Design and Analysis of Modified Bridgeless Landsman Converter for Electric Vehicle Battery Charger

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Abstract: Uses of Electric vehicle is increasing day by day. Government is also motivating and industries are developing improved electric vehicle (EV). Battery charger is a key part of EV. This paper deals with the design and analysis of a new charger for battery operated electric vehicle (BEV) with power factor improvement at the frontend. In the proposed configuration, the conventional diode converter at the source end of existing electric vehicle (EV) battery charger is eliminated with modified Landsman power factor correction (PFC) converter. This work deals with the design and analysis of a new charger for battery operated electric vehicle (BEV) with power factor improvement at the frontend. Simulated result shows that proposed electric vehicle battery charger gives improved result than previous.

***Index Terms* -** Power, Electric vehicle, battery charger, Capacity, Landsman.

I. INTRODUCTION

The charging protocol relies upon the estimate and sort of the battery being charged. Some battery types have high tolerance for overcharging (i.e., kept charging after the battery has been completely energized) and can be revived by association with a constant voltage source or a constant current source, contingent upon battery type. Basic chargers of this sort must be physically disengaged toward the finish of the charge cycle, and some battery types totally require, or may utilize a clock, to cut off charging current at some fixed time, roughly when charging is finished. Other battery types can't withstand over-charging, being harmed (diminished limit, decreased lifetime), over warming or in any event, detonating. The charger may have temperature or voltage detecting circuits and a microchip controller to securely change the charging current and voltage, decide the cut off toward the finish of charge.

A stream charger gives a moderately limited quantity of current, sufficiently just to check self-release of a battery that is inactive for quite a while. Some battery types can't tolerate stream charging of any sort; endeavors to do so may bring about harm. Lithium particle battery cells utilize a science framework which doesn't allow uncertain stream charging.

Slow battery chargers may take a few hours to finish a charge. High-rate chargers may restore most limit a lot faster, yet high rate chargers can be more than some battery types can tolerate. Such batteries require dynamic monitoring of the battery to shield it from overcharging. Electric vehicles in a perfect world need high-rate chargers. For community, establishment of such chargers and the appropriation support for them is an issue in the proposed reception of electric autos.

A decent battery charger gives the base to batteries that are sturdy and perform well. In a value delicate market, chargers frequently get low need and get the "after-thought" status. Battery and charger must go together like a steed and carriage. Judicious arranging gives the power source top need by setting it toward the start of the undertaking as opposed to after the equipment is finished, just like a typical practice. Architects are regularly unconscious of the intricacy including the power source, particularly while charging under unfavorable conditions.

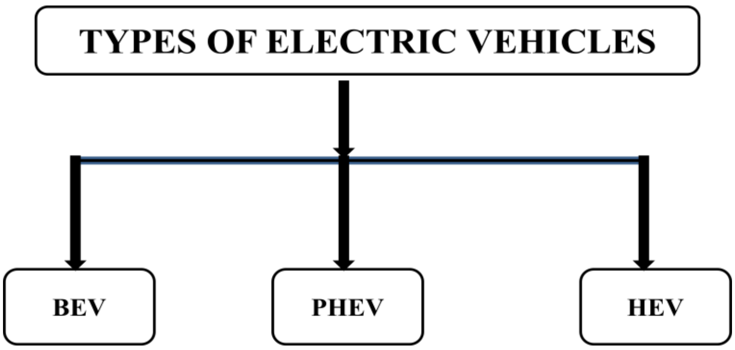

Figure 1: Types of electric vehicles

There are three fundamental kinds of electric vehicles (EVs), classed by the degree that electricity is utilized as their vitality source. BEVs, or battery electric vehicles, PHEVs of plug-in hybrid electric vehicles, and HEVs, or hybrid electric vehicles. Just BEVs are fit for charging on a level 3, DC fast charge.

