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Power Quality Improvement using Fuzzy Logic Based Modular Multilevel Converter Applying Three Winding Transformer

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Abstract :

This paper proposes a new type of Modular Multilevel Converter (MMC) applying a three winding transformer. In general, MMC requires a buffer reactor in each arm, which increases number of components and converter footprint. The proposed MMC with three winding transformer does not require the buffer reactors.A modified multilevel fundamental switching modulation scheme adopting the multicarrier pulse width modulation concept is presented. A capacitor voltage balancing technique is proposed. This new type of converter is suitable for high-voltage drive systems and power sys-tem applications such as high voltage dc (HVDC) transmission, reactive power compensation equipment and so on.In order to verify the performance of the Modular Multilevel Converter, FUZZY LOGIC method is implemented in the project and the results are shown by using MATLAB/SIMULINK. The THD analysis is also performed.

I .INTRODUCTION

In the last decade, the electrical power quality issue has been the main concern of the power companies. Power quality is defined as the index which both the delivery and consumption of electric power affect on the performance of electrical apparatus. From a customer point of view, power quality problem can be defined as any problem is manifested on voltage, current, or frequency deviation that results in power failure. The power electronics progressive, especially in flexible alternating-current transmission system (FACTS) and custom power devices, affects power quality improvement. Generally, custom power devices, e.g., dynamic voltage restorer (DVR), are used in medium-to-low voltage levels to improve customer power quality. Most serious threats for sensitive equipment in electrical grids are voltage sags (voltage dip) and swells (over voltage). These disturbances occur due to some events, e.g., short circuit in the grid, inrush currents involved with the starting of large machines, or switching operations in the grid. The FACTS devices, such as unified power flow controller (UPFC) and synchronous static compensator (STAT-COM), are used to alleviate the disturbance and improve the power system quality and reliability. In this paper, a distributed power flow controller, introduced in as a new FACTS device, is used to mitigate voltage and current waveform deviation and improve power quality in a matter of seconds. The DPFC structure is derived from the UPFC structure that is included one shunt converter and several small independent series converters. The DPFC has same capability as UPFC to balance the line parameters, i.e., line impedance, transmission angle, and bus voltage magnitude. The DPFC principle is discussed. It is dedicated to power quality improvement by DPFC.

TRANSFORMER :

A Transformer is a device that transfers electrical energy from one circuit to another through inductively coupled conductors—the transformer's coils. A varying current in the first or primary winding creates a varying magnetic flux in the transformer's core and thus a varying magnetic field through the secondary winding. This varying magnetic field induces a varying electromotive force (EMF) or "voltage" in the secondary winding. This effect is called mutual induction.

If a load is connected to the secondary, an electric current will flow in the secondary winding and electrical energy will be transferred from the primary circuit through the transformer to the load. In an ideal transformer, the induced voltage in the secondary winding (Vs) is in proportion to the primary voltage (Vp), and is given by the ratio of the number of turns in the secondary (Ns) to the number of turns in the primary (Np) as follows:

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By appropriate selection of the ratio of turns, a transformer thus allows an alternating current (AC) voltage to be "stepped up" by making Ns greater than Np, or "stepped down" by making Ns less than Np.

Faraday performed the first experiments on induction between coils of wire, including winding a pair of coils around an iron ring, thus creating the first toroidal closed-core transformer.

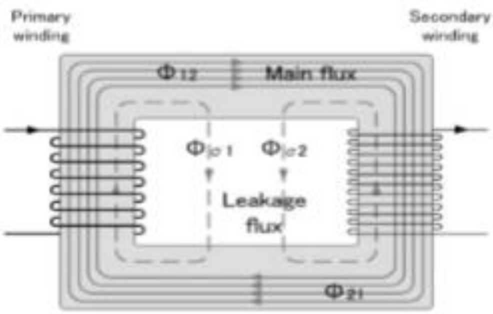
3.1.1 Basic principles

The transformer is based on two principles: first, that an electric current can produce a magnetic field (electromagnetism), and, second that a changing magn etic field within a coil of wire induces a voltage across the ends of the coil (electromagnetic induction).

Changing the current in the primary coil changes the magnetic flux that is developed. The changing magnetic flux induces a voltage in the secondary coil.

The changing magnetic field induces an electromotive force (EMF) across each winding.[31] Since the ideal windings have no impedance, they have no associated voltage drop, and so the voltages VP and VS measured at the terminals of the transformer, are equal to the corresponding EMFs.

