Optimal Power Improved Method For Induction Heating Application With High Resonant Boost Inverter

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Abstract
The induction heating is an primary work in many of the industrial applications and also it is used for medical products manufacturing units. This paper proposes an interleaved resonant boost inverter featuring single phase module to achieve high efficiency and performance IH power supply. By reducing the current of power switching device the efficiency of the converter can be increased by incorporating proposed technology. The current ripple can be reduced by implementing interleaved converter. The proposed converter can be tested by designing suitable control strategies. It is important to note the role and operation of the dc-link capacitor in the proposed converter. From the point of view of the equivalent inverter side, the inverter can be modeled as a pure resistor if constant modulation parameters are applied. By combining this fact with the use of a small dc-link capacitor, a mains power factor close to the unit can be achieved. In the case of the proposed converter, a capacitor large enough to filter the high frequency harmonics but still providing a sinusoidal current consumption will be selected.

Keywords: *Power, Induction Heating Application, High Resonant Boost Inverter*

INTRODUCTION
Electrical Induction heating (IH) has become in recent years a key technology due to its benefits in terms of performance and efficiency when compared with classical heating methods. Advances in enabling technologies including power electronics, digital control, and magnetic components has enabled a significant breakthrough in IH technology which has led to a number of relevant industrial domestic and medical applications [1]. Although alternative implementations using permanent magnets are being studied, usually, IH systems rely on a power converter to generate an alternating magnetic field to heat the IH target [2]. A typical arrangement of an induction heating system is in a longitudinal flux configuration. Eddy currents oppose to the magnetic field applied to the induction target, and they produce the heating by Joule effect [3]. This is generally the primary warmth source in IH processes .In option to this, attractive hysteresis makes extra warming in ferromagnetic materials [4]. The average working frequencies of these frameworks ranges from line recurrence, e.g. industrial and high power applications, up to a couple of MHz's, run of the mill of therapeutic systems [5]. Among the benefits of IH, the accompanying ones are ordinarily perceived: Fast warming: IH innovation straightforwardly warms the acceptance target, decreasing squandered warmth and essentially lessening warming occasions because of high power. This paper proposes an interleaved boost resonant inverter topology in order to provide an efficient and high performance IH power supply [6].

RELATED WORK

[1] Induction heating technology and its applications: Past developments, current technology, and future challenges Induction heating (IH) technology is nowadays the heating technology of choice in many industrial, domestic, and medical applications [7].

[2] "Comparative Study of a Single Inverter Bridge for Dual-Frequency Induction Heating Using Si and SiC MOSFETs" The induction surface hardening of parts with non uniform cylindrical shape requires a multi-frequency procedure so as to get a uniform surface solidified depth. This paper shows an enlistment warming high power supply made by a solitary inverter circuit and an extraordinarily planned yield thunderous circuit. The whole circuit supplies simultaneously both medium- and high-frequency power signals to the heating inductor. An initial study is made to select the most appropriated topology for this application. The resonant output circuit is analyzed, and a design procedure is presented [8]. The selected inverter operation is described and simulated. Recreations are tentatively checked on a 10-kW double recurrence thunderous inverter working at 10 and 100 kHz utilizing MOSFETs of silicon (Si) and silicon carbide (SiC) innovation. A comparative study is presented based on the measurements of power losses and the energy efficiency of the inverter using both types of MOSFETs [9].

[3] "Three-leg inverter configuration for simultaneous dual-frequency induction hardening with independent control" Parts of certain objects need hardening. Hardening is a heat treatment process which can be achieved by induction heating. Certain objects like gears require alternating source with two different frequencies. Simultaneous application of dual frequencies is desirable for proper hardening of a gear. This study proposes a three-leg inverter topology with a load resonant circuit which can provide independent and simultaneous control of low-frequency (LF) and high-frequency (HF) currents through the load coil [10]. The load circuit is a combination of two series resonant circuits which operates at the desired LF and HF. Power control is achieved with phase modulation and asymmetric duty cycle control techniques. A 240 W prototype of the proposed dual-frequency inverter is implemented and tested.

