A HIGH STEP UP RESONANT BOOST CONVERTER USING ZCS WITH PUSH-PULL TOPOLOGY

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Abstract— This dissertation proposes a push-pull boost power factor corrector (PFC). It is composed of two boost converters with a coupled inductor. The two identical modules can share the output power and increase the power capability up to the medium power level applications. The main advantage is coupling the two independent boost inductors into a single magnetic core to substantially reduce the circuit volume and the cost without degrading the conversion efficiency too much, which are the important targets of the modern switching power supply design. The interleaved operations of the switches with a cut-in-half duty cycle can reduce the conduction losses of the switches as well as both the turns and diameters of the inductor windings, which help more to the reduction of the circuit volume. Moreover, the operating frequency of the core, and thus the frequency of the two-phase inductor current ripple, is double that of the switching frequency. Also the ripple current at the input side and the output capacitor size are reduced. The power factor and the power density are improved.

Keywords— push pull topology, coupled inductor, quasi resonant converter

INTRODUCTION

Generally boost converter topology is the most commonly used technique to improve the power factor. It is always necessary to reach power factor as unity a cost effective solution can be obtained for greater than 0.95.In this proposed system we are using the push-pull technique to boost up the voltage level up to 380V dc for an input of 110 V ac supply.

A push–pull converter is a type of DC-to-DC converter that uses a transformer to change the voltage of a DC power supply. The proposed system having the capable of operating three modes of operation they are Continuous Conduction Mode, Discontinuous Conduction Mode and Transition Mode.

Even though Continuous Conduction Mode best suitable for high power applications the inductor value in this mode is high and in case of Discontinuous Conduction Mode the input harmonics level is high. But in case of transition mode the inductor value is moderate and useful for medium power applications so this mode is used for the proposed topology.

Derived from 2 TM boost converters with the interleaved operations, the power rating is increased and the input current and output current are shared equally with lower current ripples. Therefore, the total harmonic distortion (THD) of input current and the output capacitance can be reduced. However, the need of two inductors with two independent cores increases the circuit volume.

In this paper, a push–pull boost PFC composed of two interleaved TM boost PFCs and a coupled inductor is proposed and a single magnetic core is used. The two identical modules can share the output power and promote the power capability up to the medium-power-level applications.

In addition to this coupling of the two distributed boost inductors into a one magnetic core automatically reduces the circuit volume, which is the important goal of the development of switching power supply today. The interleaved operations of the switches act like a push–pull converter. The difference is that the operating frequency of the core is getting double of the switching frequency, which means that not only the circuit size is reduced and also the operating frequency of the core is getting double of the switching frequency.

The same distributions of the input current and output current, the proposed topology with a cut-in 0.5 duty cycle can reduce the conduction losses of the switches on both the turns and diameters of the inductor windings

It is also maintains the advantages of a TM boost PFC, such as QR valley switching on the switch and zero-current switching (ZCS) of the output diode, to reduce the switching losses and improve the conversion efficiency.

MATLAB/SIMULINK used for the proposed system to simulate for an universal line voltage of 110v ac, a 380-V output dc voltage and a 100-W output power in order to verify its feasibility.

CIRCUIT TOPOLOGY

Fig 1 shows block diagram for push-pull Quasi Resonant converter. Here the power conversion occurs in three segments. In the first segment single phase AC supply is fed to the rectifier, to convert AC to DC. The output from the rectifier is modulated sin wave. This modulated sin wave is given to the quasi resonant converter. Using quasi resonant converter the voltage has been boosted. Then it is given to the load

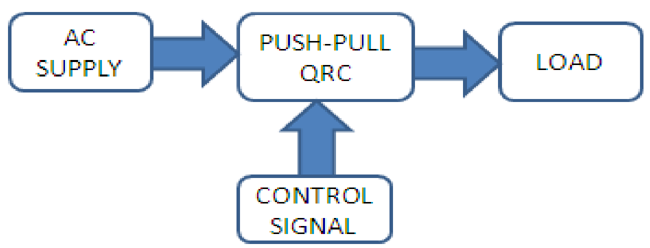

Fig.1. Block diagram of push-pull Quasi Resonant converter

A. Circuit Diagram Of Push-Pull Quasi resonant Converter

The circuit diagram for push- pull quasi resonant converter is shown in fig below. First we are converting ac voltage into dc voltage by using rectifier. The output from the rectifier is modulated sin wave then this supply is given to the push pull quasi resonant converter. This quasi resonant converter boost up the voltage to 380V. The proposed topology is operated by transition mode with constant on time and variable frequency.

