iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 9 **Issue:** VII **Month of publication:** July 2021

DOI: https://doi.org/10.22214/ijraset.2021.36662

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue VII July 2021- Available at www.ijraset.com

Quadratic Boost Converter

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Abstract: The output voltage from the sustainable energy like photovoltaic (PV) arrays and fuel cells will be at less amount of level. This must be boost considerably for practical utilization or grid connection. A conventional boost converter will provides low voltage gain while Quadratic boost converter (QBC) provides high voltage gain. QBC is able to regulate the output voltage and the choice of second inductor can give its current as positive and whereas for boost increases in the voltage will not able to regulate the output voltage. It has low semiconductor device voltage stress and switch usage factor is high. Analysis and design modeling of Quadratic boost converter is proposed in this paper. A power with 50 W is developed with 18 V input voltage and yield 70 V output voltage and the outcomes are approved through recreation utilizing MATLAB/SIMULINK MODEL.

I. INTRODUCTION

Power electronics based converters have been extensively used in many applications. For example, renewable energy generation systems, sources such as fuel cells and solar panels, and other dc sources such as batteries, usually have low-output-voltage levels with respect to the nominal requirements of grid-tied inverters. Consequently, dc–dc converters with high input-to-output-voltage gains are required. The basic family of converters such as the classical boost and buck–boost can provide a theoretical high-voltage gain with the use of extreme duty cycles. However, in practice the limited speed of switches, parasitic components and power losses limit the highest achievable voltage gain to a number around five. Owing to the reasons above, the development of high-voltage-gain converters is a very active field, and many dc–dc converters have been proposed. For example, high-gain topologies based on multilevel stages have been investigated. Other plausible solutions may be found based on magnetic coupling. Another alternative is the use of quadratic gain converters.

Parameter	Values
Power rating	50W
Input voltage	18V
Output voltage	70V
Switching Frequency	10kHz
Input Inductor	2.6mH
Inductor 2	3.9mH
Capacitor 1	33µF
Capacitor 2	10µF

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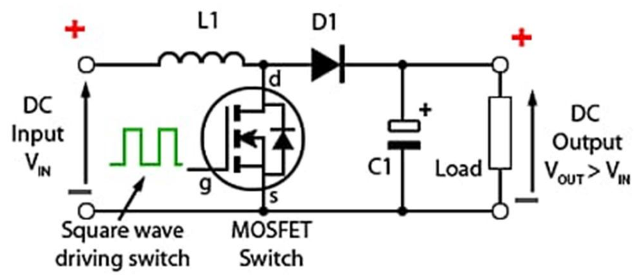
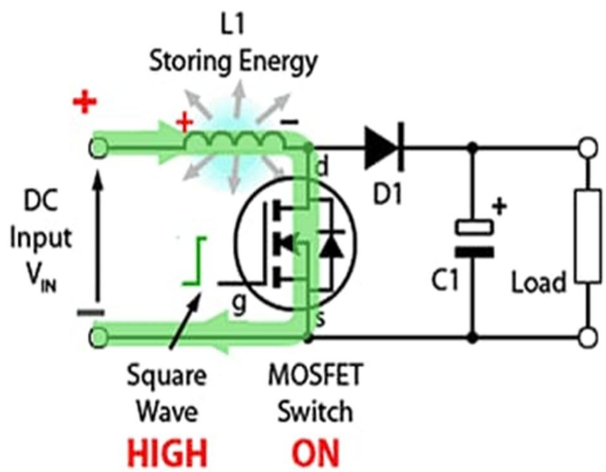
II. NORMAL BOOST CONVERTER

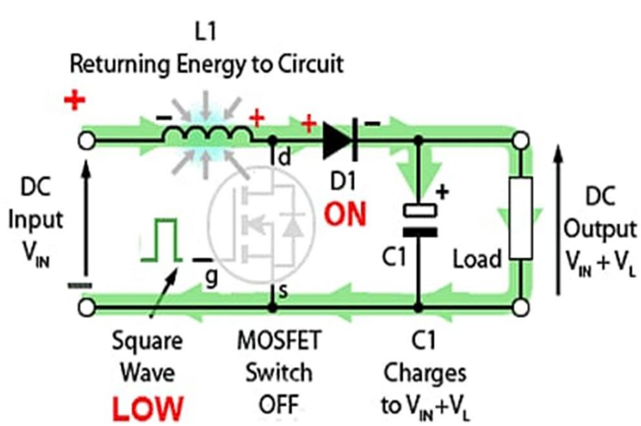


1) *Case 1:* During this time MOSFET conducts, placing a short circuit from the right hand side of L1 to the negative input supply terminal. Therefore a current flows between the positive and negative supply terminals through L1, which stores energy in its magnetic field. There is virtually no current flowing in the remainder of the circuit as the combination of D1, C1 and the load represent a much higher impedance than the path directly through the heavily conducting MOSFET.



