TO IMPROVE THE EFFICIENCY OF CLOSE LOOP LOW NOISE SMPS SYSTEM BY USING SOFT SWITCHING TECHNIQUE

Sheshnath Yadav[1], Permendra Kumar Verma[2],

Mahesh Kumar Singh[3], Ankita Singh[4]

[1,2,3,4]*Deptt. of Electronics& Communication Engineering,Buddha Institute of Technology (India)*

ABSTRACT

Simulation of DC-DC converter side in SMPSsystem is discussed in this paper. A forward type soft switchingDC-DC converter topology with neutral point inductorconnected Auxiliary resonant snubber (NPC-ARS) circuit ispresented in this paper for the switching mode power supplyapplications. Its circuit operation and its performancecharacteristics of the forward type soft switching DC-DCconverter is described and the simulation results are presented.

Keywords-Forward type DC-DC converter, Zero voltage soft switching, Zero current soft switching, neutral point inductor connected Auxiliary resonant snubber (NPCARS) Circuit.

I.INTRODUCTION

In recent years, the switching mode power supply (SMPS) system have been achieved the high power density and high performances by developed power semiconductor devices such as IGBT, MOS-FET and SiC. However, using the switching power semiconductor in the SMPS system, the problem of the switching loss and EMI/RFI noises have been closed up. This course produced the EMC limitation like the International Special Committee on Radio Interference (CISPR) and the harmonics limitation like the International Electrotechnical Commission (IEC). For keeping up with the limitation, the SMPS system must add its system to the noise filter and the metal and magnetic component shield for the EMI/RFI noises and to the PFC converter circuit and the large input filter for the input harmonic current. On the other hand, the power semiconductor device technology development can achieve the high frequency switching operation in the SMPS system. The increase of the switching losses.

Our research target is to reduce the EMI/RFI noises and the switching losses in the SMPS system by only one method. The solution method is the soft switching technique. Using LC resonant phenomenon, this technique can minimize the switching power losses of the power semiconductor devices, and reduce their electrical dynamic and peak stresses, voltage and current surge-related EMI/RFI noises under high frequency switching strategy.

Thus, a new conceptual circuit configuration of the advanced forward type soft switching DC-DC converter which has the neutral point inductor connected auxiliary resonant snubber (NPC-ARS) circuit is presented in this paper with its operating principle in steady state. In addition, its fundamental operation and its performance characteristics of the proposed forward type soft switching DC-DC converter treated here are evaluated on the basis of experimental results. A New Controller scheme for Photo voltaics power generation system is presented in [1]. The design and implementation of an adaptive tuning system

based on desired phase margin for digitally controlled DC to DC Converters is given in [2]. Integration of frequency response measurement capabilities in digital controllers for DC to DC Converters is given in [3]. A New single stage, single phase, full bridge converter is presented in [4]. The Electronic ballast control IC with digital phase control and lamp current regulation is given in [5]. A New soft-switched PFC Boost rectifier/inverter is presented in [6]. Novel soft switched PWM current source rectifier is presented in [7]. The auxiliary resonant commutated pole converter is given by [8]. Resonant snubber with auxiliary switches is given in [9].A control strategy for PWM current source rectifier is given in [10]. Comparison of active clamp ZVT techniques applied to tapped inductor DC-DC converter is given in [11].The multiple output AC/DC Converter with an internal DC UPS is given in [12].The Bi-directional isolated DC-DC Converter for next generation power distribution– comparison of converters using Si and Sic devices is given in [13]. The above literature does not deal with modeling and simulation of closed loop controlled SMPS System employing forward converter. This work aims to develop a model for the Closed loop SMPS System.

II. NOVEL FORWARD TYPE SOFT SWITCHING DC-DC CONVERTER

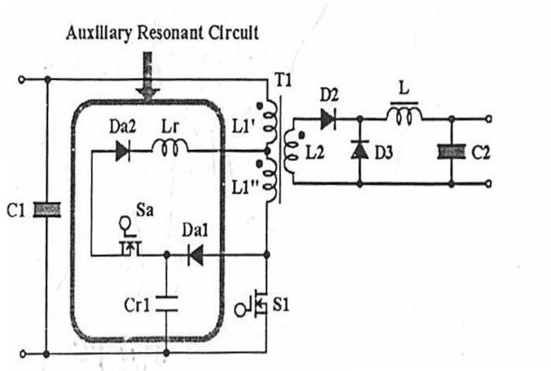

Fig.1.a Forward type soft switching DC-DC converter with a neutral point inductor connected auxiliary resonant snubber (NPC-ARS) circuit.

