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# A NARRATIVE MECHANISM ON NON-INVERTING EXTREME & SECURE DC-DC CONVERTER WITH CONTINUOUS CONDUCTION INPUT CURRENT MODE

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## ABSTRACT

This paper presents the design and development of a non-inverting extreme and secure DC-DC converter operating in continuous conduction input current mode, intended for high-performance and secure power applications. The proposed converter ensures stable and efficient power conversion while maintaining a non-inverting voltage output, making it suitable for various critical applications requiring robust operation under extreme conditions. The continuous conduction input current mode allows for reduced ripple, improved current regulation, and minimized electromagnetic interference (EMI), resulting in enhanced power quality and system stability. The converter's architecture is optimized to achieve high efficiency across a wide range of load conditions, leveraging advanced control strategies that maintain performance while safeguarding against external disturbances and internal faults. Simulation and experimental results validate the converter's performance, demonstrating its ability to maintain continuous input current conduction and provide reliable, secure operation. This novel approach makes the converter well-suited for critical applications in aerospace, defense, renewable energy, and electric vehicles, where extreme conditions and secure power management are paramount.

**Keywords:** *Non-inverting DC-DC converter, continuous conduction mode, secure power conversion, extreme conditions, input current regulation, electromagnetic interference (EMI) reduction.*

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**INTRODUCTION:**

As modern power systems expand into critical applications such as aerospace, defense, electric vehicles, and renewable energy, the demand for efficient, secure, and reliable DC-DC power conversion has increased significantly. These systems operate in extreme environments with fluctuating power sources, high temperatures, and potential electrical disturbances, requiring robust power management solutions. Conventional DC-DC converters, particularly inverting or single-output topologies, often struggle to maintain stable operation, efficient performance, and secure power delivery under such conditions. In critical applications, maintaining a positive output voltage, minimizing electromagnetic interference (EMI), and ensuring continuous power availability is essential. Current power converters, however, may suffer from discontinuous conduction, which increases ripple, EMI, and system instability, making them unsuitable for these high-performance requirements. Furthermore, many converters lack the necessary protection mechanisms to safeguard against over-voltage, over-current, and thermal stresses, which can lead to system failures or reduced reliability in extreme environments. To address these challenges, there is a need for a non-inverting, secure DC-DC converter that operates in continuous conduction input current mode. Such a converter must ensure stable, ripple-free power conversion with enhanced protection against external disturbances and internal faults, all while maintaining high efficiency and reliability under demanding conditions. The problem is to design and implement a converter that achieves these goals while being suitable for integration into critical power systems where performance, security, and reliability are paramount. In the evolving landscape of modern power systems, the need for efficient and reliable DC-DC converters has become increasingly critical, particularly in applications that demand high performance and security. Industries such as aerospace, defense, electric vehicles, and renewable energy require power conversion solutions that can operate effectively under extreme environmental conditions, including high temperatures, varying load demands, and electrical disturbances. These applications not only necessitate efficient energy management but also demand a secure power delivery system that can withstand potential faults and ensure continuous operation. Traditional DC-DC converters, particularly those that rely on inverting or single-output configurations, often face challenges in maintaining output stability and efficiency, especially when subjected to fluctuating input conditions. Furthermore, many existing designs operate in discontinuous conduction mode (DCM), which can result in increased ripple, reduced power quality, and greater electromagnetic interference (EMI). To address these shortcomings, the concept of a non-inverting extreme and secure DC-DC converter operating in continuous conduction input current mode has been proposed.

