E-Space

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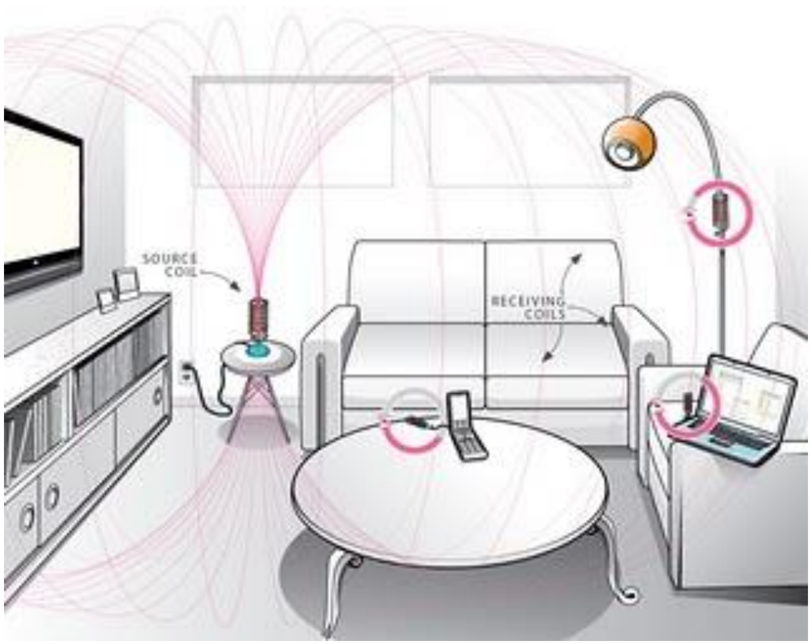
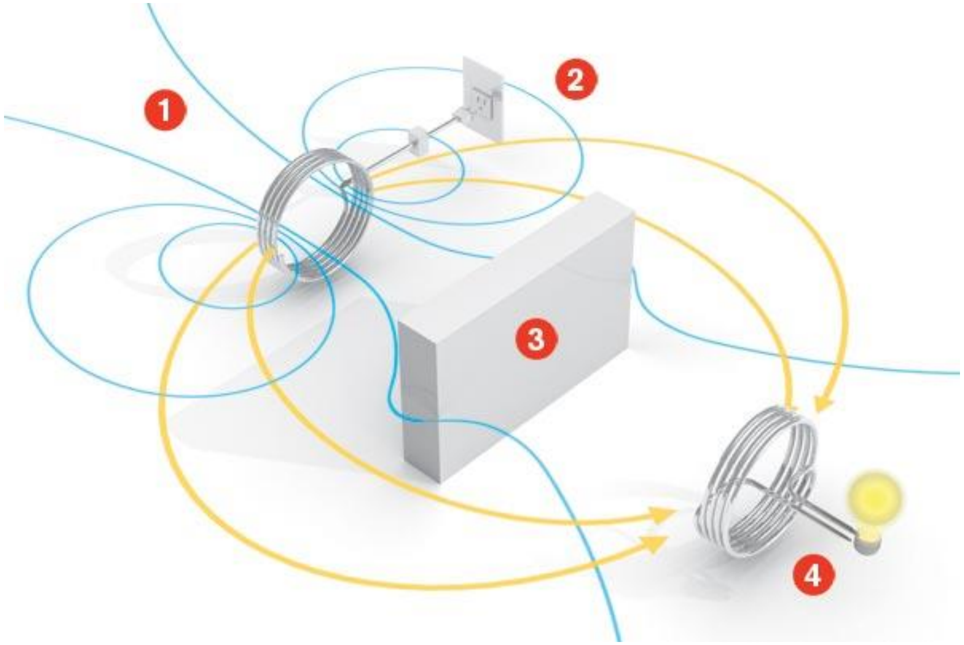
Magnetic Resonant Wireless Charging

