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A Review on Modeling and Analysis of Multi Stage with Multi Phase DC-DC Boost Converter

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ABSTRACT

A new version of the new Hybrid Boost DC-DC ready to draw power from two different DC sources for standard DC-bus feeds is presented in this paper. An important feature of the proposed converter is that both sources provide simultaneous power to a lower load than the reduced current rate. This feature is very attractive for DC grid applications. With the analysis of the time zone, steady state performance is established and the transformational power correction parameters are obtained. In this paper, a powerful converter is introduced, with its operating principles based on charging pumps and converters of reinforcement series. In addition, although three switches are used, no separate gate driver is required instead of one bridge gate driver and one gate driver on the lower side. As such, the proposed converter is easy to analyze and easy to operate. In addition, additional test results are provided to confirm the effectiveness of the proposed converter.

KEYWORD: *Boost Converter, High Voltage, DC-DC Converter*

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I. INTRODUCTION

In order to the high-voltage boost converters are widely used in the industry, the integration of renewable energy distribution systems based on renewable energy such as fuel cells, solar cells, batteries etc. [1] - [2], has made rapid progress in the modern era. A wide range of electrical power will be available from low power sources and this area is attracting the attention of many investigators, therefore, in order to obtain high power, a step-up DC-DC converter is required in the advanced phase. The standard amplifier converter is able to provide output power output, when it comes to applications that require power amplification when output, the converter must be over-operating, say the 0.9 scale when the converter is up. The problem of a performance converter that operates below the extremely poor performance rate impairs efficiency, imposes barriers to short-term response, and the need for a faster and more cost-effective measure [3]. Therefore to address the needs of such applications many of the topological modifications are introduced into existing DC-DC converters, such as switching diode capacitor cells and switching Inductor cells based on hybrid variables, incorporating inductor reciprocating cells, etc. It has been tested and reported in literature [4] - [7]. Therefore, a diode and cross-capacitor-based hybrid boost converter capable of operating under large scale-ups and providing additional power output.

In [14] - [16], although these converters have simple operating principles, their power conversion rates are very low. In [17] and [18], the voltage-lift process is used to achieve a power boost, but the values associated with the conversion of electrical energy are not so high. In [19] - [22], although power conversion rates may increase by increasing the number of energy-efficient cells, additional material or active floating switch is required, thus making all circuits more complex and individual drivers more required.

As mentioned above, a high-voltage boost boost, based on two-charge pumps with only two switches used and a series switches with only one switch used, is introduced, using two pump capacitors and two inductors to achieve power boost. It is known that the conductor of two inputs resembles an inductor in a traditional amplifier converter except that these two inductors and two pump capacitors charge their stored power out of the series. In addition, you do not need a remote gate driver instead of a single and 1 bridge gate driver the driver of the gate on the lower side. In this paper, a brief overview of the functionality of such a converter is provided and more test results are provided to confirm its effectiveness.

Objective:

Multi-phase booster converter, which is the topology chosen for boosting Inverter design, circuits must be mathematically analyzed, designed and maintained Simulated to verify the desired result. Appropriate feed-back control method the load must be applied to produce the desired output despite the variation in the input voltage and any other converter parasitic effect. It should be after the booster circuit is designed Cascaded with inverter for DC-AC conversion. Need simulation include a loss factor such as the DC resistance of the inductor, the equivalent series resistance on the resistance of the capacitor and power semiconductor switch. Small signal of multi-phase and multi-stage boosters is required for AC modeling to assess its stability and design a control system.

