Wireless Charger

ECE 110 Honors Lab

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<u>Introduction:</u>

Problem Description:

The purpose of our design was to build a phone charger that would be able to transmit energy wirelessly over a small distance. The ultimate goal was to charge a phone. We decided to put this idea into our design by using inducting coils to create an electromagnetic field to help create a current flow that was wireless.

Overview:

Wireless charging (also known as Inductive charging) uses electromagnetic field to transfer energy between two objects. In the case of typical charger, this is done with a charging station which is the transmitting end of the charger. Using this inductive method to send energy through coupling of two coils create an alternating electromagnetic field from within the charging base. A second inducting coil (usually portable) takes power from electromagnetic field and converts it back into current to charge the battery without a physical connection.

Design:

Block Diagram:

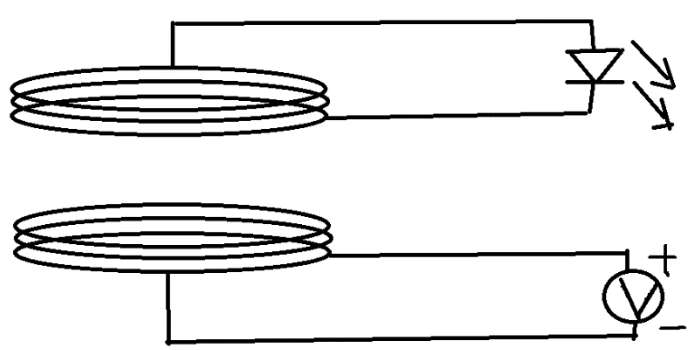


Figure 1: Block Diagram

The current in the coil connected with the power supply will produce a magnetic field around the coil. Ideally, we are having the alternating current supply which means the direction of the current in the coil is changing its direction continuously. In this way, the direction of the magnetic field, which is always consistent with the direction of the current, changes continuously. The flux, which is the number of magnetic field lines in a certain area, keeps changing from positive to negative continuously. As a result, the change in flux induces a current in the receiving end because the coil always wants to maintain the flux according to Lenz's Law.

Circuit Schematic and Concept:

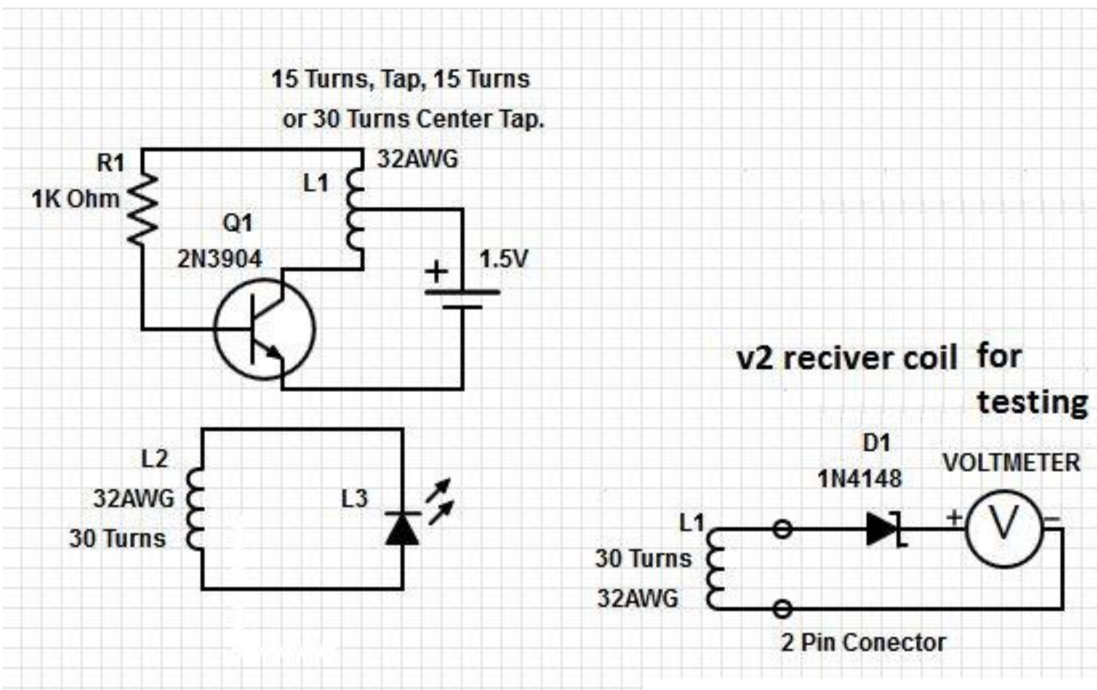


Figure 2: Perfected Concept Circuit

The transmitter circuit that we just created is an Oscillator circuit. You may or may not have heard about the Joule thief circuit which has striking resemblance to this circuit. A joule thief circuit, takes electricity from a 1.5 Volt battery, outputs electricity at a higher voltage but with thousands of intervals in between. A L.E.D requires 3 volts to light up, but a joule thief circuit could light up the L.E.D with 1.5 volt battery. So the Joule Thief circuit is known as a step up converter and also an oscillator. The circuit that we created is also an oscillator and step up converter. But the question might be, "How does it light up the L.E.D at a distance?" This happens due to induction. Let's use transformer for example. A normal transformer has a core with wires on either side. Let's suppose the wire on each side of the transformer is equal in amount. When electricity is passed through one coil, the coil becomes an electromagnet. If the electricity is oscillating voltage, that means the voltage would keep rising and dropping. So when an oscillating electricity is passed through the coil, the wire gains properties of electromagnet and then again loses electromagnetism when the voltage drops. A coil of wire becoming electromagnet and then losing its electromagnetic characteristics really fast is just like a magnet moving really fast in and out of the second coil. And when you pass a magnet really fast through coil of wires, you produce electricity, so the oscillating voltage in one coil on the transformer, induces electricity in the other coil of wire, and thus wirelessly electricity is transferred from one coil to the other. In our circuit, the air is the core, and there is oscillating voltage going through the first coil, so you induce A.C electricity in the second coil and light up the bulb!

Results:

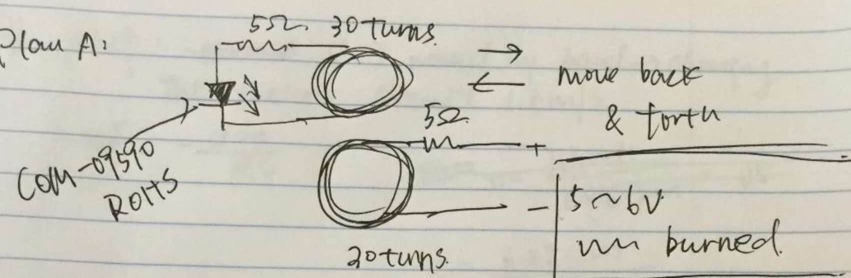
Collected Data using the test circuit:

Input Voltage (V)	Receiving Voltage (V)	Current (mA)	Power (W)
1.5	24	3	0.072
3	40-50	7.5	0.3375
4.5	60-75	7.2	0.504

Distance is kept constant around 30-35(mm)

Calculations:

Plan A:

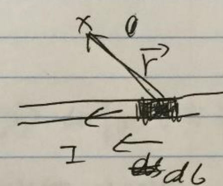


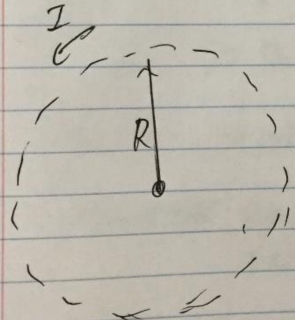
the R in kit usually smaller than labeled. ⟹ $R_5 + R_{coil} \approx 5\Omega$.

⟹ 1A.

~~Force~~ ~~B center~~

$$\vec{dB} = \frac{\mu_0}{4\pi} \frac{I\,\vec{dl} \times \vec{r}}{r^2}$$





loop

$$\int dB = B = \frac{\mu_0 I}{4\pi R^2}\int ds = \frac{\mu_0 I}{4\pi R^2}\cdot 2\pi R$$