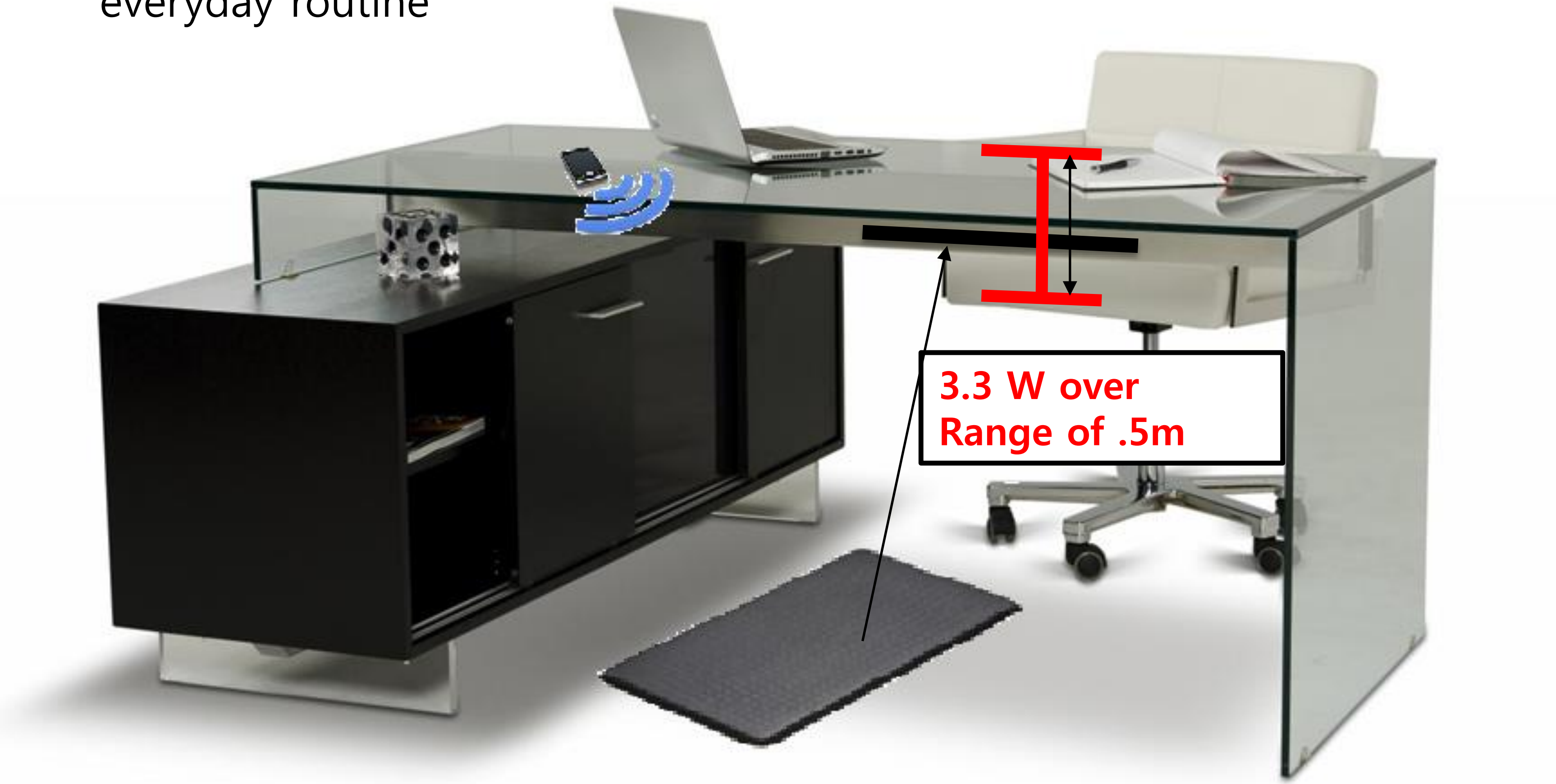
- Wireless transfer of power to charge devices or directly power devices
- Magnetic resonance charging can power multiple devices at once with high efficiencies
- Eliminate reliance on failure prone cables, connectors, and batteries





Our Application

- Our goal is to design a product that will make it easy for people to charge their phones without ever thinking about wires in their everyday routine
- Construct a charging pad and receiving phone case to allow for resonance wireless charging in a typical home or office



