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# Non-Linear Load Control for Grid-Connected Single-Phase Inverters with Voltage Regulation

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**Abstract:** This study focuses on the advancement of sustainable energy sources. This project aims to provide a functional simulation model of a solar panel with SIMULINK within the MATLAB environment. The primary aim is to integrate renewable energy principles and control systems to enhance the quality and quantity of power produced from solar and wind sources. The electricity derived from solar and wind energy sources typically operates within a specific range. However, the integration of solar and wind energy sources, together with the use of power electronic converters, is expected to result in increased quantity and enhanced efficiency of the generated electricity. By integrating the generated electricity with a smart grid system, both the customer and the producer will benefit and experience satisfaction. Keywords: PV System, Boost converter, Inverter, Filter, Grid synchronization, non-linear loads

## INTRODUCTION

Solar Power is generated from sunlight. Solar power is used in 2 ways.1) Active solar power 2) Passive Solar Power [1]. Active solar energy is used effectively in such Activities as washing clothes and heating air. Modern technology has offered several ways of utilizing these existing resources [2]. In present days because of technological improvement people are using Maximum power extracting from the Rotating solar panel by using Light dependent resistor[3]. Solar power is just a DC power source. It is important to have some basic level of knowledge on P-N junction diode working to know the complete working mechanism of photo voltaic effect[4].

In olden days, wind energy was used as a source to get the sailing boats sailed based on the direction of wind[5]. The generator present in the wind turbine generates an alternating current (AC). Some turbines contain an AC to DC converter[6]. DC current is converted from alternating current through a rectifier

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and then again back to alternating current through an inverter. The main function of this is to synchronize the frequency and the phase of grid[7].

## 1. BOOST CONVERTER

The control of the maximum power point, as stated in the introduction[8], is basically a problem that suits the load. To change the panel's input resistance to match the load resistance, if a DC – DC conversion process (using buck converter) is needed (by adjusting duty cycle)[9]. The Buck conversion efficiency has been studied to be peak for a DC – DC conversion process converter, so a buck-boost converter and minimal for a boost converter[10], but as we intend to use our system either for grid joining or for a pumping stations system that requires 230 V at the ends of a production, we are using a boost converter [11].

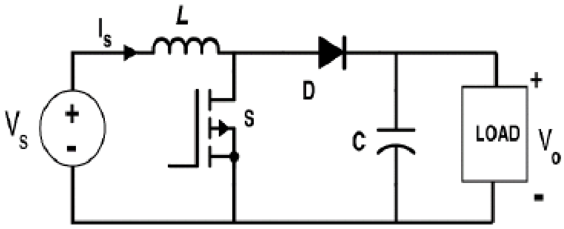


Fig 1: Circuit diagram of a Boost Converter

Mode 1 of the Boost Converter process: Whenever the switch is activated, the inducer is charged, and the energy is stored through the battery[12]. In this mode the inductor current rises (exponential rate), so we assume that the inductor charging, and discharge is linear for accuracy[13]. The diode prevents the current from flowing and therefore the charge current remains static due to the discharge of the condenser[14].

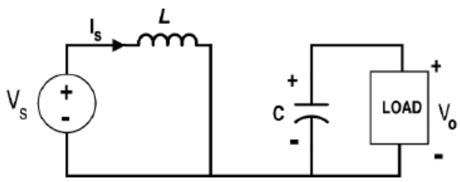


Fig 2: Mode I operation of boost converter (DC – DC)

Mode II of the Boost Converter process: Available Type II [15]the button exists disconnected as well as therefore a diode short circuited[16]. Power supply collected around the inducer is released by reverse polarity from condenser. The flow current of load stays steady during service[17].

