www.ijiarec.com

ISSN: 2348-2079 MAR-2015

International Journal of Intellectual Advancements and Research in Engineering Computations

A MULTI-STAGE SOLAR POWER CONVERTER FOR PV-BATTERY SYSTEM

S.Sasikumar[1], N.Lakshmi[2]

ABSTRACT

This paper introduces a new converter called re-configurable solar converter (RSC) for photovoltaic (PV)-battery application, particularly utility-scale PV-battery application. The main concept of the new converter is to use a single-stage three-phase grid-tie solar PV converter to perform dc/ac and dc/dc operations. This converter solution is appealing for PV-battery application, because it minimizes the number of conversion stages, thereby improving efficiency and reducing cost, weight, and volume. In this paper, a combination of analysis and experimental tests is used to demonstrate the attractive performance characteristics of the pro-posed RSC.

Index Terms — Converter, energy storage, photovoltaic (PV), solar.

INTRODUCTION

Solar photovoltaic (PV) electricity generation is not available and sometimes less available depending on the time of the day and the weather conditions. Solar PV electricity output is also highly sensitive to shading. When even a small portion of a cell, module, or array is shaded, while the remainder is in sunlight, the output falls dramatically. Therefore, solar PV electricity output significantly varies. From an energy source stand- point, a stable energy source and an energy source that can be dispatched at the request are desired. As a result, energy storage such as batteries and fuel cells for solar PV systems has drawn significant attention and the demand of energy storage for solar PV systems has been dramatically increased, since, with energy storage, a solar PV system becomes a stable energy source and it can be dispatched at the request, which results in improving the performance and the value of solar PV systems.

There are different options for integrating energy storage into a utility-scale solar PV system. Specifically, energy storage can be integrated into the either ac or dc side of the solar PV power conversion systems which may consist of multiple conversion stages. Every integration solution has its advantages and disadvantages. Different integration solutions can be compared with regard to the number of power stages, efficiency, storage system flexibility, control complexity, etc. This paper introduces a novel single-stage solar converter called reconfigurable solar converter (RSC). The basic concept of the RSC is to use a single power conversion system to perform different operation modes such as PV to grid (dc to ac), PV to battery (dc to dc), battery to grid (dc to ac), and battery/PV to grid (dc to ac) for solar PV systems with energy storage.

The RSC concept arose from the fact that energy storage integration for utility-scale solar PV systems makes sense if there is an enough gap or a minimal overlap between the PV energy storage and release time. The RSC concept provides significant benefits to system planning of utility-scale solar PV power plants. The current state of-the-art technology is to integrate the energy storage into the ac side of the solar PV system. The RSC concept allows not only the system owners to possess an expandable asset that helps them to plan and operate the power plant.

Author for Correspondence:

[1]S.Sasikumar, Assistant Professor, EEE Department, Gnanamani College of Engineering, Namakkal, Tamilnadu, India.
[2]N.Lakshmi, PG Student, EEE Department, Gnanamani College of Engineering, Namakkal, Tamilnadu, India

EXISTING SYSTEM

The existing system based on the single stage power conversion PV battery system. In olden years, single stage power conversion method was used. In power conversion IGBT was used. But their performance and control stability was very poor. It have static charge problems and costlier than MOSFET. This system is used only low load applications. The RSC concept provides significant benefits to system planning of utility-scale solar PV power plants. The current state of-the-art technology is to integrate the energy storage into the ac side of the solar PV system.

PROPOSED SYSTEM

The proposed method is "Reconfigurable Solar Converter: A Multi-Stage Power Conversion PV-Battery System" In this proposed method, we can get the high voltage at different modes of operation. By the use of simulation results, it was clearly proved that the proposed method gives very remarkable high voltage performance. The RSC is an optimal solution for PV-battery power conversion systems. The main purpose of proposed converter is reduction of the components and power delivery stage (AC/DC and DC/AC links) in multi-stage DC/AC converter. The reliability of a system is indirectly proportional to the number of its components.

BLOCK DIAGRAM

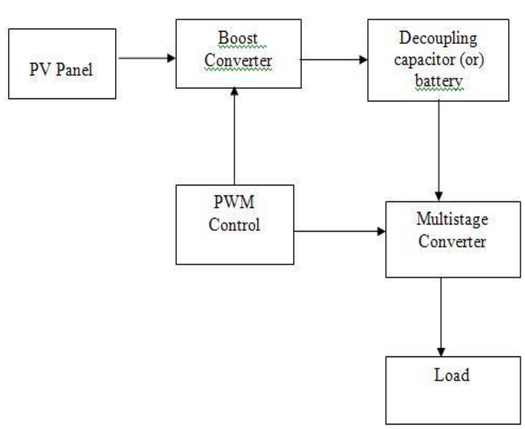


Fig Block Diagram of Proposed System

BLOCK DIAGRAM EXPLANATION

The solar energy is the clean and sustainable energy, with long lifespan and a high reliability. A solar cell is an electronic device which directly converts sunlight into electricity.

A PV array consists of several photovoltaic cells in parallel and series connections. Parallel connection is responsible for increasing the current in the array whereas the series connections are responsible for increasing the voltage of the module. A PV module is used efficiently only when it operates only when it operates at its OOP (Optimum Operating Point). At any moment, The OOP of a PV module depends on varying isolation levels, sun direction, irradiance, temperature, as well as the load of the system. The amount of power that can be extracted from a PV array also depends on the operating voltage of that array. PV solar cells have relatively low efficiency ratings; thus operating at the MPP (maximum power point) is desired, because it is at this point array will operate at the highest efficiency. With constantly changing atmospheric conditions and load variables, it is very difficult to utilize all of the solar energy available without a controlled system. For the best performance, it becomes necessary to force the system to operate at its OOP. The solution for such a problem is to use a MPPT (maximum power point tracking) system. A MPPT is normally operated with the use of a dc-dc (direct current/direct current) converter. The converter is responsible for transferring maximum power from the solar PV module to the load.

