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Research Article

Multiport converter based hybrid power generation system

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Abstract

The present paper deals the hybrid application using bidirectional Direct current-Direct current converter in order to supply a constant power supply to grid. The operation of Zero current switching and Zero voltage switching can be obtained in the non isolated bidirectional converter by eliminating the transformer. Dual operation takes place in the converter even any power demand from the inputs. The existing system deals the isolated Bi-Directional Converter with the help of diesel generator. In this proposed system, multi input attains the non isolated Bi-Directional Converter for the three phase Alternating current supply to grid. The synchronous rectifier technique is used to reduce the losses. The voltage gain of the proposed converter is the half and the double of the conventional bidirectional DC-DC boost converter in the step-up modes. Therefore the proposed converter can be operated in wide-voltage-conversion range than the conventional bidirectional converter. The voltage stresses on the switches of the proposed converter are a half of the high-voltage side The switching loss and conduction loss can be minimized The converter has simple design, low power losses due to less components and can operate in single and double input modes. This can be analyzed in MATLAB simulation.

Keywords: Non- isolated bidirectional converter; Zero voltage switching; Zero current Switching.

Introduction

Generally, generators are often used as backup power supplies for buildings, industrial facilities, and power plants in the incident of a damage of helpfulness power [1]. Not only it helps in residential but also used for remote power generation for military, industrial, and personal use requires a reliable, compact and a lightweight power generation system. Since the engine generator may not be able to respond sudden load changes, energy storage devices should be used along with the engine generator to match the voltage level. Such operation can be done in Bi-Directional converter [2] to achieve efficient charging and discharging operation. The BDC is located between the high-voltage dc bus and the low-voltage battery which is also connected to the dc loads [3].

The DC load can be antilock brakes, electric power steering, fiery spaces, electronic ignition, and HVAC in the automobile. The dc–ac inverter converts the dc power to ac power to supply the critical ac load in the vehicle such as propagation equipment of outside broadcast van and communications equipment of pre-emptive means of transportation [4]. The ac–dc converter translates the ac power from the engine generator to the dc power, regulating the high-voltage dc bus. If the engine generator is capable of supplying the total demanded power of ac and dc loads, the ac–dc converter will be able to control the high-voltage dc bus, and the BDC will deliver the power from the engine generator to the low-voltage side [5]. If the engine generator is shut down or the total demanded power of the ac and dc loads is beyond the supreme power of the engine generator, high side bus voltage will drop off to a voltage depending on the capacitances of the dc bus capacitor.

Formerly, the BDC is required to take over the regulation duty of the high-voltage dc bus by changing over from V_L control (battery charging) to V_H control (battery discharging) so that it should be capable to transport power from the battery to the ac load. Hence, in order to provide uninterrupted power to thecritical ac loads and lessen the extent and price of the dc bus capacitor, the transition from V_L control to V_H control of the BDC should be seamless and as short as possible [6]. This is a crucial performance of the BDC, especially, in the

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automotive application where electrolytic capacitors cannot be used due to limited lifespan and bulky nature. A seamless changeover of the control target from V_L control to V_H control or vice versa has not been discussed so far. The BDC should provide a galvanic isolation and a high step up/down voltage conversion ratio in the application where the low-voltage battery is used [7].

Existing system

In this existing system, a two-stage BDC is attained for automotive engine power generators. The two-stage BDC consists of a non-isolated converter and a fixed-frequency series resonant converter (SRC). The SRC is designed to be capable of operating under ZCS turn-on and turn-off regardless of voltage and load variation in both forward and reverse operation [8,9]. Also, a new autonomous and seamless bidirectional voltage control approach is projected to afford uninterrupted power to the critical ac loads and reduce the dimension of the dc bus capacitor and the transition time [10,11].

There are two possible condition takes place in the operation of bi directional converter

Condition 1: voltage flows from low voltage side to high voltage side

Condition 2: voltage flows from high voltage side to low voltage side

Low voltage side to high voltage side

Mode I: Assume that the battery has already been fully charged. The engine generator is supplying the ac and dc loads during this mode. $V_H$is regulated to 400 V by the ac–dc converter and the reference voltage of the BDC is set at 380 V [12].

