



## INTERNATIONAL RESEARCH JOURNAL ON ADVANCED SCIENCE HUB (IRJASH)

e-ISSN: 2582 4376

Open Access

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## Performance Analysis and Comparative Study of Different Types of DC-DC Converters

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### Abstract

This paper presents the design, analysis and comparison of different types of dc-dc converters. Now days due to lack of conventional energy sources like coal, petrol, diesel etc., demand of electricity is rising day to day. To fulfill this demand of electrical energy alternative methods are very much important now. The researchers stand motivating in solar energy generation, dc-dc converters etc. In this paper Performance analysis of different dc/dc converters and comparative study of them is focused. All converters will work in Continuous conduction mode. The performance analysis of different converters (Buck, Boost, Buck Boost, CUK, SEPIC, Positive Output Super-Lift Luo Converter) and comparison of those converter's simulation results discussed using MULTISIM 14.0.

**Keywords:** Dc-dc converter, non-isolated converter, renewable energy, Boost Converter, Buck Converter, Buck boost converter, CUK converter, SEPIC converter, Positive Output Super-Lift Luo Converter, MULTISIM

### 1. INTRODUCTION

Dc-dc conversion is used to change a typically unregulated dc voltage to a controlled dc output voltage. The direction is commonly fixed by PWM (Pulse Width Modulation) by a switching frequency and the switch over the driver is generally BJT, MOSFET or IGBT. The power controller can be inductor based. Each and every controller has some merits and drawbacks, depending upon their applications and requirements. The conversion of power from one form to another is essential and the switching frequency of the power devices permit these transformations. The power conversions are done with static power switched converters [7,8].

There are several dc-dc converters that are

used to modulate the input voltage depending upon their applications. Generally, there are two types of dc-dc converters which are isolated dc-dc converter and non-isolated dc-dc converter. The input and output of isolated dc-dc converter are isolated also depending on the electrical barrier. This is done by using high frequency transformer. Protecting the sensitive load is the major advantage of isolated dc-dc converter. Either positive or negative polarity can be used for configuring the converter output. The problem is it has high interference noise capability. The electrical barrier is absent in case of non-isolated dc-dc converter. The non-isolated dc-dc converters

are low cost and simple design compare to the isolated dc-dc converters. Six types of non-isolated dc-dc converters are presented in this paper. To

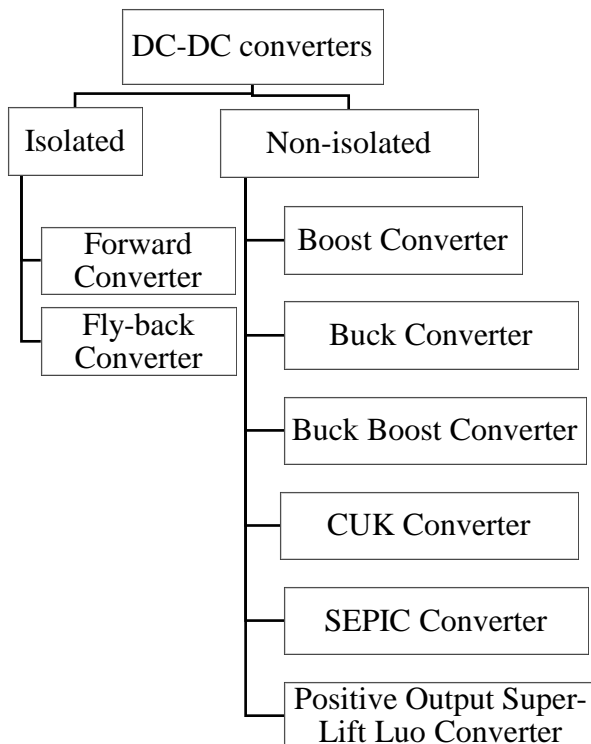
concerning reliable switching strategies control, higher efficiencies and fault-tolerant configurations, different topologies of dc-dc converters are developed and they based on renewable energy applications.

