PROTOTYPE DEVELOPMENT AND TESTING OF A POWER ELECTRONICS CONVERTER FOR GREEN ENERGY USING DSPACE

A Project report submitted in partial fulfilment

of the requirements for the degree of B. Tech in Electrical Engineering

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Name and Signature of the Student

Place:
Date:

CERTIFICATE

To whom it may concern

This is to certify that the project work entitled **PROTOTYPE DEVELOPMENT AND TESTING OF A POWER ELECTRONICS CONVERTER FOR GREEN ENERGY USING DSPACE** is the bona fide work carried out by **Akansha Kumari (11701614004), Abhijeet Kumar (11701614001), Amir Saleheen (11701614006), Faisal Rahman(11701614022)** a student of B.Tech in the Dept. of Electrical Engineering, RCC Institute of Information Technology (RCCIIT), Canal South Road, Beliaghata, Kolkata-700015, affiliated to Maulana Abul Kalam Azad University of Technology (MAKAUT), West Bengal, India, during the academic year 2017-18, in partial fulfillment of the requirements for the degree of Bachelor of Technology in Electrical Engineering and that this project has not submitted previously for the award of any other degree, diploma and fellowship.

_____   _____

Signature of the Guide   **Signature of the HOD**

 Name: **Name:**

 Designation   **Designation**

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Signature of the External Examiner

Name:

Designation:

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1.1 Introduction

With the advantages of pollution free, economical and abundantly available,
the photovoltaic (PV) has become one of the very important alternatives energy sources. It is a cost-effective for remote applications where utility power is unavailable . In addition, the conventional energy source such as fossil fuel is diminishing.

In order to exploit this PV direct current (dc) power source, an inverter is necessary to transform it to an alternative current (ac) . For the high-voltage applications, dcdc boost converters are used with the inverters . Extensive researches are being carried out to improve the inverter performance. The inverters issues include output voltage and current regulation, conversion efficiency, impact of unbalanced load on inverter output voltage, nonlinearity and low efficiency of the PV devices, electromagnetic interference, harmonics level, and high speed and frequency capability for generating pulsewidth modulation (PWM) signals .

There are many types of controllers employed in the implementation of PWM techniques, e.g. SPWM (Sinusoidal Pulse-Width Modulation), SVPWM (Space Vector Pulse-Width Modulation), for generating and regulating output of inverters. The SVPWM method is more complex compared to SPWM especially for multilevels inverters .
Some of the controllers include analogue circuit controllers, microcomputers, digital circuit controllers, field programmable gate arrays (FPGA) and digital signal processors (DSP) . Globally, researchers continue to develop and improve various areas of inverter, e.g. control algorithm, in effort to support the application of renewable energy.
The opportunities are still exist for improving the inverter controller, since inverter failure remains one of the primary causes for PV system failure . Thus, enhanced inverter controllers are necessary for improving the inverter performance in PV or renewable energy applications.
The DSP TMS320F2812 and FPGA-based PV inverters utilizing proportional-integral (PI) and PWM control algorithm have been developed in . However, it requires users to develop a quite lengthy software programming or codes for the control algorithm. Perhaps, it is a time consuming task, especially for those with little or no experience dealing with the software programming.
A different approach to this is by adopting the dSPACE DS1104 control platform which enables the user to employ the MATLAB/SIMULINK link tools for the development of control algorithm and simulation as well as hardware implementation.

The dSPACE DS1202 control platform simplifies the control algorithm programming task by means of its library blocksets. Moreover, the data codes of the successfully simulated model can be linked and loaded directly to the controller for real time hardware operation. Using the graphical object-oriented package, a dSPACE system has enables the development of userfriendly inverter control panels for on-line monitoring and supervision .

A dSPACE system is quite popular in controlling platform and is widelyused in automation systems and car manufacturing industries . Besides the car manufacturing area, the dSPACE system can also be used as a control platform in the PV standalone inverter development.

In this paper, the modeling for the hardware is developed and simulated in MATLAB/SIMULINK. Upon simulation success, it will be linked to the dSPACE DS1202 controller which enabling the inverter hardware control. The model generates the SPWM switching signals for the voltage control scheme to justify the implementation of the real inverter hardware.

A detail control strategy of dSPACE platform has been discussed. The real-time implementation of the inverter controller is carried out with the integration of the dSPACE DS1202 platform.

Fundamental circuit of two-stage PV inverter
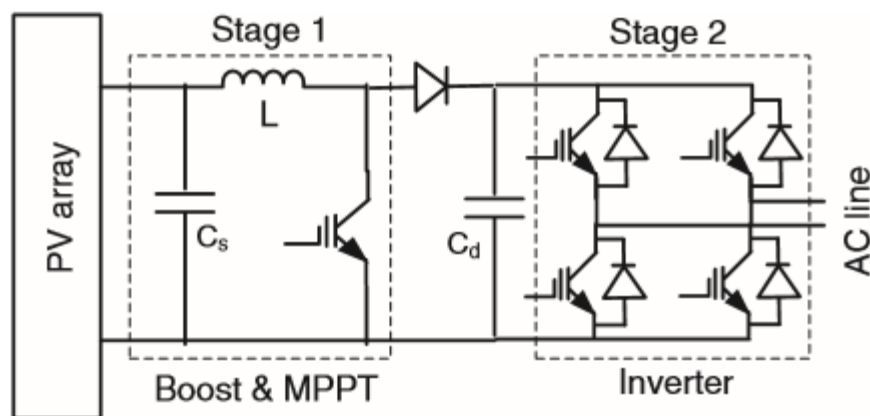
Chapter 2

SOLAR CELL MODELING

Solar Photovoltaic Arrays

The "solar photovoltaic" means "producing electricity from sunlight." A PV cell can be made by two semiconductor layers; one having positive charge and the other having negative charge. When the sunlight shines on a PV cell, some of the photons from the sunlight are absorbed by the semiconductor atoms, releasing electrons from the cell's negative layer. If there is an external circuit, the free electrons flow to the positive layer and produce electric current in the external circuit.
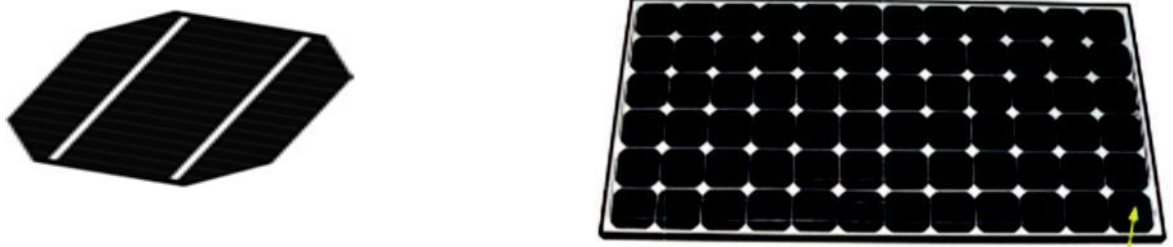

Fig 2.1 pv cell and pv module

A number of modules can be connected in series and parallel. The series–parallel combination of modules is called a PV array. Figure 2.2 shows a photograph of PV array with six 12-V modules, where 36 cells are interconnected in each module.

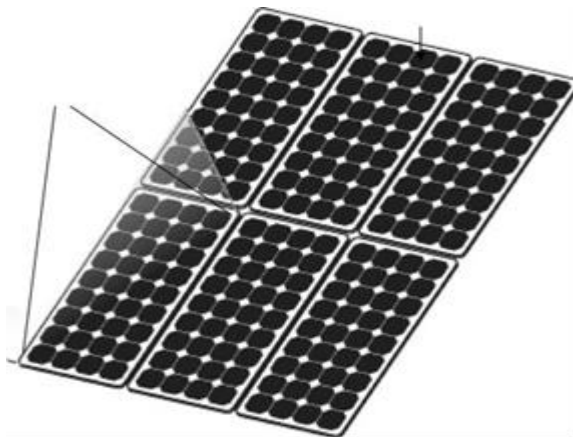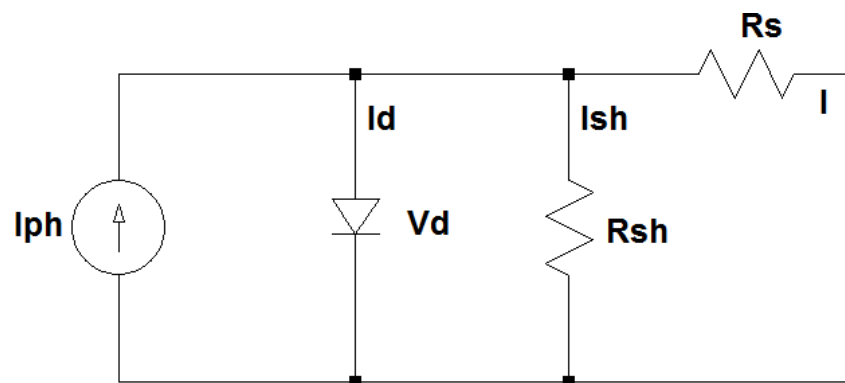Fig.2.2

2.1 MODELLING OF SOLAR CELL

A solar cell is the building block of a solar panel. A photovoltaic module is formed by connecting many solar cells in series and parallel. Considering only a single solar cell; it can be modeled by utilizing a current source, a diode and two resistors. This model is known as a single diode model of solar cell. Two diode

models are also available but only single diode model is considered here [1], [2], [4], [7], [9] and [10].

Figure 2.3: Single diode model of a solar cell

The characteristic equation for a photovoltaic cell is given by [1], [2], [4], [7], [9] and [10],

$$I = Ilg - Ios*[exp\{q*(V+I*Rs)/ A*k*T\}-1]-(V+I*Rs) /Rsh$$

Where,
$$Ios = Ior*(T/ Tr)3*[exp\{q*Ego*(1/ Tr-1 /T)/A *k\}]$$

$$Ilg = \{Iscr + Ki*(T-25)\}*lambda$$

I & V: Cell output current and voltage;

Ios: Cell reverse saturation current;

T   : Cell temperature in Celsius;
k   : Boltzmann's constant, $1.38 * 10^{-19}$ J/K;

q   : Electron charge, $1.6*10^{-23}$ C;

Ki   :   Short   circuit   current   temperature   coefficient   at   Iscr;

lambda   : Solar irradiation in W/m^2;

Iscr   : Short circuit current at 25 degree

Celsius; Ilg : Light-generated current;

Ego   : Band gap for silicon;

A   : Ideality factor;

Tr   : Reference temperature;

Ior   : Cell saturation current at Tr;

Rsh   : Shunt resistance;

Rs   : Series resistance;

The characteristic equation of a solar module is dependent on the number of cells in parallel and number of cells in series. It is observed from experimental results that the current variation is less dependent on the shunt resistance and is more dependent on the series resistance.

The I-V and P-V curves for a solar cell are given in the following figure. It can

be seen that the cell operates as a constant current source at low values of

operating voltages and a constant voltage source at low values of operating
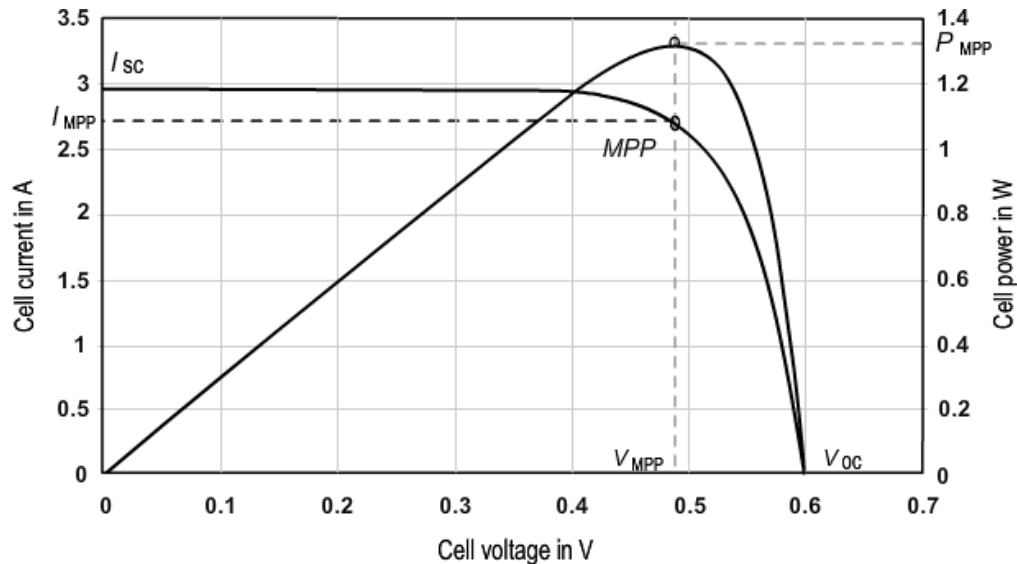
current.

