Published by :
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International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14 Issue 11, November 2025

Simulation of Super Lift Luo Converter based Multi-Port DC to DC Converter for Auxiliary Supply in Electric Vehicles

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Abstract— **Transportation has become an indispensable aspect of modern life, yet the conventional vehicles we've relied on for so long pose significant environmental challenges due to their heavy pollution. This has led to a shift towards electric vehicles (EVs) which offer cleaner alternatives. In electric vehicles, two primary power supplies are employed: the main supply used to propel the vehicle itself, and the auxiliary supply utilized for various functions such as lighting, audio systems, rainwater wipers, and USB ports, among others. Within electric vehicles, different components require varying voltage levels. These components include lighting systems, music players, and the electric motor. In response to the growing electric vehicle sector and the increasing utilization of renewable energy sources, there has been a notable surge in demand for DC-DC multi-port converters. These converters serve a crucial role in efficiently managing power distribution within electric vehicles and renewable energy systems. DC-DC multi-port converters are finding widespread application across various sectors, including portable electronics, electric vehicles, and renewable energy sources. Their versatility and efficiency make them integral components in the transition towards cleaner and more sustainable transportation and energy systems. This project focuses on the development of a DC-DC multiport converter by combining a super lift Luo converter with a buck converter. The aim is to achieve a wide range of voltage outputs with improved voltage gain, reduced electromagnetic component count, minimized output voltage ripple, and avoidance of voltage crossover issues. The integration of the super lift Luo converter and the buck converter allows for dual outputs, catering to different applications within the electric vehicle. Specifically, the super lift Luo converter, originally designed for operating compressors in air conditioning units, is utilized to generate one output, while the buck converter, tailored for lighting systems, generates the other output. Through simulation and hardware experimentation, the effectiveness of this converter is validated. It demonstrates reduced voltage ripple and a wider range of applications without encountering voltage crossover issues. Additionally, a State of Charge (SOC) based control strategy is implemented to enhance the lifespan of the auxiliary battery, ensuring optimal performance and longevity of the overall system**

Keywords: DC-DC converter, Luo-converter, single-input dual-output (SIDO), super-lift (SL), super-lift and a buck converter (SLBC).

I. INTRODUCTION

Electric vehicles, or EVs, are revolutionizing the way we move around the world. Instead of relying on internal combustion engines (ICs), EVs rely on electric power to power their vehicles. This shift is driven by the need to reduce carbon emissions, improve energy efficiency and mitigate environmental impacts. EVs promote a more sustainable future by integrating renewable energy sources, reducing reliance on fossil fuels and advancing battery technology [1][2]. The use of EV technology is in line with global efforts to combat climate change and promote a cleaner and greener mobility environment. The auxiliary supply in an EV acts as the backbone for essential functions. It powers essential electronic components that control vehicle performance [3]. It ensures smooth operation of on-board computers and control systems, as well as sensors and communication modules. It contributes to efficient energy management, and system monitoring. Furthermore, the auxiliary supply enhances the driving experience [4][5]. It powers accessories and comfort features, such as lights and infotainment, as well as climate control. Its importance extends to emergency systems where it supports critical safety features, such as airbags and anti lock braking systems, ensuring their functionality even in difficult situations.

The auxiliary supply also plays a critical role in maintaining the quality of the primary traction battery, monitoring its condition, controlling the temperature, and optimising the charging process [6]. In short, an auxiliary supply is essential for the overall safety, reliability, and life of the Electric Vehicles, providing a complete and integrated solution for their operation [7][8][11].

The multi-port converter in the Electric Vehicle (EV) industry plays an important role in managing diverse power requirements. The DC-DC multiport converter (MPC) has been in the spotlight due to the growth of the electric vehicle (EV) industry and the increase in the use of renewable energy (RES) such as PV incorporated with a wide voltage range[9].

DC-DC multipurpose converter is divided into two distinct structures: multipurpose inputs and multipurpose outputs. multipurpose inputs are used to deliver a load using different sources. On the one hand, multipurpose inputs supply a single voltage level from a single source while multipurpose outputs supply different voltage levels from different sources.

SIMO converters can be divided into different structures according to the literature. The first structures proposed for SIMOs were those with variable output voltages (VETs) using multiple port transformers (MPT)[12]. However, these converters had a number of drawbacks such as the use of bulky trans-forms and a large number of active switches which reduced reliability. They also had complicated control and driving circuits with high switching losses and a clear need for soft switching. The next structures proposed for SIMO converters were those using coupled inductors (CNI) [13]. For example, [14] introduces a converter with 2 different outputs, and the switching process is performed under a null current switching condition. These converters have high losses due to leakage current in coupled inductors and complex design procedures. In order to overcome these problems, single inductor multi-output converters were introduced. Single inductors are used to generate different voltage levels in outputs[15].

