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Simulation of Bidirectional Converter for Vechile to Grid and Grid to Vechile Application

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Abstract: This paper represents a bidirectional converter for the application of vehicle to grid and grid to vehicle application. This converter can be used in the application of electric vehicle. And the results have been verified through simulation in MATLAB. The topology can provide an energy bi-directional flow path for energy exchange between the Li-battery/supercapacitor (SC) hybrid energy storage system (HESS) of the electric vehicle and the grid.
Keywords: bi-directional converter, vehicle, HESS, Li-battery.

I. INTRODUCTION

Li-batteries with high energy densities can provide enough energy during steady-state operation, the power densities of Li-batteries are too low to meet the peak power demand [2], [3]. Combining Li-batteries and supercapacitors (SC) to form a hybrid energy storage system (HESS) can solve the problem. The reason is that SC with higher power densities can provide the transient power required by the load [4][5]. A converter that can convert DC and AC bidirectionally to any power system is called a bidirectional power supply. It supports both DC and AC by mounting a bidirectional DC/DC converter and a bidirectional AC/DC converter inside.

Bidirectional DC-to-DC converter allows power flow in both forward and reverse directions. Such a converter is especially suited for applications like electric traction because (1) It converts a fixed DC battery voltage into a higher DC voltage suitable for traction motor. Also, the output DC voltage can be varied to control the speed of the motor.

(2) During regenerative braking (a kind of energy saving electrical braking), the kinetic energy of wheels is fed back to the battery. During this process, motor acts as generator, converts wheel rotation into electricity and feeds it back to the battery through converter. Bidirectional converter is also called two quadrant converter or four quadrant converters (if both voltage and current can change directions).

II. MODELLING OF THE CONVERTER IN MATLAB

A. Figure of bidirectional converter in matlab

The Figure shown in figure 1 is of boost mode in bidirectional converter.

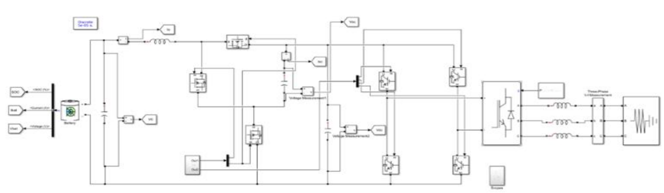

Figure 1. Boost mode of bidirectional converter

Figure 2 presents the buck mode in bidirectional converter given below.

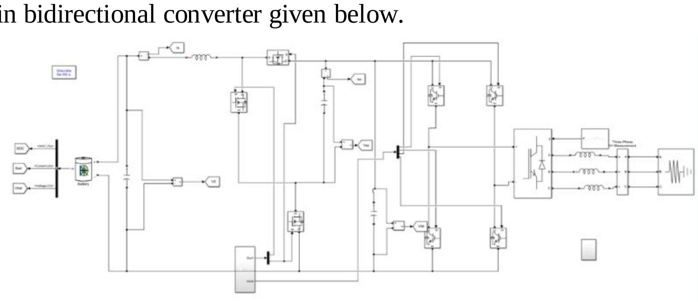

Figure 2. Buck mode of bidirectional converter

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III. SIMULATION

The simulation parameters are shown in Table 1[1]. The values for the simulation have been taken from the paper [1]

Table 1. Design parameters.

Parameter	Value	Unit
Li-battery voltage V_B	100	V
SC voltage V_{SC}	200	V
grid voltage V_G	100	V
grid voltage frequency	50	Hz
inductor L	2	mH
filter inductor L_f	2	mH
supercapacitor SC	2	F
parallel capacitance of the Li-battery C_I	470	μF
parasitic resistors R_L	800	mΩ
parasitic resistors R_C	25	mΩ
parasitic resistors R_{CI}	51	mΩ
internal resistance of the Li-battery R_B	100	mΩ
switching frequency f_s	5	kHz

A. Simulation Results from MATLAB

Figure 3 shows the simulation waveforms when the converter is operating in boost mode. The current injected into the grid is in phase with the grid voltage to achieve a unit power factor.

