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Development of 30 Watt Solar Bag with Wireless Power Transmission Unit

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ABSTRACT
The development of 30 watt Solar bag with wireless power transmission unit using photo voltaic cells to charge tablets, mobile phones, smart phones, digital cameras and all types of batteries (Including 12 volt acid and dry cell for emergency situations) using in such kind of appliances. The phenomenon that we have implanted in our project to transmit wireless power is resonant coupling. The Battery backup of the solar bag would be around 2 hours with load estimation of around 30 watts. Our product is very user friendly as it allows us the power transmission in the range of 12 inches, whereas we have also implemented the overall logic by using PIC Microcontroller based model 16F877A to enhance its versatility.
Keywords: Photovoltaic, Wireless Power Transmission, Alternating Current, Direct Current, Rucksack Enhanced Portable Power System

I. INTRODUCTION

A Solar bag can be carried by anyone easily. It contains slim film solar cells and batteries. Solar panels are used to transfer daylight into electrical energy that can be reserve in batteries and this power can be utilize to charge transferable devices like tablets, mobile phones, smart phones, digital cameras, and mini batteries. The phenomenon that we have implanted in our project to transmit wireless power is resonant inductive coupling. The Battery backup of the solar bag is around 2 hours with load estimation of around 30 watts. Our product is very user friendly as it allows us the power transmission in the range of 8 inches, whereas we have also implemented the overall logic by using PIC Microcontroller. It has capacity to give power to electronic devices those are having rated power up to 30 Watt. It can also be utilized in Army soldiers deployed in gorilla war, mountain climbers, bike riders, engineers in project site. Our solar bag is divided into two main technologies which are

- Solar Energy
- Wireless Power Transmitting

1.1 Solar Energy

Solar energy is radiation of sun that arrives to earth. Solar cell and solar thermal/power plant are used to convert solar energy into electricity [1]. Sun is one the most efficient renewable source of energy that has 1.4 million km diameter. It produces about 3.8×10^{20} MW energy that radiates from space to earth [2].

1.2 Wireless power transmission (WPT)

The transfer of electric energy without any conductor from power source to any electric load is known as the wireless power transmission [3] The power is transferred at resonant frequency in order to increase its efficiency. Traditional methods of charging mobile devices are all wired. The chief advantage of using wired charging is that it is inexpensive. However, with the new technologies being developed, wireless charging will soon replace these traditional methods as an inexpensive and practical alternate method to recharge gadgets. WPT use is valuable if wire interconnection is problematic, risky, or impossible. Wireless charging is a convenient option for users with disabilities, as instead of manually connecting a power cable the device can be placed near to charging plate. The need to keep constant track of the amount of charge on all the portable devices to prevent overcharging or overheating can also be avoided. Also, with the passage of time the increment in the portable devices like as Mobil phones, laptops etc, it becomes difficult to take multiple charges, Wireless charging provides ultimate solution for that.

This paper provides a brief idea about how resonant inductive charging works, its advantages, limitations and different applications where it can be used.

1.2.1 Types of WPT:

WPT is broadly classified in two classes depending on the distance for which power is transferred.

1.2.2 Far field Wireless Power Transfer.

Far field scheme uses collimated beams of electromagnetic waves. These include:

- Microwave Power Transfer.
- Laser Power Transfer.

1.2.3 Microwave Power Transfer.

Microwaves are used to transfer power from one place to another without the use of wires. MPT is the most commonly proposed method for transferring energy to the surface of the Earth from solar power satellites or other in-orbit power sources. In 2008 efficiently 20 watt power was transmitted over 91 miles from Maui to Hawaii Island [4].

1.3 Solar Review:

Solar is one of the most efficient renewable energy sources. Any source of energy that is not derived from fossil fuels is known as solar energy in our project solar is utilize as a renewable source [5].

Solar energy is working on the phenomena to absorb the sunlight and as a result producing the current.

