



Three Phase Ac/Dc Fed Two-Paralled Interleaved Sepic Converter For Fast Charging Application

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Abstract: Fast charging of Electric Vehicles (EVs) requires high power density, efficiency, and reduced ripple in the charging current. This project presents a Three-Phase AC/DC-Fed Two-Paralleled Interleaved Single-Ended Primary Inductor Converter (SEPIC) topology designed for fast charging applications. The proposed converter benefits from interleaving techniques, which enhance power handling capability, minimize current ripple, and improve overall efficiency. The three-phase AC supply is rectified and fed to the paralleled SEPIC stages, ensuring better Power Factor Correction (PFC) and reduced Total Harmonic Distortion (THD). Additionally, the interleaved structure leads to lower Electromagnetic Interference (EMI) and improved thermal performance, making it suitable for high-power charging stations. Simulation and experimental results validate the effectiveness of the proposed topology, demonstrating its capability to deliver stable and efficient power conversion for high-speed EV charging applications.

Keywords- Single Ended Primary Inductor Converter (SEPIC), Toltal Harmonic Distortion (THD), Eletromagnetic Interference(EMI).

I. INTRODUCTION

The increasing demand for electric vehicles (EVs) has highlighted the need for efficient, high-power, and fast-charging solutions. One of the key challenges in EV charging is the development of power converters that offer high efficiency, reduced ripple, and improved power factor while handling high-power levels. To address these challenges, a Three-Phase AC/DC Fed Two-Paralleled Interleaved SEPIC Converter has emerged as a viable solution for fast-charging applications.

The Single-Ended Primary Inductor Converter (SEPIC) is widely used due to its ability to step up or step down voltage with non-inverting output. When configured in an interleaved topology, the SEPIC converter offers reduced current ripple, improved thermal performance, and enhanced efficiency. By parallelizing two interleaved SEPIC converters, the system can handle higher power levels while ensuring load sharing, reducing stress on individual components, and increasing overall system reliability.

II. LITERATURE SURVEY

1. HIGH-EFFICIENCY THREE-PHASE AC-DC CONVERTERS FOR EV CHARGING

SmithJ.,PatelR.2021

This project presents a high-efficiency three-phase AC-DC rectifier designed for electric vehicle charging applications. The proposed rectifier improves power factor correction (PFC) and reduces total harmonic distortion (THD) using an active rectification approach. Simulation results show an efficiency improvement of 5% compared to conventional diode bridge rectifiers. However, the study does not integrate interleaved SEPIC conversion, which could further enhance efficiency.

2. Interleaved SEPIC Converter for High Power Applications

ChenL.,KumarA.2022

The research introduces an interleaved SEPIC converter for renewable energy and fast-charging applications. The interleaved structure effectively reduces current ripple and electromagnetic interference (EMI), leading to enhanced efficiency and reduced stress on power components. However, the study focuses on single-phase applications and does not explore three-phase AC-DC integration.

III. PROPOSED WORK

Proposed Work

The proposed Three-Phase AC/DC Fed Two-Paralleled Interleaved SEPIC Converter is designed to enhance the efficiency, reliability, and power quality of fast-charging applications, particularly for electric vehicles (EVs).

Unlike conventional systems, this approach utilizes a three-phase AC input, which is first rectified into DC before being fed into two interleaved SEPIC converters operating in parallel. The interleaved topology significantly reduces input and output current ripples, minimizing power losses and improving overall system performance.

The parallel operation ensures balanced load sharing, which not only increases the power handling capability but also reduces thermal stress on individual components, enhancing reliability. Additionally, the system incorporates power factor correction (PFC) to maintain a near-unity power factor, thereby reducing harmonic distortions and making it grid-compliant.

