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Power Factor Correction of AC to DC Converter Using Boost Chopper

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Abstract: Active Power Factor (PF) correction filter alliterates 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 research is carried out using MATLAB/Simulink.

Key words: Boost chopper, PF correction, THD, PI controller, line current, DC chopper

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 (Ebshish, 2014). 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 (Vineeth *et al*., 2017; Yakubu *et al*., 2011). 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 (Patel *et al*., 2016; Smith *et al*., 1993).

The harmonics source of rectifier device can be expunges by scoring (PF) (Patel *et al*., 2016; Turi *et al*., 1994). Also, as a complete exercise a closed scheme case has been studied using cascaded control for a boost converter (Hosseini, 2015; Thiele, 2016).

MATERIALS AND METHODS

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. The parameters of real boost converter (New Mar 12-24-18I) type are given in Table 1 (Anonymous, 2010). PF is given by:

$$PF = 360*f*\Delta T$$

Where:

f = Frequency in Hz

ΔT = Displacement between input voltage and input current waveforms in msec

Table 1: Boost converter parameters

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

A suitable device is used to ameliorate (PF). The objective of (PF) correction circuit is to enable input current waveform like resistive load. 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 at line frequency (50 or 60 Hz). The capacitors and inductors are used to improve the (PF) (Raju *et al*., 2014).

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 (Raju *et al*., 2014).

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 Fig. 1-3:

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

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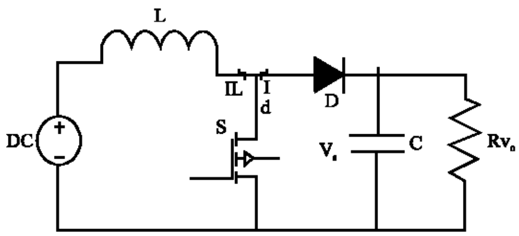

Fig. 1: Basic circuit of boost converter

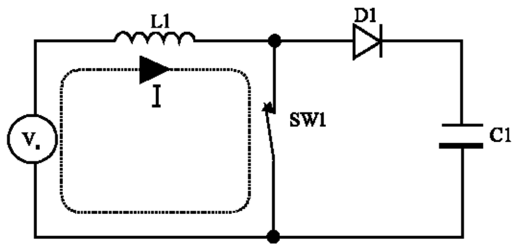

Fig. 2: Represents basic circuits of boost converter

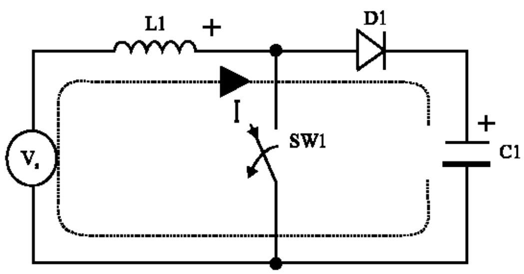

Fig. 3: Operation mode of boost converter

Continuous mode: When a boost converter operates in continuous mode, the current through the Inductor (IL) never falls to zero. Figure 4 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 (Raju *et al*., 2014):

$$V_o = \frac{V_{in}}{1-D} \tag{2}$$

When switch S is ON:

$$\frac{dIL}{dt} = \frac{V_{in}}{L} \tag{3}$$

Again when switch is OFF:

