GE 401 – INNOVATIVE PRODUCT DESIGN AND DEVELOPMENT I

PROJECT REQUIREMENTS REPORT

TEAM 6

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A. INTRODUCTION

Product Requirements Report basically presents features that innoWi® wireless charger devices supposed to have and background technical information behind all the features. There are technical details as well as possible user-features given in order to explain what should a user expect and why.

B. WHAT THE PRODUCT IS EXPECTED TO DO

Once the main charging system is established, one can easily apply and produce many versions of it for appropriate corresponding places and situations. The main function of the innoWi® charging devices is to charge the cell phones without the need of any direct connection to the power source. With the developed technology in innoWi® labs, two certain form of wireless charging devices are depicted for different situations and needs. Even though they differ in shape and usage style, they use the same underlying technology.

1. innoWi® WIRELESS CHARGING BOX

This device consists of 10cm x 15cm x 8cm box that has a chargeable battery which is responsible for the power supply of the device. This box can easily be opened for the placement of the cell phone. To receive the wireless energy provided by the box, the user should place a special case in order to receive and use the energy. This device provides mobility while charging the mobile phone. It is also useful in public places like airports or shopping malls in the form of locked boxes why the user needs charging his/her device. In addition to these properties, the box also contains ultraviolet emitter in order to clean the cell phone from hazardous bacteria.

2. innoWi® WIRELESS CHARGING PLATE

This device consists of a plate that can be fixed under the table and provide a charging energy to the cell phone put on the table. The dimensions of the device will vary according to the size of the table. The thickness is 3cm. Hence, it will not be visible. To receive the wireless energy provided by the plate, the user should place a special case in order to receive and use the energy. This device provides high usefulness in public places like cafes or libraries. In addition we have spatial invariance. This means that we are independent from the place that we put the phone on the table.

Both of the devices saves the users from cable dependency and provides easiness on charging the phones in places which lack off plug. The technology can accomplish the following issues:

- It is expected to charge the mobile phone fully in 3 hours.
- It can provide wireless energy to charge the mobile phone from 10 cm.
- It can transmit a power of 1watt to the receiver.
- innoWi® guarantees free change for innoWi® wireless charging box and innoWi® wireless plate charger for 3 years.

Parameter	**Value**
Input Voltage	240VAC
Output Voltage	5VDC
Output Power	1-3 W
Physical Seperation	5-7 cm
Efficiency	60-65%
Physical Size	10cm x 15cm x 8cm
Communications	Infrared LED
Output Specification	The voltage level will mostly vary ±5%
Nominal Resonant Frequency	9.3 MHz

Table-1: High Level Parameters of Device

Intellectual property knowledge is held in specific technology areas:

- Power electronics
- Transfer and receiver pad magnetic
- Impedance matching
- Product design, materials and construction
- Rectifier design

C. WHAT ARE THE PHYSICAL CHARACTERISTICS

1. innoWi® WIRELESS CHARGING BOX

It is a 10cm x 15cm x 8cm prismatic box that has a removable cable and weights 500 grams. It as head piece that can be opened and closed for the placement of the cell phone. It can be found in two different colors as white or light blue. Its borders are smooth and it has innoWi® logo on the head piece.

2. innoWi® WIRELESS CHARGING PLATE

Its height and weight can be adjusted according to the table. The thickness is 3 cm.

3. RECEIVER CASE

The receiver case is used in order to receive and implement the wireless energy transmitted by the transmitter. It has 2 cm thick and weights 50 grams. It can be found in two different colors as white or light blue.

