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THREE PHASE 19 LEVEL MODULAR MULTI LEVEL INVERTER

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Abstract—*Generation of electricity from renewable energy sources like wind, sun, fuel cell, biomass etc., are increased day by day due to the increase in demand. To interface these green energy sources with the utility grid, power electronics based converter is needed. In this article 19 level modular multilevel converter is used and each inverter use DC as its source. This DC source can be obtained from photovoltaic cell.The proposed 19 level modular multi Level Inverter (MMI) can be switched on either for 50 HZ or for 60 Hz frequency. The proposed system is investigated using MATLAB/Simulink environment. The results proven that there is an increase in the RMS value of output voltages, so total required Volt Ampere ratings of the inverters is reduced greatly over wide load conditions.*

Keywords-*Multilevel inverter, THD, grid MATLAB/Simulink.*

1. INTRODUCTION

Nowdays, the environmental related pollution issues, decrease in fossil fuels, cost, and increase in demand etc., increase the need of renewable energy sources. Some of the famous renewable energy sources are solar, wind, small hydro,Biomass ,Fuel Cell and MicroTurbine. The electricity from photovoltaic provides green and clean energy. At the same time the energy produced through PV cell will have low voltage and offers less efficiency. In order to increase the efficiency, a power electronics based converter is needed. It helps to convert DC into AC and it acts as an interface media in between source and Grid.For this purpose either Current Source Inverter (CSI) or Voltage Source Inverter (VSI) are used .These techniques also need converter topologies like DC to DC which may increase the complexity of the system and henceforth the cost. The literature review also reveals that either two level inverter or multi level inverter provides a solution for the grid connected system. Even though the two level inverter injects maximum PV power into the grid with Unity Power Factor (UPF), the harmonics content will be more.

Hence the researchers started to focus on Multilevel Inverter (MLI).Multilevel inverter contains power semiconductor devices with DC sources and offers sinusoidal voltage AC waveform. It has many advantages like high efficiency, reduction in harmonics and lower switching losses. The history of multi level inverter is started with a diode clamped MI in the year 1981[1].In 1992[2], capacitor clamped multi level inverter was introduced. Then cascaded MLI was introduced in the year 1995.The author H. bu-Rub et. al discussed about the multilevel inverters and its role in conversion of DC to pure AC [3-4].In this article the advantages of MLI compared to bi direction inverter was also discussed. Hence MLI is promoted as a suitable one for grid connected PV system .It also does not need transformer connection. Single phase and three phases MLI are discussed in [5-9]. Three phase technologies are specifically discussed in[10-11].

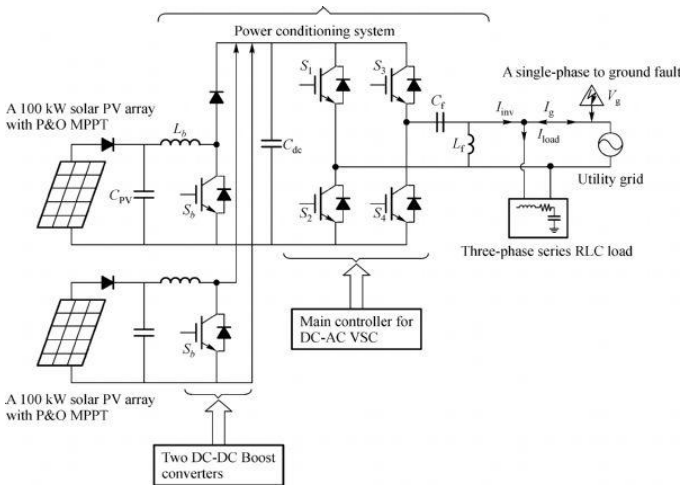

Fig [1] Transformer less PV system.

A sample of Transformer less PV connected Multilevel inverter is shown in figure 1[12]. By considering the above said issues and advantages of MLI, this paper focused three phase photovoltaic 19 level inverter is designig and implemnetation. Proposed system has 19 level Modular Multi Level Inverter(MMI) and the frequency can be switched either 50Hz or 60Hz. Also step time between each level is not constant which can be varied in order to get pure sinusoidal waveform. The organisation of this paper is as follows.Section 1 discuss about introduction part.Section 2 deals about Modular Multi Level Inverter.Various modes of operation is also discussed in this section.Section 3 discuss about the simulation model and simulation results.Section 4 concludes the work.

2. Modular Multi Level Inverter

A modular multilevel Inverter is one of the next-generation multilevel inverters intended for high or medium-voltage power conversion without transformers. MMI have ability to process both active power and reactive power with its terminals directly connected to high-voltage networks.Modular Multilevel Inverter has several advantages over conventional multilevel topologies.

Some of the advantages are highlighted below.

Generate low harmonic output voltage and so this eliminates filtering requirements.

For medium voltage application, it avoids interfacing through transformer.

Modular structure allows to extend higher number of levels easily.