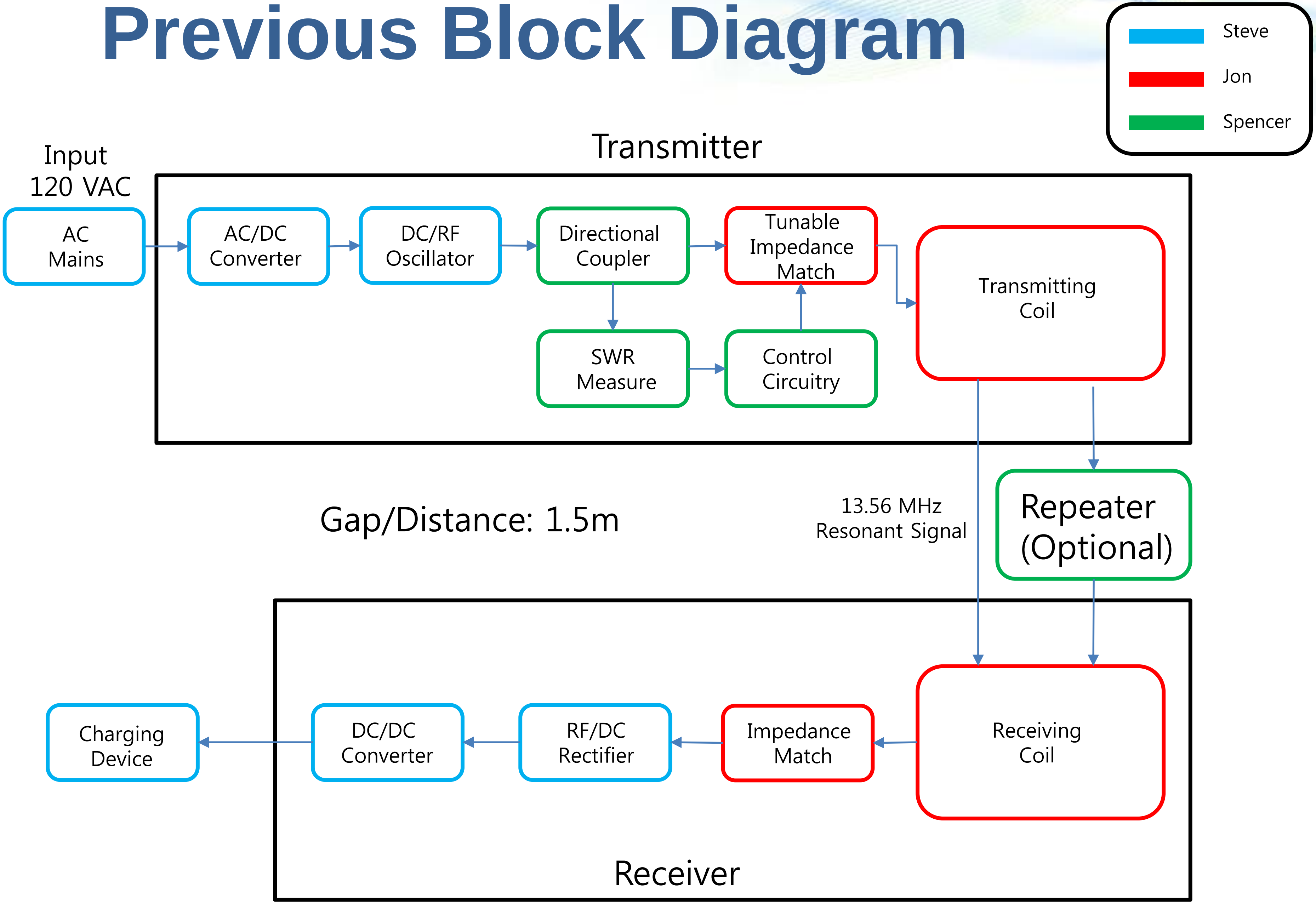
Previous System Requirements

Input Specifications	120 VAC at 60Hz
Frequency	13.56 MHz
Distance/Range	1.5 m
Minimum Output Power	5W
Minimum Wireless Transfer Efficiency	≥70%
Minimum Total System Efficiency	≥50%
Maximum Electric Field	60.75 V/m
Maximum Magnetic Field	1.20 A/m

