AC OR DC CONVERTER FOR IMPROVING POWER QUALITY IN TRANSMISSION LINES

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Abstract

This paper presents, a transmission lines for improving grid quality by using Ac or Dc power converter. These converters starts with High PF Filters like capacitors and inductors, these both follow Bride Diode, by this we can get High PF and are used in Passive PF correction (PFC) circuits. In high frequency operation the circuit size reduced, two stage of high frequency PFC converter proposed [1]. With Si-semiconductor devices, switching frequency operates from 10 to several 100 kHz. Ac or Dc PFC converter, wide-band gap devices, switching frequency operates from several 100 kHz to 10 MHz’s. Design and control part is solved by regulating output voltage and shaping input current. By changing the Dc link voltage from 400V-800V, line voltage will be within 265V and Power Factor will increase from 0.88 to 0.99

Key word: **MATLAB, SIMULINK, SSTLPFC, PFC, Dc/Dc, DLV**

I.INTRODUCTION

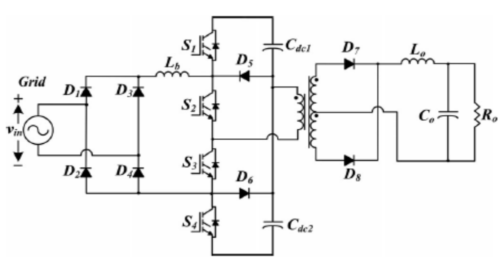


Fig .1 SSTLPFC converters

Fig.1 shows SSTLPFC converter. Two Capacitors are used and there ratings are 470 µF or 400 V. output side capacitor rating is100 µF. Input inductors and output inductor rating is 27 µH or 15 A. Switching frequency is 125 kHz. Transformers turns ratio is 1:2. Switches S1 to S4 are N Channel MOSFETs, the input ac voltage is 90 Vrms and frequency is 60 Hz. Converters starts with High PF. Filters are like capacitors and inductors are used and these both follow Bride Diode, by doing this we can get High PF and are used in Passive PF correction (PFC) circuits. In a circuit, low line frequency filters are needed but they are heavy. In high frequency operation the circuit size must be reduced.

II. OPERATION OF MODES

MODE I

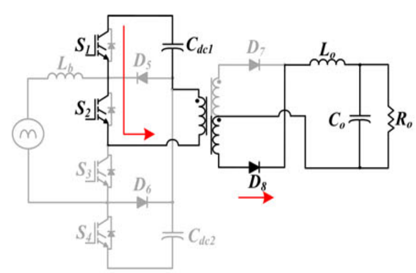


Fig. 2 Mode I

This mode is valid for t0 to t1. Switch S1 and Switch S2 are ON and diode D8 conducts in Transformers auxiliary side. In Transformers primary side apply –Vdc/2, and capacitor Cdc1 discharges to the load and VL0=Vdc/2N-V0.

MODE II

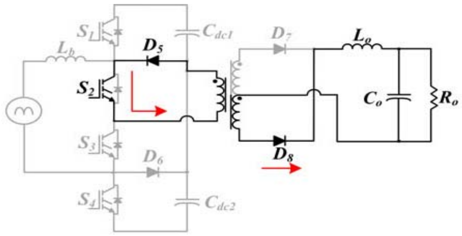


Fig.3 Mode II

This mode is valid for t1 to t2. Switch S2 remains ON and Switch S1 OFF and diode D5 conducts. Transformers Primary side applies zero voltage and Current freewheels. Output voltage of inductor is equivalent to –V0 and output current of inductor is reduces straightly.

MODE III

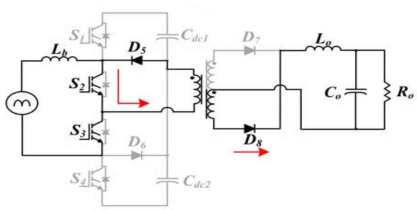


Fig.4. Mode III

This mode valid for t2 to t3, Switch S2 and Switch S3 both are ON, that time Transformers Primary side applies zero voltage and continuous Current freewheels. Under output Current and Output voltage inductor is continuously decreases. That time Vin connected crosswise over Lb.

