

# Modified LUO Based Boost Converter with Single Input and Multi Output Topology

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**Abstract-** A power electronics device that transforms a low voltage input to a higher voltage output is the Modified Luo Based Boost Converter with Single Input and Multi-Output Topology. This paper proposes a modified Luo converter utilizing a coupled inductor and a diode-capacitor network to achieve multiple output voltages. The proposed circuit operates in continuous conduction mode (CCM), ensuring stable output voltage despite input variations. Simulation and experimental results validate the converter's performance, demonstrating superior efficiency and reduced output voltage ripple compared to conventional converters. The high voltage gain and effective energy conversion make this topology ideal for various industrial and consumer applications, including telecommunications, renewable energy systems, and embedded power supplies.

**Index Terms-** Power Electronics, Boost Converter, Luo Converter, Multi-Output, Continuous Conduction Mode

## I. INTRODUCTION

A type of DC-DC converter that generates multiple output voltages from a single input voltage is the Modified Luo-Based Boost Converter with Single Input and Multi-Output Topology. To attain high efficiency and high voltage gain, this converter is a modification of the standard boost converter. Designed for efficient and reliable power conversion, the proposed topology enhances the performance of traditional Luo converters by providing multiple regulated outputs.

The operation of this converter relies on energy storage in inductors and capacitors, where energy transfer occurs through controlled switching operations. The use of coupled inductors in the modified Luo-based topology ensures galvanic isolation between the input and output ports, allowing a significant voltage step-up.

This multi-output topology eliminates the need for additional power supplies, reducing cost, size, and weight while enhancing efficiency. By utilizing a combination of inductors, capacitors, and switches, the converter effectively transforms low input voltage into multiple high-output voltage levels, making it ideal for applications in telecommunications, electric vehicles, and renewable energy systems.

With the increasing demand for multi-output power supplies in various electronic applications, including industrial control systems, computers, and mobile devices, this topology presents a promising solution for efficient and cost-effective power conversion. The proposed system ensures stable

operation under varying load conditions while maintaining high performance, making it a compelling choice for modern power electronics applications.

## II. LITERATURE SURVEY

Andrade et al. (2018) introduced a Quasi-Z-source network DC-DC converter that incorporates voltage multiplier cells in the secondary winding of a coupled inductor, which is part of the second inductor in the quasi-Z-source network. Additionally, a switched capacitor is connected at the output to enhance performance. This design exhibits several advantages, including high voltage gain, low voltage stress on components, and continuous input current, making it a promising solution for applications requiring efficient power conversion [1]. Ardi et al. (2018) explored a high voltage gain SEPIC-based DC-DC converter optimized for sustainable energy applications. This converter improves upon the traditional SEPIC design by incorporating a coupled inductor and two voltage multipliers, resulting in higher voltage gain and ensuring continuous input current, which is essential for renewable energy systems [2].

Babaei et al. (2018) introduced an extendable non-isolated high-gain DC-DC converter that utilizes active-passive inductor cells to enhance performance. This design provides high voltage gain and continuous input current, making it highly efficient for renewable energy applications. Additionally, the inclusion of a passive clamp circuit further boosts voltage gain and minimizes voltage stress on the main switch, improving overall efficiency and reliability [3].

Dhananjaya et al. (2021) reviewed multi-port DC–DC converters (MPCs), highlighting their efficiency in multi-input and multi-output applications. These converters enhance system performance and integrate independent voltage sources, making them ideal for electric vehicles (EVs) and grid-connected power systems [4]. Duran et al. (2022) explored an interleaved single-input multiple-output DC–DC converter, which offers a better dynamic response and reduced ripple, maintaining high efficiency.

The interleaved topology allows parallel operation of multiple converters, effectively distributing power losses among components. This design improves thermal management and enables handling high power levels within a compact system, making it a viable alternative to traditional single-phase solutions [5]. Faridpak et al. (2021) introduced a super-lift Luo-converter with an integrated buck converter for electric vehicles. This SIDO converter provides step-up and step-down voltages without electromagnetic components, ensuring low ripple, enhanced efficiency, and suitability for automotive power systems [6].

Hassani et al. (2021) introduced an interleaved high step-up DC–DC converter tailored for sustainable energy applications. By optimizing the turns ratio of the coupled inductor (CI) and boost inductor transformer (BIT), this topology achieves high voltage gain without requiring an extended duty cycle. Additionally, voltage stress across semiconductor devices is significantly reduced by fine-tuning the turns ratio of CI and BIT, improving efficiency and durability. The interleaved structure also minimizes input current ripple, making this design well-suited for renewable energy applications [7].