Advantages of electric vehicles-

1) No fuel, no emissions

2) Low running costs

3) Low maintenance
4) Good Performance
5) Increasing Popularity

Chargers give a DC charging voltage from an air conditioner source whether from a typical attachment outlet or all the more as of late from a reason manufactured DC charging station. Most significant are the techniques for controlling the charge and shielding the battery from over-voltage, over-current and over-temperature. These charger capacities are coordinated with and extraordinary to the battery.

Chargers for electric bicycles are generally minimal effort, separate units. To spare weight they are not generally mounted on the bicycle and charging happens at home. Their power dealing with limit is adequate for charging the generally low power bicycle batteries and altogether unacceptable for traveler vehicle applications.

Chargers for traveler autos are ordinarily mounted inside the vehicle. This is on the grounds that the vehicle might be utilized far from home, more distant than the range conceivable from a solitary battery charge. Consequently they need to convey the charger with them on board the vehicle. Charging can be done at home from a standard household electricity attachment outlet yet the accessible power is exceptionally low and charging takes quite a while, potentially ten hours or all the more relying upon the size of the battery. Since charging is generally done medium-term this isn't really an issue, yet it could be if the vehicle is away from its command post. Such low power charging is ordinarily utilized in a crisis and most vehicles are fitted with a higher power charging choice which can be utilized in business areas or with a more powerful household establishment. In numerous nations this more powerful office is executed by methods for a three stage electricity supply.

II. Background

R. Kushwaha et al.,[2019] This work manages the plan and execution of another charger for a battery-operated electric vehicle (EV) with power factor improvement at the front end. In the proposed setup, the ordinary diode converter at the source end of existing EV battery charger is eliminated with the modified Landsman power factor correction (PFC) converter. The PFC converter is cascaded to a flyback confined converter, which yields the EV battery control to charge it, first in consistent current mode then switching to steady voltage mode. The proposed PFC converter is controlled using single detected element to achieve the vigorous guideline of dc-link voltage just as to guarantee the solidarity power factor operation. The proposed topology offers improved power quality, low gadget stress, and low input and yield current wave with low input current harmonics when contrasted with the customary one.[1]

S. Deilami et al.,[2018] This work shows a viable answer for improve the performance and power nature of the smart grid (SG) with a high infiltration of plugged-in electric vehicles (PEVs). The arbitrary, versatile, and time-variation PEV requests can over-burden lines, transformers, and circulated ages while the aggregate effects of their battery charger harmonics may increase the general total harmonic distortion (THD) of SG. To beat these issues, this work incorporates the ideal rescheduling of switched shunt capacitors (SSCs) and their day-ahead schedules in an as of late created online greatest affectability determination based PEV coordination algorithm with the inclusion of harmonics. This won't just improve customer fulfillment by fully charging all vehicles before 8 A.M. for the following day travel yet additionally diminish hub voltage vacillations, by and large THD, and system misfortunes. To check the performance of the proposed approach, itemized reenactments are performed on the modified IEEE 23-kV medium voltage distribution connect with seven SSCs and 22 low-voltage private systems that are populated with PEVs with nonlinear battery chargers and industry nonlinear loads.[4]

S. Q. Ali, et al.,[2017] The investigation proposes a non-detached three-phase integrated battery charger (IBC) in light of electric vehicle drivetrains that have two permanent magnet synchronous motors with shafts coupled through a torque coupler. The windings of both machines are utilized as input channel inductances after reconfiguration and associated with a three-phase grid in charging mode. Their existing footing inverters are operated as a three-phase charger that controls the charging power from the grid. The total torque delivered on the shaft during operation is broke down and a methodology to eliminate it is proposed. The system maintains a zero-normal torque as well as eliminates the pulsating torque segment on the shaft during operation. The topology allows change of the existing drive to an IBC through minor reconfiguration and gives a chance to lessen the compelling THD injection into the grid by means of interleaving for machines with low winding inductance. A power balancing control is likewise proposed to lessen the second harmonic on the DC power yield because of machine non-ideality. Recreation and experimental outcomes approve that the topology can be utilized as both a battery charger and as a dispersed asset, while the resultant torque on the shaft remains eliminated by the proposed strategy.[7]

