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Real Time Implementation of Induction Heating Principle using Full Bridge Inverter

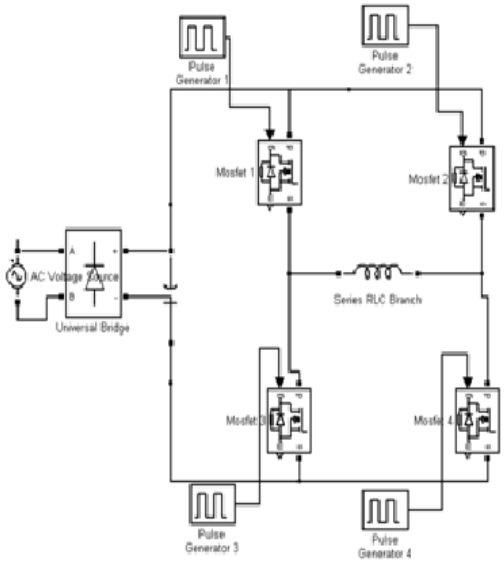
Srikant Misra, Sujit Kumar Patro, Arun Kumar Rath

Abstract: - The paper proposes an Induction Heating Principle using Full Bridge Inverter where a Single phase full bridge inverter consists of one rectifier, one capacitor, four mosfets and at the load side one induction heating rod is connected. So by this when any ac supply is given to the input side, we will get the square wave at the output side[1][3]. In this concept the induction heating rod is heated up within a short period and the heating time of the induction heating rod is under control. The frequency which is used for programming is 50 Hz, 33.33 Hz and 66.66 Hz. When 45 volts input is applied then we get 68 volts at the output side. So in this project basically the heating time of the induction heating rod is controlled. Microcontroller 8051 is used. In that the port 3 is used as the input port while port 2 is used as the output port. In the input side three switches are used for three different frequencies 50 Hz, 33.33 Hz, 66.66 Hz[5]. These frequencies can be changed depending upon the requirement but according that the microcontroller code should be written. The output of this microcontroller is given to the driver circuit. And after that the output of driver circuit is given to the input of mosfets at the gate terminal. The simulation is done in Matlab. In this the Mosfets M1, M4 and M2, M3 work as a pair. The phase delay between these pairs is 90 degree. In simulation also we are getting the same output in the form of square wave. Matlab 7.1 is used as a simulation tool.

***Index Terms*— Rectifier, Mosfets, Microcontroller 8051, Matlab 7.1**

I. INTRODUCTION

The basic dc to ac converter is called inverter. The function of an inverter is to change a dc input voltage to corresponding symmetrical AC output voltage of desired magnitude and frequency [5]. The output voltage could be fixed or variable at a fixed or variable frequency. A variable AC output voltage can be obtained by varying the input DC voltage and maintaining the gain of the inverter constant. On the other hand if the DC input voltage is fixed and it is not controllable, a variable output voltage can be obtained by varying the gain of the inverter. The single-phase full bridge inverter is shown in figure 1.0. It consists of four MOSFETs. These MOSFETs are turned on and off in pairs of M1, M4 and M2, M3. Initially the MOSFET M1 and M4 gets turned on by their respective pulse generator and when the when the pulse generator gives the pulse to MOSFET M2 and M3 at that time MOSFET M2and M3 gets turned on and in the same time MOSFET M1 and MOSFET M4 gets turned off. This is the basic principle of single phase full bridge inverter circuit. The block diagram of single phase full bridge inverter circuit is shown in figure 1.0.



At the load side of the full bridge inverter one induction heating rod is used. So at the load side induction heating principle is applied and time of induction heating is in control [2]. One microcontroller 8051 is used in order to provide the different frequencies. Based on those frequencies, turn on time of Mosfets changes. The pair of two Moshe is used. For 50 Hz, 33.33 Hz and 66.66 Hz Mosfets turn on and turn off in pair. Single phase full bridge inverter provides the output with less harmonics content. It is more convenient and more efficient then half bridge inverter. The application of Single phase full bridge inverter is in heating purposes, providing the square wave and in industrial areas[2]. The main objective of this paper to provide different time cycle to the gate terminal of mosfets and same time cycle is applied to the induction heating rod.

