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SMART CHARGING SYSTEM FOR ELECTRIC VEHICLES USING A TRANSFORMERLESS BRIDGELESS CONVERTER

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ABSTRACT

With the rising demand for sustainable transportation, efficient and power-quality-enhanced battery chargers are crucial for light electric vehicles (LEVs). This paper introduces a novel transformer less (TF) single-stage bridgeless converter-based charger designed to improve power quality while ensuring high efficiency and a compact design. By eliminating the conventional front-end diode bridge, the proposed charger reduces conduction losses and enhances overall system efficiency. Its single-stage topology seamlessly integrates power factor correction (PFC) and DC-DC conversion, minimizing switching losses and optimizing performance.

To regulate the charging process, a Fuzzy Logic Controller (FLC) is employed, offering adaptive control under varying grid and battery conditions. Unlike traditional proportional-integral (PI) controllers, the FLC-based approach delivers superior dynamic response, improved voltage regulation, and lower harmonic distortion. This results in enhanced power factor, reduced total harmonic distortion (THD), and stable charging performance. Both simulation and experimental validation confirm the effectiveness of the proposed charger, demonstrating improved power quality, higher efficiency, and minimized grid-side disturbances. This system stands as a reliable and efficient solution for the next generation of LEV charging infrastructure.

KEYWORDS — Transformer Less Charger, Bridgeless Converter, Light Electric Vehicles (Levs), Fuzzy Logic Controller (Flc),Power Factor Correction (Pfc), Total Harmonic Distortion (Thd), High-Efficiency Charging.

1. INTRODUCTION

1.1 OVERVIEW

The percentage demand of the LEVs is increasing manifolds, the charging facility equipped with an improved power quality solution is much anticipated from the power distributors as well as the consumer's perspectives. The existing chargers for the LEVs generally consist of an isolated/nonisolated dc–dc converter, followed by a combination of diode bridge rectifier (DBR) and dc link capacitor (CDC), as shown in Fig. 1. The combination of DBR with a heavy dc-link capacitor draws harmonics-rich distorted current from the supply, and therefore, it deteriorates the input power factor (PF), distortion factor (DF), displacement factor (DIF), and efficiency of

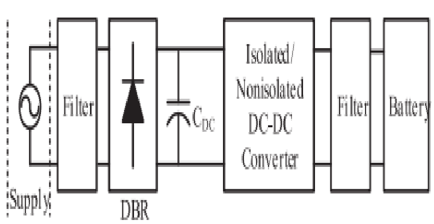

Fig. 1. Structure of conventional charger configurations for LEVs.

the charger. The single-phase active power factor correction (APFC) methods are extensively utilized to eliminate the abovementioned drawbacks of the conventional low power rating chargers. In an APFC method, a dc–dc converter is employed between DBR and CDC, to improve the supply-side performances of the charger from a power quality point of view. It is noteworthy that an APFC converter can perform multiple tasks in a charger based on the configuration of a charger, i.e., single-stage chargers or double-stage chargers. In a double-stage configuration, an APFC is employed to fulfill supply-side requirements and another dc–dc converter is required for satisfying the load-side demands, whereas only an APFC dc–dc converter performs both the tasks in the single-stage chargers. Several two-stage charger configurations based on different APFC solutions have been explored for the EVs/LEVs charging applications.

However, each solution has its benefits and drawbacks regarding its device count , conduction and switching losses control complexities and efficiency In order to improve the charger's efficiency by reducing its conduction losses in the APFC stage, many bridgeless APFC converters with partial or complete elimination of the DBR have been reported in the literature. A detailed review of bridgeless APFC converters is given in Recently, some bridgeless integrated charging solutions have been suggested to improve the component count and losses in the chargers while retaining the advantages of the two-stage chargers

In an integrated configuration, the semiconductor devices have been shared by both dc–dc converters, which reduce the device count and associate losses. However, the increased control complexities and high device stresses make them less attractive for LEVs applications. The ripple-free charging current is considered as a major advantage of a single-phase two-stage charger. However, several authors have claimed that low-frequency ripples in the charging current, if controlled properly, do not affect performance of the battery

While addressing these drawbacks of two-stage chargers, several researchers have provided various single-stage charger configurations for the EVs/LEVs along with enhanced power quality at the supply sid The single-stage chargers have high power density less component count and a simplified control structure. Moreover, a properly designed single-stage charger configuration can provide better efficiency than its two-stage counterpart. The limited output voltage capability of the conventional boost converter and the high distortion in the supply current near the zero crossing in the conventional buck converter rule out the possibilities of their application as an APFC in the single-stage LEVs chargers. Therefore, in most of the cases, the shortcomings of buck and boost derived converters are eliminated by employing the buck–boost derived converters such as buck–boost, Cuk, SEPIC, Zeta, CSC, and Luo dc—dc converters.

