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Review of reduce component count in nine level inverter employed single bi- directional switching for transformer

[1]Shalini Lakhera, [2]Asst. Prof. Deepmala, [3]H.O.D. E.Vijay, [4]Asst. Prof. Abhijeet Patil
Electrical Department, R.K.D.F Bhopal, (M.P.) - India
[1]shalinilakhera24@gmail.com, [2]deepmala.eee@gmail.com, [3]abhijeet.patil20@gmail.com

Abstract

Multilevel inverters have created a new wave of interest in industry and research. While the novel topologies have proved to be a viable alternative in a wide range of high-power medium-voltage applications, there has been an active interest in the evolution of newer topologies. Reduction in overall part count as compared to the classical topologies has been an important objective in the recently introduced topologies. In this paper, the proposed multilevel inverter topologies with reduced power switch count are analyzed. A novel cascaded transformer multilevel inverter is proposed. The number of the switching devices is reduced in the proposed topology. This topology comprises of a DC source, several single phase low-frequency transformers, two main power switches and some bidirectional switching devices. In this topology, only one bidirectional switch is employed for each transformer.

Keyword: Multilevel inverter; Power switches; Bidirectional switching.

INTRODUCTION

Multilevel inverter has picked up notoriety in high power and voltage applications, for example, electrical power transmission and lattice incorporation of sustainable power sources. Multilevel inverters are intended to accomplish higher voltage levels with low sounds and without requiring higher evaluations of individual gadgets, transformers and arrangement associated synchronized gadgets. Multilevel inverter has more points of interest then the ordinary two-level inverter yet it likewise has some constraint, for example, the exchanging misfortunes and unpredictability increments with expanding the level of output voltage [1]

Recently cascaded transformer multilevel topologies are proposed. These have the advantage of having single DC Voltage source and transformer can be used to voltage transformation and isolation [2]. The leakage reactance of the cascaded transformers provides high-performance filtering effect of the harmonic components of the inverter output voltage [3].

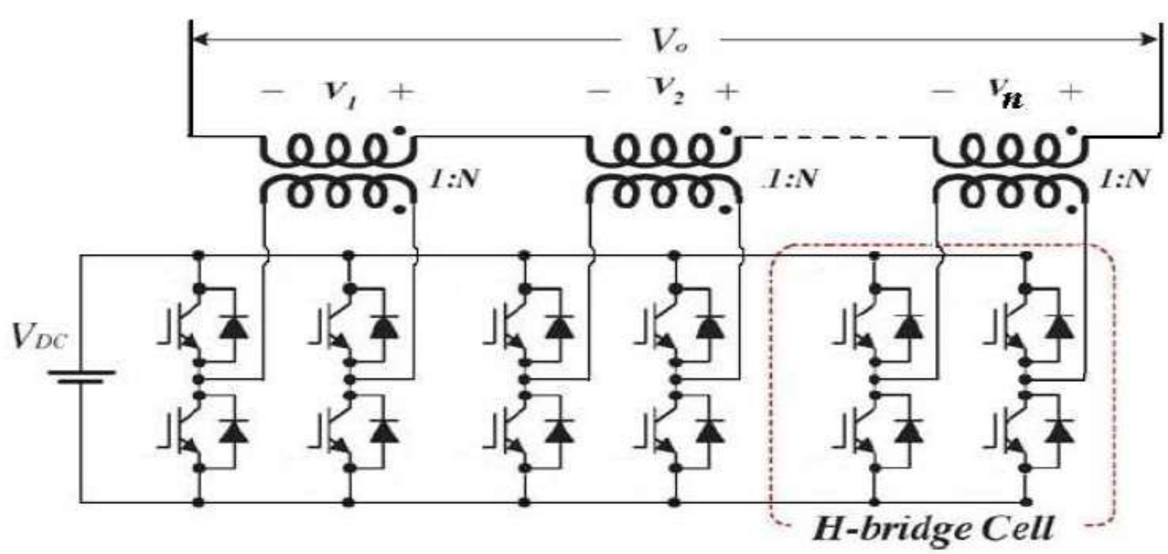

Figure 1: Circuit diagram of a single phase cascaded transformer H-bridge multilevel inverter

Fig. 1 shows a single-phase topology of a cascaded transformer converter with single DC voltage source. In cascaded transformer H-bridge multilevel inverters, selection of turn ratio of transformers is main part of inverter design. The output voltages of basic units are cascaded through the secondary of the transformers.

