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A Review Paper for Induction Motor Operation Connected with Renewable Energy Sources through Multilevel Inverter

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ABSTRACT

A novel multi-level electrical converter topology for open-end winding induction motor (IM) is given during this paper. within the planned topology one finish of the open-end IM is fed by a standard two-level electrical converter, whereas the opposite finish is connected to a nine-level cascaded H-bridge (CHB) electrical converter. The combined impact of those 2 inverters generates eighteen-level in the part voltage of open-end winding IM. The two-level electrical converter with higher DC link voltage features a lower change frequency and thereby reduces the change losses. additionally thereto, the planned topology needs fewer elements as compared to traditional structure electrical converter (MLI) topology. a noteworthy feature of the planned topology is that it will operate in nine-level mode by connecting the motor winding in star just in case of failure of the two-level electrical converter. Similarly, if the fault happens CHB electrical converter the planned electrical converter will operate in two-level mode. so the responsibility of the system is improved. associate degree thorough simulation study is dole out to guage the performance of planned electrical converter for the whole modulation vary and results square measure presented

Keywords – multilevel inverter, diode-clamped multilevel inverter, flying capacitor converter, cascaded h-bridge , converter, modular multilevel converter

I. Introduction

IN RECENT YEARS, the trade has begun to demand higher power instrumentation, That presently reaches the facility unit level. Controlled ac drives among the facility unit vary ar generally connected to the medium-voltage network. Today, it's exhausting to connect one power semiconductor activate to medium-voltage grids (2.3, 3.3, 4.16, or 6.9 kV). For these reasons, a replacement family of construction inverters has emerged as a result of the resolution for operative with higher voltage levels [1]–[3].

Multilevel inverters embody degree array of power semiconductors and capacitor voltage sources, the output of that generates voltages with stepped waveforms. The commutation of the switches permits the addition of the capacitor voltages, that reach high voltage at the output, whereas the power semiconductors ought to set about to entirely reduced voltages. Fig. one shows a schematic diagram of one half leg of inverters with all completely different numbers of levels, that the action of the power semiconductors is diagrammatic by an ideal switch with several positions.

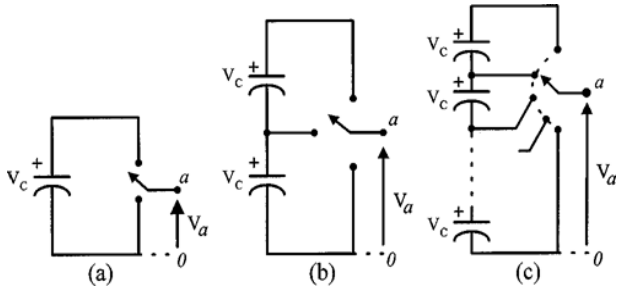


Fig. 1. One phase leg of an inverter with (a) two levels, (b) three levels, and (c) n levels.

A 2-level converter generates academic degree output voltage with 2 values (levels) with connection the negative terminal of the electrical device [see Fig. 1(a)], whereas the 3-level converter generates 3 voltages, and so on. 3 completely totally different topologies square measure projected for construction inverters: diode-clamped (neutral-clamped) [4]; capacitor-clamped (flying capacitors) [1], [5], [6]; and cascaded multiscale with separate dc sources [1], [7]–[9]. in addition, several modulation and management ways in which square measure developed or adopted for construction inverters additionally because the following: construction sickle-shaped pulse dimension modulation (PWM), construction selective harmonic elimination, and space-vector modulation (SVM).

The most partaking choices of construction inverters area unit as follows.

1) They can generate output voltages with terribly low distortion and lower
2) They draw input current with very low distortion.
3) They generate smaller common-mode (CM) voltage, thus reducing the strain at intervals the motor bearings. in addition, victimization refined modulation methods, CM voltages square measure usually eliminated [8].
4) They can operate with a lower modification frequency.

