# DESIGN OF SOLAR INVERTER

Shubhangi Landge[1], Ankita Jadhav[2], Pranali Bomble[3], Muqadas Khan[4]

[1]*Assistant Professor, Dept. Of Electrical Engineering AISSMS IOIT College, Maharashtra, India*

[2]*Pune University, AISSMS IOIT College, Maharashtra, India*

[3]*Pune University, AISSMS IOIT College, Maharashtra, India*

[4] *Pune University, AISSMS IOIT College, Maharashtra, India*

**Abstract:**

*The main purpose of this paper is to design an inverter which enable the inversion of a DC power source, supplied by Photovoltaic (PV) Cells, to an AC power source used to drive an three phase induction motor. This paper proposes a topology of one DC-DC boost converter to boost the DC voltage in addition to an inverter for DC-AC conversion. In this paper, the Sinusoidal pulse width modulation (SPWM) method have been proposed for a three-phase inverter. There are many traditional switching techniques, from them commonly used in the inverter switching is Sinusoidal pulse width (SPWM) modulation. Furthermore, Volts/Hertz (V/f) control technique is used to maintain constant flux within the induction motor. The design is simulated in Proteus software and testing has been done on CRO.*

***Keywords:*** *PV cell, DC-DC boost converter, pulse width modulation (PWM),analog to digital converter (ADC).*

## 1. INTRODUCTION:

Now a days, issues like air pollution, global warming concerns, decreasing fossil fuels and their increasing cost have made it to look towards the alternative sources like renewable sources as a future energy solution. For domestic and industrial utilization electricity plays vital role for running all appliances. Among the all renewable energy resources available, solar energy seems to be a major competitor as it is abundant in nature and its conversion to electricity through photovoltaic (PV) process is pollution-free.

Voltage source inverters (VSI) and current source inverter (CSI) are two different types of inverter. Voltage Source Inverter occurs when there is a erect DC voltage source at the input terminals of the inverter, it is also known as Voltage Fed Inverter (VFI). If the DC source at the input terminal is high, i.e. Current Source Inverter occurs when it has a erect DC current source, this inverter is also known as Current Fed Inverter (CFI).

## 2. PROJECT OBJECTIVES:

In the integration of renewable energy, the inverters is usedto convert DC power to AC power with the system frequency of operation. Here a DC/AC inverter converts direct current (DC) power generated by a Photovoltaic DC power source to sinusoidal alternating current (AC).
Therefore the main objective of the project is:

i. To simulate a three phase inverter using PROTEUS software.
ii. To analyze the output voltage of the developed system.
iii. Develop a modeling complete with its output.

### 2.1 Project scope:

1. Modeling and simulation using PROTEUS.
2. Develop a DC-DC boost converter and a three phase inverter.
3. Use PWM method for the switching operation.

**3. Block diagram :**

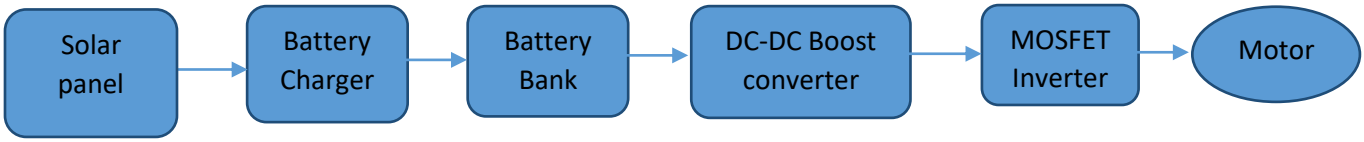



**Fig1. Main block diagram of solar system using inverter**

3.1 Solar Panel:

Solar panel is a panel designed to absorb the sun's rays as a source of energy and generating electricity. A photovoltaic (PV) module is usually in packaged form, connect assembly of typically 6×10 photovoltaic solar cell. Photovoltaic array of a photovoltaic system form photovoltaic modules that generates and supplies solar electricity in commercial and residential applications. Under standard test conditions (STC), each module is rated by its DC output power and its typical range is from 100 to 365 watts. The rated output – an 8% efficient 230 watt module will have twice the area of a 16% efficient 230 watt module hence area of a module is determined by the efficiency of the given module. 22% or 24% efficiency is also available in solar modules. Only a limited amount of power is produced by a single solar module; hence mostly installations contain multiple modules.

