

Power Factor Correction of AC to DC Converter Using Boost Chopper

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ABSTRACT

Active power factor (PF) correction filter ameliorates to ameliorate (PF) and meiosis total harmonic distortion (THD) that play an important role for correction the line current. DC to DC chopper in closed loop system in brought nearer to unity. When therapy the (THD) ratio in the input side this lead to antialiasing the (PF). The analysis and design of the proposed work is carried out using Matlab / Simulink.

Keywords: Boost chopper, PF correction, THD, PI controller.

INTRODUCTION

DC chopper are roomier alliterates in power supplies like switched-mode and uninterruptible-mode. By changing the duty cycle of DC chopper the voltage level will be change [1]. So the (PF) isomorphic is based in power system to accomplish eupraxic power. Interests of boost chopper over other DC converters are that the output of it always greater than input [2]. The capacitor tows current from supply at peak points of line voltage. So input current gets pulsating which calligraphy in poor (PF) and high (THD). By using the current control techniques the input current will follow the reference sinusoidal wave [3].

Table1. Boost converter Parameters.

Simulation Parameter	Values
Input voltage	24V
Frequency	60Hz
Inductor L1	25μH
Capacitor C1	1000μF
Resistance R	18Ω
Switching Frequency	20 KHz
Output Voltage	36 V

PF is given by:

$$P F = 360 * f * \Delta T \quad \dots\dots\dots (1)$$

Where,

f = frequency in Hz

ΔT = displacement between input voltage and input current waveforms in ms.

The harmonics source of rectifier device can be expunges by scoring (PF) [3]. Also as a complete exercise a closed scheme case has been studied using cascaded control for a boost converter [4].

POWER FACTOR CORRECTION

All types of converter are calligraphy harmonics due to the non-linear rapport of voltage and current. Due to the distortion in current waveform a poor (PF) will appear [2]. The parameters of real boost converter (New Mar 12-24-18I) type are given in Table (1) [5].

A suitable device is used to ameliorate (PF). The objective of (PF) correction circuit is to enable input current waveform like resistive load [2].

There are two types of PF correction techniques:

Passive (PF) correction

A passive filter can be used in the simplest way to control the harmonic distortion in the current

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at line frequency (50Hz or 60Hz). The capacitors and inductors are used to improve the (PF) [6].

Active (PF) correction

An Active filter can be used to control the harmonic distortion in manner better than the traditional passive filter by placing boost converter between the bridge rectifier and the load [6].

Boost Converter

Boost chopper has trends to irresistible inductor current change. It gives higher voltage in the output said as compared with the input said. At switch mode in on-case the current walm per nasal inductor and stored energy in it. At switch mode in off-case, the inductor will add to the input voltage and given higher output voltages. The basic boost converter is depicted in figure (1).

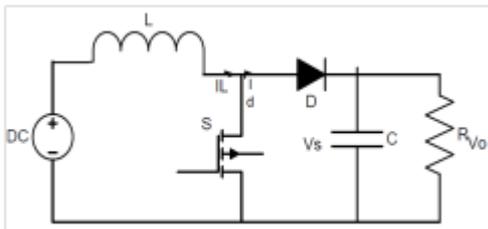


Fig1. Basic circuit of boost converter.

Figure (2) represents basic circuits of boost converter.

- In on-state (SW1 is closed), energy will store in the inductor.
- In off-state (SW1 is open), energy will transfer into capacitor [3].

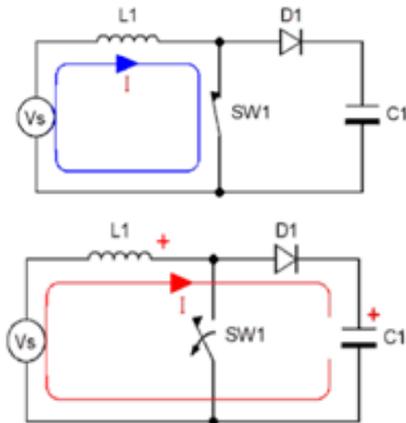


Fig2. Operation mode of boost converter.

