SOLAR MICROINVERTER

Abhishek Gupta*, Shivani Singhal[1], Shubhra Singh[2], Shweta Vyas[3], Simran Sharma[4]
[*] Associate Professor, Department of Electrical Engineering, S.K.I.T, Jaipur, India [1,2,3,4] Student, Department of Electrical Engineering, S.K.I.T, Jaipur, India

ABSTRACT:-

The conventional standalone system used in PV array to feed power in off grid load requires several stages of power conversion thus reliability and efficiency is reduced. To overcome this limitation, the solutions offered are to design the system for higher PV and/or battery voltage levels. However, increment in the PV/battery voltage level makes design and installation issues of the system more involved in order to satisfy concerns pertaining to the safety of the personnel and equipment. To overcome the above limitations of the existing standalone PV systems, a topology contains a novel boost inverter that does not require a rise in voltage levels of PV array or battery is proposed in this paper. Detailed analytical studies of the system are carried out. The effectiveness of the proposed scheme is verified through detailed simulation studies.

***Keywords*: boost inverter, dc-dc converter, full bridge inverter, solar photovoltaic (PV), standalone system**

I. INTRODUCTION

The research interest in renewable energy sources (RES) has grown considerably in recent years due to serious concerns regarding global warming, climate change and dwindling reserve of fossil fuel sources used for electricity generation. Over the years, the solar PV has become one of the promising candidates amongst available RES. The electricity produced from solar PV array can be fed directly into the grid (grid-interactive mode) or can be used to meet the power demand of the off-grid loads (standalone mode). The electricity produced from solar PV array can be fed directly into the grid (grid-interactive mode) or can be used to meet the power demand of the off-grid loads (standalone mode). The present paper deals with the issue of solar PV systems operating in standalone mode to provide power to domestic loads in locations where grid is not available. Due to variability in solar radiations, standalone systems require the service of a battery bank to act as storage thereby compensating for the variations in power generated from the solar array [1].

The standalone systems are generally designed for low power applications in the range of 250 VA to 1000 VA. The voltage levels of individual PV modules which are available in the market are generally 12 V, 17 V and 36 V. The voltage level of batteries which are generally employed for this type of applications is in the range of 12 to 48 V. The standard voltage level of domestic loads in India is 230 V. As a result voltage level of DC link of the DC-AC inverter that feeds these loads has to be maintained in the range of 360 V to 400 V. Therefore the overall voltage gain of the intermediate DC-DC converter(s) which interfaces the PV array and the battery with the DC link of the DC-AC inverter needs to be designed for a voltage gain of around 9-12. One of the possibilities to achieve such a high gain is to employ three DC-DC converters to serve the purpose [2].

This approach leads to low efficiency and reduction in reliability due to increment in the number of converters. In order to overcome the aforementioned limitation higher voltage levels for PV and battery can be chosen. This will reduce the overall gain requirement from the DC-DC converter. The voltage level of a battery bank can be increased by connecting standard 12V batteries in series. However, use of large no of batteries increases cost and size.

The other way to enhance the gain of the intermediate DC-DC converters is to employ high frequency transformer-coupled DC-DC converters presented in [3] - [6]. Further, involvement of the high frequency transformer leads to reduction in efficiency and also increases the size and weight of the circuit. In order to overcome the limitations of the aforementioned schemes, a boost type of inverter can be employed thereby reducing the overall gain requirement of the DC-DC converters. The principle of operation of the proposed boost integrated full bridge inverter (BIFBI) is presented in the following section. The block diagram description employed for the standalone scheme incorporating BIFBI is dealt with in section III.

II. PRINCIPLE OF OPERATION

The schematic circuit diagram of the projected inverter, which consists of a DC-DC boost converter and a DC-AC inverter, is shown in Fig. 1. A DC-DC boost converter is employed to step up photovoltaic (PV) output voltage 18V DC into 314 to 400V DC that is shown in Fig. 4. The use of boost converter in our proposed design ensures high voltage gain from PV array voltage and it has several benefits like lightweight, high efficiency etc. PV cell make use of semiconductor material to convert solar energy into electricity [7]. This inverter power circuit design involves a pair of two parallel MOSFET gates. The control circuit combines an analog circuit. The use of Analog circuit is to produce switching signal for inverter power circuit.