II. LITREATURE REVIEW

The PID auto-tuning technique was proposed by Stefanutty et al. Al., (2005) [٤٨] for the control of DC - DC boost converters using relay feedback techniques. The controller parameter tuning is introduced for small interruptions at the output voltage by inserting relays into the controller feedback and confirming the operation of the closed loop during the auto-tuning process. The controller parameters are tuned as the PID regulator is connected to the relay loop based on the dynamic requirement of the converter. (Liping, et al., 2009) [2.] Introduced PID and dimmer controller for DC-DC converter implemented in digital signal processors (DSPs) and faster for different load variations. A transient response and a steady state response were achieved. To reduce the parasitic resistance and excitation effects of the output capacitor of the DC-DC converter, it induces noise at the output, which is lower than that proposed by the PID controller (Capot, et al., 2010) [38]. It connects the load current feed-on and inductor current dynamic controller to improve the bandwidth and phase margin of the system. Elshar, et al. Al., (2010) [16], Elsher, et al. All., (2011) [17] proposed the PID controller for the PV-DC booster converter of the PV system to satisfy the dynamic load variation. The PID controller is tuned by a genetic algorithm (GA) to control the output voltage and the dimmer-PID to tune the derivative and integral gains in proportion to the yield of low overshoot and low waveform content. Controller implemented. The smart controller changes the function cycle of the booster converter, which produces a constant output voltage depending on the input voltage and loading conditions. The fixed frequency frequency non-linear controller was proposed by Agostinelli et al. Al., (2011) [2] to control the force switch that extends the buck-boost converter based on the sliding mode control strategy [2] used for power amplifiers. The main resolution of this controller is to increase the dynamic performance of the system and the power efficiency of the converter. Fumio and. Al., (1991) [20] designed a dimmer controller to control the cook converter, whose operation was verified by simulation. The outputs of the dimmer and PID controllers are compared to various elements such as output transient, line and load regulation. Blur controller reduces output display time. Conducts a detailed study of fuzzy logic controllers (Lynn et al., 1993) [44] using multiple control methods for buck for DC-DC power converters operating at purification switching frequency and improving converters to achieve dynamic performance and less stability. State error. The dimmer controller was proposed by de Fajivedo et al. Al., (1993) [14] for DC-DC PWM buck converter to control the output of the ZVZCS converter. Simulation results for the switching frequency of 50 KHz indicate good load and line control from no-load to full-load state and full-load to noload state. A new dimming control algorithm for dimmer-PID feedback control has been proposed for the Quasilinear DC-DC Hir-Boost converter model, which outperforms the usual dimmer control technology. The result obtained from the output of the converter shows an improvement in its performance when the converter is subjected to load variation and input interruptions. Khang Etc. Al., (1995) [18] proposed a buck converter, boost converter and dimmer controller for the buck-boost converter to control and regulate initial transactions. Simulation took place in the PSPICE and a variation in the output voltage was observed for the initial transient and load current variation. The current-mode controlled buck converter has an advantage over the dimmer controller due to its faster response and provides better control over the phase change of load, while the dimmer controller for the boost and buckboost converter is in a less stable state. Show error and better inconsistent response. Load variation in current-mode control mode. Jordi, et al. Al., (1996) [36] created a dimmer controller to control the output voltage of the buck converter, whose design included inductor and capacitor resistor losses, while transistors and diodes were considered ideal; And IF-THEN rules were obtained describing the regulatory action for each state. Simulations are performed for both initial and transient control for a variable frequency frequency of 50 kHz. This method demonstrates the importance of dynamic toss knowledge and this design process can be applied to other DC-DC converters. Blur controller designed by Wing-Chi, et al. Al., (1996) [73] to control DC-DC converters such as buck, boost and buck-booster converters, whose simulation results demonstrate the feasibility of the algorithm and how the rule base evaluates the controller's performance. This was implemented with the Texas Instrument digital signal processor TMS 320C50 and the three converters operate at a limited switching frequency of 100 kHz. The output voltage of the converter is modeled to prevent unwanted noise of the converter during the off-interval of the switching cycle.

III. SYSTEM METHODOLOGY

A novel approach to achieving maximum static gain on an undivided dc-dc converter is presented in this concept. A common lifting converter has been developed to increase power to a higher level and the first few stages have multiple components to avoid high current pressure on the switch. Multi-phase configuration can significantly reduce inductor current and voltage effect due to the operation of the same phases and related phases, thereby reducing the filter size. The operating principle and the construction process are presented in various phases, Multi-Stage and Multi-Phase integrated Multi-Stage converter. The main application of the Multi-Phase Multi-Stage booster has been identified as being in a battery sourced Inverter design, which replaces the step-up transformer.

With the growth of a battery-powered app, there is a great need for better performance, smaller size, lower cost and higher step dc-dc converter. Typical applications are a hybrid vehicle, uninterrupted power supply and a renewable energy system such as solar. The climbing stage is generally a critical point for the construction of highly efficient transformers due to the input performance of high input and output power, so detailed research is done, in order to define the local foundation for high performance action. An integrated magnetic converter such as a fly back or push-pull converter can be used to achieve maximum static gain. However, the volume of the power transformer will greatly affect the size of the converter. Leak inductance can produce energy pressure; high frequency switching will reduce the efficiency of the transformer itself and will create electromagnetic interference (EMI), thereby reducing the efficiency of the converter. A conventional renewable converter, which can offer a high rise power gain but with high power charge and current pressure on semiconductor switching, high performance cycle performance.

