A Single Phase Single Source Transistor Clamped 7-Level H-Bridge Multilevel Inverter with Voltage Boosting Capacity

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***Abstract*—Mulitilevel inveter for generating seven level output requires more power devices, more than one dc source and complex circuitry. This paper proposes a Single Phase, Single Source Transistor Clamped 7-Level H-Bridge Multilevel Inverter for producing seven level with the capability of boosting the input voltage. Multilevel inverters are widely used power electronics technology for the dc-ac electrical energy conversion system and it offers high power capability and lower commutation losses. This multilevel inverter use only one H-Bridge. In the proposed system, the first stage is a forward converter and the second stage is a transistor clamped H-bridge. Due to the presence of a forward converter, there is no need for capacitor voltage balancing.**

***Index Terms*—Forward converter, multi-level inverter (MLI), bi-directional switches**

I. Introduction

A multi level inverter is used to produce required alternating output voltage levels from various input dc source. The abstraction of multi level inverter from the limitation of the two level inverter [1] . In generic multilevel inverter is used for numerous application in voltage ranging from medium to high for example in renewable sources, motor drives, fans, and conveyors [2],[3]. A single-phase grid-connected inverter is commonly used for low-power applications of power ranges that are less than 10 kW [4]. The disadvantage of multi level inverter include it require more number of active semiconductor switches and every switch have need associate gate circuit to drive the switches and it make the circuit layout to more complex[5].

The three frequently used multilevel inverter is Diode Clamped inverter, capacitor clamped inverter or flying capacitor and cascaded H-bridge inverter. In diode clamped muliti level inverter the diode is used to clamp the dc bus voltage to obtain a higher voltage at output. The diode dispatch only few amount of voltage, so it limits the stress on another devices[6]. Flying capacitor multilevel inverter use a series connection of the capacitor to clamp the dc voltage. Capacitor transfers a limited amount of voltage to switching devices[7]. The drawback of this topology is the same as that of diode clamped multilevel inverter [8]. The cascaded H-Bridge multilevel inverter use series connected H-Bridge so that the disadvantage of this topology is each H-Bridge requires separate dc source [9],[10]. These mulitilevel topologies require a higher number of switching devices and output voltage is less than input.

This paper topology contain two parts. The first part hold a forward converter to produce a high voltage level, while the second part is a transistor clamped H-bridge. With a single dc source the proposed topology is competent to develop 7 voltage level. The inverter have the improvement of the few switching devices therefor the system has compact design as analyze with other existing seven level inverter circuit design.

II. OPERATING PRINCIPLE OF SEVEN LEVEL INVERTER

The proposed system block diagram is shown in Fig. 1.

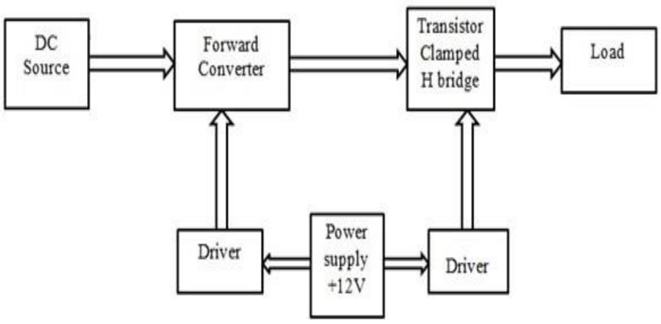

Fig. 1: Block Diagram of proposed system.

The circuit diagram of the proposed system is shown in Fig.
2. The proposed seven-level inverter consists of two-stage. The transistor clamped H-bridge has notable superiority above other topologies that is it contain fewer capacitors

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 9 Issue 06, June-2020

and diodes. At the first stage, the single-phase 30 V DC has stepup to 90 V DC. The output of the forward converter will be not pure DC so there use the filter circuit. The input to the transistor clmped H-bridge given using three capacitors

. Across every capacitor the voltage is 90 V and that is the Vdc . The transistor clamped H bridge contain 4 switching devices and 2 bi-directional switches. Output is a stepped voltage with maximum value 270 V.