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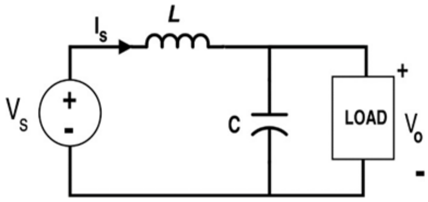


Fig 3: Mode II operation of Boost Converter

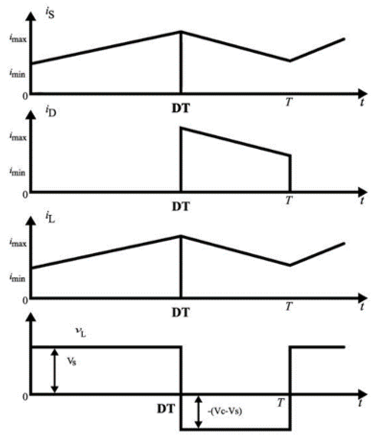


Fig 4: Boost converter waveforms IVGRID CONNECTED INVERTER

An electronic control system [18]or circuitry is a power inverter or inverter that converts direct current (DC) to AC[19]. Input voltage, output voltage and frequency voltage as well as overall power handling depend on the specific device or circuit model [20].

An electrical grid is a network that is interconnected to provide power to customers from producers [21]. This consists of the following things as shown in Fig:5. 1) generating stations supplying electrical power; 2) [22] electrical substations for stepping up electrical voltage for transmission; or down for distribution; 3) high-voltage transmission lines carrying electricity[23] from remote sources to demand centers; 4) distribution lines linking individual customers; 5) Power stations can be placed[24].

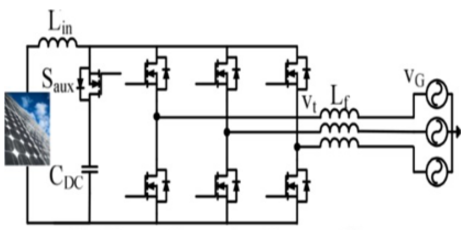


Fig 5: Block diagram of Grid connected inverter.

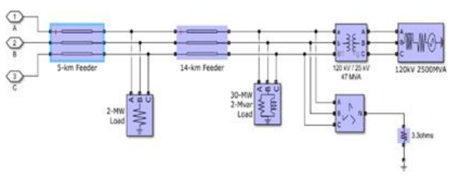

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Fig6: Electrical grid simulation.

**Characteristics of different MPPT techniques are listed in table1.**

| MPPT Technique | Convergence speed | Implementation Complexity | Peridic Tuning | Sensed Parameters |
|---|---|---|---|---|
| Perturb & observe | Varies | Low | No | Voltage |
| Incremental Conductance | Varies | Medium | No | Voltage, Current |
| Fractional Voc | Medium | Low | Yes | Voltage |
| Fractional Vsc | Medium | Medium | Yes | Current |
| Fuzzy logic control | Fast | High | Yes | Varies |
| Neural Network | Fast | High | Yes | Varies |

### 1.1 Perturb & Observe Algorithm:

This Perturb & Observe algorithm notes of photovoltaic plates operational energy disturbed little bit increase, so this resultant energy shift also +ve, so these are heading in this way of MPP as well as those are continuing to disturb in this usual way. In case ΔP is -ve, we're leaving this path of the maximum power point identifications are disturbance given must be changed [25].

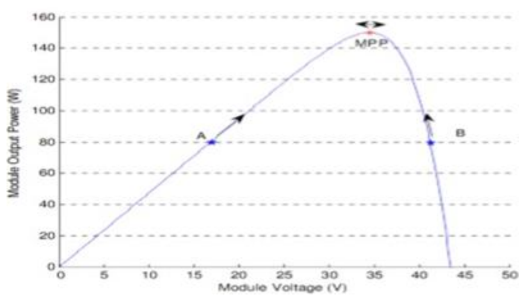


Fig 7: PV Curve with MPPT point conditions.

Attributes of the solar panel display MPP and A and B working points shown in fig 7. This displays the graph of output energy to the battery versus voltage of the part at a given irradiation For a Sun Table.

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The point marked as MPP is the maximum power point, which is the maximum theoretical performance of the PV table. Taking both A & B 2 stages of action. As illustrated above figure, point A is on the MPP's left side. We can therefore shift towards the MPP by supplying the voltage with a positive trading Point B, meanwhile, MPP's on the right - hand side. After we are giving a +ve perturbation, the half-p value is negative, therefore it is imperative to change the direction of perturbation to achieve MPP. Below is the flowchart for the P&O algorithm shown in fig 8.

