

## **Study and Simulation of Grid Connected Solar System and its Power Control**

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**ABSTRACT:** Photovoltaic (PV) application has received a great attention in research because it appears to be one of the most efficient and effective solutions to most of the environmental problem. The conventional standalone photovoltaic systems have the advantages of simple system configuration and control scheme. In this, the single stage PV inverters are studied. For these single stage PV inverters, a transformer is used for boosting the input voltage or the input voltage will be required to be higher than the peak of the grid voltage.

### **I. INTRODUCTION**

With the worsening of the world's energy shortage and environmental pollution problems, protecting the energy and the environment becomes the major problems for human beings. Thus the development and application of clean renewable energy, such as solar, wind, fuel cell, tides and geothermal heat etc., are getting more and more attention. Among them, solar power will be dominant because of its availability and reliability. This at first presents a design for a single-phase grid-connected photovoltaic system which is an inverter design for grid-connected photovoltaic arrays. The solar array which is used for collecting solar radiation which gets further converted into ac power through ZVS topology of the inverter. Then through transformer it is given to ac to ac converter through filter section to Grid. In addition to that a controller is to be used in order to achieve the voltage regulation and meeting other power standards of the grid and to perform the power management between the system and the electrical grid.

A single-phase grid connected photovoltaic (PV) inverter for residential

application is presented. The high

efficiency can be achieved because the

switch operating at high frequency at a time, and the converter allows the use of power MOSFET. [7]. The conventional stand-alone photovoltaic systems have the advantages of simple system configuration and control scheme. However, in order to draw maximum power from PV arrays and store excess energy, battery banks are required in these systems. For high power systems, they will increase system cost and weight, and narrow the application areas. Therefore, grid-connected systems, which are designed to relieve this shortcoming, have become the primary researches in PV power supply applications. A control algorithm for a single-phase grid-connected photovoltaic system in which an inverter designed for grid-connected photovoltaic arrays can synchronize a sinusoidal current output with a grid. This paper presents modeling, controller design, and simulation study of a grid connected PV system. In order to synchronize the simulated inverter to the grid the waveforms from the grid are applied to the pulse width modulation (PWM) input and drive appropriately the inverter's MOSFET's. [3]. The proposed scheme is as under.

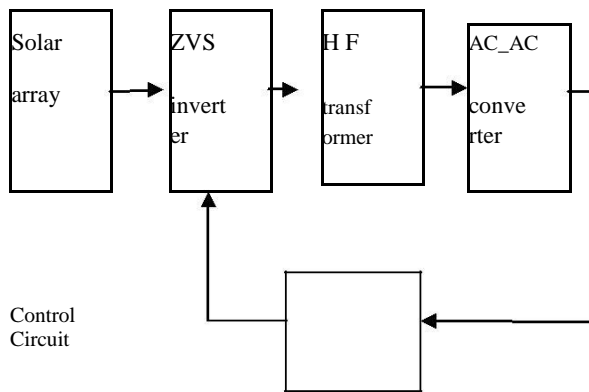


Fig : Block diagram of the scheme.

Solar Array will convert the solar energy into the electrical energy. The output of the solar array is dc power. The o/p of the solar array is then given to the inverter (ZVS topology), It will convert the dc power into the ac power. Then the ac power through the inverter is stepped up through high frequency transformer. AC-AC Converter will reduce the frequency of the ac power. Grid is the system with voltage current and limited harmonics limit is defined by the utility company. Then this power filtered by the filter section is given to the grid. There will be the controller which will control the firing pulses of the MOSFETS according to the power output to the grid.

to no-load condition. The converter employs an asymmetric auxiliary circuit to provide the reactive current for the full-bridge semiconductor switches, which guarantees ZVS at turn-on times. The proposed control scheme is able to determine the optimum value of the reactive current injected by the auxiliary circuit in order to minimize extra conduction losses in the power MOSFETs, as well as the losses in the auxiliary circuit. In this proposed approach, the peak value of the reactive current is controlled by controlling the switching frequency to make sure that there is enough current to charge and discharge the snubber capacitors during the dead time. [1]

