ANALYSIS AND SIMULATION OF EXTENDABLE TWO INPUT HIGH VOLTAGE GAIN DC-DC CONVERTER

A THESIS SUBMITTED TO THE GRADUATE SCHOOL OF APPLIED SCIENCES OF NEAR EAST UNIVERSITY

By
MUHAMMAD ZOHAIB

In Partial Fulfillment of the Requirements for the Degree of Master of Science in Electrical and Electronic Engineering

ICOSIA, 2018

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I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

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ABSTRACT

Now a day's DC-DC converters plays a vital role in our daily life routine. A maximum voltage gain DC-DC converter is proposed. The proposed topology is able to draw power from dual sources independantly, and the use of two independent source make it suitable for solar energy. The converter consists of Diode-Capacitor voltage multiplier stages to improve the voltage gain. discharging and charging of the voltage multiplier capacitors enables converter to increase the output gain. After the dual input the converter has four stages for even and can be five stages to make it odd topology. The converter works in three modes,these modes are depending on the gate pulse going to both switches. In first mode, both of the switches S2 and S1 is on and in second mode only switch S1 is on, similarly in the third mode only switch S2 will be on and switch S1 will be off. Furthermore the procedure and component selection has been done as well for the designing purpose. The simulation of converter is done using PSCAD softwere. This converter is capable of giving a high step up voltage.

Keywords: Boost converter;high voltage gain; dc-dc converter; non-isolated

ÖZET

Günümüzde DC-DC dönüştürücüler günlük yaşam rutinimizde önemli bir rol oynamaktadır. Yüksek voltajlı bir kazanç DC-DC dönüştürücü önerilmiştir. Önerilen topoloji, bağımsız olarak ikili kaynaklardan güç çekebilir ve iki bağımsız kaynağın kullanımını güneş enerjisine uygun hale getirir. Dönüştürücü, voltaj artışını arttırmak için Diode-Capacitor voltaj çoğaltıcı aşamalarından oluşur. Voltaj çarpan kapasitörlerinin şarj edilmesi ve boşaltılması, çıkış kazancını arttırmak için dönüştürücüye olanak sağlar. Çift girişten sonra dönüştürücünün tek topolojide dört aşama ve tek topolojide beş aşama vardır. Başlangıçta dönüştürücü, her iki girişin açık ve kapalı olduğu zaman üç modda çalışır. Birinci modda, S1 ve S2 anahtarları yanacak ve ikinci modda sadece anahtar 1 yanacak ve üçüncü modda benzer şekilde sadece anahtar 2 yanacak ve anahtar 2 kapalı olacaktır. Ayrıca prosedür ve bileşen seçimi de tasarım amacına yönelik olarak yapılmıştır. Dönüştürücünün simülasyonu PSCAD softwere kullanılarak yapılır. Bu dönüştürücü, voltajları hızlandırabilir.

Anahtar Kelimeler: Boost dönüştürücü, yüksek voltaj kazancı; dc-dc çevirici; Izole edilmemiş

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LIST OF ABBREVIATIONS

VM:	**Voltage Multiplier**
CCM:	Continous Conduction Mode
DCM:	Discontinous Conduction Mode
C:	Capacitor
D:	Duty cycle
DC:	Direct Current
f_{sw}:	Switching frequency
I_{sw}:	Switching current
L:	Inductor
PV:	Photovoltaic
S:	Switches

CHAPTER 1
INTRODUCTION

1.1 Introduction

Among renewable energy systems, photovoltaic systems are predictable to play a significant part in upcoming energy manufacture. Such schemes convert light energy into electrical energy, and change low voltage into high voltage through a step-up converter, which can change energy into electricity by means of a grid inverter or stock energy into a battery set. Renewable energies such as fuel cells and photovoltaic are fetching much more significant and extensively used in distribution systems. However, low-output voltage is the key features of these energies, then a DC converter with high voltage transformation ratio is used to increase the output voltage and then we will use inverter to add this energy to main grid [1].

To produce a controlled output from the source, which are parallel to the output or varied by time to erase this problem and make it more efficient we will use DC-to-DC converter. To keep the output voltage constant even if our input voltage and output current changing, to erase switching noise and get a constant DC voltage also for high frequency power changing circuit which we are using in transformer and for different capacitor we will use DC-DC converters. At more than 80% efficiency, they are on average and high, abundant, capable and effective size than linear regulators. DC-DC converter drawbacks that they are more complex and noisy. DC-DC converters derived into isolated varieties and non-isolated [2].

High gain dc/dc converters are widely used in numerous manufacturing applications such as solar, fuel cell, x-rays, laser and high strength discharge lamp balances for vehicles headlamps. Theoretically, an elementary boost converter is accomplished of providing high conversion ratio, but very high duty ratio is required. In practice, extreme duty ratios are not permit because of the large conduction losses and frequent damage of power switches [3]. Usually it is preferable to use low voltage rated power switches having low on state resistance

to reduce the conduction losses, which may not be possible in a conventional boost converter. Cascaded boost converters can provide high voltage gain. Nevertheless, high voltage stress across the switches and poor efficiency are the disadvantages. DC/DC converters using coupled inductors are a good alternative to obtain a high step up gain provided the leakage inductances handled properly. Interleaved control founded very useful in reducing converter current ripple from the input.

Nowadays, as our life is getting more advances in technology, most of the technologies use power electronics to function. A so-called boost converter is including as one of the power electronic device. Due to the growing significance of the step up converter in technology, a detail study of boost converter is necessary to make an improvement for future technology. A good boost converter can make the technology more efficient in usage. The key in headlining a DC-DC step up converter is the switching process that needs to be monitor frequently and perfectly. To gain a good output result, the switching process must be in a high switching frequency. Due to high switching frequency, it is hard to see the switching process, hence it need to be controlled by some appropriate controller such proportional integral derivative (PID) controller, hysteresis controller and others controller [4].

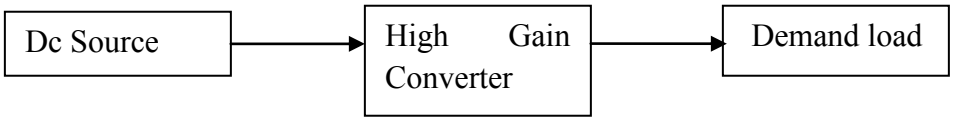

Fig 1.1: High voltage gain dc–dc Converter.

1.2 Thesis Outline

Remaining of the thesis is structured as below: Chapter 2 consists of literature review and some general information about boost and Sepic converter and about their voltage gain. Chapter 3 includes modeling and some mathematical equation of different component of dual

input boost high voltage gain of converter and the explanation of simulation results. Chapters 4 are the last chapter and consist of conclusion and upcoming work of our research.

CHAPTER 2
LITERATURE REVIEW

2.1. Introduction to Dc-Dc Converter

In numerous modern ages' applications, we need to convert our constant DC source voltage in to variable DC source voltage. A dc-dc converter changes over straightforwardly from dc to dc and essentially acknowledged as a dc converter. Converter can considered as dc equal to air conditioner transformer with constantly factor turns proportion. Like a transformer, it can utilize to advance down or venture ups a dc voltage source (Muhammad H. Rashid, 2004).

Nowadays, as our life is getting more advances in innovation, the vast majority of the advances utilize control hardware to work. An alleged boost converter is including as one of the power electronic devices. Because of the developing significance of the boost converter in innovation, an itemized investigation of the boost converter is important to make a change for future innovation. A decent boost converter can make the innovation more effective in utilization. The power electronic converters assume a critical part in numerous applications. DC-DC converters are broadly utilize as an element of switched method power supplies, variable speed drives, un-interruptible power supplies and numerous different applications to alternate the level of an info voltage to satisfy compulsory working circumstances(A. Rubaai et al, 2004).

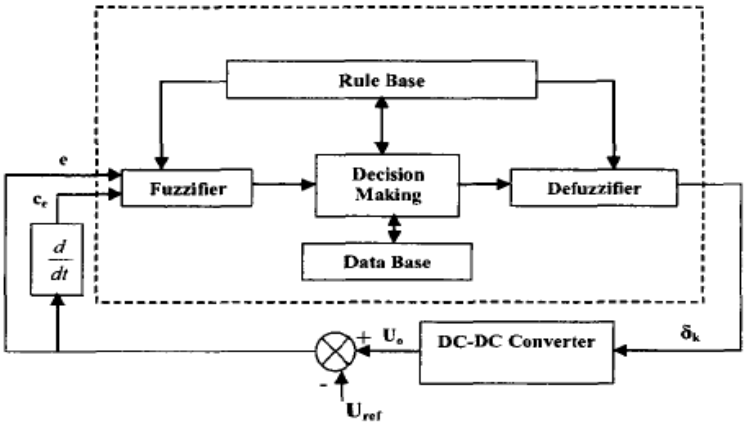

Figure 2.1: Block Diagram of Controller

The Dc-Dc converters has a few capacities, from these capacities it can change over a input voltage V_s obsessed by V_o (dc output voltage) and it regulates output voltage alongside line and output dissimilarities. Less the alternating current voltage wave on the DC output voltage beneath the necessary stage, and ensure the provided framework and the information source from electromagnetic impedance. The converters are able to have two unmistakable methods of activity: (CCM) and (DCM). Practically speaking, a converter can work in the two modes, which have fundamentally dissimilar distinctiveness. Nevertheless, for this scheme just considers the converters worked in continues time conduction mode mode. Continues time conduction mode CCM is for proficient power change and discontinues conduction mode for low power or reserve activity (Elba set, An et al, 2008).

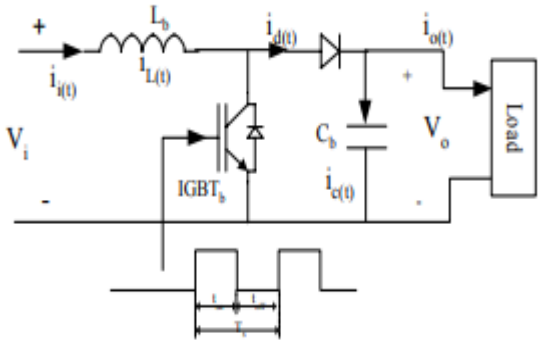

Figure 2.2: Circuit Schematic of Step-up DC/DC Converter

The DC converter is measured as the core of power supplies, in this way it will influence the general execution of the supplies framework. The DC-DC converter produces a well-ordered DC output from variable input sources. Task of the switching procedures affects the characteristically non-linear normal for the DC-DC converter. Because of these undesirable non-linear features, the converters require a regulator with an extra ordinary level of dynamic reaction. Pulse Width Modulation is the maximum every now and again consider technique among the different exchanging control strategy. In voltage controllers, it is imperative to amount a consistent output voltage; paying little respect to aggravations on the info voltage. The traditional non-disconnected boost converter has broadly utilized as a part of switched mode power supply to boost the link voltage ordinarily. Theoretically, the step up converter be able to get a maximum voltage ratio by working the duty-cycle bigger than 0.90 (Jamali et al, 2008).

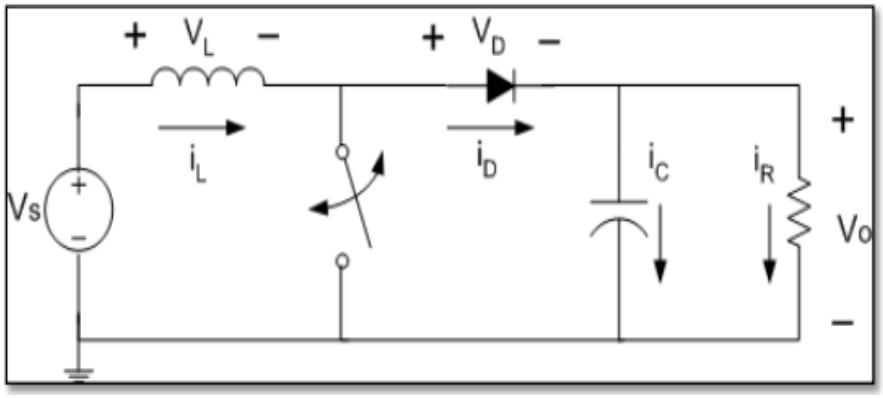

Figure 2.3: A Basic Boost Converter Circuit

A DC-DC step up converter functions, take on that the inductor is charge in the earlier cycle of process and the converter is at the stable state process and in Continuous Conduction Mode Condition.

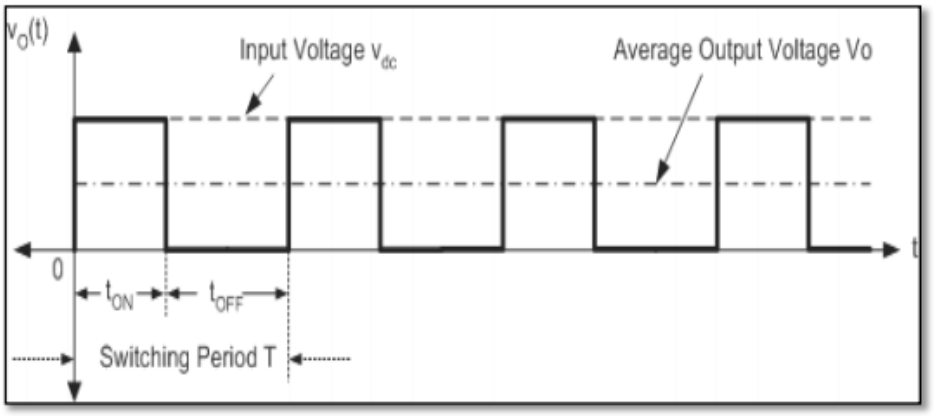

Figure 2.4: The Duty-Cycle for Switching Period

The Duty Cycle , effect on t_{on}besides switching frequency f_s

$$D = \frac{t_{on}}{t_{on} + t_{off}} = \frac{t_{on}}{T} = t_{on} f_s \quad (2.1)$$

The output and input voltage is $\frac{1}{1-D}$, throughout steady state process the ratio among the output voltages is switch by changing the duty cycle. Rangesfrom: 0 < D < 1.

$$t_{on}=D_T \quad (2.2)$$

$$t_{off}= (1-D)\ T \quad (2.3)$$

In regular methodologies as the out-put, voltages of the PV board is low; a few boards remain associated in sequences while interfacing the PV exhibit to the 400-Vdc transport over traditional boost converters. These outcomes are diminished framework unwavering maximum voltage-gain converter to every specific board. In addition, subsequently it is a multiport converter with a maximum voltage gain, free input be able to be associated and control distribution, MPPT calculations and so on can be actualize autonomously at each input port(V.A.K.Prabhala et al, 2015)[1].

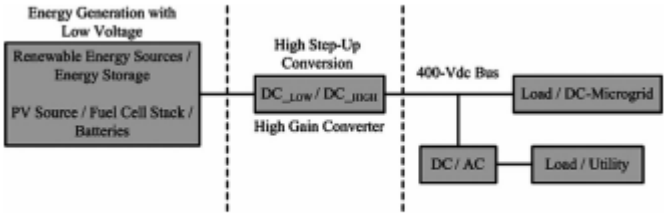

Figure 2.5: Dc-Dc converter with high voltage gain in Dc-micro grid

Newly, here has been considerable effort completed in endeavoring to accomplish extensive step up transformation proportions utilizing different boost topologies. This is principally impelled through the improvement of novel advancements that require power supply with extensive transformation proportions, remarkably fuel cells and in solar arrays (Chok You Chan et al, 2012) [2].