For example, in [15], a single input single-output converter is used to convert a single SIMO structure to SIMO structure by using a single-indirect-based configuration. In [16], the authors introduced DC-DC converters, which can simultaneously buck-boost and extend inverting outputs capability. This converter has 3 switches and is designed for low power. In this arrangement, the switches operate in the hard switching conditions.

In [17] proposed a high step-down multiple output converter utilizing a quasi two-stage architecture and a dual-output LLC resonant converter. Their work addressed challenges associated with wide input voltage ranges, presenting a design that achieved efficiency in power conversion. In the literature [18]delved into the derivation analysis and development of coupled-inductor-based non-isolated DC converters with an ultra-high voltage-conversion ratio. Their work provided insights into advanced DC converter technologies, exploring applications with exceptional voltage-conversion capabilities. In [19] introduced a high-efficiency single-input multiple-output DC-DC converter. Their innovative design addressed the need for efficient power conversion in single-input, multiple-output scenarios, contributing to advancements in power electronics. In[20] focused on single-inductor-multiple-output switching DC-DC converters. Their research explored novel solutions for compact and efficient power supply designs with a single inductor serving multiple outputs. In [22] work introduced a single-inductor multiple-output switcher capable of simultaneous buck-boost and inverted outputs, providing a versatile solution for power electronics applications with varying voltage requirements.

These converters are designed for low power and use a complex structure for evaluating zero-inducted and peak-inducted currents. A new generation of MPC is also used in technologies like electric vehicle (EV) and renewable energy sources (RES). The main benefit of these MPC is that they do not require any electromagnetic devices (EMDs)[21]. According to the literature reviews the studies are mainly focused to step up voltage by voltage lifting using arithmetic progression and step down by buck operation In previous

works related Multi port converter needed additional filter circuit due to noise and gain is less.so the system became bulky.The objective of this paper is to design and simulate a simple structured multi port converter with some features such as generating different voltage levels with considerable range, low ripple at output and less depend on electromagnetic components provides auxiliary supply in the electric vehicle[23].

II. OVERVIEW ABOUT MULTIPORT CONVERTERS USED IN ELECTRIC VEHICLE

In recent years, DC-DC multi-port converters (MPCs) have been a hot topic due to the growing industry of electric vehicles (EVs) and higher penetration of renewable energy sources (RESs) such as photovoltaics (PV) incorporated with wide voltage ranges . DC-DC MPCs are divided into two different structures: multi-inputs and multi-outputs . Multi-inputs structures are applied to supply a load utilizing different sources . On the other hand, multi-outputs supply various voltage levels by a single source . These types of converters are used in RESs , mobile transmission , LED drivers and EVs. The various devices in the EVs such as electric motor, audio system and lights need different voltage levels. several reasons why multiport converters are essential in electric vehicles:

- Integration of Multiple Power Sources: Electric vehicles often incorporate multiple power sources, such as batteries, fuel cells, and super capacitors. A multiport converter facilitates the integration of these diverse power sources, allowing for optimal energy utilization and management.
- Efficient Energy Management: Multiport converters enable efficient energy management by facilitating bidirectional power flow between different energy storage systems. This bidirectional power flow is crucial for scenarios such as regenerative braking, where energy generated during braking can be fed back into the batteries or other storage systems.
- Optimal Power Distribution: Electric vehicles typically have multiple loads with varying power requirements, such as traction drives, auxiliary systems, and on-board electronics. A multiport converter ensures optimal power distribution among these loads, helping to maximize overall efficiency and performance.
- Fast Charging Capabilities: Multiport converters can support fast charging by efficiently managing power flow from external charging sources to the battery. This is important for reducing charging times and improving the practicality of electric vehicles.

III. General Types of Multi port Converter

The multiport converter's main objective is to integrate numerous power input nodes into a single device while still allowing power to flow between each node. A photovoltaic panel, a battery energy storage system (BES), a DC-DC converter used for multiple inputs, an inverter, and a load are the components of a two-stage multiport system shown in Figure 1 . In addition, the multiport system is linked to the distribution grid.