The Cuk dc–dc converter shows excellent input and output current ripple characteristics among all buck–boost dc–dc converters. However, the conventional buck–boost dc–dc converters are less suitable to provide a transformerless single-stage charging solution for the LEVs, due to their limited gain capability. In the case of LEVs, due to low battery voltage, the transformerless charger configuration operates at a very low duty ratio, which ultimately affects the charger's dynamic performance and efficiency. Therefore, most of the single-stage LEVs chargers based on conventional dc–dc converters require a transformer for getting the desired dc voltage gain. However, the inclusion of the transformer increases the cost and size of the charger. Moreover, the leakage inductance of the transformer increases the voltage stress across the devices. Consequently, the development of the single-stage transformerless charger for the EVs is gaining the researcher's attention nowadays. However, the improved power quality based transformerless charger configuration for the LEVs is still rarely addressed by the researchers. Several efforts have been made recently to improve the voltage gain capability of conventional dc–dc converters such as by utilizing coupled inductors, by cascading of converters, by employing quadratic converters, by considering multiplier circuit, interleaved front end structure, and switched inductor or hybrid switched inductor–capacitor structure.

In the case of coupled inductors, operating characteristics of the converter largely depend upon the coupling coefficient whereas the cascading and multiplier approach in converters increases the component count, which leads to higher cost, low efficiency, and complex circuitry. However, the quadratic converter provides higher efficiency than cascaded converter at the cost of increased voltage and current stresses. In order to overcome these issues, a switching dual network based on split capacitors or split inductors along with two to three diodes is proposed in. The switched inductor (SI) and switched capacitor (SC) networks efficiently modify the dc gain of conventional converters, based on the series/parallel charging and parallel/series discharging of the capacitors or inductors. In, an SI Cuk PFC converter based charger is proposed for LEVs. However, this charger has a high cost, complex control, and has increased size of magnetic components due to CCM

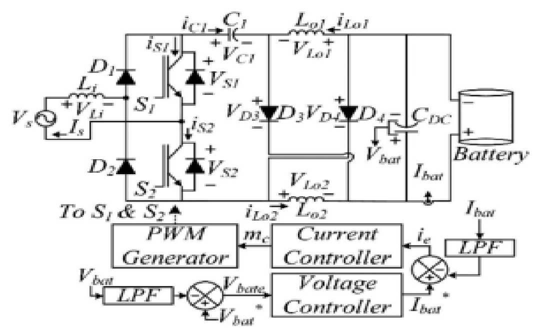

Fig. 2. BSIC PFC converter based transformerless charger configuration.

operation. Moreover, the DBR at the front side increases the conduction losses and component count in the charger. An enhanced power quality charger based on a single-stage configuration of BSIC PFC converter is presented in this work. Main contributions of this article are highlighted as follows.

1) This charger provides a single-stage charging solution for the LEVs, without having a transformer or coupled inductors with minimum component counts.

2) The design and control of the BSIC converter are carried out under the DCM condition, which not only reduces the size of magnetic components and associated losses but it also reduces the sensor requirements. Furthermore, the DCM operation rules out the need for the PLL system, and, therefore, it considerably simplifies the control implementation part.

3) The bridgeless structure at the front side reduces total device counts and the conduction losses of the charger.

4) Additionally, the enhanced power quality operation of the charger is tested and verified over a wide range of supply voltage while implementing the constant-current and constant-voltage charging modes.

5) A comparative analysis of the presented charger configuration with a conventional Cuk PFC converter and an SI Cuk PFC converter is carried out and presented based on various factors, e.g., number of components, control complexities, cost, size, and supply-side performances.

1.2 PROJECT OBJECTIVE

The main objective of your project, "Improved Power Quality Transformerless Single-Stage Bridgeless Converter-Based Charger for Light Electric Vehicles," is to develop a low-cost, compact, and efficient charging solution for light electric vehicles (LEVs) such as e-rickshaws, e-bikes, and e-cycles. This is achieved by designing a Bridgeless Switched Inductor Cuk (BSIC) converter that enhances power quality at the supply side while maintaining a single-stage, transformerless, and high-efficiency design. The project focuses on:

- Reducing the size and cost of charging components.
- Enhancing efficiency through a high-gain bridgeless configuration.
- Minimizing power losses and harmonic distortions in the supply current.
- Operating in discontinuous current mode (DCM) to reduce sensor and control requirements.

Providing constant current (CC) and constant voltage (CV) charging modes while ensuring smooth startup and safe operation.This charger is tested under various conditions to demonstrate its superiority over conventional chargers, particularly in terms of power quality, size, and cost-effectiveness

The proposed Bridgeless Switched Inductor Cuk (BSIC) converter-based charger is designed to overcome the limitations of conventional two-stage chargers, which often suffer from increased component count, higher conduction losses, control complexities, and reduced efficiency. By eliminating the bridge rectifier and transformer, the charger achieves lower conduction losses, improved power factor correction (PFC), and a simplified design while maintaining high voltage gain suitable for LEVs.

