

## Analysis and Study of Different Types of Power Converters

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### Abstract

Owing to its peculiar physical properties, Titanium Dioxide ( $TiO_2$ ) has found various applications and been an interactive material for research in the field of semiconductor physics. To study the crystallographic nature of prepared Fe/ $TiO_2$  and Ni-Fe/ $TiO_2$ , X-ray Diffraction (XRD) study was done. The result shows that both pure and doped  $TiO_2$  samples were anatase phase with the absence of diffraction peaks of Ni or Fe. The Scanning Electron Microscopy (SEM) images revealed that the particle morphology was altered by dopants incorporation which acted as nucleation sites. The dielectric properties and electrical conductivity for  $TiO_2$  and  $TiO_2$  loaded Fe, Ni and Ni-Fe composition within the temperature range 25°C-110°C and over the frequency range (100 Hz-0.3 MHz) were also carried out. The values of dielectric constant and dielectric loss decrease with increasing frequency. The dielectric permittivity for Fe/ $TiO_2$  exhibits relatively lower dielectric constant than Ni-Fe/ $TiO_2$ . A relaxation peak has been recognized and shifted to higher frequency with increasing temperature. The ac conductivity was found to increase with frequency which could be related to the hopping conduction process. The activation energy  $E_a$  for Fe/ $TiO_2$  was higher than Ni-Fe/ $TiO_2$  and decreased with increasing frequency.

**Keywords:** Fe doped  $TiO_2$ ; Ni-Fe doped  $TiO_2$ ; AC conductivity; Dielectric properties; Activation Energy

### Introduction

The electricity demand is growing recently, as many countries are prepared instead of using exact sources of other energy sources [1-3]. Generating energy produces no emissions from the fuels and reduces pollutions. The benefit of shifting to renewable energy sources are no expense, and simple access [4-6]. Thermal power plants are contributed to increase around 75-82 percent of thermal emissions, which can produce undesirable changes in the environment [7-9]. The world's energy is increasing, especially in developed countries. Global

energy consumption has tripled within the last 40 years and is growing to triple within the next 20 years [10-12].

The main requirement of energy converters, is converting a fixed to a variable DC voltage source is important for several industrial applications. A DC converter is analogous to an AC transformer with a constantly changing turn's ratio within the perspective of a DC equivalent. It functions as a transformer like a step-down or step-up converter. If the switches are BJT, MOSFET, or IGBT must perform pulse width modulation (PWM) at a specific frequency to be controlled [13-15]. Buck converter, Boost converter, Buck-Boost converter, Cuk converter, Forward converters are the examples of several types of converters. The normal scheme uses the input of the converter to offer power is transferred to the load from each energy source [16-18]. Unlike AC, DC is almost impossible to intensify or step down without the necessity for expensive machinery. The converters are high-end chopper circuits with credible and high-power rated power electronics components and switches that change the DC output from a given DC input. They are often to control voltage and power flow during the transmission process [19-20].

The traditional boost converter is used in power system for high step-up applications with large current ripples, which create conduction losses. Due to high inductance values, the majority of the converters have high input current. To limit these we can increase the switching frequency and it reduces the voltage stress across the switches. Soft switching frequency is required to reduce switching losses and increase efficiency [21-23].

Several researchers employ the Single-ended primary-inductor converter (SEPIC) and the modified SEPIC converter for high static gain applications [24-25]. The SEPIC converter has a double static gain value and a switching voltage that is half that of a conventional boost converter. The presented technique features a lower inductor input inrush current, a faster settling time, and shorter output voltage, peak duration when compared to conventional converters [26-27].

The structure of the paper is summarized below; Section 2 provides an overview of different types of DC-DC converters and compares the advantages and disadvantages of boost and SEPIC converters. Section 3 provides the converter's specification and analysis, as well as a brief overview of the converter. Section 4 of the paper summarizes the importance of the converter.

### Review on various sorts of converters

Several DC-DC converters, both isolated and non-isolated converters are analyzed. Various fly-back topologies can offer improved efficiency, decreased switching losses, reduced voltage and current pressures on the switches in the isolated converter. Many non-isolated modifier cell converters have a high voltage gain, which can be a competitive solution for many DC-DC converter topologies [27-28]. The whole study describes all DC-DC converters by using photovoltaic (PV) systems. The below sections contain the various papers studied, summarized, and compared based on some significant parameters like duty ratio, response time, size, etc.

## Implementation of DC-DC converters by using non-isolated converters

Many converters are non-isolated converters for high-quality power generation. As a result, high electrical voltages are vulnerable and loud [27-30]. Below is a review and comparison of the implementation of numerous converters that use non-isolated converters.

