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Eleven level multilevel inverter with reduced number of switches for high power applications

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***Abstract* - The current research is concerned with the investigation and analysis of three-phase multilevel inverters, as well as their various topologies and combinations. The primary goal of our research is to investigate modulation strategies and to compare them with one another, while also evaluating their benefits and drawbacks. Because of their functionality, their applications have been studied in detail; a case in point is the cascaded inverter, which can also work as a rectifier/charger for the batteries of an electric car when the vehicle is linked to an alternating current source. Despite the fact that we have examined a large number of topologies and modulation techniques, there are many more that may be identified. This project also has the added purpose of introducing innovations that will allow for a reduction in the number of independent voltage sources and sensors. This is particularly critical in high power quality cascaded multilevel inverters, which need a variety of voltage sources as well as an understanding of the various dc voltage levels.**

***Keywords:* Inverter, Topologies, Madulation, THD, DC Voltage , Electric car.**

I INTRODUCTION

In recent years, an increasing number of industrial applications have come to need the use of higher-capacity equipment. Some medium voltage motor drives and utility applications demand medium voltage and megawatt power levels, whereas others just require low voltage. It is difficult to connect just one power semiconductor switch directly to a medium voltage grid because of the high voltage. As a consequence, in high power and medium voltage conditions, a multilayer power converter structure has been presented as an option. It is possible to employ renewable energy sources because of the high power ratings achieved by a multilayer converter.

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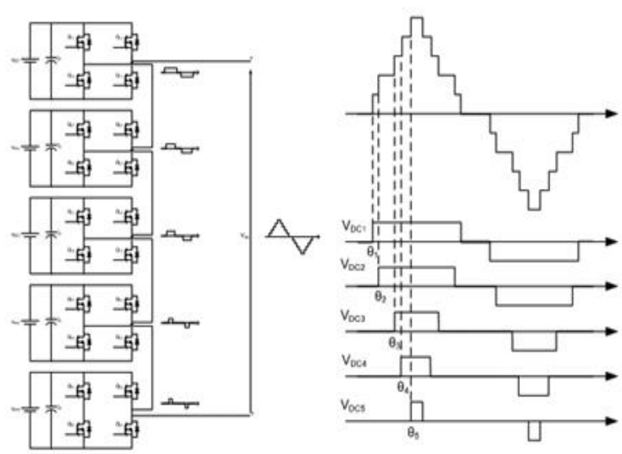

Figure 1: Multilevel Inverter concept

A multilayer converter system may readily connect with renewable energy sources such as photovoltaic, wind turbines, and fuel cells to provide high power for a high-power application. Multilevel converters have been in use since 1975, when the idea was first proposed. The three-level converter is credited with introducing the word "multilevel." Several multilevel converter topologies have been created as a result of this research.

II LITERATURE REVIEW

One of the most significant differences between a two-level voltage source inverter (VSI) and a power converter is the number of voltage levels available, which is seen schematically in Figure. Multilevel inverters, in contrast to two-level voltage stabilisers, which can produce just two amount of output, theoretically, are capable of creating an infinite number of voltage levels. There are a total of 3 voltage levels available on the multilayer inverters.

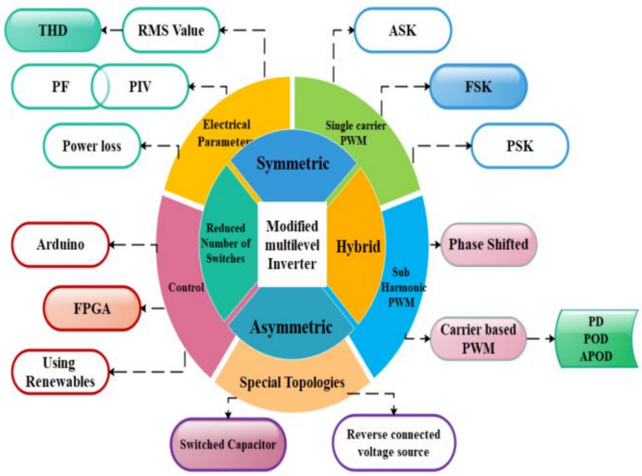

Figure 2: Review of MLIs

The quality of a power converter is determined by the quality of the waveforms produced by its voltage and current. Total harmonic distortion (THD) is a word that may be used to describe the measurement of harmonic spectra (THD).Within a multilayer inverter system, the most important criteria to consider is the reduction of harmonic components in the output voltage and current of the inverter. THD might be reduced by utilizing of levels in the voltage output, which could be accomplished via the use of certain control schemes or filter designs. The lower the total harmonic distortion (THD) value, the higher the power quality.

