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The Study of Capacitor Voltage Balancing Control for Hybrid Modular Multilevel Converter with Grid-Tied-Cascaded full Bridge Approach

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ABSTRACT

The occurrence of Harmonics in power is the unwanted outcome of non-linear loads and industrial electronic devices. The output waveform contains various different waveforms holding assorted frequencies since the current which is taken from supply is no more simply sinusoidal. As a result of the thorough usage of power converters and comparable nonlinear loads in various sectors for different purposes, combined decrease in the voltage waveforms as well as current waveforms has been observed. The current conveyed by a nonlinear load can never be free from harmonics it always contains harmonics in certain amount. Distortion of load voltage is the unfavorable result of voltage dropping non-linearly which is caused by none other than the line current harmonics. The current carried by the linear load becoming non-sinusoidal is caused by the distortion in load voltage. To overcome power quality and harmonic issue a SVPWM based multi level indirect matrix converter for nonlinear loads has proposed in this work. The implementation and simulation of proposed work has done on Matlab Simulink. The obtained results are observed and compared with existing results. It is found that the proposed work has better performance as compared to existing work.

Keywords- SVPWM, Matrix Converter, Nonlinear Loads, Harmonic generation, Power Quality Improvement, THD

Introduction

The world vitality utilization is relied upon to increment by over 54% at regular intervals. Moreover, population growth and the development of "new economies" require energy sharing that has to keep in step to guarantee electrical grid voltage stability. Then again; the Kyoto convention to the United Nations system tradition on environmental change characterized the ways and the limitations of managing vitality creation. Those in attendance at this meeting considered renewable energy sources as a good way to achieve the goal. Since the start of the 21st century, numerous nations have deregulated the power division. This has created a more flexible mix of energy sources by encouraging higher efficiencies, particularly with the introduction of private investments in the energy market. In the scenario of electrical energy transmission growth, HVDC systems seem to best meet the purposes given. As on account of their natural power stream control ability and asynchronous highlight, HVDC frameworks related with adaptable AC transmission frameworks (FACTS) are spreading everywhere throughout the world. In the last 40 years, HVDC has played a key role in transmission systems with a series of economic and technical considerations: As appeared in Fig. 1.1, contrasted with AC transmission frameworks, HVDC transmission frameworks turn out to be more advantageous for a separation relying upon the line innovation (around 800 km for overhead line and 50 km for underground or submarine connections). Regardless of the way that HVDC converter stations are costly, the transmission line requires a diminished number of conductors which around prompts a reduction of 33% of the cost.AC transmission frameworks, HVDC transmission frameworks turn out to be more advantageous for a separation relying upon the line innovation (around 800 km for overhead line and 50 km for underground or submarine connections). Regardless of the way that HVDC converter stations are costly, the transmission line requires a diminished number of conductors which around prompts a reduction of 33% of the cost.

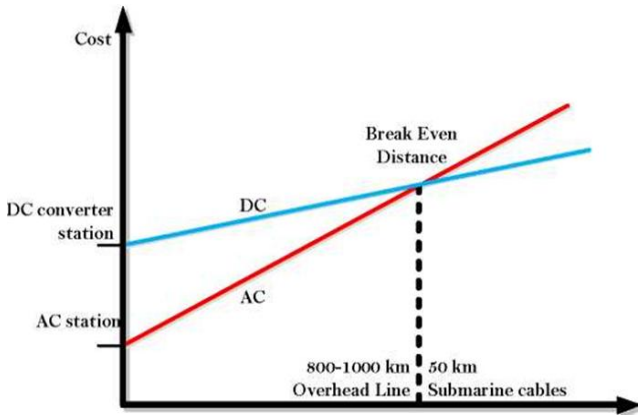

Figure: 1 Estimation of the coasts for AC and DC transmission

- The ever-increasing improvements in power electronics devices, more particularly in the field of turn-off controlled semiconductors, are at the core of HVDC technologies.
- HVDC systems allow interconnections between miscellaneous grids which can be asynchronous or with different operating frequencies. They encourage combination of sustainable sources like breeze ranches or photovoltaic plants

The aggregate power introduced in HVDC frameworks was around 55 GW, adding up to 1.4% of the overall introduced age limit. The bend appeared in Fig. 1.2 demonstrates the pattern of the primary establishments accomplished on the planet since 1970. In the next years, 48 GW of HVDC installed stations are expected by China alone.