D. WHAT ARE THE INTERFACES

The main phenomena and challenge, in fact, behind the wireless charging system is to exhibit the best energy coupling between the inductors, which is derived by Faraday's law of induction. Additionally, the power supplement, allocation and formation into AC or DC signals are considered to be the second crucial part of technical development of the devices. Basically, Faraday law states that the changing magnetic field across a closed area induces voltage around the surface so that the induction current is generated for any resistive environment as depicted in Figure-1. In this device, both transmitting and receiving parts are attributed to have coupling inductors with high quality in order to achieve the minimized power loss between the stages. Hence, one can easily imply that the parameters shown in Figure-1, the diameters of inductors, radius of inductor cable, the aligning angle and distance between them are the most crucial variables for the gather of magnetic flux generated in transmitting coil. However, the gather of all the flux, which gives the most perfect mutual inductance in ideal world, does not imply that the power generated in power supply would be distributed to the phone with the most efficiency. For this purpose, there exist compensation networks for the perfectly matching of both sides: transmitter and receiver. However, since one needs sinusoidal varying voltage across the magnetic field generating inductor in order to observe the Faraday Effect, the obtained AC power should be converted to DC for the purpose of charging which requires rectification part of device.

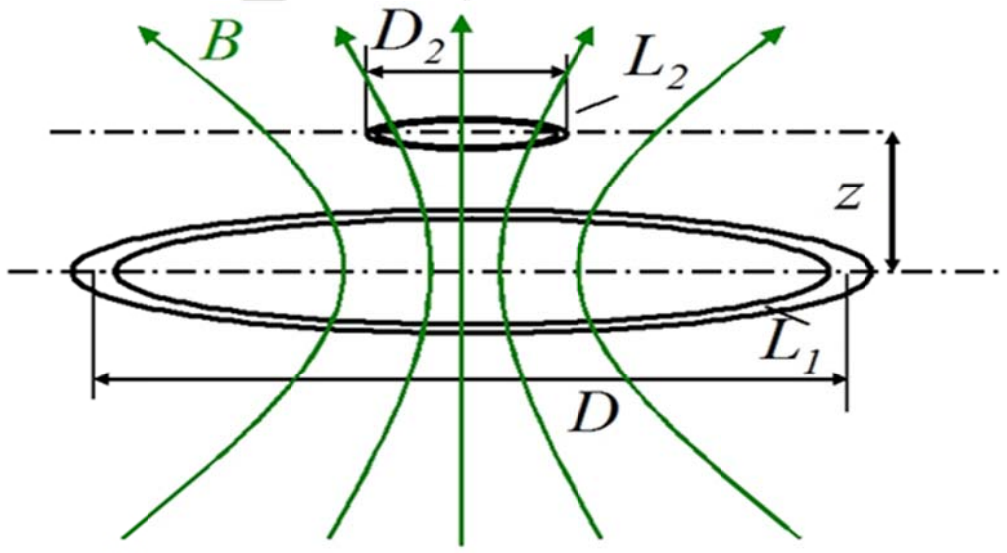

Figure-1: The coupling inductors and demonstration of distribution of magnetic fields

Additionally, since there must be a detection system for achievement of power radiation from transmitter in required time specified by user, the receiver part of device so shaped as cell phone case contains infrared LED that the dissipated light is detected by transmitter part and turns itself on.

The following chart summarizes the above process of power deliver:

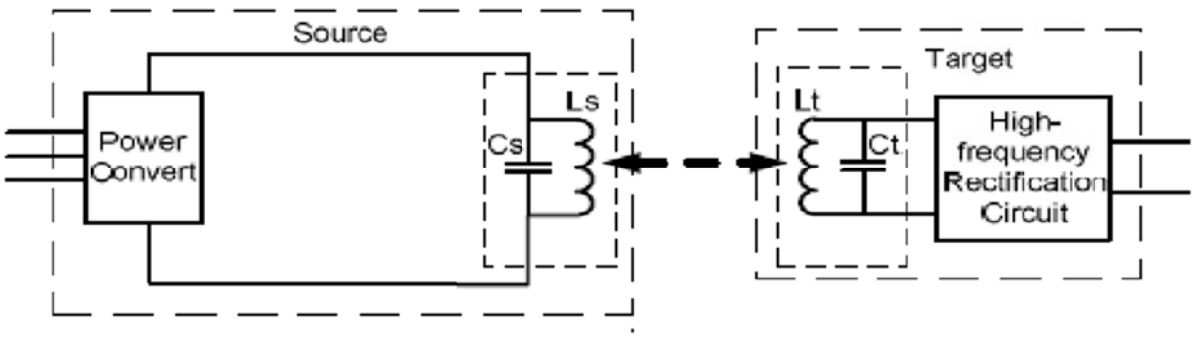

Figure-2: Flow Chart Diagram for the power delivery to load

Depending on the appropriate usage, the devices' designs are implemented to be the most maintaining and efficient so that the size of inductors for magnetic coupling is determined appropriately. Consider the case of the innoWi® wireless charger plate which promises to have power acquiring all over the table so that if the design would be like a huge transmitting inductor, but receiving inductors with smaller sizes, the most of magnetic flux is lost, hence the energy. In order to solve such a problem, we design periodically planted LC circuits in both directions all over the plate so that the power generated by one of them is completely received by the receiving coil.

Tuning the resonance at the MHz frequencies yields higher quality factors for inductances. However, greater frequency causes greater radiation loss in inductance coupling. Additionally, the corresponding wavelength for greater frequencies diminishes so that the distance determining near field effects of coupling power, which is non-radioactive and harmless, are observed is decreasing. Hence, there exists a certain trade-off between system's operating angular frequency and efficient near field effect excitations of magnetic coupling modes. For this purpose, the inductor values with radius of approximately 3 cm is arranged in such a way that the choice of value of capacitor tuning the both sides are in the order of 100 pFs, which are commercially available in non-magnetic capacitor chip formation.

The following circuit scheme demonstrates the coupling RLC circuits which are tuned to be almost perfectly matched in impedance:

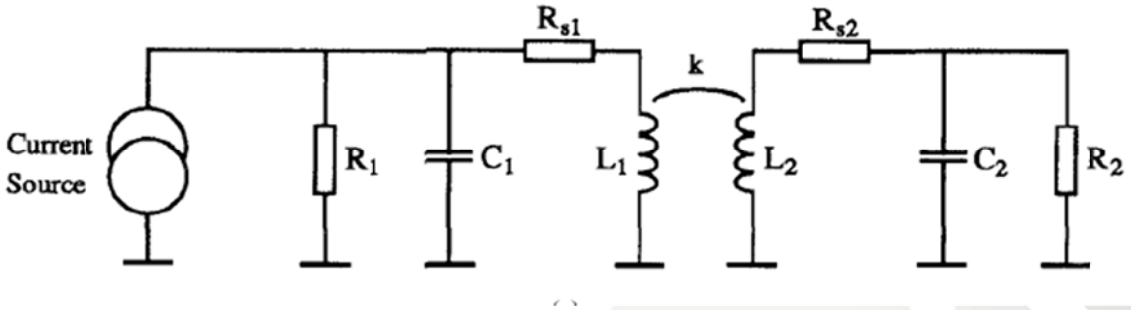

Figure-3: Theoretical demonstration of two coupled RLC circuits

In theory, the tuning frequency of both sides of parallel RLC circuits to be same with perfect arrangement of reflected impedance yields to greater impedance matching. However, in real-life, the existence of leakage inductance and radiation resistance cause the collapse of theory so that one should derivate another way of impedance matching in RLC circuits. For this purpose, the reflected impedance turns out to be imaginary so that the quasi-tuning of first circuit's capacitor is different than the nominal resonance frequency of simple LC circuit. As can be understood above, the resonance is pull into the higher frequencies for sharper and maintaining resonances yielding better quality of inductors and RLC circuits. However, in any case, the distance between coupling coils strongly alter the dissipated power.

E. CONCLUSION

In this report, all the features and technical details which are realizing these features were given. Moreover, we believe we clarified what our products will do and on top of which background working principles. After these report, as innoWi® we believe that we enlightened our path which is going through producing innoWi wireless charger.