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# A NOVEL IMPLEMENTATION OF INTERLEAVED QUASI RESONANT BOOST POWER FACTOR CORRECTOR

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***Abstract*—Thispaper proposes a novel interleaved quasi resonant boost power factor corrector. It is composed of double boost inductors with a single magnetic core. These two inductors can operate as an interleaved operation and can share the output power and increase the power capability up to medium power level applications. The interleaved operation of the switches with a cut in half duty cycle reduces the conduction losses of the switches. The main advantage of using two boost inductors into single magnetic core reduces the volume and cost without degrading the conversion efficiency too much. The output voltage and output current ripples of the proposed PFC can be reduced. The zero current switching (ZCS) of the output diode can reduce the conduction losses of the switches. The circuit is simulated using MATLAB Simulink software and implemented using hardware.**

***Keywords*:Interleaved boost inductors,power factor correctors,interleaved quasi resonant converter.**

## I. INTRODUCTION

The power factor corrector (PFC)is a measure of power from the utility grid whichis utilized. Its value is in the range between 0 and 1.It is defined as the ratio of real power to the reactive power. There are two different types of PFC techniques adopted they are active PFC technique and passive PFC technique. The aim of the PFC is to improve the power quality, decreasing the power losses, and improving the overall efficiency of a power system. The boost converter is one of the popular topology used for power factor correction. It also improves the power factor and input current harmonics.

There are three operating modes of PFC namely continuous conduction mode, discontinuous conduction mode and transition mode. CCM is suitable for high-power applications. The advantages are reducing the current stresses of the semiconductor device.CCM mode is not suitable for low power applications because of bulky inductor size.DCM mode is suitable for low power applications with high harmonic content.TM, with a moderate inductance and PF value, is a compromise between CCM and DCM. TM has an advantage of quasi-resonant (QR) valley switching of the switch, which can decrease the turn-on losses. In existing system, push pull topology is employed. Here the operating frequency is double that of switching frequency. This paper composed of double boost inductors with single magnetic core. These two boost inductors can operate as interleaved operations with 180 degree phase shift. Here the output voltage is double that of switching voltage. Here the input current is the sum of two inductor currents. Because the inductors ripple currents are out of phase so that they cancel each other out and reduce the input ripple current. A cut in half duty cycle can cancel output ripple current. Here the output current and output voltage ripples are reduced comparing with the existing system with the use of Pi-Filter I the output side. Here in the input side the use of active PFC technique is adopted. Here the resonant switch operates with Zero Current Switching only for load currents less than rated value. In Proposed topology, Switches operate at quasi resonant condition.ZCS can eliminate the switching losses at turn off and reduce the switching losses at turn on. ZCS operates with a constant on time control with variable switching frequency.In passive PFC technique, Harmonic current can be controlled in the simplest way by using a filter that passes current only at line frequency of 50 or 60 Hz .Harmonic currents are reduced and the non-linear device looks like a linear load. Power factor can be improved by using capacitors and inductors. Such filters with passive devices are called passive filters. They require large value high current inductors which are expensive and bulky. A passive PFC circuit requires only a few components to increase efficiency, but they are large due to operating at the line power frequency. This type of technique is simple and rugged but has bulky size. In this passive PFCtechnique, power factor cannot be high.

An active PFC approach is the most effective way to correct power factor of electronic supplies. Here, we place a boost converter between the bridge rectifier and the main input capacitors. In active PFC technique, power electronics DC-DC converter is employed. It is operated as a high frequency

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approach. The converter tries to maintain a constant DC output bus voltage and draws a current that is in phase with and at the same frequency as the line voltage. In this system, an active PFC technique is employed. The Proposed PFC is applicable for low power applications purpose. In proposed PFC input frequency is double the times that of switching frequency. QR mode is suitable for medium power applications and it has moderate inductance value. Here the power rating is increased to medium level with reduced harmonic content in input side.

