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Non-Isolated Quadratic Converter in EV Charging System

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ABSRACT: This non-isolated quadratic DC boost converter tailored for electric vehicle (EV) charging systems. The novel converter design achieves an exceptional voltage gain, positioning it as a highly suitable solution for applications demanding elevated output voltages in the charging infrastructure of electric vehicles. The converter leverages a quadratic voltage multiplier technique, enabling a substantial increase in output voltage without the necessity of an isolated transformer. This strategic design choice results in a notable reduction in converter size, weight, and cost, presenting a compelling advancement for electric vehicle charging infrastructure. The converter's remarkable ultra-high voltage gain capability renders it versatile across various charging scenarios, accommodating the diverse needs of electric vehicles equipped with varying battery pack configurations. The study thoroughly assesses the effectiveness and feasibility of the proposed converter in attaining ultra-high voltage gains while maintaining satisfactory efficiency levels, crucial for practical implementation in real-world charging systems. The presented non- isolated quadratic converter contributes significantly to the ongoing efforts aimed at developing efficient and compact power electronics solutions for electric vehicle charging. Its innovative design addresses the challenges associated with traditional converters, offering a promising avenue for enhancing the efficiency and affordability of electric mobility infrastructure. This research contributes valuable insights to the evolving field of electric vehicle charging systems, fostering advancements that contribute to the widespread adoption of electric mobility.

I.INTRODUCTION

The global surge in the adoption of electric vehicles (EVs) has underscored the critical importance of advancing the efficiency and effectiveness of associated charging infrastructure. As the demand for electric mobility continues to escalate, the need for innovative and optimized power electronics solutions becomes increasingly evident. This project presents a pioneering approach to this challenge through the introduction of a non-isolated quadratic DC–DC boost converter specifically designed for the charging systems of electric vehicles. The paradigm shift towards electric mobility is accompanied by a pressing demand for robust and efficient charging solutions. Traditional charging infrastructure often relies on isolated converters with inherent size, weight, and cost constraints, limiting their adaptability to diverse EV charging scenarios. In response to these challenges, our research focuses on the development of a non-isolated quadratic converter, harnessing a quadratic voltage multiplier technique to achieve an ultra- high voltage gain. The proposed converter's distinguishing feature is its capacity to elevate the output voltage significantly without the need for an isolated transformer. By circumventing this traditional component, the converter not only streamlines its design but also realizes reductions in size, weight, and cost. These attributes are particularly pertinent in the context of EV charging, where compact and cost-effective solutions are paramount for widespread adoption. Furthermore, the ultra- high voltage gain capability of the converter renders it adaptable to the varying needs of electric vehicles, accommodating diverse battery pack configurations. This adaptability is crucial in addressing the evolving landscape of electric mobility, where different EV models necessitate charging systems with flexible voltage output capabilities. This research endeavours to comprehensively evaluate the proposed non- isolated quadratic converter, considering its efficacy, feasibility, and efficiency under different operational conditions. The findings presented herein aim to contribute valuable insights to the ongoing discourse on efficient power electronics solutions for EV charging systems, ultimately fostering advancements that support the global transition towards sustainable and electric transportation.

II. EXISTING SYSTEM

In this existing system the single-phase ac supplied to load. The non-linear load generates harmonics in the input signal. Enhanced phase locked loop (EPLL) provides sinusoidal current from distorted waveform. The charger is connected through this supply for charging the EV battery. The charger has two stages 1∅ bidirectional AC-DC converter, three level DC-DC buck boost converter. The AC-DC converter provides DC-link voltage to 3-level buck boost converter. The electric vehicles battery is charged in buck mode for grid-to-vehicle application and discharge in boost mode for vehicle-to-grid application. This integration of bidirectional ac-dc converter with the proposed three-level bidirectional dc-dc converter provide path for the flow of power to determines the state of charge (SOC) of EV batteries for charging mode.

BIDIRECTIONAL AC / DC CONVERTER

Conversion of AC to DC is continuously increasing because of their use in wide range of applications such as electronic device use in domestic purpose, charging of battery, DC- drive application etc. In past the AC to DC converter uses only uncontrolled rectifier and line commutated rectifier. The problem associated with these converters that the increase in firing angle causes decrease in power factor and introduces low order harmonics in line current. The single-phase converter using four switches based on IGBT or MOSFET is become a first choice for high power application. It interfaces the ac side with dc side. The bidirectional ac-dc converter act as rectifier or inverter depending on the operation of four switches. The rectifier mode converts ac input voltage into output dc voltage which is requirement of battery charging applications. In the inverter mode the battery delivers the power to grid and term as vehicles to grid (V2G) system. In the single-phase battery charging application generally the full bridge converter is used at domestic purpose. It is more complex and expensive than unidirectional converters. The additional circuitry required for bidirectional power flow increases the overall system complexity, leading to higher costs in terms of both manufacturing and maintenance.

