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A SOLAR POWERED RECONFIGURABLE INVERTER TOPOLOGY FOR AC/DC HOME WITH FUZZY LOGIC CONTROLLER

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ABSTRACT

This study proposed a FUZZY logic controller for a hybrid AC/DC solar-powered house, with a single-phase inverter that may be configured for different applications. The key benefit of this converter is that it can operate in DC/DC, DC/AC, and grid tie modes, all of which minimize the inverter's losses and cut down on its overall cost and footprint. This is a hybrid AC/DC house, meaning it contains both AC and DC appliances. By segregating DC types of loads to the DC supply side and the remainder of the AC side, this method helps to decrease power loss by eliminating needless duplicate stages of power conversion and improves the harmonic profile. MATLAB/Semolina is used for simulation.

I. INTRODUCTION

In this century, renewable energy sources have expanded and improved in ways never seen before [1]. Increases in both the capacity and production of each and every endless innovation have been accompanied by equally impressive increases in the sophistication of their respective enabling methodologies. For the years 2009–2013, solar PVs experienced the fastest growth rate among renewable in terms of installed power capacity [2–3]. In particular, rooftop solar PV are becoming more prevalent in transportation systems due to factors such as the decreasing cost of solar board, Government strategies (such as feed in levies) to promote the use of sustainable power sources, measured quality, and less support, etc. However, the significant soundness and unwavering quality issues in the distribution system [4-6] can be traced back to the inexhaustible unpredictable nature. As a result of the revitalization of the electricity supply sector, the customer has emerged as a pivotal actor in the marketplace. Options for stockpiling energy, such as battery systems, fuel cells, and so on, are provided in the age of solar PV to reduce the associated risks. Power quality is being negatively impacted, power outages are occurring more frequently, and the challenge for electrical engineers is growing as a result of the proliferation of nonlinear modern new advancements in homes that are meant to improve efficiency and comfort[7]. Nowadays' family burdens

Are different in kind from those shown in earlier stages [8-10]. However, symphonic moderation and its minimizations are substantial challenges in the appropriation system.

II. LITERATURE SERVEY

The peak magnitude of the line-line grid voltage is used in conventional grid-connected inverters as the dc link voltage. Two-stage conversions are needed to increase the dc voltage and reverse it for this purpose. However, this will raise the system's price, size, and risk. Technology has advanced to increase efficiency and comfort as more and more nonlinear appliances make their way into homes, they become a major contributor to the generation of harmonic current in the distribution feeder. This poses a significant challenge for electrical engineers and has a negative impact on power quality and power losses. Household loads of today are different from those of the past. The distribution system faces significant difficulties, however, when it comes to harmonic mitigation and/or its minimization.

SYSTEM SUGGESTIONS (III)

The RSC is based on the idea that a single power conversion system can be used to perform multiple operational modes, including solar PV to grid (Inverter operation, DC-AC), solar PV to battery/DC loads (DC-DC operation), battery to grid (DC-AC), battery/PV to grid (DC-AC), and Grid to battery (AC-DC), for solar PV systems with energy storage. This inverter is put through its paces in a solar-

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powered, hybrid AC/DC house, which simulates real-world conditions by simulating common household loads in both AC and DC power formats. Each appliance in a typical modern home is culled for the amount of harmonic distortion they cause on the power grid. Other than what has already been mentioned, you can also expect to receive follow. The standard inductor is limited to DC/DC application. Solar PV-Battery functionality is also confirmed, taking into account the natural change in solar radiation. The action of reduces the circulatory current. The topology's switches that allow for DC/DC operation. In this project, Fuzzy logic is used as a controller to lower total harmonic distortion, which in turn improves power quality. The suggested RSC circuit is shown in a schematic form in Fig. 1.

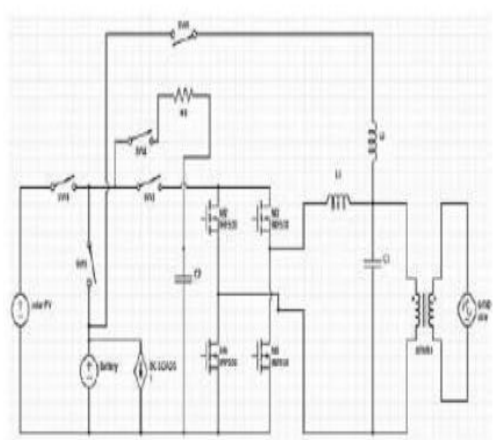
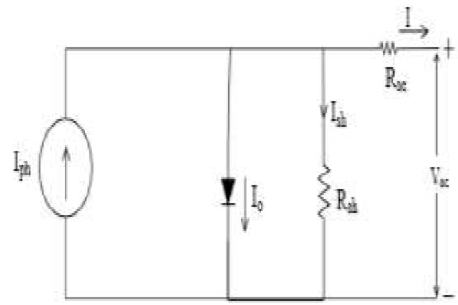


Fig.1: The suggested RSC circuit schematic.