Author in Ref. [1], improved modeling methods for steady state and dynamic systems are being developed, for circuit design, power, or to improve the system's stability and performance. This paper presents new circuit analyzer software which helps to design and analysis of electronic circuits. DC-DC converter types are useful to model and analyse the converters.

In the article Ref. [2], automobile manufacturers have been developing fuel cell-powered hybrid electric vehicles, which decrease pollutants and boost fuel efficiency. This document offers information about the various topologies and classifications of DC-DC converters. It connects the cell to engine controllers. The temperature and the loading level of your vehicle increased since the characteristics changed in electric automobiles.

Author in Ref. [3], the MPPT is a technique, used to measure the panel output voltage. A Sepic or Cuk converter is a new method to track the MPPT of a solar panel. This approach can reduce the need for 1) digital converter parameter value, 2) advanced panel output power mathematical calculations, and 3) approximation output panel characteristics.

Author in Ref. [4], the MPPT of a PV generator differ with solar insulation & it has a nonlinear – features. A fuzzy controller, a feed-

forward MPPT scheme for the coupled-inductor and inter-leaved-boost-converter-fed PV system, is established. The converter has lower switch current stress and higher performance.

Author in Ref. [5], the chosen architecture contains two conversion stages, DC-AC and AC-DC, and isolates them by using a high-frequency transformer with an input voltage range from 15 to 30 Vdc. These features are provided by employing a prototype with a power rating 700 W and switching frequency 20 kHz.

In the article Ref. [6], batteries (B) and ultra-capacitors (UC) are utilised to store more energy from the device when it is required. The major power source in this model will be an internal combustion engine with a permanent magnet synchronous generator.

Author in Ref. [8], introduces a three-phase PV with three-level MPPT. The three-level boost converter is controlled and monitored by the MPPT. This converter optimised the reverse recovery losses and improves the total power output.

Author in Ref. [9], the UC is used in energy storage devices in vehicle applications. Combinations of UC and advanced batteries are likely to be advantageous in future. Batteries are built, according to our requirement.

Author in Ref. [10], solar irradiation conditions are primary causes of low energy yield in PV systems. Non-uniform conditions result in different local MPPT on the power voltage curve. Since the global MPPT will shift over time, since the voltage window and its location, is influenced by shading patterns, identifying the global operating point under partially shaded conditions is difficult.

Ref. No.	Structure	Control Parameters	Components	Advantages & Limitations
[13]	All-non-isolated converters related to dc-dc converter. (Mummadi Veerachary, 2011)	$V_i=V_i-V_0$ $D=V_0/V$ Duty cycle, Voltage & Current	Diode =1 Inductor =1 Capacitor =1 Switch =1 Source =1 Pulse generator =1 Load =1	Efficient Power conversion extends battery life and Efficiency is poor for high gain
[7]	All-non-isolated converters related to dc-dc converter. (Jung-Min Kwon , 2008)	$V_i=(1-D)V_0$ $V_C=V_0/D$ Voltage and Current	Diode =1 Inductor =1 Capacitor =1 Switch =1 Source =1 Pulse generator =1 Load =1	High Output Voltage and Large output capacitor required.

[15]	All-non-isolated converters related to dc-dc converter. (Kashif Ishaque , 2012)	$dIL/dt = Vi/L$ $D=V0/ V0-Vi$ Voltage and Current, Duty cycle and Irradiance & Temperature	Diode =1 Inductor =1 Capacitor =1 Switch =1 Source =1 Pulse generator =1 Load =1	Efficiency of regulating the output voltage is high and Complexity in Circuit.
[3]	All-non-isolated converters related to dc-dc converter. (Henry Shu-Hung Chung, 2003)	$VC=V0/D$ $V0/Vi= D/1-D$ Duty Cycle and Voltage & Current	Diode =1 Inductor =1 Capacitor =1 Switch =1 Source =1 Pulse generator =1 Load =1	Continuous input and output current, efficient voltage regulation and High current stresses on the switch
[3]	All-non-isolated converters related to dc-dc converter. (K. K. Tse , 2003)	$VC=V0/D$ $V0/Vi= D/1-D$ Duty Cycle and Voltage & Current	Diode =1 Inductor =2 Capacitor =2 Switch =1 Source =1 Pulse generator =1 Load =1	Continuous input and output current, efficient voltage regulation and High current stresses on the switch

**Table1:** Types of converters using non-isolated converters and their advantages

### Implementation of DC-DC converters by using isolated converters

Author in the paper Ref. [11], plug-in hybrid electric vehicle (PHEV) will be improved by a spinning solar panel (SP). Traditionally, putting a PHEV with SP on the roof of an EV has been more difficult. Because the available space on the vehicle's roof is insufficient, a rotatable structure can monitor the sun utilizing mechanical Petri-net (PN)-based (MPPT) control.

