Wireless Power Transfer System to Recharge the Battery of an Implantable Cardiac Pacemaker

M. Mutheeswari
Final year,BME PSNACET
Dindigul

Mr. S. Sriram
Assistant Professor PSNACET
Dindigul

S. Revathi
Final year,BME PSNACET
Dindigul

K. Sahana
Final year,BME PSNACET
Dindigul

***Abstract*-This paper presents a method to charge the cardiac pacemaker over a wireless link by magnetic induction. Antenna is used here as a primary and secondary coil which works based on the inductive coupling principle. Through this technology we can reduce the wires or we eliminate the complications and infections caused by the wires. The aim of the system is to transfer the power efficiently to the battery of the pacemaker and automatically charge when battery charge is low. We studied the inductive coupling and coupling coefficient of the primary and secondary coil and we studied the electrical characteristics of the antenna with equivalent circuit.**

Keywords- Wireless power transfer, antenna, Inductive coupling.

I. INTRODUCTION

Nicola Tesla introduced the concept of wirelessly transmitting electrical power in
1891. In the field of wireless power transfer the main issue is transfer the power with high efficiency. In this paper we use inductive coupling to transfer the power to the implantable devices. The Implantable biomedical devices like pacemakers, monitoring devices, LVADs, and artificial hearts require power supply for long term operation. Traditionally implantable lithium- ion batteries and percutaneous link power supply systems are used for power transfer to the devices. But life span and energy storage is limited in batteries and infection risks across the Skin are high in percutaneous links.

A.INDUCTIVE COUPLING

This is one of the most popular wireless power transfer system. This system
transfer's energy from the transmitting antenna to the receiving antennas using the magnetic field generated when current passes through the transmitting antenna. However, this system has a really limited range at 1cm or 2cm, and the efficiency severely drops outside of the range. Lately, a system to transfer the energy at a high frequency (kHz range) is developed. This allows this system to be used at an approximately 10-20cm range.

II. SYSTEM DESCRIPTION

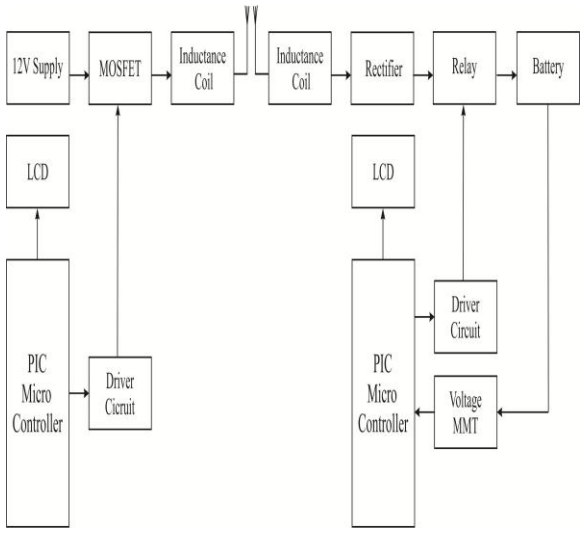

Fig.1. Block diagram

The PIC microcontroller is the main heart of our project. It is a flash type reprogrammable memory microcontroller. We have already programmed on their objective. All above the devices are connected in this controller. 12V power supply is given to the inductance coil via MOSFET. An inductor, also called a coil or reactor, is a passive two- terminal electrical component which resists changes in electric current passing through it. It consists of a conductor such as a wire, usually wound into a coil. When a current flows through it, energy is stored temporarily in a magnetic field in the coil.

The metal-oxide-semiconductor field-effect transistor (MOSFET, MOS-FET, or MOS FET), is by far the most common field-effect transistor in both digital and analog circuits. The MOSFET is composed of a channel of n-type or p-type semiconductor material (see article on semiconductor devices), and is accordingly called an NMOSFET or a PMOSFET.

III.HARDWARE AND SOFTWARE

A.HARDWARE

1. PIC MICROCONTROLLER

The microcontroller that has been used for this project is from PIC series. PIC microcontroller is the first RISC based microcontroller fabricated in CMOS that uses separate bus for instruction and data allowing simultaneous access of program and data memory.

The main advantage of CMOS and RISC combination is low power consumption resulting in a very small chip size with a small pin count. The main advantage of CMOS is that it has immunity to noise than other fabrication techniques.

PIC (16F877)

Various microcontrollers offer different kinds of memories. EEPROM, EPROM, FLASH etc. are some of the memories of which FLASH is the most recently developed. Technology that is used in pic16F877 is flash technology, so that data is retained even when the power is switched off. Easy Programming and Erasing are other features of PIC 16F877.

