Simulation of Seven Level Inverter with Five Switch Topology

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Abstract:

This paper concentrated on the non conventional energy sources requirement in now days because they are contamination free, effortlessly erectable, and unlimited. In this process one effective converter is required to produce the general ac power from the dc power which is fed back to grid. Here cascaded multi level inverter preferred for the conversion of dc power into our ac power with the integration of non conventional energy source generated power. Flying capacitor technology contains the number of capacitors higher manner in this case the controlling of charging and discharging methods are very difficult and the diode clamped inverters having the utilizations extra switches like as diodes. The MLI converters dc voltage levels into ac with less harmonic contents with presence of additional special switching operation with the SPWM technique and also provided MPPT algorithm which is utilized to enhance the system performance to the grid side by controlling the frequency. The seven level MLI are implemented with SPWM technique the models are tested and verified within the MATLAB/SIMULINK.

Keywords — *Grid interconnection, PV system, MLI, Renewable energy sources (RES, MPPT Algorithm.*

I. INTRODUCTION

Renewable energy sources are alternatives to our conventional energy sources such as fossil fuels e.g. oil, coal, gas that are not renewable. The conventional energy sources are limited and can be exhausted. Many renewable energy sources are existing such as solar, wind, biomass, hydro, geothermal and ocean power. Among PV has the advantage of clean and no pollution, and etc. Maximum power point tracking is a technique that solar inverters use to get the most possible power from the PV array. Over the past decades many methods to find the MPP have been developed and published. These techniques differ in many aspects such as required sensors, complexity, cost, range of effectiveness, convergence speed, correct tracking when irradiation and/or temperature change, hardware needed for the implementation or popularity, among others. Among these techniques, the Perturb&Observe and In Conductance algorithms are the most common techniques.

Framework interconnection of PV requires a proficient converter to converter the low voltage DC into AC. The ordinary H-span inverter creates a square yield, which contains unending number of odd music what's more, dv/dt anxiety is likewise high. Ordinary PWM inverter can lessens the THD, yet exchanging misfortunes are high furthermore this inverter is confined to low power applications. The significance of multilevel inverters [MLI] has been expanded since last few decades. These new sorts of inverters are suitable for high voltage and high power applications due to their capacity to blend waveforms with better constant range and with less THD. Among multilevel inverters we have different types. They are 1.Diode Clamped MLI 2.Flying capacitor MLI 3.Cascaded H-span MLI. Diode clamped MLIs require huge number of diodes as the level increments. In flying capacitor MLIs, Switching use and effectiveness are poor furthermore it requires substantial number of capacitors as the level builds and cost is moreover high. Fell H-span MLIs are for the most part favoured for high power applications as the regulation of the DC transport is basic. In any case, it requires separate dc sources furthermore the multifaceted nature of the structure is expansions as the level dominatingly increment.

Multilevel converters have been continuously developed in recent years due to the necessity of increase in power level to find industrial applications, especially high power applications, such as high power ac motor drives, active power filters, reactive power compensation, and FACT devices. The main reason is the capability of these topologies to handle voltage/power in the range of kilovolts/megawatts due to recent developments in the area of high power semiconductors and capacitor voltage sources which generate output voltage with stepped waveforms. For example a general multilevel inverter structure consists of a one H-bridge inverter and 'N' number of cascaded cells, which are having a dc rating of V dc. The number of levels can be given by the formula: Number of Levels = [0 (0+1) +1] Where n= Number of cells excluding the H-bridge. For

generating + V dc we need turned on switches S I and S2, for -V dc, switches S3 and S4 has to be turned on, and for zero voltage either switches Sl and S3 or switches S2 and S4 has to be turned on.