Figure 2.4: P-V I-V curve of a solar cell at given temperature and solar irradiation

2.2 EFFECT OF VARIATION OF SOLAR IRRADIATION

The P-V and I-V curves of a solar cell are highly dependent on the solar irradiation values. The solar irradiation as a result of the environmental changes keeps on fluctuating, but control mechanisms are available that can track this change and can alter the working of the solar cell to meet the required load demands. Higher is the solar irradiation, higher would be the solar input to the solar cell and hence power magnitude would increase for the same voltage value. With increase in the solar irradiation the open circuit

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voltage increases. This is due to the fact that, when more sunlight incidents on to the solar cell, the electrons are supplied with higher excitation energy, thereby increasing the electron mobility and thus more power is generated [7] and [10]
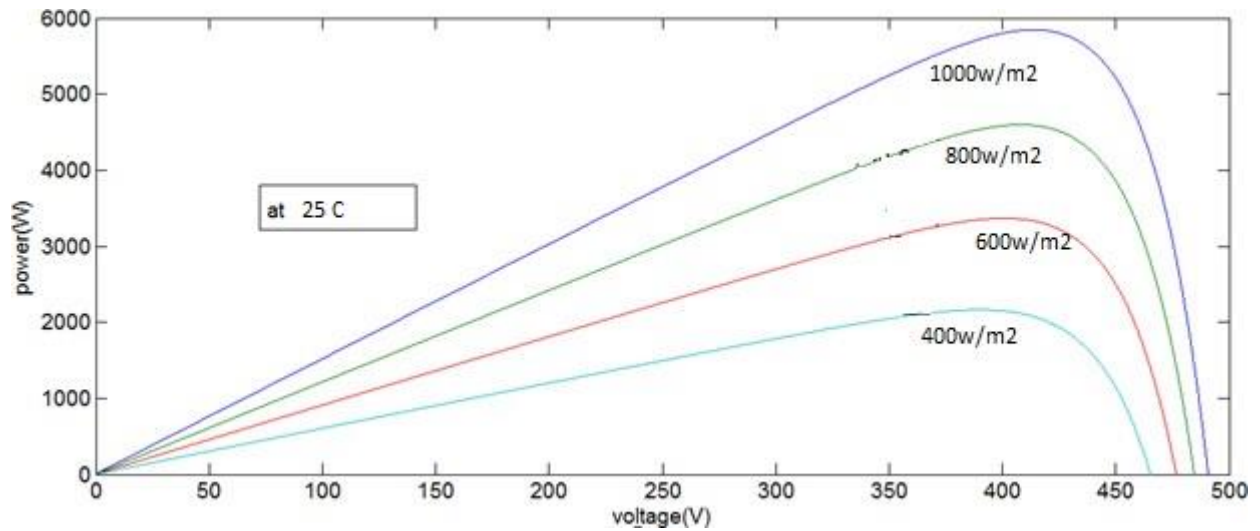

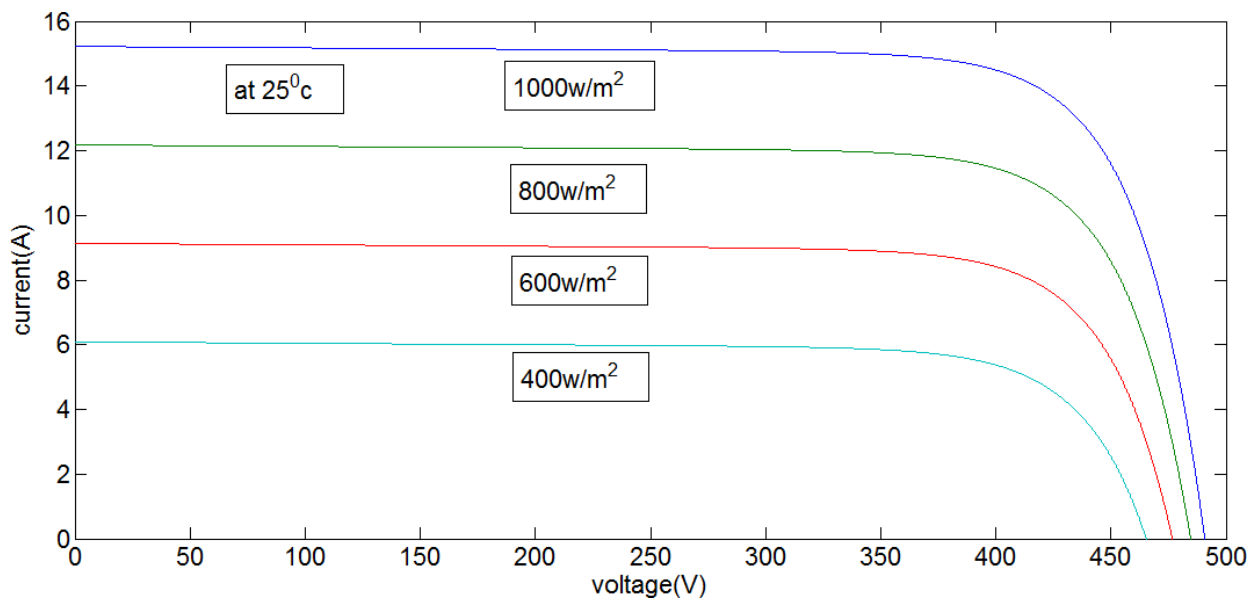Figure 2.5: Variation of P-V curve with solar irradiation

Figure 2.6: Variation of I-V curve with solar irradiation

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2.3 EFFECT OF VARIATION OF TEMPERATURE

On the contrary the temperature increase around the solar cell has a negative impact on the power generation capability. Increase in temperature is accompanied by a decrease in the open circuit voltage value. Increase in temperature causes increase in the band gap of the material and thus more energy is required to cross this barrier. Thus the efficiency of the solar cell is reduced .
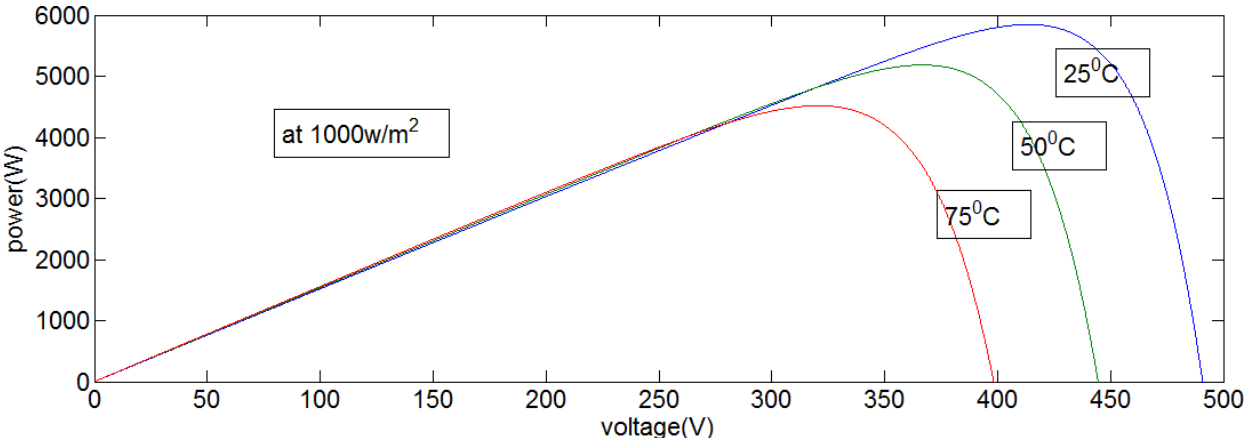

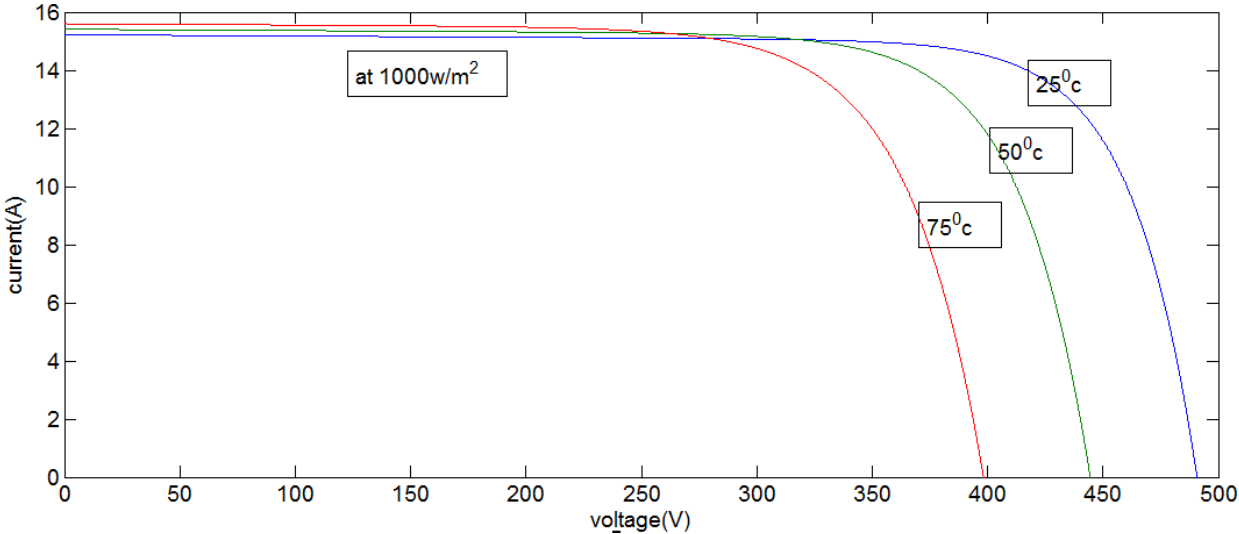Figure 2.7: Variation of P-V curve with temperature

Figure 2.8: Variation of I-V with temperature

Chapter 3

BOOST CONVERTER

3.1 BOOST CONVERTER

3.2 MODES OF OPERATION

3.3WAVEFORMS

3.1 BOOST CONVERTER

Boost converter steps up the input voltage magnitude to a required output voltage magnitude without the use of a transformer. The main components of a boost converter are an inductor, a diode and a high frequency switch. The duty cycle of a PWM signal determines the ratio between the input and output voltage. In case of an ideal switching device and when losses are neglected, the ratio between Vin and Vout can be calculated with formula 3.1. In this formula, D represents the duty cycle of the PWM signal and has an value between 0 and 1. As can be seen in formula 3.1, Vout increases as the duty cycle increases. We shall use this property to adjust the operating point of the MPPT.
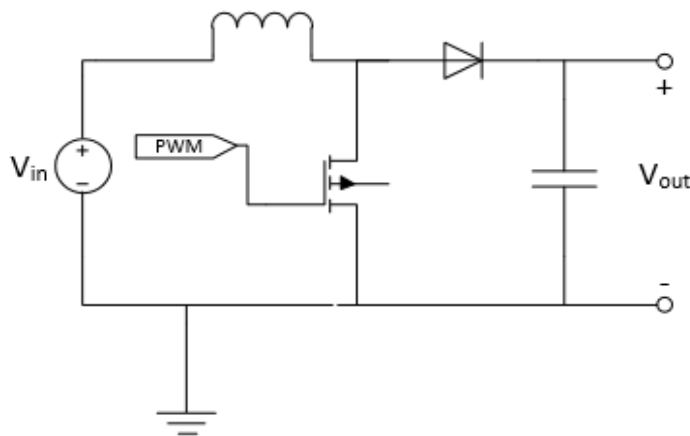
formula3.1   Vo/Vi=1/(D)

Figure 3.1: A boost converter

3.2 MODES OF OPERATION

There are two modes of operation of a boost converter. Those are based on the closing and opening of the switch. The first mode is when the switch is closed; this is known as the charging mode of operation. The second mode is when the switch is open; this is known as the discharging mode of operation .

3.2.1 Charging Mode

In this mode of operation; the switch is closed and the inductor is charged by the source through the switch. The charging current is exponential in nature but for simplicity is assumed to be linearly varying . The diode restricts the flow of current from the source to the load and the demand of the load is met by the discharging of the capacitor.

3.2.2 Discharging Mode

In this mode of operation; the switch is open and the diode is forward biased [11]. The inductor now discharges and together with the source charges the capacitor and meets the load demands. The load current variation is very small and in many cases is assumed constant throughout the operation.

3.3 Waveforms

Voltage and Current Waveforms
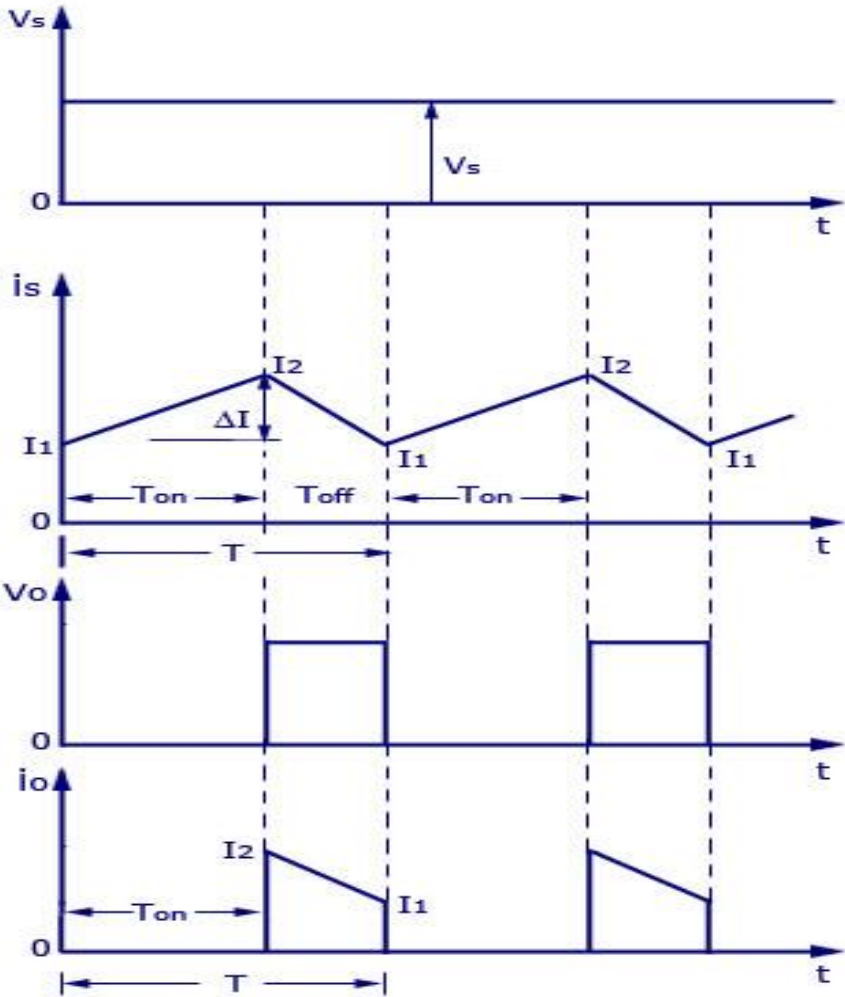
www.CircuitsToday.com

Chapter 4

MAXIMUM POWER POINT TRACKING

4.1MAXIMUM POWER POINT TRACKING

The efficiency of a solar cell is very low. In order to increase the efficiency, methods are to be undertaken to match the source and load properly. One such method is the Maximum Power Point Tracking (MPPT). This is a technique used to obtain the maximum possible power from a varying source. In photovoltaic systems the I-V curve is non-linear, thereby making it difficult to be used to power a certain load. This is done by utilizing a boost converter whose duty cycle is varied by using a mppt algorithm.

