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DESIGN OF FLOATING SOLAR PANEL WITH AUTO SUN TRACKER FOR BATTERY CHARGING APPLICATIONS

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Abstract— Solar power is the fastest growing means of renewable energy and it is the future of renewable power generation. The problem with solar panels is that they use up a lot of space on rooftops or open areas and are difficult to mount, maintain and clean regularly. Additionally, the solar panels are to be moved as per sun's position which can generate up to 40% more solar power. This project proposes a new kind of solar panel that can be mounted on water bodies like lakes, pools so that they don't occupy any land space. Additionally, this project introduces an innovative sun tracker and panel movement system using Real Time clock (RTC) mechanism to move the solar panels as per sun position and generate more power. This project is designed and implemented using simple dual axis solar tracker system. In order to maximize energy generation from sun, it is necessary to introduce solar tracking systems into solar power systems. A dualSPWMaxis tracker can increase energy by tracking sun rays from switching solar panel in various directions. This solar panel can rotate in all directions. The panels will be fitted with the solar tracker to track the sun to maximize the energy collection. In general, the output of the PV array is unregulated DC supply which is applied as input of Boost (DC-DC) converter and further it is converted to AC voltage by using inverter. The AC output voltage and frequency are regulated. A closed loop voltage control for inverter is developed by using sine wave pulse width modulation (SPWM). The regulated AC voltage is fed to AC standalone loads or grid integration. The overall system is designed and developed by using MATLAB/SIMULINK.

Keywords—Solar Power, Floating Solar Panel,SPWM,Matlabsimulink

INTRODUCTION

Among various renewable energy systems, photovoltaic power generation systems (PV systems) are expected to play an important role as a clean electricity power source in meeting future electricity demands. However, the power output of PV systems fluctuates depending on weather conditions. In future, when a significant number of PV systems will be connected to the standalone loads or grids of power utilities, combined power output fluctuations may cause problems like voltage fluctuation and large frequency deviation in electric power system operation. In future, with an increasing penetration of PV generation, their impact upon the overall control of the power system will be significant. This will lead a situation where the PV generators will be required to share some of the duties, such as load voltage control. Therefore, for the penetration of multiple or clustered PV system's output power in the utility without reduction of the reliability of utility power systems, suitable measures must be applied to the PV systems side.

Because of the nonlinear relationship between the current and the voltage of the photovoltaic cell, it can be observed that there is a unique maximum power point (MPP) at a particular environment, and this peak power point keeps changing with solar illumination and ambient temperature. An important consideration in achieving high efficiency in PV power generation system is to match the PV source and load impedance properly for any weather conditions, thus obtaining maximum power generation. The technique process of maximum power point is been tracking which is called maximum power point tracking (MPPT). In recent years, a large number of techniques have been proposed for maximum power point tracking (MPPT), such as the constant voltage tracking (CVT), the incremental conductance (INC) method, the perturb-and-observe (P&O or hill-climbing) method, and so on. At last, these algorithms modify the actual voltage in order to increase the power output. The CVT is very simple, but the constant voltage can't track MPP when solar illumination changes so the constant voltage method is not often used in the true MPPT strategy. The P&O method is based on the principle of perturbation and observation. The majority of these methods are based on the perturbation and observation (P&O), which has the advantage of simple operation. It is an iterative method of obtaining MPP. It measures the Department of EEE, RCE Page 2 PV array characteristics, and then perturbs the operating point of PV generator to encounter the change direction and incremental conductance method (INC) is also commonly used due to the rapid response.

Power for the Boost converter can come from any suitable DC sources, such as batteries, solar panels, rectifiers and dc generators. A process that changes one DC voltage to a different DC voltage is called DC to DC conversion. A boost converter is a DC-DC Converter with an output voltage greater than the source voltage. It is sometimes called a step-up converter since it ―steps up‖ the source voltage. Since power (P = VI) must be conserved, the output current is lower than the source current is tracked by using Boost converter. Then it is fed to Standalone load or grid integration through three-phase Inverter. The inverter is built of switching devices, thus the way in which the switching takes place in the inverter gives the required output. Three phase inverters are those inverters which produces three phases of ac output.

PROPOSED SYSTEM CONFIGURATION

Renewable energy is energy from a resource that is replaceable by existing flows of energy, such as sunshine, wind, water, biological processes and geothermal heat flows. These energy resources might be used directly or indirectly as forms of energy. Among various renewable energy systems, photovoltaic power generation systems (PV systems) are expected to play an important role as a clean electricity power source in meeting future electricity demands. PV has become well established in remote area power supply, where it can be the most cost-effective choice. PV is also becoming more common in grid-connected applications, standalone loads such as space heating and cooling through solar architecture, day lighting, solar hot water, solar cooking, and high temperature process heat for industrial purposes. There are three major approaches for maximizing power extraction in small, mediumand large-scale systems. They are sun tracking, maximum power point (MPP) tracking or both. MPP tracking is popular for the small-scale systems based on economical reasons. The algorithms that are most commonly used are the perturbation and observation (P&O)method, dynamic approach method and the incremental conductance algorithm. P&O method has a simple feedback structure, fewer measured parameters and easy to implement. It operates by periodically perturbing (i.e. incrementing or decreasing) the array terminal voltage and

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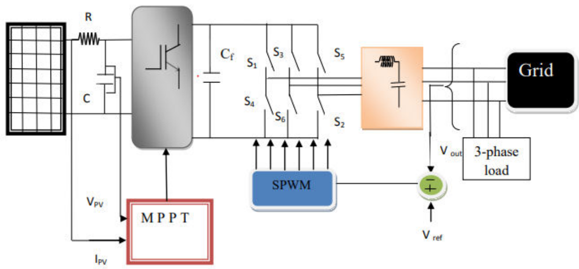

In this project, we have implemented the PV cell with the output power of the semiconductor material and on the wavelength of the incident light. Basically, the PV phenomenon may be described as the absorption of solar radiation, the generation and transport of free carriers at the p–n junction, and the collection of these electric charges at the terminals of the PV device.750watts which is dependent on temperature and irradiance of atmosphere on PV module. The output of the PV array is unregulated DC supply due to change in weather conditions. The maximum power is tracked with respect to temperature and irradiance levels by using DC-DC converter. The perturbation and observes [1] algorithm is applied for maximum power point tracking (MPPT) purpose. Here the output voltage of PV panel is 80V. The DC power from Boost Converter is fed to inverter to get ac output power. Inverters are static power converters that produce an ac output waveform from a dc power supply. For sinusoidal ac outputs, the magnitude and frequency are controllable. This is done by comparing a sinusoidal wave of the same frequency as inverter output against triangular carrier frequency wave. This technique called sinusoidal pulse width modulation (SPWM) mainly used because of its simplicity and ease of implementation. The output Voltage magnitude is controlled by closed loop control system. This output voltage is filtered by a second order low pass filter and the filtered output is given to the grid and the R-Load of 1KW.

