Evaluation of a New Nine-Level Cascaded Multi Level-Inverter with Reduced Number of Components

R. Sathish, D. Kishor Kumar, K. Asokan, M. Jagathesan, C. Thangavel

Abstract--- With the expanding requests for power supplies in PC, telecom, electric vehicle, and other comparable zones where low voltage and high current are required, the customary dc control circulation system (DC PDS) is gradually unable to meet the prerequisites because of its deficiencies, for example, more transformation stages, low effectiveness and poor transient reaction. High-frequency ac power distribution system (HFAC PDS) proposed it has become an alternative because of its merits such as fewer conversion stages, higher efficiency, faster response, high power density, distributed heat profile and potential for connector-less power transfer.

Keywords--- Switched Capacitor, an Isolation Circuit, Buffer Circuit, Controller, H-bridge Circuit, a Driver Circuit, Load, Nine Level Inverter.

1. INTRODUCTION

Dc power distribution system (DC PDS) is gradually unable to meet the requirements due to its insufficiencies such as more conversion stages, low efficiency, and poor transient response. High-frequency ac power distribution system (HFAC PDS) proposed has become an alternative because of its merits such as fewer conversion stages, higher efficiency, faster response, high power density, distributed heat profile, and potential For connector-less power transfer.

HFAC PDS has usually composed of two stages: A high frequency (HF) multilevel inverter (MLI) or a resonant inverter as the source side and several ac/ac or ac/dc voltage-regulation modules as the load side. To raise the power capacity, one of the most popular methods of the source side is to connect multiple resonant inverters in series or parallel, while the control for the HF synchronizations of both amplitudes and phases will become extremely complicated.

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2. LITERATURE REVIEW

In this, a new single-phase cascaded multilevel inverter is proposed. This inverter is comprised of the series connection of the proposed basic unit and can generate just positive Levels at the output. Along these lines, an H-connect is added to the proposed inverter. This inverter is called created fell multilevel inverter. To generate all voltage levels (even and odd) at the output of the extended topology, four distinctive algorithms are proposed to decide the extent of dc voltage sources. Reduction in the number of intensity switches, driver circuits, and dc voltage sources are advantages of the developed single-phase cascaded multilevel inverter. Subsequently, the establishment space and cost of the inverter are reduced. These features are obtained by the comparison of the conventional cascaded multilevel inverters with the proposed cascaded topology. The ability of the proposed inverter in a generation at all voltage levels (even and odd) is reconfirmed by using the experimental results of a 15-level inverter. The demand for high voltage, high power inverters are increasing, and it is impossible to connect a power semiconductor switch to the top voltage network directly. Therefore, the multilevel inverters had been introduced and are developing now. There are different kinds of the array for power switches, diodes and dc voltage sources to generate the desired ac output in multilevel inverters.

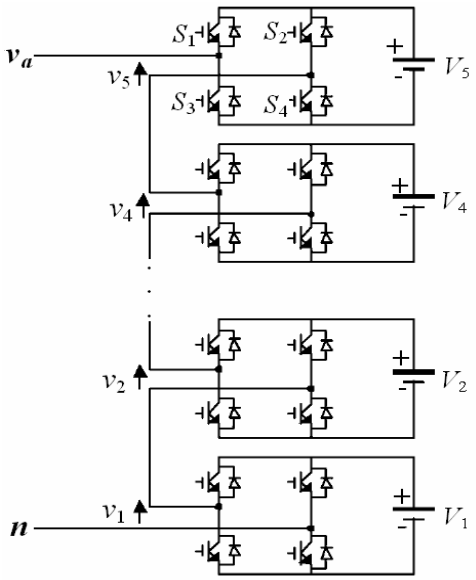

Fig. 1: A Single-Phase Cascaded Multilevel Inverter

Different basic units and so different cascaded multilevel inverters have been presented in the literature. In different symmetric cascaded multilevel inverters have been introduced. It is also shown with another topology with two different algorithms as symmetric and asymmetric one in. The primary drawbacks of the symmetric cascaded multilevel inverters are the high required number of intensity switches, protected entryway bipolar transistors (IGBTs), power diodes and driver circuits because of the same magnitude of dc voltage sources. These disadvantages will be higher in topologies which bidirectional power switches from voltage point of view have been used in them that presented.

