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DESIGN AND IMPLEMENTATION OF NEW TOPOLOGY OF THREE PHASE FIVE LEVEL CASCADED INVERTER

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Abstract— *In this paper a brief review on different cascaded inverter topologies are discussed. Inverter is a power electronic device that converts DC power into AC power at desired output voltage and frequency. Inverters nowadays have become an interesting area in the field of industrial applications. Conventional power electronic converters are able to produce an output voltage that switches between two voltage levels only. Cascaded Inverter generates a desired output voltage from several DC voltage levels at its input. The input side voltage levels are usually obtained from renewable energy sources, capacitor voltage sources, fuel cells etc. The disadvantages of cascaded inverter is it has an huge increase in output voltage hence it requires extra voltage controlers which intern increases in cost.*

Keywords— *Cascaded multilevel inverter, THD.*

INTRODUCTION:

The development of new technologies and devices during the 20th century enhanced the interest in electric power systems. Modern civilization based is operation on an increasing energy demand and on the substitutions of human activities with complex and sophisticated machines; thus, studies on electric power generation and conversion devices become every day more and more important.
The recent attention in environment protection and preservation increased the interest in electrical power generation from renewable sources: wind power systems and solar systems are diffusing and are supposed to occupy an increasingly important role in world-wide energy production in coming years.
Not only house utilities, but industrial applications and even the electrical network requirements display the importance that energy supply and control will have in the future researches.
As a consequence, power conversion and secondly control is required to be reliable, safe and available in order to accomplish all requirements, both from users and legal regulations, and to reduce the environmental impact.
Voltage Source Converter (VSC) technology is becoming common in high-voltage direct current (HVDC) transmission systems (especially transmission of offshore wind power, among others). HVDC transmission technology is an important and efficient possibility to transmit high powers over long distances.
The vast majority of electric power transmissions were three-phase and this was the common technology widespread. Main advantages for choosing HVDC instead of AC to transmit power can be numerous but still in discussion, and each individual situation must be considered apart. Each project will display its own pro and con about HVDC transmission, but commonly these advantages can be summarized: lower losses, long distance water crossing, controllability, limitation short circuit currents, environmental reason and lower cost.
One of the most important advantages of HVDC on AC systems is related with the possibility to accurately control the active power transmitted, in contrast AC lines power flow can't be controlled in the same direct way.
However conventional converters display problems into accomplishing requirements and operation of HVDC transmission. Compared to conventional VSC technology, Modular Multilevel topology instead offers advantages such as higher voltage levels, modular construction, longer maintenance intervals and improved reliability.

A multilevel approach guarantees a reduction of output harmonics due to sinusoidal output voltages: thus grid filters become negligible, leading to system cost and complexity reduction. Like in many other engineering fields, modular and distributed systems are becoming the suggested topology to achieve modern projects requirements: this configuration ensure a more reliable operation, facilitates, diagnosis, maintenance and reconfigurations of control system. Especially in fail
Multilevel inverter converters several DC voltages to desired level output voltage. To convert square wave voltage to sinusoidal voltage it reqires large size filters at output of inverter..Multilevel inverter yields output voltage which is nearly equal to sinusoidal which reduces size of filter used at output of inverter.
Single phase two level inverter gives square wave output which contains harmonics of 48% and also conversion of square wave to sine wave requires large size filters. Multilevel inverter like diode clamped multilevel inverter requires more

numbers of diodes which leads to more switching losses. The cascaded multilevel inverter will generates step wave which is nearer to sine wave which leads to lesser size filter with reduced number of switches.

Thus the attractive features can be summarized as follows
1. Reduced harmonic distortion
2. Higher no. of voltage level
3. Staircase waveform quality
4. Lower switching losses

Table 1: The difference between a 2-level and a 3- level inverter

Sl. No	Conventional Inverter	Cascaded Inverter
1	THD is high in the output waveform	THD is Low in the output waveform
2	High Switching stresses	Low Switching stresses
3	Not used for high Used for high voltage Voltage applications	Used for high voltage applications
4	High voltage levels cannot be produced	High voltage levels can be produced
5	High dv/dt and EMI	Low dv/dt and EMI
6	High switching frequency, increased switching losses	Lower switching frequency, reduced switching losses

SINGLE PHASE FIVE LEVEL CASCADED INVERTER:

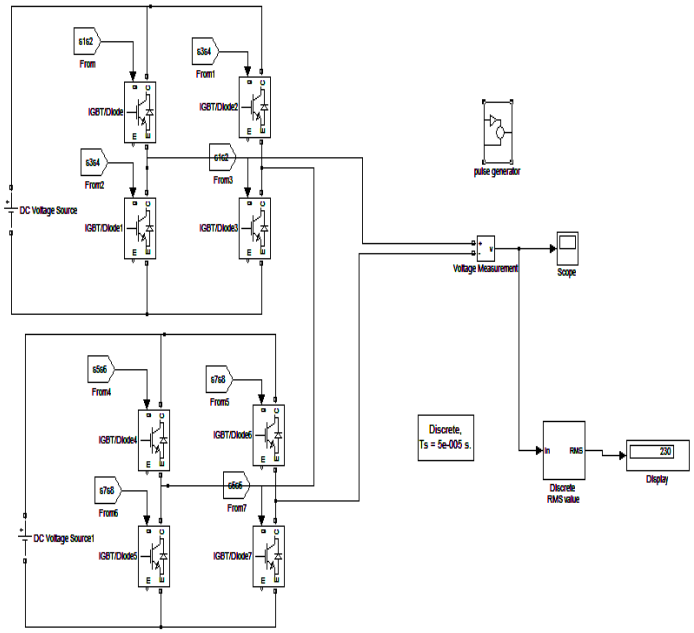

Figure 1. Single phase Five level inverter without filter.

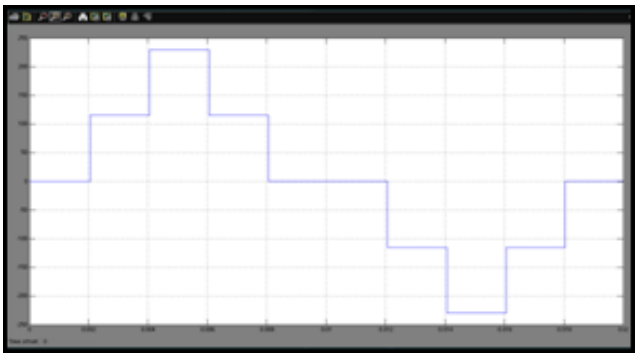

Figure 2. Output voltage waveform of single phase five level inverter without filter

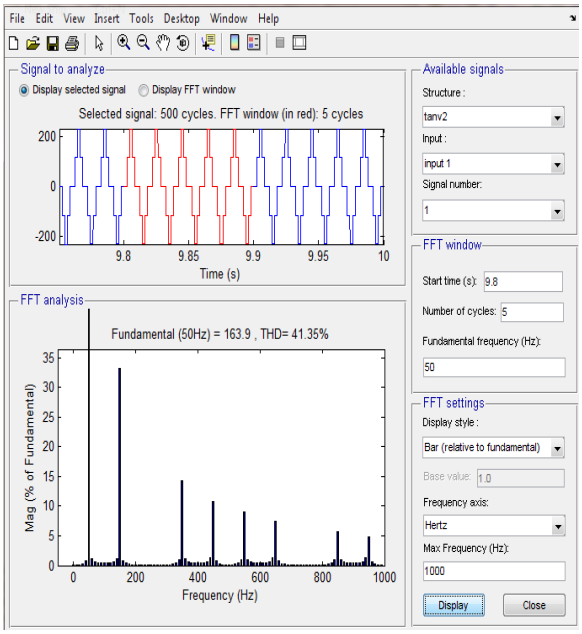

Figure 3. FFT analysis of single phase five level inverter without filter

In five level cascaded inverter output voltage is step wave (+V, +2V, 0, -V, -2V). From the FFT analysis it is observed that output voltage contains lesser harmonics then two level inverter THD=41.35%.

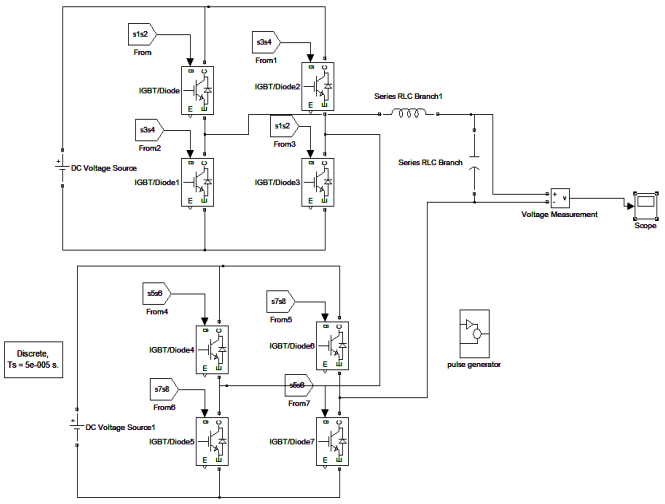

Figure 4. Single phase five level inerter with filter.