CLASSIFICATION OF INVERTERS

An inverter converts DC to AC power of desired output voltage and frequency. The output voltage and frequency can be fixed or variable. Transistorized inverters can be used for low and medium power outputs and Silicon Controlled Rectifier (SCR) can be used for high power outputs. Generally low power level inverters are used in single phase applications, medium and high power inverters are used in three phase applications. The inverter gain is a ratio of the AC output voltage to DC input voltage. The AC output voltage waveforms of ideal inverters should be sinusoidal. However, in practice, they are non-sinusoidal and contain harmonics. These harmonics can be minimized by using high speed switching methods in power semiconductor devices.

Thyristor based inverters can be classified according to the method of performance or commutation or connection or the number of phases, which is shown in figure 2.

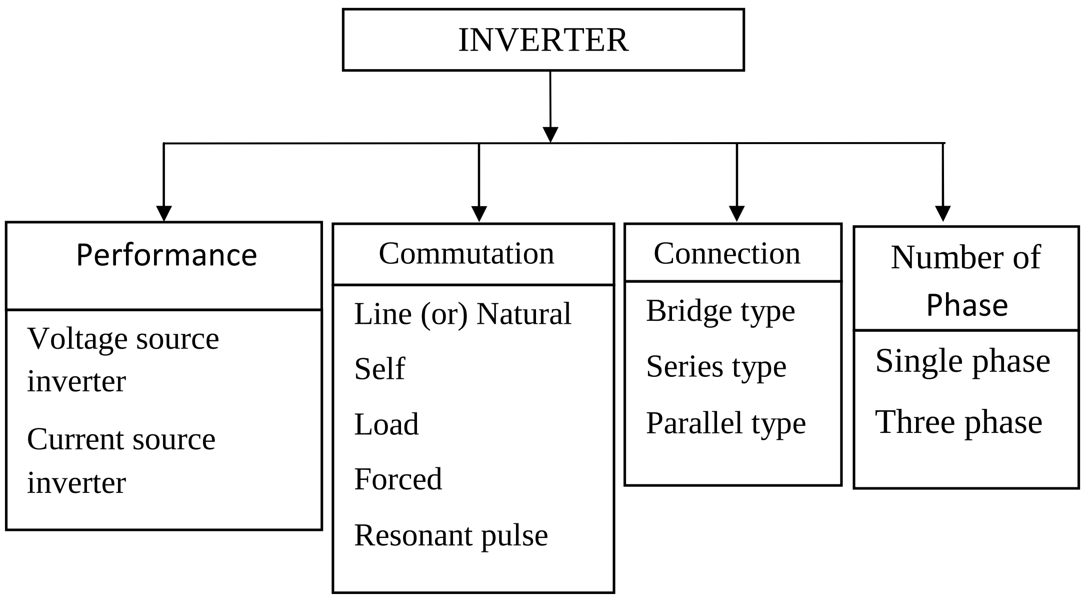

Figure 2: Classification of inverters

CASCADE MULTILEVEL INVERTER

Cascade H Bridge are multilevel converters formed by the series connection of two or more single-phase H-bridge inverters, hence the name. Each H-bridge corresponds to two voltage source phase legs, where the line–line voltage is the converter output. Therefore, a single H-bridge converter is able to generate three different voltage levels. Each leg has only two possible switching states, to avoid dc-link capacitor short-circuit. Since there are two legs, four different switching states are possible, although two of them have redundant output voltage. The zero level can be generated connecting the phase outputs to the positive or the negative bars of the inverter. When two or more H-bridges are connected in series, their output voltages can be combined to form different output levels, increasing the total inverter output voltage and also its rated power[4].