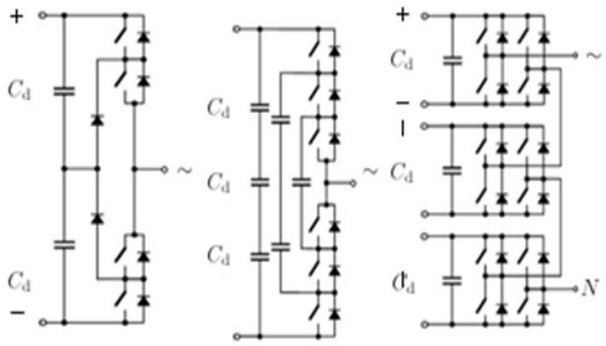
The results of a patent search show that construction converter circuits square measure around for quite twenty 5 years. Associate in Nursing early traceable patent appeared in 1975 [9], throughout that the cascade converter was first printed with a format that connects on an individual basis dc-sourced full-bridge cells nonparallel to synthesize a steps ac output voltage. Through manipulation of the cascade converter, with diodes interference the sources, the diode-clamped construction converter was then derived [10]. The diode-clamped converter was additionally known as the neutral-point clamped (NPC) convertor once it completely was first utilized during a three-level {electrical convertor} throughout that the mid-voltage level was made public as a result of the neutral purpose. as a results of the federal agency convertor effectively doubles the device voltage level whereas not requiring precise voltage matching, the circuit topology prevailed among the Eighties. The appliance of the federal agency convertor} and its extension to construction convertor was found in [11]. although the cascade convertor was fictitious earlier, its applications didn't prevail until the mid–the Nineties. a pair of major patents [12], [13] were filed to purpose the prevalence of cascade inverters for motor drive and utility applications. attributable to the great demand of medium-voltage dynamic inverters, the cascade convertor has drawn tremendous interest ever since. several patents were found for the use of cascade inverters in regenerative-type motor drive applications [14]. The last entry for U.S. construction convertor patents, that were made public as a result of the capacitor-clamped construction inverters, came among the Nineties [15,16]. Today, construction inverters unit extensively utilised in dynamic applications with medium voltage levels. the sphere applications embody use in laminators, mills, conveyors, pumps, fans, blowers, compressors, and so on.

This paper presents progressive construction technology, considering well-established and rising topologies to boot as their modulation and management techniques. Special attention is dedicated to the latest and heaps of relevant industrial applications of these converters. Finally, the chances for future development unit self-addressed

II. INVERTER TOPOLOGIES

A) DIODE-CLAMPED MULTILEVEL INVERTER

Diode-Clamped convertor (DCC) employs clamping diodes and cascaded DC capac- itors to provide AC voltage waveforms with multiple levels. However, in observe, solely the 3-level electrical converter, usually referred to as Neutral-Point Clamped convertor (NPCC) shown in Fig. 2(a), has found industrial applications thanks to the unequal distribution



(a) Neutral-Point Clamped (b) Flying Capacitor (c) Cascaded H-Bridge

Figure 2.Different types of conventional multilevel converters

of losses among the switches and difficult electrical condenser voltage equalisation for higher range of levels [17]. It should be mentioned that, the quality of the capacitor voltage equalisation in DCC is resolved in a very B2B topology [18], however it still suffers from high range of elements.

B) Flying Capacitor Converter

Flying electrical device (FCC) consists of multiple combine of switches and capacitors. The schematic diagram of a 4-level independent agency is shown in Fig. 2(b). All the capacitors ar charged at an equivalent voltage. Beside the problem of voltage equalization, independent agency needs high range of capacitors, since because the range of levels will increase, the quantity of capacitors will increase speedily [19].

C) Cascaded H-Bridge Converter

Cascaded H-Bridge device (CHBC) consists of multiple cascaded H-bridge cells to attain high voltage levels. The schematic diagram of a 4-level CHBC is shown in Fig. 2 (c). To feed these H-bridge cells, a similar variety of isolated DC provides area unit needed which can be obtained from multi pulse diode rectifiers. The modularity of CHBC not solely makes it cheaper however additionally facilitates reaching terribly high voltages. One disadvantage of this topology is that the high variety of isolated DC provides for higher levels of CHBCs [20].

