DESIGN OF ISOLATED HIGH GAIN DC-DC CONVERTER FOR LOW VOLTAGE INPUT DC SOURCE

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Abstract -**This paper presents a resonant converter for dc-dc converter to improve the voltage gain. Here LLC resonant converter is composed of two capacitors and one resonant inductor. The resonant converter has low switching losses due to zero voltage switching operation. Due to low switching losses, LLC resonant converter is operate at high switching frequencies, while maintaining high efficiency. A constant frequency phase shift control scheme between the primary and secondary controls are designed. Constant frequency switching that equals the resonant frequency of the resonant tank reduces magnetic simplicity.**

Index terms: **Resonant converter, Basic dc-dc converter, Voltage conversion ratio.**

I. INTRODUCTION

A High gain dc-dc converter is used in many application as interfaces between renewable energy, high voltage DC buses and grid integration. Buck, Boost, BuckBoost, Cuk, Zeta circuits are the mostly used configurations. It ideally works by adjusting duty cycle to increase the voltage conversion ratio. These converter can work only within specific range. Normally Transformers, Coupled inductors, Cascade structures, switch-capacitors and voltage multipliers are used to increase the voltage conversion ratio. The use of transformer will increase the size and cost of the circuit.

High efficiency and gain can be achieved by providing the method of half bridge current is fed to the converter for voltage conversion. High efficiency can also be achieved by using the following method of ZVS pulse width modulation.[3]High efficiency can be achived and losses are to be reduced. By using the method of a step up single switch quadratic buck boost converter. [5] The voltage gain is achieved in a less time by using the method of "Extended phase shift control of isolated bidirectional DC-DC converter for power distribution in Microgrid" and it needs auxilary switches for voltage balancing for Zero Voltage Switching ZVS.[7]By using the method of soft switching implementation the losses are to be reduced. The main disadvantages is it requires a dual control scheme seperately for primary and secondary controls. By using the method of DC DC converter design based on the bidirectional switches and galvanic isolation high gain can be achieved.[9]The combination of voltage multipliers and conventional boost converter can be used to reached the high voltage conversion.[10]

II. TOPOLOGY AND WORKING PRINCIPLE:

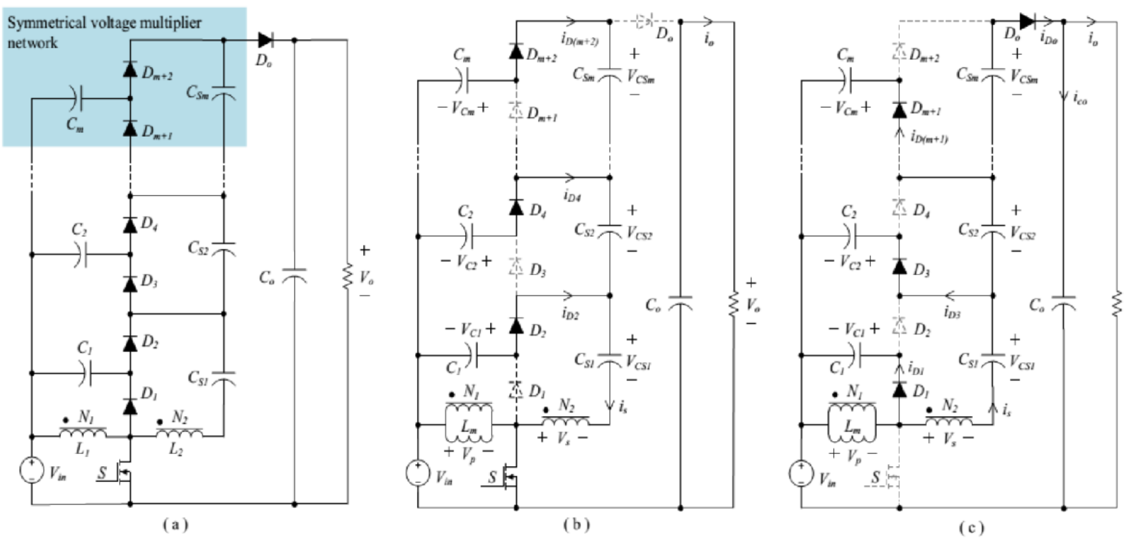

Fig 1.1: The proposed high step-up DC-DC converter (a) schematics; (b) state of switching ON;

