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PHOTOVOLTAIC BOOST CONVERTER FED BLDC DRIVE

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Abstract: Due to the depleting nature of the present energy sources as well as the increased pollution Renewable energy sources are increasingly used in many applications, solar energy is the best alternative to the conventional energy sources. This paper deals with the event of an easy , profit making, useful, reliable and fuel efficient water pumping system, a DC-DC converter fed to the brushless DC motor (BLDC drive) using the BLDC controller and Arduino which is energized by a photovoltaic array. The behavior of the proposed system is evaluated through a MATLAB/Simulink based simulation study.

Index Terms **- Solar Photovoltaic (SPV), MPPT, Converter, Arduino, BLDC Motor.**

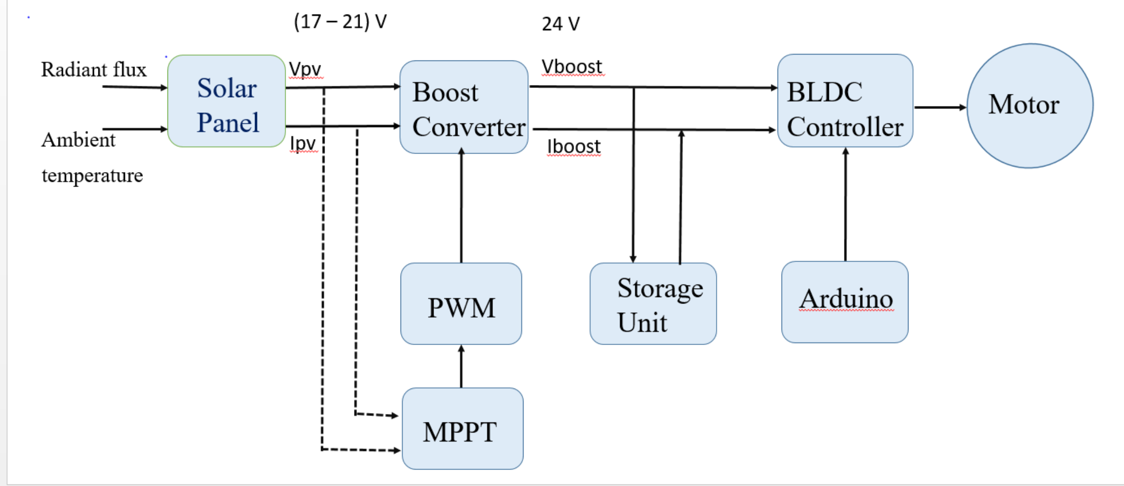
I. INTRODUCTION

In the Present scenario the energy demand is increasing gradually. But non renewable sources have existed only for a few years, this motivates us to use renewable energy sources. Renewable energy provides reliable power supplies and fuel variegation which increase energy security and lower risk of fuel spills while reducing the need for imported fuels. Out of the renewable energy sources, solar PV is becoming the current trend due to its large availability and it is capable to supply the present and future demand. A continuous reduction in the cost of the solar photovoltaic (SPV) panels and the power electronics devices has inspired the industries to utilize the solar PV array generated power for different applications.

As agriculture is one of the important sources for sustainable development, water pumping becoming critical. In remote areas solar powered water pumping is very useful. Water pumping has gained a broad attention as a decisive and cost effective application of the solar PV array generated power. A maximum efficiency of the solar PV array is achieved through a maximum power point tracking (MPPT) algorithm [1-2] using the DC-DC converters. Various DC-DC converters such as buck [3], boost [4], buck - boost [5], SEPIC (Single Ended Primary Inductor Converter) [2-3] have been used for MPPT in different solar PV array based applications. The aforesaid non-isolated DC-DC converters are compared in to find a better solution suiting an application with MPPT. It has been concluded that the best selection of DC–DC converter in the PV system is the buck–boost DC–DC converter since it is capable of achieving. Due to a number of benefits such as high reliability, less maintenance, high efficiency the conventional motor pumps such as DC motor based pumps and Induction Motor based pumps are nowadays replaced with BLDC based water pumps. A water pump is used for removing water from ponds, rivers, bore wells, or other sources of water. A solar water pump advantages of having low operating cost, low maintenance simple & highly reliable, eco-friendly, and economically beneficial.