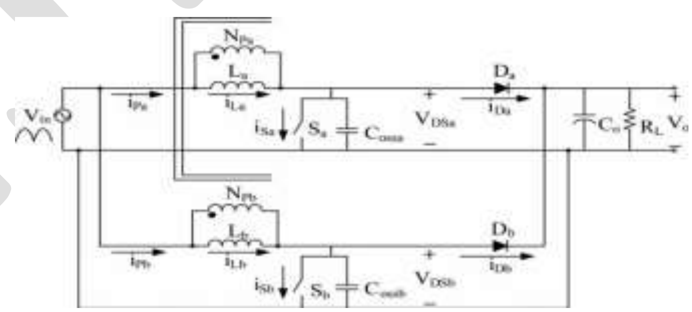

Fig.2.push pull quasi resonant converter

The proposed topology consists of two modules. Module A consists of the switch S_a , the winding N_{Pa} , the inductor L_a , and the output diode D_a . Module B consists of the switch S_b , the winding N_{Pb} , the inductor L_b , and the output diode D_b . These two modules have a common output capacitor C_o . L_a and L_b are 2 coupled windings wound on the same magnetic core.Theoretically; the same turns of these two windings will lead to the same inductances To analyze the operating principles, there are some assumptions listed as follows.

1)The conducting resistances of S_a and S_b are ideally zero. The conduction time interval is DT_s , where D is the duty Cycle and T_s will be the switching period.

2)The forward voltages of D_a and D_b are ideally zero.

3) The magnetic core for manufacturing L_a and L_b is perfectly Coupled without leakage inductance. In addition, The turns of the windings NPa and NPb will be same. Therefore, L_a and L_b are also matched

OPERATION MODES IN QUASI-RESONANT CONVERTER

The operating modes of the proposed topology are analyzed as follows

A. *Mode 1 operation:* $t_0 < t < t_1$

Referring to Fig4, in module A S_a conducts Thus, the voltage across N_{Pa} equals to the rectified line- voltage. The inductor current i_{La} increases linearly and D_a is reverse-biased. In module B, S_b is turned OFF. The voltage across NPa is coupled to N_{Pb} . Hence, the voltage across N_{Pb} is also V_{in}, and the dotted terminal is positive. L_b stores energy as L_a does. The inductor current i_{Lb} increases linearly and flows into the non dotted terminal of N_{Pb} . By the coupling effect, this current flows into the dotted node of N_{Pa} . Since the voltage across S_b is zero, Db is also reverse-biased. Co supplies the energy to the load . The constant turn-on time of Sa is decided by the management of the controller depending on the rectified line-in voltage Vin. This is the initial mode of operation.

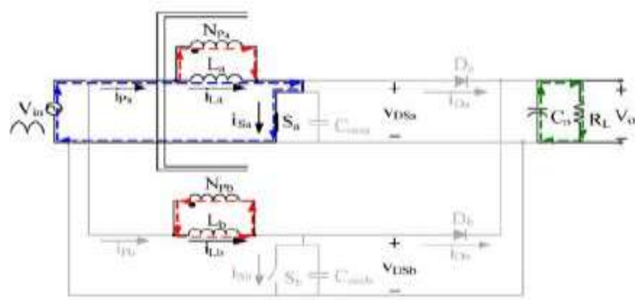

Fig.3. Module A S_a ON, module B S_b OFF

B. *Mode 2 operation:* $t_1 < t < t_2$

As shown in Fig. 5, in module A, S_a is turned OFF. D_a conducts for i_{La} to flow continuously. L_a releases its energy to C_o and the load. The voltage across N_P is ($V_o - V_{in}$) and the dotted terminal is negative. In module B, S_b is still turned OFF the voltage across N_{Pa} is coupled to N_{Pb}. Hence, the voltage across N_{Pb} is also ($V_o - V_{in}$), and the dotted node is negative. D_b is thus forward-biased to carry the continuous i_{Lb}. L_b is also releases its energy to C_o and the load. Both i_{La} and i_{Lb} are decreasing linearly. This state ends until L_a and L_b release their energies completely, and i_{La} and i_{Lb} decrease to zero. in this mode we are boosting the voltage.