## II. CONVENTIONAL PUSH PULL QUASI RESONANT BOOST PFC

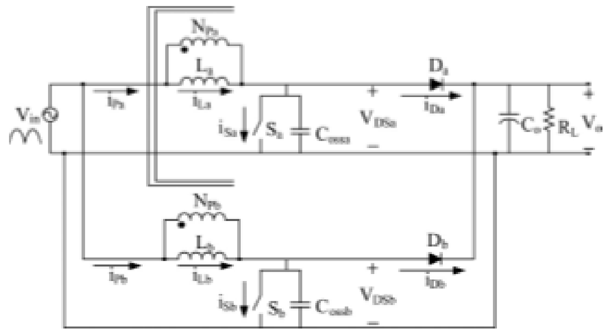

Fig.1.schematic diagram of Existing PFC

It is mainly consists of two-phase transition-mode (TM) boost-type power-factor correctors (PFCs) and a coupled inductor. By reducing the size of the inductor in to one magnetic core, the total circuit volume is reduced. Hence with the use of two phase transition mode, the operating frequency of the core is double of the switching frequency. Comparing with single-phase TM boost PFC, both the input and output current ripples of the existing PFC can be reduced. If the net inductance of the coupled inductor equals the inductance of single- phase TM boost PFC. Hence, both the power-factor value and the power density are increased. A reduction in half duty cycle of the switches can reduce the conduction losses of the switches and both the turns and diameters of the inductor windings. The advantages of a TM boost PFC, such as quasi-resonant (QR) valley switching on the switch and zero-current switching (ZCS) of the output diode are maintained to improve the overall conversion efficiency. All the inductors in existing PFC can operate in Transition mode. All PFCs are controlled under constant on-time and frequency modulation scheme. After the inductor completely releases its energy to the load, the series resonant network formed by the inductor and the output capacitor of the switch starts to resonate. During the resonances, the switches are turned on with valley-switching to reduce the turn-on switching losses. In addition, the output diodes turn OFF with ZCS since their currents undergoes natural commutation. Therefore, the turn-off switching losses can be reduced. . In addition the voltage gain can also be improved which improves the overall conversion efficiency. Under the same specifications, the inductance of the proposed PFC is the smallest of all. Concerning the stresses of the output diodes voltage stress of these three PFCs is equal to the output voltage. Both the interleaved quasi resonant boost PFC and the existing PFC can equally distribute the output current. The output diode current ripple of the proposed PFC is thus half that of a existing PFC. However, the output current ripple of the proposed PFC is small compared to the existing PFC. The output voltage ripple of Existing PFC are about 7V, while the proposed PFC reduces to 5 V.

## III.PROPOSEDINTERLEAVED QUASI RESONANT BOOST PFC

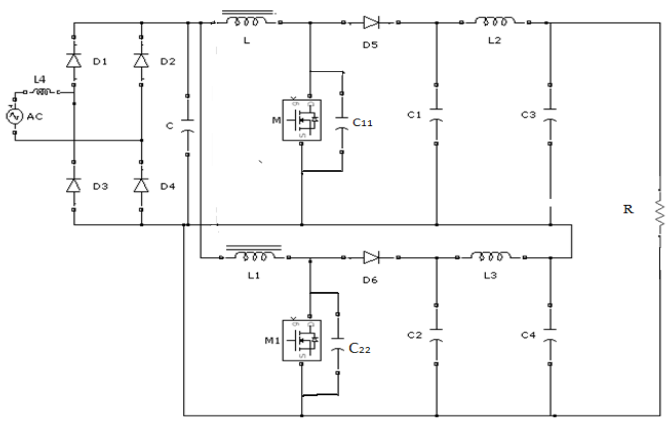

Fig.2. Power circuit for proposed PFC

The proposed system is the combination of two double boost inductors.
The following advantages are
1) Overall high efficiency.
2) Reduction of the development cost due to the modular design.
3) High reliability due to continuous conduction mode operation of switches.
4) Reduction in the output current and voltage ripples.
5) Reduction of conduction losses
6) Higher power factor.
It consists of aActivePower factor correction scheme is employed in the input side which can improve the power factor on the input side and also reduces the total harmonic

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distortion.