In the paper Ref. [12], solar photovoltaic is accomplished through impedance matching by using a dc-dc converter and MPPT via the incremental conductance technique. To achieve stability and dynamic control, we are using continuous conduction.

In the paper Ref. [13], the high-gain interleaved boost-derived converter is introduced and compared to the basic boost converter, which provides modularity, lower voltage and current ratings for various circuit components.

Author in the paper Ref. [14], the power delivered in solar PV systems contains multiple PV modules is feeding a similar load. A novel MPPT algorithm that incorporates a particle swarm optimization (PSO) technique to resolve this challenge. Due to these it optimises the cost, and simple to implement.

In the paper Ref. [15], the impedance of PVA, MPPT will become unstable; developing optimal damping that is appropriate for all solar insulation is a difficult task. The converter can monitor MP under the boundary conditions. The suggested topology is different from that of a buck converter with input filter.

Author in Ref. [16], based on a modified PSO algorithm, this research provides an improved MPPT method for PV systems. Once the maximum power point (MPP) is reached, the method's major benefit is to minimize steady-state oscillation.

In the article Ref. [17], the design and modelling of a 12 kHz transformer and battery capacity of 7.75 kW complete-bridge dc-dc converters are described. For isolation purposes, high-frequency transformers are used. The circuit topologies are reviewed for battery

charging and discharge applications employing only one transformer and bi-directional converter.

Author in paper Ref. [18], with the help of switching current and the voltage on the switch & several other factors are influencing to design the simple dc-dc converter. This study discusses DC-DC converter modeling. Two typical varieties of converters are worn for testing the suggested modeling approach. This technique is used to design isolated DC-DC converters.

Author in paper Ref. [19], this study discusses the current improvements in dc-dc converters, which are constructed based on two simple converters: the buck converter and the boost converter. Converters with high performance, high profit, and fast response objectives and produced.

Author in the paper Ref. [20], the converters are employed in power supplies, photovoltaic systems, renewable energy systems, and industrial applications. Switching failure occurs in dc-dc converters, and it affects the converter's performance and power density. To tackle the switching problem, the author developed new soft-switching PWM converter topologies.

Author in the paper Ref. [21], the semiconductor switch dead time on the operation of a dc-dc converter used in HEV. The study were utilized to create a control method that uses gain scheduling and time presetting to handle the converter current's nonlinear response to duty cycle changes.

Author in the paper Ref. [22], the two-stage controller uses the average model of the system, a -modulator is realistic. Finally, they are obtained to check the control efficiency of this strategy.

Author in the paper Ref. [23], MPP for stand-alone PV systems are employing fuzzy logic control (FLC). The FLC is simple to use and it is not necessitate thorough an understanding of the system's concept. Simulation results are compared by using the standard perturbation and observation (P&O) technique to demonstrate the effectiveness of the FLC under steady-state.

Author in the paper Ref. [24], power electronics applications in fuel cell systems, which comprise a variety of topologies combinations of DC converters and AC inverters utilized mostly in stationary applications.

Author in the paper Ref. [25], the converter design techniques implemented in this project make this statement more feasible with a controlled output voltage of 3 volts and a standard supply voltage of 1-3 volts, this DC-DC converter is a step-up converter. For the converter, PWM is used. There is a 1mV overshoot above the ideal output voltage.

The table below illustrates all sorts of converters by employing isolated converters. The transformer turns ratio is calculate circuit characteristics such as an inductor, capacitor, and resistor values. We can build circuits such as fly-back, forward, half-bridge, push-pull, and full-bridge converters by knowing the values.

Ref. No.	Structure	Control Parameters	Components	Advantages & Limitations
[52]	All-isolated converters related to dc-dc converter. (R. Kavin , 2019)	V0=N2/N1 VIN.1-D V0=D/1-D Voltage and Current	Diode =1 Capacitor =1 Switch =1 Source =1 Pulse generator =1 Load =1	voltage rating on secondary components low and more ripple current
[54]	All-isolated converters related to dc-dc converter. (Sachin kale , 2019)	V0=NS/NP VS.D V0=D/1-D Voltage & Current and Temperature	Diode =2 Inductor =1 Capacitor =1 Switch =1 Source =1 Pulse generator =1 Resistive Load =1	Due to much larger magnetizing inductance and Increased cost, transformer of the forward converter does not store energy.
[55]	All-isolated converters related to dc-dc converter. (Sachin kale , 2019)	V0=NS/NP VS.D Lf = (1-2D) R/4f Voltage & Current	Diode =2 Inductor =1 Capacitor =1 Switch =2 Source =1 Pulse generator =2	Robust, Capable of dealing with disturbances and more sensitive to disturbances.