Additionally, the charger operates in discontinuous current mode (DCM) to reduce the size of magnetic components and sensor requirements, making it a cost-effective and compact solution. The design ensures ripple-free charging current with minimal harmonic distortion in the supply current, leading to an enhanced power quality operation.

The effectiveness of this charger is validated through hardware implementation and experimental testing, demonstrating its ability to handle various supply voltages and dynamic load conditions while maintaining stable operation. Compared to existing Cuk and switched inductor (SI) converters, this solution provides higher efficiency, lower cost, and better supply-side performance, making it a viable choice for modern light electric vehicle charging applications.

2.LITERATURE SURVEY

The concept of smart charging systems for electric vehicles (EVs) has gained significant attention in recent years due to the increasing adoption of electric mobility and the need for efficient, sustainable, and cost-effective charging solutions. The integration of advanced power electronics, renewable energy sources, and smart control strategies has become essential in addressing the challenges of conventional EV charging systems. One such promising technology is the transformerless bridgeless converter, which offers improved efficiency, reduced system complexity, and a more compact design.

In the study by **Liu et al. (2017)**, a detailed analysis of various AC-DC converters for EV charging systems is provided, focusing on the importance of reducing conduction losses. The authors highlight the advantages of using a bridgeless converter over traditional bridge rectifiers, which suffer from significant losses due to the diodes' voltage drops. The bridgeless converter, by eliminating unnecessary diodes, improves efficiency and provides a more compact and reliable solution for EV charging applications. Their work suggests that the bridgeless converter is particularly effective for systems that require high power efficiency and reduced energy consumption, such as smart EV chargers.

Zhao et al. (2018) explored the application of renewable energy sources, specifically solar energy, in EV charging systems. Their study presents a hybrid solar and grid-connected charging system that incorporates an MPPT algorithm to optimize the energy harvested from the solar panels. The MPPT controller dynamically adjusts the solar panel's operating point to extract the maximum power and charges the EV's battery efficiently. The study emphasized the importance of integrating renewable energy sources to reduce the environmental impact of charging systems and enhance the sustainability of EV infrastructure.

In **Rohani et al. (2019)**, the integration of a transformerless bridgeless converter in a smart charging system was examined. The authors presented a smart charging system that dynamically adjusts the charging parameters based on the battery's voltage and current requirements. The system uses pulse width modulation (PWM) techniques to regulate the output, ensuring that the EV is charged optimally. The study also explored the communication protocols used between the charger and the EV to ensure that the charging process adapts to the needs of the battery and external conditions. This work demonstrates how intelligent control and communication strategies can be used to optimize the EV charging process and ensure the safety of both the vehicle and the charging infrastructure.

Kumar and Agarwal (2017) focused on the development of a smart grid-integrated charging system that uses the latest power electronic converters for efficient energy transfer. The authors proposed a charging system that not only reduces the cost of charging but also allows for grid balancing by enabling bi-directional charging. The system can feed energy back to the grid during periods of high demand, helping to stabilize the grid. This concept aligns with the future vision of smart grids and bi-directional charging, where EVs can serve as mobile energy storage units, contributing to grid stability and load balancing.

Singh et al. (2020) discussed the impact of smart charging infrastructure on the electric vehicle ecosystem. Their work reviews several EV charging technologies, including transformerless bridgeless converters, and highlights their benefits in terms of efficiency, reduced losses, and system size. They also explored the role of communication and control systems in enabling smart charging solutions, where users can monitor and control the charging process remotely. Additionally, the study discusses the potential for integrating energy storage systems and renewable energy sources into the charging infrastructure to reduce dependence on the grid and promote sustainable charging practices.

In **Mitra et al. (2021)**, the authors focused on the design and implementation of a low-cost and high-efficiency transformerless bridgeless converter for EV charging applications. They examined the converter's performance under various load conditions and demonstrated its ability to reduce power losses and improve system efficiency. The research also highlighted the importance of safety mechanisms, such as overcurrent protection and voltage regulation, which are essential to protect both the EV battery and the charging system.

The research conducted by **Zhou et al. (2019)** emphasized the role of advanced digital controllers and communication protocols in smart charging systems. The authors proposed an adaptive charging strategy that adjusts the charging profile based on real-time data, such as battery state of charge (SOC) and energy availability from renewable sources. This work highlights the importance of intelligent charging systems that can dynamically adjust to the needs of both the vehicle and the external energy sources.

3.METHODOLOGY

The methodology for the proposed smart charging system for electric vehicles (EVs) using a transformerless bridgeless converter is designed to enhance the efficiency and reliability of EV

charging while minimizing losses and system complexity. The system aims to provide a high-performance, cost-effective, and compact solution for charging EVs, leveraging modern power electronics and smart control strategies.

