

Single Stage Quasi Active Power Factor Correction Scheme of AC/DC Rectifiers

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ABSTRACT : In the proposed system, the power factor is improved by using an auxiliary winding coupled to the transformer of a cascade dc/dc fly back converter. The auxiliary winding is placed between the input rectifier and the low-frequency filter capacitor to serve as a magnetic switch to drive an input inductor. Since the dc/dc converter is operated at high-switching frequency, the auxiliary windings produce a high frequency pulsating source such that the input current conduction angle is significantly lengthened and the input current harmonics is reduced. It eliminates the use of active switch and control circuit for PFC, which results in lower cost and higher efficiency. In order to achieve low harmonic content, the input inductor is designed to operate in discontinuous current mode. Since the use of a single inductor, the cost is reduced and the efficiency of the system is improved. The power factor is maintained constant by using a buffer capacitor in parallel to the system for compensating the inductive components.

Keywords - AC/DC converters, power factor correction (PFC), single stage, Fly back converter.

I. INTRODUCTION

Conventional offline power converters with diode– capacitor rectifiers have resulted in distorted input current waveforms with high harmonic contents. To solve these problems, so as to comply with the harmonic standards such as IEC 61000-3-2, several techniques have been proposed to shape the input current waveform of the power converter. A common approach to improve the power factor is a two-stage power conversion approach. The two-stage scheme results in high power factor and fast response output voltage by using two independent controllers and optimized power stages.

Drawbacks:

- Its relatively higher cost
- Larger size resulted from its complicated power stage topology and control circuits, particularly in low power applications.

In the proposed scheme, the power factor is improved by using an auxiliary winding coupled to the transformer of a cascade dc/dc fly back converter. The auxiliary winding is placed between the input rectifier and the low-frequency filter capacitor to serve as a magnetic switch to drive an input inductor. Since the dc/dc converter is operated at high-switching frequency, the auxiliary winding produce a high frequency pulsating source such that the input current conduction angle is significantly lengthened and the input current harmonics is reduced. It eliminates the use of active switch and control circuit for PFC, which results in lower cost and higher efficiency. In order to achieve low harmonic content, the input inductor is designed to operate in discontinuous current mode.

II. METHODOLOGY

1. REVIEW OF PROPOSED SYSTEM

Integrated single-stage power factor correction (PFC) converters usually use a boost converter to achieve PFC with discontinuous current mode (DCM) operation. Usually, the DCM operation gives a lower total harmonic distortion (THD) of the input current compared to continuous current mode (CCM). However, the CCM operation yields slightly higher efficiency compared to the DCM operation. Generally, single stage PFC converters meet the regulatory requirements regarding the input current harmonics, but they do not improve the power factor and reduce the THD as much as their conventional two-stage counterpart. The power factor could be as low as 0.8, however, they still meet the regulation. In addition, although the single- stage scheme is especially attractive in low cost and low power applications due to its simplified power stage and control circuit, major issues still exist, such as low efficiency and high as well as wide-range intermediate dc bus voltage stress .To overcome the disadvantages of the single-stage scheme, many converters with input current shaping have been presented , in which a high frequency ac voltage source (dither signal) is connected in series

with the rectified input voltage in order to shape the input current. Another technique based on parallel connection of this dither signal is presented in , however, the harmonic content can meet the regulatory standard by a small margin. a new concept of quasi-active PFC is proposed to improve the efficiency of a single-stage converter by preventing the input current or voltage stress due the PFC cell from being added to the active switch.

2. BASIC CONCEPT OF PROPOSED SYSTEM

Block diagram of proposed circuit [3]

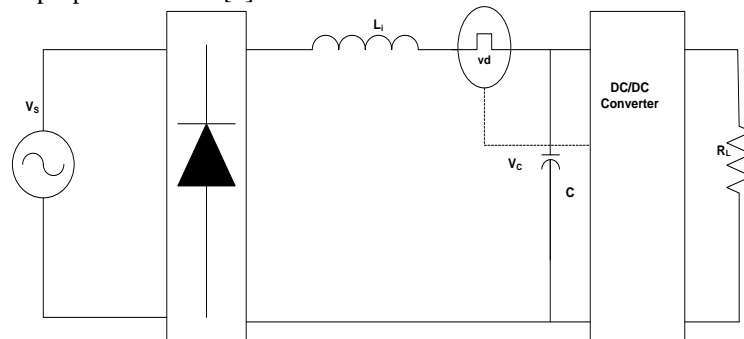


Fig.1 General circuit diagram of dither rectifier with PRC cell.

