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# Various Topology of Multilevel Inverter Used for Minimization of Total Harmonics

**Sagar Sing Tomar [1], Hitesh Lade[2], Sita Ram Raikwar[3]**
Department of Electrical and Electronics Engineering
Surbhi College of Engineering and Technology, India
[1]sagartomar1993@gmail.com, [2]hiteshlade2003@gmail.com, [3]sitaramraikwar808@gmail.com[3]

**Abstract: -** The present work deals deep review of study and analysis of 3 phase construction inverters and their totally different topologies and configurations. The most purpose of this is to review the modulation techniques and compare them with one another analyzing their benefits and drawbacks. Their applications are analyzed with their functioning like the cascaded electrical converter work as a function of a rectifier or charger for the batteries of an electrical vehicle whereas the vehicle was connected to an AC supply system.

**Keywords**: - Inverters, modulation techniques, Total harmonic distortion, multi-level inverter.

## I. INTRODUCTION

Numerous industrial applications have begun to need higher power equipment in recent years. Some medium voltage motor drives and utility applications need medium voltage and power unit power level. For a medium voltage grid, it's hard to attach just one power semiconductor switch directly. As a result, a construction power convertor structure has been introduced as an alternate in high power and medium voltage things. A construction convertor not solely achieves high power ratings, however conjointly permits the employment of renewable energy sources.

### 1.1 Inverter

The power within the battery is in DC mode and also the motor that drives the wheels typically uses AC power, so there ought to be a conversion from DC to AC by an influence convertor. Inverters will do that conversion. The only topology which will be used for this conversion is that the two-level electrical converter that consists of 4 switches. Every switch wants AN anti-parallel diode, therefore there ought to be conjointly four opposing parallel diodes. There also are different topologies for inverters.

### 1.1.1. Working of Multi-Level Inverter

A structure electrical converter may be a power electronic system that synthesizes a curving voltage output from many DC sources. These DC sources are often fuel cells, star cells, extremist capacitors, etc. the most plan of structure inverters is to own a more robust curving voltage and current within the output by mistreatment switches serial. Since several switches area unit place serial the change angles area unit necessary within the structure inverters as a result of all of the switches ought to be switched in such the simplest way that the output voltage and current have low harmonic distortion.

### 1.1.2. Type of Multilevel inverters

- Diode clamped structure inverters
- Flying capacitance structure inverters and
- Cascaded h-bridge structure electrical converter.

### 1.2 Multilevel Inverters

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### 1.2.1 Use of Multilevel Inverter

Large electrical drives and utility applications need advanced power physical science convertor to fulfill the high power demands. As a result, structure power convertor structure has been introduced as an alternate in high power and medium voltage things. A structure convertor not solely achieves high power ratings, however conjointly improves the performance of the entire system in terms of harmonics, dv/dt stresses, and stresses within the bearings of a motor.

### 1.2.2 Multilevel Inverter Topologies

From the electrical energy conversion purpose of read we tend to distinguish four basic convertor types [1]. Rectifiers convert AN input AC voltage and current to an output DC voltage and current, choppers convert AN input DC voltage and current to an output DC voltage and current of various values, inverters convert AN input DC voltage and current to an output AC voltage, current, frequency and count of phases, AC converters convert AN input voltage, current, count of phases and frequency to an AC energy with completely different parameters. The frequency converters that convert AN input frequency to AN output frequency which at the same time maintain the count of phases produce a subgroup of AC converters and that they area unit there most wide-spread converters within the field of electrical drives. The basic topologies of converters for electrical drives is classified as in Fig. 1., Even so, it's sensible to stay in mind that every power converter consists of power electronic devices that area unit connected into a selected electrical theme which area unit management by a selected control strategy.

#### 1.2.1.1 Diode-clamped Topology

Five years once the outline and realization of the primary cascaded H-bridge megacycle per second, Baker (1980) planned a brand new topology – a neutral-point-clamped construction electrical converter, particularly a three-level and a five-level affiliation. However, only one year later Nabae, Takahashi and Akagi (1981) printed a piece regarding the implementation of pulse-width modulation for this topology and that they introduced their initial results of the three-level performance. This topology was the primary one that created it doable to supply associate output voltage from only DC supply.

