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An Improved Bidirectional Grid Connected Single Power Converter with Battery Voltage

Shankar Kumar[1], Prof. N.K Singh[2]

M.Tech Scholar, Department of Electrical Engineering, Scope College of Engineering, Bhopal, India[1]

Assistant Professor, Department of Electrical Engineering, Scope College of Engineering, Bhopal, India[2]

ABSTRACT: Power converter is a kind of electronic circuits for energy conversion, which converts electrical energy of the supply into the energy suitable for the load (e.g., voltage or current with suitable frequency and/or amplitude). This investigation proposes a bidirectional grid associated single-power-conversion converter with low input battery voltage. This paper proposed improved bidirectional converter comprises of a bidirectional dc–dc converter and an unfolding bridge, and the power conversion arrange just corresponds to a bidirectional dc–dc converter. The bidirectional dc-dc converter can perform bidirectional power conversion between the low input battery voltage and a corrected sine wave because of its step-up/down voltage guideline capacities. Proposed model is more stable and give good efficiency then existing.

KEYWORDS: Power, Conversion, Converter, Energy, Battery, Storage.

I. INTRODUCTION

Today, with the development and the mass production of power semiconductors, static power converters find applications in numerous domains and especially in particle accelerators. They are smaller and lighter and their static and dynamic performances are better. A static converter is a meshed network of electrical components that acts as a linking, adapting or transforming stage between two sources, generally between a generator and a load.

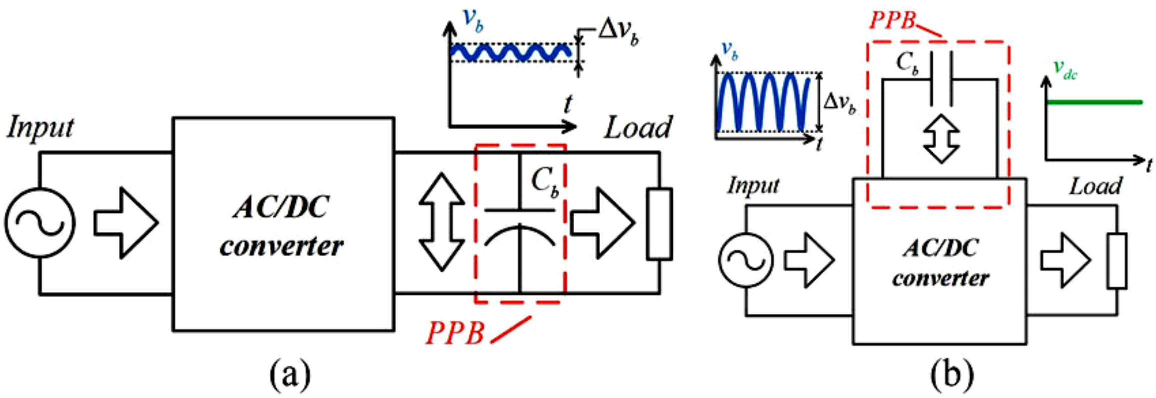

Figure 1: Power converter

Figure 1 shows power converter, the definition an ideal static converter controls the flow of power between the two sources with 100% efficiency. Power converter design aims at improving the efficiency. But in a first approach and to define basic topologies, it is interesting to assume that no loss occurs in the converter process of a power converter. With this hypothesis, the basic elements are of two types: – non-linear elements, mainly electronic switches: semiconductors used in commutation mode; – linear reactive elements: capacitors, inductances and mutual inductances

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or transformers. These reactive components are used for intermediate energy storage but also for voltage and current 13 filtering. They generally represent an important part of the size, weight, and cost of the equipment. This introductory paper reviews and gives a precise definition of basic concepts essential for the understanding and the design of power converter topologies. First of all the sources and the switches are defined. Then, the fundamental connection rules between these basic elements are reviewed. From there, converter topologies are derived. Some examples of topology synthesis are given. Finally, the concept of hard and soft commutation is introduced.