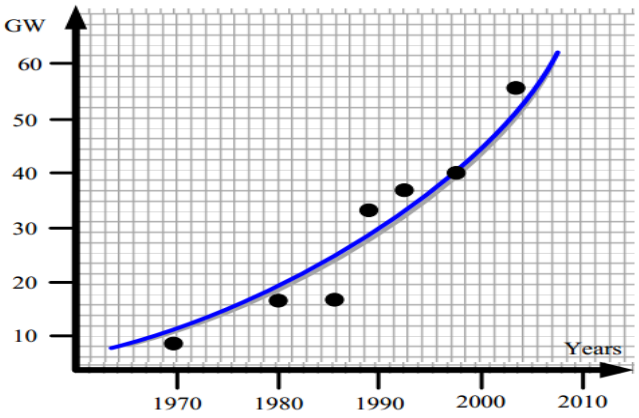

Figure: 1 Power provided by HVDC transmission

The Concept of a HVDC Connection

The progression of the solid state devices fundamentally made possible the possibility of the AC/DC change. The mercury bend valves were supplanted by solid state devices named thyristors since 1970s. The essential thyristor business was the Eel Waterway in Canada in light of Line-Commutated Converter (LCC), which was worked by General Electric and went into advantage in 1972. Since that time onwards, the thyristor LCCs or Current Source Converters (CSCs) have been diligently diffusing and making for HVDC applications, similar to the transmission frameworks for which the fundamental course of action is showed up in Fig. 1.3 The regular CSC based HVDC association assumes in consistent express that the power stream is directed by changing the indication of the found the middle value of estimation of the voltages (Vout1 what's more, Vmt2) constrained on the DC line. The framework is gotten for high power levels, past 1 GW, for foundations like the Itapiu framework in Brazil (6.3 GW), or the longest power transmission that connections.

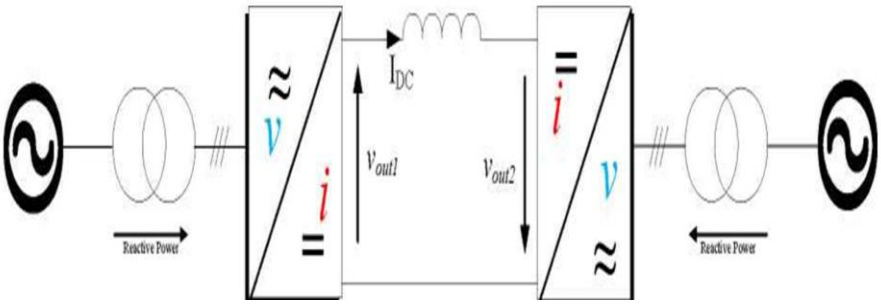

Figure: 3 CSC-HVDC system base layout

Artificial Neural Systems

ANNs is information dealing with innovation that duplicates the human tactile framework. It depends on three fundamental portions: dealing with segments (PE) which are a manufactured model of human neuron, interconnections whose capacities resemble the axon and neurotransmitters which are the place an interconnection meets a PE. Each PE gets signals from various PE s that constitute an information plan. This info design empowers the PE to reach some level of activity. If the development is adequately strong, the PE delivers a singular yield hail that is transmitted to various PE s through an interconnection.

Hybrid Modular Multilevel Converters

The upside of the two-level converter is that it contains the littlest aggregate number of semiconductors. The primary disadvantage is that it can only have a two-state in the output, and consequently requires high changing frequency to get a sinusoidal output waveform. The MMC with Half-Bridge control cells gives an answer for the power misfortunes because of high exchanging frequency in the two-level converter to the detriment of having twofold the quantity of switches and a very vast measure of capacitance. The primary impediment of the MMC with half-connect is its inability to obstruct the present path amid the DC fault. Conversely, the full-connect MMC topology allows the ride-through capability of the arrangement and suppression of the DC faults, however once more, requires twice the identical numeral digit value of semiconductors. Various fascinating converter topologies which consolidate the highlights and focal points of both of the MMC and two-level converters have been highlighted recently in the literature.

