

SYNOPSIS

PROJECT-1 (REE754)

SESSION: 2020-21

GROUP NO: 12

Title of the project:

DESIGNING AN EV CHARGING SYSTEM FOR IMPROVED
PERFORMANCE

Project supervisor's name: Dr. Sanjiba Kumar Bisoyi

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Signature of the project supervisor:

Recommended/ Not- Recommended by the Departmental Evaluation Committee

INTRODUCTION

Since the first appearance of electric vehicles (EV) in mid-19th century, there has been a need for EV charging technology. The first EVs had disposable batteries and technology for “charging “was replacing “dead “batteries. Invention of rechargeable batteries meant that new models of EVs had the possibility to use the same batteries without replacement. Also, main problem was that until early 20th century, many homes were without electricity, and that meant that it was impossible to charge the vehicle in homes. Electrification of homes meant that EVs would be more accessible to public. This would mean that more and more people would buy and use EVs. At the beginning of 20th century, 38% of automobiles were powered by electricity. These cars would charge either with batteries in the vehicle, or battery was removed from the vehicle, charged at another place, and then mounted back on vehicle. In late 20th century, public became more and more aware of air pollution, and idea of producing EVs started to rise again. Automotive companies started to make models of EVs, and question of charging infrastructure followed. First models of these EVs were able to be charged at home, using a normal socket. At first, hybrid cars were considered as compromise between ICE vehicles and EV, and home charging was enough to recharge them. As soon as companies started to make plug in EVs, need for a proper public charging infrastructure grew. This brings us to 21th century and evolution of EVs and charging technology.

Electric vehicles are a new and upcoming technology in the transportation and power sector. The U.S. Energy Information Administration states that the world has an adequate crude oil supply until about 2050. Basically, Electric vehicles are expected to enter the world market such that by 2030, 10% of the vehicles will be of EV type. The most expensive part of an EV is the battery and its charging and maintenance needs to be taken care of. The major challenges while adopting EV as an alternate to the fuel vehicles are the charging problems and it range from one charge.

LITERATURE REVIEW

In some other paper we found that It is a hardwired level 2 EV charger designed to suit a wide range of EV models. The charger is 18 feet long and charges up to six times faster than the standard wall outlet. The 240 V- and 32-Amp rating works well with a number of cars such as BMW, Jaguar, Toyota, Hyundai, Chrysler, Ford, Honda, Nissan, Tesla, etc. It can also be connected with your phone for easy control and monitoring.[43] The FLO home X5 Carbon is a high-performance, CSA certified Level 2 smart charging system that charges five times faster than the standard models. This product features sturdy and high-quality construction and is compatible with all the EV models. The 240 V, 30 Amp rating and a 25-foot power cable ensures the best of efficiency and versatility with every car design.[2] This is one of the high-power EV chargers you can find on the market. It comes in a 40 A, 10KW rating supplied by a 24-foot cable and is suitable both for indoor and outdoor installation. The Juicebox Pro is compatible with all the EV models since it automatically adjusts its power output depending on the car power rating up to 40 Amps. The rugged exterior design comes in a black-powder coated brushed aluminum that's fireproof, waterproof and durable.[3] This is a 9.6 kW, 40 A rated charger that's compatible with all the EV models. It comes in a simple and minimalist design for easy storage and

portability. The Jekayla level 2 charges 2.5 times faster than an ordinary 16 A charger and is 25-feet long for convenient charging space.[4] The EvoCharge Evolnnovate model is a wall mount and portable level 2 EV charger that guarantees faster charging speed up to 8 times the ordinary level 1 charger. The adjustable current-output setting makes it a compatible charger with all the EV models. Engineered for easy installation, the NEMA 6-50 plug plus the universal mounting bracket makes it convenient for use on any surface. This product is lightweight with a wattage rating of 7.68 KW.[45]. With a default 16-A rating, this EV charger can be adjusted along the 10A, 13A, and 20A ratings. It uses the NEMA 6-20P outlet and charges 6 times faster than a level 1 charger. The sleek design makes this charger compatible with many electric vehicles including the Ford Fusion Energi and Nissan Leaf. A high-strength ABS plastic material has been used in the design alongside overvoltage and heat protection.[5]

