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Fuzzy Optimized Quadratic Boost Converter for Photovoltaic Application

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Abstract - To enhance the Inverter and Quadratic Boost Converter utilizing Fuzzy Logic Control for the Solar Panels. The quadratic boost converter is the intermediate stage between the solar panel and the Voltage Source Inverter. In normal boost converter produces a medium level of output voltage, but a quadratic boost converter produces double voltage gain for example if you give the supply voltage 20V and duty cycle 0.7 it will be output voltage 220V produced.

Key Words: Quadratic boost converter, Single phase Voltage source inverter, Fuzzy logic control,

1. INTRODUCTION

Recently Renewable energy has major used for various purposes such as solar, wind, hydro, etc. Solar is energy power conversion to convert energy to electrical power generated. The solar panel is made of silicon because silicon has a high conversion efficiency that allows more sunlight to become electricity. High-gain DC-DC converters are needed to step up the low voltage generated from distributed generation (DG) sources. The PV array relationship between voltage and current in different conditions.

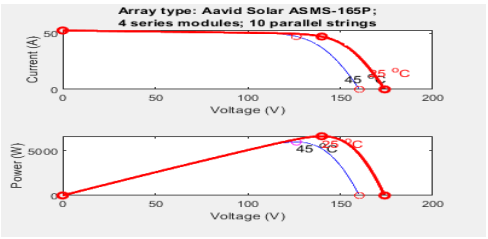

Fig 1.1 PV array – I-V, P-V characteristics

2. CIRCUIT DIAGRAM

In Figure 2.1 Solar Panel and inverter are to be connected to the quadratic boost converter. In inverter will be given a normal supply voltage to load.

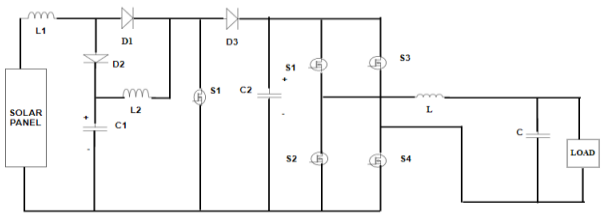

Fig 2.1 Solar Inverter with linear load

3. MODES OF OPERATION

The Quadratic boost converter consists of two inductors, two capacitors, three diodes, and a single controlled power device. They can be operating the two modes of operation.

MODE 1 – SWITCH OFF

When the switch is OFF: The way of operation and current flow direction of QBC during the OFF state. In this condition, d $D_2$are forward bias.

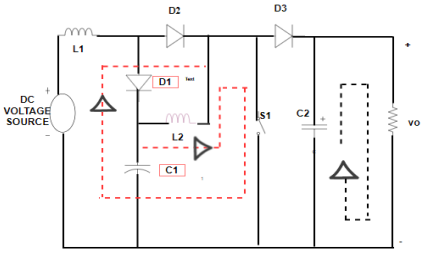

Fig 3.1 Modes 1operation Quadratic Boost Converter

$$-V_{in} + V_{L1} = 0$$

$$-V_{in} = V_{L1} \quad 1$$

$$-V_{C1} + V_{L2} = 0$$

Therefore, the mode of quadratic boost converter on condition.

$$V_{C1} = V_{L2} \quad 2$$

MODES 2 – SWITCH OPEN

The inductors $L_1$and $L_2$are charged from input supply V_{in} and capacitor C_1respectively. the current flowing through the inductor is rising and slope of capacitor voltage is decreasing due to its discharging nature Capacitor $C_1$is discharged the load and L_2 are demagnetized along with input supply V_{in}into capacitor C_2 through diodeD_3. In mode switch open, two inductors are demagnetized or current flowing through inductorL_1 and $L_2$is decreasing as. The two capacitors $C_1$and C_2 are charged from inductor L_1 and L_2 input supplyV_{in}. The current flowing through Capacitor C_1 and C_2increases the circuit diagram

