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IN ELEVATIONADEPTNESS AC–AC POWER ELECTRONIC CONVERTER SMEARED TO DOMESTIC INDUCTION HEATING

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ABSTRACT

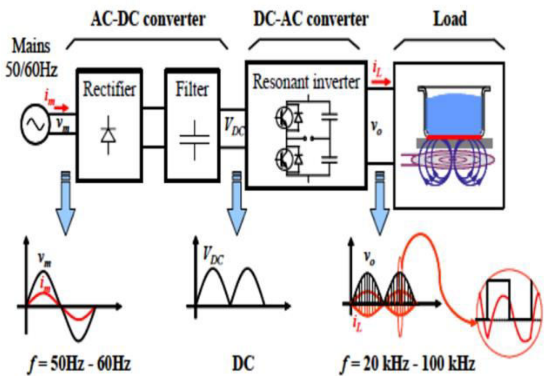
This paper presents the analysis and design of a new ac–ac resonant converter applied to domestic induction heating. The proposed topology, based on the half-bridge series resonant inverter, uses only two diodes to rectify the mains voltage. The proposed converter can operate with zero-voltage switching during both switch-on and switch-off transitions. Moreover, this topology doubles the output voltage, and therefore, the current in the load is reduced for the same output power. As a consequence, the converter efficiency is significantly improved. The analytical and simulation results have been verified by means of a 3600-W induction heating prototype. An efficiency study has been carried out, obtaining values higher than 96%.

INTRODUCTION

Induction heating is a process which is used to bond, harden or soften metals or other conductive materials. For many modern manufacturing processes, induction heating offers an attractive combination of speed, consistency and control. In the most common heating methods, a torch or open flame is directly applied to the metal part. But with induction heating, heat is actually "induced" within the part itself by circulating electrical currents. The basic principle of induction heating, which is an applied form of Faraday's discovery, is the fact that AC current flowing through a circuit affects the magnetic movement of a secondary circuit located near it. Its application, however, has not been flawless Inverters convert low frequency main AC power to a higher frequency for use in induction heating. The converter proposed in this paper is based on the direct ac-ac resonant full bridge converter. The full bridge converter can be doubled the output power when compare to the half bridge converter. It is also used for power level above 1KW. At a reasonable cost and load durable more appropriate configuration 15 KW.

These converters are more efficient because of reducing Switching losses, filter capacitor count and EMC filter requirements. The full-bridge series resonant inverter (FB-SRI) featuring some semiconductor devices like IGBTs, MOSFETs is commonly used for the domestic IH applications. In this paper MOSFET is used, because the MOSFET has positive temperature co-efficient for resistance. If a MOSFET shares increased current initially, it heats up faster, and it is a voltage control device. Due to high frequency power factor will be improved when compare to class E&D it D. Saravanan,M.E.,Assistant Professor Department of Electrical and Electronics ARASU Engineering College Kumbakonam India is better. It works in (0-500V) medium, when compare to IGBT it is cost wise cheaper. In addition the ZVS soft switching conditions are used to reduce the both conducted and radiated EMC issues. The soft switching condition is similar to the PWM converters. The classification of soft switching conditions are resonant converter and resonant (zero current or zero voltage) transistor converters. In this paper, a Direct AC-AC converter is used to obtain variable ac output voltage from a fixed ac source. It is a voltage controller. Its main advantages are high power factor and a sine wave input current. The ac-ac converters are used to change either the voltage level (or) the frequency. The frequency is usually at higher than 20 KHZ and lower than the 100KHZ to reduce the switching losses.

Induction cookers constitute the domestic application of the induction heating phenomena. In such devices, the desired heating is produced in metallic vessels by a varying magnetic field, which in its turn is generated by a planar coil fed by a power electronics inverter. Basically, a domestic induction arrangement consists of a planar turn winding situated below a metallic vessel and supplied by a medium-frequency power source, normally operated between 20 kHz and 100 kHz[1]. For generating high frequency current, there are different types of topologies that can be used, basically, half and full bridge resonant converters and single switch resonant converters. The first two topologies have their own advantages and disadvantages.