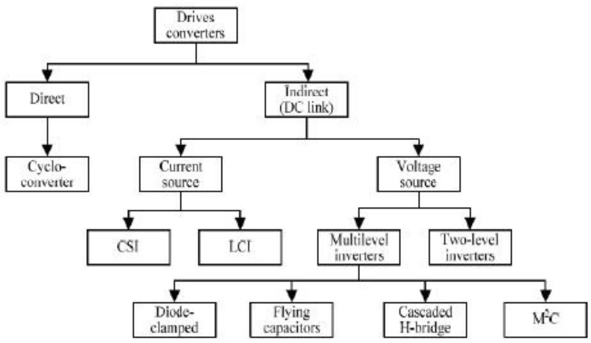


Fig. 1 Classification of drives converter topologies

#### 1.2.1.2 Flying Capacitor Topology

Generally, within the theory of structure inverters, the complexness of the ability circuit in addition because the management will increase chop-chop with each alternative addition level. Therefore, the principle operate of the flying electrical device electrical converter (FCI) are explained on a three-level electrical converter initial. The relationships and natural connections between inverters with completely different variety of levels and also the complexness growth are apparent if three-, four- and five-level inverters are introduced.

#### 1.2.1.3 Cascaded H-bridge Topology

The first multi coupling based semiconductors was delineated and made by Baker and Bannister (1975). It had been a cascaded topology that could be a serial association of one-phase converters. Today, these converters square measure called cascaded H-bridge converters. A basic theme of a three-phase five-level cascaded H-bridge construction electrical converter is shown in Fig.2, Every leg consists of 1 part full bridges connected in chain.

### 1.3 Harmonics

Harmonics square measure curved voltages or currents having frequencies that square measure whole number multiple of the frequencies at that provide system are style to control. Harmonics square measure made by linear instrumentation, like arc furnaces, variable speed drives and masses that use power physical science. Voltages or currents having frequency elements that aren't whole number multiple of frequencies at that the provision system is to control.

#### 1.3.1 How Harmonics Produced

The harmonic results thanks to the operation of power electronic converters. The harmonic voltage and current ought to be restricted to the suitable level at the purpose of association to the network. To make sure the harmonic voltage at intervals limit, every supply of harmonic current will permit solely a restricted contribution, as per the IEC-61400-36 guideline. The fast shift provides an outsized reduction in lower order harmonic current compared to the road commutated convertor, however the output current can have high frequency current and might be simply filter-out.

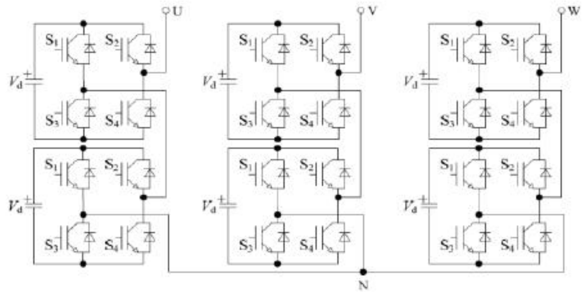


Fig.2 Basic scheme of a three-phase five-level cascaded H-bridge multilevel inverter

#### 1.3.2 Effect of Harmonics

Harmonic distortion will have prejudicial effects on electrical instrumentation. Unwanted distortion will increase the present in power systems which end in higher temperatures in neutral conductors and distribution transformers. Higher frequency harmonics cause extra core loss in motors which ends in excessive heating of the motor core. These higher order harmonics also can interfere with communication transmission lines since they oscillate at an equivalent frequencies because the transmit frequency.3 If left uncurbed, increased temperatures and interference will greatly shorten the lifetime of equipment and cause harm to power systems.

### 1.4 Methods for reduction of harmonics in multilevel

- Pulse width modulation techniques
- Sinusoidal Pulse Width Modulation Techniques

