Reconfigurable Antenna with Matching Network
Functional Description and Complete System Block Diagram

Students: Mike Bly, Josh Rohman
Advisor: Dr. Prasad N. Shastry
Date: October 6, 2011

Introduction:
Reconfigurable antennas present a new option for antenna capability and technology in wireless devices. They require less space and increase functionality of an antenna system. Reconfigurable antennas are a single system that accesses multiple specific frequencies through various switches, patch antennas and patch networks. This eliminates the need for multiple antennas or wideband antennas. Multiple antennas take up more space, as they require an antenna for each use, and are always on. Wideband antennas, due to their inherent wide-bandwidth, receive more noise at a specific frequency than a single patch antenna. The reconfigurable antenna is an alternative solution to these possible antenna options that we seek to design and analyze the performance of.

The goal of this project is to develop an antenna that has the capability of changing its resonance frequency and switch to the corresponding impedance matching network. The two frequencies chosen to switch between are both GPS signals that occur at 1.227GHz and 1.575GHz. Modern design methods will be analyzed for the best practical method concerning performance, cost, and complexity. The system will have two varying sized patches, both with length based upon ½(λ desired). These patches will be integrated through various switches in order to create a minimalist system (see Figure 2-1)

High Level System Block Diagram:

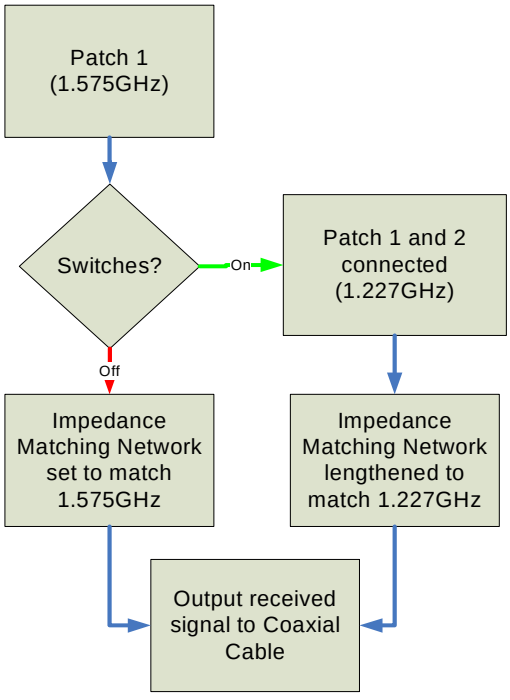

Figure 1-1: High Level System Block Diagram of Reconfigurable Antenna with Matching Network.

Functional Description:

The premise of the design is simple. The longer the resonant length of the patch antenna the lower the resonant frequency becomes. The width of the patch antenna controls the impedance of the patch antenna. If we have two nearby patch antennas with small RF switches in between them, biasing the switches will connect the patches together, thus changing the frequency being received. The same switching system can be used to match the impedance of the antenna by adjusting the lengths of the double stub impedance matching network. Therefore, we can use identical RF switches in interconnecting the patch antennas and to also interconnect an impedance matching network stub. The biasing signals of the patch antenna switches and impedance matching network switches can use the same signal to alter the frequency being received by the reconfigurable antenna. This switching will be done through a switching control system; this may be a complex circuit or a simple power biasing network depending on time constraints.