Domestic induction heating appliance: power conversion scheme

The heat produced in a part in a induction coil due to electrical current circulating in the part itself. The copper wires are the good conductors. It is used to carry electricity through power lines because of the low heat losses during transmission. By increasing the current in the circuit makes the power and efficiency should be increased in the electrical power system is P=I 2R. The proposed topology reduces both conduction and switching losses, increasing significantly the power converter efficiency. To getting the maximum efficiency chosen different diameters of induction coils.

Nowadays, the induction heating appliances' power is limited by mains maximum current and voltage. The typical maximum output power is 3600 W, and the power converter prototype has been, therefore, designed to achieve 3600-W output power. Simulation parameters are Cr = 470 nF, and the inductor is modeled by Leq = 65 μH and 6.5 Ω for the series-equivalent resistor at switching frequency. The dc-link capacitor has been selected to be low enough to obtain a high power factor and a proper power control, as it is shown in this section, and it can be neglected in this analysis.

LITERATURE SURVEY OF EXISTING METHODS

Rixin Lai et.al (2008) has proposed a single phase ACAC converter for applications like aircrafts, where the weight of the converter topology plays a vital role. The previous work concentrates only on the converter design parameters like devices losses, harmonic injection. However in heavy density applications, the author demands the need of examining all the features related to weight and size of the converter for getting aspect ratio. The main scope of the work is to build up a useful evaluation tool for the future applications in high density topology. They developed a flowchart for developing lower weigh converter system. They have compared their proposed topology with the four converter topologies, a back-to-back voltage source converter (BTB-VSC), a non-regenerative three-level boost (Vienna-type) rectifier plus voltage source inverter (NTRVSI), a back-to-back current source converter (BTB-CSC), and a 12-switch matrix converter. All the major parameters of the system like switching devices, heat sink, energy storage components. They have compared and analyzed all the four converter designs for low weight applications.

Omar Faruque et.al (2010) has developed Hardware in Loop for converters whose coefficient matrices and system equations are changed during runtime. In this paper two ztransform-based discrete techniques have been proposed and one of their derivative time-shifted Step Invariant Transformation is applied for simulating the Voltage Source-HVDC system. In the above works, the converter needs dc filter links and energy storage component for its operation. The need for DC filter link is eliminated by the matrix converters. Matrix converters employs bidirectional semiconductor switches which operates in low frequency modulation with an ability to regenerate energy by eliminating the reactive storage elements to the utility system.

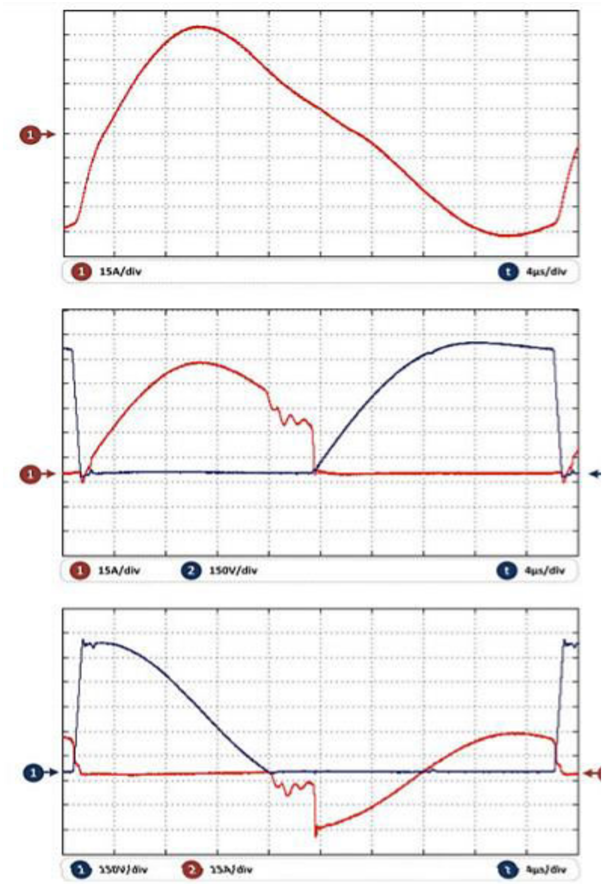
Somnida Ratanapanachote et.al (2006) developed a three phase switch mode converter which directly converts the low frequency into the high frequency output without a dc link. The system has reduced the harmonic content of the rectifiers by eliminating electrolytic capacitor. The matrix converter which consists of twelve IGBT switches which can operate as both rectifier and inverter with space vector Pulse width modulation schemes.