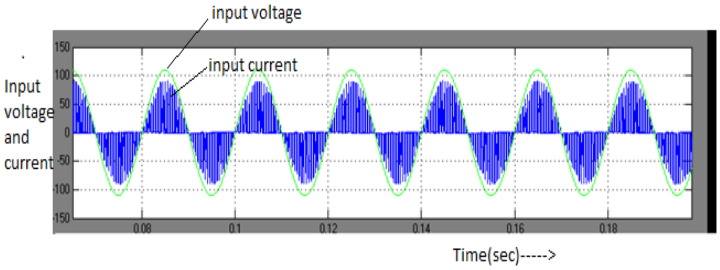


Fig 3. Shows power factor correction scheme.

The commonly used topology in active PFC scheme is boost converter. In Active PFC scheme, input power factor is almost approaches to nearly unity power factor. Active PFC scheme has many advantages compared to the passive PFC techniques they are high power factor, reduced harmonics in the input side. In proposed system, an interleaved boost inductors operating in quasi resonant fashion is employed .Here, maximum inductor ripple current occurs when the input voltage is at half the output voltage. The proposed system consists of an output filter (pi-filter) and a Load. Here the switches are operated in frequency modulation scheme with constant on time. In this scheme, a zero current switching technique is employed to reduce the switching losses. Comparing with the existing topology, in the output side the use of Pi-filter can reduce the output current and output voltage ripples. The Proposed system has high voltage gain in the output side and hence the overall conversion efficiency is improved.

## IV.SIMULATION RESULTS

A).*Design Parameters*

| S.NO | Parameters | Units |
|---|---|---|
| 1 | Input voltage | 110 V AC |
| 2 | Output voltage | 380V DC |
| 3 | rated output power | 200W |
| 4 | maximum duty cycle | 0.35 |
| 5 | minimum switching frequency | 40 KHZ |
| 6 | magnetic core: | TDK PQ32/20 |
| 7 | maximum flux density | Bmax = 2500 Gauss |
| 8 | conversion efficiency | η = 94%; |
| 9 | winding turns | NPa = 25, NPb = 25, and Nzcd = 4 |
| 10 | inductances | La = Lb = 320 µH |
| 11 | switches Sa and Sb | Infineon 11N60C3 |

