Global Academy of Technology
Department Of Electronics and Communication Engineering

Report On

FIELD THEORY

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TITLE: WIRELESS ELECTRICITY

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ABSTRACT:

The transmission of electrical energy from source to load for a distance without any conducting wire or cables is called Wireless Power Transmission. The concept of wireless power transfer was realized by Nikola Tesla.

Wireless power transfer can make a remarkable change in the field of the electrical engineering which eliminates the use conventional copper cables and current carrying wires.

Day by day new technologies are making our life simpler. Wireless charging through resonance could be one of the next technologies that bring the future nearer. In this project it has been shown that it is possible to charge low power devices wirelessly via inductive coupling.

It minimizes the complexity that arises for the use of conventional wire system. In addition, the project also opens up new possibilities of wireless systems in our other daily life uses

CONTENTS:

INTRODUCTION:

Wireless power transfer (WPT), wireless power transmission, wireless energy transmission (WET), or electromagnetic power transfer is the transmission of electrical energy without wires as a physical link.

In a wireless power transmission system, a transmitter device, driven by electric power from a power source, generates a time-varying electromagnetic field, which transmits power across space to a receiver device, which extracts power from the field and supplies it to an electrical load.

The technology of wireless power transmission can eliminate the use of the wires and batteries, thus increasing the mobility, convenience, and safety of an electronic device for all users.

Wireless power transfer is useful to power electrical devices where interconnecting wires are inconvenient, hazardous, or are not possible.

PRINCIPLE OF OPERATION:

Inductive Coupling:

Inductive or Magnetic coupling works on the principle of electromagnetism. When a wire is proximity to a magnetic field, it generates a magnetic field in that wire. Transferring energy between wires through magnetic fields is inductive coupling. If a portion of the magnetic flux established by one circuit interlinks with the second circuit, then two circuits are coupled magnetically and the energy may be transferred from one circuit to another circuit.

This energy transfer is performed by the transfer of the magnetic field which is common to the both circuits. In electrical engineering, two conductors are referred to as mutual-inductively coupled or magnetically coupled when they are configured such that change in current flow through one wire induces a voltage across the end of the other wire through electromagnetic induction.

The amount of inductive coupling between two conductors is measured by their mutual inductance.

Power transfer efficiency of inductive coupling can be increased by increasing the number of turns in the coil, the strength of the current, the area of cross-section of the coil and the strength of the radial magnetic field. Magnetic fields decay quickly, making inductive coupling effective at a very short range.

Inductive Charging:

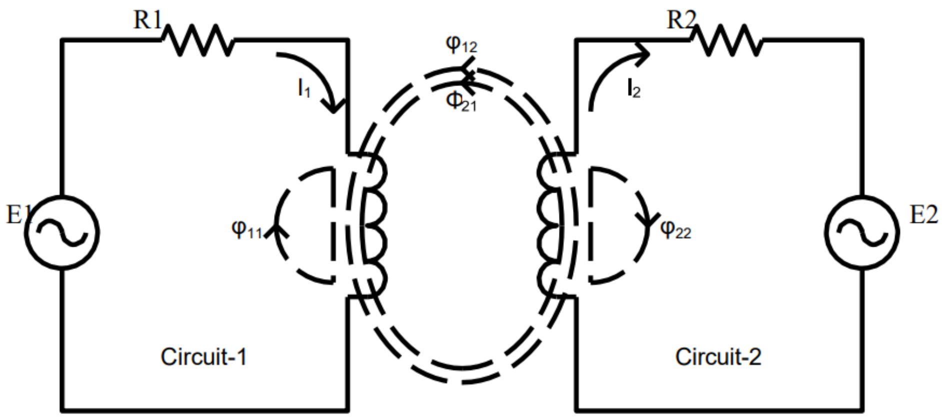
Inductive charging uses the electromagnetic field to transfer energy between two objects. A charging station sends energy through inductive coupling to an electrical device, which stores the energy in the batteries.

Because there is a small gap between the two coils, inductive charging is one kind of short distance wireless energy transfer.

Induction chargers typically use an induction coil to create an alternating electromagnetic field from within a charging base station, and a second induction coil in the portable device takes power from the electromagnetic field and converts it back into electrical current to charge the battery.

The two induction coils in proximity combine to form an electrical transformer. Greater distances can be achieved when the inductive charging system uses resonant inductive coupling.