2.1 AC source: It is the first stage of this project. So it is give the AC supply to rectifier. The input side having one inductive filter. It is used to improve the input power factor.

2.2 Inverter: It is used to convert dc to ac voltage.the phase shift pulse method is used to control the inverter as a result to achieve the ZVS

2.3 High Frequency Transformer: It is used for step down purpose. It is also used for isolation purpose. The transformer size should be small due to high frequency.

2.4 Rectifier: It converts AC supply to DC supply. DC supply having some ripples. It is filtered with the help of capacitor filter.

2.5 Filter: Rectifier converts AC to DC. This output has ripples.It is filtered with a help of Capacitor filters.

2.6 DC Load: The output has DC output voltag. It is used to run the motor, battery charging, and telecommunication applications.

2.7 AC Load: Multi level inverter is generate ac output voltage . it is used to run single phase ac motor and any appliance required for ac voltage.

2.8 Driver 1 & 2: It is also called as power amplifier because it is used to amplify the pulse output from micro controller. It is also called as opto coupler IC. It provides isolation between microcontroller and power circuits.

2.9 Regulated Power supply (RPS): RPS give 5V supply for micro controller and 12V supply for driver. It is converted from AC supply. AC supply is step down using step down transformer.

III. PROPOSED QUASI ACTIVE PFC TECHNIQUE

In this project, a new technique of quasi-active PFC is proposed. The PFC cell is formed by connecting the energy buffer (L_B) and an auxiliary winding (L_A) coupled to the transformer of the dc/dc cell, between the input rectifier and the low-frequency filter capacitor used in conventional power converter. Since the dc/dc cell is operated at high frequency, the auxiliary winding produces a high frequency pulsating source such that the input current conduction angle is significantly lengthened and the input current harmonics is reduced. The input inductor operates in DCM such that a lower THD of the input current can be achieved.[1]

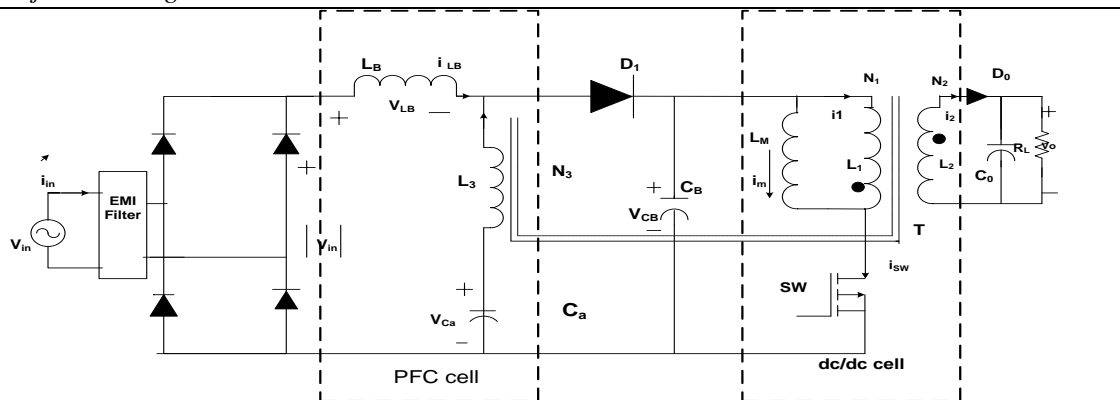


Fig.2. Proposed quasi-active PFC circuit diagram

The proposed quasi-active PFC circuit is analyzed in this section. The circuit comprised of a bridge rectifier, a boost inductor, a bulk capacitor C_a in series with the auxiliary windings, an intermediate dc-bus voltage capacitor, and a discontinuous input current power load, such as fly back converter. The fly back transformer (T) has three windings and the secondary winding = 1 is assumed. In the proposed PFC scheme, the dc/dc converter section offers a driving power with high-frequency pulsating source. The quasi active PFC cell can be considered one power stage but without an active switch.