IV.DESIGNING OF PV MODULE

A) Equivalent Circuit

If you examine the popularity of several PV module designs, you'll likely find that the single diode form shown in Figure2 has the most takers. Shunt resistance is denoted by Rash and open circuit by I in this circuit. energy produced by the sun, Saturation current in a diode (Io), generated current from sunlight (Iph), shunt resistance current (Ish) through series resistance (Rise) between the n- and p-type layers (Losses from current flow across the highly resistive emitter and contacts (Voc), and terminal voltage (Voc) are all defined.



Schematic of an equivalent circuit for a solar cell

The mathematical expression for the cell current in the single-diode model is obtained in this circuit by KCL,

$$I = Iph - Io - Ish \ (1) \ ....1$$

$$\text{Where, } Iph = [Isc + Ki\ (Tk - T)] * G/1000 \ ...... 2$$

The Iph standard test conditions photocurrent Reference solar radiation of 1000 W/m2 (STC) using a 1.5A solar spectrum and a constant temperature as a cell solar Tk 25 degrees Celsius. T represents a solar cell that can produce energy instantly. Level of heat, where Ki is the coefficient of the present solar radiation, denoted by G, arrives instantly.

B) Module Reverse Saturation Current (Irs)

The saturation current in the opposite direction of a module, Irs, is defined as

$$I_{rs} = I_{sc} / [\exp\ (q * V_{oc} / Ns * k * A * T) - 1] \ .... 3$$

Number of series-connected cells (6), open-circuit voltage of the solar module (21.24), electron charge q (1.6 x 1019 C), and current A. factor of perfection (A=1.6). Boltzmann constant (k= 1.3805 1023 J/K).

C) Module Saturation Current (I0)

Saturation current I0 in the module varies with cell temperature. In formal language, this looks like this:

$$I_0 = Irs\ [T/Tr]\ 3 * \exp\ [q * E_{g0} / Ak * \{(1/T_r) - (1/T)\}] \ .....4$$

In which Eg0 is the energy gap between the conduction and valence bands of the semiconductor (for polycrystalline Si at 25 °C, Eg0=1.1 eV). It has been simulated using equation (4), and shown in Figure 4 Module operating temperature, reference temperature, and reverse saturation current are the inputs here.

D) Module Output Current (IPV)

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Figure 5.1 depicts a simple equation that can be used to describe the IPV current at the output of a PV module.

$$I_{pv}=N_p*I_{ph}-N_p*I_0\ [\exp\ \{q*(V_{pv}+I_{pv}*R_{se})*Ns*A*k*T1]$$

V.OPERATION OF RECONFIGURABLE SOLAR CONVERTER

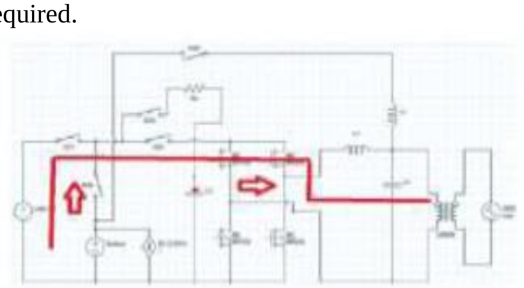
In Fig. 3, we see the circuit layout of a reconfigurable solar inverter. While this will decrease the number of power conversion steps, mechanical switches and Cables are more important in this topology. In Table 1 we can see the several ways the suggested single phase single stage converter might function. In addition, Figs. 3-6 detail other
Modes of functioning.

TABLE I MODES OF OPERATION

Modes of operation	ON switches	Off switches
PV-GRID	SW1 SW3 SW 4	SW2 SW 5
PV-BATTERY-GRID	SW1 SW2 SW3 SW4	SW5
PV- BATTERY	SW1 SW3 SW5	SW2 SW4
BATTERY-GRID	SW2 SW3	SW1 SW4 SW5

A) Mode-1

In the mode of operation depicted in Fig. 3, PV is hardwired into the national power grid. To get the most juice out of a solar array, an MPPT controller is used. Inverter In order to synchronize with the grid and send active power into the grid, a controller is required.



