CHAPTER1

INTRODUCTION

1.1 Overview

The ever increasing use of wireless devices, such as mobile phones, wireless computing and remote sensing has resulted in an increased demand and reliance on the use of batteries. With semiconductor and other technologies continually striving towards lower operating powers, batteries could be replaced by alternative sources, such as DC power generators employing energy harvesting techniques.

The growth of multifunction, high efficiency energy harvesters has greatly increased in the past few years. Using several energy sources available in the environment such as, solar, thermal, and RF, researchers have been able to come up with new ways to optimize harvesting efficiency and output power. The process of energy harvesting involves capturing ambient energy in the environment and converting it into power that can be stored and reused at any time. The available power being retrieved from a harvesting device is very limited, which is why studies are being done to integrate different energy harvesting techniques to optimize the output.

In this current project, the ambient energy focused on is RF. Radio frequency energy surrounds us from applications that have high electromagnetic fields. These fields come from sources such as Wi-Fi, cell phone towers, radio signals, broadcast television signals, among others. Each source radiates at a different frequency. When harvesting RF energy it is important to understand where in the frequency spectrum you will be receiving the most amount of RF power from the surrounding environment. The information shows different frequency levels and examples of the applications using them.

Frequency Band	**Frequency Range**	**Applications**
Low Frequency	30 to 300kHz	Navigation, time standards
Medium Frequency	300kHz to 3 MHz	Marine/aircraft navigation, AM broadcast
High Frequency	3 to 30MHz	Broadcasting, mobile radio, amateur radio
Very High frequency	30 to 300 MHz	Land Mobile and FM/TV broadcast
Ultra-High Frequency	300MHz to 3GHz	Cell phones, mobile radio,WLAN, PAN
Super-High Frequency	3 to 30GHz	Satellite, radar, backhaul, TV

Extremely High Frequency	30 to 300GHz	experimental

The more broadband the RF energy harvester, the more energy you will be able to harvest from different sources and, in turn, the more efficient your device will be.

The device used to harvest RF energy is called a rectenna. A rectenna is a rectifying antenna that is used to convert microwave energy to DC electricity. Most rectenna designs consist of an antenna that radiates for the desired frequency range, an RF diode that rectifies the AC current to produce a DC signal, and a resistive load. Although the idea of the rectenna came from Nicola Tesla over a hundred years ago, the dream was not brought to life until May 1963 at the Spencer Laboratory of Raytheon Company. The first rectenna ever constructed consisted of a half-wave dipole antenna with a single semiconductor diode placed above a reflecting plane followed by a resistive load . Since this point, it has been a goal to increase the conversion efficiency of the rectenna element. The conversion efficiency measures how accurately the RF power received by the antenna is converted to DC power. The greatest conversion efficiency ever recorded from a fabricated design was achieved in 1977 by B. C. Brown using a GaAsPt Schottky diode. The conversion efficiency was 90.6% with an input microwave power level of 8W.

Since the fabrication of the first rectenna in 1963, researchers have been finding new ways to develop and expand the rectenna design. A recent development has been a thin-film printed-circuit rectenna for high altitude atmospheric platform and space use . Expansion in the efficiency, bandwidth and size have all been researched and improved in the last several years.

1.2 OBJECTIVES

Several rectenna configurations capable of harvesting ambient RF energy are designed. Improvements on various parameters of Bandwidth, reducing losses, power and simplicity can be achieved if the antenna being selected is best.

- Design of various configurations of antennas
- Design of rectifier circuit that uses schottky diode
- Optimizing the antenna configurations
- To obtain optimum amount of power that can charge low power devices.

1.2 SUMMARY

- The design of antenna is performed using HFSS solver
- Matlab is used to obtain various dimensions
- Rectifier is analysed for its noise characteristics using TINA by Texas instruments software
- The fabrication is also carried out to measure the amount of voltage received from the designed system