In some other paper we found that Performance of Cuk ac–dc converter is presented with hysteresis current and voltage loop. DC- DC converter is used to calculate the power. To reduce the harmonics filters are designed. Converter is operates in two modes one is voltage controller mode and another is current controller mode. Power factor correction is used in input side to regulates input dc bus; controller is used in output side to regulate the output bus voltage.[7] Analysis of the Cuk converter in closed loop operation. The Cuk converter is inherently a Non-Minimal Phase (NMP) system hence, the controller design for it is a challenging task.[8] The authors has designed a control method for the modified dc-dc Cuk converter using a simple double loop PI controller for controlling the output voltage and current at a steady state in all case.[47] A DC-DC/AC Non isolated Cuk converter is designed in this paper. This system comprises the centralized switching circuit, Non-Isolated Cuk Converters, bidirectional port and battery. The performance of this proposed system is analyzed by different controllers like Sliding Mode Controller (SMC) and Proportional Integral (PI) controller. Simulation results are shown that SMC provides good performance than PI controller. [10] The application in EV of Cuk converter, which can be regarded as a combination of boost converter and buck converter, on the low voltage side DC supply electric vehicles together with the batteries, and even super-capacitors which have unique characteristics. Simulation of the Cuk converter is conducted which shows stable operation. Further research of multi-switching together with Cuk converter is given which solve the problem of start-up and braking pulse together with the interrupt of battery state. There is great potential for the application of Cuk converter in EV platform.[50] The power factor correction using Cuk topology and found that Cuk converter improve the PF with the help of eliminating high harmonic distortion.[49] High quality output with higher efficiency with AC/AC Cuk converter.[20].The comparison between single-phase PFC Cuk converter and bridgeless PFC (BPFC) Cuk converter for low power application. This study

attempts to investigate the characteristics of conventional and bridgeless PFC Cuk converter structures with three different output voltages and verified by the simulation results. The BPFC Cuk converter provides a lower Total Harmonic Distortion (THD) of input current than the conventional PFC Cuk converter.[21]

Also, we found that the proposes a low power rating SEPIC converter and uses a resonant rectifier for controlling the system.[25] The compares the SEPIC converter topology with and without coupled inductors and found that the ripple content in an uncoupled inductor circuit is more than in the coupled inductor circuit. A state-space averaged model was used for simulation.[28] A non-isolated high voltage gain DC-DC converter has been presented in this paper. The boost, SEPIC and modified SEPIC converters were analyzed and their performance was compared with the proposed converter. Their proposed converter yielded best results.[31] The proposed converter circuit with addition of capacitors and diodes have been able to increase the output voltage by 10 times and with higher efficiency but this system was used for low voltage application and increasing the voltage application may or may not yield the same results.[35] The proposes a new structure of SEPIC with high voltage gain for renewable energy applications. The proposed circuit is designed by amalgamating the conventional SEPIC with a boosting module. Therefore, the converter benefits from various advantages that the SEPIC converter has, such as continuous input current. Also, high voltage gain and input current continuity make the presented converter suitable for renewable energy sources.[9] Comparison between SEPIC and Zeta converters by applying a PI controller for reduction in THD to the mains current to the load.[11] Comparison the different topologies of a SEPIC converter and reviews their performance. It shows that the different topologies have different results under the same operating conditions.[6] The design of a SEPIC integrated Boost (SIB) converter using coupled inductor is presented. The proposed converter has various advantages such as lower voltage stress on the switches, non-inverting output voltage, high efficiency, and high voltage gain. It is difficult to operate at higher duty ratios and hence achieve high-voltage transfer gains.[22]

In another paper, we found that calculated the conduction losses of DC/DC Converter with step-up and step-down dc power supplies to know and improve the efficiency because of low voltage Application for min. Losses the passive diodes are replaced by active Synchronous Rectifier.[12] Double input Buck-boost is used to adjust the power supplied by each one of the sources. The Control scheme is based on Controlling the offset time between the switching commands while switching frequency is kept constant.[24] A fifth order BB converter suitable to point of load Application. It offers more buck boost conversion ratio together with less ripple content in the source current and thus reducing the filtering req. on the source side.[32] Two Compensator are

designed to meet the control objective of supplying constant power from one source and meeting the additional load demand through the other source load variations.[1] The Converter has only two switches in the charging path which result in alleviated conduction losses. This experimental Prototype attained good efficiency and low THD.[34]