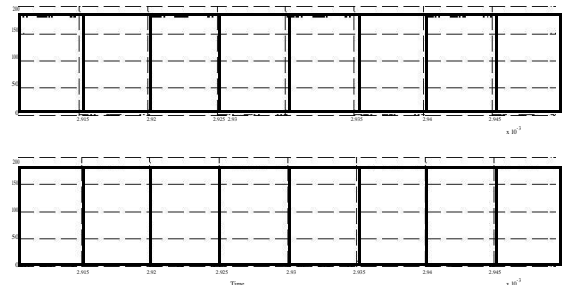


Fig : Triggerring Pulses to MOSFET 1 and 2

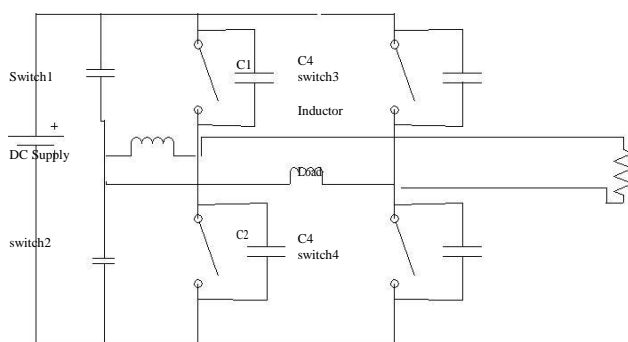


Fig : circuit diagram for ZVS inverter.

A load adaptive control approach to optimally control the amount of reactive current required to guarantee zero-voltage switching (ZVS) of the converter switches. Since there application demands a wide range of load variations, the converter should be able to sustain ZVS from full-load

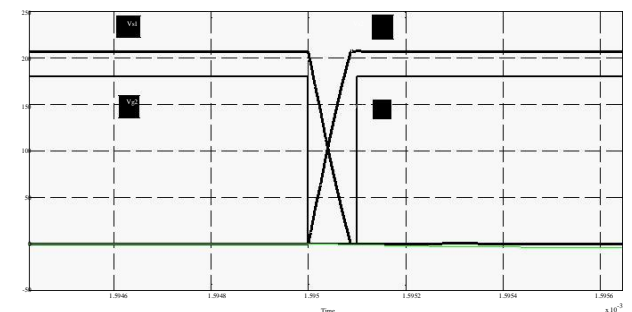


Fig: Voltages across two switches and gate pulses showing ZVS

### PV Array Mathematical Model and Implementation

The modules in a PV system are typically connected in arrays in series and parallel configurations. Electrical modeling of suggested PV array system is represented in the following equations.

$$V_{PV} = \left( \frac{B \times K \times T \times N_S}{q} \right) \times \ln \left( \frac{N_P (I_L + I_{os}) - I_{PV}}{N_P \times I_{os}} \right) \quad (1)$$

$$I_{os} = I_{or} \left[ \frac{T}{T_r} \right]^3 \exp \left( \frac{q E_{GO}}{BK} \left( \frac{1}{T_r} - \frac{1}{T} \right) \right) \quad (2)$$

$$I_L = [I_{sc} + K_I (T_c - 28)] \times \frac{H}{1000} \quad (3)$$

$$T_c = T_{air} + 0.2 \times H\% \quad (4)$$

Where,  $VPV$  is the PV array output voltage (V),  $IPV$  is the PV array output current (A),  $NS$  is the number of cells connected in series,  $NP$  is the number of cells connected in parallel,  $IL$  is the light generated current (A),  $Ior$  is the reverse saturation current ( $19.97 \times 10^{-6}$ ),  $B$  is the ideality factors (1.92),  $K$  is the

Boltzmann's constant ( $1.38 \times 10^{-23}$  joule/ $^{\circ}K$ ),  $q$  is the electronic charge ( $1.602 \times 10^{-19}$  coulomb),  $Tr$  is the reference temperature ( $301^{\circ}K$ ),  $Ios$  is the cell reverse saturation current (A),  $Tc$  is the cell temperature ( $^{\circ}C$ ),  $T$  is the cell temperature ( $^{\circ}K$ ),  $KI$  is the short-circuit current temperature coefficient ( $0.0017$  A/ $^{\circ}C$ ),  $H$  is the cell illumination ( $W/m^2$ ),  $ISC$  is the module short-circuit current at  $28^{\circ}C$  and  $1000$   $W/m^2$  (4.8 A),  $EGO$  is the band gap for silicon (1.11 e.v). The simulation of the solar module has been done.