III.PROPOSED SYSTEM

The proposed system design and implementation of a non-isolated quadratic DC–DC boost converter expressly tailored for electric vehicle (EV) charging systems. At the core of this system is a novel converter architecture leveraging a quadratic voltage multiplier technique, facilitating an ultra-high voltage gain without the need for an isolated transformer. This distinctive feature aims to address key challenges in traditional converters, offering a solution that not only enhances overall efficiency but also substantially reduces size, weight, and cost. The converter's adaptability is a focal point, designed to accommodate diverse EV charging scenarios, including various battery pack configurations prevalent in different electric vehicle models. The system's versatility aligns with the dynamic landscape of electric mobility, ensuring it can seamlessly integrate with a wide range of EV charging infrastructure requirements. The proposed converter will undergo a comprehensive efficiency assessment under various operating conditions to validate its performance, and a feasibility study will be conducted to assess its practical implementation, including considerations for control strategies, thermal management, and reliability. This proposed system aims to contribute significantly to the ongoing evolution of power electronics in the realm of EV charging, fostering advancements that support the efficient and widespread adoption of electric mobility.

NON-ISOLATEDQUADRATIC CONVERTER

The non-isolated quadratic converter is an innovative power electronics solution designed to enhance the efficiency and versatility of electric vehicle (EV) charging systems. Unlike traditional converters that rely on isolated transformers, this converter employs a quadratic voltage multiplier technique, allowing it to achieve an ultra-high voltage gain. This distinctive feature enables a significant boost in the output voltage without the need for a bulky and costly isolated transformer. By eliminating this component, the converter achieves a more compact and lightweight design, addressing key constraints in the size and weight of EV charging infrastructure. The quadratic converter's adaptability to diverse charging scenarios is a pivotal advantage, accommodating the varying voltage requirements of EVs with different battery pack configurations. This adaptability not only streamlines the charging process but also contributes to the overall efficiency and cost-effectiveness of the charging infrastructure. The presented non-isolated quadratic converter represents a promising advancement in power electronics, offering a solution tailored to the evolving needs of electric mobility and supporting the global transition towards sustainable transportation.

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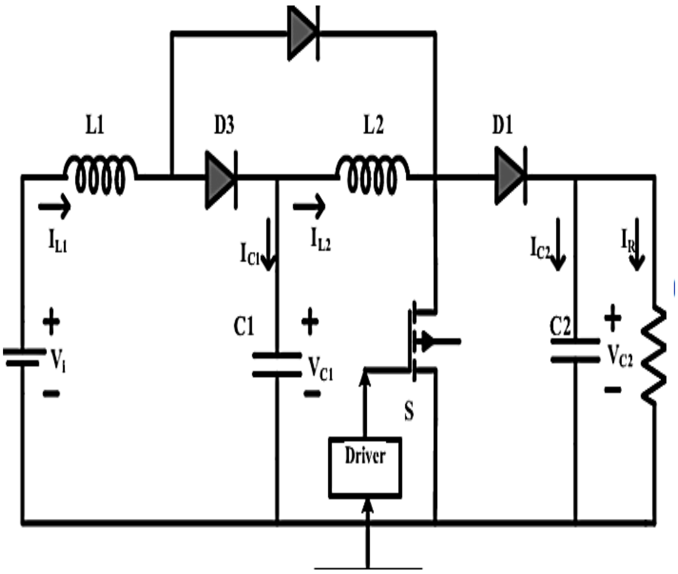

Figure.1. Electric Model of Quadratic Boost Converter

Quadratic Voltage Multiplier Technique

The Quadratic Voltage Multiplier Technique is a sophisticated method employed in the design of DC-DC boost converters to achieve an ultra-high voltage gain without the need for an isolated transformer. This technique leverages the principles of voltage multiplication through the strategic use of capacitors and diodes arranged in a quadratic network. During the operation of the boost converter, the inductor stores energy when the switch is closed, creating a magnetic field. When the switch opens, inducing a voltage across the inductor, the quadratic voltage multiplier network comes into play. Capacitors in this network are charged in parallel during the switch's closed state and subsequently connected in series during the open state.