The primary EMF, acting as it does in opposition to the primary voltage, is sometimes termed the "back EMF". This is due to Lenz's law which states that the induction of EMF would always be such that it will oppose development of any such change in magnetic field.



Single phase transformer

CONVERTER

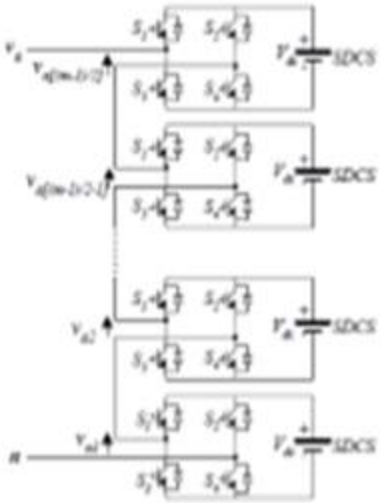
An electrical device that changes the form of an electric signal or power source, as by converting alternating current to direct current, or an analog signal to a digital signal. Compare rectifier, transformer. An electronic device that changes the frequency of a radio or other electromagnetic signal.

4.1.1 Cascaded H-Bridges Converter

A single-phase structure of an m-level cascaded converter is illustrated in Figure 31.1. Each separate dc source (SDCS) is connected to a single-phase full-bridge, or Hbridge converter. Each inverter level can generate three different voltage outputs, +Vdc, 0, and –Vdc by connecting the dc source to the ac output by different combinations of the four switches, S1, S2, S3, and S4. To obtain +Vdc, switches S1 and S4 are turned on, whereas –Vdc can be obtained by turning on switches S2 and S3. By turning on S1 and S2 or S3 and S4, the output voltage is 0. The ac outputs of each of the different full-bridge inverter levels are connected in series such that the synthesized voltage waveform is the sum of the inverter outputs. The number of output phase voltage levels m in a cascade inverter is defined by m = 2s+1, where s is the number of separate dc sources. An example phase voltage waveform for an 11-level cascaded H-bridge inverter with 5 SDCSs and 5 full bridges is shown in Figure 31.2. The phase voltage van = va1 + va2 + va3 + va4 + va5.

For a stepped waveform such as the one depicted in Figure 31.2 with s steps, the Fourier Transform for this waveform follows

$$V(\omega t)=\frac{4V_{dc}}{\pi}\sum_{n}\left[\cos(n\theta_1)+\cos(n\theta_2)+\ldots+\cos(n\theta_s)\right]\frac{\sin(n\omega t)}{n}, \quad \text{where } n = 1, 3, 5, 7, \ldots$$



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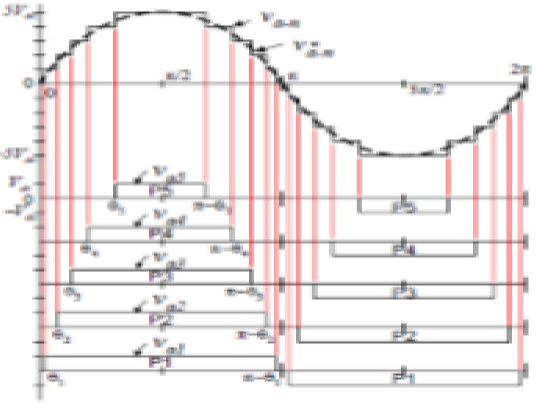
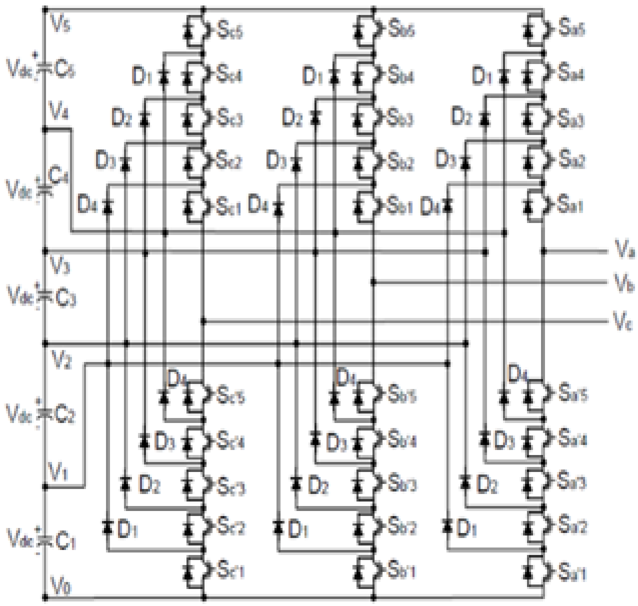


Output phase voltage waveform of an 11-level cascade converter with 5 separate dc sources.