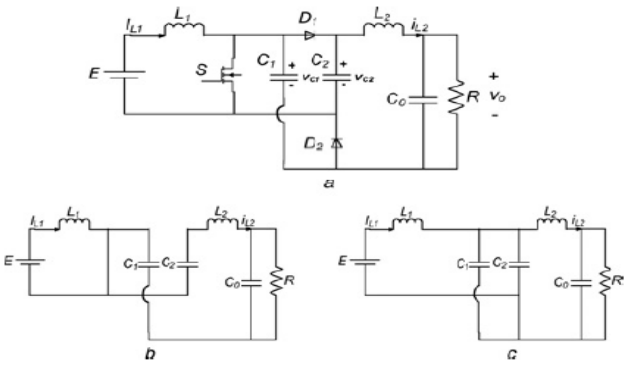

Figure 2.6: Fifth-order boost converter and its operating modes

DC-DC power converters with maximum voltage gain have turned out to be all the more broadly utilized as a part of ongoing years because of the expansion in applications where such picks up are required. Applications that drive this innovation incorporate renewable energy source frameworks nourished by photovoltaic (PV) solar cells and fuel cells that create

low input voltages and power models where batteries are utilize. In such applications, these low DC voltages should change over to substantially higher DC voltages to supply downstream converters, for example, purpose of-utilization power supplies and inverters (Prashanth Prabhu et al, 2018)[3].

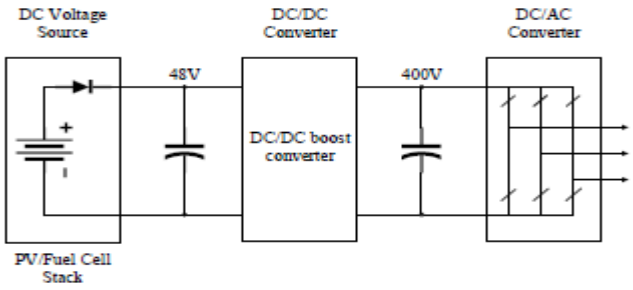

Figure 2.7: Two-stage power conversion system for PV and fuel cell applications

To enhanced the productivity and to achieve a higher voltage output gain we must reshape dc-dc converter topology by limiting current and voltage weight on the switches bringing down the transmission losses, outlining a minor converter, and limiting voltage and current weight on the semiconductor switch. Notwithstanding circuit alteration for accomplishing the on top of objectives, controller structure is likewise of incredible significance to enhance the execution, strength, un wavering quality in a broad activity go. Lamentably, these converters are still limited as far as framework unwavering quality and execution (Emre Ozsoyet al, 2017) [4].

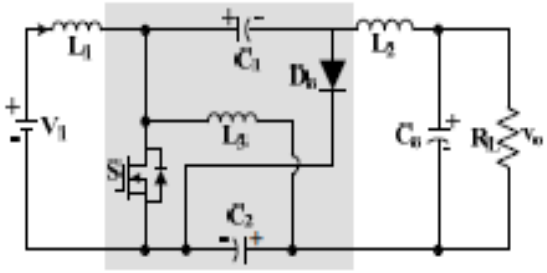

Figure 2.8: Topology of proposed novel converter.

2.2. High Step-Up DC-DC Converters

Non-isolated and Isolated converters can utilize to support low information voltages. Nevertheless, these converters have a few downsides. In commonsense applications, voltage additions of non-isolated converters, for example, the regular buck-boost and boost converter are constrained even at maximum duty cycle because of misfortunes on the lazy parts, for example, the obstruction of the inductor and comparable arrangement opposition of the capacitor. Likewise, voltages on the switches topologies at abnormal states. In addition, high duty cycles ratio proportions can aim a genuine turn around recuperation issue on diodes (Fatih Evran et al, 2014) [5].

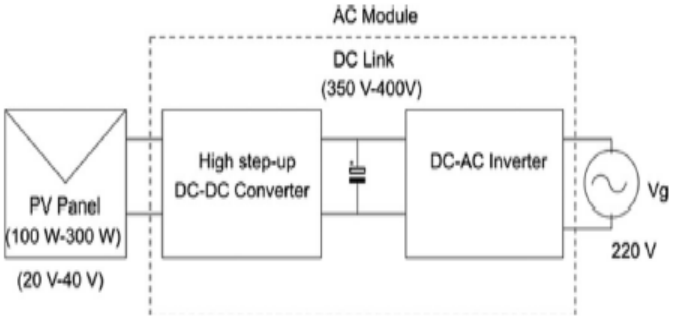

Figure 2.9: Single-phase grid-connected AC model.

A Dc boost converter with maximum voltage increases in light of the three state exchanging cell for raven capacitor nonpartisan fact compressed inverters. The projected converter is dissecting thinking about the task in non-stop transmission form and minimum duty cycle 0.5, which relates towards covering mode. The input inductor is intended for double like recurrence be aware that the main purpose is limit bulk and capacity, the voltage on the switches will be less then the partial of the voltage at the output and normally clasped by single capacitor at the output permitting the utilization of MOS field effect transistors with diminished characteristic on opposition the information current shows little ripple and voltage at the output. can be additionally proceed in face of danger by expanding the transformer turns

proportion without trading off the voltage worry over the switches; the output voltage is normally adjusted in this way assembly the converter reasonable for providing split capacitor inverters(George et al, 2013) [6].

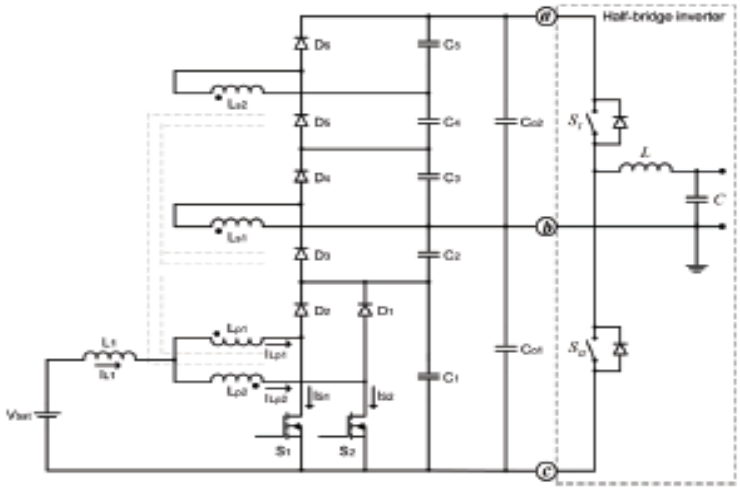

Figure 2.10: Boost converter using the 3SSCapacitor

An incorporated boost converter through multiplier capacitors is projected. This game plan remains practically equivalent to arrangement capacitors utilized as a part of the SEPIC converter, however enabling the static gain to increment. Despite the fact that it is prescribe for larger current applications where the output voltage is partial to the voltage on the switches is grater than the current ripple. the high current over the arrangement capacitors can make effectiveness diminish essentially in high power applications(René Pastor et al, 2003) [6].

The interleaved boost converter utilizes a nonspecific cell where single extra inductor is couple to separately boost inductor. The proposition keeps up a similar arrangement of the conventional di stage Dc converter, yet dual fixed inductors, double capacitor and double diodes, are included. High voltage picks up remains accomplish, while the information the voltages on the switches is lesser than semi the output voltage and the current is persistent. The topology exhibits maximum effectiveness and maximum power thickness, however, the

difficult replacement of the dynamic switches reason considerable exchanging misfortunes. Soas to limit them, it is conceivable to embrace the delicate exchanging cells examined in (Luiz Daniel et al, 2003) [6].

Introduces imaginative non-isolated and segregated delicate exchanged dc-dc topologies with the progression of boost and buck capacity. The non-isolated topology developed by including a little ac capacitor in parallel with the fundamental inductor of the regular buck-boost converter and supplanting its semiconductor gadgets with the turnaround blocking switches(Hamid A. Toliyat et al, 2014) [7].

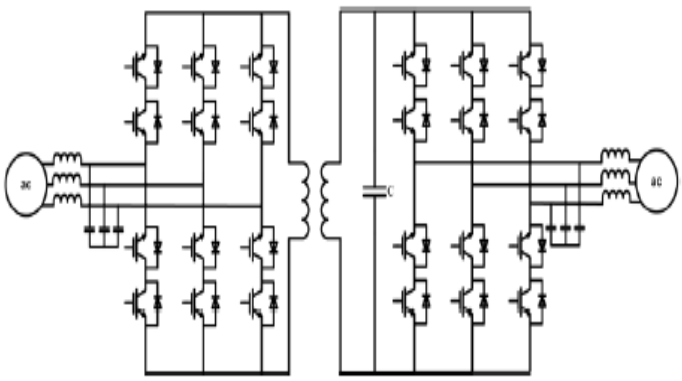

Figure 2.11: Buck-Boost converter with Soft switching

The necessary halfway full buck-boost dc-dc converter is planned. Like the traditional buck-support converter, inductor L is in charge of exchanging power from the contribution to the output. This inductor is charge from the information and after that released to the output cycle-by-cycle. Little ac capacitor C is set in parallel with this inductor. The fundamental part of capacitor C is to create halfway resonances with the inductor to acknowledge ZVS for the power gadgets, as will be demonstrated later. The converter needs two (RB switches. A RB-switch can acknowledge by a traditional turn around leading switch (IGBT or MOSFET) in arrangement with a diode. The recently accessible individuals RB-switches can utilize with the upside of lower add up to on-state voltage (Hamidreza Keyhani et al, 2014 [8].

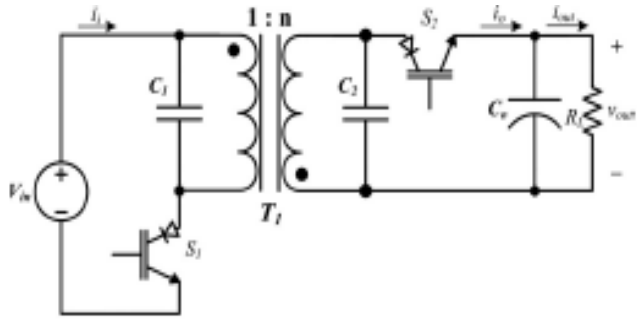

Figure 2.12. Proposed partial-resonant dc–dc converters.

New current distribution strategy on a broad instance of N parallel DC-DC support converters is display. Streamlining depends on the learning of entity boost constraint. Identical resistors display each misfortune during the structure. Utilizing an exact online opinion of those resistors, the misfortunes through every entity converter can be resolved. At that point, another present sharing plan is characterize intending to boost the worldwide effectiveness of the general structure (Hugues Renaudineau et al, 2014) [9].

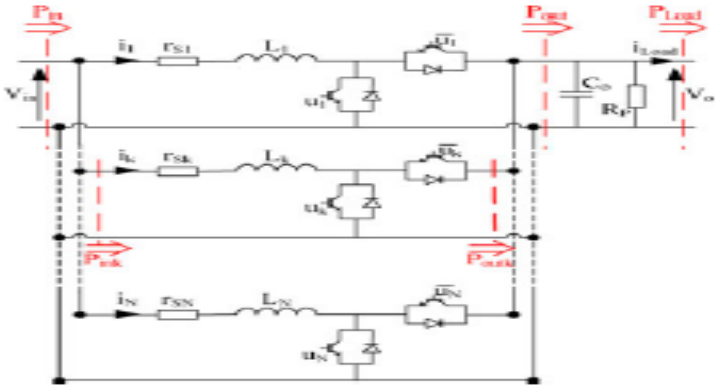

Figure 2.13: *N* parallel boost converters structure with one output capacitor.

A proportional assessment of the regular and switching copies of a Dc-Dc step up converter since the fact of opinion of real-time simulation. The converter is measured to purpose ended an extensive variety of working conditions, and might do changeover between discontinuous

conduction mode (DCM) and continuous conduction mode (CCM). Although the regular typical is recognized to be calculation ally well organized from the viewpoint of off-line simulation, the similar is exposed here to put away additional rational capitals than the switching model for real-time imitation of the Dc-Dc converter. Further, assessment of the limit condition between DCM and CCM originate to be the key aim for the augment digesting of means by the regular model (G. Narayanan et al, 2014)[10].

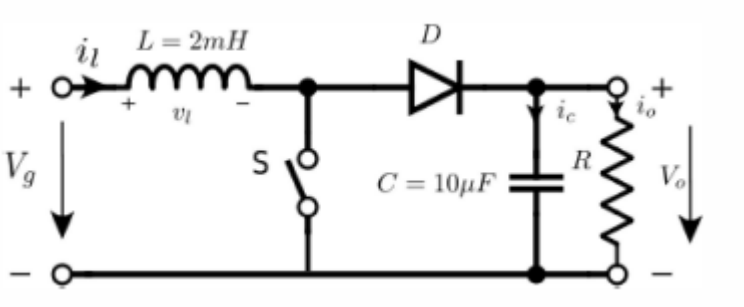

Figure 2.14: Schematic of ideal boost converter

A period-restricted power circulation control (TPDC) method that can utilize for single-inductor various output (SIMO) DC-DC converter with many uneven burdens. Moreover, the genuine all-comparator control method that raises no soundness or many-sided quality issues is proposed. This all-comparator method for SIMO converters is acknowledged just with a solitary shared hysteresis comparator at a consistent exchanging recurrence of 800 kHz. The greatest productivity achieves 92%. (Jungmoon Kim et al, 2014) [11].

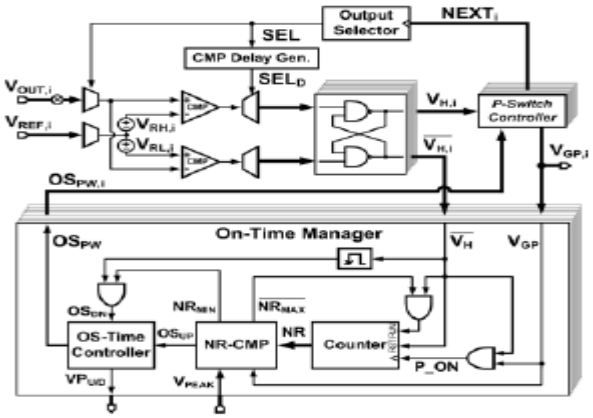

Figure 2.15: Shared hysteresis comparator control and on-time manager.

There are three outline bearings when Schottky hindrance diodes (Sic) control gadgets utilized in a power converter: maximum productivity, high temperature, or potentially maximum recurrence. In the displayed circumstance, a mix amongst task at the high exchanging recurrence and high productivity is measured. The parallel four associated Bi junction transistors with a minimum-voltage drop should switch quick keeping in mind the end goal to encourage low exchanging misfortunes at high exchanging frequencies to such an extent that the amount and volume of the inductor of the 6-kW dc/dc step up converter could be limited. (Demosthenes Peftitsis et al, 2014).

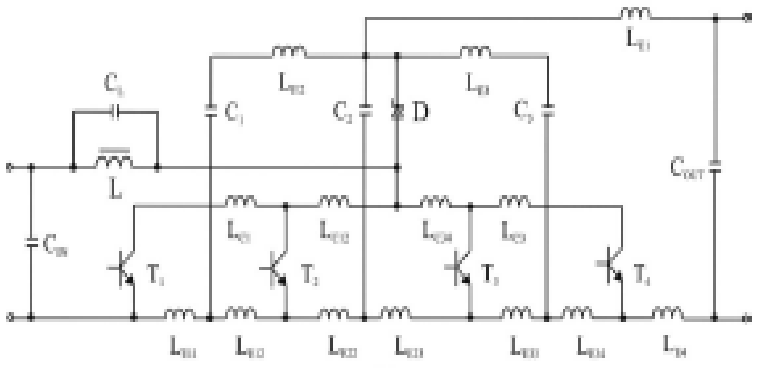

Figure 2.16: schematic diagram of the proposed circuit layout.

Another segregated switch-mode current controller planned for a LED (light emitting diode) driving framework. The double step up LED drivers are incorporated with the Dc converter, which brings about a basic arrangement and little part tally. The essential adjacent gives an air conditioner voltage foundation to the optional sideways in which single step up inductor, two switches, and diodes contain two boost drivers. Every optional switch controls apiece LED current to be adjusted. The voltage worries of the essential changes are clipped to the information voltage, and individuals of auxiliary switches and diodes are clasped to the output voltages. Besides, all switches can undoubtedly accomplish zero voltage exchanging by utilizing the transformer polarizing current without extra assistant circuits(Gun- Woo Moon et al, 2014) [13].