At the core of the proposed charging system is the bridgeless converter, which plays a crucial role in improving the overall system efficiency. The traditional AC-DC converter typically involves a bridge rectifier with diodes, which introduces conduction losses due to the voltage drops across the diodes. By using a bridgeless converter, the number of diodes involved in the conversion process is reduced, thus significantly decreasing the conduction losses and improving the overall efficiency of the power conversion process. The absence of a transformer further simplifies the system by eliminating the bulky transformer, making the converter more compact and lightweight, which is particularly important for EV charging applications where space and weight are critical factors.

The system is designed to operate with both AC and DC power sources. The AC input is typically provided by the power grid, while the DC input could come from renewable energy sources such as solar panels. The bridgeless converter converts the AC input into a DC voltage suitable for charging the EV's battery. The system is equipped with a maximum power point tracking (MPPT) algorithm when operating with renewable energy sources to ensure that the energy from the solar panels is used efficiently. The MPPT algorithm continuously adjusts the operating point of the solar panels to extract the maximum possible power, ensuring optimal charging performance.

In terms of control strategy, the system employs advanced digital controllers that manage the operation of the converter. The controller is responsible for regulating the output voltage and current to match the requirements of the EV battery. By utilizing pulse width modulation (PWM) techniques, the controller adjusts the switching frequencies of the converter to regulate the output power. Additionally, the controller is designed to adapt to various charging conditions, such as varying battery voltages and current requirements, ensuring that the EV battery is charged optimally while preventing overcharging or undercharging.

To enhance the flexibility and intelligence of the charging system, the smart charging feature is incorporated. The system is designed to communicate with the EV and other infrastructure components, such as the power grid and renewable energy sources, using communication protocols like CAN bus or Wi-Fi. This communication allows the system to adapt to dynamic charging conditions, such as peak or off-peak grid times, and make real-time decisions about the charging process. For example, the system can prioritize charging during off-peak hours to take advantage of lower electricity rates or use excess solar energy during the day to charge the EV, reducing dependence on the grid.

Another key feature of the system is the inclusion of safety mechanisms, such as overcurrent protection, voltage regulation, and thermal management. These safety features are essential to protect both the EV battery and the charging system from damage due to abnormal operating conditions. The system continuously monitors the charging process and adjusts the parameters to ensure safe and efficient operation. Temperature sensors and current sensors are used to detect any potential issues, and the controller adjusts the charging process accordingly to prevent overheating or overcurrent conditions.

The entire system is designed to be modular, scalable, and easily integrable into existing EV infrastructure. It is capable of supporting various types of EV batteries, including lithium-ion and solid-state batteries, by adjusting the output parameters. Additionally, the system can be integrated with future smart grid technologies, allowing for bi-directional charging where the EV battery can be used to supply power back to the grid during periods of high demand.

4.PROPOSED SYSTEM

The proposed system for a smart charging solution for electric vehicles (EVs) using a transformerless bridgeless converter aims to address the growing need for more efficient, cost-effective, and sustainable EV charging infrastructures. The system integrates cutting-edge power electronics, intelligent control systems, and renewable energy sources to create a charging station that minimizes energy loss, reduces system complexity, and optimizes the charging process for EVs.

The core of the proposed system is the transformerless bridgeless converter. Traditional AC-DC converters often suffer from high conduction losses due to the presence of a bridge rectifier that involves multiple diodes, leading to voltage drops. By utilizing a bridgeless converter, the number of diodes is reduced, significantly lowering the conduction losses and improving the overall efficiency of the conversion process. The absence of a transformer also eliminates the need for a bulky component, thereby reducing both the weight and the size of the charging system, making it more compact and suitable for urban and residential areas.

This system is designed to work with both AC grid power and renewable energy sources, such as solar panels. The AC power from the grid or the DC power from the solar panels is first converted to a suitable voltage level for charging the EV battery. The system employs a Maximum Power Point Tracking (MPPT) algorithm when operating with solar energy to ensure optimal energy extraction from the solar panels. The MPPT algorithm continuously adjusts the operating point of the solar panels to extract the maximum available power, ensuring that the EV charging process is efficient, even under variable sunlight conditions. The DC power from renewable sources can be used directly to charge the vehicle's battery, thus contributing to sustainability by reducing grid dependency.

The smart charging system incorporates advanced digital controllers that monitor and manage the entire charging process. These controllers regulate the output voltage and current to suit the needs of the EV battery, preventing overcharging and ensuring that the battery is charged at an optimal rate. The control system utilizes pulse width modulation (PWM) techniques to regulate the converter's switching frequency and adjust the output power according to real-time requirements. The intelligent control mechanism ensures that the charging process is adapted to varying battery voltages and current requirements, thus maintaining safe and efficient charging throughout the process.

