Rectifier Using UFO Microstrip Antenna as Electromagnetic Energy Harvester

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RESEARCH ARTICLE

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Rectifier Using UFO Microstrip Antenna as Electromagnetic Energy Harvester

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Rectifier antenna is an antenna that is integrated with a rectifier circuit that has the ability to convert RF waves into DC voltage. Microstrip antenna on the rectenna can serve as capture electromagnetic waves is then converted into AC waveform that will by rectifier will be recycled again into a DC waveform. Recycling concept can be applied electromagnetic waves at a frequency of 16500–2700 MHz, which is then the frequency will be altered to produce a DC waveform that can be measured into a voltage. Of order to make a rectenna is capable of working at a frequency of 1650–2700 MHz, it is necessary to design a microstrip antenna and a rectifier circuit that is able to work at that frequency. Microstrip antenna design dimensions obtained through calculation optimization and simulation. This microstrip antenna fabrication using materials a Phenolic White Paper - FR4 with a dielectric constant (εr) = 3.9.

Keywords: Rectenna, Antena, Rectifier, Ultra Wideband.

1. INTRODUCTION

At the present time requires a lot of human energy as a support in the process of moving and development of technology products, both electrical and mechanical technology products. Electrical and mechanical energy source has its limitations and scarcity particular source came from fossil energy is also not environmentally friendly[1] and has a fairly expensive price. But as the development of science it is found in a variety of alternative sources of energy is cheaper and environmentally friendly as well as an unlimited amount in nature such as sunlight, wind, sound, or thermal energy.

Today, Along with the development of a device that emits radio frequency electromagnetic energy and has then spread in an area, then in the spread of the energy is not entirely received by the device recaiver, but wasted in vain in the air along with other radio waves.[2–4] Then create the technology to take advantage of these energy sources called energy harvesting. One of the main tools to perform RF harvesting is rectenna which generally consists of a rectifier and antenna.[5]

Rectenna is essentially a rectifier and an antenna, a device that can convert RF waves into electrical energy that have low power. In general, the rectenna is divided into two types, the first through the Wi-Fi signal, and the second using radio waves emitted by radio or TV tower are both exempted by regulation to be accepted and absorbed by the device. However, it is possible to harvest the radio waves emitted by other devices such as the devices on GSM technology, CDMA or other device.[6, 7]

On the research that this will be done will discuss designing a rectenna using a UFO microstrip antenna at ultra wideband (UWB) frequency.[8] The purpose of design and testing of UFO microstrip antenna and the rectenna circuit using Schottky diodes as a half-wave rectifier with structure and full wave.

2. RESEARCH METHODS

2.1. Simulation Using CST 2015 and Microstrip Antenna Fabrication

Microstrip antenna design is done mathematically based on the material and references obtained from the literature.[9] Results of the draft then simulated using the design software to determine the parameters of the antenna. Stage design and simulation of this antenna is important to look at the qualifications of the design whether it is appropriate or not as desired performance.

2.2. Simulation and Implementation of Voltage Doubler Rectifier 7 Segment

For the simulation of rectifiers, also performed based on the material and references obtained from the literature. Then simulated the design that would become reference of the input voltage and output voltage of the rectifier.

The rectifier circuits there are some things that must be considered. Proposed antennas has working frequency of 1800 MHz

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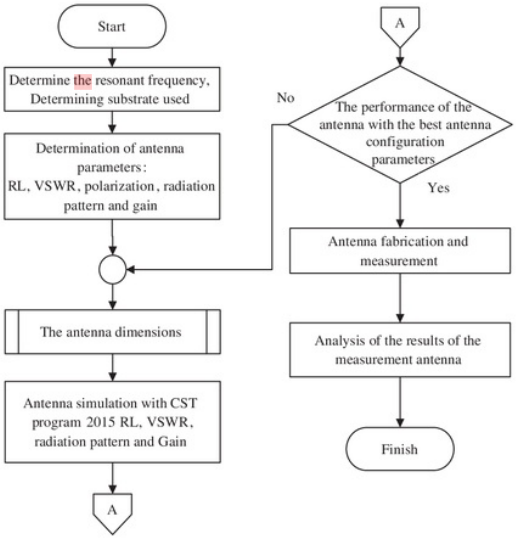

Fig. 1. Flowchart of design and fabrication antenna.

and 2400 MHz, it is necessary to design match rectifier with is antenna and is capable of capturing electromagnetic waves at a frequency of 1800 MHz and 2400 MHz.

