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Harvesting RF Energy for Wireless Devices

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ABSTRACT: Wireless gadgets that require electricity or a charge, such as batteries, mobile phones, and others, have become increasingly common in many regions in recent years. It becomes challenging for us to maintain these equipment in regions without a source of power. In this case, we require another option that can serve as a source to power these types of gadgets. In this article, we'll talk about Radio Frequency Radiation, one of the sources that is freely available in the environment. We are going to capture this radiation in the form of AC signals with the help of a microstrip antenna and then with the help of a rectifier we are going to convert these AC signals to DC.

KEYWORDS: Power Density, Rectenna, RF source, Energy Harvesting, Radio Frequency.

I. INTRODUCTION

Today, a vast variety of wireless technologies is easily accessible and crucial for everyday consumer, business, and military requirements. Unfortunately, a current technological constraint prevents wireless gadgets from running continuously without centralised power sources. As a result, the relatively sluggish development of rechargeable battery technology greatly limits the usefulness of wireless gadgets. Therefore, there is a clear market need for products that either enable wireless devices to run for an extended amount of time without centralized power supplies or enhance the power which can be provided to wireless devices. The next ten years will see a revolution brought on by energy harvesting, a unique technology.

RF energy harvesting is one of the most widely used kinds of power harvesting. It is an energy-collection method that uses the RF energy radiated by surrounding electronic devices [such as cell phones, communication towers, antennas, etc], to generate DC power. This energy can also power other devices like mobile phones and RFID software.

II. RELATED WORK

The development and evaluation of a high output voltage three-stage Cockcroft-Walton rectifier and microstrip patch antenna designed in Keysight ADS software is used for simulation in this paper. It demonstrates that rectenna can produce high output voltages of over 9 V at 19 dBm input RF power and a highest efficiency of 40% at 2.45 GHz [1]. A DC boosting system is used to increase DC output, while energy is stored in capacitors in DC form which is built for an ISM band. In order to increase the efficiency, an impedance matching network is set up and capacitors actions are examined for the charging times and appropriateness [2]. In this paper a RF switch circuitry energy harvesting system and a passive RFID tag are used where the RFID is connected to a dipole kind of antenna by an RF switch if the voltage at the storage capacitor terminals is greater than 0.58 V. In this manner, an RFID reader at the harvester can wirelessly and efficiently determine the charge storage level. The system's growths in detail as well as the outcomes of the two simulations are measured in this study [3]. The two main resources which are necessary for livelihood on earth are energy and environment. Energy harvesting via various ambient sources, such as wind, solar, vibration, heat, etc., are discussed in this work. They are offering a model for using a closed loop antenna to capture RF energy waves in the GSM 900 band. Finally, KEIL COMPILER was used to evaluate the model, which resulted in the output voltage needed for the input GSM 900 band frequency. The model generates very high voltage at frequencies of 1.8GHz and 3.5GHz, which can deliver power to a number of electronic devices [4]. The suggested circuit combines numerous threshold voltage

cancellation techniques with a cascade layout technique to increase output voltage of the appealing alternative energy that may substitute all or portion of the board batteries, which is radio frequency (RF) energy harvesting [5].

III. METHODOLOGY

Step 1: Using the Ansys HFSS tool, a Microstrip patch antenna is designed for the WLAN frequency.

Step 2: Rectifier circuit design is made from the software Keysight ADS.

Step 3: Fabrication of RF energy harvester.

Step 4: Integrate Antenna and Rectifier.

WORKING:

- Antenna picks up RF radiation from nearby equipment like mobile phones, towers, and routers, etc.
- The radiation is received by the antenna in the form of AC power, which the conversion unit then transforms into DC power for the application.
- The matching network aids in balancing the impedance of both conversion unit and antenna.

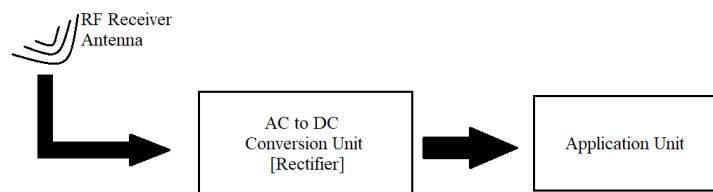


Fig.1. Basic design of proposed system

A. Steps to Design Antenna

Step 01: Create a new project folder in HFSS tool.

Step 02: Draw a ground plane of dimensions (-40mm,-40mm, 0) on the 3-dimensional plane using a rectangle.

Step 03: On top of the rectangular plane or ground draw a substrate of height 1.6mm and all the other dimensions same as ground, with the help of 3-dimensional box (material used for substrate is FR4).

Step 04: Now, on top of the ground draw a patch of length and breadth as calculated for 2.45GHz frequency.

Step 05: From the center of the coordinate axis draw a feed line with thickness of 3mm and length 40mm.

Step 06: Now, cut the patch in such a way shown in diagram below with 1mm gap between feed line and the patch.