II. POWER SUPPLY

The ac voltage, typically 230 volts is connected to a transformer, which steps that ac voltage down to the level of the desired dc output [Fig-3]. A diode rectifier then provides a full-wave rectified voltage that is filtered by a capacitor to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation [Fig-2]. A regulator circuit removes the ripples and also remains the same dc value even if the input dc voltage varies, or the load connected to the output dc voltage changes. This voltage regulation is usually obtained using one of the popular voltage regulator IC units.

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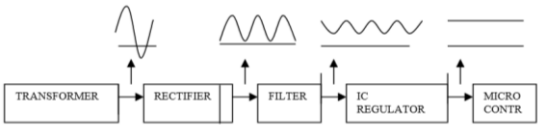
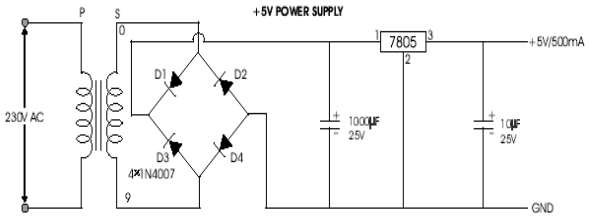
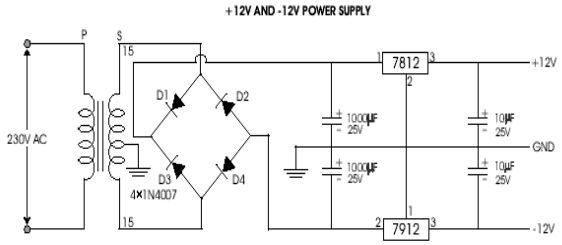


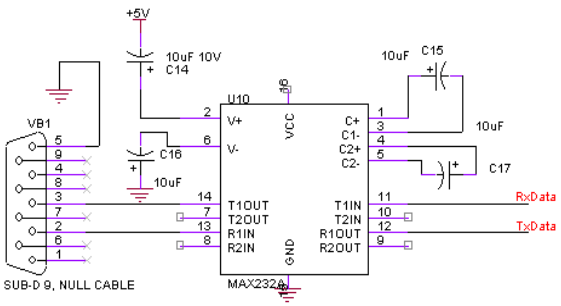
III. IC VOLTAGE REGULATORS

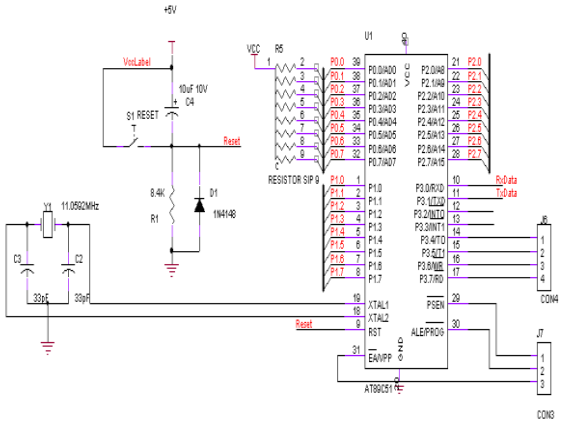
Voltage regulators comprise a class of widely used ICs. Regulator IC units contain the circuitry for reference source, comparator amplifier, control device, and overload protection all in a single IC. IC units provide regulation of either a fixed positive voltage, a fixed negative voltage, or an adjustably set voltage. The regulators can be selected for operation with load currents from hundreds of milli amperes to tens of amperes, corresponding to power ratings from milli watts to tens of watts [Fig-4]. A fixed three-terminal voltage regulator has an unregulated dc input voltage, Vi, applied to one input terminal, a regulated dc output voltage, Vo, from a second terminal, with the third terminal connected to ground. The series 78 regulators provide fixed positive regulated voltages from 5 to 24 volts. Similarly, the series 79 regulators provide fixed negative regulated voltages from 5 to 24 volts [fig-5].





IV. MICROCONTROLLER- AT89C51





The main controlling unit of the proposed system is the microcontroller. The main features of microcontroller and particularly Atmel 89c51 is discussed here. A microcontroller consists of a powerful CPU tightly coupled with memory [RAM,ROM or EPROM],various I/O features such as serial ports, parallel ports ,timer/counters, interrupt controller ,data requisition interface , Analog to digital converter[ADC],digital to analog converter, everything integrated into a single silicon chip[Table-1.0]. It does not mean that any microcontroller should have all the above said features on a single chip, depending on the need and area of application for which it is designed, the on chip features present in it may or may not include all the individual section said above. Any microcomputer systems requires memory to store a sequence of instructions making up a program , parallel port or serial port for communicating with an external system timer/counter for control purpose like generating time delay.