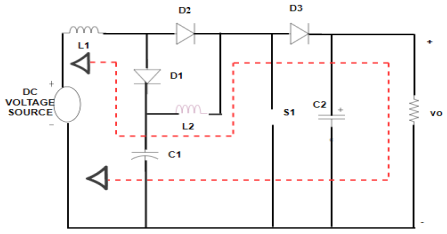

Fig 3.2 Mode 2 Operation of Quadratic Boost Converter

$$-V_{in} + V_{L1} + V_{C1} = 0$$

$$-V_{in} + V_{L1} + V_{L2} + V_O = 0$$

$$V_{L1} = V_{in} - V_{C1} \quad 3$$

$$V_{L1} + V_{L2} = V_{in} - V_O$$

$$V_{L2} = V_{in} - V_O + V_{C1}$$

Therefore, the inductor stores the energy into the conductor

$$V_{L2} = V_{C1} - V_O \quad 4$$

$$V_{L1} + (V_{L1} - V_{C1})(1 - D) = 0$$

$$V_O = \frac{V_{in}}{(1-D)^2} \quad 5$$

$$V_{L2}D + V_{L2}(1 - D) = 0$$

$$V_{L1}D + (V_{C1} - V_0)(1 - D) = 0$$

$$V_{L1}D + V_{C1}(1 - D) - V_O(1 - D) = 0$$

$$V_{C1} = V_0 (1 - D) \quad 6$$

$$V_O = \frac{V_{in}}{(1-D)^2} \quad 7$$

The quadratic boost converter two-step of modes of operation under the different condition

4] FUZZY LOGIC CONTROL

The fuzzy logic artificial intelligent processing system. Fuzzy logic is set of rule viewer membership functions plots one input variable and two input variables. They are classified into three types

Fuzzification,

Defuzzification,

Fuzzy inference.

The fuzzy logic membership function which represents fuzzy set A is usually denoted μ_A

$\frac{\Delta\epsilon}{\epsilon}$	NB	NS	ZO	PS	PB
NB	NB	NB	NB	NS	ZO
NS	NB	NB	NS	ZO	PS
ZO	NB	NS	ZO	PS	PB
PS	NS	ZO	PS	PB	PB
PB	ZO	PS	PB	PB	PB

Table 4.1 Fuzzy Logic Rule Viewer

Defuzzification is also known as the centroid method. The fuzzy logic rule can be used to reach logical conclusions from fuzzy sets of data. Fuzzy logic is three types of Singleton's fuzzifier, Gaussian fuzzifier, trapezoidal, or triangular fuzzifier. The fuzzy logic membership function which represents fuzzy set A is usually denoted μ_A

PARAMETER	SPECFICATION
Maximum power P_m	164.85
Number of series and parallel modules	4,10
Optimal voltage V_{mp}	3.5 V
Optimal current I_{mp}	4.71 A
Open circuit voltage V_{OC}	43.5 V
Short circuit current I_{SC}	5.25 A

Input voltage V_O	220V
Duty cycle D	0.7KHz
Inductor L_1	2e-3mH
Inductor L_2	2e-3mH
Capacitor C	1e-6µF
Resistive load R	400 Ω

5. SPECIFICATION VALUES OF FUZZY OPTIMIZED QUADRATIC BOOST CONVERTER FOR SOLAR INVERTER

Table 5.1 Parameter value of Fuzzy Optimized Quadratic Boost Converter

6. ACKNOWLEDGEMENT

The quadratic boost converter is the ability to efficiently step up converter it is a boost-up high gain converter. Solar Panel produces a maximum number of optimal voltage and current produced in the summer season in this project main scope is rainy season solar panel is the minimum current that can be produced so at this time boost converter minimum voltage and current to compare quadratic boost converter to produced double voltage gain so it will be maintaining the current and voltage.

7. RESULTAND DISCUSSION

The results presented in this study highlight the promising performance of the quadratic boost converter in terms of efficiency, voltage regulation, and transient response. The findings underscore its potential to drive innovation in power—electronics and accelerate the adoption of sustainable energy solutions. Further research and development efforts are warranted to fully exploit the capabilities of this promising converter topology