A. Non-Isolated Multiport Converters

The input power ports share the same ground in a non-isolated multiport converter design. High power density,

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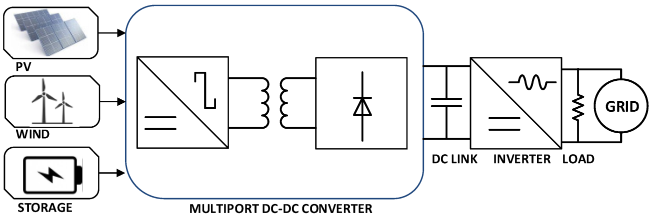

Fig. 1. Structure of a double stage MPC system

fewer switches, a relatively simple control scheme, and a compact design are a few benefits of non-isolated multiport converters. In addition, these types

of MPCs not only help lower the overall cost but also achieve low electromagnetic interference (EMI).

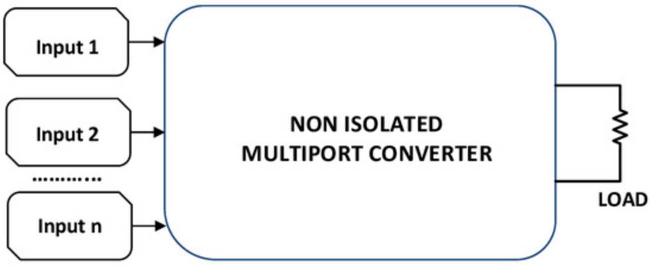

Fig. 2. Structure of non-isolated n-port MPC system

B. Isolated Multiport Converters

Galvanic isolation between the input and output stages is a typical feature of the isolated multiport converters.The isolated multiport converters' primary feature is the use of separate windings for each power input. The fluxes of each main winding contribute to the voltages induced in the secondary winding. Isolated multiport converters are typically employed in RES and hybrid electric vehicle (HEV) applications. Isolated multiport converters have a number of benefits, such as less risk of electric shock, a wide range of voltage gain, noise filtering, and integration of various voltage ratings.

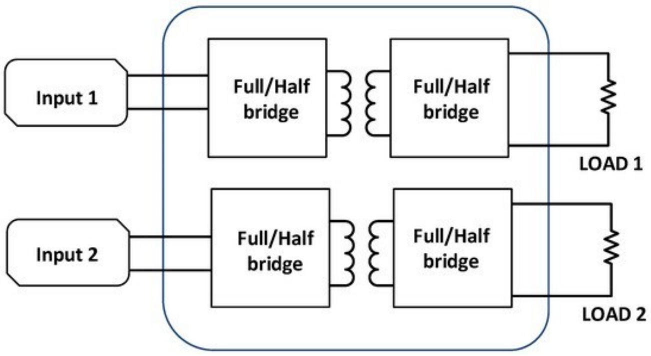

Fig. 3. Structure of isolated double-input-double-output (DIDO) port converter system.

C. Partially-Isolated Multiport Converters

The single winding of the high-frequency transformer can be connected to the input power port of an isolated multiport converter. Connecting to the input ports' common ground point is required. This converter's topology can be described as a hybrid of fully isolated and non-isolated multiport topologies. High power density, adjustable voltage ranges, and galvanic isolation of the load from the primary side are only a few of the main benefits of partially isolated multiport converters.

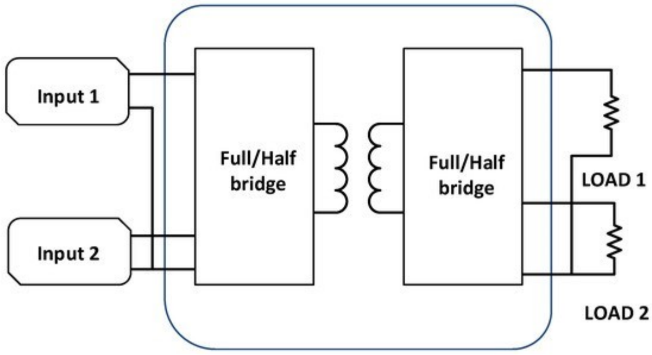

Fig. 4. Structure of partially isolated double-input-double-output (DIDO) port system.

In general multiprt converter and needs of these type of converter in electric vehicle. A multiport converter is a key component in electric vehicle power systems, offering the flexibility to integrate various energy sources, manage power distribution efficiently, and support advanced features such as bidirectional power flow for regenerative braking and V2G capabilities. This multiport converter contributes to the overall performance, reliability, and adaptability of electric vehicles in a dynamic and evolving energy landscape.