3.2 Battery charger:

A function of solar charger is to employ solar energy to supply electricity to devices or charge batteries. They are generally portableform .

Lead acid or Ni-Cd battery can be charged up to 48 V and hundreds of ampere-hours (up to 4000 Ah) capacity by using solar charger. Intelligent charge controller is use in such solar charger. Solar cells are installed in series at stationary location (i.e.: rooftops of homes, base-station locations on the ground etc.) To store energy for off-peak usage battery banks are connected to solar panel. In order to save energy during daytime solar chargers can be used.

Calculations for deciding battery charger rating

1)Output of Motor is 0.5hp =0.5*.746kW=0.373kw

2)Motor efficiency is 70% so the input real power to the motor is 0.373/0.70=0.53kw

3)Power battery has to supply is 0.53/.90=0.589Kw

4) Amperes battery need to supply is 589/415= 1.41Amps.
as it needs to run the motor for 5 hours its rating would come to 7.05Ah

5) As the exact parameters of the conversion for the inverter are not known it would recommend to use 10Ah, 415V battery That would suit our purpose.

3.3 DC-DC boost converter:

A boost converter is used to step up the dc power.DC-to-DC power converterthat steps up voltage (while stepping down current) from its input (supply) to its output (load).It is a class of switched-mode power supply (SMPS). In this DC-DC boost converter at least one energy storage element that is a capacitor, inductor, or the two in combination and at least two semiconductors (a diode and a transistor). Capacitors (sometimes in combination with inductors) are normally addedto reduce voltage ripple.

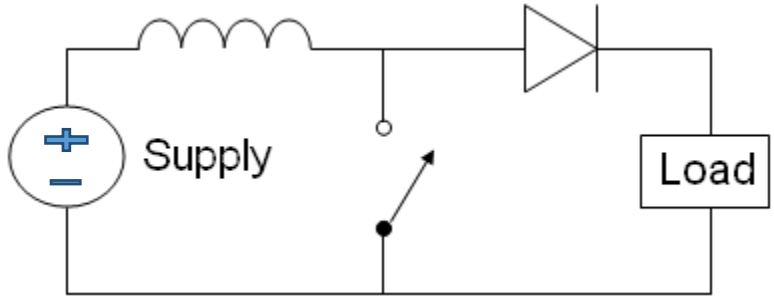



**Fig2: Basic diagram of dc-dc boost converter**

The following four parameters are needed to calculate the power stage:

1. Input Voltage Range: V in (min) and V in (max)

2. Nominal Output Voltage: V out

3. Maximum Output Current: I out (max)

4. Integrated Circuit used to build the boost converter. This is necessary, because some parameters for the calculations have to be taken out of the data sheet.

### 3.4 Three Phase Inverter Circuit:

Theinverter input is output of PV array which is a DC power.The inversion process converts DC power generated by the PV array to AC power. The use of DC power from PV arraydirectly using is not practical, except for the use in small off grid systems. AlthoughDC power is used in many home appliances, whereas AC power is used in large loads and the electrical networks. ACpower allowslong distance power distribution and minimize the energy loads.