Hsu et al. (2020) presented a multi-output interleaved high step-up DC–DC converter, which leverages advanced power management ICs to optimize performance. With the increasing integration of transistors per unit area, there is a growing demand for multiple output voltage levels in modern electronics. By utilizing a single-coupled inductor, this converter effectively reduces circuit complexity, footprint, and cost, making it an ideal choice for compact power systems [8]. Maroti et al. proposed a high voltage gain SEPIC-based converter for renewable energy applications. By combining a conventional SEPIC converter with a boosting module, this design provides continuous input current and enhanced voltage gain. Compared to standard SEPIC converters, the modified SEPIC converter (MSC) offers superior voltage conversion, making it a strong candidate for high-efficiency renewable energy systems [9]. Salvador et al. introduced a high step-up DC–DC converter that integrates an active switched-inductor and a passive switched-capacitor network. This approach is particularly useful for low-voltage renewable energy sources requiring high-gain voltage conversion in grid-connected applications. By eliminating the need for a

transformer, this topology reduces system complexity while maintaining high efficiency and voltage gain [10].

### III. PROBLEM DEFINITION

Modern DC–DC converters face challenges such as high voltage stress, increased switching losses, and inefficient multi-output regulation, making them less suitable for applications like electric vehicles (EVs), renewable energy systems, and industrial automation. Traditional multi-output converters require additional components, leading to higher costs, larger size, and increased power losses. The Modified Luo-Based Boost Converter offers a compact and efficient solution by generating multiple regulated outputs from a single input source, reducing voltage stress on switches, and minimizing cross-regulation effects for stable operation. With its enhanced voltage gain and energy efficiency, this converter provides a cost-effective and high-performance alternative for next-generation power electronics applications.

### IV. DESCRIPTION OF THE PROPOSED SYSTEM

#### Block Diagram

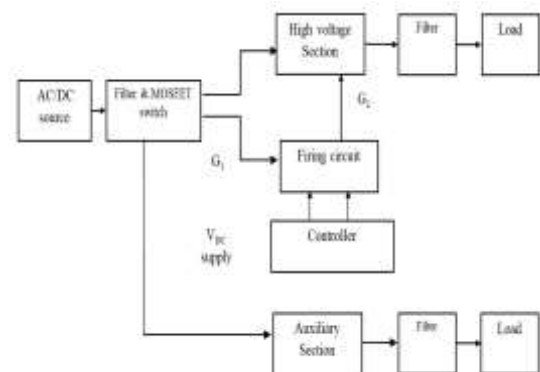


Figure 1. Block Diagram of Proposed System

#### Circuit Diagram

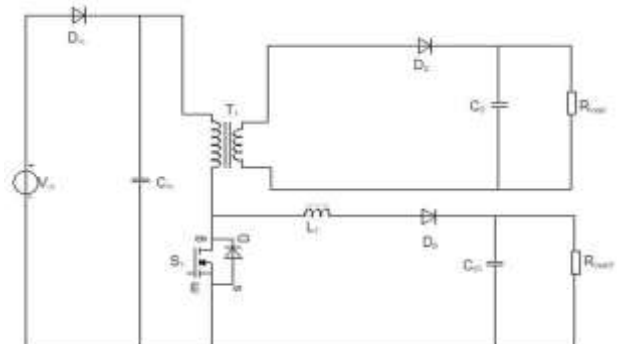


Figure 2. Circuit Diagram of proposed system

**System Operation**

The converter converts DC to AC via a half-bridge, filters noise, isolates, rectifies, and stabilizes DC.

**P Controller Operation**

The proportional (P) controller adjusts the output based on the error signal, ensuring quick response and reducing steady-state error. However, it cannot completely eliminate the error and may cause overshooting in certain conditions. This controller is effective for first-order systems and is used when fast system response is required.

**PI Controller Operation**

The proportional-integral (PI) controller enhances system stability by integrating the error over time, thereby reducing steady-state error. While it improves accuracy, it may slow down response time and affect system dynamics. This controller is widely used in applications where small steady-state errors are critical, such as industrial automation.

**PID Controller Operation**

The proportional-integral-derivative (PID) controller combines the benefits of P and PI controllers while adding a derivative component to predict future errors. This enhances system stability, reduces oscillations, and improves transient response. The PID controller is commonly used in high-precision applications like robotics and motion control systems.

**Effects of P, PI, PID Controllers**

The system gets smarter over time by learning from past detections and how effective the deterrents have been. If a peacock starts ignoring a particular sound, the system automatically switches to a different one to keep them on edge and prevent them from getting too comfortable.