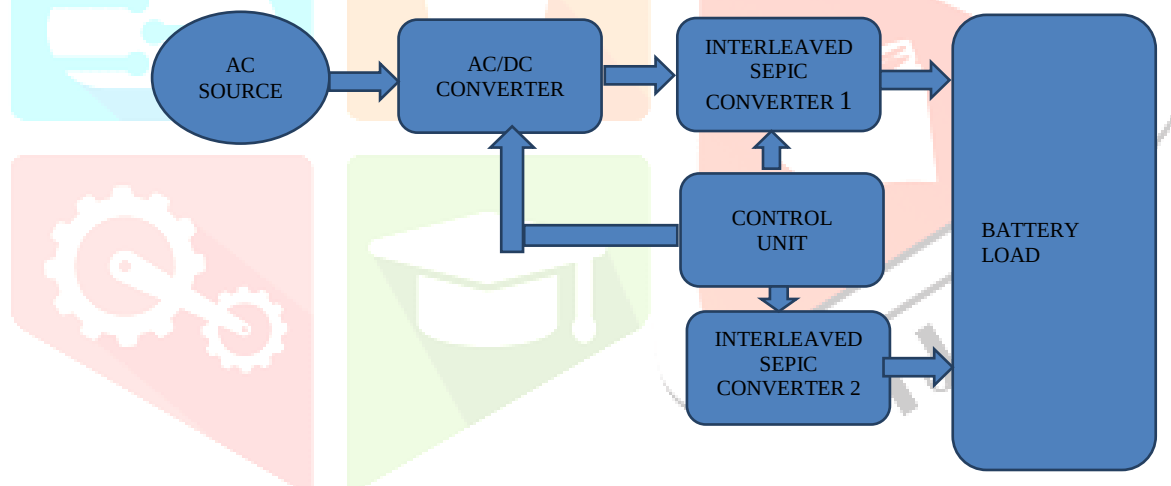


Fig 3.1 Block Diagram of Proposed System

The optimized soft-switching technique further minimizes switching losses, leading to improved thermal performance and extended component lifespan. By reducing the size of passive components, the proposed system achieves a compact and cost-effective design while maintaining high efficiency. With its ability to deliver higher power, reduced ripple, improved power quality, and enhanced scalability, the proposed converter provides a robust and energy-efficient solution for modern EV fast-charging stations and high-power applications.

IV. HARDWARE DETAILS

4.1.PIC Controller:

- Only 35 single-word instructions to learn
- All single-cycle instructions except for program branches, which are two-cycle
- Operating speed: DC – 20 MHz clock input DC – 200 ns instruction cycle
- Up to 8K x 14 words of Flash Program Memory, Up to 368 x 8 bytes of Data Memory (RAM), Up to 256 x 8 bytes of EEPROM Data Memory
- Pin out compatible to other 28-pin or 40/44-pin
- PIC16CXXX and PIC16FXXX microcontrollers

4.2. Crystal Oscillator

A Crystal Oscillator is an electronic circuit that generates an electrical signal with an exact frequency by harnessing the mechanical resonance of a vibrating piezoelectric crystal. It features automatic amplitude control and exhibits minimal frequency drift due to temperature variations. Crystal Oscillators are exclusively suitable for high-frequency applications.

Every microcontroller requires a crystal oscillator. When selecting one, consider purchasing a silicon oscillator if its accuracy is sufficient and the cost is reasonable; otherwise, opt for a quartz crystal.

Commonly used crystal oscillators include:

8MHz, 11.0592MHz, 12MHz, 16MHz, 20MHz, 32MHz

Additionally, a variety of crystal oscillators with different frequencies are available in the market for various applications.

4.3.REGULATOR

A regulated power supply is essential for every electronic device, as these devices rely on semiconductor materials that require a fixed voltage and current. Any deviation from these fixed values can lead to damage. Although batteries serve as primary sources of DC power, they are not suitable for prolonged use in sensitive electronic circuits due to their gradual loss of potential and eventual depletion. Batteries offer various voltage levels, such as 1.2V, 3.7V, 9V, and 12V. Since most integrated circuits operate with a 5V supply, a voltage regulator is necessary to ensure a stable 5V output. The 7805 voltage regulator, part of the 78XX series of linear voltage regulators, fulfills this requirement by providing a reliable 5V regulated output.

4.3.1. Voltage Regulator Circuit

The circuit diagram for the 7805 voltage regulator illustrates the process of generating a 5V regulated supply from AC mains. This circuit consists of a step-down transformer (230V-12V), a bridge rectifier, a 1A fuse, a 1000µF capacitor, an IC 7805 voltage regulator, capacitors (0.22µF and 0.1µF), and a diode (1N4007).

