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DESIGN AND SIMULATION OF CLASS-D FULL BRIDGE RESONANT INVERTER FED INDUCTION HEATING SYSTEM

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Abstract - **This paper proposes the use of the full bridge inverter in class-D operating modes to achieve higher efficiency in a high output power levels. Induction heating system technology is nowadays widely implemented in domestic appliances because of its cleanness, high efficiency, and quick heating process. Because of these advantages are due to its heating process, where the induction pot is directly heated by the induced currents generated with a varying magnetic field. IH systems are based on resonant inverters to generate the required alternating Current (20 kHz) to feed the inductor. Usually, resonant converters are helpful to achieve higher efficiencies and power densities. In such systems, the higher output power and efficiency are accomplished at the resonant frequency, and the switching frequency is greater to decrease the output power.**

Index Terms— **Induction heating (IH), full bridge inverter, and resonant power conversion.**

I. INTRODUCTION

The main advantages of domestic induction heating technology are the rapid heating, high power densities, accurate time and temperature control, minimal standby power and easily adapts to automation. Induction heaters are directly heated the vessel by varying magnetic field in the range of 20-100Khz.This magnetic field is generated by an inductor coil supply from the resonant power converter.

A cooking process can be divided in to two parts 1.Preheating –rapidly increase the vessel temperature to the desired level. Higher output power levels are used for a particular time.2.Holding the temperature for a long time with low-medium output power levels. As a result low-middle power levels have a significant impact on the whole cooking process.

The proposed network used a full bridge inverter for higher output power levels; the maximum efficiency is achieved at the resonant frequency. Performance of the proposed circuits has been tested in the experiment.

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.

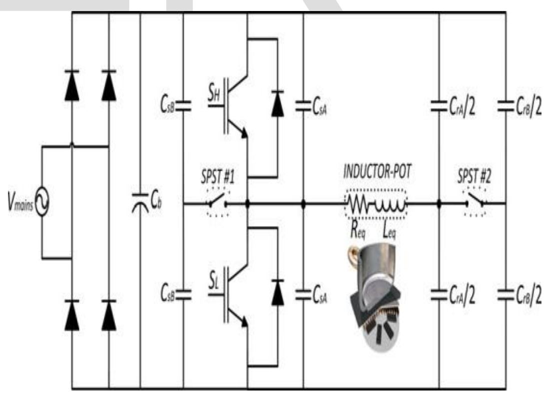

Fig-1 Half bridge resonant converter

In Half bridge resonant converter consist of passive devices resistance and inductance. The series resonant half-bridge applied to induction heating operates at switching frequencies higher than the resonant frequencies to achieve soft switching conditions. To reduce switching stress, a loss less 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. Difference between Class-D and Class-DE operation mode is only changing of both capacitance values .This operation mode contain Zero switching losses, but the maximum output power is lower than in the Class-DE operation mode.

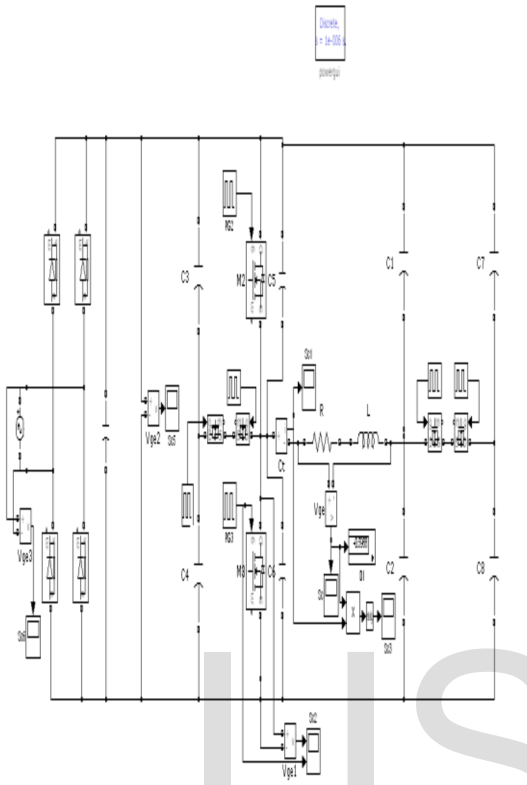

Fig-2 Conventional Network of Open Loop System

In the conventional system Class-D operation mode power levels from 0.8 up to 3KW.In Class-DE operation mode power levels lower than 800W.The overall efficiency of the conventional system to achieved the resonant frequency 20Khz.