The concept includes stable condition analysis, small signal modeling and closed loop control of the Multi-Stage Multi-Phase boost booster converter with the Type III compensator used. All variations in modeling, modeling and construction are taken into account the transformer effect effects such as copper loss and semiconductor loss. The sequence of integrated switches is discussed with the phase three converter. High frequency Inverter charging performance discussed when Inverter acts as a rectifier and booster in buck mode. Multi-Phase Multi-Stage booster designed to be validated with MatLab / Simulink.

IV. DC-DC HIGH VOLTAGE BOOST CONVERTER

The step-up stage normally is the critical point for the design of high efficiency converters due to the operation with high input current and high output voltage, thus a careful study is required in order to define the topology for a high step-up application [8]. From the section 1.3, with High Frequency Link Inverter, to reduce size and weight of the transformer the switching frequency of the converter was increased, but it ended with switching losses and the design of a customized highly efficient transformer is too difficult [3]. To avoid switching losses, resonant converter2 and the DC Link inverter topology were chosen, but it too ended with inefficiency in implementation. Thus, there is need for an alternate booster, which doesn't incorporate transformer as boosting component. As per the thumb rule used for the design of conventional boost converter, the voltage cannot be stepped up more than four times the input voltage, i.e. the maximum duty ratio allowed is 0.75. For very high static gain in conventional boost converter, the switch is stressed by very high input current during ON period of switching cycle and very high output during OFF condition. The booster should be of small size, highly efficient, and be easy in control on load variations.

BOOST CONVERTER WITH VOLTAGE MULTIPLIER CELL

The conventional boost converter is used along with voltage multiplier circuit to step up the voltage to a very higher level [2]. The Figure 6-1 below shows a boost converter cascaded with the voltage multiplier cell. For very high static gain many such voltage multipliers can be cascaded. The basic concept is to use a voltage doubler circuit composed of diodes and capacitor, as one multiplier cell.

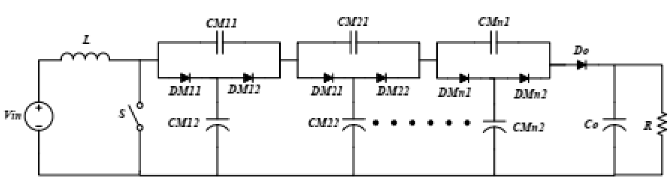

Figure 1: Boost Converter with Voltage Doubler Circuit

For a boost converter, composed of M cascaded voltage multiplier circuit, the output voltage will be multiplied by the factor (M + 1). Thus the static gain of the proposed converter is given by,

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$$q = \frac{V_o}{V_{in}} = \left(\frac{M+1}{1-D}\right)$$

Where, M – number of voltage multiplier cells D - Duty cycle the nominal duty cycle is defined by,

$$D = \frac{V_o - V_{in}(M+1)}{V_o}$$

Considering the project, the first stage booster has to boost the voltage from 12V battery to around 380V to 400V. It results the static gain of 32 and the max duty ratio allowed as per thumb rule is 0.75. Thus, the number of voltage multiplier stages required is 8. It does not replicate a good design to have boost converter with 8 voltage multiplier stages. For the inverter used in On-line UPS, the settling time is very critical but the inverter incorporating boost converter with voltage multiplier cell takes more time to settle to its final voltage level.

MULTI-STAGE BOOST CONVERTER

It is a novel approach where a cascaded boost converter results in the output voltage increasing in a geometric progression that to with a simple structure [10].

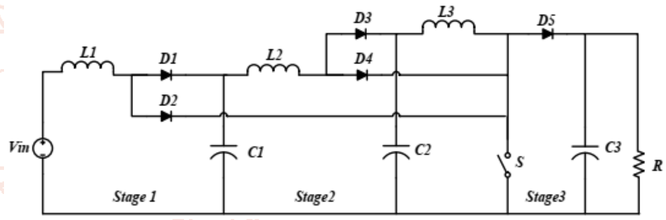

Figure 2: Multi-Stage Boost Converter with single switch

This converter topology suits much better for boosting the voltage from 12V battery to around 380V with the duty ratio of less than 0.7. In the case with high step- up static gain, as the voltage level is raised to higher level correspondingly the input current too raises to a high level, power equality [11]. Thus, with the Multistage Boost converter discussed, the high input current has to flow through the switch S and it proves to be stress on it. So a slight variation in the converter can be made by replacing the diode D2 and D4 with switch S1 and S2 and connecting to the ground.