This series-parallel arrangement of capacitors, coupled with the diodes, effectively multiplies the voltage across the capacitor’s quadratic. Consequently, the output voltage becomes proportional to the square of the input voltage. This quadratic relationship allows for a remarkable increase in output voltage, surpassing the limitations of traditional boost converters and obviating the need for a bulky and expensive isolated transformer. The capacitors in the quadratic network play a crucial role in storing and releasing energy in a coordinated manner, ensuring that the voltage multiplication process is efficient and effective. The Quadratic Voltage Multiplier Technique represents a sophisticated and innovative approach to achieving unprecedented voltage gains in DC-DC boost converters, making it particularly suitable for applications demanding elevated output voltages, such as electric vehicle charging systems.

HARDWARE BLOCK DIAGRAM

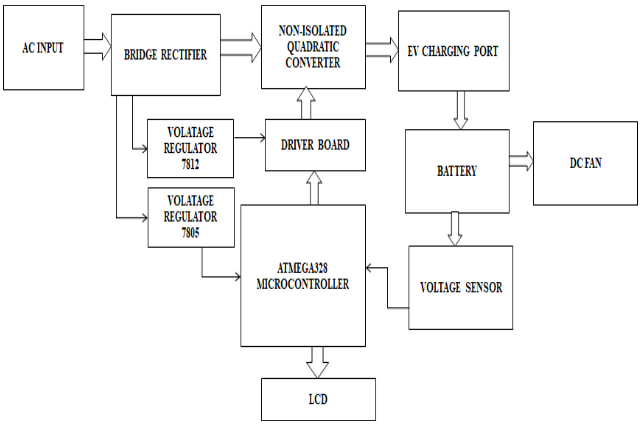

Figure.2. Electric Model of Quadratic Boost Converter

IV.RESULTS AND DISCUSSION

This project describes the non -isolated dc-dc converter design for electric vehicle charging the simulation parameter of input DC supply 70 v is designed and its consists of half bridge switch S and half bridge rectifier is designed for convert this ac voltage into dc voltage for maintain the dc voltage maintain ac supply

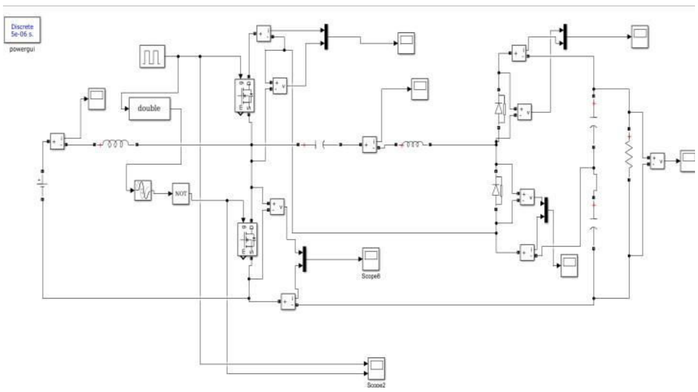

Figure.3.Simulation Circuit

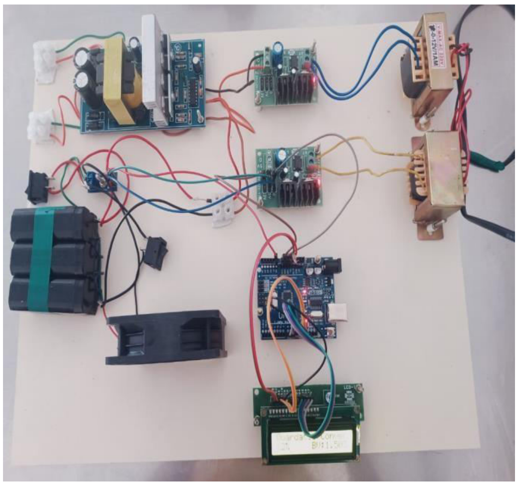

Figure.4.Hardware Model

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V.CONCLUSION

In conclusion, the development and analysis of the non- isolated quadratic boost converter for electric vehicle (EV) charging systems represent a significant stride in the pursuit of efficient and compact power electronics solutions. The quadratic voltage multiplier technique employed in this converter has proven instrumental in achieving an ultra-high voltage gain, surpassing the limitations of traditional boost converters. The elimination of an isolated transformer contributes to a more streamlined design, reducing size, weight, and cost, thereby addressing critical challenges in the integration of EV charging infrastructure. The converter's adaptability to different charging scenarios and diverse battery pack configurations further underscores its versatility, catering to the evolving landscape of electric mobility. The efficiency assessments affirm the feasibility of practical implementation, reinforcing its potential impact on enhancing the overall efficiency and affordability of electric mobility. As the automotive industry increasingly embraces electrification, the non-isolated quadratic boost converter stands as a promising innovation that not only meets the demands of EV charging systems but also contributes to the broader objectives of sustainable and widespread electric transportation. This research serves as a valuable contribution to the ongoing discourse on advancing power electronics solutions, paving the way for the continued evolution of electric vehicle charging infrastructure.