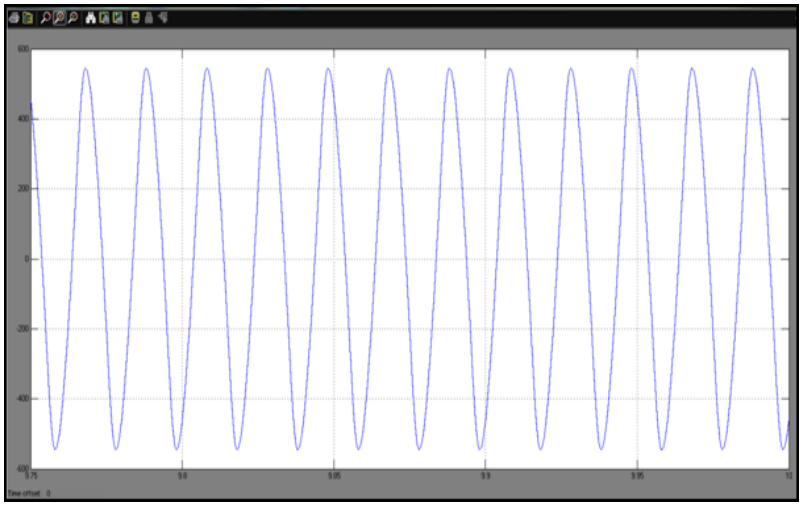

Figure 5. Output voltage waveform of single phase five level cascaded inverter with filter

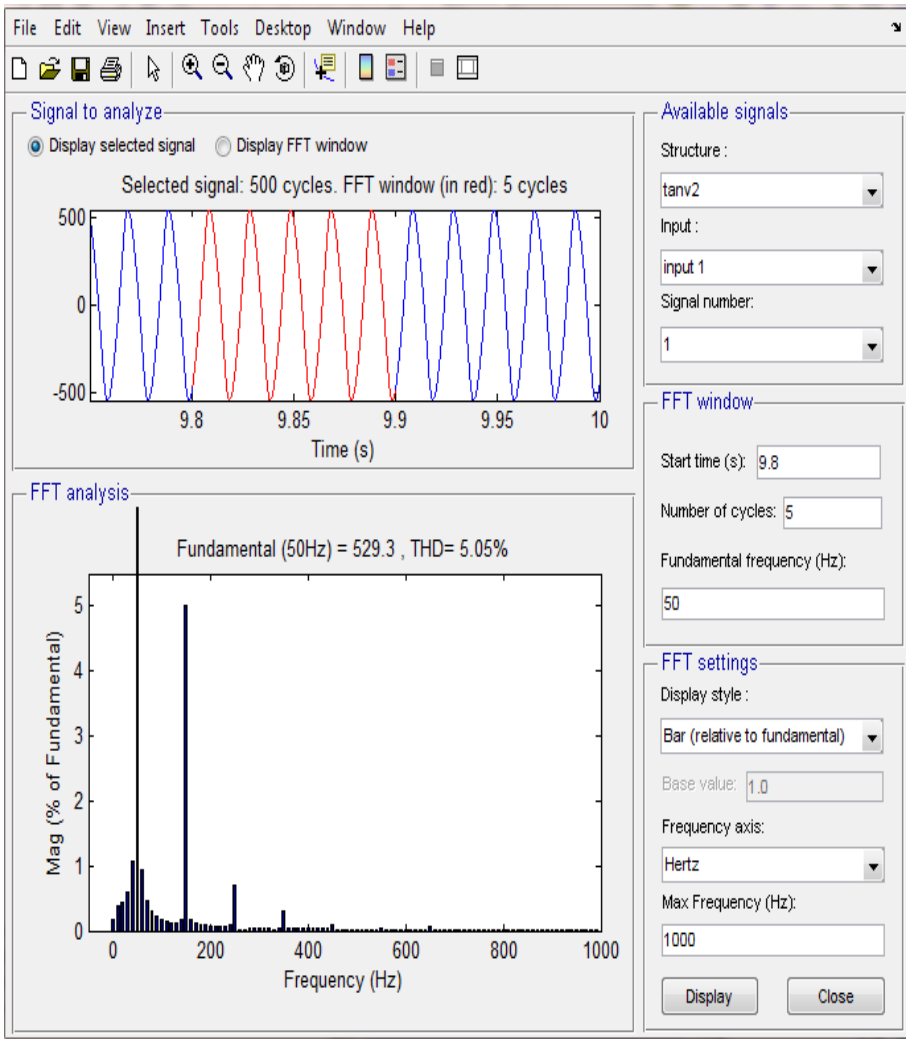

Figure 6. FFT analysis of single phase five level cascaded inverter with filter.