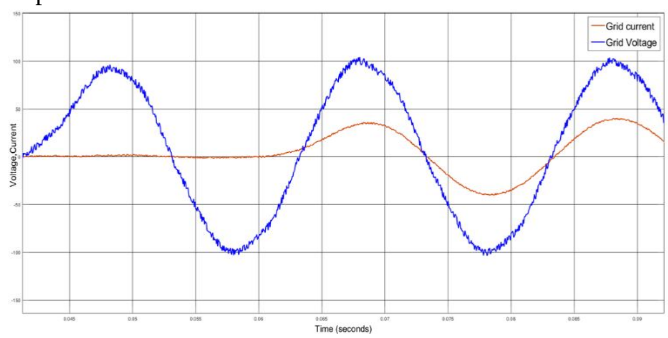


Figure 3. Grid voltage and grid current during boost mode

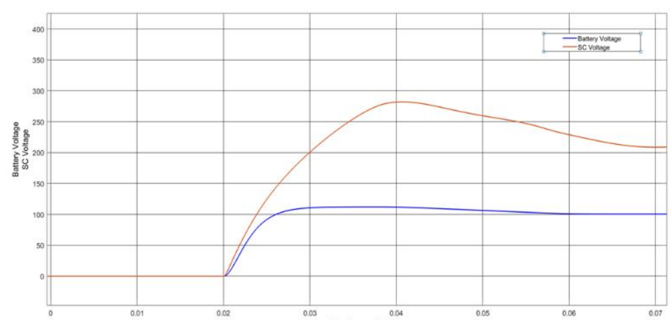


Figure 4. Battery discharge voltage and SC voltage

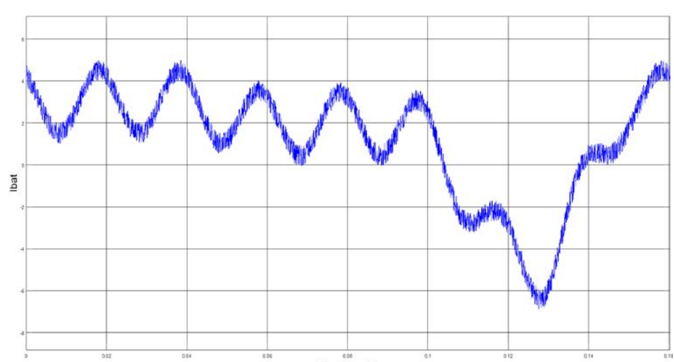


Figure 5. Battery discharge current

Figure 6 shows the main waveforms when the converter is operating in buck mode

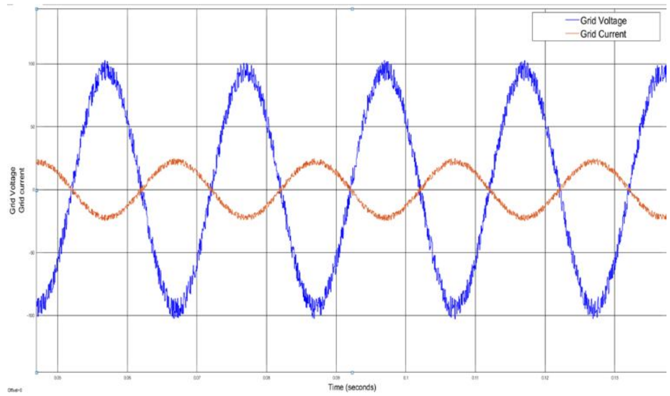


Figure 6. Grid voltage and grid current during buck mode

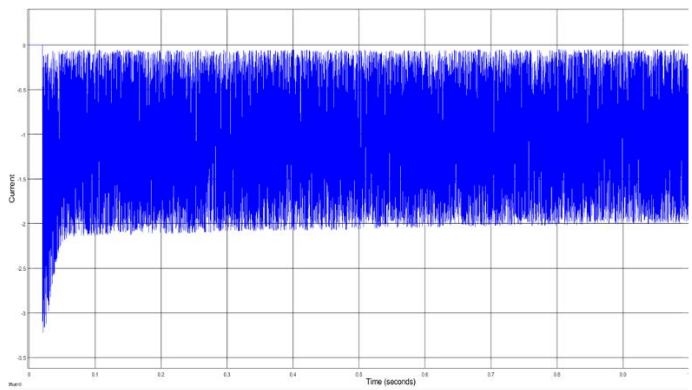


Figure 7. Battery charging current

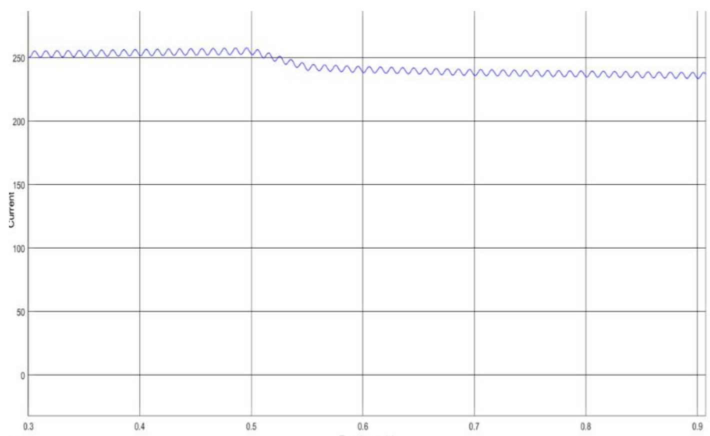


Figure 8. SC voltage

This paper presents a switching bi-directional buck-boost converter (SBBBC) for vehicles to-grid (V2G) system. The topology can provide an energy bi-directional flow path for energy exchange between the Li-battery/supercapacitor (SC) hybrid energy storage system (HESS) of the electric vehicle and the grid. This topology not only has buck-boost capability, but also has the function of energy management.[1]

This paper proposes a switching bi-directional buck-boost converter (SBBBC) and its appropriate control strategy, which is used in the HESS for vehicles-to-grid (V2G) system. The converter allows shoot-through of two switches of any phase, with anti-electromagnetic interference capability. Meanwhile, since there are three switches in the DC side, the SC and Li-battery can fulfil bi-directional power flow.[1]

IV. CONCLUSION

This paper puts forward a bidirectional converter which can be used in the application related to electric vehicle. It can be used for flow in both sides mainly vehicle to grid and grid to vehicle application. It can also operate under boost mode and buck mode conditions. The value for this simulation has been taken from reference [1]. And finally with the help of MATLAB the simulation is done for the converter and the results has been shown in the paper.

