DESIGN AND IMPLEMENTATION OF QUADRATIC BOOST CONVERTER FOR APPLICATION OF BLDC MOTOR

Mr. Manoj kumar J A[1], Mrs. Harini Vaikund[2]

[1]Department of Electrical and Electronics Engineering, Dr. Ambedkar Institute Of Technology, Bengaluru 560056
[2]Assistant Proffesor in Electrical and Electronics Engineering, Dr. Ambedkar Institue Of Technology
Bengaluru 560056

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Abstract - *The purpose of this paper is to design a quadratic boost converter (QBC) with the help of MATLAB-SIMULINK. The BLDC motor is made run using the quadratic boost converter. Numerous industries, including aviation, automation, industrial process control, precise machine tools, automotive electronics, and residential applications are using these motors extensively. The pulse width modulation (PWM) current controller technology is used in the paper to effectively control the speed of a BLDC motor. It is noted how the BLDC motor behaves in terms of speed and torque as well as the current and voltage components of the inverter. An elaborate explanation about quadratic boost converter for application of BLDC motor is shown. Here quadratic boost converter used for the application of BLDC motor simulation is done in MATLAB - SIMULINK software and in hardware also it is implemented.*

Key Words: **Quadratic boost converter (QBC), Three phase inverter, MOSFET, Aurdino UNO, Brushless dc motor (BLDC) etc…**

1. INTRODUCTION

In the majority of applications with low power demands, the demand for distributing dc-dc electricity, high-frequency power conversion is continuously rising day by day. The development of converters for point-of-load applications is given more consideration by designers, with a focus on achieving objectives including greater power density, improved conversion efficiency at full load, and less electromagnetic interference (EMI). The design challenges for the application engineer are: (i) formulation of non-isolated topologies free of transformers; (ii) minimum ripples together with minimal requirement in L, C components; and (iii) reduction in the size of the filtering components together reduced severity/impact of electromagnetic interference. Multiple point-of-load converters are increasingly used in low power distribution systems (EMI). High-frequency switching is commonly used to create point-of-load converters, which are more compact, lighter, and have higher power densities thanks to the development of low loss magnetic materials. Many power electronic converters, or dc-dc conversion systems, that can generate stable voltages to drive dc loads have been reported in the literature. They can be broadly categorised as: (i) bucking-based circuits, (ii) boosting circuits, and (iii) buck-boost and other relatively high converter circuits. These converter circuits have a broad range of uses, including: (i) specialised low-power integrated circuits; (ii) powering small automotive devices or loads; (iii) complex loads like biomedical equipment; and (iii) internet, wide area network, and local area network services, and (iv) equipment for defence, spacecraft power systems, and communications power supply systems. Commonly used in front-end power processing and power factor applications are boosting dc-dc converters. To generate greater load voltages from low voltage dc batteries, point of load converters are used in back-end applications. To achieve high voltage gain, the standard boost dc-dc converter must be powered at a high duty ratio, but the related operation may not be practical from an efficiency standpoint.

2. QUADRATIC BOOST CONVERTER

An ordinary Boost Converter (BC) has several switching properties that increase I2R losses make them unsuitable for use in high-power sectors where great efficiency is the key to success. As a result, the Quadratic Boost Converter (QBC), a cascaded version of two standard boost converters with one switch acting as a MOSFET to lower losses and boost efficiency, is presented. Low saturation levels and unsteady voltage control are drawbacks.

3. THREE PHASE VOLTAGE SOURCE INVERTER

An inverter, transforms a DC amount into an AC amount. By adjusting the duty cycle frequency of the voltage source inverter, we may alter the frequency of a output voltages, which may have a constant or variable frequency. The ac voltage output to dc input voltage ratio is known as the inverter gain. An efficient inverter will have sinusoidal output voltages. An ordinary Boost Converter (BC) has several switching properties that increase I2R losses make them unsuitable for use in high-power sectors where great efficiency is the key to success. As a result, the Quadratic Boost Converter (QBC), a cascaded version of two standard boost converters with one switch acting as a MOSFET to lower losses and boost efficiency, is presented. Low saturation levels and unsteady voltage control are drawbacks.

