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IMPLEMENTATION AND ANALYSIS OF STAND ALONE SOLAR PV SYSTEM WITH HIGH GAIN AND HIGH EFFECIENCY DC-DC POWER STAGE

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ABSTRACT:

This project proposes Implementation and Analysis of Stand Alone Solar Pv System with High Gain High Efficiency Controlled Dc-Dc Power Stages both in the forward power stage and the bidirectional battery interface. The high-voltage gain converters enable the use of low-voltage PV and battery sources. This results in minimization of partial shading and parasitic capacitance effects on the PV source. Series connection of a large number of battery modules is obviated, preventing the overcharging and deep discharging issues that reduce the battery life.

In addition, the proposed configuration facilitates required power tracking (RPT of the PV source as per the load requirements, eliminating the use of expensive and difficult to manage dump loads. High-performance inverter operation is achieved through abc to dq reference frame transformation, which helps in generating precise information about the load's active power component for RPT, regulation of ac output voltage, and minimization of control complexity. Inverter output voltage is regulated by controlling the modulation index of sinusoidal pulse width modulation, resulting in a stable and reliable system operation. The active power demand is controlled by regulating the dc link voltage. All the analytical, simulation results of this project are proposed through matlabR2011a/simulink. By this project we can supply power to the loads even under abnormal conditions through battery.

I. INTRODUCTION

In the use of nonconventional energy Sources, photovoltaic (PV) installations are being increasingly employed in several applications, such as distributed Power generation and stand-alone systems. However, a major Challenge in using a PV source is to tackle its nonlinear output Characteristics, which vary with temperature and solar Insolation. The characteristics get more complicated if the entire Array does not receive uniform Insolation, as in partially cloudy (shaded) conditions, resulting in multiple peaks. The presence of multiple peaks reduces the effectiveness of the existing maximum Power point tracking (MPPT) schemes due to their inability to discriminate between the local and global peaks. Nevertheless, it is very important to understand and predict the PV characteristics in order to use a PV installation effectively, under all conditions.

Photovoltaic systems have become an energy generator for a wide range of applications. The applications could be standalone PV systems or grid connected PV systems. A standalone PV system is used in isolated applications where PV is connected directly to the load and storage system. With a standalone photovoltaic, when the PV source of energy is very large, having energy storage is beneficial. Where as a PV system that is connected through a grid is used when a PV system injects the current directly into the grid itself. The advantage of the grid-connected system is the ability to sell excess of energy.

II. LITERATURE SURVEY

Now a day the population was increasing day by day, at the same way the industries are also increasing. So the demand for power is also increasing. As the conventional sources of energy are depleting and the cost of energy was rising day by day. In order to minimize the cost and to generate the power the alternative sources of energy are non conventional energy sources. Among the various sources of non conventional energy sources, PV is a promising source since the power from sun is depends on the irradiation and weather conditions. So MPPT plays an important role in the PV system and the generated maximum power is delivering to the grid through an inverter. The output power of PV units is not constant

during a day; it varies with changes in atmospheric conditions so robustness is essential.
In a grid connected PV System the control objectives are met by using PWM technique. It consists of two cascaded control loops. The inner current control loop is used to maintain the power quality, to control the duty ratio for the generation of sinusoidal output current and the outer control loop is voltage control loop which is used to track the MPP. Normally current controllers are used in tracking method. Normally to operate the PV systems at MPP nonlinear controllers are used but they do not account for the uncertainties in the PV system. But there is more development in the field of control theory and robust linear controllers for linear systems in the presence of uncertainties through the control scheme which is often obtained from linear matrix inequality voltage and current, and the robustness is achieved by modal analysis.

A Lyapunov-based control scheme for a grid connected PV inverter is presented in where an adaption law is included to improve the robustness. However, it is well known that the adaption technique is useful for systems with slow parameter variations which are not the case for PV systems as the changes occur rapidly.