## II. LITERATURE REVIEWS

The most common initial application of construction converters has been in traction, each in locomotives and track-side static converters [2]. More modern applications are for installation converters for volt-ampere compensation and stability sweetening [5], active filtering [6], high-voltage motor drive [9], high-voltage dc transmission [17], and last for medium voltage induction motor variable speed drives [8]. Several construction convertor applications concentrate on industrial medium-voltage motor drives [3], utility interface for renewable energy systems [10], versatile AC gear mechanism (FACTS) [11], and traction drive systems [12]. The conception of construction converters has been introduced since 1975. The cascade construction electrical converter was initial planned in 1975 [14]. Separate DC-sourced full-bridge cells are placed asynchronous to synthesize a way AC output voltage. The term construction began with the three-level convertor [15]. Later, many construction convertor topologies are developed [16]. In 1981, diode-clamped construction electrical converter conjointly known as the Neutral-Point Clamped (NPC) electrical converter schemes were planned [17, 19]. In 1992, capacitor-clamped (or flying capacitor) construction inverters, [18] and in 1996, cascaded construction inverters were planned [1]. Though the cascade construction electrical converter was fictitious earlier, its application failed to prevail till the middle Nineteen Nineties. The benefits of cascade construction inverters were distinguished for motor drives and utility applications. The cascade electrical converter has drawn nice interest because of the nice demand of medium-voltage high-octane inverters. The cascade electrical converter is additionally utilized in regenerative-type motor drive applications [20, 21]. Recently, some new topologies of construction inverters have emerged. This includes generalized construction inverters [22], mixed construction inverters [23], hybrid construction inverters [24, 25] and soft-switched construction inverters [26]. These construction electrical converters will extend rated inverter voltage and power by increasing the quantity of voltage levels. They'll conjointly increase equivalent change frequency while not the rise of actual change frequency, so reducing ripple part of electrical converter output voltage and magnetic force interference effects. A construction convertor may be enforced in many alternative ways in which. The best techniques involve the parallel or series affiliation of standard converters to make the construction waveforms [27]. Additional advanced structures effectively insert converters at intervals converters [28]. The voltage or current rating of the construction convertor becomes a multiple of the individual switches, and then the facility rating of the convertor will exceed the limit obligatory by the individual change device.

## III. CONCLUSIONS

The current trend of modulation control for multilevel converters is to output high quality power with high efficiency. For this reason, popular traditional PWM, sinusoidal PWM (SPWM) methods and space vector PWM (SVPWM) methods are not the best methods for multilevel converter control due to their high switching frequency. The resultant method can solve low order harmonic equations, but cannot solve high order harmonic equations. In this thesis, switching angles for each H-Bridge converter are equal. If the switching angle numbers for each H-Bridge converter are not equal, it may be possible to find more solutions for a wider modulation index range.

## REFERENCES

[1]. Pavelka, J., Kobrle, P., 2011. Multilevel Inverters for High Voltage Active Filters –Part I. Research report. Unpublished.

[2]. L. M. TOLBERT, PENG, F. Z., 2000. Multilevel Converters as a Utility Interface for Renewable Energy Systems. Proc. of the 2000 IEEE Power Engineering Society Summer Meeting, pp. 1271-1274.

[3]. PENG, F. Z., LAI, J. S., 1997. Dynamic Performance and Control of a Static Var Generator Using Cascade Multilevel Inverters. IEEE Transactions on Industry Applications, Vol. 33, No.3, May 1997, pp. 748-755.

[4]. PENG, F. Z., LAI, J. S., McKEEVER, J. W., COEVERING, J. V., 1996. A Multilevel Voltage-Source Inverter with Separate DC Sources for Static Var Generation. IEEE Transactions on Industry Applications, Vol. 32, No. 5, September 1996, pp. 1130-1138.

[5]. JOOS, X. H., OOI, B. T., 1997. Direct-Coupled Multilevel Cascaded Series VAR Compensators. Conference Record of IEEE Industry Applications Society 32nd Annual Meeting, pp. 1608-1615.

[6]. BEUERMANN, M., HILLER, M., SOMMER, R., 2006. Converter circuits for medium voltage and the

power semiconductor for use in industrial power converters Proc. of the VDE-ETG Conference Components of Power Electronics and their Applications. Bad Nauheim, Germany, 2006, pp. 151-160.

[7]. LAI, J. S., PENG, F. Z., 1996. Multilevel Converters - A New Breed of Power Converters. IEEE Transactions on Industry Applications, Vol. 32, No. 3, May 1996, pp. 509-517.

[8]. HOCHGRAF, C., LASSETER, R., DIVAN, D., LIPO, T. A., 1994. Comparison of Multilevel Inverters for Static Var Compensation. Conference Record of IEEE Industry Applications Society 29th Annual Meeting, pp. 921-928.