II. POWER CONVERSION CONVERTER WITH LOW-INPUT BATTERY VOLTAGE

A power inverter, or inverter, is a power electronic device or circuitry that changes direct current (DC) to alternating current (AC).

The input voltage, output voltage and frequency, and overall power handling depend on the design of the specific device or circuitry. The inverter does not produce any power; the power is provided by the DC source.

A power inverter can be entirely electronic or may be a combination of mechanical effects (such as a rotary apparatus) and electronic circuitry. Static inverters do not use moving parts in the conversion process.

Power inverters are primarily used in electrical power applications where high currents and voltages are present; circuits that perform the same function for electronic signals, which usually have very low currents and voltages, are called oscillators. Circuits that perform the opposite function, converting AC to DC, are called rectifiers.

Input voltage

A typical power inverter device or circuit requires a relatively stable DC power source capable of supplying enough current for the intended power demands of the system. The input voltage depends on the design and purpose of the inverter. Examples include:

- 12 V DC, for smaller consumer and commercial inverters that typically run from a rechargeable 12 V lead acid battery or automotive electrical outlet.[2]
- 24, 36 and 48 V DC, which are common standards for home energy systems.
- 200 o 400 V DC, when power is from photovoltaic solar panels.
- 300 to 450 V DC, when power is from electric vehicle battery packs in vehicle-to-grid systems.
- Hundreds of thousands of volts, where the inverter is part of a high-voltage direct current power transmission system.

III. PROPOSED CONVERTER MODEL

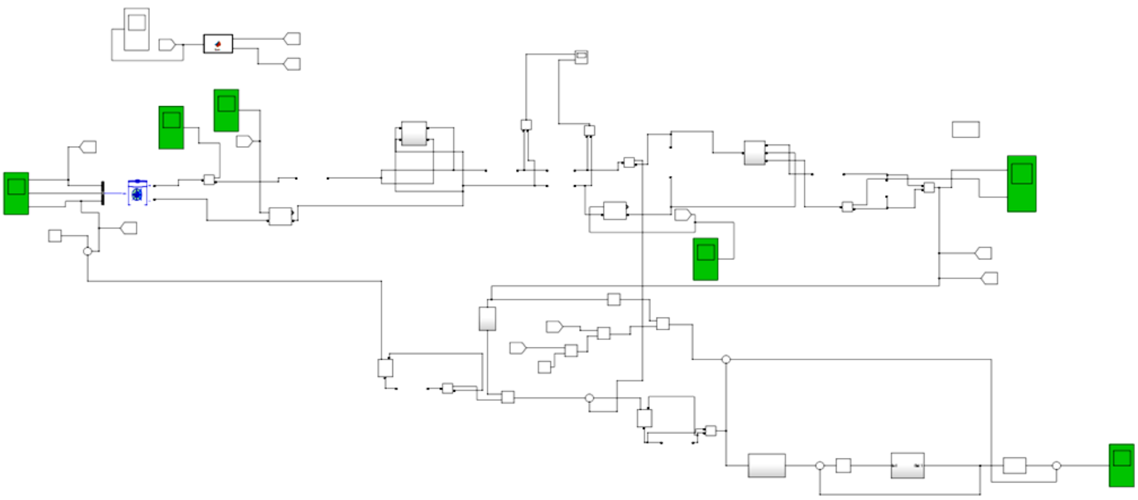

Figure 2: Proposed Power Conversion Converter Model

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Figure 2 shows proposed system is modified bidirectional grid-connected single-power-conversion converter with low-input battery voltage. It is necessary for the proposed converter to perform bidirectional power flow control and satisfy utility interface standards, with only a single power-processing stage. The folded grid current input and output represents the power flow direction and the transferred power level. It also includes the power quality on the grid side. Thus, controlling the folded grid current input and output leads to the feasibility of single-power conversion in the proposed converter.
The main switches S p and Ss in the proposed converter operate at a significantly higher frequency than the grid frequency fg. Thus, the grid voltage vg can be considered as constant during the switching period Ts, and the folded grid voltage vo is assumed as the same as the absolute value of the grid voltage vg. The proposed converter only has the following two subintervals: on-state of the primary main switch Sp with off-state of the secondary main switch Ss or off-state of the primary main switch Sp with on-state of the secondary main switch Ss in both operation modes. It is assumed that the duty of the primary main switch Sp defines the primary switch duty D.
The main component of proposed model is as followings-