	Fig 1: Schematic of Proposed Push - pull- Converter			
[57]	All-isolated converters related to dc-dc converter. (Sachin kale , 2019)	V0=NS/NP VS.D/2 $L_f = (1-2D) R/2f$ Voltage & Current	Diode =2 Capacitor =2 Switch =2 Source =1 Resistive load =1	It requires four diodes, two of which conducts alternative half cycles. This creates a voltage drop of 1.5 V.
[59]	All-isolated converters related to dc-dc converter. (Sachin kale , 2019)	V0=NS/NP VS.D $L_f = (1-2D)/4f$ Voltage & Current	Diode =2 Inductor =1 Capacitor =1 Switch =4 Source =1 Pulse generator =4 Resistive Load =1	Slower than repeaters due to filtering and Reduce collisions

Table2: Types of converters using isolated converters and their advantages

### Comparison of all types of converters by using isolated and non-isolated converters

Boost converters are employed in rectifier circuits with power factor adjustment, and as a result, the output voltage is regulated. Buck-boost or Cuk converters are used to increase the controllable voltage range [32]. Several all types of converters are implemented by using linear non-isolated and isolated converters has been studied summarized and compared in below sections.

#### Comparability of DC-DC converters

Author in the paper Ref. [26], presents an analysis of prominent strategies for high step-down dc-dc voltage conversion. Each technique/topology has circuit diagram and key points are discussed. An interleaving converter reduces ripples, and a quadratic, tapped, or switched capacitor avoids a small duty cycle for high step down. A multilevel converter is good for minimizing switching tension, and coupled inductors can reduce ripples.

Author in the paper Ref. [27], for this entire paper, many bridges have been designed for efficiency and cost of DC-DC Buck-Boost converters, and losses are comparable. Traditional PI and FLC have been used for BLDC speed control studies. The output of classical PI and FLC is compared under varying reference speed and load disturbances for different parameters in the BLDC motor drive.

In the article Ref. [28], the primary consideration for electric vehicles (EV) is range. The most essential factor in determining an EV range is the battery capacity. Because batteries are the most expensive component of an EV, other considerations such as weight, aerodynamic drag coefficient, and motor size should be made.

Author in the paper Ref. [29], solar - PV, wind, fuel cell, battery, super capacitor, and other green energy sources are highly recommended in HEV applications. Power converters are required to incorporate these renewable energy sources into the vehicle system.

In the article Ref. [30], the converter has a 15-volt input voltage and a 150-volt output voltage with 100-watt output power. The efficiency of the converter was 92.5 percent, which was higher than the other converter models.

Author in the paper Ref. [31], the converter is required to achieve high efficiency and true soft switching, which is critical for high voltage electric vehicles. MATLAB and MULTISIM were used to simulate and model the device in this analysis.

Author in the paper Ref. [32], the power grid is capable of maximizing the renewable energy sources while maintaining high levels of sustainability, performance, and grid stability. The study has two objectives: first, it examines a DC nano grid that is ideal for tiny

energetic clusters such as residential or commercial buildings and incorporates solar arrays, fuel cells, electric car charging stations, and loads, and second, it presents a solution to this problem.

In the paper Ref. [33], fuel cells use a lot of energy and generate it directly from hydrogen and oxygen at a low voltage. Finally, the paper provides some guidance to assist the designer in determining which converter topologies are most suitable in terms of compactness, performance, and cost.

In the paper Ref. [34], the proposed energy management system's goal is to concentrate on the advantage of super capacitor properties

and improving battery lifetime and device performance. The energy management system's job is to generate battery reference current.

Author in the paper Ref. [35], this paper discusses the topologies of ZVS (Zero-Voltage-Switching) and ZCS (Zero-Current-Switching) resonant DC-DC converters. It indicates the topologies of DC-DC converters can be used to create numerous equivalent converter topologies. This fact is used to create DC-DC converter topologies that are ideal for high-frequency operation.

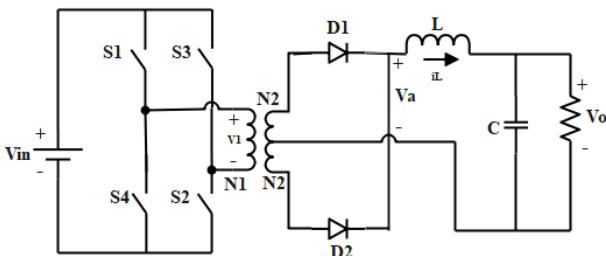
Converter	Ref. No.	Year	Control parameters	Applications
Buck-Converter	[12]	2014	Duty cycle	Fuzzy MPPT
	[14]	2010	Current	Variable inductance
	[16]	2003	Voltage and Current	P&O
Boost-converter	[18]	2008	Voltage	MPPT
	[19]	2011	Voltage and Current	P&O
	[20]	2011	Voltage	FLC with ANN
Buck-Boost converter	[21]	2012	Duty cycle	PSO
	[22]	2009	Irradiance and Temperature	ANN-Fuzzy logic controller
	[23]	2012	Voltage	ANN
	[25]	2010	Voltage and Current	P&O
	[28]	2020	Voltage and Current	MPPT
Cuk converter	[32]	2010	Voltage and Current	Maximum Power Point Tracking Technique for Solar Panels
	[33]	2011	Voltage	Fuzzy logic control system for photo voltaic
	[35]	2012	Voltage and Current	MPPT
SEPIC converter	[36]	2013	Voltage and Current	Photo voltaic Characteristics
	[38]	2009	Voltage	MPPT tracking for PV panels
	[40]	2012	Voltage	Fuzzy logic control system for photo voltaic
	[42]	2010	Voltage and Current	Energy Storage
Zeta converter	[45]	2013	Voltage and Current	Hybrid PV-Wind Micro grid
	[46]	2010	Voltage and Current	Photo voltaic Battery Charger
	[48]	2011	Voltage	Input impedance matching