Mode II: This begins when the ac load increases and the sum of the ac and dc loads is greater than the maximum power that can be produced by the generator. Then, the AC-DC converter is not able to regulate the DC bus, and V_H drops off from 400 V. This means that the BDC starts to discharge the battery and regulate V_H to 380 V. As the battery voltage decreases, the output of the low side voltage controller increases up. This is the end of the mode.

***Mode III*:** The inductance at battery side is fixed at a constant value since the ac loadis constant. The BDC keeps discharging the battery and regulating V_H to 380 V.

High voltage side to low voltage side

***Mode I*:** This mode is identical to Mode III of low voltage to high voltage side. The BDC is discharging the battery and regulating V_H to 380 V.

***Mode II*:** This mode begins when the ac load decreases andthe sum of the ac and dc loads becomes smaller than maximum power from generator this makes the ac–dc converter capable of regulating V_H, recoveringit back to 400 V. So that BDC is able to regulate V_L to 28 V. Then, the BDC starts to charge the battery with a constantcurrent

***Mode III*:** When the battery voltage $V_L$gets close to reference voltage, then the battery gets steady of charging with constant voltage.

In this method, the BDC starts regulating V_H from the moment when $V_H$drops off from 400 V. This leads to significantly reduce undershoot voltage of V_H and overshoot of inductor current. The undershoot voltage of this control method is smaller than its limit value [13]. However, There is some drawbacks attained in the existing system such as non renewable energy, operation in bi directional converter takes place by isolation transformer. Since it gives the better efficiency but the investment cost is high because of transformer. The number of switches in the bi directional converter is high. So that the switching loss and the conduction loss is high. The size of the system is high. The constant voltage must be supplied to grid and it is depends only on diesel engine [14].

Proposed system

In the proposed system, the hybrid connection attained in the non isolated bi directional converter. The hybrid system can be made in renewable energy such as solar energy and wind energy as shown in Fig 1.

The battery is connected in hybrid for backup. The wind generator is connected to AC-DC converter , filter and DC-AC inverter . The output of the inverter gets connected to AC grid. In midst converter and the inverter non isolated bi directional converter is connected to reduce the harmonics from the wind generator. The another renewable energy is solar energy.

The Fig. 2 shows the non-isolated converter, the numbers of switches are reduced and also the transformer gets eliminated. The wind generator is operated with the help of generator speed, pitch angle and the wind speed. The wind speed can be measured with the help of anemometer. The pitch angle is used to fix the blade position in order to get the maximum speed for the constant power generation. The simulation circuit for wind generator is given below in Fig. 3.