Working of Photovoltaic's (PV) needs following main characteristics.

- Light should be absorbed and creating exactions.
- Reverse charge carries should separate.

2.1 PV Cell Technologies:

The power of Photovoltaic usually depends upon energy following characteristics.

- PV energy conversion efficiency.
- Capital cost per Watt.

The efficiency of solar cell can be given as

$\eta = P_{out}/P_{impinging}$

Today in market more efficient and low cost solar cell has been developing.

2.2 Type of Solar Cell:

On the type of silicon material the solar cells are categorizes into two types:

- Single-Crystalline Silicon
- Poly Crystalline and Semi-Crystalline

2.2.1 Single-crystalline silicon:

Single crystalline silicon solar cell can be fabricated from silicon material and crucible can use for its purification such a cell can be use where space is not problem. The single crystal silicon is the widely available cell material, and has been the workhorse of the industry. In the most common method of producing this material, the silicon raw material is first method and purified in a crucible. Liquid silicon can be mix with seed crystal and drawn at steady a seed crystal is then placed in the liquid silicon and drawn at a slow constant rate [6].

2.2.2 Poly- Crystalline and Semi-Crystalline:

As compared to the single-crystalline this is more rapid and economical to manufacture thick crystalline cell for its manufacturing molten silicon can be used rather than seed crystal [7].

3.1 software modeling:

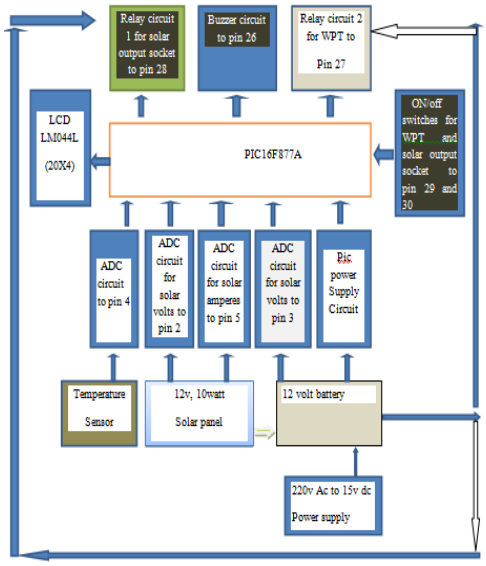


Fig no 1. Block Diagram of Project

MP lab 8.X was used to design code for the microcontroller PIC16F877A. MPLAB provided suitable environment for the development of embedded function on PIC. Microcontroller is manufactured by using the microchip technology.

3.2 Pickit-3:

Pickit-3 was used to burn code on microcontroller 16f877a.It is economical and user friendly, it can be control by using MPLAB IDE (v8.20 or greater) software on a Windows® platform.

3.3 Simulation Work

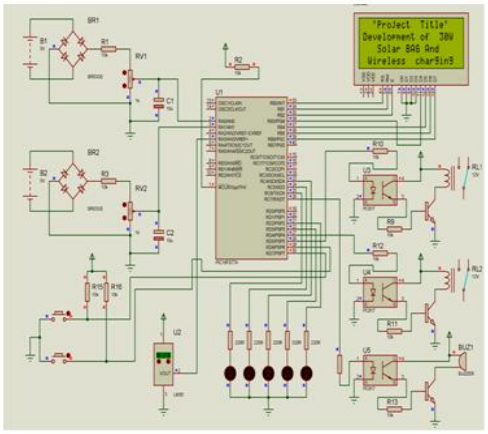


Fig no 2. Simulation Work Diagram

We have designed our entire hardware and simulate it by using Proteus **7** professional.