Diode-Clamped Multilevel converter The neutral point converter proposed by Nabae, Takahashi, and Akagi in 1981 was essentially a three-level diode-clamped inverter [5]. In the 1990s several researchers published articles that have reported experimental results for four-, five-, and six-level diode-clamped converters for such uses as static var compensation, variable speed motor drives, and high-voltage system interconnections.

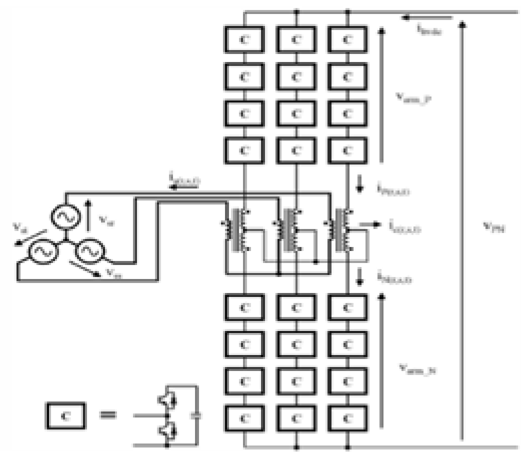
A three-phase six-level diode-clamped inverter is shown in Figure. Each of the three phases of the inverter shares a common dc bus, which has been subdivided by five capacitors into six levels. The voltage across each capacitor is Vdc, and the voltage stress across each switching device is limited to Vdc through the clamping diodes. Table lists the output voltage levels possible for one phase of the inverter with the negative dc rail voltage V0 as a reference. State condition 1 means the switch is on, and 0 means the switch is off.

Each phase has five complementary switch pairs such that turning on one of the switches of the pair requires that the other complementary switch be turned off. The complementary switch pairs for phase leg a are (Sa1, Sa'1), (Sa2, Sa'2), (Sa3, Sa'3), (Sa4, Sa'4), and (Sa5, Sa'5). Table also shows that in a diode-clamped inverter, the switches that are on for a particular phase leg is always adjacent and in series. For a six-level inverter, a set of five switches is on at any given time.



Three-phase six-level structure of a diode-clamped converter

OPERATION OF MUTILEVEL CONVERTER



This above block diagram shows modular multilevel converter applying three winding transformer. It consists of series connected half- bridge Converters and each converter consists of two IGBT'S and connected across the capacitor. This block diagram consists of 3-phase grid and two upper and lower arms three winding transformer. Multilevel refers converting of 3-phase ac voltage to dc voltage by number of levels in block diagram.

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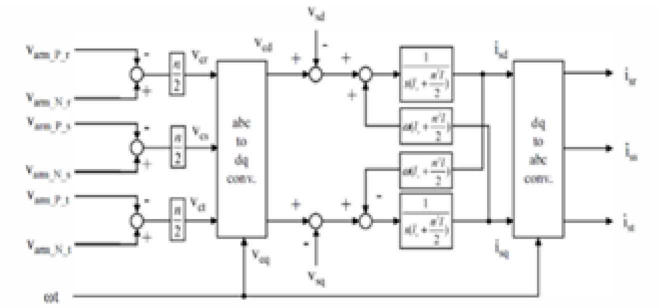
CONTROL CIRCUIT OF MODULAR MULTI LEVEL CONVERTER



During discharging period dc power is converted into ac power known as inverter operation hence input of the control circuit is dc. When the dc voltage is applied to by individual phases then the total voltage is divided by number of phases i.e. n/2.

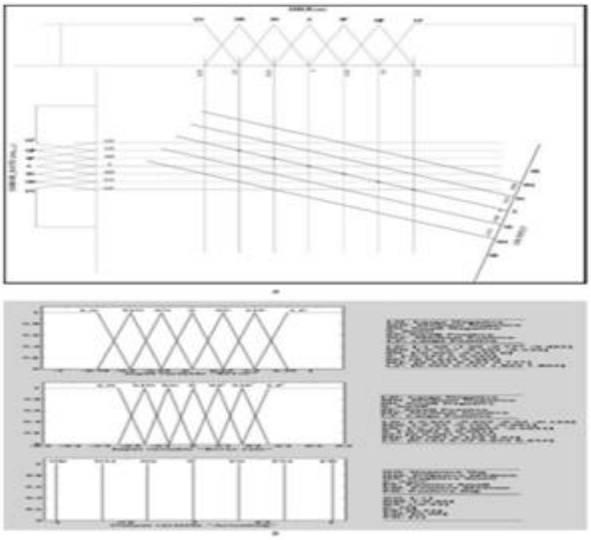
This voltage is given to parks transformation due to this transformation mathematical calculations are easy and also used to 3-phase supply is converted into 2-phase supply. After that the 2-phase supply again converted into 3-phase supply by varying the duty cycle in the controlling circuit i.e., less than 0.5,then converter acts as rectifier.

