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Design Converter for Solar System to Drive Induction Motor

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ABSTRACT
Renewable energy sources like wind & solar can be regarded as the acceptable alternative for conventional energy sources. The standalone photovoltaic system basically used to provide the electricity to the remote areas. This study illustrates the performance analysis of 1-phase induction motor working as a load with PV array is connected. In this paper input voltage of the inverter is a step–up by dc/dc boost converter. Designed boost converter boosts the voltage that is developed by the PV array to a specific required value that can run satisfactorily the 1-phase induction motor. The inverter transforms the DC voltage to the AC that is controlled with the help of PWM techniques, as the inverter output voltage is not pure sinusoidal so LC-filter is used to obtain the proper sine waveform. Thus output voltage of Inverter can be used to operate the 1- phase induction motor at different loading. The acceptable results are procured for the given loads and the load voltage is found to be steady under varying load.

Keywords- Photovoltaic, DC-DC boost converter, VSI Inverter, Induction Motor.

1.INTRODUCTION

Sun energy is essential energy source that is getting considerable attention by the researcher. Photovoltaic systems produce electricity without creation of any pollution or the noise that is the reason it is more advantageous. Renewable energy system like hydropower, wind and the photovoltaic generation system have been common now days as alternative means to fulfill the energy demands. Photovoltaic system may provide energy to the standalone load like induction motor acting as load. The purpose of photo voltaic energy converter is to provide the power and injects the sinusoidal voltage into the load applied[1]. Voltage source inverter based photovoltaic systems structurally have simple topology with small size and high efficiency. As shown in figure below the generation of electrical energy with using a boost converter and inverter the single phase induction motor is run.

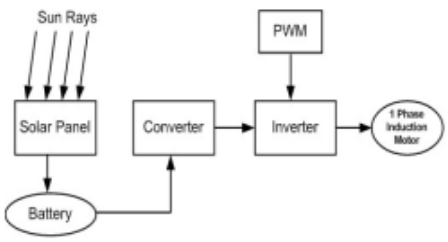

Fig 1: Block diagram of solar system to drive induction motor

The PWM converter drawing the attention of many researchers around the world, because previously used power converters switching devices have some disadvantages like having large size & low efficiency & reliability. The solid state semiconductor made thyristor gained devices overcome all these deficiencies however the self commutation feature is missing here, hence a commutation circuit like forced commutation is required but it increases its cost along with complexity and makes it bulky, therefore its utilization is limited to VSI applications. Here MOSFET switch is used for safe commutation to sort out the transient occurring at the time of switching. MOSFET has many features like easy to control and higher efficiency. Thus the MOSFET switches are most widely used devices in the PWM converters. The square pulse width modulation technique of voltage source inverter (VSI) is proposed to control the inverter voltage. A single phase induction motor is supplied at the output terminal of the solar system[2].

2. PHOTOVOLTAIC ARRAY

Since a single PV cell can produce a very low voltage which generates low power, so the cells must be connected in the series to increase its voltage rating, in parallel configurations to increase its current rating so that it generates the useful power. PV Array is the connection of PV cells in series and parallel combinations to get the desired voltage and current. When the light energy is greater than the energy band gap of the semiconductor and falls on the semiconductor, the electron-hole pair created but the developed electron hole pair recombines in few microsecond to stabilize the

semiconductor which results in disappearing of charge carrier. At this stage, if the suitable electric field is applied then this electric field provides a force on the electron to sweep away from holes in the conduction band and reaches towards the metal contact. In the PV modules, there are various PV cells which are connected in series and parallel configuration. The PV cells have two layers of semiconductor known as thin film device, for example, gallium arsenide, and indium phosphates etc. which form a p-n junction. The operating principle behind the operation of this module is a photoelectric effect. When these plates are interconnected with the help of some load then free electrons will start flowing through that load and produced a DC current whose direction is opposite to the direction of flow of electron[. Here the DC current depends on electron which further depends
on the photon or charge carrier generated that is directly proportional to the solar radiation and temperature. So if the radiation is higher than the number of electrons generated in that case higher amount of DC current generated[3].

3. DC-DC BOOST CONVERTER

Fig 2 :Hardware design of converter

A boost converter is a DC-to-DC power converter that steps up voltage while stepping down current from its input supply to its output load. It is a class of switched-mode power supply (SMPS) containing at five transistor and one energy storage element a capacitor, inductor, or the two in combination. To reduce voltage ripple, filters made of capacitors sometimes in combination with inductors are normally added to such a converter's output and input. Power for the boost converter can come from any suitable DC sources, such as batteries, solar panels. A process that changes one DC voltage to a different DC voltage is called DC to DC conversion. A boost converter is a DC to DC converter with an output voltage greater than the source voltage. A boost converter is sometimes called a step-up converter since it "steps up" the source voltage. Since power must be conserved, the output current is lower than the source current. The 555 configuration will create a PWM signal and apply that signal to the MOSFET gate. The circuit works ok but it has a big problem. The output will change if we change the output load because the circuit has no feedback. To create the PWM signal we will use the 555 timer with the PWM configuration. With the potentiometer we can change the duty cycle of the PWM signal, and at the same time the output value[4].