It is observed from the power–voltage curve of the solar PV module that on the right hand side, when the voltage is almost constant, the slope of power versus voltage is negative ($P/V < 0$), whereas on the left hand side, the slope is posi-tive ($P/V > 0$), as illustrated in Fig. Thus, the PV array has an optimum operating point called the MPP, which varies depending on array tem-perature and the present insolation level. The irradiance mainly affects the output current, and the temperature mainly affects the terminal voltage of the PV array, so that the effects of both factors have to be considered when designing a PV sys-tem.

Fig. 2.18 Maximum power point (*MPP*) determination: The slope is positive on the left side of the *P–V* curve, negative on the right side, and zero at the MPP [12, 13]
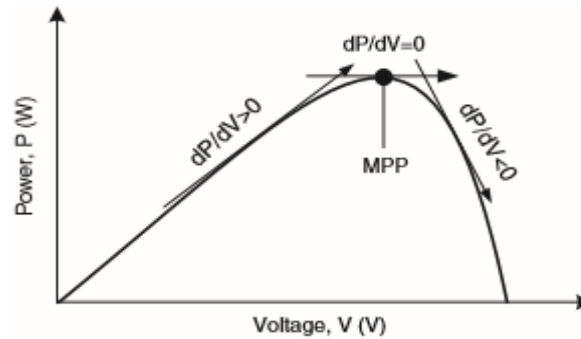
4.2 METHODS FOR MPPT

There are many methods used for maximum power point tracking . Here we are using Perturb and Observe method.

Perturb and Observe method

This method is the most common. In this method very less number of sensors are utilized . The operating voltage is sampled and the algorithm changes the operating voltage in the required direction and samples dp/dv. If dp/dv is positive, then the algorithm increases the voltage value towards the MPP until dp/dv is negative. This iteration is continued until the algorithm finally reaches the MPP. This algorithm is not suitable when the variation in the solar irradiation is high. The voltage never actually reaches an exact value but perturbs around the maximum power point (MPP).

4.3 FLOW CHART OF MPPT ALGORITHMS

Flow chart for perturb & observe:
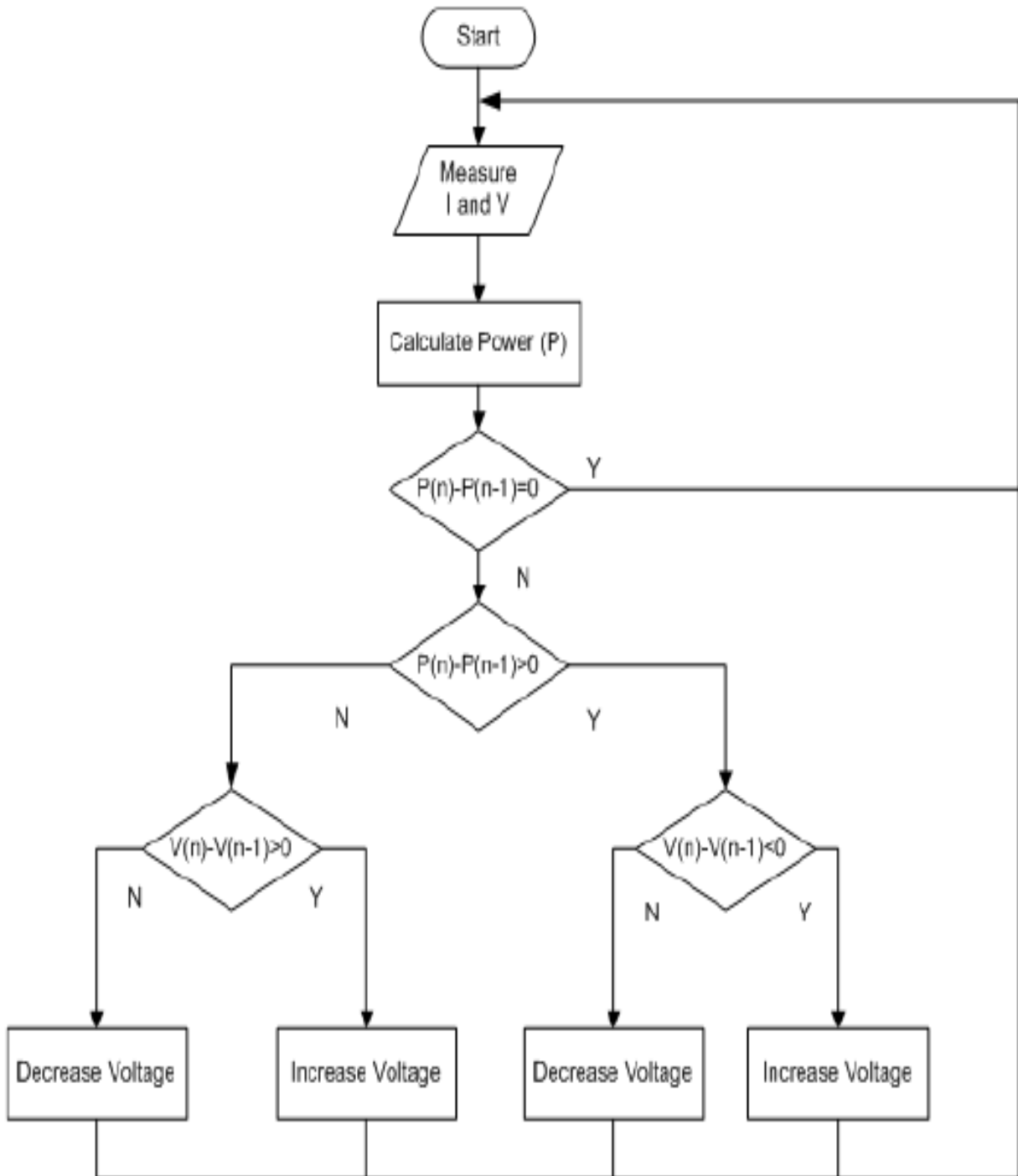
Chapter 5

INVERTER

5.1 SINGLE PHASE FULL BRIDGE INVERTER

An inverter is basically a device that converts electrical energy of DC form into that of AC. The purpose of DC-AC inverter is to take DC power from a battery source and converts it to AC. For example the household inverter receives DC supply from 12V or 24V battery and then inverter converts it to 220V AC with a desirable frequency of 50Hz or 60Hz

A single phase bridge DC-AC inverter is shown in Figure below. The analysis of the single phase DC-AC inverters is done taking into account following assumptions and conventions.
1) The current entering node a in Figure is considered to be positive.
2) The switches S1, S2, S3 and S4 are unidirectional, i.e. they conduct current in one direction.
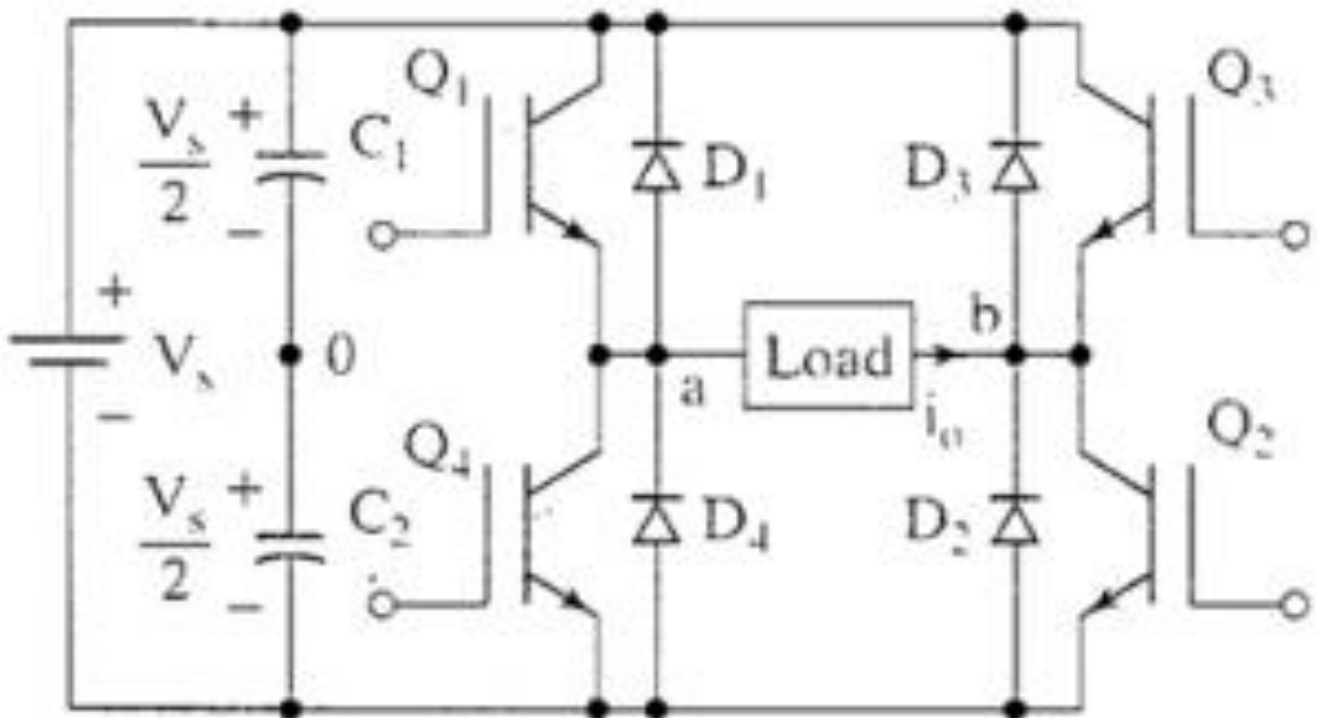
When the switches S1 and S2 are turned on simultaneously for a duration 0 $\leq t \leq T1$, the the input voltage Vin appears across the load and the current

flows from point a to b.

Q1 – Q2 ON, Q3 – Q4 OFF ==> v o = Vs
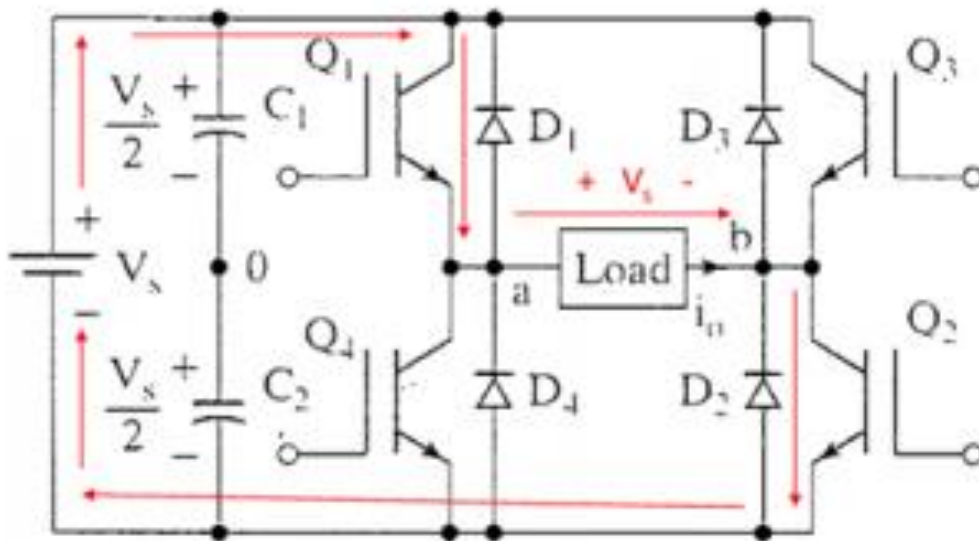
If the switches S3 and S4 turned on duration T1 ≤ t ≤ T2, the voltage across the load the load is reversed and the current through the load flows from point b to a.

