

# Designing and Simulation of Five Level Three Phase Inverter with Proper Isolation

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**Abstract** - This paper proposes three phase multi level H-bridge inverter system. This proposed inverter is based on five level topology which ensure harmonics reduction. A proper designed capacitor based voltage divider system reduces number of switches. By using isolation transformer input side each phase inverter and output of the system has isolated. This proposed inverter ensure about balanced three phase output with equal phase differences between each phases.

**Key Words:** H-bridge topology, harmonics reduction, capacitor based voltage divider system, isolation.

## 1. INTRODUCTION

For converting DC to AC one of the most efficient way is inverter. Using solid state devices in the inverter efficiency and accuracy of the waveform is increased. Major problem in an inverter is harmonics which affects the output of the system. Mainly the two process employed to reduces the harmonics are pulse width modulation (PWM) and Multi level topology. Main drawback of PWM is it reduces the magnitude of output voltage. In this project multilevel topology has introduced for harmonics reduction and improvement of output waveform. Multilevel topology gives the better waveform than a conventional output of a inverter. Inverter is designed on five levels. A capacitor based voltage divider system reduces the number of voltage source in the input. It can works only by a single voltage source. Three phase equipments are more efficient than single phase equipments [2]. A three phase motor starting current is lower than a single phase motor [2]. Most of the industry prefers three phase motor for its better performance. Nowadays properly energy consumption is very essential. By using three phase equipments it is possible to reduces losses. Everywhere three phase supply is not available. To run three phase equipment from a DC supply this inverter is suitable. Nowadays solar system is much more concentrated for electrical power generation. Three phase power generation is preferred more for its advantages. Solar panel output is DC. By using this proposed inverter it is possible to generate three phase AC power. This proposed inverter frequency is independent of load. Three phase inverter is designed by a combination of three single phase inverter isolated each other by a isolation transformer. By using isolation transformer load can be isolated from the inverter. In the isolation transformer three isolated primary and three isolated secondary winding is present. Star or delta connection does not create any effect

on the output voltage because isolation has given between inverter and load.

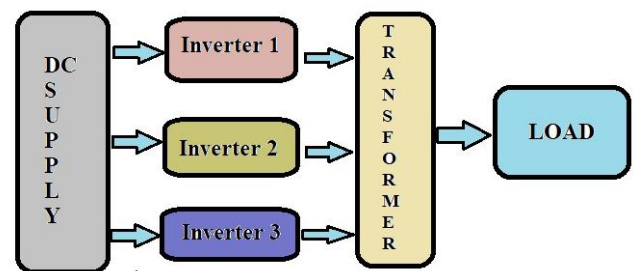


Fig -1: Block diagram of the system

## 2. WORKING OF THE SYSTEM

The proposed three phase inverter is based on three single phase inverter having same type of power circuit and different control circuit for each phase. Series connected capacitor bank works as a voltage divider circuit. For increasing the rating of the inverter capacitor rating should be increased otherwise it should effect on the output voltage magnitude and accuracy. For equal voltage division value of two capacitors must be same. For voltage divider system no need to connect additional voltage source. The diode bridge makes the adjacent switch bidirectional and reduces the number of switches of the inverter. Proposed H- bridge topology ensures the current flow in both direction of the load. Pulse for each switches are generated from a controller, so output frequency of the inverter is independent of the load. The proposed inverter is able to supply AC power to any type of load. In this type of inverter it is very difficult to find out the neutral point because at an instant same voltage is not possible for three inverter -ve point. In a transformer induced voltage is dependent on the flux and the flux is dependent on the current through the winding. By using this topology three isolated primary windings on a same core has been proposed. Secondary winding are placed by 120 degree lagging and leading so it is possible to get three phase output from the secondary. It is also possible to get a common neutral point for star connection which was a great difficulty without using the transformer. Control logic shows the conduction path of the current for that different voltage can be applied to the load terminal.

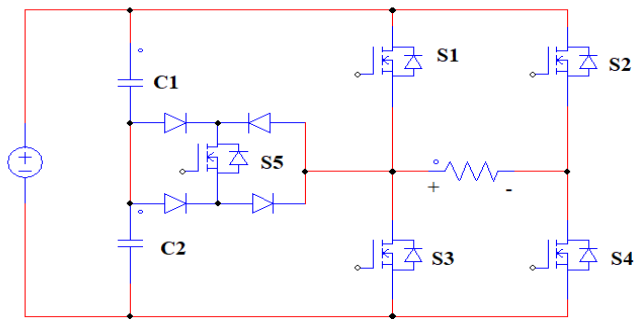


Fig-2: Schematic diagram for each phase

Table -1: control logic for phase 1

Phase angle	S1	S2	S3	S4	S5	Output (Volt)
0-45	0	0	1	1	0	0
45-90	0	0	0	1	1	$V_{DC}/2$
90-135	1	0	0	1	0	$V_{DC}$
135-180	0	0	0	1	1	$V_{DC}/2$
180-225	0	0	1	1	0	0
225-270	0	1	0	0	1	$-V_{DC}/2$
270-315	0	1	1	0	0	$-V_{DC}$
315-360	0	1	0	0	1	$-V_{DC}/2$

Control logic of phase 2 ensure about the phase difference of 120 degree lag from phase1 and 120 lead from phase 3.