Incremental conductance is one of the most widely using MPPT algorithms because it improves energy efficiency and provides steady state in output power with the help of boost converter. This method has two advantages over the P&O method especially that it stops updating the reference variable when the MPP is reached, thus reducing power oscillations. The maximum electrical energy of solar panel is stored in battery, which is connected to the input side of multi stage converter. Traditionally they used for the load.

PV PANEL

Renewable Energy is a term that refers to energy sources that are renewable in nature, meaning that

Copyrights © International Journal of Intellectual Advancements and Research in Engineering Computations, www.ijiarec.com

more and more is continuously generated, and for all practical purposes, that are virtually limitless in supply. Energy from our sun is one such example. Technically, the sunlight will fade in about 5 billion years, but for all practical purposes and human timescales, this is a continuous and infinite resource. With solar panels, a clean, renewable energy can be obtained from the sun and the energy free from dependence on polluting, non-renewable energy sources. A structural group of modules that is the basic block of a PV array. A group of panels that comprises the complete direct current PV generating unit.

DEFINITION OF PHOTOVOLTAIC

A photovoltaic cell or photoelectric cell is a semiconductor device that converts light to electrical energy by photovoltaic effect principle. If the energy of photon of light is greater than the band gap then the electron is emitted and the flow of electrons creates current. However a photovoltaic cell is different from a photodiode. In a photodiode light falls on n channel of the semiconductor junction and gets converted into current or voltage signal but a photovoltaic cell is always forward biased .

SOLAR CELL CONSTRUCTION

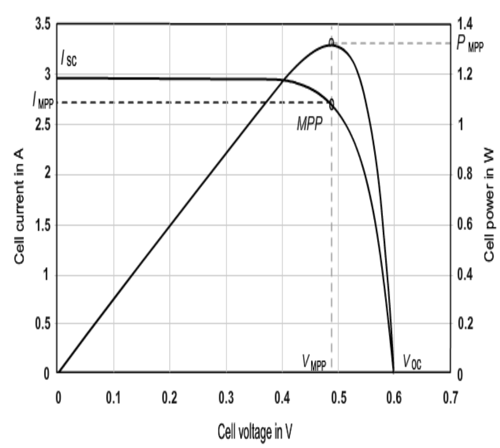
A PV array is a group of several PV modules which are electrically connected in series and parallel circuits to generate the required current and voltage. The equivalent circuit for the solar module arranged in N_P parallel and N_S series depends upon our requirement. Solar panel when exposed to the sun, a dc current is generated. The generated current varies linearly with the solar radiance. A Solar Panel is a packaged interconnected assembly of solar cells, also known as PV cells. The solar panel can be used as a component of a larger PV system to generate and supply electricity in commercial and residential applications.

Solar panels use light energy from the sun to generate electricity through the PV effect. The structural member of a module can either be the top layer or the back layer. The majority of modules use wafer-based crystalline silicon cells or thin-film cells based on cadmium telluride or silicon and consist basically of a junction between two thin layers of semiconducting materials, known as p - positive type semiconductors and n – negative type semiconductors. The p type semiconductor is created when some of the atoms of the crystalline silicon are replaced by atoms with lower valence like boron which causes the material to have a deficit of free electrons. The n type semiconductor is created when some of their atoms of the crystalline silicon are replaced by atoms of another material which has higher valence band like phosphorous in such a way that the material has a surplus of free electrons.

PHOTOVOLTAIC OPERATION

PV is the direct conversion of light into electricity at the atomic level. Some materials exhibit a property known as the photoelectric effect that causes them to absorb photons of light and release electrons. The electromagnetic radiation of solar energy can be directly converted to electricity through photovoltaic effect. Being exposed to the sunlight, photons with energy greater than the band-gap energy of the semiconductor are absorbed and create some electron-hole pairs proportional to the incident irradiation. Under the influence of the internal electric fields of the p-n junction, these carriers are swept apart and create a photocurrent which is directly proportional to solar isolation.

When these free electrons are captured, electric current results that can be used as electricity. For solar cells, a thin semiconductor wafer is specially treated to form an electric field, positive on one side and negative on the other. When light energy strikes the solar cell, it produces an electric power which can be fed to the desired load.



Copyrights © International Journal of Intellectual Advancements and Research in Engineering Computations, www.ijiarec.com

EQUIVALENT CIRCUIT OF PV CELL

The equivalent electrical circuit of an ideal solar panel can be treated as a current source parallel with a diode .There some losses exist in the real operation of the solar panel, to pick up these losses series resistance Rs and shunt resistance Rsh are added to the PV system and the equivalent circuit is shown in the Fig.

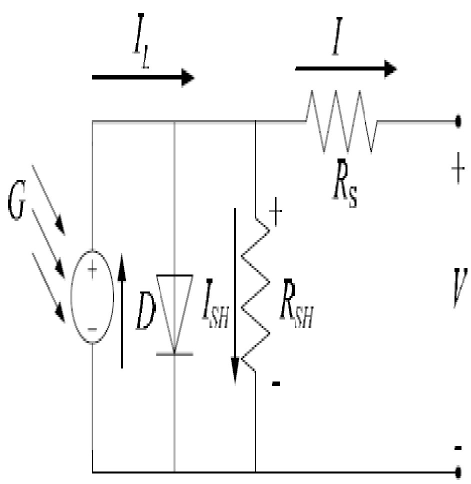


Fig: Equivalent circuit of PV cell

The electrical characteristic of solar cell used in the PN union is almost same as that of diode which is represented by the equation of Shockley.

$$I_d=I_o[\exp(q*v/a*k*T)-1) \quad (1)$$

Where:

I_d =Dark current (A).

I_o =Saturation current of the diode (A).

v =Cell voltage (T).