III **ELEVEN LEVEL INVERTER**

In this section, the reduced component count multilevel inverters are presented. A new topology for the elevenlevel inverter is proposed and its modulation methods are also discussed. Among all the types of inverter circuits, the cascaded based structures are simple and effective. Hence, in this work the cascaded based topologies are proposed.

A Conventional 11 level inverter

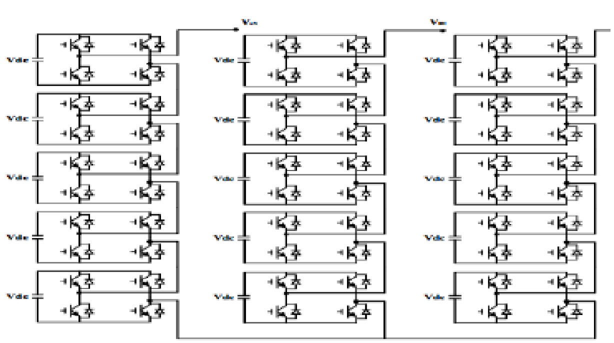

Figure 3: Eleven level conventional MLI

The eleven level MLI consists of

- Four H bridges
- Four DC sources
- Single load
- Each bridge consists of four switches
- Each switch consists of a diode in parallel to it

Following are the simulation diagrams of conventional elevenlevel MLI.

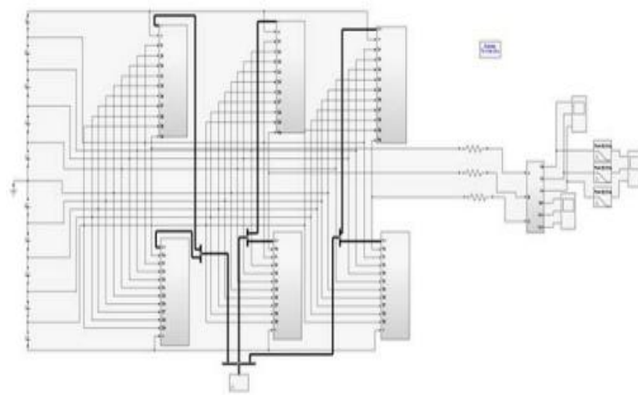

Figure 4 : With Resistive Load

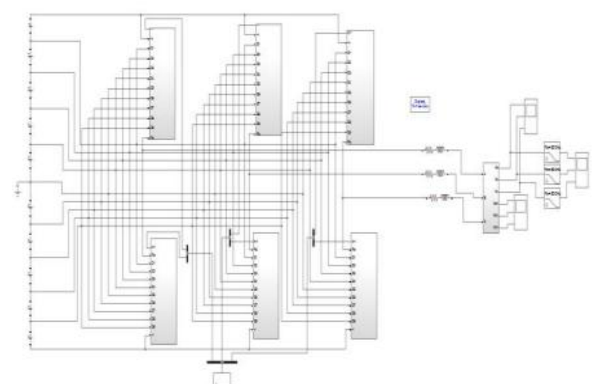

Figure 5: With Inductive Load

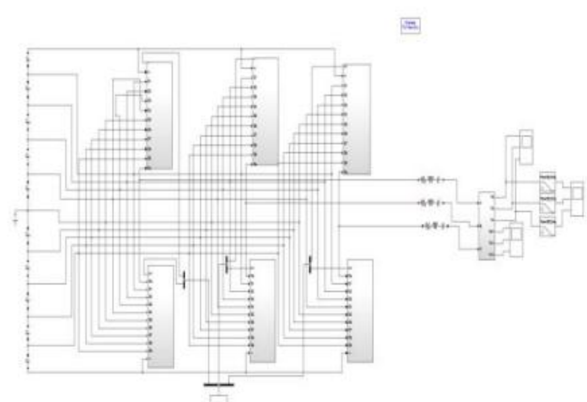

Figure 6: RLE Load.

