A SEVEN LEVEL INVERTER USING A SOLAR POWER GENERATION SYSTEM

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ABSTRACT

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. Taking the effect of solar intensity and cell temperature, the characteristics of PV model are simulated. Maximum power point tracking algorithms this model used for analysis of PV characteristics and for simulation. The seven level inverter is using a capacitor selection circuit and also using a full bridge power converter. 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. This system generates a sinusoidal output current .

Keyword : - *DC-DC converter1 , PV module2, P & O Algorithm 3.*

1. 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. 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.

The multilevel inverter in which include inverter topologies, diode clamped, capacitor and cascade hbidge type. Multilevel inverters use capacitors to develop several voltage levels. But in which regulate the voltage of capacitors. In which 12 power electronic switches are used for seven level inverters. The new seven level inverters contain only six power electronic switches.

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.

In this project the maximum power point tracking algorithm like as Perturb and Observe (P & O). The Perturb and Observe method in which senses the output voltage and current of solar panel, this solar panel to determine the duty cycle of the DC-DC converter to be increased or decreased. The P & O algorithms are used in control of MPPT, It has simple structure, reduced number of necessary measured parameters and high tracking speed.

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.

2. PROPOSED WORK

2.1 Photovoltaic Technology

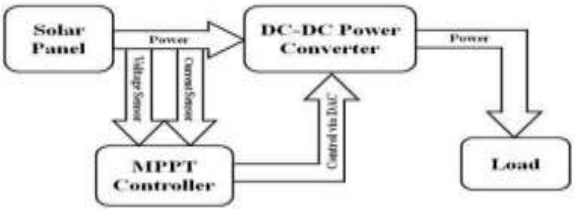
Photovoltaic's is the branch of technology and research related to the device. PV Technology is directly convert sunlight into electricity using semiconductors, that semiconductors exhibit the photovoltaic effect. Photovoltaic effect involves the creation of voltage in a material upon exposure to electron magnetic radiation. Solar cells are made up of semiconductor materials, such as silicon. In which use semiconductor properties.

The fabrication of photovoltaic solar cell in which use silicon, this silicon has four valance electrons, this is increase its conductivity. The most commonly used solar cell model is introduced and the generalized PV model using Matlab/simulink is developed.

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.

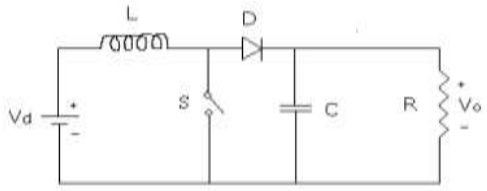
In This project voltage and current values can be input to the MPPT controller. In which the MPPT algorithm used to track the maximum power point of solar panel. The output of MPPT block is connect to input to DC-DC converter. DC-DC converter is maintaining the operating voltage at the maximum power point. Varying the duty cycle of the DC-DC converter, Usally 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 at the maximum operating point irrespective of solar irradiance and temperature.



Basic block diagram

2.2 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.



schematic diagram of Boost converter

Boost converter consists of input voltage source, switch, inductor, diode, 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.

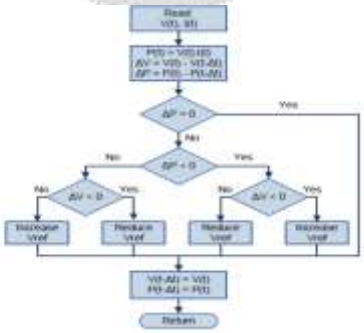
2.3 MPPT control algorithms

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.

2.4 P & O Algorithm

P & O algorithms are used in MPPT. P & O algorithm has a simple structure and in which few parameters are required. They operate by incrementing or decrementing periodically perturbing. Suppose the power is increasing, the perturbation will continue in the same direction in the next cycle, otherwise the perturbation direction will be reversed. That means the array terminal voltage is perturbed.In this cases varying constant or slowly atmospheric conditions.

