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Design of Push Pull Quasi Resonant Boost Converter for Power Factor Correction

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Abstract

This project proposes power factor correction using push pull quasi resonant converter. A boost power factor corrector converts universal AC input voltage into regulated DC output voltage. This converter is composed of transition mode boost type power factor corrector and a coupled inductor. By integrating two inductors into a single magnetic core, the operating frequency is being doubled of switching frequency. Transition mode power factor correction is to reduce the switching loss and two boost inductors are used to drive and achieve transition mode operation. The power factor is corrected by the occurrence of resonance condition in the converter. In conventional method, PID controller was used so that the switching and conduction losses are high. Fuzzy controller gives accurate output by adding new rules. Fuzzy controller is used in the proposed system to reduce the losses and also to improve the power factor
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Keywords: *Push Pull Converter, Fuzzy Logic Controller, Quasi Resonant Converter, Boost Converter.*

1. Introduction

Power Factor Correction scheme has lower efficiency due to significant losses in the diode bridge. Power supplies with active Power Factor Correction techniques are becoming necessary for many types of electronic equipment to meet harmonic regulations. The major problem with the conventional rectifiers is harmonic content. The AC current drawn by present day power supplies is non-sinusoidal and reasonably phase shifted with the supply voltage waveform resulting in poor Power Factor. Therefore, Power Factor Correction is the fundamental requirement in Switched Mode Power Supplies (SMPS) to reduce the voltage and current distortion and losses.

There are several converters for step up/step down applications such as buck converter, boost converter, buck boost converter, and Cuk converter. A buck converter is a step down DC-DC converter and its design is similar to the step up boost converter. Switched Mode Power Supply that uses two switches (a transistor and a diode), an inductor and a capacitor.

The Push Pull converter is proposed and this type of DC-DC converter that has an output voltage magnitude that is either greater than or less than the input voltage magnitude. The Push Pull converter can only have opposite polarity between input and output. It uses a capacitor as its main energy storage component, unlike most other types of converters which use an inductor. The Bridgeless rectifier reduces the switching losses and conduction loss because of having reduced number of switches.

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2. Power Factor Correction

Power factor correction is the method of improving the power factor of a system by using suitable devices. The objective of the power factor correction circuits is to make the line current is inphase with the waveform of line voltage, so that the input to the power supply becomes purely resistive or behaves like a resistor and hence to improve the power factor. In an electric power system, a load with low power factor draws more current than a load with high power factor for the same amount of useful power transferred. The higher current increases the energy loss in the distribution system, and requires large wires and other equipment. Because of the costs of larger equipment and energy loss, electrical utilities will usually charge a higher cost to industrial or commercial customers where there is a low power factor. This chapter deals with the definition and calculation of power factor, the methods of power factor correction and benefits obtained after the correction of power factor.

2.1 Power Factor Defenition and Calculation

The power factor of an AC electric power system is defined as the ratio of the real power flowing to the load to the apparent power. Real power is the capacity for performing work in a particular time. Apparent power is the product of the current and voltage of the circuit.

The power factor is defined as,

Power factor = (p/s) (1)

Where,
P is real power measured in watts (W),
S is apparent power, measured in volt-amperes (VA)
When power factor is equal to 0, the energy flow is entirely reactive, and stored energy in the load returns to the source on each cycle. When the power factor is 1, all the energy supplied by the source is consumed by the load. Power factor is usually stated as leading or lagging to show the sign of the phase angle between the voltage and current. If a purely resistive load is connected to a power supply, current and voltage will be in phase and the power factor will be unity. The electrical energy flows in a single direction across the network in each cycle. Inductive load such as transformers and motors consume reactive power with current waveform lagging the voltage. Capacitive load such as capacitor banks or buried cable generate reactive power with current phase leading the voltage. Both type of load will absorb energy during part of the AC cycle, which is stored in the devices magnetic or electric field, only to return this energy back to the source during the rest of the cycle.