$$\frac{dIL}{dt} = \frac{V_o - V_{in}}{L} \tag{4}$$

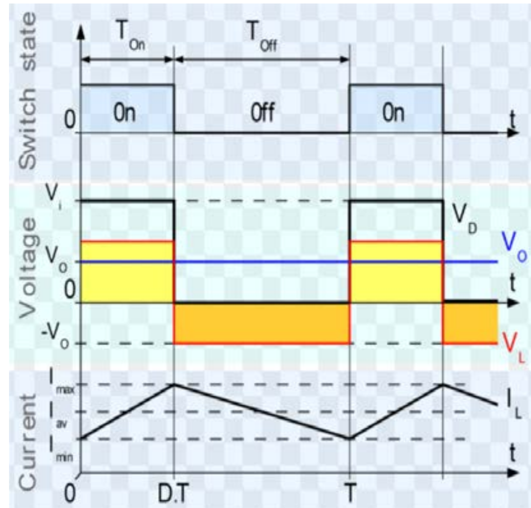

Fig. 4: Continuous mode

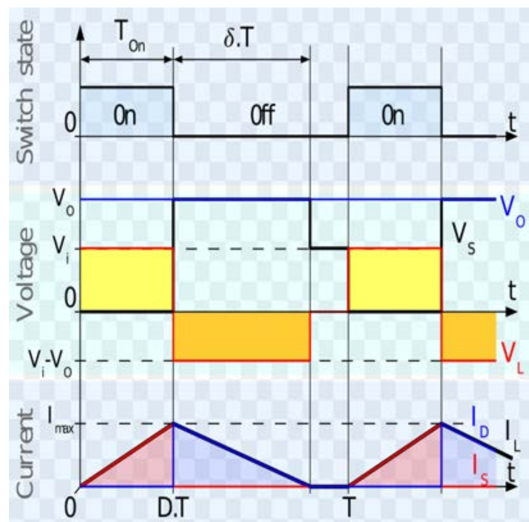

Fig. 5: Discontinuous mode

Where:

D = Duty cycle
V_{in} = Input voltage
V_o = Output voltage

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 Fig. 5.

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 6 shows the electrical circuit of rectifier without boost converter. The input voltage waveform that obtained after simulation run is shown in Fig. 7. The input current waveform after running is shown in Fig. 8. The phase shift between voltage and current waveform without boost converter is shown in Fig. 9. And the THD ratio for the current waveform above Fig. 9 is shown in Fig. 10. The output voltage waveform without boost converter is shown in Fig. 11. The THD ratio and power factor value are illustrated in Table 2. 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 Fig. 12.

The phase shift between voltage and current waveform after adding the active filter (boost converter) is shown in Fig. 13. The FFT graph of input current is shown in Fig. 14. The output waveform for rectifier with boost converter is shown in Fig. 15. And the average DC value is approximately (36 V) as given in real boost table. Table 3 shows the THD ratio and the power factor value after adding active filter.

