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RC Snubber Circuit Design for Fly-back SMPS

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ABSTRACT: This research paper aims to investigate the design and implementation of snubber circuits for fly-back Switch Mode Power Supplies (SMPS). The paper begins by presenting the fundamentals of SMPS, including the fly-back topology and its various applications. It then discusses the need for snubber circuits and their working principle in improving the performance of fly-back SMPS, such as reducing voltage spikes and ringing. The paper proposes a design methodology for snubber circuits, including component selection, calculation of parameters, and simulation techniques. The proposed methodology is applied to a practical fly-back SMPS design, and the results are compared with conventional snubber circuits. The findings demonstrate that the proposed snubber circuit offers improved performance, including reduced EMI, lower voltage stresses, and improved efficiency. The paper concludes by highlighting the importance of snubber circuit design in fly-back SMPS.

KEYWORDS: SMPS, Fly-back, Snubber circuit, Ringing Frequency, Simulation.

I.INTRODUCTION

Switch Mode Power Supplies (SMPS) have become a ubiquitous source of power in various electronic systems due to their high efficiency, compact size, and reliable operation. Among various SMPS topologies, the fly-back topology is widely used in applications such as LED drivers, telecommunication systems, and power adapters due to its simplicity, low cost, and ease of implementation. However, fly-back SMPS can suffer from several drawbacks, including voltage spikes, ringing, and electromagnetic interference (EMI), which can degrade the performance and reliability of the system [8]. To overcome these issues, snubber circuits are commonly used in fly-back SMPS to suppress the unwanted transients and improve the overall performance. We know that Rectifier operate at frequency of 50 (or 60) Hz. In order to obtain negligible ripple in the output supply, physical size of filters circuit would be very large, which will make dc power supply bulky and inefficient [1]-[7].SMPS operate at higher frequency by rapidly switching on and off due to which ac ripple frequency rises which can be easily filtered by L & C combination circuit of small size.

II.WORKING OF FLYBACK SMPS

The fly-back topology is a commonly used Switch Mode Power Supply (SMPS) topology that operates by storing energy in the transformer during the switch on time and releasing it to the load during the switch off time. The fly-back SMPS consists of a DC voltage source, a switching device, a transformer, a rectifier, and an output filter. During the switch off time, the switching device is turned off, causing the transformer's magnetic field to collapse [15]-[17]. The energy stored in the transformer is released to the load through the transformer's secondary winding. The rectifier diode converts the AC voltage from the secondary winding to DC voltage, which is filtered by the output filter [13].

PWM controller gives pulse to the switch and it work in either open loop or closed loop by taking feedback from the secondary side or it will have its own winding for feedback purpose as seen in Fig.1. Duty cycle of the fly-back depends on the required output because we know that fly-back is one type of buck-boost converter with isolation as transformer [9]-[12], [14].

The output voltage is given by the formula,

$$V_o = \frac{N_s}{N_p}\frac{D}{(1-D)}$$

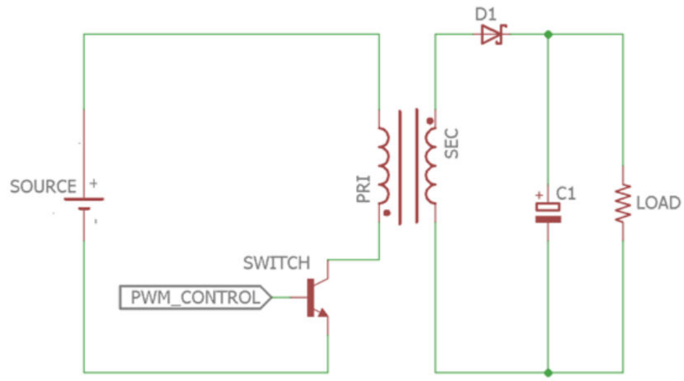

Figure 1: Fly-back SMPS Circuit

Fly-back SMPS have two circuitry operation,
1.Switch On
2.Switch off
In case if switch is turned on the primary side get charged up and when turned off the electrical energy is transferred to secondary and then to the load can see in Fig. 2 & Fig. 3.