This research focuses on different non-isolated dc-dc converter’s performance analysis and comparison. These non-isolated converters are Boost, Bulk, Buck boost, CUK, SEPIC and Positive Output Super-Lift Luo Converter.

Each converter has its unique characteristics that is different from others [1]. These converters are used in many different applications like electric vehicles, distributed DC systems, electric traction, machine tools, fuel cell, special electrical machine drives, solar PV based applications etc. [2,3,4 and 8].

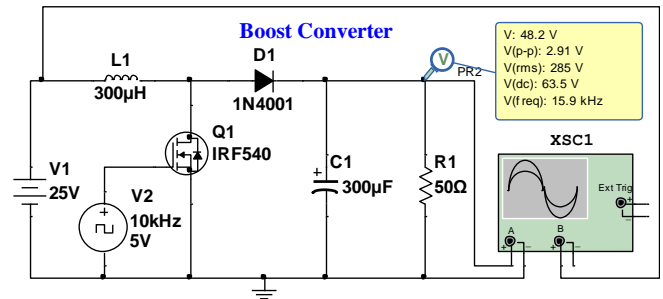
## 2. Different types of DC-DC converters

These converters are used to converts fixed dc voltage to dc variable, step up, step down the dc voltages depending of the application of the system. Each converter having advantages and drawbacks. Few converter’s performance is discussed with the help of simulation as shown below. They are

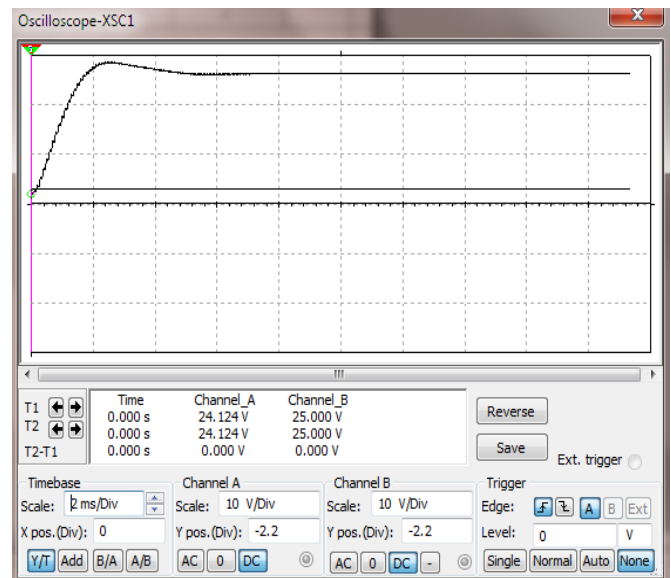


### 2.1 Boost Converter

Boost converter is also called as “Step up converter.” In the circuit given in fig1(a), the output voltage is greater than the input voltage. The output voltage is 48.2 V when supply voltage is 25 V. As shown in the simulation results in fig1(b) ( $V_i < V_o$ ), Duty cycle of diode = 0.5 and frequency =10 kHz.



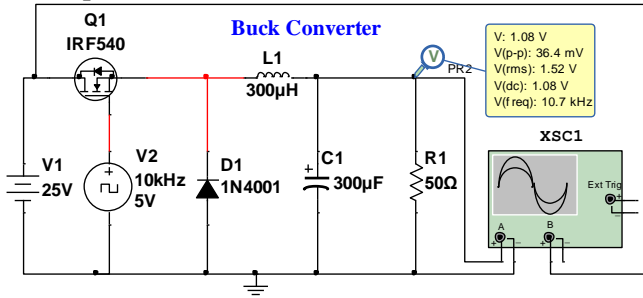
**Fig1(a): Circuit Diagram of Boost Converter in Multisim**