M. Ibrahim et al.,[2016] This work centers around the interoperability examination of a resonating contactless charging system for electric vehicles (EVs). The plan utilizes diverse inductive circles acknowledged by industrial accomplices. It highlights a progressed electromagnetic modeling (EM) concerning the geometrical characteristics, the resounding topologies, and the control circle. It is shown that the EV chassis assumes a significant job in the figuring of the electrical parameters and the radiation of the interoperable system. Furthermore, the situation of the interoperable attractive couplers regarding the EV (center or backend) has a significant impact on the estimations of the coupling factor and furthermore for the radiation of the system. Finally, a productivity of 90% is acknowledged in the experimental test with the interoperability which gives adaptability for the driver to utilize charging stations with various technologies.[11]

G. Buja et al.,[2015] The work manages wireless battery chargers (WBCs) for plug-in electric vehicles (PEVs) and investigates two plans for the collector of an arrangement full WBC. The main game plan charges the PEV battery in a straightforward way through a diode rectifier. The subsequent game plan charges the PEV battery through the course of a diode rectifier and a chopper whose input voltage is kept steady. Figures of value of WBCs such as proficiency and sizing factor of both the power source and the transmitter/recipient loops are determined. A short time later, they are talked about and contrasted with reference with the contextual investigation of WBC for an electric city vehicle. A proposition to improve the proficiency of the second game plan by a reasonable determination of the chopper input voltage is introduced. Estimations on the effectiveness of the two plans are included to help the theoretical outcomes. [12]

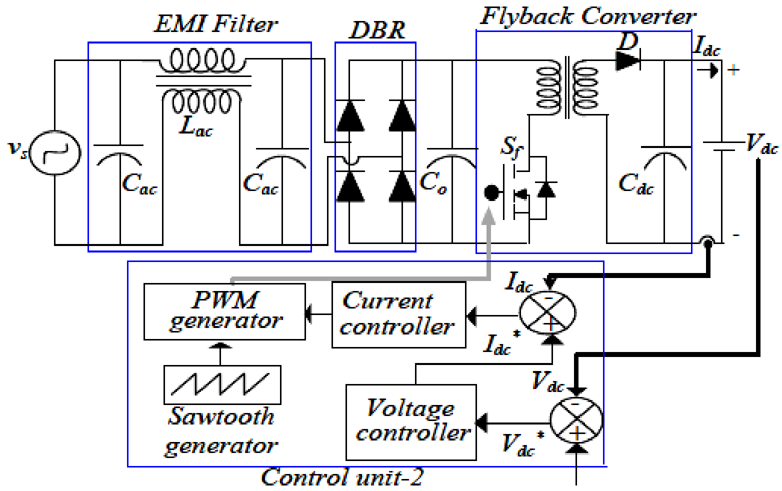

Figure 2: Conventional E-V Battery Charger

Figure 2 shows the configuration of a classical single phase DBR fed unidirectional E-rickshaw battery chargers.