Hybrid Converter with a Wave Shaping Circuit on the AC Side

The hybrid converter with a wave forming circuit on the AC side. The setup of the converter involves a two-level converter, which is related in game plan with the wave shaping circuit. The two-level converter works ordinarily and a square wave yield is made at its AC terminal; the wave-forming circuit conveys the qualification between the two-level converter output and the pined for (sinusoidal) output voltage. Using this strategy, the two-level converter can work at a much lower trading frequency than for the circumstance without the wave forming converter. This engages the two-level converter to work even at the trading recurrence of only twice per cycle. The advantages of this topology are the DC blame blocking ability and the age of a moderately come full circle sinusoidal waveform, regardless of the fact this requires wary synchronization between the two-level converter and wave forming circuit. The obstacles, as noted, are the exact synchronization necessities between the two combined circuits to sidestep high voltage spikes, and the influence setbacks of the converter in light of the two-level converter interface required to work with hard trading and the resultant moderately high trading mishaps.

Voltage Balancing Control Methods

The aim of the voltage balancing control is to control the capacitors' voltage level in the same range and limit the capacitors' swell, with a particular true objective to keep a module disappointment or bended voltage output of the converter. Also, the permitted swell by the altering control may influence the cost of the capacitors.

MMC Topology

The MMC considered in this work comprises of various fell modules, every one being a half scaffold associated with a capacitor. A few modules associated in arrangement with an inductance frame a converter arm, the structure of the MMC including module capacitors shows that an inner voltage changing control for the capacitors' voltage level is required. This modifying control fuses two segments: the control of the ordinary capacitor voltage in a leg and an individual voltage control for each one of the modules in the leg. The dc-relate voltage control.

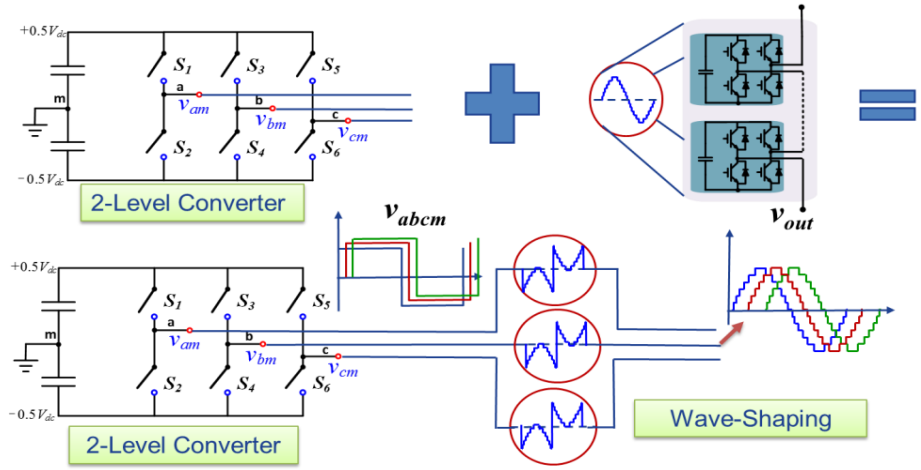

Figure: 4 Hybrid Voltage Source Multilevel Converter among Wave-shaping circuit on the AC side

Hybrid Converter with a Wave shaping Circuit on the DC Side

The single-phase, two-level converter full-bridge "H-bridge" converter is a building hinder in a few converters, for example, the fell H-Bridge converter, and so forth. Specifically, in high power, high voltage applications, the game plan of full-associate converters are used as a STATCOM to compensate for the responsive power. One unpreventable conviction about the two-level converter is that any voltage swell on the DC side will be passed on to the AC side, which generally is shocking. The crucial idea of this group of crossover converter is getting the wave-shaping circuit on the DC side of the two-level converter and making the DC capacitor dynamic instead of idle. Fig. 3.2 shows the possibility of the dynamic DC capacitor with a wave-framing circuit