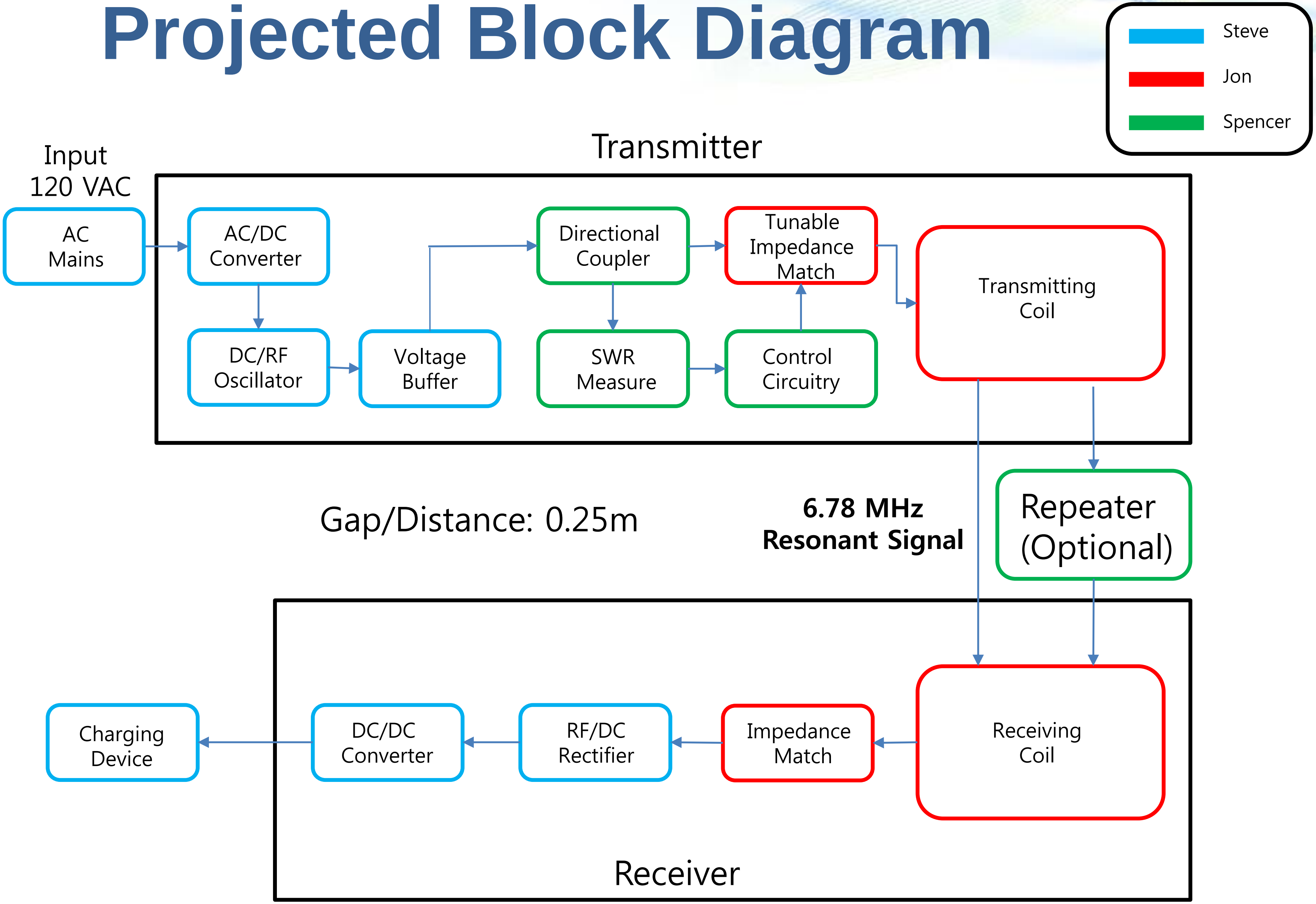
Revised System Requirements

Input Specifications	120 VAC at 60Hz
Frequency	6.78 MHz
Distance/Range	0.25m
Minimum Output Power	3.3W
Minimum Wireless Transfer Efficiency	≥40%
Minimum Total System Efficiency	≥10%
Maximum Electric Field	121.5 V/m
Maximum Magnetic Field	2.40 A/m

Previous Block Diagram

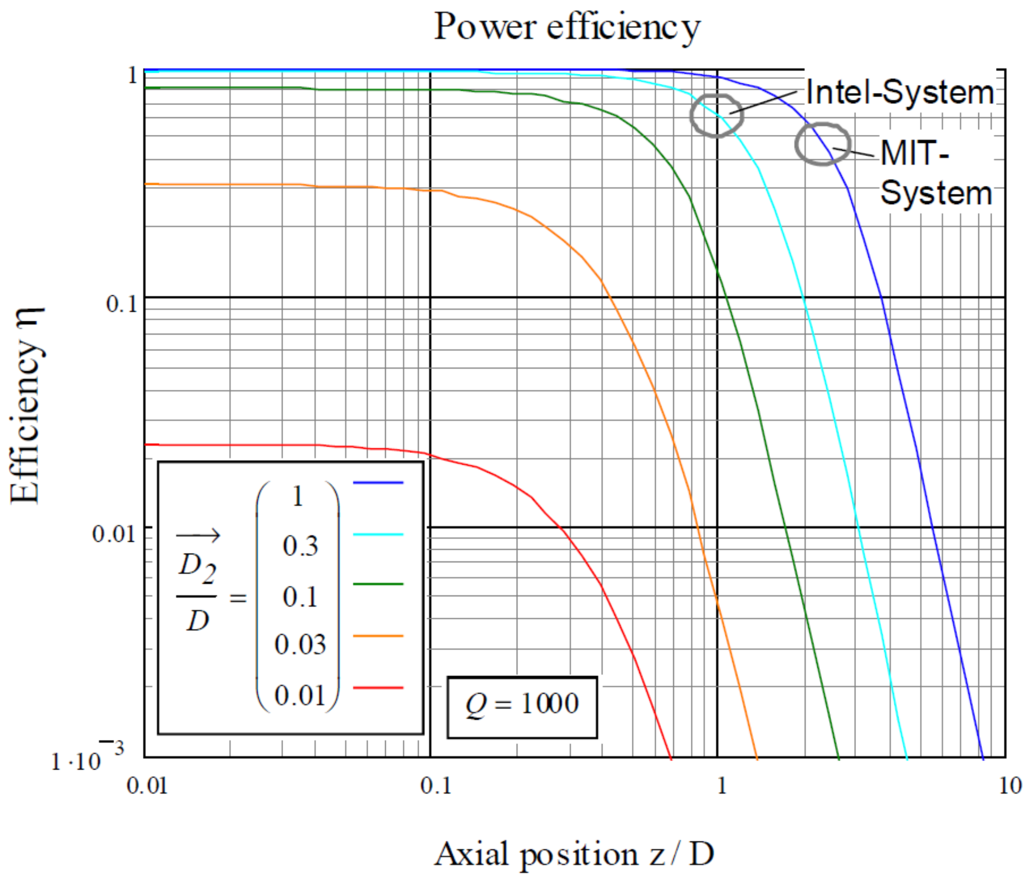


Projected Block Diagram



Transmitting and Receiving Coils

Q = 1000:



- Q factor differentiates between loosely and tightly coupled systems
- Needs high Q factor
- Higher quality factor ensures farther axial distance before drop-off
- Dependent on ratio between transmitter and receiver coils