2.3. Measurement and Testing

Tests and measurements performed by measuring the voltage measured at the output of the rectifier. These measurements include.

2.3.1. Antenna Measurement

The value of each test parameter in microstrip antenna UFO shape with ultra wideband frequency, which include: VSWR, return loss, bandwidth, polarization, radiation pattern and gain.

Table I. Dimensions of antenna after optimization.

Variable	Dimension (mm)
α	40
Lep	40
Wep	100
Lg	46
Wg	50
Leg	30
Weg	76
Lrg	10
Wrg	40
$L = W$	120

Table II. Doubler rectifier 7 segment component.

Name of component	Label	Value
Stage capacitors	C1, C3, C5, C7, C9, C11, C13, C15	100 uF
	C2, C4, C6, C8, C10, C12, C14	10 nF
Stage diodes	D1–D14	HSMS 2850

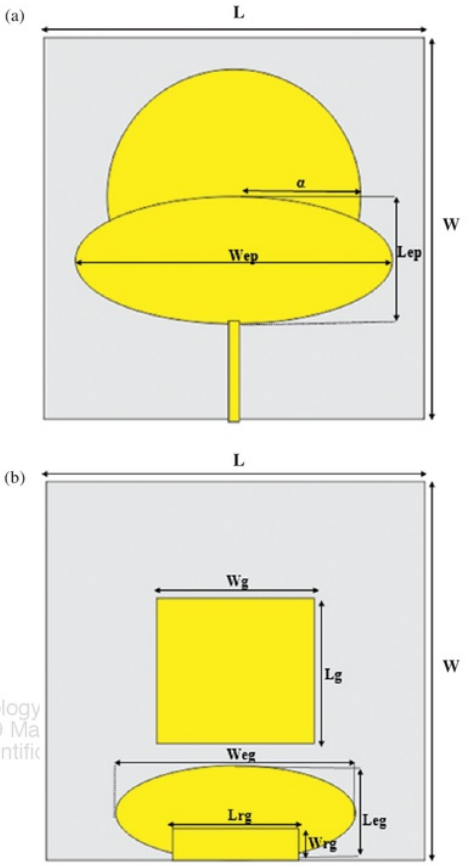

Fig. 2. Geometric shape microstrip UFO patch antenna (after optimization) (a) front (b) rear.

2.3.2. Measurement and Testing Rectifier

The magnitude of the voltage, DC voltage is generated, as well as the efficiency of the rectifier to the rectenna using half-wave rectifier schottky diode type with a source frequency of ultra-wideband microstrip antenna that is at a frequency of 1800 MHz

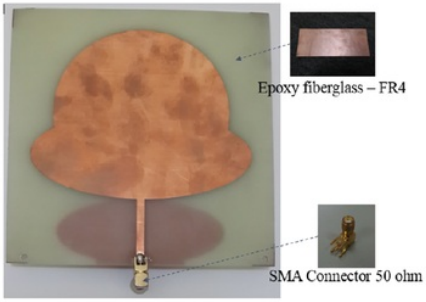

Fig. 3. Prototypes microstrip UFO patch antenna.

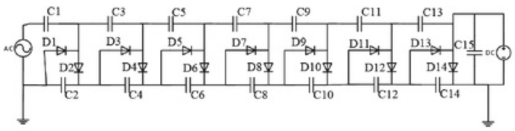

Fig. 4. The circuit rectenna.[10]
source: Kavuri Kasi Annapurna Devi and Norashidah Md. Din, 2012.

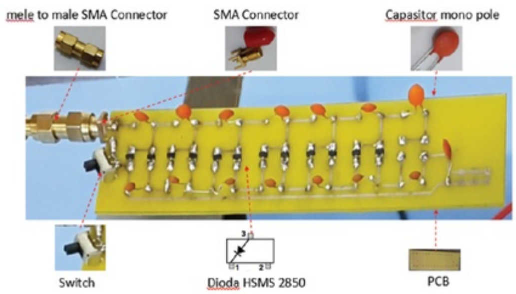

Fig. 5. Prototypes microstrip UFO patch antenna.

and 2400 MHz. Measurements done in the laboratory using the signal generator and testing is done on mobile devices, Wifi and CCTV using digital multimeter Sanwa CD800a and Krisbow KW06-272.

3. MEASUREMENT AND TEST RESULTS

3.1. Comparative of Parameter Antenna Simulation Result and Test Results

Here is a comparison chart of return loss values of simulation and measurement results.