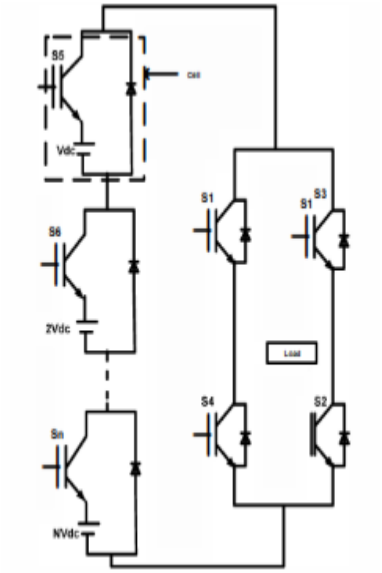

Fig 1: General Multilevel Inerter Structure

In the base paper it has a new type of multi level Inverter which requires less number of DC sources and switches compared to cascaded H-bridge MLIs. THD of the output is also less when compared to the conventional MLIs. By using that inverter they can efficiently integrate the PV into the existing conventional power grid. In that paper they used only six switches for seven level MLI.

With a specific end goal to address the above concerns, this paper proposes a special switching operation of multilevel inverter and changes contrasted with Cascaded H-span MLI. THD of the yield voltage is additionally less when contrasted with the customary MLI. By utilizing this inverter we can proficiently incorporate the PV into the current ordinary force. The proposed system uses Perturb&Observe MPPT technique and SPWM to control multilevel converter. The converters which convert dc voltage levels into ac with less harmonic contents with presence of special switching operation with the SPWM technique. And also provided MPPT algorithm which is utilized to enhance the system performance to the grid side by controlling the frequency. The seven level MLI are implemented with SPWM technique the models are tested and verified within the MATLAB/SIMULINK.

The advantages of the proposed system are 1.The presence of special converter of MLI the generation of harmonics reduced. 2.The MPPT technique the performance of the system enhanced. 3.The generation of power is integrated to grid which reduces ripple content by controlling the frequency. 4. In this we are using fewer switches when compared to cascaded MLI. So the switches cost is reduced. 5. And the switching losses are also reduced. And the disadvantage is the utilization number of dc voltage sources will requires more.

II. GRID CONNECTED PV SYSTEM WITH MPPT TECHNIQUE:

The block diagram of the grid connected PV system is shown in the figure. It consists of a PV system with MPPT technique to special switching operation of multilevel inverter to interface with the grid. From the figure the PV cell directly converters the solar energy into electricity in the form of dc. By the MPPT technique the maximum voltage obtained from the PV is converted into ac using the multilevel inverter. Finally the multilevel inverter is connected to the power grid with satisfying the grid requirements such as frequency and amplitude of the grid voltage.

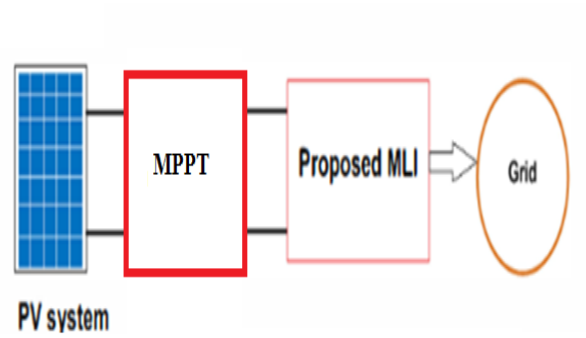

Fig 2: Grid Tied Photovoltaic System (PV)

A. PV System

The basic element of a PV system is the solar cell. A solar cell directly converts the energy of sunlight directly into electricity in the form of dc. A typical PV cell consists of a p-n junction formed in a semiconductor material similar to a diode as shown in the figure 1.