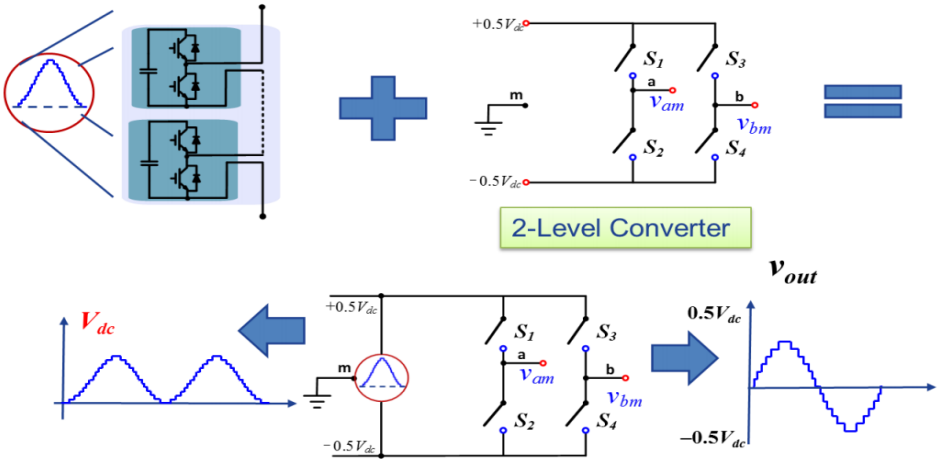

Figure: 5 H-bridge Converter with Active DC Capacitor and wave-shaping circuit on the DC side

Characteristics of Dynamic system with Faults

Elements in a control framework incorporate sensors, actuators, controllers, and the plant being controlled. The framework for the most part works in a shut circle design. Any irregular activities among these parts are alluded to as shortcomings. Issues can happen in different degrees of seriousness and indiscriminately times. As a rule, shortcomings can be classified either as per their physical areas in the framework, or their consequences for the framework performance. Fault arrangements in light of physical areas have been embraced in this proposition on the grounds that such characterizations enable us to connect flaws with framework excess specifically. Portrayed in are the deficiencies that could happen in various components of the framework.

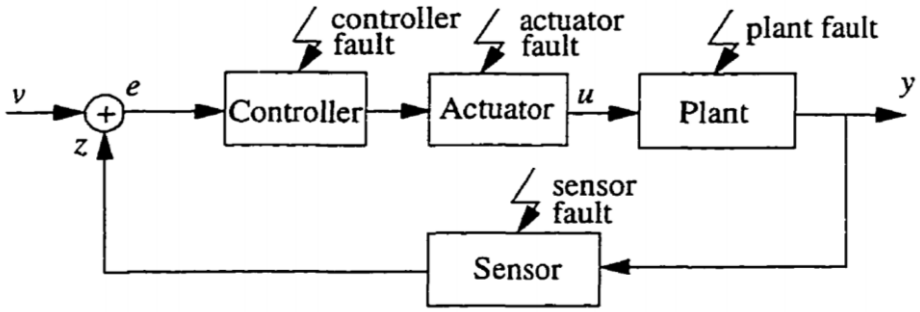

Figure: 6 Component Faults in a Closed-loop Control System

Problem Statement

The world energy consumption is expected to increase by more than 54% every ten years. Moreover, population growth and the development of "new economies" require energy sharing that has to keep in step to guarantee electrical grid voltage stability. On the other hand, the Kyoto protocol to the United Nations framework convention on climate change defined the ways and the constraints of regulating energy production. Those in attendance at this meeting considered renewable energy sources as a good way to achieve the goal. Since the beginning of the 21st century; many countries have chosen to deregulate the electricity sector. This has created a more flexible mix of energy sources by encouraging higher efficiencies, particularly with the introduction of private investments in the energy market. In the scenario of electrical energy transmission growth, HVDC systems seem to best meet the purposes given. As affirmed in thanks to their inherent power flow control capability and asynchronous feature, HVDC systems associated with flexible AC transmission systems (FACTS) are spreading all over the world..

