"A MULTIPLE –FREQUENCY INVERTER FOR INDUCTION HEATING APPLICATIONS"

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Abstract—*This project presents a multiple-frequency resonant inverter for induction heating applications. By adopting a center tap transformer, the proposed resonant inverter can give load switching frequency as twice as the IGBT switching frequency. The structure and the operation of the proposed topology are described in order to demonstrate how the output frequency of the proposed resonant inverter is as twice as the switching frequency of isolated-gate bipolar transistors (IGBTs). In addition to this, the IGBTs in the proposed topology work in zero voltage switching during turn-on phase of the switches. The new topology are verified by the experimental results using a prototype for induction heating applications. Moreover, increased efficiency of proposed inverter is verified by comparison with conventional designs.*

Keywords— Resonant Inverter; Multiple Frequency; Center Tap Transformer; Induction Heating (IH); Zero Voltage Switching (ZVS)

1. INTRODUCTION

In this era there is high demand for products with less energy consumption,, safe and better quality. Customers will be attracted more by quick heating and safe devices. Currently, the induction heating (IH) draws attention as one of the popular heating methods in industrial and domestic applications. The applications include melting, welding, brazing of metals and induction cooking. IH process is a non-contact warming procedure. It utilizes high recurrence power to warm the materials that are electrically conductive. Since it is a non-contact warming procedure, it doesn't debase the material being warmed. The most essential components in an IH framework are the piece to be warmed, otherwise called a work-piece and the inductor or work-loop. The high frequency AC (HFAC) supply applied to the work-coil produces the high frequency magnetic field required to the heat the work-piece. IH system requires a power conversion circuit to convert commercial frequency AC into HFAC supply. The circuit of an IH system typically includes a controlled or uncontrolled rectifier and a current source or a voltage source resonant inverter. The efficiency of the power converter is a key design aspect in the IH system. For the reduction in the converter losses, the resonant inverter is used to produce high frequency AC supply.

1.1 Applications of IH system

IH system can be used to heat an electrically conductive material in a clean, efficient and controlled manner. The applications include melting, welding, brazing of metals and induction cooking. The diminished cost of the IH frameworks, has prompted an across the board utilization of IH in many procedures and applications, for example, car fixing, paper making tube, aluminum liquefying and bar warming. Metal solidifying of ammo, rigging teeth, saw cutting edges and drive shafts and so on., are likewise normal applications in light of the fact that the enlistment procedure warms the surface of the metal quickly.

1.2 Resonant Inverter

In IH applications, the resonant inverters are used to minimize the switching losses. Resonant inverters are DC to AC converters whose operation is based on resonant current oscillation. It uses tuned resonant network to achieve soft switching. This type of inverter produces an approximately sinusoidal waveform at a high output frequency. Owing to the high switching frequency, the size of the resonating components is small. The resonating components such as Inductor (L) and Capacitor (C) can be connected in series or parallel with the load of the high frequency inverter.

2. METHODOLOGY

MULTIPLE-FREQUENCY RESONANT INVERTER

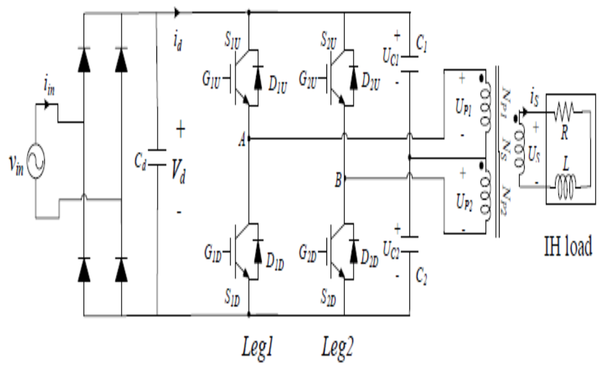


Fig 1. System configuration.

Fig. 1 shows the proposed system configuration of a multiple-frequency IGBT resonant inverter for induction heating applications. The output power stage consists of a single-phase voltage-source full-bridge inverter consisting of four IGBT modules. The output of the inverter is connected to a series resonant circuit, which is composed of a center tap transformer, two resonant capacitors C1 and C2, and the induction heating loads that can be modeled by means of a series combination of its equivalent resistance R and inductance L. The inductor is a critical component in the induction system; its characteristics in the real operation can be founded. The center tap transformer is a matching transformer which adapts the impedance of the load circuit. The capacitor Cd is the dc-link capacitor. The dc power supply for the inverter is received from a single-phase diode bridge rectifier connected to the 220V/50Hz power line.