IV. DESIGN AND ANALYSIS OF SUPERLIFT LUO CONVERTER BASED DC TO DC MULTIPORT CONVERTER (SLBC)

A superlift Luo converter is a type of voltage step-up converter that combines features of the Luo converter and the superlift Luo converter. It aims to improve efficiency and reduce voltage stress on components. When integrated with a buck converter, which is a step-down converter, the combination allows for both voltage step-up and step-down functionalities in a power supply system. This can be useful in applications where variable voltage levels are required to satisfy auxiliary loads associated with electric vehicle. In superlift luo converter the voltage lifted by using geometric progression, hence the gain can be improved.

The figure 5 shows the entire block diagram of the system. Input supply to the system is taken as auxiliary battery in electric vehicle and it directly fed to the multiport DC-DC converter. Here uses the integration of superlift luo converter with buck converter as a multiport converter to get step up and step down voltages simultaneously. So these configuration helps to supply two loads simultaneously.

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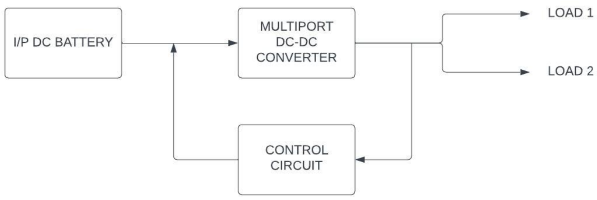


Fig. 5. Block diagram of the multiport DC- DC converter

A control algorithm implemented as a feedback loop for attaining the expected output.

A. Structure And Operation Of Superlift luo converter based DC to DC Multiport Converter

In this a SIDO DC-DC converter with two different step-up and step-down outputs. The various devices in the EVs such as electric motor, audio system and lights need different voltage levels. Accordingly, the appropriate application for this structure is EV. The DC-DC converter integrated super-lift with a buck converter (SLBC) generates two step-up and step down outputs by a single input. The step-up output uses super-lift method to lift the voltage . In this method, high gain voltages can be generated with simple structures without including any extra transformer or electric circuit to control, regulation, etc.. Accordingly, the generated output voltage has better power efficiency. In this converter, the positive output super-lift Luo-converter is utilized for the step up output . Meanwhile, the SIDO converter can supply step-down voltages simultaneously.

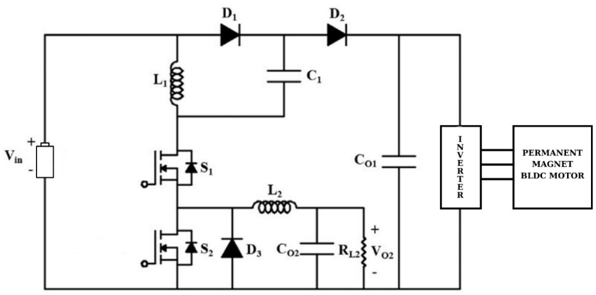


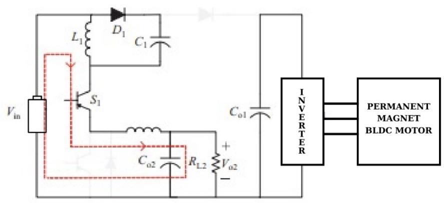
Fig. 6. Structure of multiport DC- DC converter

B. Modes of operations

In this converter performance is analyzed under the steady-state and CCM conditions. The outputs are affected by the switching of S_1 and S_2 controlled by duty cycles D_1 and D_2, respectively. For the desired operation D_1 grater than D_2 must hold for every switching period. This condition is performed to provide a necessary shoot-through condition for the SL part. Considering ideal elements, the operation modes of the converter are as following.

- Mode 1 (0 To t_1)): In this interval, S_1 is on. L_1 current is decreased to charge L_2 and to supply step-down load RL_2 This interval ends after ((D_1-D_2)/2)T_s.

Furthermore, in the previous switching interval because of the resonance path between. L_1,L_2,C_{O2}, the voltage of S_1 is became zero.



MODE 1

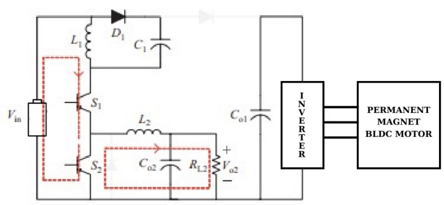
$0 \leq t \leq t_1$

$V_{02} = V_{in} - V_{L1} - V_{L2}$

$i_{L1} = i_{in} - i_{D1}$

$i_{L2} = i_{L1} + I_{C1}$

- Mode 2 (t_1 To t_2): In this interval, S_2 is turned on and D_2 is inverse biased. In this situation, the current of L_2 is decreased due to the power transition to RL_2. Also, L_1 is charged through Vin The time interval for this operation mode is equal to D_2T_s.



