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Design and Comparison of Quadratic Boost Converter with Boost Converter

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ABSTRACT: This paper presents an Quadratic boost converter is a newly proposed two stage boost converter with single switch topology. The converter will be used to boost the 12 volt AC transformer voltage to volts output level using a two parallel switch in a geometric approach. The Quadratic boost converter for its application in 50W load is designed. The proposed converter is provide the high voltage gain with reduced voltage stress in the circuit. In this paper the output voltage in renewable energy sources is improved by using DC-DC converter topology. Basically Boost converter is used for improving the voltage gain. In this converter switching frequency is limited, hence the output voltage is reduced. To overcome this issue, by combining the components of two boost converter by using single switch which improves the switching frequency and output voltage of converter. In this proposed paper for comparing the voltage stress and efficiency by using two converters topology.

KEYWORDS: Boost converter, Quadratic Boost Converter, Voltage stress.

I.INTRODUCTION

In recent years for a great number of appliances dc-dc converter topology is employed. Normally in renewable energy system, the system having low output characteristics to recover this demand DC-DC converter topology isimplemented. For maintaining the dc output voltage range in PV array and fuel cells, converter can be used to improve the output voltage. But during the switching operation the voltage stress will be raised. While choosing the converter the concentrating features are; when switch is turn on it must attain the zero voltage crossing, when Photovoltaic array is connected to the grid the converter should provide the high terminal voltage for low input range. The converter which gives the high output range at low voltage stress is more efficient. Voltage gain generally based on the duty ratio hence by choosing the passive components the duty cycle ratio can be limited . Boost converter is used to step up the given voltage to the desired voltage. The input to this converter may be from any DC source like rectifiers,solar panel,battaries etc,. Two modes of operations are there, Mode 1: When the switch S is closed the inductor gets charged through the supply voltage and stores the energy. In this mode inductor current increases gradually, but we assume that the charging and the discharging of the inductor are linear. The diode blocks the current flowing and so load current remains constant which is being supplied due to the discharging of the capacitor. Mode 2: When the switch S is open, the diode becomes forward biased. The energy stored in the inductor changes it polarity to discharge through diode and charge the capacitor. Now, the capacitor supplies voltage to load. The load current remains constant throughout the operation. Theoretically, the switches are ideal so there are no losses in the circuit. But in simulation circuit switches are non-ideal, therefore losses will occurs in the output voltage The quadratic boost converter with a single switch,where E is the input voltage, VC2 the output voltage and S independent switch. This model usually requires active and passive switches are to be appearing in pairs and to form a three-terminal network. However, this methodology can be extended for the analysis of the quadratic boost converter with a single switch, which contains an active switch and three passive switches. Thus, diode D2 and transistor switch S are replaced by the corresponding current source, and diodes D1 and D3 by voltage sources.

II.LITERATURE SURVEY

There are several DC-DC converter configurations were already proposed such as Buck, Boost, Buck-Boost, SEPIC, CUK, etc. Boost and Buck converter configurations can increase and decrease the output voltages respectively, while the other converters can perform both functions. A DC-DC converter with a high voltage gain is desirable in many modern residential applications. Generally, when there is a need to step up a DC voltage, a boost converter is usually chosen. To achieve a high voltage gain, the duty cycle of the power switch of the boost converter must be large, resulting in high conduction losses and degrading the converters efficiency. The high duty ratio also limits the switching frequency of the converter because of the minimum OFF-time of the transistor switch.

