# A Review on Modified DC-DC Converter FED to BLDC System

Saurabh Jodh[1], Suyog Debe[2], Shubham Nandanwar[3], Prof. Ashutosh Joshi[4]
[1,2,3,4] *Department of Electrical Engineering, J.D College of Engineering and Management, Nagpur, India*

***Abstract* - This paper deals with a modified DC-DC converter fed to brushless DC motor (BLDC drive) using the BLDC controller and Arduino which is powered by a photovoltaic array which will be used for water pumping application to achieve maximum efficiency. This converter step-up the applied dc voltage 17 volts into approximately 48 volts. The planning of this circuit is easy and low cost. The BLDC drive is used because its speed control is done by pulse width modulation (PWM) and maximum power point tracking (MPPT). The performance analysis of the proposed circuit is tested into MATLAB Simulation shown in this paper.**

***Index Terms* - Converter, Arduino, PWM, MPPT, MATLAB.**

## I.INTRODUCTION

Globally energy crisis has caused a lack of energy between nations. Renewable energy is reliable and very cheap once technology and infrastructure improve. They differ from fossil as they produce do not produce greenhouse gases and other air-polluting gasses. Renewable energy produces low levels of carbon emissions and therefore helps combat climate change caused by fossil fuel usage. So, the more use of renewable sources will reduce dependency on non-renewable fuel source. Renewable clean power that is produced every day of the year, even a cloudy day produce some power. It could be also used as a back-up system. We know that solar energy is clean energy which comes without harming and polluting the environment. It is used in a stand-alone system such as a water pumping system. In small villages where electricity is not provided, this system is suitable for it. A pump is especially utilized to decrease downtime from heavy rains and to transfer water from one area to another. This system converts the sunlight into electricity used for pumping waters. A solar water pump is used for removing water from ponds, rivers, bore wells, or other sources of water that are then used to fulfil the water necessities for irrigation, community water supply, and different functions. A solar water pump has advantages of low operating cost, low maintenance, simple & highly reliable, eco-friendly, and economically beneficial.

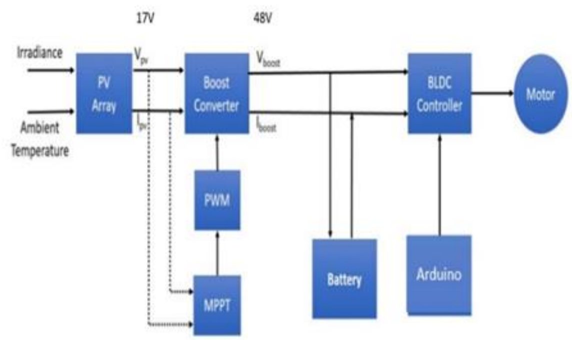


Figure (a) Block diagram of the proposed topology

The proposed boost converter topology based solar-powered water pumping system comprises of PV array, battery, BLDC drive plus its controller and boost converter. PV array generates the power depends on irradiance available on the panel and ambient temperature. Here MPPT is used to achieve maximum efficiency, as parameters of power generated by PV array are fed to MPPT. Depends on the MPPT output PWM signal generator generates pulses to operate the boost converter [3][4]. To control the speed and torque of the BLDC drive, the BLDC controller is used which operates signals given by the Arduino by converting the DC voltage from the source into pulses.

The BLDC drive is used to its high-power density, vast speed range above 10,000 rpm, high torque-speed characteristics as well as less maintenance, and high efficiency. BLDC motor so is beneficial than any other motor. A battery is used in this system to store the energy when the system is not in the application and also to use in an emergency power failure. The battery will be a rechargeable battery.

The boost converter consists of two topologies which split inductor topology and the other is switch capacitor [1]. Split inductor increases efficiency, reduce the size of the circuit and give faster transient response whereas the switched capacitor has the advantage of compactness, tenability, and by the use of this parameter in the circuit, the efficiency greater than 90%