PROPOSED HIGH RESONANCE CONVERTER

The main power supply, *vac*, is rectified by means of the half-bridge branch, *R* ($S_{H,r}$, $S_{L,r}$). It is important to remark that a synchronous rectification has been implemented to improve efficiency, being possible to use a two-diode standard half-wave rectifier branch. Consequently, $S_{L,r}$ is activated during the positive mains voltage half-cycle, and SH,R during the negative one. Two additional inverter branches, *A* ($S_{H,\ A}$, $S_{L,\ A}$) and *B* ($S_{H,\ B}$, $S_{L,B}$), simultaneously perform a voltage boost function and generates the high frequency current required for the induction heating application.

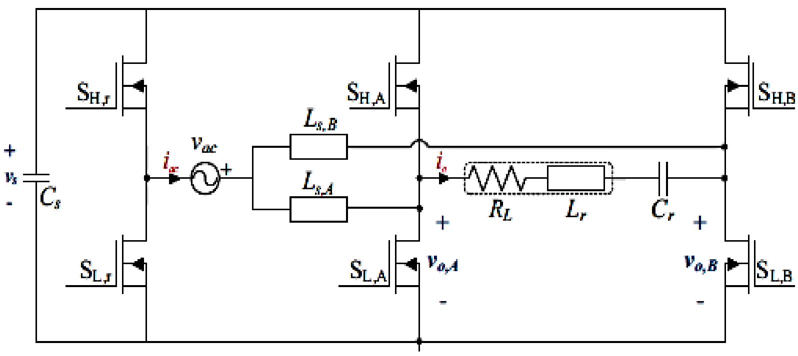

Figure 1: *Proposed converter schematic Diagram*

The proposed topology achieves high efficiency by reducing the current through the power devices and inductor, while the use of an interleaved configuration enables reduced input current ripple. Besides, the boost full-bridge inverter provides additional control degrees, enabling fine output power control. The proposed converter takes advantage of a three- phase S_{iC} module to achieve a high power density and performance implementation. Section II details the proposed topology presents a thorough analytical model of the converter divided in an interleaved boost rectifier plus a resonant full-bridge inverter. It provides a power loss model including power loss in the main power devices as well as passive devices.

