Seven Level Inverter for Multistring Photovoltaic Application

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Abstract: - In this dissertation report seven level inverter (SLI) is designed for multistring photovoltaic MVP application. In the era of electrical energy through thermal product is getting exhausted and world is turning towards the non-renewable energy sources. The efforts are more focused about solar energy and hence, need some apparatus or system which will convert the solar energy efficiently toward the load side and that's why, the paper proposes a system which will convert the solar energy into DC electrical energy and DC electrical source will be converted to AC by efficient technique of the inverter. In this project, the work is done on the " 7 level inverter " in which inverter has several advantages over conventional inverter that uses high switching frequency pulses width modulation (PWM) .These can generate output voltage with low distortion and lower dv/dt . By using this is 7 level inverter, we can convert this higher amount of energy into electrical energy to reduce the rectification losses. In this project, the proposed system is converting a solar generated DC source to the AC source by using 7 level inverter and hence yes PWM technique is used for giving the pulses to the 7 level inverter.

Key Words: —*Seven level inverter, Non-renewable energy, Pulse width modulation.*

I. INTRODUCTION

This paper proposes a new seven level inverter with a solar power generation system, which is composed of a dc-dc power converter and a new seven level inverter. The dc/dc power converter integrates a boost converter and a transformer to convert the output voltage of the solar cell array into independent voltage sources with multiple relationships. The most commonly used solar cell model is introduced and the generalized PV model using Matlab/Simulink is developed. The interface is more important to grid connected solar power generation systems. In this project converts the dc power generated by a solar cell array into ac power and it feeds this ac power into utility. In which inverter is necessary in the power conversion interface, because power conversion convert the dc power into ac power. Since the output, voltage of solar cell array is low and the capacitor circuit converts the two output voltage sources. This project output voltage of solar cell array is low and the dc/dc power converter is used in small capacity solar power generation system and in which boost the output voltage, it can match the dc bus voltage of the inverter. A filter inductor is used to process the switching harmonics.

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This system generates a sinusoidal output current. The control circuit not provides PWM signals to power stages, but also traces maximum PV module energy as well as real time grid detection and protection. The efficiency of boost converter is restricted by duty ratio for higher output voltage.

The solar energy is more important, Solar energy produces less pollution and the cost of fossil fuel energy is rising, the cost of solar arrays is decreasing. This project is design and implementation of a PV module inverter. The dc-dc converter with maximum power point tracking, in this project control raises the input voltage level into a high voltage level. There is only one MPP (MPP Maximum Power Point) and in which varies to climatic and irradiation condition. The photovoltaic power characteristics vary level of solar irradiation and temperature.

The project solar power generation system is composed of a dc-dc converter and a seven level inverter. Seven level inverter includes a capacitor selection circuit, a full bridge converter, inverter topologies, diode clamped, capacitor types. This seven level inverter contains six power electronic switches, this switches simplifies the circuit configuration. In which only one power electronic switch is switched at high frequency at any time. This switching power loss is reduced and the power efficiency is improved.

II. SIMULATION OF SOLAR CELL

A solar cell, or photovoltaic cell is, an electrical device that convert the energy of light directly into electricity by the photovoltaic effect, which is a physical and chemical phenomenon. It is a form of photoelectric cell, define as a device whose electrical characteristics, such as current, voltage, or resistance, vary when exposed to light. Individual solar cell device are often the electrical building blocks of photovoltaic modules, known as solar panels. The common single junction silicon solar cell can produce maximum open-circuit voltage of approximately 0.5 to 0.6 volts.