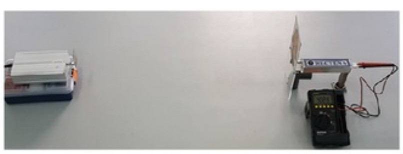

Fig. 6. Testing rectena using digital multimeter Sanwa CD800a and Krisbow KW06-272.

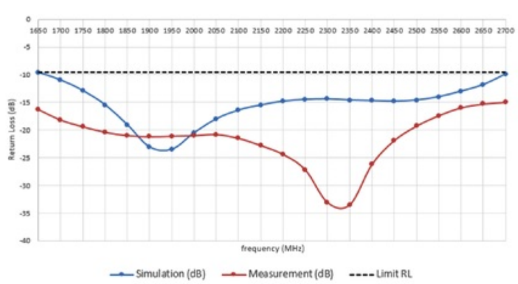

Fig. 7. Graph return loss antenna simulation and measurement results.

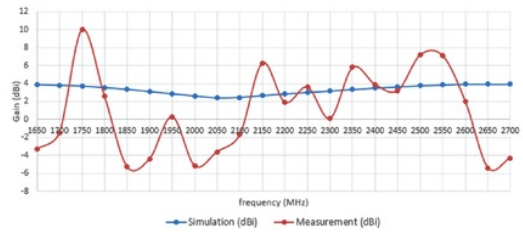

Fig. 8. Gain of antenna.

The Figure 12 above shows a comparison between the simulation results and return loss measurements. There are differences in the return loss values obtained from the simulation and measurement. Even so, the results of simulations and measurements indicate the frequency range 1650–2700 MHz is of −10 dB RL loss that it can be said that the antenna can work well on the frequency range and the antenna is an antenna ultra wideband (UWB) can work with a wide mindless bands above 500 MHz.

There is discrepancy between measurements and simulation results. Gain result on the measurement results have a frequency of 1800 MHz (GSM telecommunications frequency) is 2.6 dBi and 2400 (Wifi frequency) is 3.9 dBi with gain measurements using the reference antenna is a dipole antenna $\lambda/2$ with 2.15 dBi gain result standards.

Here is a comparison of the radiation pattern between simulation and measurement.

There is discrepancy between measurements and simulation results. Polar diagram in Figures 8 and 9 shows that the radiation pattern of the antenna radiation pattern and the simulation results are not exactly the same, but the radiation pattern in simulation

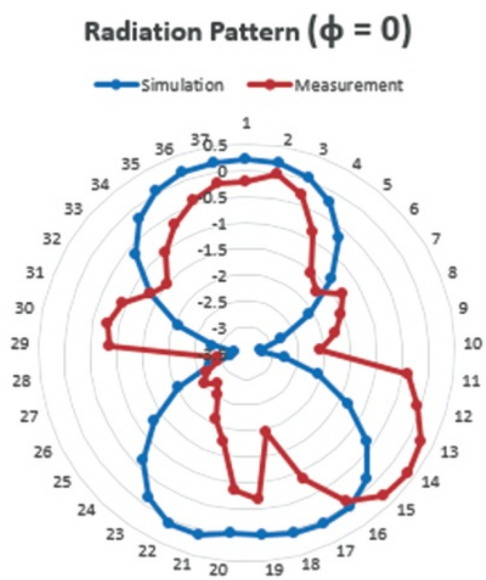

Fig. 9. Comparison of radiation pattern between simulation and measurement results of $\phi = 0$.

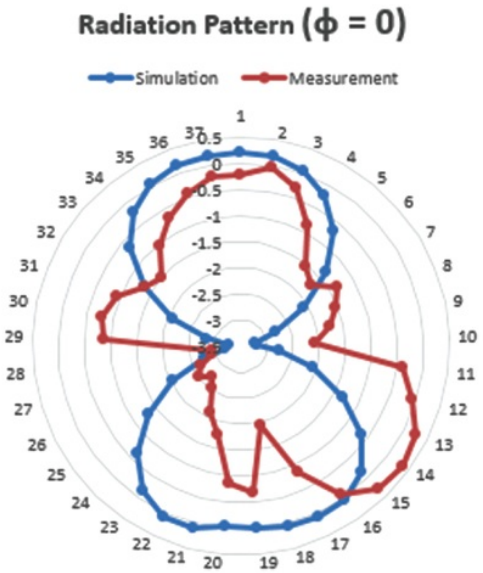

Fig. 10. Comparison of radiation pattern between simulation and measurement results of $\phi = 90°$.

and measurement antennas have a similar radiation pattern that is bidirectional.