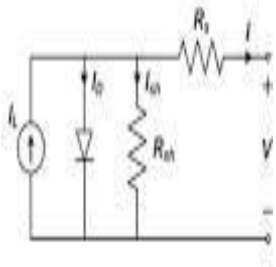

Fig 1: single diode model of solar cell

B. MPPT Technique

In MPPT techniques there are so many types. From those I used Perturb&Observe algorithm. The P&O algorithm is also called “hill-climbing”,

but both names refer to the same algorithm depending on how it is implemented. Hill-climbing involves a perturbation on the duty cycle of the power converter and P&O a perturbation in the operating voltage of the DC link between the PV array and the power converter. In the case of the Hill-climbing, perturbing the duty cycle of the power converter implies modifying the voltage of the DC link between the PV array and the power converter, so both names refer to the same technique. In this method, the sign of the last perturbation and the sign of the last increment in the power are used to decide what the next perturbation should be. The MPP incrementing the voltage increases the power whereas on the right decrementing the voltage increases the power. If there is an increment in the power, the perturbation should be kept in the same direction and if the power decreases, then the next perturbation should be in the opposite direction. Based on these facts, the algorithm is implemented. The process is repeated until the MPP is reached. Then the operating point oscillates around the MPP. P&O is the most commonly used MPPT method due to its ease of implementation. This method may result in top level efficiency. In this method if the power increases the controller adjusts the voltage by small amount from the array and measures power.

III. OPERATION OF PROPOSED SEVEN LEVELS MLI

Multi level inverters are proposed with high electromagnetic compatibilities with reduced switching losses which can deliver high power quality improvements. In this proposed multi level inverters are implemented with the cascaded inverter model because of they have separate Dc voltage sources is enough not required any additional switches like capacitors diodes. The MLI are proposed because it generates voltage without imbalance due to this the reliability increases.

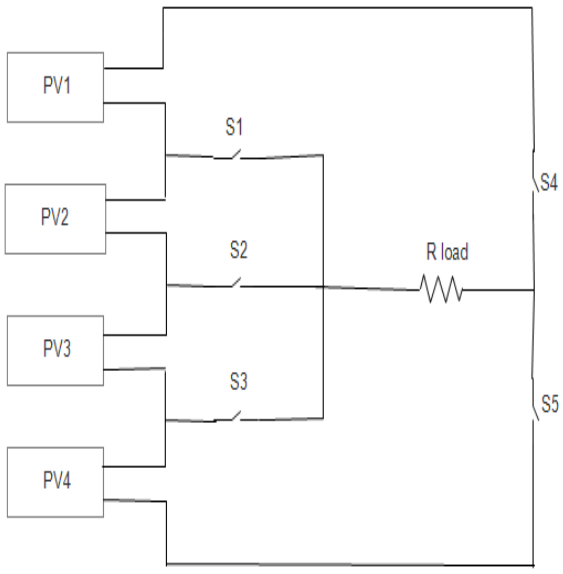

Fig 3: Block Diagram of Seven Level Inverter With Five Switches

In this presented model contains only 5 switches were utilized instead of 12 switches in the conventional multi level inverters. Which can reduces the switching losses and conduction losses very effectively. The implemented model was operated with five switch topology as shown in figure. The circuit contained four dc voltage sources with load in the single phase system.

In this proposed model implemented with Photo Voltaic model. In this model consisted the controllable current sources with temperature and irradiance parameters. The controllable voltage and current sources control current voltage and produce low voltage and high currents from entire PV systems.

IV. CONTROL STRATEGY MPPT TECHNIQUE

It is operated with the SPWM control strategy and MPPT algorithm. In this the MPPT algorithm utilized the Voltage and Currents from the PV array. In the algorithm it contains different conditions are verified under normal abnormal conditions with time delays finally it will deliver some error signals. The error signals are modulated with the help of gain mechanism with the memory storage devices. At last it produced a signal which is having higher efficiency levels by different environment conditions. The generated signal which is again compared with the signal and triangular signal by the relation operator finally it produces the pulses for to conduct the switches of MLI. The proposed controlling strategy is given in figure.