III. PROPOSED MODEL

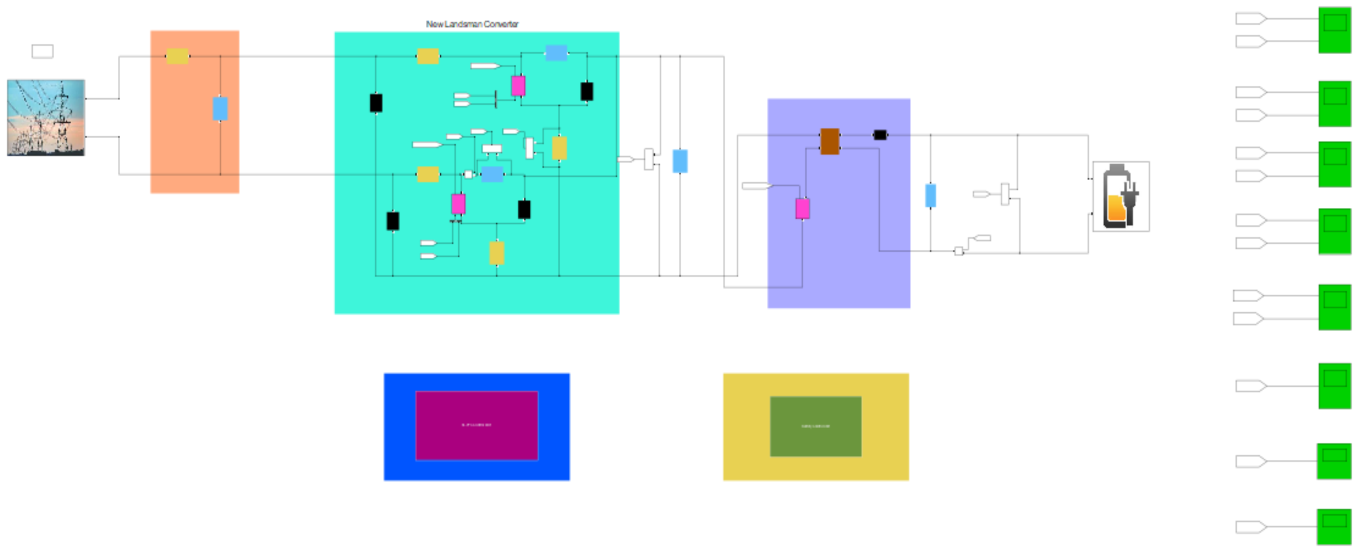

Figure 3: New Landsman Converter

Figure 3 is showing landsman converter circuit, where Implements a diode in parallel with a series RC snubber circuit. In on-state the Diode model has an internal resistance (Ron) and inductance (Lon).

The proposed modified Landsman converter fed battery charger consists of two stages, a modified BL converter for improved input wave-shaping and an isolated converter for the charging of EV battery during constant current (CC) constant voltage (CV) conditions. The operation of the modified converter is selected in DCM or CCM mode based on the application requirement of low cost or low device stress, respectively. BL converter fed EV battery charger with regulated DC link voltage at an intermediate stage. The input side of the proposed charger is fed by a single phase AC source. The input DBR is eliminated by two Landsman converters, which operates in parallel during the positive half line and negative half line, separately. Therefore, the conduction losses are reduced to half due to reduced number of components conducting in one switching cycle. For improved performance based switching, two converters, in synchronization

IV. Simulation Results

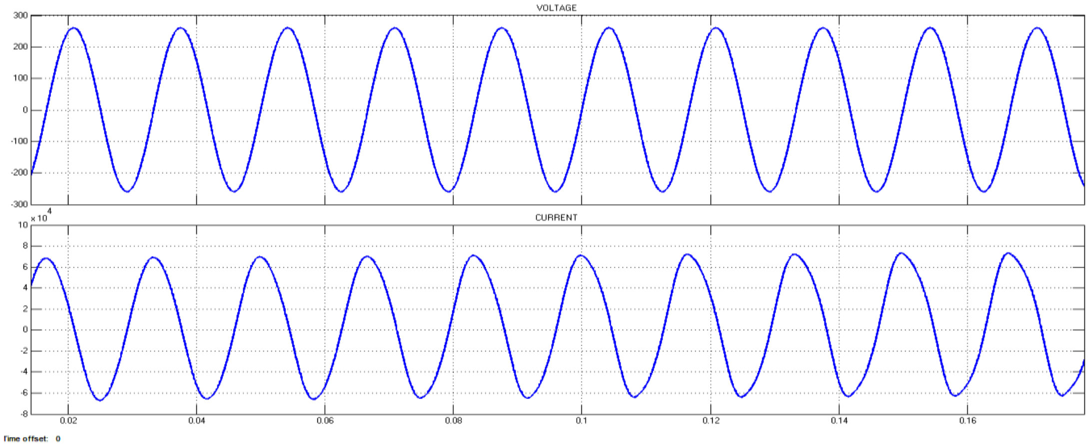

Figure 4: Output of Ac source voltage and current

Figure 4 presents output of source voltage, the value of source voltage is 260V and the value of current is 10A.

