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A Multilevel Inverter Based on SVPWM Technique using Photovoltaic System for Reduction of Harmonics

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Abstract: *Multilevel inverters can reach the increasing demand for power quality and power ratings along with lower harmonic distortion and lesser electromagnetic interference (EMI). Inverters are power electronics devices which converter DC power to AC power. When load has high impedance against to harmonic current, VSI must be used there, while the load with small impedances against to harmonic current requires CSIs to be used in recent years, various pulse width modulation (PWM) techniques have been developed beside inverters. The two and three level inverter is simulated using MATLAB/Simulink and also the experimental results are presented for verifying the effectiveness of the system. The use of Photovoltaic Cell as source for the NPC Inverter is proposed here in this paper.*

Keywords: PV cell SVPWM Two-level three phase inverter

I. INTRODUCTION

The ever growing demand for Renewable Energy resources is gaining importance day by day. Wind, Solar, Nuclear, Hydral etc are some examples of such renewable energies. It is expected that by 2050, 60% of our energy requirement will be supplied by these Renewable energy resources. The multilevel starts from a level of three and as the number of levels reach infinity, the output THD (Total Harmonic Distortion) approaches zero. The number of the achievable voltage levels, however, is limited by voltage unbalance problems, voltage clamping requirement, circuit layout, and packaging constraints. Multilevel inverters synthesizing a large number of levels have a lot of merits such as improved output waveform, a smaller filter size, a lower EMI (Electro Magnetic Interference), and other advantages. The principle advantage of using multilevel inverters is the low harmonic distortion obtained due to the multiple voltage levels at the output and reduced stresses on the switching devices used. Numerous industrial application have begun to require higher power apparatus in recent years a multilevel power converters structure has been introduced as an alternative in high power and medium voltage situations.

II. MOTIVATION

According to the demand of electric power in commercial and industrial development, we need photovoltaic energy and related technology. At present, large scale photovoltaic power generation and scale of renewable energy has become parts of development strategy, meanwhile it is the way to guide the development of photovoltaic industry. However, because of its own characteristics different from conventional power generation, grid-connected PV power station and its security, stability, reliable operation became new challenges which power grid and PV power plant need to face. So we need to develop and improve the power conversion technical using recent technology like SVPWM, multilevel invertors

III. INDUCTION MOTOR

Induction motors are highly nonlinear and multivariate devices. As a result, controlling the machine effectively is challenging. Induction motors have long been employed in industrial applications that necessitate a robust control system in unpredictable operating conditions. Induction motor speed control is accomplished using a variety of approaches, including directly and indirectly magnetic field controlling the position. A common AC electric motor is an induction motor (sometimes known as an asynchronous motor). The electric current required to produce torque in an induction motor is acquired through electromagnetism from of the stator winding's revolving magnetism. An inductive motor's rotors can be either a squirrel's cages rotor or a wound type rotor. Because they operate at a reduced speed than their synchronous speed, induction motors are referred to as asynchronous motors. A three-phase induction machine is a self-starting motor that does not require use of a capacitance, a winding start, a centrifugal switch, or any other sort of beginning mechanism. This motor is commonly utilized in commercial and industrial settings.

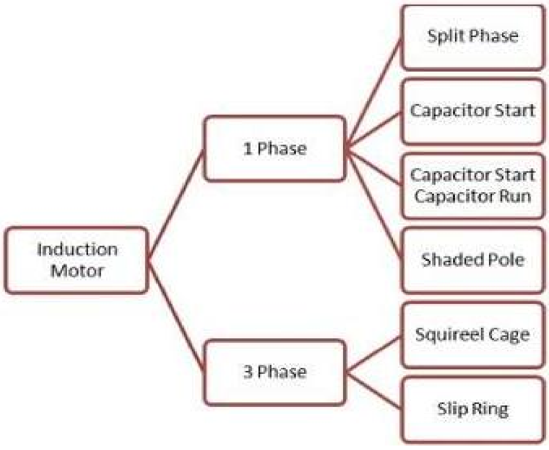

Fig.1 Induction Motor

IV. MODELING OF SOLAR PV SYSTEM

Individual component efficiency is modelled using deterministic or stochastic methodologies. This PV- System covers the fundamentals of solar power system modelling, as well as the model construction of conversion controllers in a two techniques PV energy is readily available in the environment and is pollution-free.