4. BRUSHLESS DC MOTOR

An electronically commutated DC motor without brushes is referred to as a BLDC motor. The synchronous motor's speed and torque are controlled by the controller by sending short bursts of current to the motor windings. BLDC motors are very effective at generating a lot of torque across speed range. In brushless motors, the problem of attaching electricity to the armature is resolved by moving permanent magnets with a fixed armature. Transportation based on electronics gives a wide range of options and adaptability. They are renowned for their ability to retain torque at rest and for their silent operation.

5. BLOCK DIAGRAM

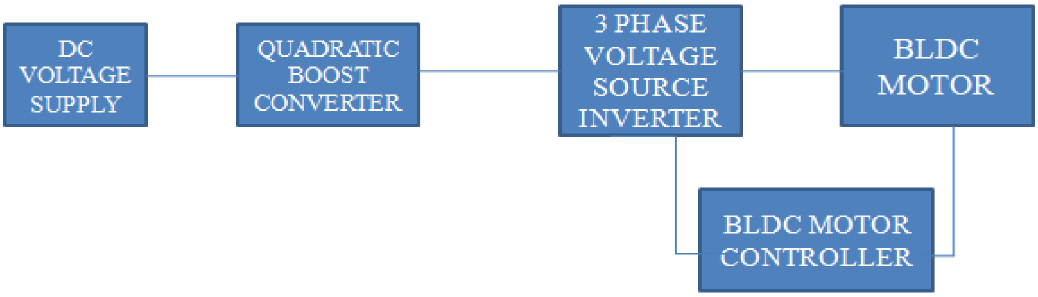


Fig-1: Block diagram

The system's implementation block diagram shows a BLDC motor, a VSI inverter, a DC to DC converter, and a controller, or BLDC motor controller, to manage the motor's behaviour and functioning. The QBC is shown in previous picture as a DC supply converter that replaces the normal converter with a QBC. Switches, input Ripple and output ripple are all reduced in the circuit by using a QBC. The output of the QBC is then sent to the inverter, which generates a constant output torque by sequentially switching the motor's stator windings, resulting in a constant output power. The motor controller uses a hall effect sensor to determine the speed and location of the motor. The whole simulation diagram of a solar power supplied BLDC is shown in the following image. A specific load application was driven by a BLDC motor in the simulation model.