7.1 SIMULATION OF FUZZY OPTIMIZED QUADRATIC BOOST CONVERTER FOR SOLAR INVERTER

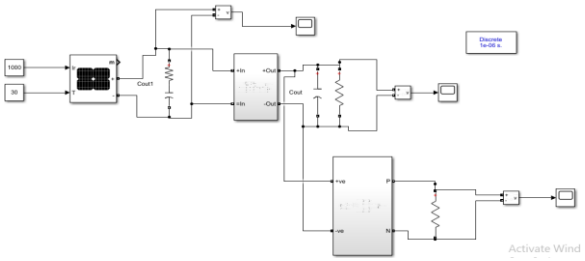

Fig 7.1 Fuzzy Optimized Quadratic Boost Converter for Solar Inverter

7.2 SIMULATION DIAGRAM OF QUADRATIC BOOST CONVERTER FUZZY LOGIC CONTROL

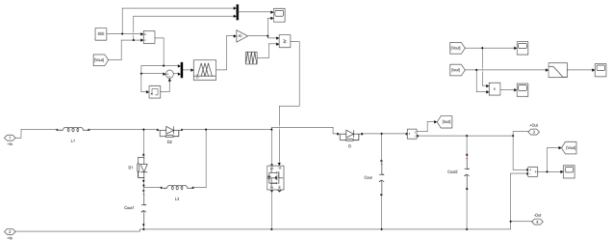

Fig 7.2 Quadratic Boost Converter with Fuzzy Logic Control

7.3 SIMULATION DIAGRAM OF SINGLE-PHASE INVERTER WITH PI CONTROLLER

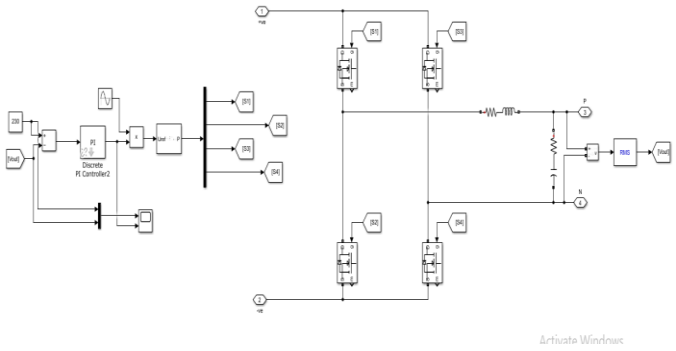

Fig 7.3 Single Phase Inverter with PI Controller

7.4 SIMULATION WAVEFORM OF SOLAR PV ARRAY OUTPUT VOLTAGE

In fig 7.4 In this condition, the solar PV fuzzy logic control has good performance with 2 seconds under slow charging and steady state condition

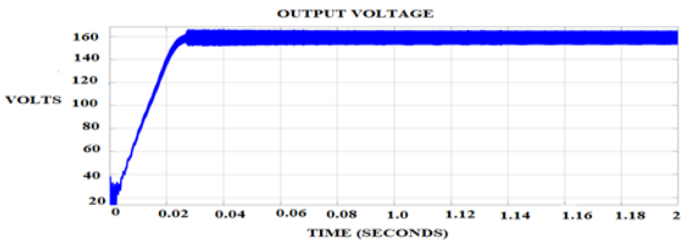

Fig 7.4 Simulation waveform of solar PV array output voltage

7.5 SIMULATION WAVEFORM OF FUZZY LOGIC OUTPUT VOLTAGE AND CURRENT CONTROL

In Fig 7.5 The fast-moving towards or far from the duty cycle raises the voltage until the power is maximum or the value fuzzy logic controls the constant value 600 output voltage and current various condition

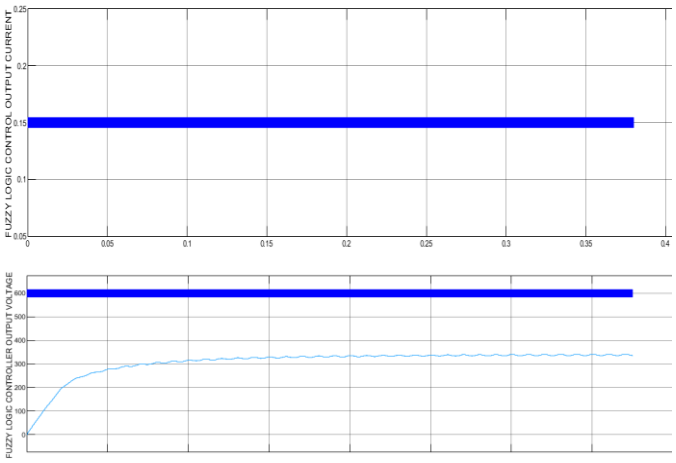

Fig 7.5 Simulation waveform of Fuzzy Output Voltage and Current Control

7.6 SIMULATION WAVEFORM OF QUADRATIC BOOST CONVERTER OUTPUT VOLTAGE AND CURRENT

The quadratic boost converter output voltage with change in duty cycle 0.7 and current with pulses dc-dc converter