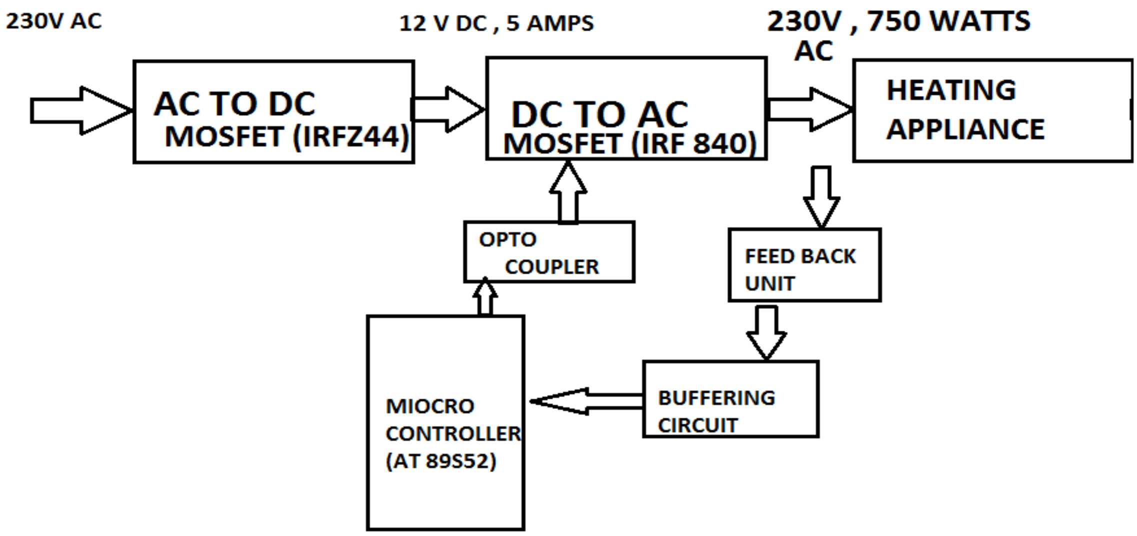

Figure 2: *Proposed Block Diagram of High Resonance Converter*

Advantages

- Induction high-performance heating system
- Advanced modulation technique
- User-friendly pot
- Advanced converter system

Applications

- Industrial applications
- domestic applications

SYSTEM MODEL

Medium and High Power Inverters

Different design approaches address various issues that may be more or less important depending on the way that the converter is intended to be used. In practice capacitors and inductors can be used to filter the waveform. If the design includes a transformer, filtering can be applied to the primary or the secondary side of the transformer or to both sides. Low-pass filters are applied to allow the fundamental component of the waveform to pass to the output while limiting the passage of the harmonic components. Thus quality of waveform can be adjusted. Note that, normal inverters always generate very low quality output waveforms. To make the output waveform qualitative, low pass (LC filter) are often added in the circuit. Thus, at this point of time readers might have a question that, why the quality of converter output is low? And why Low pass filter are frequently added in the circuit. Further, what kinds of solutions are available to increase quality of output waveform without losing its efficiency? All this are open problems associated with present day inverters.

However, eventually all this will be addressed in this thesis. But at first we try to figure out the converter applications from low power to high power and then we summarize the requirements to meet the high power demand. Finally we try to present the problems and solutions available to meet the high power demand.

Challenging Aspects In Medium And High Power Inverters

The current energy arena is changing. The feeling of dependence on fossil fuels and the progressive increase of its cost is leading to the investment of huge amounts of resources, economical and human, to develop new cheaper and cleaner energy resources not related to fossil fuels [3]. In fact, for decades, renewable energy resources have been the focus for researchers, and different families of power inverters have been designed to make the integration of these types of systems into the distribution grid a current.

Therefore, power electronic inverters have the responsibility to carry out these tasks with high efficiency. The increase of the world energy demand has entailed the appearance of new power converter topologies and new semiconductor technology capable to drive all needed power. A nonstop race to create higher-voltage and higher-current power semiconductors to drive high-control frameworks still goes on.

High-frequency inverter for induction heating applications

The basic power conversion scheme in most induction heating systems .From the above discussion on the basic principle of the IH system, it can be said that the heart of the IH system is the high-frequency inverter. This high- frequency inverter works at very high switching frequency, i.e. about 20 kHz to 100 kHz. Generally, semiconductor switches which are used in DC-DC or DC-AC converters are operated in hard switching mode. During turn-on and turn-off, there is always some amount of voltage and current present across the switches. Due to this, a large amount of switching losses occur. Also, due to the high switching frequency, EMI problem and di/dt or dv/dt type problems occur. Power loss due to switching at a higher frequency can be calculated as and it can be concluded from equation (2) that at higher switching frequency, more power loss across the switches occurs.

