SIMULATION OF INVERTER FOR PROTOTYPE MODULE OF SOLAR PHOTOVOLTAIC (PV) SYSTEM

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Abstract: - This paper is depicts information about dc-ac inverter used in solar inverter. We will get DC power from solar panels and this converter inverts DC to AC. This design and modulation is based on MATLAB software. In circuit, for switching purpose IGBT is used. There are many other devices also but IGBT has more advantages than others which are shown by comparison with others. The main thing is that this conversion and switching of IGBT is done using different types of PWM methods. Here we are using SPWM method for conversion of AC power. This method is very efficient than other methods and also it reduces harmonics to very much extent in output. Project objective are, to design an inverter model by using MATLAB and making analysis on the output voltage and to study the function of PWM in single phase inverter. Project scope are,
1. Modeling and simulation using MATLAB.
2. Using PWM method for the switching operation. Project application: This Project is based on solar inverter, this inverter will be used in our college for lab applications.

Key Words:- Single phase DC-AC converter, IGBT, MATLAB, SPWM method, harmonic reduction, etc.

I. INTRODUCTION

Presently world is facing too much challenges one of them is to generating the enough electrical power that will fulfil the requirements of mankind. Today generation of electrical power based on the conventional coal, gas and nuclear based. World population is increasing day by day so the requirement of them also increased and hence generation of electrical power is also increased. Basically there are two types of power generation sources: 1. Conventional 2. Nonconventional. Today most of generation of electrical power based on Conventional sources such as coal, gas and nuclear etc. Conventional sources are no more after some of the years and which are not sufficient to fulfill the requirement of the mankind. Nuclear energy is not much preferable because its radiation effect. Therefore some part of energy should be generated based on non-conventional sources. There are also problems of increasing pollution and energy demands and hence the exploitation of solar has received more and more attentions. This project is also focus on modeling and simulation of single phase solar inverter by Pulse Width Modulation. Pulse Width Modulation is a technique that use as a way to decrease total harmonic distortion in inverter circuit. The model is implemented using MATLAB software with the SIMPOWER SYSTEM block set based on computer simulation. Computer simulation plays an important role in the design, analysis, and evaluation of power electronic converter and their controller. MATLAB is an effective tool to analyze a PWM inverter. Advantages of using MATLAB are the following:
1. Faster response
2. Availability of various simulation tools
3. Various functional blocks, etc.
II. LITERATURE SURVEY

**SOLAR PANEL:** A photovoltaic (PV) module is a packaged, connect assembly of typically 6x10 photovoltaic solar cells. Photovoltaic modules constitute the photovoltaic array of a photovoltaic system that generates and supplies solar electricity in commercial and residential applications. Each module is rated by its DC output power under standard test conditions (STC), and typically ranges from 100 to 365 Watts (W). The efficiency of a module determines the area of a module given the same rated output – an 8% efficient 230 W module will have twice the area of a 16% efficient 230 W module. There are a few commercially available solar modules that exceed efficiency of 22% and reportedly also exceeding 24%. A single solar module can produce only a limited amount of power; most installations contain multiple modules. A photovoltaic system typically includes an array of photovoltaic modules, an inverter, a battery pack for storage, interconnection wiring, and optionally a solar tracking mechanism.

**COMPARATOR:** An electronic circuit for comparing two electrical signals. A comparator consists of a specialized high-gain differential amplifier. They are commonly used in devices that measure and digitize analog signals, such as analog-to-digital converters (ADCs), as well as relaxation oscillators.

**RELAY:** A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

**DC-DC CONVERTER:** DC to DC converters are used in portable electronic devices such as cellular phones and laptop computers, which are supplied with power from batteries primarily. Such electronic devices often contain several sub-circuits, each with its own voltage level requirement different from that supplied by the battery or an external supply (sometimes higher or lower than the supply voltage). Additionally, the battery voltage declines as its stored energy is drained. Switched DC to DC converters offer a method to increase voltage from a partially lowered battery voltage thereby saving space instead of using multiple batteries to accomplish the same thing.
Most DC to DC converter circuits also regulate the output voltage. Some exceptions include high-efficiency LED power sources, which are a kind of DC to DC converter that regulates the current through the LEDs, and simple charge pumps which double or triple the output voltage. DC to DC converters developed to maximize the energy harvest for photovoltaic systems and for wind turbines are called power optimizers.

**INVERTER:** A solar inverter, or converter or PV inverter, converts the variable direct current (DC) output of a photovoltaic (PV) solar panel into a utility frequency alternating current (AC) that can be fed into a commercial electrical grid or used by a local, off-grid electrical network. It is a critical balance of system (BOS)–component in a photovoltaic system, allowing the use of ordinary AC-powered equipment. Solar power inverters have special functions adapted for use with photovoltaic arrays, including maximum power point tracking and anti-islanding protection.

### III. BUCK-BOOST CONVERTER

The average output voltage $V_o$ is less than or greater than the input voltage $V_s$ of converter, it will be decided by value of $k$ and its voltage equation is written as under. Output voltage of this converter is having opposite polarity than the input voltage hence it also known as Inverting converter. The circuit arrangement of buck boost converter.