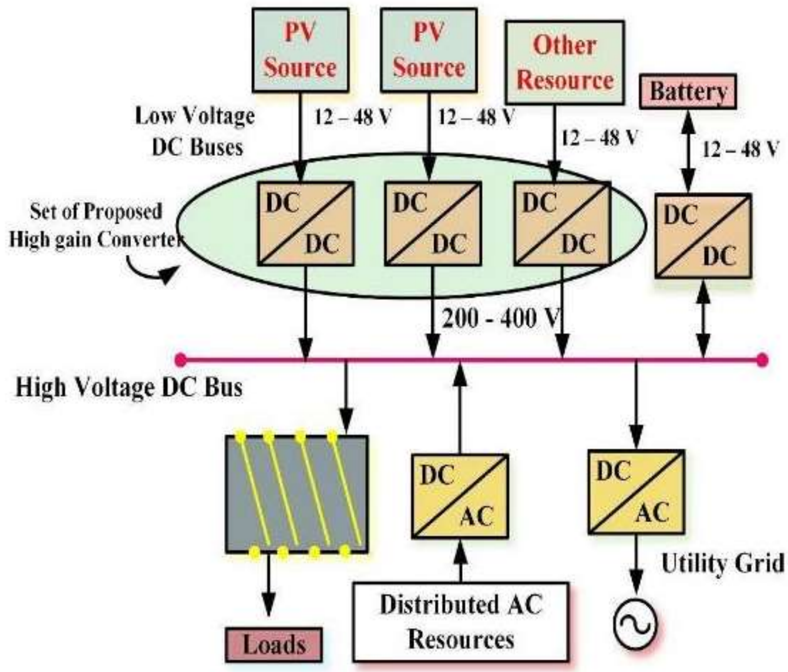


Figure1: Strategy of DC Microgrid

## LITERATURE SERVEY

DC-DC converters are essential components in a wide range of applications, from power supplies for portable devices to larger systems such as electric vehicles and renewable energy systems. Several types of converter topologies, such as buck, boost, buck-boost, and Cuk converters, have been extensively studied for their ability to step up or step down voltage, regulate power flow, and improve efficiency. According to Erickson and Maksimovic, the choice of topology depends on factors such as the required voltage output, efficiency, and application. For secure and reliable power delivery, non-inverting converters have been developed to maintain the output voltage in the same polarity as the input, which is particularly important in sensitive electronic applications. Continuous Conduction Mode (CCM) in DC-DC Converters

Continuous conduction mode (CCM) is a widely used mode of operation in DC-DC converters where the current through the inductor never falls to zero during a switching cycle. CCM operation results in improved current regulation and reduced electromagnetic interference (EMI), which is crucial for maintaining power quality. Kazimierczuk explains that operating a converter in CCM enhances its stability and efficiency, especially when dealing with high-current applications. This is a key advantage over discontinuous conduction mode (DCM), which can introduce higher ripple and increased losses. In converters used in critical applications, CCM plays a vital role in maintaining the performance under extreme conditions, such as fluctuating loads or input voltages. Non-Inverting DC-DC Converters Non-inverting DC-DC converters, such as non-inverting buck-boost converters, are designed to provide a positive output voltage regardless of whether the input voltage is stepped up or down. This topology is crucial in applications where maintaining the polarity of the output voltage is necessary, such as in systems with sensitive electronic components. Zhou et al. highlighted the importance of non-inverting converters for applications requiring reliable, positive voltage outputs, such as industrial power supplies and electric vehicle systems. The non-inverting topology also simplifies the design of power systems by eliminating the need for additional stages to correct voltage polarity. Extreme and Secure Power Applications In high-stakes industries such as aerospace, defense, and renewable energy, the need for secure and reliable power conversion is critical. Power systems in these environments must be designed to withstand extreme conditions, including temperature fluctuations, high vibration, and electrical disturbances. Cucuzzella et al. (2019) investigated secure power architectures for aerospace applications, emphasizing the need for robust DC-DC converters that can operate under extreme environmental conditions without compromising safety or performance. In such scenarios, protection features such as over-voltage, over-current, and thermal stress handling are essential for ensuring secure operation.