**Table3:** Various types of converters by using the control parameters and applications

### Types of DC-DC Converters

DC-to-DC converter is a class of power converters and it is an electric circuit, which converts a one magnitude of voltage level to another magnitude of voltage level, by keeping the input energy for the moment and then releases that energy to the yield at a different

voltage [33-34]. All types of converters are shown in Fig 1. DC-DC converters are categorized into Linear mode regulator and Switching mode regulators.



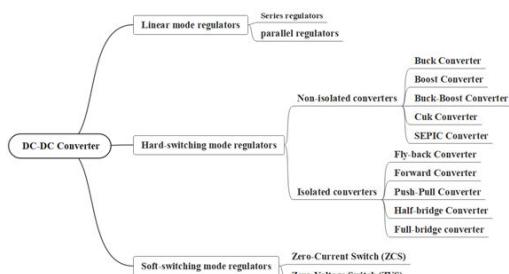
**Figure1:** Types of power converters

### Linear mode regulator

Voltage regulators (VR) are almost all-electronic hardware. A VR's job is to maintain the constant voltage on the regulator's output while the input voltage is variable. The fundamental benefit of a linear mode regulator is it produces less noise and boosts efficiency [35]. VRs are classified in series and shunt regulators.

#### Series voltage regulator

The VR is a voltage-controlled circuit, as the name implies. The output of the voltage is unaffected by changes in its load current or temperature. In almost all electronics or households, voltage regulators are available to stabilize the voltage and most of the appliances such as TV, refrigerator, machine etc. The Series Voltage Regulator, also known as Series Pass Regulators are shown in Fig 2, it seems to be a member of the Linear Voltage Regulator [36-38]. Variable element is connected in series with the load and maintains a linear voltage. By changing the resistance value the voltage drop across the series element can be changed.



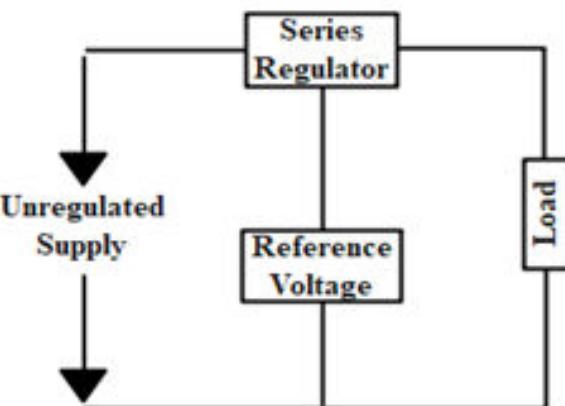
**Figure2:** Schematic representation of a series voltage divider

#### Shunt Voltage Regulator

A shunt VR works by supplying a variable resistance channel from the supplied voltage to the ground.

The shunt regulator has been diverted by the load due to the current flowing in it and is now flowing uselessly to the ground. Shunt VR is less efficient, less complicated and it consists of a voltage reference element as shown in Fig 3 [39-40]. It is used as a low-power applications and it is taken as a reference.

Table 4 compares series and shunt voltage regulators based on their connection, control components, stability, and efficiency.



**Figure3:** Schematic representation of a shunt energy push button

Comparison	Shunt regulator	Series regulator
Connection	Shunt voltage regulator is connected in parallel / shunt with the load.	Series voltage regulator is connected in series with the load.
High Load currents	It has good voltage regulation even at high load currents	It does not have an effective voltage regulation at high load currents
Suitability	The regulator is suitable for light loads.	The regulator is suitable for heavy loads.
Output DC	In this regulator, the output DC voltage is constant.	In this regulator, the output DC voltage is not constant.
Control Element	The control element has to bear the load voltage across it. Therefore, it is a high voltage low current device.	The control element has to carry the load current. Therefore, it is a high current low voltage device.
Efficiency	It has good efficiency for low load currents.	It has good efficiency for high load currents.

