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Two Mode Deep Changes for Strong Power Conversion in Heating System

N.VijayaSarathi[1], C.Mohanapriya[2]

Assistant Professor, Dept. of EEE, Saranathan College of Engineering, Trichy, Tamilnadu, India [1,2]

PG Student [PED], Dept. of EEE, Saranathan College of Engineering, Trichy, Tamilnadu, India [3]

ABSTRACT: Two mode strong changes use the half bridge inverter in two operating modes to achieve efficiency in a wide power levels. By comparing with dual mode resonant converter the class D full bridge resonant inverter operates only in single mode where low range of power levels are not possible. The dual mode strong change can operate with Zero Voltage Switching and Zero Current Switching so the switching losses are minimised. Induction heating is the fast growing technology in domestic appliances it has high efficiency and faster heating times. In this paper dual mode deep change function has been used for heating system applications.

KEYWORDS: Induction heating (IH), Half bridge inverter, resonant converter.

I.INTRODUCTION

The main advantage of domestic induction heating is cleanliness, rapid heating, high power densities, accurate time and temperature control. IH is a non contact process. It uses high frequency electricity to heat materials that are electrically conductive. When the pot is directly heated by the induced currents generated within a varying magnetic field in the range of 20-100KHZ.The magnetic field is generated by a inductor coil system, supplied by a resonant converter. In Resonant converter higher output occurs at resonant frequency, yielding efficiency also high. The conventional series half bridge ZVS resonant inverter is using IH application.

In this converter the resonance frequency is higher than the switching frequency, yielding to the maximum efficiency at maximum output. Whereas if the switching frequency is higher than the resonant frequency. Thus with the increased switching frequency the losses are increased for lower power output range [2] [3].To overcome this limitation dual mode resonant converter is used. The main advantage of resonant converter is to improve the efficiency even at low output power range by reducing switching losses. Class-D half-bridge converter is used in the high output power range, whereas class-DE half-bridge converter [3], [4] is used in the low to medium output power range. The combination of these operation modes achieves high efficiency levels in a wider range of output power levels.

II.HALF BRIDGE RESONANT CONVERTER

The conventional method used half bridge series resonant converter. It is one switch topology method for medium-high output power levels due to its high efficiency and low voltage stress across the switching devices. In Half bridge resonant converter consist of passive resistance and inductance. The series resonant half bridge applied to induction heating operates at switching frequency higher than the resonant frequency to achieve soft switching conditions. To reduce switching losses a snubber capacitor is added.

In class D operation mode implies the snubber capacitor C_s is much lower than the resonant capacitor C_r .In class-DE operation mode is achieved at ZVS and Zero Voltage derivative Switching (ZVDS) at the turn off. The change of mode from class D to class DE occurs by changing the capacitor values.

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III.TWO MODE DEEP CHANGER

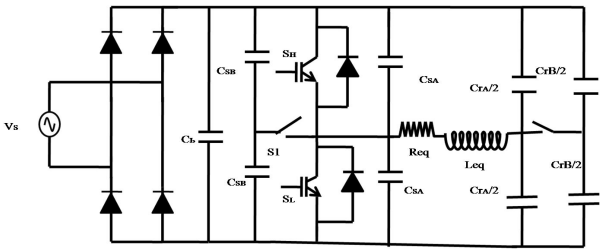

Fig.1. Two mode strong converter

The dual mode resonant converter can be used in order to improve efficiency in whole operating range. In dual mode resonant converter electromechanical switches SPST 1 and SPST 2 allow varying the snubber and resonant capacitance in order to change the operation mode. They are six operation modes for the converter.

MODE I:

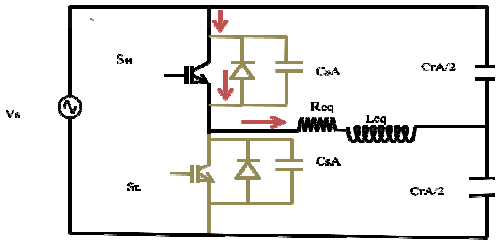

Fig.2. High side transistor are turned on

In mode I when high side transistor is turned on low side transistor are turned off the load current is positive and it flows to the load.

MODE II:

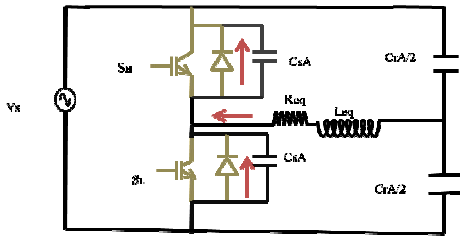

Fig .3.Transistors are off state

When high-side transistor is turned off. The switch-off current is used to charge/discharge the snubber capacitors. The high-side snubber capacitor is charged to the supply voltage. The low -side snubber capacitor is discharged there is no power flows to the load.