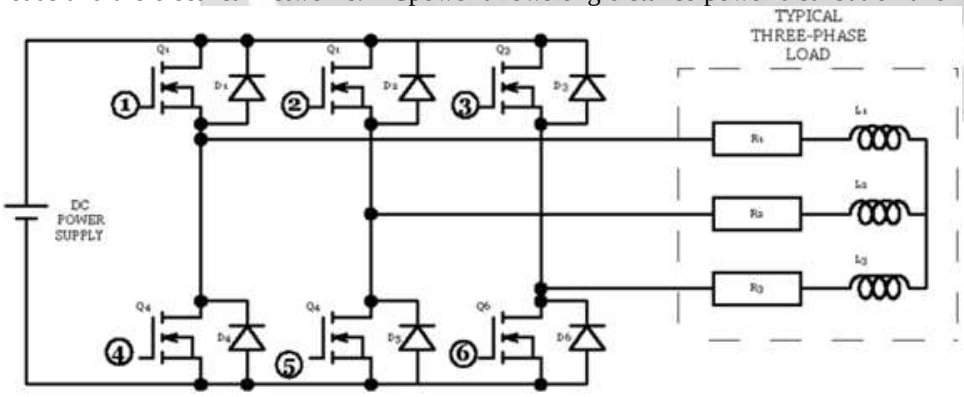



**Fig3 Bridge Inverter**

**Table of Switching Modes of MOSFET:**

| State no. | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | $V_{ab}$ | $V_{bc}$ | $V_{cb}$ |
|---|---|---|---|---|---|---|---|---|---|
| 1 | On | On | Off | Off | Off | On | $V_s$ | 0 | $-V_s$ |
| 2 | On | On | On | Off | Off | Off | 0 | $V_s$ | $-V_s$ |
| 3 | Off | On | On | On | Off | Off | $-V_s$ | $V_s$ | 0 |
| 4 | Off | Off | On | On | On | Off | $-V_s$ | 0 | $V_s$ |
| 5 | Off | Off | Off | On | On | On | 0 | $-V_s$ | $V_s$ |
| 6 | On | Off | Off | Off | On | On | $V_s$ | $-V_s$ | 0 |
| 7 | On | Off | On | Off | On | Off | 0 | 0 | 0 |
| 8 | Off | On | Off | On | Off | On | 0 | 0 | 0 |

**Fig.4 Switching Modes of MOSFET**

In this three phase inverter is formed by six Step Bridge. This six Step Bridge is using six switches. The distribution of switches in each phase of this inverter consists of two switches. Each step is having 60°intervalfor one complete cycle of 360° in a six step inverter.

For gating switches two different patterns can be used.

(a). 180° Conduction Mode

(b). 120° Conduction Mode

In this paper we were using 180° conduction mode for gating switch. In 180° Conduction Mode each switching each MOSFET, conducts for 180° and three switches will in ON condition at any instant of time.Here in this controlling technique, each switch conducts for a period of 180°. Three switches remains ON at any instant of time. Positive terminal of input DC voltage is connected when the switch MOSFET S1 is switched ON. Negative terminal of input DC voltage connected when switch MOSFET S4 is turned. Each mode is of 60° duration and in each cycle there are six modes of operation. Depending up on the gating pulse sequence the numbering of MOSFET is done. The gating signals are shifted by 60° with one another in order to obtain balanced three phase voltage. The load which is connected to the output it may be of Star connection or Delta connection. Same timing switching on the same leg (S1 and S4, S3 and S6, S5 and S2) should be avoided. Otherwise it will cause serious damage i.e. short circuit of DC link voltage supply. To avoid undefined AC output line voltages switching of the same leg should not be switched off at the same time.

## 3.5 SPWM Technique:

To generate a constant amplitude pulse in Pulse Width Modulation (PWM) technique by modulating pulse duration and by modulating the Duty cycle we can do it. Reference and the carrier signals is required in PWM technique. In this carrier signal is having triangular wave with high frequency and reference is taken as low frequency.This output signal is used for controlling the switches. The comparison is shown in the fig. Below

