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Grid Tied PV system with Trans-ZSI based AC Load by using Fuzzy Logic Controller

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Abstract

Now-a-days the power generation using renewable energy sources has gained attention. Here the power generation is done using solar energy. Solar based microgrid can be operated in isolated mode (DC grid) and can be integrated with AC grid. Generally, PI controller is used at the Boost converter at DC side and at Inverter at AC grid side. But due to the manual tuning problems in PI controller, here fuzzy controller is proposed. To integrate the PV system to AC grid, Trans-ZSI is used. It reduces the circuit complexity by eliminating both boost converter and inverter at grid. The system is simulated for fuzzy controller for both cases 1) Boost converter at DC grid side and 2) Trans ZSI at AC grid.

Keywords: Photovoltaic (PV) power system, DC grid, Boost Converter, Fuzzy logic controller (FLC), Trans-ZSI.

1. INTRODUCTION

The pv standalone system can be operated as DC grid or can be integrated to AC grid using the Inverter circuit. The DC grids are used for the HVDC transmission and AC grids are used for integrating various renewable energy sources.

Due to partial shading of PV array MPPT technique is used to obtain the maximum power from pv and array and to give the duty cycle to the boost converter. Generally, Perturb and Observation (P&O) with PI controller is used. And to integrate the DC grid to AC grid Inverter operation is done.

Generally, PI controller is used, but tuning of the controller is difficult and takes more time. The proper gains are calculated by using the mathematical calculations and the error obtained is also not accurate. And it is not suitable for the dynamic systems as the irradiance and loads are variable.

Besides this to integrate PV standalone system to the AC grid a Boost converter and inverter circuit are needed and for the both converters controlling techniques are required to provide switching of the circuits. So, to eliminate this complex circuitry, here it is proposed with the trans-ZSI circuit which provides both boost converter and inverter circuit operation.to

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obtain the efficient operation of the system the PI controller is proposed with Fuzzy Logic Controller. As the fuzzy logic controller produces the accurate error by using the fuzzy rules and depending upon the fuzzy rules output the desired output can be obtained.

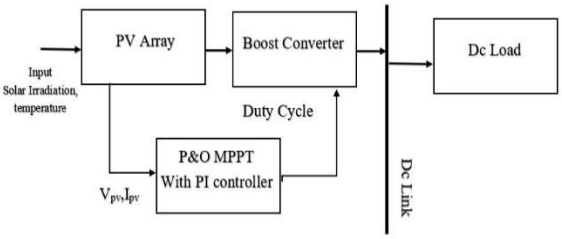

Fig.1: DC Grid with PI Controller

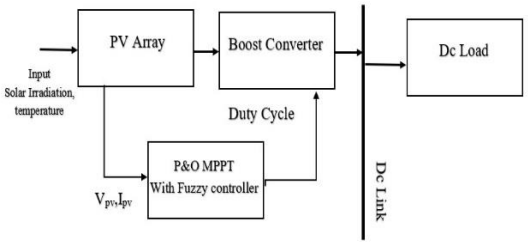

Fig.2: DC Grid with Fuzzy Controller

Here PV standalone system operated in DC grid mode, the Perturb and Observation (P&O) MPPT with conventional PI controller and proposed non-conventional Fuzzy Logic Controller (FLC) is shown in fig. 1 and 2.

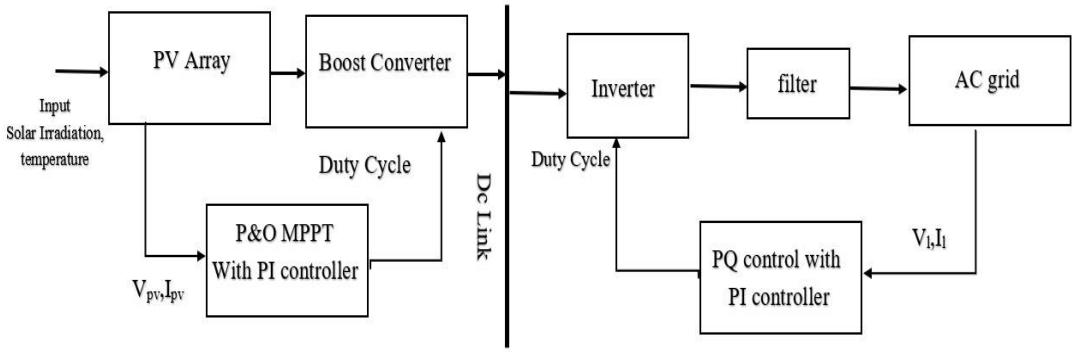

Fig.3: PV System with Boost converter and inverter connected to AC grid

When the PV standalone system is integrated to AC grid the boost converter and inverter circuit is shown in fig.3

And the proposed system with trans-ZSI is shown below in fig.4.