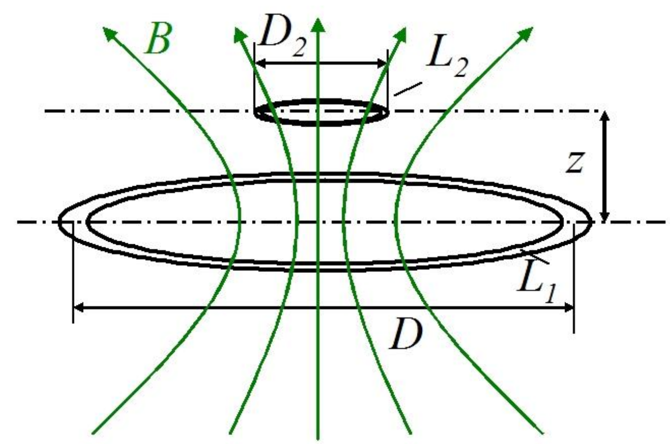


Figure 1 Typical arrangement of an inductively coupled power transfer system

Transmitting and Receiving Coils

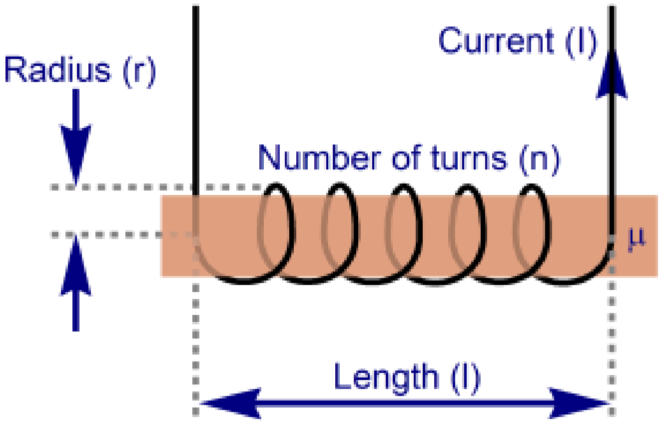
Current Coils:

- Flat Coil Design
- 8 AWG
- Two Turns
- Q ~ 1800 at 6.78 MHz
- Receiver Coil: D=35 cm
- Transmitter Coil: D=42 cm

$$Q = \frac{\omega_0}{2\Gamma} = \sqrt{\frac{L}{C}}\frac{1}{R} = \frac{\omega_0 L}{R}$$