5. SIMULATION

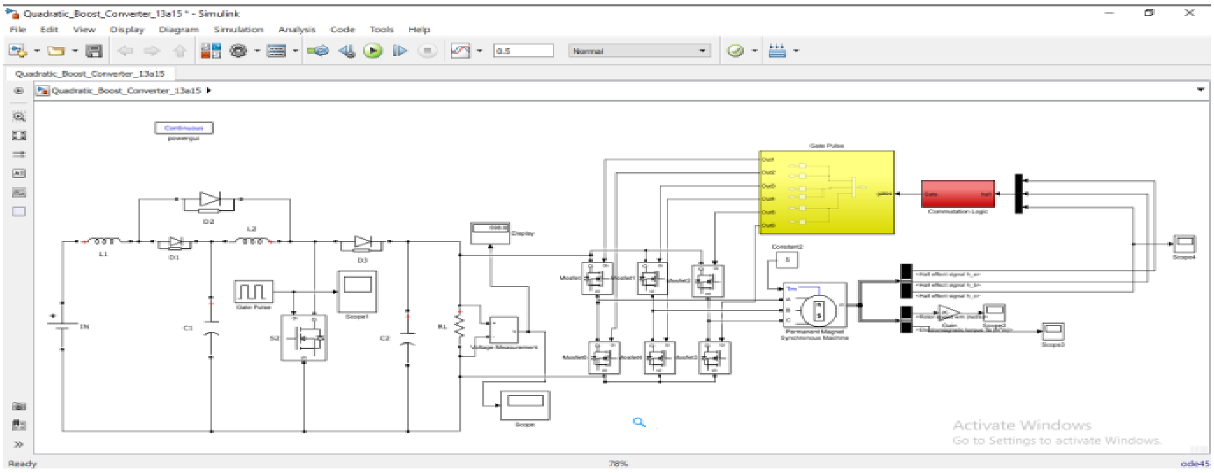


Fig-2: Simulation of the Block diagram

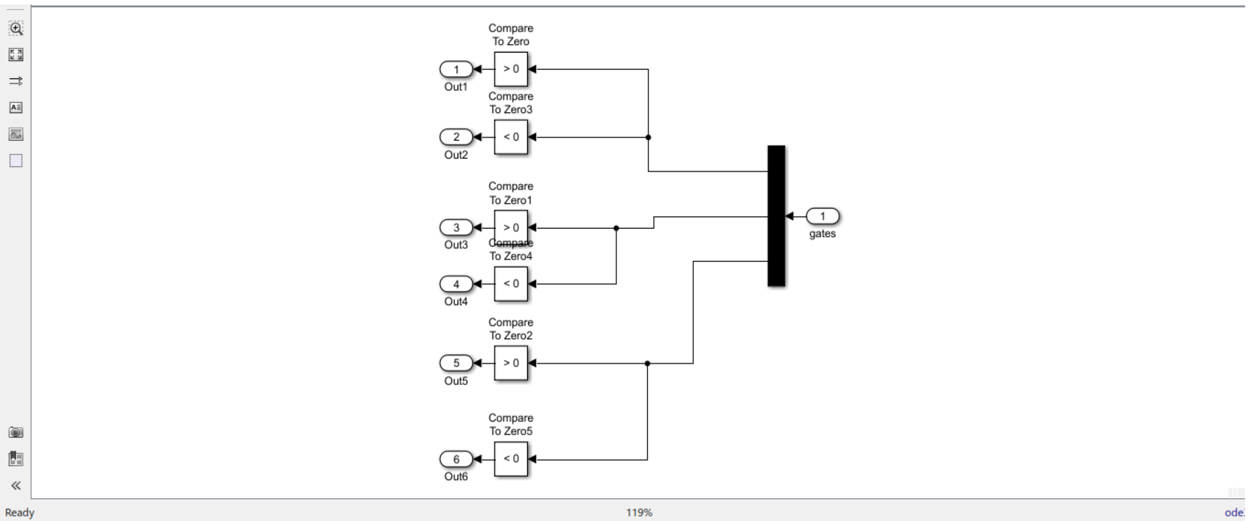


Fig-3: Gate Pluse circuit

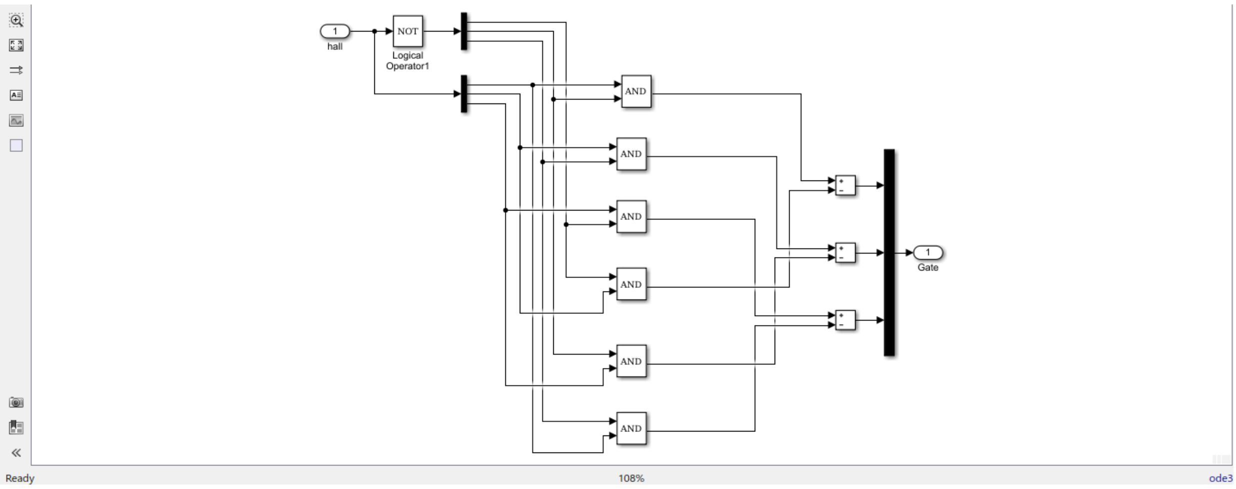
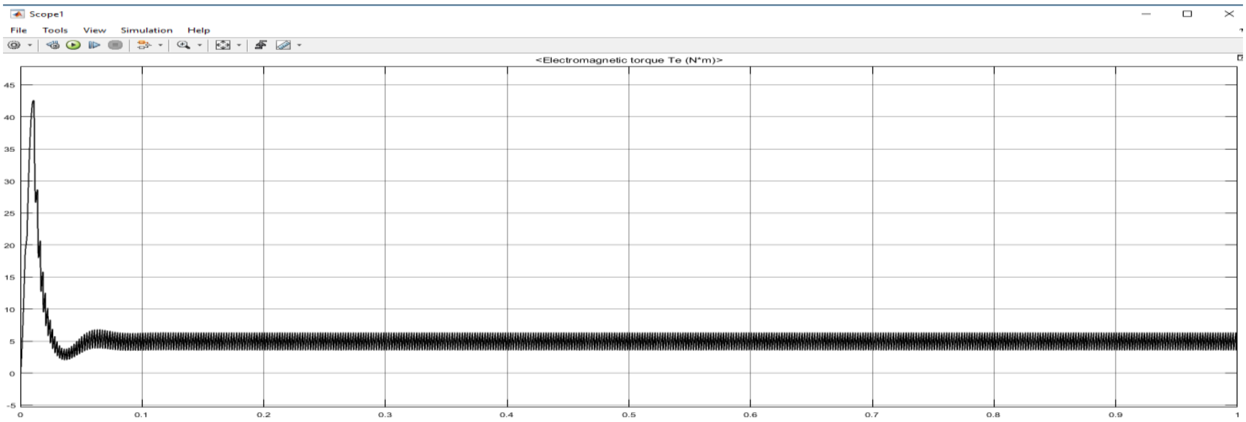


