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CONTROL OF Z-SOURCE INVERTER USING ADVANCED FUZZY LOGIC CONTROL FOR PV SYSTEM APPLICATIONS

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Abstract

The Z-source inverter (ZSI) has some advantages and suitable for all the Photo Voltaic (PV) system. This paper deals with a new topology for all ZSI with battery for PV power generation and distribution system. Thus the battery is connected parallel to one of the capacitors in Z-Source (ZS) network, instead of involving an additional DC/DC converter. This system builds all the advantages of ZSI. The operating principle of the new topology is designed and the design scheme of the ZS network is explained and also closed-loop control strategy for the proposed system is analyzed to manage the three power flow of PV panel, grid, and battery in the system. Maximum Power Point Tracking (MPPT) has been implemented in the ZSI with battery based PV system by using the proposed control strategy. Different modes of operation are simulated. Simulation for this proposed system using fuzzy logic control technique is completely analyzed through the MATLAB/SIMULINK software.

Keywords*:* VSI, CSI, ZSI, Fuzzy Controller, Photovoltaic Cell.

1. INTRODUCTION

Photovoltaic (PV) power is one of the most advance new energy management sources, and the power converter plays a major role in the PV power generation and distribution system. The output of PV battery varies a lot under different load conditions, so the system needs extra DC/DC convertor to keep the output part as a stable one. However, the DC/DC convertor will increase the cost of the system, reduce the efficiency, also the traditional voltage-source inverter and current source inverter may appear shoot-through state and reduce the system operation, reliability, increased losses, reduce the efficiency of the system while introducing the dead band will cause output waveform distortion. This paper analyzes a novel inverter Z-source inverter (ZSI), it has only once power transformation, but can have a major boost and buck the input voltage to meet the wide variation of PV battery output.

1.1 Block diagram of a proposed method

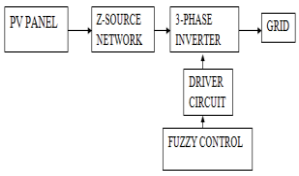

Figure: 1 Block diagram of proposed method

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The above block diagram explains the overall operation of the proposed method. Here the sunlight falls on the PV panel and further the operation continues to the Z-Source Inverter. Then output from the PV panel will observe as DC and the involvement of the inverter operation DC is converted into AC. Further the operation of the inverter is controlled by the advanced fuzzy logic and the driver circuit controls the operation of fuzzy and finally the system is connected to the grid in order to attain a greater performance.

2. SYSTEM DESCRIPTION

2.1 Advanced fuzzy logic description

An uncertain approach that combines real values and logic operations is referred to as Fuzzy Logic. A branch of logic that uses degrees of membership in sets rather than a strict true/false membership. A quantified framework to deal with the imprecise nature of the real world where conventional mathematical equations become intractable. Fuzzy Logic is a Tool for Embedding Human Structured Knowledge (Experience, Expertise**,** and Heuristic). Fuzzy is a way to model expert's knowledge which are often imprecise in nature. Human reasoning is approximate, non- quantitative, linguistic, Model inconsistent and conflicting opinions of multiple experts. Conflict opinions can co-exist. It has an ability to deal with uncertainties, and unstructured knowledge.

2.1.1 Fuzzy membership values

Fuzzy sets are functions that map each member in a set to a real number in [0, 1] to indicate the degree of membership of that member. Membership values (in fuzzy sets) are indicated by a value in the range [0.0, 1.0], with 0.0 representing absolute Falseness and 1.0 representing absolute Truth. The membership function μ is a mapping from each element x in the universal set X to a real number.

Crisp set – c: X ∈ {0, 1} (two elements)

Fuzzy set – μ: X ∈ [0,1] (an interval)

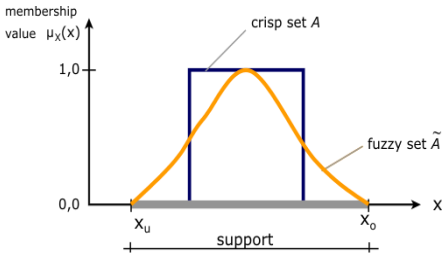

Figure: 2 Diagram for fuzzy membership values

2.1.2 Systematic description for fuzzy controller

Fuzzy consist of an input stage, a processing stage, and an output stage. The input stage maps sensor or other inputs, such as switches, and so on, to the appropriate membership functions and truth values. The processing stage invokes each appropriate rule and generates a result for each, then combines the results of the rules. Finally, the output stage converts the combined result back into a specific control output value.

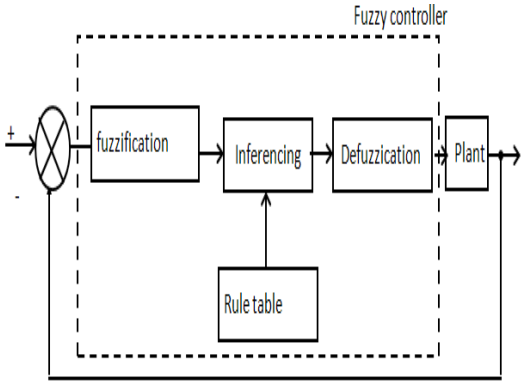

Figure: 3 Block diagram for fuzzy controller

2.2 Description of Z-source inverter

Z-Source Inverter source can be either a voltage source or a current source. The DC source of a Z-Source Inverter can either be a battery, a diode rectifier or a thyristor converter, a fuel cell stack .The main circuit of a Z-Source Inverter can either be the traditional VSI or the traditional CSI. It can work as a buck-boost inverter. The load can either be inductive or capacitive or Z-Source network.