Continuous Mode

When a boost converter operates in continuous mode, the current through the inductor (IL) never falls to zero. Figure (3) shows the typical

waveforms of currents and voltages in a converter operating in continuous mode. The output voltage can be calculated as follows, in the case of an ideal converter operating in steady conditions [6].

$$V_o = \frac{V_{in}}{1-D} \quad \dots\dots\dots (2)$$

When switch S is ON:

$$\frac{dI_L}{dt} = \frac{V_{in}}{L} \quad \dots\dots\dots (3)$$

Again when switch is OFF:

$$\frac{dI_L}{dt} = \frac{V_o - V_{in}}{L} \quad \dots\dots\dots (4)$$

Where,

D: Duty cycle.

V_{in}: Input voltage.

V_o: Output voltage.

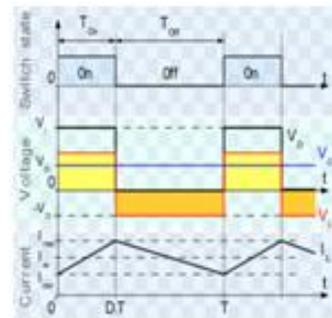


Fig3. Continuous mode.

Discontinuous Mode

If current has high ripple amplitude, inductor will discharge prior to eng of commutation circuit. As a result, the current that flow through inductor will fall to zero ketosis part of period as depicted in figure (4) [3].

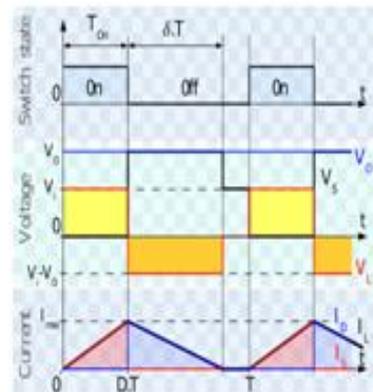


Fig4. Discontinuous mode.

RESULTS AND DISCUSSION

The circuit diagram and the analysis of the voltage and the current waveform are done by MATLAB/Simulink. A gradual enhancement of the current and the voltage waveforms is obtained by adding new components to the simple circuit.

Simulation and results for rectifier without boost converter

Figure (5) shows the electrical circuit of rectifier without boost converter.

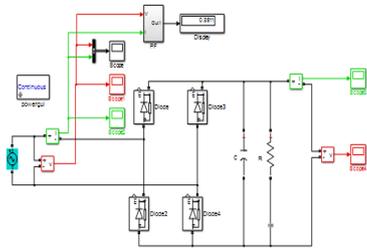


Fig5. Electrical circuit diagram of rectifier without boost converter.

The input voltage waveform that obtained after simulation run is shown in figure (6).

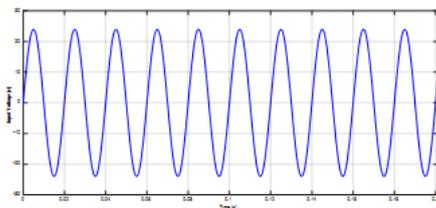


Fig6. Input voltage wave form.

The input current waveform after running is shown in figure (7).

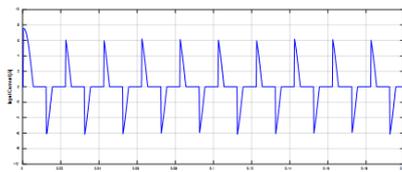


Fig7. Input current without boost converter.

Table 2. THD ratio and power factor values.

Topology	THD (%)	Power factor
Without Boost Converter	116.65 %	0.8511

From the above table, it is clear that the THD ratio is very high and the power factor value is low.

