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## New Approaches for Harmonics Reduction in Solar Inverters

### Abstract

This paper analyzes and compares two approaches for dc to ac power conversion. First approach uses cascaded H-Bridge Inverter and second uses new Multi-level Scheme having Level Modules and H-Bridge. The simulation is done in SIMULINK/MATLAB Software. The Total Harmonic Distortion in output load voltage. It is shown that THD produced in second scheme is better up to a certain stages of the first scheme.

**Keywords:** *H-Bridge Inverter, Harmonic Distortion, dc to ac power conversion*

## 1. INTRODUCTION

Rising fuel costs, increasing concerns for global climate change and a growing worldwide demand for electricity has led to global effort towards increasing use of renewable energy sources such as solar, wind, biomass etc. In case of solar PV the energy is harnessed in dc form. This dc power is converted into ac form and then fed to the grid or used in isolated load. Various methods are available for dc to ac conversion. Multilevel Inverters have gained popularity in recent times. The power quality gets increasingly better with the number of levels in the output wave. Two approaches for dc to ac conversion are discussed in this project.

- A. Cascaded H Bridge Inverter
- B. New Multilevel Approach

## 2. CASCADED H BRIDGE INVERTER

Conventional cascaded multilevel inverter is one of the most important topologies in the family of multilevel and multi-pulse inverters. The cascade topology allows the use of several levels of DC voltages to synthesize a desired AC voltage. The DC levels are considered to be identical since all of them are fuel cells or photovoltaic, batteries, etc. H-Bridge Inverter consists of four switches, a dc source and a load (Isolated or Grid) across the two arm of H-Bridge. Each switch conducts for a period of  $180^\circ$ . The gate pulses for diagonal switches are identical.

A cascaded multi-level inverter consists of a number of H-Bridge inverter units with separate dc source for each unit and it is connected in cascade or series as shown in Fig. 1.

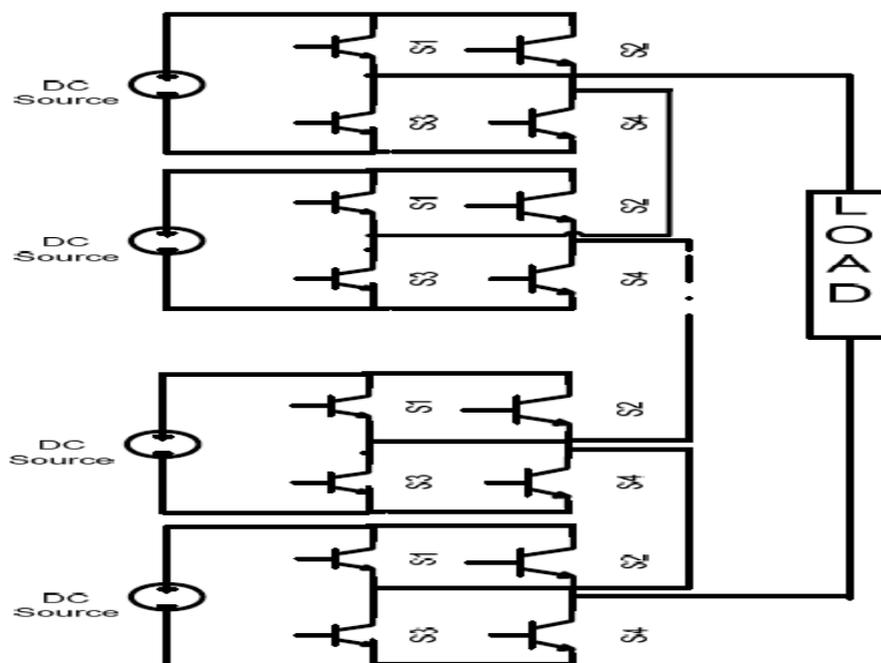


Fig. 1 cascaded multilevel h-bridge inverter

The THD is calculated for multi stage H-Bridge inverter. SIMULINK/MATLAB software is used for simulation of the circuit. THD reduction is achieved by increasing the stages of the converter. If the number of stages of the converter is increased, the level of the output wave is also increased. In this case, the number of level is one higher than the number of stages. For single stage, output has two levels. For three stage, output level is seven. The simulation is done up to 8 stages and the THD obtained in voltage is continuously decreasing with the stages. For the simulation we taken three voltage inputs are 6V, 12V, 24V. The simulation is done for a fixed RL load having  $R=5\Omega$  and  $L=5mH$ . The output is seven levels for the 42V and the THD is 32.26%. Simulation of Cascaded H bridge inverter shown in Fig.2 Cascaded 7 Level voltage output waveform shown in Fig.3