3.4 Hardware Modeling:

Major hardware parts used in project are as follows;

- Solar panel
- Microcontroller (PIC 18f452)
- LCD
- Transformer
- Voltage regulator
- Battery
- Transmitting and Receiving coil
- Load

3.5 Solar Panel key Features:

- 12V DC standard output
- Efficient low-light performance
- Power output tolerance (-5 /+10 %)
- Suitable for high snow and wind loads
- Anodized frames
- 36 Polycrystalline Cells

Fig no 3. Solar Panels

3.4.1 Microcontroller (PIC 18f452):

- 2 PWM 10-bit
- Self-Programming
- Slave port parallel
- 256 Bytes EEPROM memory
- 25mA sink/source per I/O
- Self-Programming

3.4.2 Voltage Regulator:

Electricity regulator manufactured to maintain the constant voltage regulator. LM7805 was used that is a member of 78xx series of fixed linear voltage regulator ICs. 7805 provides +5V regulated power supply.

We interface LM044Al to display solar amperes, solar voltage, solar power, battery voltage, and to show on/off of wireless circuit and 15 volt output socket**.**

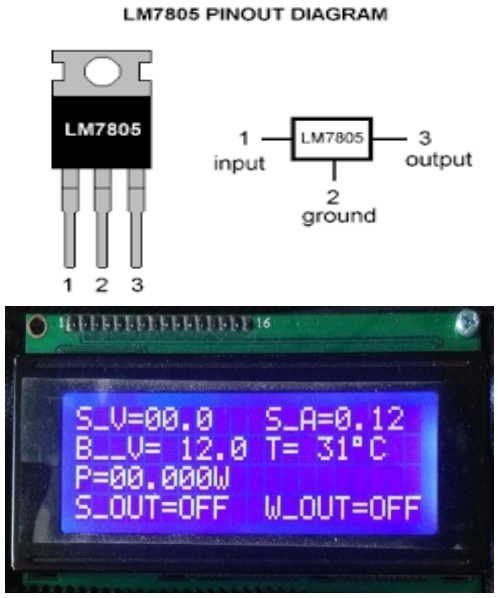


Fig no 4. LCD (20x4)

3.4.3 Relay Circuits:

It is Electrical switch that uses electromagnetic phenomenon for switching mechanically alongside others switching methods.

We use two Relay circuits in Hardware.

- Relay solar circuit to ON/OFF output socket.
- Relay circuit to ON/OFF the wireless transmitter.

Relay circuit which is shown below is used to on/off the output socket of 15 volt to charge the 12 volt appliances directly from solar which is attached to pin 28, shown in figure below.

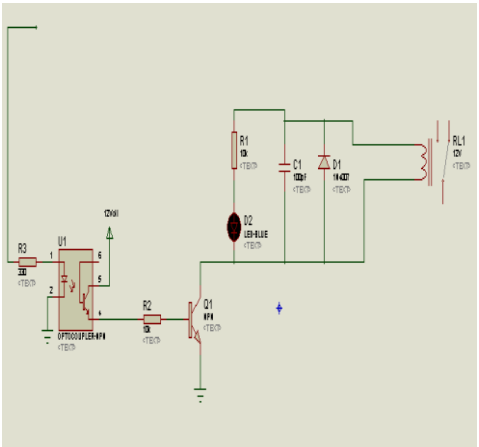


Fig no 5. Schematic of relay for solar to ON/OFF Output socket

3.4.4 Buzzer Circuit:

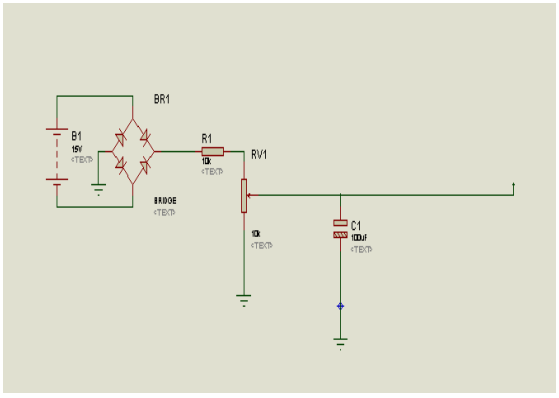


Figure no 6. Buzzer circuit schematic diagram

We use analogue to digital converter circuit for Buzzer. Buzzer is using to indicate the battery percentage. When battery percentage is less than 30 % it will on. This Circuit is attached to pin # 26 of PIC.