Connection of photovoltaic cells to the electrical grid

B) Mode-2

Figure 4 depicts a mode of operation where solar PV and batteries are both feeding electricity into the grid. When the power supply is low, this mode kicks in. solar PV because of environmental factors like weather and other factors. The need for perfect parity between battery voltage and PV voltage is a limitation of this setup. The battery voltage is too high for an MPPT controller to work properly.

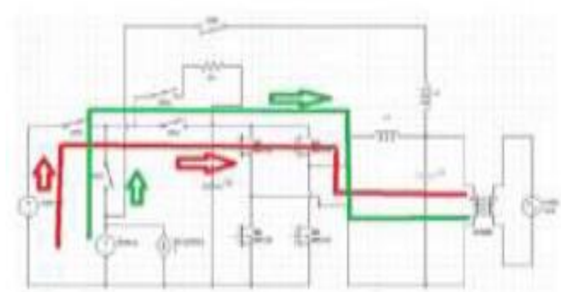


Figure 4.Grid-Connected Photovoltaic and Battery System

C) Mode-3

The proposed topology's DC/DC operation, depicted in Figure.5, involves the converter's chopping action to charge the battery. An additional inductor is not required in minimize the shakiness of the charging current even more. A battery is charged during the day to be used later at night when there is no sun.

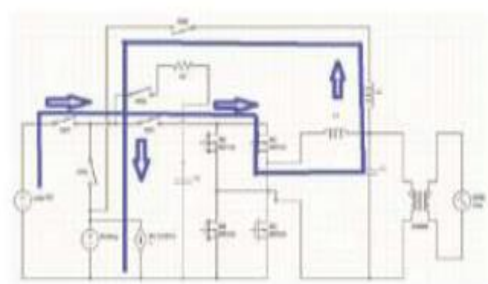


Fig.5 PV to Battery Charging

D) Mode-4

As can be seen in Fig. 6, batteries can be used to provide power to appliances and the grid even when the sun is not shining or there are clouds in the sky. Or wet weather. The inverter can rely on reliable power from a battery. As a result, it can be incredibly useful for enhancing power quality and supplying ancillary services.

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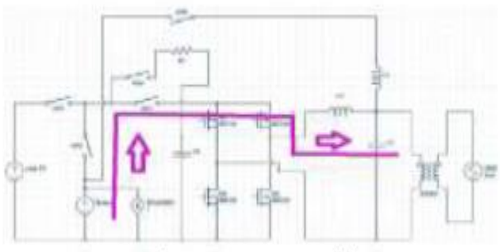
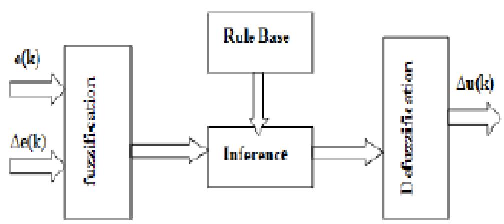


Fig 6.Battery to Grid

VI. PROPOSED FUZZY LOGIC CONTROLLER

The output of the Fuzzy logic controller is determined and controlled by the controller's internal fuzzy logics. Fuzzy logic's central building blocks Figure 7 demonstrates the three components of an MPPT controller: fuzzification, rule-base, inference, and defuzzification.



Block diagram of fuzzy logic

As a kind of dynamic control, fuzzy logic is becoming more popular. Validation is achieved by the application of many criteria and procedures. Dependent settling. Fuzzy maximum power point tracking has been more popular during the last decade. Fuzzy logic controllers provide a number of benefits, including the flexibility to work with imprecise inputs, accommodate non-linearity, and function without a perfect mathematical model. Both the suggested Fuzzy MPPT Simulink model and the Fuzzy MPPT flow chart are shown in Fig. There are two inputs and a single output. Two inputs into the FLC are error (E) and the rate of change in error (CE).

The percentage of time the power is really on, denoted by "D," is an output variable. The tracking performance of linear and nonlinear loads may therefore be enhanced by using a fuzzy control algorithm instead of traditional approaches. Fuzzy logic is suitable for nonlinear control since it does not rely on complicated mathematical equations. The components of a fuzzy logic controller are shown in Figure.10 (FLC). One of the factors on which an FLC's behavior relies is the form of its membership functions in its rule base.