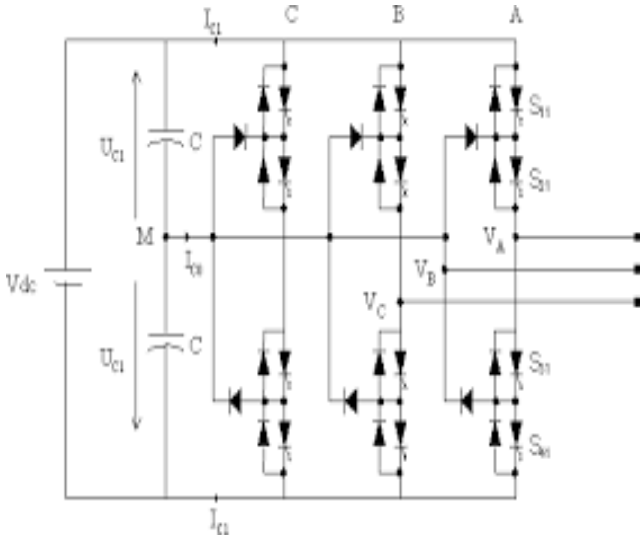

Fig 2 Typical module of modular multi level inverter.

Fig 2 shows a typical MMI model.Each module is basically constructed from four unidirectional-blocking- idirectional-conducting IGBT power electronic switches *S*11, *S*21, *S*31 and *S*41. It is the modification of the classical H-bridge Inverter.The switch pair in both arms (*S*11, *S*21) and (*S*31, *S*41) is complimentary in nature.

There are two modes of operation in MMI.The feature of this proposed 19 level MMI has its ability to operate in both symmetrical and asymmetrical modes.

Symmetrical Mode:

In this mode, the magnitude of the DC voltage sources in each MMI module and 19 level inverter are set at equal value.

Asymmetrical mode:

Employing different dc voltages with proper ratios can improve the output voltage total harmonic distortion (THD) and hence the power quality. In this mode, the magnitudes of the DC voltage sources in each MMI module and that of 19 level inverter are set at distinct values.

Each phase leg of the converter has two arms, each one constituted by a number N of SMs. In each arm there is also a small inductor to compensate for the voltage difference between upper and lower arms produced when a SM is switched in or out.

MODELLING AND SIMULATION RESULTS

The 19 level MMI is simulated using MATLAB/SIMULINK Platform. Each Inverter uses a DC source.Fig 3 shows the

simulink model of MMI

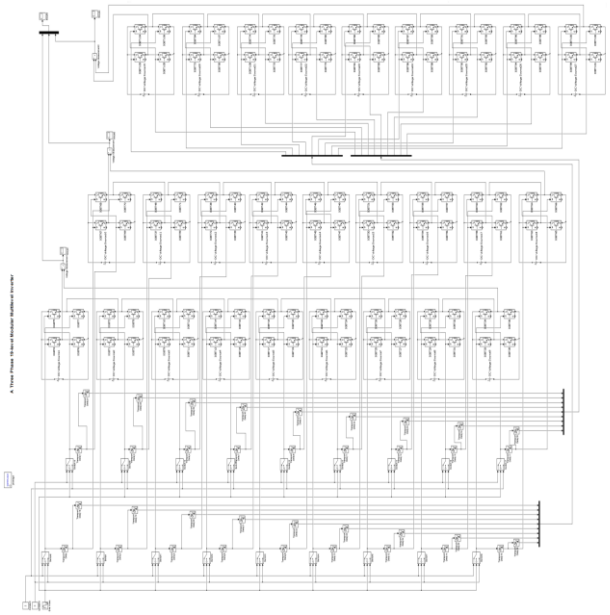

Fig 3.Simulink Model of 19 level Inverter

The R load is connected for evaluation. Each Inverter consists of 6 switches that are arranged in H model. The various results are plotted below.

