



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJIRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 11, Issue 8, August 2022

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.118

9940 572 462

6381 907 438

ijirset@gmail.com

www.ijirset.com

Soft Switching Boost Converter using a Auxiliary Resonant Circuit

Suraj Phadte¹, Noah Dias²

P.G. Student, Department of Electrical & Electronics Engineering, Goa Engineering College, Farmagudi, Goa, India¹

Associate Professor, Department of Electrical & Electronics Engineering, Goa Engineering College, Farmagudi, Goa, India²

ABSTRACT: AC supply is widely accessible at various line frequencies. The maximum applications containing electronic circuitry such as vehicle applications and battery chargers require regulated DC output supply. A appropriate AC-DC converter used in these applications. The switching power supply retail flourishing fast in day today's world. In order to make the design work, designing team not always get the suitable amount of output voltage as per the design data. Every time adding a surplus voltage supply design is not always a cost efficient. Boost converter is used for stepping up the DC voltage. In these there occurs a switching losses. This paper presents soft switching for DC-DC boost converter using an auxiliary resonant circuit. By using the said circuit the switching losses of boost converter are reduced. Basically boost converters have a snubber circuits where switching losses are dissipated in external passive resistors which is called as hard switching. After adding an auxiliary resonant circuit, the overall efficiency is increased due to decreased in switching losses. Simulations are carried out in LTspice simulator to verify the theoretical analysis.

KEYWORDS: Boost converter, auxiliary resonant converter, diodes, capacitors and inductors

I. INTRODUCTION

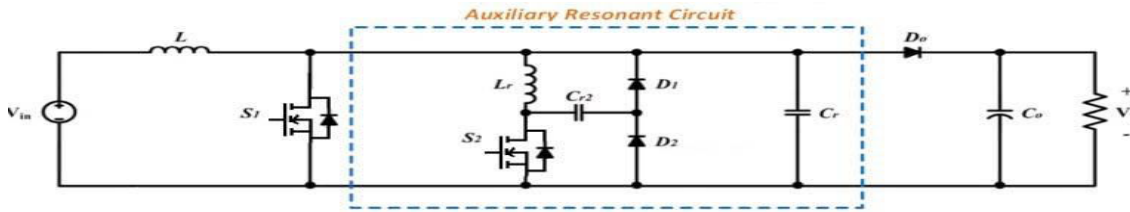
Boost converter is one of the most crucial and widely used in devices of latest applications around the globe. Till date Boost converter with snubber circuit are used widely which causes switching losses and dissipated in external resistors leading to higher switching losses and low overall efficiency. Now a days Boost converter uses IGBT switches which are having multiple following properties such as voltage rating, high current, fast switching, low power gate drive. These properties causes various disadvantages such as at high blocking voltage the switching frequency is minimised to low values. Boost converter with auxiliary resonant circuit overcomes these problem in best possible way. Because Boost converters are used widely, our aim is to minimise the switching losses and therefore abundant amount of power is saved from wastages.

II. RELATED WORK

A lot of former research has been used to bring off the project which contains various data on converter simulation and design. Reference [1] gives an overview of Soft Switching Boost Converter with auxiliary resonant circuit. In this paper simple auxiliary resonant circuit (SARC) is proposed for soft switching. To minimise the switching losses zero current switching and zero voltage switching are adopted. Reference [2] adds on soft switching boost converter with H-I bridge auxiliary resonant circuit. As compared to conventional hard switching boost converter this circuit has better efficiency of about 96%. The efficiency is improved by reducing switching losses by techniques given in references [1] to [9]. Due to large overlapping area of voltage and current in hard switching the switching losses are more. The switching losses are proportional to switching frequency hence higher switching frequencies are not used. By adopting zero voltage switching (ZVS) and zero current switching (ZCS) switching frequency is increased and switching losses are minimized. References [1] to [5] verify the above concepts. Operations with wide range of load and duty cycle can't be performed by above techniques hence zero voltage transition and zero current transition techniques are adopted. These are given in [5] to [8]. Zero current transition (ZCT) and Zero voltage transition guarantees soft switching with minimum switching losses.