MODE 2

$t_1 \leq t \leq t_2$

$V_{02} = -V_{L2}$

$i_{L2} = i_{C\_02} + \frac{V_{02}}{R_{L2}}$

$V_{C1} = V_{L1} = V_{in}$

- Mode 3 (t_2 To t_3): This mode is similar to mode 1. So, avoid repeating the explanations.
- Mode 4 (t_3 To T_s)): In this interval, S_1 and S_2 are turned off. The current of L_1 and L_2 is decreased to supply both Load 1 and RL_2 respectively.
- The super lift luo converter with buck converter (SLBC)is a multi-output structure consisting of a super-lift Luo-converter and a buck converter based on series-

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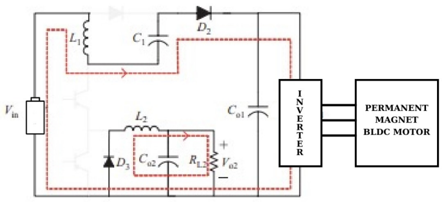

MODE 4

$t_3 \le t \le t_s$

$V_{01} = V_{C1} + V_{in} - V_{L1}$

$V_{C1} = V_{in}$

$V_{02} = -V_{L2}$

$i_{L1} = i_{C1} = i_{C01} + \frac{V_{01}}{R_{L2}}$

connected switches.Using this structure, various range of auxiliary applications associated with electric vehicle can be achieved.After 4 modes of operation the output voltage are available in both converters simultaneously.

C. Design Considerations

The SuperLift Luo Converter combines a Luo Converter with a Buck Converter, offering advantages like reduced voltage stress and improved efficiency. The Luo Converter's energy transfer capability complements the Buck Converter's voltage reduction, creating an efficient power conversion system. This hybrid design enhances performance, making it suitable for various applications where high efficiency and voltage regulation are crucial.

Voltage gain of Step down can be calculated as,

$$V_{02} = \left[\left(D_2 - D_1\right) + \left(D_1 - D_2\right)\left(\frac{2 - D_2}{1 - D_2}\right) \right] \times V_{in}$$

$$\frac{V_{02}}{V_{in}} = \frac{D_1 - D_2}{1 - D_2}$$

$V_{02} = 5V$

$V_{in} = 12V$

$$\frac{V_{02}}{V_{in}} = \frac{D_1 - D_2}{1 - D_2}$$

$D_1 = 0.7$

Calculation of voltage gain

The voltage gain can be calculated for superlift luo converter as,

$$V_{in} \times \left(D_2 T_s\right) = \left(V_{01} - 2V_{in}\right) \times \left(1 - D_2\right) T_s$$

$$\frac{V_{01}}{V_{in}} = \frac{2 - D_2}{1 - D_2}$$

$V_{01} = 36V$

$V_{in} = 12V$

$$\frac{36}{12} = \frac{2 - D_2}{1 - D_2}$$

$D_2 = 0.5$

Component Design

Current ripple of L_1

$$\triangle i_{L1} = \frac{V_{in}}{L_1 f_s} \times D_2$$

$$\triangle i_{L1} = \frac{12}{3 \times 10^{-3} \times 20000} \times 0.5$$

$\triangle i_{L1} = 0.1$

Current ripple of L_2

$$\triangle i_{L2} = \frac{V_{02}}{L_2 f_s} \times \left(1 - D_1\right)$$

$$\triangle i_{L2} = \frac{5}{730 \times 10^{-6} \times 20000} \times (1 - 0.71)$$

$\triangle i_{L2} = 0.1$

Assume $\triangle V_{C01} = 1$

$$C_{01\ min} = \frac{V_{in}}{\triangle V_{C01} f_s L_1} \times \left(1 - D_1\right)$$

$$C_{01\ min} = \frac{12}{1 \times 20000 \times 3 \times 10^{-3}} \times (1 - 0.71)$$

$C_{01\ min} = 58 \times 10^{-3}$ F

$$C_{02\ min} = \frac{V_{in}}{\triangle V_{C02} f_s L_2} \times \left(D_2 - D_1\right)$$

$C_{02\ min} = 1000 \times 10^{-6}$ F

- The circuit parameters are designed with respect to the modes of operations and voltage ripple and current ripple considerations.Input of the system taken as 12V by using a battery and it step up to 36V by superlift luo converter and step downed to 5V by buck converter.load of superlift luo converter taken as BLDC air compressor as a demonstration of air conditioning unit in EV , load of buck converter taken as resistive load it may USB port,audio system, rain water wiper etc..