In five level cascaded converter with filter output voltage is sine wave. From the FFT analysis it is observed that output voltage contains lesser harmonics than two level inverter and THD=5.05%

THREE PHASE FIVE LEVEL CASCADED INVERTER WITHOUT FILTER

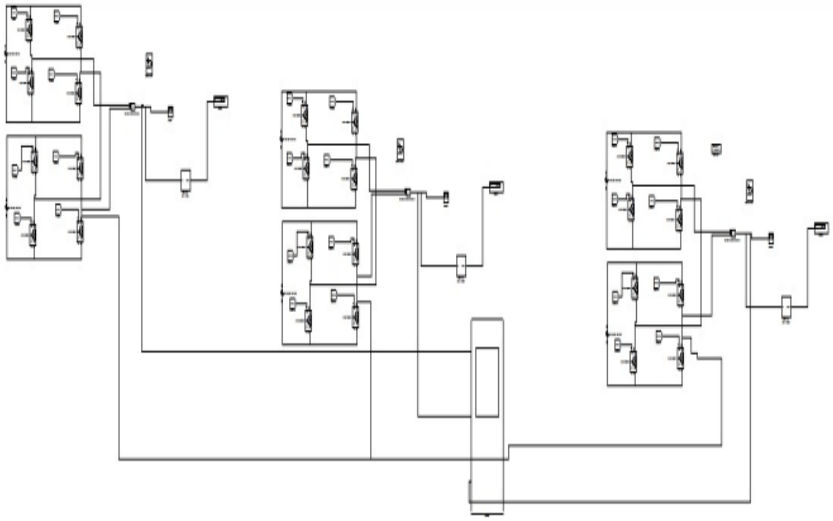

Figure 7. Three phase five level cascaded inverter

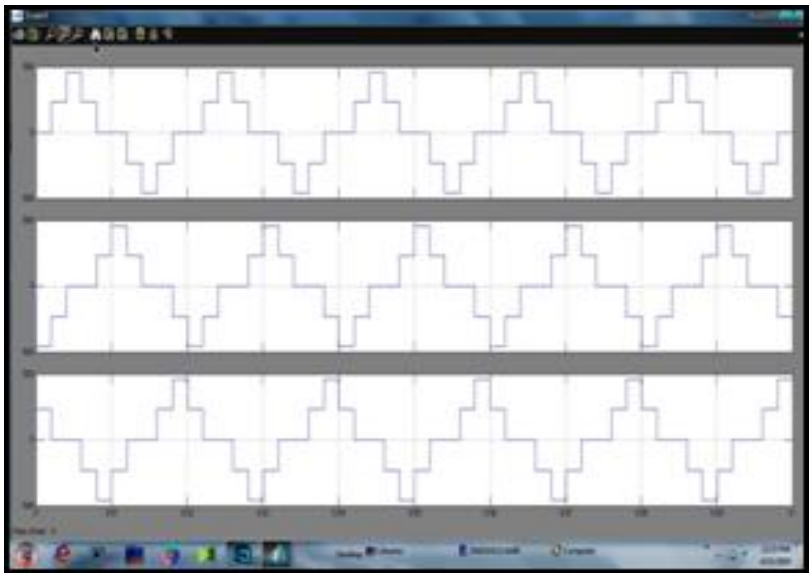

Figure 8. Output waveform of three phase five level cascaded inverter

In five level multi modular inverter with filter the output voltage sine wave. From the FFT analysis it is observed that output voltage contains lesser harmonics than two level converter and THD=3.73%

ADVANTAGES:

1. The regulation of DC buses is simple.

2. Modularity of control can be achieved. Unlike the diode clamped capacitor clamped inverter where the individual phase legs must be modulated by a central controller, the full-bridge inverters of a cascaded structure can be modulated separately.

3. Requires the least number of components among all multilevel converters to achieve the same number og voltage levels.

4. Soft-switching can be used in this structure to avoid bulky and loss resistor-capacitor-diode snubbers.

CONCLUSION:

From comparison it is observed that five level cascaded multi level inverter has control over the output voltage with lesser harmonics (within 5% which is acceptable according to IEEE standards) with lesser size filter and without pwm technique. Hence cascaded multi level inverter is preferred for any single phase AC application.

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