III. PROPOSED SYSTEM

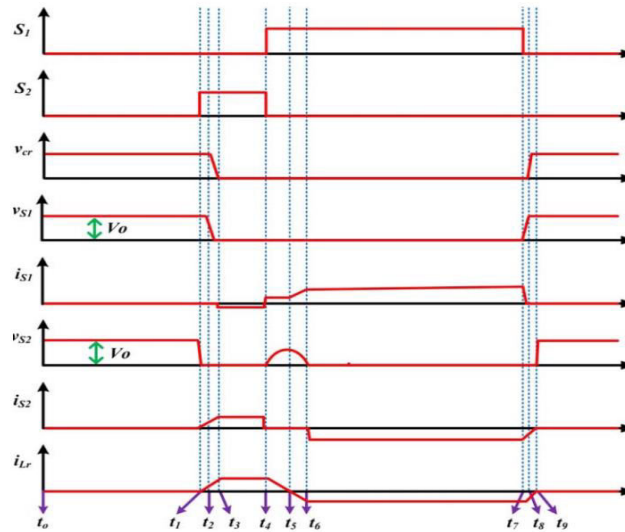
In these proposed system we will see the schematic and modes of operation that how the boost converter with auxiliary resonant circuit works.



Proposed soft switching boost converter

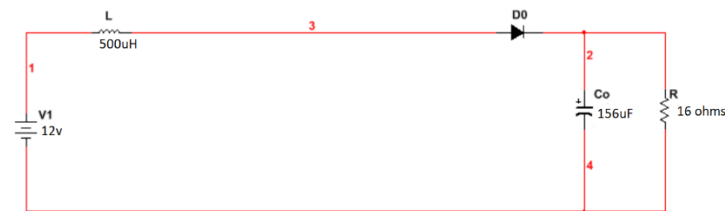
In this figure, a general Boost converter with auxiliary circuit which consist of switch, inductor, capacitors and diodes.

The below figure represents the waveform of operation modes.



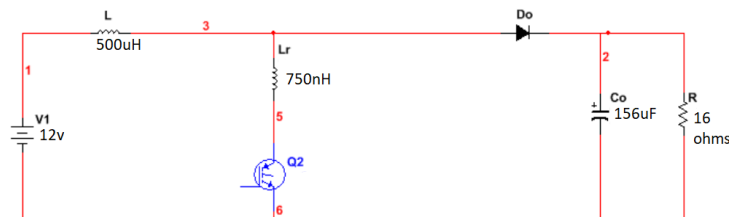
Further nine modes of operation are given below :

Mode 1 :



In this all the switches are turned off

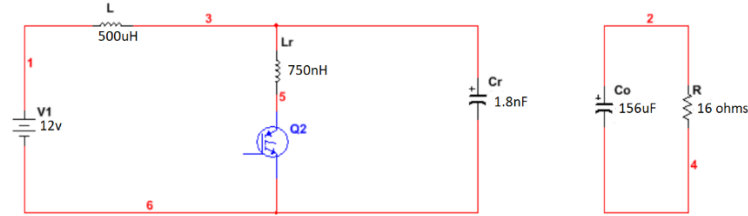
Mode 2 :



Switch S2 is turned ON

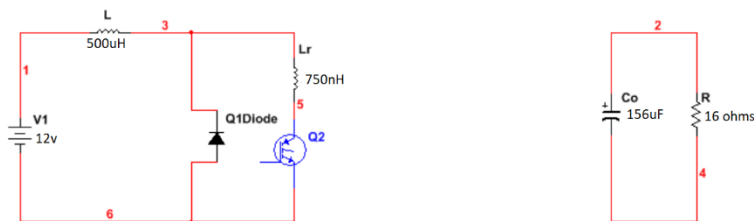


Mode 3 :