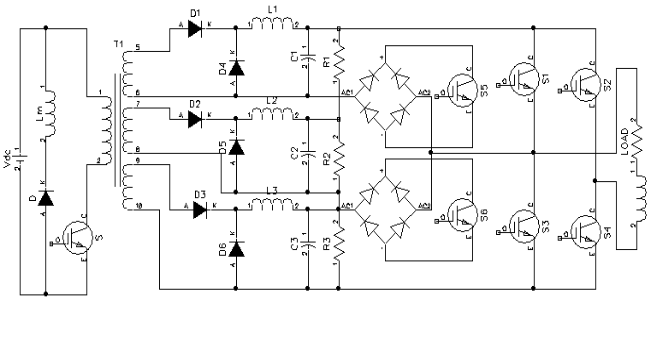

Fig. 2: Circuit diagram of proposed system.

A. *Forward Converter*

In the proposed system the first stage is a forward converter. Fig. 3 shows the forward converter with single output winding [12]. The forward converter is used to up or down the output voltage from a low or high input voltage and it also provide galvanic isolation. In the system step up transformer is used so it increase the input voltage. With multiple output windings, it provide various voltage at a time in the output

. The transformer turns ratio determines the highest output voltage obtained from the circuit [13].

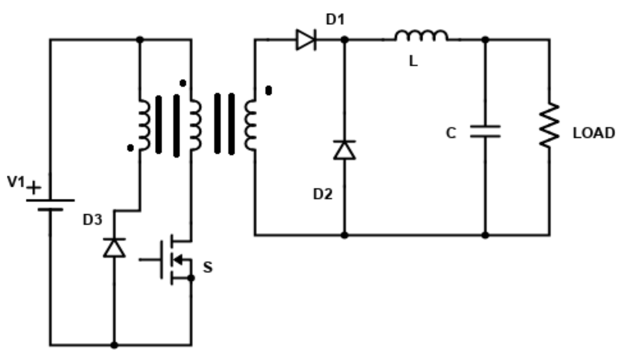

Fig. 3: Circuit diagram of forward converter.

In this topology, continous conduction mode of operation is considered because the inductor carry the current always. When the switch is in ON state then it is called as powering mode and at that time diode D1 is forward biased and diode D2 is reverse biased. So the input voltage come across the primary winding and secondary side voltage is based on the turns ratio. So in this mode both the windings are conducting. When the switch is OFF, then the diode D1 is reverse biased and D2 is forward biased. If D1 is reverse biased then the tranformer is unconnected from the input voltage that is the transformer winding are does not conducting. So the current through the transformer is immediately goes to zero. But there get a output voltage due to the continuos flow of current through the inductor and the freewheeling diode D2. So the mode is called as freewheeling mode. Here the charged capacitor and the inductor maintain the presence of constant voltage at the output and the stored energy dissipated to the load [12].

During the turn off time there will be sudden demagnetization of core occurs. But in the case of practical transformer it is not possible because it cannot support the change in flux. Any method to change flux cause a large magnitude in voltage. So that there require a path for trapped energy in the primary due to magnetizing current. Due to that a tertiary winding with series diode is provided in the pratical circuit. Then the magnetization energy produce a current path around closely coupled tertiary winding during OFF state. During ON state that diode is reverse biased so no current flow through it and in OFF state that diode is forward biased and there will be current flow through it. After some time the core flux goes to zero and it maintain for a certain time, until the next cycle begin[12].

B. *Transistor Clamped H-Bridge*

It has seven modes of operation [11] i.e is shown in Table 1.

TABLE I: Modes of Operation

Vo	S1	S2	S3	S4	S5	S6
Vdc	1	0	0	1	0	0
2Vdc/3	0	0	0	1	1	0
Vdc/3	0	0	0	1	0	1
0	0	0	1	1	0	0
0*	1	1	0	0	0	0
-Vdc/3	0	1	0	0	1	0
-2Vdc/3	0	1	0	0	0	1
-Vdc	0	1	1	0	0	0

III. SIMULATION RESULT

In the proposed system phase opposition disposition si- nusoidal pulse width modulation technique was used for producing the switching signals. In this method, the sinusoidal reference signal is compared with the triangular carrier wave- form. The pulses from this method are used for driving the active switches to produce the desired voltage level. Fig. 4. shows the switching signals generated by this technique. In this modulation technique sinusoidal waveform is compared with all the seven carrier waveforms. Result after differentiation are 1, 0 and -1. If the carrier is above the x axis then the outcome become 0 or 1 and if the carrier is below x axix then the outcome become 0 or -1. The combined signal is identical

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 9 Issue 06, June-2020

to the desired output wave in the case of number of level. The output signal from this differentiation again combained with desired level using the table and the result given to the switches. The lookup table is generated by using the switching states of the 7-level inverter.