Type of polarization based on the measurement results can be seen in the polar diagram in Figure 10 which shows that the UFO microstrip patch antenna has linear polarization.

4. ANALYSIS OF SETUP OF MEASUREMENT AND TESTING

The main objective of this rectifier output measurement is to determine whether the rectifier can work optimally. Rectifier output reference of measurement using a signal generator as a signal transmitter frequency 1800 MHz and 2400 MHz and The main

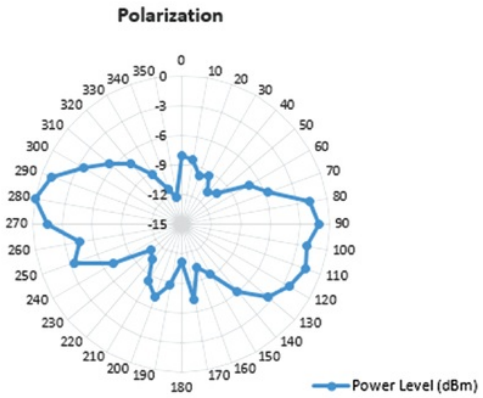

Fig. 11. Polarization.

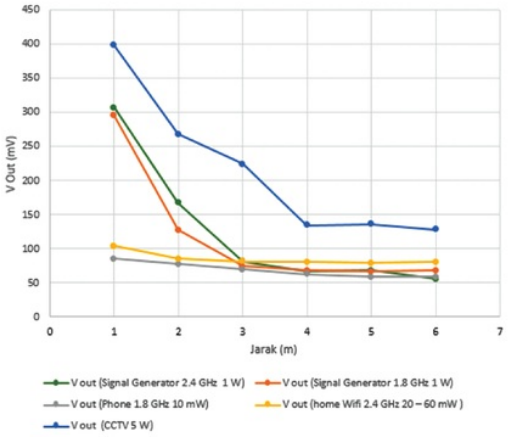

Fig. 12. Comparison chart Measurement and Testing Against output voltage at a distance of 1–6 m.

purpose of this rectifier testing is to determine whether the rectifier to work optimally of the frequency 1650–2700 MHz.

The greatest DC voltage at the closest distance of 1 m is 398 mV from the transmitter CCTV 5 W and the greatest DC voltage at the closest distance of 10 cm is 4,85 V from the transmitter CCTV 5 W.

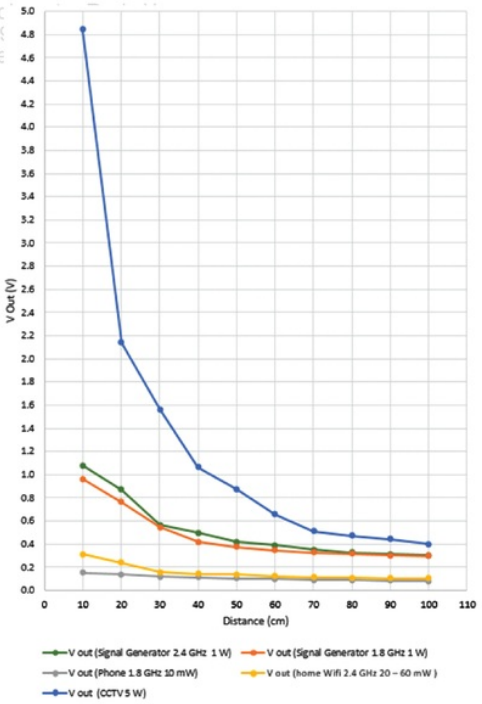

Fig. 13. Comparison chart Measurement and Testing Against output voltage at a distance of 10–100 cm.

Fig. 14. Data retrieval results using digital multimeter Krisbow KW06-272.

5. CONCLUSIONS

Based on the results of the design, testing, measurement, and analysis parameters UFO microstrip patch antenna, it can be concluded as follows:

1. Microstrip patch antenna UFO has of working at a frequency of 1650–2700 MHz.
2. Output voltage (output) generated by the rectifier circuit is influenced by the distance between the transmitter antenna electromagnetic waves with the rectenna.
3. The value of the output voltage (output) generated by the rectifier circuit is strongly influenced by the electromagnetic wave transmitter power.
4. Rectenna is able to convert AC voltage into DC voltage. It was found to yield at 4.85 V output DC voltage. It is better then.[4, 10]

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