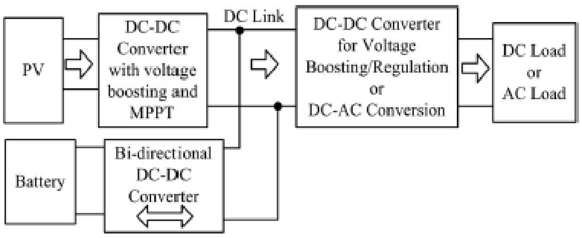

Fig: Block diagram of two way system

A sliding mode controller for a nonlinear grid-connected PV system is proposed along with a new MPPT technique for providing robust tracking against uncertainties and unknown disturbances within the system. The performance of the sliding mode controller is confined to the sliding surface which is constructed from a linear combination of output injected errors.

III.OBJECTIVE OF THIS PROJECT

The objective of this project is to design a novel 3φ solar PV inverter system for stand-alone applications to improve solar efficiency. Here we propose a linearizing controller where the robustness of the controller is achieved by the satisfaction of matching conditions. And high performance inverter operation is achieved by using DC-DC converter. The effectiveness of the proposed system designed at different conditions as well as changes in atmospheric conditions, such as various solar irradiations.

IV.MODELLING OF PHOTO VOLTAIC SYSTEM

As a result of human activities, greenhouse gases are increasing in the earth's atmosphere. Many in the scientific community now believe that this increase in carbon dioxide (CO_2), methane (CH_4) and other greenhouse gases is causing the earth's temperature to rise, and that this increase in greenhouse gases will lead to even greater global warming during this century. Renewable energy resources are clean and environmental friendly. They can provide many immediate environmental benefits by avoiding the emission of greenhouse gases and can help conserve fossil resources as electricity supply for future generations. One technology to generate electricity in a renewable way is to use solar cells to convert the energy delivered by the solar irradiance into electricity. PV energy generation is the current subject of much commercial and academic interest. Recent work indicates that in the medium to longer term PV generation may become commercially so attractive that there will be large-scale implementation in many parts of the developed world.

The integration of a large number of embedded PV generators will have far reaching consequences not only on the distribution networks but also on the national transmission and generation system. If the PV generators are built on the roof and sides of buildings, most of them will be located in urban areas and will be electrically close to loads. On the other hand, these PV generating units may be liable to common mode failures that might cause the sudden or rapid disconnection of a large proportion of operating PV capacity.

The following modes of failures have been identified:
1. Embedded generation (such as PV units) is normally equipped with protection schemes designed to disconnect it from the network in the

event of loss of mains. If the system is affected by a large disturbance (e.g. tripping of the DC link with France or of a large conventional generator), such protection schemes could cause the sudden disconnection of a large proportion of the PV generation. Since this disconnection would be compounded with the original disturbance, its consequence could be severe.

2. Similarly, a large disturbance could also temporarily perturb the voltage seen by the PV generating units. The controller of the inverters interfacing these PV units to the grid system may not be able to cope with this perturbation. Consequently they may fail or trigger a shutdown of the inverter.

3. It is likely that a large majority of the PV generating units will be located in dense urban areas. A rapidly moving weather front can, in a matter of a few minutes, reduce the irradiance over such an area from its maximum value to value below the minimum required for operating the PV units.

V.EFFECT OF IRRADIANCE AND CELL TEMPERATURE

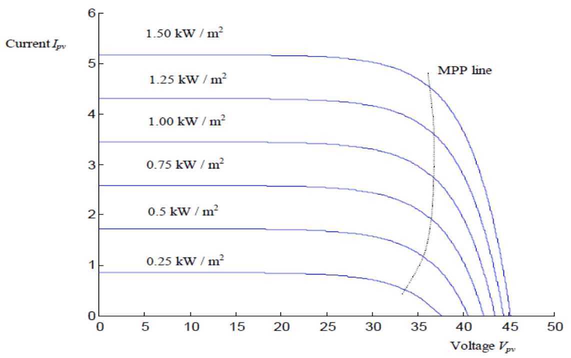

Fig:Effect of irradiance on the I-V characteristic at constant cell temperature

The effect of irradiance and cell temperature on I_{pv} - V_{pv} characteristic curve