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The large duty cycle also means the diode has less time to conduct; therefore the diode current becomes a narrow pulse with a high instantaneous value. This high diode current subsequently causes severed reverse recovery loss and EMI problem. In order to overcome the above disadvantages of conventional boost converters, the obvious solution would be the use of transformers to get high voltage step-up ratio, such as forward or flyback converters. However they cannot be used in energy systems as they have low power ratings below 100 watt. As a result modified boost designs such as the half and full bridge converters can be used. Looking at the disadvantages of these converters one can see that they lack the ease of design factor and have lower efficiencies due to the use of transformers. Cascaded connection of two boost converter stages [1] can increase the voltage gain without extending the duty cycle. This cascaded technique requires more switches and suffers from low overall efficiency as a number of the cascade stages increases

III. QUADRATIC BOOST CONVERTER

In PWM (square-wave) dc-to-dc converter topologies, dc conversion ratio M is a function of duty ratio D of the active (transistor) switch. Both minimum and maximum attainable conversion ratios are limited in practical converters. Mmax is limited by the degradation in efficiency as duty ratio D approaches 1. On the lower end, minimum ON-time of the transistor switch results in a minimum attainable duty ratio and, consequently, in a minimum conversion ratio Mmin. Conversion range can be extended significantly if conversion ratio M has a quadratic dependence on duty-cycle. Quadratic boost converter (QBC) is a modified step up converter with single switch and better conversion ratio. Figure Quadratic boost converter The circuit diagram of a quadratic boost converter [3] is shown in Fig 3. The circuit comprises of 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.