$$B_{center} = \frac{\mu_0 I}{2R}$$

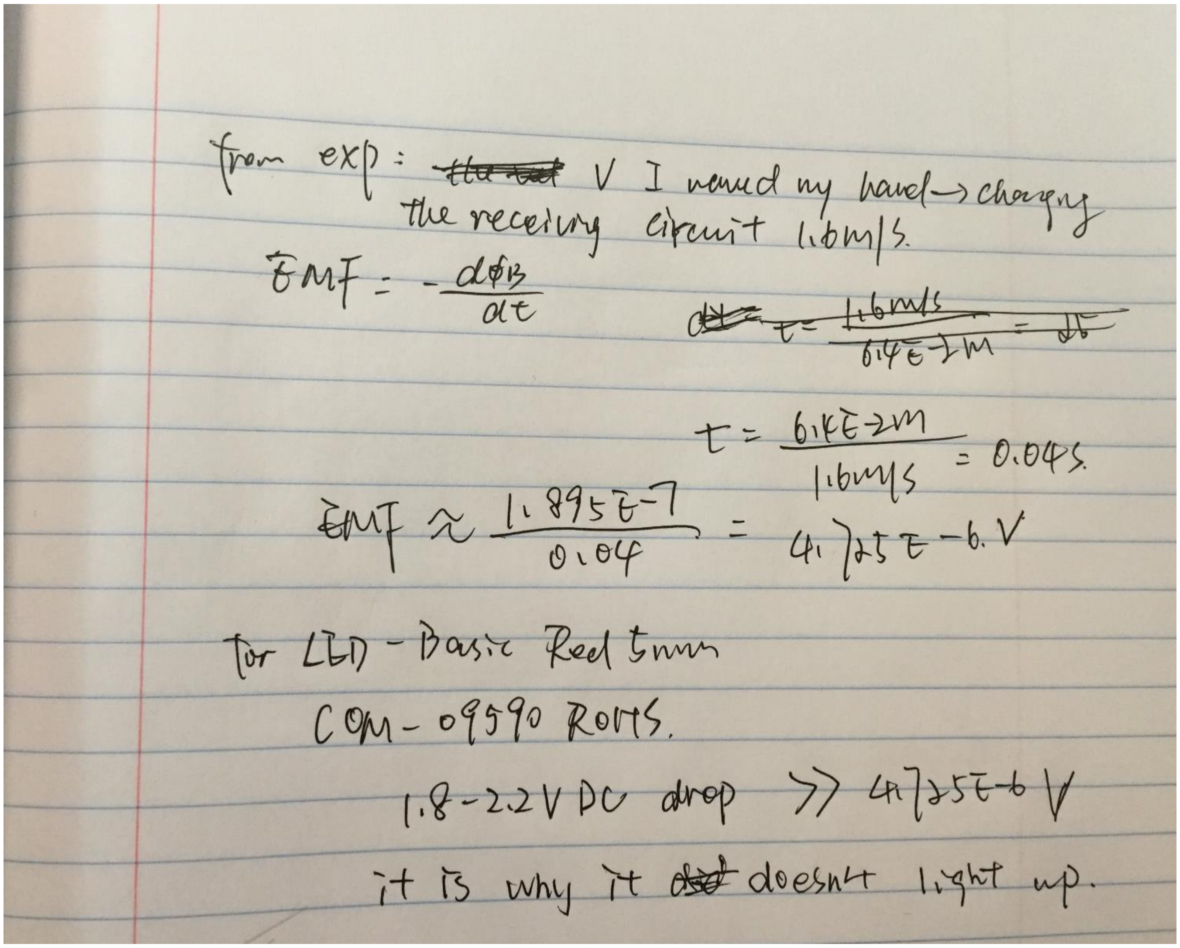
$$30\text{ turns} \rightarrow 30 \times \frac{\mu_0 I}{2R} = \frac{15\mu_0 I}{R}$$

$R \approx 3.2\,cm = 3.2$

$\mu_0 = 4\pi \times 10^{-7}$

$$B_{center}\text{ for 30-tuns} = \frac{15 \times 4\pi \times 10^{-7} \times 1}{3.2 \times 10^{-3}} = 0.0059\,T$$

$$\text{max } \Phi_B = \int \vec{B}\cdot\vec{A} = (3.2E-3)^2 \pi \times 0.0059 = 1.895E-7\ T\cdot m^2$$



from exp: ~~the rod~~ V I moved my hand → changing the receiving circuit 1.6m/s.

$EMF = -\frac{d\Phi_B}{dt}$

~~$dt = t = \frac{1.6m/s}{6.4E-2m} = dt$~~

$t = \frac{6.4E-2m}{1.6m/s} = 0.04s.$

$EMF \approx \frac{1.895E-7}{0.04} = 4.725E-6.V$

for LED - Basic Red 5mm

COM-09590 ROHS.

