ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Design of Quasi Resonant Boost Converter Using Zero Current Switching With Push Pull Technology

K.Sravanthi
M.Tech (POWER ELECTRONICS)
EEE Department
Pathfinder engineering college
Hanmakonda, Warangal , Telangana

N. Avinash
Assistant Professor, 2years exp
EEE Department
Pathfinder engineering college
Hanmakonda, Warangal,Telangana

Abstract- ***In this project reduced switching losses and high efficiency is proposed for quasi resonant converter. An AC/DC quasi resonant converter with push pull topology is coupled to two distributed boost inductors into a single magnetic core which hereby reducing the circuit volume and the cost are the development targets of switching power supply today. The quasi resonant converter has ideally zero switching losses as it is having a salient feature that the switching devices can be either switched on at zero voltage or switched off at zero current. The boost power factor corrector operates in the transition mode with a constant on time and variable switching frequencies, wherein the quasi resonant valley switching of the switch, decreases the turn on losses and zero current switching(ZCS) of the output diode in order to decrease the switching losses and improving the conversion efficiency. QRC-ZCS has low total harmonic distortion as conducted on the prototype with experimental and simulation results.***

Keywords- ***power factor corrector, push pull topology, Quasi resonant (QR) converter, Zero current switching, coupled inductor***

Introduction-The quasi resonant converter evincing high efficiency is able to control output voltage to a large extent. Due to the inductive character of the load the switching losses are also limited with the help of pulse width modulation through changing the width of pulses in order to control the output voltage, the converters are managebely controlled. System oscillating at a particular frequency with large amplitude is called resonance. The electrical resonance occurs when the impedance is at minimum. The boost converter is a step up power stage non -isolated power stage topology as here the required output is always higher than the input voltage. For a non-pulsating and continuous input current the output diode conducts only for a portion of the switching cycle. The power factor correction is simply defined as the ratio of real power to apparent power. In AC to DC power conversion system of the switching mode the power factor correction technique is used. The basic principle of Turning on the power device for attaining zero current switching (ZCS) is achieved through the transition mode , hence here the coupled inductor is used. Among the three operating modes of a boost power factor corrector which are the transition mode(TM) continuous conduction mode(CCM) and the discontinuous conduction mode(DCM), the transition mode is the best mode for PFC as in this mode the inductance is neither higher nor lower, it has moderate inductance, the turn on losses are reduced due to the quasi-resonant valley switching of the switch which is an added advantage of

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the transition mode of boost power factor corrector. The rating of power is increased also the total harmonic distortion(THD) can be reduced both of the output capacitance and the input current. This paper proposes two interleaved TM boost PFC of the push pull boost power factor corrector. along with the coupled inductor which is coupled o a single magnetic core. The power capability is promoted till the higher power level applications as the output power is shared between the two identical modules. This interleaved actions or operations of the push pull converter doubles the core operating frequency of the switching frequency along with the reduction of circuit volume and the cost hereby increasing the power density and the power factor value and improving conversion efficiency.

PROPOSED COVERTER OPERATING PRINCIPLES

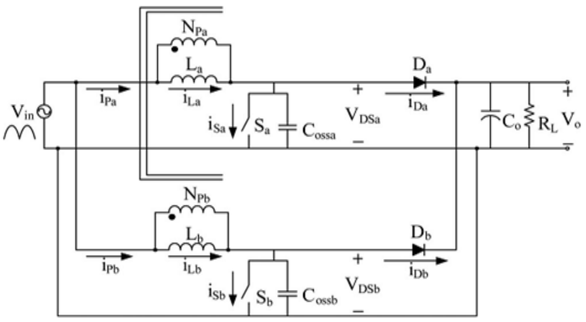

Fig. 1. Power circuit of the proposed PFC.