PHOTOVOLTAIC SYSTEM MODEL

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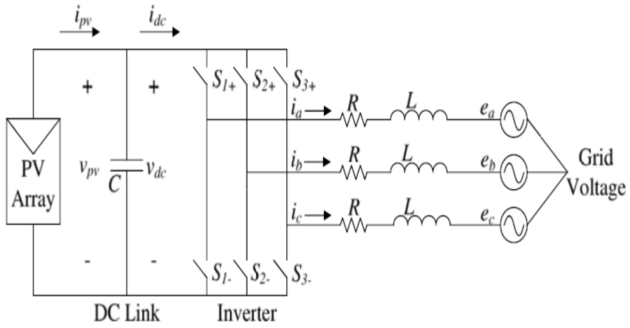

Fig: Three-phase grid-connected PV system

Schematic diagram of a three-phase grid-connected solar system which is the main focus of this thesis is shown in Fig. 2.5 .The considered PV system consists of a PV array, a dc-link capacitor *C*, a three-phase inverter, and a filter inductor *L* and is connected to the grid with voltage e_a, e_b, and e_c. Therefore, the maximum power point can be obtained by matching the load resistance to the PV array characteristic

VI.MAXIMUM POWER POINT TECHNIQUES FOR PV

From the characteristic I-V and P-V curves of photovoltaic modules, it is shown that there was a unique point for the maximum power (PMPP). This point is defined as the maximum power point (MPP) with the optimal voltage V_{mpp} and the optimal current I_{mpp}. At this point, the entire PV system should operate with the maximum efficiency and produce its maximum output power.

The solar cell I-V characteristic is nonlinear and changes with irradiation and temperature. The location of the MPP is not known but need to be located. Different MPPT methods have been realized. They vary in "complexity, sensors required for the voltage or current, convergence speed, and cost, range of effectiveness and implementation hardware". The three main categories of MPPT algorithms are model-based algorithms, training based algorithms and searching algorithms

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REQUIRED POWER TRACKING

Tracking is the most important part performed by a coordinated control system in the power smoothing process. **RPT** or **Required Power Tracking** is algorithm that included in charge controllers used for extracting maximum available power from PV module under certain conditions.

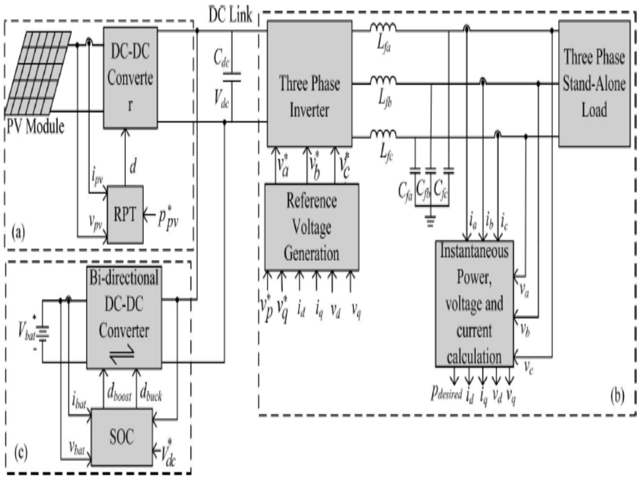


***Fig: 3.3.Block diagram showing the complete system and the control signals*.**

The voltage at which PV module can produce maximum power is called 'maximum power point' (or peak power voltage). Maximum power varies with solar radiation, ambient temperature and **solar cell** temperature. Hence the amount of solar power radiation requires to track is essential which is not too much lower or higher .RPT acts as a controller with suitable voltage regulation. A RPT solar charge controller is the charge controller embedded with MPPT algorithm to maximize the amount of current going into the battery from PV module.RPT checks output of PV module, compares it to battery voltage then fixes what is the best power that PV module can produce to charge the battery and converts it to the best voltage to get maximum current into battery. It can also supply power to a DC load, which is connected directly to the phases.