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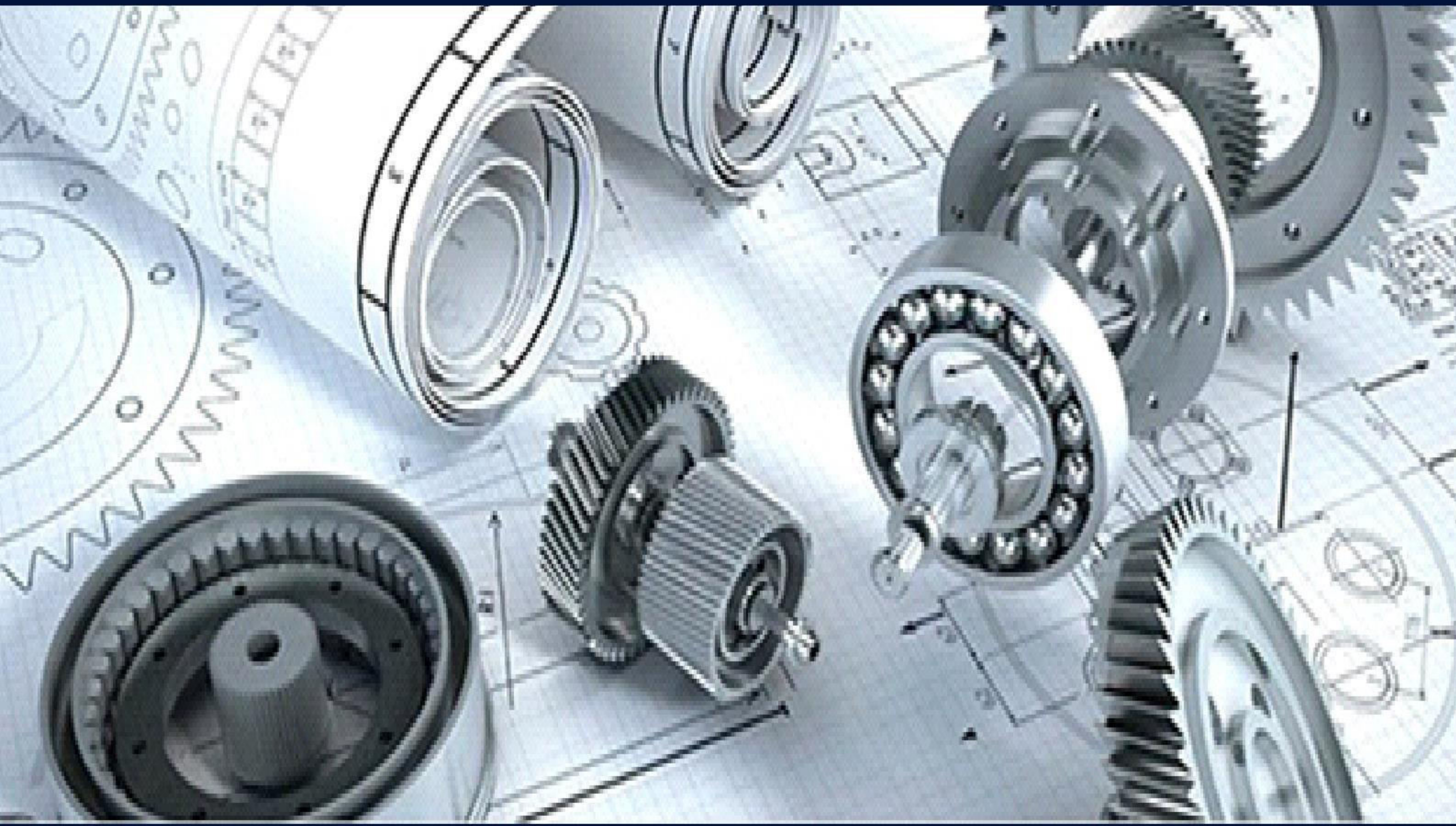

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