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# Designing Efficient Inductive Coupling Based Wireless Power Charging System for Bio-Medical Instrument

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## Abstract

Wireless power transfer system is an emerging that is useful to recharge the battery with wireless for various portable and biomedical implant devices, battery-free sensors, passive RF identification, near-field communications, and many others in the near-field regions. WPT is a fundamental enabling technology that eliminates wired power connections. It is a very research area that has recently become applicable to implantable medical devices. Biomedical implanted devices are becoming popular in health and medical applications in a wide range of areas, such as cardiac pacemakers, retinal prosthesis, cochlear implants, defibrillators, smart orthopedic implants, artificial hearts, etc. The traditional approach of supplying power to these devices is implantable batteries, biofuel cells, and percutaneous links. However, any battery has limited energy storage and life span similarly bio-fuel cell has low output power and percutaneous links are susceptible to infection and reliability problems. Currently, most commercial implanted devices utilize high-volume, non-rechargeable batteries. These batteries inevitably need to be replaced at the end of their life span by costly surgery. In addition, the bulky size of the batteries due to high energy requirements becomes an obstacle in the design of compact implantable devices.

**Keywords:** Coupling coefficient magnetic resonant coupling Passive shield power transfer efficiency

## INTRODUCTION

Clinical disciplines involving the cardiovascular, respiratory, gastrointestinal, and urological systems typically require the measurement of physiological pressures as an aid to medical diagnosis and monitoring. Besides blood pressure, many physiological pressures are measured invasively with catheters or similar devices, which tether the patient to cumbersome external equipment and present a risk of infection. Urodynamics is one of the most common urological point-of-care techniques but can be problematic in chronic applications such as neurostimulation in bladder rehabilitation because at present it requires catheterization. Cather-based urodynamics, used to diagnose urinary incontinence, is considered unreliable because it can be difficult to accurately reproduce symptomatic leakage in a clinical setting some urologists instead diagnose and treat incontinence based upon on the patient reporting of symptoms. The long-term physiological confirmation of patient complaints in an ambulatory environment cannot presently be achieved but would lead to more precise diagnoses and treatments with higher success rates.

## PROPOSED SYSTEM

Our proposed concept is to implement an automatic electric application charging station wireless power transfer (WPT) [1]. Our modern electric application consists of a power sensor to analyze the amount of power EA has and if the battery power is low it will point out to charge in the nearest WPT station. The Automatic WPT station was implemented. Finally, the power is transferred wirelessly to the Electric vehicle using the WPT technique.

### Transformer

The potential transformer will step down the power supply voltage (0-230V) to (0-6V) level. Then the potential transformer of secondary will be connected to the precision rectifier, which is constructed with the help of op-amp. The advantages of using a precision rectifier are it will give peak voltage output as DC, rest of the circuits will give only RMS output.

#### Bridge rectifier

When four diodes are connected like in the figure, the circuit is called a bridge rectifier. The input to the circuit is applied opposite to the corners of the network, and the output is taken as the remaining two corners.

Let us assume as the transformer is working properly and there is an positive potential, at point A and a negative potential at point B. The positive potential at point A will be forwarded bias D3and reverse bias D4.

The negative potential at point B will forwarded bias D1 and reverse D2. At this time D3 and D1 are forwarded bias and will allow flow current to pass through them; D4 and D2 are reversed bias and will block current flow.

### IC voltage regulators

Voltage regulators comprise a classes of widely used IC. Regulator ICs contain the circuitry for reference source, comparator amplifier, control device, and overload protection in a single IC. IC units provide regulation with either a fixed positive voltage, a fixed negative voltage, or with adjustably set voltage. The regulators can be selected with an operation with load currents from hundreds of milliamperes to tens of amperes, corresponding as a power ratings from milliwatts to tens of watts.