Resonant Frequency

$F_r = 1/2\prod\sqrt{Lr}Cr$ (1)

Q-Factor

$Q = WL_r/R$ (2)

Inductance

$L_r = QR/W$, Where (3)

$W = 2\prod f$

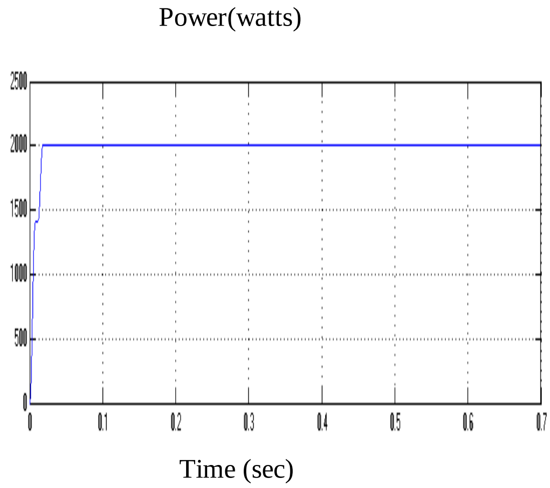

Fig-3 Class-D Half bridge converter Output power 2KW in Open Loop System

From the above given figure3 the conventional system results of half bridge inverter output power 200W obtained as in open loop system with RL load. To improve the efficiency of system and to avoid the constraints, the Full bridge resonant inverters are proposed.

III. FULL BRIDGE RESONANT CONVERTER

The Proposed Full bridge resonant converter used two switch topology methods. it consists of four switches, passive devices such as inductance, resistance, snubber capacitance and resonant capacitance. After trigger the switches switched at high frequency (20 kHz) such as resonant frequency. Then the alternating current feeds to the inductor at high frequency, coil exhibits a electro motive force. The induced emf (power) losses in the form of heat to heated up the vessel to the desired levels. The source of induction heating is eddy current losses, Copper losses and Hysteresis losses.

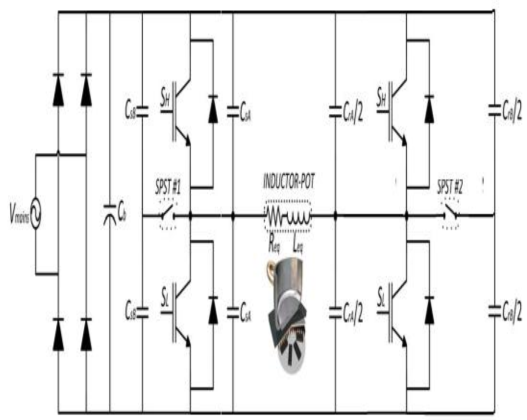

Fig-4 Full Bridge Resonant Converter

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F_r=20 kHz **(4)**

Q=1.3 **(5)**

P=3.7W **(6)**

V=220V **(7)**

R=2.6ohm **(8)**

C_r=2.2 μF **(9)**

L_r =29μh **(10)**

To redesign the Half Bridge into Full bridge network in this proposed network the value of inductances value is obtained as 29μh and capacitance value is obtained as 2.2 μF.

In the proposed system the Class-D operation mode the power levels up to 0.8 to 3KW.The Class-DE Operation mode the power levels up to less than 800W.

The advantages of system which improved the efficiency and low voltage stress across the switching devices. This inverter can be operated in two different types.

Non overlapping and overlapping type. In non overlapping mode, the firing of a transistor device is delayed until the last current oscillation through the diode has been completed. In an overlapping mode, a device is fired, while the current in the diode of the other part is still conducting .Although overlapping operation increases the output frequency, the output power is increased.

Advantages half bridge over full bridge converter is 1.Voltage across each switching device was vd/2.2.No dielectric loss in potential divider capacitor.3.Input voltage is equal to output voltage.