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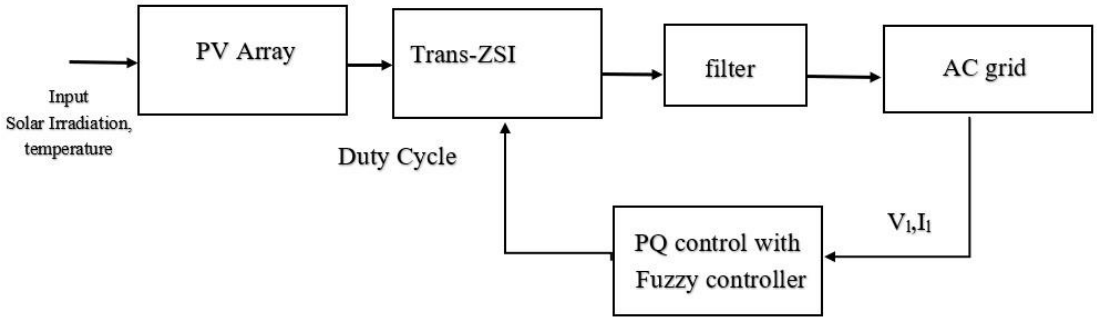

Fig.4: PV System with Trans-ZSI connected to AC grid

2. METHODOLOGY

When the solar based renewable energy is used maximum power tracking point is used to obtain the maximum power from PV array and also to give gate signal to the Boost converter, to step-up the voltage, as the voltage from PV system is not sufficient to supply the loads. Perturb and Observation (P&O) MPPT with fuzzy controller is used. To connect pv system with AC grid Trans-ZSI converter is proposed here.

2.1 Z-Source Inverters

ZSI is a buck boost invert er that has a wide range of voltage. The shoot through period is the time period when two switches of the same leg are gated, this allows the voltage to be boosted to the required level when the input DC voltage is not up to the required level. The diode D is used to prevent the reverse flow of current in the circuit.

The pulse width modulation of the Z-source inverters produces the AC voltage boost by controlling the duty cycle of the switches used on the circuit.

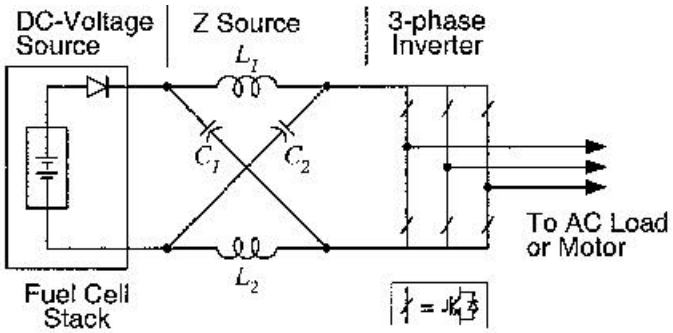

Fig. 5**:** Z source network

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The pulse width modulation of the Z-source inverters produces the AC voltage boost by controlling the duty cycle of the switches used on the circuit Sinusoidal PWM is employed to turn on the switches. The extent to which the dc voltage is boosted is decided by the modulation index of the PWM used. The switches 1, 4 are simultaneously gated to provide the shoot through condition for the inverter. This enables the voltage to be increased to the required value without the additional need of switches. The shoot through condition is also used to buck the voltage given to the load side through proper gating signals thus providing a dual buck/ boost function using the same ZSI.

2.2 Fuzzy Logic System:

A block diagram fuzzy logic controller is shown below. It contains the inputs, fuzzification, rule base, defuzzification and output are all known to the knowledge-based module. The two to the system are error and change in error, and the output is controlled action depending upon the fuzzy rules.