2) *Case 2:* As the MOSFET is rapidly turned off the sudden drop in current causes L1 to produce a back e.m.f. in the opposite polarity to the voltage across L1 during the on period, to keep current flowing. This results in two voltages, the supply voltage VIN and the back e.m.f.(VL) across L1 in series with each other.

This higher voltage (VIN +VL), now that there is no current path through the MOSFET, forward biases D1. The resulting current through D1 charges up C1 to VIN +VL minus the small forward voltage drop across D1, and also supplies the load.



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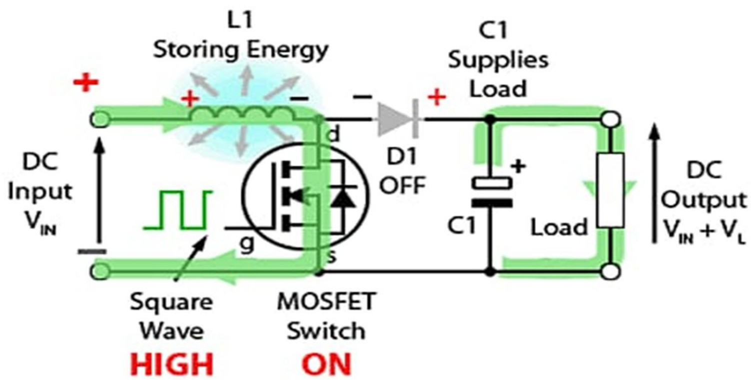
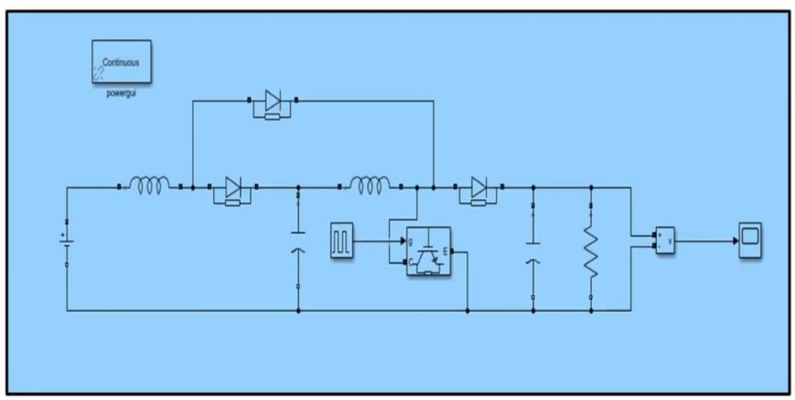
3) *Case 3:* The fig shows the circuit action during MOSFET on periods after the initial start up. Each time the MOSFET conducts, the cathode of D1 is more positive than its anode, due to the charge on C1. D1 is therefore turned off so the output of the circuit is isolated from the input, however the load continues to be supplied with VIN +VL from the charge on C1. Although the charge C1 drains away through the load during this period, C1 is recharged each time the MOSFET switches off, so maintaining an almost steady output voltage across the load.

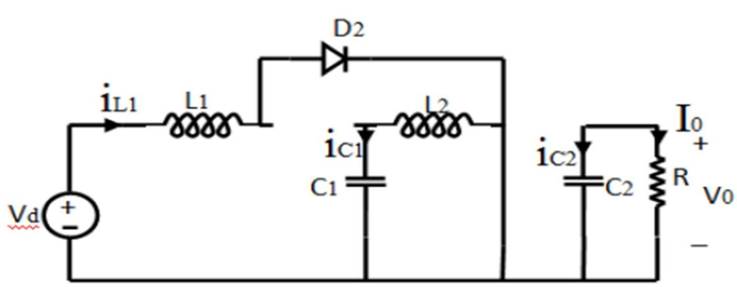


III. QUADRATIC BOOST CONVERTER

The circuit operation is strictly based on the assumption that the switch S is ideal in operation and capacitors C1 and C2 is assumed to be large so that the voltage across the capacitors VC1 and VC2 are nearly constant over a switching period.



1) *When the switch is ON:* The equivalent circuit schematic of the QBC during the ON state is shown in Fig. When switch S is turned on D2 is forward biased, whereas D1 and D3 reverse biased. Currents are supplied to L1 and L2 by Vin and C1 respectively.