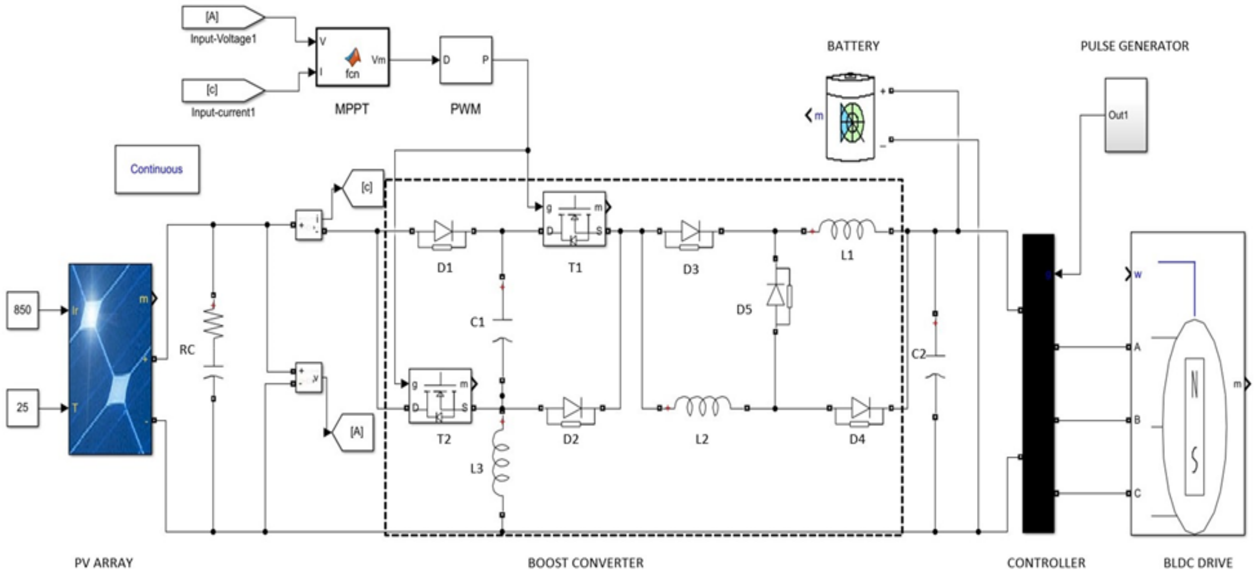


Figure (b) Proposed DC-DC Converter Fed To BLDC System

is achievable [5][6]. By the insertion of a split inductor instead of a single inductor in a switch capacitor-based converter the output voltage gain is increased which is verified and analysed in MATLAB Simulink shown in this paper.

## II. BOOST CONVERTER

A boost converter is DC to DC power electronic circuit which steps up the input voltage. The figure shows the basic circuit of dc to dc boost converter. The basic circuit consists of minimum two semiconductor devices such as diode and transistor and minimum one inductor and capacitor. A combination of both elements can reduce ripples in output voltage. Input can be a DC source, such as batteries, solar panels, rectifiers, and DC generators.

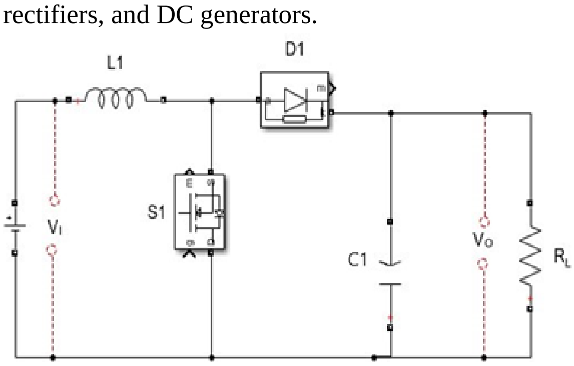


Figure (c) Basic structure of boost converter

## III. PROPOSED WORK

It is not possible to run BLDC motor on 12V of battery since it requires 48V for its operation. Thus, the voltage obtained from the battery is boosted to 48V using a boost converter. The boost converter always provides 48V voltage to the motor irrespective of the battery input voltage. The figure below shows the proposed topology for dc to dc boost converter.

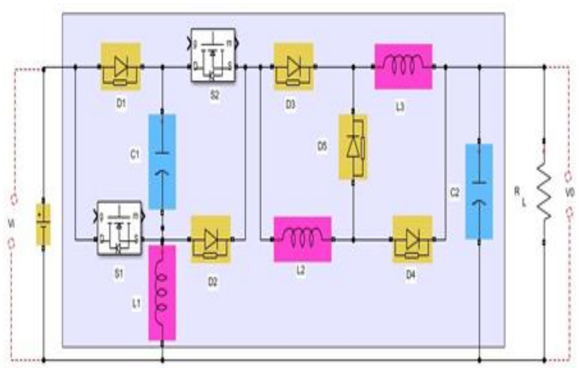

Figure (d) SI & SC-based converter topology [1]

## IV. WORKING OF BOOST CONVERTER

The objectives of this research article are shown below:

1. Explain the working of the proposed high gain Boost using a combination of a split inductor and switch capacitor topology.
2. Describe the modes of operation for the proposed converters to explain the use of converter for independent PV systems.
3. Analyze the voltage gain and efficiency of the proposed boost converter
4. Guide for future work on a combination of SIBBC and SCBBC.

The content of this paper shows the topology of SIBBC and SCBBC. The mode of operation is discussed in section A and the MATLAB Simulink results are shown in Section B.

A. MODE OF OPERATION

MODE 1: -

In Type-A operation, both switches S1 and S2 are in pulse width modulation (PWM).

MODE 2: -

Simultaneously in Type-B, operation S1 is completely OFF and S2 is in PWM mode.

MODE 3: -

In Type-C operation, S1 is in PWM mode and S2 is continuously in ON-state.