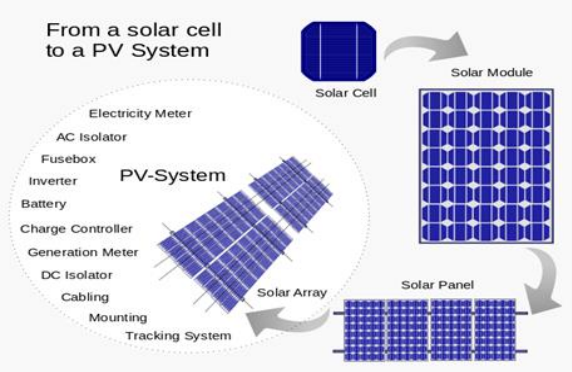

Fig.1. Solar cell

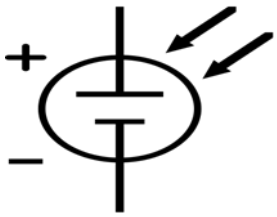

Fig.2. Symbol of photovoltaic cell

A. Photovoltaic Technology:

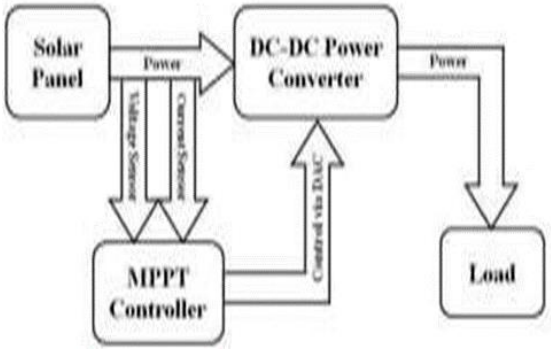

Fig.3. Block diagram of solar cell

Photovoltaic is the branch of technology and research related to the device. PV Technology is directly convert sunlight into electricity using semiconductors, that semiconductors exhibit the photovoltaic effect. Photovoltaic effect involves the creation of voltage in a material upon exposure to electron magnetic radiation. Solar cells are made up of semiconductor materials, such as silicon. In which use semi-conductor properties. The fabrication of photovoltaic solar cell in which use silicon, this silicon has four valance electrons, and this is increase its conductivity. The most commonly used solar cell model is introduced and the generalized PV model using Matlab/Simulink is developed.

B. Basic Block Diagram

The basic block diagram consists of Solar panel, DC-DC power converter, MPPT controller, Load. In which voltage and current from the solar panel is sensed by using voltage and current sensor. In This project, voltage and current values can be input to the MPPT controller. In which the MPPT algorithm used to track the maximum power point of solar panel. The output of MPPT block is connect to input to DC-DC converter. DC-DC converter is maintaining the operating voltage at the maximum power point. Varying the duty cycle of the DC-DC converter, usually in this basic block diagram used Buck, Boost, Buck-Boost configuration. This is used in their requirement, in this project Boost converter is used to step up the operating voltage at the maximum power point. DC-DC power converter is connected the solar panel and load. The heart of this project is the MPPT block, which is finding the maximum operating point of solar panel. In which gating signal to Boost converter, In which maintains the operating voltage the maximum operating point irrespective of solar irradiance and temperature.