Table 2: THD ratio and power factor values

Topology	THD (%)
Power factor	116.65
Without boost converter	0.8511

Table 3: THD ratio and power factor values

Topology	THD (%)
Power factor	10.15
Without boost converter	0.9995

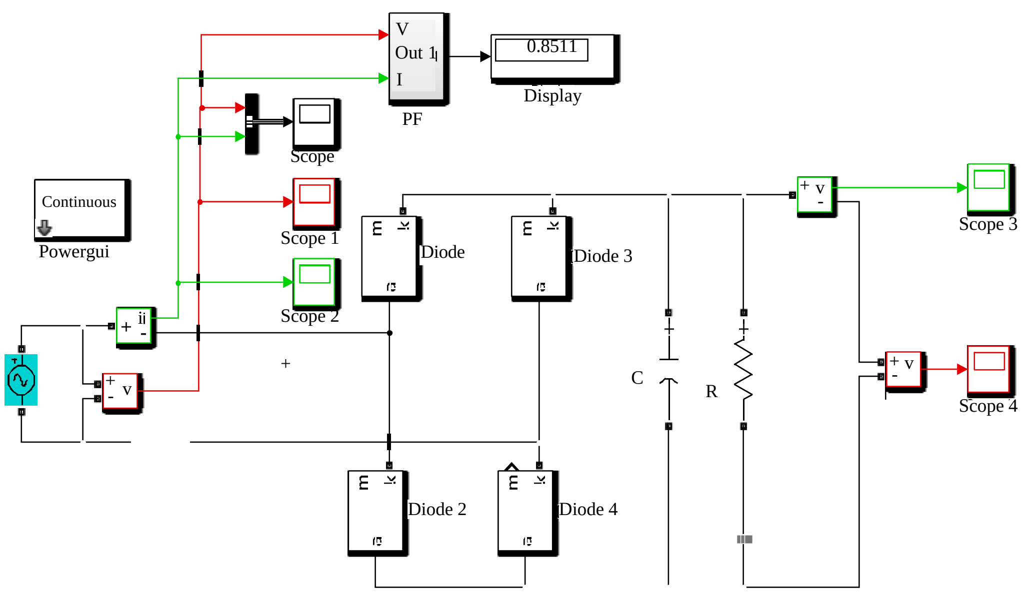

Fig. 6: Electrical circuit diagram of rectifier without boost converter

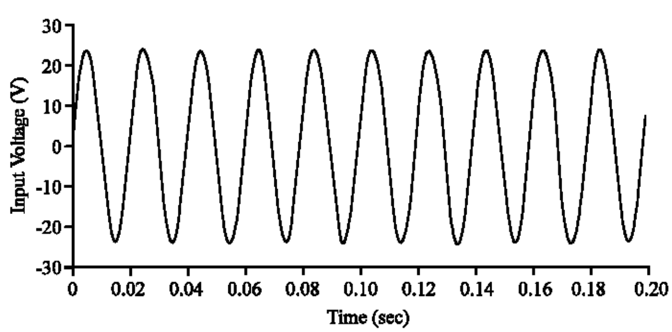

Fig. 7: Input voltage wave form