- Bidirectional DC-AC converter
- Unfolding bridge
- AC grid
- Single power conversion control

This power converter can be operated in five different modes:

1) Power flow from the battery to the dc grid,
2) Power flow from the dc grid to the battery,
3) Traction mode,
4) Power flow from the battery to single-phase ac grid and
5) Power flow from a single-phase ac grid to the battery

The most significant advantage is that MOSFETs don't need current on their control pin, but require more voltage. Some don't turn on fully at 5v, some do. A BJT is limited to something like 0.3v for the lowest voltage drop on the current path, but MOSFETs are only limited by their resistance. MOSFETs are usually more efficient switches for power supplies, etc where we want a switch rather than an amplifier. FET's are only more efficient because they can be switched a lot faster and thus small SMPS can be used. MOSFETs can easily be placed in parallel; bipolars unless external emitter resistors are added.

IV. SIMULATION RESULTS

The simulation studies involve the deterministic converter model as shown in Fig.3. The proposed bidirectional grid connected single power converter model is implemented with MATLAB simulink.

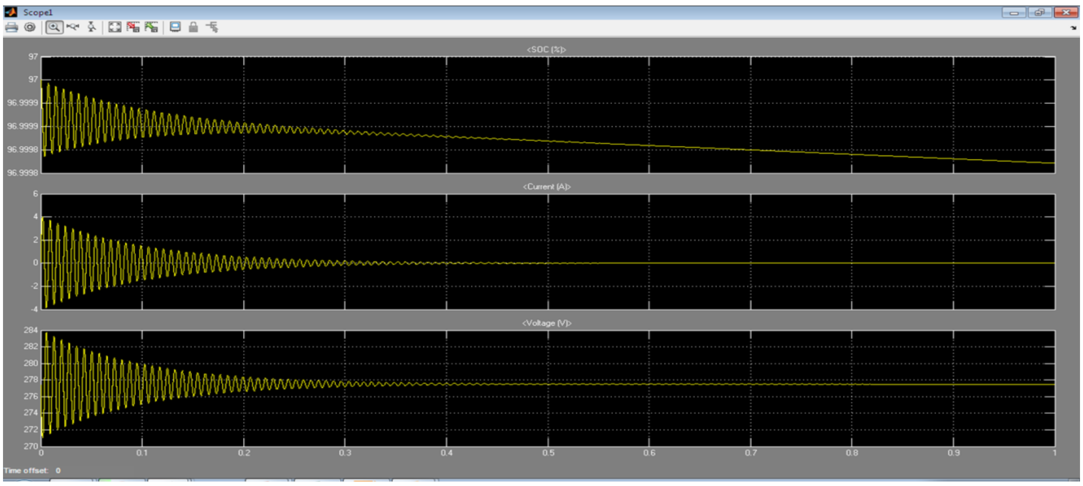

Figure 3: Battery Output

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In figure 3, it is clear that the state of charge (SOC), voltage and current of output performance of applied battery.