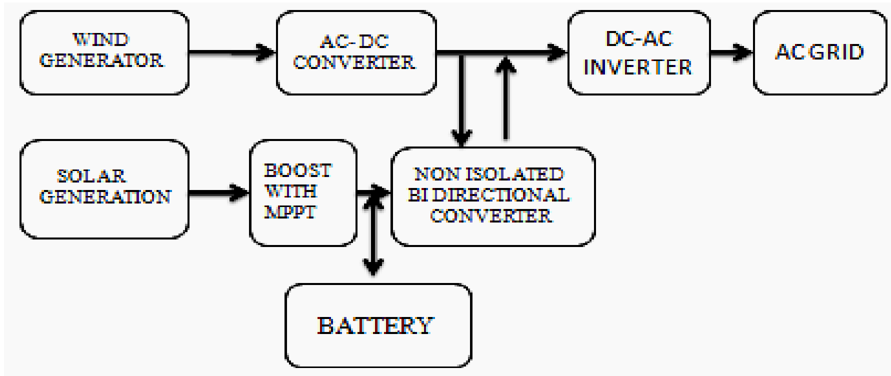

Fig. 1. Block diagram of proposed system

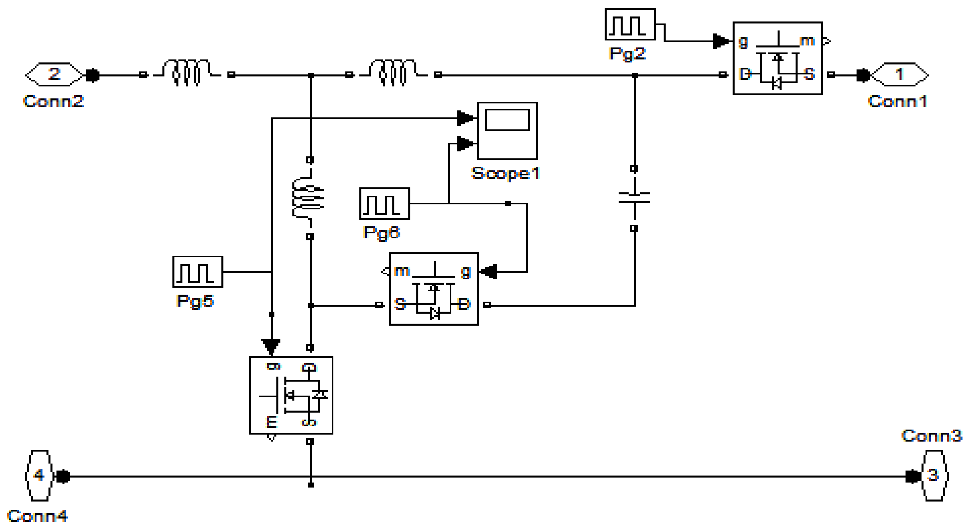

Fig. 2. Non isolated bi directional converter

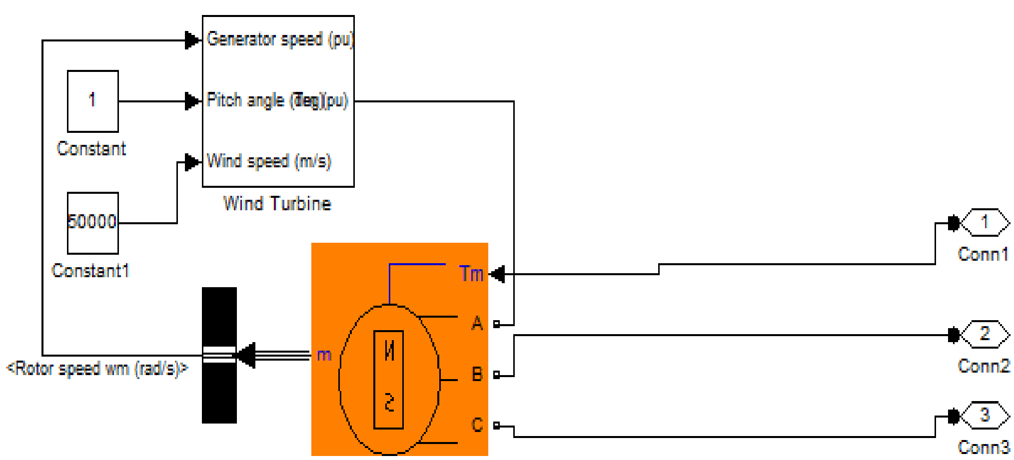

Fig. 3. Wind power generator circuit

The solar energy is utilized by the solar panel as shown in Fig 4. The required parameters for the solar panel are open circuit voltage and short circuit current. The PV module is connected to battery for back up. But we can't say that the required output would be getting from the panel. So that MPPT technique is required with boost converter to compensate the problem.