CIRCUIT ANALOGY:



Inductive Coupling with Four Component Fluxes

LIST OF COMPONENTS:

1. RESISTOR

R = 470Ω , 5W

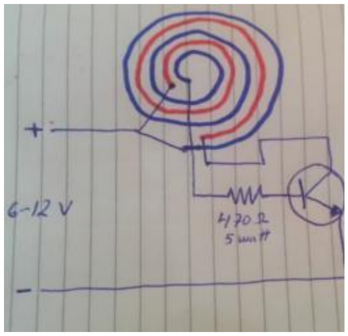
2. TRANSMITTER COIL AND RECIEVER COIL

•The electromagnetic field of one coil induces a voltage of the other coil by the principle of Faraday's 2nd law of induction.

3. POWER SUPPLY

•The main purpose of the battery is to provide the power to the detector / Circuit.

CIRCUIT DIAGRAM:



Finding the Length of the Spiral (TRANSMITTER COIL)

Before we can find the length of the spiral, we need to know its equation.

An Archimedean Spiral has general equation in **polar coordinates**:

$$r = a + b\theta,$$

where

r is the distance from the origin,
a is the start point of the spiral and
b affects the distance between each arm.
($2\pi b$ is the distance between each arm.)

NOTE:all calculation are taken in terms od centimetre.

- For the spirals we selected it to start after 1cm from the center , , since the curve starts at 1.

a= 1cm

- We selected a 9mm gauge wire so the distance between the two spirals will be 9mm. $2\pi b = 0.9$, giving us

$b = 1.8\pi$.

- So the formula for the first spiral is

$r = 1 + 1.8\,\pi\,\theta$

- We selected the spiral to be of 25 turns

T=(Turns)x2π

T=50 π

We'll use the formula for the Arc Length of a Curve in Polar Coordinates to find the length.

$$L = \int_{a}^{T} \sqrt{r^2 + \left(\frac{dr}{d\theta}\right)^2}\, d\theta$$

So

$\odot\ r = 1 + 1.8\pi\theta$.

$\odot\ r^2 = (1 + 1.8\pi\theta)^2$

$= 1 + 3.6\pi\theta + 3.24\pi^2\theta^2$.

$\odot\ \dfrac{dr}{d\theta} = \dfrac{d}{d\theta}\left[1 + 1.8\pi\theta\right]$.

$= 1.8\pi$

Now substituting in the equation

$$L = \int_a^T \sqrt{r^2 + \left(\frac{dr}{d\theta}\right)^2}\, d\theta .$$

$$= \int_1^{50\pi} \sqrt{1 + 3.6\pi\theta + 3.24\pi^2\theta^2 + (1.8\pi)^2}$$

$$= \int_1^{50\pi} \sqrt{(1 + 3.24\pi^2) + 3.6\pi\theta + 3.24\pi^2\theta^2}\, d\theta$$

$= 699.30$ cm.

≈ 700 cm ≈ 7 mtr

Hence the length of the wire should be 7meters.

Finding the Length of the RECIEVER COIL

We took the radius of the coil being 3cm,
Length of one turn=2xπx(3)=18.84cm.
For 150 turns=18.84x150=2826cm=282.6mt
Approximately we took a copper wire of 283 meters.

WORKING OF CIRCUIT

Working of transmitter circuit:

The transmitter module of our project is made up of a D.C. power source, a transistor (2N3904 npn), a load resistor (470Ω) and a transmitter coil.
The D.C. power source provides a constant D.C. voltage to the input of the transistor circuit which amplifies the voltage. There, this D.C. power is converted to a high frequency A.C. power and is supplied to the transmitter coil.
The transmitter coil, energized by the high frequency A.C. current, produces an alternating magnetic field.

Working of Receiver:

The receiver module of our project is made up of a receiver coil and LED. Voltage is induced in the receiver coil. The LED connected to the receiver coil glows when brought near to the electromagnetic field generated by the transmitter coil.

APPLICATIONS:

- The largest application of the WPT is the production of power by placing satellites with giant solar arrays in Geosynchronous Earth Orbit and transmitting the power as microwaves to the earth known as Solar Power Satellites (SPS).
- WPT is used in moving targets like fuel-free-electric vehicles, fuel- free airplanes, fuel-free rockets and moving robots.
- The other applications of WPT are Wireless power source or Ubiquitous Power Source, RF Power Adaptive Rectifying Circuits and Wireless sensors.

ADVANTAGES:

- Simple design
- Lower frequency operation
- Low cost
- Practical for short distance

DISADVANTAGES:

- High power loss
- Non-directionality
- Inefficient for longer distances
- Effects of eddy currents

Bibliography:

- YouTube
- Goggle
- Wikipedia
- Field theory text book

CONCLUSION:

• This project has been developed considering the need for low cost.

• The equipment is compact, simple in design and can be used practically anywhere needs.