3. PROPOSED METHOD

A nine-level inverter employing one voltage source and two capacitors is proposed for High-frequency ac power distribution system. Compared with the topologies above, the proposed inverter has more voltage levels with fewer components. Lower THD of the output voltage is obtained, and the voltage stress on the power switches in the back-stage is relatively relieved. More importantly, the inherent self-voltage balancing ability of the two capacitors has simplified the modulation algorithm.

3.1 Block diagram

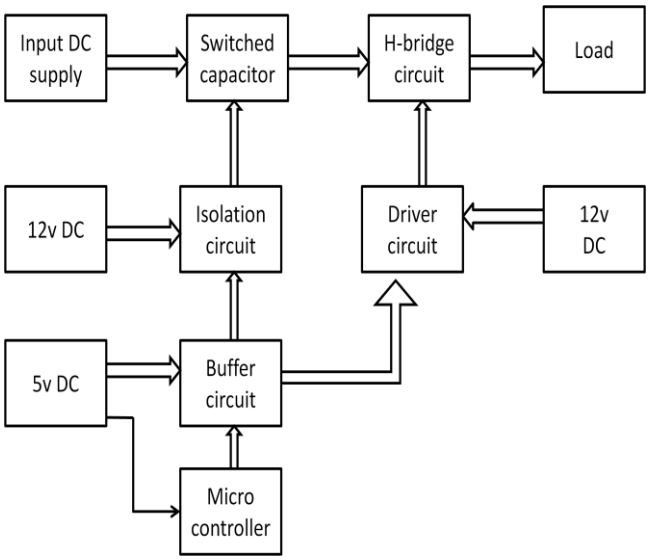

Fig. 2: Block Diagram for Proposed Method

3.1.1 Block Diagram Description

- The input power is getting from various source like solar, Fuel cell.
- The range of fuel cell is Voltage 12VAmpere=7.5A
- The energy is transferred from an unregulated line to a regulated sinusoidal output through a controlled switched-capacitor (SC) circuit.
- The SC circuit is formed by two symmetrical sub-circuits, which operate in anti-phase in each half-cycle of a switching period: when one of them is in the charging state, the other one is in the discharging state.
- Here the H-bridge cells are typically connected in dc input on their ac output side to achieve medium voltage operation and low harmonic distortion.
- The cascaded H- multilevel bridge inverter requires many isolated dc supplies, each of which feeds an H-bridge power cell.
- Inverter Its Convert Dc/Ac Ranges
- 12v Dc/12v Ac
- Capacitor For Reduce Noise Present In The Circuit
- 2200 Micro Farad, Voltage =24v
- Finally, the inverted output voltage is given to step-up transformer to for load consume. The step-up transformer output voltage is 230V AC.

3.2 Switched-Capacitor

In this section, we consider a run of the mill class of discrete-time systems called "switched capacitor (SC) circuits." Our goal is to give the establishment to further developed subjects, for example, channels, comparators, ADC, and DACs. The majority of our investigation manages exchanged capacitor enhancers. However, the ideas can be connected to other discrete-time circuits too. Starting with a general perspective of SC circuits, we depict testing switches and their speed and exactness issues. Next, we investigate switched capacitor amplifiers, considering unity-gain, no inverting, and multiply-by-two topologies. Finally, we examine a switched-capacitor integrator are used in many analog systems. Examples include filters and oversampled analog-to-digital converters. Sampled-data systems, we must devise a discrete-time counterpart of this circuit.

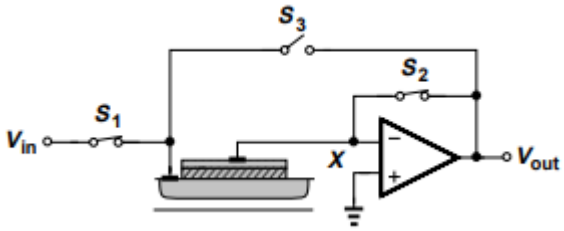

Fig.3: Switched-Capacitor

3.3 Isolation Circuit

Isolation circuits intended to withstand the rigors of mechanical conditions are the focal point of this white paper. Modern electronic hardware ordinarily utilizes galvanic isolators to shield systems and users from possibly dangerous voltages.