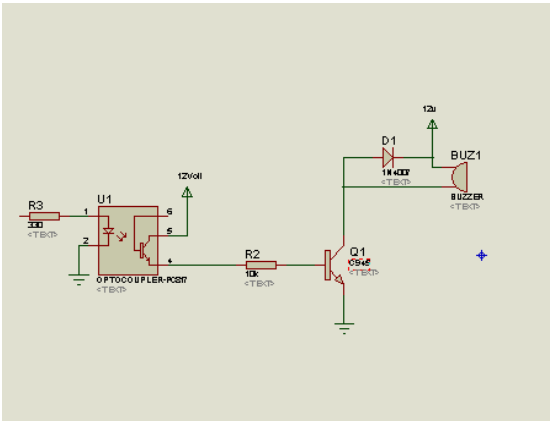


Figure no 7. Buzzer circuit

3.4.5 Circuit for Analog to Digital convertor:

Four analog digital converter circuits were used.

1) We designed analog to digital converter (ADC) circuit to measure the volts of 12 volt battery which is attached to Pin #3 of PIC.

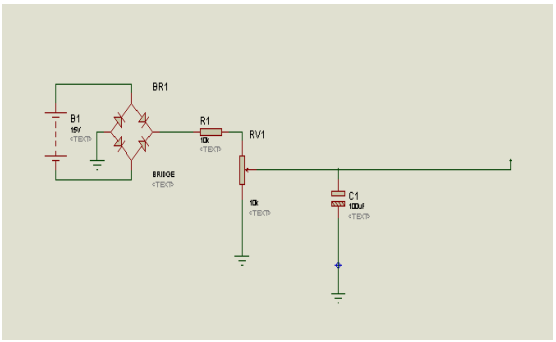


Figure no 8 Circuit for ADC to measure Battery Voltage

2) We designed the same circuit for analogue to digital converter (ADC) of solar volts. This is attached to pin#2 of PIC.

Circuit for ADC to measure Solar Volts

3) We designed circuit for analog to digital converter to measure the solar Amperes using LM 358.LM358 is an inverting amplifier, which is attached to Pin#5 of PIC.

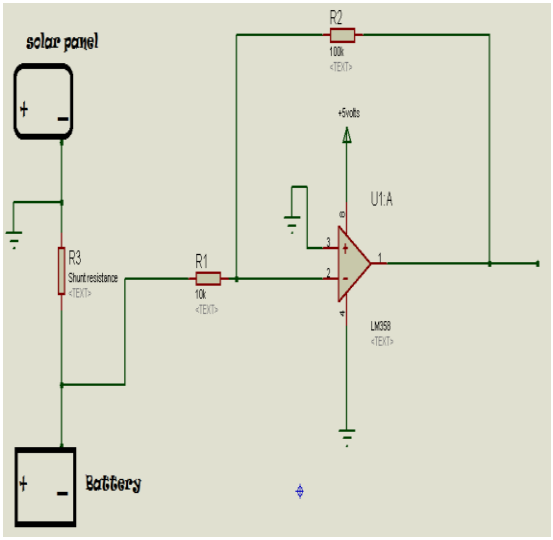


Figure 9 ADC circuit to measure solar amperes.

4) We designed circuit for analog to digital converter using LM 35 to sense the temperature, which is shown in the below figure. This circuit is attached to pin 4 of Pic.