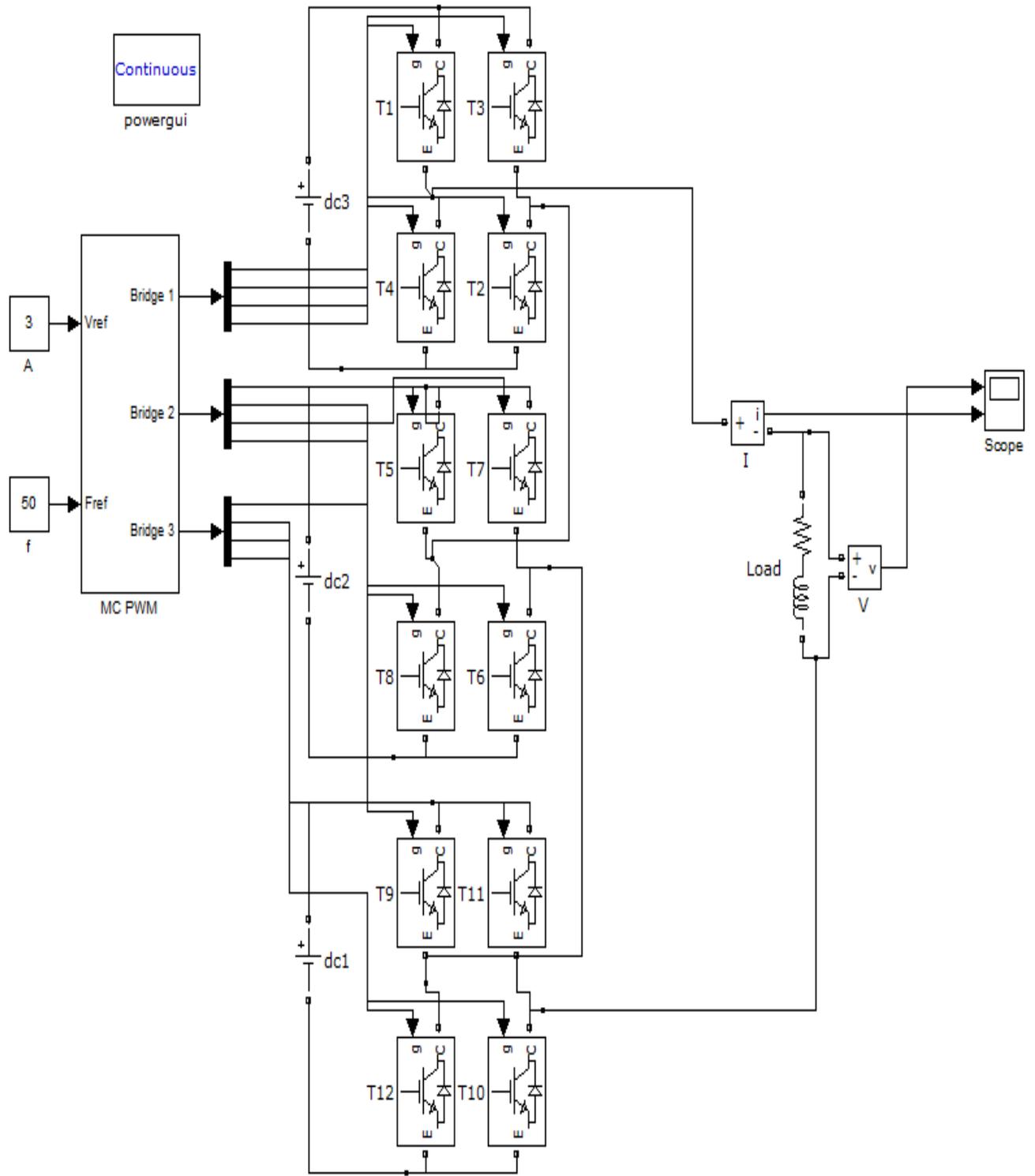


Fig.2 Simulation of Cascaded H bridge inverter

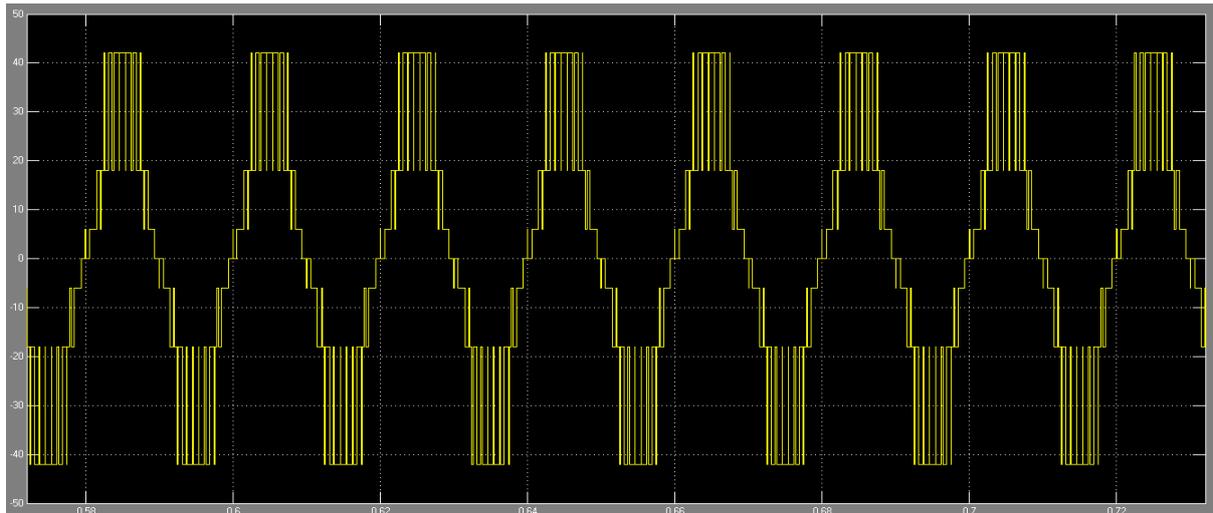


Fig.3 Cascaded 7 Level voltage output waveform

### 3. NEW MULTILEVEL APPROACH

The proposed multilevel inverter circuit consists of Level Module, H-Bridge inverter, input dc voltage and RL load. This load may be an isolated RL type or a grid. The level of output voltage shape depends on the level module used in the circuit. The fig.4 shows the proposed multilevel inverter circuit.

For designing the new multilevel approach we design output levels, number of switches used and input dc voltages.

For output level

$$n=2^{(m+1)}-1$$

The numbers of switches used in circuit are

$$r=2m+4$$

And for input dc voltages are

$$V_k = 2^{(k-1)} * V_d$$

Where  $k = 1, 2, 3, \dots, m$

In the proposed circuit, 3 Level modules, 1 H-Bridge inverter, and 3 dc voltage sources of 6Vd, 12Vd and 24Vd are used. Output wave has 15 level and the total number of switches used are 10. SIMULINK/MATLAB software is used for simulation of the circuit. The output is fifteen levels for the 42V and the THD is 8.82%. Simulation model of proposed multilevel inverter circuit shown in Fig.5 & Simulation model of proposed multilevel inverter circuit shown in Fig.6