Fig. 1 shows the schematics of the proposed topology. Module A consists of the switch Sa, the winding NPa, the inductor La, and the output diodeDa. Module B consists of the switch Sb, the winding NPb, the inductor Lb, and the output diode Db. These two modules have a common output capacitor Co. La and Lb are two coupled windings wound on the same magnetic core. Theoretically, the same turns of these two windings will lead to the same inductances. The proposed PFC is operated by the TM control with a constant on-time and variable switching frequencies. To analyze the operating principles, there are some assumptions listed as follows.

1) The conducting resistances of Sa and Sb are ideally zero. The conduction time interval is DTs, where Dis the duty cycle and Ts is the switching period.
2) The forward voltages of Da and Db are ideally zero.
3) The magnetic core for manufacturing La and Lb is perfectly coupled without leakage inductance. In addition, the turns of the windings NPa and NPb are the same. Therefore, La and Lb are also matched.

MODES OF OPERATION

Mode 1: Conduction period between t0 to t1

From the following figure Fig.4. it is infered that initially module A is in the operating condition where switch Sa is conducting. The input voltage is Vin hence when this input voltage flows in the circuit the diodes Da and Db gets reversed biased, with a gradual increase in the inductor current iLa. The input voltage Vin flows through the winding Npa. Whereas on the other side in module B, same input voltage Vin flows through the winding Npb. There is same voltage flowing through both the windings Npa and Npb are coupled to the same magnetic core. The coupling effect makes the inductor current iLb which gradually increases flows through winding Npa also, Co is the common output capacitor, from where the load is supplied energy.

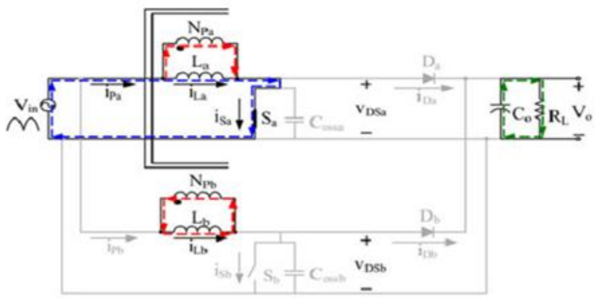

Fig. 2. Mode 1 Conduction Path

Mode 2: Conduction period between t1 to t2

In this mode both the switches Sa of module A and switch Sb of module B are turned off, the load receives the stored energy from the inductor La and the common capacitor Co. both the windings Npa and Npb have same voltage (VoVin). There is a lnear decrease in both the currents iLa and iLb.

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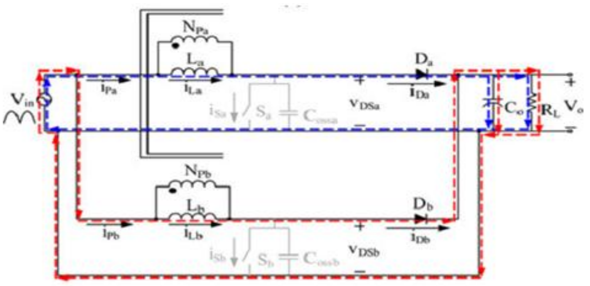


Fig. 3. Mode 2 Conduction Path

Mode 3: Conduction period between t2 to t3

In this mode, the Zero Current Switching technique (ZCS) is used for the turning off of the diode Da, the current iLb reduced to Zero as ZCS is used to turn off diode Db. Through the quasi resonant valley switching switch Sb is turned on. In this mode only both the capacitors Cossa and Cossb starts to resonate.

