An Efficient Bidirectional Grid Connected Single Power Conversion Converter with Hybrid Input Battery Voltage

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Abstract : Power conversion is converting electric energy from one form to another such as converting between AC and DC; or changing the voltage or frequency; or some combination of these. This paper proposed efficient bidirectional converter comprises of a bidirectional dc–ac converter and an unfolding bridge, and the power conversion arrange just corresponds to a bidirectional dc–ac converter. The bidirectional dc-ac 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. Simulated results show that proposed model is more stable and give good efficiency then previous.

***IndexTerms* -** 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.

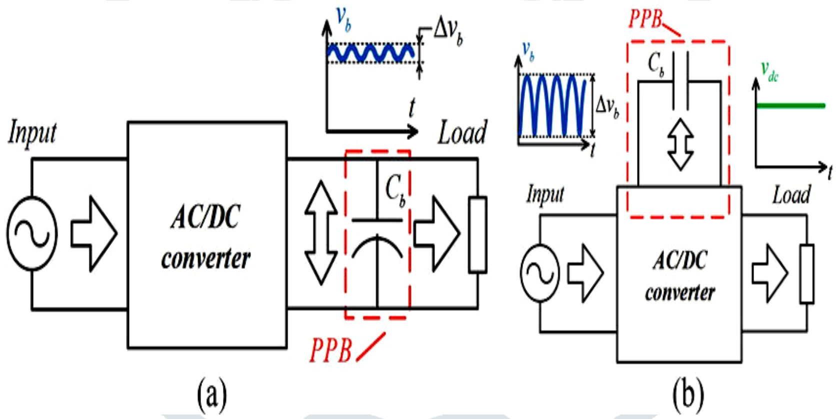

Figure 1: Power converter

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 or transformers. These reactive components are used for intermediate energy storage but also for voltage and current 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

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.

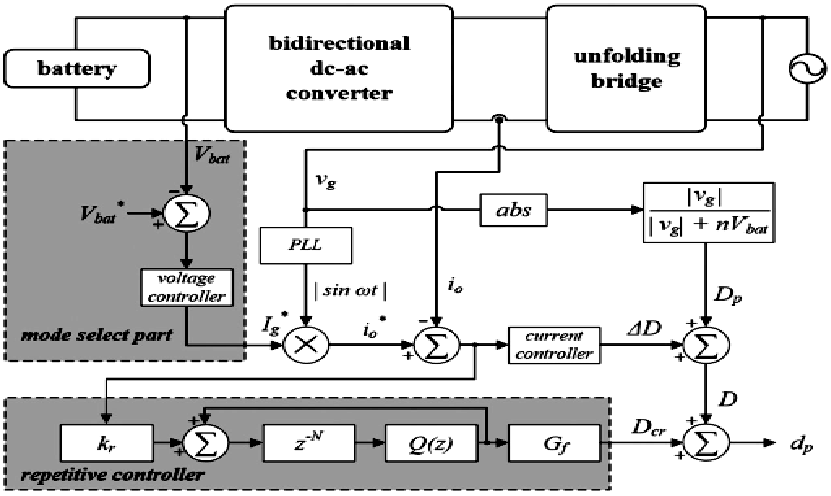

Figure 2: Previous model block diagram [1]

It is essential for the proposed converter to perform bidirectional power flow control and fulfill utility interface measures, with just a single power-handling stage. The collapsed grid current input and output speaks to the power flow direction and the moved power level. It additionally remembers the power quality for the grid side. Along these lines, controlling the collapsed grid current input and output prompts the attainability of single-power conversion in the proposed converter.

A single power-conversion air conditioning dc converter with high power factor. The proposed converter is inferred by coordinating a full-bridge diode rectifier and an arrangement thunderous dynamic cinch dc–dc converter. To get a powerful factor without a power factor correction circuit. The proposed converter gives single power-conversion by utilizing the novel control algorithm for both power factor correction and output control. traditional single-arrange air conditioning dc converters have high voltage stresses or a low power factor in correlation with the two-organize air conditioning dc converter.

