Performance of Three Phase Grid Connected Inverter for Low Voltage Weak Grid System Using Super Lift Luo Converter

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Abstract— The implementation of a Fuzzy logic based PV grid system with reactive power compensation. Ina Fuzzy logic controller and inverter based system and MATLAB is used to perform simulation analysis. The solar system provides voltage to the inverter through super lift Luo converter with fuzzy based MPPT algorithm .This converter will reduce ripple contents in the voltage and maintain the constant voltage to the inverter system The three phase voltage source inverter will convert the constant DC voltage into two level AC output voltage .This AC voltage is given to the grid, the PV system reduces the PQ problems in the grid. As it can be placed near to the load centers when compared with other renewable souce of generation. A maximum power point is tracked using Super Lift Luo Converter with variation in the irradiations all throughout the year This paper proposes theory based current controlled PWM controller for the voltage improvemen. Low THD synchronized current output, and limited reactive power compensations are improved. MATLAB based simulation results shows the efficient working of rooftop PV with proposed control methodologies in grid connected mode with limited reactive power conditioning. This project is implemented in MATLAB simulation and experimental results.

Keywords: Fuzzy logic controller, Photovoltaic Cells, Super Lift Luo Converter, maximum power point Tracking

I. INTRODUCTION

The modified output Luo converter (MOLC) is a DC-DC converter, derived from the positive output Luo converter. In place of two switches in the positive output Luo converter, the modified topology uses a single switch to perform the same action. The re-lift configuration of the topology is derived from the self-lift configuration to perform a DC-DC step up voltage conversion, double of that of a boost converter with application of a single switch. detailed analysis of the positive output Luo converter with re-lift configuration has been presented. A two stage grid integrated solar photovoltaic (PV) system has a DC-DC converter as its first stage and a DC-AC converter as its second stage. The DC-DC converter stage has PV array at its input side and the output is coupled through a de-coupling capacitor to the DC-AC conversion stage. The output of the DC-AC converter is fed to the grid through a ripple filter Diverting a sizeable renewable power into grid becomes a policy decision adopted by several developed. Focus has been placed in the development of efficient and low cost power conditioning units to serve as interface between the PV array and the utility grid. A typical system block diagram for a grid connected system with electrical isolation. In order to connect an inverter to the grid the generated power has to agree with the standards given by utility companies. The limitation on maximum amount of injected harmonic current into the grid at point of common coupling (PCC).

II. THESIS ORGANIZATION

The double-stage topology has low power transfer efficiency due to additional losses in the boost converter. The parallel operation of two single-stage solar PV system is modelled and analysed in to improve the power quality of the distribution network along with droop characteristics. The ideal magnitude and phase characteristics of notch filter make it complex in real-time implementation of solar PV grid interfaced system. Moreover, sensitive performance parameters variations of the system make it least feasible for the practical applications of solar PV grid interfaced system.

III. PV SYSTEM

In 1839, a French physicist Edmund Becquerel proposed few materials have the ability to produce electricity. When he exposed to sunlight. But Albert Einstein explained photoelectric effect and the nature of light in 1905. Photoelectric effect state that the photons or sunlight strikes to a metal surface flow of electrons will take place. Later photoelectric effect for the technology of photovoltaic power generation. The first PV module was manufactured by Bell laboratories in 1954.

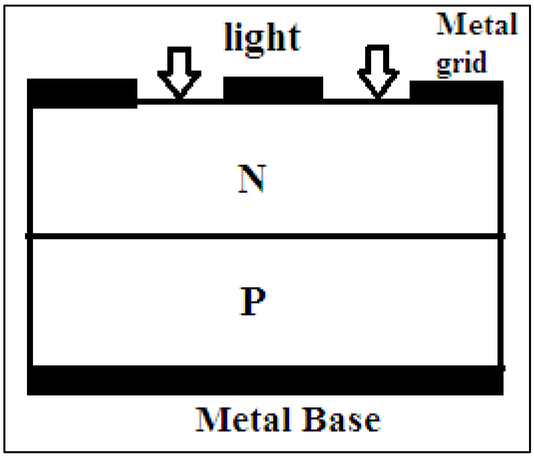

Fig. 1. Structure of PV Cell

IV. PV CELL

Photovoltaic cell is the building block of the PV system. The semiconductor also block of the PV system. Silicon is used for photovoltaic cell due to its advantages over germanium. When photons hit the surface of solar cell, the electrons and holes are generated by breaking the covalent bond inside the atom of semiconductor material and in response electric field is generated by creating positive and negative terminals. When these terminals are connected by a conductor an electric current will start following.

strings are connected in parallel order to produce more current based on the requirement.

