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THREE PHASE 19 LEVEL MODULAR MULTI LEVEL INVERTER FOR RENEWABLE ENERGY RESOURCE

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Abstract— *The present scenario structure of grid accommodates complex network which increases instability. At the same time, a small scale generating units using renewable energy sources is rapidly increasing. These renewable energy sources are interfaced with the main grid via power electronics converter/Inverter. The number of levels that are used to invert the Dc output decides the performance of the inverter. There are many level inverters are in implementation in RES. In this work, 19 level H Bridge modular multilevel inverter is used to invert the given output. For Input, Photovoltaic cell is used as the source which generates DC.*

- *The proposed 19 level H Bridge type modular multi Level Inverter (MMI) can be switched on either for 50 HZ or for 60 Hz frequency. Also step time between each level is not constant which can be varied because to get pure sin wave.*

The proposed system is investigated using MATLAB/Simulink 2015 environment.

Keywords*-H Bridge Multilevel inverter, Photvoltaic Cell, MATLAB/Simulink.*

1. INTRODUCTION

Day by day the usage of Renewable Energy resources has been increasing widely because of the issues related to the usage of fossil fuels like coal, gas, oil etc., and its lack of availability. The widely used renewable energy sources are PV, wind, small hydro, Biomass , Fuel Cell and MicroTurbine. The electricity from renewable energy sources offer pure green and clean energy to the environment. Among other RES,PV has much awareness among people for the electricity generation. But the PV generate low voltage which needs a suitable power electronics converter to get high efficiency network. The main aim of this converter is to invert the DC input from PV source and also it acts as an interface media in between PV source and utility Grid. In general either Current Source Inverter (CSI) or Voltage Source Inverter (VSI) are used for this purpose. But most of the researches chosen VSI as the converter. From the various historical review of the paper , it has been found 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. High efficiency, Reduced THD level and lower switching losses, reliability are some of the advantages of Multi level Inverter.. 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].

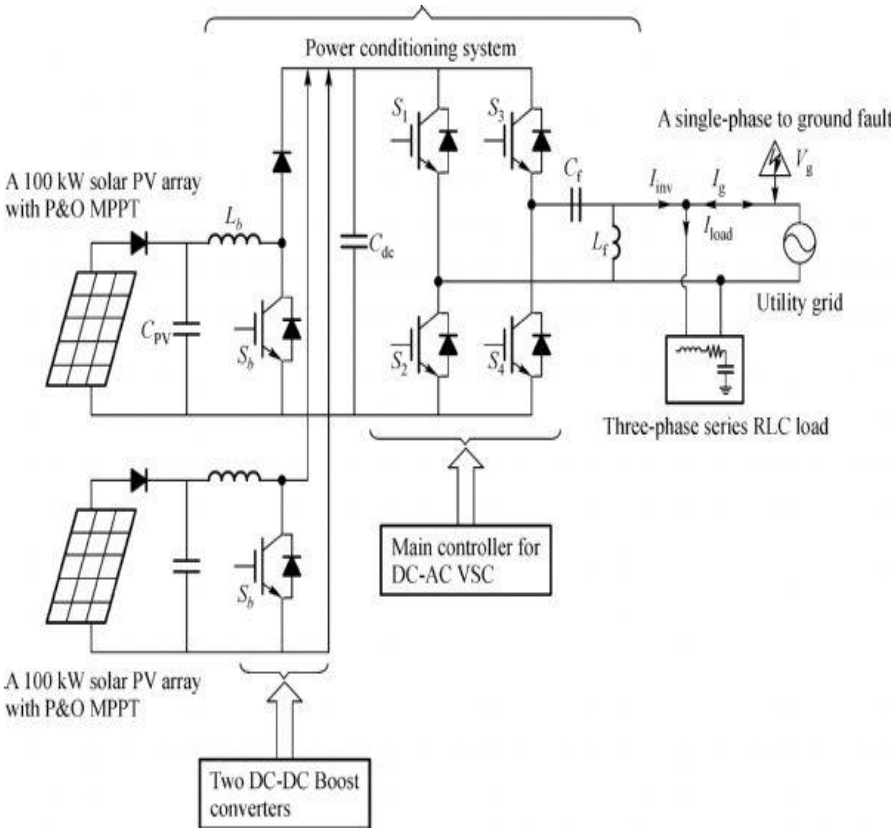

Fig [1] Transformer less PV system.

A sample of Transformer less PV connected Multilevel inverter is shown in figure 1[12].