T =Cell temperature.

k= Boltzmann's constant, $1.38*10^{-23}$ (J/K).

a =diode ideality constant.

The net current of the solar panel is given by,

$$I=I_L-I_d \quad (2)$$

As shown in equation (2) the difference of the photocurrent I_L, (the current generated by the incident light, directly proportional to the sun irradiance) and I_d (the normal diode current) is the net current of the solar panel.

$$I=I_L-I_o[\exp((V+IR_s)*q/(a*k*T))-1)(3)$$

Equation (3) presents the net current of the solar panel of a simplified model.

To Perform Matlab Simulation of Battery Charging Using Solar Power is,

$$I=I_L-I_o[\exp((V+IR_s)*q/(a*k*T))-1)]-[(V+I*R_s)/R_{sh}] \quad (4)$$

Equation (4) represent the generated output current depends upon solar irradiance, voltage of the PV panel and ambient temperature.

CHARACTERISTICS OF PV CELL

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

Fig: P-V & I-V Characteristics of PV Cell

DC- DC Converter

Fig illustrates the circuit of a classical linear power converter. Here power is controlled by a series linear element; either a resister or a transistor is used in the linear mode. The total load current passes through the series linear element. In this circuit greater the difference between the input and the output voltage, more is the power loss in the controlling device (linear element). Linear power conversion is dissipative and hence is inefficient.

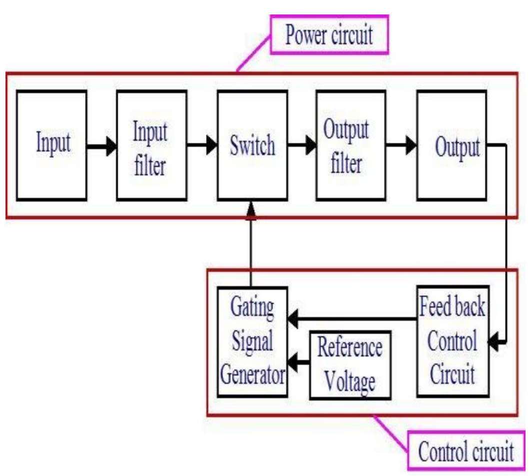


Fig DC-DC Converter Block Diagram

The circuit illustrates basic principle of a DC-DC switching-mode power converter. The controlling device is a switch. By controlling the duty cycle, (the ratio of the time in on positions to the total time of on and off position of a switch) the power flow to the load can be controlled in a very efficient way. Ideally this method is 100% efficient. In practice, the efficiency is reduced as the switch is non-ideal and losses occur in power circuits. Hence, one of the prime objectives in switch mode power conversion is to realize conversion with the least number of components having better efficiency and reliability. The DC output voltage to the load can be controlled by controlling the duty cycle of the rectangular wave supplied to the base or gate of the switching device. When the switch is on, it has only a small saturation voltage drop across it. In the off condition the current through the switch is zero. The reference voltage is set for the particular output voltage. The comparator generates the error signal. This error signal acts as the control voltage. The control block uses the control voltage to generate the drives of the chopper.

FUNCTIONS OF DC – DC COVERTER:

- Convert a DC input voltage Vs into a DC output voltage Vo.
- Regulate the DC output voltage against load and line variations.
- Reduce the AC voltage ripple on the DC output voltage below the required level.
- Provide isolation between the input source and the load (if required).
- Protect the supplied system and the input source from electromagnetic interference.

The DC-DC converter is considered as the heart of the power supply. The converter accepts DC and produces a controlled DC output.

TYPES OF DC – DC COVERTER:

- Buck converter
- Boost converter
- Buck-Boost converter
- Cuk converter

BUCK CONVERTER (DC-DC)

In the buck converter (dc-dc), the average output voltage is less than the supply voltage. Buck converter is similar to the step down chopper. Also a diode (termed as free wheeling) is used to allow the load current to flow through it, when the switch (i.e., a device) is turned off. The load is inductive (R-L) one. In some cases, a battery (or back emf) is connected in series with the load (inductive). Due to the load inductance, the load current must be allowed a path, which is provided by the diode; otherwise, i.e., in the absence of the above diode, the high induced emf of the inductance, as the load current tends to decrease, may cause damage to the switching device. If the switching device used is a MOSFET, this circuit is called as a step-down chopper, as the output voltage is normally lower than the input voltage. Similarly, this dc-dc converter is termed as buck one, due to reason given later. Buck converter is used in battery portable equipments and for unidirectional supplies. Buck converter is very simple and it requires only one MOSFET (switch).Efficiency is 90%. This is the low cost and size and large tolerance of line voltage variation. The disadvantage of the buck converter is only unidirectional output is available, high output ripple, slow transient and input filter is normally required. In the buck converter (dc-dc), the average output voltage is less than the supply voltage. Buck converter is similar to the step down chopper.

BOOST CONVERTER (DC-DC)

A boost converter (dc-dc) is shown in Fig. Only a switch is shown, for which a device belonging to transistor family is generally used. Also, a diode is used in series with the load. The load is of the same type as given earlier. The inductance of the load is small. An inductance, L is assumed in series with the input supply. The position of the switch and diode in this circuit may be noted, as compared to their position in the buck converter.

A boost converter (step-up converter) is a power converter with an output DC voltage greater than its input DC voltage. It is a class of switching-mode power supply (SMPS) Containing at least two semiconductor switches and at least one energy storage element. Filters made of capacitors are normally added to the output of the converter to reduce output voltage ripple.