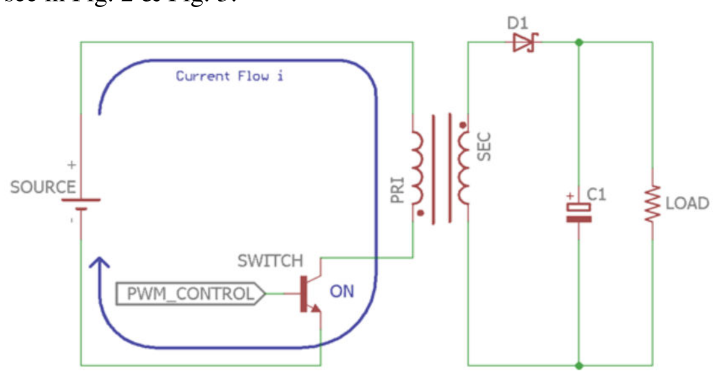

Figure 2: Current Flow During ON Period

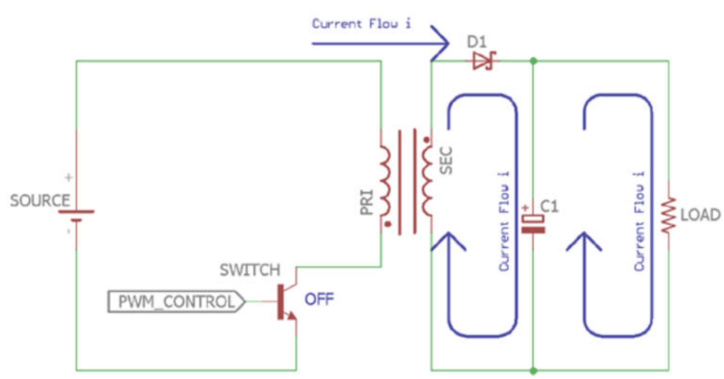

Figure 3: Current Flow During OFF Period

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The fly-back topology is suitable for low power applications, and it offers several advantages, such as simplicity, low cost, and ease of implementation. However, it also has some limitations, such as voltage stress on the switch and the rectifier diodes, high electromagnetic interference (EMI), and poor regulation.

To overcome these limitations, several techniques can be used, such as snubber circuits, soft switching, and active clamp. Snubber circuits are passive circuits that are used to limit voltage spikes and ringing, while soft switching and active clamp are techniques that provide zero voltage switching and reduce the voltage stress on the switch and the rectifier

III.NEED OF SNUBBER

A snubber circuit is a passive electronic circuit that is used to suppress voltage spikes and ringing in electronic systems. In fly-back topology it works by storing energy in the transformer during the switch on time and releasing it to the load during the switch off time. During the switch off time, the transformer's leakage inductance generates voltage spikes and ringing due to the parasitic capacitances and the switching action. These transients can cause voltage stress on the switch and the rectifier diodes, leading to reliability issues and reducing the system's efficiency.

Actual output is completely different from the ideal output waveform which is being shown in Fig.4 & Fig.5.

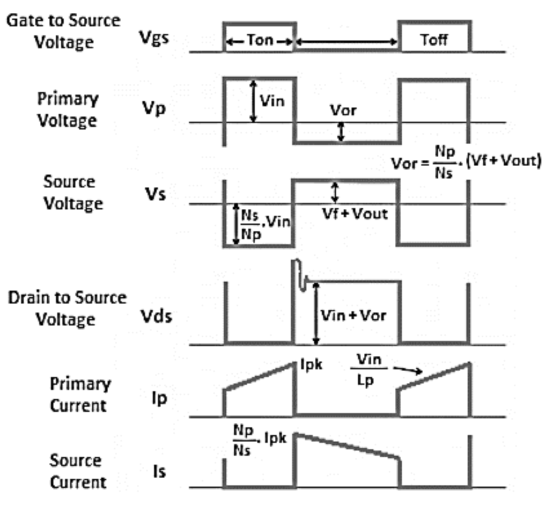

Figure 4: Ideal Waveform of Fly-back

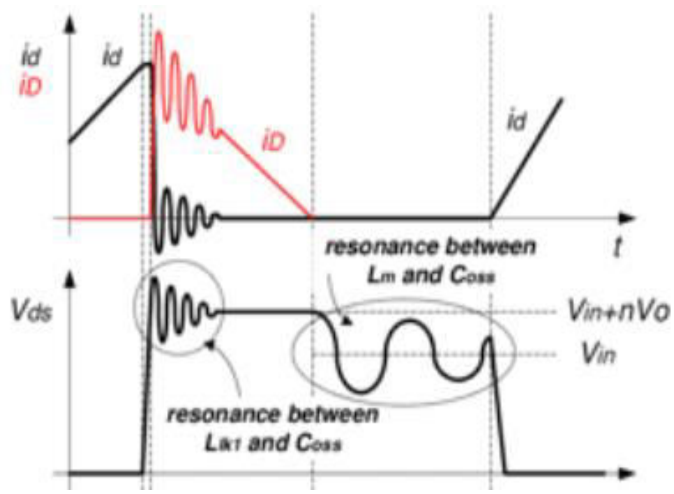

Figure 5: Actual Waveform of Fly-back

IV. SNUBBER DESIGNING

RC snubber circuit is used across MOSFET to damp the ringing on the drain of the FET as shown in Fig.6. In this resistor damp the LC resonance and the series capacitor prevent the voltages at switching frequency, so that it does not appear at resistor.