## BLOCK DIAGRAM

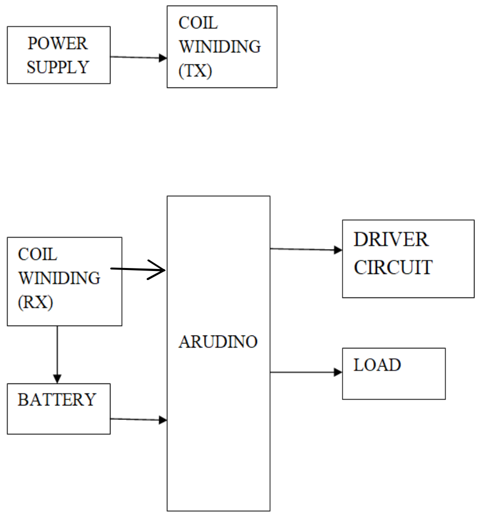



**Figure 1: Block diagram**

## EXISTING SYSTEM

One of the major issues in the existing power system is the losses occurring in the transmission and allocation of energy to the end-users. Because the claim drastically increases daily, the power generation increases, and also the power loss can be increased. The percentage of loss with power during transmission and circulation is approximation as 26%. The primary reason for power loss during transmission and circulation may be the resistance of wires used for the grid. The efficiency of power transmission may be increased to a particular level by employing high-strength composite overhead conductors and underground cables that use warm superconductors. But, the transmission is incompetent. The EVs cannot get ready immediately if they have no energy. To overcome this, the owner has to find any possible opportunity to plug in and charge the battery. The charging cables may cause tripping hazards. Leakage from cracked old cable, in particular in cold zones, can provide additional hazardous conditions to the owner and it produces some back EMF during transmission.

## POWER SUPPLY

The ac voltage, typically 220V RMS, is connected with transformer, which steps as an ac voltage down to the level of the desired dc output. A diode rectifier than provides a full-wave rectified voltage that is initially filtered as a  capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation. A regulator circuit removes with the ripples and also remains the same value of dc even if the input as an dc voltage varies, or the load connected to the output dc voltage changes. This voltage regulation as an usually obtained using one of the popular voltage regulator IC units.

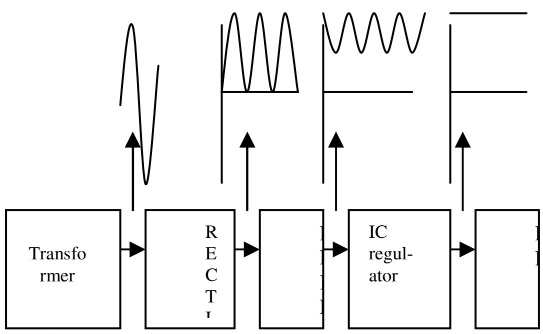



**Figure 2: Power Supply**

## WORKING PRINCIPLE

### Transformer

The potential transformer will be as a step down the power supply voltage (0-230V) to (0-6V) level. Then the secondary of  potential transformer will be connected as a the precision rectifier, which is constructed with help of an op-amp. The advantages of using a rectifier as a precision are it will give peak voltage output as DC, reset of the circuits will give RMS output.

**Bridge rectifier**

When four diodes are connected as shown as figure, the circuit is called as a bridge rectifier. The input in the circuit is applied to the opposite diagonallycorners of the network, and the output is taken from remaining two corners.

Let us assume that the transformer is working properly and there as a positive potential, at point A and a negative potential at point B. the positive potential at point A will forward biased D3 and reverse biased D4.

The negative potential at point B will forward bias D1 and reverse D2. At this time D3 and D1 are forward biased and will allow current flow to pass through them; D4 and D2 are reverse biased and will block current flow.

The path for current flows asthe from point B through D1, up through with RL, through D3, through the secondary of the transformer back to as point B. this path is indicated by the solid arrows.

One-half cycle later with the polarity across the secondary of the transformer reverse, forwarded biasing D2 and D4 and reversed biasing D1 and D3. The current flow will be from point A through to D4, up through RL, through D2, through with secondary of T1, and back to point A. This path is indicated by the broken arrows. Waveforms as (3) and (4) can be observed as D2 and D4. The current flow through RL is as always in the same direction. In flowing through RL this current develops as a voltage corresponding to that shown waveform (5). Since the current flows as the the load (RL) during both half cycles as an applied voltage, this bridge rectifier as a full-wave rectifier.

