A Review Paper on Design of Rectenna
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Abstract—This review paper describes the design of a rectenna that convert the electromagnetic energy into the DC power which is much more useful to run the Microelectronics device. A new rectenna topology consisting only of an antenna, a matching circuit, a Schottky diode, and a DC filter. The amounts of power that can be transferred by using rectenna are heavily dependent on geometric properties of diodes and this has a great effect on output DC voltage [1]. Compact dual-band rectenna, the measured result show an efficiency of 37% and 30% at 915 MHz and at 2.45 GHz [2].

Key words: Rectenna, Rectifying Antenna

I. INTRODUCTION

Rectifying antenna (rectenna), which can capture and convert electromagnetic power to electric power, plays an important role in free space wireless power transmission (WPT) [3]. This feature is an attractive solution to supply a node in a Wireless Sensor Network (WSN) [4] or the electronic circuits of the radio frequency identification (RFID) [5]. In the literature, several publications deal with the rectenna. The initial development of rectenna focuses on its efficiency for great power reception and conversion. But in the last few years, excluding high power applications, wireless power transfer has been often used in microwave radiation with relatively low power densities [6,7]. This approach offers the possibility to use the rectenna as an energy module in a Wireless Sensor Network. To this end, we have chosen to develop a rectenna operating at very low power densities (several μW/cm²). Indeed, the rectenna efficiency at low power level is an important feature (0dBm, and −10dBm), because it would allow one to power a node or a tag located far away from the RF transmitting source. For this purpose, we must take into account several considerations, such as the size, and a good conversion efficiency. The Basic block diagram of rectenna structure is illustrated in Fig. 1.

![Fig. 1: Basic block diagram of Rectenna [6]](image)

II. RECTENNA DESIGN

A. Antenna Design

Antennas can be considered as the backbone in the wireless communication without which the world would not have reached till this age of technology. Microstrip patch type antenna used in rectenna design due to its compactness, low cost and gives better output for designed frequency. There are many shapes of microstrip patch antennas and they have been designed to match specific characteristics. Some of the common types are square, circular, disk slot, rectangular, triangle, circular ring, ellipse etc. There are many types of feeding method for the microstrip antennas are Microstrip line, coaxial probe, Proximity coupling, Aperture coupling etc. Fig 2. Shows Rectangular microstrip patch antenna.

![Fig. 2: Rectangular microstrip patch antenna](image)

III. RECTIFIER DESIGN

Rectifier section for rectenna consists of Matching circuit, first filter, diode circuit and second filter which shown in figure 2.

![Fig. 3: Block Diagram of Rectenna Design [7]](image)

A. Matching Circuit

This matching circuit was composed of three lines stubs TL1, TL2, and TL3 shown in figure 4.

![Fig. 4: Different Section of Rectifier Design [7]](image)

B. Band Pass Filter (F1)

To minimize the rectifier size, we chose to suppress the band pass filter (BPF) F1 of this rectifier the conversion efficiency is increased by the suppression of inherent losses associate to the BPF.

C. Diode

The efficiency of the rectifier depends mainly on Schottky diode. The diode used in the rectenna is the HSMS-2860 from Agilent. It has a series resistance Rs = 5 Ohms, zero bias junction capacitance Cjo = 0.18 pF, and breakdown voltage Vb = 7V. The diode is a critical part in the realization of the rectifier. A correct modeling of this diode is a critical step to the rectenna simulation.
device is mandatory to the achievement of precise simulations. From the literature survey, comparison between different substrate material and different diode used in rectenna circuit are in table 1.

<table>
<thead>
<tr>
<th>Operating Frequency</th>
<th>Substrate</th>
<th>Diode</th>
<th>Size</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.56 MHz</td>
<td>Melinex ST560</td>
<td>Organic</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>24 GHz</td>
<td>Duroid 5880</td>
<td>MA4E1317</td>
<td>30 x 30</td>
<td>24%</td>
</tr>
<tr>
<td>C, X, Ku, K-band</td>
<td>Rogers 6002</td>
<td>MA4E1317</td>
<td>20 x 14</td>
<td>42%</td>
</tr>
<tr>
<td>915 MHz</td>
<td>FR-4</td>
<td>HSMS286c</td>
<td>10 x 12.5</td>
<td>71.3%</td>
</tr>
<tr>
<td>2.45 GHz</td>
<td>FR-4</td>
<td>HSMS286c</td>
<td>100 x 100</td>
<td>82.3%</td>
</tr>
<tr>
<td>915 MHz</td>
<td>Arnol 25N</td>
<td>SMS7630</td>
<td>60 x 60</td>
<td>37%</td>
</tr>
<tr>
<td>2.45 GHz</td>
<td>Duroid 5880</td>
<td>HSMS2860</td>
<td>110 x 100</td>
<td>63%</td>
</tr>
<tr>
<td>2.45 GHz</td>
<td>Arnol 25N</td>
<td>SMS7630</td>
<td>70 x 66</td>
<td>38.2%</td>
</tr>
<tr>
<td>5.8 GHz</td>
<td>Rogers 6002</td>
<td>HSMS8202</td>
<td>87 x 73</td>
<td>68.5%</td>
</tr>
</tbody>
</table>

Table 1: Different diode used in Rectenna circuit

D. Low Pass Filter (F2)

Output filter for rectifier design is low pass filter for good efficiency.

E. Rectenna Efficiency

\[ \eta_{\text{rect}} = \frac{P_d}{P_r} = \frac{V_d^2}{R_{\text{in}}/R_{\text{rev}}} \]  

(2.1)

IV. EXAMPLE OF RECTENNA DESIGN

Fig. 5: Integrated Single Patch Antenna [8]

Fig. 6: Integrated Patch Array Antenna [8]

REFERENCES


[10] Getting Started with HFSSv9 for Antenna Design v0.pdf