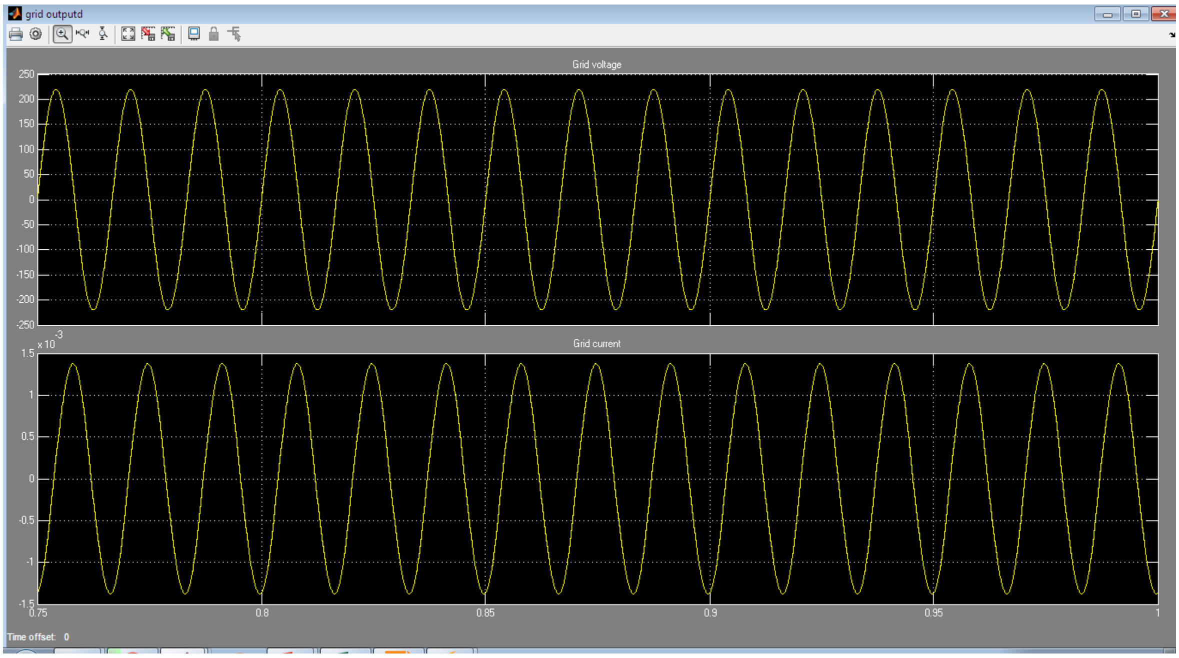

Figure 4: AC Grid outputs

Figure 4 is showing output voltage and current of applied AC grid. It is clear that ac input voltage is 220V and current is 1.4 A.