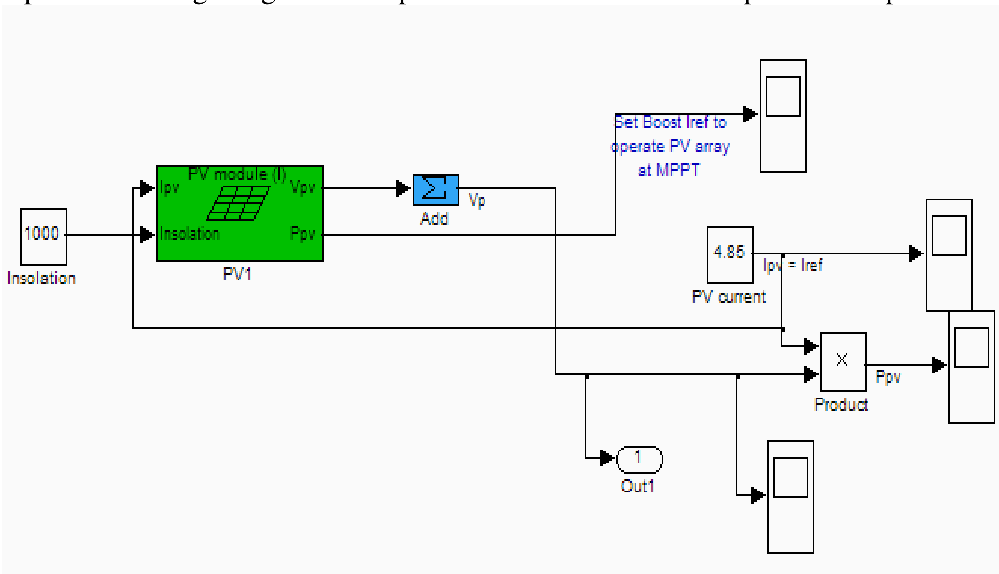

Fig. 4. Solar power generation circuit

The Fig. 5 shows the proposed simulation diagram the numbers of switches is reduced and also the transformer gets eliminated. Fig. 6 & Fig. 7 shows the input voltage from wind and solar. The Fig. 8 shows battery output voltage and Fig. 9 given status rectifier output voltage respectively. Tentative results confirmed the proposed control with the MPPT function. Fig. 10 shows the inverter switching pulses with the proposed control, the efficiency is improved load condition and the output power rating is increased up to 280 W as shown in Fig. 11. But the output power rating in the existing system is only 80 W. Thus the efficiency and the output power rating of the system are increased over wide long range. This project has proposed where a comparative study of different stages is been done and observed that the output voltage up to 220 v as shown in Fig. 12. Gain and efficiency are improved by replacing bi directional converter by non isolated bi directional converter. An important characteristic that can be seen in this topology is the reduced current ripple in Fig. 13, switching losses and conduction loss. Finally, we can say that as the number of stages increases the output voltage get boosted there by increasing the efficiency. Hence the proposed converter can be used in high Load applications.

Comparison of existing and proposed system

Parameters	Existing system	Proposed system
Output voltage	170 V	220 V
Output power	80 Watts	280 watts
Output current	1 Amps	3.5 Amps
Number of Switches	6	3
Needs Isolation Transformer	Yes	No

Conclusion

A hybrid system for a non-isolated bidirectional DC-DC converter was obtained. The isolated bidirectional DC-DC converter will always have the high frequency transformer. Converter without transformer was designed in the present work. The aim for the high frequency transformer reduces the flux in the operation. In he present work, zero voltage switching and zero current switching methods were used to decrease the equipment cost. High voltage spike, more conduction loss due to leakage inductance can be overcome by this method. It also increases the system reliability and efficiency.