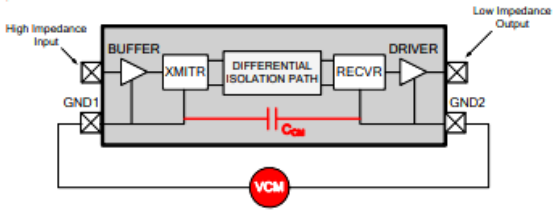

Fig.4: Isolation Circuit

It is outstanding that modern hardware must work dependably in the harshest situations, where stable electromagnetic fields, surges, fast transients, and high commotion floors are the standard. This condition presents challenges for planning solid confinement circuits that convey blunder free activity over long hardware lifetimes.

3.4 PIC Microcontroller

Peripheral Interface Controller (PIC) is microcontroller created by Microchip; PIC microcontroller is quick and simple to execute a program when we think about different microcontrollers like 8051. The simplicity of programming and simple to interfacing with different peripherals PIC wound up useful microcontroller.

We realize that the microcontroller is an integrated chip which consists of RAM, ROM, CPU, TIMERS, and COUNTERS, etc. PIC is a microcontroller which also comprises of ram, rom, CPU, timers, counter, ADC (analog to digital converters), DAC (digital to analog converter). PIC also supports the protocols like CAN, SPI, UART for interfacing with other peripherals. PIC mainly used modified Harvard architecture and also supports RISC (Reduced Instruction Set Computer) by the above specification RISC and Harvard we can say comfortably that PIC is faster than the 8051 based controller which is made-up of Von-Newman architecture.

3.4.1 PIC Microcontroller Architecture

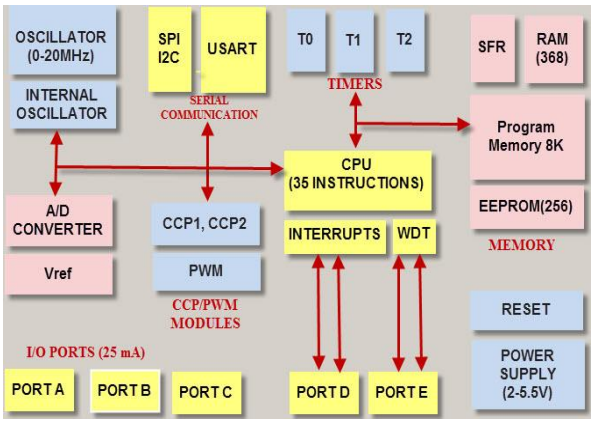

Fig.5: PIC Microcontroller Architecture

The PIC Microcontroller Pic16f877a Is The most Renowned Microcontroller in the Industry. This Microcontroller Is Very Convenient To Use, The Programming Of This Controller Is Also Easier. The fundamental advantages of interest are that it can be Write-Erase As Many Times As Possible Because It Uses Flash Memory Technology. It has 40 Pins, And There Are 33 Pins For Input And Output. Pic16f877a Is Used In Many PIC Microcontroller Project**.** Pic16f877a Also Have Many Applications In Digital Electronics Circuits**.** Where Microcontrollers Have Never Been Used Before As In Coprocessor Applications And Timer Functions.

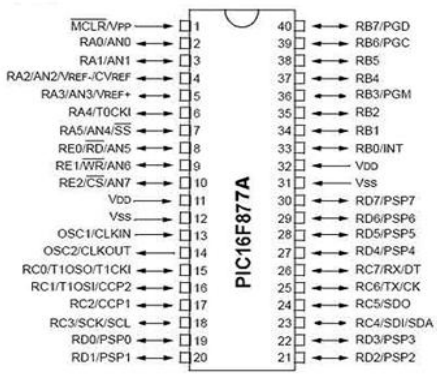

Fig.6: PIC Microcontroller Pin Configuration

3.5 H-bridge Circuit

The h-bridge configuration is a standard approach to alter the course of the power supply. The h-connect is named as it is formed similarly to a letter H and utilizations two sets of changes that should be exchanged together. So by reversing the positive and negative supply, we can make the Load change direction. The switch sets are a corner to corner inverse to each other. Each combination of changes should be shut in the meantime. This is the H-connect in it's off position. Every one of the four switches is turned off, and no power is given to the Load.