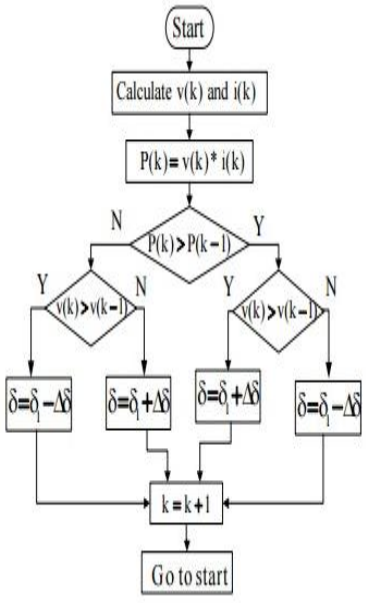

Fig 4: Control Strategy By MPPT Algorithm

The outline of heartbeat era circuit makes the topology contrast from others in order to acquire the exceptional heartbeat example to trigger the switches at the correct moment. Switches S1, S2, and S3 should be mandatorily unidirectional or else the yield waveform will get twisted. Decreased switches make the circuit conservative and easy to understand. In spite of the fact that the use of 4 dc hotspots for the era of 7-level MLI results in less use of sources, switch lessening advantages in low exchanging misfortunes. No H-Bridge is utilized. Only 2 switches assume the part of extremity inversion.

Sw1	*Sw2*	*Sw3*	*Sw4*	*Sw5*	*Load Voltage*
Off	Off	On	Off	On	V_{dc}
Off	On	Off	Off	On	$2V_{dc}$
On	Off	Off	Off	On	$3V_{dc}$
Off	Off	Off	Off	Off	0
On	Off	Off	On	Off	$-V_{dc}$
Off	On	Off	On	Off	$-2V_{dc}$
Off	Off	On	On	Off	$-3V_{dc}$

Switching operation for the proposed seven level inverter is as shown in above table.

The model produces the output voltage level as m= ((2*n)-3):
Where m= generation of voltage level
N= number of utilizing switches
The generation of output voltage with considering the dc- voltage source requirement m=((2*v)-1)
V= utilization of dc voltage sources.

The generated voltage and current waveforms are shown in figure. The waveforms contains less THD values because of they utilized only 5 switches.

V. SIMULATION RESULTS:

The following figures are the simulink diagrams and outputs.