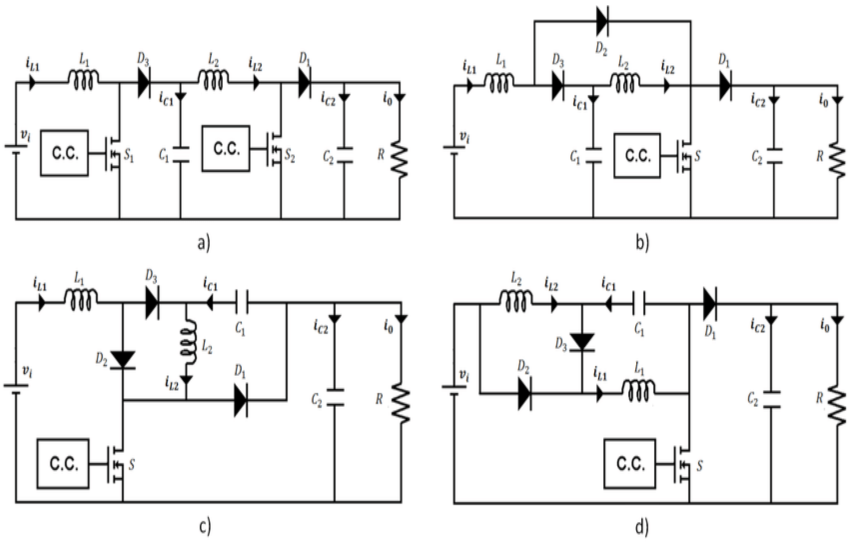

Figure : Quadratic boost converter

IV.PROPOSED SYSTEM

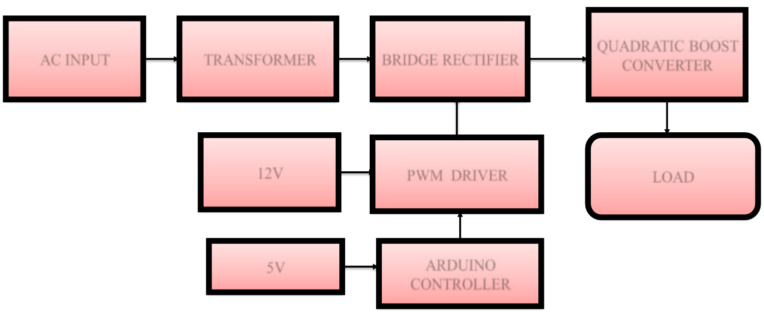

Figure : Block Diagram

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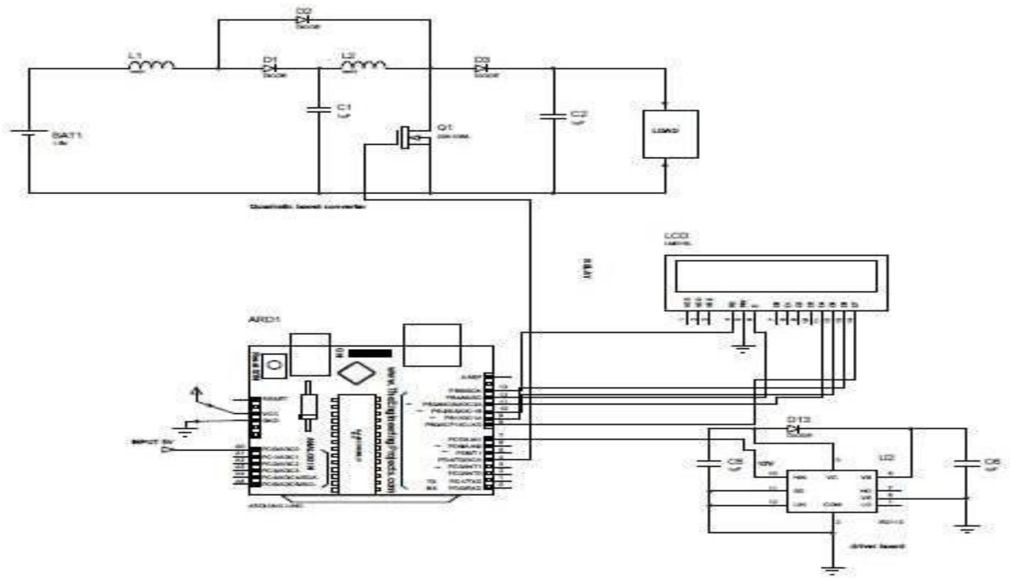

Figure : **Proposed System**

DC-DC converters are considered to be of great economical importance in today and are widely used at home solar systems to produce the desired output power. DC nanogrid is a low-power dc distribution system suitable for residential power applications. The average load demand in the nanogrid is generally met by the local renewable energy sources like solar, wind, etc. An energy storage unit is also required in the nanogrid to ensure uninterruptible power supply to the critical loads and to maintain power balance in the system. Fig.1 shows the general architecture of a nanogrid, consisting of both ac and dc loads. The diode D in figure is associated as a series blocking diode in order to avoid reverse power flow. As the dynamic behaviours of all the different units of nanogrid are not uniform, they are interfaced to a common dc bus using power electronic converters, solar panel as an energy source, a storage unit and some dc and local ac loads. The Fig.1 incorporates three different power converter stages to interface with the renewable energy resources for ac as well as dc loads. This paper analyse and implement a new double stage boost converter with single switch is developed which has the same voltage gain as the series connection of two boost converters and termed as quadratic boost converter (QBC).Fig.2 shows quadratic boost based dc nanogrid, where there is no need to incorporate step up transformers and conversion range is large compared to conventional boost converters

V. RESULT AND DISCUSSION

For Boost converter on the basis of theoretical and simulated output it is verified that for the input voltage of 10V the output get boosted only upto 20V at duty ratio 0.5.But in Quadratic Boost converter for the same input voltage the output get boosted up to 40V for same duty ratio.

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Duty Ratio	Quadratic Boost Converter				
	Input Voltage (V)	Input Current (A)	Output Voltage (V)	Output Current (A)	Efficiency
0.2	10	0.3	13.54	0.1354	61%
0.5	10	1.85	35.35	0.3535	67%
0.7	10	10.5	88.26	0.8826	74%

Parameters	Specification
Maximum power (P_m)	100 W
Open circuit voltage (V_{oc})	21.5 V
Short circuit current (I_{sc})	6.22 A
Voltage at maximum power (V_m)	17.30 V
Current at maximum power (I_m)	5.8 A
Short-circuit current temp coefficient	6.928 mA/°C
Open-circuit voltage temp coefficient	−0.068 V/°C
Module size	36 cells (4 × 9)
Inductor L_1	250 μH
Inductor L_2	250 μH
Inductor parasitic resistance r_L	1.00 Ω