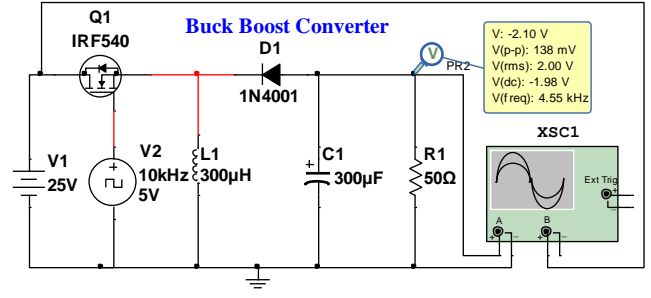
**Fig1(b): MULTISIM Output of Boost Converter in Oscilloscope**

### 2.2 Buck Converter

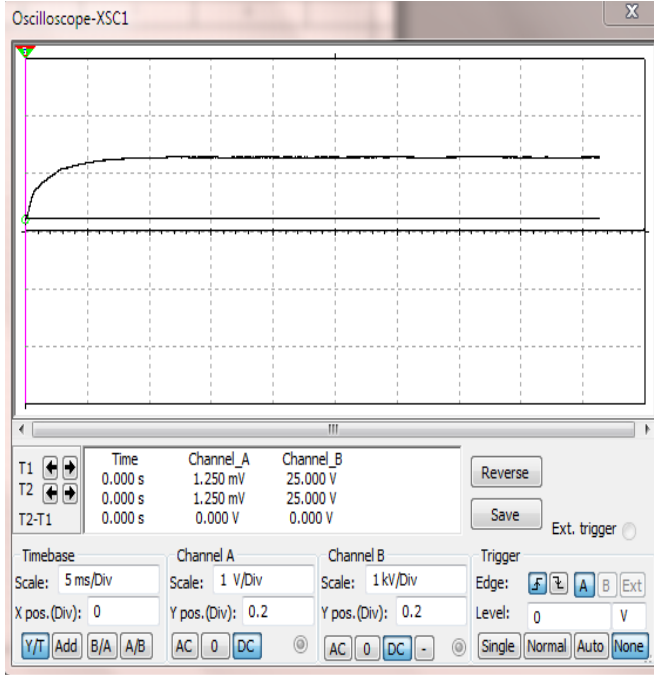
Buck converter is also called as “Step down converter.” In the circuit shown in fig2(a), the output voltage is less than the input voltage. The output voltage is 1.08 V when supply voltage is 25 V. As shown in the simulation results in fig2(b) ( $V_i > V_o$ ), Duty cycle of diode = 0.5 and frequency =10 kHz.



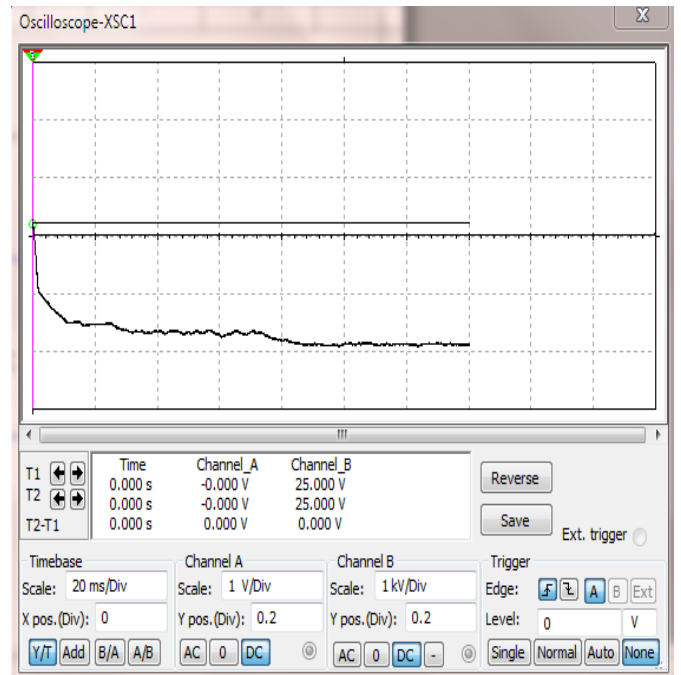
**Fig2(a): Circuit Diagram of Buck Converter in Multisim**