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International Journal of Engineering Research & Technology (IJERT)
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$$L_1 = \frac{V_{02}}{\triangle i_{L2} f_s} \times \left(1 - D_1\right)$$

$$L_1 = \frac{12}{0.1 \times 20000} \times (1 - 0.71)$$

$$L_1 = 3 \times 10^{-3}\ \mathrm{H}$$

$$L_2 = \frac{V_{02}}{\triangle i_{L2} f_s} \times D_2$$

$$L_2 = \frac{12}{0.1 \times 20000} \times 0.5$$

$$L_2 = 730 \times 10^{-6}\ \mathrm{H}$$

SL. NO	CIRCUIT PARAMETERS	SPECIFICATIONS
1	Input voltage (V_{in})	12 V
2	Inductor L_1	3x10^{-3} H
3	Inductor L_2	730x10^{-6} H
4	Capacitor C_{01}, C_1	58x10^{-3} F
5	Capacitor C_{02}	1000x10^{-6} F
6	Output voltage of superlift luo converter (V_{01})	36 V
7	Output voltage of buck converter (V_{02})	5 V
8	Duty cycle D1	0.71
9	Duty cycle D2	0.5
10	Speed of BLDC motor	4000 rpm
11	Input voltage of motor	36 V

Fig. 7. Circuit parameters and its specifications.

V. SIMULATION RESULTS AND DISCUSSIONS

Simulation is essential for analyzing the integration of the Superlift Luo Converter with the Buck Converter in this project due to the inherent complexity of hybrid systems. It provides a controlled environment to assess the efficiency, optimize parameters, and evaluate the safety and reliability of the combined converter. Simulation allows for rapid iteration, reducing time and costs associated with hardware prototyping, while also offering predictive insights into system dynamics. By simulating various scenarios, potential challenges can be identified and addressed before real-world implementation, ensuring a more robust and reliable final system.

In Matlab/Simulink, the PI control's static and dynamic performance for the Super Lift Luo Converter Based Multi-Port Dc To Dc Converter is assessed.

1) Simulation of open loop sysm: In open loop simulation input supply taken as lithium ion battery with input voltage as 12V given to multiport SLBC . The switching frequency of triangular waveform is 20kHZ . The output of superlift luo converter is given to dc motor and buck converter connected to resistive load.

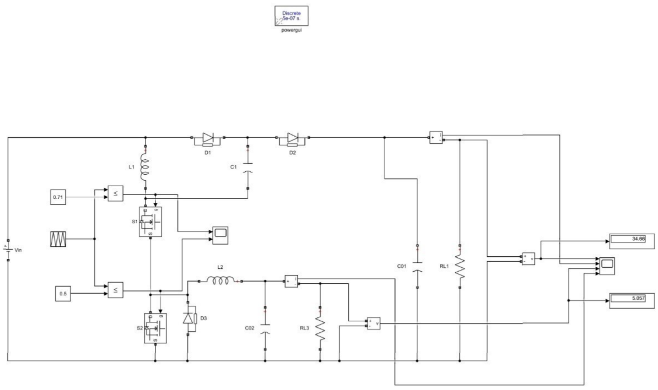

Fig. 8. Open loop Simulink model of Super Lift Luo Converter Based Multi-Port Dc to Dc Converter with resistive load

- In the open loop simulation input given as 12V , inductor and capacitor values are gives as per the design. The loads are resistive for both converters taken as 5ohms.

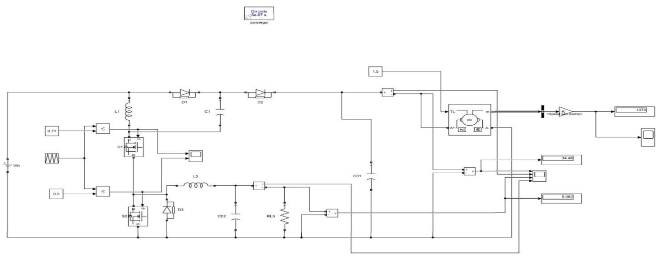

Fig. 9. Open loop Simulink model of Super Lift Luo Converter Based Multi-Port Dc to Dc Converter with DC motor and resistive loads

- In the open loop simulation input given as 12V , inductor and capacitor values are gives as per the design. The loads are resistive for buck converter with 5ohms and for superlift luo converter taken as a DC motor.