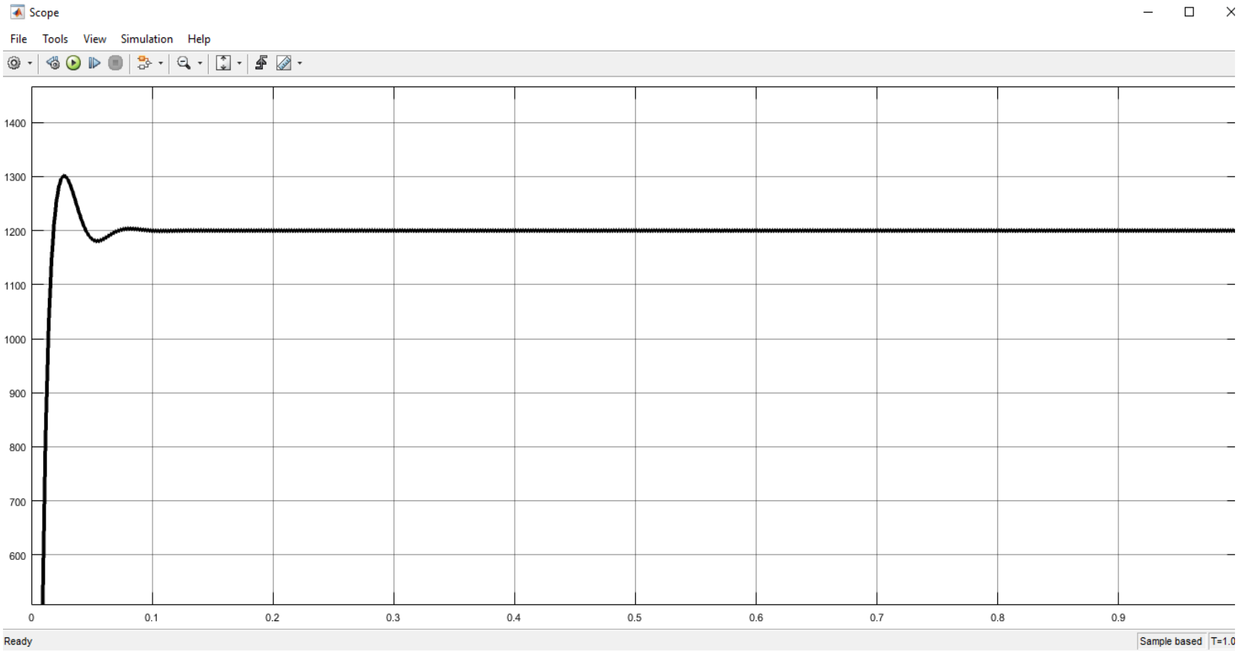
Fig-4: Commutation Logic circuit



Duty cycle (x-axis), Torque (y-axis)

Fig-5: Electromagnetic torque (Te)