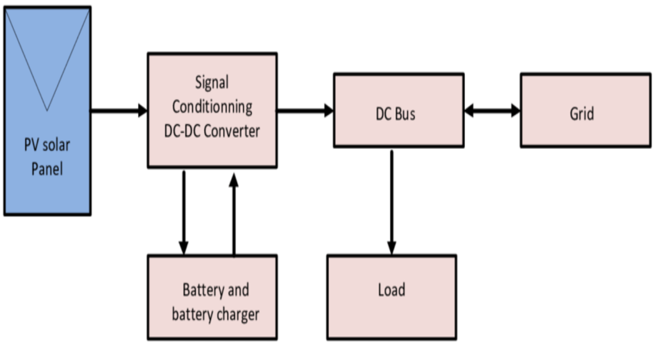

Fig.2 Modelling of Solar PV System

The voltage output of a PV system is determined by its geographical area. PV systems are one type of renewable energy source that can be used to reduce reliance on fossil fuels hybrid PV generation unit that includes a PV generation, DG, inverters, and batteries systems. To examine the potential advantages and efficient use of PV-diesel systems to meet the customer peak load requirements.

4.1 Principle of Pulse Width Modulation (PWM)

Model of a single-phase inverter with a centre-taped grounded DC bus, and principle of pulse width modulation

- When $V_{control} > V_{tri}$, $V_{A0} = V_{dc}/2$
- When $V_{control} < V_{tri}$, $V_{A0} = -V_{dc}/2$

Also, the inverter output voltage has the following features:

- PWM frequency is the same as the frequency of V_{tri}
- Amplitude is controlled by the peak value of $V_{control}$
- Fundamental frequency is controlled by the frequency of $V_{control}$

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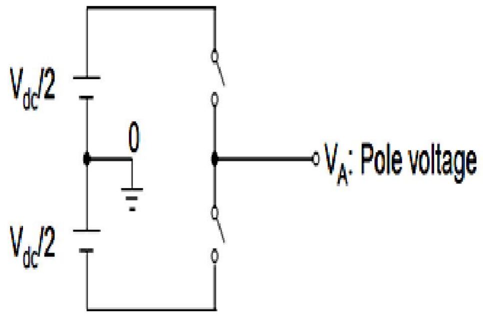

Fig.3 Circuit model of a single-phase inverter

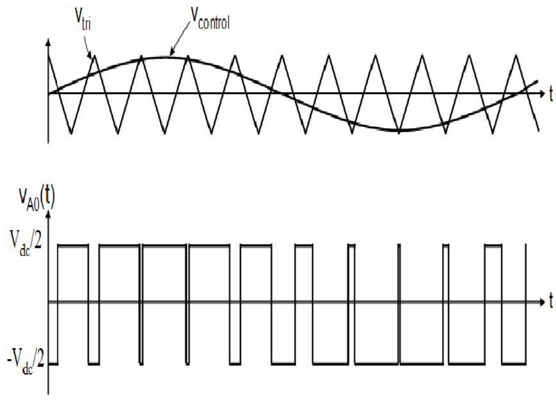

Fig.4 Pulse width modulation

4.2 Principle of Sinusoidal PWM

Comparison of the efficiency of planned converters with feed-back control under varying load levels.

As described the frequency of V_{tri} and $V_{control}$ is

- Frequency of $V_{tri} = f_s$
- Frequency of $V_{control} = f_1$

Where, f_s = PWM frequency and f_1 = Fundamental frequency

The inverter output voltages are determined as follows:

- When $V_{control} > V_{tri}$, $V_{A0} = V_{dc}/2$
- When $V_{control} < V_{tri}$, $V_{A0} = -V_{dc}/2$