Table 1. Performance Analysis of PID Controller

Parameter	Speed of response	Stability	Accuracy
Increasing K	Increase	Deteriorate	Improves
Increasing Ki	Decrease	Deteriorate	Improves
Increasing Kd	Increase	Improves	No impact

The parameters K and Ti are chosen so that the closed-loop system is oscillatory. Damping increases with increasing derivative time, but decreases again when derivative time becomes too large. Recall that derivative action can be interpreted as providing prediction by linear extrapolation over the time Td. Using this interpretation, it is easy to understand that derivative action does not depend on the Ld. If the prediction time Td is too large. Action.

Derivative actions cease to be effective when Td is larger than a 1s done sixth of the period. Also notice that the period of oscillation increases when derivative time is increased. To obtain a good PID controller it is also necessary to consider

- Noise filtering and high frequency roll-off
- Set point weighting and 2D OF
- Wind up
- Tuning
- Computer implementation

**V. PRACTICAL IMPLEMENTATION**

**Hardware Components**

**Transformer**

A transformer is an inductive electrical device for changing the voltage of alternating current. A transformer consists of two magnetically coupled coils. Alternating current in one (called the "primary") creates a changing magnetic field which induces a current in the second coil (the "secondary").

**Diode**

Rectifier diodes are used in power supplies to convert alternating current (AC) to direct current (DC), a process called rectification and it allows current in only one direction. A bridge rectifier of four diodes (4\*1N4007) is used to achieve full wave rectification. Two diodes will conduct during the negative cycle and the other two will conduct during the positive half cycle. The 1N4007 is suitable for most low voltage circuits with a current of less than 1A.



Figure 3. Diode

**Filtering Unit**

Filter circuits, which usually capacitor is acting as a surge arrester, always, follow the rectifier unit. This capacitor is also called as a decoupling capacitor or a bypassing capacitor, is used not only to short the ripple with frequency of 130Hz to ground but also to leave the frequency of the DC to appear at the output.

- 1000µF for the reduction of ripples from the pulsating.
- 100µF for bypassing the high frequency disturbances.

### Mosfet

The metal–oxide–semiconductor field-effect transistor (MOSFET) is a type of field effect transistor (FET), most commonly fabricated by the controlled oxidation of silicon. It has an insulated gate, the voltage of which determines the conductivity of the device. This ability to change conductivity with the amount of applied voltage can be used for amplifying or switching electronic signals. Metal-insulator-semiconductor field-effect transistor (MISFET) is a term almost synonymous with MOSFET.



Figure 4. MOSFET

### Microcontroller

The microcontroller is like the central command center. PIC16F877A is a 40 pin 8-Bit CMOS FLASH microcontroller. The microcontrollers are similar to microprocessors, but they are designed to work as a true single-chip system by integrating all the devices needed for a system on a single-chip. The timing and control unit will generate the necessary control signals for internal and external operation of the microcontroller. Microcontrollers with internal ADC can directly accept analog signals for processing.

The switching pulses required for inverter operation are generated using PIC16F877A Microcontroller, thus reducing the overall system cost and complexity. The Microcontroller generates a PWM pulse at Particular frequency and switching pulses for the MOSFET switches.

### Voltage Regulator

The voltage regulators play an important role in any power supply unit. The primary purpose of a regulator is to aid the rectifier and filter circuit in providing a constant DC voltage to the device.

#### Fixed Voltage Regulators:

##### Positive Voltage Regulator

The 78xx series consists of three terminal positive voltage regulators with seven voltage options. These ICs are designed as fixed voltage regulators and with adequate heat sinking can relieve output currents in excess of 1 A. We used 7812, 7815 & 7805 IC voltage regulators, they give output voltages of +12v, +15 V and +5v respectively.

##### Negative Voltage Regulator

The 79xx series of fixed output negative voltage regulators are complements to the 78xx series devices. These regulators are also three terminal devices. The three terminals are ground, input and output.

We used 7912 IC voltage regulator to give output voltage of –12v. Almost all power supplies use some type of voltage regulator IC because voltage regulators are simple to use, reliable, low in cost and available in a variety of voltage and current ratings.

These ICs are monolithic silicon chip and it is a fixed voltage regulator type, which gives low cost, high reliability, reduction in size and excellent performance. In this regulator, a capacitor is usually connected between the input terminal and ground to cancel the inductive effects due to long distribution leads. The output capacitor improves the transient response. Thus, the filtered DC voltage is regulated using 7805, 7812 and 7912.