MODE IV

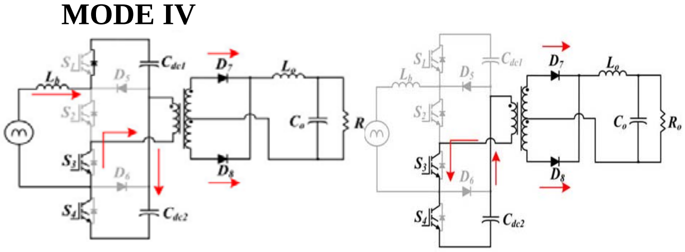


Fig.5. Mode IV

Switch S2 is OFF and Switch S4 and S3 are ON, this mode valid for t3 to t5. Energy Stores in inductor and transfers that energy into Dc link capacitor. In between Vin - Vdc inductor current decreases straightly, that time Transformers primary side apply Vdc/2. In leakage inductance, current is transferred to Cdc2 in this situation output current flows from D8 to D7.

MODE V

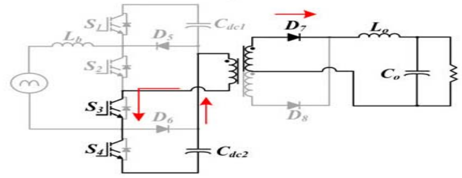


Fig.6. Mode V

This mode is valid for t5 to t6.Switch S3 and Switch S4 are ON and diode D7 conducts. That time Cdc2 is discharges and Transformers primary side apply Vdc/2 and VL0=Vdc/2N-V0.in a discontinuous conduction mode input current always at zero.

MODE VI

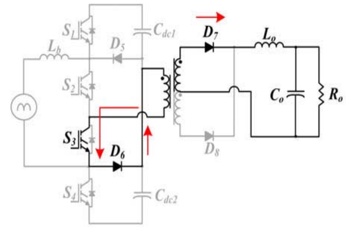


Fig.7. Mode VI

This mode is valid for t6 to t7, Switch S4 OFF and Switch S3 is ON. Both diode D6 and D7 are conducts and D6 allows leakage current to freewheel. Under –V0 output current is decreases.

MODE VII

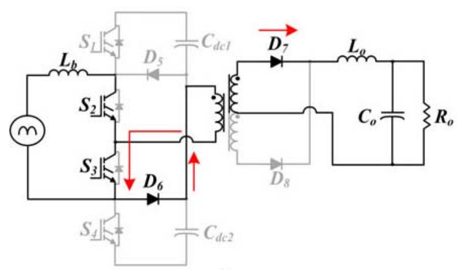


Fig. 8 Mode VII

This mode is valid for t7 to t8. Switch S2 and Switch S3 are ON. Input side of energy is stored in inductor and its operation is same as mode 3. Excluding that in mode 3 primary side current is opposite.

MODE VIII

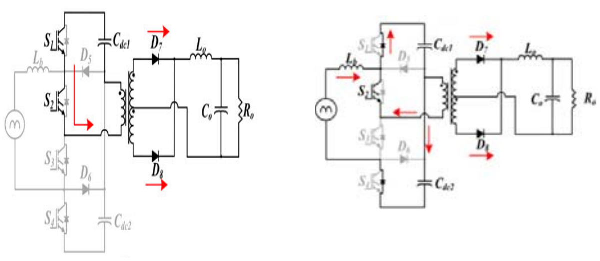


Fig. 9 Mode VIII

This mode valid for t8 to t10.S_3 is OFF and S_1, S_2 are ON. Its operation is same as mode 4. In inductor energy is stored and that energy transferred to Dc bus capacitor. In this situation output current of inductor flows in between D7 and D8.

III. HIGH POWER FACTOR:

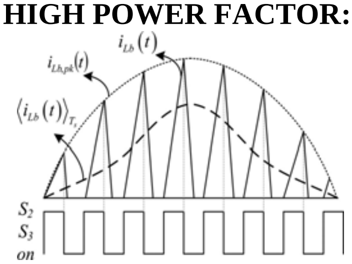


Fig 10 Input Inductor Current

PF will be high when DLV is maximum so i/p current turns out to be Discontinuous. When Peak Current follows a sinusoidal waveform, converter operates that time Duty ratio must be constant.