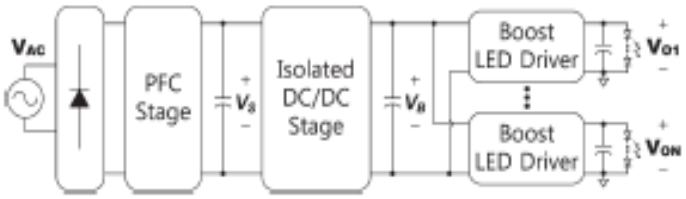

Figure 2.17: Block diagram of an LED system with boost drivers.

Here they depicted another path for high power connected mount for electrical automobiles. It be contingent on a broken conduction mode. Control feature revision (PFC) converter with consonant regulation procedure that enhances the power factor in DCM PFC activity and a double organize Dc converter completed out of a complete converter and a DCM buck converter. Isolating the fundamentals of the Dc-Dc organizes into regulator and departure decreases the modifier by employing high reappearance reverberation. The opportunity of the proposed charger has tested with a 6.6-kilo Watt model (Hyung-Jun Chae et al, 2014) [14].

Another efficient outline technique for the load voltage direction of a step up compose Dc converter utilizing developmental calculations. The input organizer outline for output voltage

direction defined as an advancement issue and the supervisor coefficients recognized through transformative pursuit. PC recreation comes about upheld by exploratory proof plainly show that the controllers evaluated through developmental calculations are equipped for conveying upgraded output voltage direction under various kinds of load and supply unsettling influences(Panugothu Srininivasa et al, 2014) [15].

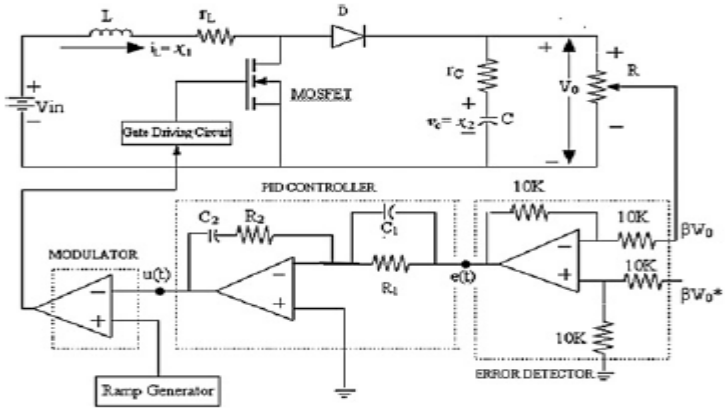

Figure 2.18: Experimental circuit of boost-type Dc–Dc converter

Analysis of the high boost dc converters in light of attached inductors and multiplier cells introduced and the real difficulties outlined. A few topologies utilize coupled inductors, with therefore lessen the voltage worry over the switches, in spite of the fact that the info current is discontinues and the utilization of a LC channel might be essential. A voltage dual rectifier as the output phase of an incorporated boost converter with coupled inductors. They got voltage gain is double that of conventional step up converters because of the paired phase, as joined inductors give extra voltage pick up, in spite of the fact that voltage worry over the switches isn't expanded (Ranoyca N. A. L. Silva et al, 2014) [16].

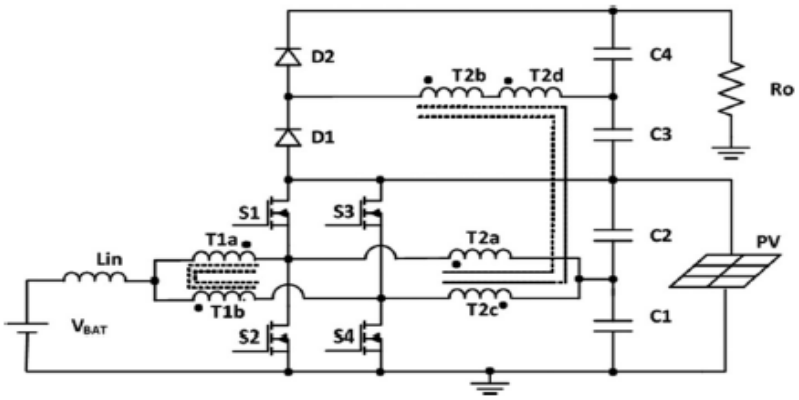

Figure 2.19: Proposed topology using a PV array.

Due to their exceptional benefits, the delicate exchanging join all-inclusive power converters have gotten observable consideration amid the most recent couple of year. These converters, which can designed as Ac– Ac, Ac– Dc Dc-Dc, Dc– Ac, , or, are minimal, solid, and present longer lifetime contrasted with alternate kinds of converters. Nevertheless, they want additional switches, which influence the regulator to procedure more confused. They propose an altered setup for the power transformation, which decreases the quantity of switches without varying the standards of task. This converter, with a named scanty ac join buck-support inverter, lessens the quantity of changes from20 to 18 (Hamid A. Toliyat et al, 2014) [17].

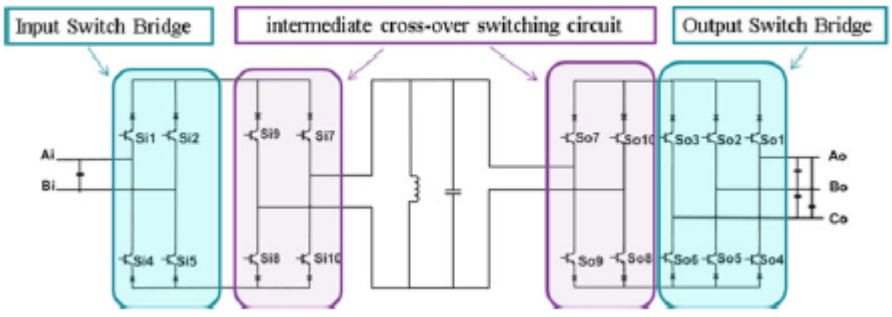

Figure 2.20: Proposed inverter.

The present rating of the switches and the effectiveness of the dual converter are analyzed. The projected converter needs additional switches, however the normal current of individually switch in this converter is a large portion of the normal current of the switches in the Dc-connect converter. Contingent upon the exchanging qualities and the exchanging recurrence in the dc-connect converter, the proficiency of this converters might be advanced or lesser than that of the projected converter (Mahshid Amirabadi et al, 2014) [17].

A staggered DC converter gives a reasonable answer for non-disengaged topologies to acquire maximum voltage gain. Nevertheless, ordinary staggered boost converter required countless and capacitors to accomplish high voltage pick up. The exchanged inductor utilized to accomplish maximum voltage gain. Exchanged inductor staggered boost-buck-support converters essential fewer amount of diodes and capacitors contrasted with ordinary staggered boost converter. Here non-segregated exchanged inductor-drifting load, DC-DC staggered boost converter projected for power module purpose. Drifting output circuit employed to limit the ground associated impedance issues (Nandyala Sreeramula Reddy et al, 2014) [18].

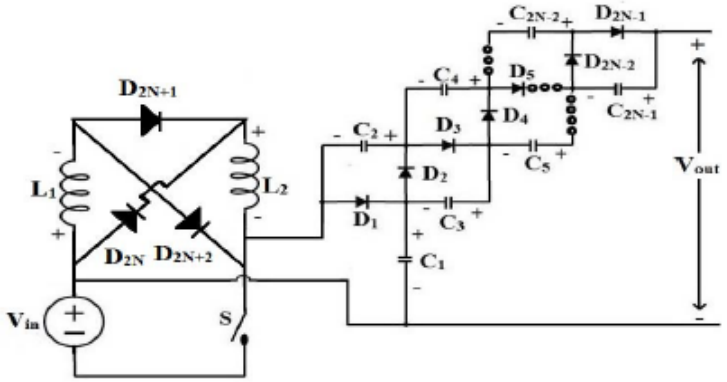

Figure 2.21: N-level of DC-DC multilevel converter

A new non-isolated switched inductor fluctuating output DC-DC multilevel step up converter is proposed. While Non-isolated maximum gain, DC–DC converters are indispensable for fuel cell purpose to step up the supplies voltages through an extraordinary changing ratio.

Predictable DC-DC boost converter is not appropriate for maximum gain applications for the reason that of high voltages pressure and high duty cycles. The projected converter is non-isolated fluctuating output DC-DC multilevel converter, which syndicates the switched inductor and voltages multiplier purposes to achieve high voltage gain (Pavan Kumar et al, 2014) [18].

A model prescient control (MPC) approach in view of specification for step up converter suggested that straightforwardly directs the output voltage along its reference, without the utilization of a hidden current control circle. This empowers quick elements amid homeless people. Since the converter demonstrate incorporated into the controller, the tedious regulation of controller picks up maintained a strategic distance from the computational intricacy to some degree articulated, however kept under control by utilizing a move-blocking plan. Notwithstanding that, the exchanging recurrence is variable. A heap estimation conspire, to be specific a discrete-time exchanged Kalman channel, is actualized to deliver stack varieties and to guarantee heartiness to parameter varieties. Recreation and trial comes about show the potential favorable circumstances of the proposed strategy (Tobias Geyer et al, 2014)[19].

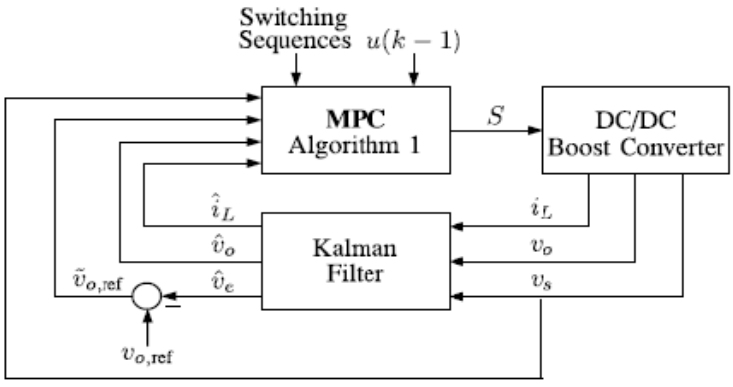

Figure 2.22: Block diagram of the MPC scheme and Kalman filter.

An outline, model advancement, task and testing of a 1 kW, 800 V output every Sic help DC-DC converter employing Sic MOSFET and Sic-Schottky diode chips. The exchanging

recurrence rose up to as extraordinary as 800 kHz besides a 230 °C intersection temperature takes to come by exchanging misfortune-overwhelming self-warming. A high-recurrence exchanging characteristic of the projected converters assessed in detail. In light of those assessments, the (ZVS) and (CrCM) delicate exchanged examinations done on the same Sic module. The exchanging loss of Sic MOSFET is drastically lessened, along these lines altogether enhancing the converter mostly productivity and mitigating the high-temperature push incited on the exchanging gadgets. This work will give helpful data to the high recurrence and maximum-temperature uses of Sic gadgets (Xueqian Zhong et al, 2014) [20].

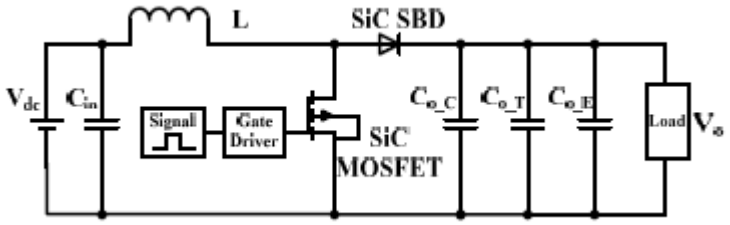

Figure 2.23: Topology of the proposed DC-DC converter

Another multi input output Dc-Dc step up converter with brought together construction for crossing of info foundations in electronic automobiles suggested here. The suggested converter has only single inductor. The suggested converter can utilize for exchanging energy among numerous energy resources. Additionally, the converter may use as a solitary info multi output converter. It is conceivable to consume a few outputs with numerous voltage stage. The converter has dual standard action method, which in battery discharging mode mutually of info sources transfer capacity to an output and in battery accusing mode one of the info sources provide masses as well as conveys bulk to the next source. (Ali nahavandi et al, 2014) [21].

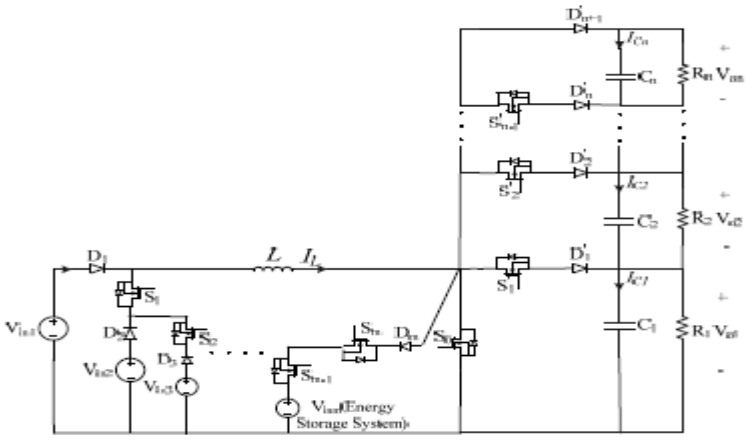

Figure 2.24: Topology of the proposed converter

A double deck step up and step down device with an efficient ZVS method planned. The operative values of the planned device square measure surveyed and shortened in eight modes. A laboratory check circuit meant and enforced to gauge the pertinence of the planned device. It has shown that the device potency will increase well up to ninety-three all told circumstances of the examined load power commencing a 100W to 220 W. Furthermore, it is conjointly complete that consuming of double converters in parallel causes rarer ripples within the output voltage. Moreover, the very fact of exploitation individual 1 electrical device as an extra component to understand the maximum goal is to proposes that the deliberate device is additional inexpensive than the soft switched converters by accepting attached inductors or convertors(Erfan Maali Amiri et al, 2015) [22].

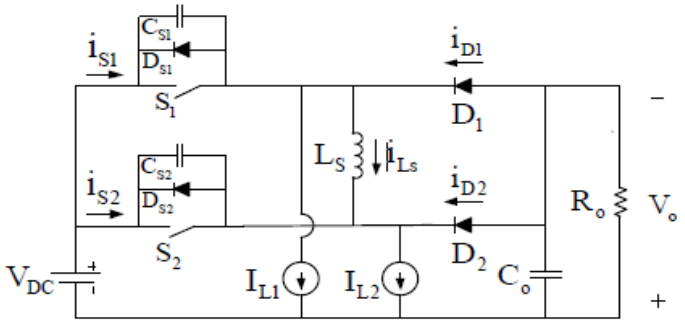

Figure 2.25: Equivalent-circuit diagram.

The potency of step up DC-DC converters in operation in spurt mode underneath light load situations often enhanced by a satisfactory choice of electrical device current that transfer is energy commencing the input towards the output. A theoretic investigation assesses the most power wounded (fixed, conductivity and change-losses) worried in these converters and the way organize tube contingent upon the electrical scheme current. This Investigation displays us that around it is a best importance of this current that reasons smallest losses and, henceforward, most effectiveness. These theoretic calculations in area unit then associated with investigation align for resultant from an ad boost DC-DC convertor (TPS61252) where as its ordinary electrical device current is adaptable(Ferran Reverter et al, 2015) [23].

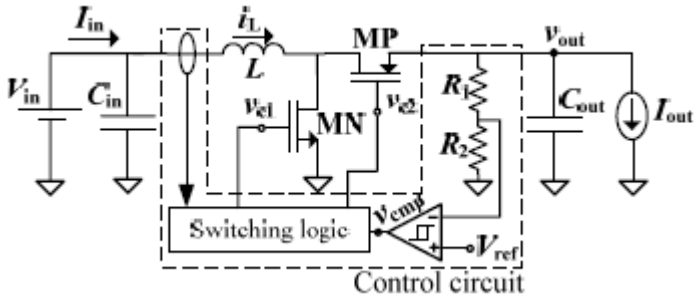

Figure 2.26:A Synchronous Boost DC-DC converter.