We have modified the part of DC-DC converter to achieve the complete soft switching operation in active power semiconductor devices of the forward converter. Fig.1.a shows the schematic configuration of the modified forwardtype soft switching DC-DC converter with a neutral point inductor connected auxiliary resonant snubber (NPC-ARS) circuit. The proposed NPC-ARS circuit consist of an active power semiconductor devices; Sa, a resonant capacitor Crl, two power diode Da1 and Da2. Using this NPC-ARS circuit, the zero voltage soft switching (ZVS) turn off or the zero current soft switching (ZCS) turn on can be achieved in main switching device S1 and ZCS turn on and turn off be in auxiliary switch Sa. So that, the switching losses in each active power semiconductor device will be zero completely.

III. OPERATION PRINCIPLE OF NPC-ARS CIRCUIT

The operation principle of the proposed forward type soft switching DC-DC converter with the NPC-ARS circuit is illustrated in Fig.1.b. The conventional forward type DCDC converter operates only two circuit condition mode which is described in Fig.1.c as the steady state mode on and off. On the other hand, there is 4 mode in case of the proposed one as depicted in Fig.1b. The operating principle of the proposed forward type soft switching DC-DC converter is described as follows;

Steady State Mode one : In this state, the transformercurrent flows through the main active power semiconductordevice S1 and the primary energy conducts to secondaryside of transformer. If the main active power semiconductordevice S1 is turned off, the operation mode changes to thenext circuit condition mode, Commutation Mode 1.

[Commutation Mode 1]; The energy in the leakageinductance of transformer T1 is flowing through theresonant capacitor Crl by turned main active power semiconductor devices S1 off. When the leakage inductancecurrent reach zero, the operation mode changes to the nextsteady state mode, Steady State Mode OFF.

[Steady State Mode OFF]; The energy in the primary sideof transformer is broken off the secondary side in thiscircuit condition mode. If the main active powersemiconductor device S1 and auxiliary active powersemiconductor device Sa are turned on the operation modechanges to the next circuit condition mode, CommutationMode 2.

Commutation Mode 2: In this mode, the active powersemiconductor devices S1 and Sa can be achieved thecomplete ZCS transition by the leakage inductance andauxiliary resonant inductor Lr. The energy in theprimary side of transformer T1 is conducted to thesecondary side. Furthermore, the energy in the resonantcapacitor Crlflow to the secondary side of the transformerthrough the transformer T1. When the voltage of theresonant capacitor Crl reaches zero, the operation mode ischanged to the first circuit condition mode, Steady StateMode ON.

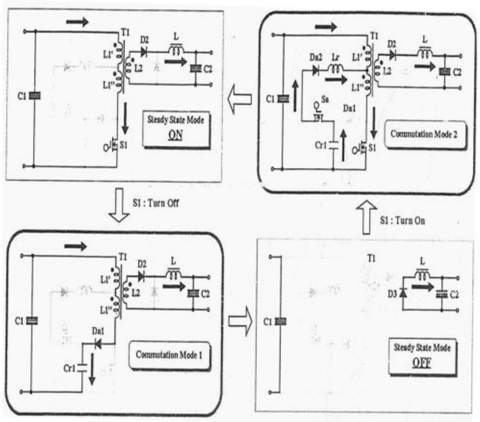

Fig.1.b Equivalent circuit for each operation stage of the proposed forward type soft switching DC-DC converter with the NPC-ARS circuit

IJARSE
ISSN: 2319-8354

IV. SIMULATION RESULTS

The SMPS system is modelled and simulated using the blocks of MATLAB SIMULINK. The SMPS system using conventional boost and forward converters is shown in Fig.2.a. Diode rectifier with capacitor filter was represented as a D.C source at the input. The current and voltage waveforms of S2 are shown in Fig.2.b. The voltage across the primary of the transformer is shown in Fig.2.c. The voltage across the secondary of the transformer is Fig.2.d, the voltage across the diode d3 is shown in Fig.2.e.From the waveforms it can be seen that the output contains noise.