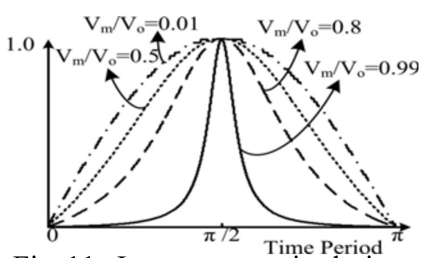


Fig 11 .Input current is designed for different DLV

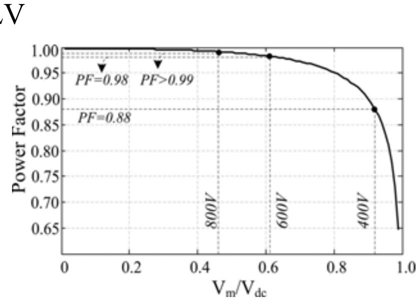


Fig 12 PF v/s Vm/Vdc

In Fig 11 shows Input current is designed for different DLV. To obtain input currant as pure sinusoidal waveform, Dc Link Voltage must be infinity. In Fig 12 shows PF v/s V_m/V_{dc}.

IV . DESIGN CONSIDERATIONS

1 Input Inductor:

In Discontinuous Conduction Mode PF is High and at constant Duty ratio PFC converters operate. In DLV, Input Inductor and Duty ratio, Power is transfer this happens in operation of DCM. Using equation (1), the Lb can be written as

$$L_b = D1^2 V m^2 \int_0^{\pi} \frac{\left(\frac{\sin^2(wt)}{1 - V_m|\sin(wt)|/V_{dc}}\right) d(wt)}{\pi f_s P_o} \qquad (1)$$

2 Output Inductor:

Output inductor is fully depends on its design principle so it may be Continuous or Discontinuous. At Light Load condition operation of converter can transfer to DCM so that output inductor size will be decreases. Output inductor can be written as

$$L_0 \geq V_0^2 (0.5 - D_2) T_{sw} / 2P_x \qquad (2)$$

Transformer ratio:

At Steady State Duty ratio of S1 and S4, indicated as D2, it can be written as

$$D_2 = \frac{NV_0}{V_{dc}} \qquad (3)$$

N = number of turns ratio, in DCM D2 can be written as

$$D_2 = \sqrt{2L_0 / RT_s\left(\left(\frac{V_{dc}}{NV_0} - 1\right)^2 - 1\right)} \qquad (4)$$

The practical voltage of Transformer by turning ON S1 to S2 or S3 to S4 is limited to 0.5

$$D1 + D2 \leq 0.5 \qquad (5)$$

Fig 13 show Switches and Diodes operations in less time period

Switches and Diodes operations in less time period are shown in Fig 13. Dc is known as Duty ratio and it can be written as

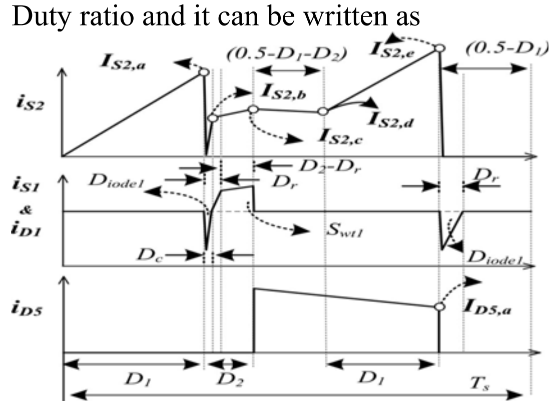


Fig 13 Switches and Diodes operations in less time period

$$Dc(t) = \frac{(NIs2,a(t) - I0)LbL0fs}{\left(\frac{Vdc}{aN} - V0\right)Lb - NL0(Vdc - Nin(t))} \quad (6)$$

Inductor current can be written as

$$Is2,a\ (t) = \frac{Vin(t)}{Lb} D1Ts \quad (7)$$

Minimum Current in Transformer can be written as

$$Is2,b\ (t) = \frac{I0}{N} - \left(\frac{\frac{Vdc}{aN} - V0}{NL0}\right)\left(\frac{D2}{2} - Dc\ (t)\right)Ts$$

Peak Current in Transformer can be written as

$$Is2,c = \frac{I0}{N} + \left(\frac{\frac{Vdc}{aN} - V0}{2NL0}\right)D2Ts \quad (8)$$

ID_5 can be calculated as

$$ID5,a = \frac{I0}{N} - \left(\frac{V0}{2NL0}\right)(0.5 - D2)Ts$$

Standard diode currents can be written as

$$ID1,4,ave\ (t) = \frac{1}{2} Is2,a(t)\left(Dc(t) + Dr(t)\right)$$

Standard current of freewheeling Diodes can be written as

$$ID5,6,ave\ (t) = \frac{Is2,b(t) + ID5,a}{2}(0.5 - D2) \quad (9)$$

V.POWER FACTOR CORRECTION TECHNIQUES

To improve PF and to eradicate Current harmonics several methods are used. PFC has two techniques, to decrease or to eradicate Current harmonics and they are