RESULT AND DISCUSSION

Circuit Diagram

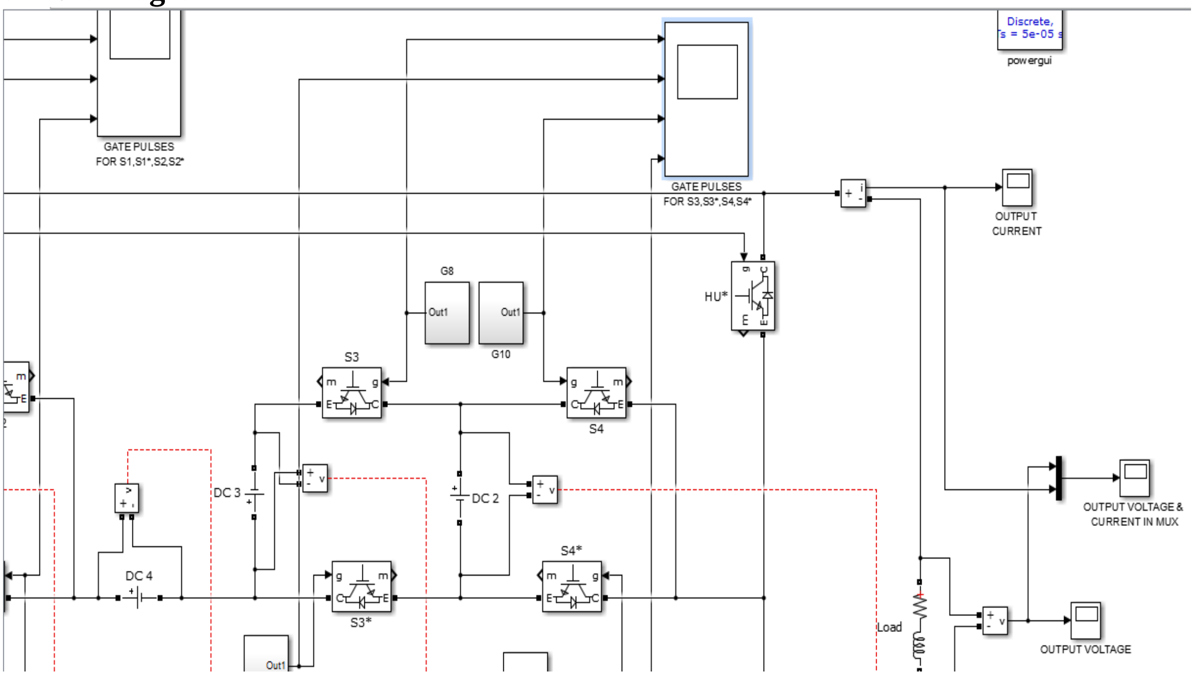

Figure 3: *Matlab Simulink model of proposed system*

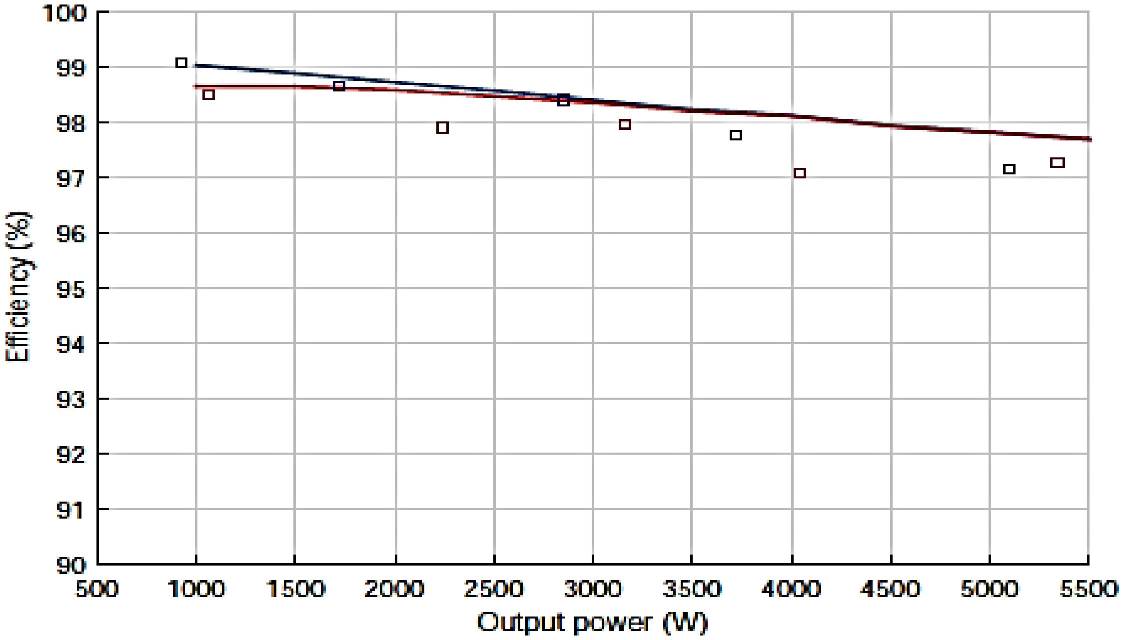

***Figure 4:** Minimum input ripple and the Maximum efficiency control strategies*

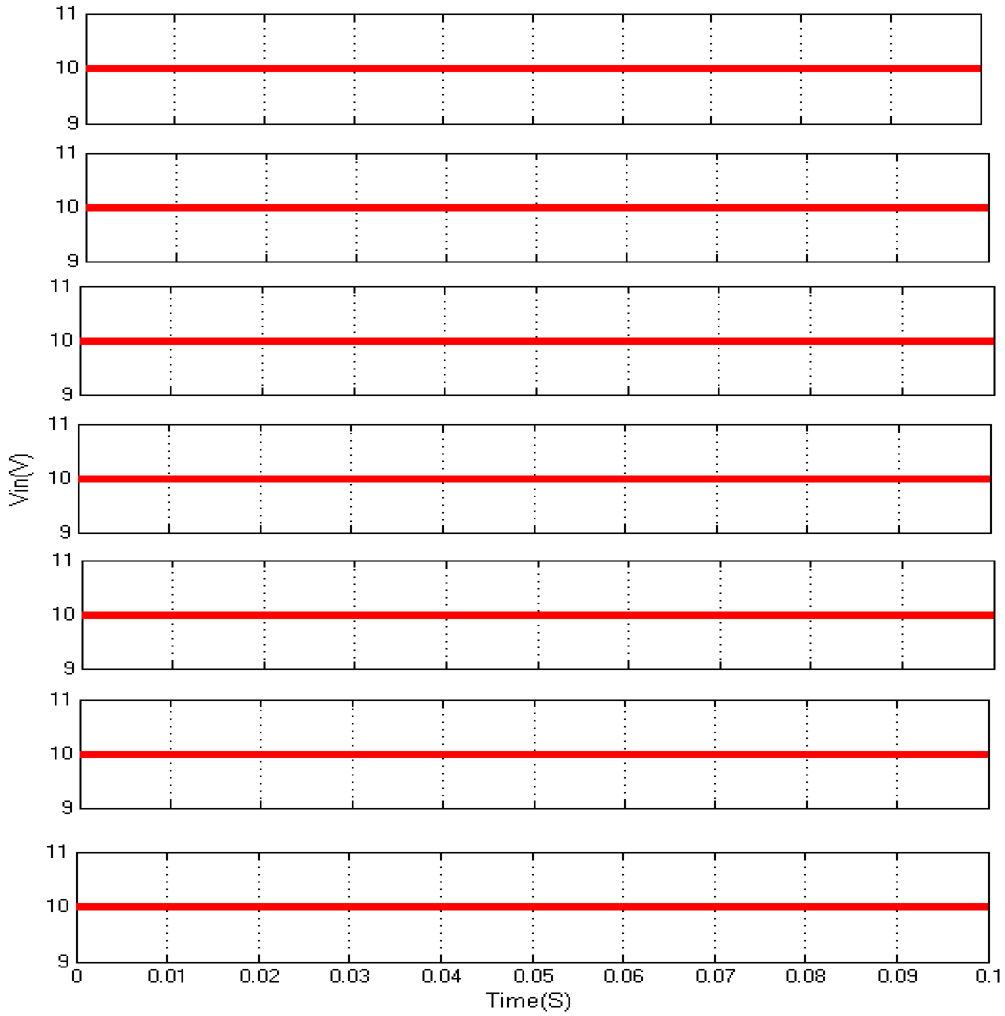

***Figure 5:** Input voltages*

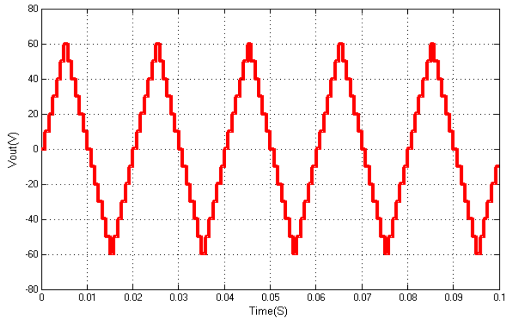

Figure 6: *Output voltage*

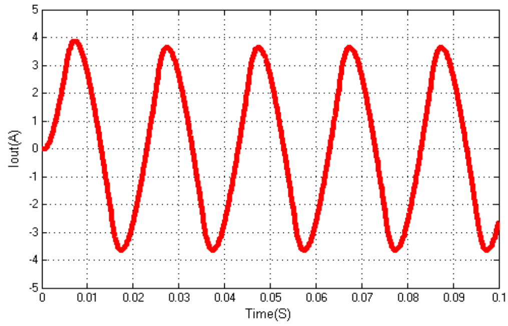