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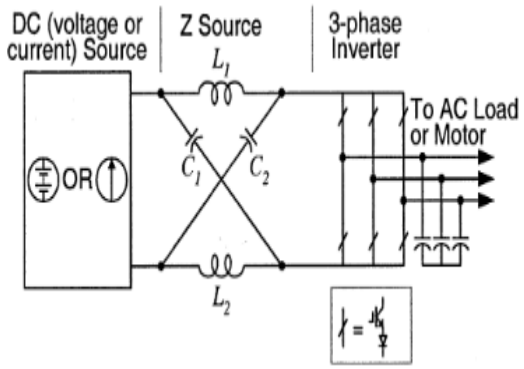

Figure: 4 Representation for Z-source inverter

3. SIMULATION AND RESULTS

3.1 Simulation for proposed method

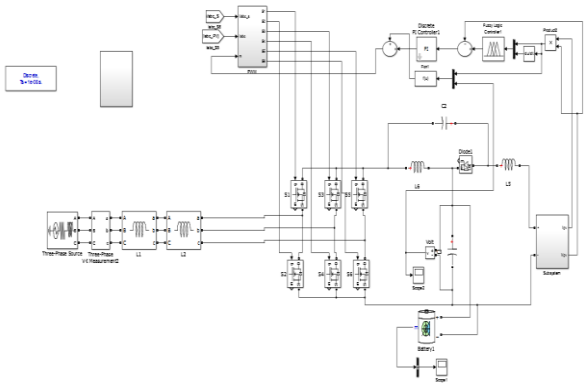

Figure: 5 Simulation diagram for proposed method

The above figure shows the simulation for new method described and it involves the output for load voltage, load current and also shown the THD for the output current.

3.1.1 Simulation for pulse generation

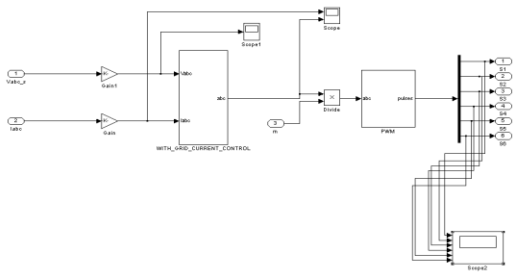

Figure: 6 Simulation diagram for pulse generation

The above figure shows the simulation for the pulse generated for six switches and by using the above simulation technique the pulses are generated for six switches that were used in the proposed method.

3.2 Output waveform

3.2.1 Load current

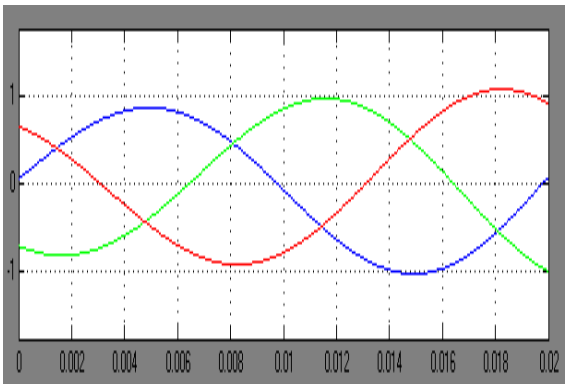

Figure: 7 Waveform for load current

The above three phase sine waveform shows the waveform generated for the output current and hence the THD analysis shown in the load current that was achieved very well.

3.2.2 Load voltage

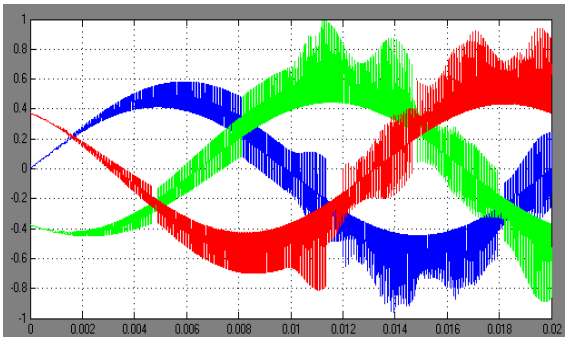

Figure: 8 Waveform for load voltage

The above figure shows for the waveform generated for the output voltage that was shown in proposed technique and this waveform shows that by using Z-Source Inverter it attains both the buck and also boost operation.

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3.2.3 THD analysis

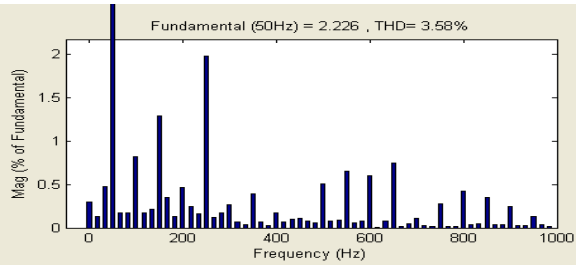

Figure: 9 THD analyses for proposed controller.

The above figure describes the THD analysis of the proposed technique and it deals with the output current. From this THD analysis the proposed method attains the minimum amount of switching losses, good linearity in the output region and also efficiency was attained to its greater level. Therefore the THD achieved is shown as 3.58%.

4. CONCLUSIONS

Thus the control of Z-Source Inverter using Advanced Fuzzy Logic Control For PV System Applications has the new concept for building a several advantages for easy handling in all applications and also with low cost with minimum loss measures by analyzing with the Total Harmonic Distortion. Finally THD is achieved at 3.58%, which shows the expensive performance of the overall system.

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