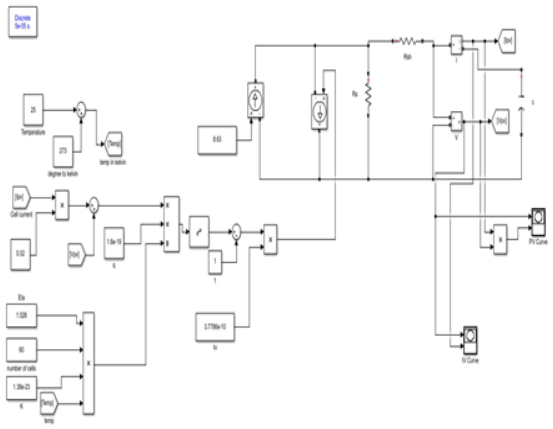

Fig.4. Simulation of solar cell

C. Simulation of Boost Converter:

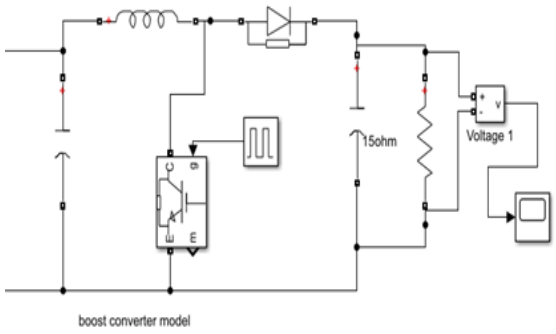

Fig.5. Simulation of Boost converter

Step up converter also called as the Boost converter. The output of Boost converter is always greater than the input. The schematic diagram of Boost converter is shown in below fig.

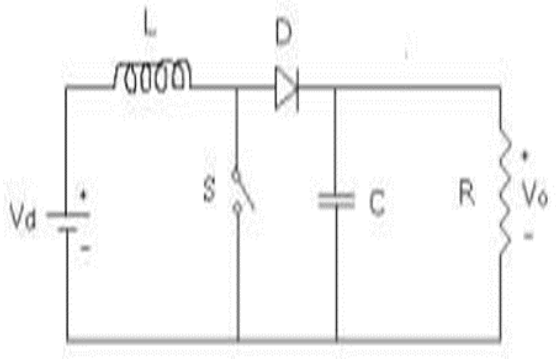

Fig.6. Schematic diagram of Boost converter

Boost converter consist of input voltage source, capacitor and resistor, resistor acts as a load. Boost converter switches close or open depends on the output requirement of switch. The output voltage of the load Resistor is always greater than input voltage. The boost converter input current is continuous. The output voltage is very sensitive to changes in duty cycle D in equation. The output current is less than the inductor current by a factor of (1 -D), and a much higher rms current would flow through the filter capacitor.

In order that the power transferred from the source to the load is maximized, according to the maximum power transfer theorem, it is essential that the source impedance is identical to the load impedance. The PV array impedance varies with respect to climate condition. For eg. Solar insolation and temperature. Thus, MPPT is nothing but a tractable impedance matching, which result leads to maximum power transfer.

D. Solar Module Connected To Boost Converter

The key principle that drives the boost converter is the tendency of an inductor to resist changes in current by either increasing or decreasing the energy stored in the inductor magnetic field. In a boost converter, the output voltage is always higher than the input voltage. A schematic of a boost power stage.

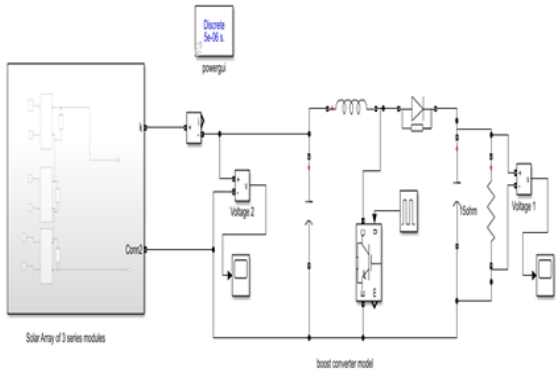

Fig.7. Solar model connected to boost converter

When the switch is closed, current flows through the inductor in the clockwise direction and the inductor stores some energy by generating a magnetic field. Polarity of the left side of the inductor is positive. When the switch is opened, current will be reduced, as the impedance is higher.

The magnetic field previously created will be reduced in energy to maintain the current towards the load. Thus, the polarity will be reversed As a result; two sources will be in series causing a higher voltage to charge the capacitor through the diode. As a result, two sources will be in series causing a higher voltage to charge the capacitor through the diode.