- Basec on the above said surve,this article is mainly focused three phase 19 level modula multi level inverter for reneable energy sources. A modular multilevel Inverter (MMI) is one of the next-generation multilevel inverters intended for high or medium-voltage power conversion without transformers.MMI may be its ability to process both active power and reactive power with its terminals directly connected to high-voltage networks.
  This MMi can be switched for a frequency 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.

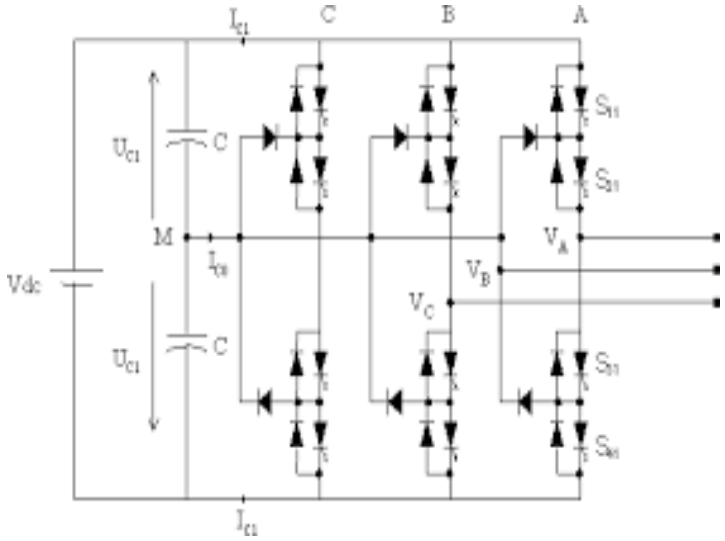

Fig 2 Typical module of modular multi level inverter.

Fig 2 shows a typical MMI model. Each module is basically constructed from four unidirectional-blocking-bidirectional-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.

2. MODELLING AND SIMULATION RESULTS

The proposed 19 level MMI is evaluated through simulation using MATLAB/SIMULINK 2015 Platform. Each Inverter uses a PV cell for DC source generation. Fig 3 shows the block diagram for the proposed system.

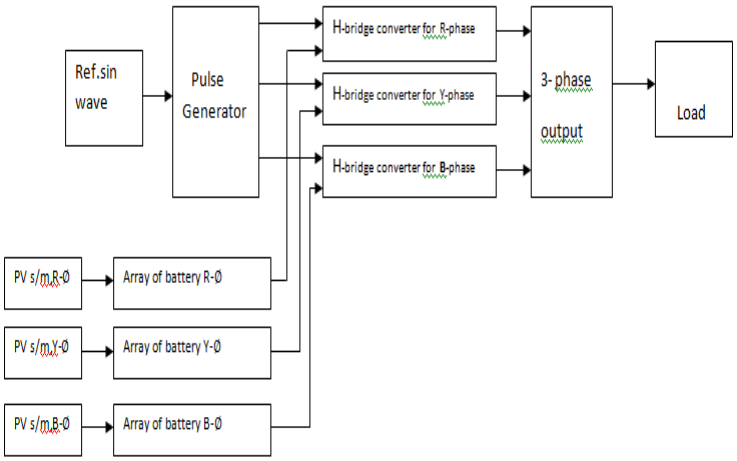

Fig 3.Block Diagram of 19 level Inverter.

The corresponding simulink model is shown in figure 4. The R load is connected for evaluation. Each Inverter consists of 6 H bridge model switches.The effectiveness of this H bridge MMI has been verified through following results. The various simulation results are shown below.

