

Implementation of Three and Two Switch Inter-Leaved Forward Converters



R. Lakshmi, K. Karunanithi

Abstract: In this work the DC-DC forward converter is proposed. The forward converter system nonlinear dynamic performance is present, as it works in switch-mode. Besides, it is revealed to significant inequality which may take this system during the nominal conditions, due to fluctuations on the load or on the line voltage at the input. Traditional converters like, boost converters, switched- inductor converters, switched -capacitor converters etc. are restricted because of at most duty cycle (unity). Fundamentally transformer is introduced to improve the voltage and also it gives the benefits of supplying power to various loads, therefore it is further acceptable for different DC power applications. Examination at open control of the suggested converters are described in this work and we investigate the equations of a forward converter and propose a design for components and also simulated two and three switches forward converter. The suggested converter (FC) has been verified theoretically by simulating it in MATLAB Simulink.

Keywords: converters, three switch, two switch ,inductors, power applications.

I. INTRODUCTION

An industrial and some commercial applications need DC power. An Electronic DC Converter that transforms Direct Current from low/high level to another. With isolated DC converters, level of DC voltage is changed to another level by exchanging the input for the time being and delivering that energy to the output at a various voltage level. Majorly these converters are used in easily movable electronic gadgets like computers and cellular phones which are provided with power from batteries. Some of the applications of these forward- converters (FC) supply power for DCM, Power Supply Electric vehicle, Telecommunication -applications (TA), Battery charging etc.

II. RELATED WORK

Comparative analysis of “Proportional Integral and Fuzzy logic Control for a Dual-Input DC/DC-Converter in Hybrid-Energy-Application” by “Tapan Vanker &-Gangavarapu Gurkumar (2017)”.

Revised Manuscript Received on October 30, 2019.

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In 2010 Smedley, “Analyzed and designed forward converter with energy regenerative snubber”. In 2008 Liao, “Designed high efficiency fly-back converter with energy regenerative snubber”. “An efficient active LC snubber for forward -converters” by Jinno (2009). “A novel integrated non-dissipative snubber for fly-back converter” is given by Ai in the year 2005. “Wei in the year 2005 given Wide range dual switch forward-fly back converter with symmetrical RCD clamp”.

III. FORWARD- CONVERTER

Schematic representation of forward- converter (FC) is shown in Fig 1. It changes uncontrolled DC input power to controlled DC power. Proposed FC has high-frequency transformer also known as an isolation transformer. It isolates the load and prime circuit.

When the frequency increases, then the size of the transformer will decrease.

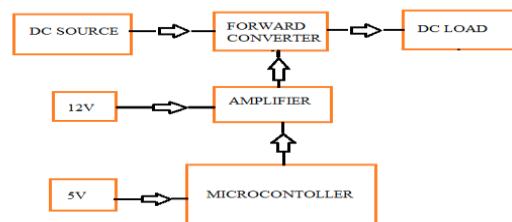


Fig-1 Schematic Diagram of Forward-Converter

3.1 Microcontroller

The microcontroller is to create triggering pulses which are feed to MOSFETs. The pulses are of similar size and have equal intervals. The controller will regulate the output given to forward converter (FC) by changing the width of the pulses fed to MOSFETs switches. This controller has huge benefits when compared with analog -circuits like a quick response, lesser- size, low- cost and better reliability.

3.2 Power Amplifier

Power -amplifier (PA) will boost the pulse generated by the microcontroller. Later, it passes the magnitude amplified signal to MOSFETs which is in the prime circuit and it isolates the controller circuit from the prime circuit. A step-down transformer and a rectifier provide 12volts, by which the driver IC operates.

3.3 Dc- Load

The controlled DC (direct current) power is widely used for various applications such as telecommunication, motors speed control, computers, battery charging (BC), electrical drives (ED), cellular phones (CP) and others which requires DC output.

The model calculations are made by the following assumptions:

Flux (Φ_m) = 20microweber, Frequency (f) = 10Kilo Hz. (KH₂), $E_1=4.44N_1\Phi_m f$ in volts, E_1 =Primary transformer voltage, E_2 =Secondary transformer voltage, N_1 =Primary transformer turns N_2 =Secondary transformer turns, From, $N_1 = E_1/(4.44\Phi_m f)$, $N_2 = E_2/(4.44\Phi_m f)$,

we get, $N_1=338$ turns, $N_2=28$ turns, Where, $r = \sqrt{3}/12\omega^2 L_1$, $C_3, r = 1.7*10^{-9}$, $C_3 = 470\text{mF}$ and $L_1 = 46\text{mH}$, $T=1/10,000 = 100\mu\text{s}$, Load Resistance $R=5\Omega$.