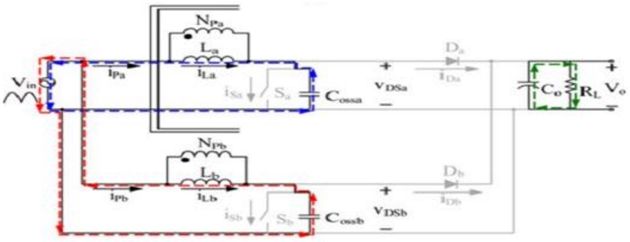


Fig. 4. Mode 3 Conduction Path

SIMULATION RESULT OF CONVENTIONAL CIRCUIT

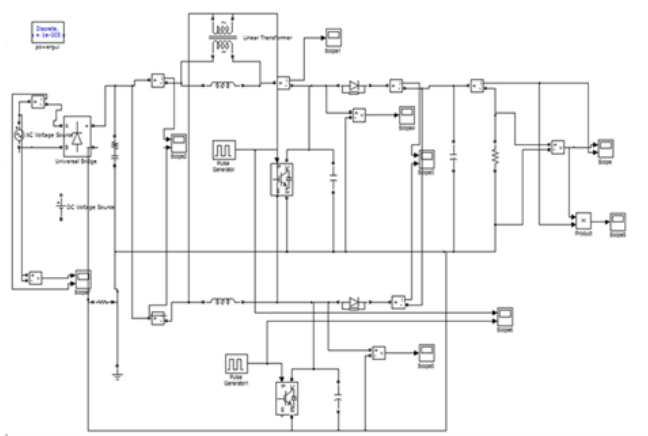
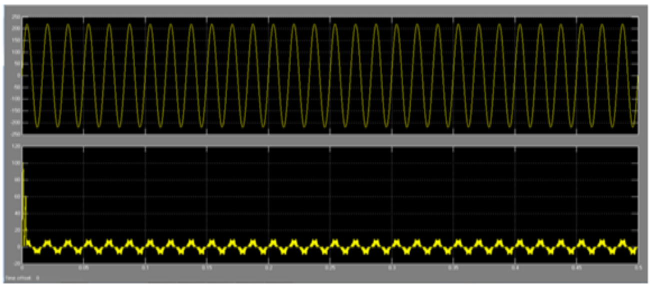
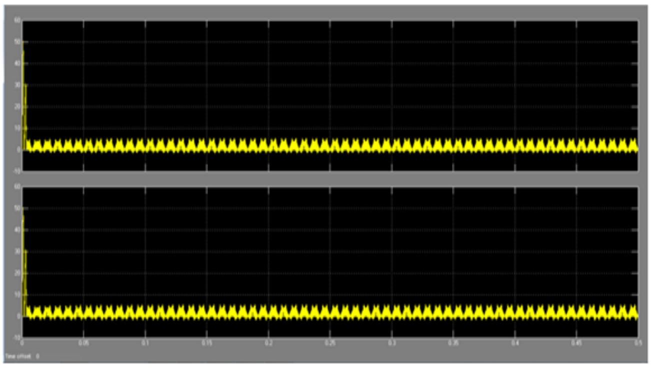


Fig 17: MATLAB/SIMULATION model of the proposed Push–Pull Quasi-Resonant Boost Power Factor Corrector