RPT in DC to DC converter which operates by taking DC input from PV module, changing it to AC and converting it back to a different DC voltage and current to exactly match the PV module to the battery.RPT algorithm can be applied to both of them depending on system design. Normally, for battery system voltage is equal or less than 48V, buck converter is useful. On the other hand, if battery system voltage is greater than 48V, boost converter should be chosen.

MPPT solar charge controllers are useful for off-grid solar power systems such as standalone solar power system, solar home system and solar water pump system, etc. Cold weather, cloudy or hazy days: Normally, PV module works better at cold temperatures and MPPT is utilized to extract maximum required power available from them. When battery is deeply discharged: RPT can extract more current and charge the battery if the state of charge in the battery is lowers.

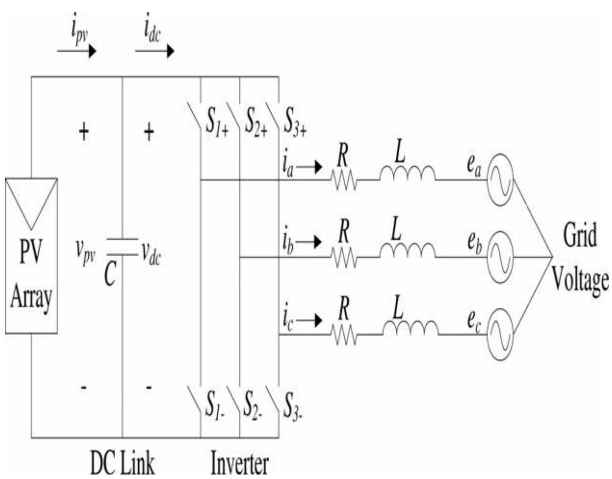
Examples of DC to DC converter are:

1. Boost converter is power converter which DC input voltage is less than DC output voltage. That means PV input voltage is less than the battery voltage in system.

2. Buck converter is power converter which DC input voltage is greater than DC output voltage. That means PV input voltage is greater than the battery voltage in system.

VII.PHOTO VOLTAIC GRID CONVERTER

This Chapter details the background and literature for converter control schemes, power transfer theory, control of ac current and ac voltage using PWM techniques. The synchronization process and control of dc link voltage is explained.



INVERTER CONTROL TYPES

It shows system integration of PV inverter system which comprises of a PV panel, associated with a dc-dc converter and a widely used dc-ac pulse width modulation (PWM) inverter connected to the utility grid. A single phase PV power conditioning system is often selected for low power applications (< 3 kW) i.e., residential applications. For higher power applications i.e., commercial or industrial applications, a three-phase PV power conditioning system is preferable.

The two control techniques that are used in grid connected system are voltage control and current control. PV inverters inject energy directly into the grid and are controlled as power sources i.e. the PV inverters inject a "constant" power into the grid at a power factor nearer to unity. The control system constantly monitors power extracted from the PV array and adjusts the magnitude and phase of the ac voltage (in voltage control mode) or current (in current control mode) to export the power extracted from the PV array.

a. VOLTAGE CONTROL

A voltage controlled inverter produces a sinusoidal voltage at the output. It can be used in standalone operation supplying a local load. If non-linear loads are connected within the rating of the inverter, the inverter's output voltage remains sinusoidal and supplies non sinusoidal current as demanded by the load. Since it is a voltage controlled source it cannot be directly connected to the grid and therefore it is connected via an inductance. With respect to grid voltage the voltage of inverter are controlled in magnitude and in phase. The inverter voltage is usually controlled by controlling the modulation index and this controls the reactive power. The phase angle of the inverter may be controlled with respect to the grid which controls the active power.

b. CURRENT CONTROL

A current controlled inverter produces a sinusoidal current at output. It is only used for injection into the grid and not for standalone applications. The output is generated using a sinusoidal reference which is phase locked to the grid voltage. The output stage is switched so that the output current follows the generated sinusoidal reference.

The reference waveform may be varied in amplitude and phase with respect to the grid and the output current automatically follows the reference. The output current waveform is ideally not influenced by the grid voltage waveform quality and always produces a sinusoidal current. The current controlled inverter is inherently current-limited because the current is tightly controlled even if the output is short circuited.