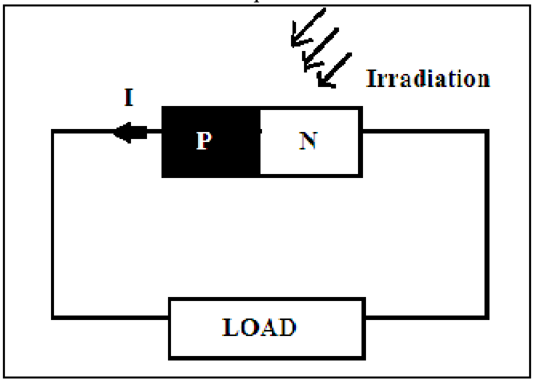

Fig. 2: Working of PV Cell

V. PV MODULE

A single cell generate very low voltage, so more than one PV cells can be connected either in serial or in parallel or as a grid (both serial and parallel) to form a PV module. We need the higher voltage connect PV cell in series and if load demand is high current then we connect PV cell in parallel. In general PV modules are 36 or 76 cells. But we are using only 54 cells. The front side of the module is transparent. There are buildup of low-iron and transparent glass material. And the PV cell is encapsulated. The efficiency of a module is not good as PV cell, because the glass cover and frame reflects some amount of the incoming radiation.

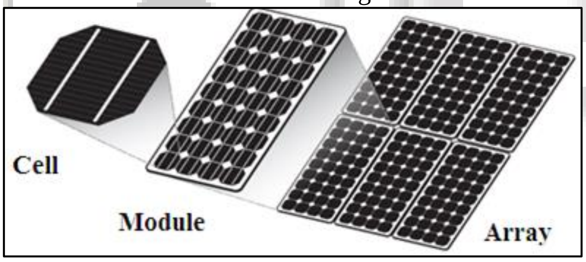

Fig. 3: Photovoltaic System

VI. PV ARRAY

A photovoltaic array is simply an interconnection of several PV modules in series and parallel. The power generated by individual modules. May not be sufficient to meet the requirement of trading applications. So the modules are secured in a grid form an array to gratify the load demand. In an array, the modules are connected like as that of cells connected in a module. While making a PV array, generally the modules are initially connected in serial manner. To obtain the desired voltage and the

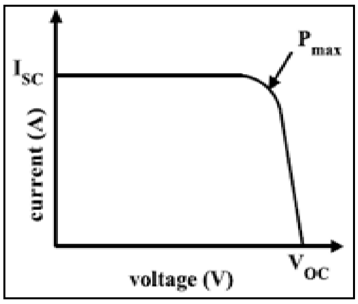

Fig. 4: IV Characteristics

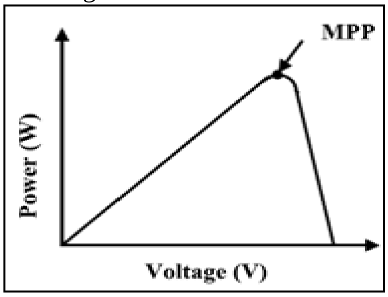

Fig. 5: PV Characteristics

VII. MAXIMUM POWER POINT TRACKING

The current perturbed MPPT algorithm moves the operating point toward the MPP by increasing or decreasing the output current of the PV array. The current through the inductor is the quantity to be controlled here according to the reference current generated from MPPT controller. In current perturbed MPPT algorithm, PV voltage (ripple voltage across PV output capacitor is assumed to be negligible) and inductor current are sampled with predetermined sampling time[8]and compute power supplied by the PV panel in each iteration which compared with previous iteration so as to reach MPP for different insolation and temperature. In the Power Vs Voltage characteristic of a PV. we can observe that there exist single maxima. Maximum power point associated with a specific voltage and current are supplied. The overall efficiency of a module is very low around 13%. So it is necessary to operate the crest power point .so that the maximum power can be provided to the load irrespective of continuously changing environmental conditions. This increased power makes better for use of the solar PV module. A DC to DC converter which is placed next to the PV module extracts maximum power by matching the impedance of the circuit to the impedance of the PV module and transfers it to the load. Impedance matching can be done by varying the duty cycle of the switching elements.

A. Incremental conductance

This algorithm, shown below, compares the incremental conductance to the instantaneous conductance in a PV system. Depending on the result, it increases or decreases the voltage until the maximum power point (MPP) is reached. Unlike with the P&O algorithm, the voltage remains constant once MPP is reached. Maximum PowerPoint tracking (MPPT) algorithm is used to track the optimum power from the PV panel and a grid side control ensures the effective power transfer to the grid. Following claims are made in this paper,

1) The detailed analysis of the OLC with re-lift configuration is not found in the literature. This paper presents this analysis with the derivations of the related equations.
2) A possible application of this converter as a first stage of a transformer-less grid integrated solar PV system is suggested. The high gain of this converter enables a transformer-less operation.