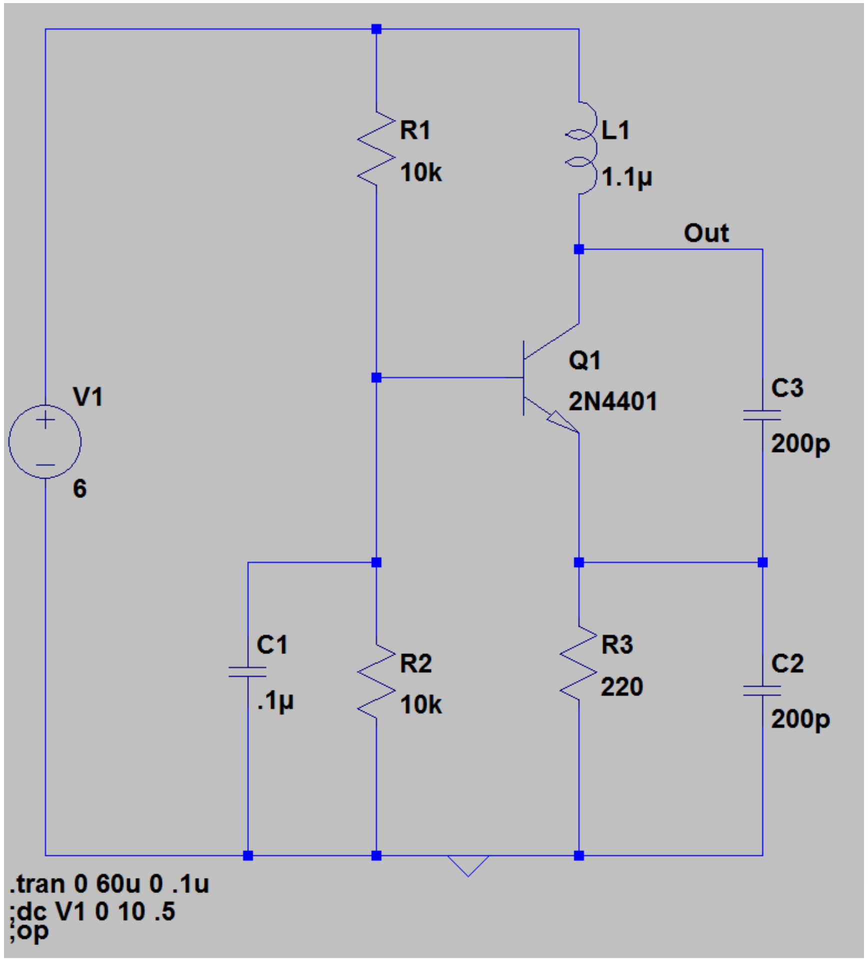
$$L = \frac{N^2 \mu A}{l}$$

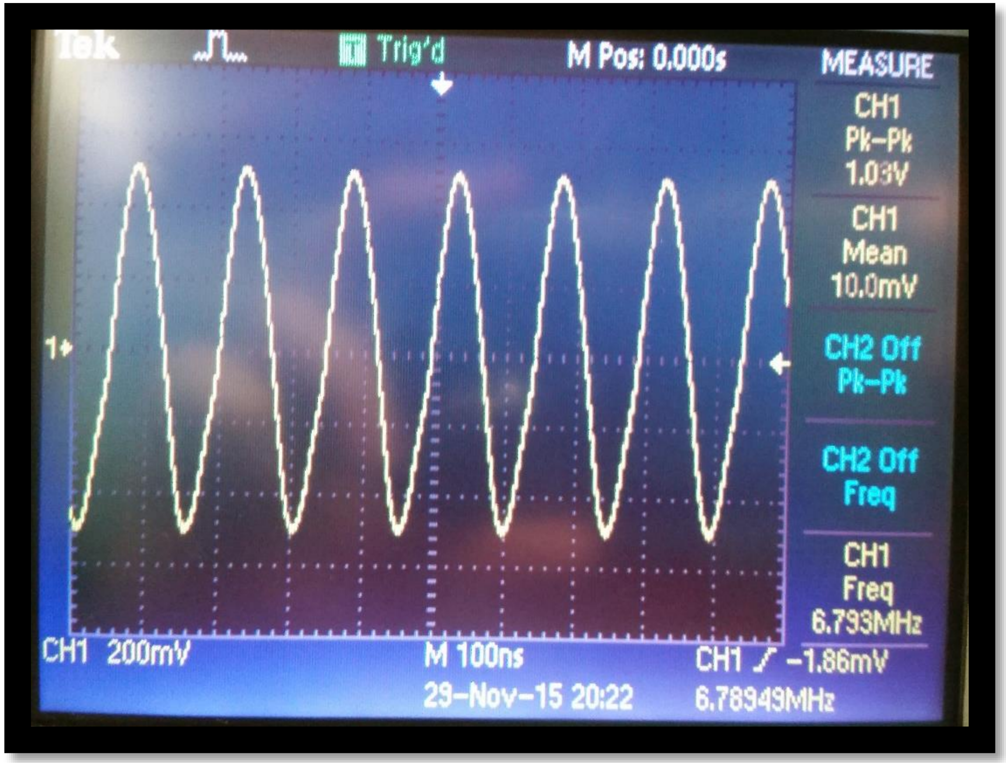
$$R = \frac{2\pi a N}{\sigma 2\pi r \delta} = \frac{aN}{\sigma r \delta}$$



Oscillator

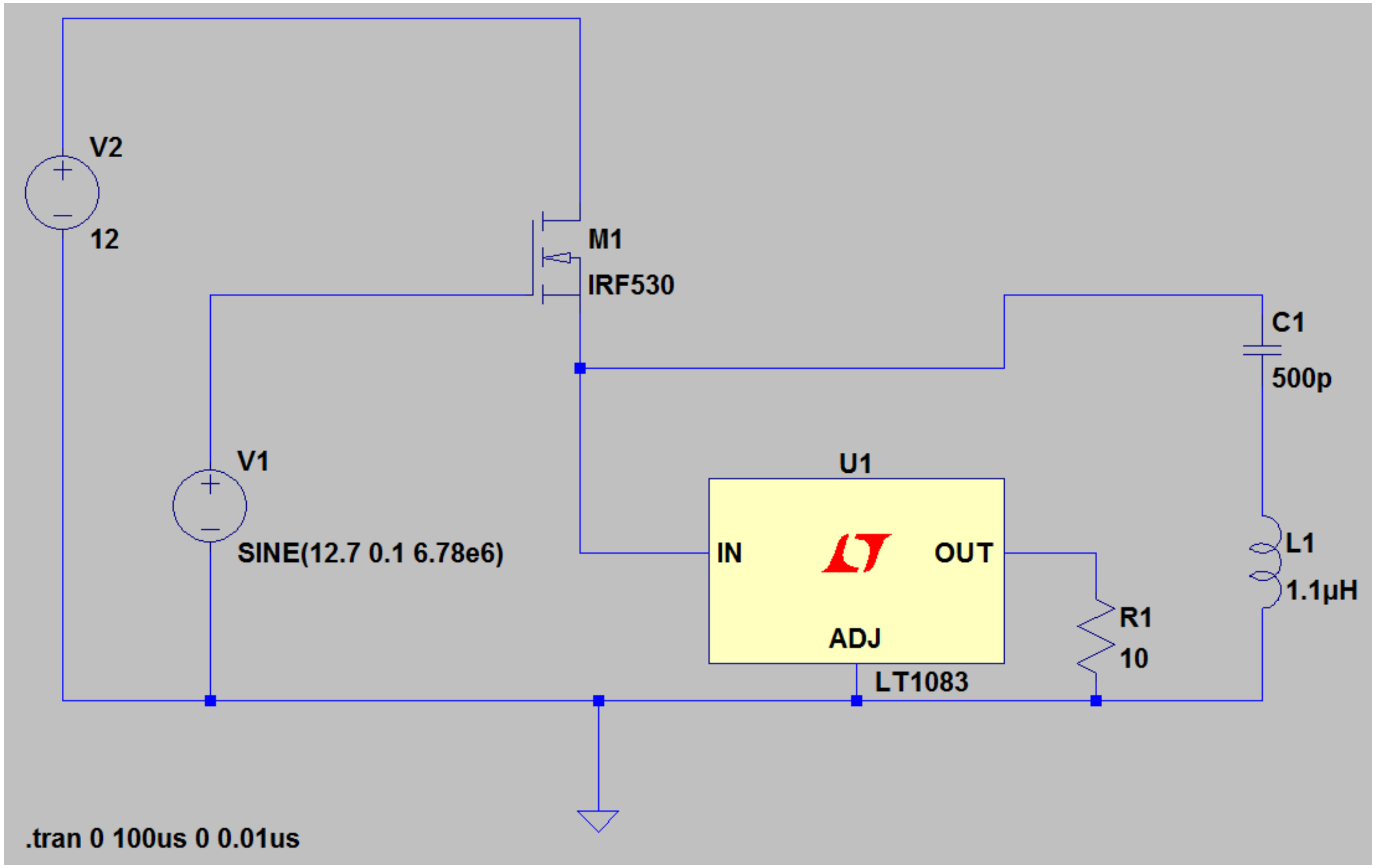
- Colpitts Oscillator
- Can use transmitting coil as inductor
- Shifts frequency – need buffer stage