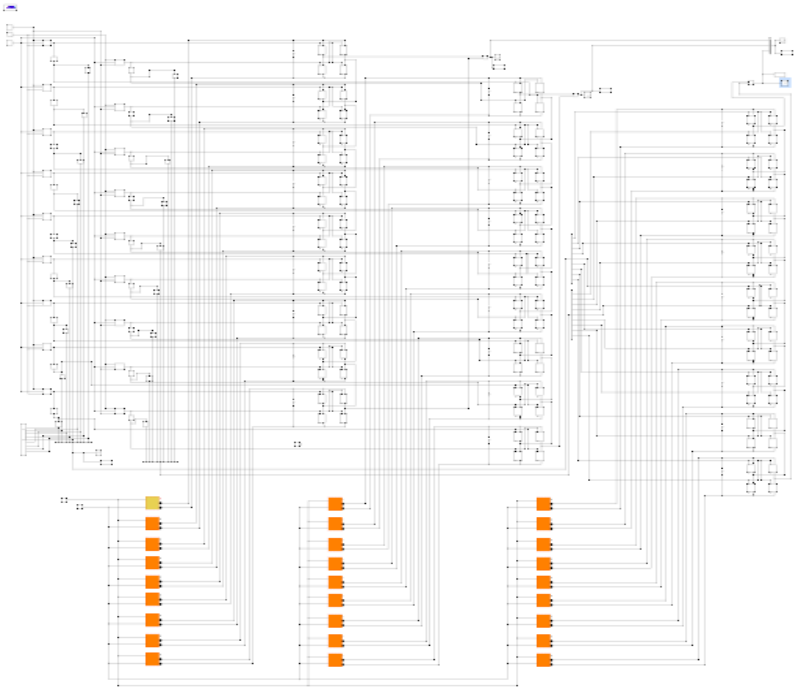

Fig 4. Simulink Model of 19 level MMI.

The output voltage from the Photovoltaic cell is shown in fig 5.

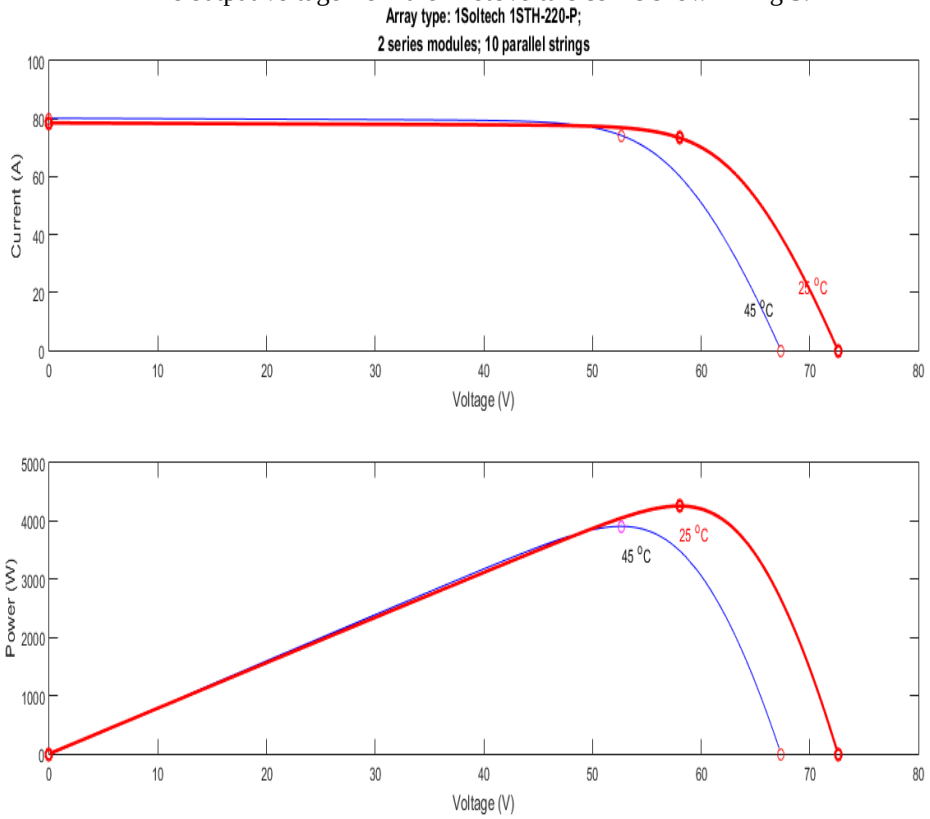

Fig 5. Voltage & Current waeform of PV Cell.

The output voltage for each level of 19 level MMI is shown in fig 6.