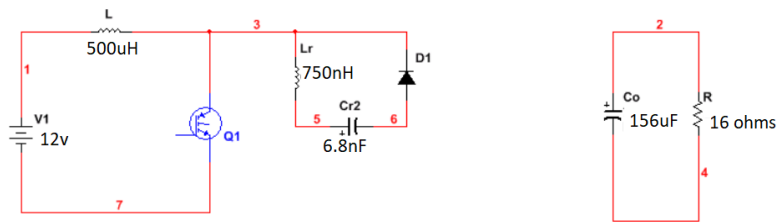
Main diode Do is turned OFF

Mode 4 :



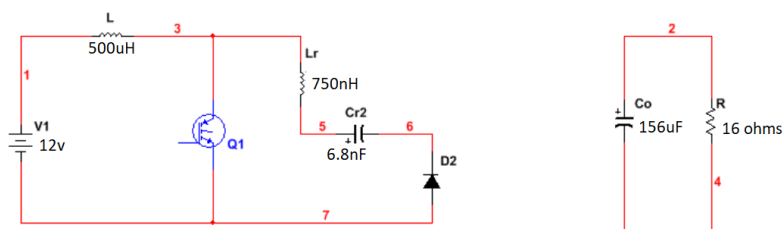
Main switch S1 is turned ON

Mode 5 :



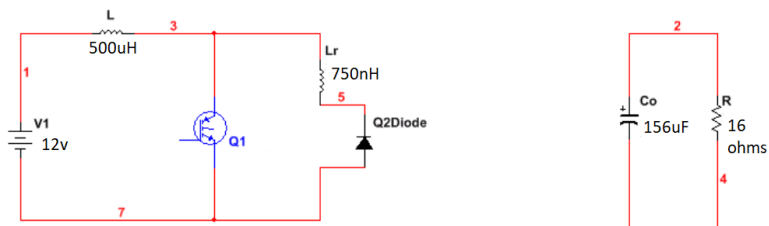
Auxiliary switch is turned OFF

Mode 6 :



Current flow reverses through resonant inductor Lr

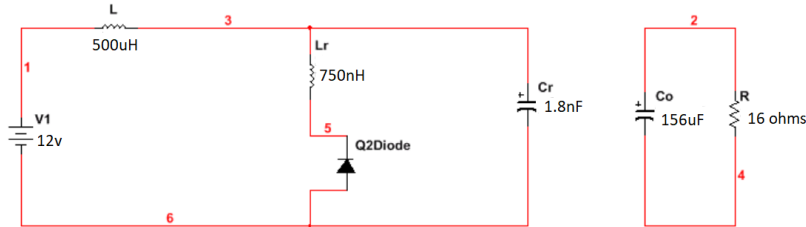
Mode 7 :



Auxiliary switch turns ON

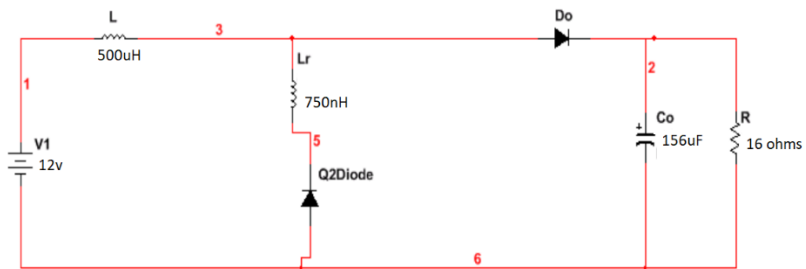


Mode 8 :



Main switch is turned OFF

Mode 9 :