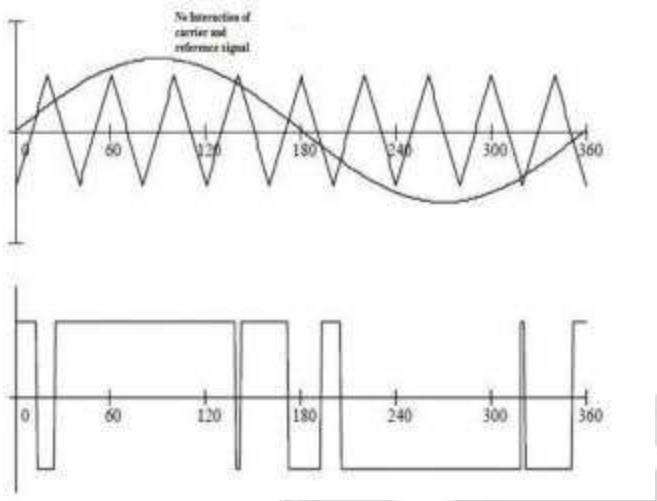
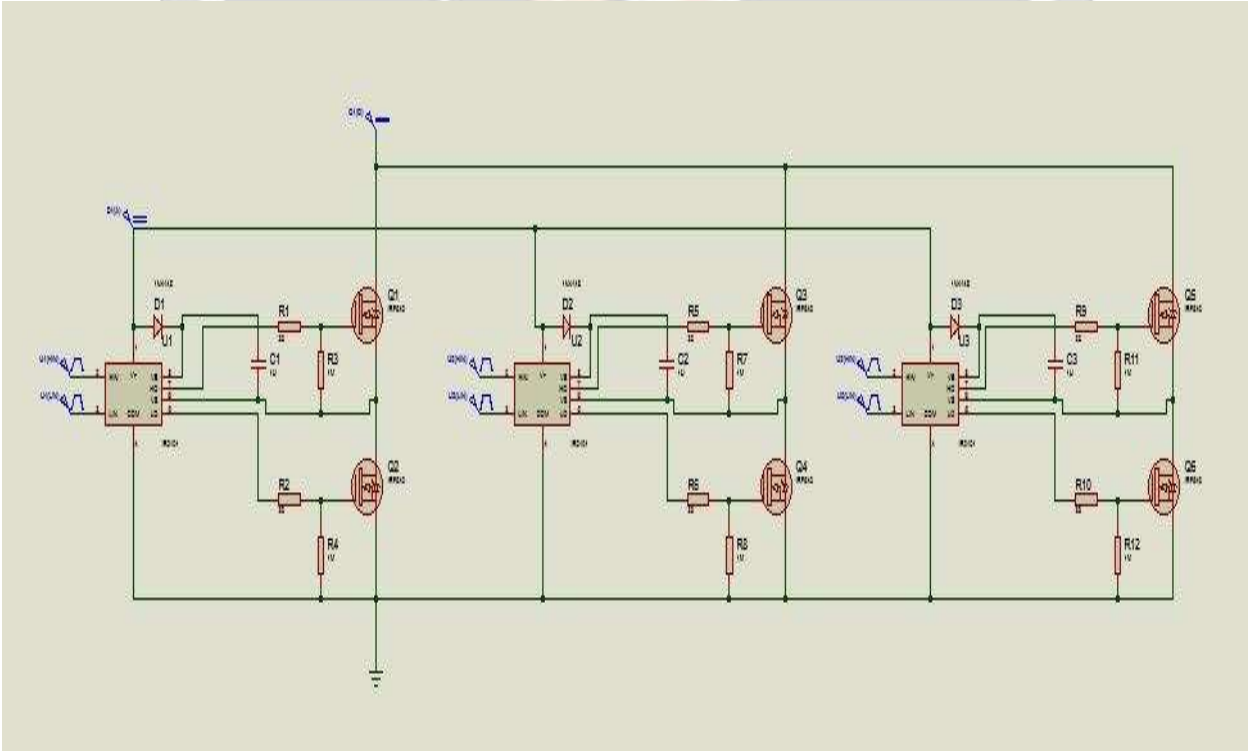



**Fig: SPWM pulse**

## 4. OBSERVATION AND SIMULATION RESULTS:

The output of the inverter has been observed on CRO screen. Simulations were done on PROTEUS Software. The simulations presented are of each component working by itself, except for the solar panel which was simulated with the whole system. The whole system is shown on fig.