PHOTOVOLTAIC SYSTEM

PV cells are being used in space and terrestrial applications where they are economically competitive with alternative sources. Generally, PV systems can be divided into three categories: stand-alone, grid-connection and hybrid systems. For places that are far from a conventional power generation system, stand-alone PV power supply systems have been considered a good alternative. These systems can be seen as a well-established and reliable economic source of electricity in rural remote areas; especially where the grid power supply is not fully extended. Such systems are presented in two scales: applications at a smaller scale, from 1 to 10 kW, are used to supply electric power in developing countries, the so-called solar home systems (SHS) and stand-alone PV systems of several hundred thousand watts in size, from 10 to 100 kW, on the roofs of dwellings. In general, they have the advantages of using a simple system configuration and simple control scheme. In those systems, the performance of a PV system relies on the operating conditions. Then, the maximum power extracted from the PV generator depends strongly on three factors: isolation, load profile (load impedance) and cell temperature (ambient temperature). The variation of the output I–V characteristic of a commercial PV module as a function of irradiation is shown in Figs. 2.1–2.2

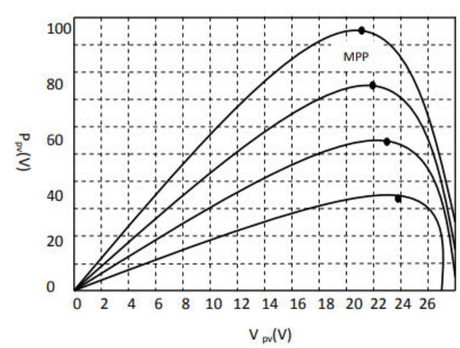

Fig. 2.1 P–V characteristics of PV cell for four different irradiation levels.

WORKING OF PV CELL

A photovoltaic cell is basically a semiconductor diode whose p–n junction is exposed to light. Photovoltaic cells are made of several types of semiconductors using different manufacturing processes. The mono-crystalline and poly-crystalline silicon cells are the only found at commercial

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scale at the present time. Silicon PV cells are composed of a thin layer of bulk Si or a thin Si film connected to electric terminals. One of the sides of the Si layer is doped to form the p–n junction. A thin metallic grid is placed on the Sun-facing surface of the semiconductor. Fig. 2.3 roughly illustrates the physical structure of a PV cell. The incidence of light on the cell generates charge carriers that originate an electric current if the cell is short-circuited. Charges are generated when the energy of the incident photon is sufficient to detach the covalent electrons of the semiconductor—this phenomenon depends onThe rate of generation of electric carriers depends on the flux of incident light and the capacity of absorption of the semiconductor. The capacity of absorption depends mainly on the semiconductor band-gap, on the reflectance of the cell surface (that depends on the shape and treatment of the surface), on the intrinsic concentration of carriers of the semiconductor, on the electronic mobility, on the recombination rate, on the temperature, and on several other factors.

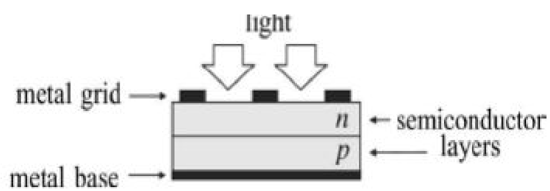


Fig 2.3: Physical structure of a PV cell

MATHEMATICAL MODELING OF PV CELL

The equivalent circuit of the ideal photovoltaic cell. The basic equation from the theory of semiconductors that mathematically describes the I-V characteristic of the ideal photovoltaic cell is:

I =$IPV. CELL$ - $Io. CELL$ exp $qVakT - 1$ (2.1) where

Ipv, cell is the current generated by the incident light (it is directly proportional to the Sun irradiation), Id is the Shockley diode equation, I0, cell [A] is the reverse saturation or leakage current of the diode, q is the electron charge [1.60217646 * 10−19C], k is the Boltzmann constant [1.3806503* 10−23J/K], T [K] is the temperature of the p-n junction, and a is the diode ideality constant. The basic Eqn. 2.1 of the elementary photovoltaic cell does not represent the I-V characteristic of a practical photovoltaic array. Practical arrays are composed of several connected photovoltaic cells and the observation of the characteristics at the terminals of the photovoltaic array requires the inclusion of additional parameters to the basic Eqn. 2.1.

$$I = I_{PV} - I_o \left[\exp\left(\frac{V + R_s I}{V_t a}\right) - 1\right] - \frac{V + R_s I}{R_p}$$

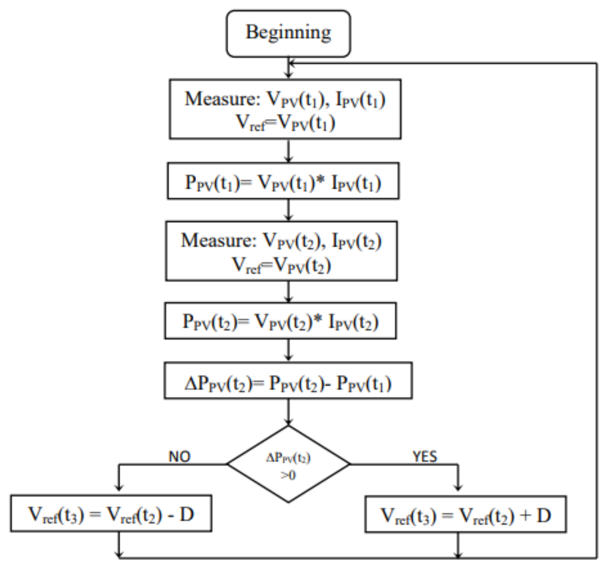
WhereIpv and I0 are the photovoltaic and saturation currents of the array and Vt = NskT/q is the thermal voltage of the array with Ns cells connected in series. Cells connected in parallel increase the current and cells connected in series provide greater output voltages. If the array is composed of Np parallel connections of cells the photovoltaic and saturation currents may be expressed as: Ipv=Ipv,cellNp, I0=I0,cellNp. In Eq. 2.2 Rs is the equivalent series resistance of the array and Rp is the equivalent parallel resistance. 2.5

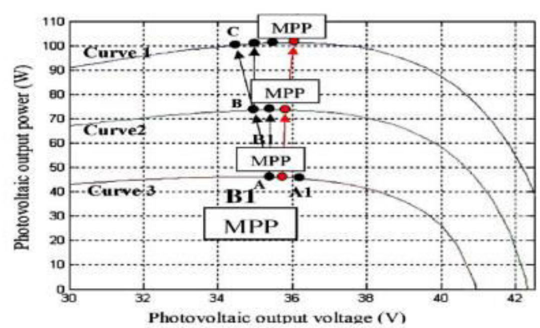
DIFFERENT MPPT TECHNIQUES

There are different techniques used to track the maximum power point. Few of the most populartechniques are:

1) Incremental Conductance method
2) Fractional short circuit current
3) Fractional open circuit voltage
4) Perturb and observe (hill climbing method)

PERTURBATION AND OBSERVE (''P&O'') METHOD The __P&O'' method is that which is most commonly used in practice by the majority of authors. It is an iterative method of obtaining MPP. It measures the PV array characteristics, and then perturbs the operating point of PV generator to encounter the change direction. The maximum point is reached when = 0 pvpvdVdP . An example algorithm flowchart of the most basic form is shown in Fig. 2.4 Doing this, the operating voltage of the PV generator is perturbed, by a small increment ΔVpv, and the resulting change, ΔPpv, in power, is measured. If ΔPpv is positive, the perturbation of the operating voltage should be in the same direction of the increment. However, if it is negative, the system operating point obtained moves away from the MPPT and the operating voltage should be in the opposite direction of the increment. The logic of this algorithm





In other words, the voltage will diminish and go to point B. Furthermore, if the irradiance is increased again quickly to curve 3, there will be another increase in positive power, with which the operation point will now be C. That is, due to two increases of irradiance, the operation point has been transferred from A to C, moving away from the maximum point. This process remains until the increase of the irradiance slows or stops

MAXIMUM POWER POINT TRACKING OF PV-SYSTEM

A typical solar panel converts only 30 to 40 percent of the incident solar irradiation into electrical energy. Maximum power point technique is used to

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improve the efficiency of the solar panel.

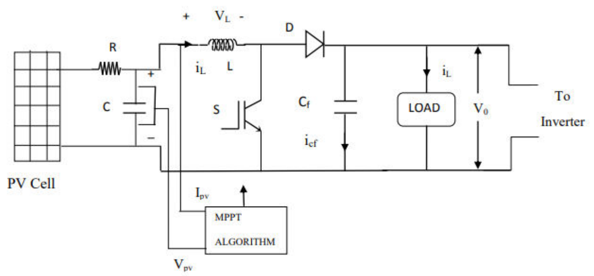

Fig. 2.7 Closed loop block diagram of solar powered Boost converter

According to Maximum Power Transfer theorem, the power output of a circuit is maximum when the Thevenin impedance of the circuit (Source impedance) matches with the load impedance. Hence our problem of tracking the maximum power point reduced to impedance matching problem

BOOST CONVERTER

The DC to DC converters are widely used in regulated switch mode DC power supplies.The input of these converters is an unregulated DC voltage, which is obtained by PV array and therefore it will be fluctuated due to changes in radiation and temperature. In these converters the average DC output voltage must be controlled to be equated to the desired value although the input voltage is changing. Boost converters are used in battery powered devices, where the electronic circuit requires ahigher operating voltage than the battery can supply, e.g. notebooks, mobile phones andcamera-flashes.A Boost regulator using a Power MOSFET shown in following figure.3.1

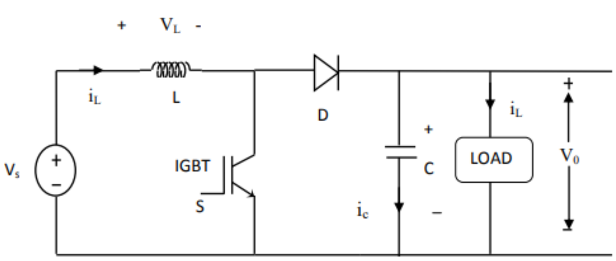

Fig 3.1 Basic DC-DC Boost Converter

OPERATION OF BOOST CONVERTER

The circuit operation can be divided into two modes. (a) Mode1 When the switch is closed, current flows through the inductor in clockwise direction and the inductor stores the energy. Polarity of the left side of the inductor is positive as shown in following Fig 3.2

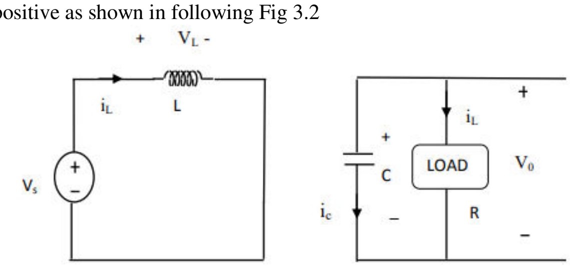

Fig 3.2 Mode 1 Operating Circuit

When switch is opened, the current that was flowing through the transistor would now flow through L, C, Load and diode D. the inductor current falls until transistor M1 is turned in again in the next cycle. The energy stored in inductor L is transferred to the load. Mode 2 operating circuit is shown following fig.3.3

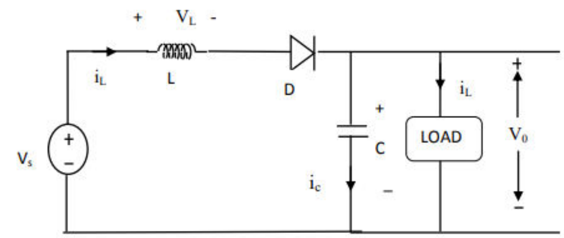

Fig 3.3 Mode 2 Operating Circuit

CONTINUOUS MODE

When a boost converter operates in continuous mode, the current through the inductor (IL) never falls to zero.Figure 3.4 shows the typical waveforms of currents and voltages in a converter operating. The output voltage can be calculated as follows, During the On-state, the switch S is closed, which makes the input voltage (Vi) appear across the inductor, which causes a change in current (IL) flowing through the inductor during a time period (t) by the formula:

$\Delta IL\ \Delta t = Vi\ L$ (3.1)

At the end of the On-state, the increase of IL is therefore:

$\Delta ILOn = 1\ L\ Vi\ DT\ 0\ dt = DT\ L\ Vi$ (3.2)

D is the duty cycle. It represents the fraction of thecommutation period T during which theswitch is On. Therefore D ranges between 0 (S is never on) and 1 (S is always on). During the Off-state, the switch S is open, so the inductor current flows through the load. If we consider zero voltage drop in the diode, and a capacitor large enough for its voltage to remain constant, the evolution of IL is:

$Vi - Vo = LdIL\ dt$ (3.3)

Therefore, the variation of IL during the Off-period is:

$\Delta ILOff = Vi - Vo\ dt\ L\ T\ DT = Vi - Vo\ 1 - D\ T\ L$ (3.4)