2. DRIVER CIRCUIT

In electronics, a driver is an electrical circuit or other electronic component used to control another circuit or other component, such as a high-power transistor. The term is used, for example, for a specialized computer chip that controls the high-power transistors in AC-to-DC voltage converters. An amplifier can also be considered the driver for loudspeakers, or a constant voltage circuit that keeps an attached component operating within a broad range of input voltages.

The following circuit will allow you to drive a 12V relay using logic voltage (an input of 4V or greater will trip the relay). The circuit has its own 12V power supply making itself contained but the power supply portion can be left out if an external supply will be used. The circuit shows an output from the power supply that can be used to power other devices but it should be noted that the supply is unregulated and not particularly powerful with the parts stated. The 12V DC output is suitable for powering a few LEDs or low voltage lights but should not be used to power other electronic boards or motors.

3. MOSFET

The metal-oxide-semiconductor field-effect transistor (MOSFET), is by far the most common field-effect transistor in both digital and analog circuits. The MOSFET is composed of a channel of n-type or p-type semiconductor material and is accordingly called NMOSFET or a PMOSFET. In this paper N-MOSFET is used. When a voltage is applied between the gate and source terminals, the electric field generated penetrates through the oxide and creates a so-called "inversion channel" in the channel underneath. The inversion channel is of the same type P-type or N-type as the source and drain, so it provides a conduit through which current can pass. Varying the voltage between the gate and body modulates the conductivity of this layer and makes it possible to control the current flow between drain and source INDUCTANCE

4. COIL

An inductor, also called a coil or reactor, is a passive two-terminal electrical component which resists changes in electric current passing through it. It consists of a conductor such as a wire, usually wound into a coil. When a current flows through it, energy is stored temporarily in a magnetic field in the coil. When the current flowing through an inductor changes, the time- varying magnetic field induces a voltage in the conductor, according to Faraday's law of electromagnetic induction, which opposes the change in current that created it.

An inductor is characterized by its inductance, the ratio of the voltage to the rate of change

of current, which has units of henries(H). Inductors have values that typically range from 1 µH (10^{-6}H) to 1 H. Many inductors have a magnetic core made of iron or ferrite inside the coil, which serves to increase the magnetic field and thus the inductance. Along with capacitors and resistors, inductors are one of the three passive linear circuit elements that make up electric circuits. Inductors are widely used in alternating current (AC) electronic equipment, particularly in radio equipment. They are used to block AC while allowing DC to pass; inductors designed for this purpose are called chokes. They are also used in electronic filters to separate signals of different frequencies, and in combination with capacitors to make tuned circuits, used to tune radio and TV receivers

5. RECTIFIER

A rectifier is an electrical device that converts alternating current (AC), current that periodically reverses direction, to direct current (DC), current that flows in only one direction, a process known as rectification. Rectifiers have many uses including as components of power supplies and as detectors of radio signals. Rectifiers may be made of solid state diodes, vacuum tube diodes, mercury arc valves, and other components. A device which performs the opposite function (converting DC to AC) is known as an inverter .

6. RELAY

A relay is an electrically operated switch. Many relays use an electromagnet to operate a switching mechanism, but other operating principles are also used. Relays find applications where it is necessary to control a circuit by a low-power signal, or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits, repeating the signal coming in from one circuit and re- transmitting it to another. Relays found extensive use in telephone exchanges and early computers to perform logical operations. A type of relay that can handle the high power required to directly drive an electric motor is called a contactor. Solid- state relays control power circuits with no moving parts, instead using a semiconductor device to perform switching. Relays with calibrated operating characteristics and sometimes multiple operating coils are used to protect electrical circuits from overload or faults; in modern electric power systems these functions are performed by digital instruments still called "protection relays".

7. LCD DISPLAY

Liquid crystal displays (LCDs) have materials which combine the properties of both liquids and crystals. Rather than having a melting point, they have a temperature range within which the molecules are almost as mobile as they would be in a liquid, but are grouped together in an ordered form similar to a crystal.

An LCD consists of two glass panels, with the liquid crystal material sand witched in between them. The inner surface of the glass plates are coated with transparent electrodes which define the character, symbols or patterns to be displayed polymeric layers are present in between the electrodes and the liquid crystal, which makes the liquid crystal molecules to maintain a defined orientation angle.