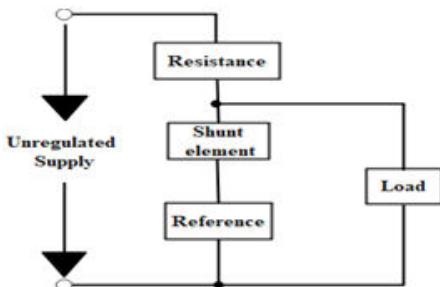
**Table4:** Comparison of shunt and series voltage regulators

## Switching mode regulator

Switching regulators convert one voltage to another by momentarily storing energy and then releasing it to the output as a different voltage. Switched mode power supply, switching regulators, and switching converters are all terms used to describe DC to DC converters.

### Hard switching mode regulator

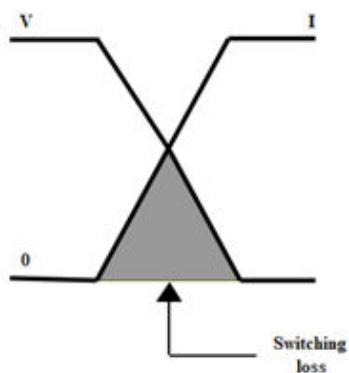
The losses during turn on, turn off, or both are associated with hard switching regulators. The voltage across the switch is reduces and the current is increases whenever the switch is in on. Both the voltage and currents are overlap; this area represents the switching losses. Figure 4 shows the hard-switching losses.



**Figure4:** Graphical portrayal of a hard-exchanging misfortune

### Soft-switching mode regulator

These regulators are soft-switching, which means there is no loss. The voltage is reduced and the currnt is increase whenever the switch is in on position. Due to these there is no overlap between them. It helps to decrease the noise and loss. The switching device is turn on and off of a zero voltage and current. In Figure 5, the soft-switching losses are depicted.



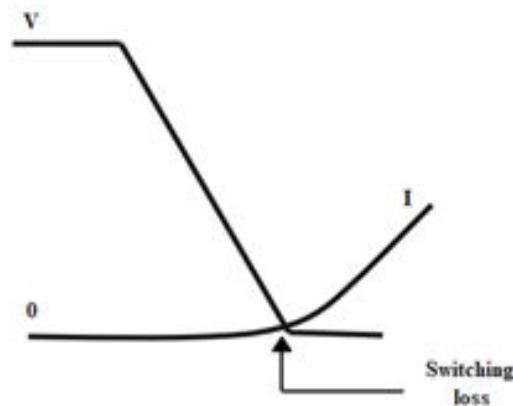
**Figure5:** Graphical portrayal of a delicate exchanging misfortune

## Non-isolated DC-DC converters

### Buck converter

Buck converter is a device it converts a one voltage to another. A solid state switch is connected to the input souce. The components are pulse generator, inductor, capacitor and diode is required to design the circuit. The switch is may be power MOSFET and IGBT. Thyristors

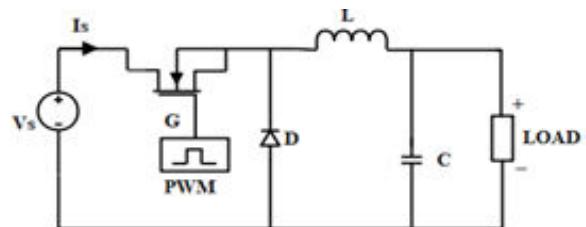
are not used because to turn off the thyristors we required forced commutation and it requires one more thyristor. The terminals of the switch in between the gate and source the voltage can be reduced to zero. A diode can act as a secondary switch. An inductor and capacitor is connected across the switch and diode. The load is of resistive nature. The converters mainly used time-based modulation. It is simple to use in these type of converters. In this method of PWM modulation, the frequency remains constant [41-43] in Buck-converter shown in Fig 6.



**Figure6:** Circuit diagram representation on buck-converter

### Boost converter

A boost converter (sometimes referred to as a step-up converter) is a converter is used to increase the output voltage than the input voltage. It is an SMPS with two switches are diode and transistor. The components are inductor, capacitor, diode and switch. These converters are used in mainly communication systems [44-45]. An inductor is connected to the input sorce. Diode and capacitor is connected across the switch. PWM is connected to the switch and it gives pulses to the input of the converter. The switch is connected across the source. A diode can act as a secondary source. The load is connected to the capaciior, which is in series with the diode as shown in diagram [46]. To optimise the ripples we are using capacitor filters and those are attached to the output of the converter are shownin Fig7.