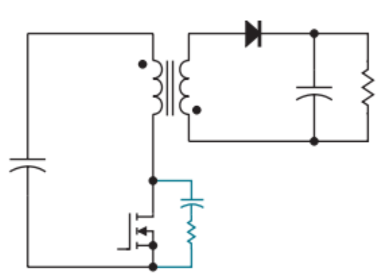

Figure 6: RC Snubber Parallel to FET

To implement the above sited circuit, we follow the steps given as under:

1. Measure the leakage inductance:
In order to measure it, simply short the secondary side of transformer, and after that set the meter into inductance mode, it will provide us actual inductance of primary side.

2.Measure the snubber Ringing Frequency:
To measure the ringing frequency, we just need to take two adjacent peak wave and adjust oscilloscope in such a way that we can measure the frequency between them as seen from Fig7.

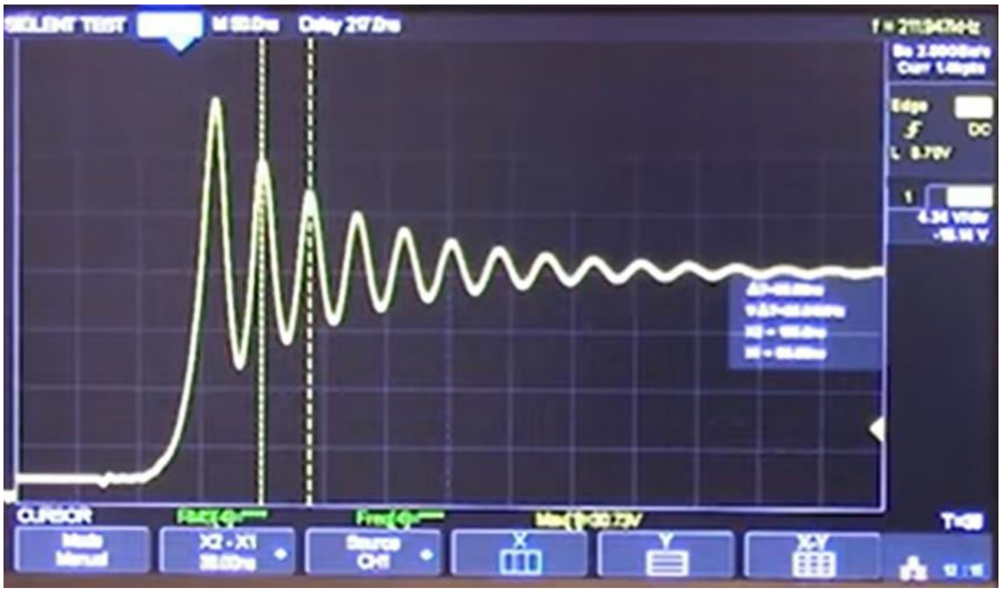

Figure 7: Ringing Frequency in Oscilloscope

3.Calculate the Snubber Resistor and capacitor:

To damp the ringing, we must measure the impedance of resonant circuit;
Given by;

$$Z = 2\pi f_r L$$

So, ringing can damp as good as if we connect equal value of resistor R as that of impedance Z. Capacitor is selected to minimize dissipation at switching frequency, which help resistor to be effective at the ringing frequency.

$$C = \frac{1}{2\pi f_r R}$$

4.Dissipation of snubber:
In order to keep the losses as low as possible we need to Design a snubber which have as much as low losses in the circuit.
Approximate Dissipation is given by;

$$P_{sn} = CV^2 f_s$$

V.SIMULATION RESULT

In the simulation we have compared the two-fly-back converter, without RC snubber and with RC snubber.Simulation shown in Fig.8 below consists of two circuit, which have following parameters. Responses are depicted in Fig.9.