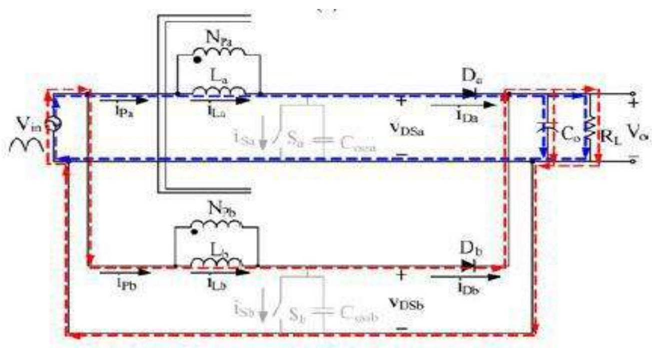

Fig .4.Module A S_a OFF Module B S_b OFF

C. *Mode 3 operation:* $t_2 < t < t_3$

As shown in Fig. 6, in module A, S_a keeps turned OFF. At t_2, D_a is turned OFF with ZCS since i_{La} decreases to zero naturally. Similarly, in module B, S_b is still turned OFF. D_b is turned OFF with ZCS at t_2 since i_{Lb} decreases to zero naturally, too. In this interval, C_o supplies the energy to the load. At the same time, in module A, the series resonant loop formed by V_{in}, the parallel connection. of L_a and L_b, and the output capacitor switch S_a, C_{ossa}, starts to resonate. Similarly, in module B,the series resonant loop formed by V_{in}, the parallel connection of L_a and L_b, and the output capacitance of the switch S_b, C_{ossb},begins to resonate. Therefore, v_{DSa} and v_{DSb} decrease simultaneously. This mode is helpful to increasing the power factor.

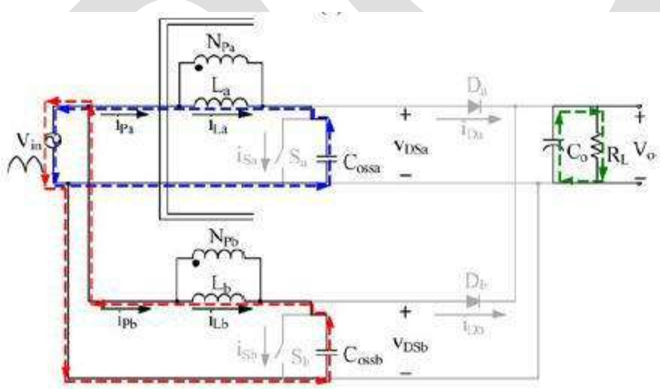

Fig.5.*Module A Sa OFF & Module B Sb OFF*

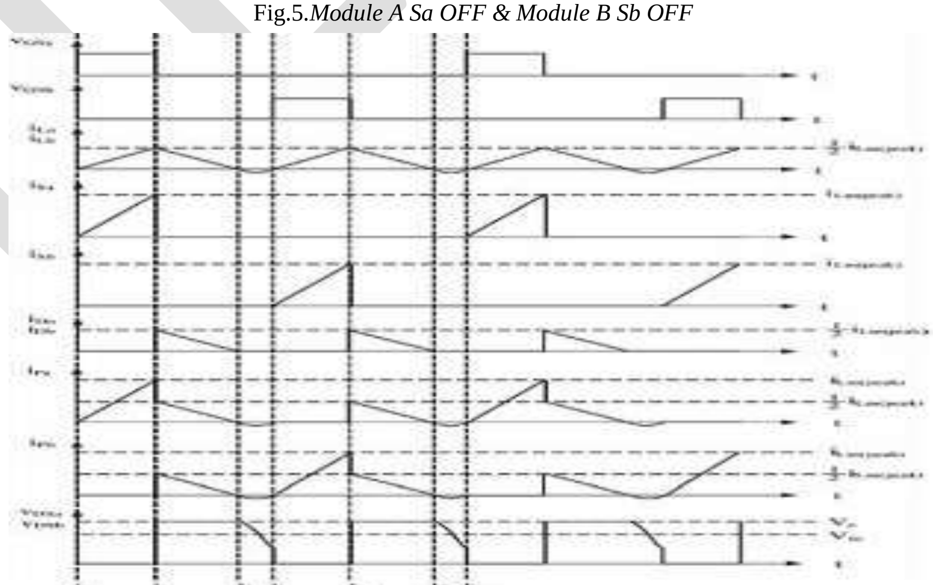

Fig.6.Key wave forms for proposed topology

SIMULATOIN RESULTS

MATLAB/SIMULINK is used for the simulation studies. Fig 7 shows the simulation circuit of push pull quasi-resonant converter with input voltage of 110V AC the corresponding output voltage is 380 dc, Po=100W. The Efficiency of the converter and input current distortion is shown in fig 12 and fig 13.