Table -2: control logic for phase 2

Phase angle	S1	S2	S3	S4	S5	Output (Volt)
0-30	0	1	0	0	1	$-V_{DC}/2$
30-75	0	1	1	0	0	$-V_{DC}$
75-120	0	1	0	0	1	$-V_{DC}/2$
120-165	0	0	1	1	0	0
165-210	0	0	0	1	1	$V_{DC}/2$
210-255	1	0	0	1	0	$V_{DC}$
255-300	0	0	0	1	1	$V_{DC}/2$
300-345	0	0	1	1	0	0
345-360	0	1	0	0	1	$-V_{DC}/2$

Control logic of phase 3 ensure about 120 degree lagging from phase 2 and 240 degree lagging from phase 1

Table -3: control logic for phase 3

Phase angle	S1	S2	S3	S4	S5	Output (Volt)
0-15	1	0	0	1	0	$V_{DC}$
15-60	0	0	0	1	1	$V_{DC}/2$
60-105	0	0	1	1	0	0
105-150	0	1	0	0	1	$-V_{DC}/2$
150-195	0	1	1	0	0	$-V_{DC}$
195-240	0	1	0	0	1	$-V_{DC}/2$
240-285	0	0	1	1	0	0
285-330	0	0	0	1	1	$V_{DC}/2$
330-360	1	0	0	1	0	$V_{DC}$

#### 4. RESULT AND DISCUSSION

This proposed system is able to supply three phase AC from a DC source. Output of the inverter ensure about the proper phase difference. Inverter output ensure about equal voltage in each phase. In failure of voltage generation in any phase does not affect the other phase voltage generation because each phase are isolated. In highly loaded condition due to transformer inductive effect output waveform is filtered which reduces the cost of filter circuit and simplified the system. The output waveform is looks like sine wave. This output can able to drive any three phase load. The proposed inverter is simulated at a MATLAB "Simulink". The transformer works as a isolation which not only isolate the primary and secondary it also isolates the each inverters connects in the primary side. By using the proposed topology if any fault occurs in any phase it will easier to find out the fault. It has been observed that failure in any phase does not affect on the other phases output.

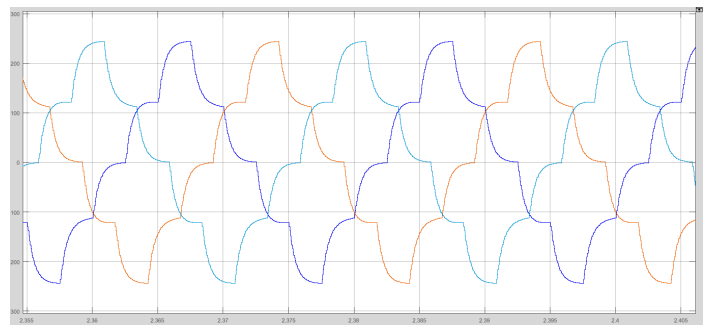


Fig-3: Output of the inverter

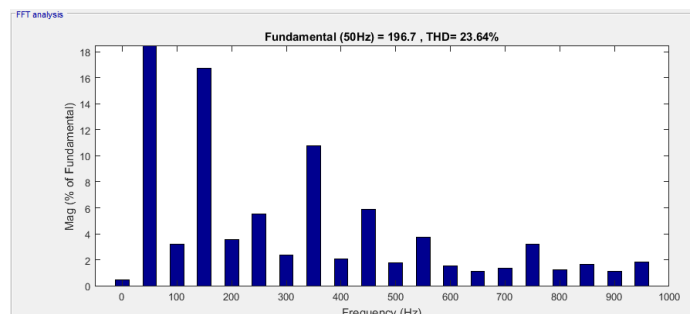


Fig-4: FFT analysis of the output

Most of the three phase loads are the induction motor. In case of inverter feed system harmonics is the major problem. Harmonics affects the output if the motor. To find out the harmonics contain in a wave FFT has used. After FFT of output wave Total Harmonic Distortion (THD) is 23.64%.

#### 5. CONCLUSION

This paper proposes a design and simulation of three phase five level H-bridge inverter. In this inverter voltage divider system is build by series capacitors. Nowadays renewable energy are more concentrated. Three phase Power generation using PV array can be possible by using this proposed inverter. This inverter can also be used as a

battery powered electric drive. In future by adding PWM and filter circuit it can be connected to the grid. For future development if a three phase capacitor bank can be added with the output of the inverter it will filtered the output and also improve the power factor of the system. Isolation transformer between load and the inverter is also works in protection purpose. Low THD of the inverter ensure about better performance of the equipment connect to the output of the inverter.

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