One of the advantages of a bridge rectified over an conventional full-wave of rectifier is that with a given transformer of the bridge rectifier produces a voltage output which is nearly twice that of the conventional full-wave circuit. This may be shown by assigning values to some of the components shown in views A and B. Assuming as the same transformer is used as the both circuits. The peak voltage developed as the points X and y are 1000 volts in both circuits. In the conventional of the full-wave circuit shown—in view A, the peak voltage of the center tap to either X or Y is 500 volts. Since only one the diode can conduct at any instant of the maximum voltage that can be rectified at any instant is 500 volts.

The maximum voltage that appears across the load resistor is nearly but never exceeds500 v0lts, as a result of the small voltage drop across the diode. In the bridge rectifier shown in view B, the maximum voltage that can be rectified is the full secondary voltage, which is 1000 volts. Therefore, the peak of the output voltage across as the load resistor is nearly 1000 volts. With the both circuits using as the same transformer, the bridge rectified of circuit produces as a higher output voltage than the conventional the full-wave rectifier circuit.

**IC voltage regulators**

Voltage regulators comprises as an class of widely used ICs. Regulator IC cotains as the circuitry for reference source, comparator of the amplifier, control device, and overload protection as in a single IC. IC units as provide regulations of the a fixed positive voltage, a fixed as the negative voltage, or as an adjustably set voltage. The regulators can be selected with the operation of an load currents from hundreds with a milliamperes to tens of amperes, corresponding to as an power ratings from milliwatts to tens of watts.

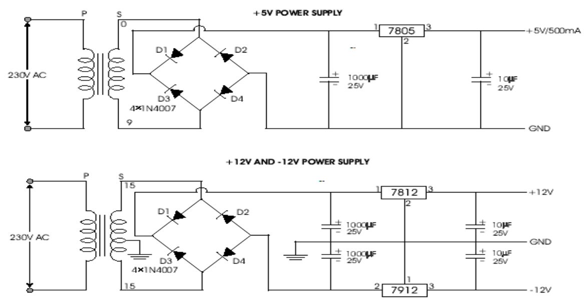



**Figure 3: Circuit Diagram of Power Supply**

A fixed three-terminal dimensional voltage regulator has an unregulated as dc input voltage, Vi, applied to input terminal, a regulated dc output voltage, Vo, from as second terminal, with the terminal connected to ground.

The series 78 regulators provide the fixed positive regulated voltages as 5 to 24 volts. Similarly, the series with 79 regulators as to provide fixed negative regulated voltages from 5 to 24 volts.

**Hardware Requirement**

- Coil Winding
- Battery

**Software Requirement**

- Arduino

## ARDUINO UNO CONTROLLER

The Arduino Uno is a microcontroller board based at the ATmega328. It has an 14 digital input/output pins (for which six can be used as an PWM outputs), six analog inputs, a 16 MHz of crystal oscillator, a USB connection, as a power jack, an ICSP header, and a reset button. It contains everything as to be needed support the microcontroller; simply connect it as a computer with the help of USB cable or power it with an AC-to-DC adapter or to battery to get started. The Arduino Uno differs from every preceding boards because it does not use as the FTDI USB-to-serial driver chip. Instead, it features the ATmega8U2 programmed as a USB-to-serial converter. Revision 2 of the Arduino Uno board has a resistor pulling the 8U2 HWB line to the ground, making it easier to put into DFU mode.

"Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases.Uno board is the first in a best series of USB Arduino boards, and the model for the reference Arduino platform; for an extensive the list of current, past, or outdated boards see the Arduino index of boards.

This is the Arduino Uno R3. In addition to all these the features of previous board, the Uno now with the uses an ATmega16U2 instead of the 8U2 found on those Uno (or the FTDI). This allows for faster transfer rates and more memory. No drivers are needed for Linux or Mac (inf file for Windows is needed and included in the Arduino IDE), and the ability to have the Uno show up as a keyboard, mouse, joystick, etc.

In addition, there are two new pins placed near the RESET pin. Once is the IOREF which allow as the shields to adapt with the voltage provided by the board. The other is not connected with and is reserved for future purposes. The Uno R3 works with all existing shields but can adapt to new shields which use these additional pins.