### Software Requirements

#### MATLAB

The analysis of the Half-Bridge DC/DC Converter using MATLAB Simulink relies on several essential software components for modeling and simulation. MATLAB provides a powerful environment for numerical computing and Simulink enhances its capabilities with graphical modeling tools, making it ideal for system simulation. In this project, MATLAB's SimPowerSystems library is extensively used to implement various electrical components such as the DC voltage source, MOSFET, transformer, and series RLC branches.

Simulink's real-time simulation features enable dynamic testing and tuning of these components under varying conditions. Each block, including the DC Voltage Source and MOSFET, offers adjustable parameters like amplitude and gate voltage, which can be monitored and altered during the simulation for analysis. This flexibility is crucial for evaluating the converter's performance, including voltage regulation and switching behavior.

#### CCS Compiler

The CCS C Compiler is specifically designed for Microchip's PIC microcontroller (MCU) series, making it a highly optimized choice for embedded system development. The compiler supports a wide range of PIC MCUs, from 8-bit to 24-bit processors, and provides a comprehensive suite of features to accelerate the development of embedded applications. It includes a rich library of built-in functions, preprocessor commands, and ready-to-run example programs.



Figure 5. CCS Compiler Step 1

The CCS compiler also offers specialized drivers for various peripherals, including real-time clocks and analog-to-digital converters (ADC), which are essential for handling external signals and sensors in embedded systems. This makes the CCS C Compiler an ideal tool for projects requiring precise and efficient firmware development.

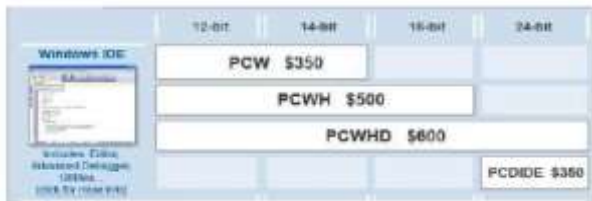


Figure 6. CCS Compiler Step 2

## VI. RESULT ANALYSIS

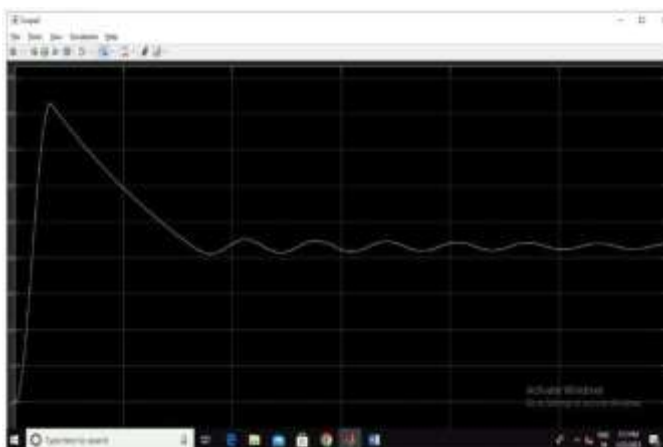


Figure 7. Simulated output result of Modified LUO Based boost Converter

The modification is aimed at improving the overall performance of the converter by adding an additional inductor and diode to the circuit. The single input multi-output topology refers to the configuration of the circuit where a single input voltage is used to generate multiple output voltages. This is achieved by using multiple windings on the output inductors and connecting them to different output capacitors and loads. One potential benefit of the modified Luo-based boost converter single input multi-output topology is improved efficiency. By adding an additional inductor and diode, the converter can operate at higher frequencies, reducing switching losses and improving overall efficiency.

## VII. CONCLUSION

The Modified Luo-Based Boost Converter with Single Input and Multi-Output Topology offers an efficient and reliable solution for modern power conversion needs. By optimizing component selection and design, it achieves high voltage gain, reduced switching stress, and stable multi-output performance. Advanced control techniques further enhance efficiency by mitigating voltage spikes and improving system longevity. Its compact and cost-effective design makes it ideal for industrial and renewable energy applications.

With advancements in power electronics, this converter can be further improved through high-frequency switching, better semiconductor materials, and enhanced thermal management. As demand for efficient power solutions grows, this converter remains a promising option for next-generation energy systems.

### Future Scope

There Future advancements can expand this converter's applications, particularly in renewable energy systems like solar and wind power. Its efficient multi-output regulation makes it ideal for off-grid and sustainable energy solutions. Integrating it with hybrid topologies can further enhance performance and efficiency.

Continued research in semiconductor technology, magnetic components, and digital control can improve voltage regulation and adaptability for high-power applications. As energy needs evolve, this converter can play a key role in efficient and sustainable power systems.

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