QBC when switch is ON

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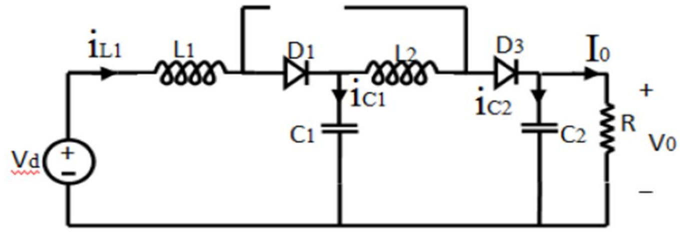
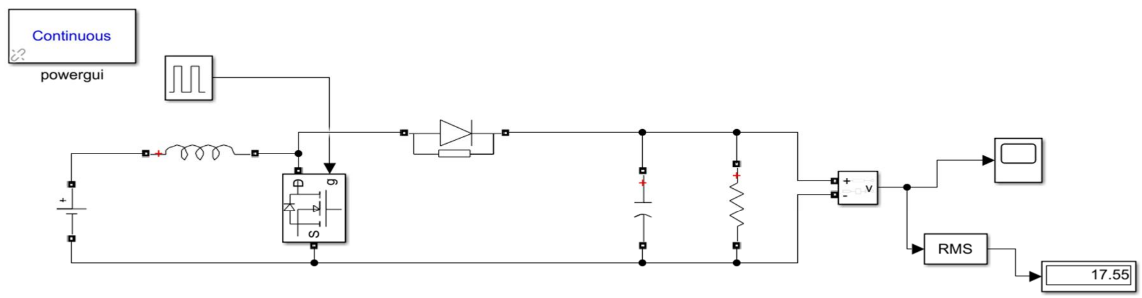
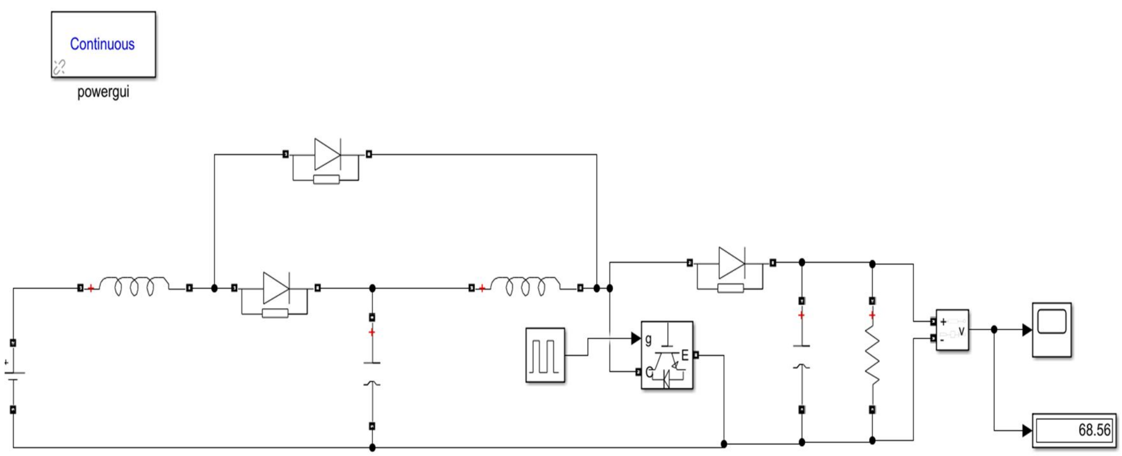
2) *When the switch is OFF:* The way of operation and current flow direction of QBC during OFF state is shown in Fig. In this condition D1 and D3 are forward biased, whereas D2 reverse biased. L1 and L2 are charging C1 and C2 respectively. During this state, iL1 and iL2 is decreased.