Proposed Work

A matrix converter based on SVPWM has been modeled in this work on MATLAB Simulink. Matrix converters enables some interesting features, for example, conservativeness and sinusoidal waveform of the input and output streams. The intricacy of the matrix converter topology makes the investigation and the assurance of suitable modulation methodologies has carried out in this work. A Space Vector Modulation (SVM) approach has used in this work proposed System SIMULINK

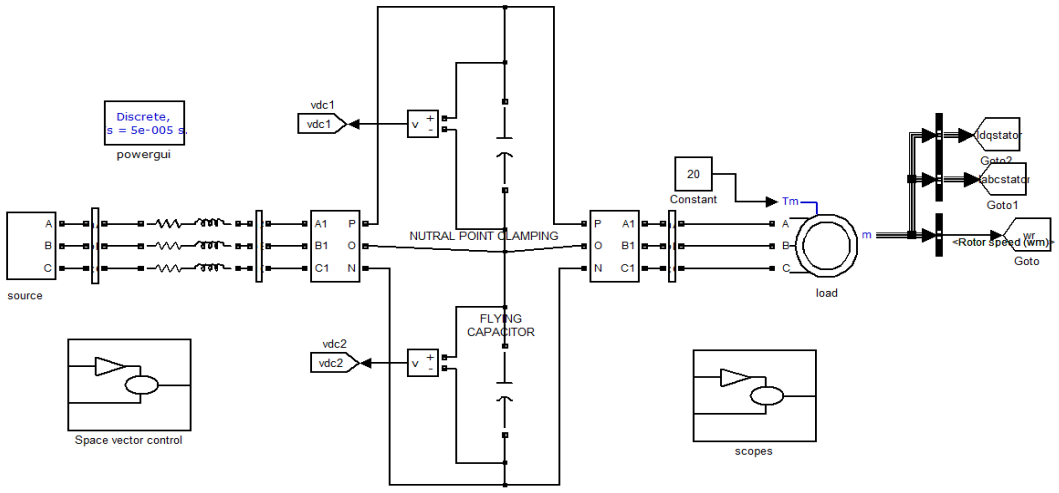

Figure: 7 Proposed System Simulink Circuit

Fuzzy logic

The Fuzzy logic (FL) implies a method of reasoning framework which addresses learning and reasons in a free or fuzzy approach to reason under uncertainity. Not under any condition like the built up basis frameworks, it goes for exhibiting the questionable techniques for feeling that have a central impact in human capacity to interpret a harsh reaction to a request in light of a store of data that is assessed, inadequate or not absolutely solid. it is normally reasonable to use fuzzy logical model does not exist or exists yet rather is exorbitantly troublesome, making it difficult to encode and unnecessarily unusual, making it difficult to be surveyed adequately brisk for constant errand. The accuracy of fuzzy method of reasoning frameworks relies upon the data of human masters from this time forward; it is only in an indistinguishable class from the legitimacy of guidelines.

Fuzzy Logic System

A FL framework delineates the control activity of a methodology as far as fundamental If-Then standards. It delineates the algorithm for process control as a fuzzy association between information on the system conditions to be controlled and the control activity. Hereafter it gives a semantic or fuzzy model that is made in perspective of human experience and capacity rather than a logical model. in a FL framework, the control activity is resolved from the assessment of a game plan of fundamental phonetic rules. The progression of guidelines requires a thorough perception of the method to be controlled, yet it doesn't require logical model of the framework. The model can be single information single output or multi-input multi-output composes.