D) Modular Multilevel Converter

The standard structure convertor (MMC) may be a newer generation of structure VSCs that was projected in 2003 by Marquardt and 1st used commercially within the Trans Bay Cable project in metropolis

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III. previous related work

Over the previous couple of decades, structure inverters (MLI) become highly regarded within the field of medium and high voltage drives the most blessings of MLI square measure low total harmonic distortion (THD) within the output voltage wave shape, less change losses and low dv/dt stress on semiconductor switches the primary MLI topology was planned by A. Nabae in 1981 and is termed neutral purpose clamp (NPC) inverter. excluding authority, flying electrical condenser (FC) and cascaded H-bridge (CHB) square measure different well-established MLI topologies. The authority electrical converter needs an outsized range of clamping diodes whereas FC inverters need such a large amount of capacitors once the amount of levels in MLI multiplied. The CHB inverters square measure appropriate for top voltage applications because of the use of standard structures. However, they need AN isolated power supply for every module that makes the system large and costly. the standard of output voltage improves with the increase in range of levels, however at constant time structure of MLI becomes advanced and fewer reliable because of the employment of an outsized number of change devices. The researchers have reportable several MLI topologies and management schemes [9]–[13] to scale back circuit complexness, increase responsibleness and potency. In 1993 H. Stemmler and P. Guggenbach planned the idea of three-level section voltage generation mistreatment AN open-end stator coil
winding induction motor fed by a two-level electrical converter Since then many topologies are planned by researchers based on open-end winding IM. A three-level voltage profile generation in open-end winding IM is planned in The number of levels within the output voltage will be multiplied more by employing a cascade three-level electrical converter at the place of two-level inverter A hybrid seven-level and nine-level the electrical converter is given in These hybrid inverters use 2 three-phase 2-level inverters and two capacitors fed H-bridge per section to come up with totally different levels within the motor section voltage.

IV. Modulation Techniques

Several modulation techniques are planned for structure inverters [29]. The high range of switches in AN MMC compared to a 2-level VSC, results in the next range of doable modulation schemes and additional difficult modulation techniques. Modulation techniques for AN MMC might be classified into 2 teams consistent with their switch frequency as shown in Fig. 3:

• Fundamental shift frequency, wherever every switch has just one commutation per cycle, such as multilevel Selective Harmonic Elimination (SHE), nearest voltage level and nearest vector management methods;

• High switch frequency, wherever every switch has several commutations per cycle, like construction PWM and area Vector Modulation (SVM) strategies.

Among completely different techniques of structure convertor modulation, multicarrier PWM and Nearest Level management (NLC) square measure explained here because of their quality in mul-tilevel convertor modulation.

A) Multicarrier Pulse Width modulation

There area unit 2 common multicarrier modulations applied to construction converters as shown in Fig. 1.7. Phase-shifted PWM is that the most typically used modulation for cascaded construction converters because it offers an excellent power distribution among cells. This modulation technique shifts the part of every carrier at a correct angle to cut back the harmonic content of the output voltage. Figure 1.8 shows the modulation waveforms for Associate in Nursing MMC arm with 3 FBSMs.

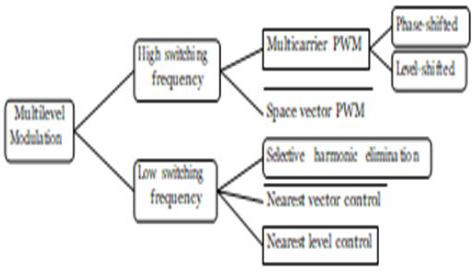


Figure 3.Classification of multilevel converter modulation techniques.