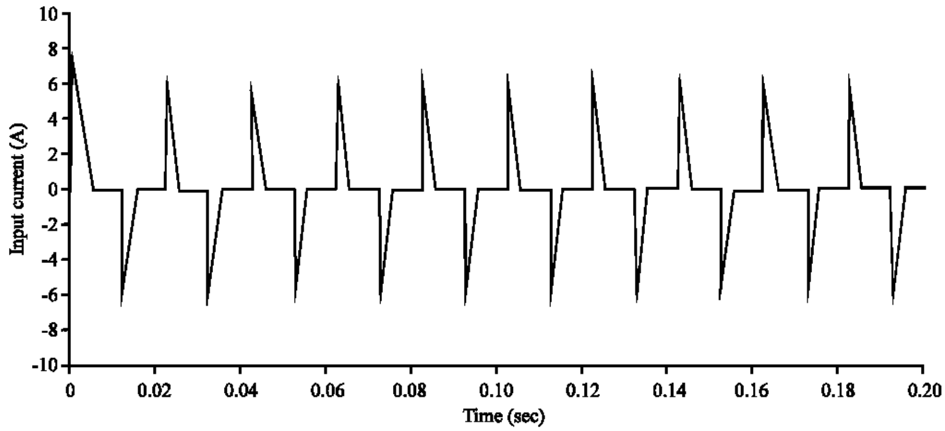

Fig. 8: Input current without boost converter

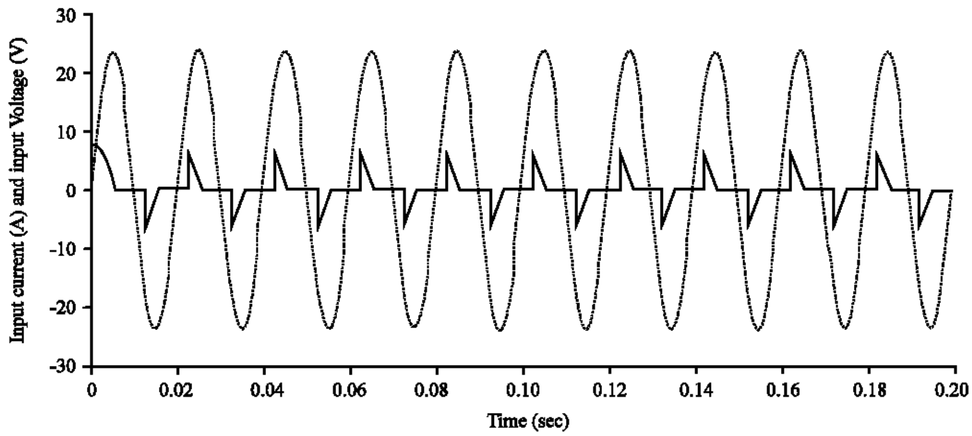

Fig. 9: Input current and voltage

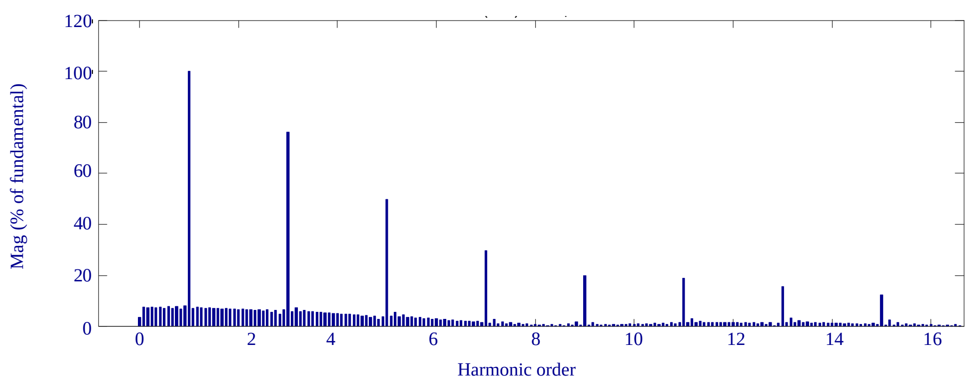

Fig. 10: THD without boost converter

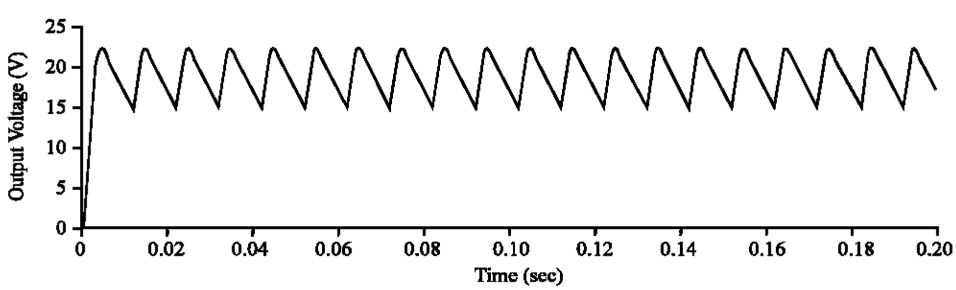

Fig. 11: Output voltage wave form

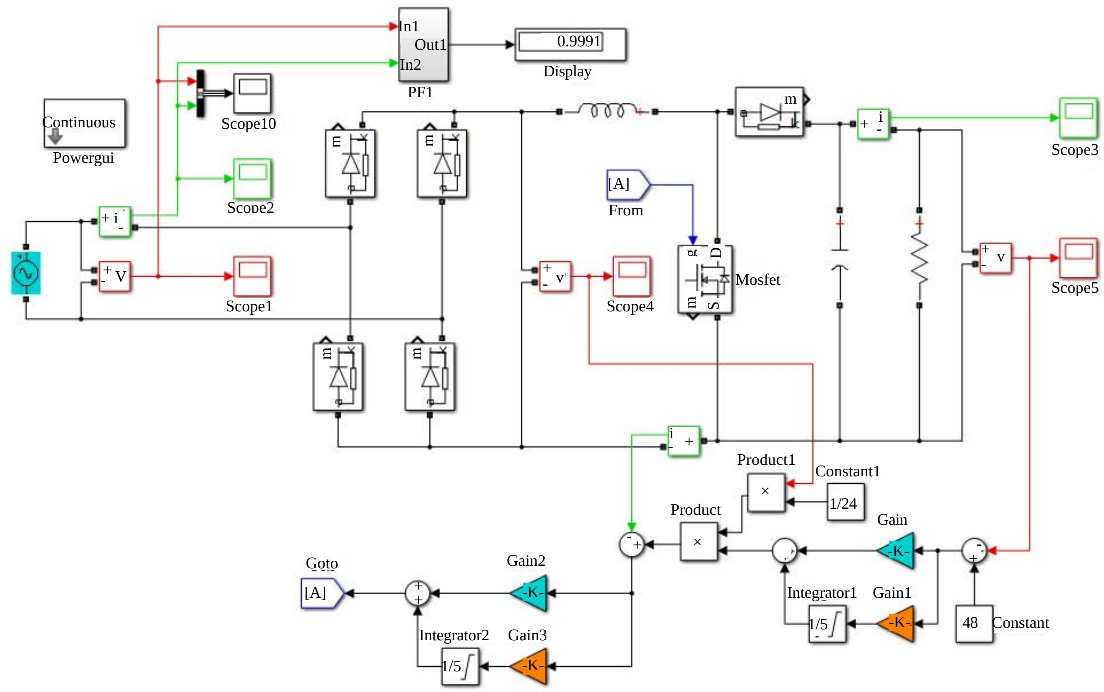

Fig. 12: Electrical circuit diagram of rectifier with boost converter