Another important feature of the system is its smart charging capability, which involves the communication between the EV, the charging station, and other external systems. Communication protocols, such as CAN bus, Wi-Fi, or Bluetooth, are employed to enable data exchange between the vehicle and the charger. This allows the system to adjust the charging rate based on the battery's state of charge (SOC), health, and other real-time parameters. Furthermore, this communication allows the charger to be integrated into a larger network, where it can respond to signals from the grid to charge the vehicle during off-peak hours, optimizing electricity usage and taking advantage of lower electricity costs. In the case of solar power, the system can prioritize charging from renewable sources during the day, further promoting sustainability.

Safety is a critical aspect of the proposed system. The design incorporates various protective mechanisms, including overcurrent protection, voltage regulation, and thermal management. These safety features ensure that the system operates within safe limits and protects both the charging station and the EV battery from potential damage. Additionally, temperature and current sensors are employed to continuously monitor the system's performance, enabling automatic adjustments to prevent overheating and ensure safe operation.

The system is scalable and flexible, meaning it can support various battery types, including lithium-ion and solid-state batteries, which are commonly used in EVs. Furthermore, it can be easily adapted for use in both public and private charging stations. By integrating renewable energy sources, the system is able to reduce the reliance on grid power, minimize carbon emissions, and contribute to the overall sustainability of EV infrastructure.

The smart charging system's modular design ensures that it can be seamlessly integrated into existing charging infrastructure. It offers the potential for bi-directional charging, where EVs can supply power back to the grid during peak demand times, helping to stabilize the grid and balance energy supply and demand.

5.EXISTING SYSTEM

The existing system for electric vehicle (EV) charging primarily relies on traditional AC-DC converters, which utilize a bridge rectifier to convert AC from the grid into DC for charging the vehicle's battery. These systems are widely used in public and private charging stations and typically consist of an AC input, a rectifier circuit, a DC-DC converter, and a charging control unit. While these systems are functional and efficient to a certain extent, they suffer from several limitations that affect their performance, efficiency, and scalability, especially as the demand for electric vehicles increases.

One of the main issues with traditional charging systems is their reliance on large, bulky transformers. These transformers are essential for stepping down the voltage from the grid to a level suitable for charging the EV, but they add significant size, weight, and cost to the charging station. Additionally, the presence of transformers introduces additional energy losses in the system, primarily due to the core and copper losses in the transformer.

Another drawback of conventional systems is the use of bridge rectifiers, which are responsible for converting AC to DC. The rectifier consists of four diodes arranged in a bridge configuration. While the bridge rectifier is effective, it causes conduction losses due to the voltage drop across the diodes. This results in reduced overall system efficiency. Additionally, the need for four diodes makes the system more complex and larger in size.

The existing systems also tend to be less flexible in terms of energy sources. Most charging stations are heavily dependent on the grid for power, and when renewable energy sources like solar panels are used, they are typically integrated with separate, dedicated power conversion units. This increases the complexity and cost of the system. Furthermore, many existing systems lack sophisticated communication protocols to enable smart charging, such as dynamically adjusting charging rates based on factors like battery condition, electricity costs, or grid demand.

In terms of charging speed, many existing EV charging stations use Level 1 or Level 2 chargers, which offer relatively slow charging speeds. Although Level 3 fast chargers provide higher charging rates, they are less common due to their high cost and power requirements. The lack of intelligent control systems in existing stations means that charging is often inefficient, leading to longer charging times and increased energy consumption.

Safety is another concern in traditional charging systems. While most systems include basic protection features like overcurrent protection and thermal management, they may not be sufficient for optimizing the charging process under varying operating conditions. Additionally, these systems may lack real-time monitoring and adaptive control, meaning they are unable to dynamically adjust charging parameters based on external factors, such as fluctuating grid power availability or varying solar generation levels.

Existing charging systems also tend to be fixed in terms of their charging profiles. For instance, they might not be able to adjust charging patterns based on the energy needs of the EV battery or the surrounding infrastructure. This static approach can lead to inefficiencies, particularly during peak load times, where grid demand is high, and the charging station could benefit from smarter energy distribution techniques.

Despite these limitations, existing charging systems remain the backbone of EV infrastructure and have been widely adopted worldwide. However, with the rapid increase in electric vehicle adoption and the shift toward smart cities, there is a growing demand for more efficient, flexible, and intelligent charging solutions. The existing systems are gradually being upgraded with features such as integration with renewable energy sources, the use of smart charging algorithms, and improved energy management strategies to address these challenges.

In conclusion, while the existing EV charging systems have proven effective, they face several limitations related to energy efficiency, system complexity, and flexibility. The reliance on transformers, bridge rectifiers, and limited integration with renewable energy sources make them less optimal in terms of energy consumption and scalability. As the electric vehicle market grows, there is a need for more advanced, smarter charging systems that can overcome these limitations and offer more sustainable, efficient, and cost-effective solutions.