IV. STEADY STATE ANALYSIS

To facilitate the analysis of operation, it is assumed that both the input inductor L_B & the magnetizing inductance of the fly back converter operate in DCM. Therefore, currents i_{LB} , i_m , and i_2 are zero at the beginning of each switching period. It is also assumed that the average capacitor voltage V_{Ca} is greater than the average rectified input voltage V_{in} . For the proper operation of converter, the transformer's turn ratio should be $(N_1/N_3) > 2$ and the boost inductor $L_B < L_M$. [1]

$$i_m = \frac{V_{CB}}{L_m} (t_0 - t_1)$$

And as diode D_1 is OFF, the input inductor L_B is charged by input voltage, therefore, the inductor current i_{LB} is linearly increased from zero since it is assumed that PFC cell operates in DCM & this current can be expressed as

$$i_{LB} = \frac{|V_{in}| + \left(\frac{N_3}{N_1}\right) V_{CB} - V_{Ca}}{L_B} (t_0 - t_1)$$

Ampere's law is given as,

$$N_1 i_1 + N_2 i_2 - N_3 i_{LB} = 0$$

Where $i_2 = 0$, therefore

$$i_1 = \frac{N_3}{N_1} i_{LB} = -\frac{N_3}{N_1} i_3$$

$$i_m = i_{CB} - i_1 = i_{CB} + \frac{N_3}{N_1} i_3$$

The current through main switch is given by

$$i_{SW} = i_{CD} = i_m - \frac{N_3}{N_1} i_3 = i_m + \frac{N_3}{N_1} i_{LB}$$

And hence

$$i_{SW} = i_m + i_{LB}$$

V. KEY SWITCHING WAVEFORM OF PROPOSED CIRCUIT

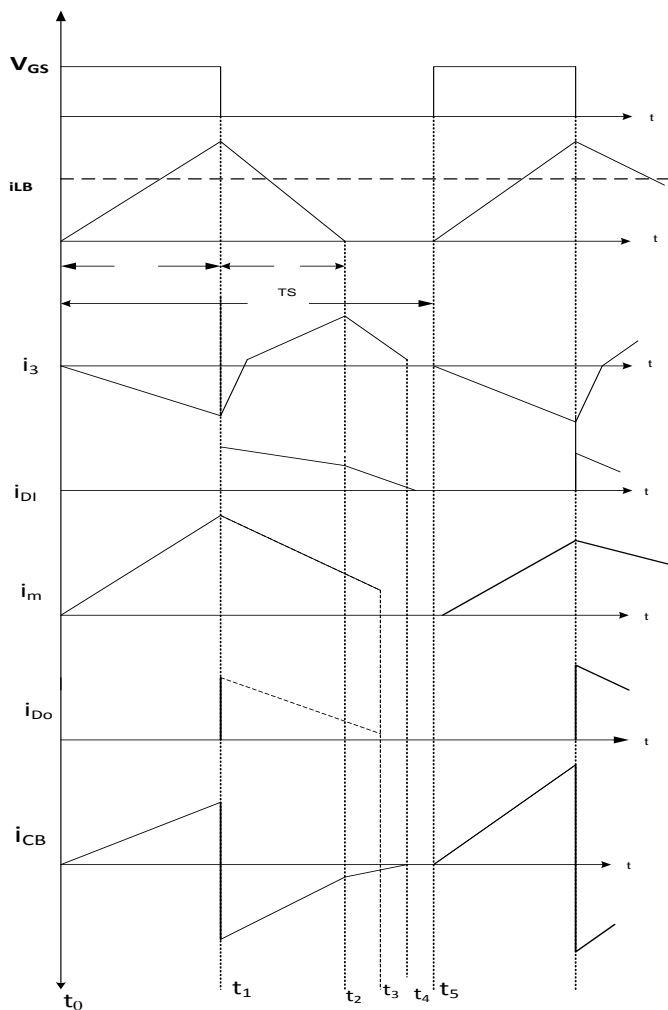


Fig.3.(a) Key Switching waveforms of the proposed PFC.

VII. CONCLUSION

In this paper a new ac/dc converter based on a quasi-active PFC scheme has been presented. The proposed method produces a current with low harmonic content to meet the standard specifications as well as high efficiency. This circuit is based on adding an auxiliary winding to the transformer of a cascade dc/dc DCM flyback converter. The input inductor can operate in DCM to achieve lower THD and high power factor. By properly designing the converter components, a tradeoff between efficiency and harmonic content can be established to obtain compliance with the regulation and efficiency as high as possible. Operating principles, analysis, and expected experimental results of the proposed method are presented.

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