Linear and Non Linear Load

Loads usually encountered in power systems can be broadly categorized into industrial, residential, municipal and commercial loads. When voltage and current in same frequency have a linear relationship, this load can be called linear load. Most of time, this type of loads is sets of linear resistors or linear inductors. However, different from classic load theory, in reality there is no load is pure constant power or pure constant impedance. So practical loads should be viewed as mixtures of linear loads and nonlinear loads. Because of massive applications of power electronics, many electrical devices are driven by multiple controllers or rectifiers. Different combinations of diodes and capacitors can cause significant nonlinearity. For example, there is a battery charger which is driven by a diode bridge rectifier (DBR) and if supplied by a pure sinusoidal AC source of 110V the current waveform is shown in Figure.Thus how to model loads becomes a significant topic for power system research in order to simulate systems accurately. Load models, regardless of the modeling techniques, are divided into static and dynamic load models. Static loads describe the relationship between the power consumption, voltage and frequency, while dynamic loads provide the additional advantage of representing time-sensitive behavior of the load.

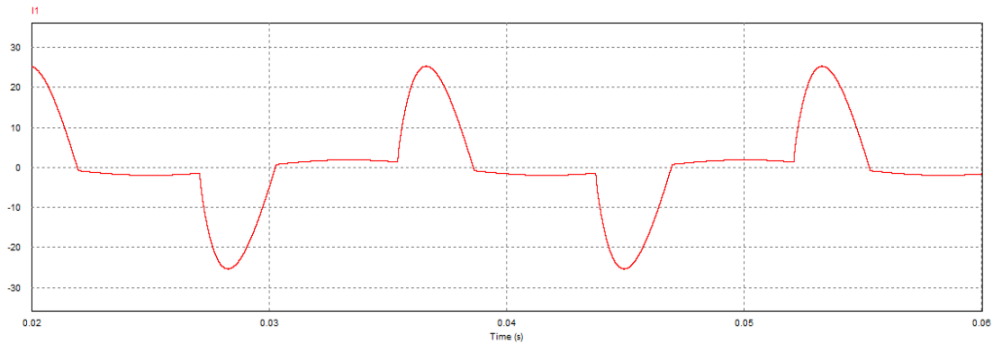

Figure: 7 Current Waveform of DBR.

Conclusion

This work presents a SVPWM based multi level indirect matrix converter for nonlinear loads. SVPWM is more complex and intricate than other methods of harmonics elimination, it may be executed with great ease involving recent digital signal processing based control mechanism. Vector theory allows through a simple and direct geometrical representation, an immediate comprehension of the modulation basic principles. The performance of the proposed strategy and of the existing, in terms of THD of input and output quantities, has been analyzed by means of realistic numerical simulations. The comparison has been carried out assuming either the same cycle period or the same switching frequency. The obtained results clearly emphasize the effectiveness of the proposed approach through THD analysis. The total harmonic distortion SVPWM based multi level indirect matrix converter for nonlinear loads is 1.90 %, 1.11% and 1.17%. Here, is it clearly visible that % THD is less in case of SVPWM as compare existing approach. Hence, it can be easily conclude that the proposed Technique is more efficient in eliminating harmonics.

Future Scope

However in spite of all the previously mentioned favorable circumstances that SVPWM in light of Matrix converter appreciates over previous scheme, thus it is obviously unmistakable that there is a advantageous while utilizing SVPWM for inverters for Adjustable speed Drive Operations. Because of this there is a need to choose carefully as to which of the techniques to use weighing the pros and cons of each strategy.

References

[1]. M. B. Ghat and A. Shukla, "A New H-Bridge Hybrid Modular Converter (HBHMC) for HVDC Application: Operating Modes, Control and Voltage Balancing," in IEEE Transactions on Power Electronics, vol. PP, no. 99, pp. 1-1.

[2]. M. A. Abdel-Moamen, S. A. Shaaban and F. Jurado, "France-Spain HVDC transmission system with hybrid modular multilevel converter and alternate-arm converter," 2017 Innovations in Power and Advanced Computing Technologies (i-PACT), Vellore, 2017, pp. 1-6

[3]. Shahu, T. Bandaru, T. Bhattacharya and D. Chatterjee, "Control of hybrid modular multilevel converter based HVDC system under DC short circuit faults," IECON 2017 - 43rd Annual Conference of the IEEE Industrial Electronics Society, Beijing, 2017, pp. 171-176.