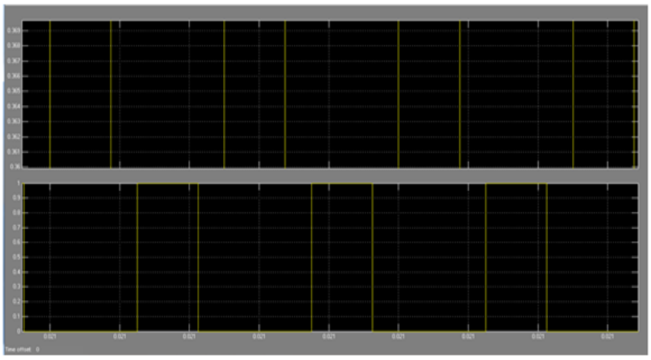
i. Input voltage and input current



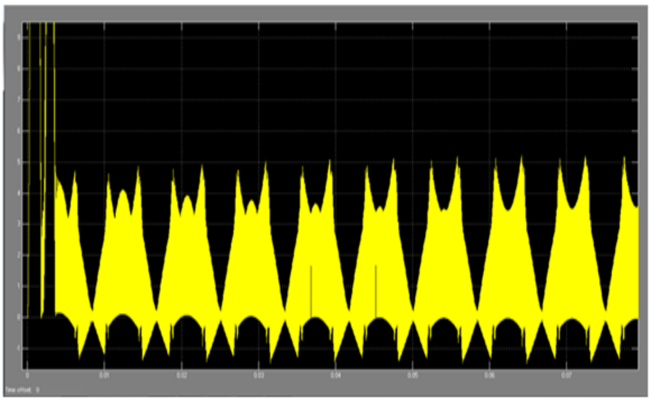
ii. Current wave forms



iii. Pulse signals



iv. Current wave form



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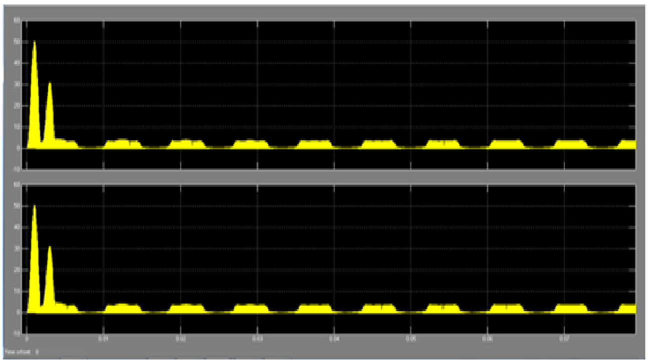
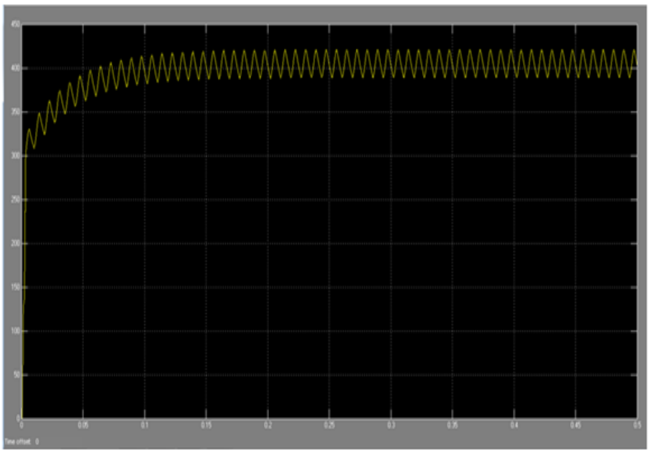
v. Output current



vi. Output voltage



CONCLUSION

The detailed analysis and design of the proposed push–pull QR boost PFC are presented in this paper. Simulation results verify its feasibility. A prototype is implemented with a universal line voltage, an output dc voltage of 380 V, and an output power of 200W. The average efficiencies with 110-V and 220-Vac input voltages are 95.92% and 96.26%, respectively. The measured PF values are all above 0.91. Finally, comparisons among a TM boost PFC, an interleaved TM boost PFC, and the proposed PFC are made for the same medium-power-level applications. From the experimental results, the efficiencies of the proposed PFC are higher than the ones of a TM boost PFC at heavier loads since the cut-in-half duty cycle reduces the conduction losses and copper losses. The overall features of the proposed PFC are the higher heavy-load efficiencies than the ones of a TM boost PFC, and the smallest inductor size of all.

SCOPE OF THE FUTURE WORKS

The paper i.e. Analysis and Design of a Push–Pull Quasi-Resonant Boost Power Factor Corrector can be extended by considering the fuel cells as input power supply. Power factor can maintained within the limit by using the renewable energy source. Fuels cell can be renewable or nonrenewable resources. A fuel cell is an electrochemical device that generates electricity from hydrogen. You can get hydrogen from various sources such as nonrenewable fossil fuels (natural gas, coal, petroleum, etc.) or renewable resources such as water or anaerobic digester gas (ADG). There are a few solar and wind-powered electrolyzes that generate hydrogen from water, which is renewable. Fuel cells that use alcohol, methane from waste digestion, and hydrogen from wind or solar conversion of water are renewable. Fuel cells that use hydrogen or methane from oil and gas production and alcohol from industrial processes are nonrenewable.

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