Figure 7: *Output current*

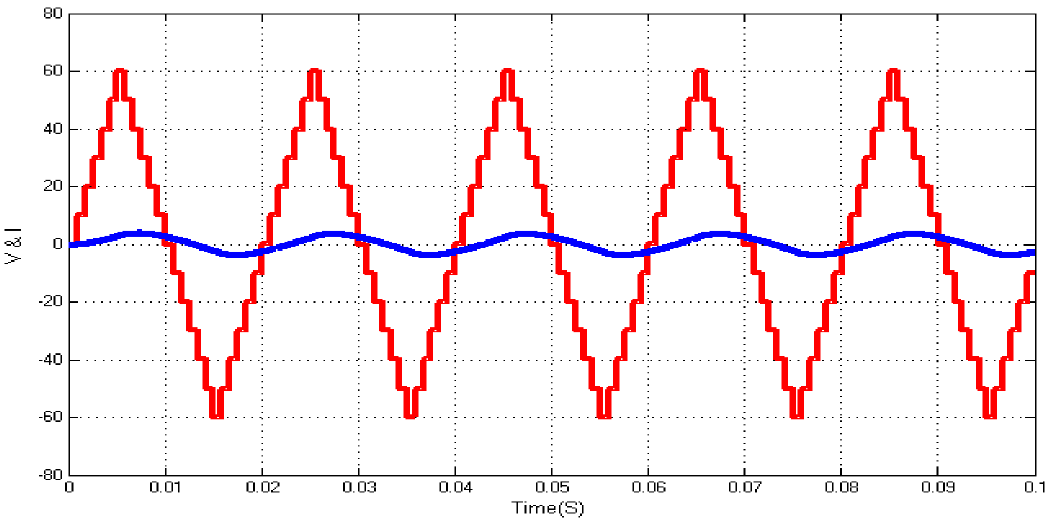

Figure 8: *Voltage and Current in MUX*

CONCLUSION

An interleaved boost resonant inverter for induction heating applications has been proposed and deeply analyzed. The proposed converter enables high efficiency and high performance operation, with improved control and reduced input current ripple. An analytical model for the proposed converter has been provided, and a detailed power loss analysis has been performed, enabling the converter design and optimization. The proposed converter has been designed and implemented taking advantage of SiC technology and the main experimental results proving the feasibility of this topology has been discussed. As a conclusion, the interleaved boost resonant converter is proposed as a high performance topology for industrial IH applications.

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