[4]. M. Lu, J. Hu, L. Lin and K. Xu, "Zero DC voltage ride through of a hybrid modular multilevel converter in HVDC systems," in IET Renewable Power Generation, vol. 11, no. 1, pp. 35-43, 1 11 2017

[5]. K. Xu, J. Hu and M. Miao, "Analysis and control of hybrid modular multilevel converter with scheduled DC voltage reducing in a HVDC system," 12th IET International Conference on AC and DC Power Transmission (ACDC 2016), Beijing, 2016, pp. 1-6.

[6]. Rui Li, Jing Wu, Liangzhong Yao, Yan Li and B. Williams, "Hybrid modular multilevel converter with reduced three-level cells in HVDC transmission system," 2016 IEEE 8th International Power Electronics and Motion Control Conference (IPEMC-ECCE Asia), Hefei, 2016, pp. 708-712.

[7]. R. Li, G. P. Adam, D. Holliday, J. E. Fletcher and B. W. Williams, "Hybrid Cascaded Modular Multilevel Converter With DC Fault Ride-Through Capability for the HVDC Transmission System," in IEEE Transactions on Power Delivery, vol. 30, no. 4, pp. 1853-1862, Aug. 2015.

[8]. J. Qin and M. Saeedifard, "A Zero-Sequence Voltage Injection-Based Control Strategy for a Parallel Hybrid Modular Multilevel HVDC Converter System," in IEEE Transactions on Power Delivery, vol. 30, no. 2, pp. 728-736, April 2015.

[9]. D. Casadei, G. Serra, A. Trentin, L. Zarri, M. Calvini, ”Experimental analysis of a matrix converter prototype based on new IGBT modules,” IEEE ISIE 2005, June 20-23, 2005, Dubrovnik, Croatia, Vol. II, pp. 559-564.

[10]. C. Klumpner, F. Blaabjerg, ”Short term braking capability during power interruptions for integrated matrix converter motor drives,” IEEE Trans. on Power Electronics, Vol. 19, No. 2, March 2004, pp. 303-311.

[11]. L. Helle, K.B. Larsen, A.H. Jorgensen, S. Munk-Nielsen, ”Evaluation of modulation schemes for three-phase to three-phase matrix converters,” IEEE Trans. Industrial Electroncs, Vol. 51, No. 1, pp. 158-171, February 2004

[12]. J.Igney, M. Braun, ” A New Matrix Converter Modulation Strategy Maximizing the Control Range,” PESC 2004, June 20-25, Aachen, Germany,Vol. 3, pp. 2875-2880

[13]. D. Casadei, G. Serra, A. Tani, L. Zarri, ”Effects of input voltage measurement on stability of matrix converter drive system,” IEE Proceedings on Electric Power Applications, vol. 151, No. 4, July 2004, pp. 487-497.

[14]. YanhuiXie, YongdeRen, ”Implementation of DSP-based three-phase AC- AC matrix converter,” Proc. of IEEE APEC ’04, vol. 2 , 2004, pp. 843 - 847..

[15]. D. Casadei, G. Serra, A. Tani, L. Zarri, ”Effects of the switching strategy on the input power quality of matrix converters,” IEEE Power Tech 2003, 23- 26 June 2003, Bologna, Italy, Vol. 1, 8 pp.

[16]. M. Apap, J.C. Clare, P.W. Wheeler, K.J. Bradley, ”Analysis and comparison of AC-AC matrix converter control strategies”, in Proc. IEEE PESC Conf., 2003, Vol. 3, pp. 1287-1292..

[17]. F. Blaabjerg, D. Casadei, C. Klumpner, M. Matteini, ”Comparison of two current modulation strategies for matrix converters under unbalanced input voltage conditions,” IEEE Trans. on IE, vol. 49, n. 2, April 2002, pp. 289- 296.

[18]. P.W. Wheeler, J. Rodriguez, J. C. Clare, L. Empringham, ”Matrix Converter. A technology review,” IEEE Transactions of Industrial Electronics, vol.49, no.2, April, 2002, pp. 276-288