As we consider that the converter operates in steady-state conditions, the amount of energy stored in each of its components has to be the same at the beginning and at the end of a commutation cycle. In particular, the energy stored in the inductor is given by:

$E = 1\ 2\ LIL\ 2$ (3.5)

So, the inductor current has to be the same at the start and end of the commutation cycle. This means the overall change in the current (the sum of the changes) is zero:

$\Delta ILOn + \Delta ILOff = 0$ (3.6)

Substituting ΔILOn and ΔILOff by their expressions yields:

$\Delta ILOn + \Delta ILOff = ViDT\ L + Vi - Vo\ 1 - D\ T\ L = 0$ (3.7)

This can be written as:

$Vo\ Vi = 1\ 1 - D$ (3.8)

which in turn reveals the duty cycle to be

$D = 1 - Vi\ Vo$ (3.9)

The above expression shows that the output voltage is always higher than the input voltage (as the duty cycle goes from 0 to 1), and that it increases with D, theoretically to infinity as D approaches 1. This is why this converter is sometimes referred to as a step-up converter. 3.2.2

DISCONTINUOUS MODE

If the ripple amplitude of the current is too high, the inductor may be completely discharged before the end of a whole commutation cycle. This commonly occurs under light loads. In this case, the current through the inductor falls to zero during part of the period (see waveforms in figure 3.4).

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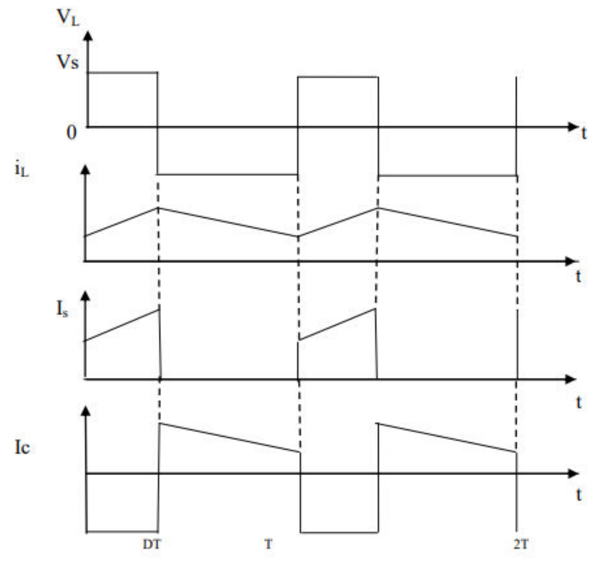


Fig 3.4 Waveforms of Current and Voltages

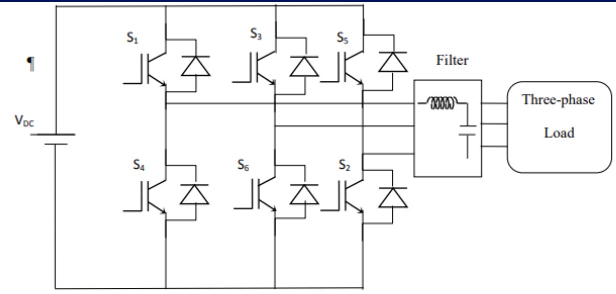
Although slight, the difference has a strong effect on the output voltage equation. It can be calculated as follows: As the inductor current at the beginning of the cycle is zero, its maximum valueILMax (at t = DT) is

ILMax = ViDT L (3.10)
During the off-period, IL falls to zero after
δT: ILMax + Vi−Vo δT L = 0 (3.11)
Using the two previous equations, δ is:
δ= ViD Vo−Vi (3.12)
The load current Io is equal to the average diode current (ID). As can be seen on figure 4, the diode current is equal to the inductor current during the off-state. Therefore the output current can be written as:
Io= ID = ILMax 2 δ (3.13)
ReplacingILMax and δ by their respective expressions yields:
Io = ViDT 2L .ViD Vo−Vi = Vi 2D 2T 2(Vo−Vi) (3.14)
Therefore, the output voltage gain can be written as follows: Vo
Vi = 1 + Vi 2D 2T 2LIo (3.15)
Compared to the expression of the output voltage for the continuous mode, this expression is much more complicated. Furthermore, in discontinuous operation, the output voltage gain not only depends on the duty cycle, but also on the inductor value, the input voltage, the switching frequency, and the output current.

INVERTER AND PWM TECHNIQUES

OPERATION OF INVERTER The dc to ac converters more commonly known as inverters, depending on the type of the supply/source and the related topology of the power circuit, are classified as voltage source inverter (VSIs) and current source inverter (CSIs). The three phase inverters are explained in detail below

The main purpose of these topologies is to provide a three-phase voltage source, where the amplitude, phase and frequency of the voltages can be controlled. The three phase dc-ac voltage source inverters are extensively being used in motor drives, active power filters and unified power flow controllers in power systems and uninterrupted power supplies to generate controllable frequency and ac voltage magnitudes using various pulse width modulation(PWM) strategies. The standard three-phase inverter shown in following figure 4.1 has six switches and the switching of the switches depends on the modulation scheme. The input dc is usually obtained from PV cell through a boost converter.



Three Phase Full-Bridge Inverter
The inverter has eight states given in Table 4.1. As explained earlier in order that the
circuit satisfies the KVL and the KCL, both of the switches in the same leg cannot be turned
ON at the same time, as it would short the input voltage violating the KVL. Thus the nature
of the two switches in the same leg is complementary. In accordance to figure 4.1,
$S11 + S12 = 1$ (4.1)
$S21 + S22 = 1$ (4.2)
$S31 + S32 = 1$ (4.3)

S_{11}	S_{12}	S_{21}	V_{ab}	V_{bc}	S_{ca}
0	0	0	0	0	0
0	0	1	0	$-V_{DC}$	V_{DC}
0	1	0	$-V_{DC}$	V_{DC}	0
0	1	1	$-V_{DC}$	0	$-V_{DC}$
0	0	0	V_{DC}	0	$-V_{DC}$
0	0	1	V_{DC}	$-V_{DC}$	0
0	1	0	0	V_{DC}	V_{DC}
0	1	1	0	0	0

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PWM SWITCHING STRATEGIES

The basis of PWM control scheme is the switching strategy applied to generate the switching edges of the PWM waveforms. The various available strategies are:

1. Natural sampled PWM
2. Regular sampled PWM

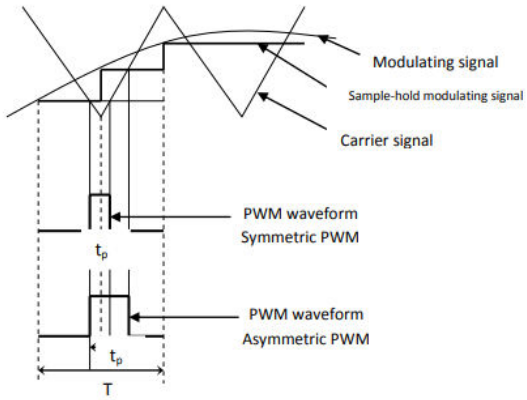
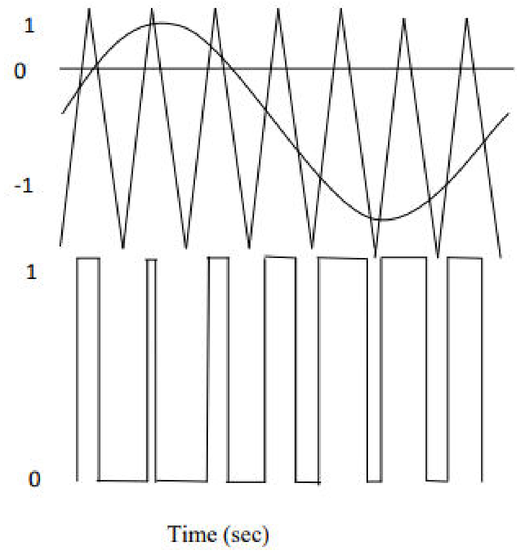


Fig.4.2 Details of symmetric and asymmetric PWM

The difficulties of the natural-sampled PWM can be totally eliminated using regularsampled PWM techniques. The significant advantage of the regular sampled PWM is the inherent linear sampling process which allows samples of the modulation wave to be taken at regularly spaced intervals. It is an improved method where in the digital realization is made possible.

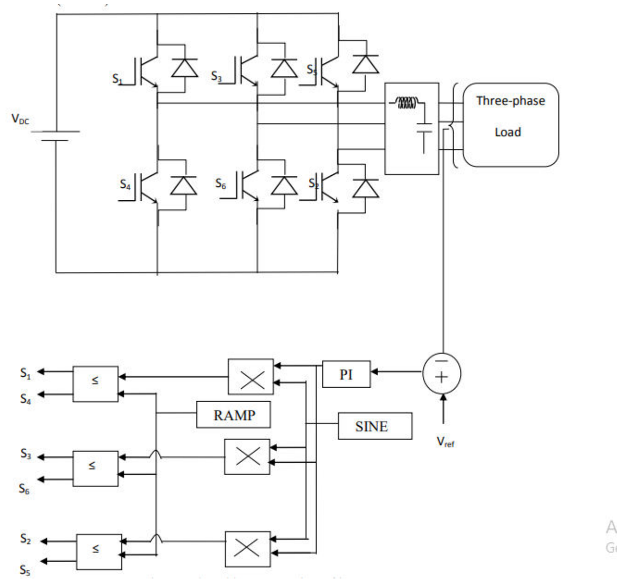
SINUSOIDAL PULSE WIDTH MODULATION THREE-PHASE INVERTER

PWM technique can be used in three-phase inverters, in which three sine waves phase shifted by 1200 with the frequency of the desired output voltage is compared with a very high frequency carrier triangle, the two signals are mixed in a comparator whose output is high when the sine wave is greater than the triangle and the comparator output is low when the sine wave or typically called the modulated signal is smaller than the triangle. This phenomenon is shown in Figure 4.3. It is explained the output voltage from the converter is not smooth but is a discrete waveform and so it is more likely than the output wave consists of harmonics, which are not usually desirable since they deteriorate the performance of the load, to which these voltages are applied.



CLOSED LOOP OPERATION OF INVERTER

The block diagram of closed loop operation of three phase inverter is shown in Fig4.3. Output voltage of inverter is controlled by using PI controller. Sine wave pulse width modulation (SPWM) is used to control the six switches of inverter.



SIMULATION RESULTS

The Simulink model of 750W PV cell operating at 250C with irradiance value of 1000. It is connect to a load of 250Ω.

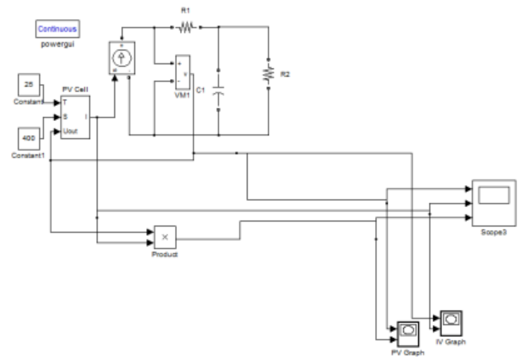


Fig.5.1 Simulink diagram of a PV Panel

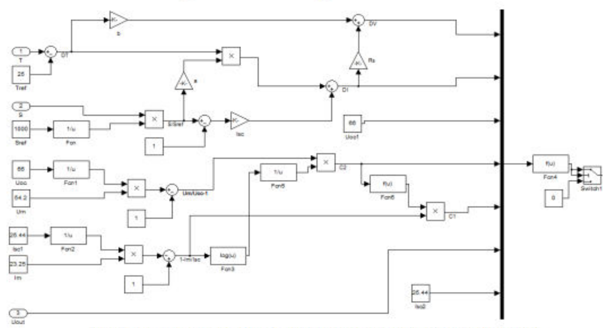


Fig 5.1.1 Unmasked block diagram of modeled solar PV panel

SIMULATION RESULTS OF PV PANEL

The results arevoltage, current and power outputs of a PV panel. Fig.5.1.3 and 5.1.4 shows the characteristics of P-V and I-V.