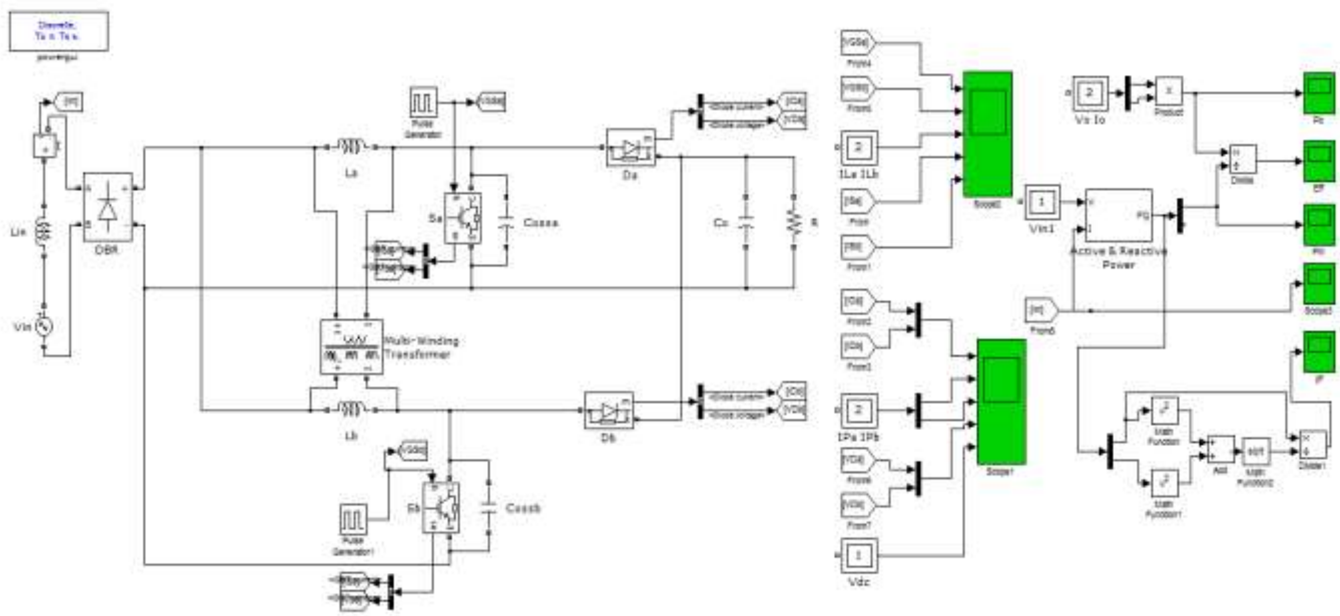

Fig.7.Simulation circuit of push pull quasi resonant converter

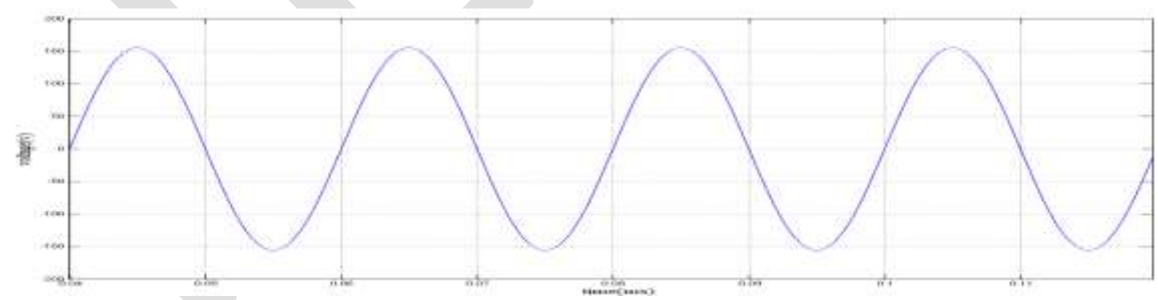

Fig.8.Input voltage of the converter 110 Vac

ISSN 2091-2730

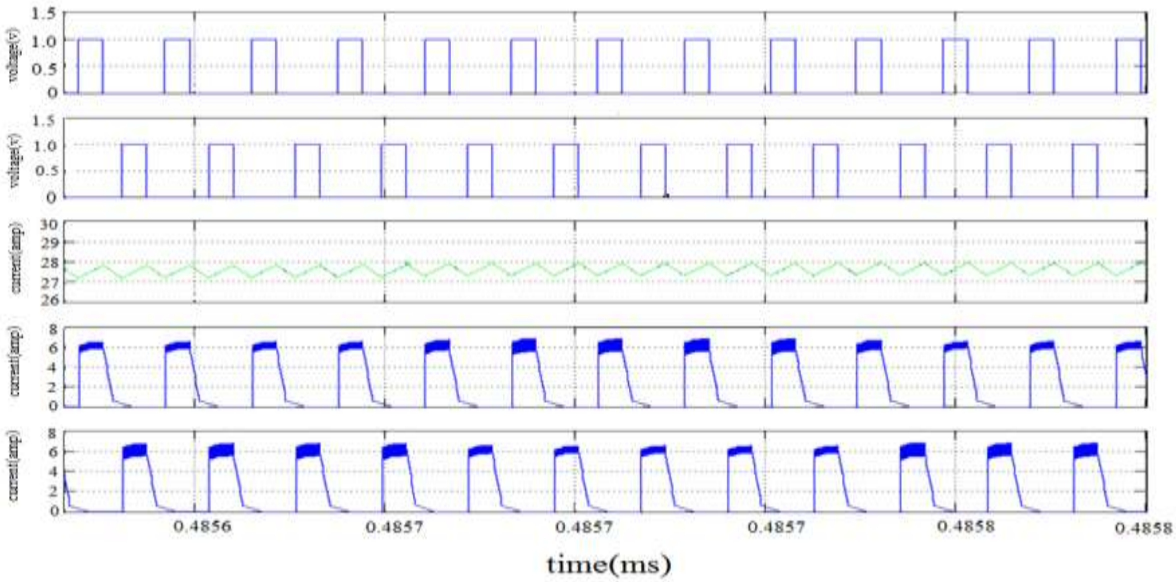

Fig.9.Gate pulses V_{Gsa} &V_{Gsb} , Inductor currents I_{La} & I_{Lb} , Switches currents I_{Sa} &I_{Sb}