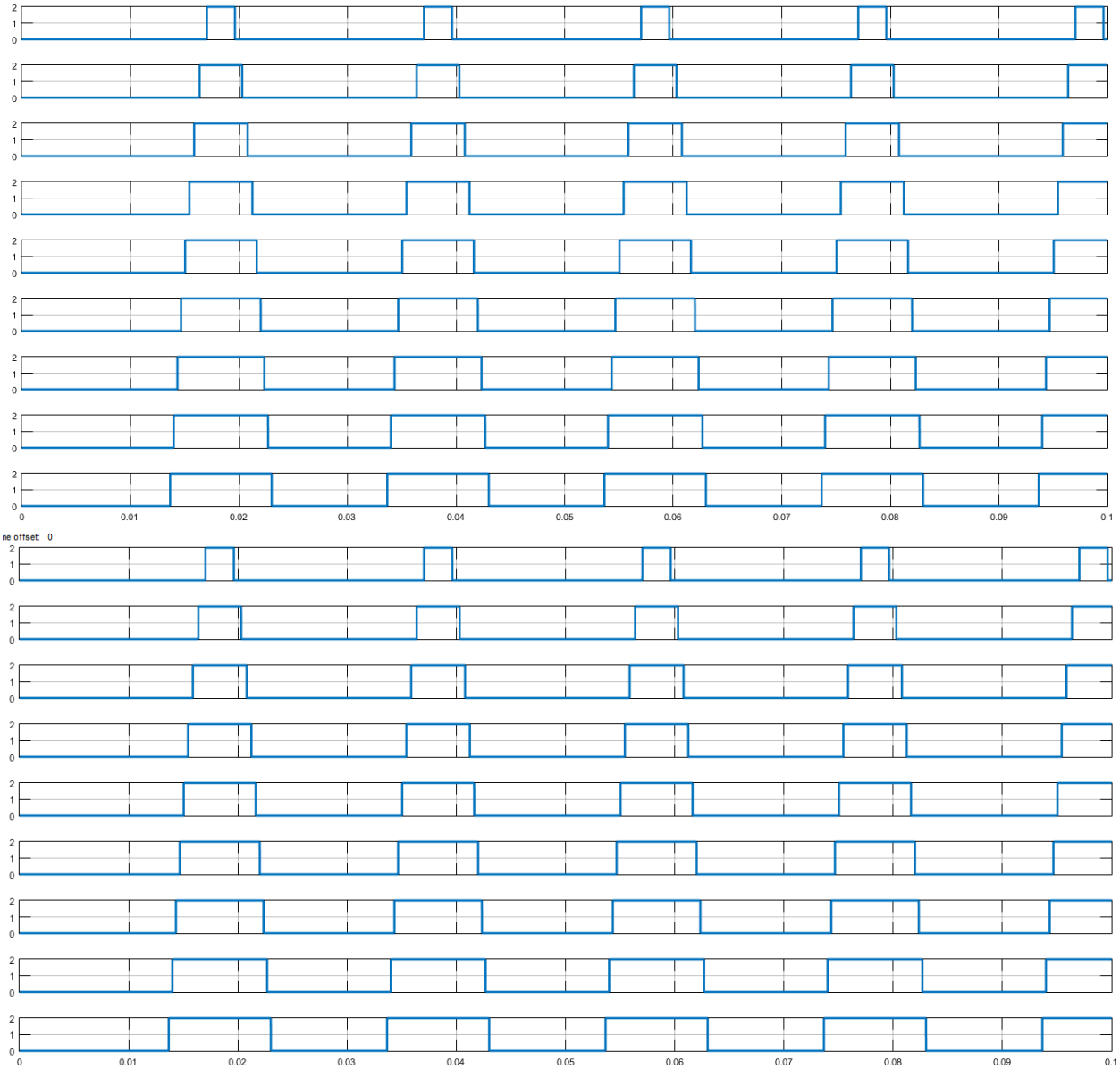

Fig 6. Output voltage for each level of 19 level MMI.