(c) State of switching OFF

The voltage gain to be increased and the leakage energy can also be recycled by combined the clamp circuits to the voltage lift circuits. Voltage multipliers are integrated with the coupled inductors for increasing the voltage gain and reduce the voltage stress on diode. The integration of half wave voltage multiplier and integrated clamp circuit is also used to raising the gain of the circuit.

The proposed system has some features,

- The system can be controlled by a single switch. So this topology can be easily extended without adding extra windings for ultra-high step-up conversion ratio.
- Voltage spikes are avoided, and the conversion efficiency is increased by using the lossless clamp circuit in the proposed system.

SVMN is abbreviated from the symmetrical voltage multiplier networks. It is one of the component of proposed system. SVMN contains two diodes and two capacitors for achieving high step up conversion ratio.
The voltage across the capacitors can be determined as,
When the power switch is turned on condition

$$\begin{cases} V_{CS1} = V_{C1} + (1+n)V_{in} \\ V_{CSi} = V_{Ci} - V_{C(i-1)} \quad i = 2,3,\ldots\ldots m \end{cases} \quad (1)$$

The voltage across the capacitors can be expressed as,
When the power switch is turned off condition

$$\begin{cases} V_{C2} = V_{CS1} + (1+n)V_{C1} \\ V_{Ci} = V_{C(i-1)} + V_{CS(i-1)} \quad i = 3,4,\ldots\ldots m \end{cases} \quad (2)$$

$$\begin{cases} V_{C1} = \dfrac{D}{1-D}V_{in} \\ V_{Ci} = \dfrac{(i-1)+(i-1)n+D}{1-D}V_{in} \quad i = 2,3,\ldots\ldots m \end{cases} \quad (3)$$

$$\begin{cases} V_{CS1} = \dfrac{1+n-nD}{1-D}V_{in} \\ V_{CSi} = \dfrac{1+n}{1-D}V_{in} \quad i = 2,3,\ldots\ldots m \end{cases} \quad (4)$$

III. DESIGN AND GUIDELINES:

A 100KHZ switching frequency is suitable for 40V-60V input 400V/400W- output Prototype. The parameters of resonant tank L_r and C_r are designed by the main constraints resonant frequency and output power. The DC voltage on the capacitor is equal to half of the output voltage. The DC voltage is comparatively higher then the maximum voltage ripple. The value of resonant capacitance is,

$$C_r > \frac{P_o T_S}{2V_o^2}$$

Let assume V_O=400V, P_o=400W and T_S=10µs in the above formula, we get C_r>12.5nF

IV. VOLTAGE CONVERSION RATIO:

The converter works in two modes namely buck and boost mode. Buck mode for primary phase shift control and boost mode for secondary phase shift control.The voltage conversion ratio of the proposed converter is,

Mccm=V0/Vin= (3+2nK)/(1-D)

In voltage gain the effect of coupling coefficient is insufficient. Let neglected the leakage inductor and assume k=1, the ideal transfer relationship can be written as

Mccm =V0/Vin =(3+2n)/(1-D)

The Converter operates in boost mode when the conversion ratio G>1.Here the primary side $d_{\varphi P}$ is constant and secondary side $d_{\varphi P}$ is used to regulate the output voltage.

The Converter operates in buck moode when the conversion ratio is G<1.Here the primary side $d_{\varphi P}$ is used to regulate the voltage.