MPPT Algorithm	PV array Dependent	Digital or Analog	Convergence speed
Perturbation and Observation	N	B	V
Incremental Conductance	N	D	V
Fractional Open Voltage	Y	B	M
Fuzzy Logic Control	Y	D	F
Neural Network	Y	D	F

Table 1: Main characteristics of different MPPT techniques

VIII. FUZZY CONTROLLER

The inputs are most crisp measurements from some measuring equipment rather than linguistic. A preprocessor condition measurement before they enter the controller. Examples of preprocessing are,

- Quantisation in connection with sampling or rounding to integers.
- normalisation or scaling into a particular, standard range.
- filtering in order to remove noise.
- averaging to obtain long term or short term tendencies.
- a combination of several measurements to obtain the key indicators.
- differentiation and integration or their discrete equivalences.

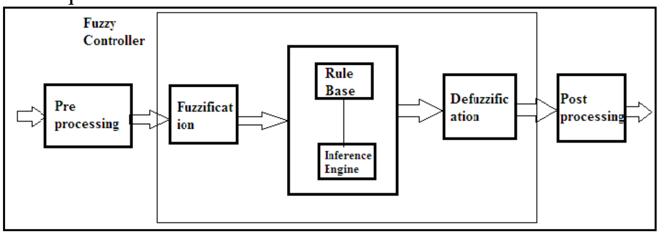

Fig. 6: Fuzzy Controller Block Diagram

In an effort to improve performance. Some instrumentation manufacturers are exploring the value of using "fuzzy logic" for process control. Individual sections address

- PID challenges
- Introduction to fuzzy logic for control
- PID plus adaptive fuzzy logic

IX. SUPER LIFT LUO CONVERTER

The Voltage Lift technique has a very high boosting ability. It successfully applied in the design of DC-DC converters. In the first-generation converters, the output voltage increases in an arithmetic progression. The Luo series super lift converters have a unique approach. The super lift technique is allows output voltage to increase geometrically. This effectively increases the voltage transfer gain.In this work, positive output Super-Lift Luo Converter will be used. Each circuit in the baseline has a switch S; one inductor L1; two capacitors C1, C2 and two diodes. The duty-cycle is expressed as d, switching frequency as f and resistive load as R. If we assume an ideal system in which no power loss occurs as a result of the switching operation

$$V_{IN} / I_{IN} = V_O / I_O \tag{1}$$

where V_{IN} and I_{IN} are input and V_O and I_O are output voltage and current values respectively.

When S switch is closed, the inductor L is charged. When the PV output current flows through inductor L, it is proportional to duty cycle, d. Therefore, C1 is charged with V_{IN} voltage. After this stage, the switch is open (1– d)T and charged voltage discharges over the load $-(V_O - 2V_{IN})$. Hence, the inductor current ripple Δi_L can be calculated using

$$I_N = V_{IN} / L_1 dt = V_0 - 2V_{IN} \tag{2}$$

Voltage output and the gain can be calculated using the equation below

$$G = V_0 / V_{IN} = (2\text{-}d) / (1\text{-}d) \tag{3}$$

DC gain of the Super-Lift Luo Converter as a function of duty cycle. It is clearly seen that the SLLC has very high gain compared to other DC-DC converter types. The operating point of the converters indicated as a red dot.

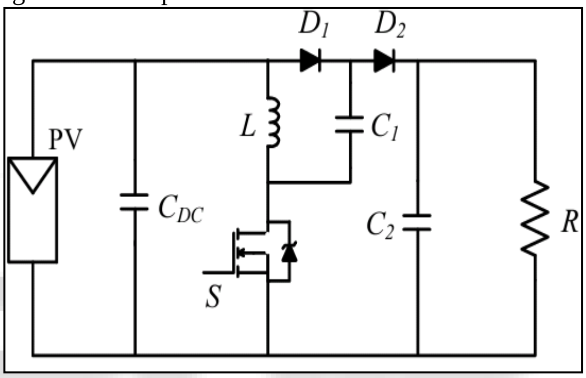

Fig. 7: Proposed Circuit Diagram

X. SYSTEM SIMULATION RESULTS

The converter system was simulated using converter. Switches and passive circuit elements are assumed ideal. The system proposes a topology which includes an array of PV panels followed by a Super Lift Luo DC-DC converter which has an MPP tracking for PV applications, after that the output of the converter is connected to the 3-ph inverter controlled by P-Q controller. The inverter is connected to grid using a low-pass filter. It is observed that SLLC is applicable to the grid-connected PV generation systems due to their gain stability and ease of control. Also, the structure of the converter is robust to the fluctuations caused by the AC side. The SLLC is a suitable converter, which tracks the MPP and boost the input Voltage.