Modified SMPS system using auxiliary switch in the forward converter is shown in Fig.3.a. The voltage and current waveform of S2 are shown in Fig.3.b. Voltage across the primary of the transformer is shown in Fig.3.c. The voltage across the secondary of the transformer is shown in Fig.3.d. The voltage across the diode D3 is shown in Fig.3.e. From the above waveforms it can be seen that the output is free from noise.

Open loop controlled SMPS system with a disturbance at the input is shown in Fig.4.a. A step change in input voltage is shown in Fig.4.b. The driving pulses for S2 and S3 are shown in Fig.4.c. Output voltage with disturbance is shown in Fig.4.d. It can be seen there is an increase in the output when there is an increase in the input. Closed loop controlled modified SMPS system is shown in Fig.5.a. Output voltage is sensed and it is compared with a reference value. The error is processed using PI controller. The output of the PI controller drives the MOSFET in the boost converter to regulate the output voltage. The driving pulses of S1 are shown in Fig.5.b. D.C output voltage is shown in Fig.5.c. The output voltage reduces to the set value. Thus the closed loop system is able to maintain constant voltage at the output.

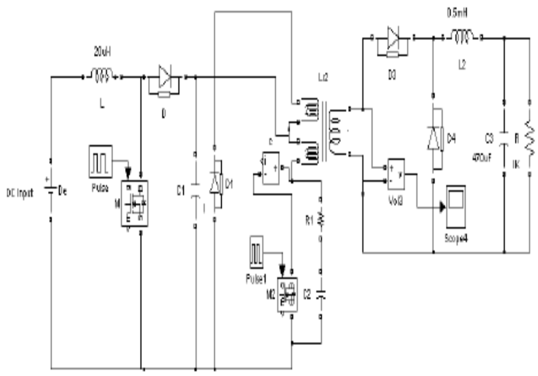

Fig.2.a. Conventional Boost & forward

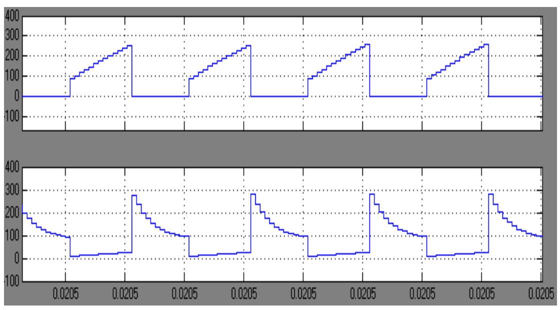

Fig.2.b. Current and voltage waveforms of S2

IJARSE
ISSN: 2319-8354

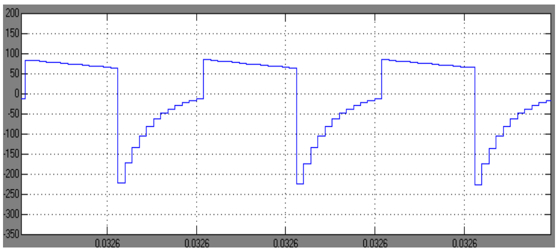

Fig.2.c. Transformer primary

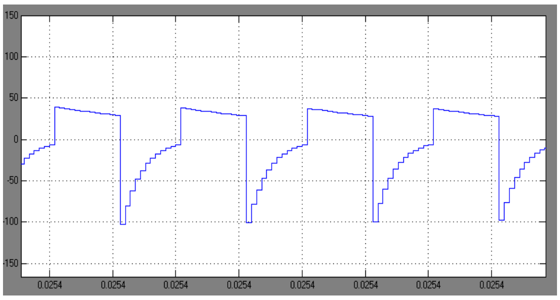

Fig.2.d. Transformer secondary voltage

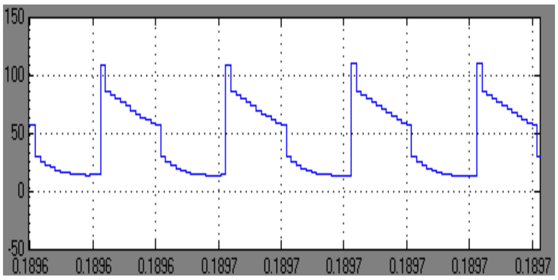

Fig.2.e. Voltage across diode D3

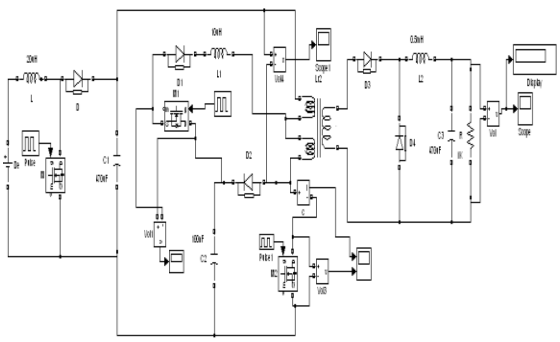

Fig.3.a. Modified SMPS system using auxiliary switch in the forward converter

IJARSE
ISSN: 2319-8354

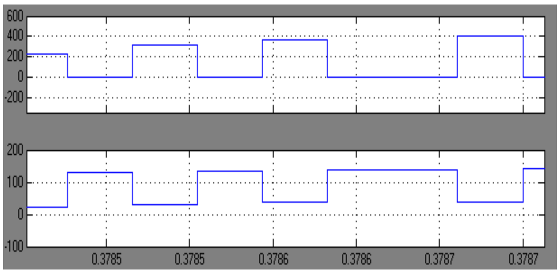

Fig.3.b. Current and voltage waveforms of S2

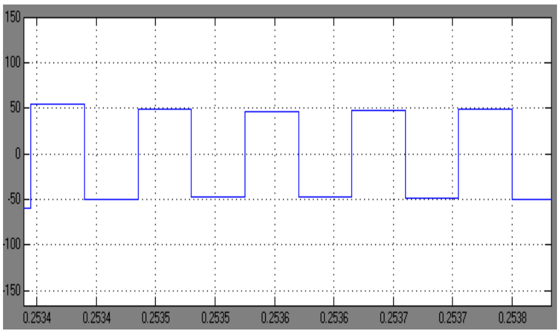

Fig.3.c.Transformer primary voltage

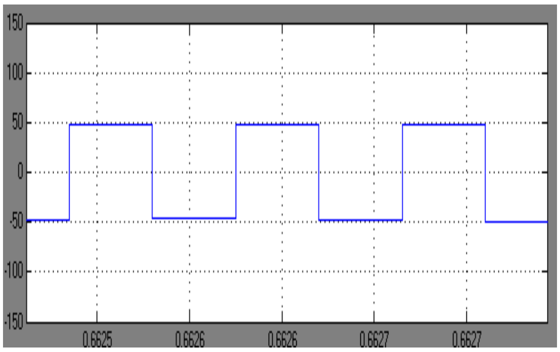

Fig.3.d. Transformer secondary voltage

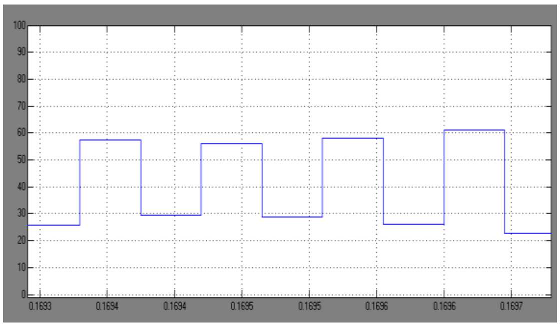

Fig.3.e. Voltage across diode D3

International Journal of Advance Research in Science and Engineering
Volume No.07, Special Issue No.01, April 2018
www.ijarse.com
IJARSE
ISSN: 2319-8354