![Basic Schematic of a Buck Boost Converter](image)

When $0 < k < 0.5$ - Converter operate in Buck Mode. $0.5 < k < 1$ - Converter operate in Boost mode. $0.5 = k$ - Converter operate in Ideal mode.

$$V_o = V_s \frac{k}{(1-k)}$$

### IV. PERFORMANCE REQUIREMENTS OF PV INVERTERS

**Efficiency** :-The increase in use of PV inverter in domestic and industrial made to decrease the losses and concentrate on efficiency. Many industries have come up with transformer less inverter with efficient topology and control strategy removes zero crossing detection with the aim of reducing the size and cost. Meanwhile number of switches is reduced with new topologies. Recent studies proved that efficiency has higher values when silicon carbide (SiC), and gallium nitride (GaN) power semiconductor devices used in PV inverters.

**Power density** :- The development of new PV converter topology by the manufacturer motivates to come up with very high power density. This can be achieved by employing higher switching frequencies and omission of DC/DC converter mainly for domestic and commercial applications.

**Power Quality** :- Due to many power electronics, non linear, reactive loads and intermittent nature of DG makes poor power quality at PCC. However, power quality is major consideration for stable and economical operation of grid connected inverter (GCI). However, effectual response should be taken
to eradicate poor power quality. There are two response strategies to be considered. The effective strategy is active or passive power quality conditioners as dynamic voltage regulator (DVR), shunt active power filter (SAPF), unified power flow conditioner (UPQC), and power factor correction (PFC) are discussed in literature. Former, the effective ride through approach to manage poor power quality.

The above mentioned advanced control strategies equipped with new topologies of inverter to enhance the power quality placed at the point of common coupling (PCC) is commonly known as multi-functional grid connected inverter (MFGCI) modified from conventional grid connected inverter is discussed in detail in literature.

**Installation cost** :- In recent days, reduced cost of PV modules has impacted the balance of system (BoS) cost and reduced the levelized cost of energy (LCOE). Transformer less inverter topologies with reduced number of switches have reduced the inverter cost. Installation charges vary from region to another as land, labour and other local factors.

### V. WORKING PRINCIPLE OF INVERTER

An inverter is a device that changes or inverts direct current (DC) input to alternating current (AC) output. It doesn't "create" or "make" electricity, just changes it from one form to another. DC in is changed to AC out. The input voltage, output voltage and frequency, and overall power handling depend on the design of the specific device or circuitry. The inverter does not produce any power; the power is provided by the DC source. DC to AC inverters efficiently transform a DC power source to a high voltage AC source, similar to power that would be available at an electrical wall outlet. Inverters [12] are used for many applications, as in situations where low voltage DC sources such as batteries, solar panels or fuel cells must be converted so that devices can run off of AC power. One example of such a situation would be converting electrical power from a car battery to run a laptop, TV or cellophone.

#### VI. MEASURED PARAMETERS

<table>
<thead>
<tr>
<th></th>
<th>Input voltage.</th>
<th>12 V (DC)</th>
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<tbody>
<tr>
<td>2</td>
<td>Output voltage.</td>
<td>230 V (AC)</td>
</tr>
<tr>
<td>3</td>
<td>Input Current.</td>
<td>0.83 A</td>
</tr>
<tr>
<td>4</td>
<td>Output Current.</td>
<td>0.0217 A</td>
</tr>
<tr>
<td>5</td>
<td>Input power.</td>
<td>12*0.83=10W</td>
</tr>
<tr>
<td>6</td>
<td>Output power.</td>
<td>230*0.0217=5W</td>
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**Simulation model and results**

Simulation of single phase full bridge inverter using IGBT:

Figure 1 shows the simulation of single phase full bridge inverter using MATLAB SIMULINK. When the S1 and S2 conducts the load voltage is +Vs whereas the S3 and S4 conducts the load voltage is -Vs. Frequency of the output voltage can be controlled by varying periodic time T. The circuit connected with the RL load, in the circuit there are four IGBTs .the basic working principle of the inverter is to converts the DC power into AC power at desired output voltage and frequency. The inverters are mainly classified into two types 1) voltage source inverters 2)currents source inverters.
In the above circuits it uses voltage source inverters. the voltage source inverters is the one in which the dc source has small or negligible impedance. The output voltage and currents waveforms are shown in figure.

The parameters values is shown below Vdc=12V, pulse generator: amplitude=1V, period (sec)=0.02 sec pulse width(% of period)=50% phase delay(sec)=0 load: R load=1 ohms L load=10e-3 H.

![Fig 1 simulation of single phase full bridge inverter using matlab / simulink](image)

**Fig 2. Pulse voltage S1 & S2**
Fig 3. Pulse voltage S3&S4

Fig 4. Current waveform

Fig 5. Voltage waveform
VII. CONCLUSION

In this paper, the modeling and simulation of a solar PV/battery hybrid energy system with a five level inverter has been presented. The outlook of recent standard grid codes and regulation of interconnecting PV inverter to the grid have covered in detail, which focuses on the performance requirement and power quality. The advanced material of SiC and GaN based power converter shows enhanced future performance in PV inverter technology. Further, detailed study on current control strategy and grid synchronization method for single phase and three phase have been differentiated with analysis. The robustness of PV control strategy believes to withstand in grid abnormalities by the advanced synchronization method.

REFERENCE