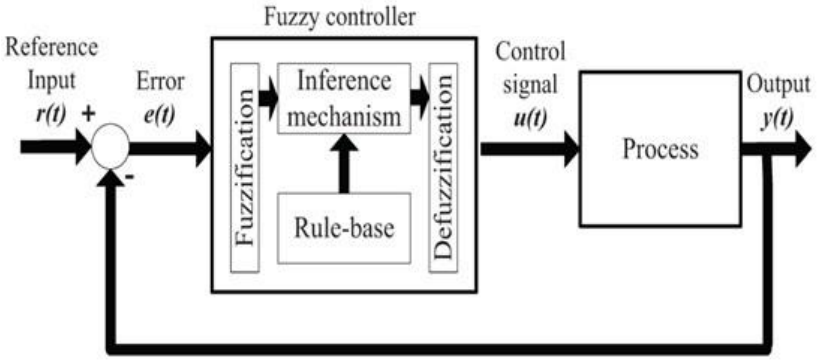

Fig.6**:** Simple Fuzzy Logic System

In a fuzzy logic control system, one of the two inputs is the reference signal, which is used to determine the amount of error in the system's output. The two primary inputs of a fuzzy logic controller are the magnitude of the error and the rate of change in that error. This paragraph provides an in-depth explanation of the three parts that make up the fuzzy logic controller: the fuzzification stage, the inference mechanism, and the De-fuzzification stage. The data is subsequently sent into the fuzzy logic controller, which uses the designer-established fuzzy rules to arrive at the

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intended output. The output of a fuzzy logic controller is processed and then passed on to the system.

3. RESULTS & DISCUSSION

Here the PV system is simulated for the DC loads and also the PV system is connected to AC grid using the Trans-ZSI. Perturb and Observation(P&O) MPPT Fuzzy controller is used for providing gate signals. The below Simulink diagram represents PV system with DC grid