The solar energy available is less compared to the requirement. Thus a DC-DC converter is used in between the panel and load to tracked maximum power. It can boost up the voltage and using some maximum power point tracking (MPPT) methods the duty ratio of converter controlled to bring off the maximum power point.

Figure (a) Block diagram of the proposed topology



II. SYSTEM DESCRIPTION

The block diagram of the proposed boost converter topology based solar-powered water pumping system consists of the PV array, battery, BLDC drive plus its controller and boost converter. The solar panel is the power source of the whole system. Here MPPT is used to achieve maximum efficiency, as parameters of power generated by PV array are fed to MPPT. Based on the MPPT output PWM signal generator generates pulses to operate the boost converter [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 motor having the merits of high efficiency, high reliability, high ruggedness, low EMI problems and excellent performance over a wide range of speed above 10,000 rpm is used to drive this centrifugal pump. A battery is used in this system to store the energy when the system is not in the application and also to use in emergency power failure. The battery will be a rechargeable battery.

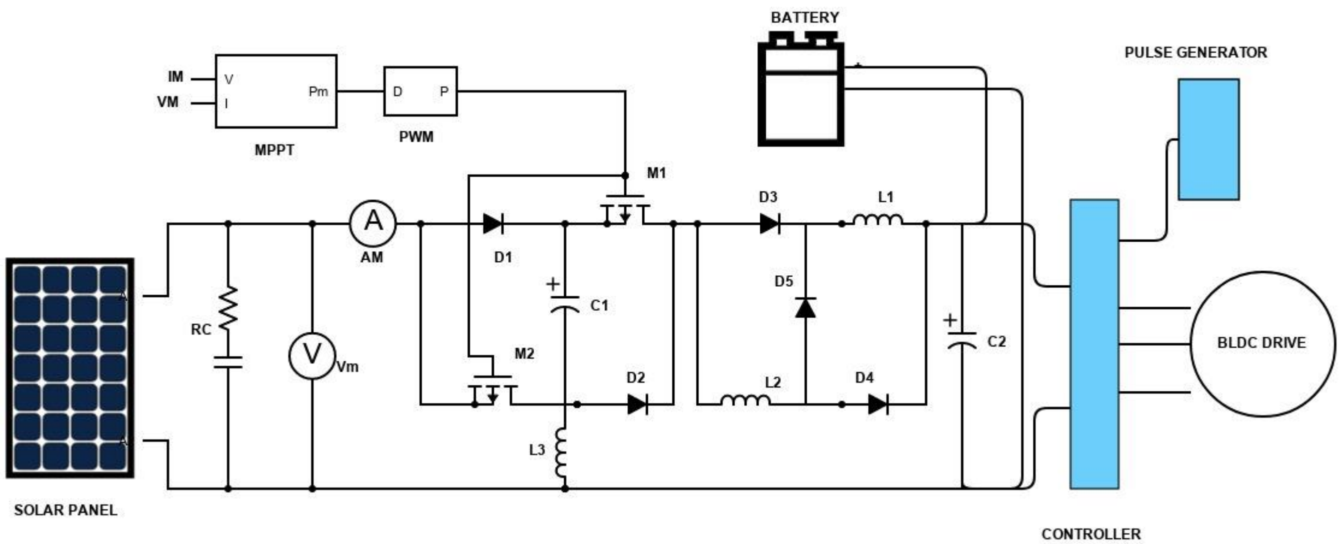


Figure (b) Proposed DC-DC Converter fed to BLDC system

The boost converter consists of two topologies which split inductor topology and the other is switched capacitor. Switched capacitor is a high gain converter.

It can achieve high voltage gain even with low duty cycle. Hence the voltage stress and conduction loss decrease. Whereas Split inductor increases efficiency, reduce the size of the circuit and give faster transient response. By the insertion of split inductor rather than one inductor in switch capacitor-based converter the output voltage gain is increased which is verified and analysed by MATLAB Simulation shown in this paper.

