# Charging of Electric Vehicle Battery Using Bidirectional DC-DC Converter

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**Abstract –** The increased accessibility of electric vehicles has accelerated the development of new research. This innovation enables for two-way power exchange among the system .Here reduces surge demand, balances loads with voltage control, and enhance potential scheme dependability. The design advanced a two way battery charger for charged vehicles that supports the three modes. In G2V using style, the battery receives potential and power influence load from the power network. The V2G operating style commit to the balance of this power arrangement by permitting the efficiency saved in the battery to be fed behind to the network..

**Index Terms** - Electric Vehicles (EV),Grid to vehicle (G2V),Vehicle to grid(V2G),Phase locked loop(PLL)

## I. Introduction

In global transportation business automobile are a major concept. As a result, interest in EV technologies has increased dramatically in recent times. To maintain the quality of power on power grids the charging method necessary controlled. Nonetheless, when EVs proliferate, a significant quantity of possibility of fuel can hold in their power banks, opening up when charge passes in the inverse way. EV will the first technology to introduce this type energy backup.[1]

Several smart grid initiatives are now being developed around the world. In this novel approach, to feeding home loads , EVs can operate as voltage sources in addition from the G2V and V2G operation choices, particularly in homes equipped with EV charging connections. [2-3]. Using the "EV supply centre" equipment, this method uses energy from battery packs to power household loads. The first phase of the development of the intelligent system can be new homes consists with optimal flow of utilization result.. A double pack is developed in this study to enable V2G mode of operation whereas the car is parked. [2]

The single phase alternating current is provided to the load in this arrangement. The unbalanced load causes harmonics to appear in incoming pulse An improved phase-locked loop generates annular current by a error graph. The power strip is linked to this source in order to charge the EV pack[4]. The power strips includes a pair of reversibile AC-DC converter and a high low converter. The voltage is supplied to the 3-level buck boost converter by the converter. For grid-to-vehicle applications, an electric car battery is charged in low mode, and discharged in high mode for vehicle-to-grid purposes .[4]

Automobiles reduce environmental pollution concerns and overcome conventional IC-engine vehicles in terms of performance. New vehicles include innovation for energy vehicle batteries at home or at charging stations at night, as well as extending vehicle parking duration [5-6]. Because electric vehicles have some limitations, not everyone uses them. Its limitations include expensive costs as compared to fluid-based cars, longer recharge times, and a lack of significant growth in battery infrastructure. Many of these issues have been addressed by power electronics devices. These gadgets are utilised in the creation of electric vehicle infrastructure.

## II. Circuit Description

The power pack described is builted of diffrent power conversion devices that share a connection . The grid connection are first importance, and the next is to make a connection to the batteries. A bidirectional converter, as shown in Figure , is utilised to communicate with the power network. During the inverter operation mode, this converter can act rectifier for the needed parameters. In inverter mode , the converter acts for a regulated current source, injecting the necessary power into the power grid.

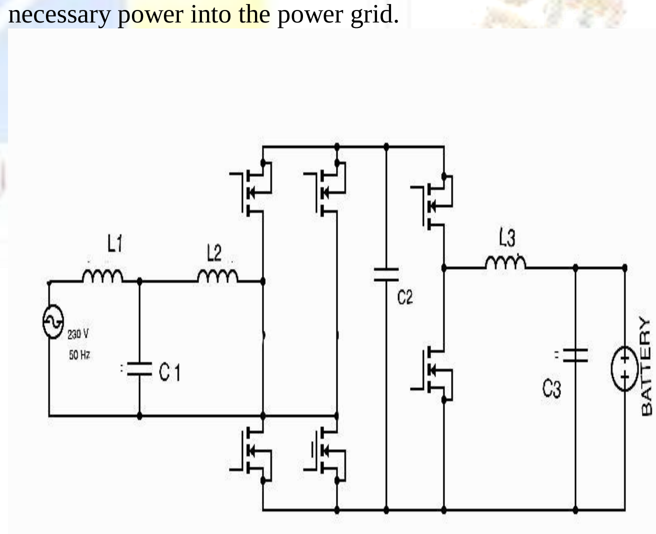


**Fig. 1 Circuit diagram for EV battery charging**

## III. Control algorithm

The algorithm for three modes of operation with two converters is described below.