Arduino is an open-source,with the help of an prototyping platform and its simplicity makes it is in ideal for hobbyists to use in arduino as well as professionals. The Arduino Uno has upto 14 digital input/output pins (of which total 14 exactly 6 can be used as an PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, as power jack, and ICSP header, and as a reset button. It contains everything which is needed to support with the microcontroller; simply connect it with a computer with a USB cable or power as with an AC-to-DC adapter or battery is to get started.

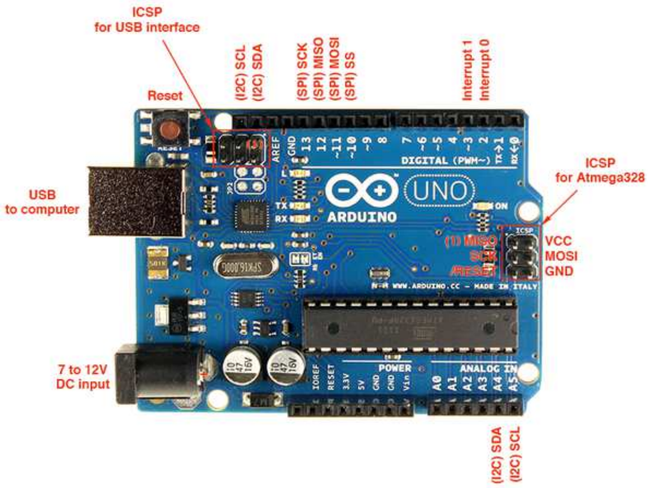



**Figure 4: Diagram of Arduino**

The Arduino Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega8U2 microcontroller chip programmed as a USB-to-serial converter.

"Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Arduino Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards and the reference model for the Arduino platform.

## PROGRAMMING

The Arduino Uno can being programmed with the (IDE). Select "Arduino/Genuino Uno from the Tools > Board menu (according to the microcontroller on your board). For details, see the reference and tutorials. The ATmega328 with the Arduino Uno comes pre-programmed with the need of boot loader that allows you to upload as new code to it without the use of an external hardware programmer. You can be also with bypass the boot loader and programmer the microcontroller through the ICSP (In□Circuit with Serial Programming) header using Arduino ISP or as similar; see these instructions for the details.

The ATmega16U2 (or 8U2 in leve1 and rev2 boards) firmware with the source code is available in Arduino repository. The ATmega16U2/8U2 is loaded with a DFU boot loader, which can be activated by: On Rev1 boards: connecting the solder jumper on the back of the board (near the map of· Italy) and then rising the 8U2. On Rev2 or later boards: there is an resistor that used to pulls the 8U2/16U2 HWB line to·be grounded and making it easier to put into DFU mode. You can then use Atmel's FLIP software (Windows) or with the DFU programmer (Mac OS X and Linux) to a load new firmware. Or you can use with ISP header with an external programmer (overwriting an DFU boot loader)with the need of boot loader that allows you to upload as new code to it without the use of an external hardware programmer

## BATTERY

An electric battery is a device consisting of two or more electrochemical cells that convert stored chemicalenergy into electrical energy. Each cell has a positive terminal, or cathode, and a negative terminal, or anode. The terminal marked as a positive is at a higher electrical energy of potential than is terminal marked negative. The terminal is marked as an negative is the source of electrons that when be connected with external circuit will flow and delivery of energy to an external device. When a battery is connected to an external circuit, electrolytes can move as ions within, allowing the chemical reactions to be completed at the separate terminals and so deliver energy to the external circuit. It is the movement of those ions within the battery that allows current to flow out of the battery to perform work.[1] Although the term battery technically means a device with multiple cells and single cells are known as batteries.