Where, $V_{AB} = V_{A0} - V_{B0}$, $V_{BC} = V_{B0} - V_{C0}$, $V_{CA} = V_{C0} - V_{A0}$

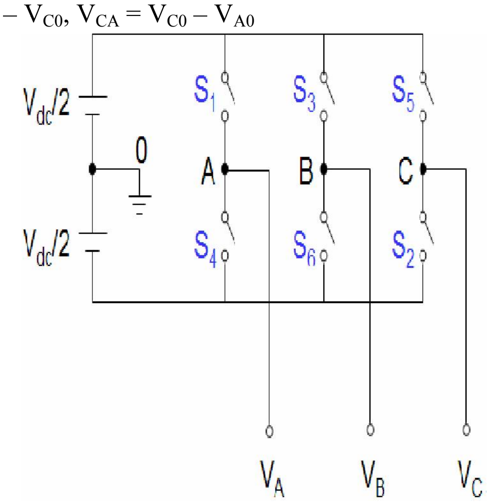

Figure 5: Three-phase PWM Inverter of general three-phase sine-PWM inverter

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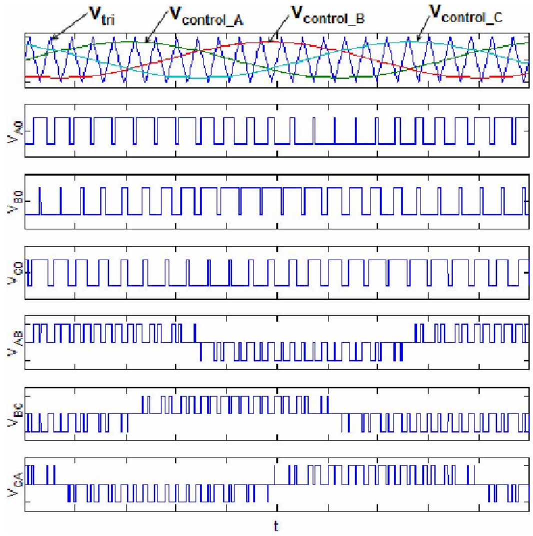

Figure 6: Waveforms of carrier wave signal (V_{tri}) and control signal

V. PROBLEM DEFINITION

Efficiency of a multilevel inverter that appears to be well suited for PV application. Improvement in efficiency is essential to impact the cost of conversion of solar energy to electricity. In present technique there are some problems regarding stability (o/p voltage), THD and efficiency (temperature control). Due to direct interfacing of PV cell to invertor leakage current arise capacitance between the PV panels and the earth, circulating leakage currents can flow through the panels and grid ground, leading to increased output harmonic content

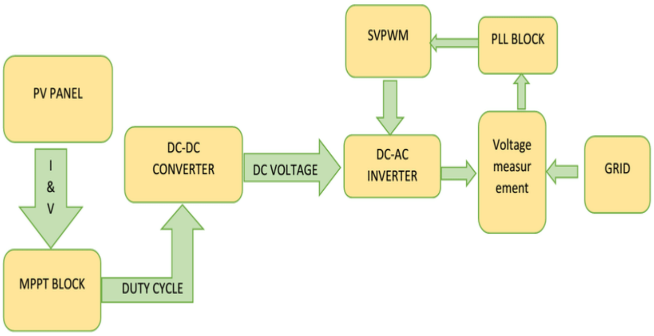

Figure 7: Basic block diagram of solar power system with PV cell

The higher losses, safety, and electromagnetic interference (EMI) problems Inverters are power electronics devices which converter DC power to AC power. AC voltage can be produced at desired output frequency and voltage level by using inverters the o/p of invertor is not sufficient due to a. Total Harmonics Distortion. b. Temperature variance in photo voltaic cell. c. Current variance by load

VI. PROPOSED METHODOLOGY

Design of SVPWM based multilevel invertor for improvement in stability (o/p voltage), THD and efficiency (temperature control) of grid connected system with based of PV cell as input.

1. Design power circuit and control circuit which basically inverter consists.
2. Design and verification of basic power circuit blocks such as SVPWM, multilevel invertor.
3. Integration of all basic building blocks.
4. Simulation studies
5. Performance Evaluation

By using SVM topology for switching of multilevel invertor can overcome following problems a. Total Harmonics Distortion. b. Temperature variance in photo voltaic cell. c. Current variance by load.

