Review on Modelling and Simulation of PV based single phase seven level grid connected inverter system

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ABSTRACT

This paper reviews several multi-cells with independently powered DC sources. Because the output voltage waveform of multilevel inverters is nearly sinusoidal, they are promising. A single seven-level inverter with a novel pulse width-modulated (PWM) control technology is the norm for grid-connected solar systems. In this project, two H-bridge inverters with different dc sources were used. The main purpose of the suggested system is to reduce fluctuation, and if there are any louds, a pure sinusoidal waveform is required. That much room is created and consumed by the industry. When used in a tiny grid like this, any device will function properly. A buck boost converter is utilized to regulate photovoltaic power in this review article. The MPPT technology is used in the proposed system to fully use the maximum amount of energy accessible from solar panels to the grid. In this paper the Review of cascaded H-bridge multiInverter for PV connected grid is discussed in detailed.

Keyword: *Pulse width Modulation, Multilevel inverter, Modified H – Bridge Inverter, Bidirectional Switches*

I. INTRODUCTION

Solar photovoltaic power is getting increasingly widespread, and applications of nonconventional energy sources are becoming more relevant. Because of unique benefits like easy allocation, high dependability, high flexibility, low fuel cost, low maintenance, noiseless operation, and little wear and tear due to the lack of moving components. Solar energy offers the added benefit of being a pollution-free, clean source of energy. Solar and wind facilities are among the most widespread types of renewable energy sources, thanks to improved power electronic equipment and procedures. Photovoltaic sources are used in a wide range of applications, including low- and medium-power.

PV with inverter converts DC power from PV panels to AC power, which is then delivered to the load. Multilayer inverters for medium and high voltage applications have aroused the interest of academics and business in recent years. Multilevel inverters have garnered more attention as a result of their capabilities and high-power applications. Multilayer inverters have several advantages, including higher power quality, lower order harmonics, fewer switching losses, and reduced electromagnetic interference. These multilevel generate a stepped inverter waveform using a number of input voltage sources as the input and a proper combination of power semiconductor switches. The ultimate goal of a multilayer inverter is to maintain power quality while keeping output waveforms close to sinusoidal. The multilayer inverter not only has high power ratings, but it also allows for the utilisation of renewable energy sources. For high-power applications, photovoltaic, wind, and fuel cell energy sources can all be easily coupled to a multilevel inverter system.

The article of Modeling and simulation of single phase seven level inverter for grid connected PV system they has been studied by large amount of researchers. A brief literature review related to seven level inverter using PV system theory.

V. Vinoth Kumar, et al. [3] presented the Multilevel inverter has emerged recently as a very important alternative in the area of high-power medium voltage energy control. This project present cascaded multi cell with separate DC sources. Multilevel inverters are promising they have nearly sinusoidal output-voltage waveforms, output with better harmonic profile, less stressing of electronic components. The conventional is a single-phase seven-level inverter for gridconnected photovoltaic systems, with a novel pulse width-modulated (PWM) control scheme.

Lalit Dutta, et al [4] focuses on Photovoltaic systems are becoming more widespread with the increase in the energy demand and it also reduces the environmental pollution around the world. Out of different structures of multi-level inverters, Cascaded H Bridge (CHB) inverter is more suitable converter for PV applications since each PV panel can act as a separate DC source for each cascade H bridge module. A mathematical model for the photovoltaic panel is developed and implemented with the multilevel inverter. There are many limitations in extracting power from renewable energy resources. To minimize the power demand and scarcity we have to improve the power extracting methods. Multilevel inverter can be used to extract power from solar cells. It synthesizes the desired ac output waveform from several dc sources. The main objective of this paper is to study the5-level and 7-level Cascaded Multilevel Inverter. In this paper the different parameters (like voltage, current, THD) in 5-level and 7-level Cascaded Multilevel Inverter are observed.

G.Balasundaram, et al. [2] Focuses on a single phase seven level modified H–Bridge inverter with less number of power switches for renewable energy applications. The main objective of proposed system is less number of power switches for improves the output waveforms and better harmonic profile. The structure of the system is simple and easy to extend for higher levels. The proposed system using MPPT technique for fully utilize the maximum energy from photovoltaic to grid. This system employed comprises of single bridge with two bidirectional switches and allows the flexible, efficient and also reliable generation of high quality electric power from PV array. The performance of the proposed system was verified by simulation using MATLAB/SIMULINK, PROTEUS and Hardware model.