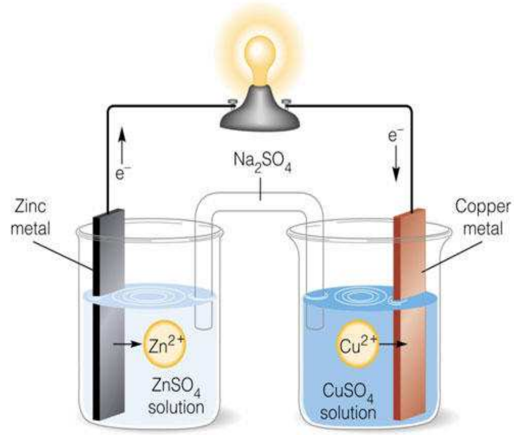



**Figure 5: Diagram of Battery**

The battery is used to store the electrical energy in the form of DC (Direct current). The energy generated by solar panel is stored in the battery which is used to glow the light during nighttime. Low maintenance of the tubular with lead-acid type battery is normally as street lights. The battery is housed inside a battery box, which is fixed onto the pole at a suitable height from the ground for easy maintenance and replacement. Here, we are using 350 AH and 100 AH batteries.

## POWER

AC-DC adapter (wall□wart) or battery. The adapter can also be connected with the plugging a 2.1mm center of the positive plug into the board's power jack. Leads battery can be inserted to GND and Vin pin headers with the POWER connector. The board can operate on an external supply from 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may become unstable. If we use more than 12V, the voltage regulated with overheat and the damage of board.

The input voltage with Arduino/Genuino board when it's using in an external power source (as opposed with as an 5 volts from USB connections or as other regulated power source). You can be use as supply voltage through with the pin, or, if supplying voltage via the power jack, access with through this pin.This pin with outputs a regulated 5V with the regulator on the board. The board can be supplied with power either from the DC power jack (7 □ 12V), the USB connector (5V), or the VIN pin of the board (7□12V). Supplying voltage through the 5V or 3.3V pins bypasses the regulator, and can be damaged your board. We don't advise it. 3V3.The maximum current draw is 50 mA. GND. Ground pins. MORE. This pin are the Arduino/Genuino board provides with voltage reference with which as microcontroller operates. The properly configured shield can be read the IOREF pin voltage and select as the appropriate power source or enable voltage translators with the outputs to work as the 5V or 3.3V.

## INPUT AND OUTPUT

Serial: 0 (RX) and 1 (TX). Used with the receive (RX) and transmit (TX) TTL serial data. These are the pins connected with the corresponding pins of the ATmega8U2 USB□to□TTL with an Serial chip.

External Interrupts 2 and 3. These pins will be configured to a low value, a rising or falling edge, or an changes in value. See the attach Interrupt() function for details.

PWM: 3, 5, 6, 9, 10, and 11. Provide 8□bit PWM output with the analogWrite() function.

LED: 13. There is an built with LED driven by an digital pin of 13. When the pin is on the HIGH value, the LED is on, when the pin is on the LOW, it's off.

TWI: A4 or SDA with pin and A5 or SCL with pin. Support TWI with communicates using the Wire library.

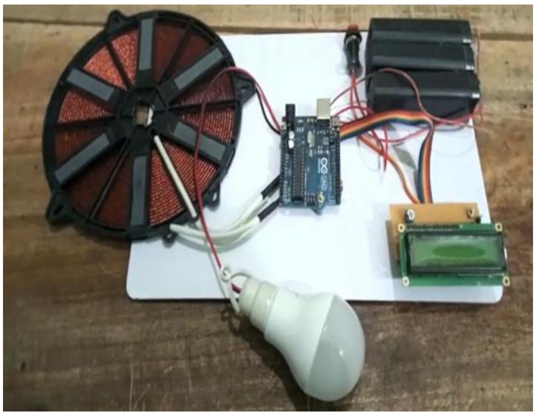
The Uno has the 6 analog inputs, labeled with A0 through A5, each of the which provides an 10 bits of resolution (i.e. 1024 different values). By default, there is a measure from ground to 5 volts, though is it possible to change with the upper end of their range using with the AREF pin and the analog Reference() function. There are a couple of an other pins on the board:

AREF. Reference voltage for the analog inputs. Used with analog Reference().

Reset. Bring this is an line LOW to reset with the microcontroller. Typically used to add a reset button to shields that block the one on the board.