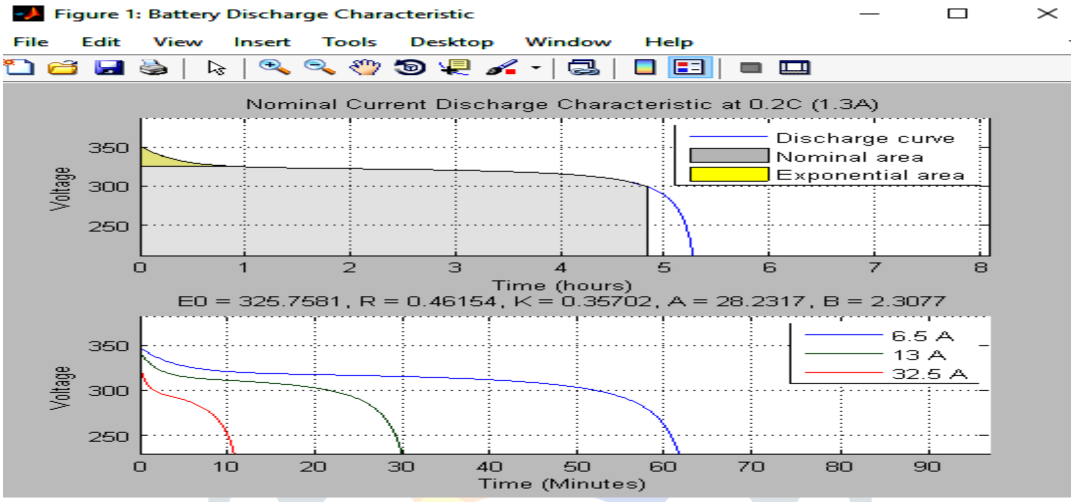

Figure 5: Battery discharge characteristic

Above figure 5 shows nominal current discharge characteristic graph between voltage and time. It is clear that battery discharge at 5.30 Hours.

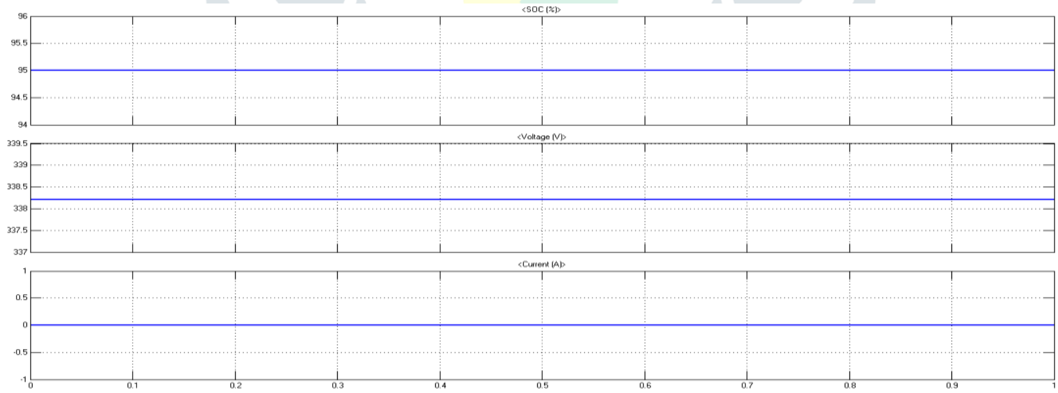

Figure 6: Performance of Battery

Figure 6 is showing output performance of battery. Here it can be seen that state of charge of battery is 95% and voltage is 338.25V.