### A. Grid to vehicle operation mode

The converter operator should be synchronised to the network . As a result, the digital controller's first method is a PLL. A one-phase PLL in the alpha-beta directions is applied to meet this criterion. This method generates two waves with single amplitudes offset by 90 degrees: pll- alpha and pll-beta The signal pll-alpha correlates to PLL is synchronised with it.

The converter parameters is calculated by second control method. The current's amplitude is attained through the separation of the grid voltage standard active power influenced by the signal. A PI controller used to control the DC link voltage provides the power. The control block layout for generating the current reference can be seen in Fig. 3. Using the circuit model components and data from the above sample, this current control determines generate in each cycle

### B. Vehicle to grid operation mode

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In the V2G mode, like in the G2V mode, will be synchronised with the network basic voltage. So previously stated, synchronisation is achieved using a PLL in alpha beta sections.In order to allow, the active power to be supplied to the power system is introduced as a data portal channel.

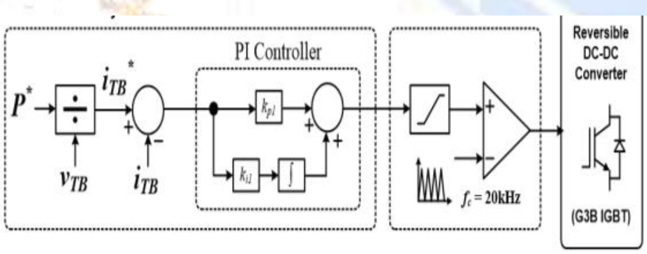


**Fig. 2 Control block diagram for DC -DC converter**

### C. Vehicle to Home operation mode

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. The converter works as a high mode converter in the V2G mode to keep the voltage at an acceptable to function properly. The power getting by the loads movement over time, The energy pack vary to get the power for battery..

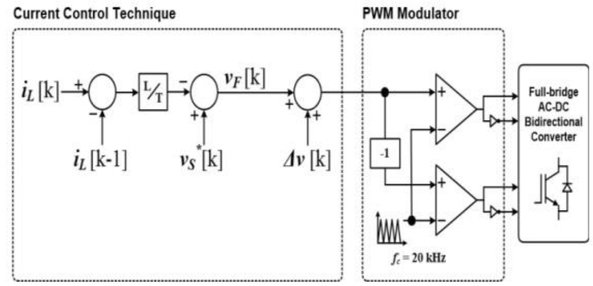


**Fig. 3 Control block diagram for AC-DC converter**

## IV. Design of bidirectional converter

### A. Buck mode design

Input and output rate buck mode is given by equation

$$V_{in}=230\text{ v},\ V_o=48\text{ v}$$

Duty ratio is given by the equation

$$\frac{V_o}{V_{in}}=D=0.2$$

Inductance is given by the equation

$$L=\frac{V_{in}*D*(1-D)}{f*\Delta i_L}=3.6\text{ mH}$$

Capacitance is given by the equation with ratio of peak value of inductance current and product of frequency and peak value of capacitor voltage.

$$C=\frac{\Delta i_L}{8f\Delta V_C}=1.\ 3\mu F$$

### B. Boost mode design

Input and output voltage in boost mode is given by equation with discharge of battery process so input is reversed as boost mode.

$$V_{in}=48\text{v},\ V_o=230\text{v}$$

Duty ratio is given by the equation,

$$\frac{V_o}{V_{in}}=D=4.7$$

Inductance is given by the equation with product of duty ratio and input voltage ratio with frequency and peak value of inductance current.

$$L=\frac{V_{in}*D*(1-D)}{f*\Delta i_L}=8.3\text{mH}$$

Capacitance is given by the equation with ratio of peak value of inductance current and product of frequency and peak value of capacitor voltage.

$$C=\frac{\Delta i_L}{8f\Delta V_C}=21\ \mu F$$

*C Bidirectional ac-dc converter*

. To create gate pulse for the MOSFET, hysteresis-based current control is used.
Connection between rectifier voltage and source voltage is:

$$V_0 = \frac{\sqrt{2V_S^2 + 2(I_s^2 + X_l^2)}}{m}$$

Where, Vo = rectified output voltage,
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The value of capacitor is given by