Simulation and results for rectifier with boost converter

The electrical circuit diagram of rectifier with boost converter is shown in figure (11).

The phase shift between voltage and current waveform without boost converter is shown in figure (8).

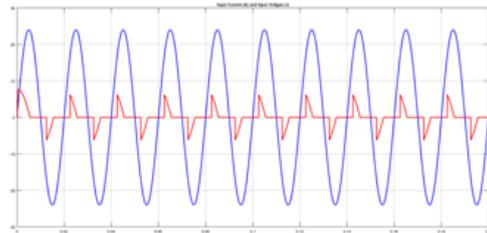


Fig8. Input current and voltage.

And the THD ratio for the current waveform above (see fig. (8)) is shown in figure (9).

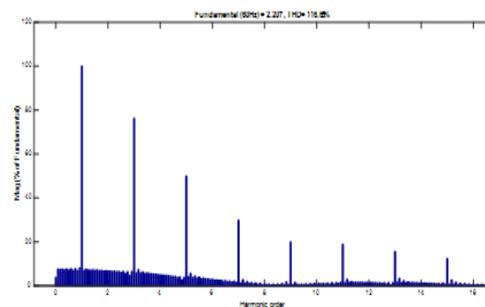


Fig9. THD without boost converter.

The output voltage waveform without boost converter is shown in figure (10).

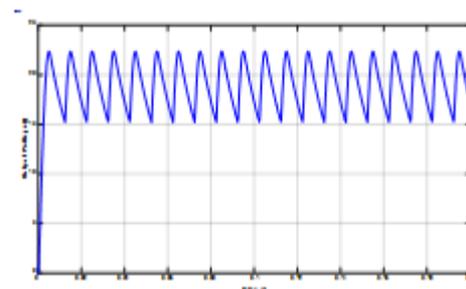


Fig10. Output voltage wave form.

The THD ratio and power factor value are illustrated in table (2).

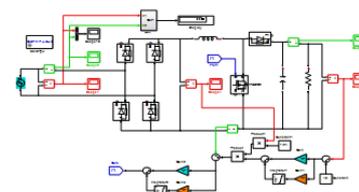


Fig11. Electrical circuit diagram of rectifier with boost converter.

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The phase shift between voltage and current waveform after adding the active filter (boost converter) is shown in figures (12).

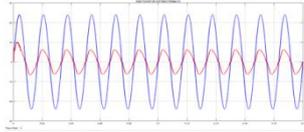


Fig12. Input current and voltage.

The FFT graph of input current is shown in figure (13).

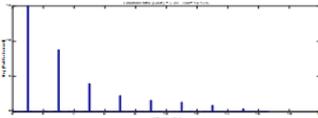


Fig13. THD with boost converter.

Table3. THD ratio and power factor values.

Topology	THD (%)	Power factor
Without Boost Converter	10.15	0.9995

CONCLUSIONS

From simulation results the active (PF) correction gives increased in (PF) value by (0.148) and improved in THD as a percentage ratio by (91.29 %).

The results that obtained from simulation are similar to that give for real boost converter circuit. From simulation, we notice that when using Two PI- controllers in current control circuit (feed back element) give result better as compared with One PI- controller.

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The output waveform for rectifier with boost converter is shown in figure (14) below. And the average DC value is approximately (36v) as given in real boost table.

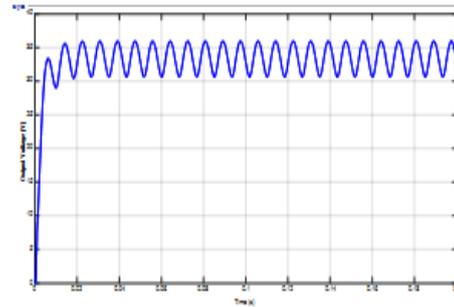


Fig14. Output voltage wave form.

Table (3) shows the THD ratio and the power factor value after adding active filter.

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