Copyrights © International Journal of Intellectual Advancements and Research in Engineering Computations, www.ijiarec.com

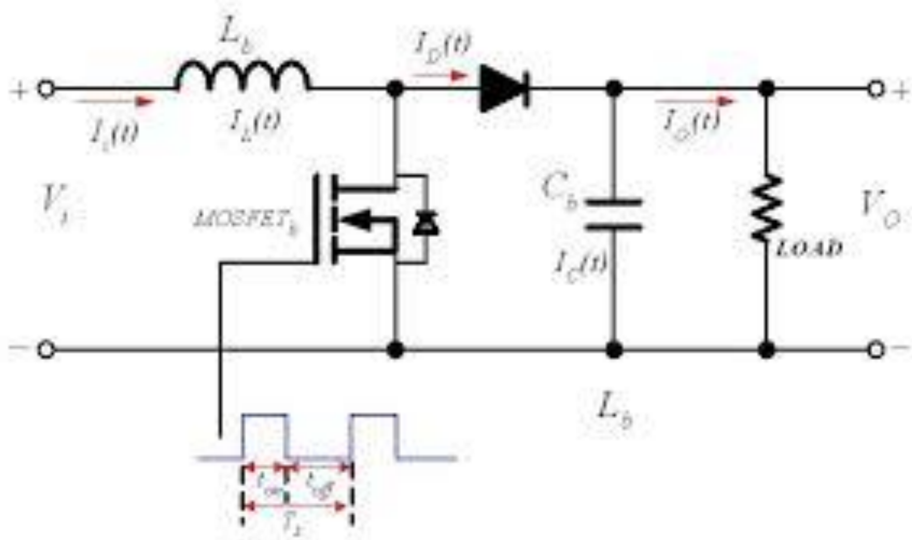


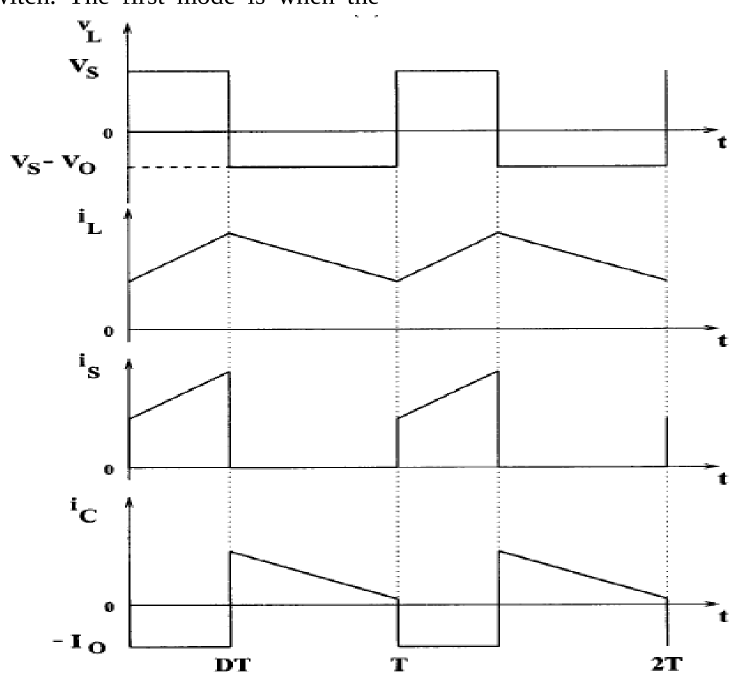
Fig Equivalent Circuit of Boost Converter

The key principle that drives the boost converter is the tendency of an inductor to resist changes in current. When being charged it acts as a load and absorbs energy when being discharged it acts as an energy source. The boost converter provides higher output voltage than the input voltage. The booster converter is like the step-up chopper.

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. The MOSFET is used as a switch in the boost dc-dc converter.

CHARGING MODE

In charging mode the switch is closed i.e., turn ON depends on gate pulse received from the MPPT algorithm 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.

DISCHARGING MODE

In discharging mode the switch is open i.e., turn OFF depends on gate pulse received from the MPPT algorithm and the diode is forward biased. 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.

WAVEFORMS OF BOOST CONVERTER

Fig: Waveforms of Boost Converter

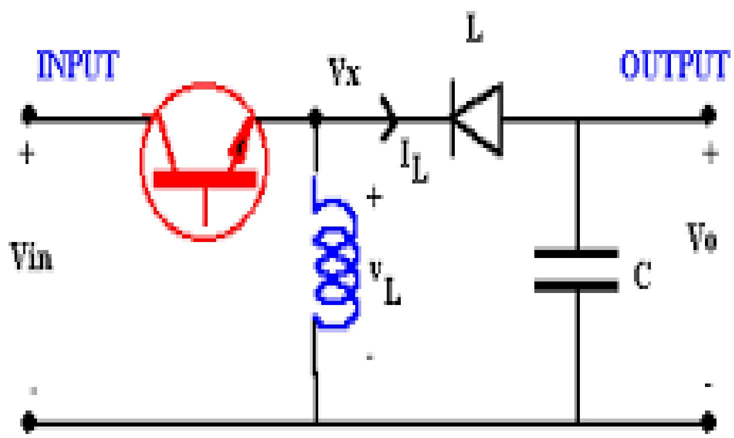
Waveforms of boost converter are shown in fig, where Vs=supply voltage, V_L=load voltage, i_s=supply current, i_c=capacitor current, i_L=inductor current, io=output current

BUCK-BOOST CONVERTER (DC-DC)

The output voltage polarity of buck boost converter is opposite to that of input voltage. Also, a diode is used in series with the load. The connection of the diode may be noted, as compared with its connection in a boost converter the inductor, L is connected in parallel after the switch and before the diode. A capacitor, C is connected in parallel with the load. The polarity of the output voltage is opposite to that of input voltage here. When the switch, S is put ON, the supply current flows through the path, S and L, during the time interval. The currents through both source and inductor increase and are same, with being positive. The polarity of the induced voltage is same as that of the input voltage. Then, the switch, S is put OFF. The inductor current tends to decrease; with the polarity of the induced emf reversing is negative now, the polarity of the output voltage, and being opposite to that of the input voltage. Hence this is called inverting regulator. The output of the regulator can be greater than or less than the input voltage. Hence, the name is given as buck boost regulator. It provides the inverted output. Both buck/boost operations simultaneously and short circuit protection can be easily implemented.