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VII. RESULT ANALYSIS

The project includes a solar panel arrays model with 900 Wb/m2 irradiation and a temperatures of 300°C for each modules. The research here is being done in order not only to increase the output power supplied by renewable energy resources, but also to tolerate variations in point loads whereas the software is geared to start the motor at two regions that are separated by a certain distance. The goal is to design an inverters controller that will generate increased and reliable output electricity to the system. This chapter will examine the output of solar-based renewable sources that is also designed to be grid-connected. The comparison was done out in term of the program's output power

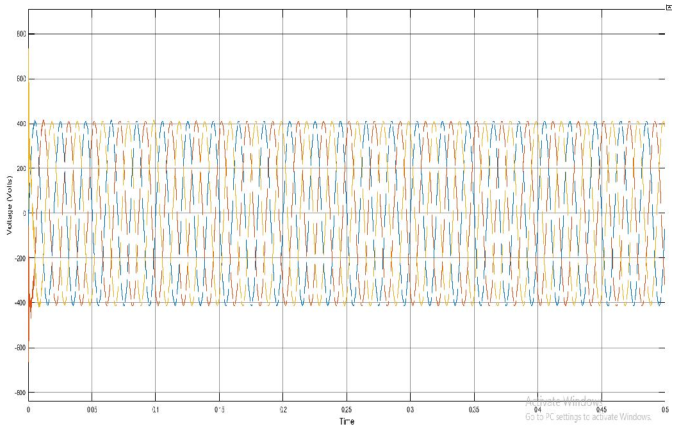
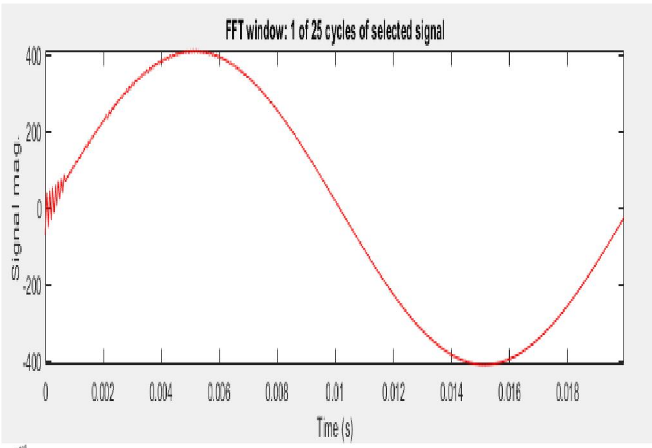


Figure 8: Voltage at the loading line in system 1 with loads from area-1



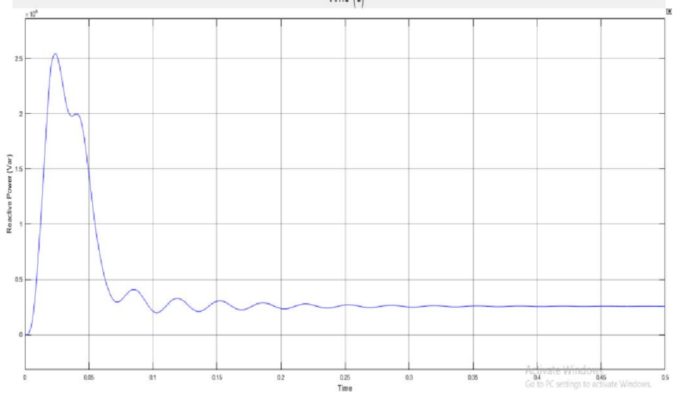


Figure 9: Reactive Power at the loading line in system

VIII. CONCLUSION

The space vector technique method has been studied. This method has the advantage of improving the total harmonic distortion over other PWM methods. Also this technique features easy implementation and more importantly, minimum harmonic content in the inverter output voltage and current of the Induction Motor Load, First, the improved PWM inverter control method can make the voltage and the current waveform of the grid tend to sine wave effectively and quickly, and the power factor will reach to one. Second, the power can be sent to the grid or load arbitrary through controlling the PWM regulator, while the control system has a good stability The SVPWM technique can be further applied to three level, four leg and multilevel inverters. This software implementation used in this paper can be extended further to over modulation region i.e. modulation index m>1which will be a future enhancement.

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