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Quadratic Boost Converter

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ABSTRACT: Quadratic boost converter is similar to cascading of two boost converters but with single switch topology. The converter will be used to boost the **12**volt DC voltage to **46**volt output level using a single switch in a geometric approach. The quadratic boost converter is designed, and the gains and values of the passive parts can be computed theoretically using equations. The performance of the designed converter is validated using simulation.

KEYWORDS: Quadratic boost converter, highly efficient, low switching loss

I.INTRODUCTION

DC-DC converters are commonly employed in home solar systems to create the desired output power and are considered to be of major economic relevance nowadays. The DC nano-grid is a low-power dc distribution system designed for domestic use. The nano-average grid's load demand is typically covered by local renewable energy sources such as solar and wind. In the nano-grid, an energy storage unit is also necessary to assure uninterruptible power supply to important loads and to maintain system power balance. The general architecture of a nano-grid, which includes both ac and dc loads, is shown in Fig.1. To avoid reverse power flow, the diode D in the diagram is connected as a series blocking diode. As a result of the diverse dynamic behaviours of all the distinct. The various nano-grid components are all connected to a common dc bus via power electronic converters, a solar panel as an energy source, a storage unit, and certain dc and local ac loads since their dynamic behaviour varies.

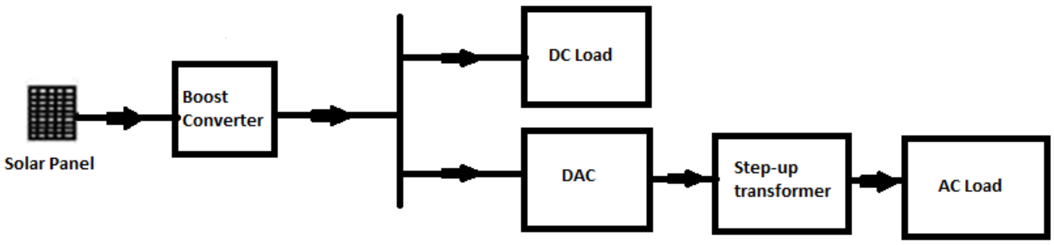

Figure 1: General solar micro-grid with boost converter

This paper analyses and implement a new two stage boost converter with single switch is developed which has the same voltage gain as cascade of two boost converters and termed as quadratic boost converter (QBC)

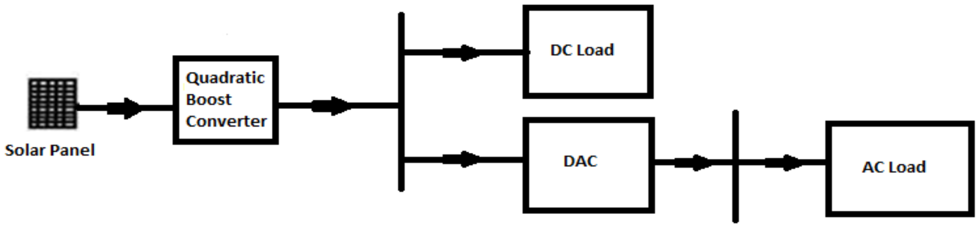

Figure 2: Modified solar micro-grid with QBC

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II. LITERATURE SURVEY

Buck, Boost, Buck-Boost, SEPIC, CUK, and other DC-DC converter designs have already been proposed. Other converters can accomplish both functions, whereas Boost and Buck converter types can increase and reduce output voltages, respectively. In many current home applications, a DC-DC converter with a high voltage gain is desirable. When a boost converter is required to step up a DC voltage, it is commonly chosen. The duty cycle of the boost converter's power switch must be high to produce a high voltage gain, resulting in substantial conduction losses and lowering the converter's efficiency.Because the transistor switch has a short OFF-time, the converter's switching frequency is limited by the high duty ratio. Because the diode has less time to conduct due to the fast duty cycle, the diode current becomes a narrow pulse with a high instantaneous value. As a result of the high diode current, there is substantial reverse recovery loss and an EMI concern.