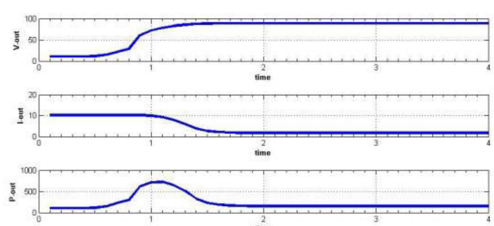


Fig. 5.1.2 Voltage, current and power outputs of a PV panel

P-V GRAPH

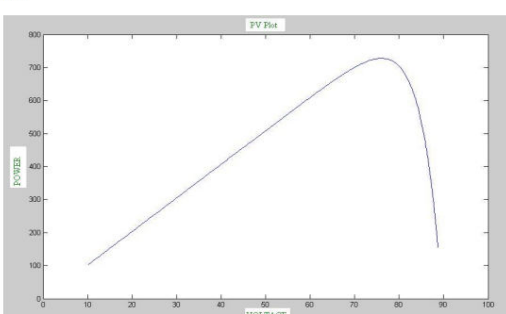


Fig 5.1.3 Plot of P-V

I-V GRAPH

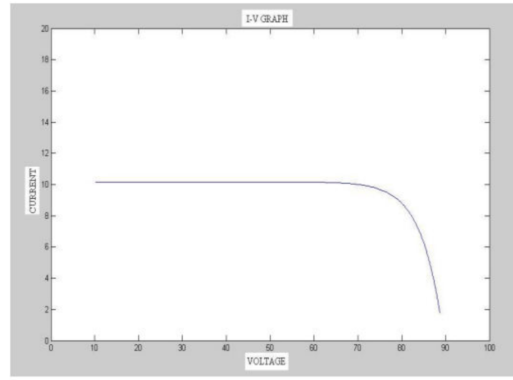
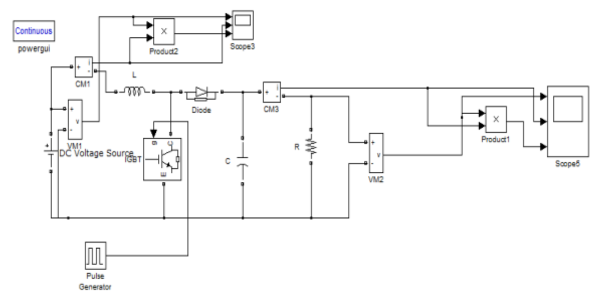


Fig 5.1.4 Plot of I-V

SIMULINK MODEL OF BOOST CONVERTER:

Fig.5.2 shows the Simulink model of a basic Boost converter with input voltage 90V and duty ratio of 50%, to obtained output voltage (VB_out) which is double the input voltage (VB_in).



SIMULATION RESULTS FOR BOOST CONVERTER Fig.5.2.1 shows the simulation results of voltage, current and power inputs are 90V, 7.9A and 730W respectively of Boost converter. Fig.5.2.2 shows the voltage, current and power outputs are 178V, 3.9A and 720W of boost converter with a load of 250Ω

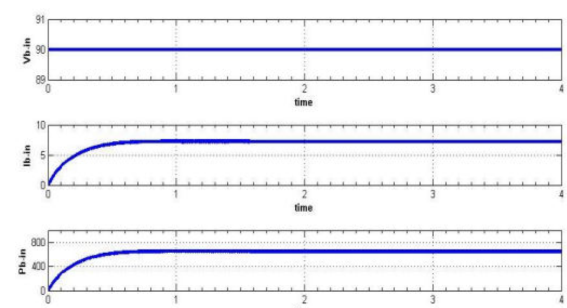


Fig.5.2.1 Voltage, current and power inputs of Boost converter

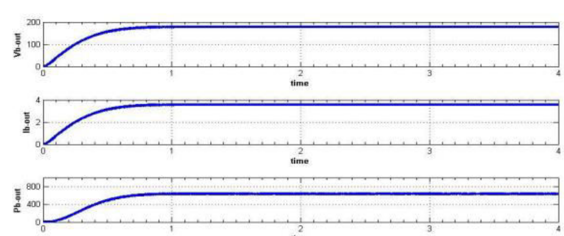


Fig.5.2.2 Voltage, current and power outputs of Boost converter

SIMULINK MODEL OF PV FED BOOST CONVERTER (WITHOUT MPPT)

Fig. 5.3(a) shows a Simulink model of 750W PV panel operating at 250C with irradiance value of 1000, fed Boost converter without MPPT with a 50% duty ratio. It is connected to a load of 250Ω

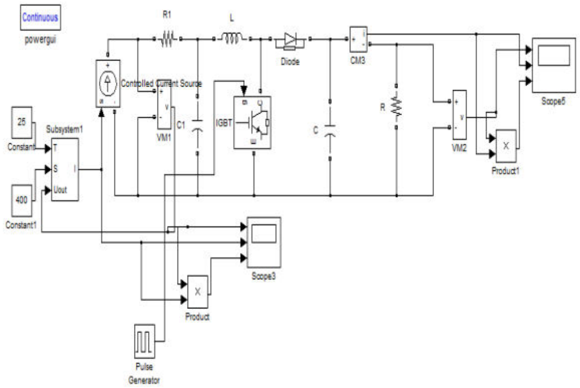


Fig 5.3(a) Simulink diagram of PV fed Boost converter without MPPT

SIMULATION RESULTS FOR PV FED BOOST CONVERTER WITHOUT MPPT:

Fig. 5.3.1 shows the simulation results of 750W PV panel fed Boost converter without MPPT, the voltage, current and power outputs of PV Panel are 84V, 6.7A and 560W. Fig. 5.3.2 shows the voltage, current and power outputs of boost converter are 165V, 3.3A and 550W.

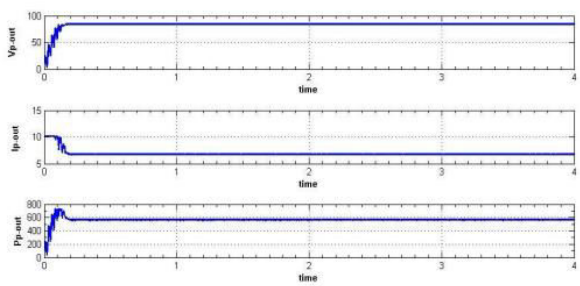


Fig 5.3.1 Voltage, current and power outputs of PV Panel

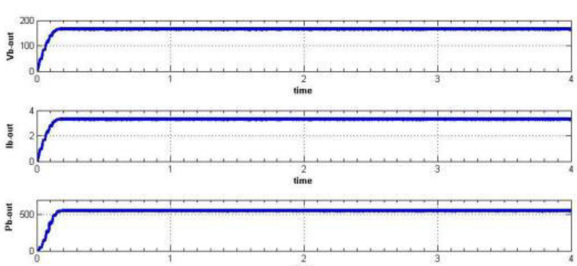


Fig 5.3.2 Voltage, current and power outputs of Boost converter with PV Panel

SIMULINK MODEL OF PV FED BOOST CONVERTER(WITH MPPT)

Fig 5.3(b) shows simulink model of 750W PV paneloperating at 250C with irradiance value of 1000w/m2 , is fed boost converter with MPPT.