V. HARDWARE IMPLEMENTATION:

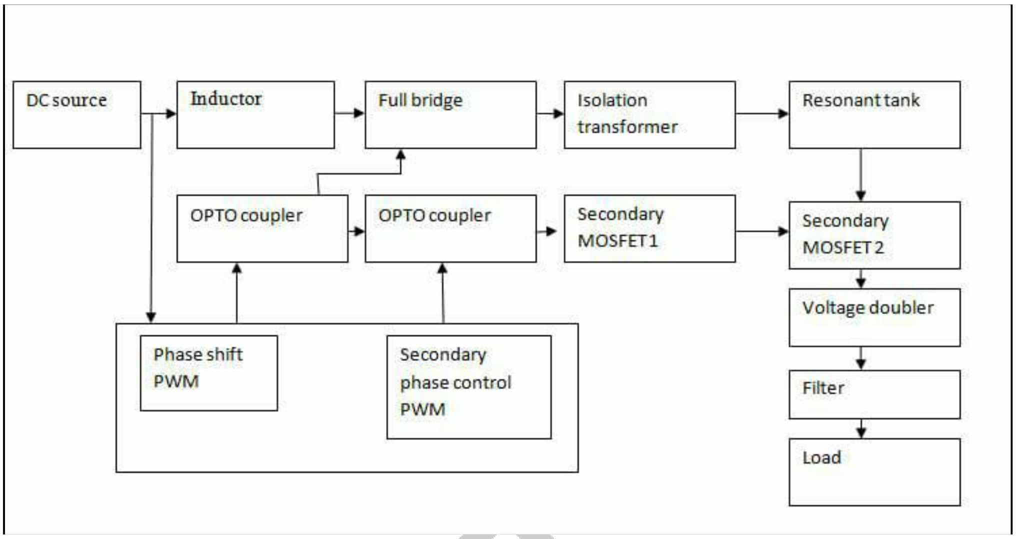

Figure 1.2: Block diagram of Proposed system

- A PIC microcontroller is used to generate the required PWM which is used to switch the gates of the mosfet.
- The microcontroller is been isolated using a opto coupler which acts asa isolation between the power circuit and the control circuit.