1.8-2.2V DC drop >> 4.725E-6 V

it is why it ~~did~~ doesn't light up.

Future Work/ Conclusion:

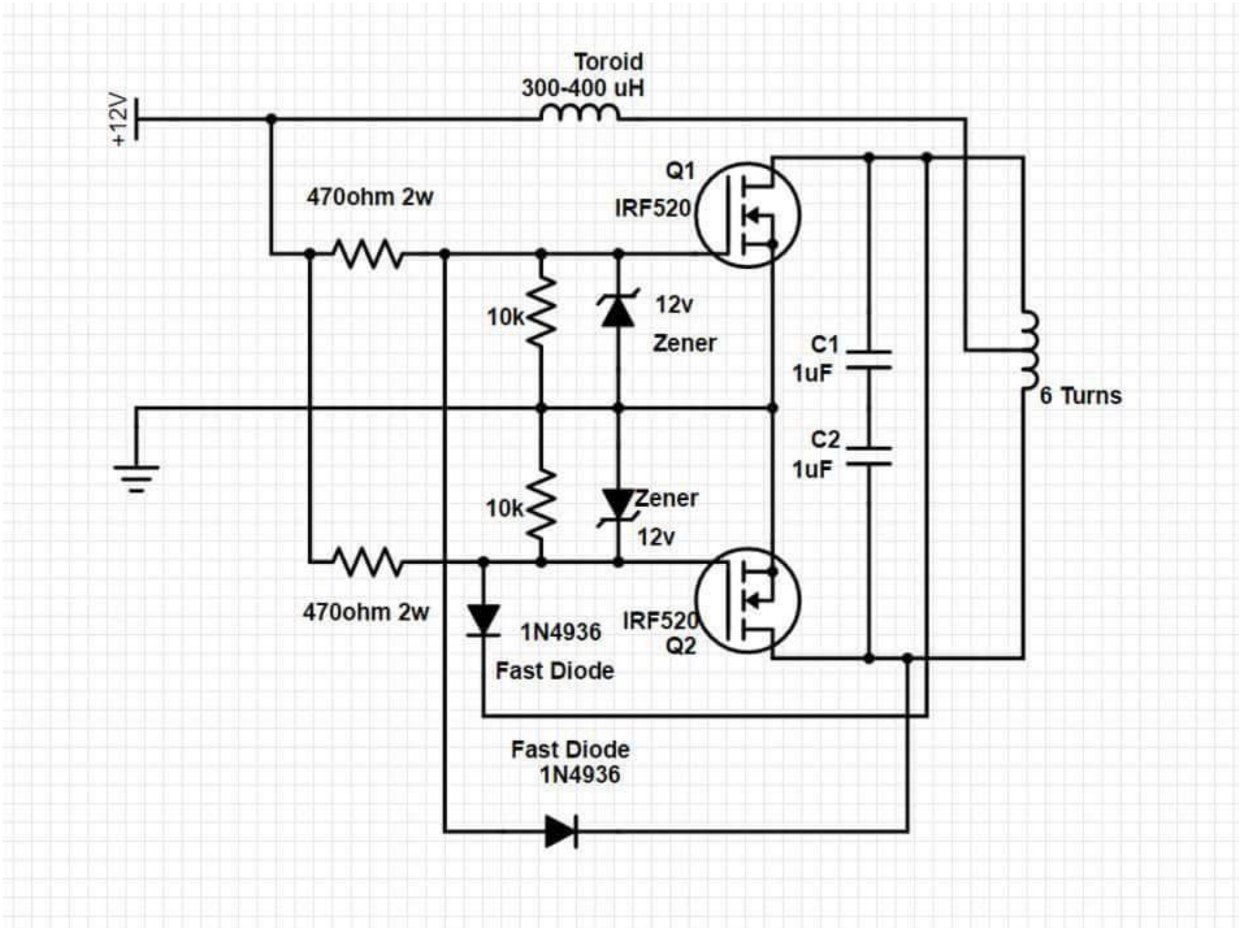


Figure 3: In progress transmitting end

We already started on working on the schematic above and have it put together but for some reason the research that we did to put together bits and pieces of this circuit did not line up and the transmitting end of the actual charger and it would not output enough circuit on the receiving end to charger up a phone. If we had more time, then we would've had enough time to do more research and make more calculations to make the schematic work out properly. While doing all of these adjustments we learned that it necessary to fully test and adjust the circuit before displaying it for verification.