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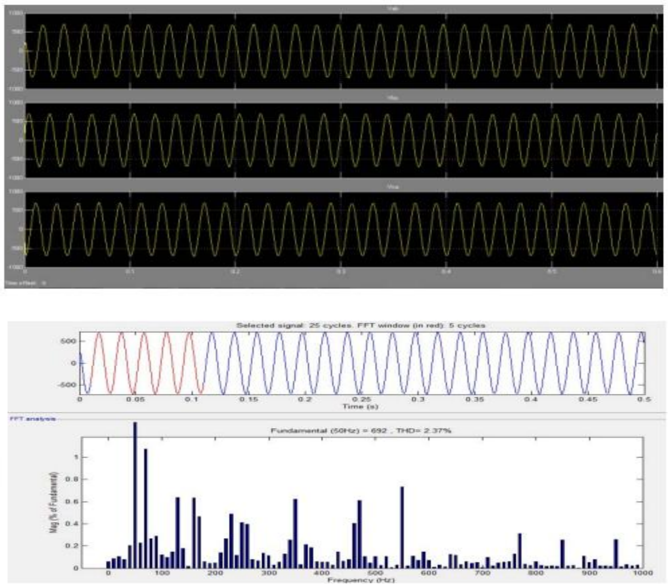

Figure 7: Output wave and THD with resistive load

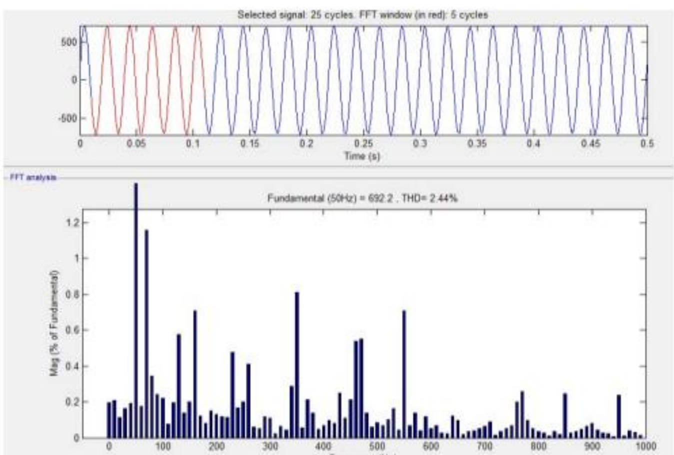

Figure 8: Output wave with RL load

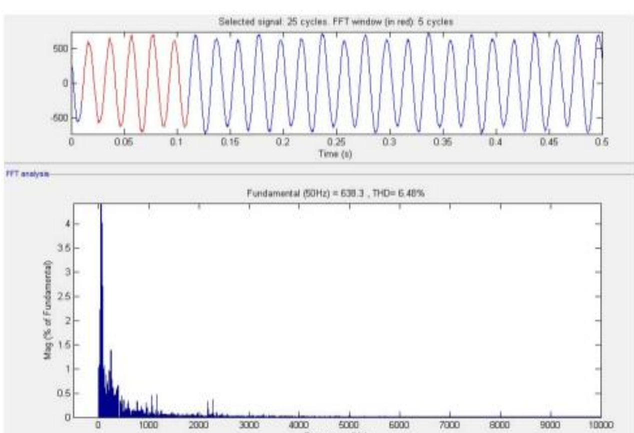

Figure 9: For RLE load

Following table gives the list of simulation parameters.

Voltage	350 V (Line to Line)
Nominal Power	3730 W
Frequency	50 Hz
Pole Pair	2
Torque	3 N-m
Speed	1500 RPM
Rotation Inertia	0..02 Kg-m^2
Stator Resistance(R_s)	1.115 Ω
Rotor Resistance(R_r)	1.083 Ω
Stator Inductance (L_s)	0.005974 H
Rotor Inductance (L_r)	0.005974 H
Mutual Inductance (L_m)	0.2037 H

The table below shows the THD values of various waveforms. From the table it is clear that The THD is less with R load. THD is almost same with inductive and motor loads.