Fig Equivalent circuit of Buck Boost Converter

With continuous conduction for the Buck-Boost converter $V_x = V_{in}$ when the transistor is ON and $V_x = V_o$ when the transistor is OFF. For zero net current change over a period the average voltage across the inductor is zero. The circuit diagram is shown above. When switch is ON inductor stores energy. Diode isolate input from the output, capacitor supplies the



load. When switch is OFF .The inductor stores energy charges the capacitor and supplies the load through the load. As the inductance polarity is reversed, when it transfer the output is reverse

PWM CONTROL

OBJECTIVE

The controller is key to the stability and precision of the power supply, and virtually every design uses a pulse-width modulation (PWM) technique for regulation. There are two main methods of generating the PWM signal: Voltage-mode control and current-mode control. Voltage-mode control came first, but its disadvantages—such as slow response to load variations and loop gain that varied with input voltage encouraged engineers to develop the alternative current – based method today, engineers can select from a wide range of

Copyrights © International Journal of Intellectual Advancements and Research in Engineering Computations, www.ijiarec.com

power modules using either control technique. These products incorporate technology to overcome the major deficiencies of the previous generation. This article describes voltage- and current-mode control technique for PWM-signal generation in switching-voltage regulators and explains where each application is best suited.

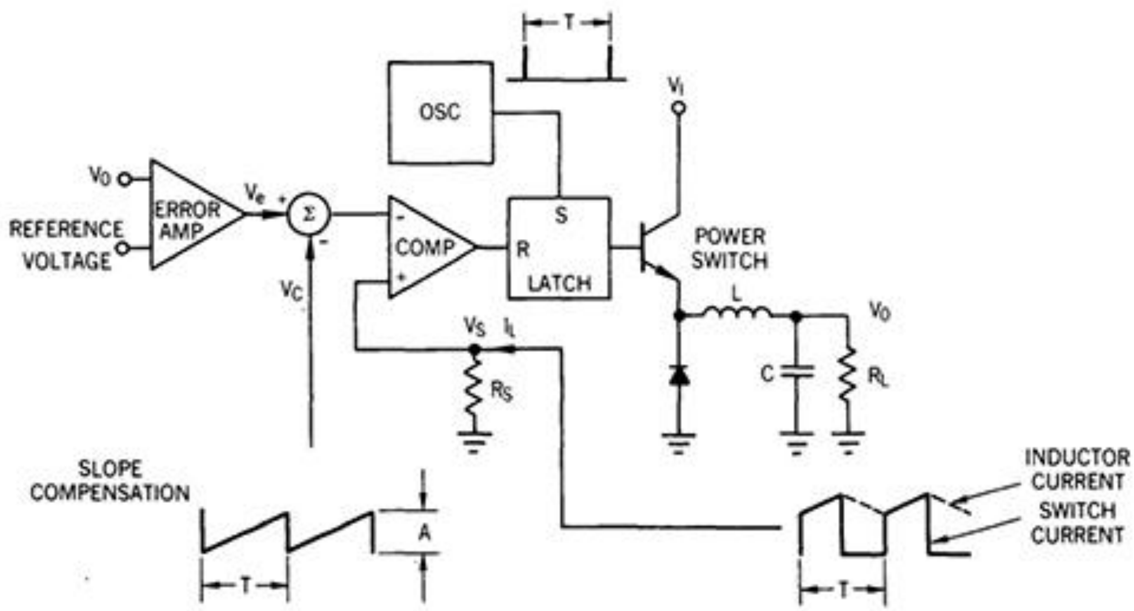
VOLTAGE-MODE CONTROL

In a voltage-mode controlled regulator, the PWM signal is generated by applying a control voltage (V_C) to one comparator input and a sawtooth voltage (V_{ramp}) (or "PWM ramp") of fixed frequency, generated by the clock, The duty cycles of the PWM signal is proportional to the control voltage and determines the percentage of the time that the switching element conducts and therefore, in turn, the output voltage. The control voltage is derived from the difference between the actual-output voltage and the desired-output voltage (or reference voltage).

A look through some silicon vendor catalogs reveals that voltage-mode control regulators have not gone away. The reason for this is that the key weaknesses of the previous generation of devices have been addressed by using a technique called voltage feed-forward. Voltage feed-forward is accomplished by modifying the slope of the PWM ramp waveform with a voltage proportional to the input voltage. The technique improves circuit response to line and load transients while eliminating sensitivity to the presence of an input filter.

CURRENT-MODE CONTROL

In the early 1980s, engineers came up with an alternative-switching-voltage regulator technique that addressed the deficiencies of the voltage-mode control method. Called current-mode control, the technique derives the PWM ramp by adding a second loop feeding back the inductor current. This feedback signal comprises two parts: the AC-ripple current, and the DC or average value of the inductor current.



An amplified form of the signal is routed to one input of the PWM comparator while the error voltage forms the other input. As with the voltage-mode control method, the system clock determines the PWM-signal frequency.

Fig Current Control Method

Current-mode control addresses the slow response of voltage-mode control because the inductor current rises with a slope determined by the difference between the input and output voltages and hence responds immediately to line- or load-voltage changes. A further advantage is that current- voltage mode control eliminates the loop-gain variation with input voltage drawback of the voltage-mode control method. Engineers are able to select from a wide range of voltage-mode control regulators from the

Copyrights © International Journal of Intellectual Advancements and Research in Engineering Computations, www.ijiarec.com

major suppliers. Current-mode control devices are recommended for applications where the supply output is high current or very-high voltage; the fastest dynamic response is required at a particular frequency, input-voltage variations are constrained, and in applications where cost and number of components must be minimized.