To solve the aforesaid drawbacks of traditional boost converters, the logical approach is to use transformers to achieve a high voltage step-up ratio, such as forward or flyback converters. They cannot, however, be employed in energy systems due to their low power ratings of less than 100 watts. As a result, half and full bridge converters, as well as modified boost designs, can be used.

III.QUADRATIC BOOST CONVERTER

Quadratic boost converter is a modified step-up converter with single switch and better conversion ratio.

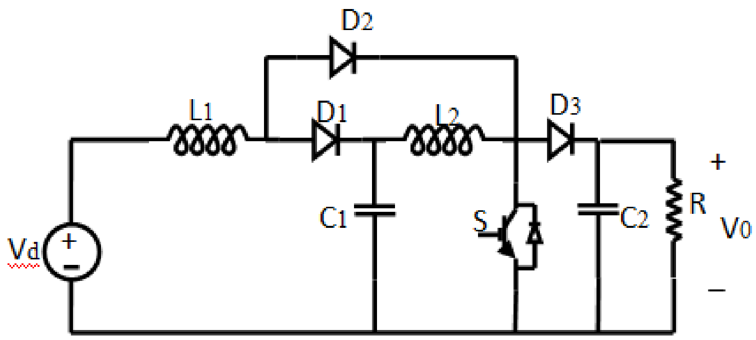

Figure 3: Quadratic boost converter

A single power MOSFET switch, S, two diodes, D1 and D2, two capacitors, C1 and C2, two inductors, L1 and L2, and a load resistor R make up the circuit.

The operation of the circuit is strictly reliant on the assumption that the switch S is perfect in operation and that the capacitors C1 and C2 are large enough to keep the voltage across the capacitors VC1 and VC2 roughly constant across the switching time. When the switch is ON: The operation of the circuit is based on the premise that the switch S is perfect in operation and that the capacitors C1 and C2 are large enough that the voltage across the capacitors VC1 and VC2 is virtually constant across the switching time. D2 is forward biased when switch S is turned on, but D1 and D3 are reverse biased. Vin and C1 provide current to L1 and L2, respectively.

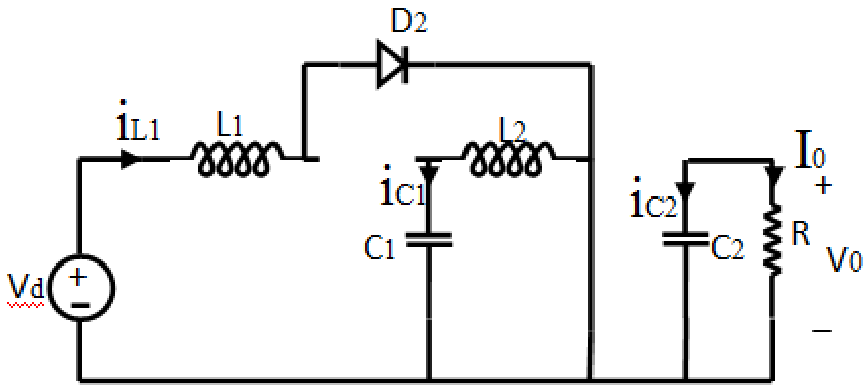

Figure 4: QBC when MOSFET is ON

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When the switch is OFF: D1 and D3 are forward biased in this situation, but D2 is reverse biased. C1 and C2 are being charged by L1 and L2. iL1 and iL2 levels are lower in this state.

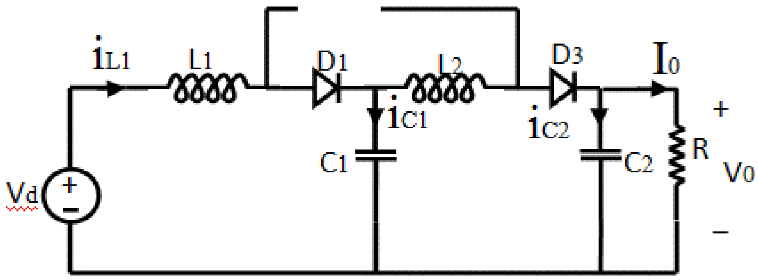

Figure 5: QBC when MOSFET is OFF

V. SIMULATION AND EXPERIMENTAL RESULTS

The Quadratic boost converter was analysed by MATLAB Simulink model.