MATLAB's Fuzzy Logic Tool Box is used to create the membership functions and rule base. Figure 9 is a graphical representation of the membership function for error. Figure 10 depicts the fluctuation in error, while Figure 1 shows the duty cycle of the fuzzy logic controller.

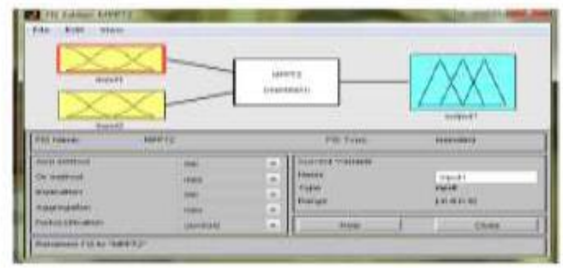


Fig. 8 Fuzzy logic Implementation in Simulation

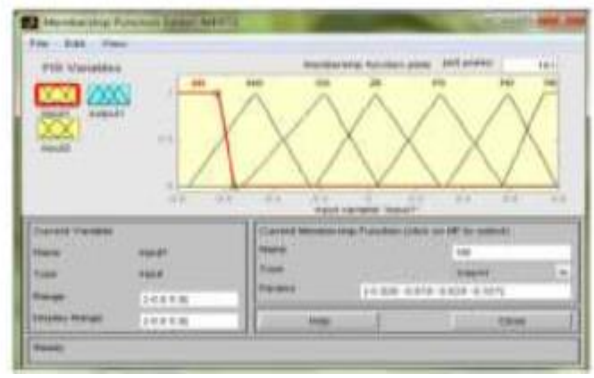


Fig.9 Fuzzy logic input Error (E)

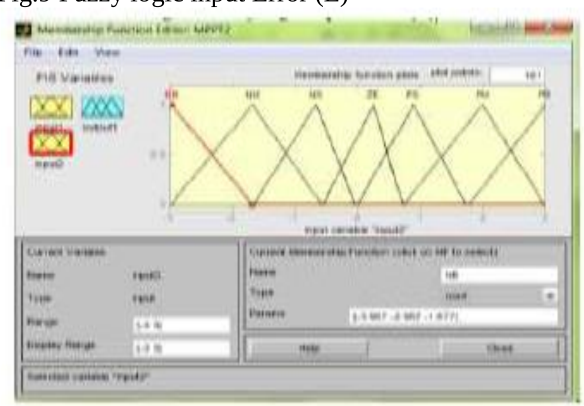


Fig.10 Fuzzy logic input change of Error (CE)

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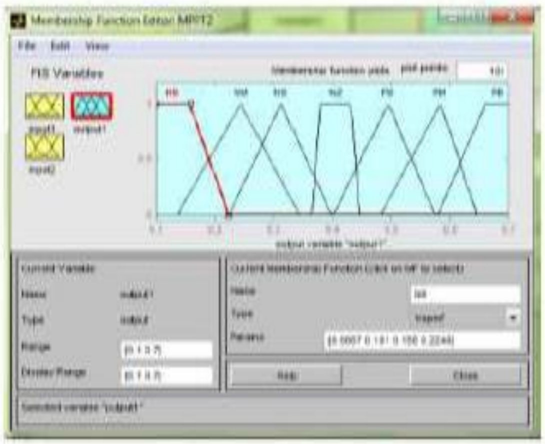

Fig.11 Fuzzy logic output (D)

Membership function depicted graphically for (a) error signal, (b) error signal variation, and (c) duty cycle.
The number of subsets used for rule development varies. Ambiguity-based Maximum Power Point Tracking (MPPT) Settings. Seven rules-based subsets were used in this case. Even though tuning the 49 rules results in improved precision and responsiveness, the process is laborious.