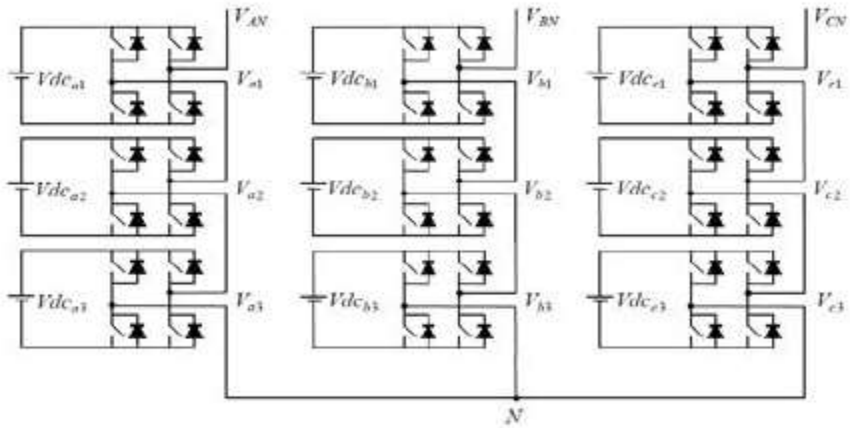

Figure 3: Cascade Multilevel converter

GENERALISED H-BRIDGE CASCADED TOPOLOGY

Figure 4(a) shows the basic H-Bridge cascaded topology and the operational waveforms is shown in figure 4(b). For obtaining a three level output a basic H-Bridge topology requires one DC source along with four MOSFET switches and one balancing capacitors. In order to obtain consequent levels we need a same set of topology as shown in Figure 4(a) which increases the number of components needed which in turn creates design complexity and increases the cost and number of components used [5].It is also found that the maximum output voltage cannot exceeds the sum of voltage of individual sources which becomes the major setback of this topology [6]. Therefore in an application which requires high output voltage from low voltage level, it needs H-bridge module in addition or step-up transformers. To overcome this proposed configuration is employed as in figure 4(b).

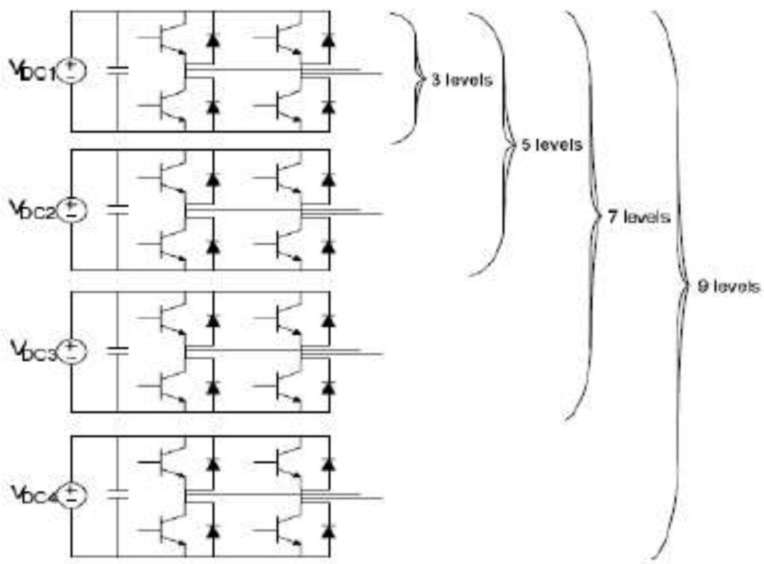

Figure 4(a) : Traditional cascaded H-bridge cell multilevel inverter (nine levels)