REFERENCES

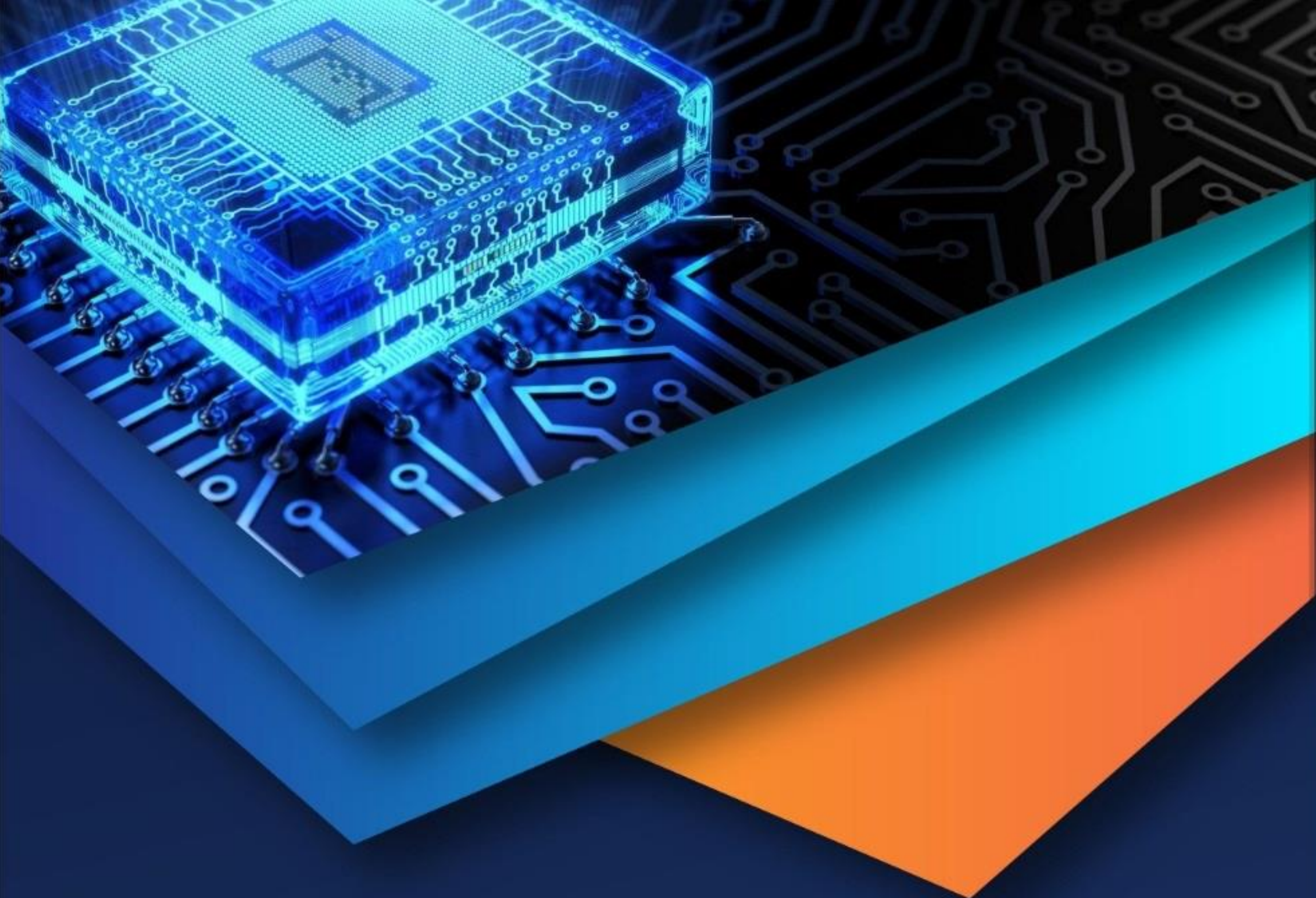
[1] SHUO LIU 1, XU XIE 1, AND LIYONG YANG “Analysis, Modelling and Implementation of a Switching Bi-Directional Buck-Boost Converter Based on Electric Vehicle Hybrid Energy Storage for V2G System”IEEE ACCESS,VOLUME 8, 2020

[2] J. Cao and A. Emadi, ‘‘A new battery/ultraCapacitor hybrid energy storage system for electric, hybrid, and plug-in hybrid electric vehicles,’’ IEEE Trans. Power Electron., vol. 27, no. 1, pp. 122–132, Jan. 2012.

[3] O. Hegazy, J. V. Mierlo, and P. Lataire, ‘‘Analysis, modeling, and implementation of a multidevice interleaved DC/DC converter for fuel cell hybrid electric vehicles,’’ IEEE Trans. Power Electron., vol. 27, no. 11, pp. 4445–4458, Nov. 2012.

[4] A. Khaligh and Z. Li, ‘‘Battery, ultracapacitor, fuel cell, and hybrid energy storage systems for electric, hybrid electric, fuel cell, and plug-in hybridelectric vehicles: State of the art,’’ IEEE Trans. Veh. Technol., vol. 59, no. 6,pp. 2806–2814, Jul. 2010.

[5] H. H. Eldeeb, A. T. Elsayed, C. R. Lashway, and O. Mohammed, ‘‘Hybrid energy storage sizing and power splitting optimization for plug-in electric vehicles,’’ IEEE Trans. Ind. Appl., vol. 55, no. 3, pp. 2252–2262, May 2019.



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