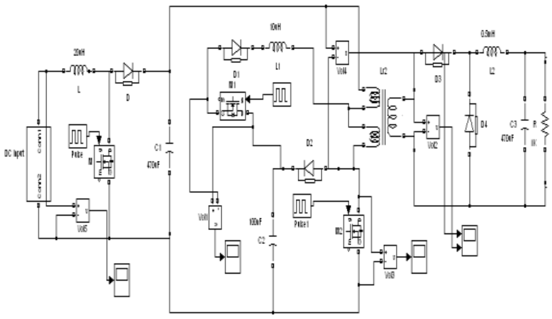

Fig.4.a. Open loop controlled SMPS system with a disturbance at the input

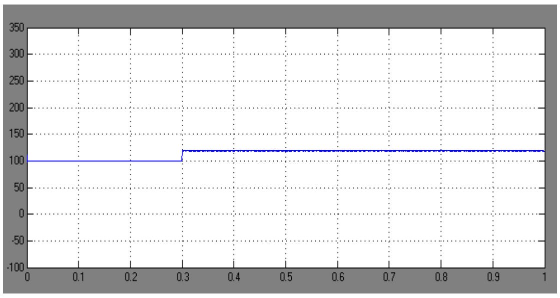

Fig.4.b. Input DC voltage with disturbance

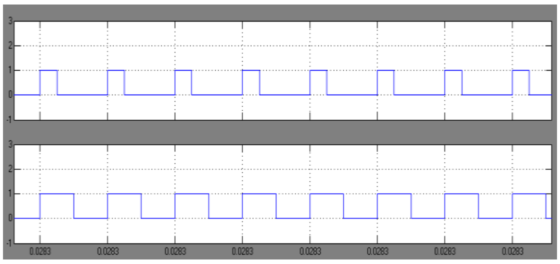

Fig.4.c. Driving pulses for S2 & S3

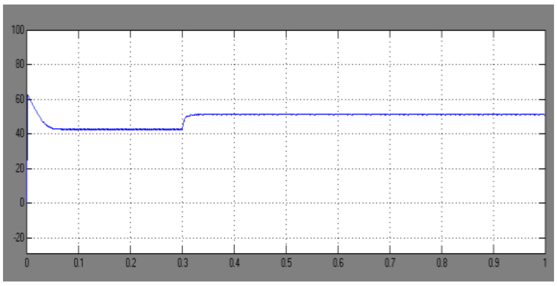

Fig.4.d. Output DC voltage with disturbance

IJARSE
ISSN: 2319-8354

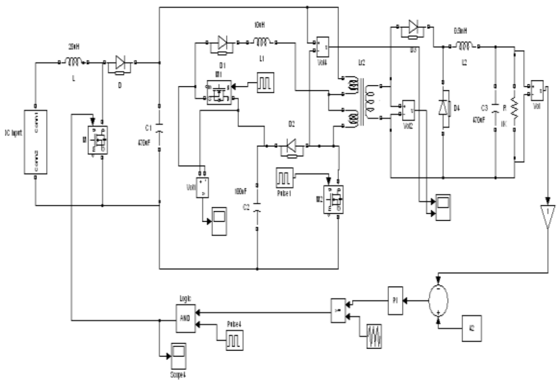

Fig.5.a. Closed loop controlled modified SMPS system

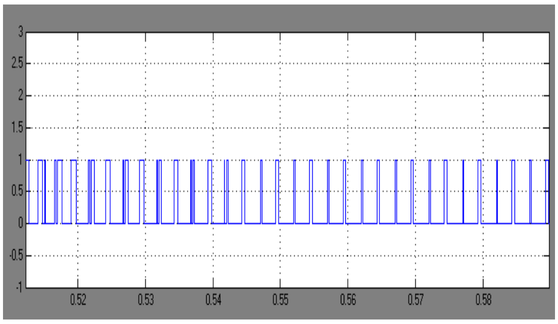

Fig.5.b. Driving pulses of S1

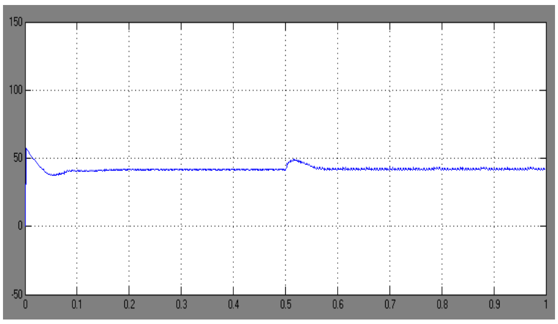

Fig.5.c.DC output voltage

V. CONCLUSION

Modified circuit configuration of forward type D.C –D.C converter with its working principle is presented in thispaper. The conventional and modified SMPS system aredigitally simulated using Sim power systems. From thesimulation results it is conformed that the modifiedconverter has reduced noise in the output. Closed loopcircuit model is developed and it is used for performing thesimulation of closed loop system. From the simulationresults it is observed that the steady state error in the outputis reduced using closed loop system.

REFERENCES

[1]. Tamer T.N.Khabib, Azah Mohamed, Nowshad Admin,"A New Controller Scheme for Photo voltaics power generationsystem,"European journal of scientific research ISSN 1450-216Xvol.33 No.3 (2009), pp.515-524.

[2] J.Morroni, R.Zane, D.Maksimovic, "Design and Implementation ofan adaptive tuning system based on desired phase margin for digitally controlled DC-DC Converters, "IEEE Trans. PowerElectron.,vol.24,no.2,pp.559-564,feb.2009.

[3]M.Shirazi,J.Morroni,A.Dolgov,R.Zane,D.Maksimovic,"Integration offrequency response measurement capabilities in digital controllers forDC-DC,Converters,"IEEETrans.Power Electron.,vol.23,no.5,pp.2524-2535,sep.2008.