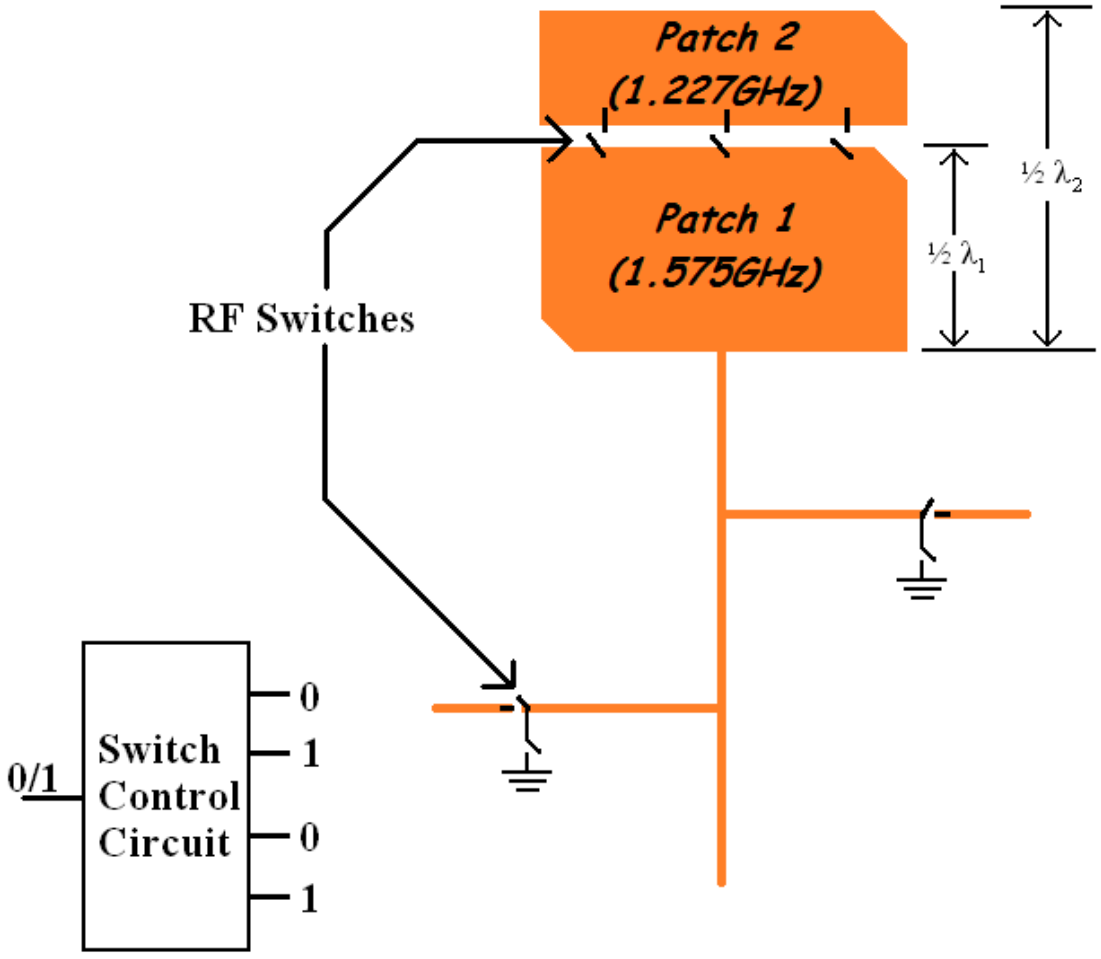

Figure 2-1: Basic design pattern of the reconfigurable antenna for two GPS frequencies.

If the 1.575GHz GPS signal is desired, then the switches will be off, holding the patch antenna at the smaller length and thus higher resonant frequency. If the 1.227 GHz is desired, the switches will be turned on thus closing the connections between the patch antennas and impedance matching networks, this will adjust the length of both the antenna and matching network to resonant at 1.227 GHz.

Polarization:

The GPS frequencies that we will be receiving use right-hand circular polarization according to http://www.fcc.gov. Right hand circular polarization allows for a signal to be received regardless of orientation. To match the signal's right hand circular polarization, our antenna must be designed as right hand circularly polarized. There are several design methods that will need to be researched and chosen from. In the initial antenna polarization design, the corners will be shaped as shown in Figure 2-1. The exact calculations and type of switches still need to be researched, but the overall function of the system will remain the same.

Switching Technology:

We will need to determine which method of switching will not only be the most plausible but the best for our system. A small switch size is desired to limit the gap size between patch antennas. It is also very important that the RF switches have low loss and work at RF frequencies. Our goal is to implement RF MEMS switches. However, since they are a new technology the plausibility of finding and implementing theses switches may be more difficult than the lesser RF transistor switches. Either way the system will act inherently the same, though some calculations and lengths may vary.

Switching Control System:

If time allows we will look into the possibility of designing our own switching control system. This system would simplify the switching process by sending the desired biasing signals to the RF switches which adjust the patch antenna resonant frequency and the corresponding impedance matching network. All of this would be controlled by a single switching control system that would correspond to 1.227GHz or 1.575GHz. Ideally this would be placed on the lower corner of the microstrip board of the reconfigurable antenna so that the system is consolidated to a single board without any interference.

Conclusion:

The goal of the project is to create the GPS reconfigurable antenna described throughout this paper. The system will switch through RF switching technology, hopefully through the use of RF MEMS. It will implement a double stub matching network for proper antenna use, by creating an impedance matching network. The antenna will be configured to recognize a right hand circular polarization GPS signal. If possible with the time allotted a switching control system, to allow for a simplified switching between 1.227GHz and 1.575GHz, will be designed and implemented.

Works Consulted:

DeSignor, Jessica A., and Jayanti Venkataraman. "Reconfigurable Dual Frequency Microstrip Patch Antenna Using RF MEMS Switches." *IEEE Xplore*. May 2007. Web. 20 Sept. 2011.

Rebeiz, Gabriel M., and Jeremy B. Muldavin. "RF MEMS Switches and Switch Circuits." *IEEE Xplore*. Dec. 2001. Web. 20 Sept. 2011.

Yang, Songnan, Chunna Zhang, Helen K. Pan, Aly E. Fathy, and Vijay K. Nair. "Frequency Reconfigurable Antennas for Multiradio Wireless Platforms." *IEEE Microwave Magazine* (2009): 67-84. Print.