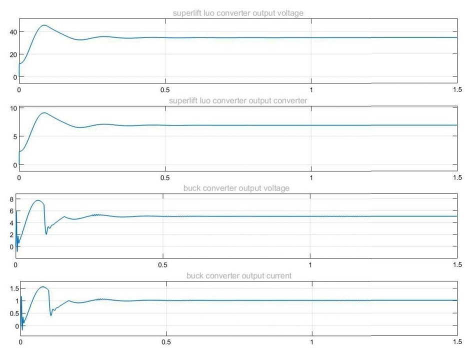

Fig. 10. Open loop output waveforms of Super Lift Luo Converter Based Multi-Port Dc to Dc Converter

- By analysing open loop simulation results can seen that output voltage of superlift luo converter as 34.66V and for buck converter it is 5.057V.As a consideration of current input current measured as 28.25A . The inductor currents for L_1 and L_2 are 14.35A 1.011A respectively.

2) *Simulations Of Closed loop system:* In closed loop simulation input supply taken as lithium ion battery with input voltage as 12V given to multiport SLBC . The switching frequency of triangular waveform is 20kHZ . The output of superlift luo converter is given to BLDC motor through a inverter as a representation of air conditioning system in electric vehicle.and buck converter connected to resistive load, PI controller is connected across both converters input and output side.

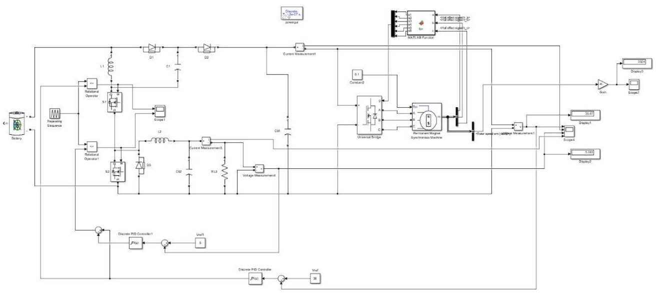

Fig. 11. Closed loop Simulink model of Super Lift Luo Converter Based Multi-Port Dc to Dc Converter

- In the closed loop simulation input given as 12V , inductor and capacitor values are gives as per the design. The loads are resistive for buck converter with 5ohms and for superlift luo converter taken as a BLDC motor with 4000rpm and 200W.

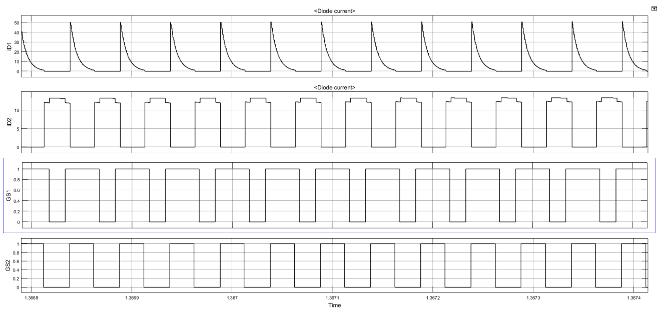

Fig. 12. Output current wave forms across diode in SLBC

- In the waveform analysis currents across diode 1 and 2 considered and compared with gate pulses of two converter with magnitude 1
- From the waveform analysis voltage across capacitor 1 considered and compared with gate pulses of two converter with magnitude 1. In mode 1 voltage across the capacitor decreases and in mode 2 it increased .In mode 3 and 4 it decreases.
- In the waveform analysis voltage across Both converter increases from zero and for superlift luo converter it become 35.87V and for buck converter5.08V attained the desired value.