The circuit parameters for the simulation are listed in Table.

parameter	**values**
Input Voltage	18V
Output voltage	70V
Switching Frequency	5KHz
Input Inductor	2.6mH
Inductor2	3mH
Capacitor	10µF

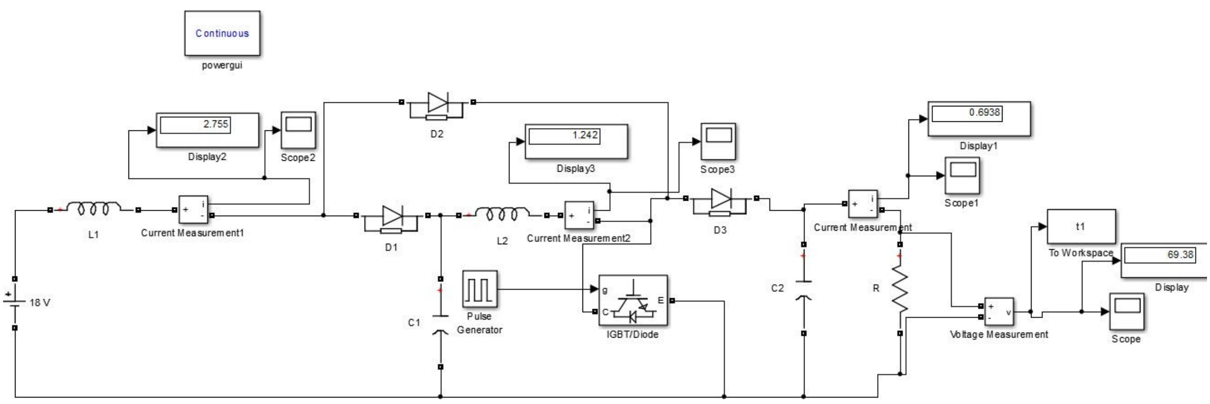

Figure 6: MATLAB-SIMULINK model of QBC

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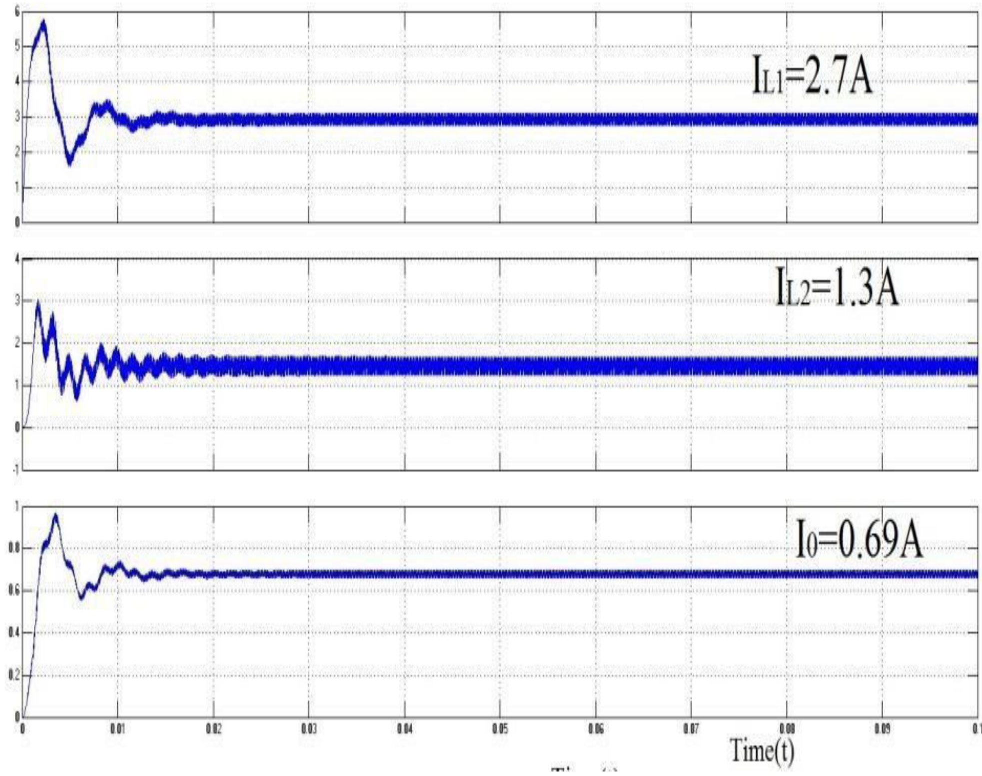