1.Passive power factor correction:

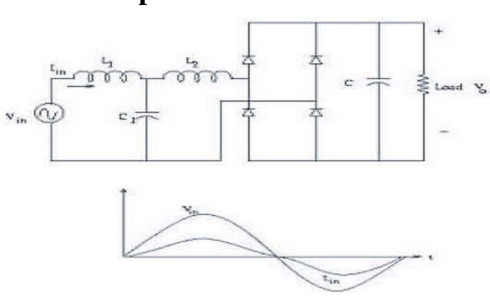


Fig 14 PPFC

In PPFC techniques, two inductors and one capacitor are connected to Ac mains line and Diode rectifier converter as shown in Fig.6. It is simple and harsh. In Passive correction technique PF is not high. It has large size and its weight should be heavy. At this moment it is not suitable for Current trends of harmonic norms. Generally in PPFC Power rating are not more than 25W and above this value the PPFC will be heavy. It has high Efficiency and its EMI is Low. For 50/60 Hz, power distribution systems, the LC filter is tuned at the fifth harmonic frequency and a series tuned Filter is connected in corresponding to the rectifier to trap third harmonic current to prevent damping the fundamental component.

2.Active power factor correction:

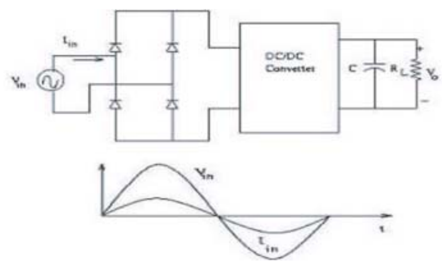


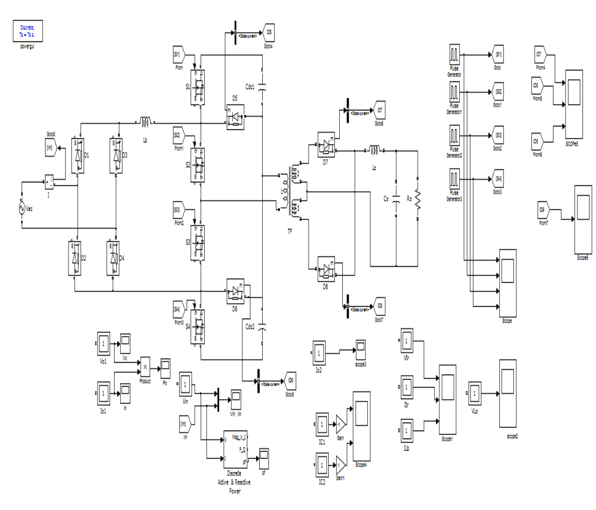
Fig 15 APFC

APFC presents a extra challenging converter design and control problem as compared to the passive approach. Usually two control rings are required to achieve this: first a wide bandwidth internal current ring to shape the Input Current; second, a narrow bandwidth outer ring is designed to control the output dc Voltage of the load.

4.Two Stage Power Factor Correction:

Two-stage PFC using an input current shaper go behind a Dc/Dc converter is fundamental approach for active PFC. By using Nonlinear carrier control, Hysteresis control, Current mode control we can shape Input Current. Stage of Dc/Dc converters are buck, Fly back or Forward converter. TSPFC has good Hold up time, High PF and its Input harmonics should be Low. So these all qualities show greater performance of TSPFC.

VI.SIMULINK DIAGRAM



VII.SIMULATION DIAGRAM

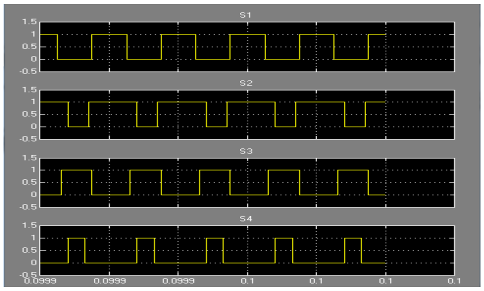


Fig.8.1 switching operations

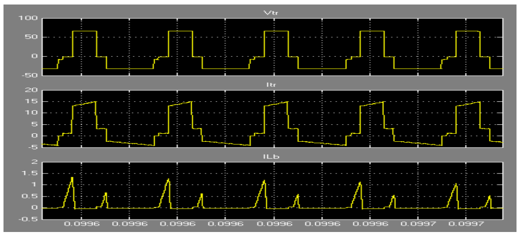


Fig.8.2 Transformers Voltage and Current Wave form.