Duty cycle(x-axis)	Torque (y-axis)(Nm)
0.01	43
0.03	2
0.05	7
0.1	5
0.5	5



Duty cycle (x-axis), Rotor speed (y-axis)

Fig-6: Rotor speed (w_m)

Duty cycle(x-axis)	Rotor speed (y-axis)(Wm)
0.02	1300
0.05	1170
0.1	1200
0.2	1200
0.9	1200

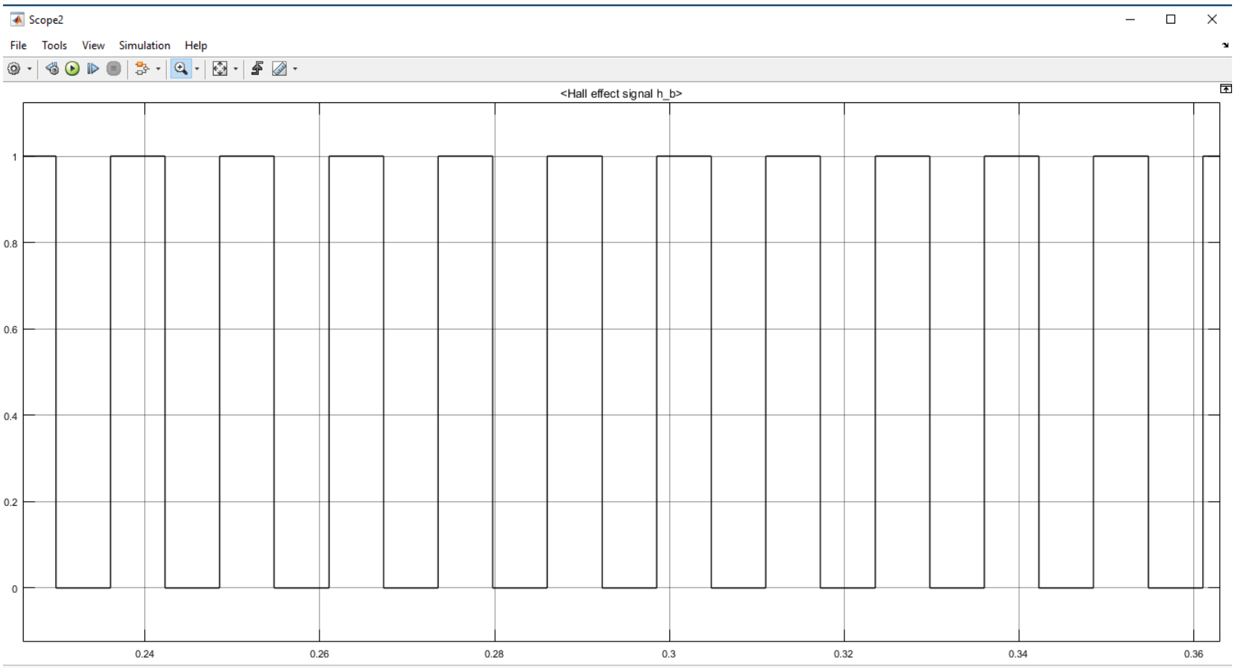


Fig-7: Hall effect signal

6. HARDWARE IMPLEMENTATION

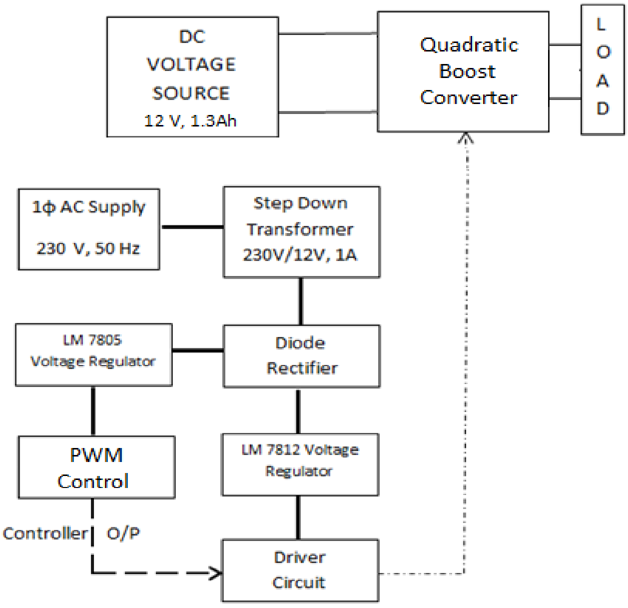


Fig-8: Hardware implementation of QBC

To convert the voltage ratio of the step down transformer, which is 230/12 V, 1A, 50Hz, to DC voltage and control it, a single phase AC supply of 230V, 50Hz, is used. The 12V ac voltage is changed to 12V DC voltage using a diode rectifier. The 5V and 12V voltage regulators receive the rectified dc voltage.