Additionally, the PFC circuit utilized in the single-arrange air conditioning dc converter requires the dc-connect electrolytic capacitor and the inductor. The dc-interface electrolytic capacitor and the inductor raise the size and the expense of the converter. To take care of these issues, the dc-interface electrolytic capacitor ought to be expelled from the circuits. A single power-conversion air conditioning dc converter with high power factor based , The proposed converter is inferred by incorporating a full-bridge mosfet diode rectifier and an arrangement thunderous dynamic cinch dc–dc converter. To acquire a powerful factor without a power factor correction circuit. The proposed converter gives single power-conversion by utilizing the novel control algorithm for both power factor correction and output control. Additionally, the dynamic clasp circuit braces the flood voltage of switches and reuses the energy stored in the spillage inductance of the transformer. Moreover, it gives zero voltage turn-on switching of the switches. Likewise, an arrangement thunderous circuit of the output-voltage doubler expels the turnaround recuperation issue of the output diodes.

III. PROPOSED MODEL

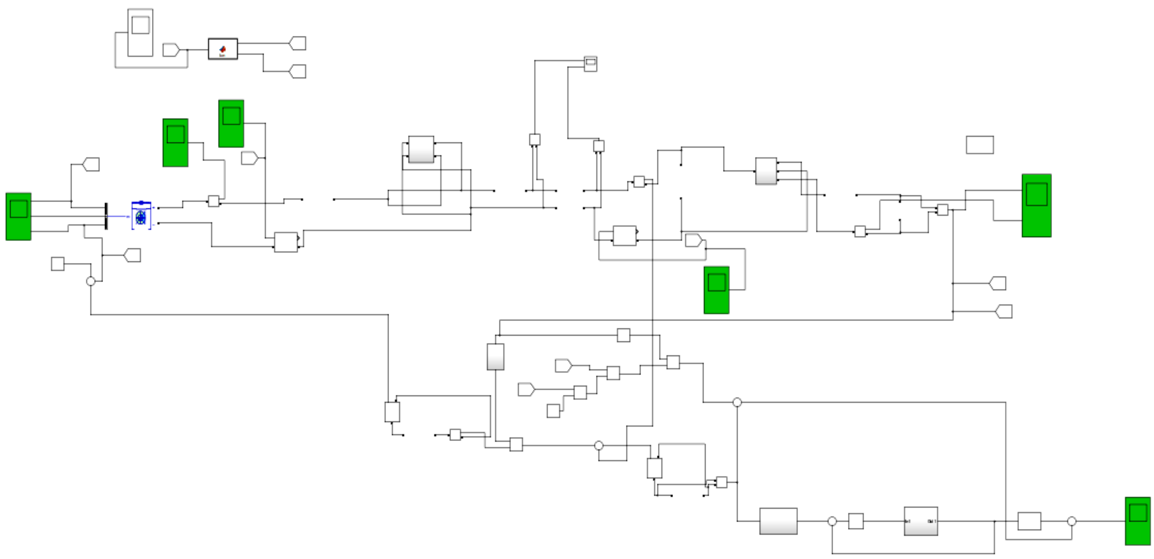

Figure 3: Proposed Power Conversion Converter Model

Figure 3 shows proposed system is modified bidirectional grid-connected single-power-conversion converter with low-input battery voltage. Showing proposed power conversion converter model which have hybrid voltage source is connected to the DC battery. Proposed model is made from sub models like DC-AC converter, unfolding bridge, AC grid, pulse width modulation etc. MOSFET switch uses instead of IGBT in this model. 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) Power flow from the battery to single-phase ac grid and
4) 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; bipolar unless external emitter resistors are added.