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V_{in}	100V
V_o	7 V
N_p	100 turns
N_s	8 turns
Output Filter Capacitor	50 microfarads
Switching frequency	100kHz
Step Time	0.02 microsecond

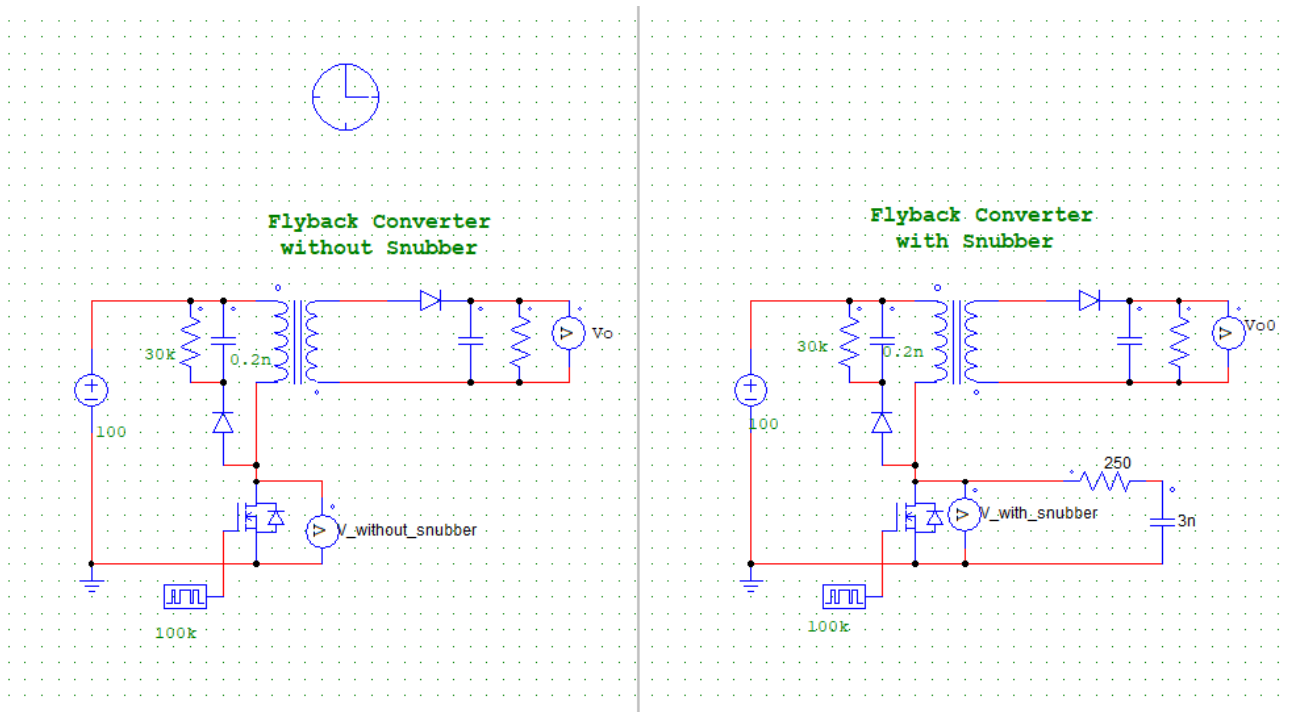

Figure 8: Simulation Circuit of Fly-back

.VI. CONCLUSION

In this paper we have come across the working of fly-back SMPS with circuit diagram and waveform. We have also compared the ideal and actual waveform of the SMPS. We extensively elaborated the snubber designing circuit step by step by measuring of leakage inductance, ringing frequency, measuring the required value of resistor and capacitor and dissipation due to snubber. We have also done simulation in P-sim software and obtained waveform for the circuits and its responses.