Q1 – Q2 OFF, Q3 – Q4 ON ==> v o = -Vs
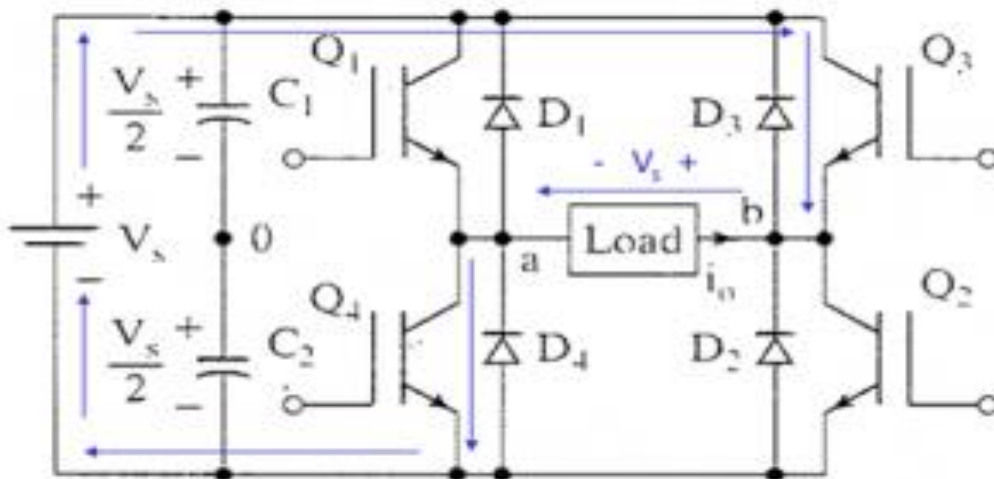
5.2 WAVEFORM

The voltage and current waveforms across the resistive load are shown in Figure below.
There is 180 degree phase difference between positive group of switch (Q1 and Q2) and negative group of switches(Q3 and Q4).

5.3 Pulse Width Modulation (PWM)

The Pulse Width Modulation (PWM) is a technique which is characterized by the generation of constant amplitude pulse by modulating the pulse duration by modulating the duty cycle. Analog PWM control requires the generation of both reference and carrier signals that are feed into the comparator and based on some logical output, the final output is generated. The reference signal is the desired signal output maybe sinusoidal or square wave, while the carrier signal i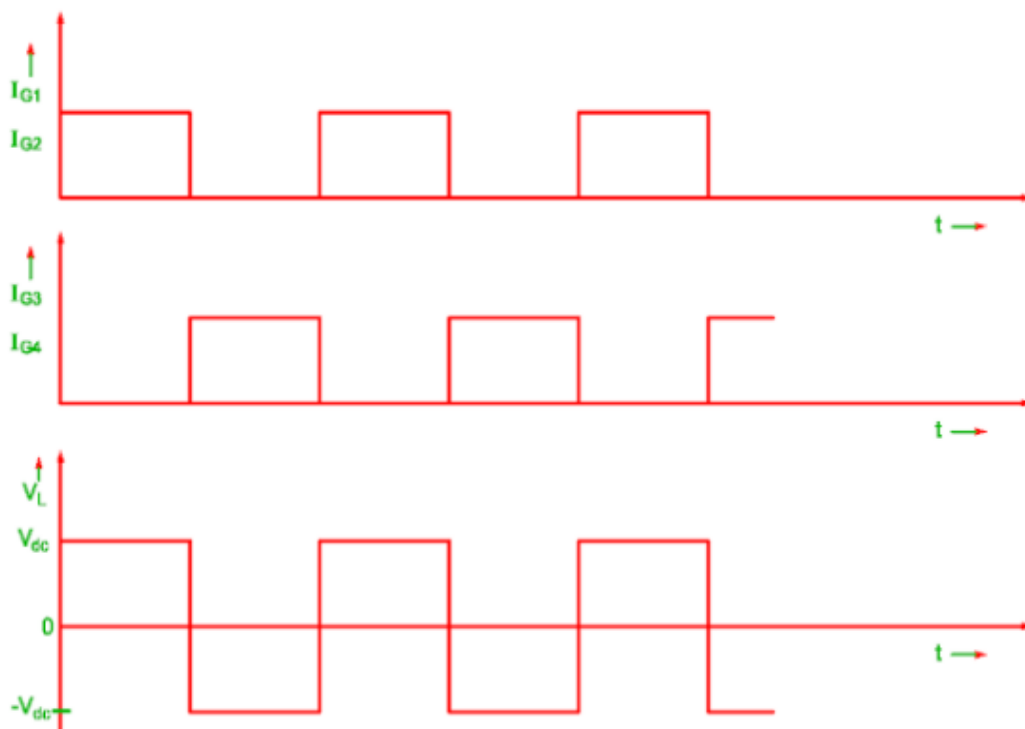s either a sawtooth or triangular wave at a frequency significantly greater than the reference. There are various types of PWM techniques and so we get different output and the choice of the inverter depends on cost, noise and efficiency.

5.3.1 Basic PWM Techniques

There are three basic PWM techniques:
1. Single Pulse Width Modulation
2. Multiple Pulse Width Modulation
3. Sinusoidal Pulse Width Modulation

Here we are using Sinusoidal Pulse Width Modulation.

5.3.2 Sinusoidal Pulse Width Modulation.
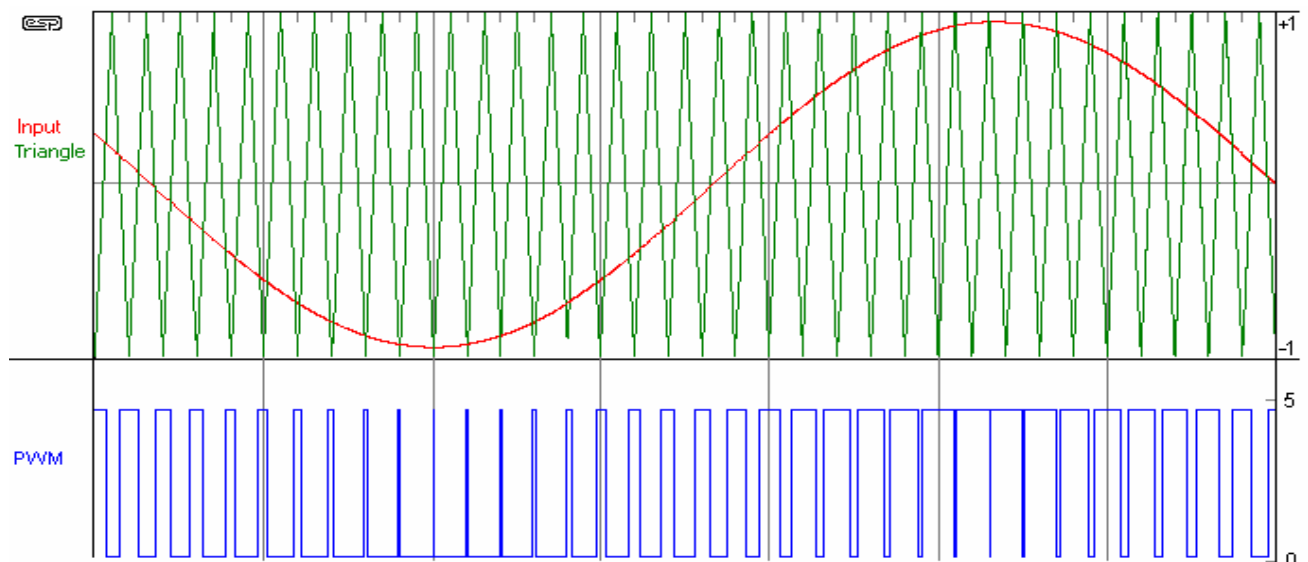
The most common and popular technique for generating True sine Wave is Pulse Width Modulation (PWM). Sinusoidal Pulse Width Modulation is the best technique for this. This PWM technique involves generation of a digital waveform, for which the duty cycle can be modulated in such a way so that the average voltage waveform corresponds to a pure sine wave. The simplest way of producing the SPWM signal is through comparing a low power sine wave reference with a high frequency triangular wave. This SPWM signal can be used to control switches.

Through an LC filter, the output of Full Wave Bridge Inverter with SPWM signal will generate a wave approximately equal to a sine wave. This technique produces a much more similar AC waveform than that of others.

Chapter 6

Mosfet protection and gate driver circuit

6.1 Snubber circuit

6.2 Gate driver circuit

6.1 Snubber circuit

Protection of switching devices and circuits: Switching devices and circuit components may fail due to the following reasons.

1. Overheating – thermal failure

2. Overcurrent

3. Overvoltage – usually happens during turn-off

4. Excessive di/dt

5. Excessive dv/dt

6. Switching loss –excessive switching loss is a major contributing factor of overheating.

Power electronic circuits and their switching devices and components can be protected from overcurrent by placing fuses at suitable locations. Heat sinks, fins and fans are used to take the excess heat away from switching devices and other components. Snubber circuits are required to limit di/dt , dv/dt and overvoltage during turn-on and turnoff. Some typical snubber circuits are described below.

Power MOSFETS A small RC turn-off snubber as shown in Figure 10 can be used to prevent voltage spikes and voltage oscillations across a MOSFET during device turn-off. The large peak current handling capability of the MOSFET and the fact that its switching speed can be easily controlled by controlling the gate current eliminates the need for a turn-on snubber in most case.
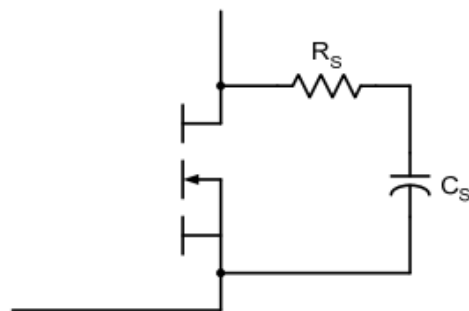
Figure 10. A turn-off snubber for a MOSFET.

6.2 Gate driver circuit

It is a power amplifier that accepts a low-power input from a controller IC and produces the appropriate high-current gate drive for a power MOSFET. A gate driver is used when a pulse-width-modulation (PWM) controller cannot provide the output current required to drive the gate capacitance of the associated MOSFET. Gate drivers may be implemented as dedicated ICs, discrete transistors, or transformers. They can also be integrated within a controller IC. Partitioning the gate-drive function off the PWM controller allows the controller to run cooler and be more stable by eliminating the high peak currents and heat dissipation needed to drive a power MOSFET at very high frequencies.

 Here we are using ir 2110 as mosfet driver.

Circuit diagram
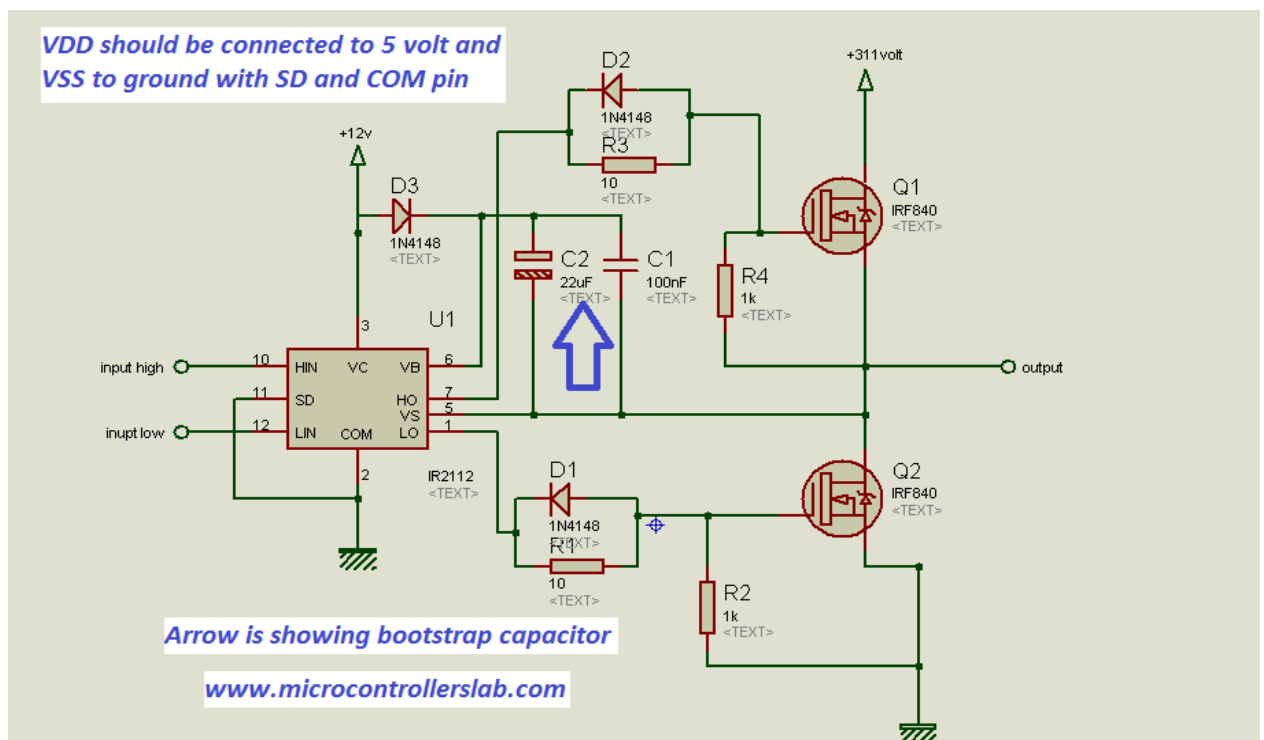
Ir2110 pin diagram
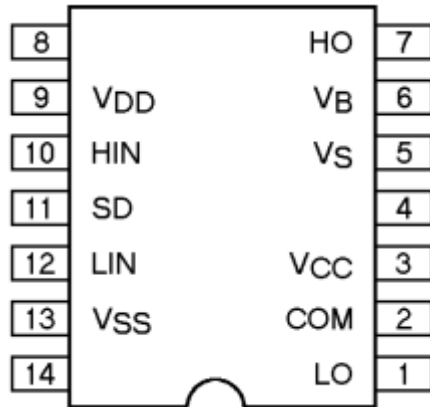
Circuit Connections -