$$C = \frac{P_{rated}}{V_0 \times 4 \times \pi \times V_{orip}}$$

## V. SIMULATION OF BIDIRECTIONAL CONVERTER

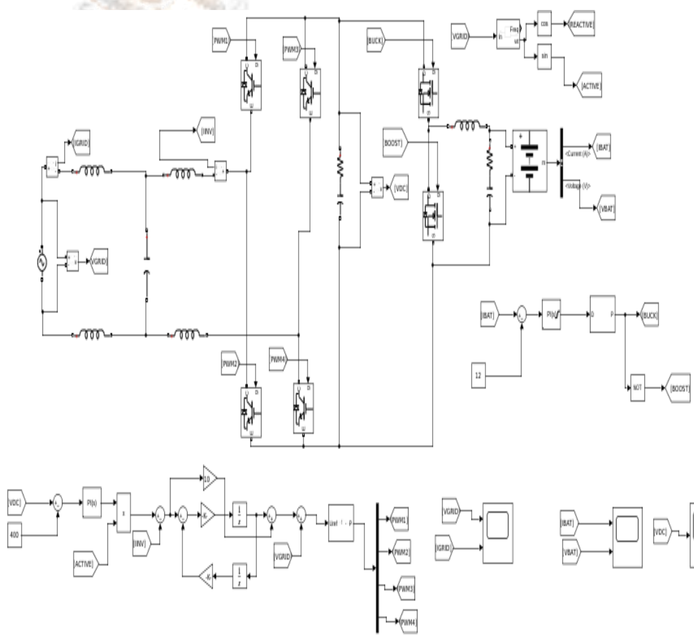

**Fig. 4. Matlab simulation**

MATLAB is used to simulate the proposed converter model. A 230 V alternating current supply is considered for the simulated model,. A grid-connected bidirectional converter and a DC-DC bidirectional input 230 volts and output 48 volts in charging mode and 48 volts to 230 volts in discharging mode are used in the simulation

After filtering, the 230 volt supply is given to the converter, and the resulting voltage is the input to the 48 volt battery. Following the stage, the procedure was reversed and connected to the boost operation, converting 48v to 230v. The rectifier and inverter components make up the ac-dc converter portion. We may receive the results of the matlab simulation to validate the values we provided

## VI. SIMULATION RESULTS

*A. Battery to grid waveform*

The suggested device make alternating current from the network with atwo values, reducing the likelihood of system pollution and extending the two life. It also provides spike free power to a stand-alone pack, guaranteeing that it operates safely

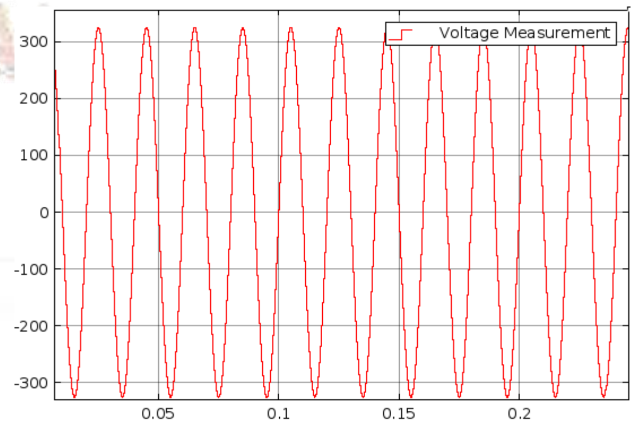


**Fig. 5. Battery to grid waveform**

*B. Grid to battery waveform*

The buck converter simulation was performed using a constant duty ratio PWM generator as the switch control, with the duty ratio set to 50%. Figure depicts the simulation parameters and outcomes.
The boost converter simulation was performed with the parameters marked, and the PWM wave is a control signal with duty ratio is constant. The simulation results are shown in Figure below, and as expected, the output voltage is more compard to the input . The overshoot effect is caused by the capacitor's high size; because it takes a lot of charge to attain the desired voltage, the inductor will be overcharged.

In rectifier that converts system current to direct current . The model specifies a tolerance range of 0.3 A for charging current, and the above simulation results show that current ripples range.