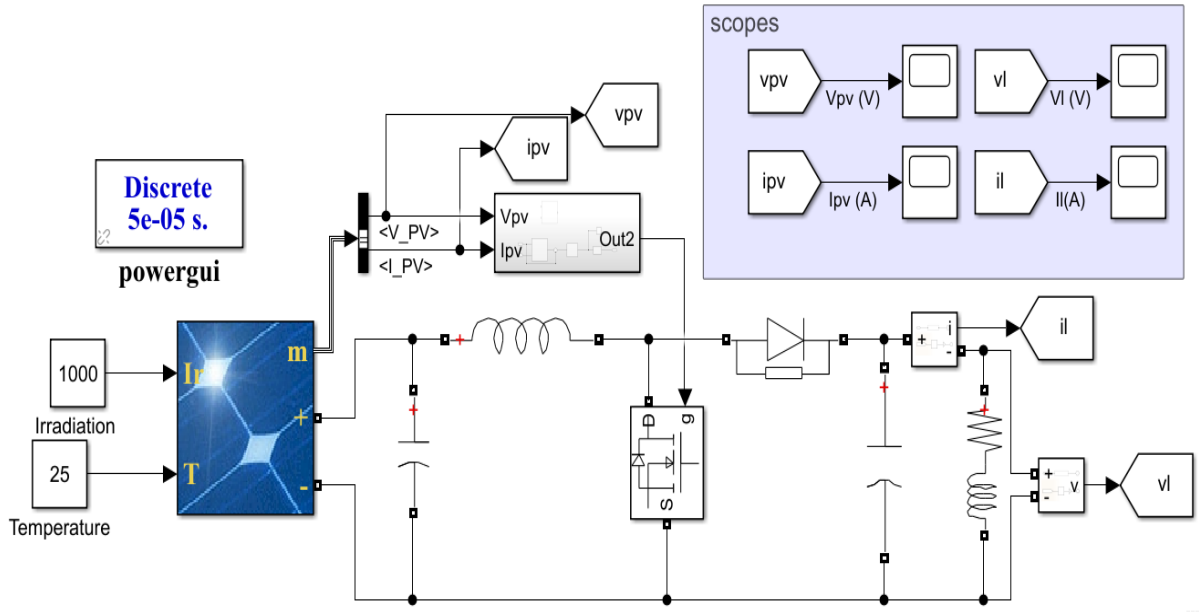

Fig. 7: Simulation and modelling of MPPT based PV system

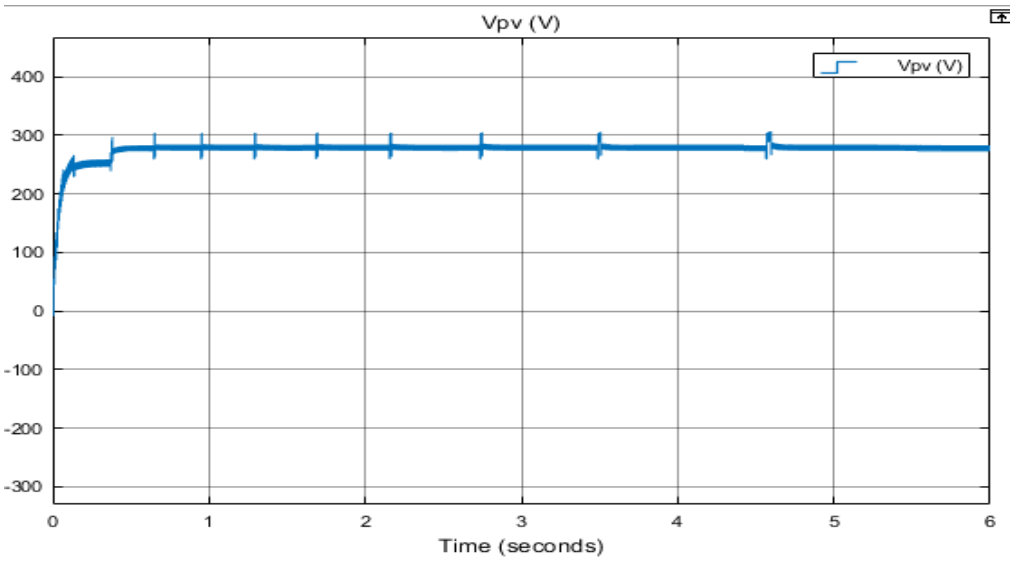

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Fig. 8: Output voltage of PV array by using PI controller

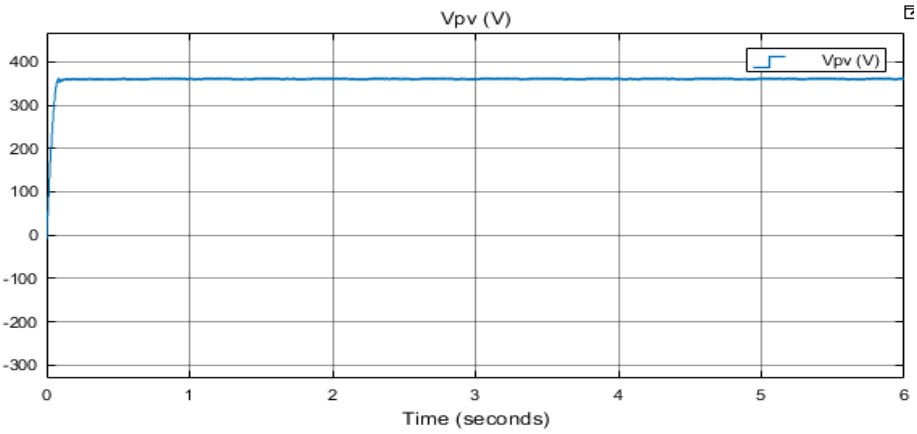

Fig. 9: Output voltage of PV array by using Fuzzy controller

Here the system is implemented for DC grid the Perturb and Observation (P&O) MPPT with PI controller and the proposed Fuzzy Logic Controller (FLC) is implemented.

By observing the fig. Output power with PI controller has more ripples and the magnitude of voltage is also less. Which reduces the efficiency.

And by observing the fig. Output of PV system with Fuzzy Logic Controller, it can be concluded that the output obtain is smooth and the ripples are eliminated and the magnitude of voltage is also high compared with PI controller.

PV system is connected to AC grid using the Trans-ZSI. Here in the PQ control of microgrid is done by using Fuzzy control.