A completely unique electrical phenomenon based mostly device is meant and enforced. The key components of the charger square measure a completely unique high potency increase DC/DC device together with just one switch and 2 diodes, and a completely unique most electric outlet pursuit controller. It has shown that the only real switch and 2 diodes of the device square measure turned on/off below zero current change and/or zero voltage change situation, thus there are not any change losses (Hassan Fathabadi et al, 2015) [24].

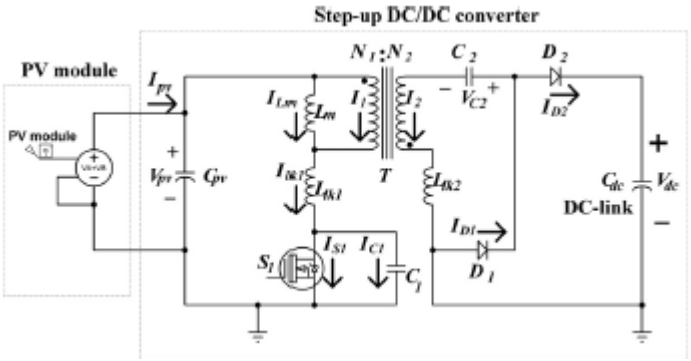

Figure 2.27: High efficiency voltage gain DC-DC converter.

Some non-isolated maximum-voltage-gain converters, that use voltage multiplier factor and techniques to increase their voltage gains, are according. The switched-inductor techniques utilized to attain high change of magnitude voltage gain while not the extraordinarily high duty magnitude relation. Similarly, high change of magnitude dc-dc converters with switched-capacitor projected in, which may give any voltage gain. In adding, the voltage and current pressures of the interleaved-boost device remain comparatively low. They describe a unique Z-source device that not solely can do a high voltage-gain, however moreover has the mutual ashore feature, and so called mutual beached Z-source Dc-Dc device with high voltage-gain. Moreover, this device has other benefits, like the straightforward assembly and little voltage pressures on the switch in addition with diodes (Dongyuan Qiu et al, 2016) [25].

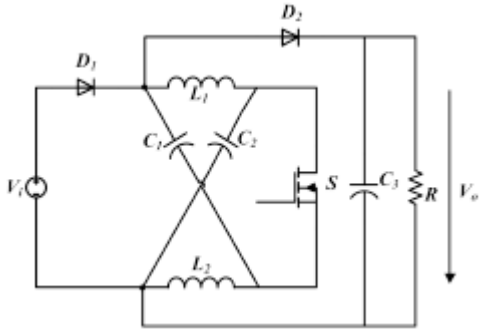

Figure 2.28: Configuration of the proposed converter.

For the isolated reduction and change of magnitude applications, several isolated Buck and Boost topologies planned. The majority of the IBB converters root within the non-isolated converters. For instance, the fly back convertor is that the isolated version of non-isolated Buck/Boost convertor. Similarly, isolated Cuk, Sepic and letter of the alphabet converters are often derived by inserting an electrical device into the initial non-isolated Cuk, Sepic and letter of the alphabet converters, severally. However, the efficiencies of those single-switch IBB converters are still low owing to the maximum voltage-current stress scheduled the elements and the solid switching of dynamic switches and rectifying diodes. Additionally to the minor conversion potency and maximum stress, these only switch IBB converters will solely use for low power applications (Kai Sun et al, 2015) [26].

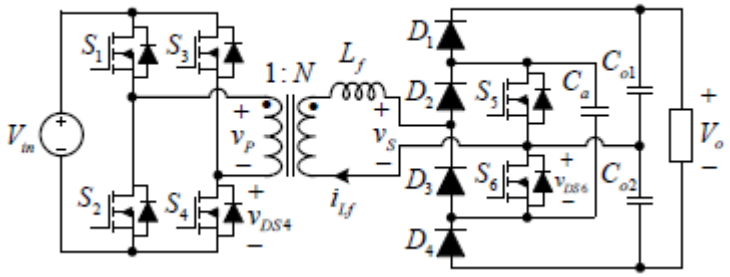

Figure 2.29: Topology of the proposed FB-IBB converter.

An isolated multilevel Dc power convertor planned. The isolated multilevel Dc-Dc power convertor contains of an isolated power convertor, a series and parallel change circuit at an output LC filter. The isolated power convertor contains of a half bridge electrical converter, a three winding electrical device and two full bridge rectifiers. The half bridge electrical converter switched in continuous duty to become dual output DC voltages over dual secondary windings of the three winding electrical device besides dual full bridge rectifiers, separately. To confirm the presentation of the isolated multi-level Dc-Dc power convertor, a model established and verified. (Jun-Jie Huang et al, 2015)[27].

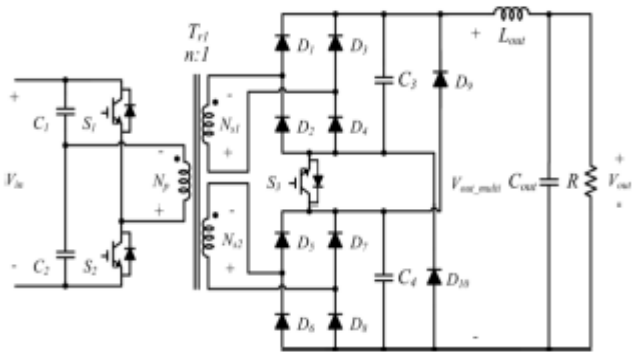

Figure 2.30: An isolated multilevel Dc-Dc powers converters

The high increase, high productivity converter projected here is very reasonable for little output voltage bases (e.g. sunlight based PV, Fuel Cell Stack, Battery). A circuit effectiveness of 96%accomplished under full load conditions gives a correlation of the key circuit factors esteems got logically with equipment estimations. The mistake in the outcomes between expository deduction and test comes about is observed to be between 0 to 5%. This could credit to estimation blunders, nearness of parasitic and utilization of loose estimations of circuit parts for experimentation. High voltage gain accomplished without utilizing outrageous duty cycle esteems, which is a major favorable position above ordinary high gain converters (Moumita Das et al, 2015) [28].

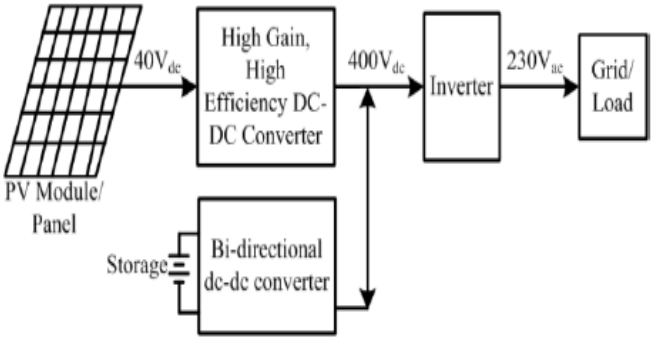

Figure 2.31:PVpower conversions system

Another single-organize single-stage three input Dc-Ac step up converter for remain solitary crossbreed PV /FC/UC frameworks. The converter appreciates a non separate lone power change organize, which edges dual uni-directional info ports for PVand FC bases besides dual bi-directional ports for UC and resistive load. Its wants six control changes and specifically venture up the little level info Dc voltage into an abnormal state output sinusoidal-voltage minus requiring any output percolation organize. Truth told, the system exhibits an organization including of four Dc boost converter s, which are effectively well-ordered to deliver dual output Dc-one-sided sinusoidal voltages over the heap(M. Sabahi et al, 2015) [29].

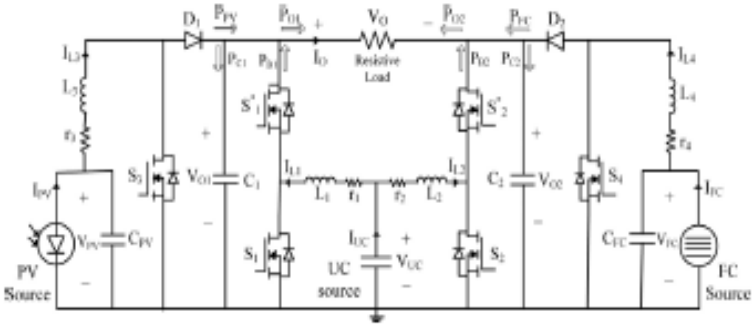

Figure 2.32: Proposed converter topology.

By exploitation the averaging methodology and geometrical method for solid the mutual worth, the enhanced tiny signal classical of the voltage-increasing device with mix energy driving in CCM and DCM modes of processes is recognized and consistent transmission do from the duty cycle to the load voltage, that is, Gvd(s), comes and analyzed. The theoretic controls, PSIM simulations gate experimentations concerning the signal drawing of Gvd(s) are in sensible contract with one another (Ma Xikui et al, 2013) [30].

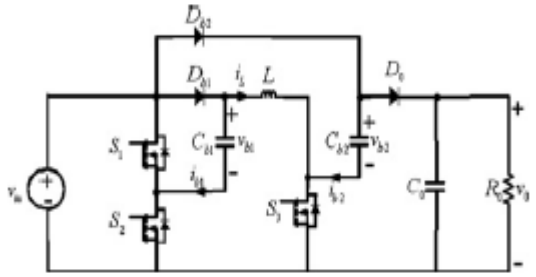

Figure 2.33: Circuit of voltage boosting converter with hybrid energy-pumping

A high competence Dc–Dc boost device to border a reduced50 μL microbe cell (MFC) consuming one cm^2 vertically associated annotate anode and one cm2 Cr/Au cathode. The miniaturized MFC gave up to about ten μW with an output voltage of zero.4–0.7 V. Such little voltage, that is additionally loading reliant, avoids the MFC straight energy low power physical science. A pulsation frequency modulation sort Dc–Dc device in irregular physical phenomenon mode is meant and enforced to handle the contests and delivers a load freelance output voltage with maximum conversion potency. The made-up dc–dc device in UMC zero.18 μm been verified with the MFC. At the 0.9 Voltage output, the device features a highest potency of eighty-fifth through nine-μW load (Jongbaeg Kim et al, 2015) [31].

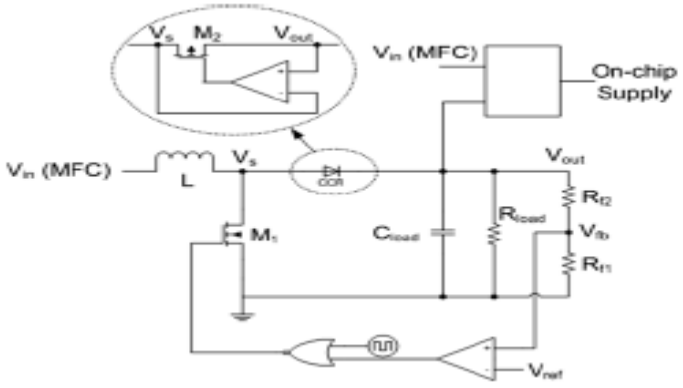

Figure 2.34: Dc–Dc converter for PFM model.

The flexible Y-source step up DC/DC device meant for distributed power generation, wherever maximum gain commonly ordered. The planned devices utilize a Y-source electrical phenomenon network complete with a firmly coupled three-winding electrical device for top voltage boosting that is presently unmatched by existing electrical phenomenon networks. These capabilities are incontestable by mathematical derivation and experimental testing. For the experiments, a 300-W model has been in-built the laboratory victimization carbide devices for higher potency. The model has been tested with a regulated power offer, earlier than operative it with a heat nucleon Exchange Membrane (PEM) cell. Results obtained make sure the usefulness and show of the planned device (Graham E. Town et al, 2015) [32].

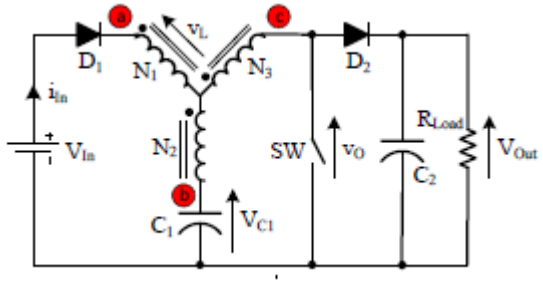

Figure 2.35: Y-source boost DC/DC converter.

To get a maximum increase voltage gain, high potency convertor, they planned a twin switches Dc-Dc convertor with three winding coupled electrical device and pump. The convertor poised of identical switches construction, three winding joined electrical device and charge pump. This mixture enablesunderstanding of great increase in voltage gain by a coffee voltage and current stress on the capacity switches. Finally, an example esteemed at 500W remained established, and therefore the new results confirm the precision of the examination. The convertor will giveSusa comparatively high-voltage conversion of magnitude relation with high potency and the identical switches structure scale back the voltage and current pressure of the switches and theattractive parts will be combined into unique core that is useful

to shortened the constructionto take the benefits of the leak inductance all diodes will understand the ZCS to cut back the losses. (Yu Tang et al, 2015) [33].

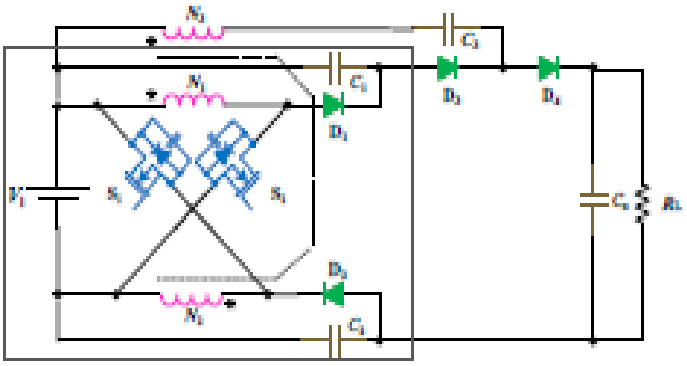

Figure 2.36: proposed converter circuit diagram

2.3. Literature Review Conclusion

Literature review is focused on previous work done by other researchers so what we need to doin this portion is to find the related work to our research and study it.

Firstly, in a chapter we studied about DC-DC converters, A DC-to-DC converter is an electronic circuit or electromechanical device that converts a source of direct current (DC) from one voltage level to another. It is a type of electric power converter.

Secondly, we reviewed a different article about Boost Converter;a **boost converter** (**step-up converter**) is a DC-to-DC power converter that steps up voltage (while stepping down current) from its input (supply) to its output.

At last we reviewed some article about SEPIC converter, the single-ended primary-inductor converter (SEPIC) is a type of **DC/DC converter** that allows the electrical potential (**voltage**) at its output to be greater than, less than, or equal to that at its input.

CHAPTER 3
METHODOLOGY AND SIMULATION RESULTS

3.1 Introduction

The proposed converter is a maximum boost voltage converter consists of dual input step up converter. The converter that is proposed is depicted from Dickson Charge pump. The Dickson multiplier or Dickson Charge pump takes a DC supply, as its input so is a form of DC-to-DC converter. Diode capacitor voltage multiplier (VM) stages are integrated with two input step up stages at the input that gave us a very high voltage output as desired. Voltage multiplier stages are directly proportional to the conversion ratio and duty cycle also played an important role in providing a circuit with high gain. The voltage is perfect for inverting application and can be used in the vast variety of maximum voltages systems.