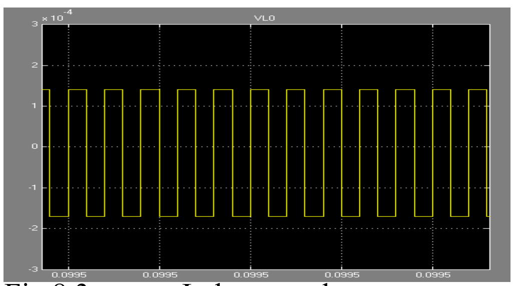


Fig.8.3 output Inductor voltage

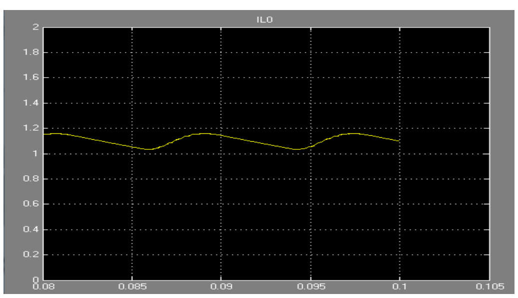


Fig.8.4 output Inductor current.

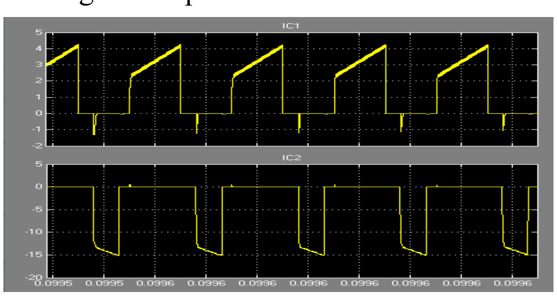


Fig.8.5 capacitor’s side current

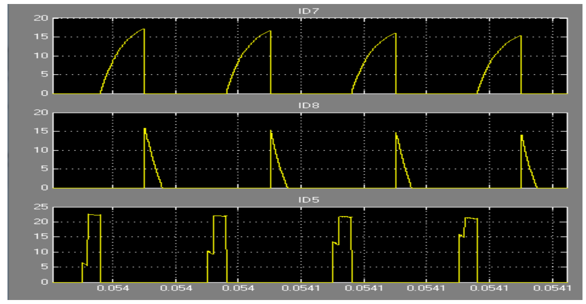


Fig.8.6 Diodes side current.

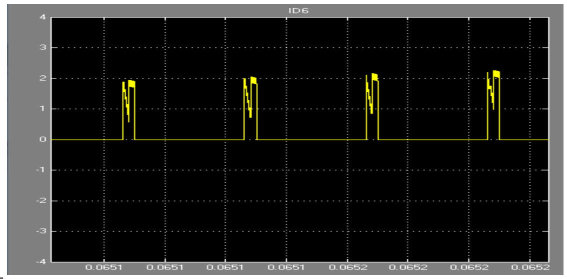


Fig.8.7 shows current flows in Diode D6

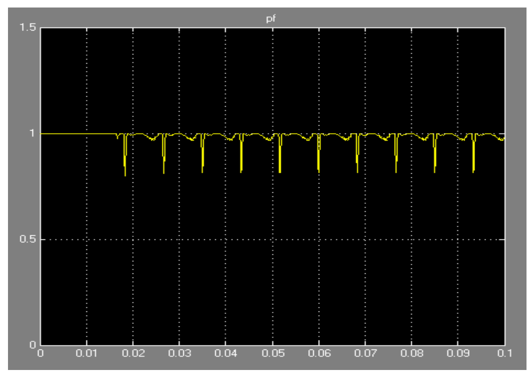


Fig.8.8 Power Factor of conventional circuit

IX. CONCLUSION

In low power applications we can use this SSTLPFC converter and shows, in a constant duty ratio how high Power Factor will be achieved by using minimum number of Diodes or Switches. By adding inductor and Diode Bridge in SSTL converter the switching operation is modified and consistent. Design and control part is solved by regulating output voltage and shaping input current. By changing the Dc link voltage from 400V-800V, line voltage will be within 265V and Power Factor will increase from 0.88 to 0.99.

IX.REFERANCES

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