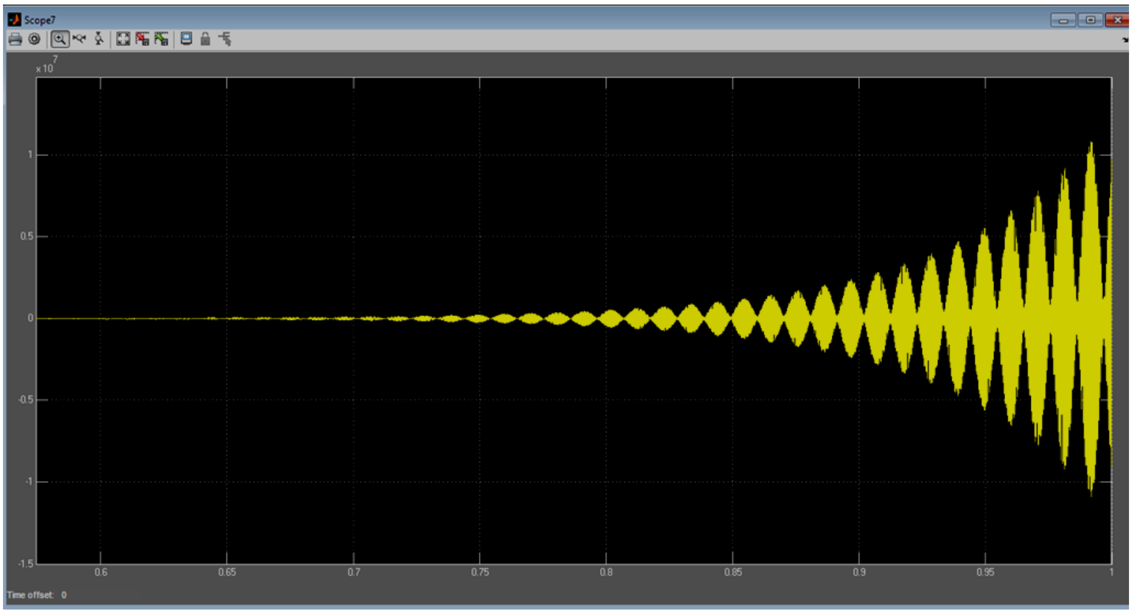

Figure 5: Battery Charges

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Figure 5 shows battery charges state from input source. SOC characteristics shows the charging and discharging (i.e) It increasing means Charging and it decreasing means Discharging Also this will occurred on - Terminal voltage is lower than the battery voltage means, battery get Discharge . Terminal voltage is greater than the battery voltage means, battery will get charge.

Table 1: Comparison of proposed design result with previous design result

Sr No.	Parameter	Previous Model	Proposed Model
1	The number of series connected 12-V battery pack	2–5	1-7
2	Input voltage	24–60 V	20-70V
3	DC-link voltage	24–60 V	20-70V
4	Output voltage	220 Vrms	230 Vrms
5	Rated power	250 W	260 W
6	Total efficiency	95%	97%

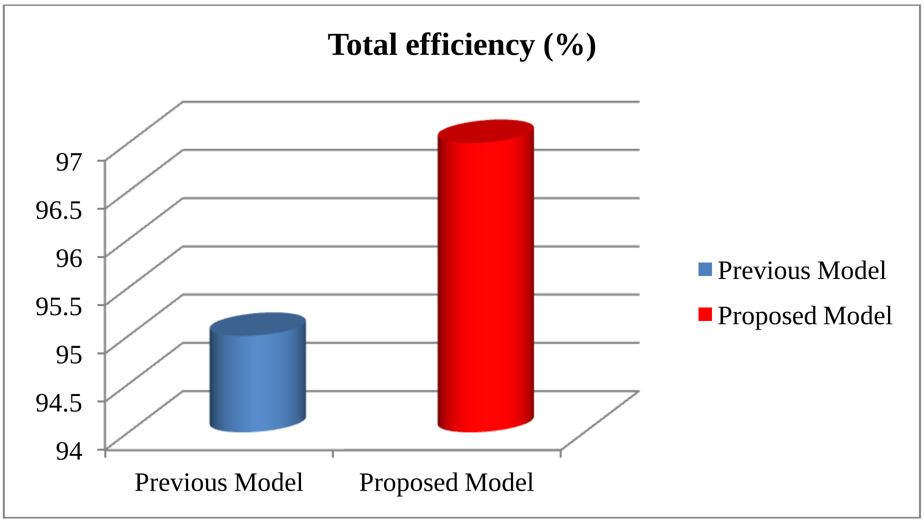

Figure 6: Comparison chart of Efficiency

Table 1 showing comparison of proposed model results with previous design model results in terms of output voltage, rated power, efficiency etc. Figure 6 shows bar chart of efficiency of proposed and previous model.
Therefore above result shows, proposed model give significant improved result rather than then the existing model.

V. Conclusion

The simulation results showed that the proposed research work involved investigating a bidirectional grid connected single-power-conversion converter with a low-input battery voltage and a control system. Additionally, theoretical analysis and experimental results are presented. A single power-conversion technique was used by the proposed

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converter to perform bidirectional power conversion between the battery and the grid through a single-power processing stage. The experiment results using a 250-260W prototype verify that the proposed converter possesses a bidirectional dc–ac power conversion capability with an efficiency that exceeds those of conventional grid-connected converters and that the developed control system is suitable for the proposed converter.

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