## METHODOLOGY:

### Proposed Converter

The conventional quadratic boost is shown in Figure. 2(a) with two inductors. Proposed converter uses a voltage multiplier to boost the voltage to achieve voltage gain of twice the quadratic boost converter with three inductors. The proposed converter consists of two inductors

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but with an advantage greater than the converters. The presented converter includes single switch S1, two inductors L1 and L2, five capacitors named C1, C2, C3, C4 and C0 and six diodes specified as D1, D2, D3, D4, D5, and D6 and load R. All capacitances and inductances are taken as large for analysis so that voltage across capacitors and current through inductors are constant. The converter has two operating states within one switching. The circuit is analyzed in two modes: the first one has been analyzed during switch ON, and the second one is during switch off. Both modes of the circuit are shown in Figure 4. And some graphs related to converter such as diode voltage VD1, inductor current IL1, IL2, and so more are in Figure 3. In the graph, the interval to-t1 is the ON period, and t1-t2 is the OFF period During switch ON, D1, D3, and D5 are forward biased while D2, D4, and D6 are reversed biased. The equivalent circuit is depicted . In this interval, inductor currents IL1 and IL2 rise to the peak value at the same time, and it means that inductors store the energy. During this interval, capacitor C1, C3, and C3 are transferring their energy to the inductor L2 and load, respectively.

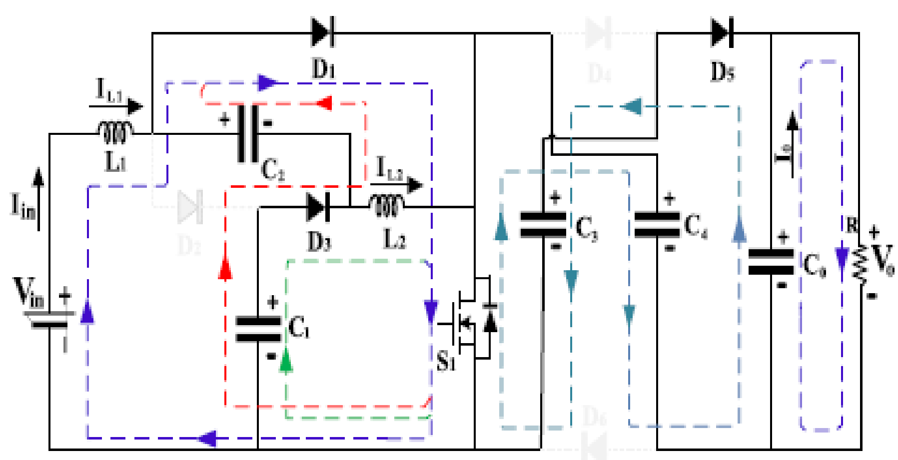


Figure2: Forms of functions for the proposed converter

**Comparison Among Other Similar**

The proposed converter’s features with other similar high gain DC-DC boost converters are listed in Table 1. Comparative analysis of the proposed converter is based on the following: the number of components, voltage gain, and voltage stress of switch. The proposed converter provides 2(2-D) times of CQBC (Conventional Quadratic Boost Converter) utilizing only a single switch and two inductors. The converter introduced in Lee and Do provides the gain (at

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turn ratio n = 1 to 2) lower than the proposed converter while one inductor and one coupled inductor are brought into service, and as a result voltage stress across the switch is higher than the proposed topology. The converters detailed in Pires *et al.*, Fardoun and Ismail and Mohamed . Fardoun utilize the same number of inductor and switch as proposed one but voltage gains of the converters are low and voltage stress on the switches are higher than the proposed converter. The converter analyzed in Javed et al provides a voltage gain of 2 times of CQBC that is lower than the proposed converter and in this converter stress across the switch is the same as that of CQBC. DFIG rotor current dynamics under sudden voltage swells. The power system's low or high-voltage faults will occur due to short circuits, lightning, or disturbances in the grid load. Such abnormal behavior will damage the DFIG rotor windings and the back-to-back converters. Also, open circuit fault leads to a drastic effect on DFIG and its converter. Understand the behavior of the DFIG under abnormal conditions is explained using differential equations and solved with a robust method. The classification of power system faults sequences is pre-fault, during fault or fault on, and post-fault. The system ride-through capability depends on withstanding at low voltage sag known as LVRT, and voltage swell is called HVRT. The external sources, namely battery energy storage system and SFCL, SMES coordination, are used in coordination described SMES based external resource for DFIG. The converter's efficiency depends on the number of the components present in the circuit, their conduction time as well as on switching Several topologies of DC-DC converter with isolation using high-frequency transformer are proposed in the literature. High voltage gain is achieved by raising the transformer's turn ratio but due to the transformer the cost, size, and weight of the converter increases. Moreover, transformers also introduce non-idealities in the system. Sometimes the leakage inductance of coupled inductor can also create a problem of current transients through the switch. High voltage gain could be achieved using coupled inductors, but a clamp circuit needs to be designed. The converter efficiency can decrease in the two-stage operation of the converters with coupled inductor because of reverse recovery issues and leakage inductance if the energy stored in the leakage inductance is not properly utilized.