VI. HARDWARE PROTOTYPE

Fig.1.3.Hardware setup

VI. EXPERIMENTAL RESULTS:

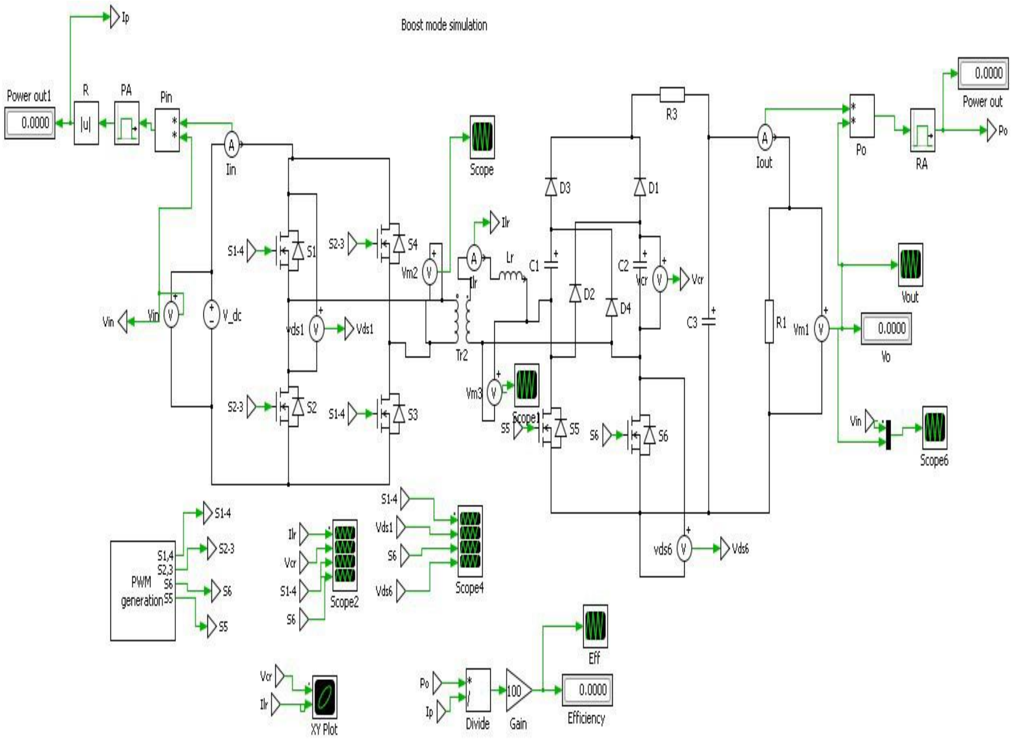

Figure 1.4: Simulink model of Resonance based High gain converter-open loop

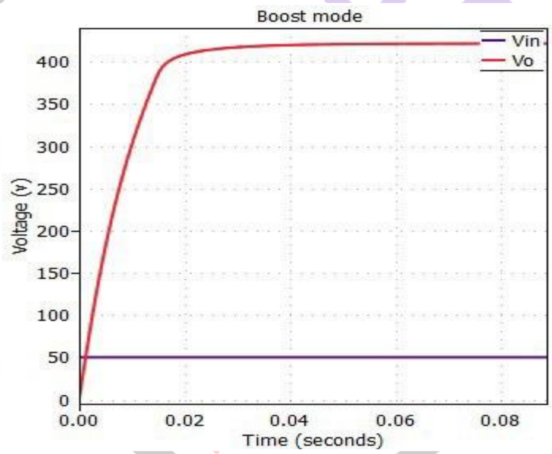

Figure 1.5: Boost mode waveforms

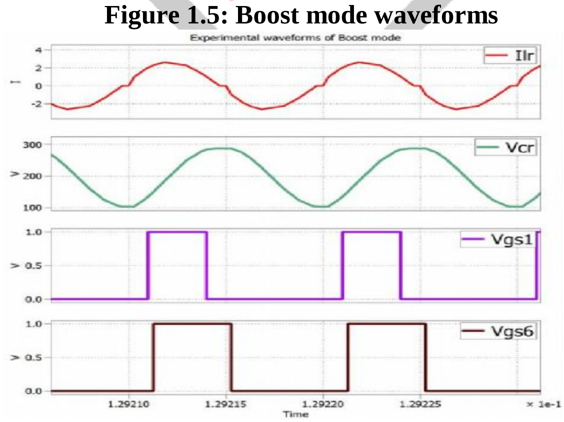

Figure1.6: Input and Output Voltage

The figure 1.5 shows Input and the Output voltage of the converter and PWM driving schemes of the converter.It provides a boost operation with Vin= 50V and Vout=421V.

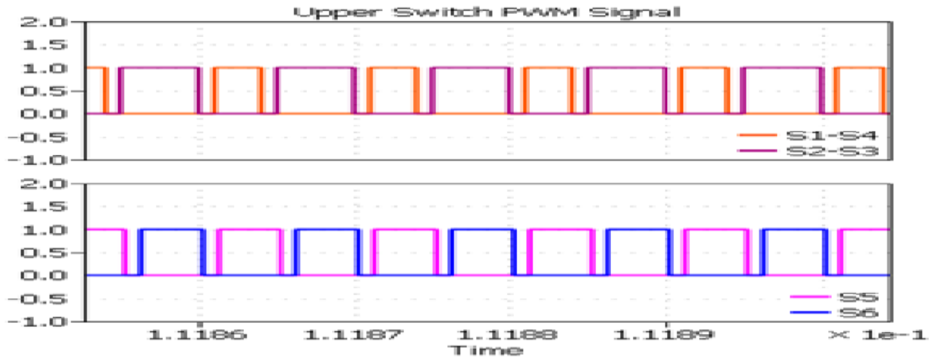

Figure 1.7: PWM signal for switches

The primary side switches S1 & S4 operates with a duty of 50% whereas S2 & S3 operates with phase shift control of 1µs with 30% duty. The secondary side switches operates with 45% duty.