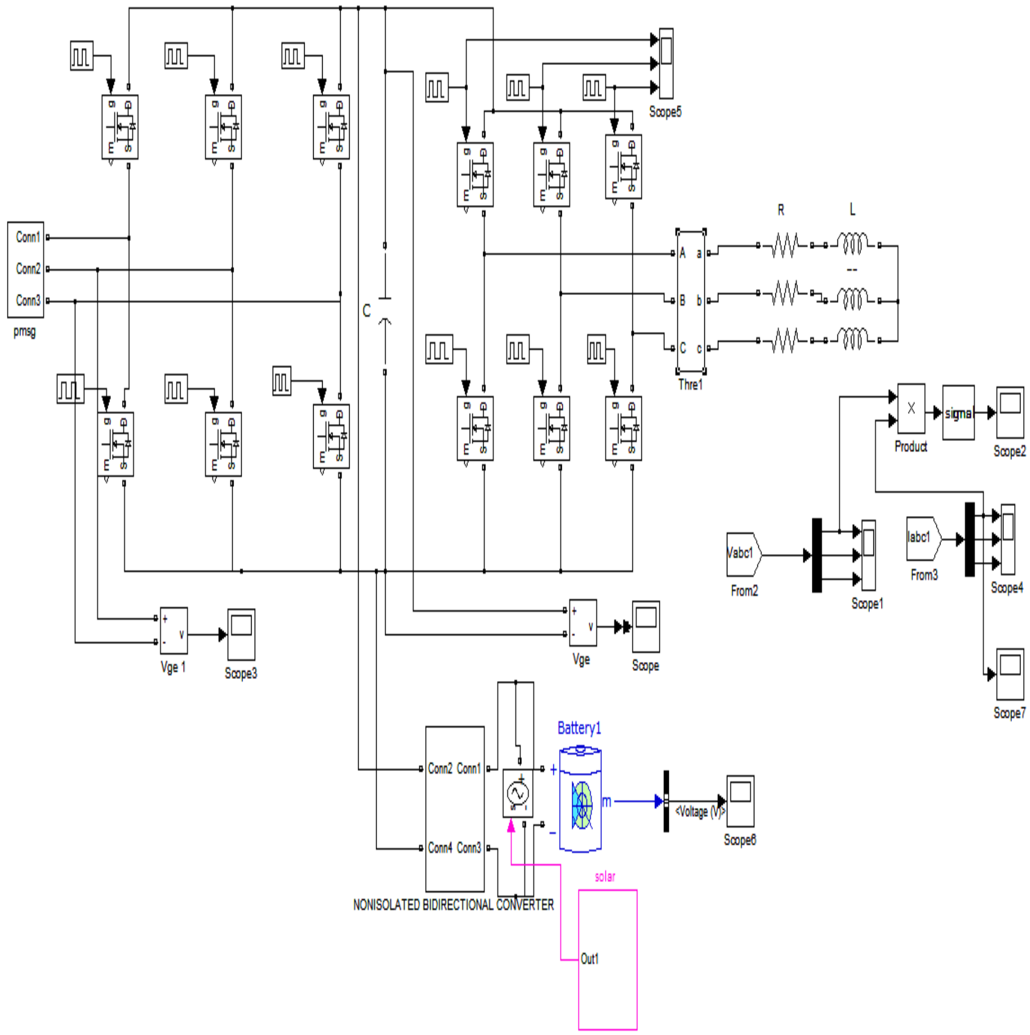

Fig. 5. Simulation circuit diagram

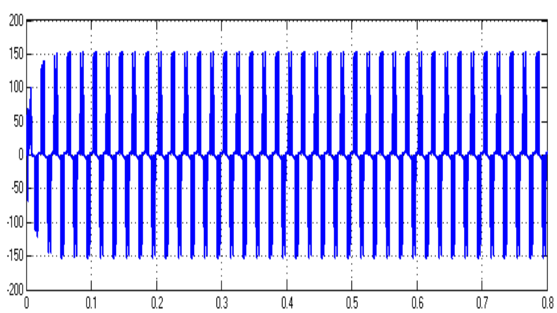

Fig. 6. Wind output voltage

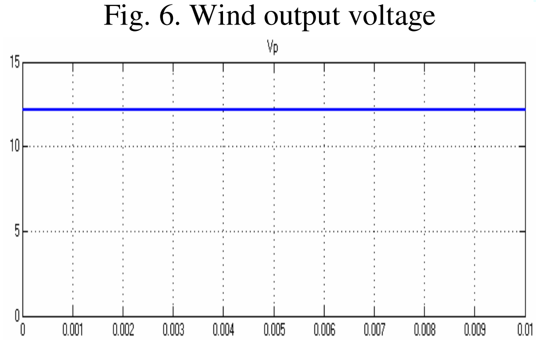

Fig. 7. Solar output voltage

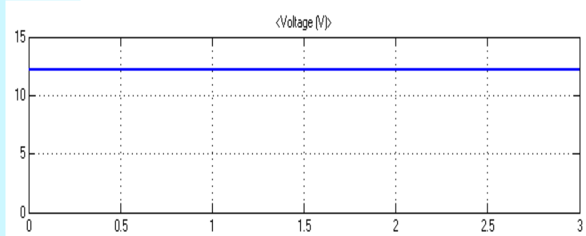

Fig. 8. Battery output voltage

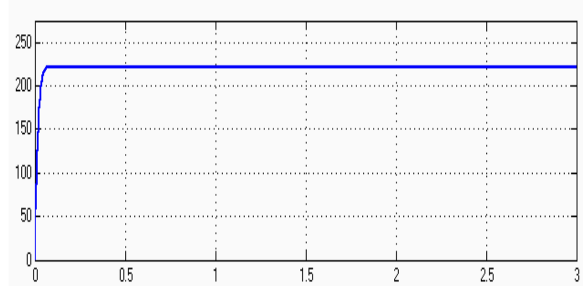

Fig. 9. Rectified output voltage

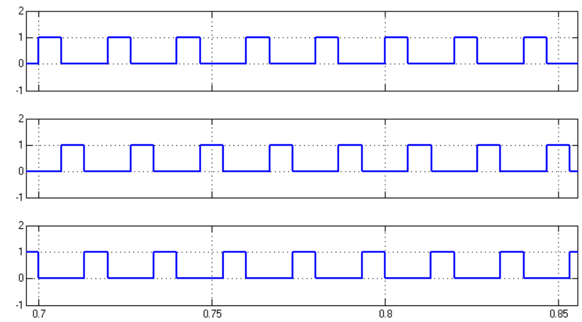