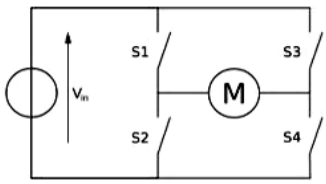

Fig.7: H-Bridge Circuit

3.6 Driver Circuit

A given size of a motor, limited space is available for the windings. In the process of optimizing a motor drive system, efficient utilization of the open winding space, and also a coordinating of driver and winding parameters, is of incredible significance. This section discusses the essential electrical characteristics of a motor winding. Particular attention is given to driving configurations and current control methods. In electronics, a driver is an electrical circuit or other electronic component used to control another circuit or element, such as a high-power transistor and numerous others. Typically the driver stage of a course requires different characteristics to other circuit stages.

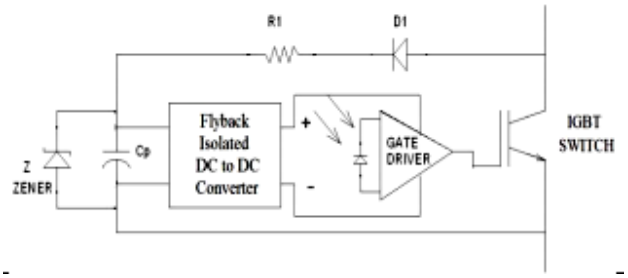

Fig.8: Driver Circuit

3.7 Load

The fixed voltage and resistive loads, the I-V characteristics of motor loads are non-linear. Motor I-V curves differ considerably among motor types and are also dependent on the torque and speed characteristics of the mechanical load being driven by the motor. In for three DC motor types are described: series, shunt, and separately excited. In three types of mechanical loads commonly used in direct-coupled systems are defined as a centrifugal water pump, centrifugal ventilator fan, and positive displacement. Manufacturers do not ordinarily provide continuous functions describing pump and fan performance. All the more regularly, information must be perused from a single performance curve which relates pressure flow rate, efficiency, and speed.

3.8 Battery

Batteries are an accumulation of at least one cells whose synthetic responses make a stream of electrons in a circuit. All batteries are comprised of three fundamental parts: an anode (the '- ' side), a cathode (the '+' side), and some electrolyte (a substance that synthetically responds with the anode and cathode).

At the point when the anode and cathode of a battery are associated with a circuit, a concoction response happens between the anode and the electrolyte.

This response makes electrons move through the circuit and once more into the cathode where another synthetic response occurs.

At the point when the material in the cathode or anode is expended or no longer ready to be utilized as a part of the response, the battery can't create power.

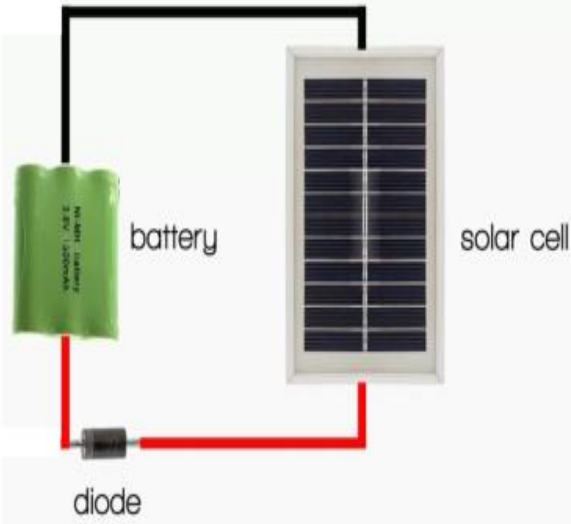

Fig. 4.3: Battery

3.9 Cascaded H- bridge Multilevel Inverter

- Multilevel cascade inverters are utilized to dispose of the massive
- transformer required if there should arise an occurrence of traditional multiphase
- inverters, clipping diodes required if there should be an occurrence of diode clasped
- inverters and flying capacitors required if there should arise an incident of flying
- Capacitor inverters. Be that as it may, these need an expansive number of separated
- Voltages to supply every cell.
- The mix of capacitors and switches match is called an H-connect

Gives the separate input DC voltage for each H-bridge

3.10 Multilevel Inverters

Advantage

- They can create high yield voltages with low twisting and lower dv/dt.
- They can acquire input current with low information distortion.
- Well suited for responsive power pay.
- They can be worked with a much lower switching frequency.