[4] Hugo Ribeiro, Beatriz V.Borges,"New single stage, single phase, fullBridge Converter, "submitted for appreciation to the Technicalcommittee of IEEE ECCE-Energy conversion congress andexhibition, January 2009.

[5] Y.Yin, M.Shirazi, R.Zane,"Electronic Ballast control IC with digitalphase control and lamp current regulation,"IEEETrans.PowerElectron., vol.23, no.1, pp.11-18, jan.2008.

[6] Yungtaek Jang,David L.Dillman and Milan M.Javanovie,"A Newsoft-switched PFC Boost Rectifier with Integrated Flyback Converterfor stand –by Power,"IEEE Trans.on Power Electronics,pp.66-72,No.1,2006.

[7] Gerry Moschopoulos and Geza Joos, "A Novel Soft-Switched PWMCurrent Source Rectifier/ Inverter", Proc. of 25th IEEE AnnualPower Electronics Specialists Conference, pp.978-984, 1994.

[8] R.W. De Doncker "The Auxiliary Resonant Commutated PoleConverter", IEEE IAS '89 Records, pp.829-834, 1989.

[9] W.MacMarray "Resonant Snubbers with Auxiliary Switches", IEEEIAS7'89 Records, pp.829-834, 1989.

[10] Braz J. Cardoso Filho, Steffen Bernet and Thomas A. Lipo, "A NewControl Strategy for the PWM Current Stiff Rectifier/Inverter withResonant Snubber", Proc. of 28th IEEE Annual Power ElectronicsSpecialists Conference, pp.574-579, June, 1997.

[11] S. Abe, T. Ninomiya, Comparison of Active-Clamp and ZVTTechniques Applied to Tapped-Inductor DC-DC Converter with LowVoltage and High Current, Journal of Power Electronics, Vol.2, No.3,pp.199-205, 2002.

[12] Arturo Fernandez,Member,IEEE,Javier sebastin,Member IEEE,MariaHernando Member IEEE,"Multiple output AC/DC Converter with an

Internal DC UPS,"IEEE Trans on IndustrialElectronics.vol.53.no.1.Feb.2006.

[13] Aggeler,D-;Inove,S-;Akagi,H-;Kolar,J.W,"Bi-directional isolated DCto DC Converter for next generation power distribution-comparisonof converters using Si and Sic devices "Power conversionconference-Nagoya.2007.PCC apos; 07,volume,Issue,2-5 April 2007Page(s):510-517.