FUZZY LOGIC CONTROLLERS

7.1 INTRODUCTION TO FUZZY LOGIC:

The logic of an approximate reasoning continues to grow in importance, as it provides an in expensive solution for controlling know complex systems. Fuzzy logic controllers are already used in appliances washing machine, refrigerator, vacuum cleaner etc. Computer subsystems (disk drive controller, power management) consumer electronics (video, camera, battery charger) C.D. Player etc. and so on in last decade, fuzzy controllers have convert adequate attention in motion control systems.

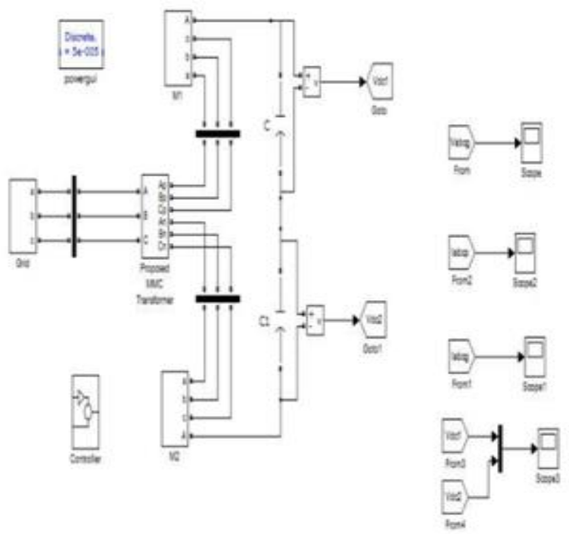
As the later possess non-linear characteristics and a precise model is most often unknown. Remote controllers are increasingly being used to control a system from a distant place due to inaccessibility of the system or for comfort reasons. In this work a fuzzy remote controllers is developed for speed control of a converter fed dc motor. The performance of the fuzzy controller is compared with conventional P-I controller.