The IR2110 IC comes in a 14-pin DIP package. It has the following pin configuration

Pin Number	Pin Name	Function
1	LO	Output of Low Side MOSFET Drive
2	COM	Return Path for Low Side MOSFET
3	VCC	Low Side Supply Voltage
4	-	-
5	VS	High side floating supply return or offset voltage
6	VB	High side floating supply voltage
7	HO	High side gate driver output
8	-	-
9	VDD	Logic supply voltage
10	HIN	Input signal for high side MOSFET driver output
11	SD	Logic input for shutdown
12	LIN	Input signal for low side MOSFET driver output
13	VSS	Logic Ground
14	-	-

Chapter 7

dSPACE Platform

7.1 dSPACE Platform

7.2 System Configuration

7.3 Control Strategy
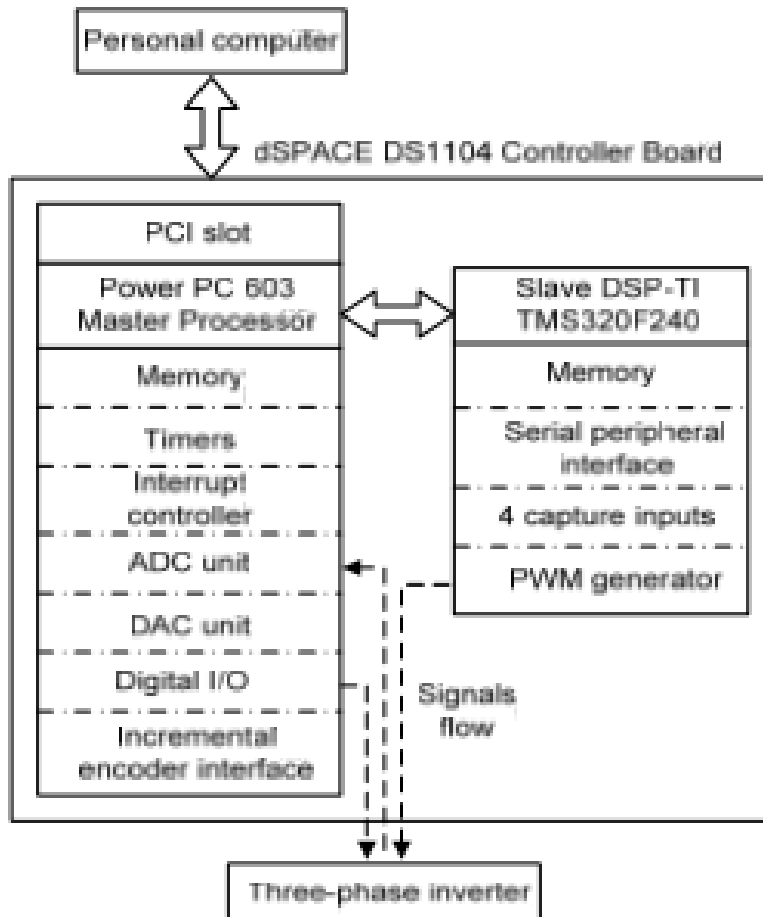
7.1 dSPACE Platform

The dSPACE DS1202 acquires the ability of linking MATLAB/SIMULINK model to the real hardware which is suitable to be used as an inverter control platform. This feature is accomplished by introducing the dSPACE RTI (Real-Time Interface) library blocks into the MATLAB/SIMULINK inverter model. An example of such blocks is the input-output (I/O) interface block. This blocks contain many library blocks such as DS1202ADC_Cx (analog to digital converter), DS1202DAC_Cx (digital to analog converter), DS1202BIT_OUT_Cx, DS1202SL_DSP_PWM (singlephase PWM signal) and DS1202SL_DSP_PWM3 (threephase PWM signal) block. Using the MATLAB/SIMULINK Real-Time Workshop (RTW) function, the SIMULINK model with the dSPACE interface blocks is converted to the C-code automatically. Then this code is compiled by a compiler and linked to the real-time dSPACE DS1202 processor board. With the application of the dSPACE graphical user interface software, the monitoring of the performance and behavior of the inverter in real time is made possible . Moreover, user is able to change the controller parameters and observe the performance in a real time as well. The dSPACE DS1202 controller board has been utilized in the design of high frequency link inverter . Another different way to control and regulate the ac output voltage is by utilizing the PI controller. A block diagram of the dSPACE DS1202 controller board is illustrated in Fig. 1. It consists of a master processor PowerPC603 with speed of 250 MHz, 64-bit floating-point processor, and 16-bit DSP with processor of Texas Instruments TMS320F240 (slave).

This controller is used since it is an ideal platform for prototype development system especially for costsensitive rapid control prototyping. It is specially designed for the development of high-speed multivariable digital controllers and real-time simulations in various fields .