3. Active Power Factor Correction

An Active Power Factor Corrector (APFC) is a power electronic system that controls the amount of power drawn by a load in order to obtain a power factor closer to unity. In most application the active PFC controls the input current of the load so that the current waveform is proportional to the main voltage waveform. Active power factor correctors can be single stage or multi stage. Some of the active PFC types are:

- Buck Converter.
- Boost Converter.
- Buck boost Converter.

3.1 Boost Converter

A boost converter is a step up converter DC-DC power converter with an output greater than its input voltage. It is a group of Switched Mode Power Supply (SMPS) containing at least two semiconductor switches (a diode and a transistor) and at least one energy storage element, capacitor, inductor, or the two in combination. Filters made of capacitors (sometimes in combination with inductors) are normally added to the output of the converter to reduce output voltage ripple.

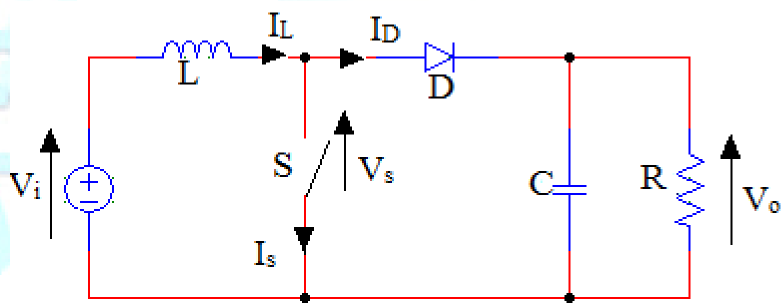


Fig1: Boost Converter circuit diagram

The basic principle of a Boost converter consists of two distinct states On state and Off state is shown in Figure 3.3. In the On state, the switch S is closed, resulting in an increase in the inductor current. In the Off state the switch is open and the only path offered to inductor current is through the flyback diode D, the capacitor C and the load R. These results in transferring the energy accumulated during the On state into the capacitor. The input current is the same as the inductor current. So it is not discontinuous as in the buck converter and the requirements on the input filter are relaxed compared to a buck converter.

4. Fuzzy Logic Controller

4.1 Introduction to FLC

Fuzzy logic has rapidly become one of the most successful of today's technology for developing sophisticated control system. With it aid complex requirement so may be implemented in amazingly simple, easily minted and inexpensive controllers. The past few years have witnessed a rapid growth in number and variety of application of fuzzy logic. The application range from consumer products such as cameras, camcorder, washing machines and microwave ovens to industrial process control, medical instrumentation and decision support system, many decision making and problem solving tasks are too complex to be understand quantitatively however, people succeed by using knowledge that is imprecise rather than precise . Fuzzy logic is all about the relative importance of precision. Fuzzy logic as two different meanings in a narrow sense, fuzzy logic is a logical system which is an extension of multi valued logic but in wider sense fuzzy logic is synonymous with the theory of fuzzy sets.

Fuzzy set theory is originally introduced by Lotfi Zadeh in the 1960'sresembles approximate reasoning in it use of approximate information and uncertainty to generate decisions. Several studies show, both in simulations and experimental results, that Fuzzy Logic control yields superior results with respect to those obtained by conventional control algorithms thus, in industrial electronics the FLC control has become an attractive solution in controlling the electrical motor drives with large parameter variations like machine tools and robots. However, the Fuzzy logic Controllers design and tuning process is often complex because several quantities, such as membership functions, control rules, input and output gains must be adjusted. The design process of a FLC can be simplified if some of the mentioned quantities are obtained from the parameters of a given Proportional Integral Controller (PIC) for the same application.