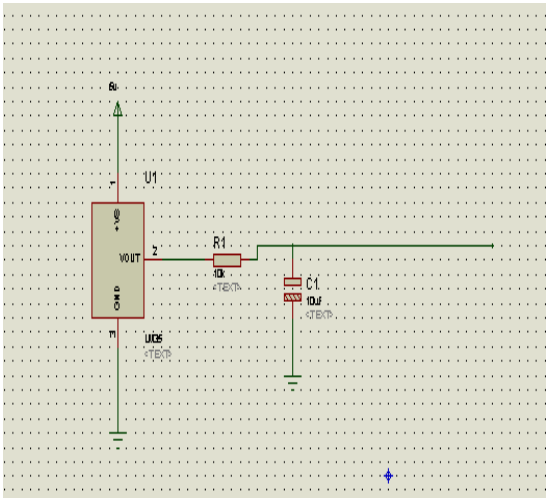


Figure no 10 LM35

ADC circuit to measure Temperature

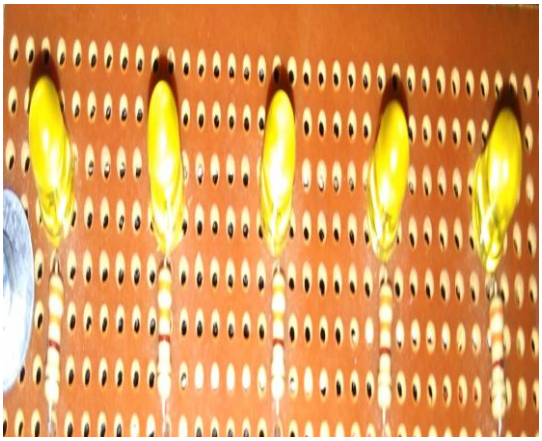
LM 35 was used which is an accurate IC temperature that use sensor whose output is directly proportional to the temperature.

3.4.6 NiMH Battery:

NiMH battery was used whose power is rated 1.2 volts/ cell, Its performance is much better than others all rechargeable batteries.

3.4.7 LED:

A light-emitting diode (LED) is a semiconductor light source. LEDs are used as indicator lamps in many devices and are increasingly used for other lighting.



LED

Figure no 11 of LED.

3.4.8 220 volt Ac to 15 volt dc charger:

220 volt Ac to 15 volt dc charger is used to charge the battery using LM7815. hot during the operation due to which a suitable heat sink is required.

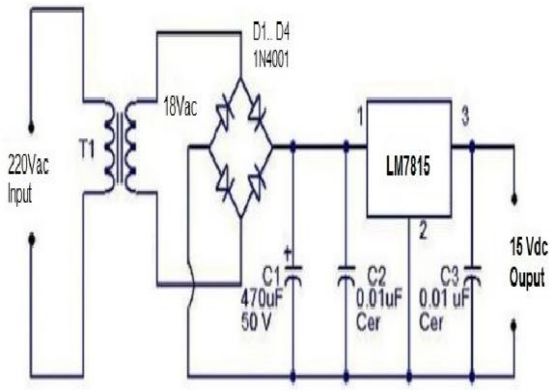


Figure no 12. Schematic of 220V AC to 15V DC charger

3.4.9 Power Supply of PIC 16F877A:

We designed power supply of pic16f877a using LM7805 as shown in the figure. We designed the same circuit to charge tablets and mobile phones by getting 5v dc output from 12v dc battery.

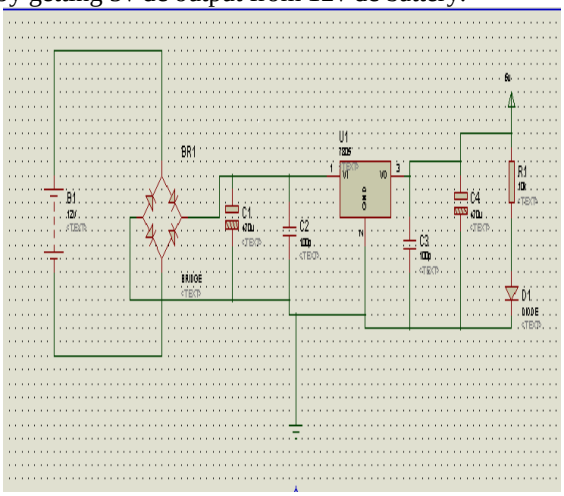


Figure no 13. Schematic of 12 V to 5V PIC 16F877A

Wireless Power Transmissions:

By the following block diagram, the overall functioning of wireless power transmitting circuit is clear

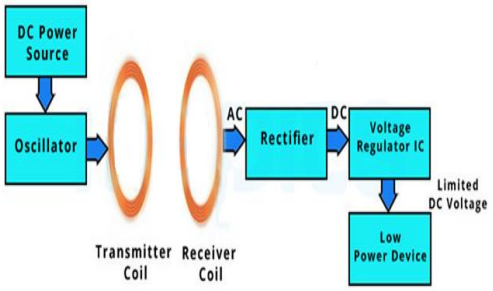


Figure no 14.

4.1 Working of Wireless Power Transmitter:

This project has two main sections first part is WPT and WPR sections. As it is clear from the above figure that transmitter part contains DC power source, oscillator that converts the DC supply into AC voltages and transmitted to transmitter coil. Owing to the high frequency Ac supply the transmitter coil will be energized and caused for the Ac magnetic field in coil.

4.1.2 DC power Source:

Step down transformer was used in order to bring the supply voltages according to our desired,

while rectifier converts the Dc Signal into Ac voltages.

4.1.3 Oscillator Circuit:

The oscillator circuit used in the Wireless power transmitter section is given below:

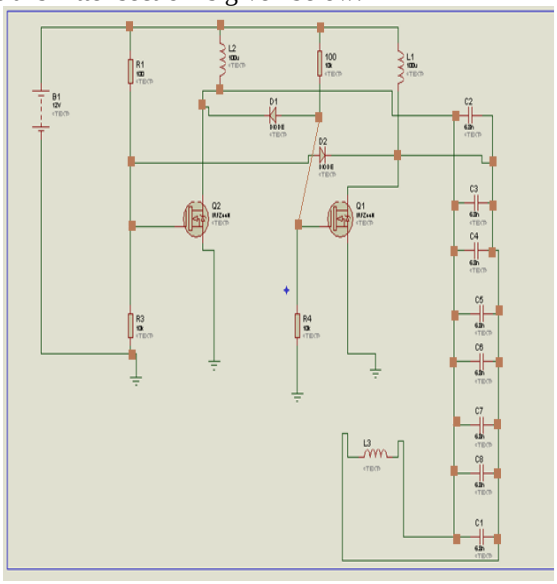


Figure no 15 Schematic of WPT Transmitter Section

4.1.4 Hardware of WPT Transmitter Section:

In the transmitter circuit section, we uses two N channel enhancement power MOSFET (IRz44n -Q1,Q2),Two chokes (L1 and L2) , capacitor C (works as a resonating capacitors), diode D1 and D2(provide cross coupled feedback) , the transmitter coil L(inductor), resistors R1,R2,R3 and R4 (works as a biasing network for Q1andQ2) etc. are used. Oscillator frequency can be found by the following formula.

F = ½ × □ × □ (LC)

Figure no 16 Transmitter hardware circuit.