Fig. 10. Inverter switching pulses M1, M2, M3

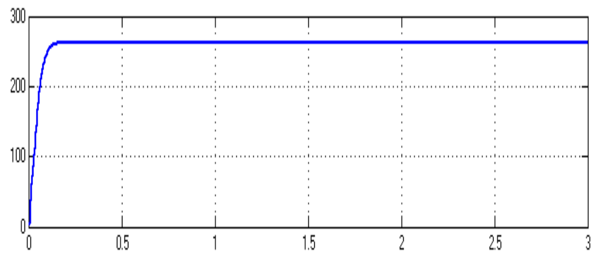

Fig. 11. Output power

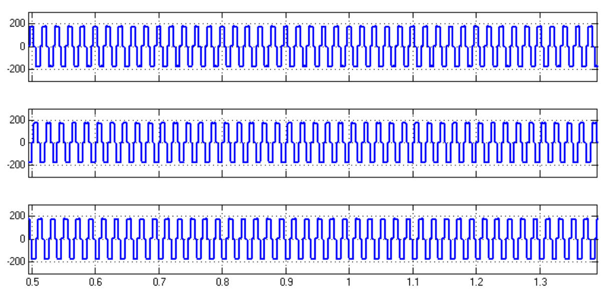

Fig. 12. Output voltage

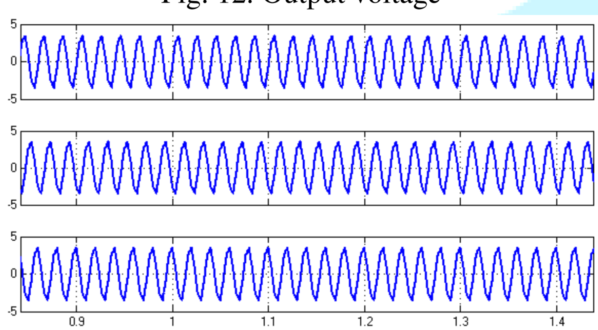

Fig. 13. Output current

Conflict of Interest

Authors declare there are no conflicts of interest.

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