**Fig3(a): Circuit Diagram of Buck Boost Converter in Multisim**



**Fig2(b): Multisim Output of Buck Converter in Oscilloscope**

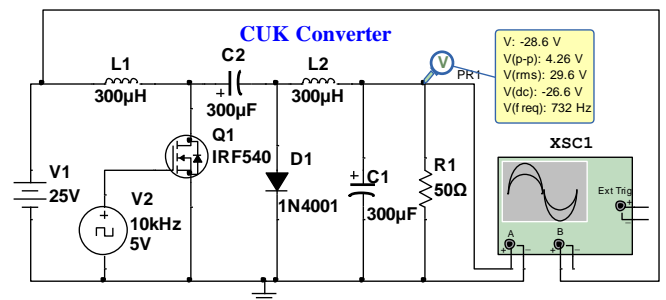


**Fig3(b): Output of Buck Boost Converter in Oscilloscope**

### 2.3 Buck Boost Converters

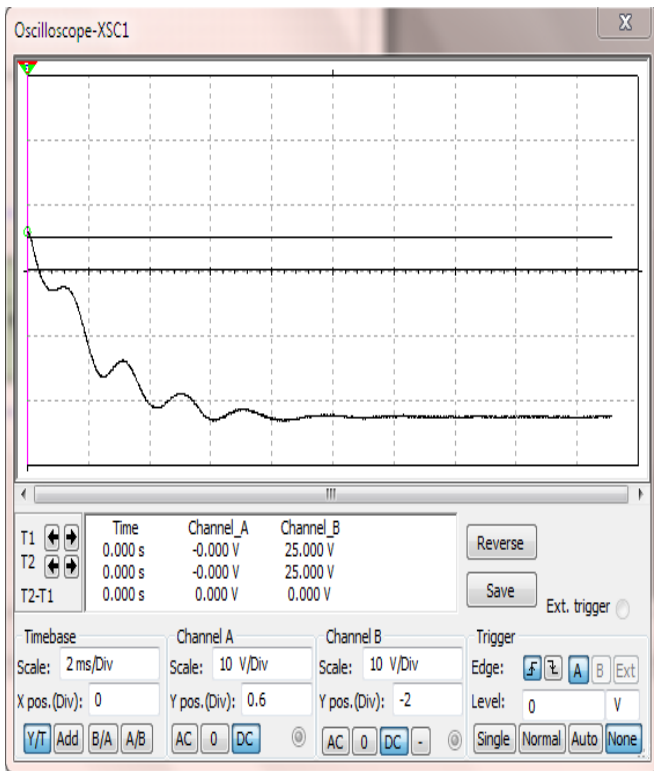
Buck Boost converter is also called as “Step up or Step-down converter.” In the circuit given in fig3(a), the output voltage is greater than or less than the input voltage, Step up and Step down of voltage is mainly depend on the duty cycle of the converter. The output voltage is -2.10 V when supply voltage is 25 V. Duty cycle of diode = 0.5 and frequency = 10 kHz.