Block Diagram of dSPACE DS1104 Controller Board

```
                    ┌──────────────────────┐
                    │  Personal computer   │
                    └──────────────────────┘
                              ↕
                        dSPACE DS1104 Controller Board
    ┌─────────────────────────────────────────────────────────────┐
    │  ┌─────────────────────┐        ┌─────────────────────┐      │
    │  │      PCI slot        │        │   Slave DSP-TI      │      │
    │  ├─────────────────────┤  ⟺     │   TMS320F240        │      │
    │  │  Power PC 603        │        ├─────────────────────┤      │
    │  │  Master Processor    │        │     Memory          │      │
    │  ├─────────────────────┤        ├─────────────────────┤      │
    │  │     Memory           │        │  Serial peripheral  │      │
    │  ├─────────────────────┤        │  interface          │      │
    │  │     Timers           │        ├─────────────────────┤      │
    │  ├─────────────────────┤        │  4 capture inputs   │      │
    │  │   Interrupt          │        ├─────────────────────┤      │
    │  │   controller         │        │  PWM generator      │      │
    │  ├─────────────────────┤        └─────────────────────┘      │
    │  │     ADC unit         │ ←                                   │
    │  ├─────────────────────┤                                     │
    │  │     DAC unit         │                                     │
    │  ├─────────────────────┤         Signals                     │
    │  │    Digital I/O       │         flow                        │
    │  ├─────────────────────┤                                     │
    │  │   Incremental        │                                     │
    │  │   encoder interface  │                                     │
    │  └─────────────────────┘                                     │
    └─────────────────────────────────────────────────────────────┘
                         ↓    ↓
                    ┌──────────────────────┐
                    │  Three-phase inverter │
                    └──────────────────────┘
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7.2 System Configuration

The system configuration for the single-phase inverter hardware development consists of system model and simulation model.

System Model Fig. 7.1 shows the block diagram of the PV inverter system model used in this work.
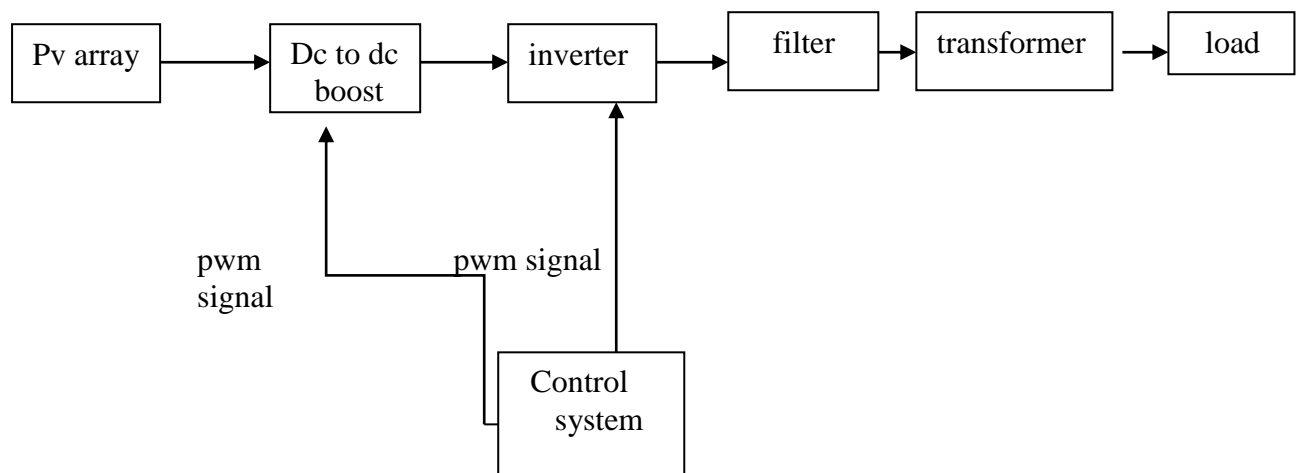

Fig7.1

The system model consists of system control, PV array, dc boost converter, single-phase inverter, filter, transformer and load. The system control is the main player that made up of mainly the data conversion, and PWM generators.
 This mission is accomplished with the generation of PWM signals for both dc boost converter and inverter. As for the system input, the PV array converts the energy from the sun into a dc power and channels it to the dc boost converter. In this converter, the dc voltage is stepped up to a specific dc voltage level to fulfill the requirement of the next stage that is the inverter. With the essence of the control strategy in the PWM signals generation, this dc input power is converted to an ac power and then step up by the transformer for the load requirement. To lessen the load burden from the adverse effect of harmonics content, the ac output voltages of the inverter have to go through the filter. As a result, the noise and most of the higher order harmonics components are removed and the output voltages become nearly sinusoidal.