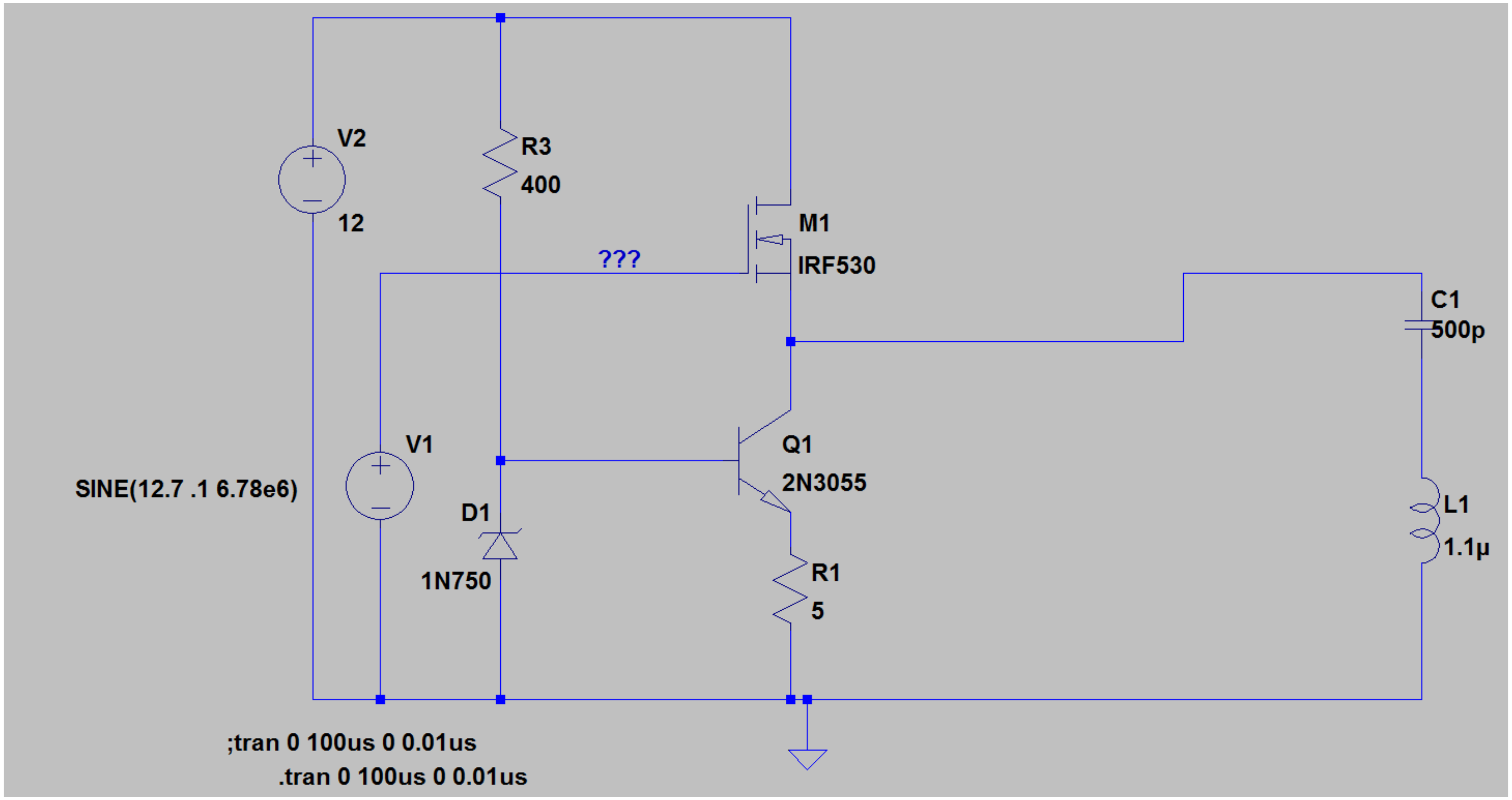
Voltage Buffer

- Oscillators don't function well when loaded
- Buffer presents high input impedance and low output impedance
- Voltage Gain: 1.8
- Current Gain: 25.8