### 2.4 CUK Converter

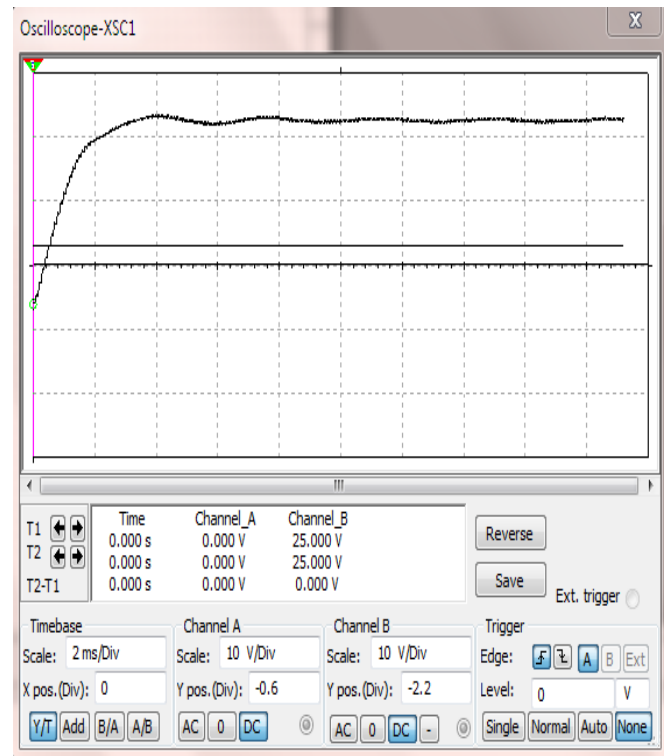


**Fig4(a): Circuit Diagram of CUK Converter in Multisim**

In the circuit as shown in fig4 (a) the output voltage is negative when positive voltage applied in the input terminal. The output voltage is -28.6 V when supply voltage is 25 V. Duty cycle of diode = 0.5 and frequency = 10 kHz.



**Fig4 (b): Multisim Output of CUK Converter in Oscilloscope**



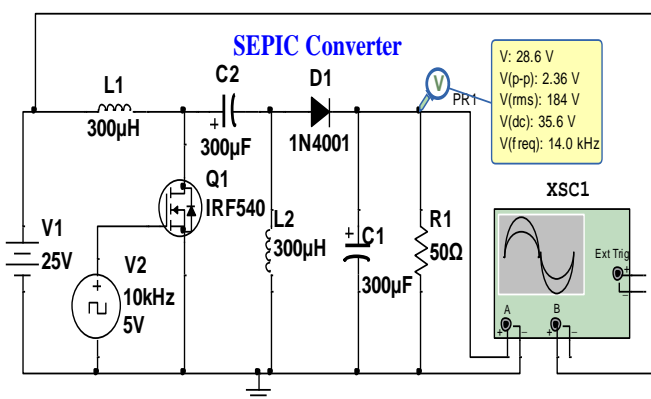
**Fig5 (b): Multisim Output of SEPIC Converter in Oscilloscope**

**2.5 SEPIC (Single Ended Primary Inductor Converter)**

In this circuit the output voltage is 28.6 V when supply voltage is 25 V. Duty cycle of diode = 0.5 and frequency = 10 kHz.

**2.6 POSLLC (Positive Output Super-Lift Luo Converter)**

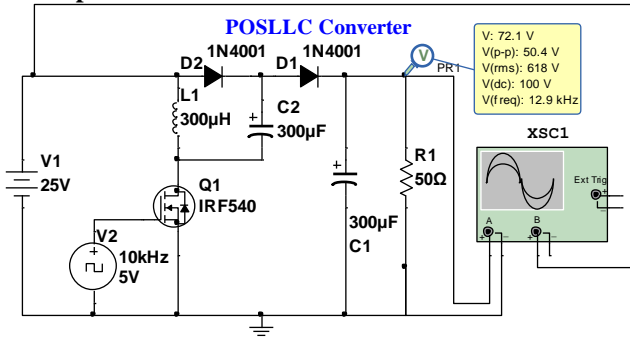
Super-lift technique is more powerful than CUK and SEPIC converters. It can generate arithmetic progression output voltage with high efficiency and power density. A positive output super-lift Luo converter operates high voltage transfer gain and large voltage amplification.



**Fig5(a): Circuit Diagram of SEPIC Converter in Multisim**

This converter is used by industrial and domestic applications but it is still under research. Luo et al. introduced a new super left technique that contains series of inductors and capacitors which are implemented together to rise the output voltage in high geometric progression [5-8].