Fig. 2 shows the simplified schematic diagram of the inverter circuit where the center tap transformer has been transformed and the resonant capacitors C1 and C2 are relocated. The proposed inverter consists of two half-bridge inverter, namely Leg 1 and Leg 2, which contains two IGBT power modules. For each IGBT, there is a free-wheeling diode connected in parallel. S1U - S1D and S2U – S2D are, respectively, the IGBT transistors of Leg 1 and Leg 2. D1U - D1D and D2U – D2D are, respectively, the free-wheeling diodes of the corresponding IGBT modules. G1U – G1D and G2U – G2D represent the driving signals of the IGBTs. The center tap transformer contains two primary turns, Np1 and Np2, and a secondary turn, NS, where Np1= Np2 and the turn ratio n= Np1/ NS= Np2/ NS. The resonant capacitors C1 and C2 have the same value C. The switches S1U - S1D and S2U – S2D are commutated in ZVS operation due to the edge resonant by the capacitors C1 and C2 with the aids of Lp1 and Lp2.

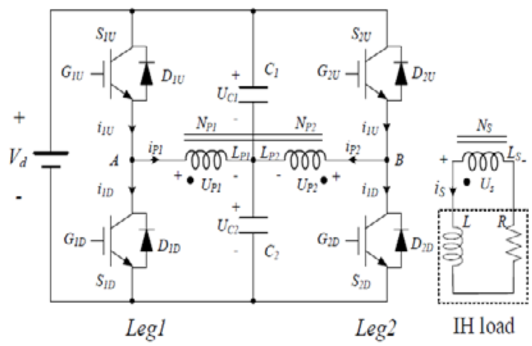


Fig. 2.

Schematic diagram of the proposed inverter.

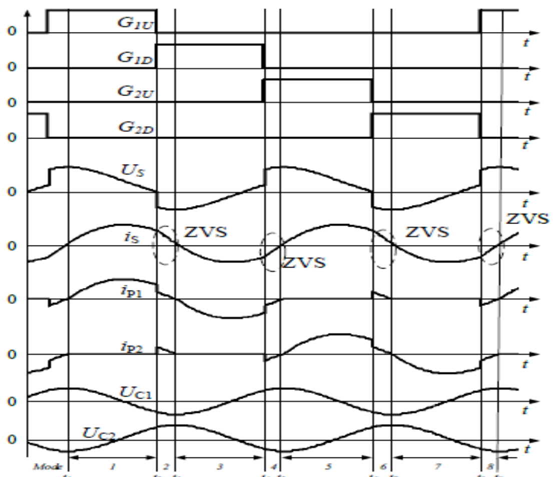
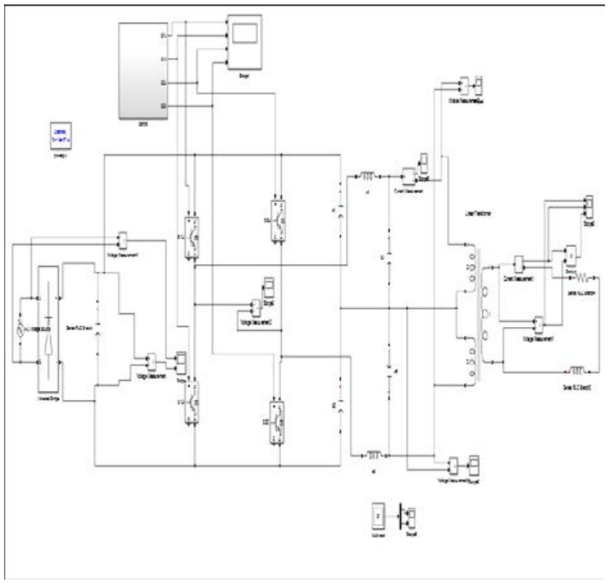
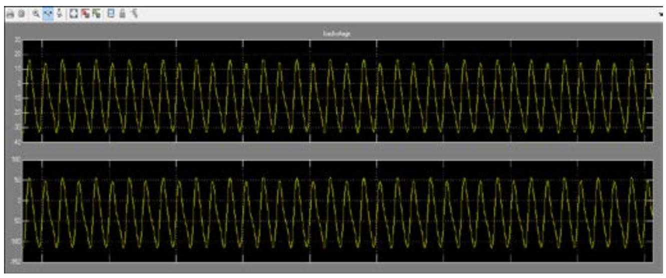


Fig. 3.Relevant voltage and current operating waveforms

3. OVER ALL SIMULATION MODEL



4. SIMULATION RESULT AND DISCUSSIONS



LOAD VOLTAGE AND CURRENT

To evaluate the feasibility of the proposed resonant inverter, some Simulation results are presented in this section. An experimental 1kW prototype has been implemented for an induction heating appliance, as shown in Fig. 8. The input power of the proposed resonant inverter is 220V/50Hz.

5. CONCLUTIONS

A multiple-frequency resonant inverter has been proposed in this project, and its analysis and experimental results have been shown. The proposed resonant inverter adopts a center tap transformer and shares two equal resonant capacitors, which has the special property that the switching frequency is half of the load resonant frequency.

And under wide load variation, the proposed inverter achieves high efficiency by providing zero-voltage switching (ZVS) operation to all the switches. To confirm the validity of the proposed resonant invert, a Simulation was built and tested. The simulation results prove the proper operation of the proposed topology, and also illustrate the ZVS operation when the switches are turned on. Thus, the proposed resonant inverter can be applied in the high frequency situation with high efficiency.

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