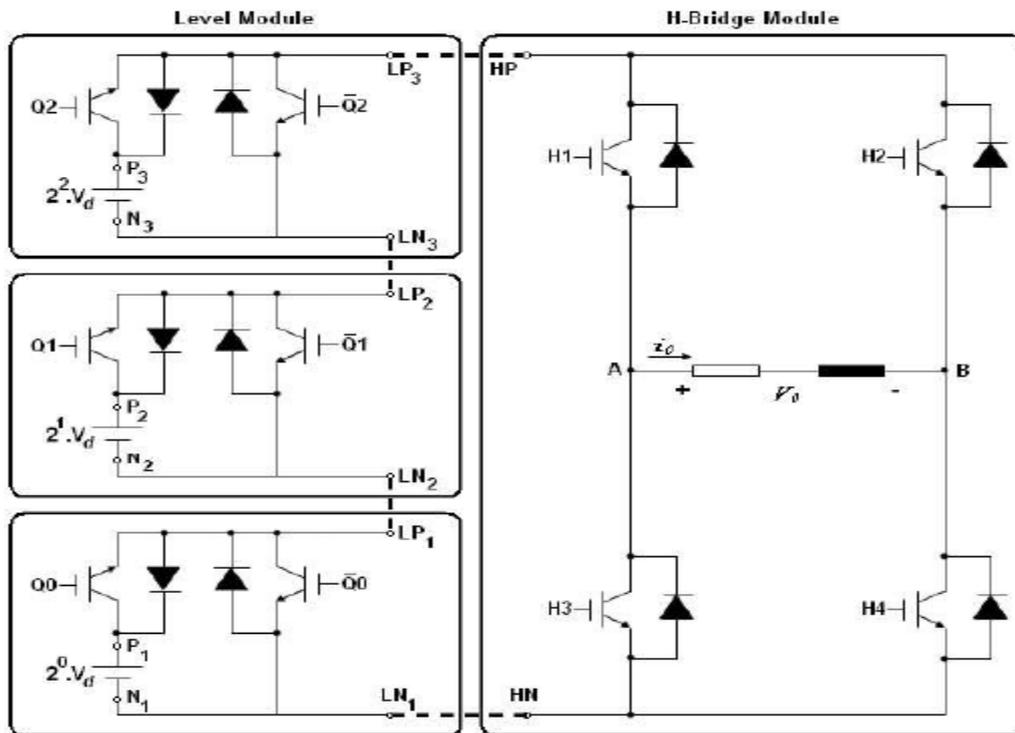


Fig. 4 Proposed multilevel inverter circuit

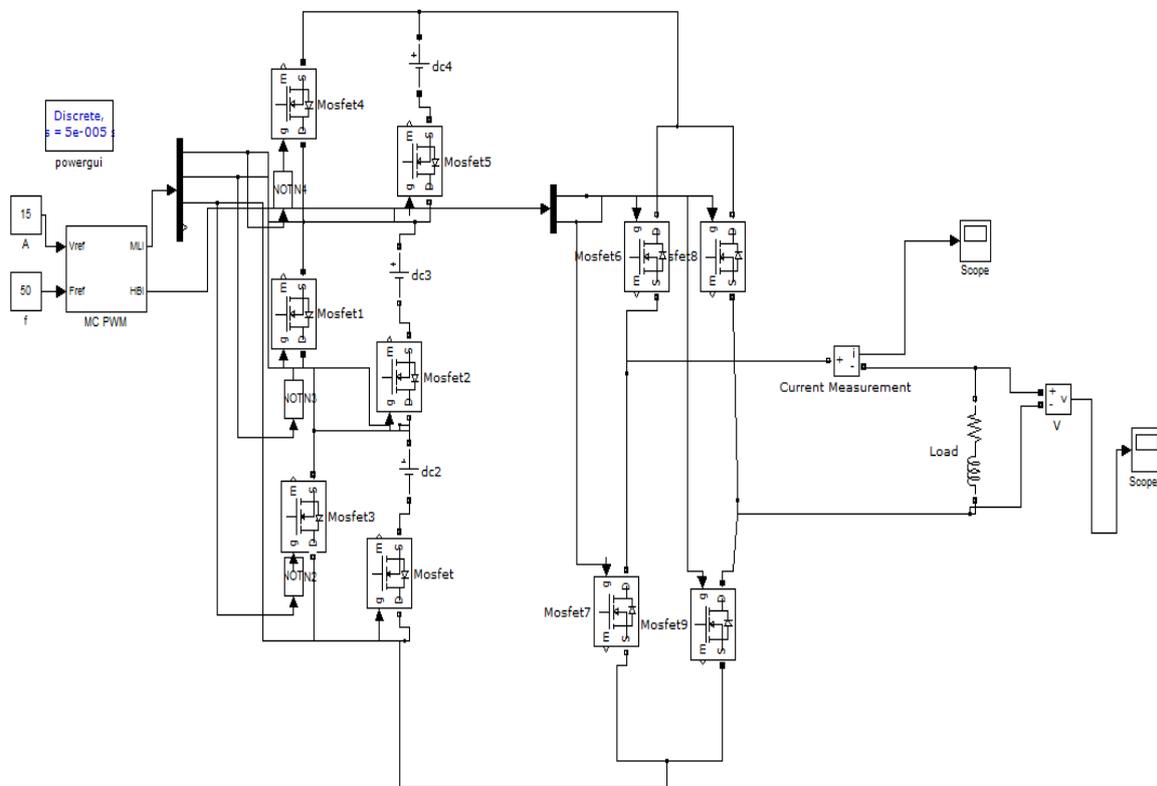


Fig.5 Simulation model of proposed multilevel inverter circuit

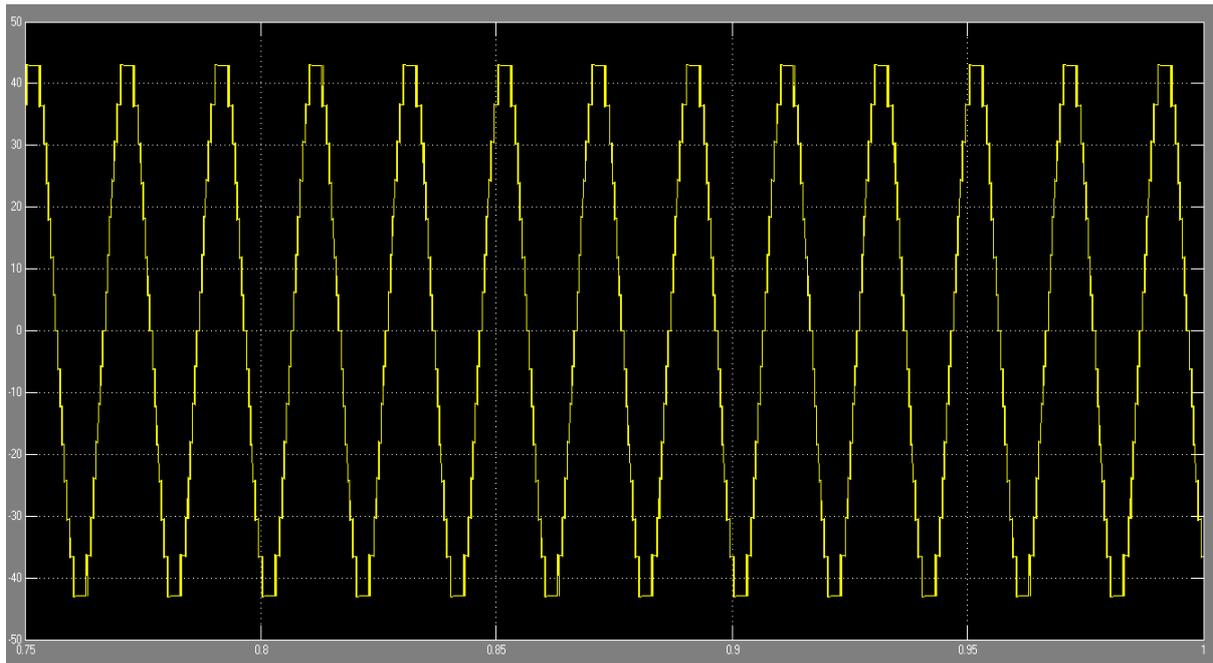


Fig.6 Multilevel 15 Level voltage output waveform

#### 4. COMPARISON OF CONVENTIONAL SCHEME AND MULTILEVEL SCHEME

Sr.No.	Parameters	Conventional Scheme	Multilevel Scheme
1	H-Bridge Inverter	3	1
2	Number Of Switches	12	10
3	Output Levels	7	15
4	Level Module	Not Used	Multilevel Circuit
5	THD	32.26%	8.82%
6	Cost	High	Low
7	Size	Bulky	Compact
8	Switching Losses	More	Less
9	Heating Losses	More	Less
10	Beneficial	Better From 7 Level	Constant throughout all Levels

#### 5. CONCLUSION

In this paper, THD in load voltage is evaluated for the two schemes using SIMULINK /MATLAB software and then compared for the same dc input voltage and same RL load without using the filter. In both schemes, THD obtained in load voltage may always be reduced below 5% by the use of filter. The THD is better as well as cost is less for the second scheme. This means that if the Solar Panels having same power rating and same

characteristics are connected in both the scheme, the Power Quality will be better and cost is less for second scheme.

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