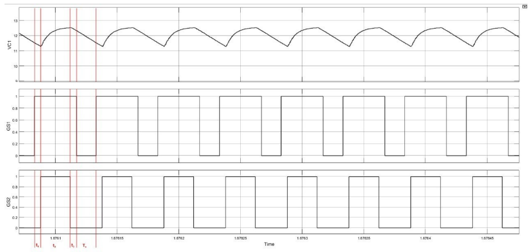

Fig. 13. Output waveform across capacitor C1 in SLBC

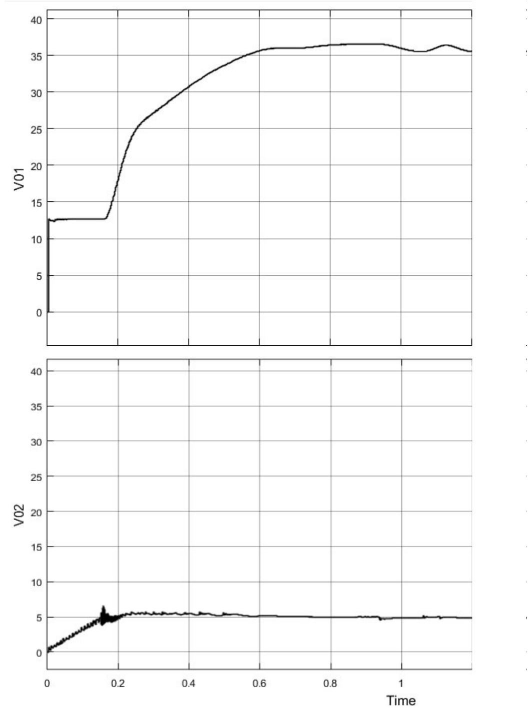

Fig. 14. Output voltage wave forms in SLBC

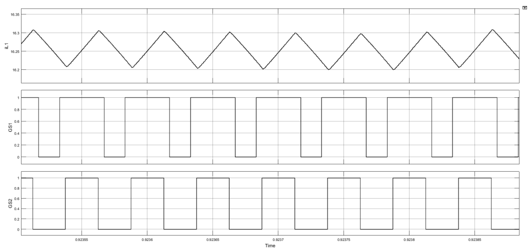

Fig. 15. current waveform of inductor L_1 of Super Lift Luo Converter Based Multi- Port Dc to Dc Converter

- In this waveform analysis inductor current in L_1 decreases in mode 1 and increased up-to the end of mode 4.
- From this waveform analysis inductor current in L_2 increased in mode 1 and decreased up-to the end of mode 4

3) *Overview of Simulation Results:* Using simple switching control method, the range of 36V can be generated by Superlift converter and 5V by Buck converter. After

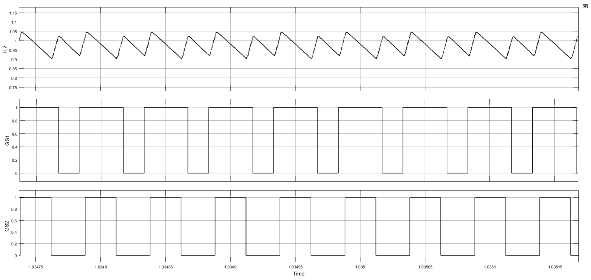

Fig. 16. Current waveform of inductor L_2 of Super Lift Luo Converter Based Multi- Port Dc to Dc Converter

simulation in open loop control input as 12V and frequency as 20kHZ output of superlift luo converter as 34.66 and for buck converter it as 5.057V. and the inductor current across L_1 and L_2 are 14.35A 28.25A. in closed loop control input as 12V and frequency as 20kHZ output of superlift luo converter as 35.84 and for buck converter it as 5.052V. and the inductor current across L_1 and L_2 are 7.25A 1.002A respectively .

4) Frequency and voltage ripple analysis: In general, the ripple current / voltage will decrease as switching frequency goes up as their is less time for the inductor/capacitor to charge/discharge between cycles, creating ripple.

FREQUENCY	VOLTAGE RIPPLE IN SUPERLIFT LUO CONVERTER	PERCENTAGE VOLTAGE RIPPLE IN SUPERLIFT LUO CONVERTER IN TERMS OF NOMINAL VOLTAGE	VOLTAGE RIPPLE IN BUCK CONVERTER	PERCENTAGE VOLTAGE RIPPLE IN BUCK CONVERTER IN TERMS OF NOMINAL VOLTAGE
1kHZ	1.3	3.61	0.6	12
5kHZ	0.063	0.175	0.5	10
10kHZ	0.048	0.133	0.004	0.08
20kHZ	0.03	0.0833	0.003	0.06

Fig. 17. Frequency and voltage ripple analysis data

- From this its clear that frequency and ripples are depended. when the switching frequency improved the ripples are reduced. so the system with 20kHZ has less ripple.

VI. CONCLUSION

A multiport converter is essential in electric vehicles (EVs) to efficiently manage power flow among various components. Unlike traditional internal combustion engine vehicles, EVs incorporate multiple power sources, such as the main battery pack, regenerative braking systems, and auxiliary systems. The super lift luo converter with buck converter (SLBC)is a multi-output structure consisting of a super-lift Luo-converter and a buck converter based on series-connected switches. Using simple switching control method, the range of 36V can be generated by Superlift converter and 5V by Buck converter Hence the voltage gain is improved. Using this structure, various range of auxiliary applications associated with electric vehicle can be achieved. with This can be achieved by utilization of less number electromagnetic components to generate a dual output, ad ripples are less.As a future scope can implement a SOC based control strategy to improve the life span of the auxiliary battery used in electric vehicle.

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International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14 Issue 11, November 2025

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