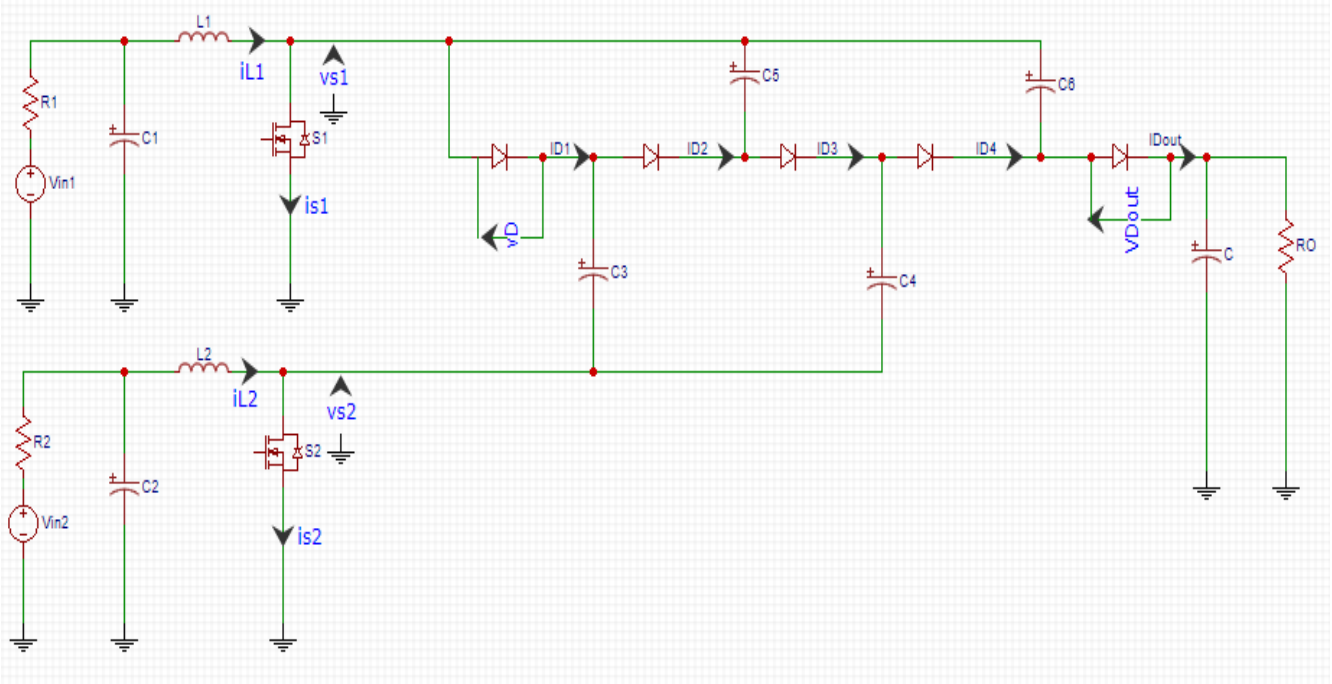

Figure 3.1:Circuit diagram for Proposed Converter

There will be some over-lapping time in normal mode of operations for the proposed converter, when both of the switches S1 and S2 are turn on and while also there should be one of the switches will operate in ON condition at any time whic is given (as shown in Fig. 3.2). Consequently, the converter can operate in three modes. When we have no overlapping time between the trasmission of switches and also the duty ratio is less then out designed converter can operates.

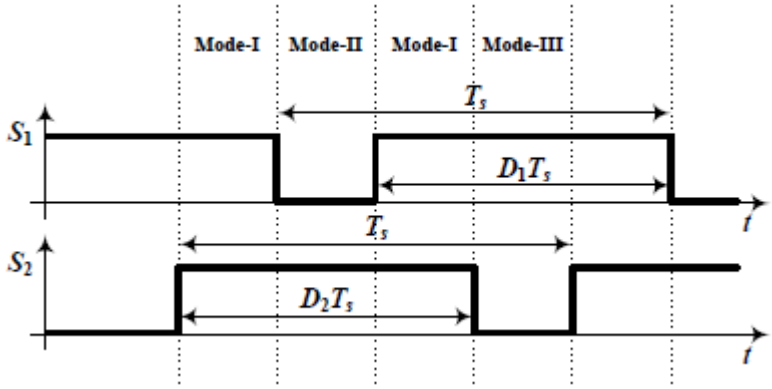

Figure 3.2: Input boost stagesswitching signals

3.2 Modes of Operations

In modes of operation, we have three modes, which are as fallows

3.2.1 Mode No: 01

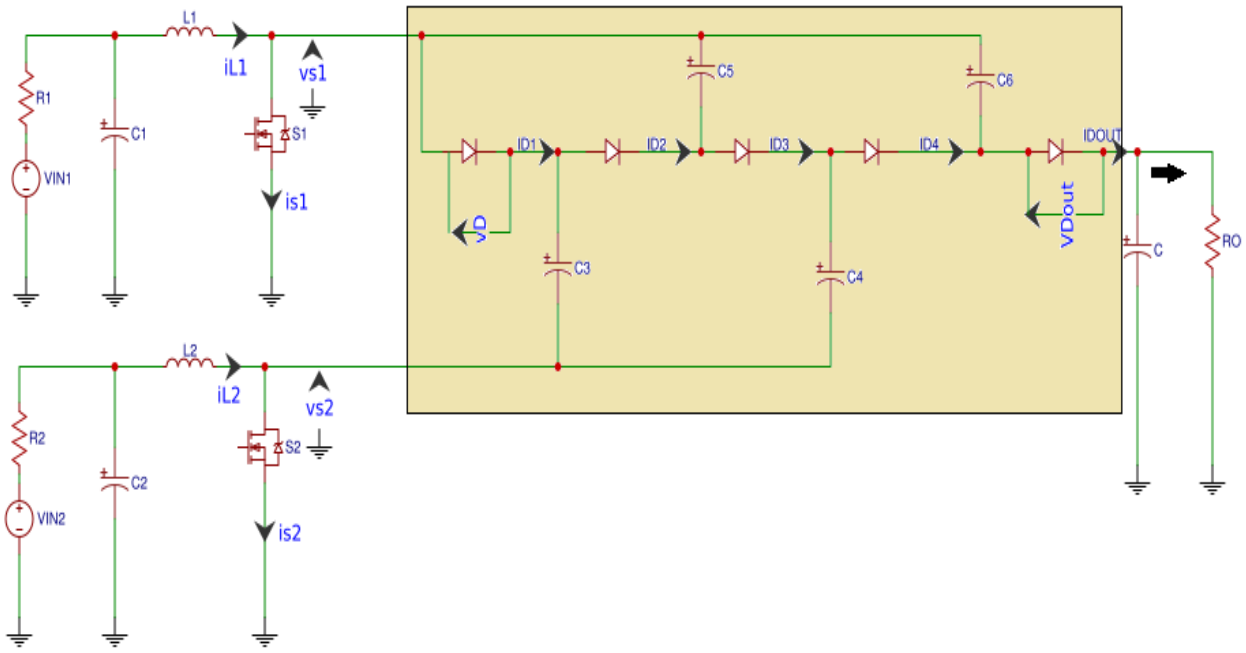

Figure 3.3: Mode no 01

In first mode of operating both of the switches S_2 and S_1 are continuously carry out in this mode. Inductors will be charged from its input sources V_{in1}, V_{in2}, so in result current is increasing linearly. In this mode diode will not conduct because they are in reverse biased in different voltage multiplier stages. The voltage multiplier capacitor voltage is unmovable and the output diode is reverse biased $D_{out.}$ Only through the output capacitor C_{out} the load is supplied.

3.2.2 Mode No: 02

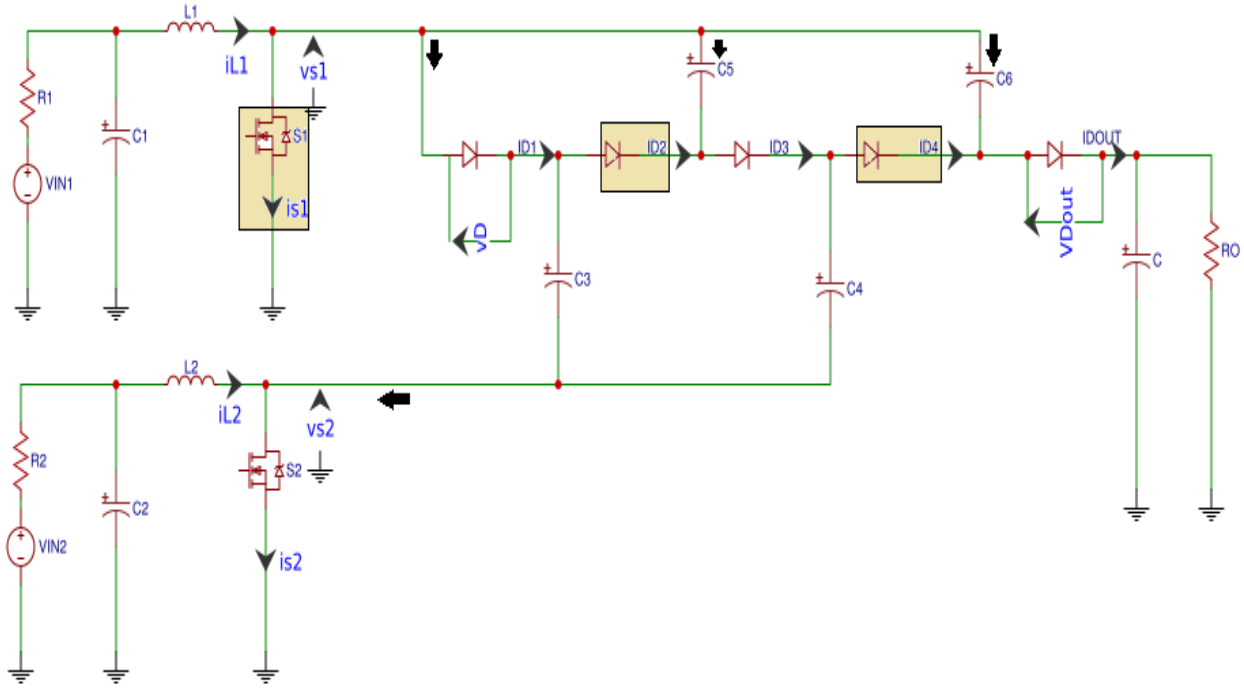

Figure 3.4: Mode No: 02

In the next mode of procedure switch S_1 is off only switch S_2willoperate. In (figure 3.4) you can see that since switch S_2 is turn ON so all the odd numbered diodes will be in ahead biases. Due to flow of inductor current I_{L1}all the even number of capacitors (C_2, C_4…)will charge and odd number of capacitors (C_1, C_3…)will be discharged. The load will be supplied by the output capacitor $C_{out}$and the output diode D_{out} is reverse biasedif the number of voltage multiplier is odd. And if the amount of voltage multiplier is even then output diode $D_{out}$is forward biased and will charge the load capacitor and will also delivering the load. So here in this mode the number of voltage multiplier stages are even so the output diode is forward biased.

3.2.3 Mode No: 03

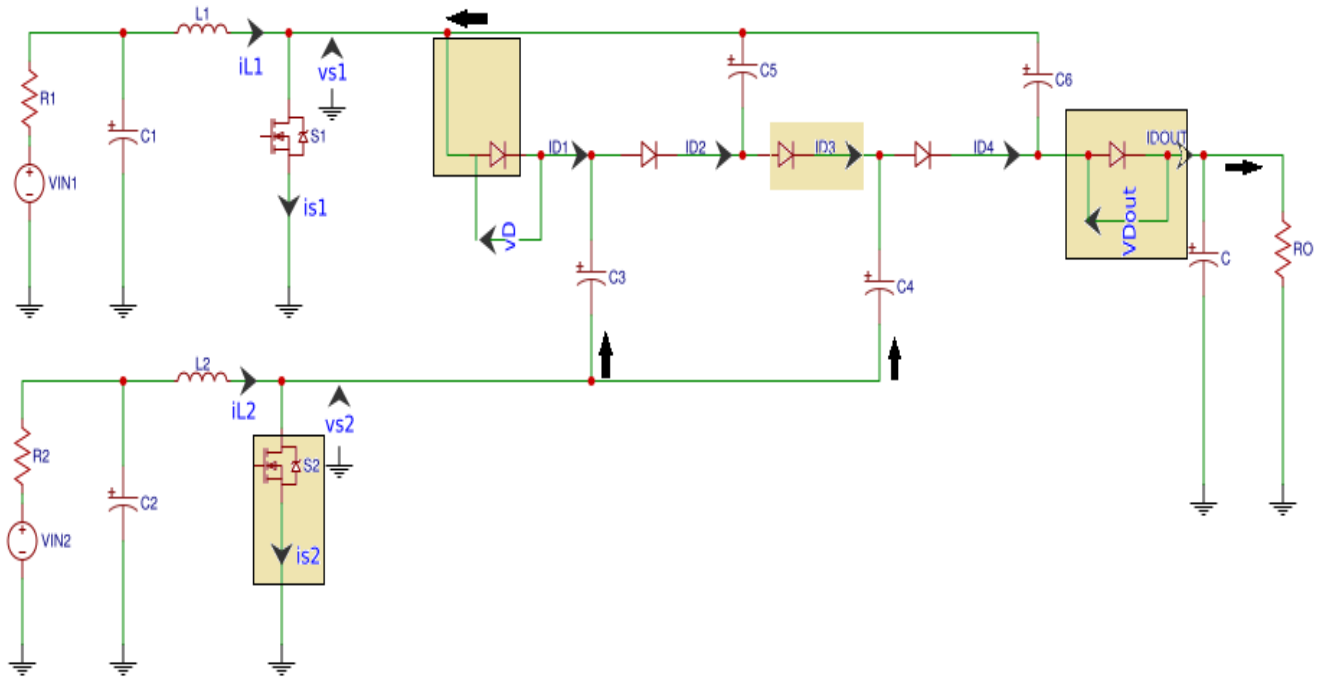

Figure 3.5:Mode No: 03

In third and last mode of operation only switch S_1 will conduct and S_2 is off shown in (figure 3.5). Here in this mode all the even number of diode are forward biases and Due to the flow of inductor current I_{L2} through thevoltage multiplier capacitor charging all the even number of capacitors (C_2, C_4…)and will discharged the odd number of capacitor (C_1, C_3…).If the amount of voltage multiplier stages are odd, then the out-put diode $D_{out}$is forward biased charging the out-put capacitor and providing the load. Though, if the amount of voltage multiplier stages is even, then the output diodeD_{out} is reverse biased and the load is providedby the out-put capacitor.