Nasrudin A. Rahim, et al. [1] discusses the concept of a single-phase seven-level inverter for grid-connected photovoltaic systems, with a novel pulsewidth-modulated (PWM) control scheme. Three reference signals that are identical to each other with an offset that is equivalent to the amplitude of the triangular carrier signal were used to generate the PWM signals. The inverter is capable of producing seven levels of output-voltage levels (Vdc, 2Vdc/3, Vdc/3, 0, −Vdc, −2Vdc/3, −Vdc/3) from the dc supply voltage. A digital proportional–integral current-control algorithm was implemented in a TMS320F2812 DSP to keep the current injected into the grid sinusoidal. The proposed system was verified through simulation and implemented in a prototype.

Over the years, various topologies for multilayer inverters have been developed. like Diode-clamped [5–10], flying capacitor or multicell [11–17], cascaded H-bridge [18]–[24], and modified H-bridge multilevel inverter [25]–[29]. In this paper the Review of cascaded H-bridge multi inverter for PV connected grid is discussed in detailed.

II. Configuration of PV Array Modelling

A PV system is composed of one or more solar PV panels, an AC/DC power converter (also known as an inverter), and a rack system that holds the solar panels, and the mountings and connections for the other parts customers. The PV Array block is a five parameter model using a current source IL (light-generated current), diode (I0 and nI parameters), series resistance Rs, and shunt resistance Rsh to represent the irradiance- and temperature-dependent I-V characteristics of the modules.

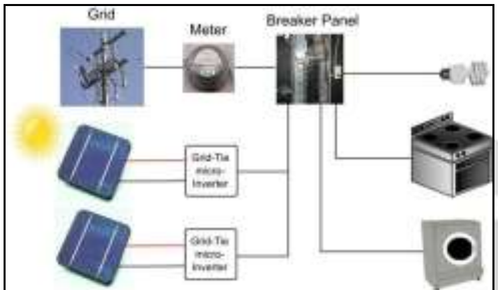

Fig 1: Schematic diagram of a simple photovoltaic system

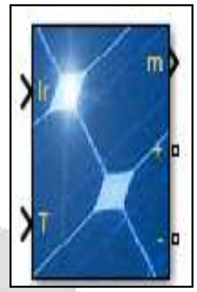

Fig 2: PV Array block

The PV Array block implements an array of photovoltaic (PV) modules. The array is built of strings of modules connected in parallel, each string consisting of modules connected in series.

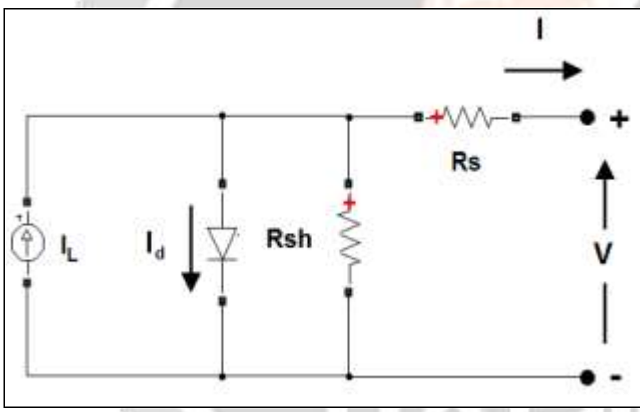

Fig 3: PV array equivalent Circuit

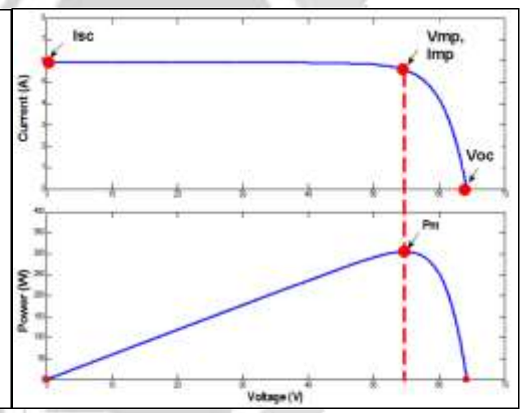

Fig 4: PV array V-I and P-V characteristics of solar cell

The diode I-V characteristics for a single module are defined by the equations

$$I_d = I_0\left[\exp\left(\frac{V_d}{V_T}\right) - 1\right]$$

$$V_T = \frac{kT}{q} \times nI \times Ncel$$

Where, Id *= Diode Current (A)*

Vd *= Diode Voltage (V)*

Maximum Power Point Tracking PV (P&O) algorithm

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. Maximum power point tracking (MPPT) is an algorithm implemented in photovoltaic (PV) inverters to continuously adjust the impedance seen by the solar array to keep the PV system operating at, or close to, the peak power point of the PV panel under varying conditions, like changing solar irradiance, temperature, and load. MPPT algorithms are typically used in the controller designs for PV systems. The algorithms account for factors such as variable irradiance (sunlight) and temperature to ensure that the PV system generates maximum power at all times. The perturb-and-observe (P&O) maximum power point tracking approach is employed in this study shown in fig 5. The P & O method has a simple structure and only requires a few parameters. They work by periodically perturbing and incrementing or decrementing. The P&O algorithm works by increasing or decreasing the PV's output terminal voltage And P&O is a perturb-and-observe algorithm that compares the power obtained in the current cycle to the power obtained in the previous cycle.

