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High-Fidelity Battery Modeling and Dual-Battery Strategy for Efficient Electric Vehicle Operation

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ABSTRACT:

A battery management system has been developed for EVs to ensure reliable, efficient and consistent operation of batteries under different environmental and driving conditions. Firstly, for the development of battery management system a high fidelity battery model dependent on different operating conditions is developed. Then battery model parameters are identified using manufacturer data sheet without conducting expensive and time-consuming experiments. Secondly, this research work focuses on the estimation of internal states of batteries such as the State of Charge, State of Health and Remaining Useful Life. Determination of internal states of batteries helps in maintaining battery operation in safe operating window. Automobile industry presently designs and produces single large pack EVs which offers an extended range on the cost of a heavyweight vehicle with a high price. The researchers have suggested EV having two different size batteries. The overall weight of the vehicle is decreased for short-range travel by using smaller size fixed battery. The larger size battery is swappable and is used for longer distances. As it is seldom used, it has longer lifetime and its cost is distributed over the lifetime of the vehicle.

1. INTRODUCTION

There is a fuel shortage as a result of the rising number of automobiles on the road, which may pollute the environment. In light of this scenario, numerous research efforts have focused on fuel-free vehicles. As a result, electric vehicles (EVs) use battery power and renewable energy to replace gasoline-powered vehicles. It has discussed reviews of various EV technologies. In the fundamental plan of EV framework, some completely rely upon the battery power and some are coordinated with the energy units or other power sources. Due to their load power and the capacity of the battery with the driving components, electric vehicles, which are entirely dependent on battery power, can only move at a limited speed. The EV system has been integrated with other power sources, such as fuel cells, to boost performance and motor power. This allows the EV to operate at high speeds and to carry a heavy load, just like a conventional fuel-powered vehicle. For high power reaction of EV framework, BLDC engine has been utilized as the vehicle motor alongside the driving circuits. It has provided an explanation for the EV system's effectiveness, which were approved in the US. Since the EV framework is still under the exploration express, the strength level must be superior in a few testing conditions. Here, a portion of the essential conditions are that it ought to run on the slanting way with weighty burden, the speed of vehicle ought to be in the controlled level, the stopping mechanism of the vehicle ought to have better soundness and other updated properties ought to be added to run it with standard usefulness.

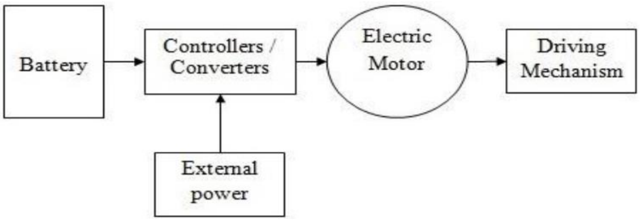


Figure 1.1 Block diagram of EV system

2. BATTERIES

The voltage source (Versus) and current source (CS) inverter are the primary sorts of inverter. They have their own benefits and faults anyway in the sustainable power framework VSI is more proper contrasted with CSI. The researchers have demonstrated that transformer-less inverters in renewable applications pique interest due to the system's weight and size, which are caused by the transformer. Due to switching losses, a two-level inverter is not utilized in high-power applications. Due to its numerous advantages, the electric power conversion device known as a multilevel voltage source inverter (MLVSI) has received a lot of attention. Due to their ability to generate high voltage with semiconductor switches with much lower rated power, their potential has been utilized in DC-AC and AC-DC converters with medium and high power ratings. Compared to two-level inverters, MLVSI produces fewer harmonics and puts less stress on the switching devices because of its stepped output. Truly, yield turns out to be nearer to the sinusoidal waveform on the off chance that the voltage level is expanded, bringing about a superior sounds profile. The more voltage output levels there are, the more options there are for getting rid of transformers from the distribution system, which is always a bad idea because they cost money and take up space.

The utilization of MLVSI provides an economical operational elucidation in the energy sector. Neutral point clamped (NPC), cascaded H-bridge (CHB), and flying capacitors (FCs) are the conventional topologies of MLI. CMLI's modularity allows for adaptability and high power handling with low power-rated devices.