3.10 (a) Switching Characteristics

S1	S2	S3	S4	S5	S6	S7	S8	OUTPUT
0	1	0	1	1	0	1	0	4
1	1	0	1	0	0	1	0	3
0	0	0	1	1	1	1	0	2
0	1	1	1	1	0	0	0	VS
1	1	1	1	0	0	0	0	0
0	0	0	0	1	1	1	1	0
1	0	0	0	0	1	1	1	-
1	1	1	0	0	0	0	1	-2
0	0	1	0	1	1	0	1	-3
1	0	1	0	0	1	0	1	-4

$$\text{Power Factor} = \frac{\text{Real power}}{\text{Apparent power}} = \cos\emptyset$$

4. CIRCUIT DIAGRAM

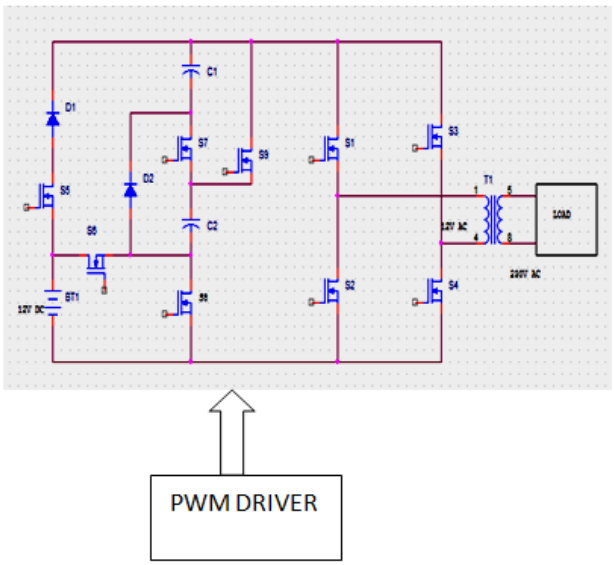

Fig. 9: Circuit Diagram for the Proposed 9-Level Inverter

4.1 Circuit Diagram Explanation

The input power is getting from various sources like solar, Fuel cell. The range of fuel cell is Voltage 12VAmpere=7.5A. The energy is transferred from an unregulated line to a regulated sinusoidal output through a controlled switched-capacitor (SC) circuit. The SC circuit is formed by two symmetrical sub-circuits, which operate in anti-phase in each half-cycle of a switching period: when

one of them is in the charging state, the other one is in the discharging state. Here the H-bridge cells are typically connected in dc input on their ac output side to achieve medium voltage operation and low harmonic distortion. The cascaded H- multilevel bridge inverter requires some isolated dc supplies, each of which feeds an H-bridge power cell. Inverter It's Convert Dc/Ac Ranges12v Dc/12v Ac Capacitor for Reduce Noise Present in the Circuit2200 Micro Farad, Voltage =24vFinally the inverted output voltage is given to step-up transformer to for load consume. The step-up transformer output voltage is 230V AC.

5. RESULT AND DISCUSSION

Fig. 10: Hardware model for the proposed technique

5.1 Hardware Output

Hardware	Specification	Input ranges	Output ranges
Solar	Input power	1-10W	12V
Fuel cell	Input power	12V	7.5A
Rectifier	Input power	12V AC	12 V DC
Inverter	Output power	12vDC	12vAC
Transformer	step-up	24VAC	230VAC
Load	Load	230V	4A

5.2 Advantages

- The proposed HF inverter can output nine levels using only one voltage source and fewer components.
- Fewer harmonic.
- Thus the switching loss is significantly decreased.

5.3 Application

- Power supplies in the computer.
- Telecom.
- Electric vehicle.

6. CONCLUSION

The proposed nine-level inverter, which consists of two stages. By implementing a switched capacitor, he changed the capacitor filter allows for very sophisticated, accurate, and tunable in that it can output more voltage levels with relatively fewer components. An H-bridge circuit (HBC) is used in the backend to change the polarity of the frontend output. When the two capacitors in proposed nine-level inverter discharge to supply the load separately or in series with the voltage source, voltage ripples will appear on them, which should be limited to no more of the capacitors' maximum voltages.

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