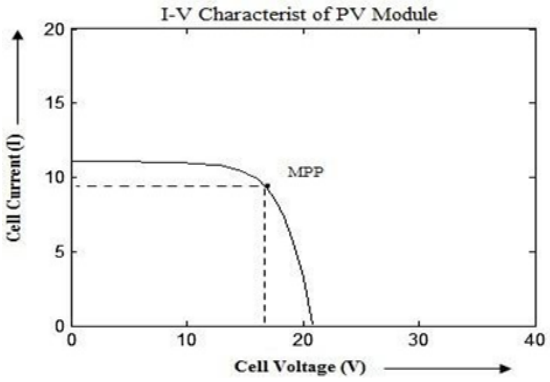

Fig.8. IV Plot

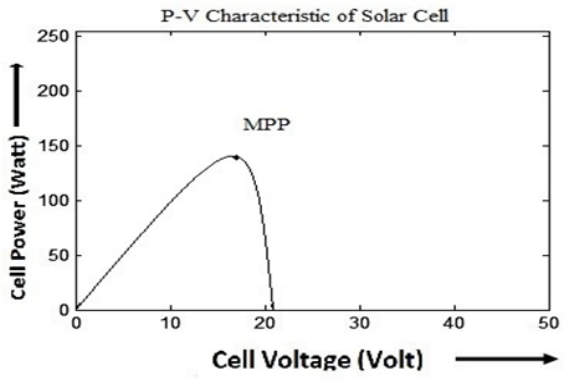

Fig.9. PV Plot

If the switch is cycled fast enough, the inductor will not discharge fully in between charging stages, and the load will always see a voltage greater than that of the input source alone when the switch is opened. Also while the switch is opened, the capacitor in parallel with the load is charged to this combined voltage. When the switch is then closed and the right hand side is shorted out from the left hand side, the capacitor is therefore able to provide the voltage and energy to the load. During this time, the blocking diode prevents the capacitor from discharging through the switch. The switch must of course be opened again fast enough to prevent the capacitor from discharging too much.

E. Inverter:

Inverters are used for voltage conversion such as DC to AC. Output voltage of an inverter can be rectangle, trapezoid or sine shaped. In which Grid connected inverters have sine wave output voltage with low distortion ratio. Inverter input voltage depends on inverter power, for small power of some 100 the voltage is 12 to 48v.

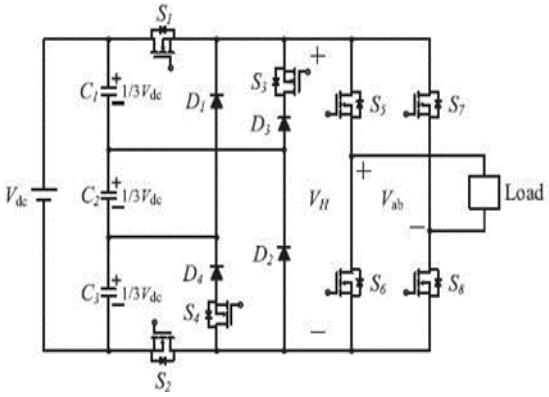

Fig.10. Seven level inverter topology

F. Seven Level Inverter:

Grid connected inverter input voltage range is from 200 to 400 V. The inverters connected in parallel series when higher powers are required. Large systems 3-phase inverters are available on the market. This Inverter connecting a PV system. In this inverter wide power range up to 100kW. The Central inverters are used in large PV power plants. Inverters connected to strings are used in wide power range applications allowing for more reliable operation. Module inverters are also called as micro inverters, it is used in small photovoltaic systems. Such solutions are applicable to larger systems. Special design inverters are available for the purposes of off-grid or hybrid systems. The multilevel inverter has a unique structure, This inverter allows high voltages with low harmonics without transformer.

The multilevel converter to accept higher power is to use a series of power semiconductor switches. In this project multiple dc voltage sources consist batteries, capacitor, renewable energy voltage source. The multilevel inverter has varies method, the simple method of inverter are parallel or series connection inverter.