V. DESCRIPTION

The AT89C51 is a low-power, high performance CMOS 8 – bit micro computer with 4 Kbytes of flash Erasable and Programmable Read Only Memory (EPROM) [fig-6].The device is manufactured using a Atmel's high density nonvolatile memory technology and is compatible with the industry standard MCS-51tm instruction act and pin out. The on-chip flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with flash on a monolithic chip, the At89c51 is a powerful microcomputer which provides a highly flexible and cost effective solution to many embedded control applications. The AT89C51 provides the following standard features: 4K bytes of Flash, 128 bytes of RAM, 32 I/O lines, two 16-bit timer/counters, five vector two-level interrupt architecture, a full duplex serial port, and on-chip oscillator and clock circuitry. In addition, the AT89C51 is designed with static logic for operation down to zero frequency and supports two software selectable power saving modes. The Idle Mode stops the CPU while

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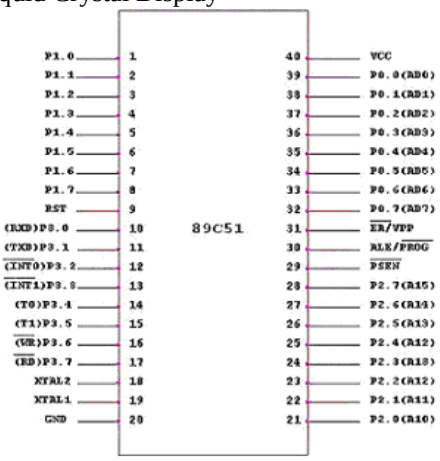
allowing the RAM, timer/counters, serial port and interrupt system to continue functioning. The Power-down Mode saves the RAM contents but freezes the oscillator disabling all other chip functions until the next hardware reset.

VI. FEATURES OF 8051

Feature	Quantity
ROM	4K bytes
RAM	128 bytes
Timer	2
I/O pins	32
Serial port	1
Interrupt sources	6

VI. CHIP DESCRIPTION

It includes the chip details of microcontroller 89C51,A/D converter, Multiplexer and I/O Expander and Liquid Crystal Display

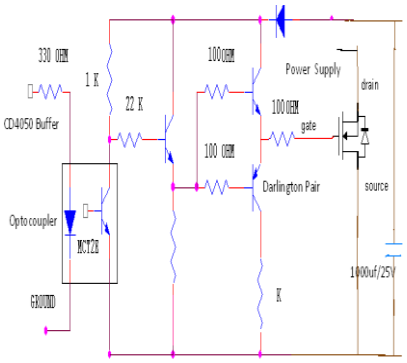


VII. SOFTWARE (KEIL MICROVISION 2)

Keil micro vision 2 features include Project Setup for the Make and Build Process. Editor facilities for Modifying and Correcting Source Code. Program Debugging and Additional Test Utilities. The Device Database makes it easy to start writing programs for a particular CPU. Just select the microcontroller to be used and micro vision 2 sets the necessary options automatically. We may add new devices to the database as the need arises. Micro vision 2 provides a Books tab in the Project window where extensive on-line manuals for the tool chain and selected CPU are found. We may double-click on a book title to open the on-line manual. Most dialogs have a help button which provides detailed information about the dialog controls. To get help on menu items, select the item and press F1.Micro vision 2 lets us set the options for all files in a target, a group, or even a single source file. The options dialog opens via the local menu in the Project window. In the Target page of this dialog, we may specify the CPU and memory parameters of the target system. Micro vision 2 uses this information to configure basic tool options including the linker/locater settings and the simulator driver. The Output page defines the output files generated by the assembler, compiler, and linker.