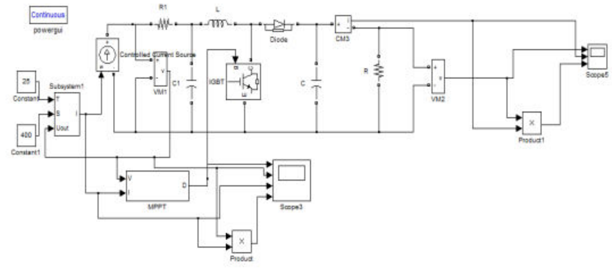


Fig 5.3(b) Simulink diagram of PV fed to Boost Converter with MPPT

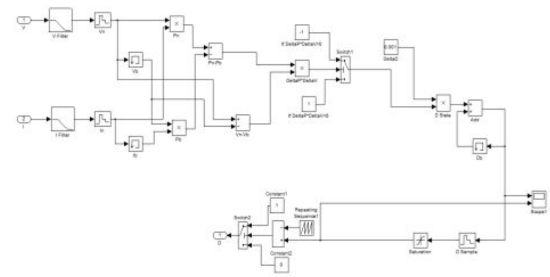


Fig 5.3.3 Simulink diagram of Maximum power point tracking by P & O method

SIMULATION RESULTS FOR PV FED BOOST WITH MPPT

Fig 5.3.4 shows the simulation results of a PV panel outputs are 78V, 9.5A and 720W.Fig 5.3.5 shows the obtained duty ratio from MPPT. Fig 5.3.6 shows the simulation results of outputs of boost converter are voltage, current and power are 420V, 1.6A and 710W respectively

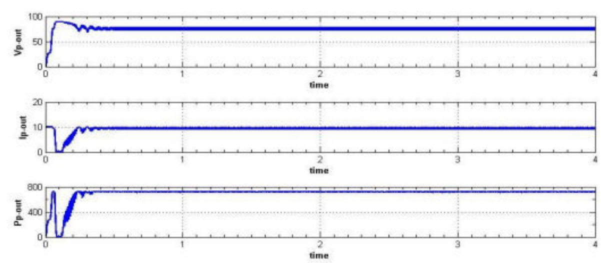


Fig 5.3.4 Voltage, current and power outputs for PV panel

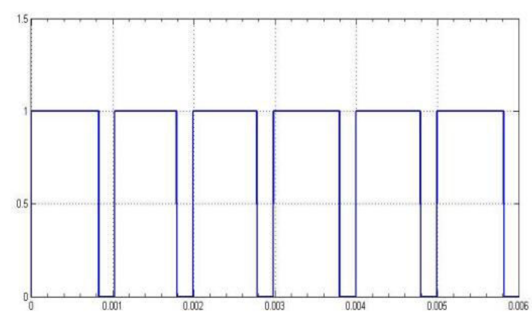


Fig 5.3.5 Obtained pulse

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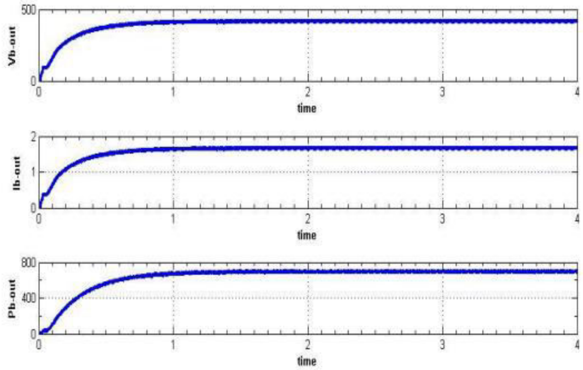

Fig 5.3.6 Voltage, current and power outputs of boost converter

SIMULINK MODEL OF 3-Ø INVERTER: Fig 5.4shows the Simulink model of 3-Ø Inverter of input voltage is 400V. Fig 5.4.1 shows Simulink model of the sub system of inverter. Fig 5.4.2 shows the Simulink model of generating PWM pulses

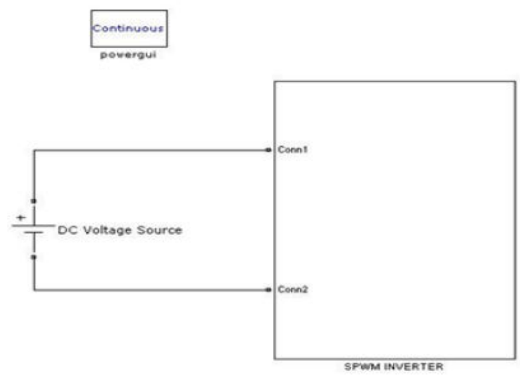

Fig 5.4 Simulink diagram of SPWM Inverter

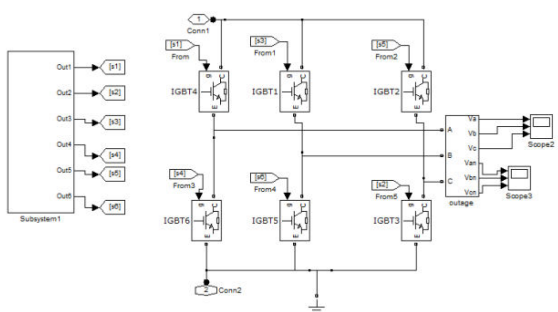

Fig 5.4.1 Simulink diagram of Sub system of 3-Ø Inverter

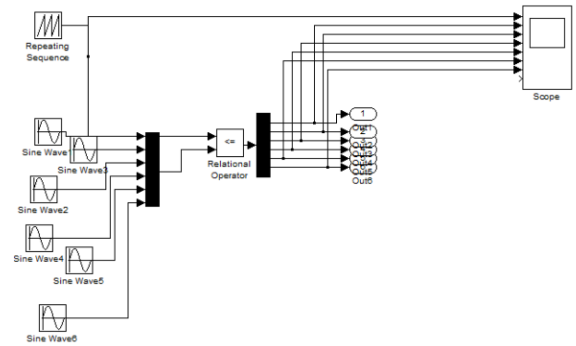

Fig 5.4.2 Simulink diagram of PWM Pulses

SIMULATION RESULTS FOR 3-Ø INVERTER

Fig 5.4.3 shows the simulation results are input, line, phase voltages of inverter. The input of inverter DC is given as 400V and we getLine and phase voltages are 400V, 230V

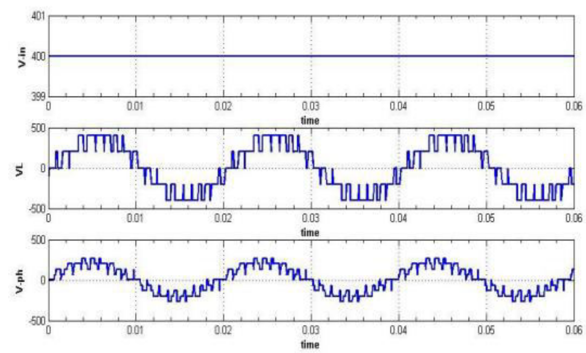

Fig 5.4.3 Input, Line, Phase voltages of SPWM Inverter

SIMULINK MODEL OF PV FED BOOST WITH 3-Ø INVERTER TO GRID Fig 5.5 shows the Simulink model of 750W PV fed boost with 3-Ø inverter to grid integration. It is connected a load of 1KW to the grid.