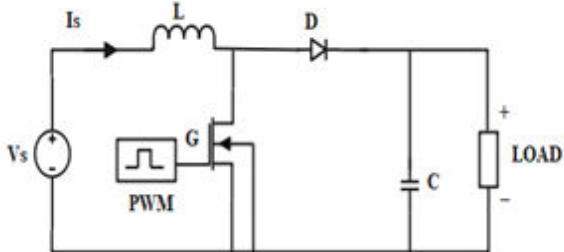


**Figure7:** Circuit diagram representation on boost-converter

### Buck-boost converter

A DC-DC converter with an output voltage magnitude equal to or greater than the input voltage magnitude is known as a buck-boost converter. The components are used in these converter are diode, inductor, capacitor and switch. By comparing buck-boost converter to the fly-back converter a single inductor is used instead of transformer [47]. A switch is attached to the input source. The inductor and diode

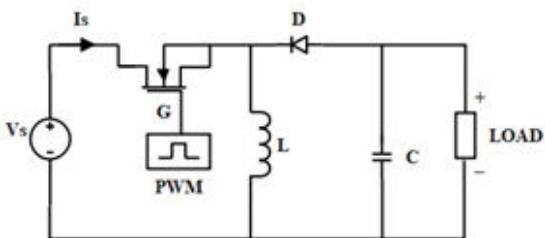
are connected in series, load and capacitor are connected in parallel and those are connected in series are shown in Fig 8. The ripples in the converter are small when it operated in continuous conduction mode (CCM).



**Figure8:** Circuit diagram depiction on the buck-boost converter

#### Cuk converter

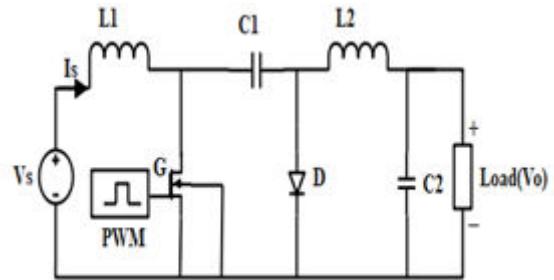
The Cuk converter works on the same principle as a buck-boost converter, raising or lowering the input voltage. Capacitor and inductor is used to store the energy in buck, boost, and buck-boost converters but in cuk-converter we are using only one inductor as a storage component. The cukconverter have two sections one is input stage and another one is output stage. When the switch is in on, the current  $i_1$  is used to build the magneticfield of the inductor at the input stage. The inductor is connected to the input source. If the diode is reverse biased, the inductor is dispating energy at the output stage. When he switch is in off, the inductor  $L_1$  maintains the current is flowing in reverse direction and magnetic field of the source current is small [48]. In non-isolated converters either replaced by a short circuit when the switch is ON (or) by an open circuit when the switch is in OFF. When the input source is in off, the input source charges capacitor via the inductor  $L_1$ . When the capacitor  $C$  was turned on, it transfers the energy to the output capacitor via the inductor  $L_2$  is as shown in Fig9.



**Figure9:** Schematic representation on cuk- converter

#### SEPIC converter (Single ended primary inductance converter)

A DC-DC converter with a single-ended primary-inductor converter allows the output voltage to be greater than, less than, or equal to the input voltage. A boost converter is followed by an inverted buck-boost converter in the SEPIC's circuit layout. As a result, it has the appearance of a traditional buck-boost converter. A SEPIC converter contains two inductors, the first inductor is connected to the input source and second inductor is connected to the ground [49]. These two inductors are connected across the capacitor; with these we are getting non-inverted output. The main purpose of series capacitor is to combine the enrgy from the input and output. These converter is used to store energy temporarily, and that will be used an uninterrupted supply, is as shown in Fig 10.

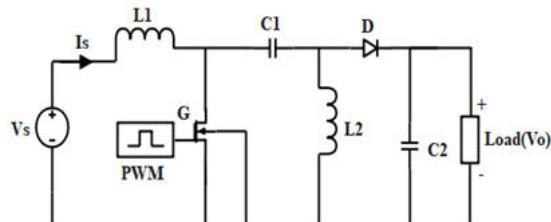


**Figure10:** Schematic representation on SEPIC Converter

#### Isolated converters

##### Fly back converter

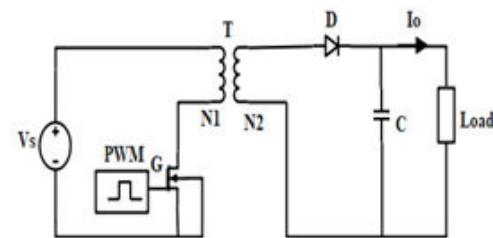
It contains transformer, switch, rectifier, filter, diode and capacitor to make a fly-back converter. This converter can be used as step-up and step-down converter. The fly-back converter is used as a most of the applications such as cell phones, notebooks, and laptop chargers. The main circuit is turn on and turns off by the switch. The PWM is used to control the switch [50]. The rectifier is used to rectify the voltage on the secondary winding and convert it to Pulsating DC. The capacitor filters are used to rectify the voltage, raising the voltage level is to be utilised.