LOADS	THD (%)
R	2.37
RL	2.44
RLC	2.44
RLE LOAD LINE VOLTAGE 1	6.48
RLE LOAD LINE VOLTAGE 2	5.99
RLE LOAD LINE VOLTAGE 3	5.99

IV SIMULATION RESULTS

In this section, the simulation results of the proposed eleven level inverter are shown. All the simulations are carried out in MATLAB/SIMULINK.

Following are the specifications of the inverter:

Voltage: 2500

Power: 1KW

Frequency: 50Hz

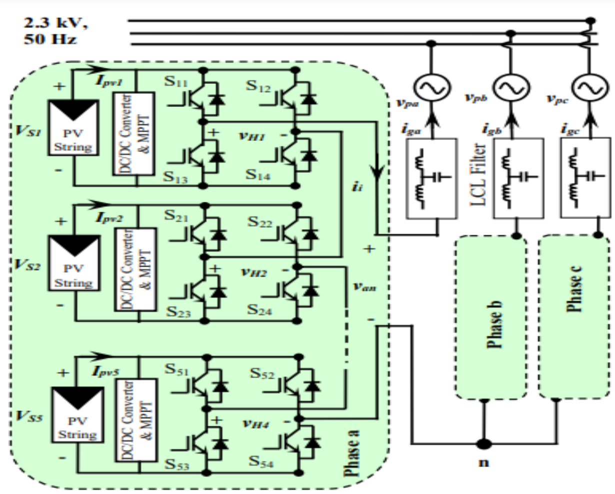

Figure 10: Block diagram of conventional inverter inverter

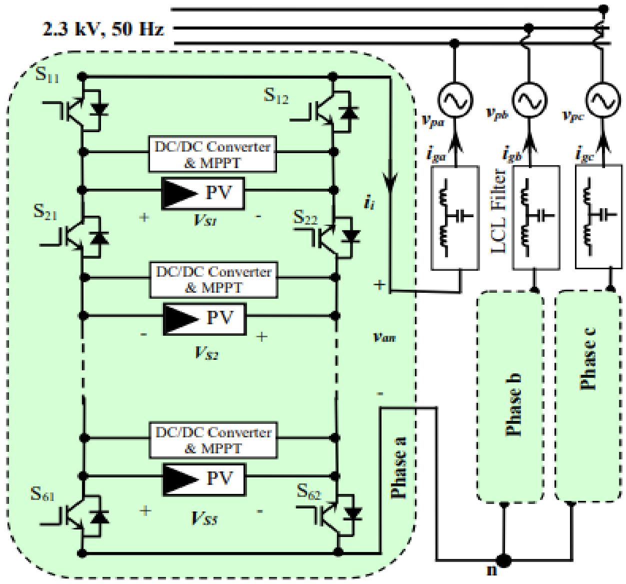

Figure 11: Block diagram of proposed MLI.