4.2 Fuzzy Logic Controller (FLC)

Fuzzy logic controller is used to design nonlinear systems in control applications. The design of conventional control system essential is normally based on the mathematical model of plant. If an accurate mathematical model is available with known parameters it can be analyzed, for example by bode plots or nyquist plot, and controller can be designed for specific performances such procedure is time consuming. Fuzzy logic controller has adaptive characteristics. The adaptive characteristics can achieve robust performance to system with uncertainty parameters variation and load disturbances. Fuzzy logic expressed operational laws in linguistics terms instead of mathematical equations. Many systems are too complex to model accurately, even with complex mathematical equations. Therefore traditional methods become infeasible in these systems. However fuzzy logics linguistic terms provide a feasible method for defining the operational characteristics of such system. Fuzzy logic controller can be considered as a special class of symbolic controller. The configuration of fuzzy logic controller block diagram is shown in Figure 4.1. By applying a non zero voltage vector for only a portion of the switching period, and the zero voltage vector for the remainder of the period, the effective switching frequency is doubled. Therefore, over any single switching period, the torque variations above and below the average value are smaller.

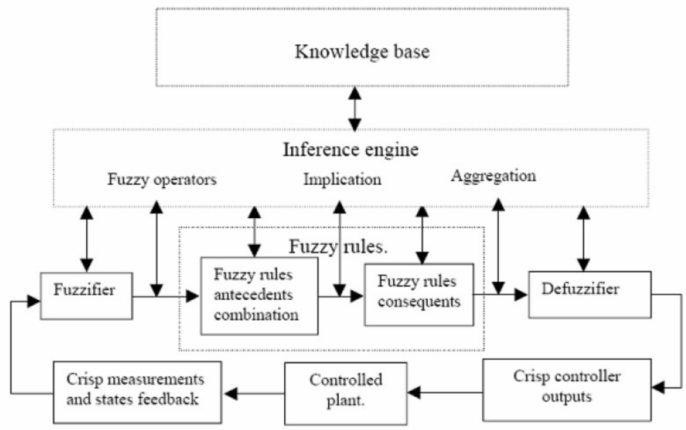


Fig4.1: Block diagram for Mamdani type FLC

The fuzzy logic controller has three main components

1. Fuzzification
2. Fuzzy inference
3. Defuzzification

5. software Implementation

MATLAB is a software package for high performance numerical computation and visualization it provides an interactive environment with hundreds of built in function for its own high level programming language. The name MATLAB stands for Matrix laboratory. MATLAB's built in functions provide excellent tool for linear algebra computation, data analysis, signal processing, optimization, and numerical solutions of ODES, quadrature, and many type of scientific computation. Most of these functions use state of the art algorithm. These are numerous functions for 2D and 3D graphics as well as for animation also, for those who can't do without their FORTRAN or C courses, MATLAB even provides an external interface to fun those programs from within MATLAB even provides an external interface to fun those programs from within MATLAB.

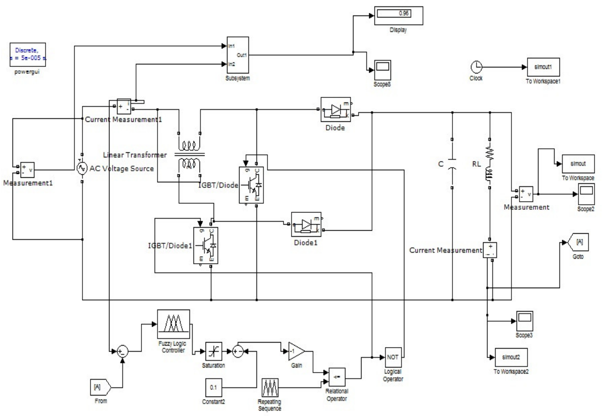
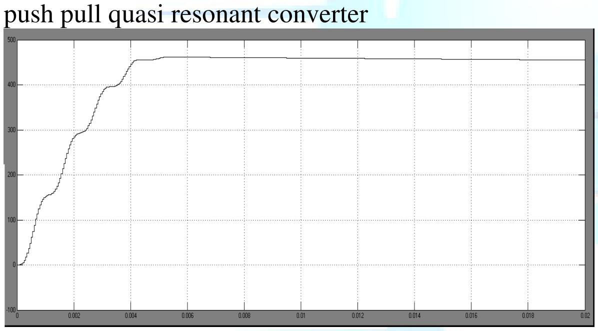