Diode Do turns ON

IV. DESIGN OF BOOST CONVERTER WITH AUXILIARY RESONANT CIRCUIT

A. Output current and output resistance

$$P_o = 36W \quad V_o = 24V \quad V_{in} = 12V$$

Let $\Delta V_o = 1\%$ of V_o

We know that, $P_o = V_o \cdot I_o$

$$I_o = 1.5A$$

Also we know that, $V_o = I_o \cdot R_o$

$$R_o = \frac{V_o}{I_o} = \frac{24}{1.5}$$

$$R_o = 16 \Omega$$

For a conventional Boost converter

$$\frac{V_o}{V_{in}} = \frac{1}{1 - D}$$

Where: $D = D_{main} + D_{aux}$

Since $V_{in} = 12V$ and $V_o = 24V$, $D = 50\%$

Hence let $D_{main} = 45\%$ and $D_{aux} = 5\%$

B. Design of Inductor and Capacitor

$$L_{min} \geq \frac{(1-D)^2 \cdot DR}{2f}$$

$$L_{min} \geq 500uH$$

So let $L = 560uH$

$$\text{Also we know that } \frac{\Delta V_o}{V_o} = \frac{DT}{RC}$$



$$C = \frac{DV_o}{\Delta V_o.R.f}$$

$$C = 156\mu F$$

C. Design of Resonant Inductor and Resonant capacitor

$$C_r = 20 * \text{Output capacitance}$$

$$C_r = 1.8nF$$

Assume $L_r = 750nH$

$$\pi\sqrt{L_r C_{r2}} \leq \frac{0.1}{F_s}$$

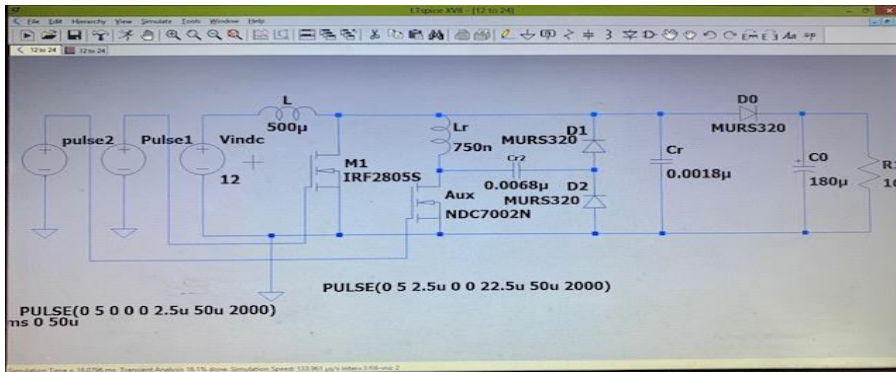
$$C_{r2} \leq 3.38\mu F$$

$$C_{r2} = 6.8nF$$

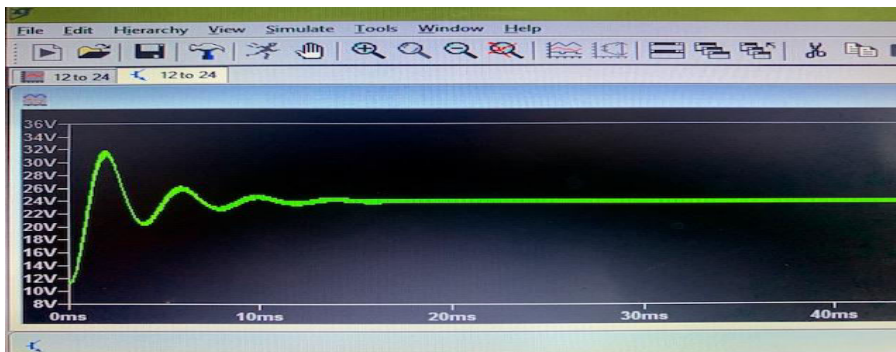
V. SIMULATION RESULTS

Open loop simulation :

The below figure is open loop simulation circuit is performed in LTspice simulator.



The output voltage obtained is 24V is shown in below figure



VI. CONCLUSION

In this paper we discussed a soft switching boost converter topology using an auxiliary resonant circuit. The schematic proposed boost converter with auxiliary resonant circuit and each mode of operation is simulated in LTSpice simulator software. The design is for 12V to 24V boost converter with higher efficiency due to soft switching as compared to the conventional boost converter. The switching losses are reduced by soft switching and the efficiency of the converter is improved.