A single phase PV power conditioning system is often selected for low power applications (< 3 kW) i.e., residential applications. For higher power applications i.e., commercial or industrial applications, a three-phase PV power conditioning system is preferable.

The advantage of this system is that low-voltage PV and battery can be used, integrated through the same high-gain converter. However, the control flexibility is low because of the complexity of the converter. The two control techniques that are used in grid connected system are voltage control and current control. PV inverters inject energy directly into the grid and are controlled as power sources i.e. the PV inverters inject a "constant" power into the grid at a power factor nearer to unity.

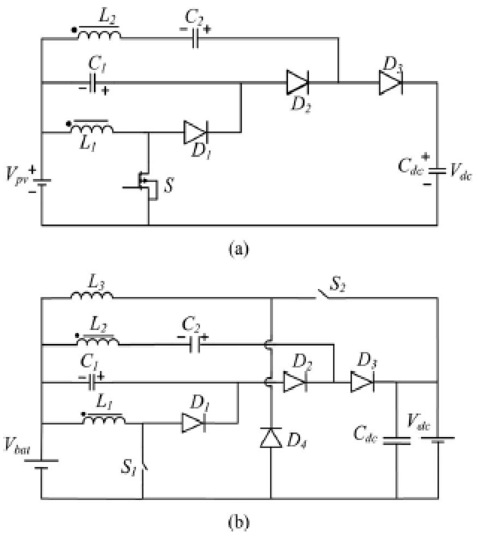


Fig: a) High-gain high-efficiency dc–dc converter
(b) High-gain

High-efficiency bidirectional converter

A system that accepts input from any dc source (PV, battery, etc.) to convert into high-voltage ac output has been proposed by Ray. It consists of a bidirectional quadratic boost converter-based voltage source inverter. However, the system is silent on the management of excess PV power vis-à-vis battery life due to overcharging and discharging. Amirabadi *et al.* [24] have proposed a stand-alone PV system based on a multiport high-frequency ac link inverter. The high-frequency ac link reduces the harmonics in the ac output current of the inverter. A drawback of the system is the use of relatively high PV and battery voltage. Another stand-alone PV system with battery backup, based on a novel three-port dc–dc converter has been proposed by Chen for dc loads. The advantage of this system is that low-voltage PV and battery can be used, integrated through the same high-gain converter. However, the control flexibility is low because of the complexity of the converter. Caracas *et al.* [26] have proposed a battery less standalone solar PV system for water pumping application using a high-voltage-gain dc-dc converter stage in the system. In accordance with the ongoing discussion, this paper presents a novel configuration that overcomes the stand-alone PV systems' drawbacks described in the preceding paragraphs.

The proposed two-stage PV power conversion system for standalone ac loads has the following features.

It has a novel front-end dc–dc power conversion stage with high voltage gain capability. In spite of the required high voltage gain (40–400 V, i.e., a gain of ≈ 10), the efficiency (≈ 96%) is not compromised. A conventional dc–dc converter would give much lower efficiency for this kind of gain. The front-end dc–dc stage is capable of performing both electrical MPPT and the required power tracking (RPT) of the PV source depending on the load requirement and the battery state of charge (SOC). RPT capability obviates the dump load requirement.

A BESS is interfaced through another high-gain high efficiency bidirectional converter. In conjunction with RPT, the battery charge is strictly regulated to ensure its life. The control strategy proposed in this paper ensures fast transient response, low harmonics, and small steady-state errors with a simple and compact control. This system can be easily upgraded to higher power rating by interfacing additional renewable energy sources with the dc link.

VIII. SYNCHRONIZATION AND CONTROL OF 3-Ø GRID CONNECTED INVERTER

One of the most important and necessary features of a power converter connected to electric utility grid is proper synchronization with the three-phase voltages in a three phase system. The synchronization methods used for three-phase systems are more complex than in single phase systems due to the relationship of phase shift and phase sequence of the coordinated three phase voltages. Fig. 4.2 shows the voltage vector describing a circular locus on a Cartesian plane, generally referred to as the α-β plane. The modulus and the rotational speed of the three phase voltage vector are maintained constant when balanced sinusoidal waveforms are present in the three-phase system.