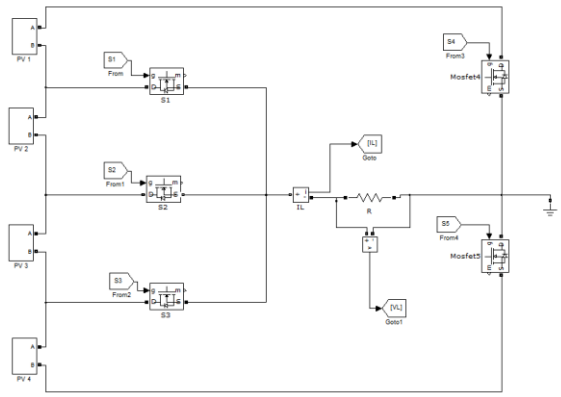

Fig 5: Matlab/Simulink Circuit of Proposed Seven Level Inverter

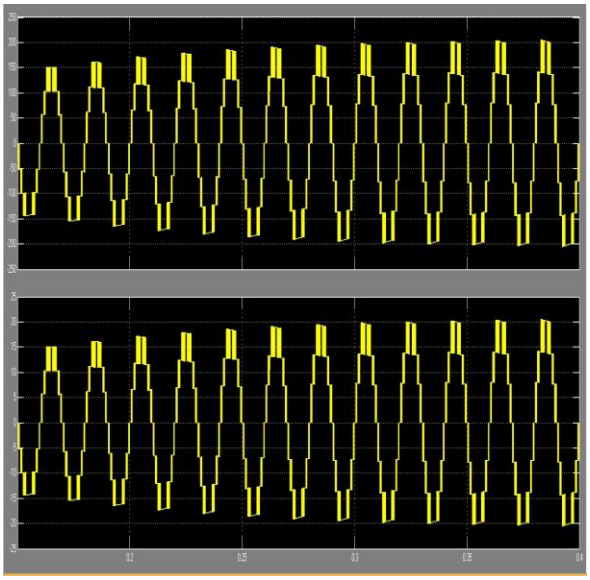

Fig 6: Output Voltage and Current Waveform of Proposed Seven Level MLI

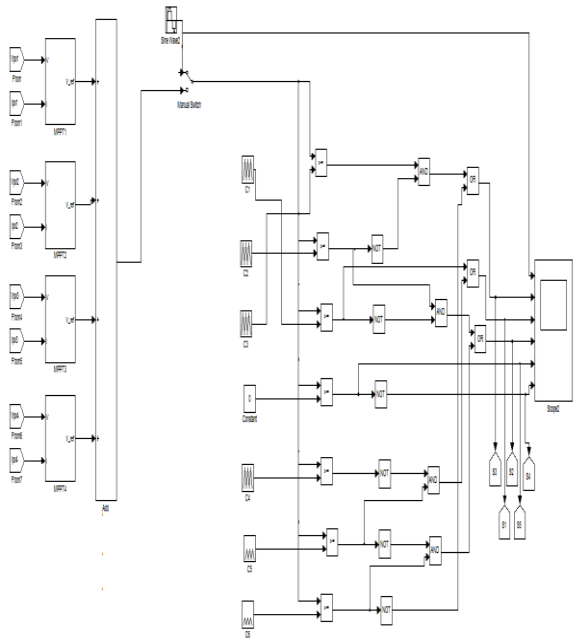

Fig 7: Matlab/Simulink Circuit of MPPT of MLI

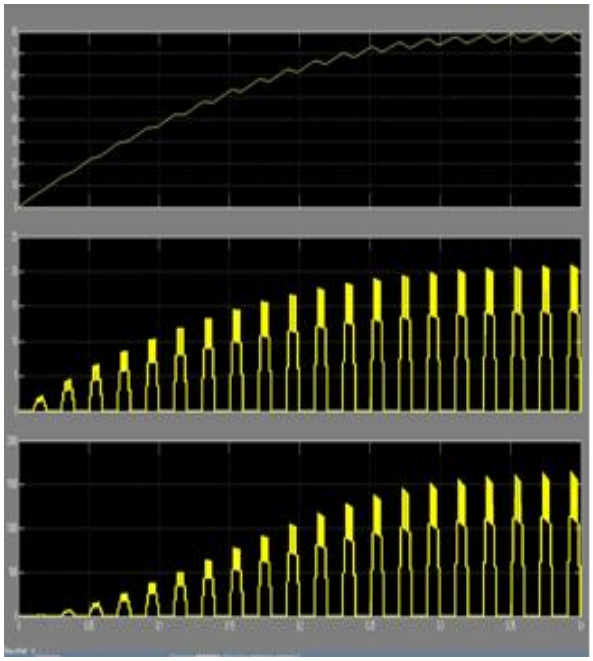

Fig 8: Outputs Of PV Voltage,Current and Power

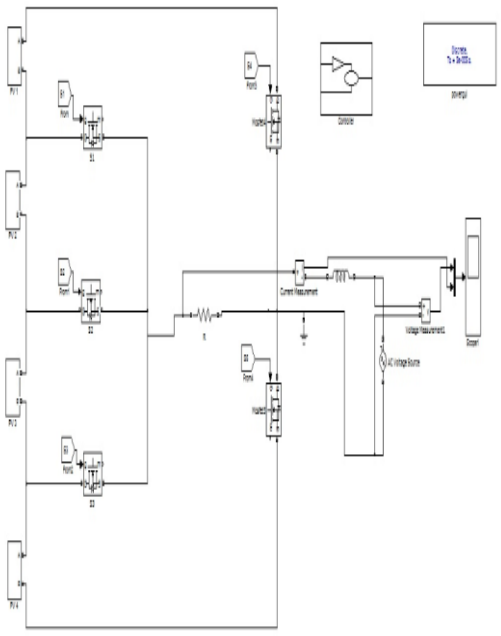

Fig 9: Matlab/Simulink Diagram of Grid Connected Sevel Level Inverter

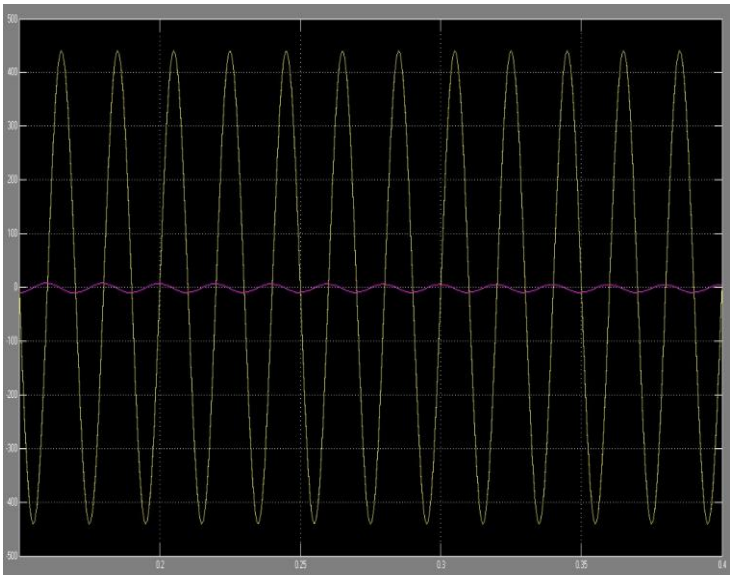

Fig 10: Grid Voltage And Grid Connected Current

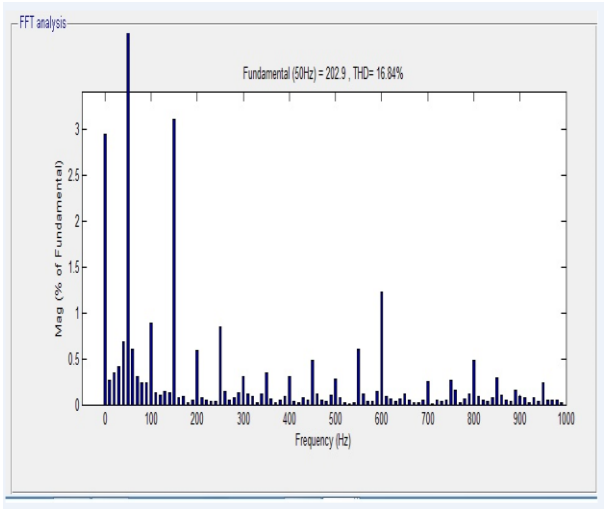

Fig 11: THD of the Proposed 7-Level Inverter

From figure 11, the THD of the proposed seven level inverter is 16.84%.When compared to the existed system the THD value is decreased.

Pv Array Output Parameters

V	***75V***
I	***20A***

Seven Level Inverter Output Parameters

V	**200V**
I	**20A**

Grid Parameters

V	***440V***
I	***10A***

Sinusoidal wave time period	**0.02s**
Triangular wave time period	**1/15000s**
Operating frequency	**50hz**
Switching frequency or carrier frequency	**15000hz**

VI. CONCLUSION

This paper concentrated on the grid connected PV system power generation with MLI with special switching operation. The proposed converter having less number of switches can control the conversion in smooth manner. But whenever the switches were reduced the presence of switching losses reduced and also to compensate the losses and enhances the efficiency levels purpose I used in the proposed system MPPT technique with SPWM technique. This can reduce the harmonic contents will effectively which also minimizes of THD content values then automatically the utilization of filters cost reduced at grid side. Finally the generated power at grid side very effectively because of frequencies compensated by the integration.

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