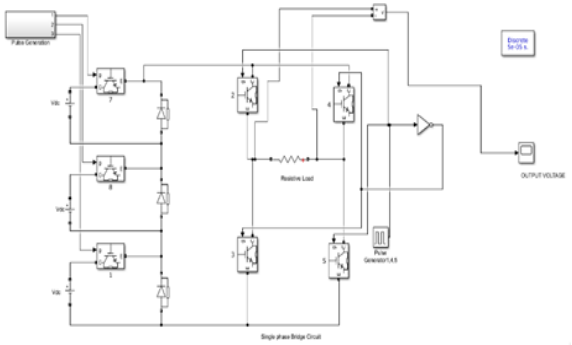

Fig.11. Simulation of seven level inverter

G. Simulation:

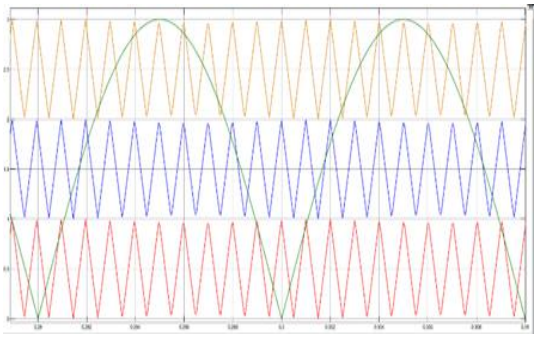

Fig.12. Simulation

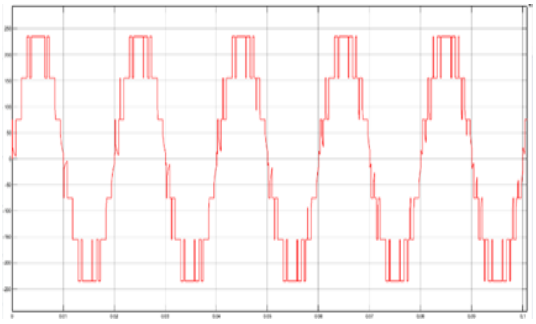

Fig.13. Simulation

H. Complete System

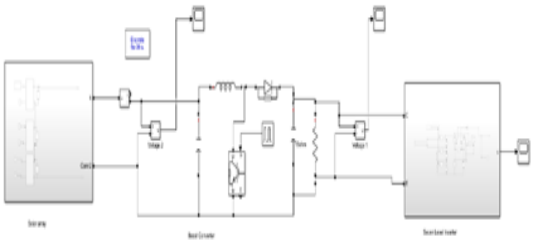

Fig.14. Seven level inverter simulation

I. Simulation

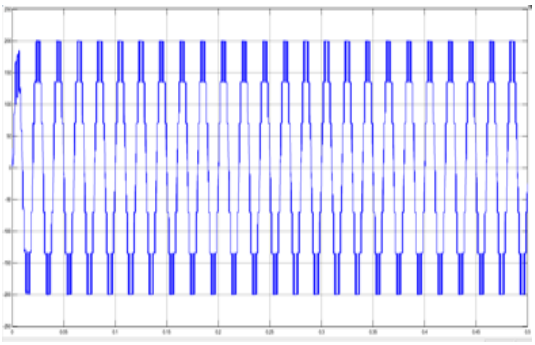

Fig.15. Waveform of seven level inverter

III. CONCLUSION

This project is a seven level inverter using solar power generation system; this system is convert DC energy to AC energy. This project output voltage of solar cell array is low and the dc/dc power converter is used in small capacity solar power generation system and in which boost the output voltage. This inverter contains six power electronic switches, this simplifies the circuit configuration. In which only one power electronic switch is switched at high frequency at any time to generate the seven-level output voltage.

This inverter reduces the switching power loss and it has improve the power efficiency. In which use two DC capacitor this inverter are balanced automatically. In which only one power electronic switch is switched at high frequency at any time. This switching power loss is reduced and the power efficiency is improved. This project output voltage of solar cell array is low and the dc/dc power converter is used in small capacity solar power generation system and in which boost the output voltage, it can match the dc bus voltage of the inverter. A filter inductor is used to process the switching harmonics. This system generates a sinusoidal output current.

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