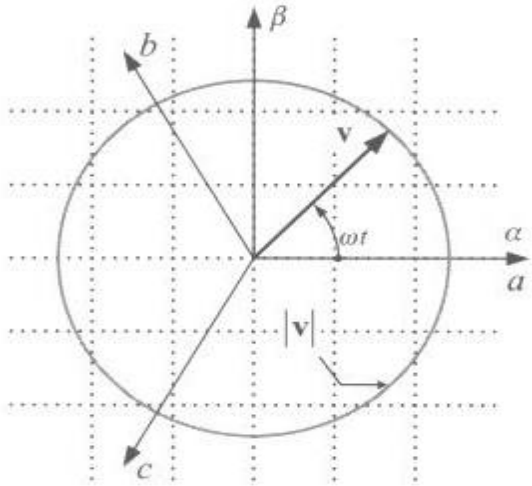


Fig:Ideal three-phase voltage vector

$$V_{abc} = \begin{bmatrix} V_a \\ V_b \\ V_c \end{bmatrix} = V \begin{bmatrix} \cos(\omega t + \emptyset) \\ \cos\left(\omega t - \frac{2\pi}{3} + \emptyset\right) \\ \cos\left(\omega t + \frac{2\pi}{3} + \emptyset\right) \end{bmatrix}$$

GRID SYNCHRONISATION METHOD

In the synchronous frame control method, the amplitude and phase of the grid voltage needs to be known for the control system. These pieces of information are essential for the current and voltage control loops in order to stabilize the system and force it to work at its optimal point where the system will generate and deliver maximum power.

To obtain these vital pieces of information, a synchronization method should be employed to synchronize the inverter output and utility grid. There are various methods to extract the phase information from a given signal. In the following some of these approaches will be discussed.

a) Zero-Crossing Method: In the zero-crossing method, the phase angle of the grid is determined according to the time difference between two zero-crossing points of the grid voltage. Since the zero-crossing points are only updated at every half cycle of the utility voltage frequency, the dynamic performance of this technique is low.

b) αβ and dq Filtering Algorithm: The grid phase angle can be obtained by filtering the grid voltage in stationary (αβ) or synchronous (dq) frames. the schematic of these methods of synchronization. In stationary frame, the arc-tangent function is directly applied to the frame but in synchronous frame, the dq signal must be transformed back into the stationary frame before applying the arc-tangent function. The drawback of this method is the use of filtering, which introduces a delay to the system, and therefore the calculated phase angle will lag the real phase angle. More details regarding the concept and implementation of this synchronization technique can be found in literature.

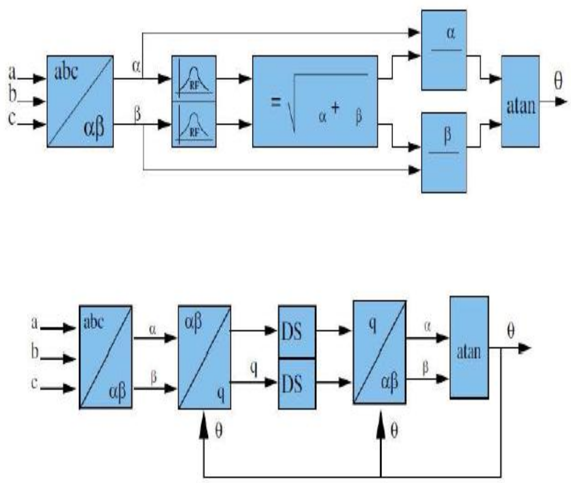


Fig: Synchronization method using αβ and dq frames

c. Phase-Locked-Loop (PLL): The third method of synchronization is the phase-locked-loop technique. A basic PLL circuit often consists of three essential components: a phase detector, a loop filter, and a Voltage Controlled Oscillator (VCO). Using a negative feedback loop, PLL minimizes the phase and frequency errors between the input and output signals..