Step 07: Change the axis from XY to YZ and draw the port using rectangle.

Step 08: Give excitation to the port by using lumped port to match the impedance of the antenna.

Step 09: Then assign perfect electric boundary to patch and ground.

Step 10: Draw a radiation box such that whole microstrip patch antenna fits in that and assign a radiation boundary to the radiation box (make it transparent such that our antenna is visible).

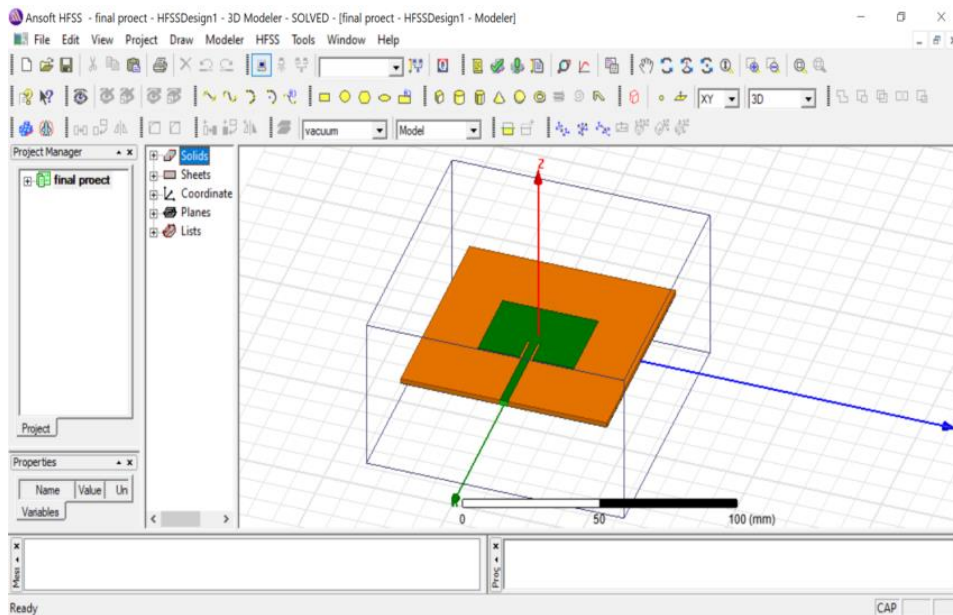


Fig.2. Antenna geometry in Ansys HFSS tool



Fig.3. Fabricated Antenna

B. Design of Rectifier in Keysight ADS software

Step 01: Create a new project on the ADS software.

Step 02: Create a new schematic under the project folder.

Step 03: Design the circuit diagram as shown below, with the available tools on the software.

Step 04: Give the appropriate measurements for capacitors, inductors and resistors.

Step 05: Save the circuit design and assign the terminals at both the ends, i.e., input and output ends.

Step 06: Now, run the design for result and obtain the graph to know how much power is totally generated.

Step 07: After getting the total power output, try to optimize the output power as per the objectives.