The P&O algorithm operates incrementing or decrementing the output terminal voltage of the PV. and The P&O algorithm comparing the power obtained in the current cycle with the power of the previous cycle. In which the voltage varies and the power increases and the control system changes the operating point in that direction, otherwise change the operating point in the opposite direction. Once the direction for the change of current is known, the current is varied at a constant rate. This project flowchart algorithm as shwon in bellow fig. A modified version is obtained when the steps are changed according to the distance of the MPP, resulting in higher efficiency. This is an excellent method to reach the MPP and it is independently from the PV panel, although this method may suffer from fast changes in environmental conditions.



Flowchart of the P&O Algorithm.

2.5 Incremental conductance

P & O algorithm has a simple structure and in which few parameters are required. They operate by incrementing or decrementing periodically perturbing. MPPT algorithm is also called incremental conductance algorithm. In which maximum power point compare to incremental and instantaneous conductance . this project incremental conductance procedure is explained in fig.

The PV panel voltage and current are measured at fixed sampling intervals and fed to the controller to calculate the PV panel power. Once these variables are updated, the method tracks the maximum power point by comparing the incremental and instant conductance of the solar array until the maximum power point (MPP) is reached, as illustrated in Fig.

2.6 DC-DC Power Converter

The DC–DC power converter is a boost converter and a current-fed forward converter. The boost converter consist inductor LD, power electronic switch, diode. The boost converter charges capacitor of the seven-level inverter. The current-fed forward converter to inductor , power electronic switches, a transformer, and diodes. In which the current-fed forward converter charges capacitor of the seven-level inverter. The inductor LD and the power electronic switch SD1 of the current-fed forward converter are used in the boost converter.When switch is turned ON In this project solar cell array supplies energy to the inductor LD. It should be noted that the current of the magnetizing inductance of the transformer increases when Switch is in the ON state.

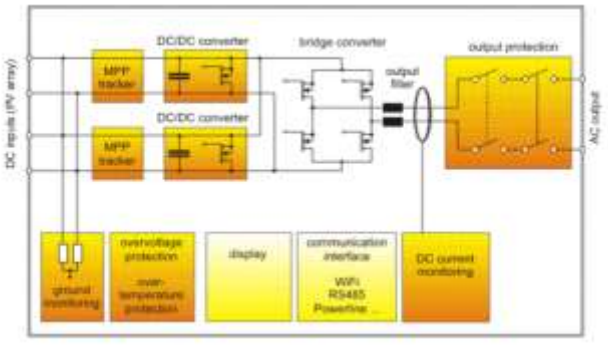
2.7 INVERTER

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 48 V.

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. Some inverters can be connected to the *master-slave* criteria. 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. Inverters consist of microprocessor circuits, classic or RISC, and on power MOS, IGBT.

Inverter Construction

The inverter consist MPPT algorithm, Input, MPP unit ,DC/DC converter, switching bridge, output inductance, output DC current detection (protection function), ENS protection.



Main parts of an inverter

Solar inverters classified into three broad types:

1. Stand-alone inverters: It is used in isolated systems, In which the inverter draws its DC energy from batteries charged by photovoltaic arrays. Many stand-alone inverters also incorporate integral battery chargers.

2.Grid-tie inverters: In which the match phase with sine wave.This inverter is designed to shut down automatically. This inverter does not provide back up power.

3.Battery backup inverters: This battery backup inverter are special inverters, yjis inverter are designed to draw energy from a battery. This inverter manage the battery charge via an onboard charger, and export excess energy to the utility grid.

2.8 Multilevel Inverters

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

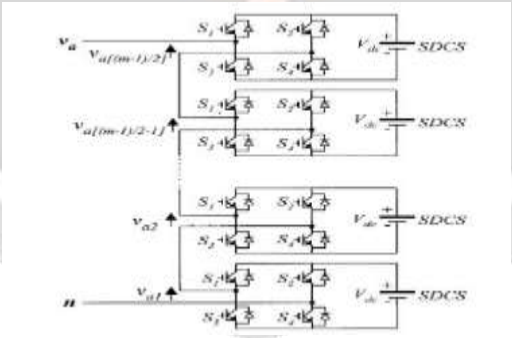
Multilevel inveter has varies topologies such as diode clamped, flying capacitors, cascaded. The cascaded or H-bridge converter separate DC source. In which convert power medium and high, This is application of multilevel converter.