IV. SIMULATION RESULTS

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

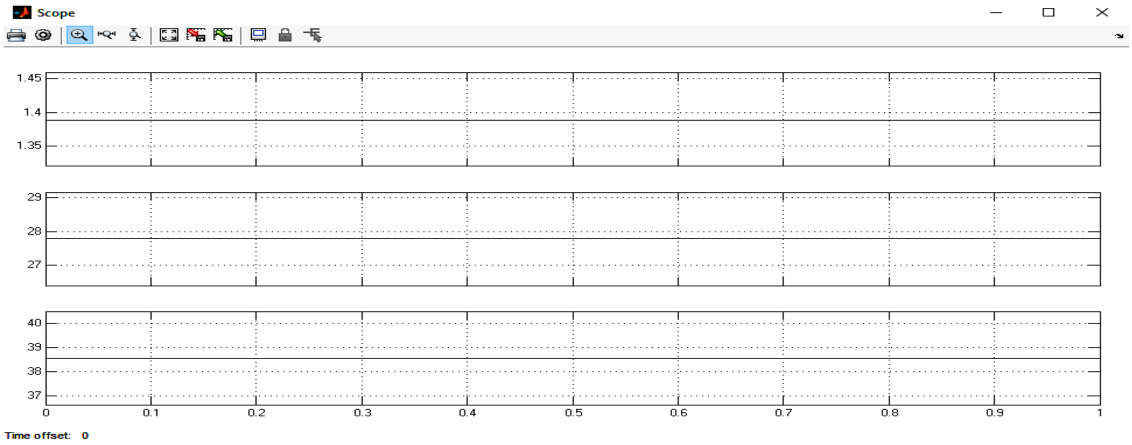

Figure 4: Solar Panel output

Figure 4 is showing solar panel output current, voltage and power. Therefore according to this output graph the value of current is approx 1.4 A. The value of voltage is approx 28V and value of power is 38.5W approx.

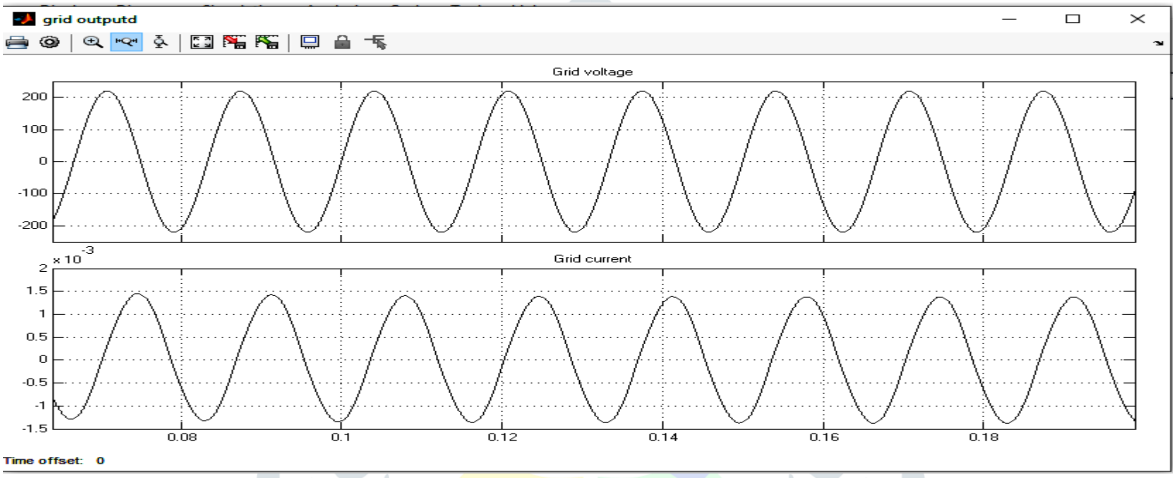

Figure 5: AC Grid outputs

Figure 5 is showing output voltage and current of applied AC grid. So the value of AC grid voltage is 220v and current value is 1.5 mA.