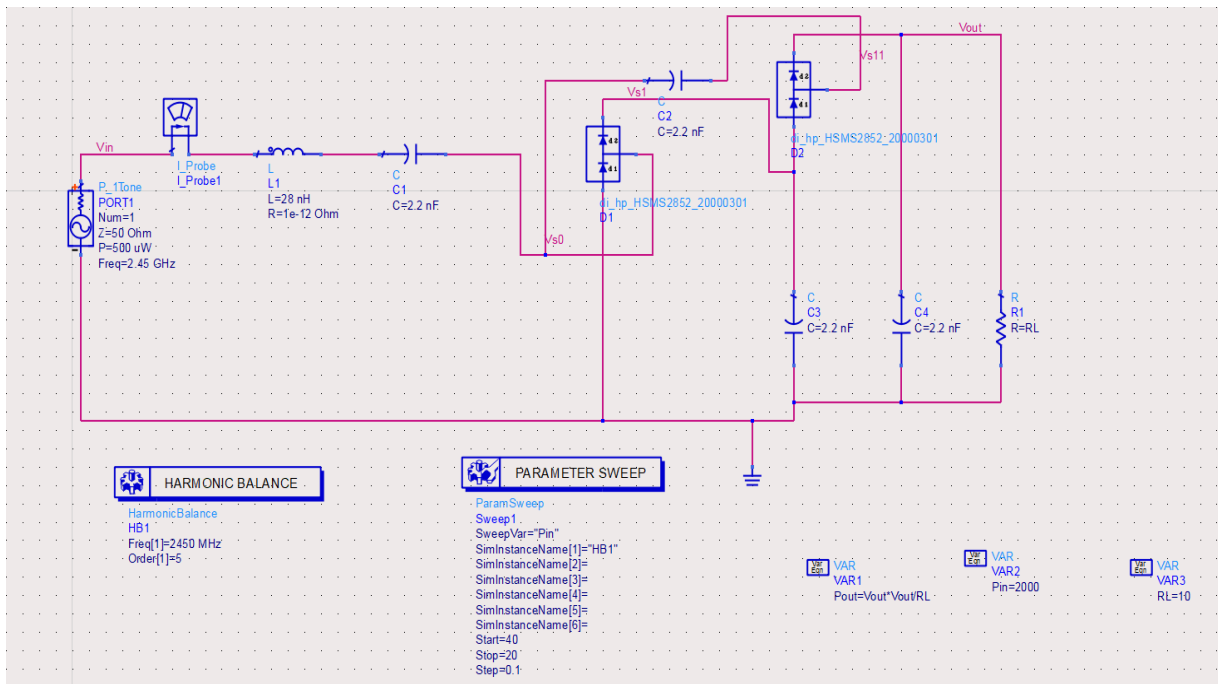


Fig.4. Rectifier circuit constructed in Keysight ADS tool

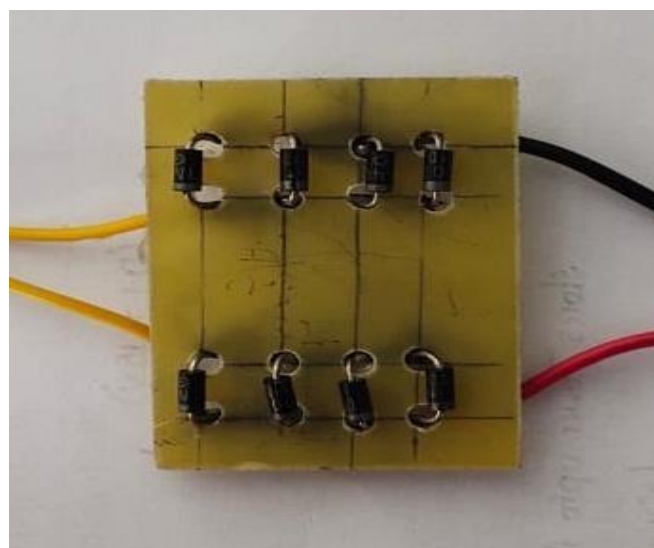


Fig.5. Fabricated Rectifier

IV. EXPERIMENTAL RESULTS

The prototype of the energy harvesting system is shown below:

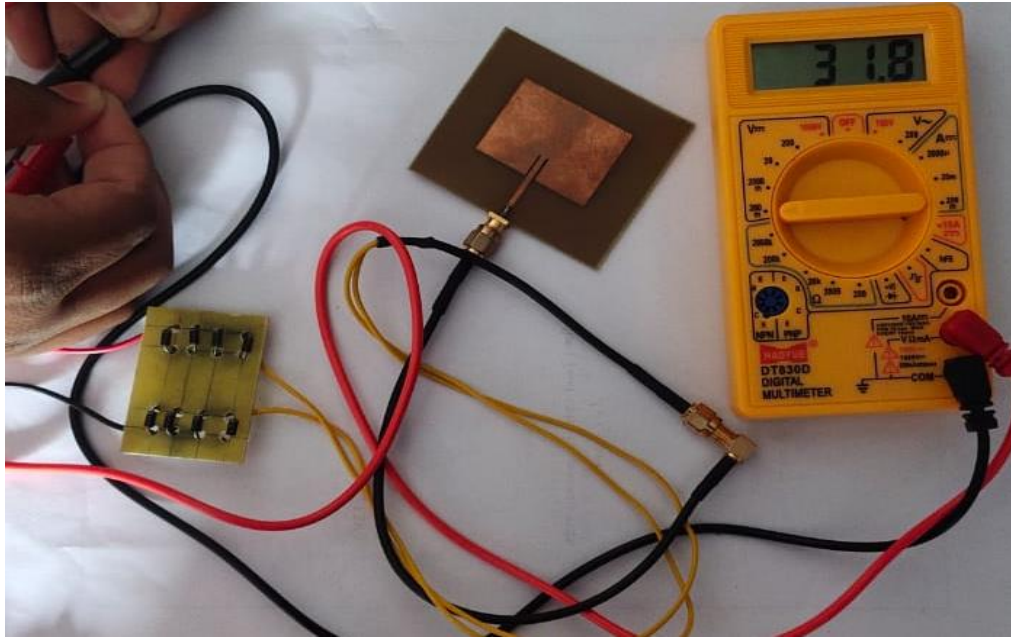


Fig.6. Hardware prototype of the Implementation

V. CONCLUSION

This article demonstrates that RF energy is widely distributed throughout the planet's atmosphere. The energy produced from RF energy harvesting is used to operate low power electronics applications, which will reduce the requirement for electricity, in addition to removing harmful RF energy from the atmosphere. Although RF energy harvesting will benefit the environment, it is a very challenging task due to the low energy density of RF signals. Thus, research into RF harvesting has a bright future.

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