III. BOOST CONVERTER

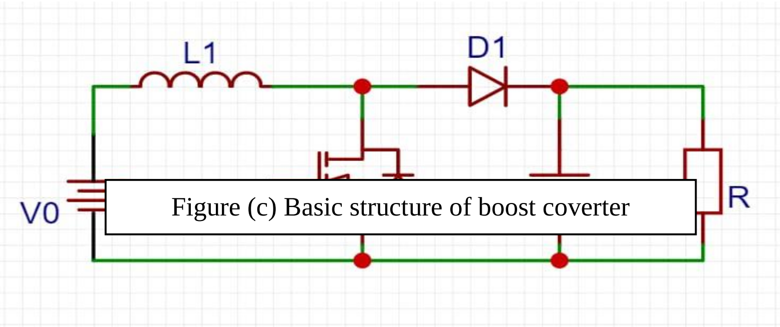


Figure (c) Basic structure of boost coverter

A boost converter is also known as a step-up converter or step up the chopper. It is a DC-to-DC power converter that increases the input DC voltage to a specified DC output voltage.

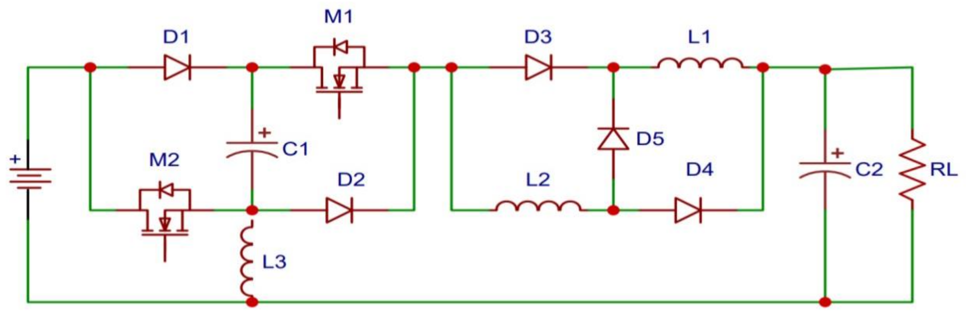


Figure (d) Operating circuit

The figure shows the basic circuit of DC-to-DC boost converter. Switching transistor is a Metal Oxide Silicon Field Effect Transistor (MOSFET) are used in power Switching. The DC input to a boost converter can be from many sources such as batteries, solar panels, rectifiers, fuel cells, dynamos and DC generators. However, it is important to remember that as power = voltage * Current. If the output voltage ids increased the available output current must be decreased.

IV. PROPOSED WORK

It is not practicable to run a 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.

V. WORKING OF BOOST CONVERTER

MODE OF OPERATION :

MODE-1 In type-A operation both switches M1 AND M2 are in pulse width modulation.

MODE-2 In type-B operation M1 is completely close and M2 is in pulse with modulation mode.

MODE-3 In type-C operation M1 is in pulse with modulation mode and M2 is continuously in an Open- state.

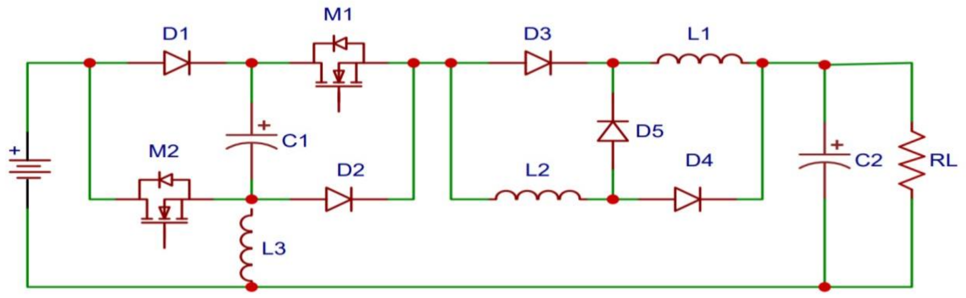


Figure (e) Basic structure of boost coverter

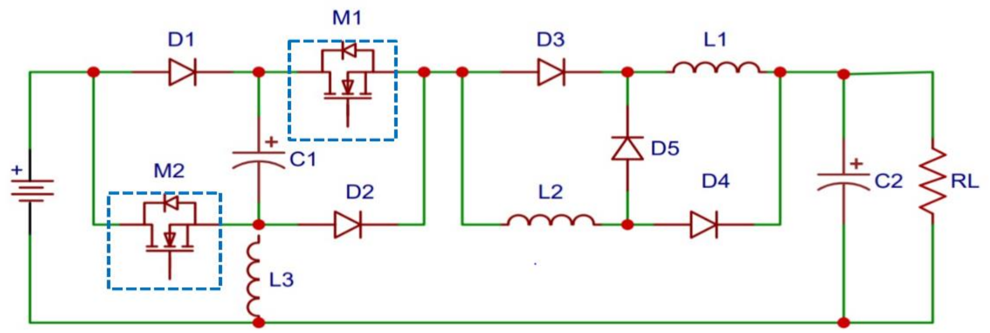


Figure (f) Mode of operation TYPE A

The SBBC topology shown in Fig. (f) Performs Type-A operation when its controllable switches M1 and M2 undergo PWM mode simultaneously. With this switching action, the capacitor C1 is connected either at the source side or load Side. It is this switching action of the capacitor C1 which is primarily responsible for the Transmit of energy from source to load.