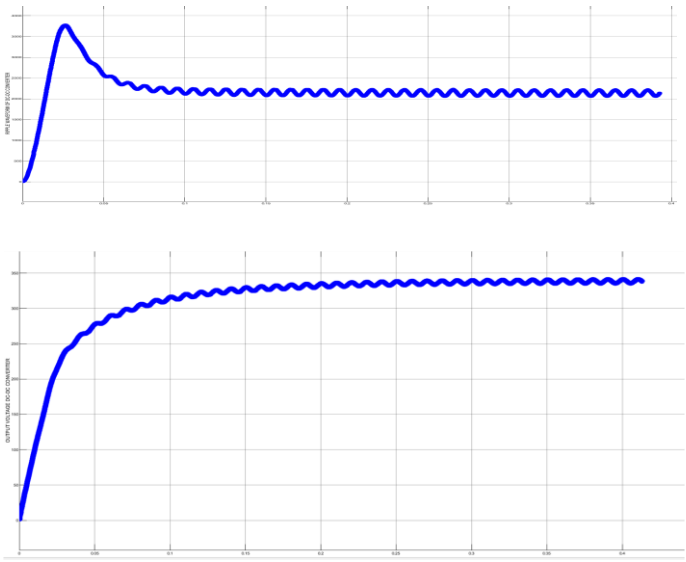

Fig 7.6 Simulation waveform of Quadratic Boost Converter for output voltage

7.7 SIMULATION WAVEFORM OF SINGLE-PHASE OUTPUT VOLTAGE

The pulses are generated which are applied to the switching devices near the supply voltage 230V and frequency 50KHZ

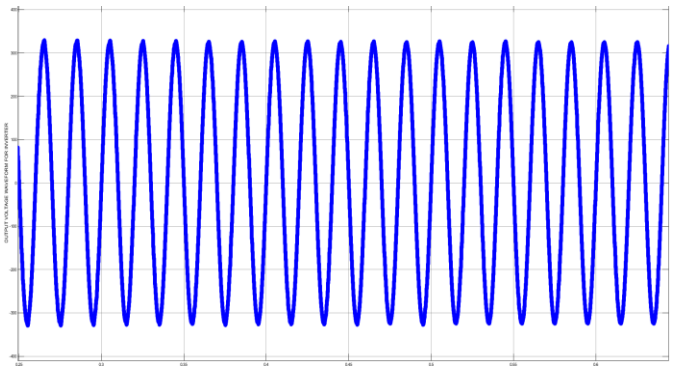

Fig 7.7 Simulation waveform of Single-Phase Output Voltage

7.8 SIMULATION WAVEFORM OF AC LINEAR LOAD

Ac linear load for inverter rms output voltage and ripple content with constant load maintains supply voltage with 0.2 seconds

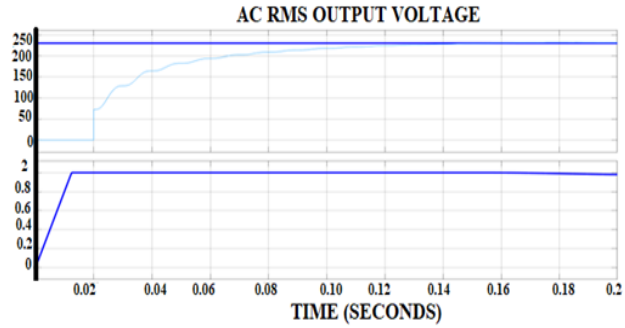

Fig 7.8 Simulation waveform of AC linear load

Overall, the fuzzy logic controls the mathematical model of vague qualitative or quantitative data, frequently generated Utilizing the natural language. The fuzzy logic system is capable of providing the most effective solution to complex issues. The fuzzy logic is a rules membership function. The quadratic is a high gain step converter up converter with a single switch nonisolated. In single-phase voltage source inverter converts a DC input source into a single-phase AC output.

8. CONCLUSIONS

The quadratic boost converter has a higher voltage conversion ratio when compared to the conventional boost converter. It is commonly used in renewable energy applications. The efficiency of the quadratic boost converter is 94%. The single-phase voltage source inverter pulses are generated in waveform to control the linear load normal supply voltage. Fuzzy logic is an application for automotive systems, domestic goods, environment control, etc.

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