IX.VOLTAGE SOURCE INVERTER

The type of inverter to be used in the power conditioning unit for this study was selected to be a VSI.

This type of inverter was selected not only because of the readily available power electronics building block (PEBB) based inverter system, but also because of the type of control systems to be implemented. The VSI is controlled in voltage mode using well known pulse width modulated (PWM) switching technique. The three-phase inverter comprises of three legs of two IGBT switches each. The three top switches are enabled using three generated PWM pulses and the bottom switches are enabled using the complementary of three generated PWM pulses. To avoid the shorting of a single leg, a dead band needs to be incorporated between the top and bottom PWM pulses of the same leg.

GENERATION OF PWM PULSES

PWM is generated using Sine Triangle PWM. For simulation purposes, due to the high frequency of the carrier (10 kHz), a much higher sampling frequency is chosen to run the simulation which reduces the speed of execution badly. In Sine Triangle PWM, in order to produce the output voltage of desired magnitude waveform, phase shift and frequency, the desired signal is compared with a carrier (triangular waveform signal) of higher frequency to generate appropriate switching signals as shown in Fig.4.6. The dc link capacitor is alternately connected to the inverter outputs with positive and negative polarity. When the switches are closed at ton, the voltage time averaging over one carrier wave begins. Control of t_{on} and t_{off} is achieved by comparing the modulating voltage with the carrier voltage. When the magnitude of the carrier voltage exceeds the magnitude of the modulating voltage, one of the active switches is opened to end any contribution to the time average voltage. Similar triangles on the control plot f voltage vs. time show that

$$\frac{T}{T_s} = \frac{V_{carrier} - V_{moculation}}{V_{carrier}} .$$

The average voltage at any time is:

$$V_{average} = \frac{T_s - T}{T_s} \times \frac{V_{dc}}{2} = \frac{V_{modulation}}{V_{carrier}} \times \frac{V_{dc}}{2} = M \times \frac{V_{dc}}{2} \quad (4.3)$$

Where the modulation index, M, varies with time to synthesize the average voltage. If the average voltage were plotted, it would look like the modulating voltage waveform (inverter sine output). The output voltage of the VSI does not have the shape of the desired signal, but switching harmonics, can be filtered out by the series LCL low pass filter, to retrieve the 50Hz fundamental sine wave. The three top switches are enabled using three generated PWM pulses and the bottom switches are enabled using the complementary of three generated PWM pulses The drawback of this method is the use of filtering, which introduces a delay to the system, and therefore the calculated phase angle will lag the real phase angle. More details regarding the concept and implementation of this synchronization technique can be found in literature.

X.ENERGY STORAGE IN PV SYSTEMS

A Residence with PV system and energy storage, can obtain a greater autonomy from the utility grid. That is getting the ability to use the generated energy in the same system by compensating the load and the battery deficiency. The purpose of a battery engaged in a PV system is to deliver the power when the PV power is not enough to compensate the load in a peak hour. Several aspects have to be considered to find out the required capacity and the amount of cells needed for an acceptable battery for the PV system.

ENERGY STORED TECHNOLOGIES

Since the founding of electrical energy, different effective technologies have been found out to store it and to use when there is a demand for that. During the recent past, the energy storage industry has continued to develop and get used to varying energy needs and progresses in technology. Energy storages offer a broad range of technical approaches to controlling the power supply, in order to create a flexible energy infrastructure and achieve cost savings to the grid owners and customers. There are different types of energy storage approaches being used in the present world. The four main categories of energy storage types are discussed under this section.

a) Electrochemical Energy Storage

Currently, this is the most general form of energy storage used in most of the applications. Batteries and fuel cells are the two main types in electrochemical energy storages. In electrochemical energy storages the chemical energy is transformed into electrical energy. Batteries can be classified into two main types as rechargeable and non-rechargeable batteries. Rechargeable batteries are used in renewable energy systems to store excess production.
The Fuel cell is a device which converts the chemical energy of the fuel into electrical energy. All the fuel cells consist with anode, cathode and electrolyte. Hydrogen and hydrocarbons used as the fuel for the fuel cells. Fuel cells are dissimilar from batteries such a way that needs a continuous fuel supply to maintain the chemical reaction. The fuel cell is generating electricity as long as fuel is supplied to the anode of the fuel cell.