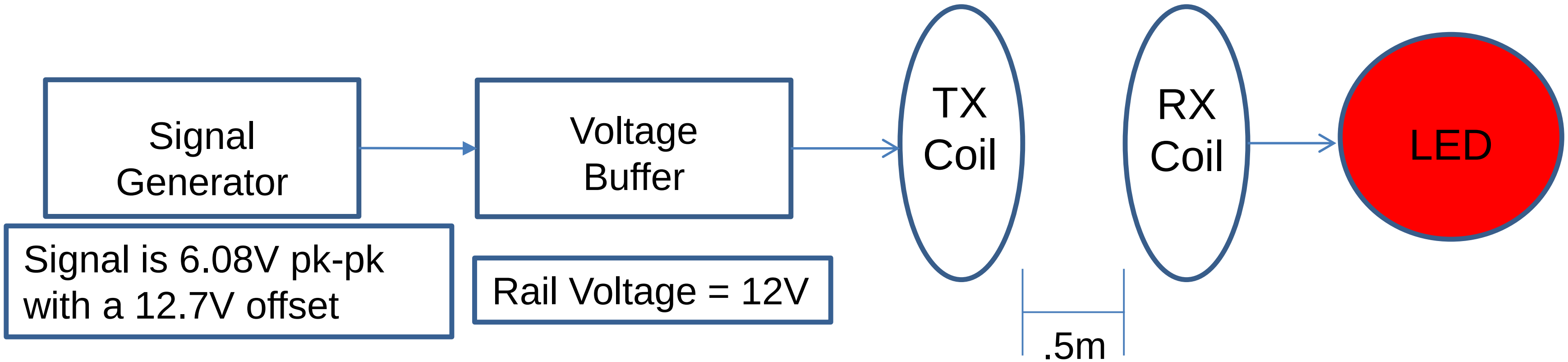
Voltage Buffer

- MOSFET: IRF540
- BJT: 2N3053

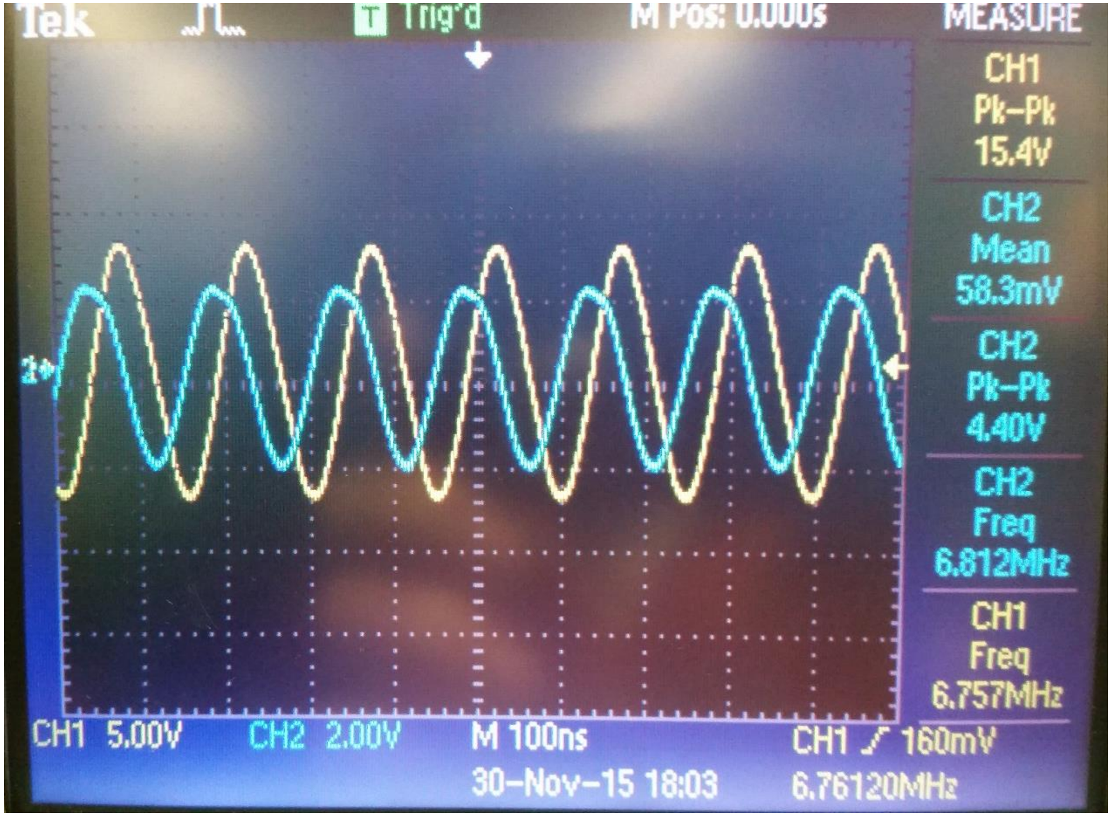


Demonstration

- Created transmitter and receiver coils.
- Use signal generator as power source and oscillator.
  - Fed to voltage buffer
- Illuminate LED over a distance of a half a meter.
  - Red LED (V_f =1.8-2.2V, I_f =20 mA)
  - P≈ 0.04W to light the LED



Test Results



Team Responsibilities

<table>
<tr><th></th><th>December</th><th>January</th><th>February</th><th>March</th><th>April</th></tr>
<tr><td rowspan="3">Jon Scharf</td><td colspan="2">Coil Redesign, Phone Case</td><td></td><td></td><td></td></tr>
<tr><td></td><td colspan="2">Impedance Matching</td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td colspan="2">PCB Design</td></tr>
<tr><td rowspan="3">Steve Bevacqua</td><td colspan="3">Increase Power</td><td></td><td></td></tr>
<tr><td colspan="3">Oscillator Design</td><td></td><td></td></tr>
<tr><td></td><td></td><td colspan="3">Rectifier, Voltage Regulation</td></tr>
<tr><td rowspan="3">Spencer Pietryka</td><td colspan="3">SWR Measure, Control Algorithms</td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td colspan="2">Repeater</td></tr>
<tr><td></td><td colspan="4">Control Circuitry</td></tr>
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CDR Deliverables

- Demonstrate system output: 3.3 W over 10 cm
- Implement tuned impedance match network for 10 cm
- Final coil sizes constructed
- Effectively measure SWR on line

Demo

Questions and Comments