REFERENCES

- [1] S.H. Park, G.R. Cha, Y.C. Jung and C.Y. Won, "Design and application for PV generation system using a soft switching boost converter with SARC," IEEE Trans. On Industrial Electronics, vol. 57, no. 2, pp.515-522, February 2010.
- [2] S.H. Park, S.R. Park, J.S. Yu, Y.C. Jung and C.Y. Won, "Analysis and design of a soft switching boost converter with an HI-bridge auxiliary resonant circuit," IEEE Trans. on Power Electronics, vol. 25, no. 8, pp. 2142-2149, August 2010.
- [3] E.H. Kim and B.H. Kwon, "Zero-voltage- and zero current- switching full-bridge converter with secondary resonance," IEEE Trans. on Industrial Electronics, vol. 57, no. 3, pp. 1017-1025, March 2010.
- [4] Charles J. McAtee, Jai P. Agrawal and Hassan Moghbelli, "A 100 watt power supply using ZVS boost converter," Applied Power Electronics Conference and Exposition 1995(APEC 1995), Dallas(USA), March 1995.
- [5] Mirosław Luft, Elzbieta Szychta and Leszek Szychta, "Method of designing ZVS boost converter," Power Electronics and Motion Control Conference 2008(EPEPEMC 2008), Poznan(Poland), September 2008.
- [6] Hacı Bodur and A. Faruk Bakan, "A new ZVT-PWM DCDC converter," IEEE Trans. on Power Electronics, vol. 17, no. 1, pp. 40-47, January 2002.
- [7] R. Gurunathan and A. K. S. Bhat, "A zero-voltage transition boost converter using a zero-voltage switching auxiliary circuit," IEEE Trans. on Power Electronics, vol. 17, no. 5, pp. 658-668, September 2002.
- [8] Chien-Ming Wang, "Novel zero-voltage-transition PWM DC-DC converters," IEEE Trans. on Industrial Electronics, vol. 53, no. 1, pp. 254-262, February 2006.
- [9] R. Gurunathan and A. K. S. Bhat, "ZVT boost converter using a ZCS auxiliary circuit," IEEE Trans. on Aerospace and Electronic System, vol. 37, no. 3, pp. 889-897
- [10] H. Bodur and A. F. Bakan, "A new ZVT-ZCT-PWM DC-DC converter," IEEE Trans. Power Electron., vol. 19, no. 3, pp. 676-- 684, May 2004
- [11] H. Bodur and A. F. Bakan, "A new ZVT-PWM DC-DC converter," IEEE Trans. Power Electron., vol. 17, no. 1, pp. 40--47, Jan. 2002.
- [12] S. S. Saha, B. Majumdar, T. Halder, and S. K. Biswas, "New fully soft-switched boost-converter with reduced conduction losses," in Proc. Power Electron. Drive Syst. 2005 Int. Conf., Jan., 2006, vol. 1, pp. 107--112.
- [13] N. Jain, P. K. Jain, and G. Joos, "A zero voltage transition boost converter employing a soft switching auxiliary circuit with reduced conduction losses," IEEE Trans. Power Electron., vol. 19, no. 1, pp. 130--139, Jan. 2004.
- [14] B. R. Lin and J. J. Chen, "Analysis and implementation of a soft switching converter with high-voltage conversion ratio," IET Power Electron., vol. 1, no. 3, pp. 386--394, Sep. 2008.
- [15] L. Jong-Jae, K. Jung-Min, K. Eung-Ho, and K. Bong-Hwan, "Dual series resonant active clamp converter," IEEE Trans. Ind. Electron., vol. 55, no. 2, pp. 699--710, Feb. 2008.
- [16] X. Wu, J. Zhang, X. Ye, and Z. Qian, "Analysis and derivations for a family ZVS converter based on a new active clamp ZVS cell," IEEE Trans. Ind. Electron., vol. 55, no. 2, pp. 773--781, Feb. 2008.



INNO SPACE
SJIF Scientific Journal Impact Factor
Impact Factor: 8.118



ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 **9940 572 462**  **6381 907 438**  **ijirset@gmail.com**



www.ijirset.com

Scan to save the contact details