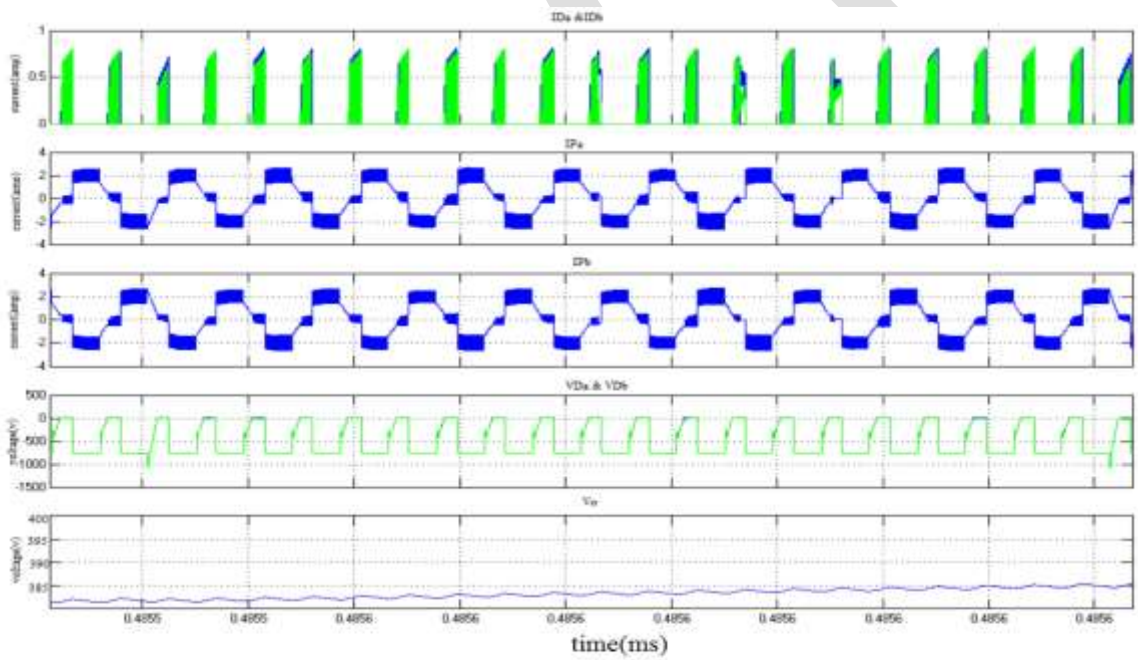

Fig.10. Diode currents I_{Da} & I_{Db}, Winding currents I_{Pa}&I_{Pb}, Voltage across switches V_{Da}&V_{Db}, Output voltage V_o

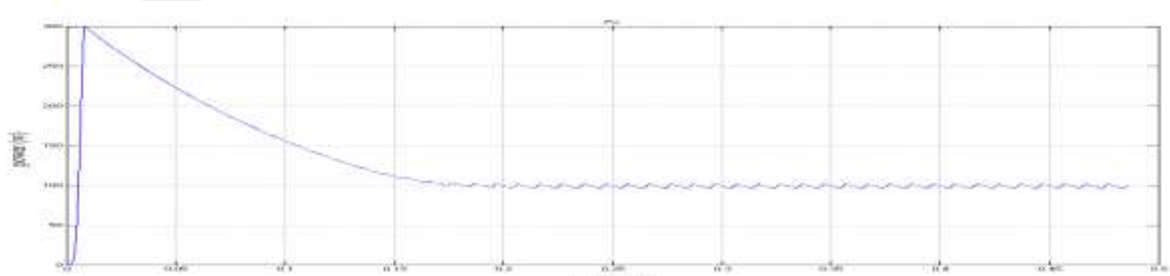

Fig.11.output power 100W

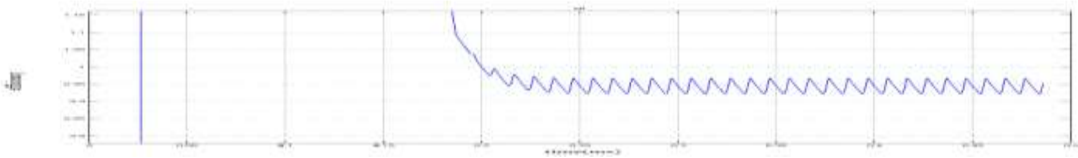

Fig.12. Efficiency of the converter

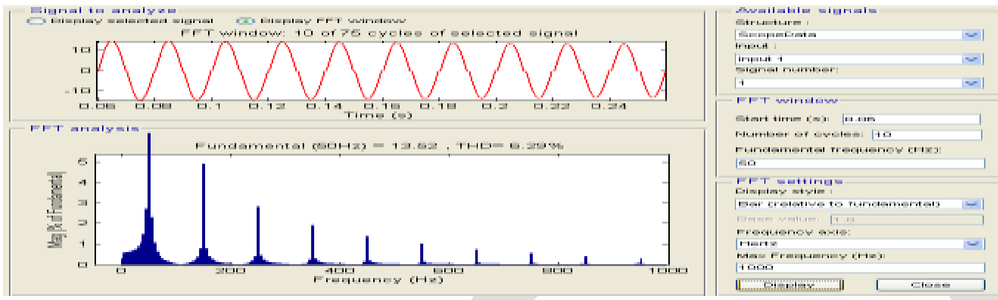

Fig.13. Input currents THD

LOAD	EFFICIENCY	THD	P.F
50	93.2%	7.01%	0.9
100	95.2%	6.24%	0.912
150	96.3%	4.63%	0.99
200	97.3%	3.22%	0.993

Table 1 : Efficiencies, P.F, and THD values at different load levels measured under 110 V_{ac}

LOAD	EFFICIENCY	THD	P.F
50	92.1%	1.12%	0.9224
100	96.2%	6.36%	0.95
150	98.1%	10.43%	0.98
200	98.2%	7.62%	0.995

Table 2 : Efficiencies, P.F, and THD values at different load levels measured under 220 V_{ac}

CONCLUSION

In this paper, a novel of push pull quasi resonant converter techniques for Boost PFC is simulated in order to boost up the voltage level and improve the power factor. Simulation has been done using MATLAB/SIMULINK for an input voltage of 110V AC and power output 100w for 380dc output voltage. In the systems we are gaining the power factor nearby unity

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