Transmitter Coil:

6mm enameled wire (Magnet wire) was used for constructing the transmitter coils. Actually this enameled wire is a copper wire, which has a thin layer of insulation coatings on it. The formula for measuring the inductance is given below

L = 0.001 N2 (a/2)2 / (114a + 254l)

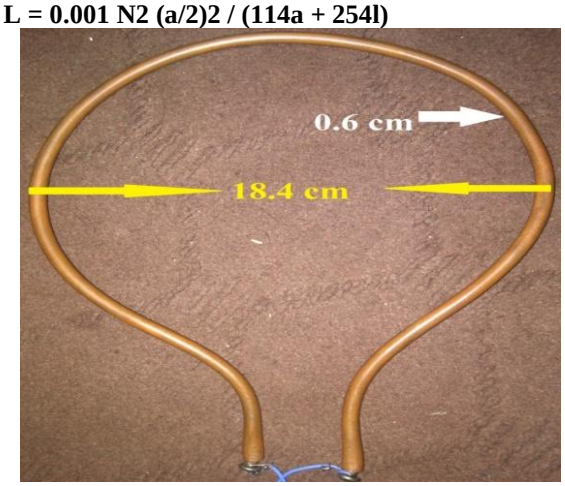


Figure no 17 WPT transmitter and receiver coil.

4.2 Working of Wireless Power Receiver Section:

Receiver part of WPR contains rectifier that converts Ac signal in to Dc signal and voltage regulator IC. AC current flowing from transmitter coil produces magnetic field that induced Ac voltages in the receiving coil. Rectifier converts the Ac voltages into Dc, while regulated IC provides the constant voltages to load for low power gadgets.

LM 7805 IC voltage regulator was used in this project.

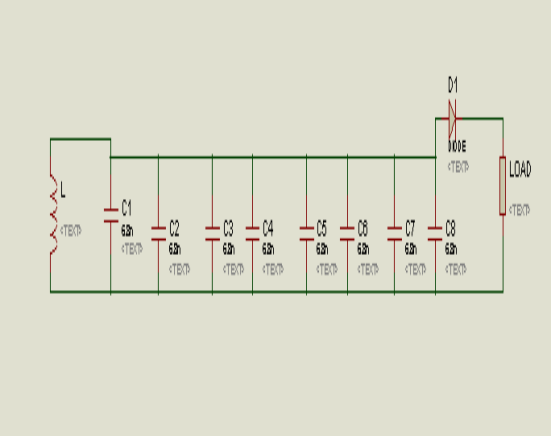


Figure no 18 Schematic of WPT Receiver Section

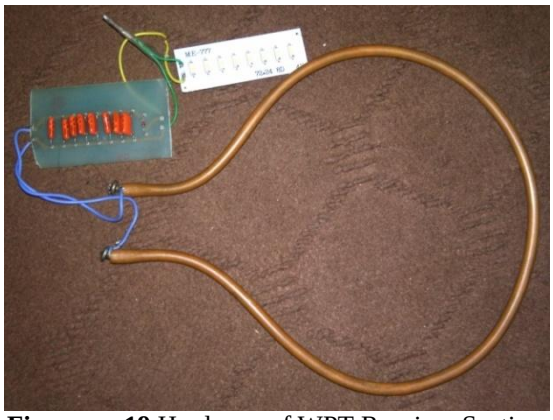


Figure no 19 Hardware of WPT Receiver Section

4.3 WPT Practical Results:

4.3.1 Table for power efficiency of WPT:

Ex. No.	Distance b/w transmitter And receiver in inches	Volts at Transmitter input	Volts at receiver Output	Current At transmitter input	Current at receiver Output	Power taking by transmitter	Power taking by receiver at output	Power efficiency
1	1 inch	12 V	4.0 V	150 mA	200mA	1.8 W	0.80 W	44.44%
2	2 inch	12 V	3.9 V	145 mA	177.5mA	1.75 W	0.69 W	39.42%
3	3 inch	12 V	3.8 V	140 mA	145mA	1.68 W	0.551 W	33%
4	4 inch	12 V	3.7 V	135 mA	80.7mA	1.62 W	0.3 W	18.51%
5	5 inch	12 V	3.6 V	130 mA	51.1mA	1.56 W	0.18 W	11.53%
6	6 inch	12 V	3.1 V	127 mA	34mA	1.524 W	0.106 W	6.9%
7	7 inch	12 V	3.0 V	124 mA	25.5mA	1.48 W	0.076 W	5.1%
8	8 inch	12 V	2.6 V	123 mA	18mA	1.47 W	0.046 W	3.1%