B) Capacitor Voltage Balancing

In MMC, SMs area unit perpetually inserted into or bypassed out of the part arms. to stay the condenser voltages as equally distributed as potential, the correct SMs should be chosen to control at any given time. Failure to adequately balance the voltages not solely distorts the output voltage however can also lead to instrumentality injury if individual SM voltages fluctuate outside of the rated values of the instrumentality. The amendment of a given SM's condenser voltage depends on its inserted/bypassed state, in addition because the magnitude and direction of the arm current. once the SM is inserted, the condenser voltage will increase (decreases) if this is flowing into (out of) the SM. On the opposite hand, if the SM is bypassed, the condenser voltage remains unchanged. This reality is shown for each HBSM and FBSM in Figs. four and five severally.

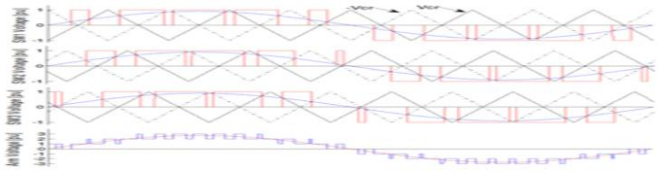


Figure 3. Multilevel phase-shifted carrier-based technique.

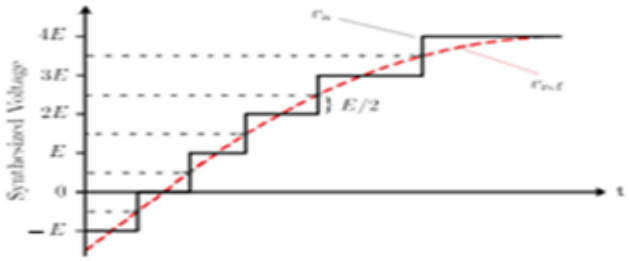
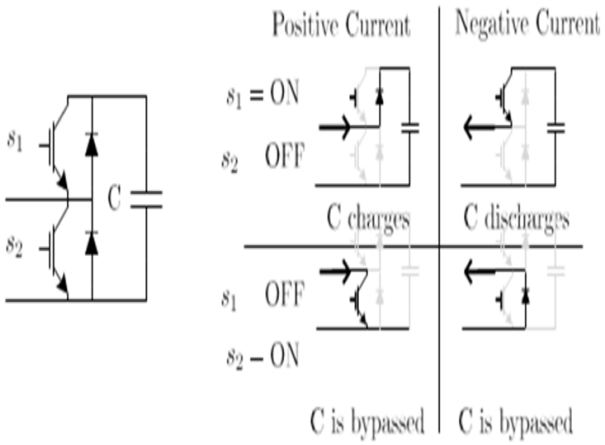


Figure 4. Nearest level control technique**.**

SMEs should be selected to work at any given time. Failure to adequately balance the voltages not solely distorts the output voltage however can also lead to instrumentation harm if individual SM voltages fluctuate outside of the rated values of the instrumentation. The amendment of a given SM's condenser voltage relies on its inserted/bypassed state, additionally because the magnitude and direction of the arm current. once the SM is inserted, the condenser voltage will increase (decreases) if this is flowing into (out of) the SM. On the opposite hand, if the SM is bypassed, the condenser voltage remains unchanged. This reality is shown for each HBSM and FBSM in Figs. 6



Figs. 6 HBSM and FBSM

The electrical device voltage sorting methodology in every arm remains the foremost well-liked technique for electrical device voltage reconciliation in MMCs [26, 28, 31]. during this methodology, first, all electrical device voltages in every arm square measure sorted and therefore the sign of the arm current is detected. Then, if the arm current is charging the SM capacitors, the SMs with all-time low capacitor voltages are selected to be inserted. Otherwise, if the arm current is discharging the SM capacitors, the SMs with the very best capacitance voltages are elite to be inserted. In different words, by generating a sorted list of SM capacitance voltages and therefore the arm current direction at any time, the best SMs to be inserted or bypassed would be known.

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