Wireless Power Transfer Solutions and Their Effectiveness

Johnathan Radcliff; Joyelle Harris, Ph.D.
Georgia Institute of Technology, North Ave NW, Atlanta, GA 30332

Abstract

My research focuses on the problems related to the creation of a wireless power transfer system designed for energy transmission at a distance of at least one meter. The project was created to provide data for the advancement of wireless power, specifically via radio frequency transmission. Previous research efforts that attempted to develop this technology have run into unforeseen obstacles that have hindered its consumer and commercial adoption. This research will yield more information into those barriers and what can be done to assist wireless power in its future development as an applied technology. It is currently still in progress, but the data that has been accumulated shows that transmission is possible but with lower power yields than initially expected. The maximum range of received power was one meter, but because the transmitted voltage and current did not meet the calculated values, the project must have reached one or more of the unknown obstacles in wireless power design. To isolate and learn more about them, the project will be revised to gather more data. It will change into different models of power transfer and be tested for their effectiveness for the benefit of future research in this topic.

Methods

To begin producing data, a wireless power system first must be created.

- The central design element of the transmitter was a Texas Instruments PLL and integrated VCO wideband frequency synthesizer programmed to output a 3.6GHz sine wave.
- That signal was amplified in a two phase amplifier circuit and finally transmitted via a wideband Molex antenna.
- The receiver circuit was much simpler, consisting of a second Molex antenna and a bridge rectifier circuit to convert the AC signal to DC.
- A multipurpose ATmega328 (Arduino) programs the frequency synthesizer on the transmitter and reads the voltage and current from the receiver with its integrated ADC.

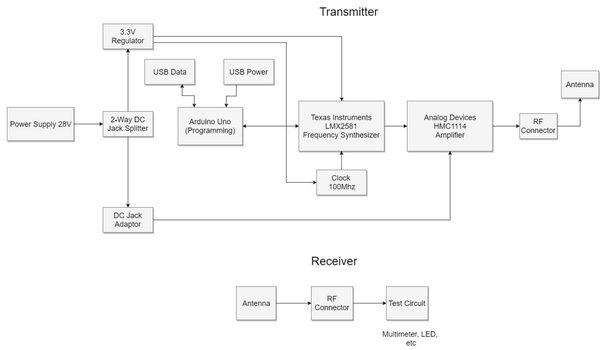

Figure 1. A block diagram representing the functionality of one of the designs

Designs

- Because this project focuses on testing the functionality of a potential wireless power transfer solution, at least one prototype was required to test one of the many control variables in a system of this nature. Choosing to focus on the power output of the transmitter, two designs were created in hardware with the option of software-programmable power modification.

- While both modules were built with the same gallium nitride main amplifier in their circuits, one specifically had an initial amplification prior to the signal's passing into the main amplifier to test if power-in levels affected the power-out levels in any meaningful manner.

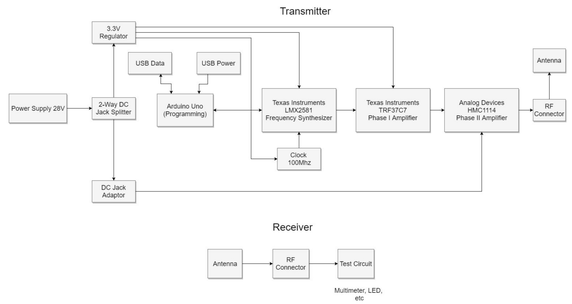

Figure 2. A block diagram representing the functionality of the other design

Experiments

1. Ensure that both the transmitter and receiver are communicating with each other via a wireless handshake.
2. Place the transmitter immediately next to the receiver (~0m) and measure the power output of the receiver
3. Move the transmitter 20cm back from the receiver and measure the power output of the receiver
4. Repeat this process until the transmitter is 1.0m away from the transmitter
5. Repeat steps 1 – 4 with both designs of the hardware to test any differences between the two, iterating over the various output power levels from the amplifier(s)

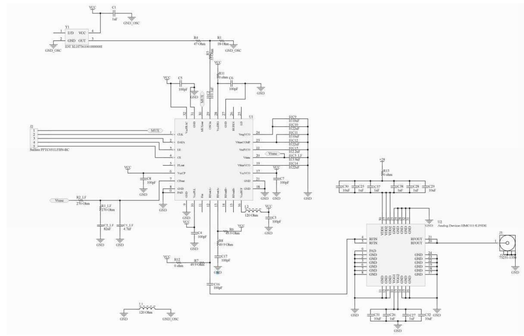

Figure 3. A schematic used in one of the designs

Results/Analysis

- The results from the experiments showed that regardless of the output levels that the circuits were pushing, the levels on the receiver did not have an output consistent with the theoretical values obtained beforehand.

- While this initially shows that output power may not be the innovation needed to successfully transfer meaningful power outputs, it does not completely eliminate it as an option

- Other factors such as noise, interference, phase shift, and other irregularities in the experiment may have hindered the results, which only future experiments can show

Next Steps

- From this study, a need for further experimentation and development is in order to find the ultimate solution to wireless radio-frequency power harnessing

- Some areas of improvement may include proper antennae matching, proper EMI shielding, tighter resistance matching, more secure ground and voltage levels to the amplifiers, etc.

- While this experiment was not successful, the knowledge it provides to the general body of science will help researchers move one step closer to true wireless power transfer.

Contact

Johnathan Radcliff
Undergraduate Researcher
Georgia Institute of Technology
Email: jradcliff@gatech.edu
Phone: (901)-562-3231

Joyelle Harris, Ph.D.
Associate Director, CREATE-X LEARN programs
Georgia Institute of Technology
Email: joyelle.harris@ece.gatech.edu
Phone: (404)-894-8365

About

Johnathan Radcliff is a first-year electrical engineering undergraduate at the Georgia Institute of Technology. He participated in the school's entrepreneurship program Idea to Prototype under the larger Create-X organization to turn his solution for wireless power into a product.

Joyelle Harris, Ph.D. is a professor at the Georgia Institute of Technology under the School of Electrical and Computer Engineering. She serves as the Associate Director of the Institute's entrepreneurial Create-X program, the director of the Engineering for Social Innovation Center, and on several boards across many organizations and schools including the Scheller College of Business MBA program.