## RESULT AND DISCUSSION

The main purpose of a wireless power transfer system is to send adequate power to charge the implant's battery at a better efficiency. Coil and shield material plays a key role in achieving higher WPT efficiency. Different coil and shield materials, as well as various test cases, are employed to explore the WPT performance (Table S3 and Table 1). It is found that the use of high conductivity coil material and high permeability shield material improves WPT performance. WPT performance at 800 kHz is quite low in test case #3, due to the presence of pacemaker casing, low permeability polyurethane, and low conductive coil material (Titanium). As a result, the frequency of 6.78 MHz is used to improve WPT performance by retaining the polyurethane and titanium biomaterial for biomedical applications. The proposed WPT system is compared with previous work comprising various coil and shield materials, number of turns geometrical shape, frequency, topology, efficiency, and distance for biomedical application.



In the proposed system, the WPT efficiency at 800 kHz and 6.78 MHz is examined using a biocompatible low conductivity titanium coil and a low permeability polyurethane shield material. Previous researchers have used a high conductivity coil and high permeability shield material (Non-biodegradable materials), as well as frequencies higher than 6.78 MHz, to improve WPT performance, but this study employs biocompatible materials and examines WPT efficiency at 6.78 MHz.

## CONCLUSION

A passive shielding method using various shield materials has been used to minimize EMF noise generated around the WPT coils. High conductivity coils and high permeability shield materials are better solutions for improving WPT efficiency in biomedical applications. Several test cases of WPT coils at two different frequencies (800 kHz and 6.78 MHz) have been examined to recharge the implantable batteries. It is found that WPT efficiency at 6.78 MHz is higher than at 800 kHz. WPT efficiency by simulation method at 6.78 MHz for test case #3 is 72.59%, whereas, for test case #5, the efficiency of 95.96% has been achieved over a 10 mm distance, which is in close approximation with the analytical method. The voltage gain observed in the lab is quite close to both an analytical and a simulation method at 800 kHz and 6.78 MHz frequencies. To improve WPT efficiency in the future, the proposed system would incorporate a high electrical conductivity coil and high magnetic permeability shield biocompatibility material for the secondary (implanted) coil.

### REFERENCES


1 T.Campi, S. Cruciani, F. Palandrani, V. De Santis, A. Hirata, M. Feliziani, " Wireless Power Transfer Charging System for AIMDs and Pacemakers," IEEE Transactions on Microwave Theory and Techniques, Vol. 64, No. 2, February 2016

2 T. Campi, S. Cruciani, V. De Santis, and M. Feliziani, "EMF Safety and Thermal Aspects in a Pacemaker Equipped With a Wireless Power Transfer System Working at Low Frequency," IEEE Transactions on Microwave Theory and Techniques, Vol. 64, No. 2, February 2016

3 X. Lu, P. Wang, D. Niyato, D. In Kim, Z. Han, "Wireless Charging Technologies: Fundamentals, Standards, and Network Applications," IEEE Communications Surveys and Tutorials,Novmber 2015.

4 A. Kumar RamRakhyani, S. Mirabbasi, and M. Chiao, "Design and Optimization of Resonance-Based Efficient Wireless Power Delivery Systems for Biomedical Implants," IEEE Transactions on Biomedical Circuits and Systems, vol. 5, no. 1, February 2011

5 M. Zargham and P. Glenn Gulak, "Maximum Achievable Efficiency in Near-Field Coupled Power-Transfer Systems," IEEE Transactions on Biomedical Circuits and Systems, vol. 6, no. 3, June 2012

6 L. Chen, Shuo Liu, Yong Chun Zhou, and Tie Jun Cui, "An Optimizable Circuit Structure for High-Efficiency Wireless Power Transfer," IEEE Transactions on Industrial Electronics, Vol. 60, No. 1, January 2013

7 K. Na, H.Jang, H. Ma, and F. Bien, "Tracking Optimal Efficiency of Magnetic Resonance Wireless Power Transfer System for BiomedicalCapsule Endoscopy," IEEE Transactions on Microwave Theory and Techniques, Vol. 63,No. 1, January 2015.