6.RESULTS AND DISCUSSION

The overall analysis, design, control, and performance of the BSIC converter based single-stage transformerless enhanced power quality charger are experimentally verified through a hardware prototype in the laboratory environment. Furthermore, the effectiveness of overall control is evaluated not only for steady state but also during various dynamics while operating at different charging conditions.

Table I Comparative Analysis Of Proposed Bsic Pfc Converter With Existing Chargers Configurations

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S. No	Parameters	Conventional Cuk Converter Based PFC Charger [4]	Switched Inductor Cuk Converter Based PFC Charger [29]	Proposed Bridgeless Switched Inductor Cuk Converter Based PF
1	Number of Stages	Two Stage	Single Stage	Single Stage
2	No. of Components- D/S/L/C*	7/3/3/5 (Total = 18)	6/1/3/2 (Total = 12)	4/2/3/2 (Total = 11)
3	Requirement of Transformer	Yes	No	No
4	Number of Sensors (VS, CS)	5 (3 VS, 2 CS)	4 (2 VS, 2 CS)	2 (1 VS, 1 CS)
5	Complexity of Control	High	High	Low
6	Operating Modes Input / Output Inductors of Cuk Converter	CCM/CCM	CCM/CCM	CCM/DCM
7	Power Rating of Charger	580 W	500 W	850 W
8	Input Inductor	2.6 mH (With 50 % Permissible Ripple)	15 mH (With 25 % Permissible Ripple)	6 mH (With 25 % Permissible Ripple)
9	Output Inductor	2.6 mH (With 50 % Permissible Ripple)	4.5 mH (With 25 % Permissible Ripple)	40 µH