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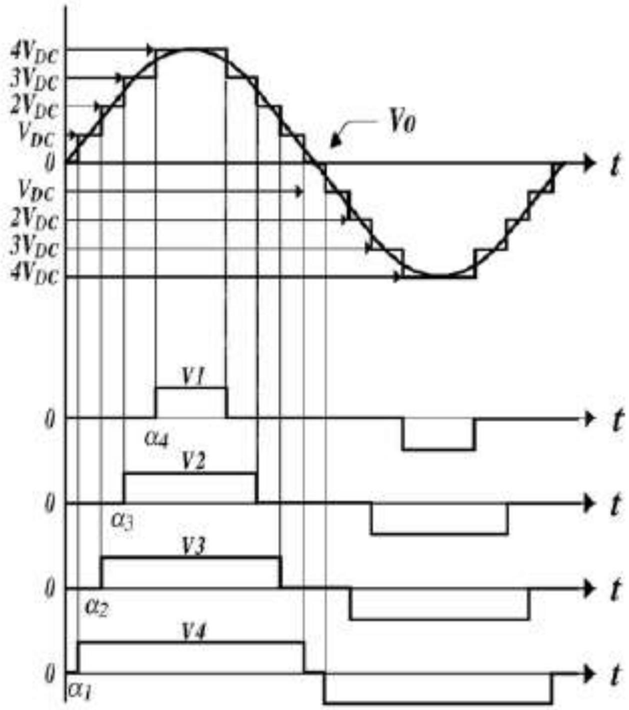

Figure 4(b): Operational waveforms

CONFIGURATION OF PROPOSED MULTILEVEL INVERTER

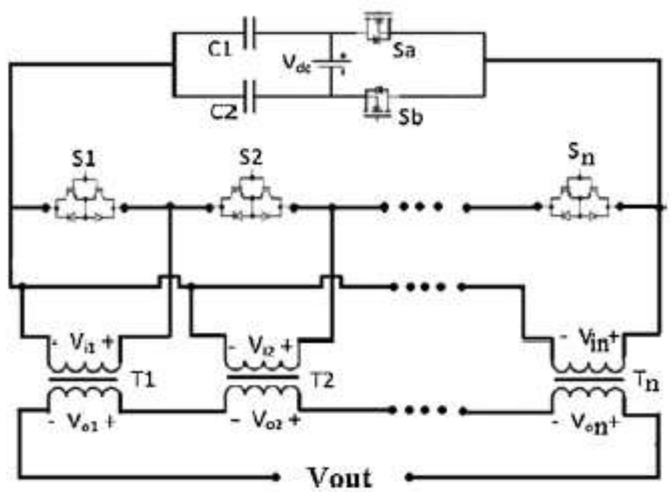

Figure 5: proposed multi-level inverter

In the proposed inverter, each transformer can generate three voltage levels zero, +Vdc and -Vdc. The secondary sides of the transformers are series connected. Therefore, the maximum voltage can be generated from the configuration shown in Fig. 5 is +nVdc where n is the number of transformers. Different switching states and their corresponding output voltage for the proposed will be developed, for symmetric operation of the inverter, turn ratios of the transformers are chosen to be the same. The main aims of proposed multilevel inverter are:

- A cascaded transformer multilevel inverter with reduced number of switching components will be presented.
- The proposed topology utilizes low-frequency single-phase transformers and a DC voltage source.
- This configuration can reduce the number of switches in comparison with conventional cascaded transformer multilevel inverters.
- Selective harmonic elimination technique is applied to mitigate the low order harmonic components.

CONCLUSIONS

The proposed cascade transformer multilevel inverter output will be validated through the simulation. The reduction in switch count to achieve the same voltage level with comparison to proposed and novel topologies will also be presented. Selective harmonic elimination technique will be also applied to reduce the low order harmonics. Different Switching states will also be developed in the proposed inverter.

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