Figure: Parameter of Quadratic Boost Converter

VI.CONCLUSION

Compared to basic converter topologies, quadratic boost converter posses quadratic conversion ratio which offers significantly wider conversion range. As far as conversion efficiency is concerned, it is quite clear that a singlestage 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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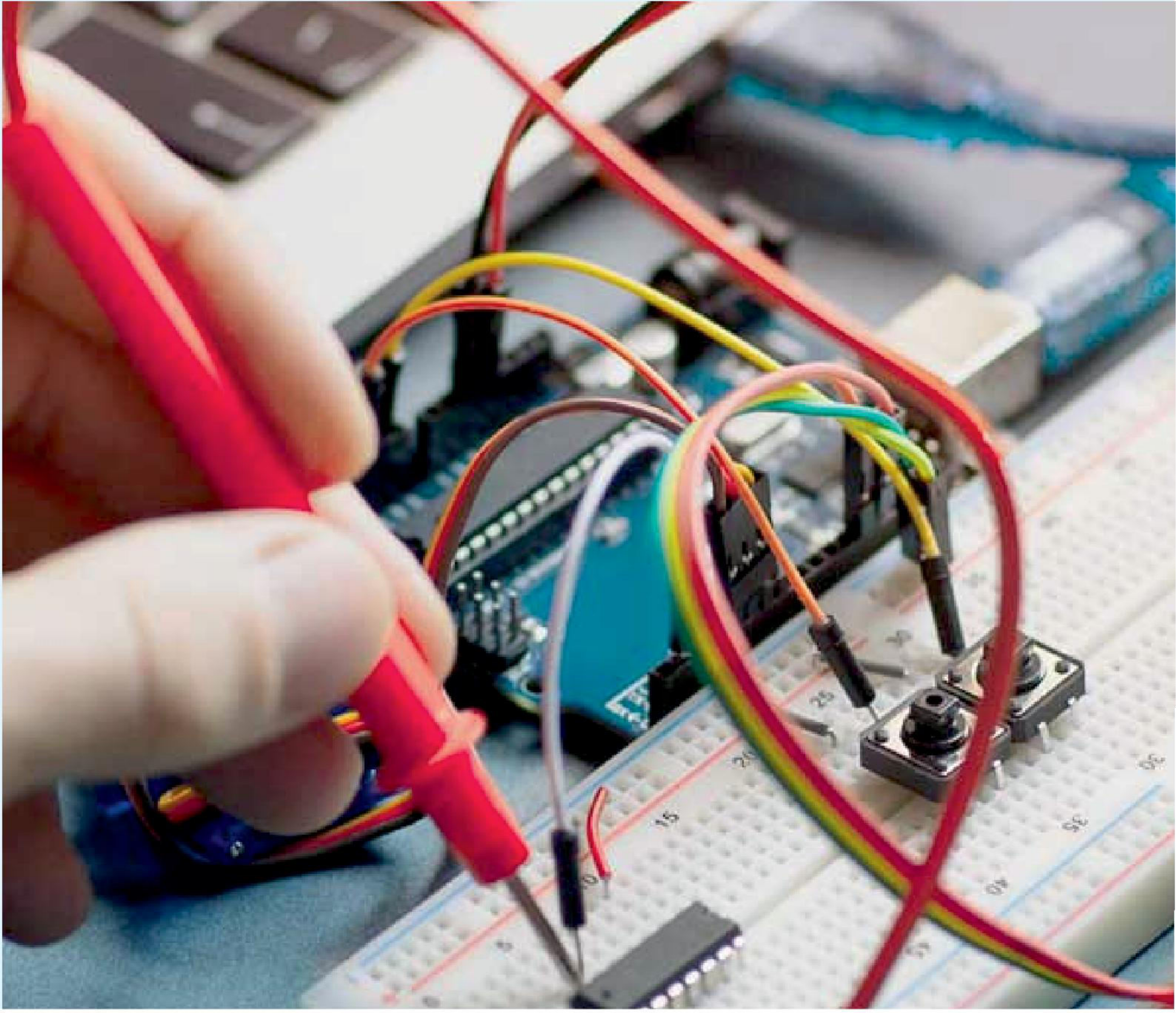

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