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MODE III:

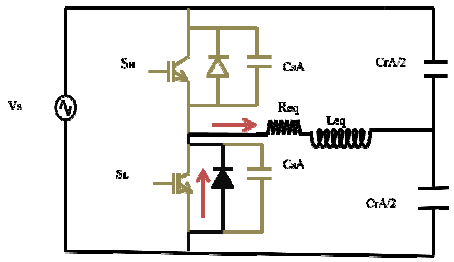

Fig. 4. Low side diode turns on

Both the side high and low side transistor are turned off.The load current is positive. It is supplied by the low-side diode. The power flows to the load.

MODE IV:

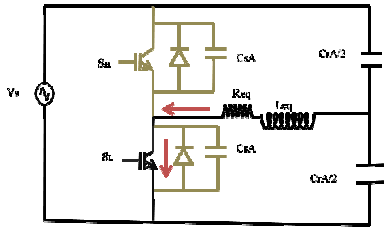

Fig .5. Low side transistor are turn on

When low side transistor are turned on.The load current becomes negative no power flows to the load.

MODE V:

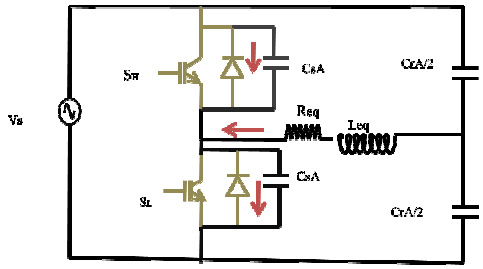

Fig.6.Both capacitors are discharged condition

The low-side transistor is deactivated. The load current charges the low-side snubber capacitor to the supply voltage. The high-side snubber capacitor is discharged.

MODE VI:

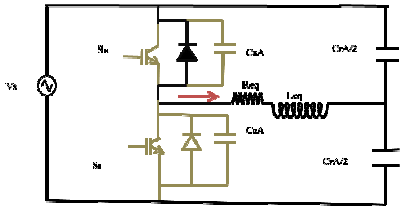

Fig.7. Diode are on

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When both snubber capacitors are charged/discharged. The negative load current flows through the high-side diode.

IV. SIMULATION

The simulation is done in a step by step manner in MATLAB-Simulink R2010a.The simulation of entire Series Resonant Converter system with diode bridge rectifier, inductor, capacitor.

SIMULATION CIRCUIT IN D MODE:

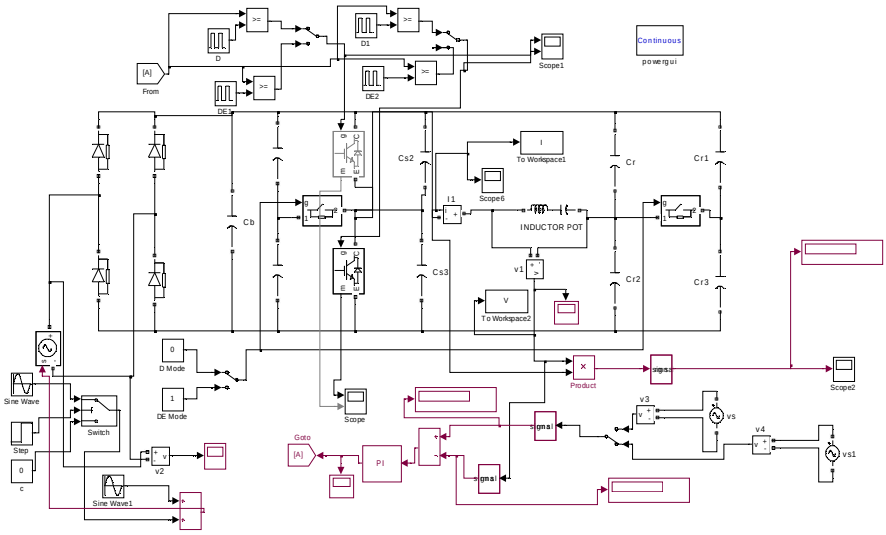

Fig 8 Simulation in D mode

The results for the simulation of class D under varying Power, voltage and current are shown below

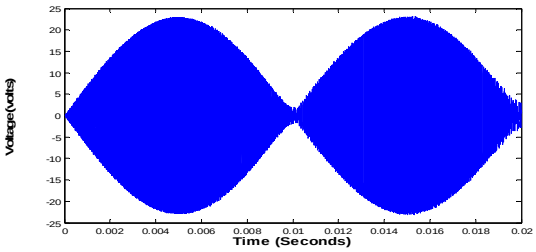

Fig.9. Output Voltage waveform

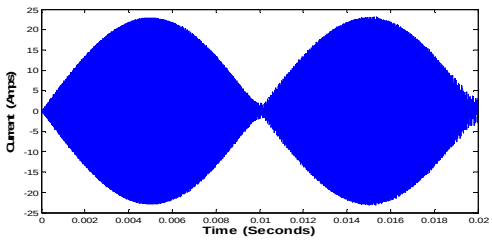

Fig.10.Output Current waveform

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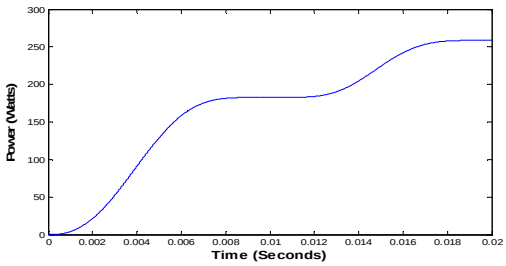