VIII. DRIVER CIRCUIT

The main purpose of driver circuit is we have to enhance the switching voltage for the mosfet or any switching device. And also we have to isolate the power circuit from the microcontroller circuit. Because the power circuit current must not enter into the microcontroller circuit.MCT2E is the opt coupler which will be connected to the buffer CD4050 which send pulse signals from microcontroller to the driver circuit.MCT2E is the device which isolates the power circuit with the microcontroller circuit. After it gets the signal from the microcontroller it will get enhanced using the 2N2222 transistor to higher level of voltage after this the voltage get regulated by the use of Darlington pair. The Darlington is made of 2N2222 (NPN) and SK100 (PNP) transistor



IX. FULL BRIDGE INVERTER

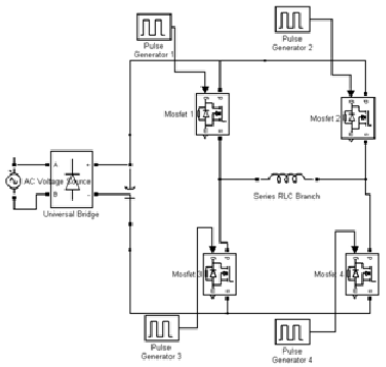


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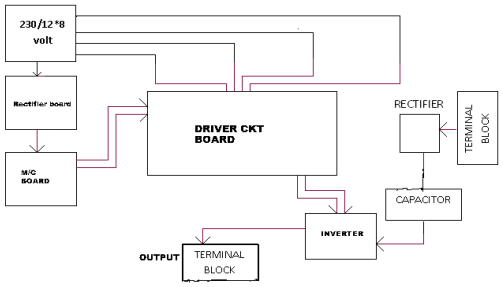
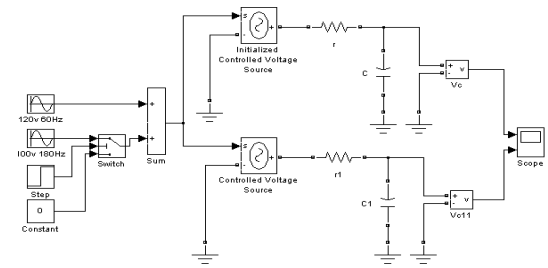
Fig.8 shows the circuit diagram of single phase full bridge inverter. The circuit diagram includes the 45 volts ac supply, bridge rectifier, filter, four mosfets and a load resistance. Here BR68 bridge rectifier is used and in place of filter one capacitor of rating 200 volts/1000 Uf .And after that IRFP460 mosfet is used, in place of load one resistance of 100Ω is used. In the full bridge rectifier first the 230/12 volt step down transformer used and this provides the 12 volts ac supply to the bridge rectifier and this rectifier converts the ac voltage into the pulsating dc and after that the output of bridge rectifier is applied to capacitor and capacitor converts the pulsating dc to complete dc. The output of capacitor is passed to mosfets and gate supply to all mosfets is provided by gate driver supply. And after that at the load side we get output as square wave of different frequencies. The full bridge inverter consists of following stages