SIMULATION OF TWO SWITCH FORWARD CONVERTER

The circuit is designed using the elements of MATLAB Simulink. Interleaved two-switch forward converter using resistive load is shown in Fig 2. These two transformers stepdown the voltage and an uncontrolled rectifier is used to rectify the secondary voltage.

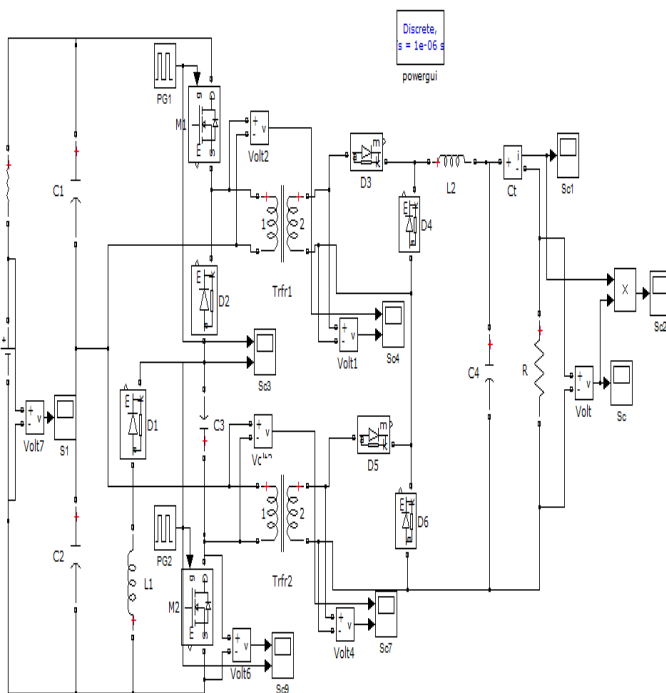


Fig-2 Simulation of two-switch forward converter using LC filter

The input voltage to the two-switch forward converter using an LC filter is represented in Fig 2 and the input voltage is 300 Volts. Fig 3 shows output voltage which is equal to 48.38 Volts.

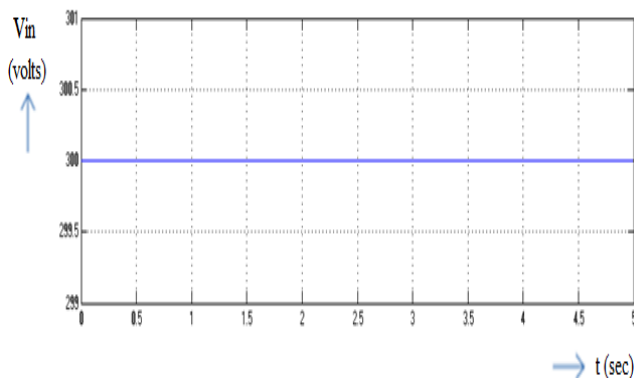


Fig-3 Input voltage waveform

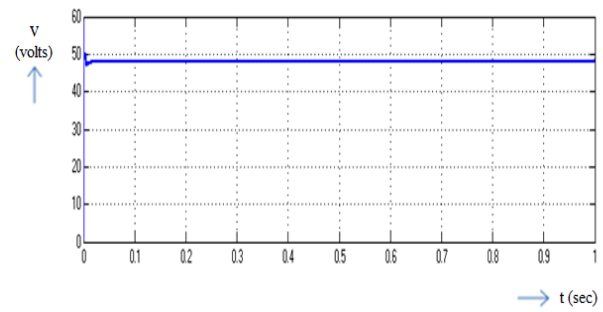


Fig-4 Output voltage waveform

The waveforms are shown in Fig 5 and 6. The o/p -current is 9.6 Amps and the output -power is 464.448 Watts.