8. BATTERY

Lithium has the highest specific energy of all but it has only become possible since mid1970's to manufacture practical batteries. Because lithium reacts violently with water, non-aqueous electrolytes must be used. Organic solvents such as acetonitrile and propylene carbonate, plus inorganic solvents such as thionyl chloride (SOCl2) are typical, with a compatible solute to provide conductivity. Many different materials such as sulfur di thionyl chloride, manganese dioxide, and carbon mono fluoride, are used for the active cathode material.

B. SOFTWARE

1. MP LAB

MPLAB IDE is an integrated development environment that provides development engineers with the flexibility to develop and debug firmware for various Microchip devices MPLAB IDE is a Windows-based Integrated Development Environment for the Microchip Technology Incorporated PIC microcontroller (MCU) and ds PIC digital signal controller (DSC) families. In the MPLAB IDE, Create source code using the built-in editor. Assemble, compile and link source code using various language tools. An assembler, linker and librarian come with MPLAB IDE. C compilers are available from Microchip and other third party vendors. Debug the executable logic by watching program flow with a simulator, such as MPLAB SIM, or in real time with an emulator, such as MPLAB ICE.

2. MPLAB SIMULATOR

MPLAB SIM is a discrete-event simulator for the PIC microcontroller (MCU) families. It is integrated into MPLAB IDE integrated development environment. The MPLAB SIM debugging tool is designed to model operation of Microchip Technology's

3. IC PRO

The PRO MATE II is a Microchip microcontroller device programmer. Through interchangeable programming socket modules, PRO MATE II enables you to quickly and easily program the entire line of Microchip PIC micro microcontroller devices and many of the Microchip memory parts.PRO MATE II may be used with MPLAB IDE running under supported Windows OS's (see Read me for PRO MATE II.txt for support list), with the command-line controller PROCMD or as a stand-alone programmer

4. COMPILER-HIGH TECH C

A program written in the high level language called C; which will be converted into PIC micro MCU machine code by a compiler. Machine code is suitable for use by a PIC micro MCU or Microchip development system product like MPLAB IDE.

5. PIC START PLUS PROGRAMMER

The PIC start plus development system from microchip technology provides PIC microcontrollers to assist users in debugging software for these devices the product development engineer with a highly flexible low cost microcontroller design tool set for all microchip PIC micro devices. The pic start plus development system includes PIC start plus development programmer and MPLAB IDE. The PIC start plus programmer gives the product developer ability to program user software in to any of the supported microcontrollers. The PIC start plus software running under MPLAB provides for full interactive control over the programmer. The energy signals passed through the battery via rectifier. A rectifier is an electrical device that converts alternating current (AC), current that periodically reverses direction, to direct current (DC), current that flows in only one direction, a process known as rectification. Rectifiers have many uses including as components of power supplies and as detectors of radio signals. Rectifiers may be made of solid state diodes, vacuum tube diodes, mercury arc valves, and other components. Here relay switch operation function is ON/OFF purpose. Because we maintained the accurate 6V on battery, in case low voltage is defining means automatically switch ON the relay. This process works on with help of PIC microcontroller. Driver circuit is used to activate the relay switch. Finally voltage MMT measure the battery voltage and display throughout the LCD.

IV. CONCLUSION

In this paper, we have studied the technology of wireless power transfer to the pacemaker with inductive coupling. The proposed system based on PIC microcontroller. It is more compact, user friendly and less complex, which can be readily used in order to perform several tedious and repetitive tasks. The proposed system transfer 0.48milliWatt power in transmitter side and receives 0.06milliWatt in receiver side. Due to the probability of high technology (PIC microcontroller) used this "WIRELESS POWER TRANSFER SYSTEM TO RECHARGE THE BATTERY OF AN IMPLANTABLE CARDIAC PACEMAKER" is partially software controlled with complete hardware circuit.

V. REFERENCES

[1] Farid Jolani, Jeetkumar Mehta, Yiqiang Yu, and Zhizhang (David) Chen" Design of wireless power transfer systems using magnetic resonance coupling for implantable medical devices" Progress In Electromagnetics Research Letters, Vol. 40, 141–151, 2013.

[2] Ping Si, Member, Aiguo Patrick Hu, Senior Member, Simon Malpas, and David Budgett" A frequency control method for regulating wireless power to implantable devices" IEEE transactions on biomedical circuits and systems, vol. 2, no. 1, march 2008.

[3] Ravi Jon, Charlie Eapen, A.Ashhok, Nishita Sahoo, Anil Kumar "Performance analysis of wireless power transfer to the implantable drug delivery system using helical antenna with inductive coupling" International Journal of Engineering and Advanced Technology (IJEAT) Volume-1, Issue-5, June 2012 .