3. MULTI-LEVEL TOPOLOGIES

The neutral point clamped (NPC) MLI, which was introduced in 1981, the flying capacitor (FC) MLI, which was introduced in the early 1990s, and the cascaded H-bridge (CHB) MLI, which was first proposed in 1975, are the conventional MLIs that are most commonly recommended for use in PV applications. The upper and lower halves of a traditional NPC MLI are connected by clamped diodes and series dc-bus capacitors. The braced diodes are associated in series to share the hindering voltage. The dc-bus capacitors divide the total dc source voltage. The 5L output voltage is produced by a three-level NPC topology as depicted in Figure 1.4(a). Diodes are used to clamp the capacitor voltages because the capacitors' middle point has no voltage. subsequently this geography is called as diode clipped MLI or NPC MLI. The fact that the NPC MLI only requires a single dc source to produce the required output voltage level is its primary advantage. Clamping diodes are also used to reduce the voltage stress placed on the active switches. However, the main issue with this topology is that as output voltages rise, the circuit becomes more complicated because it needs more clamping diodes, dc-bus capacitors, and switches. Additionally, as the level rises, the voltage balance and capacitor balance become more challenging

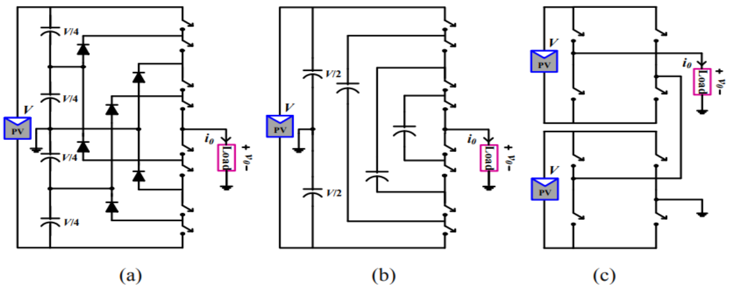


Figure 3.1: Five-level conventional MLI topologies (a) NPC, (b) FC, (c) CHB

4. *H-BRIDGE RECTIFIER*

Classical converters, Multi-Quadrant converters, Switched component converters, Soft switching converters, Synchronous rectifier converters, and Multi-element resonant converters are all examples of these types of converters. Furthermore, based on the DC-to-DC conversion method, each generation is further divided into distinct types. There are five types of the classic converter: namely, transformer type, developed circuits, fundamental circuits, developed circuits, and converter circuits based on voltage lift (VL) and super lift (SL) techniques. Due to the inductor's stored energy, the voltage across the MOSFET cannot immediately reach its peak value in this instance. After the switching MOSFET is quickly turned off, this stored energy is released into the circuit as back-electromotive force (back-EMF).

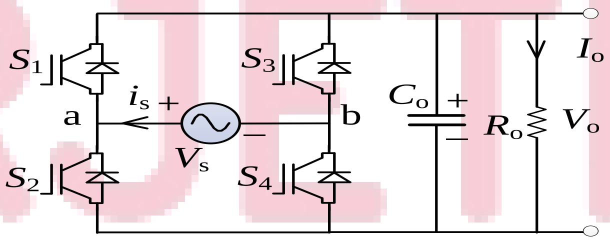


Figure 4.1: Rectifier topology for H-bridge

5. *DC-DC CONVERTER*

In a buck-help converter, the result voltage size is by the same token more noteworthy than or lesser than the information voltage greatness. It is a type of switched mode power supply that incorporates the buck converter and boost converter principles into a single circuit. This topology can basically operate in either the inverted or the non-inverted modes, which are described above.

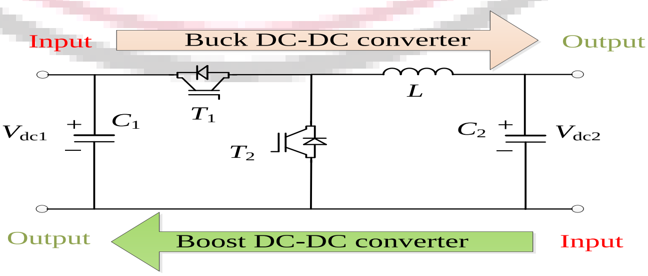


Figure 5.1: Bidirectional DC-DC converter for non-isolated

6. SIMULATION RESULTS

Table 6.1: Parameters

Parameters	**Value**
Grid voltage (v_s)	230 VRMS
Filter inductor (L_s)	4.5 mH
Filter capacitor (C_o)	2200 uF
Resistive load (R_o)	20 Ohm
Switching frequency (F_{sw})	10 kHz
Grid frequency (f_g)	50 Hz
EV battery load	Lithium ion (72V)

Fig. 6.1 shows the information and result voltage of proposed converter, here input voltage is 50 V, regarding that result voltage documents 110 V that shows charging activity or lift activity of the converter works really with lesser wave contrast with past proposed converter. The thunderous tank voltage and current waveforms of recreated converter, here thunderous current is achieve lesser wave with following sinusoidal reaction, here thunderous tank serves to accomplish delicate exchanging activity of proposed converter with the utilization of thunderous tank circuit in proposed converter interest of snubber circuit in already proposed converter is annihilated.