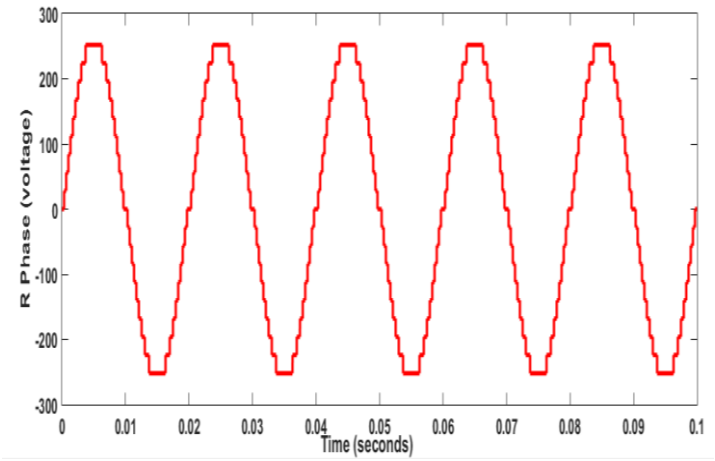

Figure 7 R-Phase Output voltage waveform

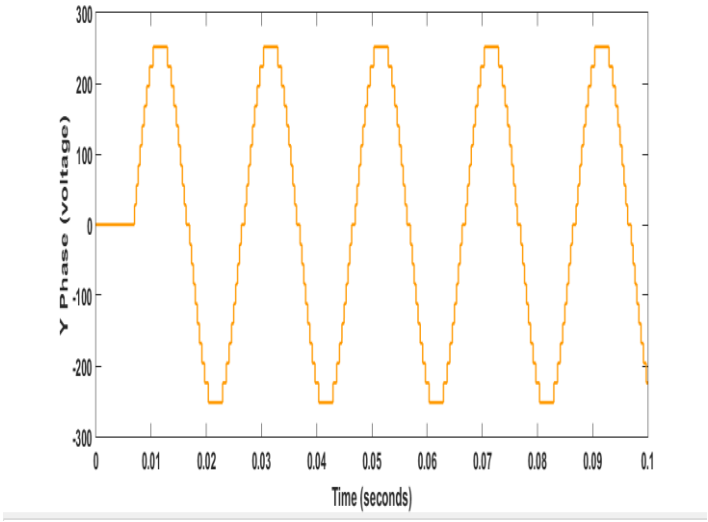

Figure 8 Y-Phase Output voltage waveform

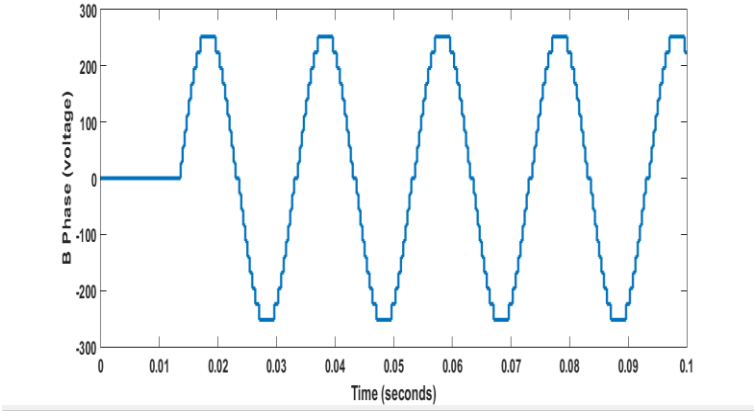

Figure 9 B-Phase Output voltage waveform

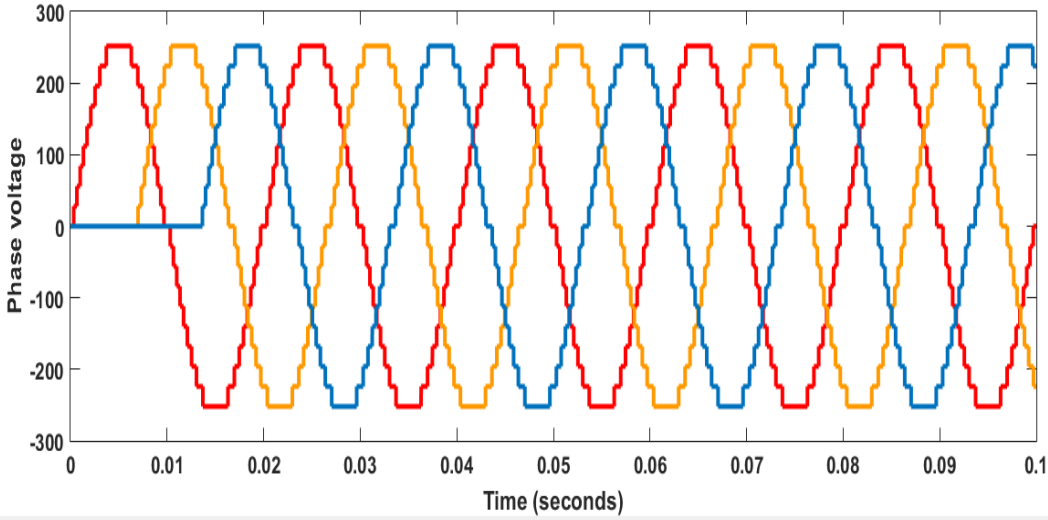

Figure 10 RYB Output voltage waveform

Figure 7-10 presents output three phase voltage (R phase, Y Phase, B Phase and RYB phase individually).

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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