**RESULT ANALYSIS:**

The parameters used to extract the simulation results using PLECS software are shown in Table 2. From (1) and (2), it has been drawn out theoretically that VC3 = Vo/2. For input voltage of

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24V with 0.3 duty cycle, output voltage Vo is found to be 166V and VC3 to 83V. Figure 8 shows the value of inductor currents IL1 and IL2 along with a gate pulse at a duty cycle of 0.3. It can be seen that inductor currents are continuous, and the average values are found to be 5.8A and 2.6A respectively. The ideal output voltage Vo is found to be 166V for a duty ratio of 30% at Vin = 24 V as shown in Figure 9. It can be inferred that approximately a voltage gain of more than 6.8 times can be achieved at a small duty ratio of 0.3. Practically the voltage gain will be reduced owing to the voltage drop across switch, diodes, capacitors and inductors.

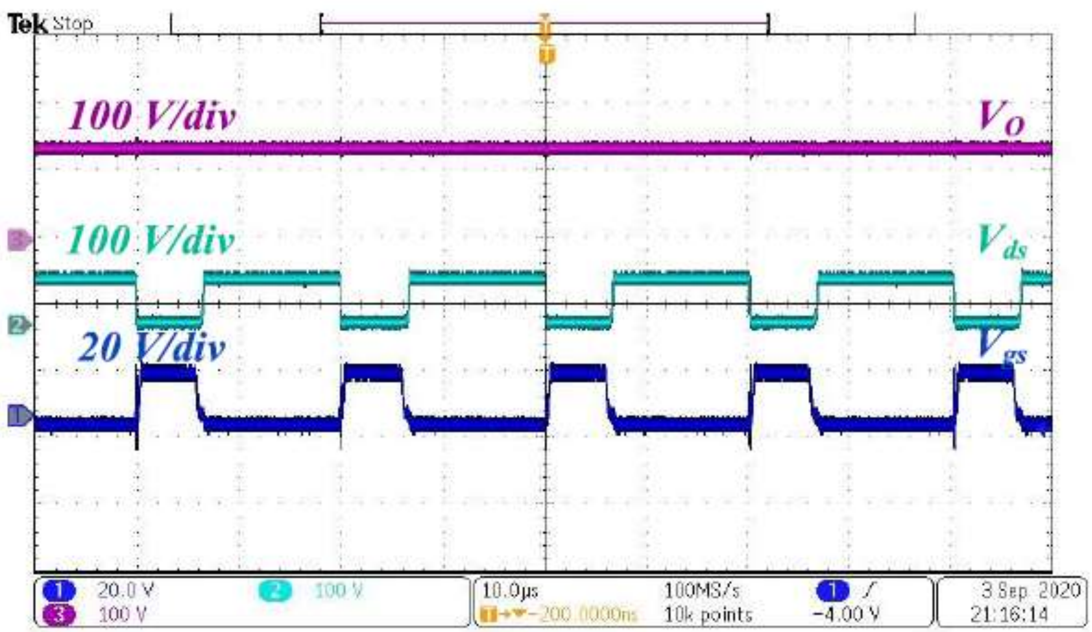


Figure3: Simulated Waveforms of Vo, VS and VgS1

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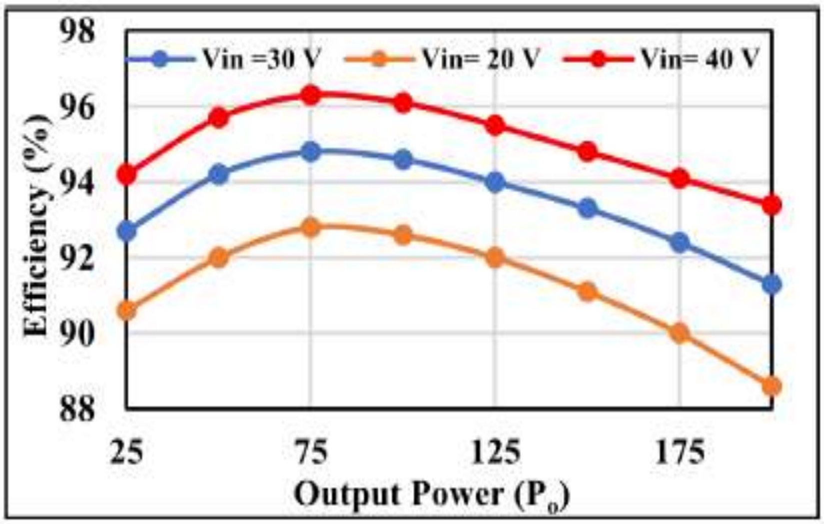


Figure4: The competence of the Proposed Converter

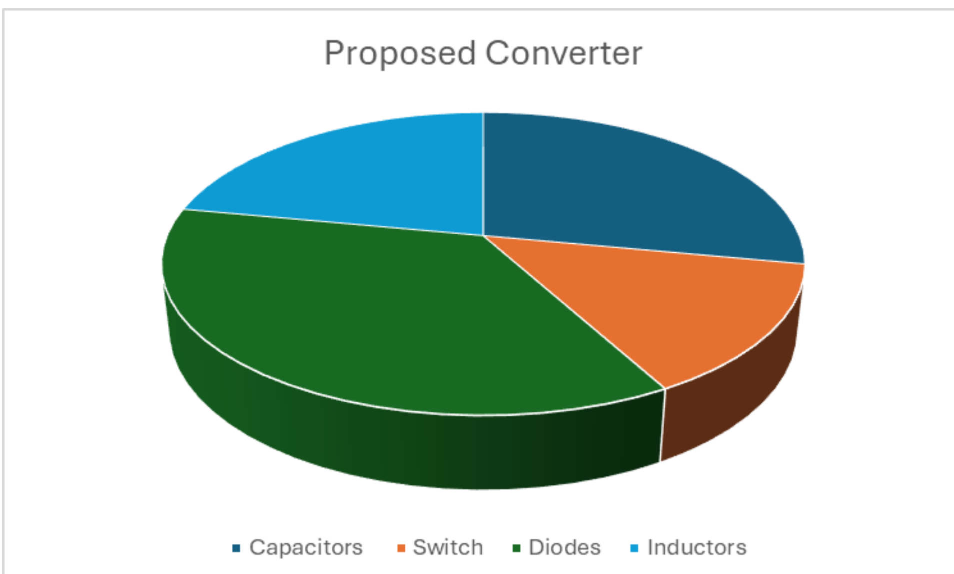


Figure5: Losses in different modules in the proposed converter

**CONCLUSION:**

In this paper, a non-inverting extreme and secure DC-DC converter operating in continuous conduction input current mode has been developed and analyzed for high-performance and secure power applications. The proposed converter successfully achieves stable, efficient power conversion with minimal ripple and improved current regulation, making it ideal for applications that require precise power management under extreme conditions. The continuous conduction input current mode significantly reduces electromagnetic interference (EMI) and enhances system stability, ensuring consistent and reliable operation across a broad range of load conditions. The secure design of the converter incorporates robust protection mechanisms against over-voltage, over-current, and thermal stresses, ensuring safe operation even in demanding environments. Simulation and experimental results have validated the converter's ability to maintain continuous conduction, secure input current, and non-inverted voltage output, confirming its suitability for critical applications such as aerospace, defense, renewable energy, and electric vehicles. Future work could explore further optimization of the converter's design for higher power densities and integration with advanced control strategies to enhance performance in next-generation power systems.

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