The proposed new control on PV solar system will help accomplishing the following objectives:

- Increasing the utility of the Rooftop Solar PV system
- Power Factor improvement through reactive power compensation
- Incentives from the Utility for maintaining power factor near to unity MPPT fails to provide required results

when there are changes in irradiations. Re Boost Luo Converter provides a better alternative to MPPT controller when the irradiations are varied throughout the year. This system has implemented in Matlab.

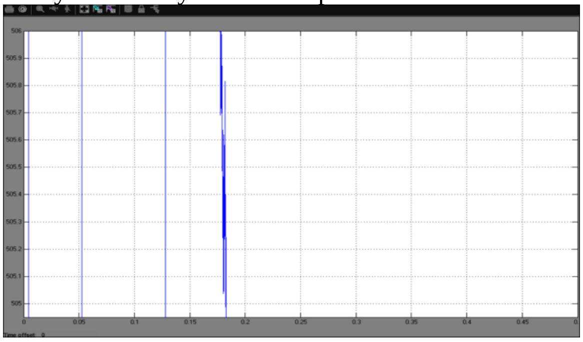

Fig. 8: Battery Output

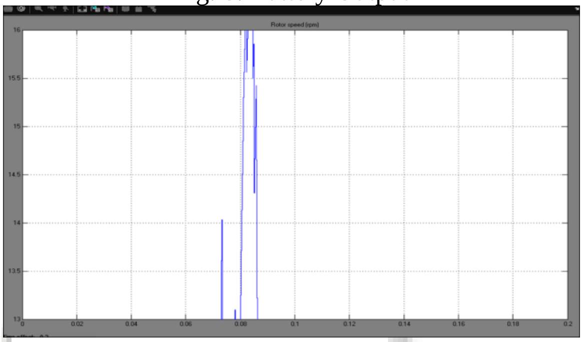

Fig. 9: Output Voltage Using Fuzzy Controller

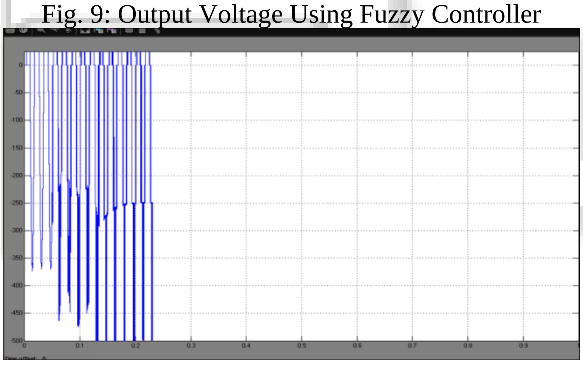

Fig. 10: Inverter Voltage Output

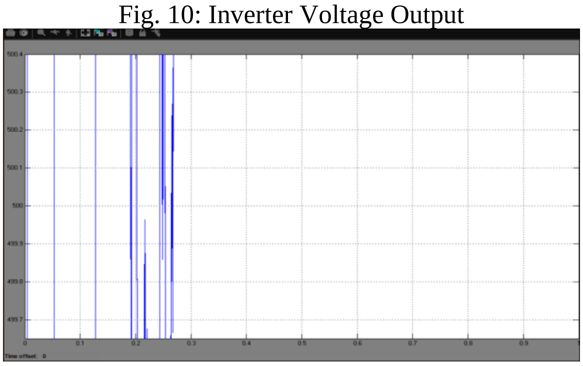

Fig. 11: Constant Output Voltage

XI. Conclusion

In this paper,a three-ph grid-connected inverter utilizing a Super Lift Luo converter was simulated. It can be observed that the high gain output of the SLLC is applicable for the systems which require high DC input voltage. Also due to the circuit topology, AC ripple can be reduced easier compared to the other first-generation DC-DC converters [13-14].The simulation of the SLLC which is connected to well-known 3-ph H-bridge VSI topology shows that the voltage source system is suitable for grid-connected PV applications. A small DC link capacitor can be used in systems using SLLC, without complex control techniques. It is observed that the proposed design can be applied for both PFmicro generation and solar power plant systems due to high efficiency, low PF and ease of design and application.

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