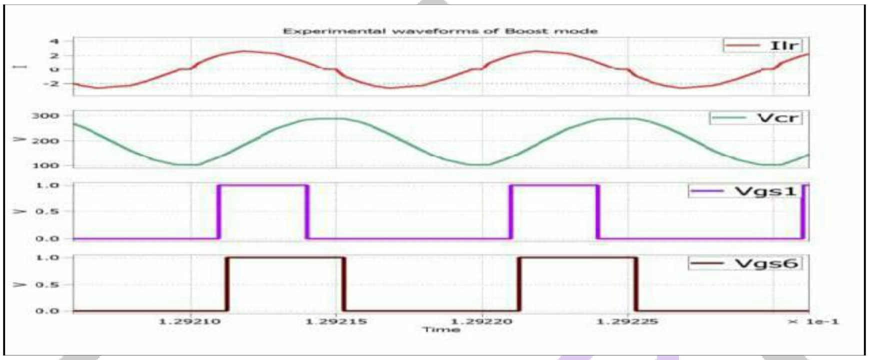

Figure1.8: Resonant state waveforms

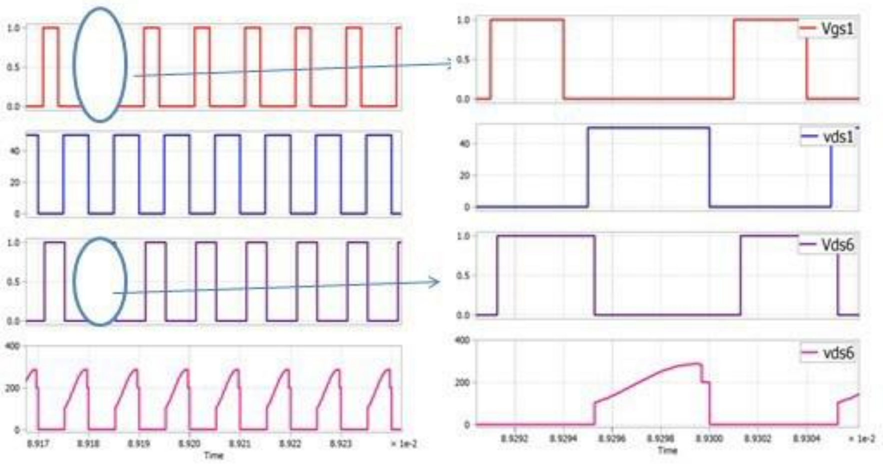

Figure 1.9: Soft switching waveforms of the switches S1 and S6

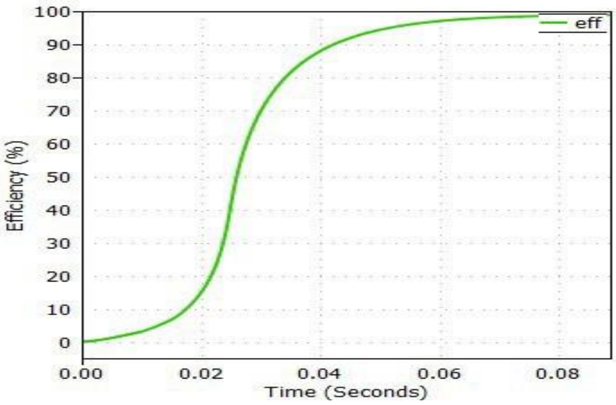

Figure 1.10: Proposed system Efficiency

CONCLUSION

To achieve a high efficiency for low voltage input dc sources the resonant converters with constant-frequency phase-shift control is proposed in this paper. The Design of the resonant converters with constant-frequency phase-shift control are designed to achieve high efficiency over a wide operating range for applications such as the converter provides efficiency over a range , With the enhanced efficiency and high power control this converter can be applied to low voltage input dc-dc conversions.

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