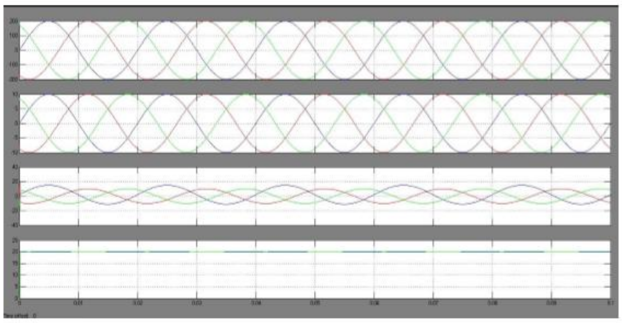
Fuzzy rules

SIMULATION AND RESULTS

8.1MATLAB/SIMULINK OF APPLIED THREE WINDING TRANSFORMER TO MULTILEVEL CON VERTER



Simulation Results Of Ac To Dc Conversion Without Fuzzy



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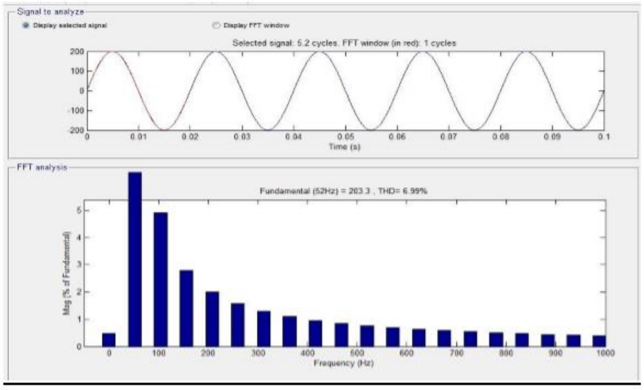
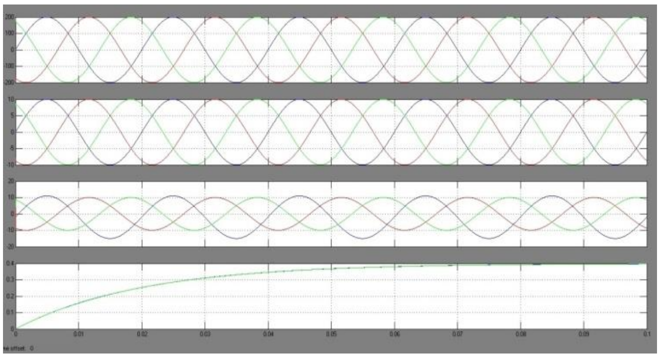
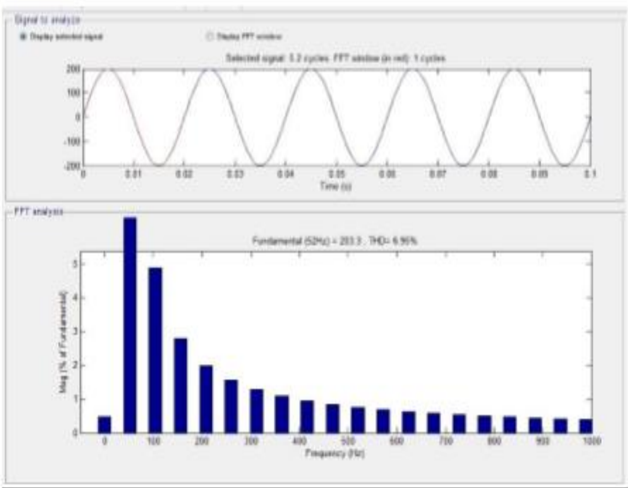
AC TO DC CONVERSION WITHOUT FUZZY-THD ANALASYS



AC TO DC CONVERSION WAVEFORMS WITH FUZZY



AC TO DC CONVERSION WITH FUZZY-THD ANALASYS



CONCLUSION

This work proposes a new type of Modular Multilevel Converter applying a three winding transformer. The proposed topology can merge buffer reactors into a grid connected transformer. In addition, this work described mathematical property of the proposed MMC with transformer and experimentation by 10kVA prototype shows the converter can operate as same as MMC with buffer reactors. Furthermore, it is described that it does not adversely affect the DC bias magnetism at the transformer to merge buffer reactor into a grid connected transformer and the proposed MMC with three winding transformer does not require a special transformer.

In order to verify the performance of the Modular Multilevel Converter, FUZZY LOGIC method is implemented in the project and the results are shown with the help of THD analysis.

References

[1] Lesnicar. A, Marquardt. R, "A new modular voltage source inverter topology", EPE 2003, 105, 2003.

[2] Lesnicar. A, Marquardt. R, "An innovative modular multilevel converter topology suitable for a wide power range," Power Tech Conference Proceedings, 2003 IEEE Bologna, vol. 3, 2003.

[3] Hagiwara. M, Akagi. H, "Control and Experiment of PulsewidthModulated Modular Multilevel Converters," IEEE Trans. on Power Electronics, vol. 24, no. 7, pp. 1737-1746, 2009.

[4] Antonopoulous. A, Angquist. Lennart, Nee. H.-P, "On dynamics and voltage control of the Modular Multilevel Converter", EPE2009,2009.

[5] Angquist, L, Antonopoulos. A, Siemaszko. D, lives. K, Yasiladiotis. M, Nee. H.-P., "Inner control of Modular Multilevel Converters - An approach using open-loop estimation of stored energy", International Power Electoronics Conference 2010, pp.1579-1585, 2010.

[6] lives. K, Antonopoulos. A, Norrga. Staflan, Nee. H.-P, "SteadyState Analysis of Interaction Between Harmonic Components of Arm and Line Quantities of Modular Multilevel Converters", IEEE transactions on Power Electronics, vol. 27, no. 1, pp.57-68, 2013

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

[7] Rohner. S, Bernet. S, Hiller. M, Sommer. R, "Modulation, Losses, and Semiconductor Requirements of Modular Multilevel Converters," IEEE Trans. on Industrial Electronics, vol. 57, no. 8, pp. 2633-2642, 2009.

[8] Munch. P, Gorges. D, Izak. M, Liu. Steven, "Integrated Current Control, Energy Control and Energy Balancing of Modular Multilevel Converters," IECON 20l0s, pp. 150-155, 2010