In this circuit the output voltage is 72.1 V when supply voltage is 25 V. Duty cycle of diode = 0.5 and frequency = 10 kHz.



**Fig6 (a): Circuit Diagram of POSLLC Converter in Multisim**



**Fig6 (b): Multisim Output of POSLLC Converter in Oscilloscope**

SEPIC	25	300µH	300µF	28.6
POSLLC	25	300µH	300µF	72.1

**4. Comparison for Performance Analysis**

A brief comparison between the different non-isolated dc-dc converters based on theoretical performance using MULTISIM 14.0 discussed in this section. There are different characteristic properties for each converter in various aspects. In this section, the performance of six dc-dc converters are presented for optimum operating point. To find out the dependency of efficiency on input voltage we consider and fixed the switching frequency at 10 kHz. To find the dependency of efficiency on switching frequency we consider and fixed input voltage at 25 V. For both the cases all other circuit parameters are kept same as discussed in section-3.

The Greek symbol Eta “η” is usually used to represent “Efficiency.” Here is the formula for determining the converter’s Efficiency (η),  $\eta = P_{out}/P_{in}$ ,

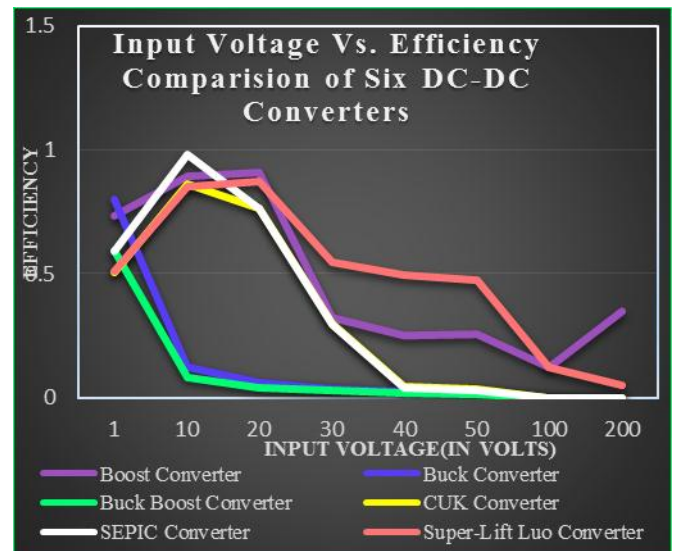
and total loss of a converter is given by,

Total Power loss = (Pin–Pout),

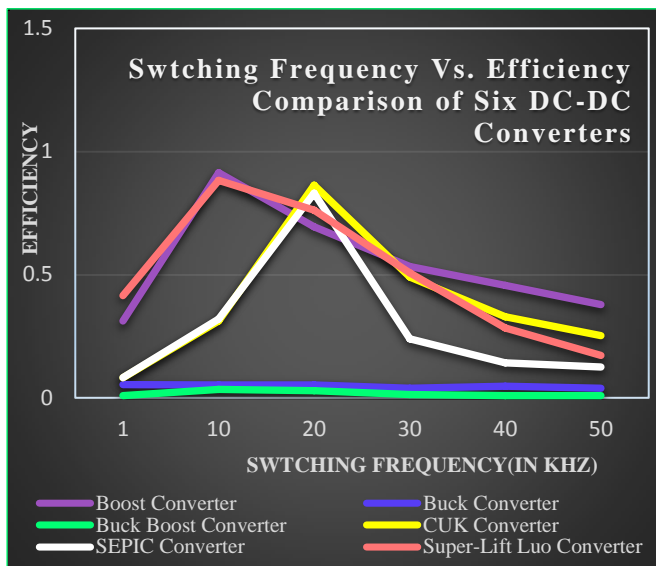
where Pin indicates the total input power and Pout indicates the total output power.