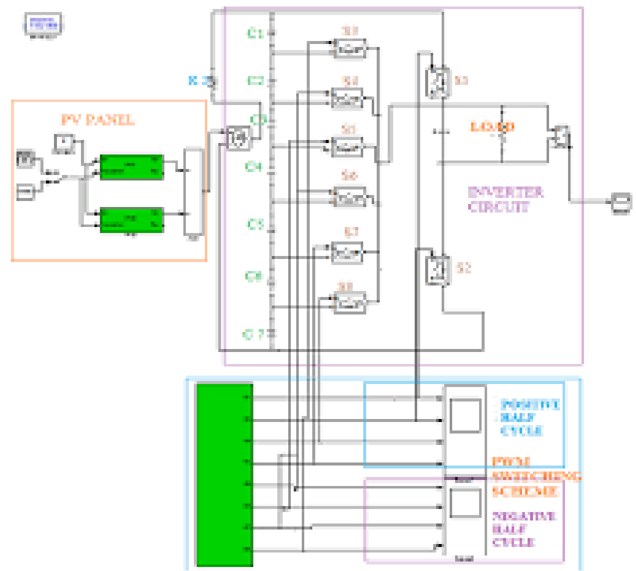

Figure 13: MATLAB Circuit

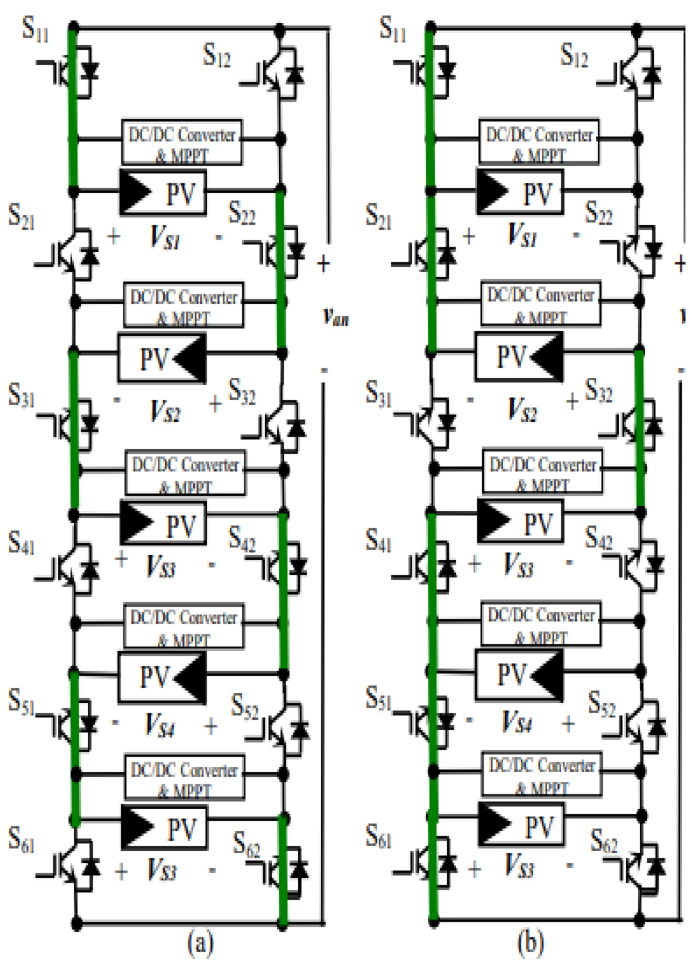

Figure 12: Switching states.

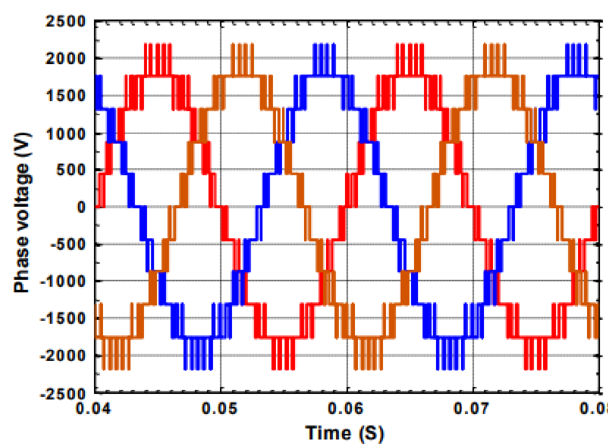

Figure 14: Output voltage waveform.

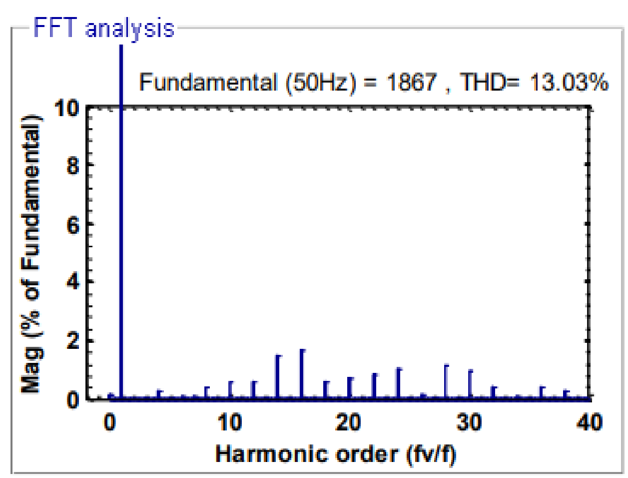

Figure 15: FFT analysis of Output voltage.