6.1 MATLAB SIMULINK EXISTING CIRCUIT

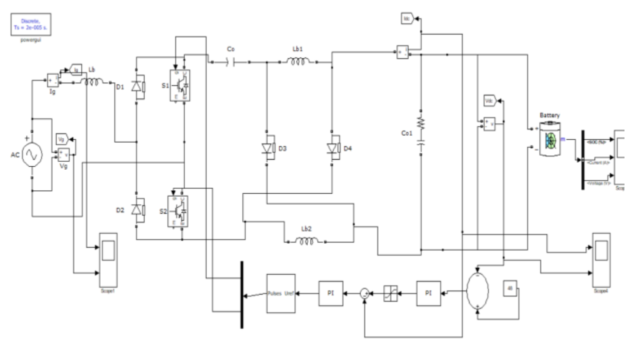

Fig.1 Existing System

OUTPUTS FOR EXISTING SYSTEM

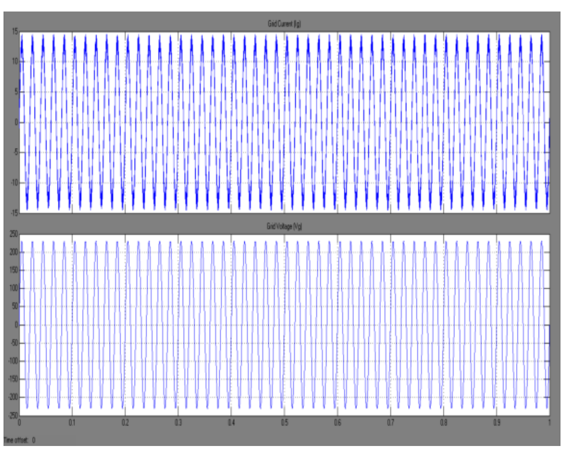

Fig .2 Voltage and Current at Grid

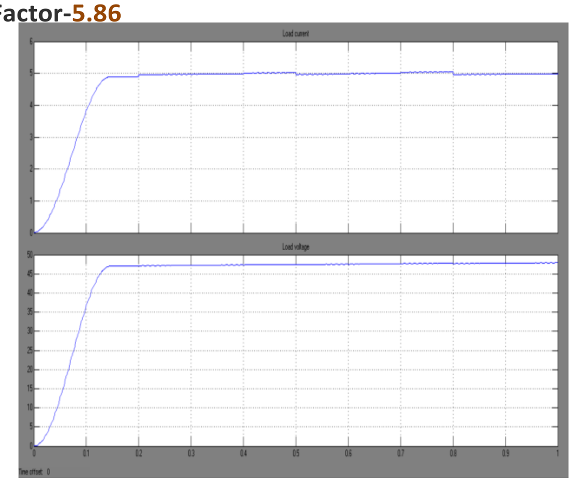

Fig .3 Voltage and Current at the Load

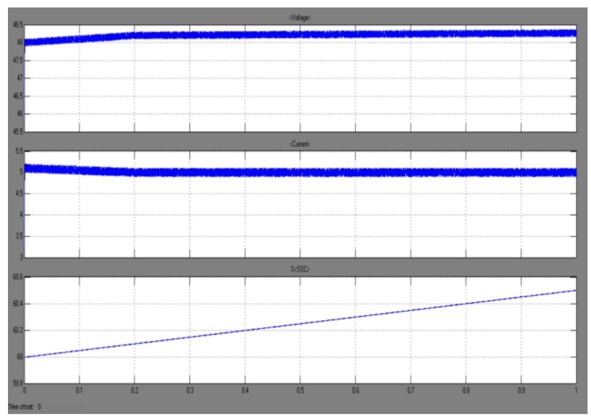

Fig .4 Voltage, Current, SOC of Battery

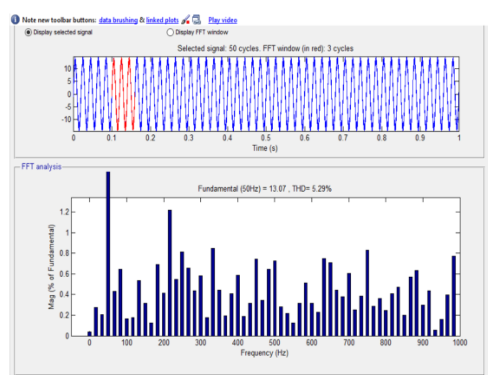

Fig .5 Total Harmonic Distortion of Existing System At Grid

6.2 MATLAB SIMULINK PROPOSED CIRCUIT

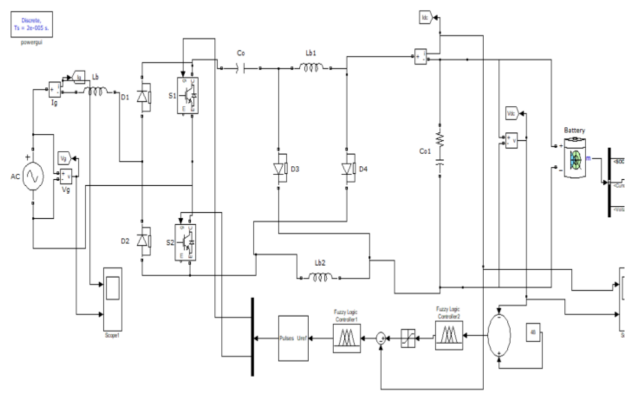

Fig .6 Proposed System

OUTPUTS

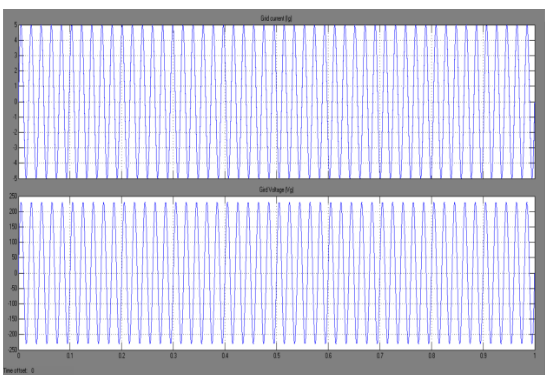

Fig .7 Voltage and Current at Grid

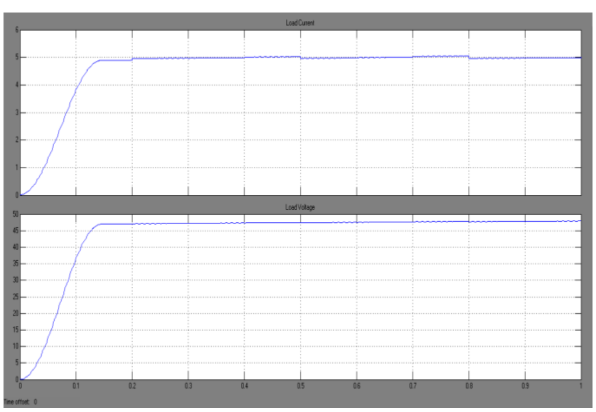

Fig :8 Voltage and Current at the Load

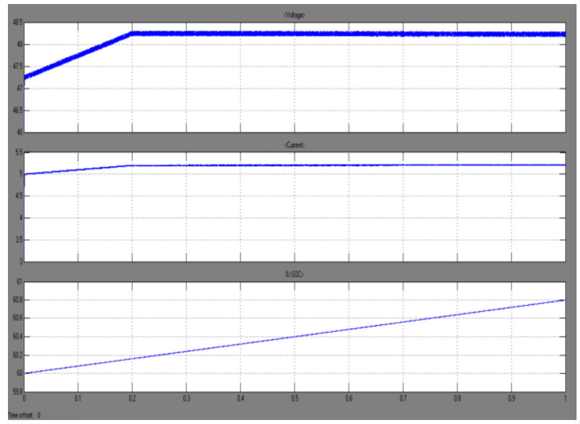

Fig .9 Voltage, Current, SOC of Battery

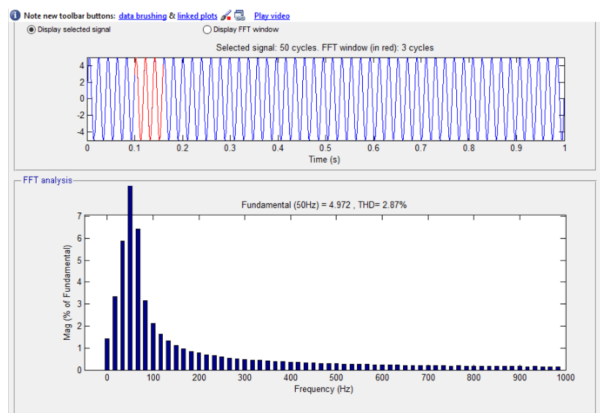

Fig .10 Total Harmonic Distortion of Proposed System At Grid

Table – 2 THD Comparison Between Pi And Fuzzy Controller

Controller	Total Harmonic Distortion
Pi	5.29%
Fuzzy	2.86%

7.CONCLUSION

In this article, a bridgeless switched inductor Cuk (BSIC) PFC converter based charger has been put forward, to provide a single-phase single-stage transformerless charging solution for the LEVs. This charger has alleviated the drawback of limited step-down dc voltage gain in conventional dc–dc converters. Therefore, the higher step-down voltage gain has been availed for the LEVs batteries, without employing a transformer. The CC and CV modes have been accomplished in a single-stage with excellent supply-side power quality indices such as power factor, distortion factor, and supply current THD. Furthermore, fewer sensing devices with optimized control complexities have been considered while implementing the control of the charger. Moreover, the design of the charger has been carried out in a way to enhance the safety and reliability of its components while operating over the defined supply voltage and battery voltage range. The test results under the steady-state and during various dynamics have been demonstrated to support the theoretical analysis. The operation of the charger during line and load regulation has been tested and verified. A short comparison of the presented BSIC converter based charger with the other charger topologies has been carried out and presented in a tabular form. Finally, it has been shown that the presented charger configuration is advantageous in many ways such as low cost, less size, enhanced supply-side performances, minimum components counts, and fewer control complexities.