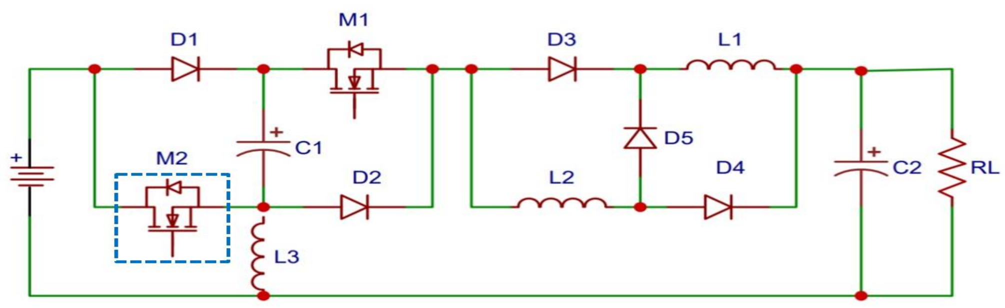


Figure (h) Mode of operation TYPE B

Fig. (g) Performs Type-B operation when its controllable switch, M2 undergo PWM mode

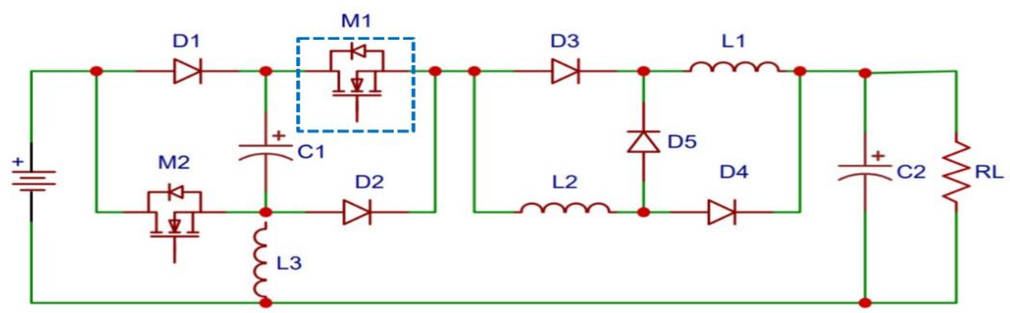


Figure (h) Mode of operation TYPE C

Fig. (h) Performs Type-C operation when its controllable switch M1 undergoes PWM mode

VI. INPUT AND OUTPUT WAVEFORM

We use the MATLAB Simulation over the 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 (i) Input voltage 17 volt Figure (j) Output voltage 48 volt.