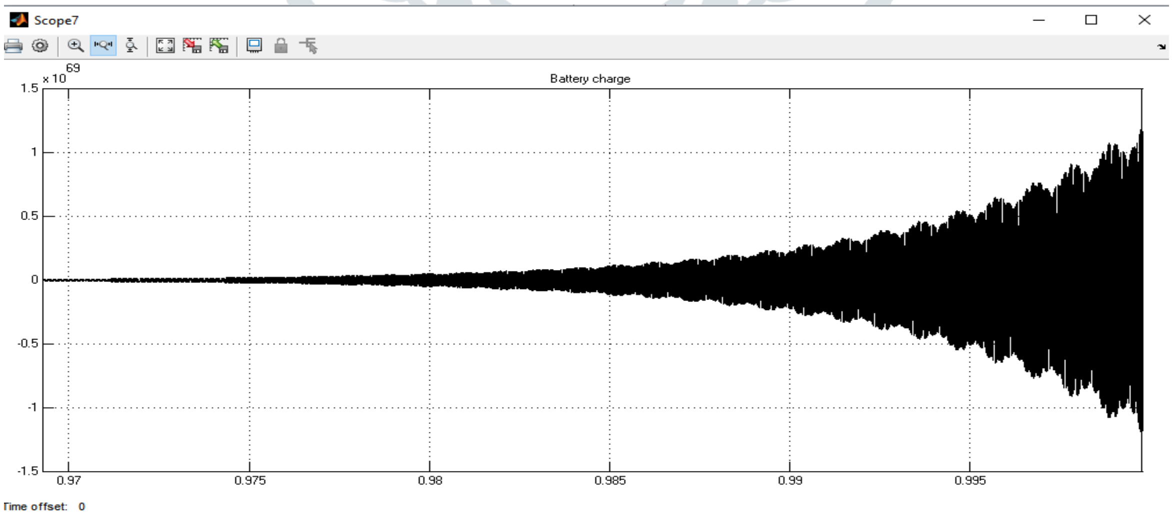

Figure 6: Battery Charges

Figure 6 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.

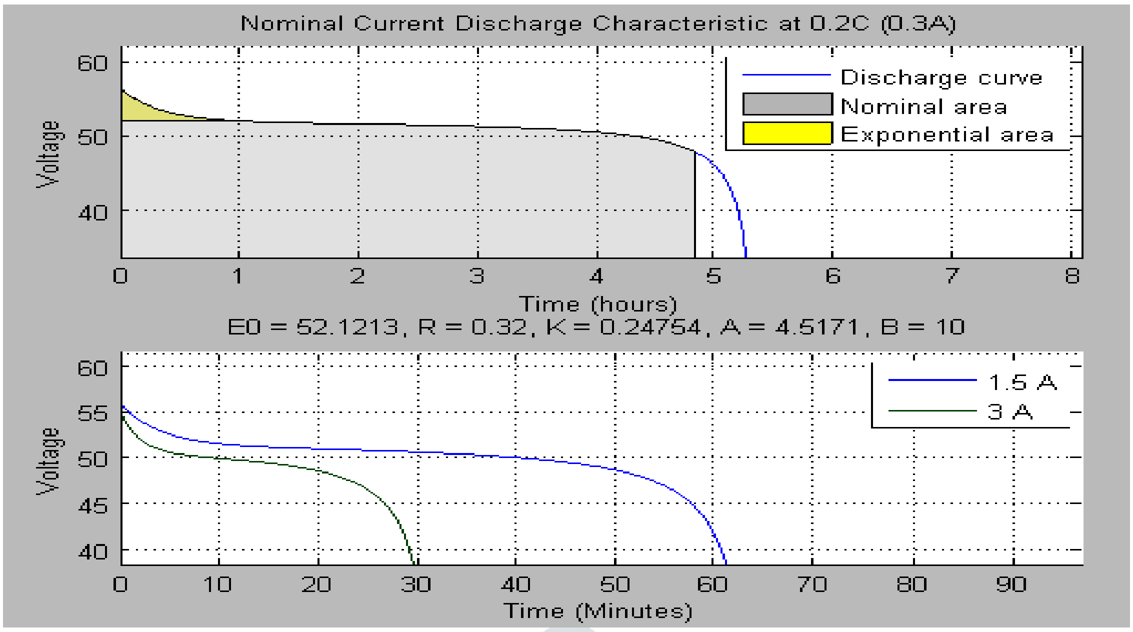

Figure 7: Battery discharge time

Figure 7 is showing the battery discharge characteristic in terms if ampere-hour (Ah) and time (minutes)

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	1-4
2	Renewable Energy Source	NA	48 Cell
3	DC-link voltage	24V	28V
4	Output voltage	220 Vrms	230 Vrms
5	Battery Voltage	48V	55.2V
6	Battery Charge	95%	98%

Table 1 showing comparison of proposed model results with previous design model results in terms of output voltage, rated power, efficiency etc. Figure 8 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 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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