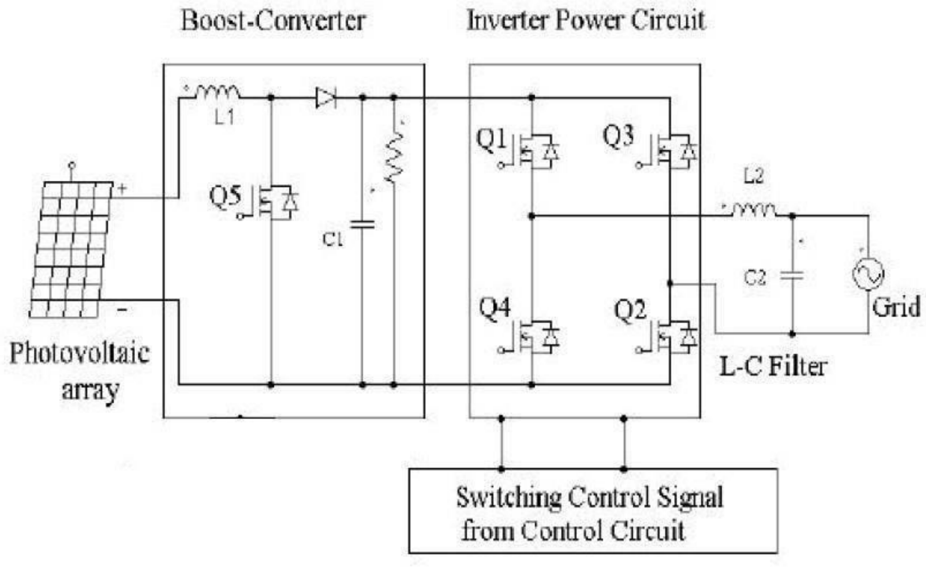

Fig 1: Circuit diagram of two stage grid-connected PV system

Conventional inverters use only one type of switching technique. Instead it, this proposed design uses a combination of SPWM and square wave to reduce the switching loss by reducing the switching frequency. The sine wave sampled is used to generate the SPWM signal thus ensuring output voltage from GTI will have same frequency as the grid. After sampling, the sinusoidal AC wave is rectified with a precision rectifier.

III. CIRCUIT DIAGRAM

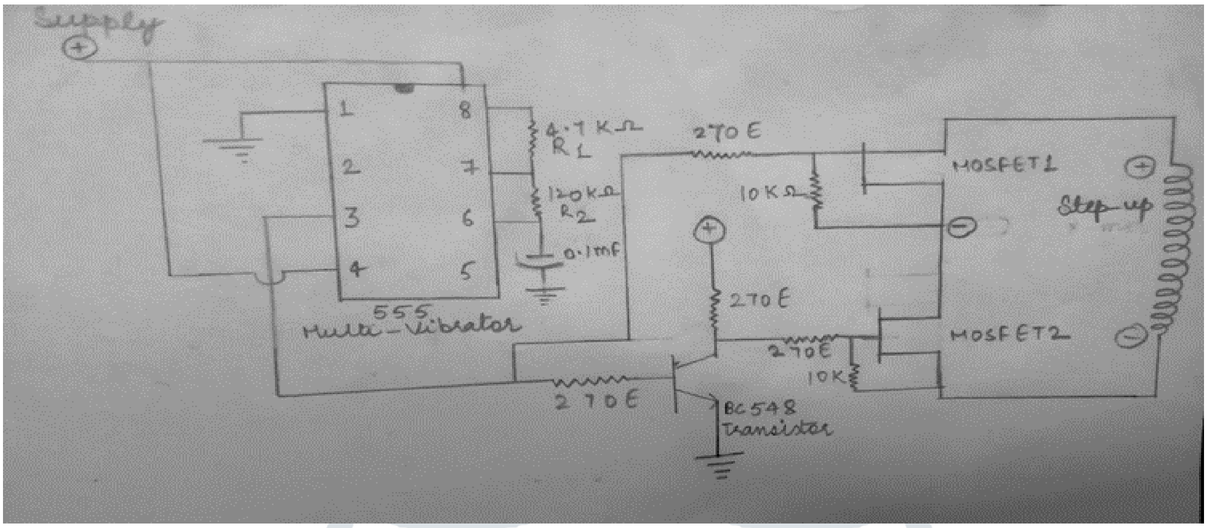

Fig 2: Circuit diagram of solar micro inverter

Among all the renewable energy resources available, solar energy seems to be a major competitor as it is abundant in nature and its conversion to electricity through photovoltaic (PV) process is pollution free. In conventional standalone system in PV array to feed power to off grid load requires several stages of power conversions. It's a commercial project and is the practical implementation of electrical engineering.