SPACE VECTOR PWM

Variable voltage and frequency supply to ac drives is invariably obtained from a three-phase voltage source inverter (VSI). A number of Pulse width modulations (PWM) scheme is used to obtain variable voltage and frequency supply. The most widely used PWM schemes for three-phase VSI are carrier-based sinusoidal PWM and space vector PWM (SVPWM). There is an increasing trend of using space vector PWM (SVPWM) because of their easier digital realization and better dc bus utilization. Firstly model of a three-phase VSI is discussed based on space vector representation. Space vector modulation is one of the real time modulation techniques and widely used in digital control of voltage source converter. The SVC considers inverter as a single unit rather than three separate phases. The required output waveforms are generated by driving the inverter in eight unique states.

- Digital circuits are used to implement SVM technique. The control is such that PWM load line voltages are in average equal to a given reference load line voltages.
- The states of the switches are properly selected in each sampling period. The period of the states are selected such that the output waveforms have quarter cycle symmetry.
- The states of the switches and their time periods are accomplished with the help of Space Vector transformation.
- There can be six switching states of the inverter. These six states generate six non zero voltage vectors V1 to V6. These switching states are referenced to a vector.
- Frequency or amplitude to achieve the desired result.

Variable voltage and frequency supply for as drives is invariably obtained from a three-phase VSI. A number of PWM techniques have been presented to obtain variable voltage and frequency supply. The most popular among those are carrier-based sinusoidal PWM and SVPWM. The major advantage of SVWPM stem from the fact that there is a degree of freedom of space vector placement in a switching cycle. This improves the harmonic performance of this method. Space Vector Modulation (SVM) can directly transform the stator voltage vectors from an α, β-coordinate system to Pulse Width Modulation (PWM) signals (duty cycle values).The standard technique for output voltage generation uses an inverse Clarke transformation to obtain 3-phase values.

Using the phase voltage values, the duty cycles needed to control the power stage switches are then calculated. Although this technique gives good results, space vector modulation is more straightforward and realized more easily by a digital signal controller. SVPWM is actually just a modulation algorithm which translates phase voltage (phase to neutral) references, coming from the controller, into modulation times/duty-cycles to be applied to the PWM peripheral. It is a general technique for any three-phase load, although it has been developed for motor control. SVPWM maximizes DC bus voltage exploitation and uses the "nearest" vectors, which translates into a minimization of the harmonic content. The classical application of SVPWM is vector motor control, which is based on the control of currents' projection on two orthogonal coordinates, called Field Oriented Control (FOC). For induction machines, the most common choices for the direct axis are to align it to the rotor field (rotor FOC) or to the stator field (stator FOC). The basic concept is that with a known motor and known voltage output pulses you can accurately determine rotor slip by monitoring current and phase shift. The controller can then modify the PWM "sine" wave shape,

Copyrights © International Journal of Intellectual Advancements and Research in Engineering Computations, www.ijiarec.com

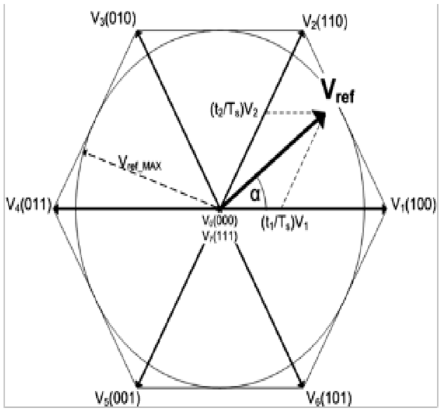


Fig Vector Diagram of SVPWM

The binary numbers on the figure indicate the switch state of inverter legs. Here 1 implies upper switch being on and 0 refers to the lower switch of the leg being on. The most significant bit is for leg A, the least significant bit is related to leg C and the middle is for leg B.

The switching states V1 to V2can be controlled according to the locus of reference vector. This is shown in figure. If the locus exceeds the length of V1 to V6, then it is called over modulation. This PWM method is frequently used in vector controlled and direct torque controlled drives. In vector controlled drive this technique is used for reference voltage generation when current control is exercised in rotating reference frame.

SVPWM is actually just a modulation algorithm which translates phase voltage (phase to neutral) references, coming from the controller, into modulation times/duty-cycles to be applied to the PWM peripheral. It is a general technique for any three-phase load, although it has been developed for control. SVPWM maximizes DC bus voltage exploitation and uses the "nearest" vectors, which translates into a minimization of the harmonic content.

SVPWM can directly transform the converter voltage vectors from the two-phase α,β-coordinate system into pulse-width modulation (PWM) signals (duty cycle values). The output voltage of the inverter needs to be varied as per load requirement. Whenever the input DC varies the output voltage can change. Hence these variations need to be compensated.

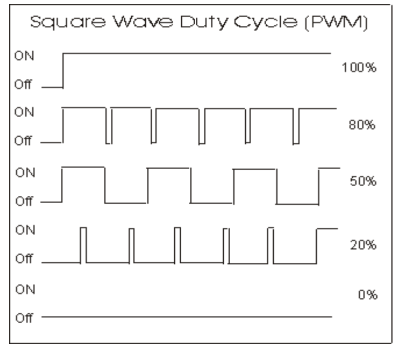


Fig PWM control signal.

The output voltage and frequency of the inverter is adjusted to keep v/f constant. Similarly, in UPS the output voltage of inverter is to be regulated. These all the reasons indicate that the output voltage of inverter is to be controlled. The pulse width modulation techniques are mainly used for voltage control. For pulse width modulation scheme, the conventional space vevtor PWM scheme is utilized in the RSC system.

Pulse width modulation (PWM) is the usage of a high frequency switching technique which allows control over the output voltage of an inverter. The basic concept of PWM is the comparison of a reference signal to that of another waveform, typically triangular, to control the gating signals for inverter switches.