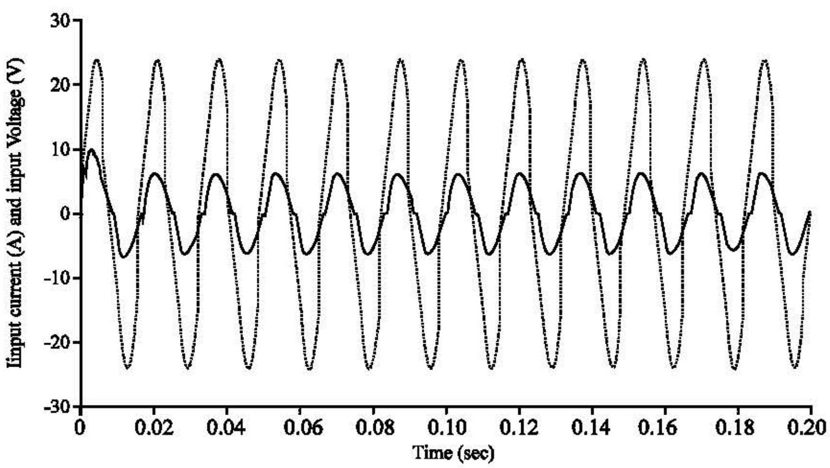

Fig. 13: Input current and voltage

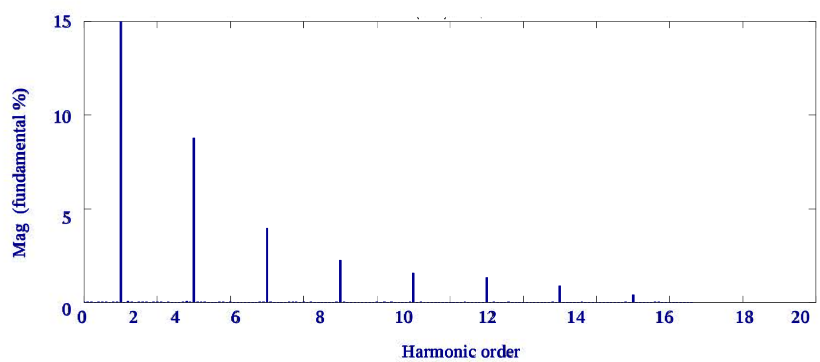

Fig. 14: THD with boost converter

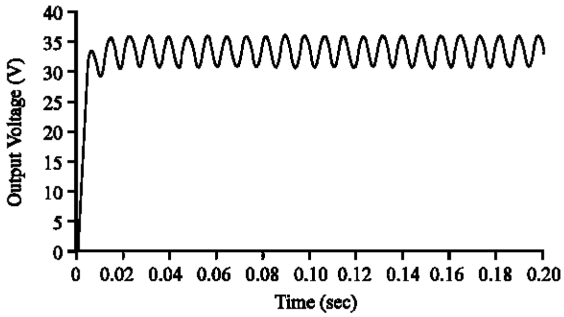

Fig. 15: Output voltage wave form

CONCLUSION

From simulation results the active (PF) correction yives 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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