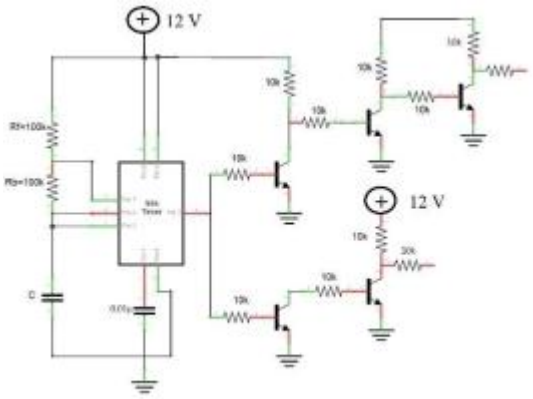

Fig 3: Circuit diagram of Converter

4. INVERTER

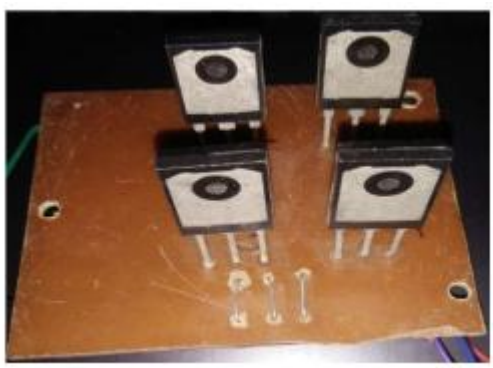

Fig 4 : Hardware design of inverter

The H-bridge inverter is used for the dc to ac conversion. An H bridge is built with four switches. When the switches S1 and S4 are closed and S2 and S3 are open a positive voltage will be applied across the motor. By opening S1 and S4 switches and closing S2 and S3 switches, this voltage is reversed, allowing reverse operation of the motor. The switches S1 and S2 should never be closed at the same time, as this would cause a short circuit on the input voltage source[6].

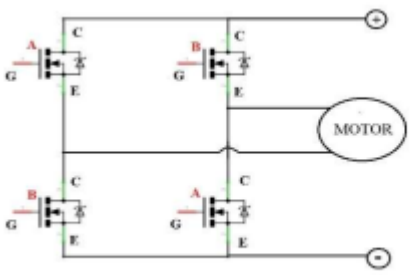

Fig 5 : H -Bridge Inverter circuit

The same applies to the switches S3 and S4. This condition is known as shoot-through. A solid-state H bridge is typically constructed using opposite polarity devices P-channel MOSFETs connected to the high voltage bus. Alternatively, a switched-mode power supply DC–DC converter can be used to provide isolated supplies to the gate drive circuitry. A common use of the H-bridge is an inverter. The arrangement is sometimes known as a single-phase bridge inverter. The H-bridge with a DC supply will generate a square wave voltage waveform across the load. To create the PWM signal there is the use of 555 timer with the PWM configuration. With the potentiometer we can change the duty cycle of the PWM signal, and at the same time the output value[7].This proposed system consists of different components.

i. Photovoltaic generation system
ii. Dc/Dc step-up converter
iii. VSI (Voltage source inverter)-PWM
iv. Load (1-phase induction motor)

As discussed above proposed system consists of different components. The first step of this is the generation of power by PV array and store it into a battery then extracts the maximum power with the application of dc/dc step-up converter. Here boost converter is acting like the intermediate to transfer power between the PV system and the inverter, the inverter converts the dc power to the ac power filter smooth the inverter output so that high-quality ac is obtained that derive can the single phase induction motor. Here induction motor is acting as the load and its complete parameter is shown in the table. The controller makes the voltage generated at the output end of filter i.e. dc link voltage constant so that inverter always get its input constant appropriate DC that can be resulted to 1-phase sinusoidal output voltage on the line side of the inverter.

5. CONCLUSION

This paper has presented a simple solar generation to design dc-dc boost converter to control the 1-phase VSI solar system. The Photovoltaic powered single-phase i0nduction motor drive system is successfully modelled .The proposed system is thus successfully used to derive the 1- phase induction motor[8].

APPENDIX

The 3-phase induction motor is acting like load the parameters are shown in the table below.

TABLE : PARAMETER OF INDUCTION MOTOR

Type of load	1Phase I.M.
Pole	4pole
Mounting	Foot mounting
Rated voltage	220-230V
Speed	1440rpm

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