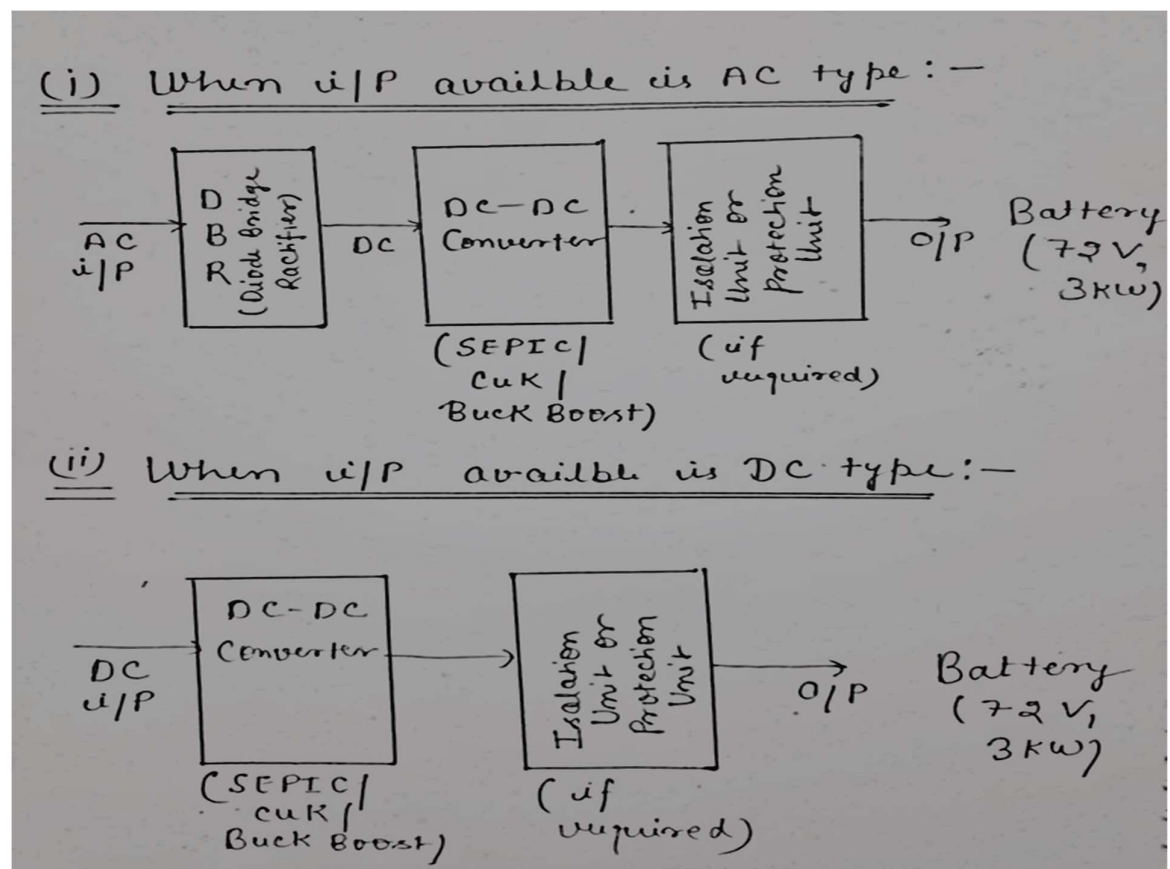
OBJECTIVES OF THE PROJECT

- Complete the literature review for the proposed topic and identify the charger rating required.
- To analyze the performance of different converters and select the most suitable converter.
- To design the selected converter for the rating of the battery chosen with reduced THD and ripple content.
- To develop safety circuit if required and complete the charging system design.

CHALLENGES

- The battery rating selection is a major challenge as different cars have different system and no standard rating has been proposed for EV batteries.
- A suitable protection unit is not readily available and should be compact.
- The losses also reduce the efficiency of the system and reducing it is not easy.

PROPOSED BLOCK DIAGRAM OF THE PROJECT



METHODOLOGY TO ACHIEVE THE SPECIFIC OBJECTIVE

The proposed method is to install a DC-DC converter with improved performance specification for the given battery rating. This is done by comparing different converters and analysing their performance and finding out which converter yields the best possible output and efficiency. This DC-DC converter will be fed either from a Diode-Bridge Rectifier or from the Direct DC supply. After output is received from the converter, a protection unit may be installed if the need arises. This will protect the car from supply faults and provide an extra level of security.

RESPONSIBILITY OF EACH MEMBER

Rishabh Khare: Simulation of SEPIC converter and designing of the selected converter.

Sarthak Singh: Simulation of Cuk converter, giving its performance specifications and comparing it with other converters.

Luv Pathak: Selection of battery and protection device for the charging system.

Abhinav Kumar Singh: Simulation of Buck-Boost converter, giving its performance specifications and comparing it with other converters.

TIME LINE AND TASKS TO BE ACCOMPLISHED:

Tasks	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Task1	←→								
Task2			←→						
Task3				←→					
Task4						←→			
Task5							←→		
Report Writing								←→	

- Task 1: Literature review and Selection of Battery Rating.
- Task 2: Simulation and comparison between Buck-Boost converter and Cuk converter.
- Task 3: Simulation and comparison between Cuk converter and SEPIC converter.
- Task 4: Designing of the above selected converter for the power rating of the battery.
- Task 5: Checking for the need of Protection Unit and completing the charger system.

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