## MPPT Techniques

In the incremental conductance method, the controller measures incremental changes in array current and voltage. This method utilizes the incremental conductance ( $dI/dV$ ) of the photovoltaic array to compute the sign of the change in power with respect to voltage ( $dP/dV$ ). This method exploits the assumption of the ratio of change in output conductance is equal to the negative output Conductance Instantaneous conductance.

We have

$$P = V I \quad (1)$$

Applying the chain rule for the derivative of products yields to

$$\frac{dP}{dV} = \frac{d(VI)}{dV} \quad (2)$$

$$\text{At MPP, as } \frac{dP}{dV} = 0 \quad (3)$$

The above equation could be written in terms of array voltage  $V$  and array current  $I$  as

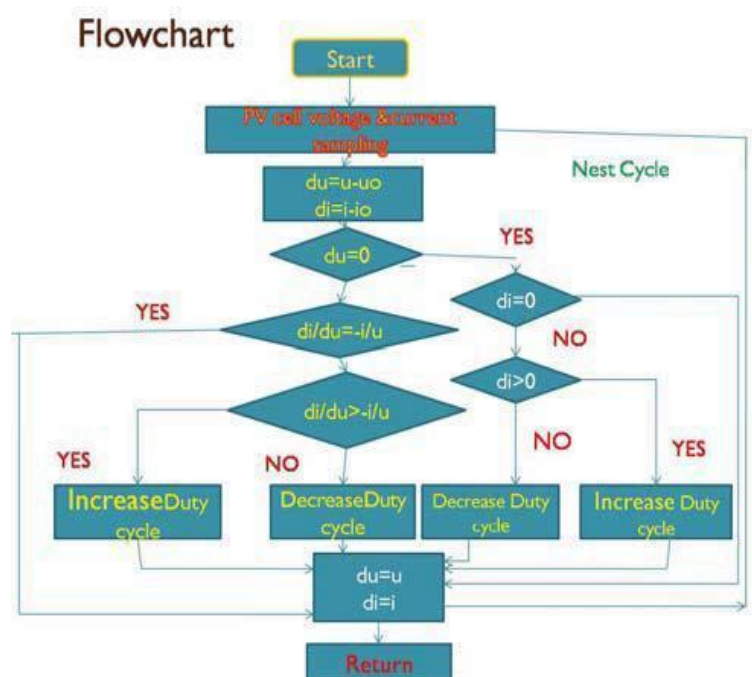
$$\frac{dI}{dV} = -I/V \quad (4)$$

The MPPT regulates the PWM control signal of the dc – to – dc boost converter until the condition:

$$\left( \frac{dI}{dV} \right) + (I/V) = 0 \quad (5)$$

is satisfied. In this method the peak power of the module lies at above 98% of its incremental conductance.

The Flow chart of incremental conductance MPPT is shown below.



The proposed MPPT algorithm is called Incremental conductance Method. However, by using this MPPT method we have increased efficiency by 44%. This method compute the maximum power and controls directly the extracted power from the PV. The proposed method offers different advantages which are: good tracking efficiency, response is high and well control for the extracted power.

## II. CONCLUSION

This will fulfill the energy deficiency in India. This will help to reduce the pollution factor from the atmosphere. Hence it is beneficial & eco friendly mission. In order to construct a PV grid connected system, a number of parameters have to be taking into account and to be optimized in order to achieve maximum power generation. The controller has to be used in order to achieve the synchronization to the grid and to perform the power management between the system and the electrical grid. Moreover, this study shows that the proposed control scheme offers a simple way to study the performance for utility interface applications. It is simple to implement and capable of producing satisfactory sinusoidal current and voltage waveforms. To get better power quality, other control schemes for different inverter configurations and topologies are suggested.

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