MULTI-PHASE BOOST CONVERTER

To avoid high current stress on the switch and inductor of the boost converter, the conventional boost converter can be multi phased, thus higher efficiency is ensured [1], [7]. The multi-phase booster can be achieved by adding more parallel legs to the conventional boost converter [28], [29]. The Figure 6-4 below shows a threephase boost converter, where two more legs are connected in parallel with the conventional one. A suitable algorithm is required for control switches to achieve the interleaved switching sequence [6]

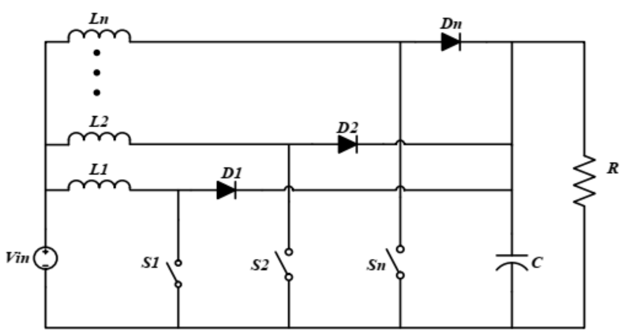

Figure 3: Multi-Phase Boost ConverterIntroduction

Because of the phase difference in the multi-phasing the inductor ripple currents tend to cancel each other, resulting in a smaller ripple current with increased frequency flowing into the output capacitor [9]. The output voltage will be same as that of the conventional converter, but the input inductor current will be reduced by the number of phases.

Multi-phase converters reduce the input and output ripple currents by interleaving the gate pulse for paralleled power stages. With a proper choice of phase number, the output ripple voltage and the input capacitor size can be minimized without increasing the switching frequency.

MULTI-PHASE MULTI-STAGE BOOST CONVERTER

By combining the advantages of the Multi-Stage and Multi-Phase Boost converter, a novel topology is structured called Multi-Phase Multi-Stage Boost converter, as shown in figure. Thus, high current at the initial stage is shared due to multiphase and the high static step-up gain is achieved due to multi-stage.

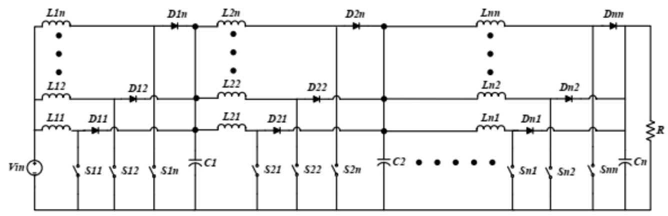

Figure 4: Multi-Phase Multi-Stage Booster

V. EXPECTED OUTCOMES

Short-signal AC models of multi-phase and single-phase boosters will be develope to assist in control design and they will analyze the right half-plane zero complexity. A normal voltage-mode controlled booster transfer function was obtain from the suggested model and the frequency response was analyzed using a bad diagram. Independent control strategies were used for individual steps to design a more direct control system. Analysis, modeling derivative and simulation and closed-loop control designed for continuous circulation mode for improved functional properties. Type III compensators were employed in replacing the system because the maximum phase boost could be achieved. The compensation system has improved phase margin and close-loop performance. With the comprehensive operation of the Type III compensation, a high DC gain is achieved for tight output voltage control. Improvements in frequency response after compensation were compared using the Bod plot. With the correct position of the pole and zero fillings, the RHP zero complexity is eliminated..

VI. CONCLUSION

The work presented in this paper explored the multi-stage booster topology for high-frequency inverter applications, which will be eventually replace the high-frequency step-up transformers. This idea discusses static-state analysis, short-signal AC modeling, and closed-loop control of a three-phase boost converter. Problems related to high-frequency transformers to increase voltage are discussed. Defects of optional voltage boosting power stage topology such as booster converter with voltage multiplier cell options are also discussed.

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