The driver circuit is given a 12V regulated dc supply so that it may drive the Power Electronic switches of the suggested inverter as in accordance with the gate pulses produced by the controller.

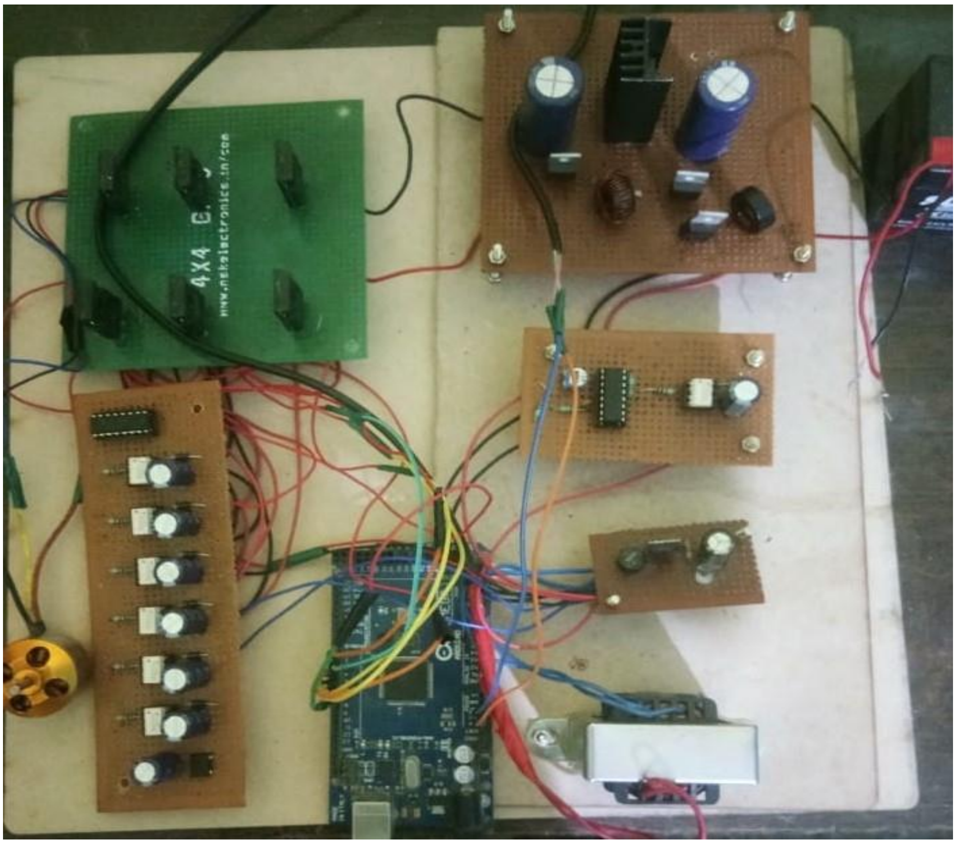


Fig-9: Hardware model of quadratic boost converter application of bldc motor

The quadratic boost converter is powered by a 12V, 1.3Ah battery and has a 100 resistive load. For the switch's gate terminal, 10 KHz pulses are offered.

Fig-10: Pulse of MOSFET

Fig-11: Output of quadratic boost onverter

The load voltage is around 44V which is 3.67 times higher than that of input battery voltage for the duty ratio 0f 33%.

7. CONCLUSION

It has been noted that the input voltage given in both the hardware and software situations is around 12 V. Originally rated at 50 W, the device's power consumption has decreased to about 32W as a result of loss in the hardware implementation. In both the hardware implementation and simulation, the output voltage increased by a factor of four to 48 V, which is exactly twice the 24 V target value for a traditional boost converter. In both instances, the switching frequency was set at 50 kHz, which is recommended for QBC's with efficiency and high gain. The BLDC motor made to run by quadratic boost converter using the three phase inverter for the power of 32W.

8. REFERENCES

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