**B) Existing system circuit**

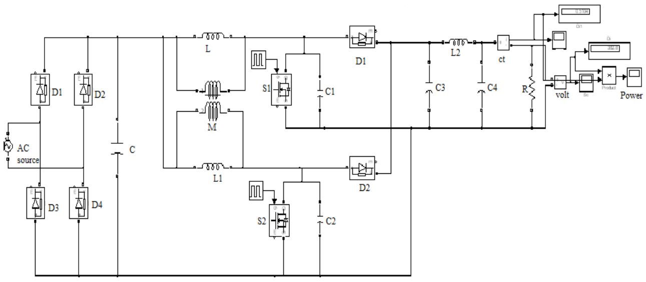

Fig.4.Design of a Existing circuit with pi filter by using MATLAB SIMULINK

**C) Power factor correction circuit**

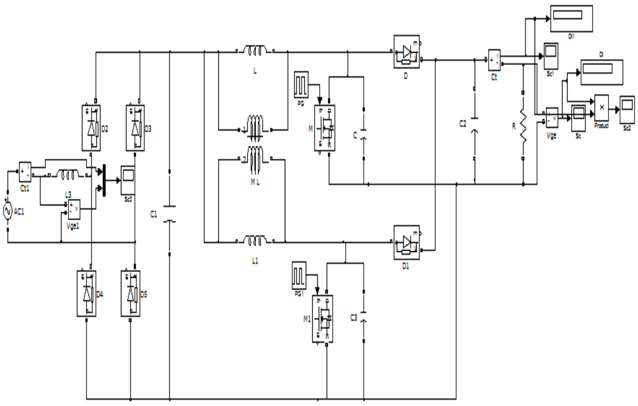

Fig.5.Design of a power factor correction circuit by using MATLAB SIMULINK

**D) Proposed system circuit**

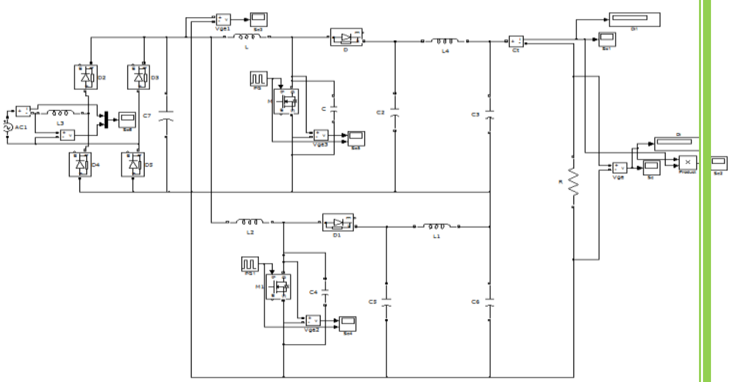

Fig.6.Design of a proposed circuitby using MATLABSIMULINK

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### E) Proposed circuit using closed loop operation

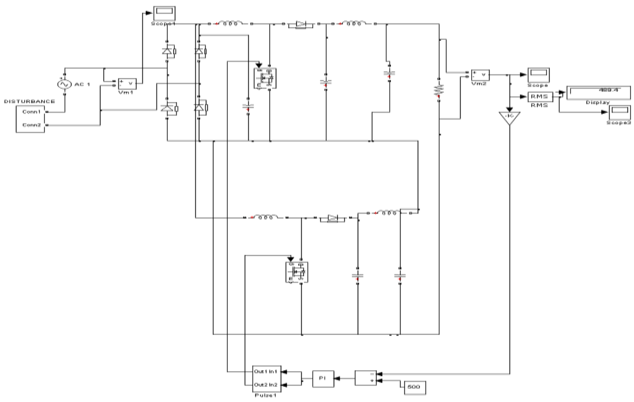


Fig.7.Design of a proposed circuit using closed loop operation by using MATLAB SIMULINK

### F).Existing System Results

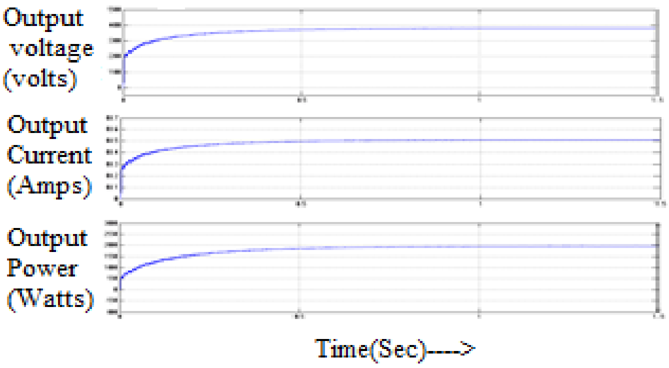



Fig.8.Output voltage, Output current and Output Power waveform for Existing system

Here the output voltage is 380V dc .Output current 0.5A; Output Power is 200W.with the use of PI-filter the output voltage and output current ripples can be reduced.