8.REFERENCES

[1] NITI Aayog and WEC, "Zero-emission vehicles: Towards a policy framework," NITI Aayog, New Delhi, India, Rep., 2008. [Onlne]. Available: https://niti.gov.in/writereaddata/files/document_publication/ EV_report.pdf

[2] Z. Yang and P. C. Sen, “Recent developments in high power factor switch-mode converters,” in Proc. IEEE Can. Conf. Electron. Comp. Eng., Waterloo, ON, Canada, 1998, vol. 2, pp. 477–480.

[3] H. Wang, S. Dusmez, and A. Khaligh, “A novel approach to design EV battery chargers using SEPIC PFC stage and optimal operating point tracking technique for LLC converter,” in Proc. IEEE App. Power Electron. Conf. Expo., Fort Worth, TX, USA, 2014, pp. 1683–1689.

[4] R. Pandey and B. Singh, "A power-factor-corrected LLC resonant converter for electric vehicle charger using Cuk converter," IEEE Trans. Indus. Appl., vol. 55, no. 6, pp. 6278–6286, Nov–Dec. 2019.

[5] D. Kim and B. Lee, "Asymmetric control algorithm for increasing efficiency of nonisolated on-board battery chargers with a single controller," IEEE Trans. Veh. Technol., vol. 66, no. 8, pp. 6693–6706, Aug. 2017.

[6] A. V. J. S. Praneeth and S. S. Williamson, "A wide input and output voltage range battery charger using buck-boost power factor correction converter," in Proc. IEEE Appl. Power Electron. Conf. Expo., Anaheim, CA, USA, 2019, pp. 2974–2979.

[7] S. Ryu, D. Kim, M. Kim, J. Kim, and B. Lee, "Adjustable frequency–dutycycle hybrid control strategy for full-bridge series resonant converters in electric vehicle chargers," IEEE Trans. Indus. Electron., vol. 61, no. 10, pp. 5354–5362, Oct. 2014.

[8] A. M. Elrajoubi, S. S. Ang, and K. George, "Design and analysis of a new GAN-Based ac/dc converter for battery charging application," IEEE Trans. Ind. Appl., vol. 55, no. 4, pp. 4044–4052, Jul./Aug. 2019.

[9] H. Yang, H. Chiang, and C. Chen, "Implementation of bridgeless Cuk power factor corrector with positive output voltage," IEEE Trans. Ind. Appl., vol. 51, no. 4, pp. 3325–3333, Jul./Aug. 2015.

[10] A. Dixit, K. Pande, S. Gangavarapu, and A. K. Rathore, "DCM-based bridgeless PFC converter for EV charging application," IEEE J. Emerg. Sel. Topics Ind. Electron., vol. 1, no. 1, pp. 57–66, Jul. 2020.