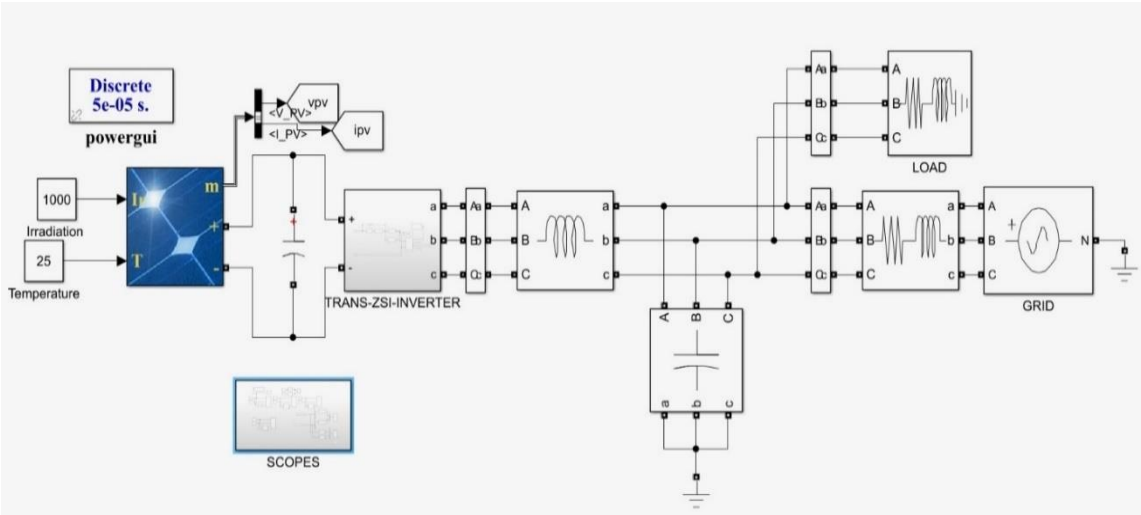

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Fig. 10: Simulation and modelling of for PV-system to Grid connected to using Trans-ZSI converter with fuzzy controller

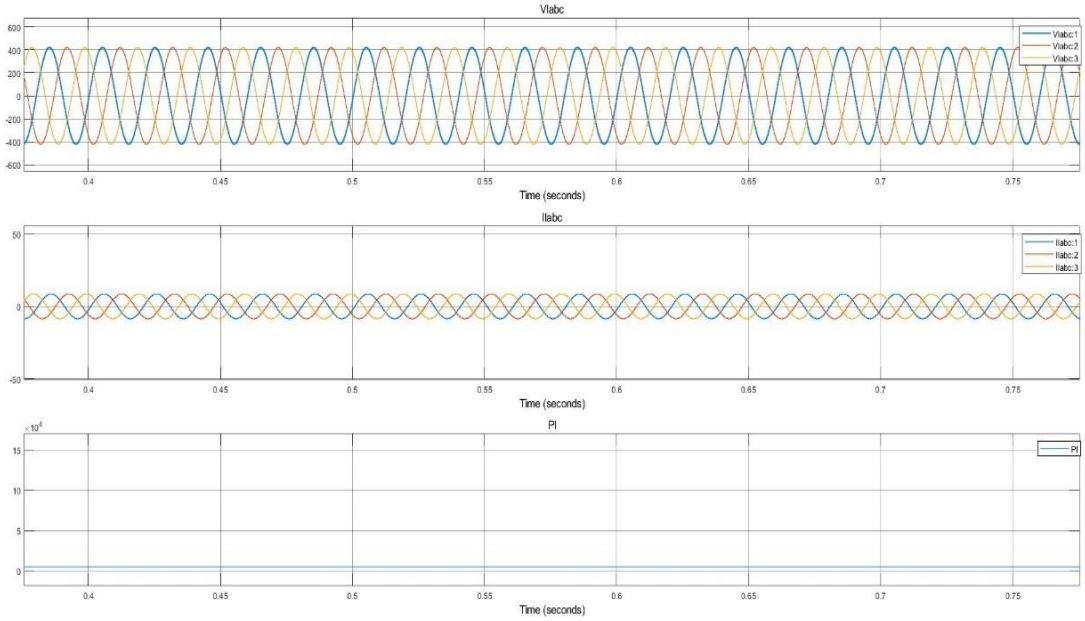

Fig. 11: 3-phase output waveforms at trans-ZSI by using Fuzzy controllers

The integration of the PV system with AC grid is done by using Trans- ZSI with fuzzy logic controller (FLC) is implemented.

The output obtained from the system is balanced and the circuit complexity is reduced.

IV. CONCLUSION

The proposed Trans-ZSI with Fuzzy Logic Controller (FLC)architecture has several advantages, the complexity of the circuit has reduced by Eliminating inverter circuit and the boost converter. It has also eliminated the controlling techniques used for switching the circuits, as only Trans-ZSI converter is used.

The problems of using PI controller, that is tuning of controller and selecting the proper gain values consumes more time and mathematical calculations, the error obtained is also not accurate, so the output is also not accurate. So, to overcome this problem Fuzzy Logic Controller (FLC) is used, it is auto tuning controller and gives the accurate error depending upon the fuzzy rules, and so that the desired output is obtained.

Thus, by using Fuzzy Logic Controller (FLC) with trans-ZSI makes the

circuit simple, cheaper and the efficient operation of system is obtained

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