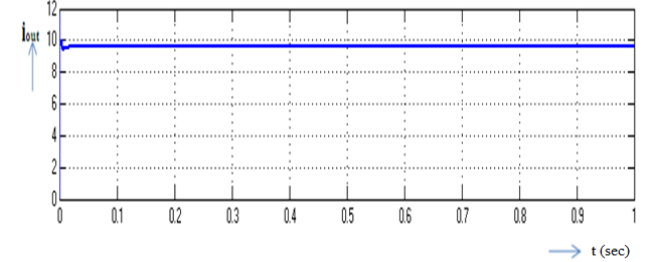


Fig-5 Output current waveform

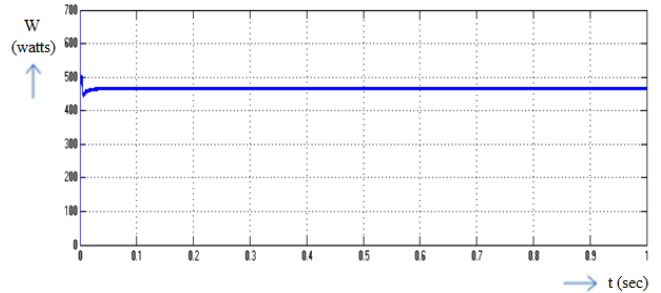


Fig-6 Output power waveform

IV. PROTOTYPE OF TWO SWITCH FORWARD CONVERTER

The hardware of the ILFC system is shown in Fig 7. It consists of a control circuit and a power circuit. Fig 8 shows the input voltage (DC). Fig 9 & 10 shows switching pulse1 and output of driver1 respectively. Fig 11 & 12 shows switching pulse2 and output of driver2 respectively. Fig 13 shows output voltage (DC) waveform.

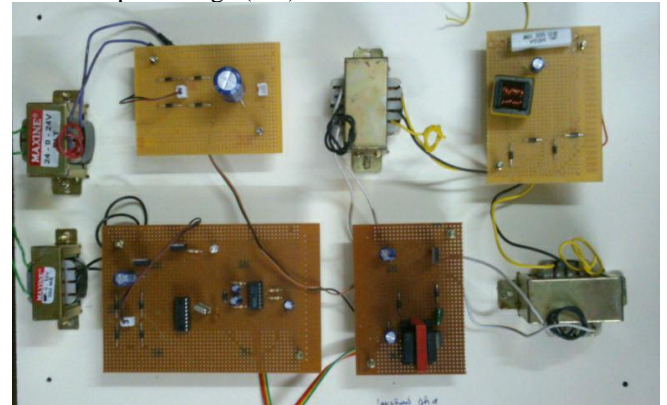


Fig-7 Hardware setup

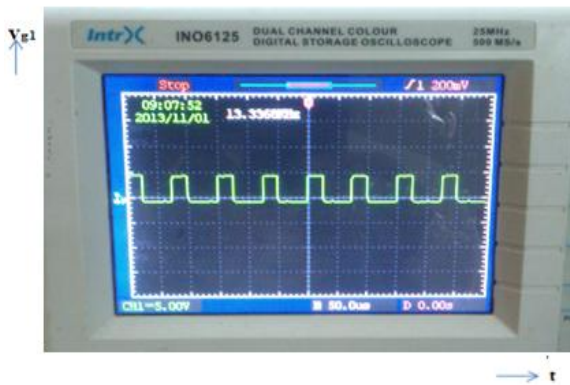


Fig-8 Input Voltage(DC)