G) Proposed system Results

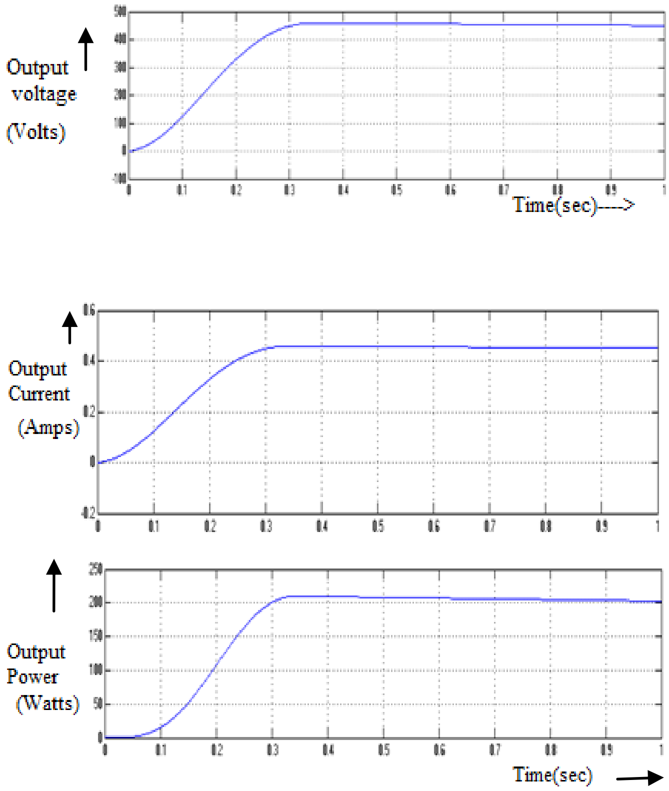
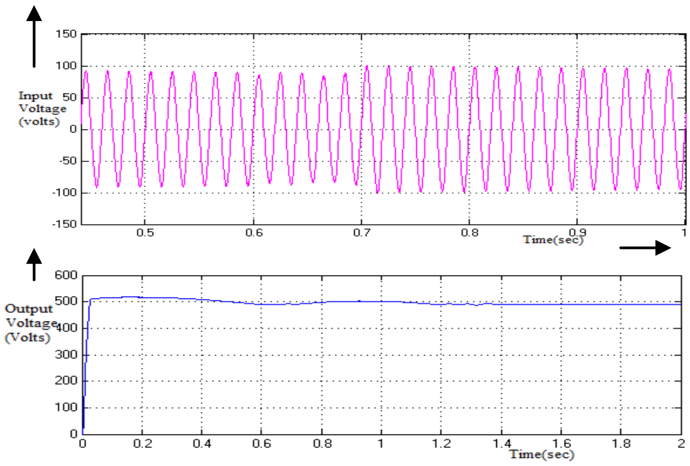



Fig.9.Output voltage, Output current and Output Power waveform for proposed system

Here the output voltage is 450V dc .Output current 0.5A; Output Power is 200W.Comparing with the Existing system Output Voltage can be improved and hence Voltage gain is also improved.

H) Proposed circuit using closed loop operation Results



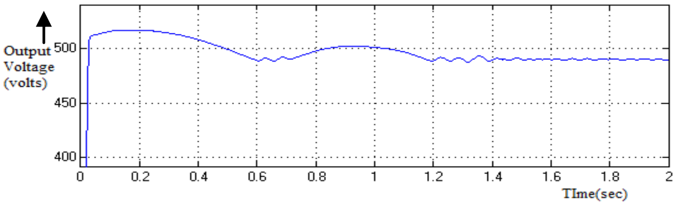



Fig.10.Output voltage, Output current and Output Power waveform for closed loop proposed system

Here the output voltage is 500V dc with and without disturbance. In closed loop operation the steady state accuracy is maintained. Here PI controller can be used for calculating the output, hence closed loop operation is having fast response, High output voltage compared to open loop system

V.COMPARISON OF RESULTS

Input Voltage: 110V (DC)

| S.NO | Switching Method | Output Voltage | Output Current |
|---|---|---|---|
| 1 | Single stage TM mode Boost PFC | 215V | 0.43A |
| 2 | Push Pull quasi resonant Boost PFC(Existing system) | 382V | 0.5 A |
| 3 | Interleaved quasi resonant Boost PFC(Proposed system) | 450V(improved) | 0.45 A |
| 4 | Interleaved quasi resonant Boost PFC(closed loop with PI controller) | 500V | 0.48A |

## VI..CONCLUSIONS

This Project has been presented a novel implementation of interleaved quasi resonant boost power factor corrector. Simulation results were obtained, showing a good agreement with the theoretical analysis. The main objective throughout the project has been to improve the power factor with simultaneous reduction of input current harmonics and also to improve the output voltage and voltage gain. Simulations were initially done for existing system circuits with closed loop preparation and the performance for proposed system. The changes in the input and output waveform current were observed and studied.

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