3.3 Voltage Gain for Converter

Voltage multiplier continuously transfers charge from in-put to out-put by charging the voltage multiplier stages capacitor. For L_1 we can write

$$v_{L1,av} = 0 \tag{3.1}$$

$$\frac{1}{T_s}\int_0^{T_s} v_{L1}\ dt = 0 \tag{3.2}$$

According to the equivalent circuit of the converter

$$\frac{1}{T_s}\int_0^{d_1 T_s} V_{in1}dt+\frac{1}{T_s}\int_{d_1 T_s}^{Ts}(V_{in1}-V_{c1})dt = 0 \tag{3.3}$$

$$V_{in1}-V_{c1}+d_1V_{c1}=0 \tag{3.4}$$

$$V_{c1}=\frac{V_{in1}}{1-d_1} \tag{3.5}$$

İt can be observed that in terms of upper boost switching node voltage the capacitor voltage can be written.

$$V_{c1}=V_{c3}-V_{c2}=V_{out}-V_{c4}=\frac{V_{in1}}{1-d_1} \tag{3.6}$$

$$V_{L2,av}=0 \tag{3.7}$$

$$\frac{1}{T_s}\int_0^{T_s} V_{L2}dt=0 \tag{3.8}$$

According to the equivalent circuit of the converter from eq. 8

$$\frac{1}{T_s}\int_0^{d_2 T_s} V_{in2}\,dt+\ \frac{1}{T_s}\int_{d_2 T_s}^{T_s}(V_{in2}+V_{c1}-V_{c2})dt = 0 \tag{3.9}$$

$$V_{in2}-(V_{c2}-V_{c1})+d_2\,(V_{c2}-V_{c1})=0 \tag{3.10}$$

$$V_{c2}-V_{c1}=\frac{Vin1}{1-d_2} \tag{3.11}$$

Whered_2 is the switching duty cycle for S_2.

$$V_{c2}-V_{c1}=V_{c4}-V_{c3}=\frac{V_{in2}}{1-d_2} \tag{3.12}$$

The capacitor voltage are obtained as follows from eq.3.24

$$V_{c1}=\frac{V_{in1}}{1-d_1} \tag{3.13}$$

$$V_{c2} = \frac{V_{in1}}{1-d_1} + \frac{V_{in2}}{1-d_2} \tag{3.14}$$

$$V_{c3} = \frac{2V_{in1}}{1-d_1} + \frac{V_{in2}}{1-d_2} \tag{3.15}$$

$$V_{c4} = \frac{2V_{in1}}{1-d_1} + \frac{2V_{in2}}{1-d_2} \tag{3.16}$$

The output voltage is given by eq (3.6)

$$V_{out} = V_{c4} + \frac{V_{in1}}{1-d_1} = \frac{3V_{in1}}{1-d_1} + \frac{2V_{in2}}{1-d_2} \tag{3.17}$$

VM stage capacitor voltages are given by

$$V_{cn} = \left(\frac{N+1}{2}\right)\frac{V_{in1}}{1-d_1} + \left(\frac{N-1}{2}\right)\frac{V_{in2}}{1-d_2} \qquad \textit{if n is odd and } n \leq N \tag{3.18}$$

$$V_{cn} = \left(\frac{N}{2}\right)\frac{V_{in1}}{1-d_1} + \left(\frac{N}{2}\right)\frac{V_{in2}}{1-d_2} \textit{if n is even and } n \leq N \tag{3.19}$$

Equation of the converter output voltage with *N* number of voltage multiplier stages depends on whether *N* is even or odd and is given by

$$V_{out} = V_{cn} + \frac{V_{in2}}{1-d_1} = \left(\frac{N+1}{2}\right)\frac{V_{in1}}{1-d_1} + \left(\frac{N+1}{2}\right)\frac{V_{in2}}{1-d_2} \qquad \textit{If N is Odd} \tag{3.20}$$

$$V_{out} = V_{cn} + \frac{V_{in1}}{1-d_1} = \left(\frac{N+2}{2}\right)\frac{V_{in1}}{1-d_1} + \left(\frac{N}{2}\right)\frac{V_{in1}}{1-d_2} \qquad \textit{If N is Even} \tag{3.21}$$

İf $d_1$and d_2 is same then $d_1 = d_2 = d$ so the output voltage is

$$V_{out} = (N+1)\frac{V_{in}}{1-d} \tag{3.22}$$

The load voltage equation for this topology is given by

$$V_{out} = \left(\frac{N+1}{2}\right)\frac{2V_{in1}}{1-d_1}+\left(\frac{n+1}{2}\right)\frac{Vin2}{1-d2} \qquad If\ N = Odd \tag{3.23}$$

$$V_{out} = \left(\frac{N}{2}\right)\frac{Vin1}{1-d1}+\left(\frac{n+2}{2}\right)\frac{Vin2}{1-d2} \qquad If\ N = even \tag{3.24}$$

If we have N number of VM stages then we can write the equation for even and odd which are as fallow.

$$V_{out} = \left(\frac{n+1}{2}\right)\frac{Vin1}{1-d1}+\left(\frac{n+1}{2}\right)\frac{Vin2}{1-d2} \qquad If\ N\ is\ Odd \tag{3.25}$$

$$V_{out} = \left(\frac{n}{2}\right)\frac{Vin1}{1-d1}+\left(\frac{n+2}{2}\right)\frac{Vin2}{1-d2} \qquad If\ N\ is\ even \tag{3.26}$$

3.4 Component Selection and Simulation Results

3.4.1 Selection of Inductor

$$I_{L1,\ avVin1} + I_{L2,\ avVin2} = V_{out}I_{out} \tag{3.27}$$

In this relation, $I_{L1,\ av}$ is the average flow of the inductor L_1, $I_{L2,\ av}$, the average flow of the L_2inductor, and the output current I_{out} *from eq* (3.20) and(3.27)

$$I_{L1,av}V_{in1} + I_{L2,av}V_{in2} = \left(\frac{n+1}{2}\right)\frac{Vin1}{1-d1}I_{out}+\left(\frac{n+1}{2}\right)\frac{Vin2}{1-d2}I_{out} \tag{3.28}$$

In this case, the average flow of the L_1 *and* L_2 is obtained

$$I_{L1,av}=\left(\frac{N+1}{2}\right)\frac{Iout}{1-d1} \qquad If\ N\ is\ odd \tag{3.29}$$

$$I_{L2,av}=\left(\frac{N+1}{2}\right)\frac{Iout}{1-d2} \quad the\ value\ is\ same\ as\ I_{L1,av} \tag{3.30}$$

From eq (3.21) and (3.28).

$$I_{L1,av}=\left(\frac{N+2}{2}\right)\frac{Iout}{1-d1} \qquad \textit{If N is Even} \qquad (3.31)$$

$$I_{L2,av}=\left(\frac{N}{2}\right)\frac{Iout}{1-d2} \qquad (3.32)$$

It can be seen from a converter with poly input source and same duty ratio d_1 and d_2, when N is odd, then both boost phases have same inductor current. An increase in the average flow will be equal. Whenever N is even, in$I_{L1,\ av}$ greater than $I_{L2,\ av}$.

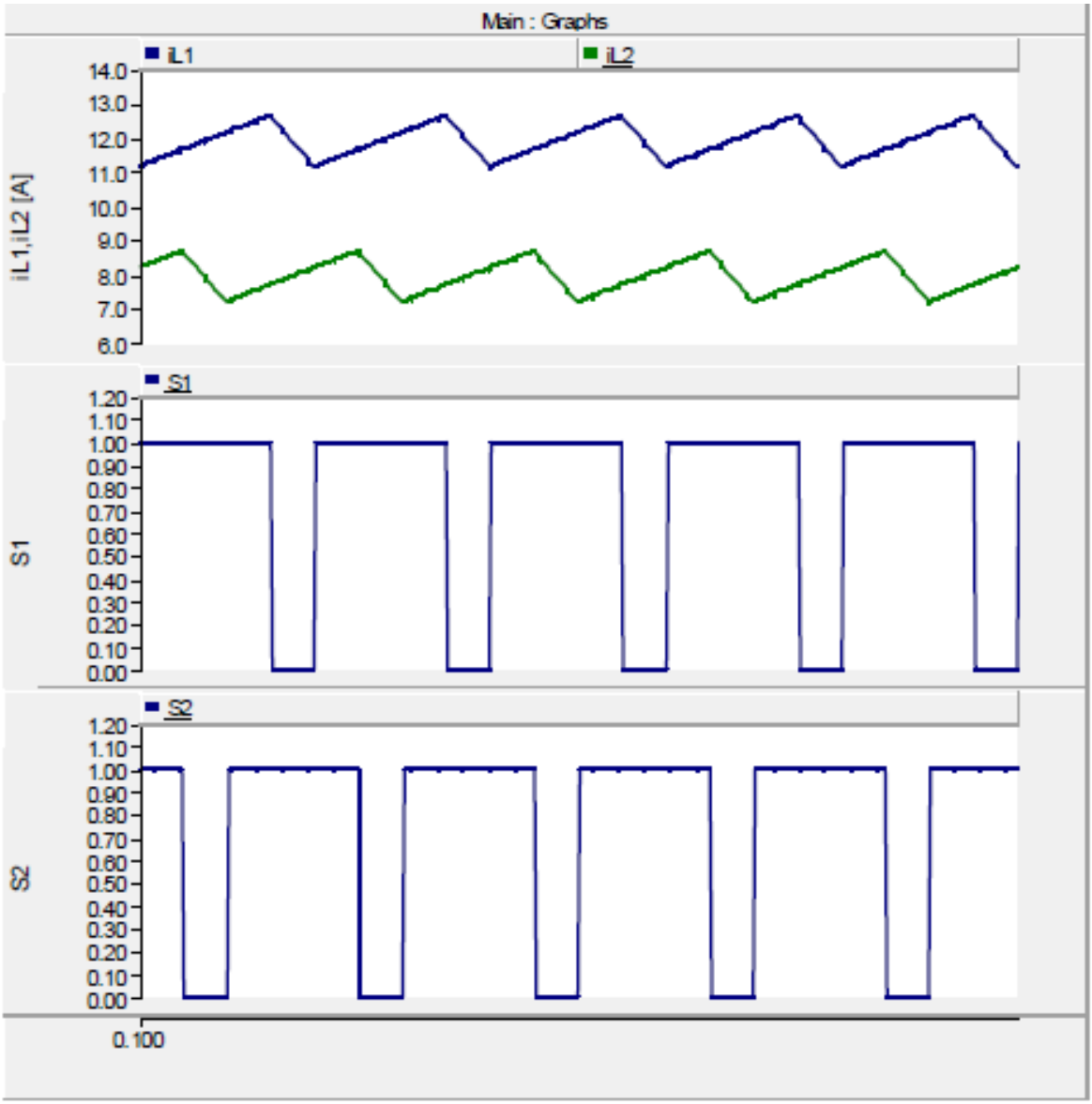

Figure 3.6: Odd-no of voltage-multiplier stage inductor-currents

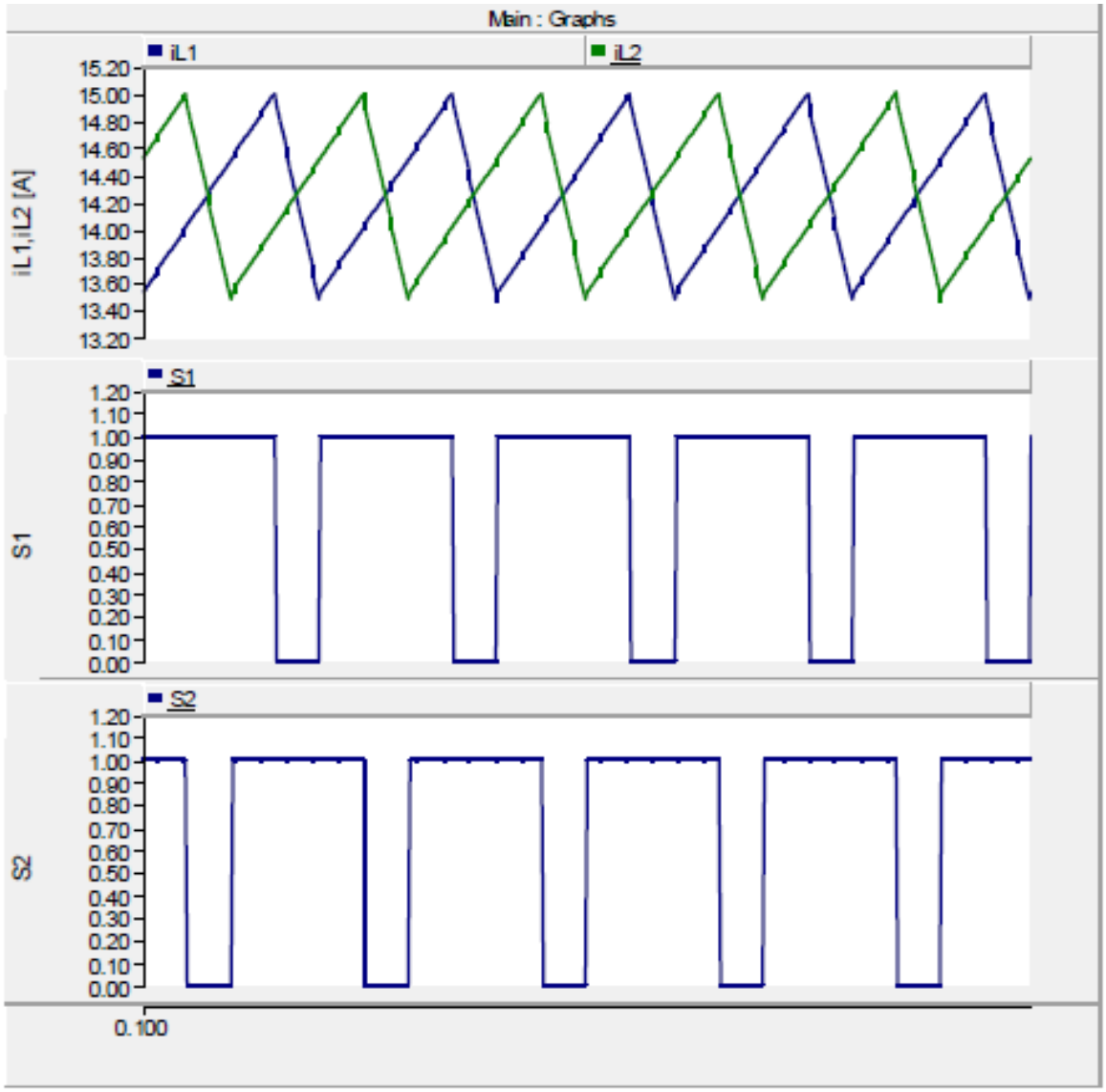

Figure 3.7: Even-no of voltage-multiplier stages in inductor-current

The inductor design is like to the design of normal step up converter. The value of the inductor is chosen, with both increasing boost phases work in Continuous conduction mode. WhereI_{L1}, *av* and $I_{L\,2}$, *av* are half their maximum.

$$I_{L1,\,av}=\frac{1}{2}\frac{Vin\,1d1Tsw}{L1,crit} \tag{3.33}$$

$$I_{21,\,av}=\frac{1}{2}\frac{Vin\,2d2Tsw}{L2,crit} \tag{3.34}$$

The lowest values of L_1 and L_2 at the frequency of $f_{sw}$for N are as follows from eq (3.29) and (3.30)

İf N is odd then

$$L1,crit=\frac{Vin\,1d1(1-d1)}{(N+1)Ioutfsw} \tag{3.35}$$

$$L2,crit=\frac{Vin\,2d2(1-d2)}{(N+1)Ioutfsw} \tag{3.36}$$

İf N is even then

$$L1,crit=\frac{Vin\,1d1(1-d1)}{(N+2)Ioutfsw} \tag{3.37}$$

$$L2,crit=\frac{Vin\,2d2(1-d2)}{NIoutfsw} \tag{3.38}$$

Also, the inductors selected for the I_{L1} for the inductive current for the inductor L_1, and I_{L2} for the inductor.

$$L_1=\frac{Vin\,1d1}{\Delta IL1fsw} \tag{3.39}$$

$$L_2=\frac{Vin\,2d2}{\Delta IL2fsw} \tag{3.40}$$

The value of current for inductors, I_{L1}, pk and $I_{L2,\,pk,}$ for$N$ can be written as follows.

$$I_{L1,\,pk}=I_{L1,\,avg}+\frac{\Delta IL1}{2} \tag{3.41}$$

$$I_{L2,\,pk}=I_{L2,\,avg}+\frac{\Delta IL2}{2} \tag{3.42}$$

The peak value of inductor current is given by from eq (3.29), (3.30) and (3.39)

İf N is odd then

$$I_{L1,\,pk}=\frac{(N+1)Iout}{2(1-d1)}+\frac{Vin\,1d1}{2L1fsw} \tag{3.43}$$

$$I_{L2,\,pk}=\frac{(N+1)Iout}{2(1-d2)}+\frac{Vin\,2d2}{2L2fsw} \tag{3.44}$$

İf N is even then

$$I_{L1,\,pk}=\frac{(N+2)Iout}{2(1-d1)}+\frac{Vin\,1d1}{2L1fsw} \tag{3.45}$$

$$I_{L2,\,pk}=\frac{NIout}{2(1-d2)}+\frac{Vin\,2d2}{2L2fsw} \tag{3.46}$$

To calculate the losses of copper conductors, the effective value of their flow must be known, the effective amount of inductors, $I_{L1,\,rms}$ and $I_{L2,\,rms,}$ forN.The individual is assisted by the above relationships as follows.

$$I_{L1,\,rms}=\sqrt{\left(\frac{(N+1)Iout}{2(1-d1)}\right)^2+\left(\frac{Vin\,1d1}{2\sqrt{3}L1fsw}\right)^2} \tag{3.47}$$

$$I_{21,\,rms}=\sqrt{\left(\frac{(N+1)Iout}{2(1-d2)}\right)^2+\left(\frac{Vin\,2d2}{2\sqrt{3}L2fsw}\right)^2} \tag{3.48}$$

The value of the inductors current for the *N* obtained as follows.