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VII. SIMULATION RESULTS

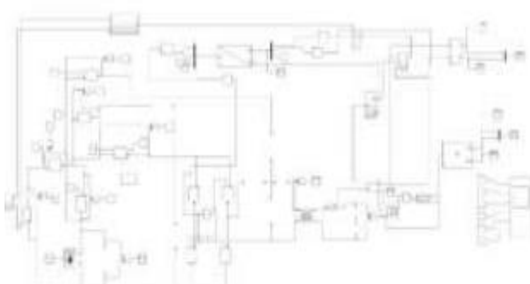

Fig.12 Simulation Block Diagram DC/AC inverter Operation

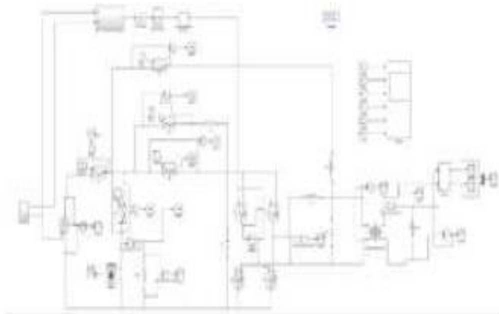

Fig.13 Simulink DC/DC chopper operation

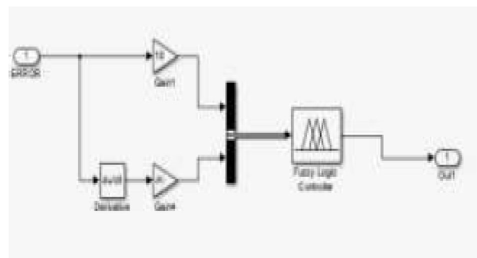

Fig 14.FUZZY controller subsystem

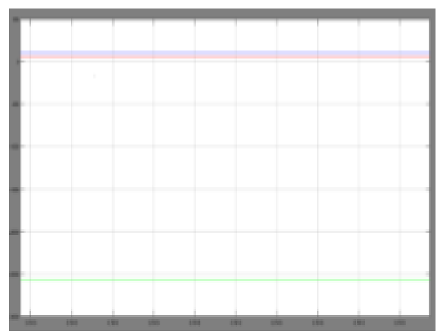

Fig 15.Battery voltage

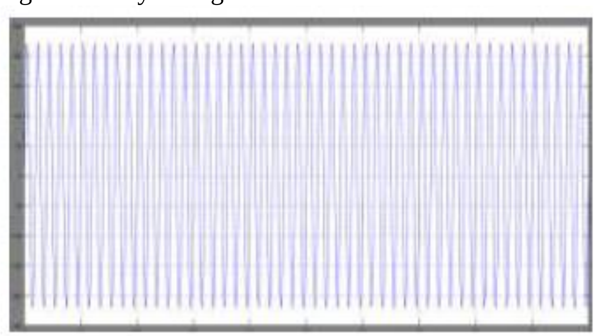

Fig 16.grid voltage

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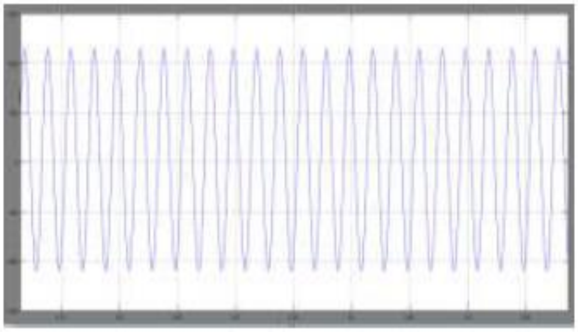

Fig 17. Grid current

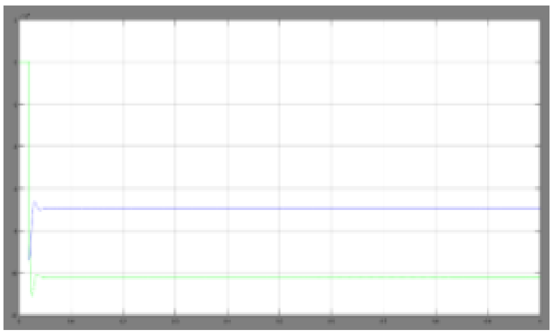

Fig 18. Active and reactive power

Fig 19. Extension system Current THD 0.69%

CONCLUSION

This work proposed an improved converter topology for a FUZZY logic controller-based solar hybrid AC/DC dwelling. Central ideas in this topology use a DC-to-AC and AC-to-DC conversion with a single phase, which improves efficiency, decreases size, and increases dependability. Simulation results confirm that the proposed converter topologies would be useful in the future Smart Grid's residential feeders for lowering harmonics. Though in this setup only solar PV is considered, the same topology could be used with wind, fuel cells, and so on.

FUTURE SCOPE

A solar-powered house using this new inverter topology could serve as a fundamental component of a highly efficient smart grid or micro grid of the future. By THD in the inverter voltage waveform can be further reduced with the help of Neuron fuzzy control.

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