**3. Table.1. Comparison Table for Simulated Output**

Converter's Name	Circuit Parameters (D=50% and f=10kHz)			
	Supply Voltage (Vin) in Volts	Value of L1, L2	Value of C1, C2	Output Voltage (Vout) in Volts
Boost Converter	25	300µH	300µF	48.2
Buck Converter	25	300µH	300µF	1.08
Buck Boost Converter	25	300µH	300µF	-2.10
CUK Converter	25	300µH	300µF	-28.6



**Chart.1. Comparison of Six different dc-dc converter in terms of their Input Voltage (in Volts) Vs. Efficiency (η) for a fixed 10 kHz switching frequency.**



**Chart.2. Comparison of Six different dc-dc converter in terms of their Switching Frequency (in Volts) Vs. Efficiency ( $\eta$ ) for a fixed 25V input.**

Chart-1 gives the comparison of Input Voltage vs. Efficiency for all the above-mentioned dc-dc converters and Chart-2 gives the comparison of Switching frequency vs. Efficiency for all the above-mentioned dc-dc converters

## 5. Conclusions

The best solution to reduce system cost and increase the efficiency is by using non-isolated dc to dc converters. Six types of non-isolated dc-dc converters are reviewed in this paper. These are Boost, Buck, Buck boost, CUK, SEPIC and Super-Lift Luo converter. There are limitations for each kind of these converters which are well discussed in this paper. Different parameters are analyzed to determine the characteristics of each converter.

From the simulation result given in chart-1 (Dependency of each converter's efficiency on input voltage) we can conclude that Boost Converter and SEPIC Converter is best for low Voltage (0 V to 20V) applications. Super-Lift Luo Converter is the best one for mid voltage (30V to 50V) applications.

Dependency of each converter's efficiency on switching frequency is given in chart-2 for a fixed input voltage (25V). From that result we can conclude that at approx. 10 kHz switching frequency Boost Converter and Positive Output Super-Lift Luo converter is best performing. At 20

kHz switching frequency CUK and SEPIC Converter is best performing.

From the simulation result we can also conclude that Boost converter is best for low power applications. It is applicable for many low power applications like solar PV, portable applications, drives motor and fuel cell.

## 6. REFERENCES

### Journals

- [1] Kwasinski Alexis, "Identification of feasible topologies for multiple input DC to DC converters", IEEE Trans Power Electron 2009;24(3):856–61.
  - [2] Peng Fang Z, "A new ZVS bidirectional DC to DC converter for fuel cell and battery application", IEEE Trans Power Electron 2004;19(1):54–65.
  - [3] Xu Haiping, Kong Li and Xuhui Wen, "Fuel cell power system and high power DC to DC converter", IEEE Trans Power Electron 2004;19(5):1250–5.
  - [4] Brekken TKA, Hapke HM, Stillinger C and Prudell J, "Machines and drives comparison for low power renewable energy and oscillating applications", IEEE Trans Energy Convers 2010; 25(4):1162–70.
  - [5] Luo Fang Lin and Hong Ye, "Hybrid split capacitors and split inductors applied in positive output super-lift Luo converters", IET Power Electron. 2013; 6(9): 1759–68.
  - [6] International Journal of Engineering Research and Applications (IJERA), Vol. 2, Issue 6, November- December 2012, pp.657-663
- ### Conference Proceedings
- [7] Positive Output Elementary Superlift Luo Converter for PV Applications Dr.G.Justin Sunil Dhas1, Dr.D.Anto Sahaya Dhas2, and Sreesna M K3 3rd International conference on Innovative Engineering Technologies (ICIET'2016) August 5-6, 2016 Bangkok (Thailand).
  - [8] Myers Ira T, Baumann Eric D, Kraus Robert and Hammound Ashmad N, "Multi megawatt inverter / converter technology for space power applications", Proceeding of the AIP conference, vol.246;1992. pp.401–409 DOI.