Fig.11.Output Power waveform

SIMULATION CIRCUIT IN DE MODE:

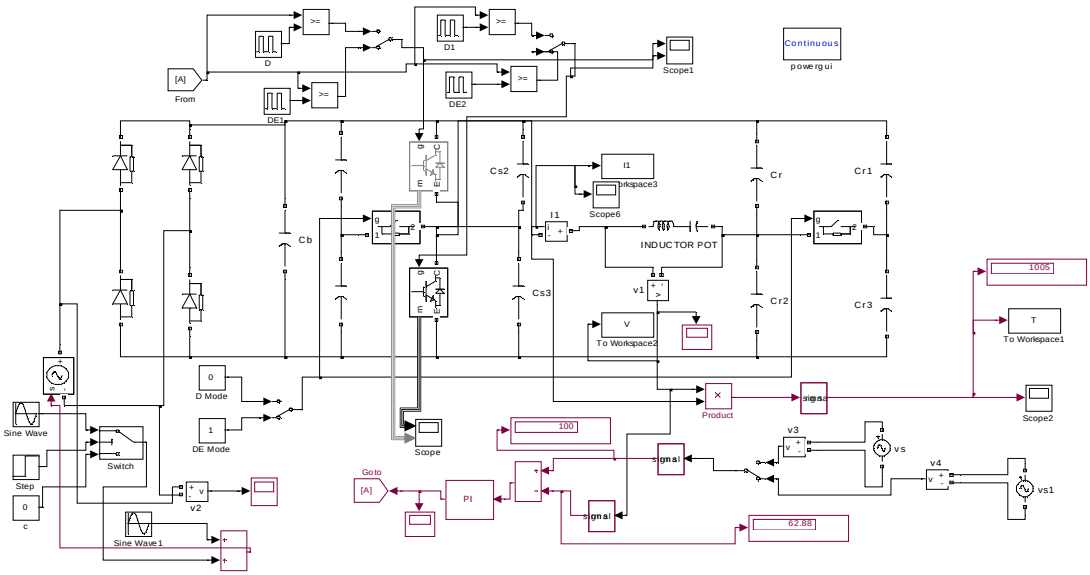

Fig .12.Simulation circuit in DE mode

The results for the simulation of class DE under varying Power, voltage and current are shown below

Output waveforms in DE mode

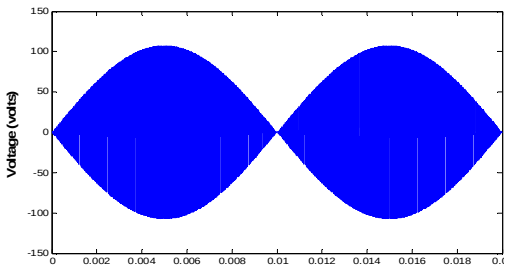

Fig.13.Output voltage waveform

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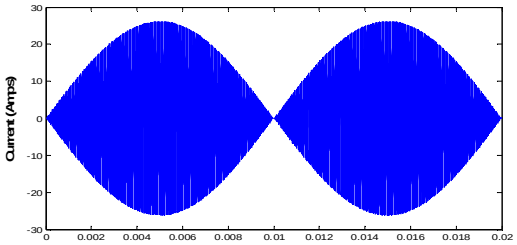

Fig.14. Output Current waveform

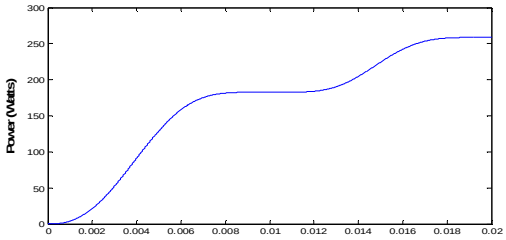

Fig.15. Output Power waveform

In Fig 10 and 15we get the Output Power, Voltage, Current .Comparison between D and DE mode are listed below.

Table I: Comparison in D and DE mode

Closed loop	Class D mode	Class DE mode
Input voltage	230V	230V
Output voltage	150V	100V
Output current	50 A	30A
Output power	1005W	280W

V.CONCLUSION

Class-D half bridge converter is used in the high output power range, whereas class-DE half-bridge converter is used in the low to medium output power range. The combination of these operation modes achieves high efficiency levels in a wider range of output power levels. In the dual-mode resonant converter, class -D and class- DE operation modes are combined to optimize the efficiency in wide range of output power levels. Thus, the presented dual-mode resonant converter topology is a cost-effective implementation for domestic induction heating appliances.

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BIOGRAPHY

MOHANAPRIYA.C Received B.E degree in Electrical and Electronics Engineering from Sudharsan Engineering College. She is pursuing 4th semester, M.E in Power Electronics and Drives at Saranathan College of Engineering. Her major research interest are in the field of Power Electronics Modelling and Simulation.