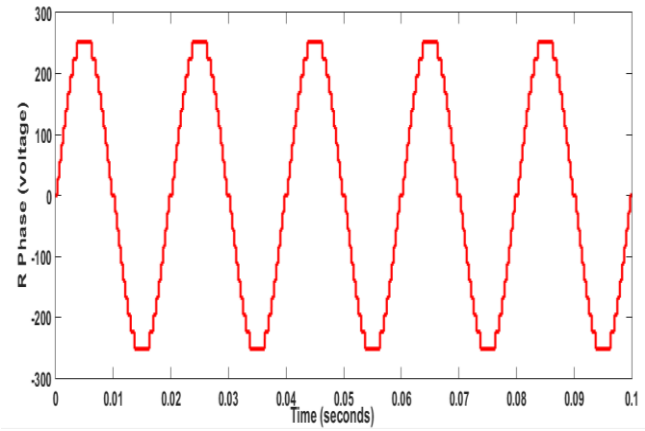

Figure 4 R-Phase Output voltage waveform

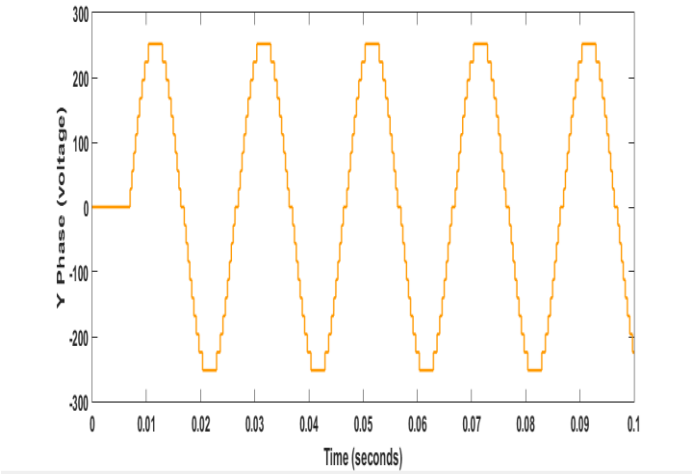

Figure 5 Y-Phase Output voltage waveform

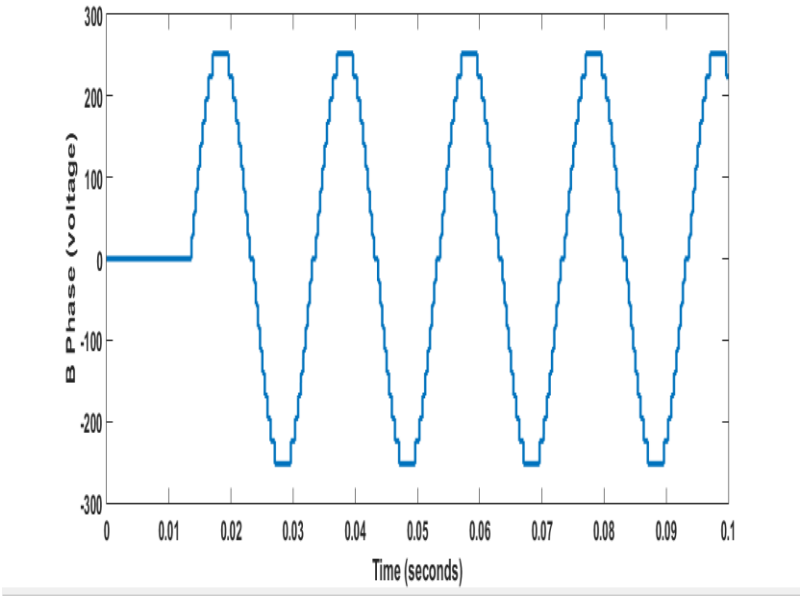

Figure 6 B-Phase Output voltage waveform

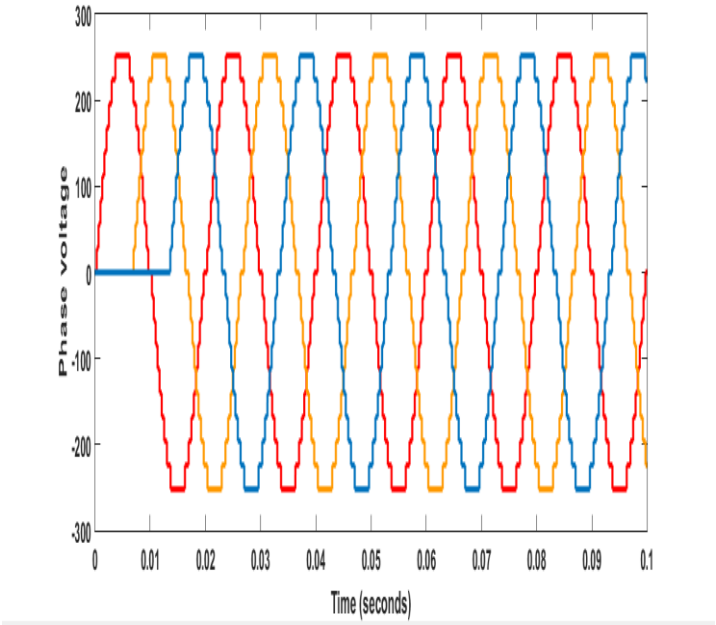

Figure 7 RYB Output voltage waveform

Figure 4-7 represents voltage waveforms of R phase, Y Phase, B Phase and RYB phase.

Conclusions

19 level modular multilevel converter is implemented in this article. Here each inverter utilize DC as its source. This DC source is obtained from photovoltaic array.

The proposed 19 level modular multi Level Inverter (MMI) can be switched on either for 50 HZ or for 60 Hz. The proposed system is modeled using MATLAB/Simulink platform. The results evidence that there is increase in the RMS value of output voltages, so total required VA ratings of the inverters reduced greatly over wide load conditions.

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