Fig-12 Driver2 Output

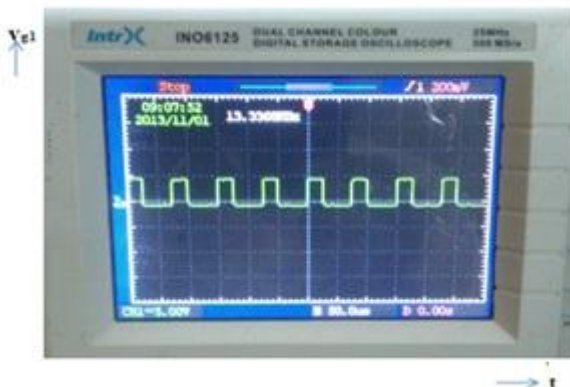


Fig-9 M_1 switching pulse

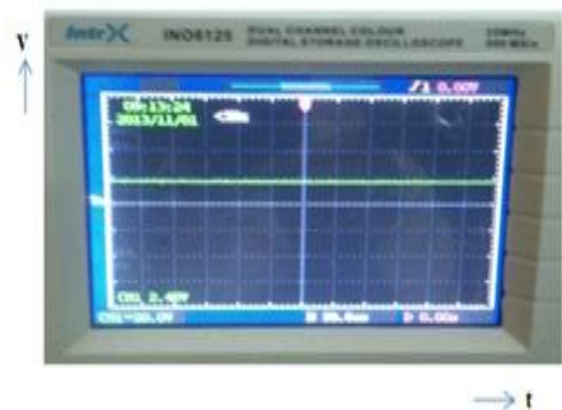


Fig-13 Output Voltage

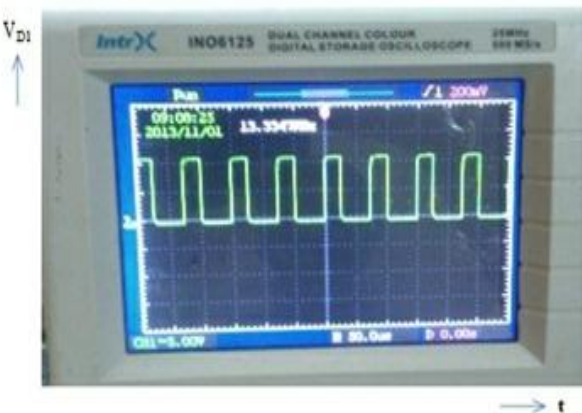


Fig-10 Driver1 Output

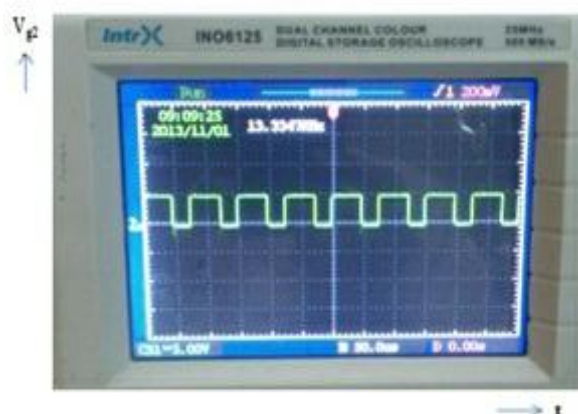


Fig-11 M_2 Switching pulse

V. SIMULATION OF THREE SWITCH FORWARD CONVERTER

Fig 6.1 shows the model Simulink for three switch converter. Output voltage waveform output current waveform and output power waveform are measured using scopes.

Fig 6.1 Three switches forward converter using a resistive load

Input voltage (300Volts) is represented in Fig 14. The output voltage is shown in Fig 15.

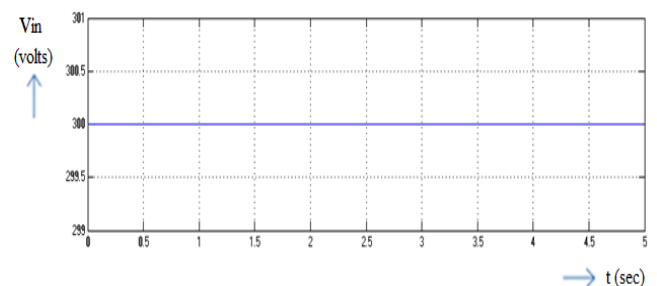


Fig-14 Input voltage waveform

The output voltage is 48.35Volts. Output current and power waveforms are shown in Fig 16 & 17 respectively. Output current is 9.7Amps and output power is 469 Watts.