Figure no 20 Practical results of WPT

4.4.2 Table for output wave forms at receiver coil of WPT using digital oscilloscope:

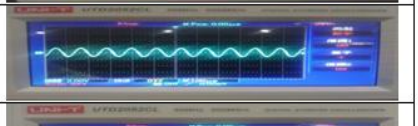
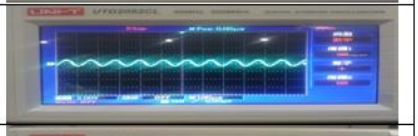
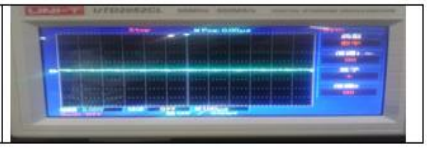
Experiment #	Distance b/w transmitter and Receiver	Output at receiver coil time/division=1 micro second volts/division=2 volts Frequency = 700 kHz approx.
1	1 inch	
2	3 inch	
3	5 inch	
4	7 inch	
5	9 inch	
6	12 inch	

Figure no 21 WPT results on Oscilloscope

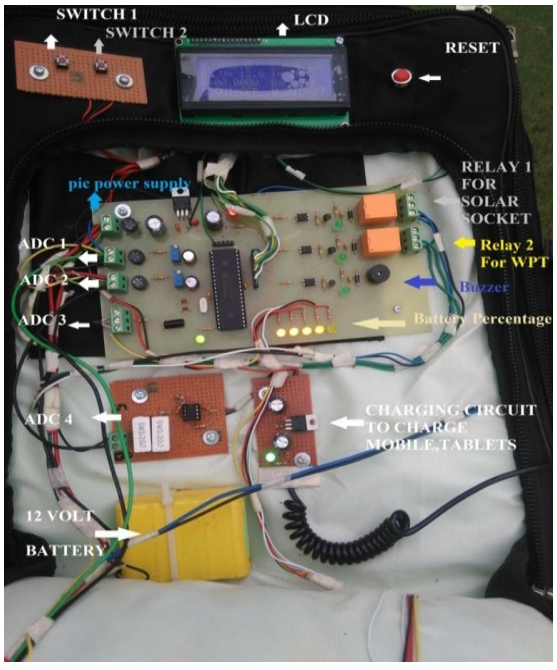
After modification and advancements our WPT unit could bring revolution in field of medical, Nano technology etc. We develop our wireless power transfer unit using resonant inductive coupling method and the power is transferring through the solid substances like bricks, plastic and even through water. Our WPT unit does not harm the living things. We tested this on fish and it does not harm the fish. Fish is behaving normally as shown in figure below:

4.4.3 Hardware working of solar bag:

We explain the working of our designed solar bag as a user guide in the table below:

Function #	Function	Working
1	Push Button	On/off the entire solar bag
2	Switch 1	On/off solar output socket to directly charge the all kind of batteries in emergency situations etc.
3	Switch 2	On/off WPT unit
4	Reset button	To reset the microcontroller
5	Multiple charging lead	To charge all kind of Cell phones and tablets

Internal Hardware Model



II. CONCLUSION

Renewable energy is not a new concept, nevertheless at an exponential growing population, the development and improvement of them are essential to sustain world power hunger. In 2050 the population expectation on earth is about 9 billion people, where approximately 5 billion will use mobile phones. The application of renewable energy at portable devices starts to plays a significant role at global energy saving. Solar chargers are simple, portable, and ready to use devices which can be used by anyone especially in remote areas. From this Wireless power transmission charger circuit using inductive coupling experiment, we conclude that wireless charging through inductive coupling is a better way for future energy transmission systems that is WiTricity (wireless electricity) because we can transfer power wirelessly to the equipments.

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