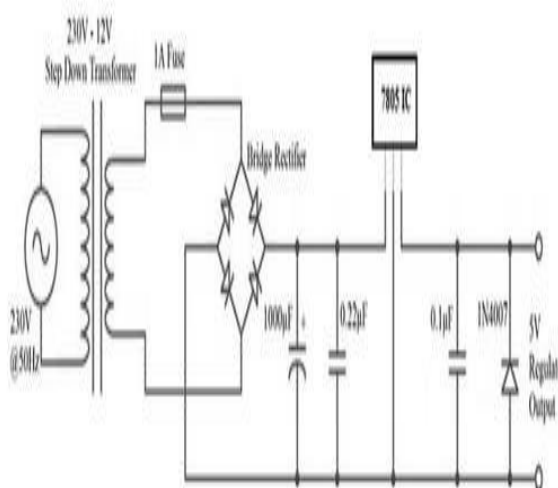


Fig.2. 7805 Voltage Regulator Circuit

4.3.2.IC 7805 Voltage Regulator Working

In the circuit described, AC power is converted into DC. It includes components such as a transformer, a bridge rectifier, an IC 7805 linear voltage regulator, and capacitors. The circuit is divided into two sections: in the first section, the AC mains are converted to DC, and in the second section, this DC is regulated into a 5V DC output.

Initially, a step-down transformer reduces the voltage from 230V to 12V by connecting its primary winding to the mains supply, while its secondary winding connects to the bridge rectifier. A 1A fuse is placed between the bridge rectifier and the transformer to prevent excess current flow in the circuit.

The bridge rectifier produces rectified DC, which is then smoothed by a 1000 μ F capacitor. The output of this capacitor is a 12V unregulated DC, which serves as input to the IC 7805 voltage regulator. The voltage regulator then converts this unregulated DC into a stable 5V DC output, available at the output terminals.

Ensuring that the input voltage exceeds the output voltage is crucial. The input and output currents remain approximately the same. For instance, when a 7.5V 1A supply is provided at the input, the output will be 5V 1A. The excess power is dissipated as heat through the 7805 IC.

4.4.Capacitors

The term "capacity" signifies the ability to contain something, which aligns perfectly with the purpose of a capacitor—to store electric charge.

A basic capacitor consists of two conductive plates separated by a dielectric medium, an insulating material that can be polarized, forming positive and negative charges on opposite surfaces. When voltage is applied to the plates, current flows through them, causing one plate to accumulate a positive charge (electron deficiency) and the other a negative charge (electron surplus). Since opposite charges attract, the charges on the plates exert a mutual force of attraction.

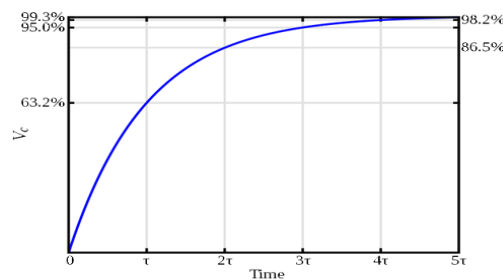
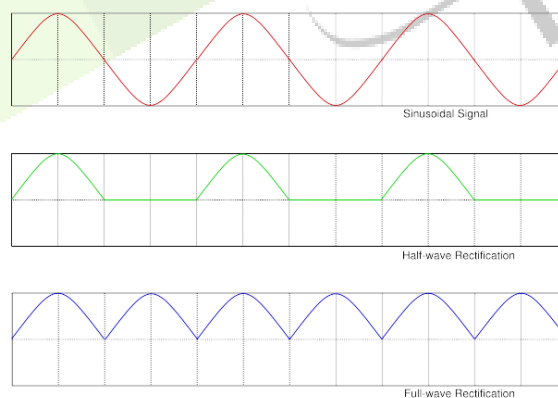


Fig.3.From the graph you can see that the capacitor reaches 63% of the applied voltage in one time constant.