From the FFT analysis of the output voltage, the THD of the proposed inverter is 13.03%. This THD is very less than the THD that is obtained by conventional topology.

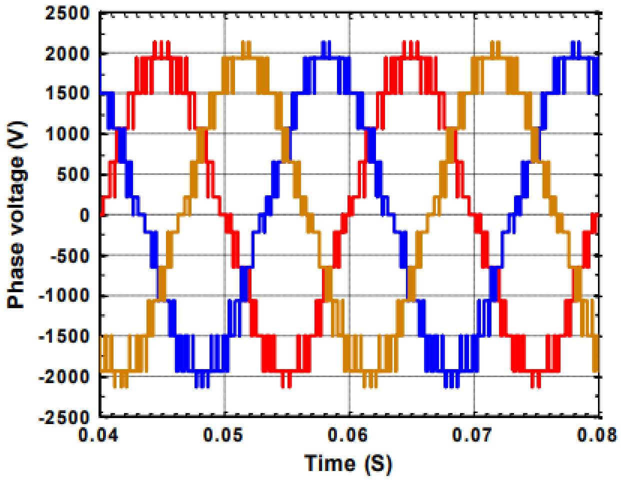

Figure 16: Output Phase voltage

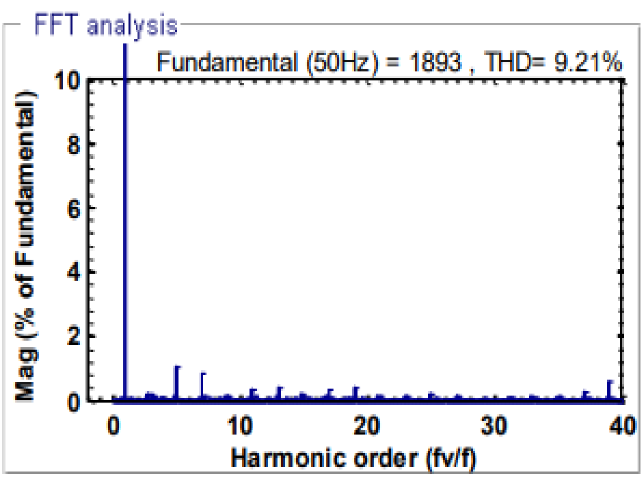

Figure 17: FFT analysis of phase voltage

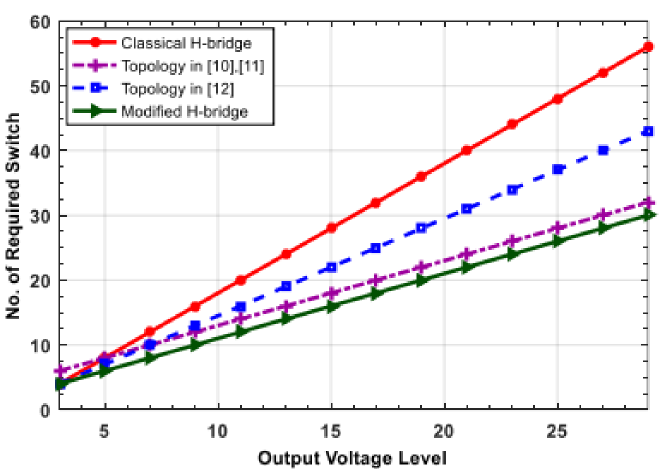

Figure 18: Comparison of various topologies.

The above figure shows the comparison of various topologies, with the proposed topology. The number of switches used with the proposed topology is less compared with the other topologies existing in the literature.

Conclusion

Following are the conclusions made from the work carried out

A eleven level reduced count multilevel inverter is proposed
The inverter is designed in SIMULINK.
The inverter is controlled using SPWM.

Future Scope

The future scope of the project is

The advance controlled technique can be implemented.
The power modules can be analyzed
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