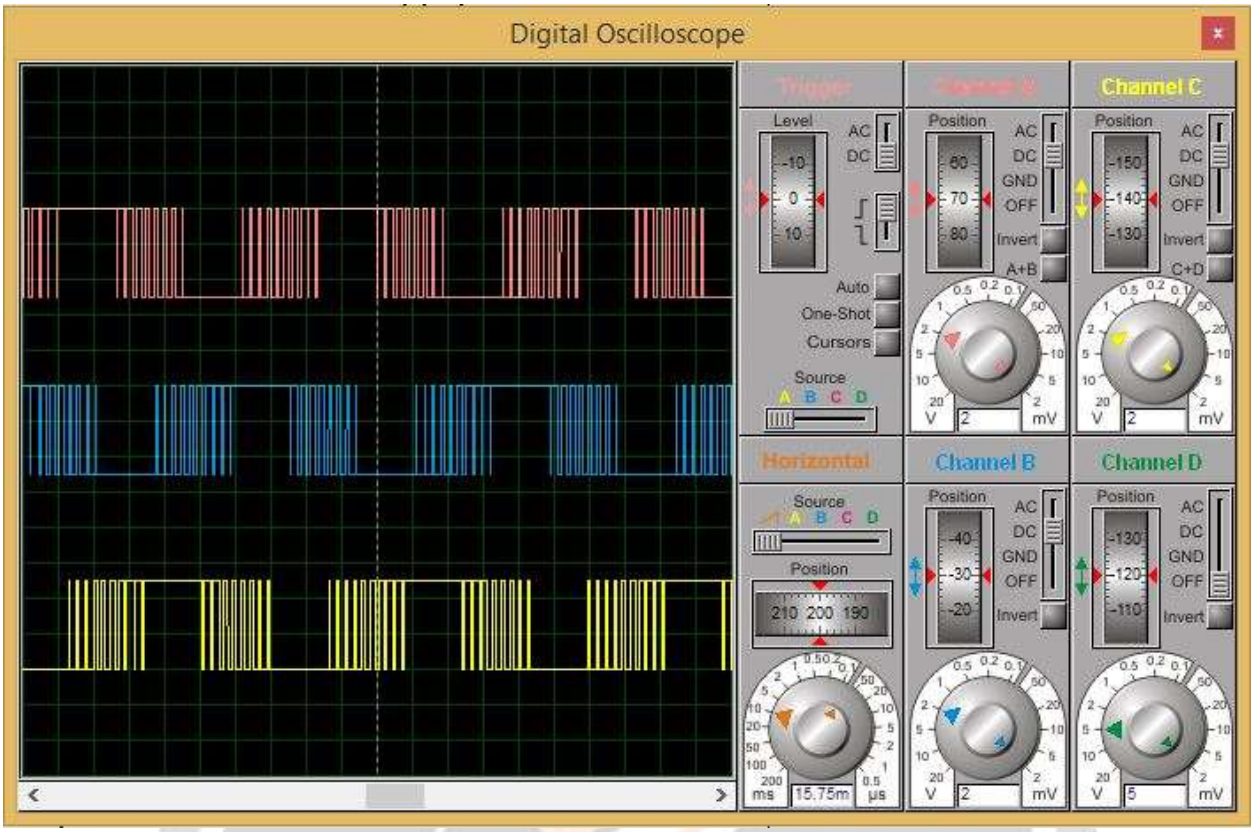



**Fig.7 PROTEUS Simulation and Result**

6. CONCLUSION:

Thus we design a solar inverter circuit diagram. Initially we simulate the inverter circuit in PROTEUS software and then hardware is developed, hence we observe the result. It is also a preferred power backup to a computer and other appliances because it switches automatically to the battery when the AC mains is not available.

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