[9]. TOLBERT, L. M., HABETLER, T. G., 1998. Novel Multilevel Inverter Carrier-Based PWM Methods. IEEE IAS Annual Meeting, October 1998, St. Louis, Missouri, pp. 1424-1431.

[10]. SIVKOV, O., Five-level Inverter with Flying Capacitors. Doctoral thesis, Czech Technical University in Prague, Prague, 2011.

[11]. RIZET, C., 2010. Multi-level topologies for medium power UPS. ECPE-Workshop Advanced Multilevel Converter System, Västerås, September 2010.

[12]. SINHA, G., LIPO, T. A., 1997. A New Modulation Strategy for Improved DC Bus Utilization in Hard and Soft Switched Multilevel Inverters. IECON, pp. 670-675.

[13]. B. Mwinyiwiwa, Z. Wolanski, and Boon-Teck Ooi. High power switch mode linear amplifiers for flexible AC transmission system. IEEE PES Winter Meeting, January 1996.

[14]. Y. Yoshioka, S. Konishi, N. Eguchi, M. Yamamoto, K. Endo, K. Maruyama, and K. Hino. Self-commutated static flicker compensator for arc furnaces. In IEEE Applied Power Electronics Conference, volume 2, pages 891–897, 1996.

[15]. Frank M. Flinders, Peter J. Wolfs, and Ken C. Kwong. Improved techniques for switching power amplifiers. IEEE Trans. Power Electronics, 8(4):673–679, October 1993.

[16]. M. Marchesoni. High performance current control techniques for application to multilevel high-power voltage source inverters. IEEE Trans. Power Electronics, 7(1):189–204, January 1992.

[17]. L. Gyugyi, "Power electronics in electric utilities: static var compensators." Proc. IEEE, vol. 76, pp. 3, 1987.

[18]. T. A. Meynard and H. Foch, "Multilevel conversion: High voltage choppers and voltage source inverters," in *Proc. IEEE PESC'92*, 1992, pp. 397–403.

[19]. F. Z. Peng, J.-S. Lai, J. Mckeever, and J. Van Covering, "A multilevel voltage-source inverter with separate DC source for static var generation," in Conf. Rec. IEEE-IAS Annul Meeting, 1995, pp. 2541–2548.

[20]. P. W. Hammond, "Four-quadrant AC-AC drive and method," U.S. Patent 6 166 513, Dec. 2000.

[21]. M. F. Aiello, P. W. Hammond, and M. Rastogi, "Modular multi-level adjustable supply with series connected active inputs," U.S. Patent 6 236 580, May 2001.

[22]. F. Z. Peng, "A generalized multilevel inverter topology with self-voltage balancing," IEEE Trans. Ind. Applicat., vol. 37, pp. 611-618, 2001.

[23]. W. A. Hill and C. D. Harbourt, "Performance of medium voltage multi-level inverters," Conf. Rec. IEEE-IAS Annul Meeting, 1999, pp. 1186-92.

[24]. M. D. Manjrekar, P. K. Steimer, and T. A. Lipo, "Hybrid multilevel power conversion system: a competitive solution for high-power applications," IEEE Trans. Ind. Applicat., vol. 36, pp. 834- 841, 2000.

[25]. Y.-S. Lai and F.-S. Shyu, "Topology for hybrid multilevel inverter," IEE Proc. Electr. Power Applicat. vol. 149, pp. 449-458, 2002.

[26]. B.-M. Song, J. Kim, J.-S. Lai, K.-C. Seong, H.-J. Kim, and S.-S. Park, "A multilevel soft switching inverter with inductor coupling," IEEE Trans. Ind. Applicat., vol. 37, pp. 628-36, 2001.

[27]. E. Cengelci, S. U. Sulistijo, B. O. Woom, P. Enjeti, R. Teodorescu, and F. Blaabjerg, "A New Medium Voltage PWM Inverter Topology for Adjustable Speed Drives," in Conf. Rec. IEEE-IAS Annul. Meeting, St. Louis, MO, Oct. 1998, pp. 1416-1423.

[28]. P. Jahn, and H. Leichtfried: "Traction equipment of the class 1822 dual-system locomotive", ABB Rev., 1992, (4), pp. 15-22.

[29]. A. Nabae, I. Takahashi, and H. Akagi, "A new neutral point clamped PWM inverter", ZEEE Trans., 1981, 1A-17, (5), pp.518-523.