State	Phase voltage space vector
1	(2/3)Vdc
2	(2/3)Vdc exp(jπ/3)
3	(2/3)Vdc exp(j2π/3)
4	(2/3)Vdc exp(jπ)
5	(2/3)Vdc exp(j4π/3)
6	(2/3)Vdc exp(j5π/3)
7 and 8	0

Table Phase voltage space vectors

The switching time and corresponding switch state for each power switch is calculated in Matlab function block ‘sf’ using expressions. The Matlab code requires magnitude of the reference, the angle of

Copyrights © International Journal of Intellectual Advancements and Research in Engineering Computations, www.ijiarec.com

the reference and timer signal for comparison. The angle of the reference voltage is hold for each switching period so that its value does not change during time calculation. The angle information is used for sector identification in Matlab code 'aaa'. Further, a ramping time signal is generated to be used in Matlab code. This ramp is generated using 'repeating sequence' from the source sub-library.

ADVANTAGES OF SVM

- More effective and precise harmonic and voltage control.
- All the three phases are controlled as a single unit

BATTERY

An electrical battery is one or more electrochemical cells that convert stored chemical energy into electrical energy. Since the invention of the first battery (or "voltaic pile") and especially since the technically improved, batteries have become common power sources for many household and industrial applications.

TYPES OF BATTERIES

Batteries are classified into two broad categories, each type with advantages and disadvantages.

- Primary batteries irreversibly (within limits of practicality) transform chemical energy to electrical energy. When the initial supply of reactants is exhausted, energy cannot be readily restored to the battery by electrical means.
- Secondary batteries can be recharged; that is, they can have their chemical reactions reversed by supplying electrical energy to the cell, restoring their original composition.

PRIMARY BATTERIES

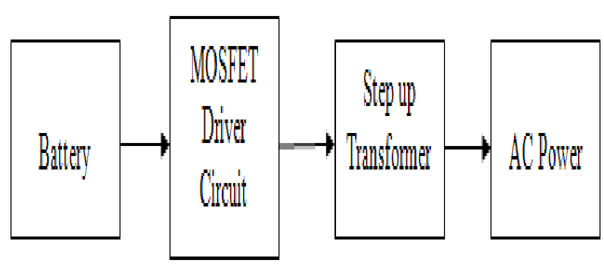
Primary batteries can produce current immediately on assembly. Disposable batteries are intended to be used once and discarded. These are most commonly use in portable devices that have low current drain, are used only intermittently, or are used well away from an alternative power source, such as in alarm and communication circuits where other electric power is only intermittently available. Disposable primary cells cannot be reliably recharged, since the chemical reactions are not easily reversible and active materials may not return to their original forms. Battery manufacturers recommend against attempting recharging primary cells. Common types of disposable batteries include zinc–carbon batteries and alkaline batteries. In general, these have higher energy densities than rechargeable batteries, but disposable batteries do not fare well under high-drain applications with loads under 75 ohms

SECONDARY BATTERIES

Secondary batteries must be charged before use; they are usually assembled with active materials in the discharged state. Rechargeable batteries or secondary cells can be recharged by applying electric current, which reverses the chemical reactions that occur during its use. Devices to supply the appropriate current are called chargers or rechargers.

The oldest form of rechargeable battery is the lead–acid battery. This battery is notable in that it contains a liquid in an unsealed container, requiring that the battery be kept upright and the area be well ventilated to ensure safe dispersal of the hydrogen gas produced by these batteries during overcharging. The lead–acid battery is also very heavy for the amount of electrical energy it can supply. Despite this, its low manufacturing cost and its high surge current levels make its use common where a large capacity (over approximately 10 Ah) is required or where the weight and ease of handling are not concerns.

Basic construction of a lead acid battery is made up of more than one electrochemical cells interconnected in such a way to provide the required voltage and current. Lead acid battery is constructed of two electrodes, the positive one consists of lead dioxide PbO_2 and the negative consists of pure lead.



Copyrights © International Journal of Intellectual Advancements and Research in Engineering Computations, www.ijiarec.com

MULTISTAGE (DC-AC) INVERTER

Multistage converter is a small circuit which will convert the direct current (DC) to alternating current (AC). The power of a battery is converted in to' main voltages' or AC power. This power can be used for electronic appliances like television, mobile phones, computer etc. the main function of the inverter is to convert DC to AC and step-up transformer is used to create main voltages from resulting AC. Two or more universal bridges are connected to form the multistage inverter.

BLOCK DIAGRAM OF INVERTER:

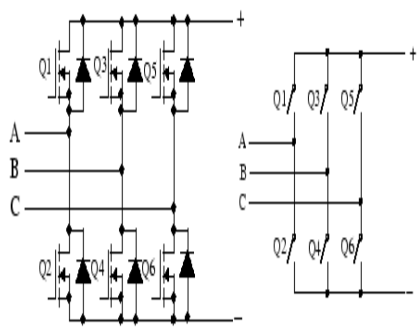


Fig Block Diagram of Inverter

In the block diagram battery supply is given to the MOSFET driver where it will convert DC to AC and the resulting AC is given to the step up transformer from the step up transformer we will get the original voltage. When the MOSFET is turned on the current flows from drain to source. The voltage is applied between gate-source to turn on the MOSFET. Very small current flows from gate to source. Only voltage is applied to be applied to turn on the MOSFET. It can be turned off by removing the gate to source voltage .Thus gate has full control over the conduction of the MOSFET. The turn on and turn off times of MOSFETs are very small. Hence they operate at very high frequencies. Hence MOSFETs are preferred in applications such as choppers and inverters. Since only voltage drive is required. The drive circuits of MOSFETs are very simple. It is majority carrier device and have positive temperature coefficient, hence their paralleling is easy. Gate has full control over the operation of MOSFET. It is used high frequency and low power inverter, high frequency SMPS, high frequency inverters and choppers and low power AC and DC drives.