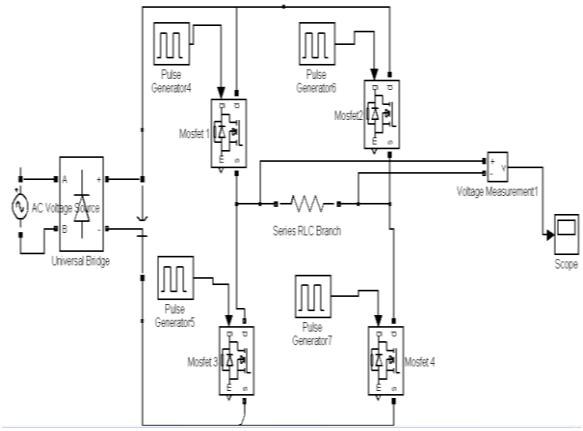
X. BLOCK DIAGRAM OF HARDWARE MODEL



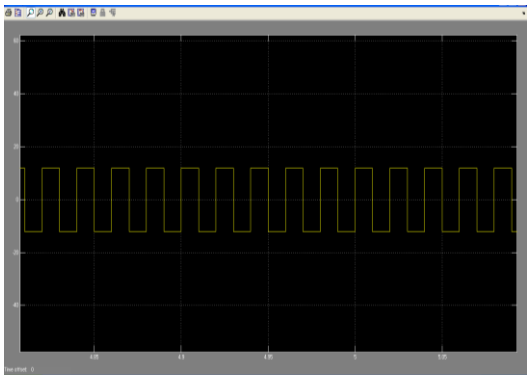
XI. SIMULATION WITH MATLAB

Interfacing Electrical Circuit with Simulink

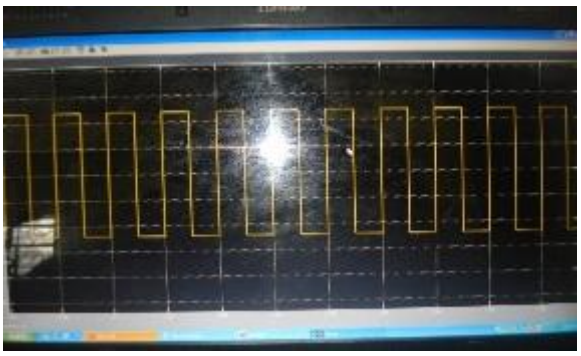




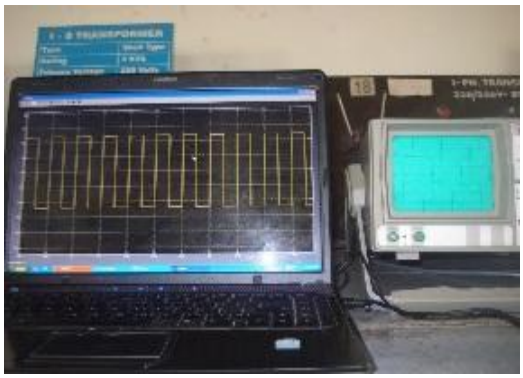
XI. WAVEFORM OF SIMULATION



XII. PHOTOGRAH OF MODEL AND WAVEFORM ON MATLAB SIMULATION



XIII. WAVEFORM ON C.R.O. AND ON MATLAB SIMULATION



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XIV. CONCLUSION

Single phase full bridge inverter consists of one rectifier, one capacitor, four mosfets and at the load side one induction heating rod is connected. So by this when any ac supply is given to the input side, we will get the square wave at the output side. In this concept the induction heating rod is heated up within a short period and the heating time of the induction heating rod is under control. The frequencies which are used for programming are 50 Hz, 33.33 Hz and 66.66 Hz. When 45 volts input is applied then we get 68 volts at the output side. So in this project basically the heating time of the induction heating rod is controlled. Microcontroller 8051 is used. In that the port 3 is used as the input port while port 2 is used as the output port. In the input side three switches are used for three different frequencies 50 Hz, 33.33 Hz, 66.66 Hz. These frequencies can be changed depending upon the requirement but according that the microcontroller code should be written. The output of this microcontroller is given to the driver circuit. And after that the output of driver circuit is given to the input of mosfets at the gate terminal. The simulation is done in Matlab. In this the Mosfets M1, M4 and M2, M3 work as a pair. The phase delay between these pairs is 90 degree. In simulation also we are getting the same output in the form of square wave. Matlab 7.1 is used as a simulation tool. The harmonic components are very less at the output. The mosfets which is used are capable of working at high frequency also. The single phase full bridge inverter is used for heating purpose, for generating square wave and for industrial purpose. Hence for heating the load as induction heating rod, the single phase full bridge inverter is used

XV. SCOPE FOR FUTURE

The single phase full bridge inverter is used for variable voltage and variable frequency, as we have seen by giving 45 volts input, 68 volts output is achieved. It can also be used for high frequencies but by using inverter at high frequency, causes high frequency noises. After using the noise reduction techniques, we can use full bridge inverter at high frequency. By using the microcontroller, the gate pulse time is controlled. If we use the IGBT as a switch instead of MOSFET then the efficiency of single phase full bridge inverter is improved. Single phase full bridge inverter is effectively used for heating purpose, for providing square wave and also for providing uninterrupted power supply. By making some modification the full bridge inverter can be made more efficient.

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AUTHOR’S PROFILE

Srikant Misra received his M. Tech Degree in Power Electronics and Drives from GIET, Gunupur under BPUT UG from BPUT. A life time member of ISTE and also a life time member of SESI. He working as a Asst. professor in EEE Department at Gandhi institute of engineering & Technology. He is having overall more thane 7 years experiences in Industrial and teaching fields. His interest areas are Renewable power system and Power Electronics.

Sujit Kumar Patro received his M. Tech Degree in Power Electronics and Drives from NIST, Berhampur under BPUT UG from BPUT. He working as a Asst. professor in EEE Department at Gandhi institute of engineering & Technology. He is having overall more thane 3 years experiences teaching fields. His interest areas are power system and Power Electronics

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