IV.SIMULATION MODEL AND RESULTS

The design of the proposed system is given below

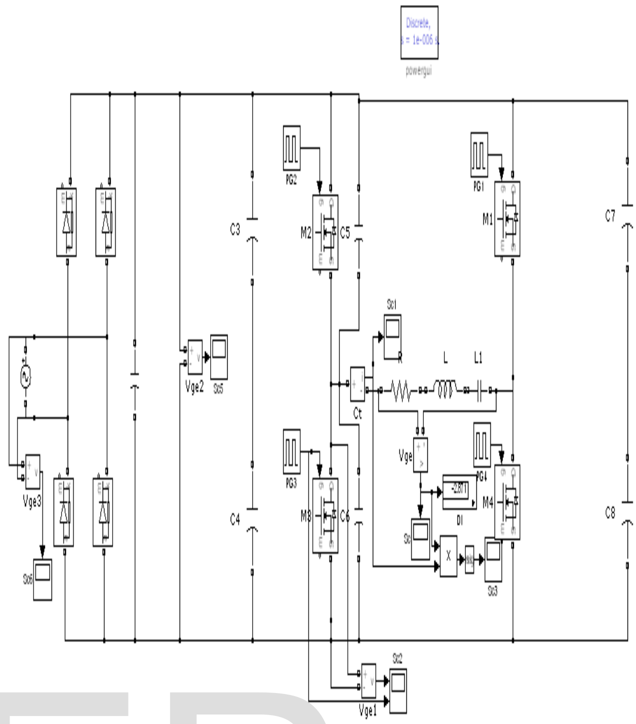
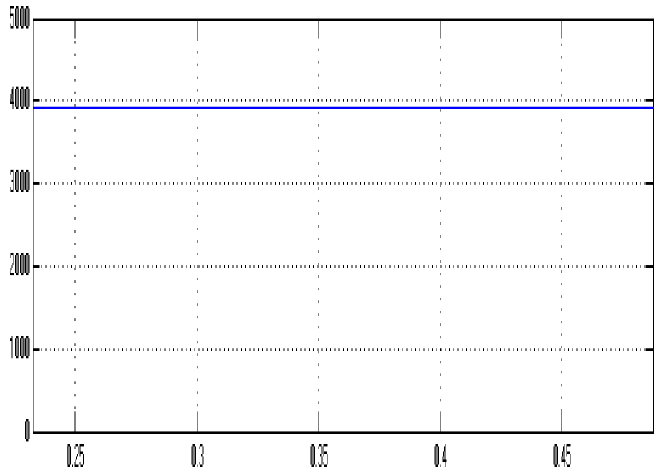


Fig-5 Full Bridge Resonant converter

Power(watts)



time(sec)

Fig-6 Class-D Full bridge converter output Power 3.8KW in open loop system

V.CONCLUSION

The proposed system output power from the full bridge converter shows that higher output power levels. Here the efficiency is increased in the higher output power range .Full bridge output power is two times of half bridge output power. In this situation ZVS and ZCS conditions are executed, and the switching losses are reduced.

In this project, an improved full bridge resonant inverter topology for induction heating application had been done. Resonant inverter hardware is implemented for induction heating applications by using iron material at load side and also it is observed that iron material gets heated up by an induction principle whenever the supply is given.

VI.FUTURE SCOPE

Ways to reduce harmonics and ripples, output power increases achieved by full bridge resonant converter to improve the efficiency with low switching losses.

REFERENCES

[1] O.Lucia, J.M.Burdio, I.Millian, J.Acero, and L.A.Barragan "Efficiency oriented design of ZVS half bridge series resonant inverter with variable frequency duty cycle control,''IEEE Power Electron July 2010.

[2] Y.Kawaguchi,E.Hiraki,T.Tanaka,and M.Nakaoka,''Full. bridge phase shifted soft switching high-frequency inverter with boost PFC function for induction heating system,"in Proc.Eur.Conf.Power Electron

[3]Y.Kawaguchi,E.Hiraki,T.Tanaka,M.Nakaoka.A. Fujita,and H.Omori, ,"Feasible evaluation of a Full bridge inverter for induction heating appliances with discontinuous current mode PFC control,''in proc.

[4] H.Sarnago,A.Mediano,and O.Lucia,"High efficiency ac-ac power electronic converter applied to domestic inducting heating,''IEEE Trans Power Electron.,vol.27,no.8,pp.3676-3684.

[5] H.Sarnago,O.Lucia,A.Mediano,and J.M.Burdio,.,Feb.2012,''Dual-mode operation half-bridge resonant converter for improved efficiency inductionheatingsystem,''in proc.IEEE Appl.Power Electron.Conf.Expo,pp.2184-2188

[6] H. W. Koertzen, J. D. V. Wyk, and J. A. Ferreira, "Design of the half bridge, series resonant converters for induction cooking," in Proc. IEEE Power Electron. Spec. Conf., , pp. 729–735.

[7] N. Park, D. Lee, and D. Hyun, "A power-control scheme with constant switching frequency in class-D inverter for induction-heating jar application," IEEE Trans. Ind. Electron., vol. 54, no. 3, pp. 1252–1260,

[8] M. Kamli, S. Yamamoto, and M. Abe, "A 50–150 kHz half-bridge inverter for induction hearting applications," IEEE Trans. Ind. Electron., vol. 43, no. 1, pp. 163–172.

[9] Y. C. Jung, "Dual half bridge series resonant inverter for induction heating appliance with two loads," Electron. Lett., vol. 35, no. 16, pp. 1345–1346.

[10] L. Meng, K. Cheng, and K. Chan, "Systematic approach to high-power and energy-efficient industrial induction cooker system: Circuit design control strategy and prototype evaluation*,"* IEEE Trans. Power Electron., vol. 26, no. 12, pp. 3754–3765.