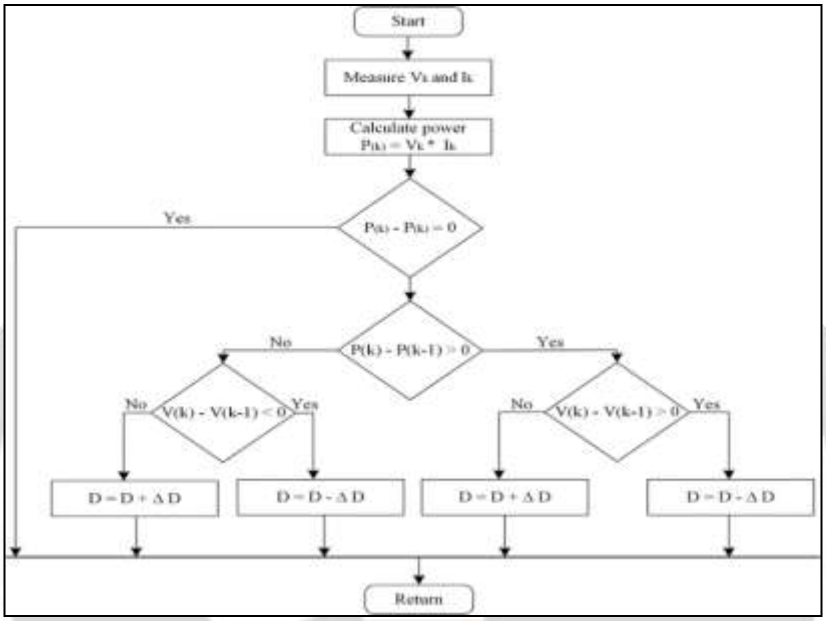

Fig-5 Flow chart of P & O algorithm

III Proposed Cascaded H-bridge Multilevel Inverter Configuration

The seven-level inverter in [7] has been used to develop the proposed single-phase seven-level inverter. As illustrated in Figure 2, it consists of a single-phase conventional H-bridge inverter, two bidirectional switches, and a capacitor voltage divider constituted by C1, C2, and C3. For inverters of the same number of levels, the modified H-bridge architecture has substantial advantages over other topologies, such as fewer power switches, power diodes, and capacitors. A dc–dc boost converter was used to connect photovoltaic (PV) arrays to the inverter.

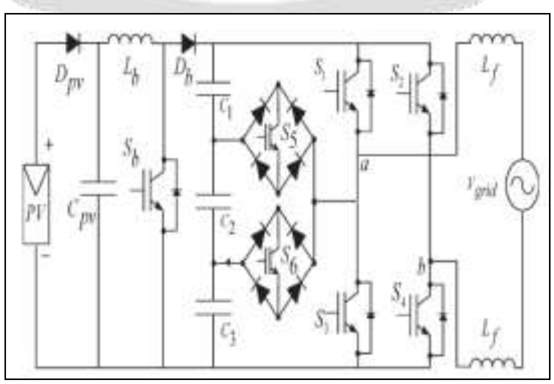

Fig-6 Single-phase seven-level grid-connected inverter for photovoltaic systems.

The utility grid, instead of just a load, was employed to deliver the power produced by the inverter to the power network. Because the PV arrays' voltage was lower than the grid voltage, a dc–dc boost converter was necessary. To ensure that power flows from the PV arrays to the grid, high dc bus voltages are required. The current injected into the grid was filtered using a filtering inductance Lf. From the dc source voltage, the inverter may produce seven output voltage levels (Vdc, 2Vdc/3, Vdc/3, 0, -Vdc, -2Vdc/3, -Vdc/3) with proper switching. Fig. 7. Switching pattern for the single-phase seven-level inverter Output voltage for 7 levels of output voltage according to the switches' on–off condition is shown in the table below.