$$I_{L1,\,rms}=\sqrt{\left(\frac{(N+2)Iout}{2(1-d1)}\right)^2+\left(\frac{Vin\,1d1}{2\sqrt{3}L1fsw}\right)^2} \tag{3.49}$$

$$I_{21,\,rms}\sqrt{\left(\frac{NIout}{2(1-d2)}\right)^2+\left(\frac{Vin\,2d2}{2\sqrt{3}L2fsw}\right)^2} \tag{3.50}$$

3.4.2 Selection of Mosfet

The peak voltage blocking of all switches is like that of the ordinary step up converter (appeared in Fig. 3.1) which is given by

$$V_{s1}=\frac{Vin1}{1-d1} \tag{3.51}$$

$$V_{s2}=\frac{Vin2}{1-d2} \tag{3.52}$$

The current Stress flow on all switches depends on the amount of stages of voltage multipliers, so that the average current passing through each switch, $I_{S1,\,av}$and $I_{S2,\,av}$, calculated for N as follows:

İf N is odd

$$I_{s1,\,av}=\left(\frac{(N+1)d1}{2(1-d1)}+\frac{(N-1)}{2}\right)I_{\text{out}} \tag{3.53}$$

$$I_{21,\,av}=\left(\frac{(N+1)d2}{2(1-d2)}+\frac{(N-1)}{2}\right)I_{\text{out}} \tag{3.54}$$

İf N is even

$$I_{s1,\,av}=\left(\frac{(N+2)d1}{2(1-d2)}+\frac{(N)}{2}\right)I_{\text{out}} \tag{3.55}$$

$$I_{s1,\,av}=\left(\frac{Nd2}{2(1-d1)}+\frac{N}{2}\right)I_{\text{out}} \tag{3.56}$$

In view of the above relations, it can be seen that for a converter with a source of single input and an equal duty ratiod_1 and d_2, when N is an odd, the average current of the $S_2$is greater than S_1 (Fig. 1-21-a). If N is even, as shown in (Figure 1-21b) the average current of S_1 will be larger than of S_2. Also, the rms value of switch current, $I_{S1,\,\text{rms}}$ and$I_{S2,\,rms,}$ in order to obtain the losses in the voltage multiplication stages (N of the individual), is obtained as follows:

İf N is odd

$$I_{s1,\,rms}=\left(\sqrt{\left(\frac{(N+1)}{2(1-d1)}\right)^2(d1+d2-1)+\left\{\frac{(N-1)}{2(1-d2)}+\frac{(N-1)}{2(1-d1)}\right\}^2(1-d2)}\right)Iout \qquad (3.57)$$

$$I_{21,\,rms}=\left(\sqrt{\left(\frac{(N+1)}{2(1-d2)}\right)^2(d2+d1-1)+\left\{\frac{(N-1)}{2(1-d1)}+\frac{(N-1)}{2(1-d2)}\right\}^2(1-d1)}\right)Iout \qquad (3.58)$$

İf N is even

$$I_{s1,\,rms}=\left(\sqrt{\left(\frac{(N+2)}{2(1-d1)}\right)^2(d1+d2-1)+\left\{\frac{N}{2(1-d2)}+\frac{(N-2)}{2(1-d1)}\right\}^2(1-d2)}\right)Iout \qquad (3.59)$$

$$I_{21,\,rms}=\left(\sqrt{\left(\frac{(N)}{2(1-d2)}\right)^2(d2+d1-1)+\left\{\frac{(N-1)}{2(1-d1)}+\frac{N}{2(1-d2)}\right\}^2(1-d1)}\right)Iout \qquad (3.60)$$

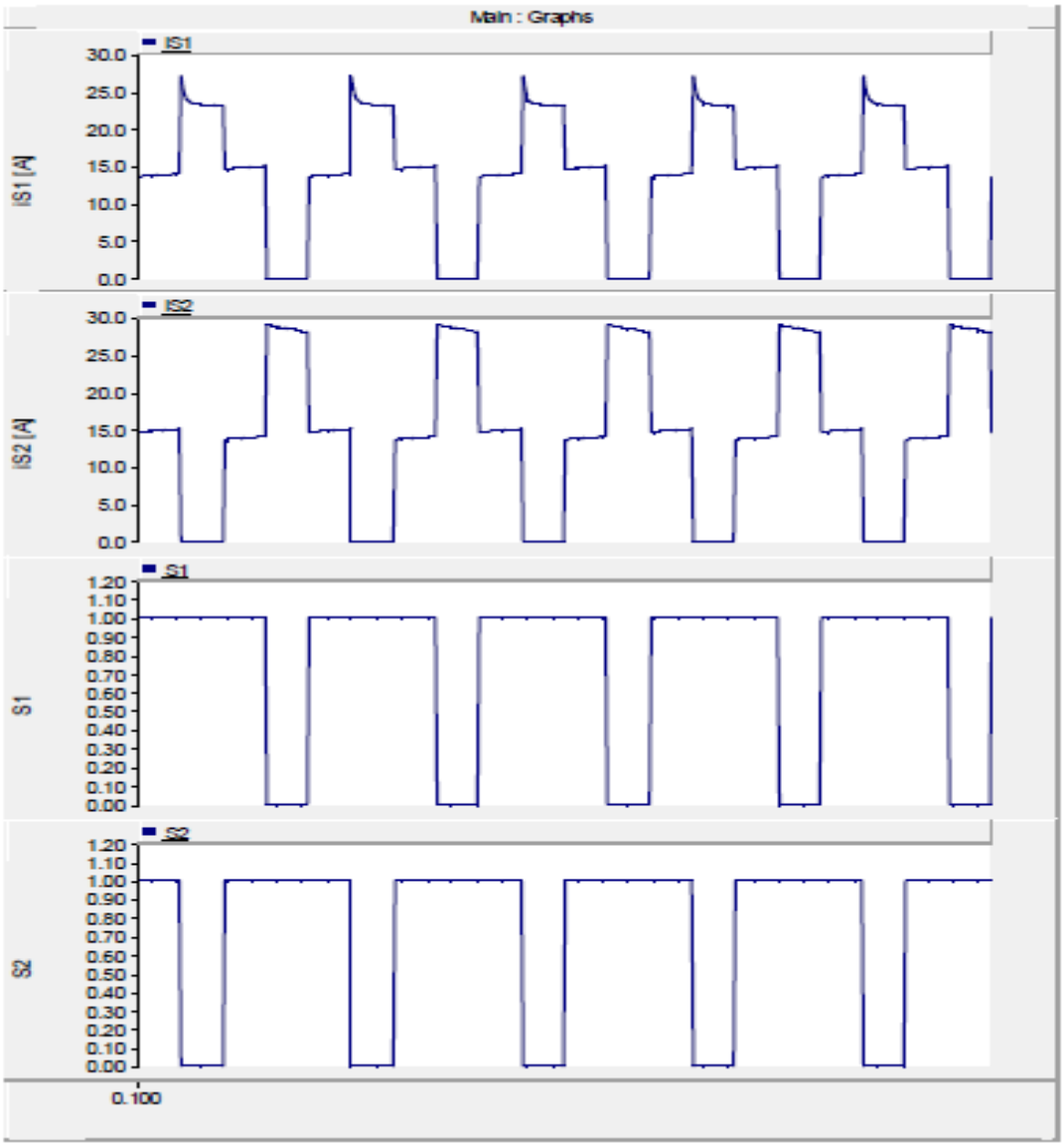

Figure 3.8odd no of switch current for voltage-multiplier stage.

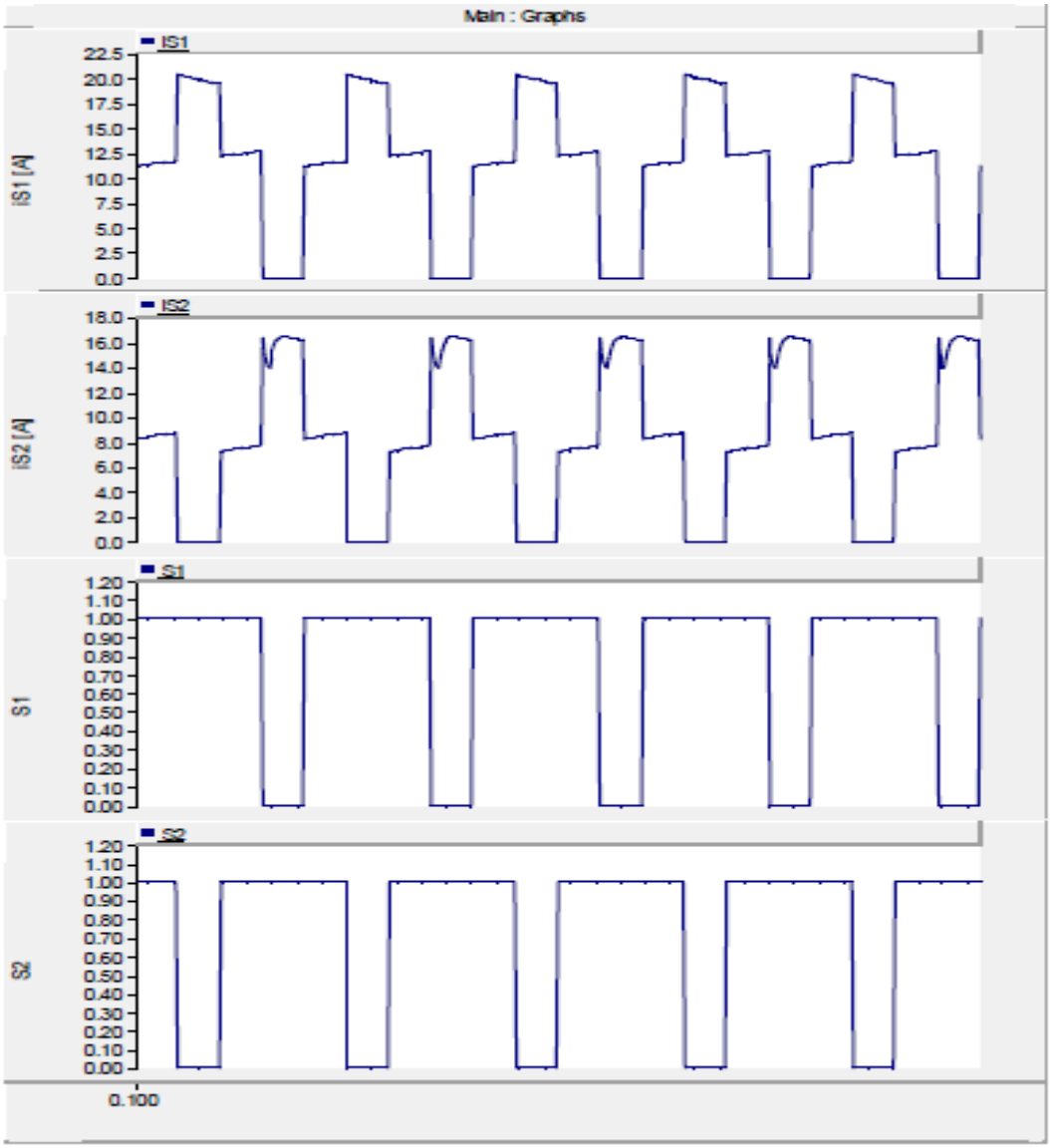

Figure 3.9: Even no of voltage multiplier stages for Switch current

It is detected that here is a bending and spike in the switch current waveforms .The spike is seen in I_{S1} when the numbers, of Voltage Multiplier stages are in odd. Be that as it may, while the number of Voltage Multiplierphases are indeed, the spike is seen in I_{S2}. The spike in switch currents is because of the voltage unbalance between voltage multiplier stage capacitors.

demonstrates the switch and diode currents for the converter with four voltage multiplier stages The spike in I_{S2} shows up in mode-2of task of the converter .At first diode D_3 conducts the aggregate inductor current I_{L1}, meanwhilev_{C3}-v_{C2} is under v_{C1} and v_{out}-v_{C4}. At the point when v_{C3}-v_{C2} and v_{out}-v_{C4} are both adjusted, at that point diodes D_3 and D_{out} begin directing and share relatively rise to inductor current $I_{L1}/2$. Diode D_1 begins directing when v_{C1}, v_{C3}-v_{C2}, and v_{out}-v_{C4} are all adjusted. Throughout this time diode current I_{D1} is more prominent than I_{D3} and I_{Dout} since the impedance seen by the present way is lower. The proportion amongst the current is subject to the value decided for the voltage multiplier stage capacitors. Switch currentsI_{S2} amid this period is the total of I_{L2}, I_{D1}, and I_{D3} and henceforth there is spike and twisting of the switch current.the greatness of the spike is equivalent to the whole of both the inductor currents I_{L1} and I_{L2}. It may be watched the current display qualities like charging/releasing of an RC circuit which is for the most part because of the circuit parasitic protections, for example, switch $R_{DS(on)}$, inductors andvoltage multiplier stage capacitor.