Lixiang Wei et.al (2010) has compared the dual bridge matrix converter using IGBT with conventional matrix converter and DC-AC converter. The author has applied zero current and zero voltage PWM techniques for switching and ZVPWM technique has higher power cycling capacity (mean time to failure of devices) than the ZCPWM techniques. The MTTF is a main parameter in matrix converter, since it has a much higher number of powers switches.

Thiago B. Soeiro et.al (2011) has applied the commercial configurations in the converters by using voltage restorer. These voltage regulators are mainly used to regulating voltage from grid and to reduce the harmonic content. But the fast switching strategy is a problem. Oscar Lucia et.al (2010) has presented a load adaptive control algorithm in series resonant inverter which is employed in domestic heating applications. The paper pays attention on EMC requirements like digital integrality, efficiency, flicker standards and user performance. The load adaptive algorithm is the combination of different modulation schemes. The proposed algorithm has used two modulation schemes such as Square wave modulation in the medium and high output power applications and Pulse density modulation in the low output applications.

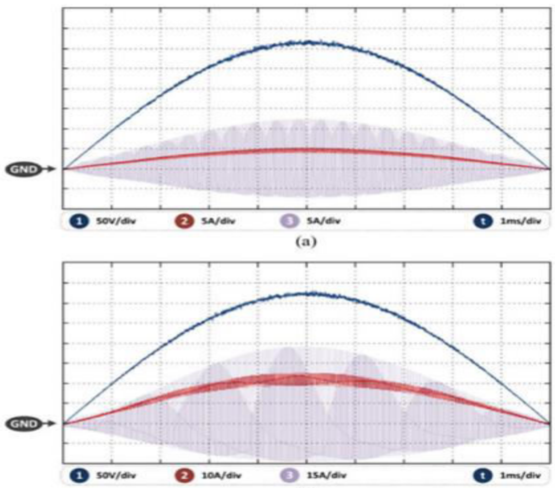
RESULTS

To verify the proposed topology, a laboratory prototype was built. The desired maximum output power level is 3.6 kW, obtained at a switching frequency higher than 20 kHz to avoid the audible range. The inductor–pot system is characterized by Req = 6.5 Ω and a measured equivalent inductance of 67 μH. The measurements have been performed by means of a precision LCR meter from Agilent (E4980A). The power supply is fixed to 230 V and the input inductance Ls in this paper was set to 1.4 mH to avoid high-frequency ripple in the ac supply.

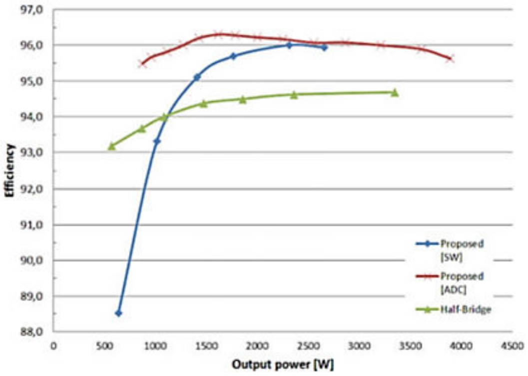


Measured main waveforms. From top to bottom: inductor current (15 A/div), voltage (150 V/div), and current (15 A/div) in the high-side switch; and voltage (150 V/div) and current (15 A/div) in the low-side switch. Time: 4 μs/div.

The main waveforms during a switching period for a 50% duty cycle are shown in Fig. 10, including the inductor current, and voltage and current through the switching devices. Besides, Fig. 11 shows the input voltage and current, and the load current during a mains half-cycle period. These measurements have been performed with an input inductor Ls = 1.4 mH, considered in the measured efficiency. If further input current ripple reduction is required, either the power converter switching frequency or the input inductance can be increased. As a conclusion, these waveforms match up with the theoretical expected ones, and verify the proper operation of the converter.