2.9 CASCADED H-BRIDGE INVERTER

Cascaded H-Bridge application is adjustable speed drive. It has consist of single phase full bridge inverter units. Every units has own dc source means it has separate dc source. This inverter is connected in series connection. cascaded H-bridge inverter has separate dc sources as shown in bellow fig. In which four switches and it has different output, +Vdc, -Vdc and zero. The AC outputs of different converters are connected in series.

Output-phase voltage levels (M)=2N+1

Where ‘M’ is the no of levels and ‘N’ is the number of DC sources.



Single phase structure of a cascaded H-bridge inverter

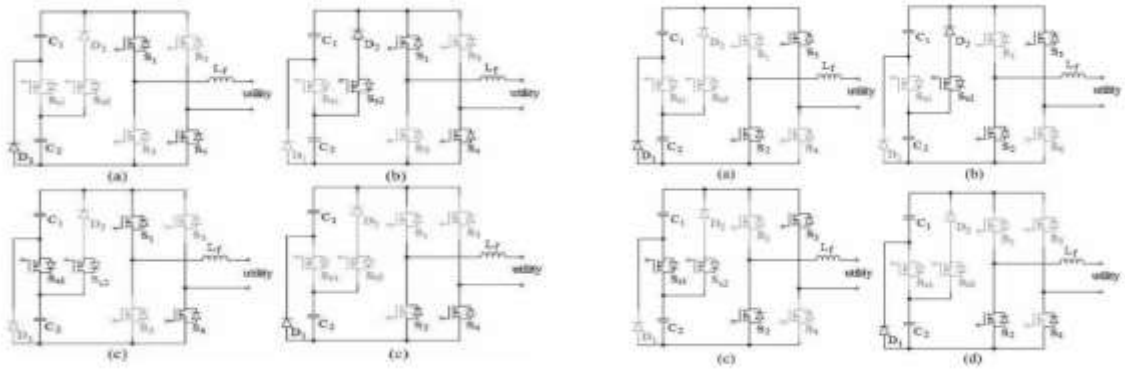
The cascaded H-bridge inverter as shown in Fig. above, we can make the seven level without using any modulation technique.

Mathematical relation M=2N+1

2.10 Seven Level Inverter

The seven-level inverter is connected in cascade. This seven level inverter divided into the positive half cycle and negative half cycle. It consist capacitor, power electronics switches, capacitor selection circuit, diode.

The output current of the project system will be controlled to be sinusoidal, the output current of the seven-level inverter is also positive in the positive half cycle of the utility. The seven-level inverter in the positive half cycle can be further divided into four modes, as shown in bellow Fig.



Operation in the positive half cycle
(a) mode 1 (b) mode 2 (c) mode 3 (d) mode 4

Operation in the negative half cycle
(a) mode 5 (b) mode 6 (c) mode 7 (d) mode 8

3. CONCLUSIONS

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 .

5. REFERENCES

[1] Buticchi, G.; Barater, D.; Lorenzani, E.; Concari, C.; Franceschini, G. A nine-level grid-connected converter topology for single-phase transformerless PV systems. IEEE Trans. Ind. Electron. 2014, 61 , 3951–3960.

[2] Z. Zhao, M. Xu,Q. Chen, J. S. Jason Lai, and Y. H. Cho, "Derivation, analysis,and implementation of a boost–buck converter-based high-efficiency pv inverter,"IEEE Trans. Power Electron., vol. 27, no. 3, pp. 1304– 1313,

[3] K. Hasegawa and H. Akagi, "Low-modulation-index operation of a five level diode-clamped pwm inverter with a dc-voltage-balancing circuit for a motor drive," IEEE Trans. Power Electron., vol. 27, no. 8, pp. 3495–3505,Aug. 2012

[4] N. A. Rahim, K. Chaniago, and J. Selvaraj, "Single-phase seven-level grid-connected inverter for photovoltaic system," IEEE Trans. Ind. Electr. vol. 58, no. 6, pp. 2435– 2443, Jun. 2011.