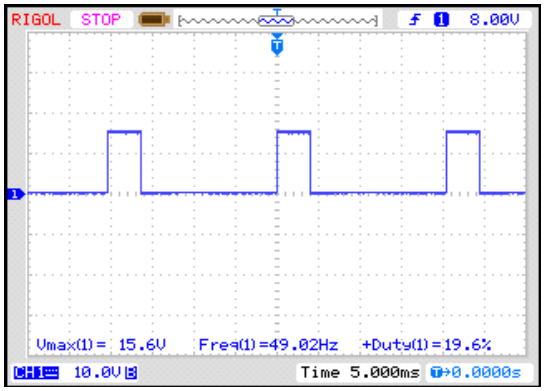

Fig 4.5: Gating pulse of switch5

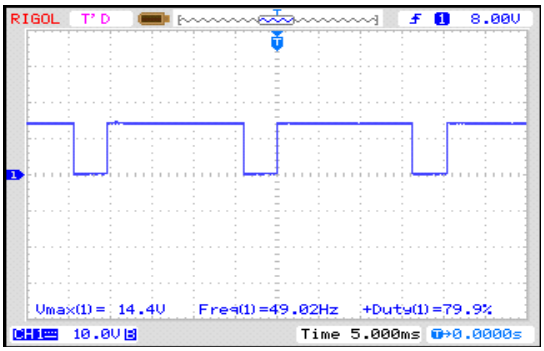

Fig 4.6: Gating pulse of switch6

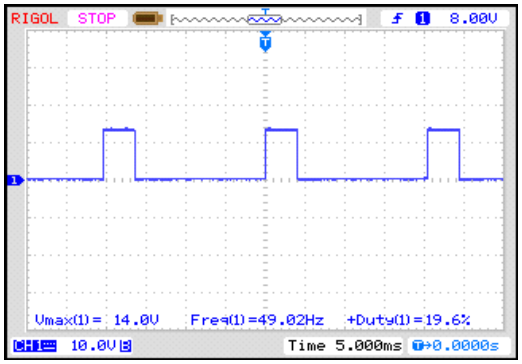

Fig 4.7: Gating pulse of switch7

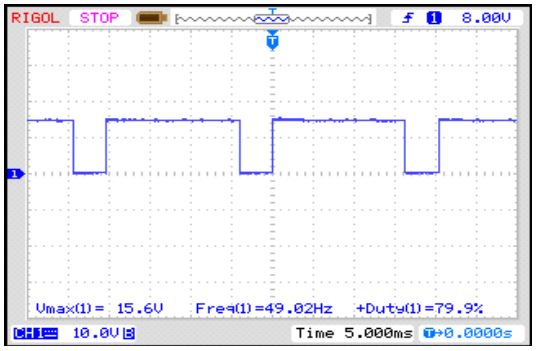

Fig 4.8: Gating pulse of switch8

5. CONCLUSION

In this project digital switching scheme is employed and the advantage of using digital scheme is that it reduces the uneven degradation of power switches, switching losses when compared to the conventional PWM technique and harmonics are reduced. From the FFT analysis THD obtained is 9.79% and the value can be still reduced by increasing the number of stages. Consequently, the system efficiency can be improved. This proposed system eliminates the complexity of generating gate signals when the stages are added. The simulation results show that this hybrid multilevel inverter topology can be applied for high power applications.

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