Figure 7: Inductor currents and load current

In order to verify the circuit operation and confirm the simulation results a prototype is built and lab tested. The converter is supplied with a constant source voltage of 6 volts and loaded with a light bulb. Fig.8 shows the built circuit in which L1 =2.6mH,L2=3mH, F=5Khz, C=10 µF and D=0.5.

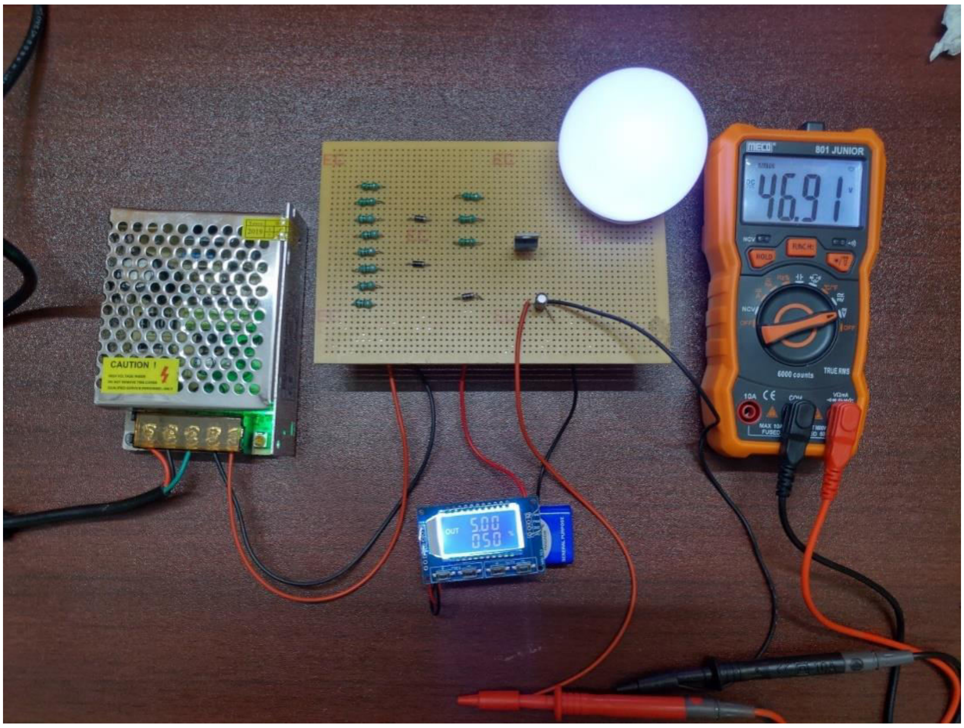

Figure 8: Experimental prototype of QBC

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The efficiency of power electronic circuits is one of the most essential characteristics. The following equation can be used to calculate efficiency by comparing the circuit output power to the power given by the supply.

$$Eff = \frac{P_0}{P_{in}} = \frac{V_0 \times (1-D)^2}{V_{in}}$$

VI. CONCLUSION

Compared to basic converter topologies, quadratic boost converter possesses quadratic conversion ratio which offers significantly wider conversion range. As far as conversion efficiency is concerned, it is quite clear that a single-stage converter is always a better choice than a two-stage converter. Therefore, the quadratic converters are proposed and intended for applications where conventional, single-stage converters are inadequate. The designed QBC circuit is simulated by MATLAB Simulink model and the results were verified by successfully building a laboratory prototype