b) Electrical Energy Storage

An electric field is used to store the energy in electrical energy storages. Those are mainly classified as capacitors and super capacitors. Even though the electric charge energy is stored in each of the devices, the super capacitors have the ability to store more charge energy density compared to common capacitors. The capacitor is normally used as a temporary backup, whereas the super capacitor is used usually to provide energy for large engines. Super capacitors are used to operate low power equipments such as computer memory cards, portable players, etc. Superconducting magnetic energy storage is an electrical energy storage, which stores energy within a magnetic field, generated by the flow of DC in a superconducting coil. During this procedure, the temperature of the superconducting coil decreases below the critical temperature of the superconductor.

c) Chemical Energy Storage

The potential energy of some chemicals is used as energy storages. The popular chemicals are mainly liquid nitrogen, hydrogen and Oxy hydrogen. Liquid nitrogen shows possibility as a basis of energy and it is utilized as a type of energy storage. Liquid nitrogen is used to produce electric energy or refrigeration and cooling. Hydrogen has a potential as a source of energy. The smallest amount of hydrogen is kept in pressurized vessels and large amounts are stored in underground caves. Oxy-hydrogen is a combination of hydrogen and oxygen, which discharges higher temperature and pressure steam, which can be used to produce electricity. Other than those above mentioned chemicals hydrogen peroxide and vanadium pent oxide are also used as chemical storages.

d) Mechanical Energy Storage

The kinetic or potential energy of different sources used to store the electricity in this type of storage systems. Pumped hydroelectric energy storage, hydraulic accumulator and flywheel energy storage are the main types of mechanical energy storages used in the industry. The pumped hydroelectric energy storage is the oldest energy storage type used in the world. Its easiness of design, comparatively low cost and the equality to hydroelectric energy has happened to sustain its operation during such a long period. These systems operate by pumping water into a higher reservoir and using its potential energy as and when required.

e) **Thermal Energy Storage**

Thermal energy storage consists of different types of methods. Basically, this shows the methods which are used to store thermal energy with the aim of utilizing to decrease or increase the heat amount of the buildings. When compared to chemical and mechanical energy storages, this type has many advantages like minor capital cost and higher operating efficiencies.

XI. CONCLUSION

This project has described and implemented a Implementation and Analysis of Stand Alone Solar PV System with High Gain High Efficiency applications. Considering that high PV side voltage leads to several drawbacks, a low voltage PV source is used in the system. The limitation of low-voltage PV source is overcome by using a special high voltage-gain front-end dc–dc converter capable of operating at high efficiency and MPPT. The proposed scheme is particularly conducive to long battery life by as it ensures no battery overcharge or deep discharge. For this purpose, the conventional MPPT scheme is replaced by RPT, which ensures that only the required power is tracked from the PV source.
This prevents the drawing of excess power from the PV source and the use and management of expensive "dump" loads. Not only the main power stage but also the battery interfacing bidirectional stage also supports high voltage gain with high efficiency. Due to the use of special high-gain high-efficiency converters in the power stage, the overall efficiency of the system is 94%. Preliminary investigations have yielded encouraging results.

XII.FUTURE SCOPE

The Future scope for MPPT algorithm is Z-source inverter. The Z-source inverter is a new power inverter topology that is very promising for photo voltaic power generation and utility interfacing. Unique Buck and Boost capability of the Z-source inverter allows a wide range of input voltage and eliminates the usage of line frequency transformer or dc-dc boost converter, this improves the overall efficiency of the system also, the shoot through-state is permitted and the system reliability .The performance of the power inverter depends on the PWM technique applied to it like wise in z-source are inverter the voltage gain and voltage stress across the switching device based on control techniques only.

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