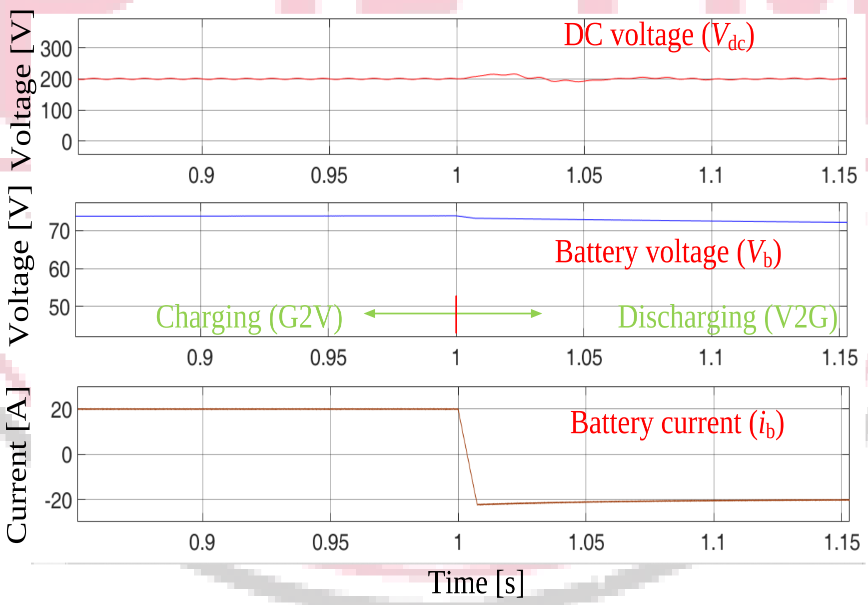
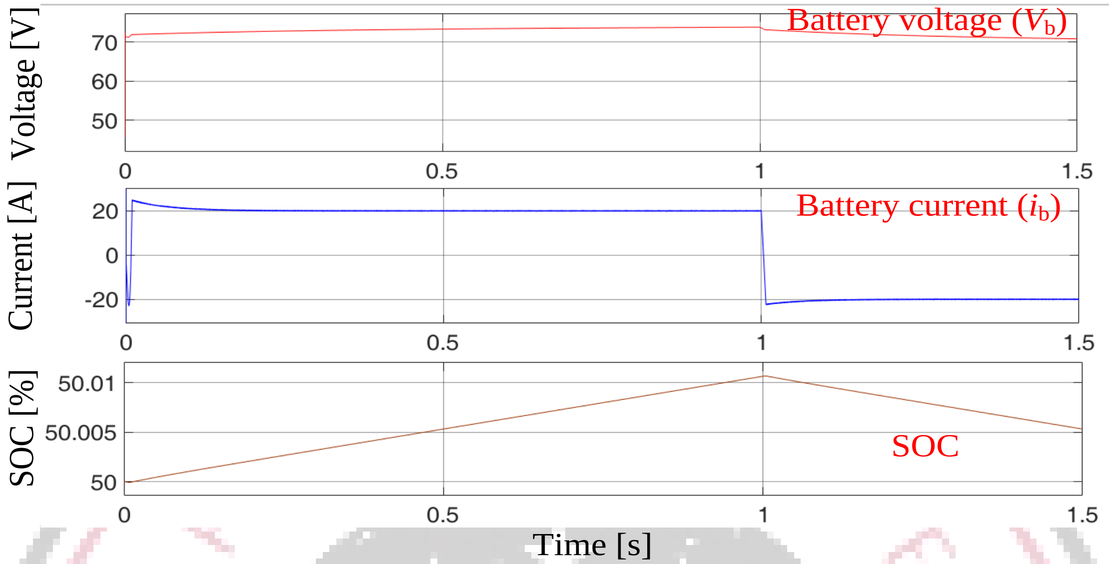


Figure 6.1: V2G operation for charging and discharging

The proposed converter's input and output voltages are shown in 6.2, where the input voltage is 100 V and the output voltage is 25 V. This indicates that the converter's discharging or buck operation is effective and has less ripple than the previous proposed converter.



. Figure 6.2: V2G activity with battery

The simulated primary and secondary voltages of the high frequency transformer are depicted in Fig. 6.2, with the primary side reaching 50 V and the secondary side reaching 100 V. In this mode of operation, the HFT performs well in comparison to other proposed converters in the discharge mode of conductivity.

7. CONCLUSION

Several designs of DC to DC converter models are available based on this idea. These models regulate the DC voltage and supply power to high-power motors and small driving components of low-power devices. Buck-boost DC to DC converters are typically considered for step-up and step-down power with regulated power when multiple components are used.

The EV framework has likewise been considered for the inexhaustible wellspring of energy to produce extra capacity to the vehicle. This kind of force age will re-energize the battery and expands the vehicle running time. In the majority of the EV framework, Photograph voltaic based sunlight powered charger has been utilized as the sustainable power asset contrasted with the breeze turbine and it is not difficult to fix alongside the vehicle and to plan the model of vehicle alongside the PV board. The PV framework can likewise be associated with the lattice framework for the utilization of PHEV framework.