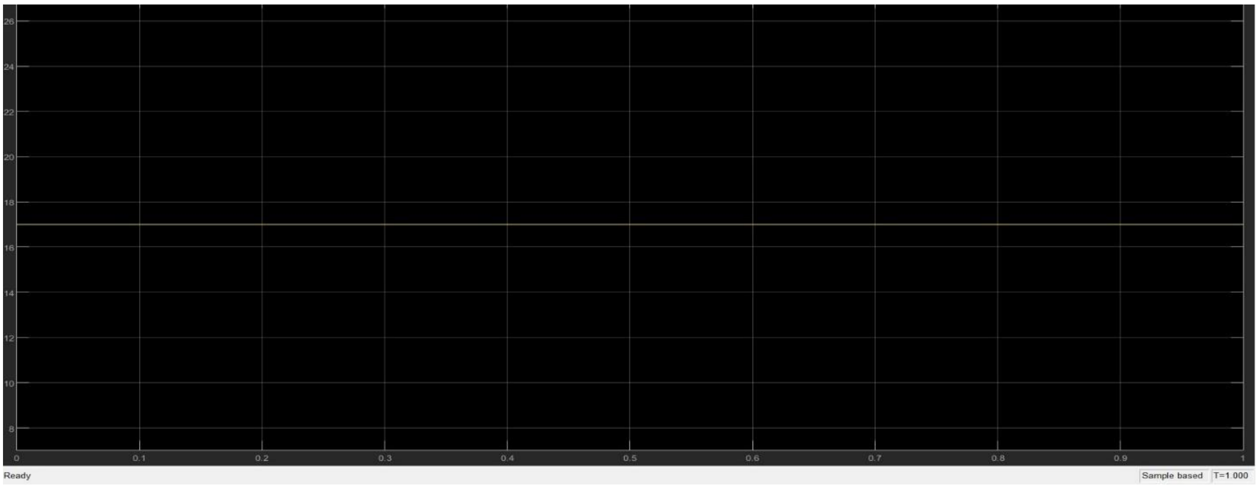


Figure (i) Input waveform voltage 17 V

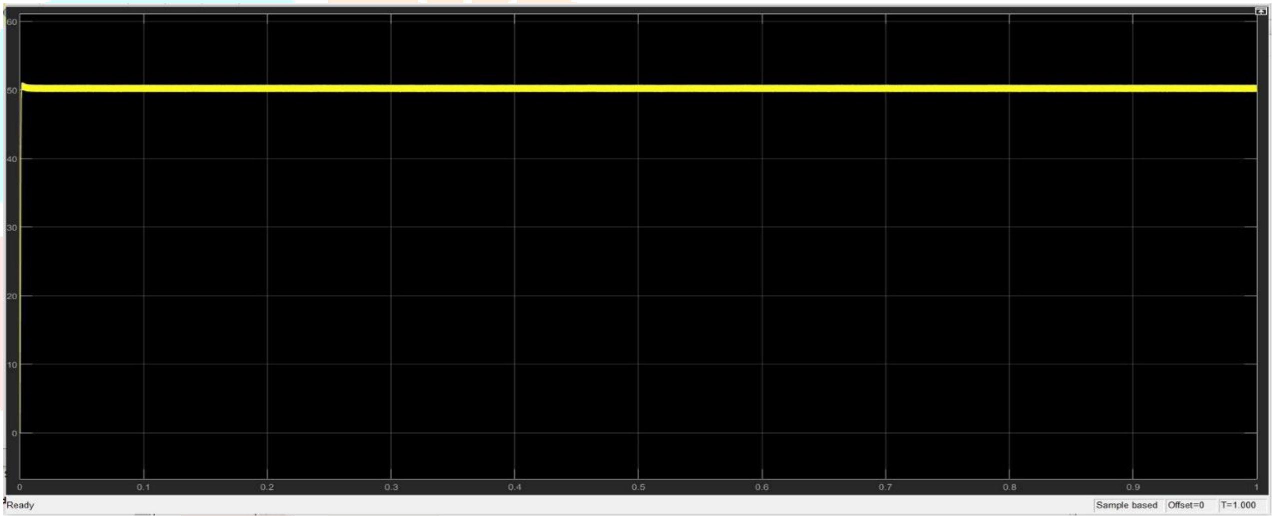


Figure (j) Output waveform voltage 48 V

VII. ADVANTAGES

1. Solar Energy is clean, renewable, sustainable and helping to protect our environment. It does not contribute to global warming which is the main problem the world is facing. The solar energy doesn't affect by the supply and demand of fuel and this leads the system to become economic. This system is virtually maintenance free. As per the future need more solar panels can be easily added. As there are no moving parts this system operates silently.

2. The converter results more efficient as it is boosting the quantity with less ripple and high voltage gain.

3. Batteries are used to store the energy to be used in case of emergency condition. This makes the system standalone.

4. BLDC drives has the properties like low operating noise, higher efficiency, precise control of torque and speed this makes it 85% hence it saves more energy. This stored additional energy can be used in emergency condition.

5. For extraction of maximum power from the PV module, MPPT solar charge controller is used. This makes the PV module to draw maximum power by operating it, at voltage close to maximum power point.

VIII. CONCLUSION

A split-inductor cell-based boost converter and switch capacitor-based boost converter topologies were formed in this paper. The analysis confessed that replacing anyone inductance of the switching-capacitor based boost converter to 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 the regulation was shown experimentally.

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