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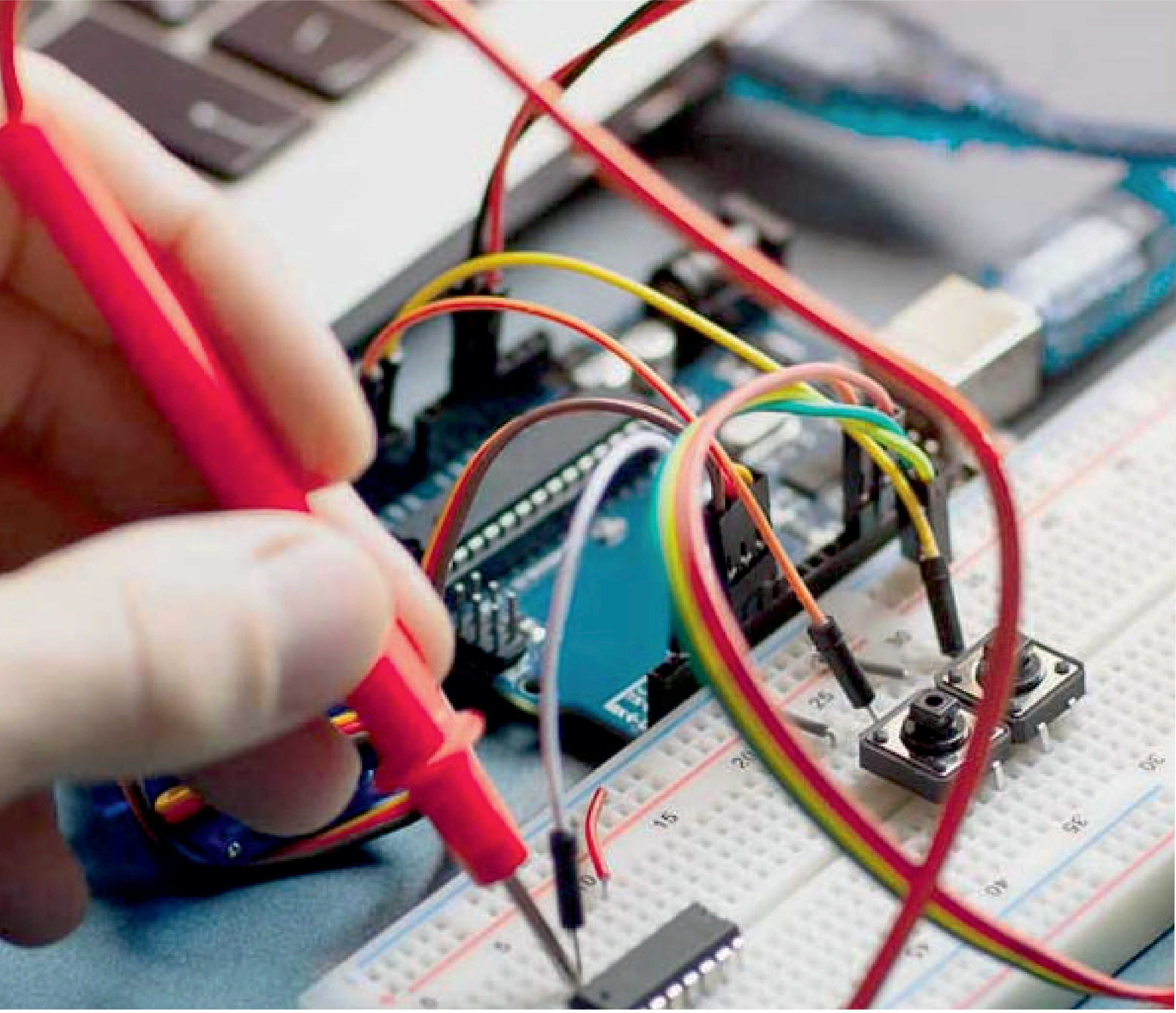

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