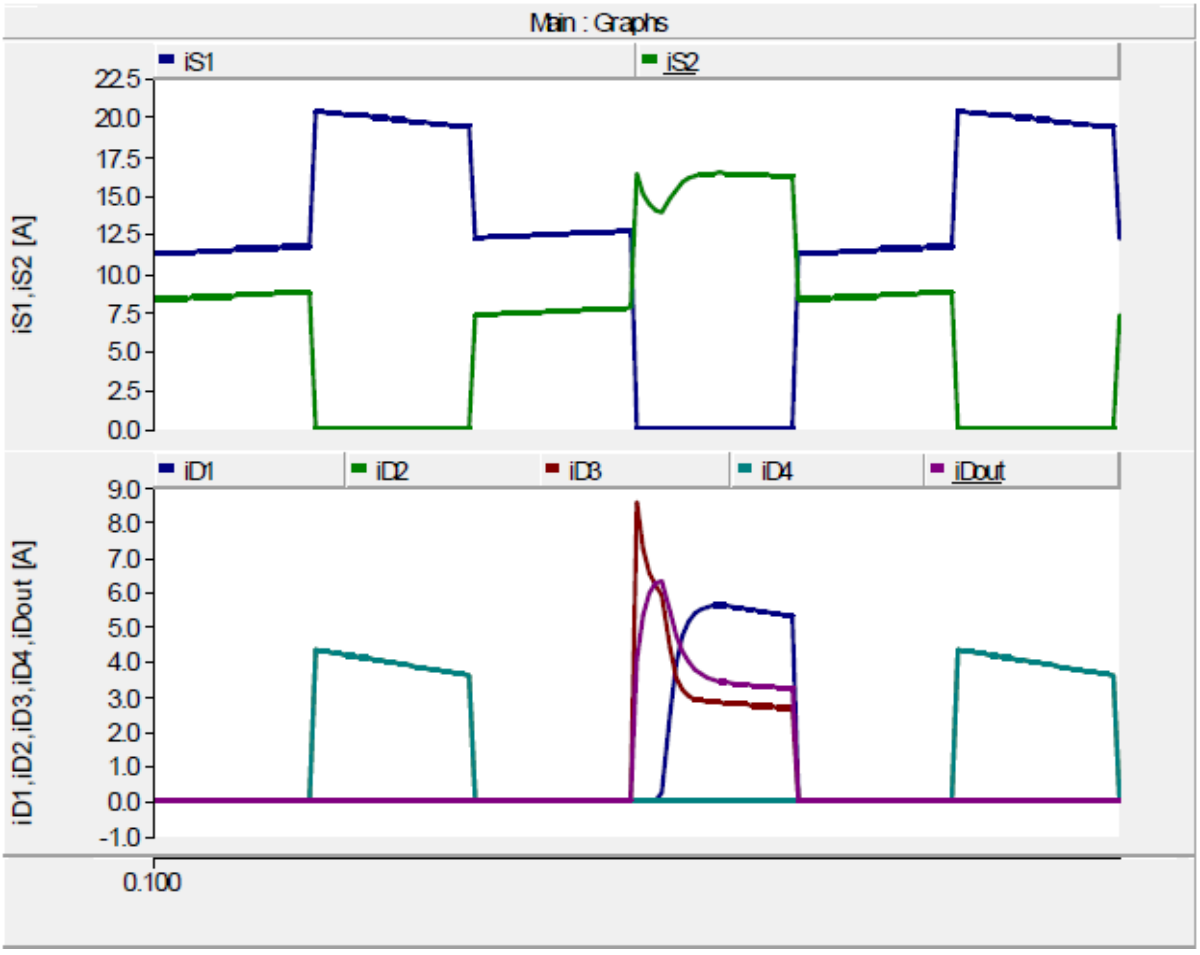

Figure 3.10: Switch current for four Vm stages of i_{s1} and i_{s2}andI_{Dout}

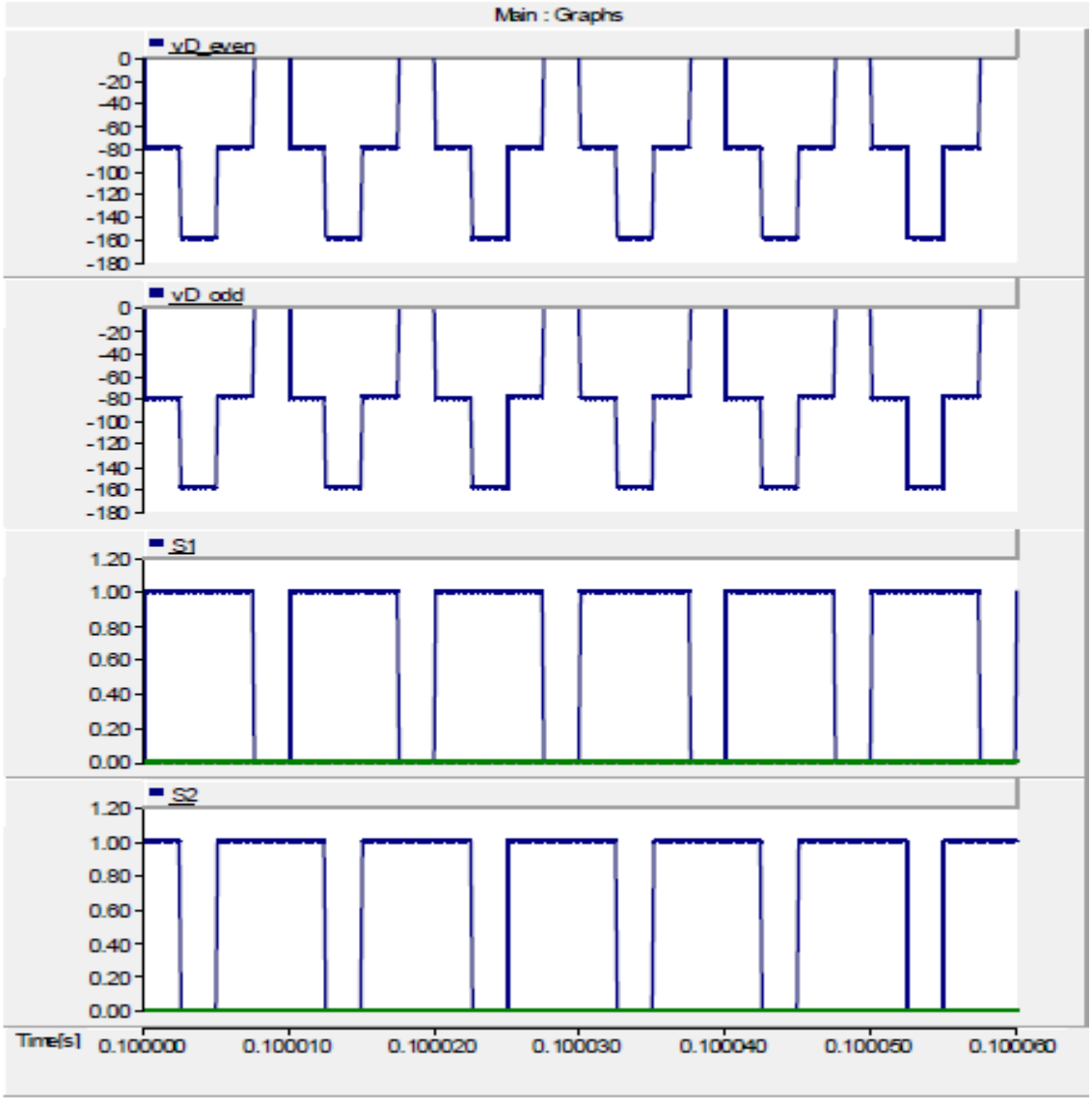

Figure 3.11: Even and odd no of diode voltage of voltage multiplier stages

You can see in the above figure 3.11 waveform for the diode current of the proposed converter for voltage multiplier stages are shown here. In this waveform blue color is used for first diode while green is for second diode, marron color is for 3rddiode,sky-blue color is used for diode number four and in last purple color showing us current for output diode. So you can easily find the spike of the diode from its color which is already explained above.

3.4.3 Selection of Diode

The voltage over the diodes rely upon the capacitors voltages as it is associated between two voltage multiplier organize capacitor. It can be watched that in mode two of activity, whileS_1 is *OFF* and S_2 is *ON*, the odd number diode are forward single sided and even number diode are in obstructive mode. Additionally, the odd number diode are in obstructive modes in the mode three of task, whileS_1 is ON and S_2 *is OFF*. The greatest obstructive voltage of the diode is prearranged by

$$V_{Dn}=\frac{Vin1}{(1-d1)}+\frac{Vin2}{(1-d2)} \tag{3.61}$$

The Out-put diode conducts in mode three of operations, when we have an odd number of voltage multiplier, stages and conducts amid mode two of stages when there is the considerable number of voltage multiplier arranges. The highest obstructive voltage of the output diode given by

İf N is odd

$$V_{Dout}=\frac{Vin2}{(1-d2)} \tag{3.62}$$

İf N is even

$$V_{Dout}=\frac{Vin1}{(1-d1)} \tag{3.63}$$

As discussed in start, the odd numbered diodes conduct during mode-II of operation and the even numbered diodes conduct during mode-III of operation. The average and rms diode currents needed for diode selection and loss calculation are as fallow.

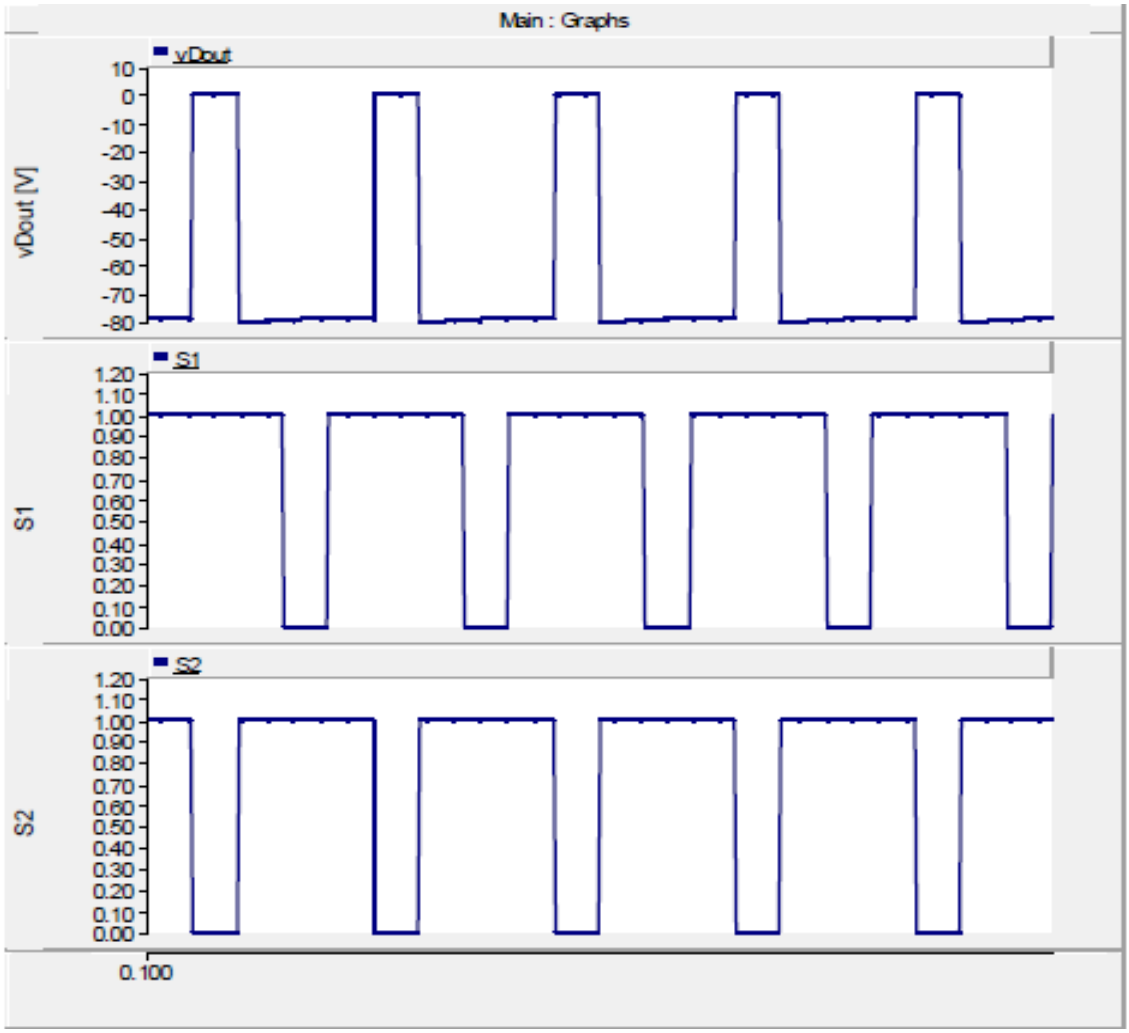

Figure 3.11: Output D_{out} for odd no of voltage multiplier stage.

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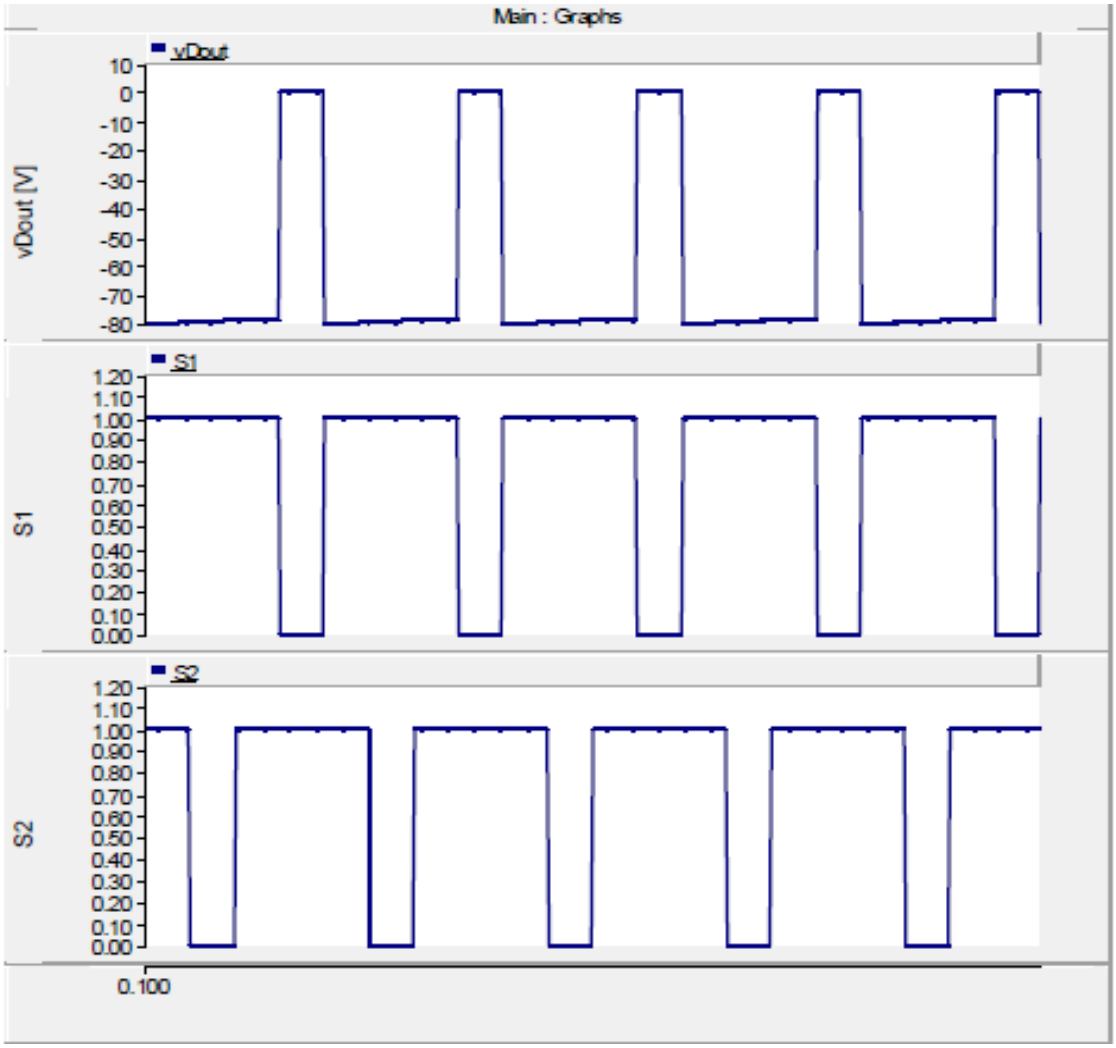

Figure 3.12: Output D_{out} for even no of voltage-multiplier stage.

$$I_{Dodd,avg}=I_{Deven,avg}=I_{Dout}=I_{out} \tag{3.64}$$

$$I_{Dodd,rms}=\sqrt{\frac{1}{1-d1}}I_{out} \tag{3.65}$$

$$I_{Deven,rms}=\sqrt{\frac{1}{1-d2}}I_{out} \tag{3.66}$$

And the pair are given the following relationships, respectively: *N,* $I_{Dout,\ rms}$,

İf N is odd

$$I_{Dout,rms}=\sqrt{\frac{1}{1-d2}}I_{out} \tag{3.67}$$

İf N is even

$$I_{Dout,rms}=\sqrt{\frac{1}{1-d1}}I_{out} \tag{3.68}$$

We proposed a converter which has two input boost stages. As the complete analysis is shown above gives us a clear understanding that how this converter is working. This chapter is giving us a clear view of all the important mode of this topology, as the proposed converter has three mode according to the semiconductor switch ON and OFF condition. Proposed circuitry is consist of differetn stages depend on theEVEN and ODD topolgies. Even topology is consist of four number of voltage multiplier stages while ODD included five number of voltage multiplier satges. Each voltage multiplier stage consistt of diode and capacitor. These modes enables the anylytical anaylysis with the simulation. All the results and important graphs of voltages and currents of component is also shown.

CHAPTER 4

CONCLUSION AND FUTURE WORK

In this research we used PSCAD software and obtained different waveform for different output voltage and current. An Extendable maximum voltage gain DC-DC converter with two step up stages at the input has been proposed. our projected converter is stand on the diode capacitor voltage multiplier phases and at the output voltage gain is increased by the increase in the number of Voltage multiplier stages. Our proposed converter work like multiport because it can get power from multi input sources or can operate an interleaved manner when it is connected to a single source. Since it is a multi-port converter with a maximum voltage gain, self-regulating sources can be connected and power sharing, MPPT algorithms can be implemented independently at each input port. As the complete analysis is shown above gives us a clear understanding that how this converter is working. Its giving us a clear view of all the important mode of this topology, as the proposed converter has three mode according to the semiconductor switch ON and OFF condition. Proposed circuitry is consist of differetn stages depend on the EVEN and ODD topolgies. Even topology is consist of four number of voltage multiplier stages while ODD included five number of voltage multiplier satges. Each voltage multiplier stage consistt of diode and capacitor. These modes enables the anylytical anaylysis with the simulation. All the results and important graphs of voltages and currents of component is also shown.

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