IV. HARDWARE DESCRIPTION

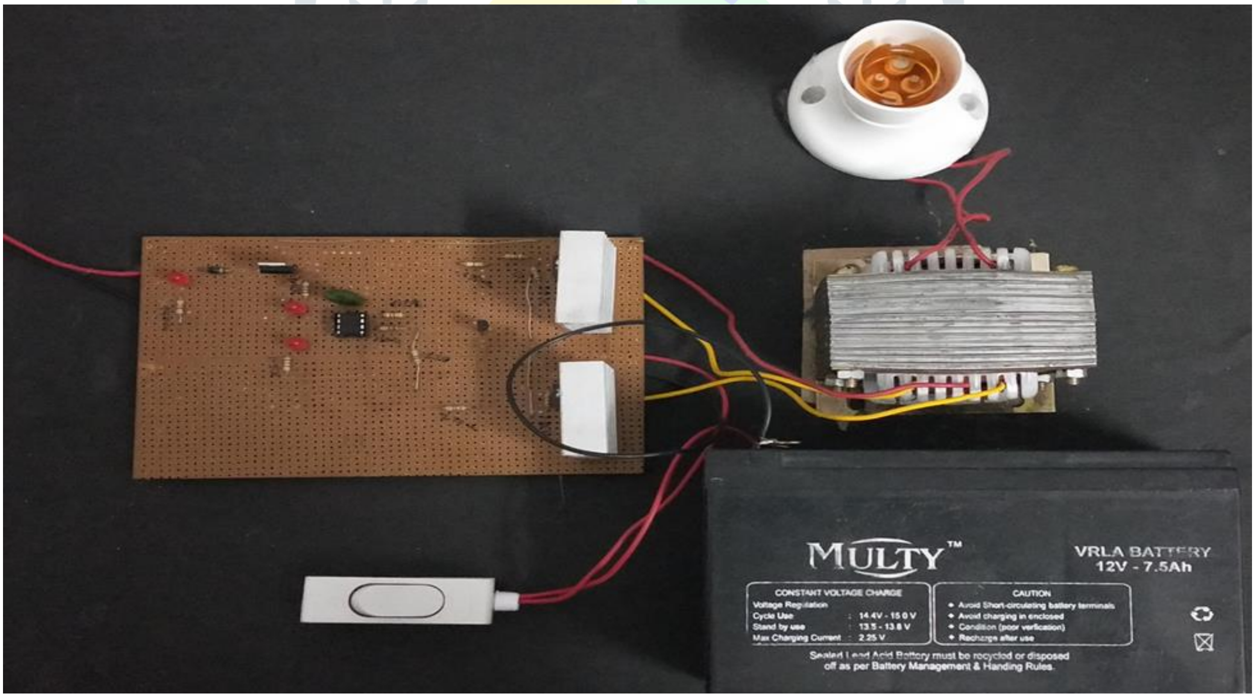

Fig3: Hardware of solar micro inverter

An 18V DC solar plate fed power as input to the circuit. Then LED glow which indicates that supply is on. A resistance of 470 ohm is connected to LED. The diode connected in the circuit makes sure that power does not flow in reverse direction. It is unidirectional i.e. from solar panel to battery.

A 5V, 7805 voltage regulator is connected in the circuit that restricts the output voltage to 5V. It can provide a constant steady voltage flow of 5V for higher voltage input till the threshold limit of 35V. Then output is fed to the multi vibrator. Along with the 555 IC resistance of 4.7 K and 120K ohm and a capacitor of 0.1 microfarad are connected. It gets charged through R2. The values of R and C are fixed which make frequency constant, so that some devices which are frequency sensitive can work ideally.

The 555 IC, Astable multi vibrator converts DC into AC which is a square wave [8]. The output of multi vibrator goes to the MOSFETS. It goes to MOSFET 1 and MOSFET 2 in alternate positions. The supply goes directly to the MOSFET 1 while inverted supply goes to the MOSFET 2 through the driver circuit. In driver circuit BC548 transistor and resistances of 270 ohm is connected which inverts the supply and feds to MOSFET 2. Both the MOSFETs are mounted on aluminium plate which sink heat to the MOSFET and stop sending heat into the environment. From MOSFETs, the supply goes to 12V to 220V step-up transformer. The supply is stepped up to the 220 V and fed to the load. In case supply is not available from solar plate, battery is connected for backup.

V. CONCLUSION

The main purpose of this paper is to establish a model for the grid-connected photovoltaic system with maximum power point tracking function for residential application. A single phase two-stage grid-connected photovoltaic inverter with a combination of SPWM and square-wave switching strategy is designed using MATLAB. In the proposed design, a boost converter is designed to operate using (P&O) method to control the PWM signals of the boost converter, which is adapted to the maximum power tracking in our PV system., A DC-DC boost converter is used between solar panel and inverter instead of using line frequency transformer the inverter output terminals. This DC-DC boost converter efficiently amplify the 24V PV arrays output into 312V DC, which is then transformed into line frequency (50Hz) sinusoidal ac 220V rms voltage by the inverter and thus ensuring system deficits and ensures high voltage gain and higher efficiency output. The simulation results suggest that the proposed grid connected PV inverter squeeze the maximum point of solar cell array power and then converts it to a high quality ripple free sinusoidal ac power with a voltage THD below 8%. The simulation also confirms the proposed photovoltaic inverter can be used as a GTI and able to supplies the AC power to utility grid line. However, the existing topologies of inverters that can be used in the boost mode have drawbacks of experiencing high voltage stress across dc capacitor, higher requirement of passive element count [9]- [11], complex control and high input ripple current. In order to overcome the aforementioned limitations a new topology for a boost type inverter is proposed in this paper which operates as a combination of buck-boost DC-DC converter and standard full bridge inverter.

VI. REFRENCES

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