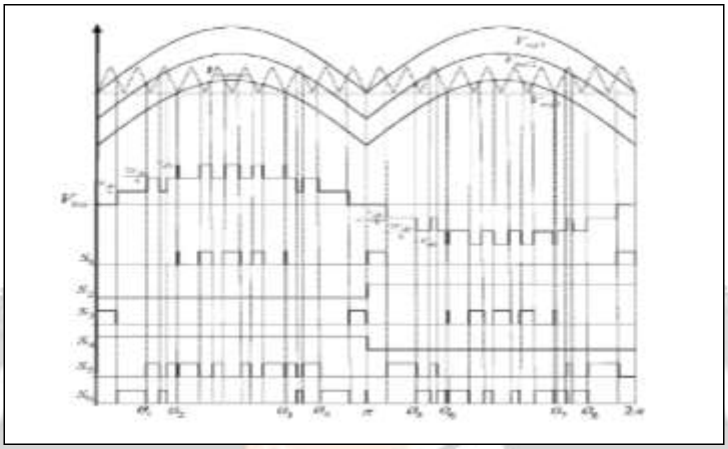

Fig. 7. Switching pattern for the single-phase seven-level inverter.

Table -1 OUTPUT VOLTAGE ACCORDING TO THE SWITCHES' ON–OFF CONDITION

v_0	S_1	S_2	S_3	S_4	S_5	S_6
V_{dc}	on	off	off	on	off	off
$2V_{dc}/3$	off	off	off	on	on	off
$V_{dc}/3$	off	off	off	on	off	on
0	off	off	on	on	off	off
0*	on	on	off	off	off	off
$-V_{dc}/3$	off	on	off	off	on	off
$-2V_{dc}/3$	off	on	off	off	off	on
$-V_{dc}$	off	on	on	off	off	off

As the performance of the PV panel changes, the MPP shifts, and the ability to locate the MPP at any given time is critical. Recognizing the MPP allows the inverter to extract all of the power produced by the PV panel by drawing the proper voltage and current from it. The PV panel's efficiency is maximised when it is operated at the MPP. Because of the complicated link between the PV module's output current and voltage, determining where the MPP is located is difficult. The perturb-and-observe (P&O) maximum power point tracking approach is employed in this study shown in fig 3. The P & O method has a simple structure and only requires a few parameters. They work by periodically perturbing and incrementing or decrementing. The P&O algorithm works by increasing or decreasing the PV's output terminal voltage And P&O is a perturb-and-observe algorithm that compares the power obtained in the current cycle to the power obtained in the previous cycle.

IV Proposed Multilevel Inverter Model for PV connected Grid

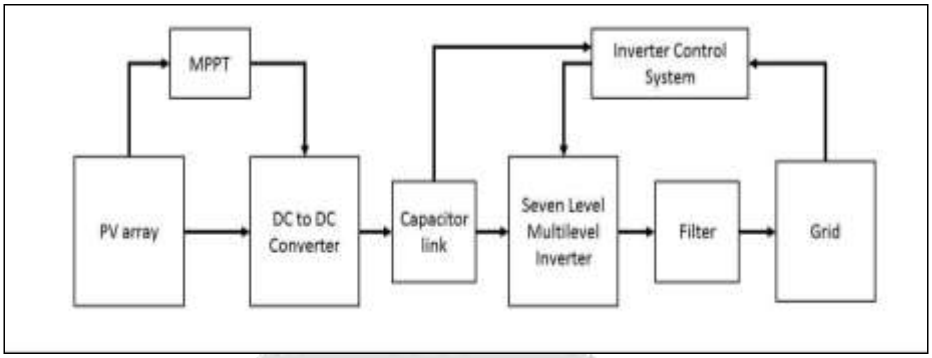

Fig-8 Block diagram of a single phase seven level inverter for grid connected photovoltaic system

The construction of a modified single-phase multilevel inverter with two diode integrated bidirectional switches and a novel pulse width modulated (PWM) technology is described in this paper. Figure 8 shows a block schematic of a single phase seven-level inverter for grid-connected photovoltaic. With considerations for a maximum-power-point tracker (MPPT) and a current-control algorithm, the topology was applied to a grid-connected photovoltaic system. While the number of voltage levels rises, the harmonic content of the output voltage waveform falls dramatically. Multilevel inverters are more expensive because to the increased number of capacitors, clamping diodes, and DC sources required as the number of levels is increased. For medium and high power applications, a modified H-Bridge inverter is employed to overcome the difficulties mentioned above.

V. Conclusion

In this paper the detail review on Modelling and Simulation of PV based single phase seven level grid connected inverter system carried out. Author analysis that suggested single phase modified seven level inverter produces virtually sinusoidal output waveforms with only a few power switches. There are fewer capacitors, a single DC source, a compact filter, and better harmonic profiles in the proposed design than in earlier multilayer inverters. The system improves power quality while increasing voltages. Multilevel inverters have evolved from a promising technology to a well-established and appealing medium- and high-power alternative. On the other hand, further equipment development and the growth of industrial applications will bring a new challenge and opportunity.

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