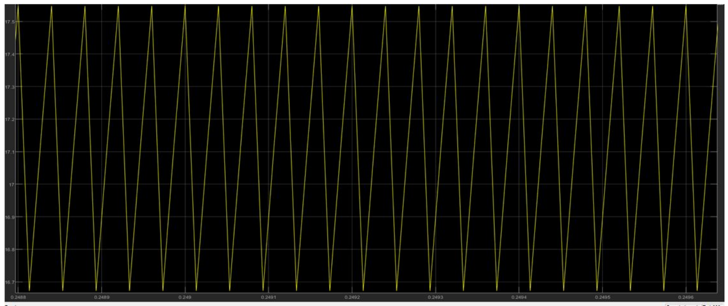
QBC when switch is OFF

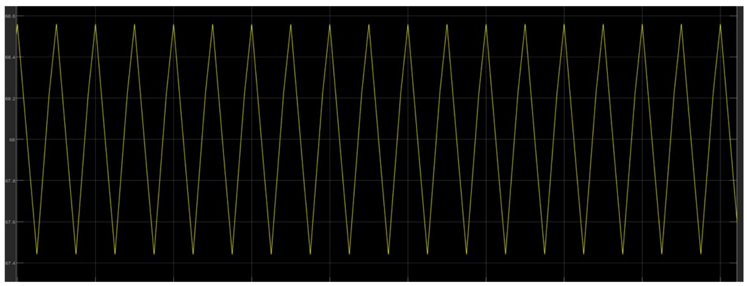
IV. SIMULATION





V. RESULT





VI. CONCLUSION

Compared to basic converter methods, quadratic boost converter is 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 50W laboratory prototype.

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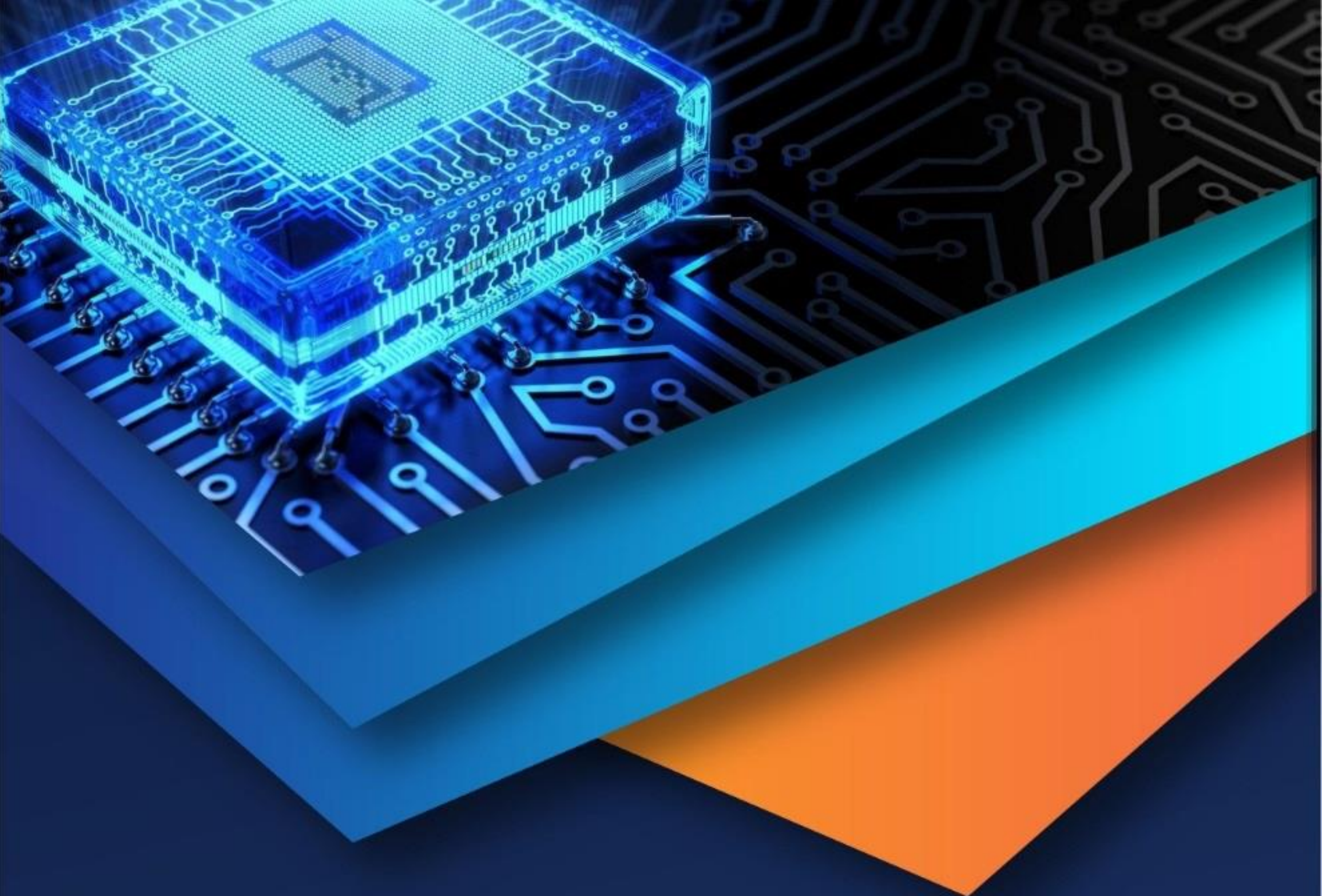

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