7.3 Control Strategy

The block diagram of the proposed inverter control system is illustrated in Fig. 7.2. The main blocks which make up the system are voltage sensors, dspace DS1202 controller, dc boost converter, and inverter. The final stage of the inverter is connected to the resistive load. The two types of PWM switching signals that generated from the dspace DS1202 controller board are used for the dc boost converter and inverter. To cater the dc boost converter PWM, the dspace controller board generates the required duty cycle and transfers it to the digital I/O block which immediately connects it to the driver and MOSFET. The driver serves as an interface between the PWM signals of the DS1202 controller board and the mosfet.
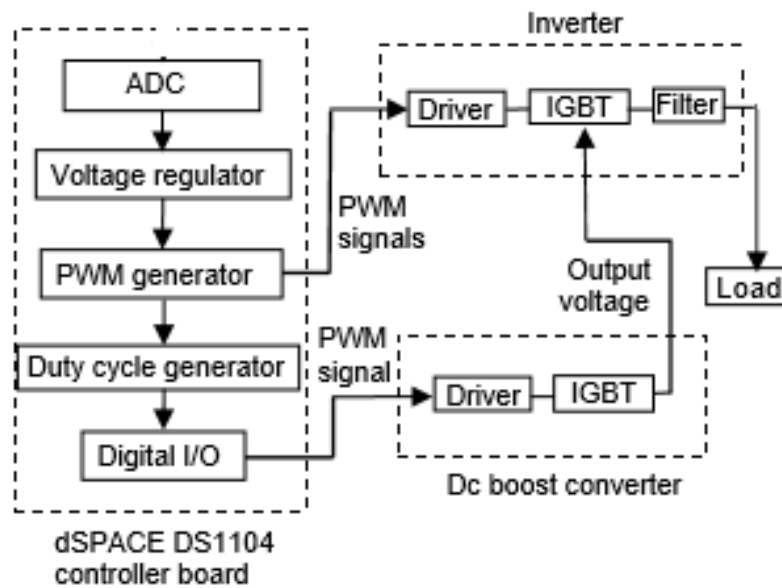
For both the dc boost converter and inverter operation, it is important that the PWM switching signals acquire the correct voltage levels for the MOSFET switching on and off completely. Another important criterion is that there must be isolation between system control circuit which deals with low voltage and high voltage of the inverter. This is achieved by the implementation of driver circuits.
The dc output voltage of the converter is fed to the inverter for conversion to ac voltage.
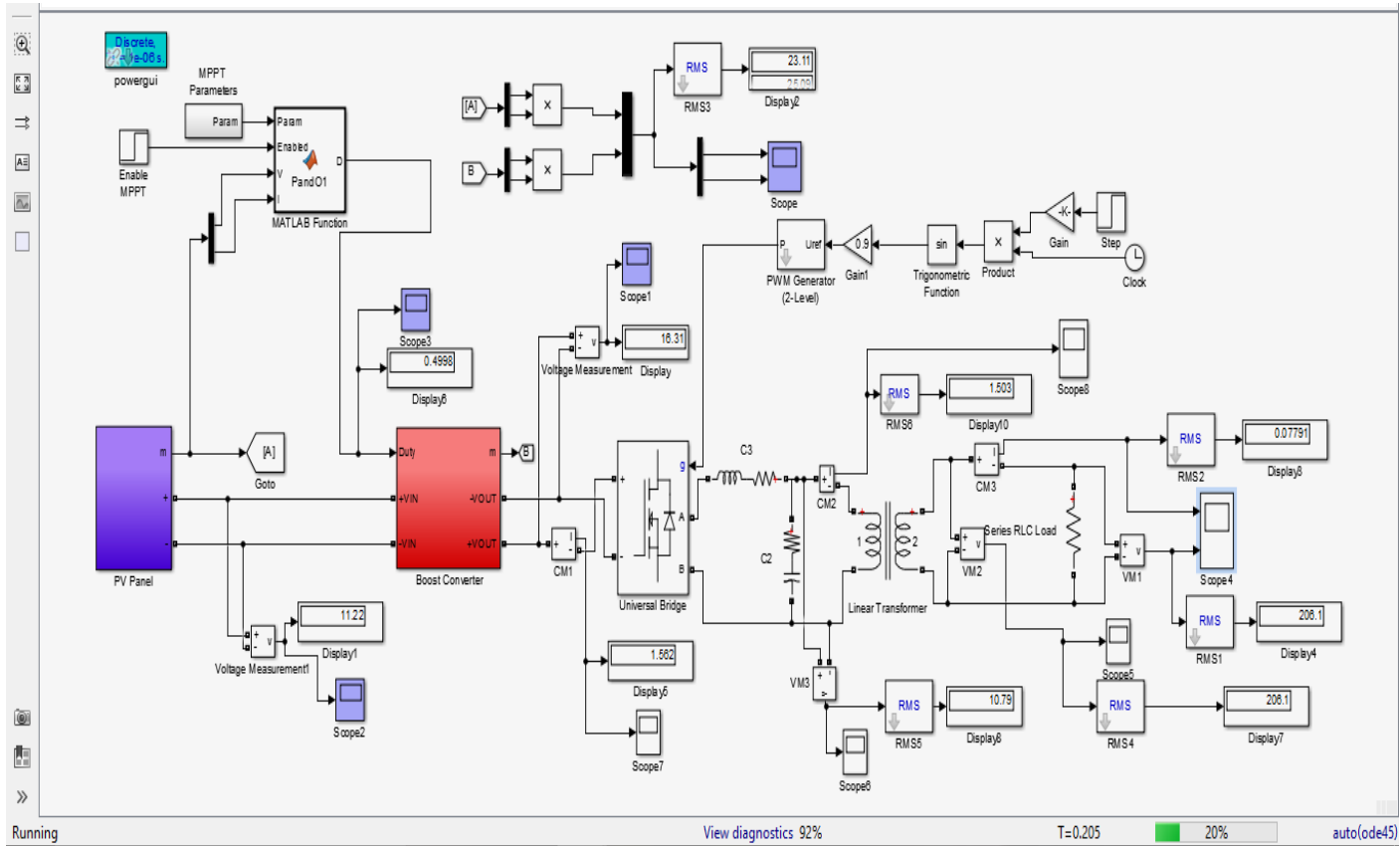
Chapter 8

SIMULATION MODEL AND RESULT

8.1 SIMULINK MODEL

8.2 SIMULATION RESULTS

8.1 SIMULINK MODEL

This is the Simulink model of converter with p&o mppt control.

Here the solar cell is represented by a block named 'PV Panel' and the MPPT control and gating signal generator are shown in a single unit called 'MATLAB function block'.

Other elements of the model constitute the boost converter ,universal bridge , filter circuit , transformer ,load and spwm generator which fed to gate of universal bridge.

Simulink model without mppt control

This is the Simulink model of converter without mppt control.Here we are using dc voltage source of 12v in place of 12v pv cell. So we do not need any mppt control.
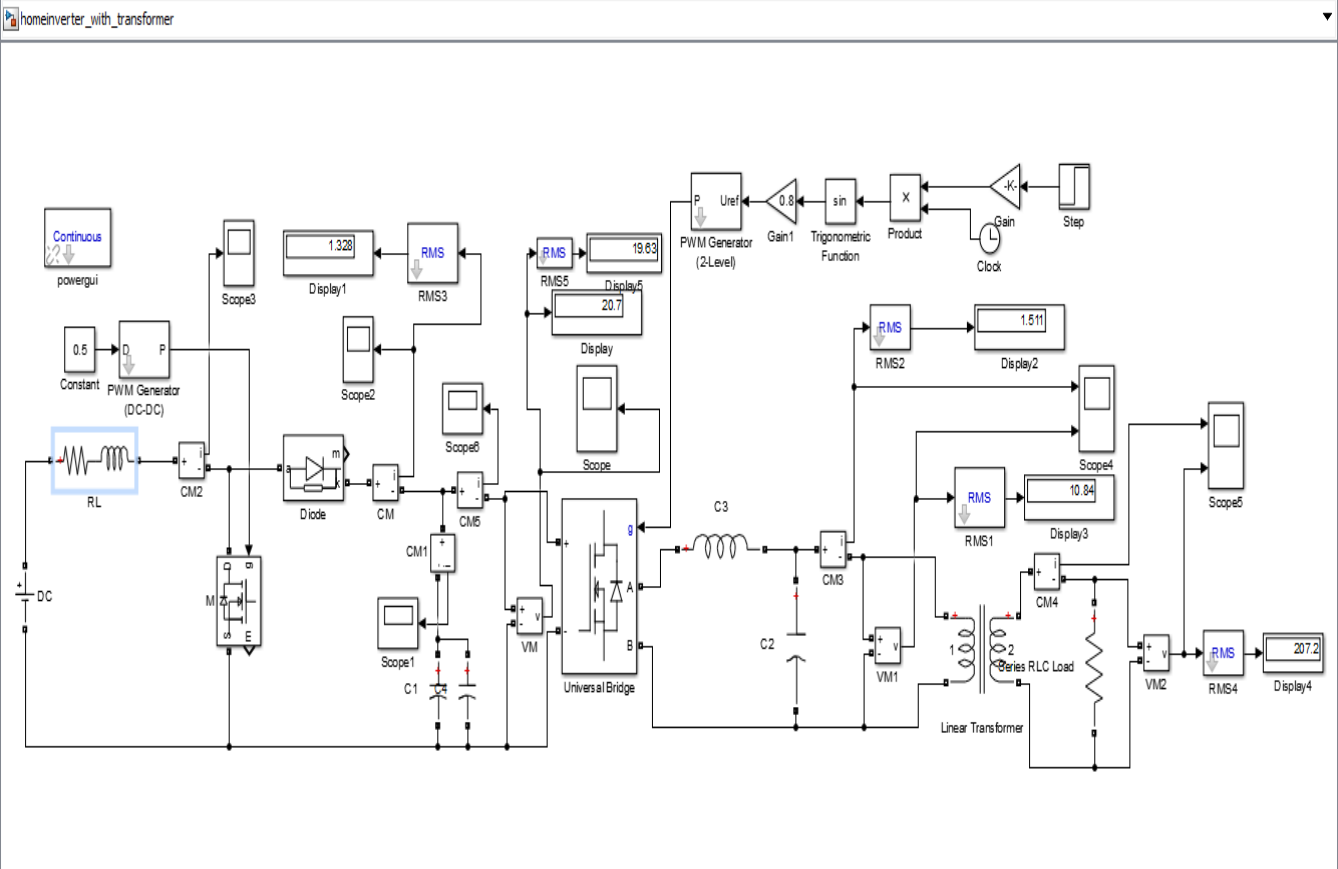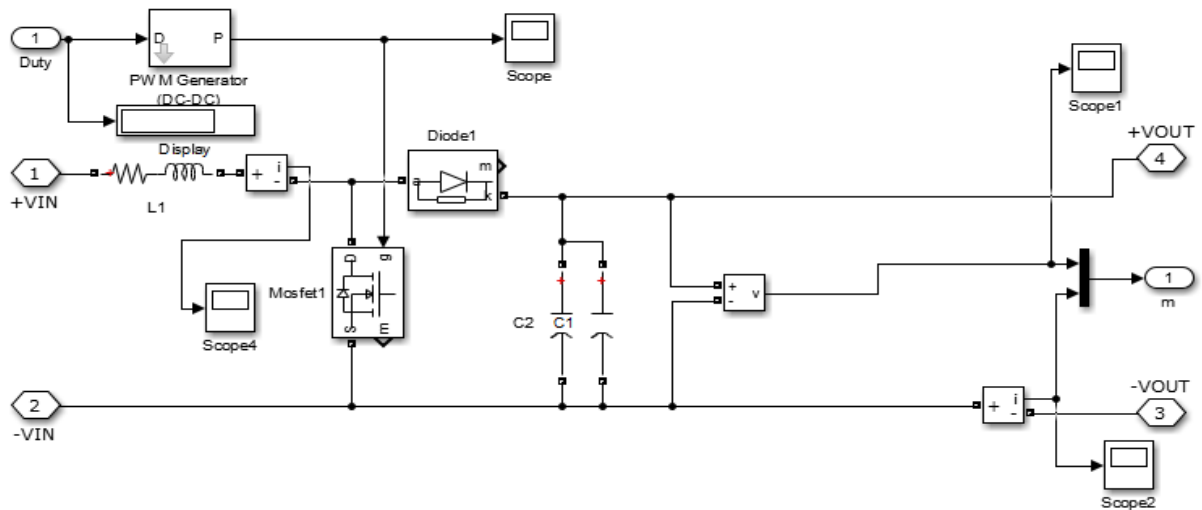
Photovoltaic Cell model
The solar cell was modeled in the single diode format.
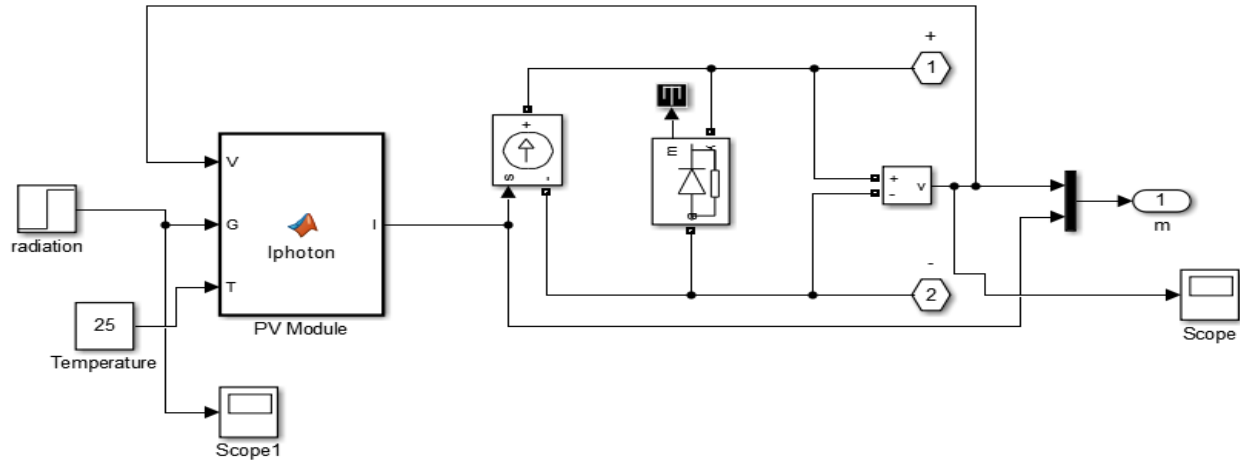
Boost converter model

The model constitute the boost converter, which consists of a 1 ohm (5w) resistance ,250 micro Henry inductor and two parallel connected 470 micro Farad capacitor. The switching frequency of pwm generator is 20000hz.This boost converter is used to step up the voltage to the required value. The gating
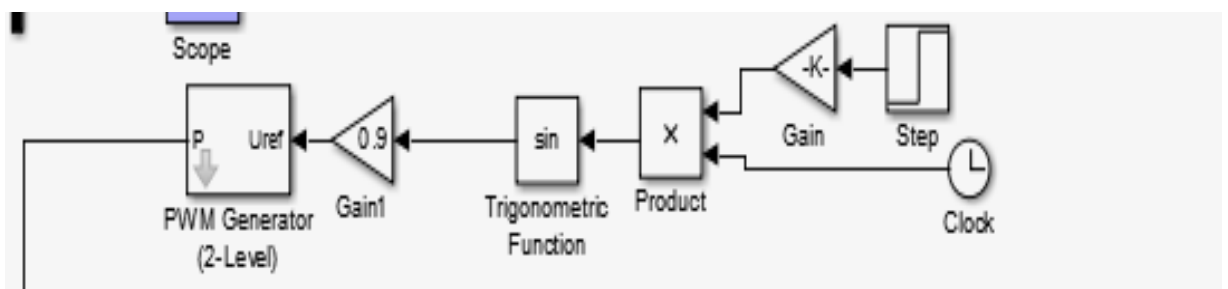
signal to the boost converter is generated by comparing the signal generated by the MPPT algorithm to a repeating sequence operating at a high frequency.

Inverter model

Universal Bridge
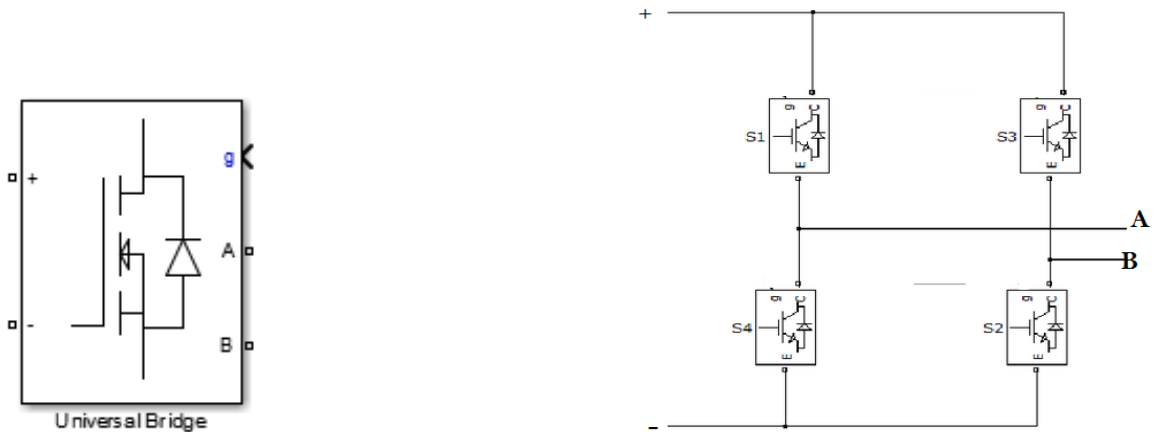
This is the model of single phase full bridge inverter using mosfet as switch.

Spwm generator model

This blocks generate spwm signal and fed to inverter gate to get sinusoidal waveform. The switching frequency of pwm generator is 5000 hz.
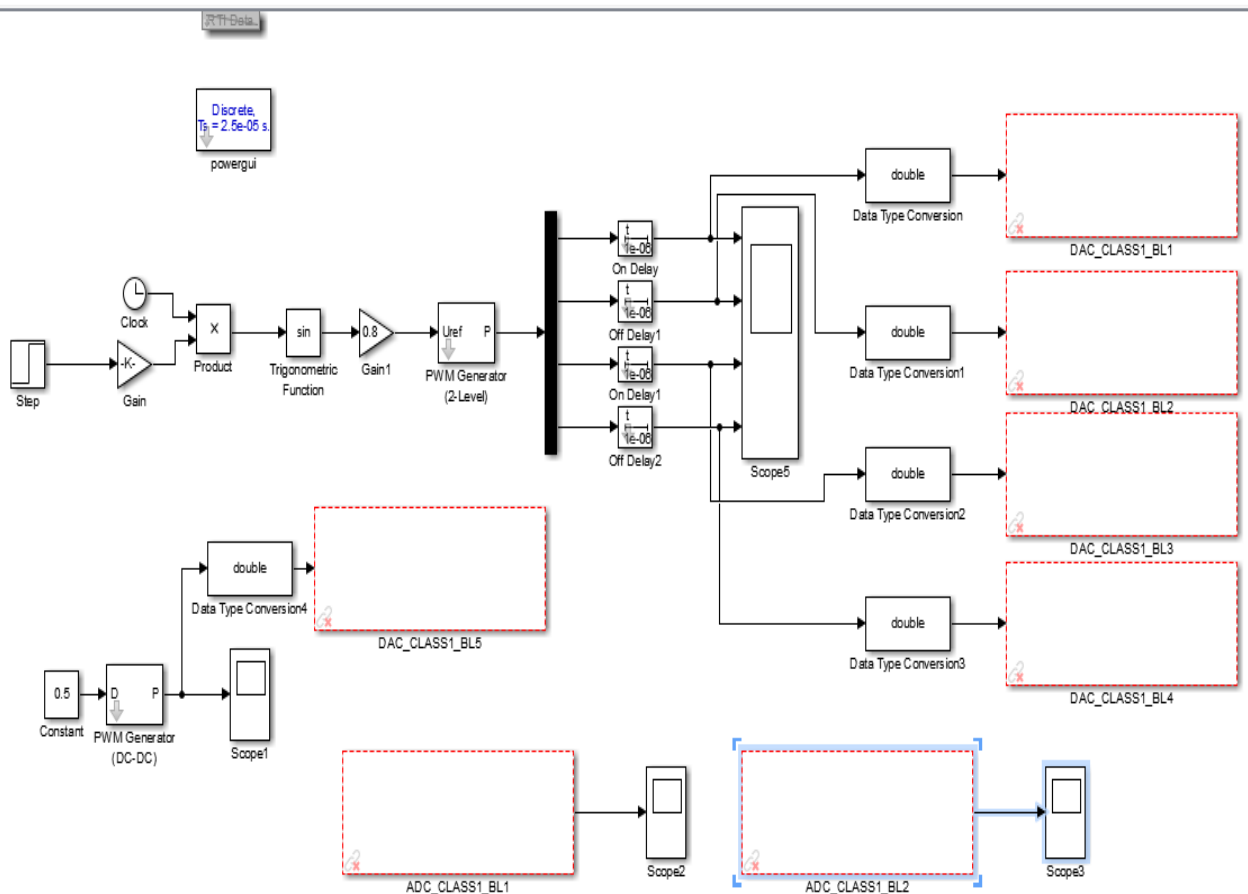
Filter, transformer and load model

In this model red box show the RL and RC filter .The value of the RLis 0.1 ohm 250 micro henry and RC is 1 ohm 220micro farad.

There is a step up transformer whose rating is 12v to 220v,60w and a 30w load is connected across it.
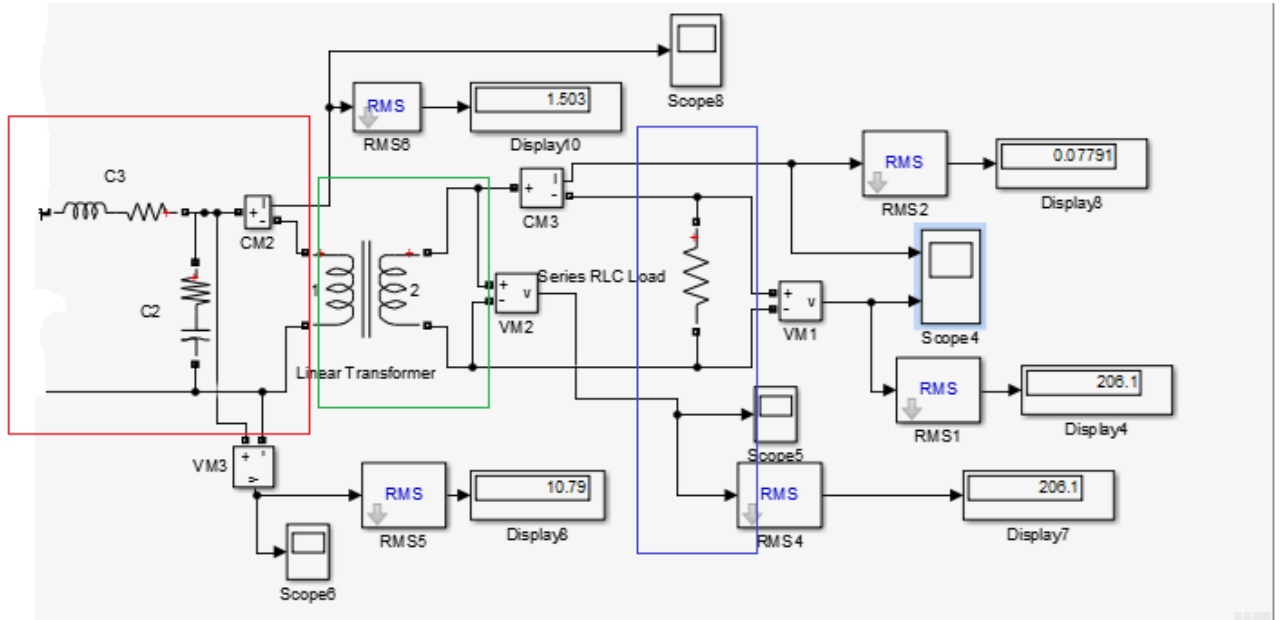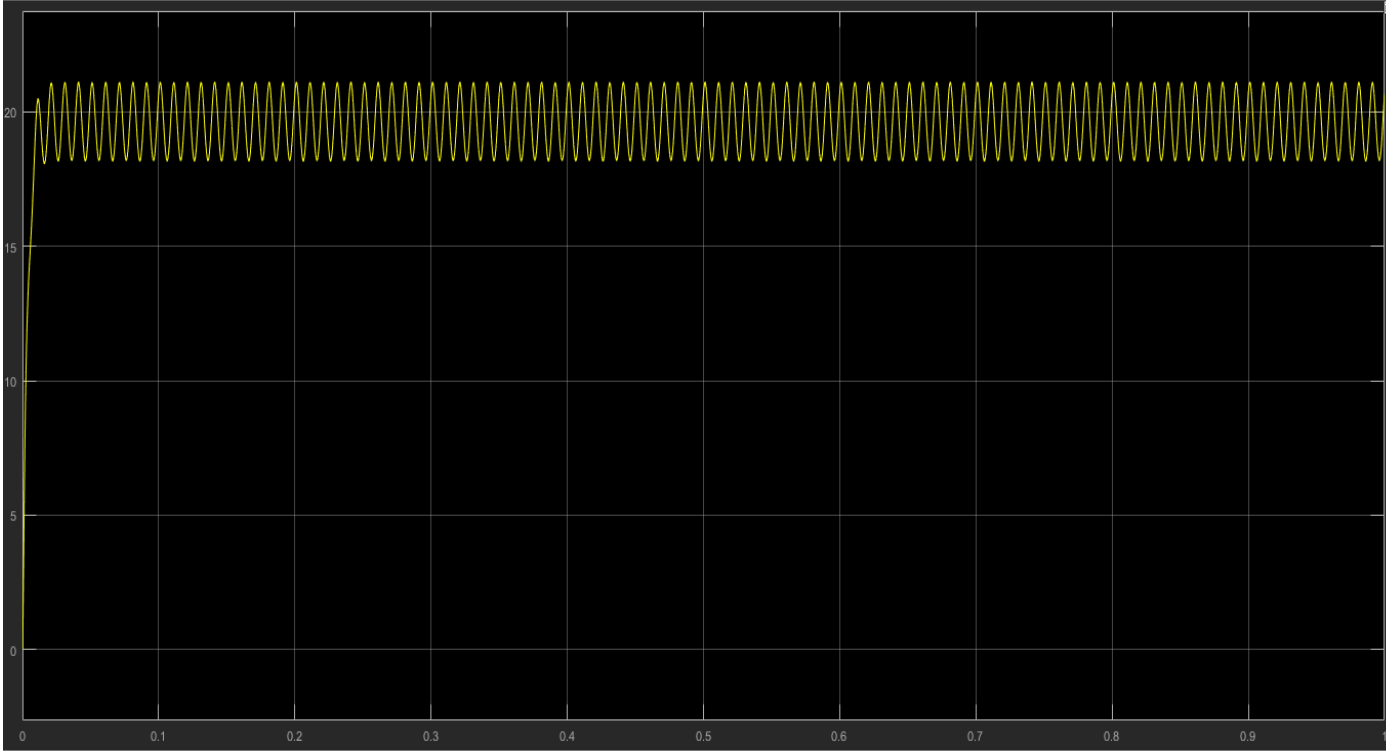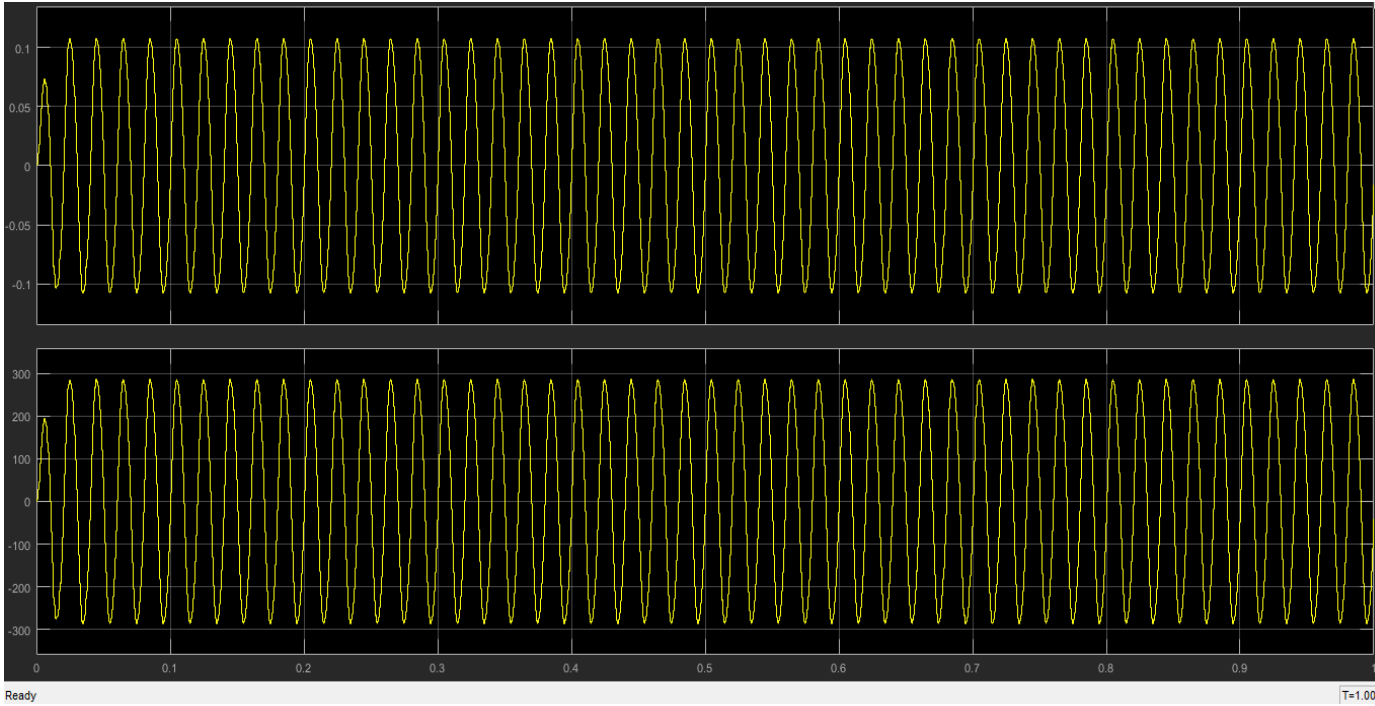