Fig5.1: Simulation circuit of push pull converter

The above waveform figure 5.1 shows simulation circuit of push pull quasi resonant converter

Voltage (volts)



Time(sec)

Fig5.2: Output voltage

The figure 5.2 shows output voltage characteristics of push pull converter. The voltage is increased with respect to time. Here x axis donated time and y axis denoted voltage.

6. Hardware Implementation

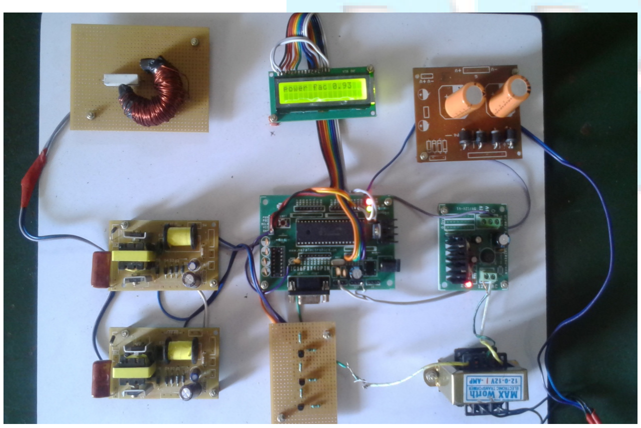


Fig 6: Hardware Result

7. Conclusion

Fuzzy controller is used in this project. Fuzzy logic controller is suited to low cost implementation based on cheap sensor low resolution analog to digital converter. Fuzzy can be upgraded by adding new rules to improve the performance. A Push pull quasi resonant boost power factor corrector has been designed. Simulation results verify its feasibility. A prototype is implemented with a universal line voltage, an output dc voltage of 430 V. The measured power factor values are all above 0.93. Finally, comparisons among a transition mode boost power factor corrector, an interleaved transition mode boost power factor corrector, and the proposed power factor corrector are made for the same medium power level applications. From the experimental results, the efficiencies of the proposed power factor corrector are higher than ones of a transition mode boost power factor corrector at heavier loads since the cut in half duty cycle reduces the conduction losses and copper losses. The overall features of the proposed power factor corrector are high efficiencies, and the smallest inductor size. Also, the fuzzy logic controller gives better improvement of power factor on comparing with PID controller.

Reference

[1] Yu-kang lo, Chung-yi Lin, Huang-jen chiu, Shihjen cheng and Jing yuan lin,"Analysis and design of a push-pull quasi resonant boost power factor corrector,"IEEE Trans. Power Electron, vol.28, no.1, Jan.2013.

[2] K. Yao, X. Ruan, X. Mao, and Z. Ye, "Reducing storage capacitor of a DCM boost PFC converter," IEEE Trans. Power Electron., vol. 27, no. 1, pp.151–160, Jan. 2012.

[3] Y.-T. Chen, S. Shiu, and R. Liang, "Analysis and design of a zero voltage switching and zero-current-switching interleaved boost converter," IEEE Trans. Power Electron., vol. 27, no. 1, pp. 161–173, Jan. 2012.

[4] X. Zhang and J.W. Spencer, "Analysis of boost PFC converters operating in the discontinuous conduction mode," IEEE Trans. Power Electron., vol. 26, no. 12, pp. 3621–3628, Dec. 2011.

[5] B. Su, J. Zhang, and Z. Lu, "Totem-pole boost bridgeless PFC rectifier with simple zero-current detection and full-range ZVS operating at the boundary of DCM/CCM," IEEE Trans. Power Electron., vol. 26, no. 2, pp. 427–435, Feb. 2011.