4.5.RECTIFIER:

A rectifier is an electrical device that converts alternating current to direct current or at least to current with only positive value, a process known as rectification. Rectifiers are used as components of power supplies and as detectors of radio signals.



V. RESULT AND DISCUSSION

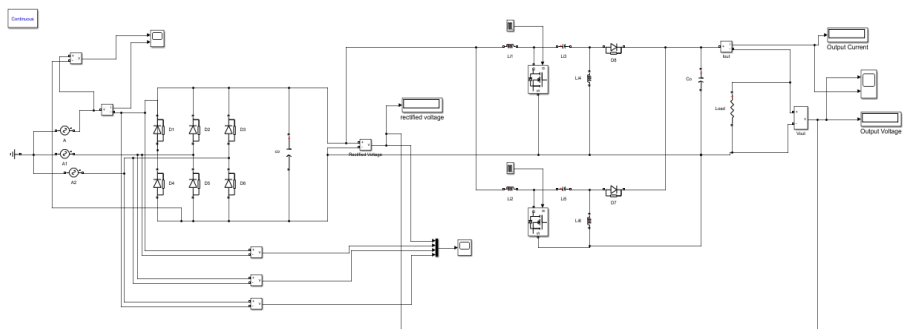


Fig 5.1 Simulation Circuit of Proposed System

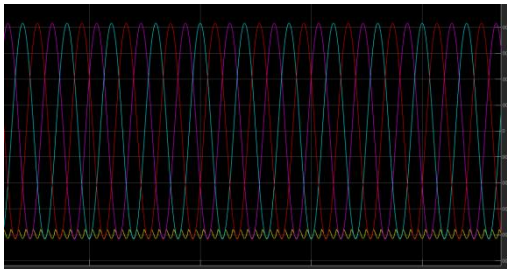


Fig 5.2 Waveform of Input Voltage

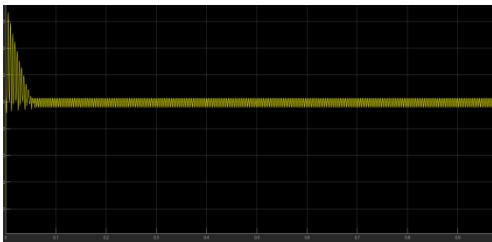


Fig 5.3 Waveform of DC Voltage



Fig 5.4 Waveform of Output Voltage

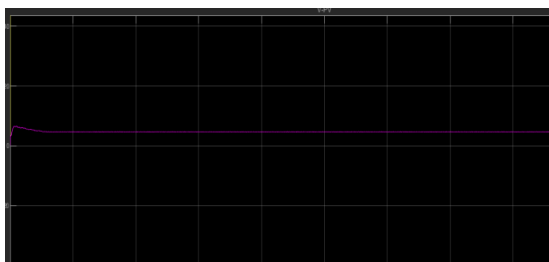


Fig 5.5 Waveform of Output Current

VI. CONCLUSION

The Three-Phase ACDC Fed Two-Paralleled Interleaved SEPIC Converter presents a highly efficient and reliable solution for fast-charging applications, particularly for electric vehicles (EVs). Conventional fast-charging systems face several challenges, including high ripple, low efficiency, and increased switching losses, which negatively impact power conversion performance, thermal management, and overall system reliability. By integrating three-phase AC-DC conversion, interleaved SEPIC topology, and parallel operation, the proposed converter effectively reduces ripple, enhances power quality, and improves energy conversion efficiency.

The interleaved approach minimizes input and output current ripple, ensuring smooth power transfer, while parallel operation allows optimized load sharing, reducing stress on individual components. Additionally, the three-phase AC-DC rectification enhances power factor correction (PFC) and ensures better utilization of grid power. This converter is highly scalable and adaptable, making it suitable for high-power EV charging stations, renewable energy systems, and industrial power supplies. In summary, the Three-Phase ACDC Fed Two-Paralleled Interleaved SEPIC Converter overcomes the limitations of traditional charging systems by providing higher efficiency, improved thermal management, and enhanced operational stability. Its advanced design makes it a promising candidate for next-generation fast-charging infrastructure, supporting the growing demand for reliable, high-performance EV charging solutions.

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