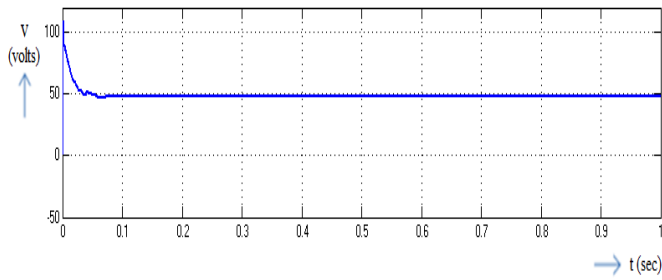


Fig-15 Output voltage waveform

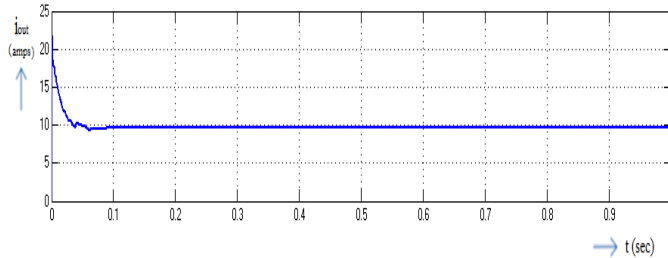


Fig-16 Output current waveform

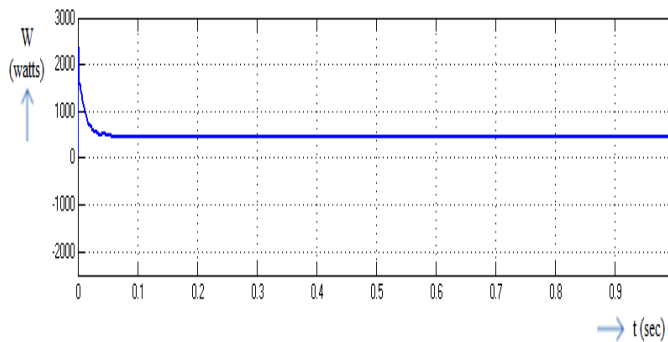


Fig-17 Output power waveform

VI. PROTOTYPE OF THREE SWITCH INTERLEAVED FORWARD CONVERTER

The hardware of the three switch ILFC system is shown in Fig 18. It composed of a control circuit and prime circuit. Input voltage (DC) is shown in Fig 19. The waveform of switching pulse1 and driver1 are represented in Fig 20 & 21 respectively. The output voltage is shown in Fig 22.



Fig 18 Hardware setup



Fig 19 Input Voltage



Fig-20 M1 Switching pulse

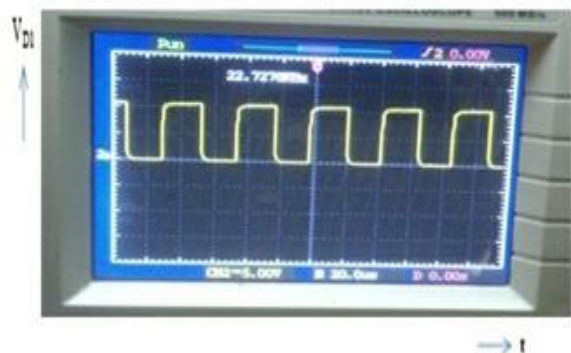


Fig-21 Driver1 output

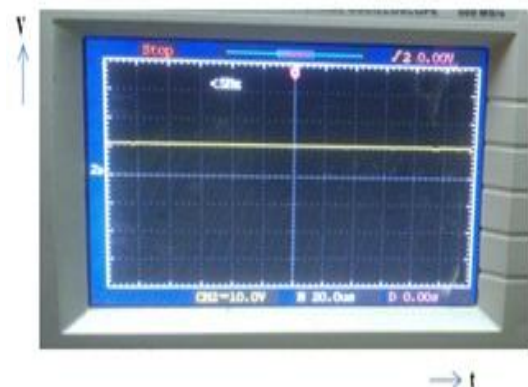


Fig-22 Output Voltage

VII. COMPARATIVE RESULTS

Type of Filter	V_o	I_o	V_r
LC	48.35V	9.7A	0.12V
PI	47.73V	9.6A	0.008V

7.1 COMPARISON BETWEEN TWO SWITCH FORWARD CONVERTER WITH LC AND PI FILTER

The output voltage, output voltage ripple and current of two-switch forward converter using LC and PI filter are listed in table 1.

While comparing the output current and voltage, the two-switch forward converter with an LC filter has a better result than the PI filter. But ripple content of voltage is lesser in two-switch forward converter with PI filter compared to that of the LC filter.

Type of filter	V_o	I_o	For V_r
LC	48.38V	9.6A	0.3V
PI	47.74V	9.5A	0.03V

Table 1 Comparison of a two-switch forward converter with LC and PI filter

7.2 COMPARISON BETWEEN THREE SWITCH FORWARD CONVERTERS WITH LC AND PI FILTER

Output voltage, current and output voltage ripple of three switches forward converter using LC and PI filter is shown in table 2. While comparing the output voltage and current, the two-switch forward converter with an LC filter has a better result than the PI filter. But ripple content of voltage is lesser in two-switch forward converter with PI filter compared to that of the LC filter.

Type of Filter	V_o	I_o	V_r
LC	48.35V	9.7A	0.12V
PI	47.73V	9.6A	0.008V

Table 2 Comparison of three switches forward converter with LC and PI filter

VIII. CONCLUSION

Two and three switch serial- input forward -converters with resistive load is simulated using MATLAB Simulink. The results of two switch forward converter using LC and PI filter are compared. The output of the LC filter is greater than that of the PI filter system. The output of three switches forward- converter system has better performance when compared to the two-switch forward converter system. Hardware is fabricated for both forward converters with resistive load and tested. Experimental results on prototype confirm the theoretical performance of the suggested converter.

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