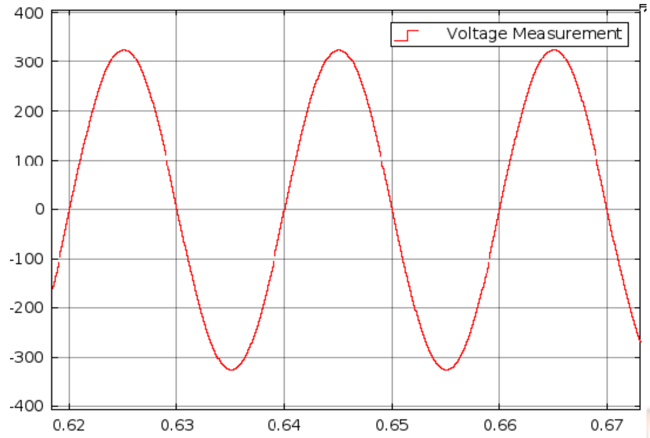


**Fig. 6. Grid to battery waveform**

To avoid this, a maximum inductor current can be set, which means that even if the capacitor is charged quickly, the inductor will never retain so much energy that there is a significant overshoot. Setting a maximum current also protects the inductor component.

### *C. Battery waveforms*

The SOC of the battery when charging is 40%. It takes time for the converter to develop and stabilize while the capacitor is being charged. No power is supplied to the battery during this time. When the charge is completed, the charger will tell him to develop the charge to get the current

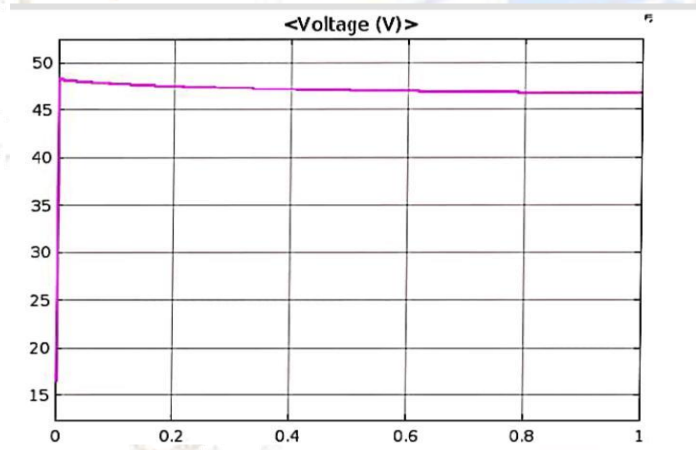


**Fig. 7. Battery voltage waveform**

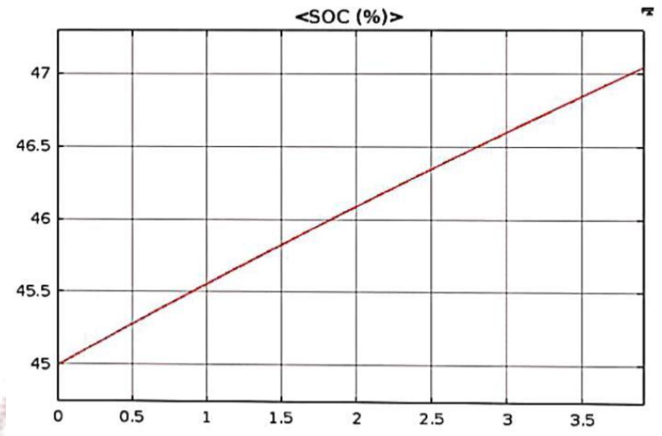


**Fig. 8. Battery soc waveform at charging**

When in discharging mode The initial discharge current of the battery charges the two side capacitors. After the circuit breaker is closed and the load is attached, the battery powers a resistive load. As a battery feeds power to a resistive AC load,. SOC drops linearly as the battery empties. The converter model has a charging efficiency of 45% and a discharging efficiency of 45.2%.


**Fig. 9. Battery soc waveform at discharging**

Using matlab simulation, we can examine the waveforms of buck and boost mode operations.Here, we may run the simulation using the necessary parameters such as voltage, current, inducer value, and resistance value.45% of the soc is dedicated to battery charging and draining phases.High performance chargers require correct information on battery.

## CONCLUSION

This work discusses the creation of an bidirectional battery charging circuit for automobiles that can operate in the two modes, both of which incorporate critical technologies. Bidirectional topology has just recently improved to the point where it can be used by more people.

Energy self-sufficient. The bidirectional charger is being developed for the V2G and G2V power flows. With the suggested architecture, it is possible to charge and discharge with a single unit. It uses constant ratingsbattery charging methods occur when the unit power factor changes. The operational components by adjusting the controller's control signal. This architecture enables two modes at various power level

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