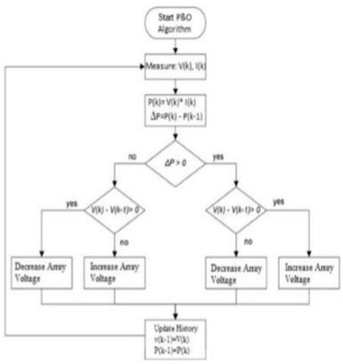


Fig 8. Flowchart of Perturb & Observe algorithm

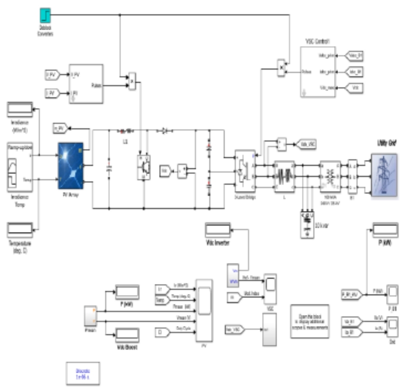

Fig 12: Simulink diagram

The fig 12 represented above shows the circuit simulation of PV- array module works along with the combination of closed loop path program.

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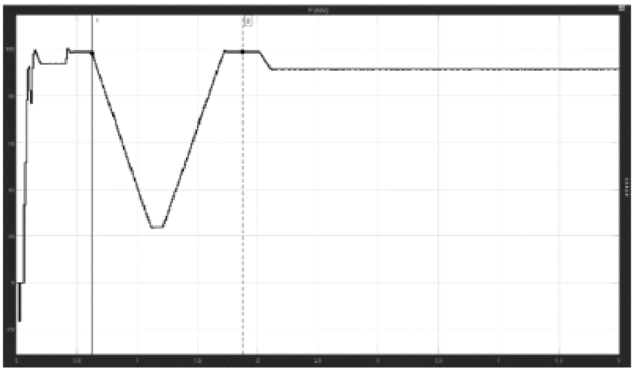

Fig 13. Output Power

The above graph fig13 represents the output wave form of power at the ending terminals of the inverter connected in series to the grid. The photovoltaic production energy is varied by varying those two inputs of the panel i.e., (Irradiance and temperature)

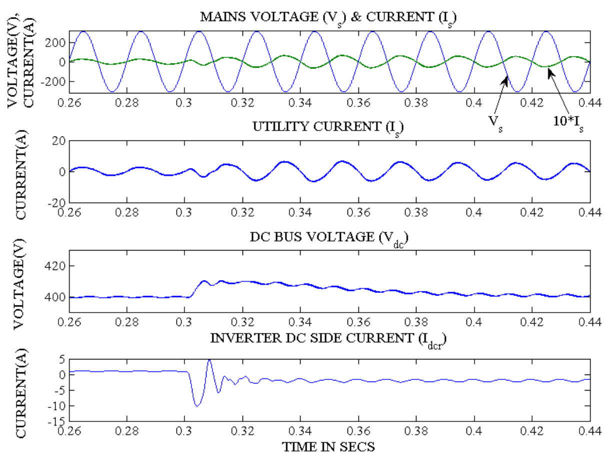


Fig: 14 Output waveforms, Current, voltage

From the output waveforms output voltage and current out of phase from 0.32 to 0.44 sec before that voltage and current are in phase ie power taking from the grid. DC bus voltage 400V.

## CONCLUSION:

In this paper, we examined how a solar inverter that is connected to the grid works. The control is the output from the PV panel such that utilising the closed loop path from the control systems. Two basic control difficulties have been explored. The second type of control that we might implement is the control of output power from the inverter based on the simulation, and if the inputs of that solar panel were made constant using the MPPT approach. Therefore, the output power could be kept constant by employing these two control approaches, the load demand could be satisfied while keeping the necessary power quality, and the dependability of renewable energy sources could be increased.

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