**Figure11:** Circuit diagram representation on fly-back converter

##### Forward converter

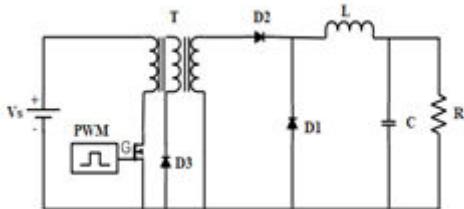
The converter is used to increase or decrease the voltage levels with the help of transformer and it provides galvanic isolation for the load. Multiple output windings are used to produce both greater and lower voltage. The load is connected to the secondary winding of the transformer is used to rectify the output. The output voltage of the transformer is connected across the LC filter and load [51]. The current in the transformer is reduced to zero when the switch is in off position.



**Figure12:** Circuit diagram representation on forward-converter

##### Push-pull converter

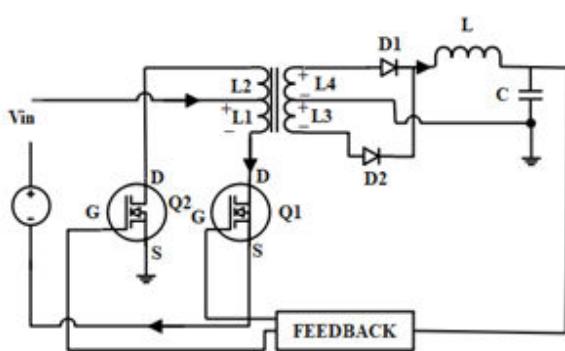
A push-pull converter is a converter that continuously pushes currents through it and pulls currents from something. Using this push-pull mechanism, the transformer transmits flux to the secondary coil and creates some kind of isolated voltage [52]. The transformer is turned on, then the current is pushed and released concurrently because this is a switching regulator. A push-pull converter is used as a transformer to adjust the voltage levels. During the asymmetrical push-pull circuit, a pairs of transistors supply current to the transformer from the input line, as shown in Fig 13.



**Figure13:** Schematic representation on push-pull converter

#### Half-bridge converter

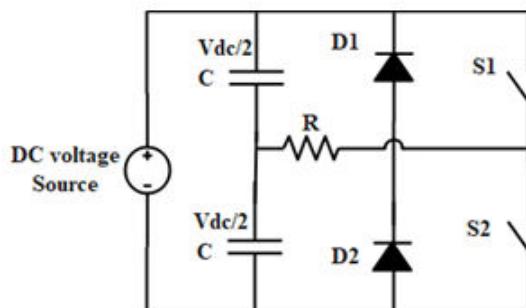
One disadvantage of the push-pull converter is flux in the center-tapped transformer's main and secondary windings becomes imbalanced, causing heating issues. Another issue is that each transistor blocks double voltage as other converters. The half-bridge converter has a lot of advantages over a push-pull converter. Figure shows the electronic diagram for the half-bridge converter. This circuit, like the push-pull circuit, uses two transistors and two pairs of diodes. The two huge bulk capacitors distinguish the half-bridge converter ( $C_1$  and  $C_2$ ) [53]. This ensures that power is delivered to the output of each transistor, resulting in up to 90% efficiency. Due to the flux imbalance we are not using center-tapped transformer. It can be employed in power supplies up to 1000 Watts.



**Figure14:** Circuit diagram representation on half-bridge converter

#### Full-Bridge converter

Two pairs of MOSFETS symmetrically power the primary transformer. The switches  $S_1$  and  $S_2$  perform the first cycle and remaining switches  $S_3$  and  $S_4$  perform the next cycle. All unipolar switching devices are controlled by the bridge voltage and which can create the losses. In a full-bridge converter is formed by using the two buck-boost converters [53]. Figure 15 shows how this layout readily enables for a single power conversion step and zero voltage.



**Figure15:** Circuit diagram representation on full-bridge converter

## Conclusion

This article discusses the different topologies of isolated and non-isolated DC-DC converters for fuel cell applications. Their advantages and drawbacks have been examined. Duty cycle, time, Irradiations, and temperature, and their corresponding topologies, have all been examined. Finally, this study offers some advice to designers to choose the best converter topologies for specific applications like compactness, performance, and cost. In this literature review, the converters (buck, boost, buck-boost, SEPIC, Cuk, and Zeta converters) are addressed and explored. Five distinct types of non-isolated converters were discussed. Analyzing numerous parameters yields the characteristics of each converter. In many converters, hard switching is used, resulting in considerable semiconductor losses and poor performance.

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