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

Sr No.	Parameter	Previous Model	Proposed Model
1	Number of components	Increased	Constant
2	Control (with PFC)	Voltage Follower	Voltage Follower
3	Control(Battery)	Simple (dual PI)	Simple (dual PI)
4	Losses (with DBR and PFC)	5.88%	5.2%
5	Power density	0.369kW/kg	0.32W/kg

6	Power factor	0.88	0.92
7	Efficiency	91%	95%

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

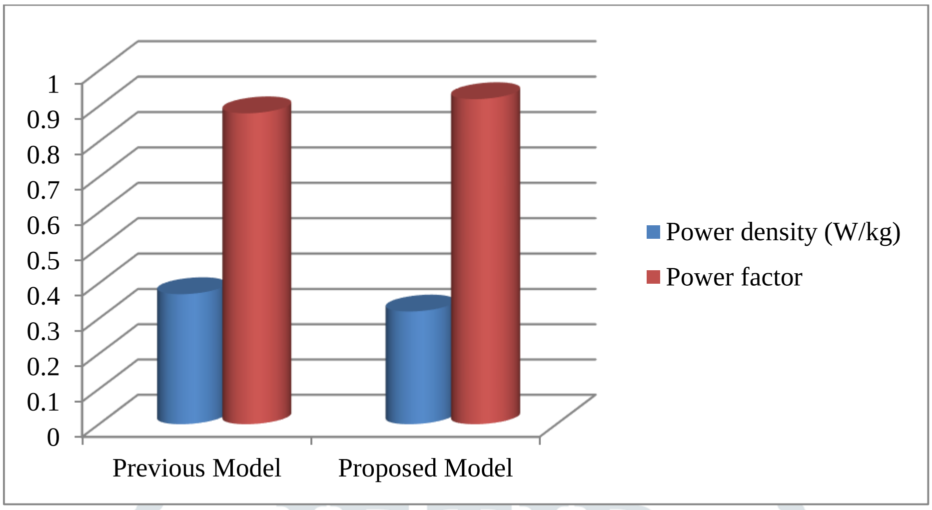

Figure 7: Comparison graph-I

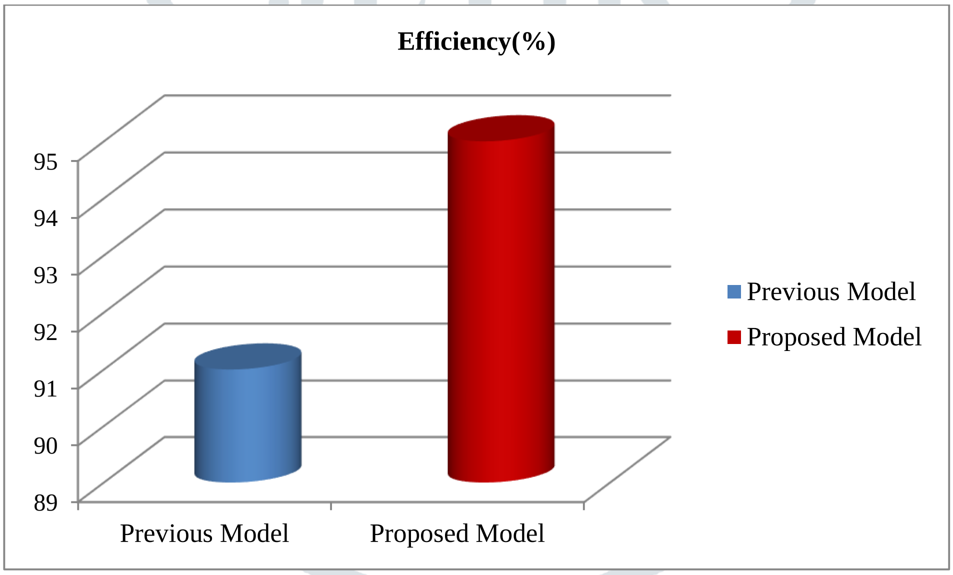

Figure 8: Comparison graph-II

Figure 7 and 8 are showing comparative result graph of efficiency, power density and power factor.

V. CONCLUSION

An improved EV charger with modified BL Landsman converter followed by a flyback converter has been proposed. Simulation is done using MATLAB simulink software. Simulated results are analyzed and validated. This work achieves better charge an EV battery with inherent PF Correction. The design and control of the proposed EV charger in DCM mode have offered the advantage of reduced number of sensors at the output. Moreover, the proposed BL converter has reduced the input and output current ripples due to inductors both in input and output of the converter. Therefore proposed model gives significant better performance than previous model.

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