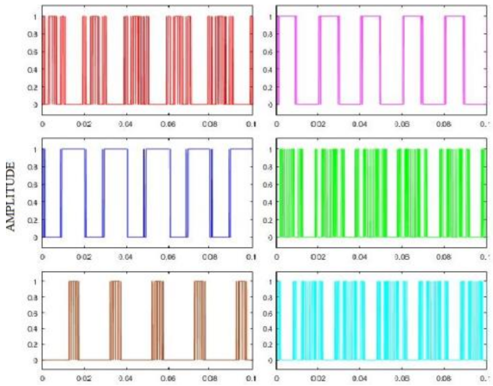

Fig. 4: Switching signals for switches S1 to S6

The input to the system is 30 V supply. The required switching frequency for the forward converter is taken as 10 Khz. Output of the forward converter is 82 V. Fig. 7 shows the output voltages from the forward converter with a single output winding. The 7 level output voltage and the output current obtained in the proposed system is shown in Fig. 5 and 6. The maximum output voltage is t he sum of the load voltages of the multi output forward converter. The output voltage was 250 V and output current was found to be 1.3 A.

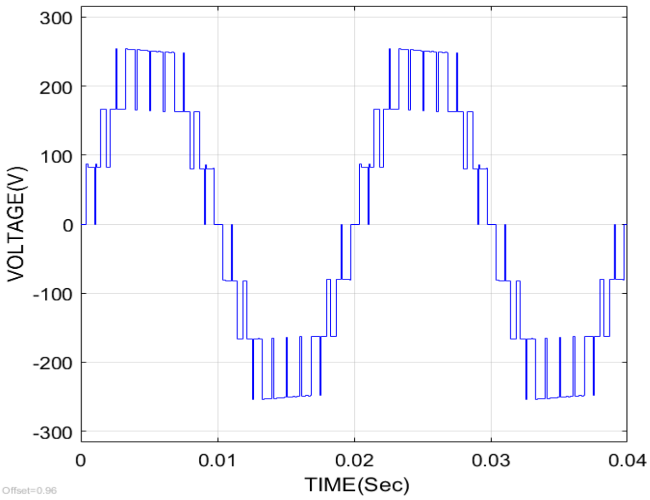

Fig. 5: Output voltage waveform of seven level inverter

IV. CONCLUSION

In this paper, a single phase single source transistor clamped H-Bridge multilevel inverter has ben established. This topol- ogy has advantages over conventional topologies. The pro- posed multilevel inverter topology generate seven voltage levels with maximum voltage equals eight times that of input voltage. The proposed system uses a lesser number of components and a single source. The proposed topology does not need a voltage balancing circuit.

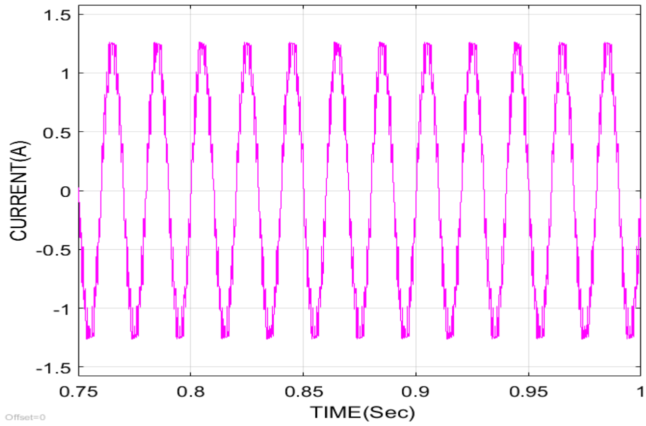

Fig. 6: Output current waveform of seven level inverter

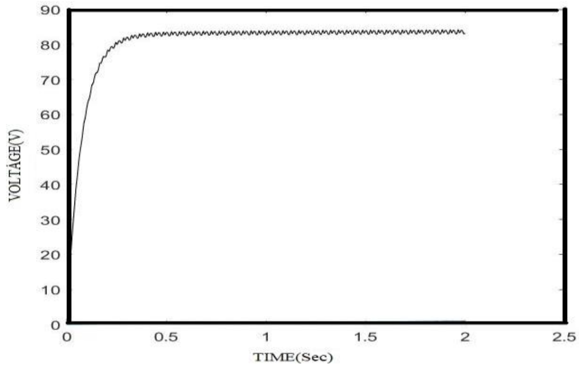

Fig. 7: Output voltage waveform of forward converter

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