Minimum output power (900 W; input voltage 50 V/div, input current and load current 5 A/div). Time: 1 ms/div



Measured efficiency

On one hand, the SW control strategy achieves a higher efficiency in the high-output power range. However, the efficiency significantly decreases in the low-output power range due to the switching losses. On the other hand, the ADC control achieves the same high efficiency in the high-output power range, but it remains constant due to the soft-switching conditions. It is important to note that the proposed topology with ADC control achieves a significant efficiency improvement compared with the classical half-bridge topology due to the power devices and current reduction and the soft-switching conditions.

CONCLUSION

This paper presents a new ac–ac converter applied to domestic induction heating. An analytical analysis has been performed in order to obtain the equations and operation modes that describe the proposed converter. The converter can operate with zero-voltage switching during both turn-on and turn-off commutations. Besides, the output voltage is doubled compared to the classical half-bridge, reducing the current through the switching devices. As a consequence, the power converter efficiency is improved in the whole operating range. A 3.6-kW prototype has been designed and implemented in order to validate the analytical and simulation results. The experimental measurements show a significant efficiency improvement compared to the classical half-bridge topology and validate the feasibility of the proposed converter.

REFERENCES

[1] J. Acero, J. M. Burdio, L. A. Barragán, D. Navarro, R. Alonso, J. Ramon, F. Monterde, P. Hernandez, S. Llorente, and I. Garde, "Domestic Induction Appliances," IEEE Industry Applications Magazine, vol. 16, pp. 39-47, 2010.

[2] S. Llorente, F. Monterde, J.M. Burdio and J. Acero, “A Comparative Study of Resonant Inverter Topologies Used in Induction Cookers”, Applied Power Electronics Conference and Exposition, APEC 2002, Vol. 2, pp. 1168-1174.

[3] Satyanarayana, P. and Subramanyam Pavuluri, D.A., 2013. PARAMETRIC MODELING AND DYNAMIC CHARACTERIZATION FOR STATIC STRENGTH OF STEAM TURBINE MOVING BLADES. International Journal of Innovative Research in Science, Engineering and Technology, 2(7).

[4] PAVULURI, S. and KUMAR, D.A.S., 2013. „“ Experimental Investigation On Design Of High Pressure Steam Turbine Blade“‟. International Journal of Innovative Research in Science, Engineering and Technology, 2(5), pp.1469-1476.

[5] Sreenivas, P., Kumar, A.S. and Subramanyam Pavuluri, D.A., 2013. Investigations on transient dynamic response of functionally graded materials. a a, 1, p.2.

[6] Pavuluri, S., Rajashekar, B. and Damodhar, B., Process of Press Tool Design and its Manufacturing for Blanking Operation.

[7] KUMAR, S.S. and SUBRAMANYAM, P., DESIGN AND WEIGHT OPTIMIZATION OF OIL PAN BY FE ANALYSIS.

[8] PAVULURI, S. and KUMAR, D.A.S., 2013. „" Experimental Investigation On Design Of High Pressure Steam Turbine Blade"". International Journal of Innovative Research in Science, Engineering and Technology, 2(5), pp.1469-1476.

[9] B. Saha, L. Hyun Woo, and M. Nakaoka, "Utility Frequency AC to High Frequency AC Power Converter with Boost-Half Bridge Single Stage Circuit Topology," in IEEE International Conference on Industrial Technology, pp. 1430-1435, 2006

[10] G. Biji, P. Vidyalakshmi , "High-Efficiency Resonant Converter topologies for Domestic Induction Heating", Proceedings of the 4th National Technological Congress Kerala (NATCON 2014), Wayanad, pp 264-269, February 2014

[11] J.Rodriguez, M. Rivera, JW Kolar, Wheeler, "A review of control and modulation methods for matrix converters." IEEE Transcations on Industrial Electronics2012 Page No:58–70

[12] M. Hornkamp, M. Loddenkötter, M. Münzer, O. Simon, and M. Bruckmann, "EconoMAC the first all-in-one IGBT module for matrix converters,"in Proc. EUPEC, 2005.

[13] J. J. Acero, JM Burdio, L. A. Barragan, D. Navarro, R. Alonso,J. R. Garcia, F. Monterde, P. Hernandez, S. Llorente, and I. Garde, "The domestic induction heating appliance: An overview of recent research," in Proceedings. IEEE Applications of Power Electronics. Conference. Expo., 2008, page number. 651–657.