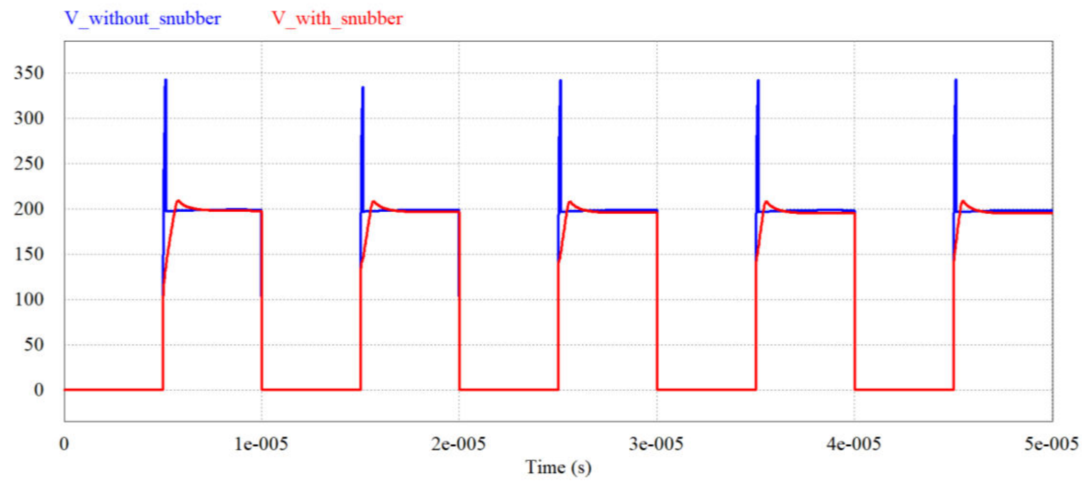

Figure 9: Comparison of Waveform across FET

REFERENCES

[1] M. H. Rashid, “Power Electronics Circuit, Device and Application” Third Edition, Published by Pearson Education Pte. Ltd, 2004.
[2] Ned Mohan, Tore M. Undeland, William P. Robbin, “Power Electronics Converters, Applications, and Design”, Published by John Wiley,2003.
[3] Henry Ott, “Foundations of Electromagnetic Compatibility Engineering”, Published by Wiley,2009.
[4] Bill Spence, “Snubber Design: Reducing SMPS EMI,” Lunch and Learn, Gentex Corp, 2014.
[5] Bogdan Adamczyk, “Foundations of Electromagnetic Compatibility with Practical Applications”, Published by Wiley, 2017.
[6] J. Humphreys, C.J. Hammerton, D.Brown,R.Miller,L.Burley,“ Power Semiconductor Applications-Switched Mode Power Supplies”, Philips Semiconductors, Chapter 2, Hamburg, 1994.
[7]Shoyama M., Tsumura T., and Ninomiya T., “Mechanism of Common-Mode Noise Reduction in Balanced Boost Switching Converter”, 35th Annual IEEE Power Electronics Specialists Conference, p.p 1115-1120, 2004.
[8] Ishan S. Chintawar, Sonalee P. Suryawanshi, Prashant Wanjar, “Linear PWM Strategy for SMPS”, IJSRCSEIT, Volume-1, Issue-2, March-April-2013, IF(7.254).
[9] A. Hassanpoor, J. Hafner and B. Jacobson, "Technical assessment of load commutation switch in hybrid HVDC breaker", IEEE Trans. Power Electron., vol. 30, no. 10, pp. 5393-5400, Oct 2015.
[10] C. M. Franck, "HVDC Circuit Breakers: A Review Identifying Future Research Needs", IEEE Transactions on Power Delivery, vol. 26, no. 2, pp. 998-1007, April 2011.
[11] L. Fei, L. Wenjun, Zh. Xiaoming, Y. Hua and F. Kun, "Solid-State Circuit Breaker Snubber Design for Transient Overvoltage Suppression at Bus Fault Interruption in Low-Voltage DC Microgrid", IEEE Transactions on Power Electronics, vol. 32, pp. 3007-3021, April 2017.
[12] J. Magnusson, R. Saers, L. Liljestrand and G. Engdahl, "Separation of the energy absorption and overvoltage protection in solid-state breakers by the use of parallel varistors", IEEE Trans. Power Electron., vol. 29, no. 6, pp. 2715-2722, Jun 2014.
[13] E. Carroll, S. Klaka and S. Linder, "Semiconductors ASL. IGCT thyristors: a new approach to superpowerful electronics", Russian Electrical Engineering, vol. 69, no. 7, pp. 54-63, 1998.
[14] R. Hermann, S. Bernet, Y. Suh and P. Steimer, "Parallel connection of integrated gate commutated thyristors (IGCTs) and diodes", IEEE Trans. Power Electron., vol. 24, no. 9, pp. 2159-2170, Sep. 2009.
[15] Flyback Converter Circuit, https://circuitdigest.com/electronic-circuits/flyback-converter-circuit-diagram
[16]Simulation of Snubber Circuits and observing turn-on of SCR,https://in.mathworks.com/matlabcentral/fileexchange/72257-simulation-of-snubber-circuits-and-observing-turn-on-of-scr
[17]RC Snubber Design for SMPS Protection, https://passive-components.eu/rc-snubber-design-for-smps-protection-part-ii/

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