REFERENCES:

[1] Y N. Neyestani M. Y. Damavandi M. Shafie-khah A. G. Bakirtzis and J. P. S. Catalao "Plug-in electric vehicles parking lot equilibria with energy and reserve markets" IEEE Trans. Power Syst. vol. 32 no. 3 pp. 2001-2016 May 2017.

[2] J. Freytes G. Bergna J. Are Suul S. D’Arco H. Saad and X. Guillaud "State-space modelling with steady-state time invariant representation of energy based controllers for modular multilevel converters" Proc. IEEE Manchester PowerTech pp. 18-22 Jun. 2017.

[3] S. Mehrnami S. K. Mazumder and H. Soni "Modulation Scheme for Three-Phase Differential-Mode Ćuk Inverter" IEEE Transactions on Power Electronics vol. 31 no. 3 pp. 2654-2668 March 2016.

[4] K. Kandasamy D. M. Vilathgamuwa U. K. Madawala and K.-J. Tseng "Inductively coupled modular battery system for electric vehicles" IET Power Electron. vol. 9 no. 2 pp. 1-10 Mar. 2016.

[5] G. Bergna J. A. Suul and S. D'Arco "State-space modelling of modular multilevel converters for constant variables in steady-state" Proc. IEEE 17th Workshop Control Model. for Power Electron. (COMPEL) pp. 27-30 Jun. 2016.

[6] F. Briz M. Lopez A. Rodriguez and M. Arias "Modular power electronic transformers: Modular multilevel converter versus cascaded H-bridge solutions" IEEE Ind. Electron. Mag. vol. 10 no. 4 pp. 6-19 Dec. 2016.

[7] F. Palone M. Rebolini S. Gentili G. M. Giannuzzi M. Schembari and S. Lauria "Connection of very large public charging station to the HV transmission grid" Proc. IEEE 15th Int. Conf. Environ. Electr. Eng. (EEEIC) pp. 1262-1267 Jun. 2015.

[8] S. Bayram A. Tajer M. Abdallah and K. Qaraqe "Capacity planning frameworks for electric vehicle charging stations with multiclass customers" IEEE Trans. Smart Grid vol. 6 no. 4 pp. 1934-1943 Jul. 2015.

[9] F. Briz M. Lopez A. Zapico A. Rodriguez and D. Diaz-Reigosa "Operation and control of MMCs using cells with power transfer capability" Proc. IEEE Appl. Power Electron. Conf. Exposit. (APEC) pp. 980-987 Mar. 2015.

[10] M. Lopez F. Briz A. Zapico A. Rodriguez and D. Diaz-Reigosa "Control strategies for MMC using cells with power transfer capability" Proc. IEEE Energy Convers. Congr. Exposit. (ECCE) pp. 3570-3577 Sep. 2015.

[11] H. Saad X. Guillaud J. Mahseredjian S. Dennetiere and S. Nguefeu "MMC capacitor voltage decoupling and balancing controls" IEEE Trans. Power Del. vol. 30 no. 2 pp. 704-712 Apr. 2015.

[12] M. Mao T. Tao Y. Ding J. Li and L. Chang "Interactive energy management strategy for MMC-based EV fleet integrated into smart grid" Proc. IEEE Energy Convers. Congr. Exposit. (ECCE) pp. 4745-4752 Sep. 2015.

[13] T. Soong and P. W. Lehn "Internal power flow of a modular multilevel converter with distributed energy resources" IEEE J. Emerg. Sel. Topics Power Electron. vol. 2 no. 4 pp. 1127-1138 Dec. 2014.

[14] B. S. Riar U. K. Madawala and D. J. Thrimawithana "Analysis and control of a three-phase modular multi-level converter based on inductive power transfer technology (M2LC-IPT)" Proc. IEEE Int. Conf. Ind. Technol. (ICIT) pp. 475-480 Feb. 2013.

[15] L. Harnefors A. Antonopoulos S. Norrga L. Angquist and H.-P. Nee "Dynamic analysis of modular multilevel converters" IEEE Trans. Ind. Electron. vol. 60 no. 7 pp. 2526-2537 Jul. 2013.

[16] B. S. Riar and U. Madawala "A modular multi-level converter (M2LC) based on inductive power transfer (IPT) technology" Proc. 3rd IEEE Int. Conf. Sustain. Energy Technol. ICSET pp. 54-59 Sep. 2012.

[17] H. Akagi "Classification terminology and application of the modular multilevel cascade converter (MMCC)" IEEE Trans. Power Electron. vol. 26 no. 11 pp. 3119-3130 Nov. 2011.

[18] S. Rohner J. Weber and S. Bernet "Continuous model of modular multilevel converter with experimental verification" Proc. IEEE Energy Convers. Congr. Expo. pp. 4021-4028 Sep. 2011.