TABLE I. MODE OF OPERATION

| Modes of operation / Status of Switch | Type | | |
|---|---|---|---|
| | *Type A* | *Type B* | *Type C* |
| S1 | MPPT based PWM signal | Completely OFF | MPPT based PWM signal |
| S2 | MPPT based PWM signal | MPPT based PWM signal | Continuously ON |

The below figure shows the basic structure of the proposed boost converter.

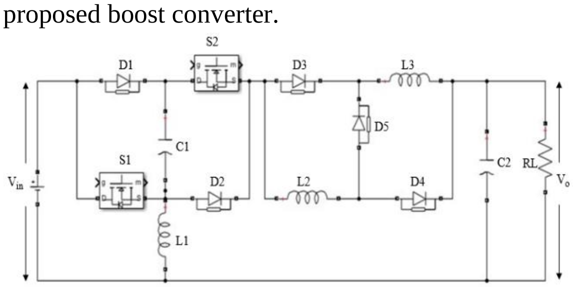


Figure (e) Operating Circuit [1]

The topology is shown in Fig. (d) performs Type-A operation where the switches S1 and S2 are turned on simultaneously. With this switching action (S1 and S2 in PWM together), the capacitor C1 is connected at the source side and capacitor C2 load side. It is this switching action of the capacitor which is primarily responsible for the transfer of energy from source to load [2] [7]. When the switches (S1, S2) are ON (mode-1), C1 & C2 gets connected to the load side via inductor L2 & L3, whereas with D1, D3 are ON together (mode-2) as shown in Fig. (e). C1 gets connected to the source via inductor L1. Due to this interconnection of C1 with input dc-source in all modes (either through L1 or L2 or L3), the source current is always equivalent to the value of the three inductor currents. As the inductor (L1, L2, and L3) currents are continuous with less ripple content, the dc-source current also exhibits limited ripple content. Although the proposed has two extra switching devices over which are capacitor and inductor, it possesses the following salient features:

1. Buck-boost features like that of CBBC and conventional TSBBC.
2. Lesser source current ripple for Type-A to Type-C operations.
3. Positive output voltage polarity with the common ground between the source and load.

B. Input & Output Waveform

We use the MATLAB Simulation for analysis of the efficiency of the proposed topology. Input voltage from was given 17V and the output voltage was observed approximately 48V constant. The input and output waveform is shown below.

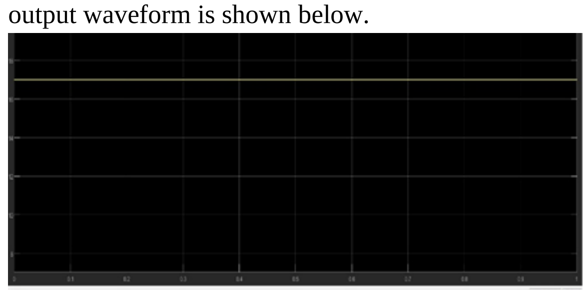

Figure (f) Input Voltage 17V

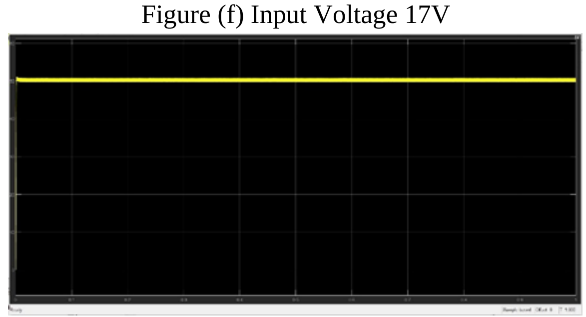

Figure (g) Output Voltage 48V

## V. ADVANTAGES

1. The solar panel is a reliable and very cheap technology. It is also a renewable energy source that produces low levels of carbon emissions. It is clean power which reduces the dependence on foreign oil and fossil fuels. It increases income automatically, particularly for remote users as it consumes less energy with no fuel cost.
2. The converter can boost the input with less ripple and high voltage gain output.
3. The proposed system is a standalone system. In emergency power failure the stored battery power can be used.
4. BLDC Drive is 90% more efficient than induction motor as it has higher efficiency, precise control of torque, and speed and hence saves more energy which will be stored in the battery. The stored energy in the battery will be used at nighttime as well in the daytime in case of supply failure through the solar panel.
5. MPPT algorithm is easy to comprehend just as execute and it is programmed with customizable set-points that can be altered and adjusted changed by user needs.

## VI. CONCLUSION

A split-inductor cell-based boost converter (SIBBC) and switch capacitor-based boost converter (SCBBC) topologies were generated in this paper. The analysis revealed that replacing anyone inductance of the switching-capacitor based boost converter with a split-inductor cell modifies the voltage gain features. The switch voltage stress of the SIBBC topologies is identical to the basic switching-capacitor based boost converter. The proposed SIBBC and SCBBC effectiveness in terms of load voltage bucking/boosting together with regulation was shown experimentally.

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