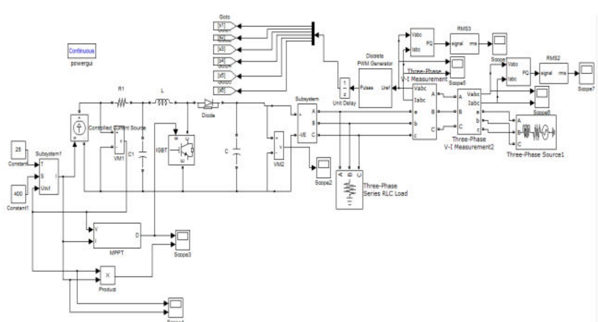

Fig 5.5 Simulink diagram of PV fed boost converter with 3-Ø Inverter to grid integration

SIMULATION RESULTS FOR PV FED BOOST WITH 3-Ø INVERTER TO GRID Fig 5.5.1 shows the simulation results of outputs of PV panel are 78V, 9.8A and 720W. Fig 5.5.2 shows the simulation results of boost converter. Fig 5.5.3 and 5.5.4 shows the simulation results of inverter which arevoltage, current and Active and Reactive powers. Fig 5.5.5 and 5.5.6 shows the simulation results 230V and 2.4A of grid integrated voltage and current.

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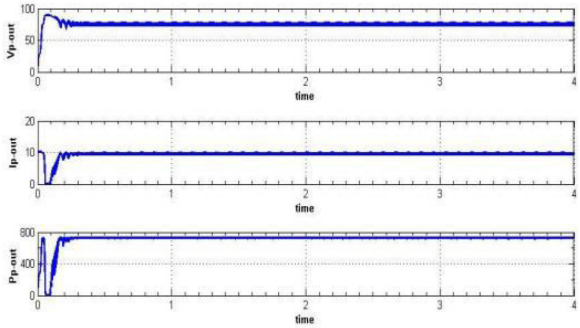


Fig 5.5.1 Voltage, current and power outputs of PV Panel

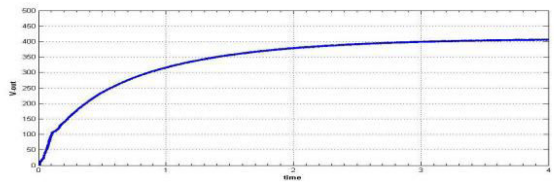


Fig5.5.2 Output Voltage of Boost converter

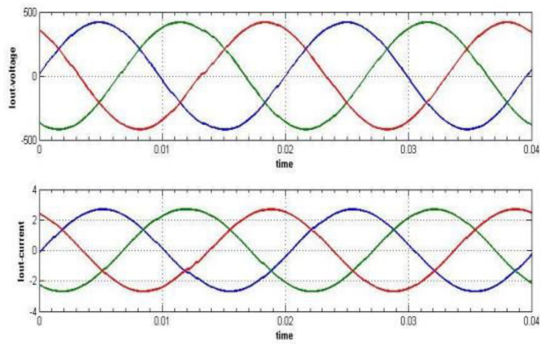
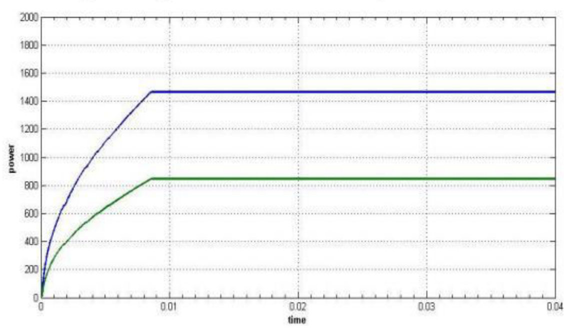


Fig 5.5.3 Output waveforms of inverter voltage and current



5.5.4 Active and Reactive power of inverter

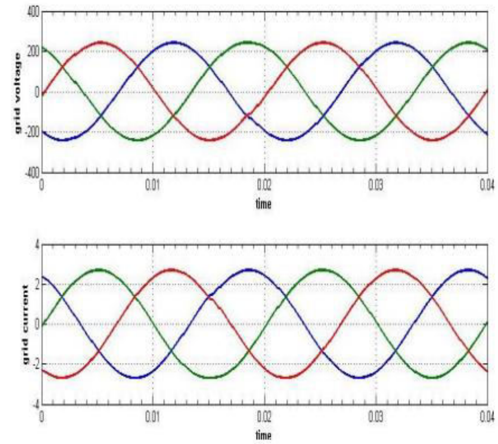


Fig 5.5.5 Output voltage and current of grid integration

Hardware setup details

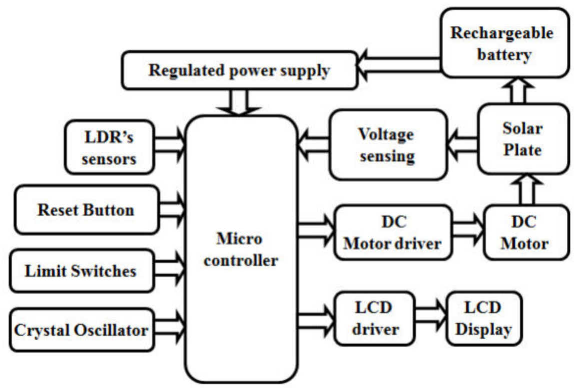


Fig 5.6.1 Block diagram of Hardware setup of proposed system

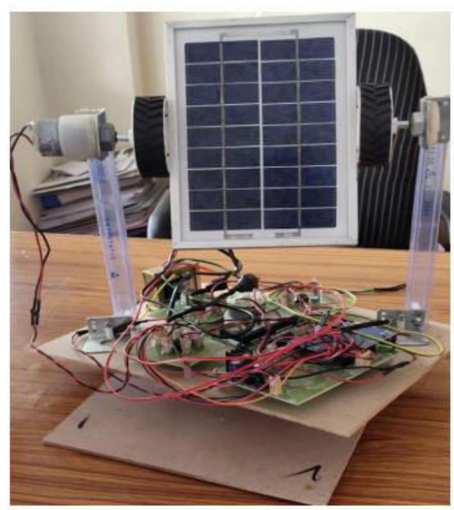


Fig 5.6.2 Hardware setup developed with dual axis tracking Solar panel

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'ig 5.6.3 Hardware setup developed with dual axis tracking Solar panel with floating bed

CONCLUSION

The mathematical modeling of photovoltaic cell has been analyzed. When the PV cell is used as a source of power supply to grid integration, it is necessary to use the MPPT to get the maximum power point from the PV cell, which is obtained using boost converter.The MPP is tracking by using a Boost-Converter, which is designed to operate under continuous conduction mode. The perturbation and observe algorithm is used as the controlalgorithm for the MPPT.

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