Dspace control circuit model

8.2 Simulation result

Boost converter output

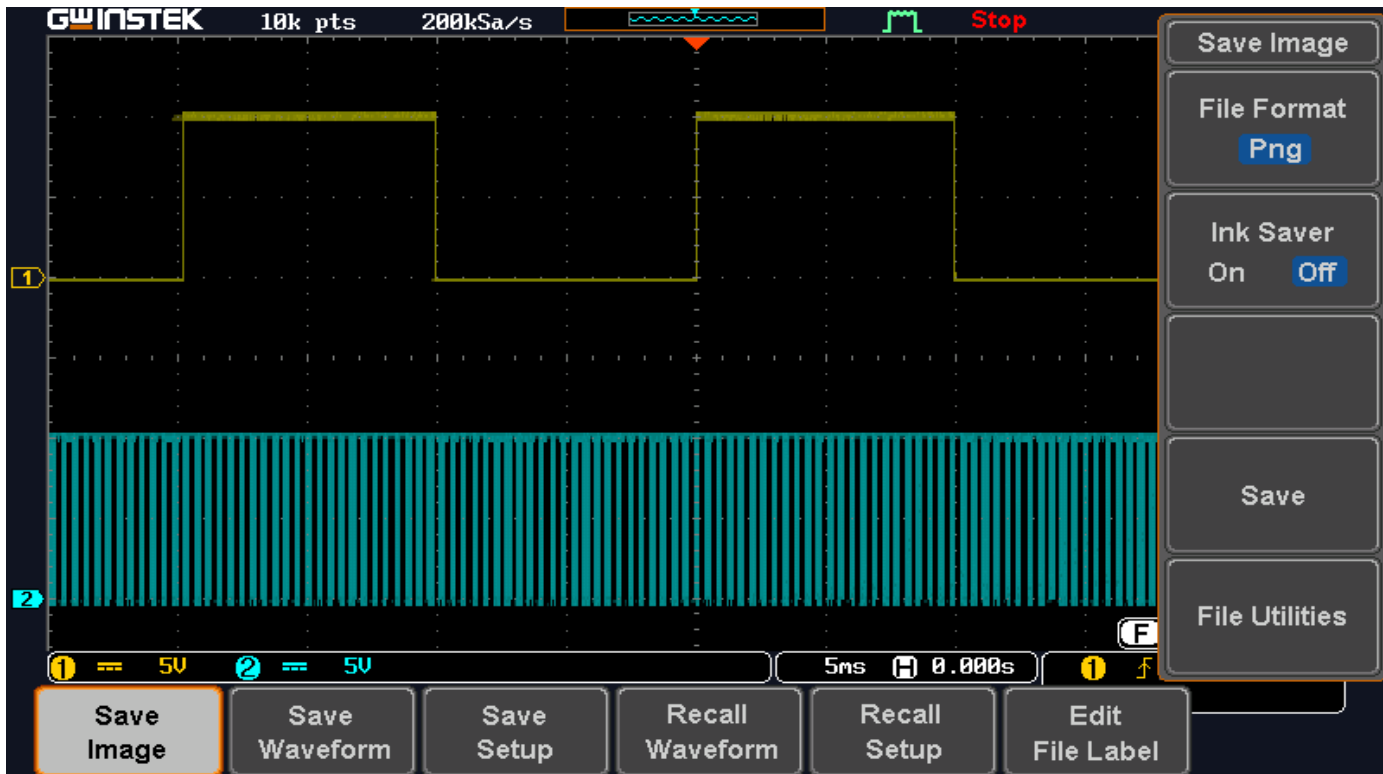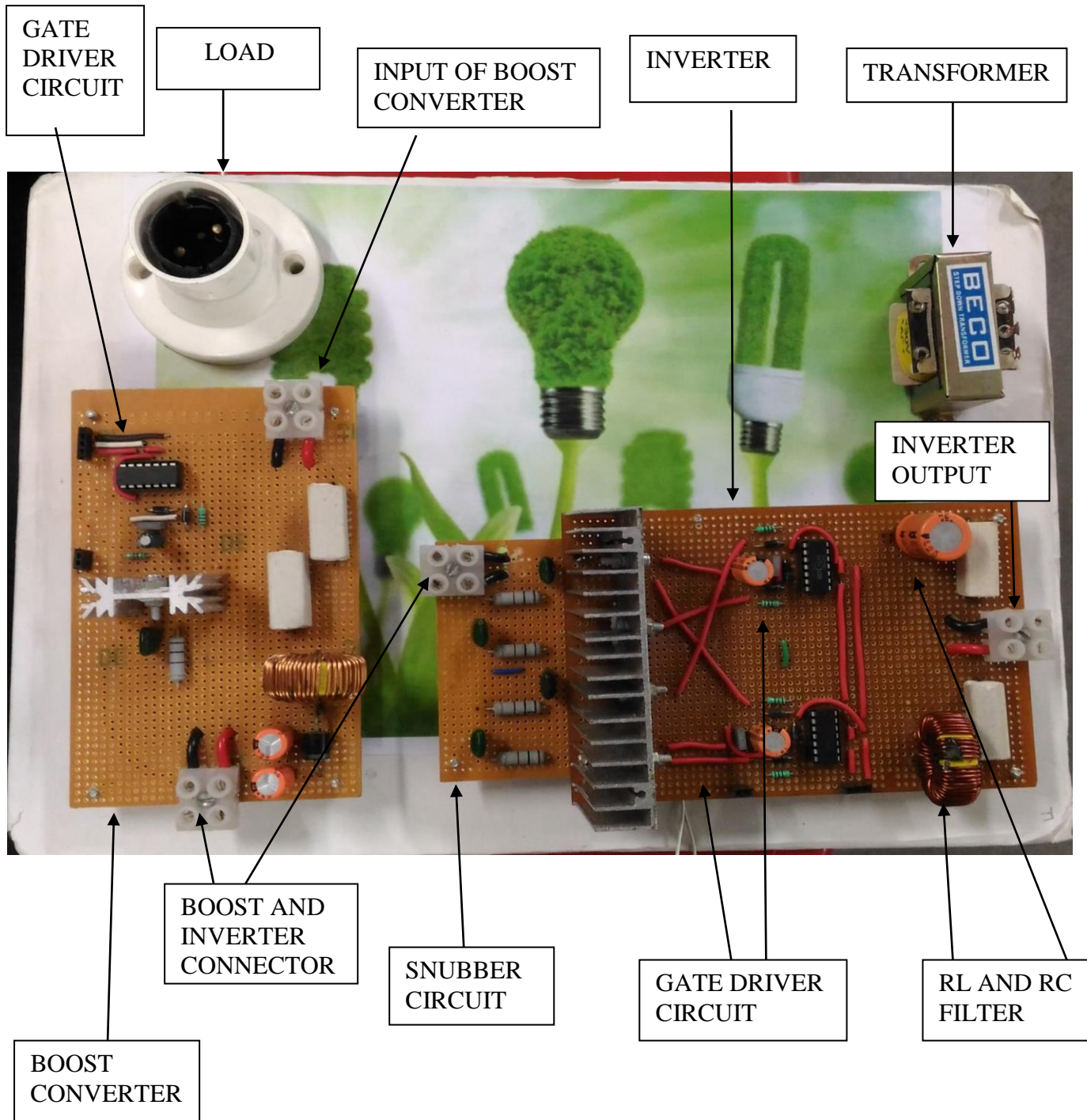## Inverter waveform

Dspace output waveform for boost converter and inverter

9. Hardware Model

GATE DRIVER CIRCUIT

LOAD

INPUT OF BOOST CONVERTER

INVERTER

TRANSFORMER

INVERTER OUTPUT

BOOST AND INVERTER CONNECTOR

SNUBBER CIRCUIT

GATE DRIVER CIRCUIT

RL AND RC FILTER

BOOST CONVERTER
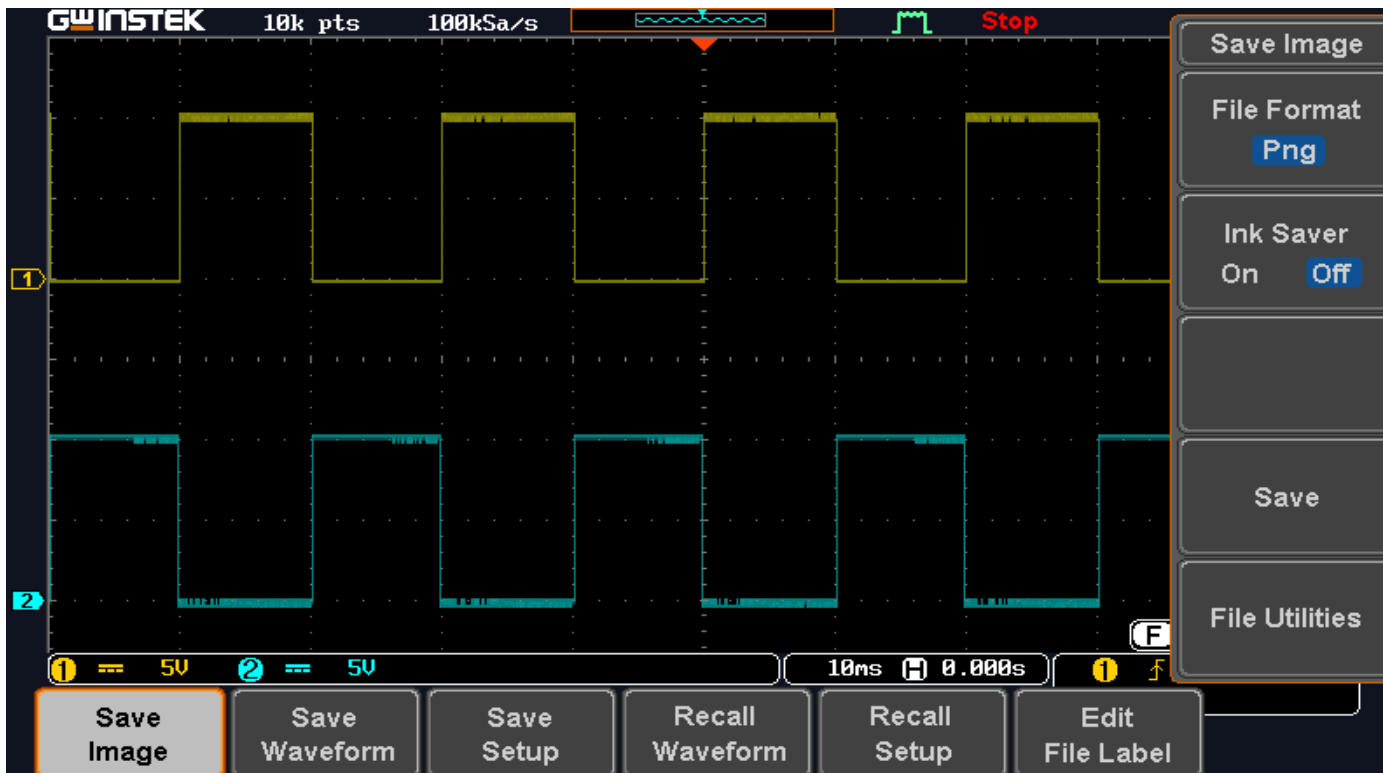
Chapter 10

CONCLUSION

10. CONCLUSION

The paper describe the prototype development and testing of spwm inverter for pv application using dspace.An accurate spwm inverter and its controller was simulated in the matlab simulink environment and prototype was tested in laboratory.
The link of the matlab simulink with real inverter is done with the help of dspace DS1202 controller board.

Ds1202 control board using ADC and DAC interface.The ADC block is used for reading the analog signal whereas DAC interface helps to take the pulse out to subsequent drive the mosfet gate.

The result obtained is near to the expected ones. Further development process may be continue to reduce harmonics ,regulation waveform based on the actual application environment like different type of load ,local solar insolation ,module characteristics system with storage battery or without storage battery, grid connected hybrid and stand alone system.

The project helped us to have a clear knowledge about matlab environment and the dspace board and its functional mechanisms.
The combined effort of mentors and all of our group members are the reason for the completion of our project.The project taught us group work,coordination and appreciating each others idea.

The result and output of our project are verified with the theoretical results. We through this project have gained knowledge about the future prospects and we will surely like to work on those concepts in the near future.

Future work

Improvement to this project can be made by feedback control by which we can use variable voltage. Other improvement to this project can be made by tracking the maximum power point in changing environmental conditions. Environmental change can be change in solar irradiation or change in ambient temperature or even both. This can be done by using Simulink models to carry out MPPT instead of writing it code in Embedded MATLAB functions. In the Simulink models the solar irradiation and the temperature can be given as variable inputs instead of constant values as done here.

Appendix A

A.1 Specifications of the Hardware components

dc to dc boost converter hardware component specification;

Nos.	Items	specification	quantity
1	Inductor	250 micro henry,max.current 4 amps	1
2	Resistance	1ohm ,5w	1
3	Diode	6 amps	1
4	Capacitor	470 micro farad 50v	2
5	Mosfet	IRF540	1
6	Dc source	12v	1

Inverter hardware component specification;

1	Mosfet	IRF540	4
2	Inductor	250 micro henry	1
3	Capacitor	220 micro farad 100v	1
4	Resistance	1 ohm ,0.1 ohm ,5w	2
5	Transformer	12/220 step up ,60w	1
6	Load	30w lamp	1

Mosfet driver circuit hardware component specification;

1	Gate driver ic	IR2110	3
2	Resistance	10 ohm	6
3	Capacitor	22 micro,100 neno farad	3,3
4	Diode	1N4148	9

Snubber circuit hardware component specification;

1	Resistance	100 ohm	5
2	Capacitance	o.1 micro farad	5

References

Books ;
- Power electronics by P.S.bimbhra
- Basic power electronics by Rashid

WEBSITE ;

- Wikipedia
- Ieee.org.in
- Dspace.org
- Matlab example