UNIVERSAL BRIDGE

The Universal Bridge block implements a universal three-phase power converter that consists of up to six power switches connected in a bridge configuration. The types of power switch and converter configuration are selectable from the dialog box. The Universal Bridge block allows simulation of converters using both naturally commutated power electronic devices (diodes or thysistors) and forced-commutated devices (GTO, IGBT, MOSFET)

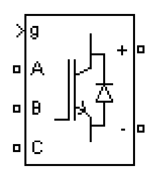
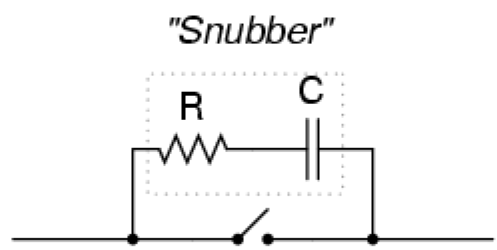


Fig Universal Bridge

The Universal Bridge block is the basic block for building two-level voltage sourced converters. The device numbering is different if the power electronic devices are naturally commutated or forced commutated.

SNUBBER RESISTANCE AND CAPACITANCE



Snubber resistance Rs, in Ohms. Set the snubber resistance parameter to inf to eliminate the snubbers from the model. Snubber capacitance Cs in farads. Set the snubber capacitance parameter to eliminate the snubbers or to get a resistive snubber. In order to avoid numerical oscillations when your system is discretized, you need to specify Rs and Cs snubber values for diode and thysistor bridges for forced commutated devices (GTO,IGBT or MOSFET), the bridge

Operates satisfactorily with purely resistive snubbers.

TUNING THE SNUBBERS

If firing pulses to forced –commutated devices are plocked, only antiparallel diodes operate, and the bridge operates as a diode rectifier. In this condition appropriate values of Rs and Cs must also be used. When the system is discretized, use the formulas to compute approximate values of Rs and Cs. These Rs and Cs values are derived from the following two criteria: The snubber leakage current at fundamental frequency is less than 0.1% of nominal current when power electronic devices are not conducting. The RC time constant of snubbers is higher than two times the sample time Ts. These Rs and Cs values that guaranee numerical stability of the discretized bridge can be different from values of a physical circuit. The switch can be protected against transient voltages by a RC network. This RC network is connected in parallel across the switch. It is called snubber circuit. The RC snubber circuit is very commonly used for protection of switch against transcient voltage.

CONCLUSION AND FUTURE WORK

This paper introduces a new converter called RSC for PV- battery application, particularly utility-scale PV- battery application. The basic concept of the RSC is use multi power conversion system to perform different operation modes such as PV to load (dc/ac), PV to battery (dc to dc) for solar PV systems with energy storage. The proposed solution requires is very attractive for PV battery application, because it improving efficiency and reducing cost, weight and volume.

The Incremental conductance Method is computes the maximum power and control directly the extracted power from the PV. In this method offers different good tracking efficiency, response is high and well control for the extracted power. The incremental conductance algorithm gives the optimum duty cycle as compare to Constant duty cycle control, to extract the maximum power from PV system. The model of multistage dc-ac converter with PV and MPPT algorithm has been successfully implemented, simulated in MATLAB/SIMULINK, carried out outputs and waveforms.

In phase2 this system will implement in hardware with MPPT algorithm programmed in microchip on PCB board.

REFERENCES

[1]. U.S. Department of Energy, “Solar energy grid integration systems-energy storage SEGISES),” May 2008.

[2]. H. Ertl, J. W. Kolar, and F. Zach, “A novel multicell dc-ac converter for applications in renewable energy systems,” IEEE Trans. Ind. Electron., vol. 49, no. 5, pp. 1048–1057,Oct. 2002.

[3]. M. Bragard, N. Soltau, R. W. De Doncker, and A. Schiemgel, “Design and implementation of a 5 kW photovoltaic system with Li-ion battery and additional dc/dc converter,” in Proc. IEEE Energy Convers. Congr.Expo., 2010, pp. 2944–2949.

[4]. W. Li, J. Xiao, Y. Zhao, and X. He, “PWM plus phase angle shift control scheme for combined multiport dc/dc converters,” IEEE Trans. PowerElectron., vol. 27, no. 3, pp.1479–1489, Mar. 2012.

[5]. N.Benavidas and P.Chapman, “Power budgeting of a multiple-input buckboost converter,”IEEE Trans. Power Electron., vol. 20, no. 6, pp. 1303–1309, Nov. 2005.

[6]. S. J. Chiang, K. T. Chang, and C. Y.Yen, “Residential photovoltaic energy storage system,”Trans. Ind. Electron., vol. 45, no. 3, pp. 385–394,Jun. 1998.

[7]. Z. Zhao, M. Xu, Q. Chen, J. Lai, and Y. Cho, “Derivation, analysis,and implementation of a boost-buck converter-based high-efficiency PV inverter,” IEEE Trans. Power Electron.,vol. 27, no. 3, pp. 1304–1313,Mar. 2012.

[8]. S. Jain and V. Agarwal, “An integrated hybrid power supply for distributed generation application fed by non conventional energy sources,” IEEE Trans. Energy Convers., vol. 23, no. 2, pp. 622–631, Jun. 2008.

[9]. L. Ma, K. Sun, R. Teodorescu, J. M. Guerrero, and X. Jin, "An integrated multifunction dc/dc converter for PV generation system," in *Proc.* IEEE Int. Symp. Ind. Electron. Jul. 2010, pp. 2205–2210.

[10]. R. Carbone, "Grid connected PV systems with energy storage," in Proc.Int. Conf. Clean Electr. Power, Jun. 2009, pp. 760–767.

Copyrights © International Journal of Intellectual Advancements and Research in Engineering Computations, www.ijiarec.com