Implementation of DC Dual Band Rectenna for Energy Harvesting

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Abstract **In this paper, a novel approach towards the implementation of DC Dual Band Rectenna is discussed. This paper focuses on improving rectenna for changed productivity for the case of low info control thickness. Expanding the rectenna change proficiency for low power thickness is outstanding for improving rectenna execution. As of now, there are few of research concentrated on wideband rectenna clusters for low info control. Another wideband rectenna exhibit with a reflector is created to build the rectenna change proficiency and yield voltage through expanding the addition of the reception apparatus. Moreover, two association techniques are utilized to fabricate the rectenna exhibit and focal points and drawbacks for every strategy are displayed. The RF to DC transformation productivity of proposed rectenna exhibits is plenteous improved for low info control thickness over a wide transfer speed.**

Keywords —Rectenna, Energy Harvesting, Antenna, Dual Band, wireless, DC combiner rectenna.

I. INTRODUCTION

The advanced history of free space control transmission might be considered to have its starting point in the late 1950s [3] with applications in microwave-fueled flying machine and the sunlight based power Satellite Concept. Since the primary remote transmission frameworks was shown [4]it has turned into an inexorably fascinating subject for the remote vitality network. This intrigue appears to have been started by short-extend (< 2 m) radio recurrence recognizable proof (RFID) applications, concentrating on accessible industry, science and medicinal (ISM) recurrence groups around 0.9 GHz, 2.4 GHz, 5.8 GHz and higher. Very for the higher frequencies, the wavelengths are little enough for the acknowledgment of small remote items [5].

A standout amongst the most imperative and primary prerequisite of WPT framework is the proficient exchange of the electrical power. The key segment for the framework comprises of a radio wire coupled to a correcting unit. The mix of a radio wire and a rectifier is normally called a rectenna and it can change over electromagnetic vitality to coordinate current (DC) vitality. A decent audit of amendment of microwave signals for providing DC control through remote transmission has been given in [4].

II. MOTIVATION

In this work, every reception apparatus is associated with a correcting diode, keeping the non-mandate properties of every component. Furthermore, the power is gathered from any discretionary polarization episode on the amending reception apparatus cluster. In any case, these wideband rectennas had low RF to DC transformation efficiencies. For instance, the change proficiency around 20% was exhibited in [22].

By and large talking, there square measure 3 basic cutoff points of the greater part of current rectenna styles. The essential one is that most of rectennas were performed for narrowband, exceptionally one recurrence. As far as possible is that top RF to DC transformation strength needs high information control level. a definitive drawback is bandrectennas had low RF to DC transformation strength or DC yield voltage.

The main inspiration of this examination is to defeat these constraints. Effectively expanding the rectenna data transfer capacity and improving the RF to DC transformation proficiency for wideband rectennas at low information control thickness are the primary inspiration. The wideband rectenna can be incorporated into various remote gadgets, where the rectenna can catch and correct bigger measure of vitality noticeable all around at various frequencies. Low information control rectennas can effectively use in low power thickness zone with reliable high change effectiveness execution.

To supply high DC yield voltage, the rectenna exhibit is likewise an imperative and fundamental strategy for rectenna plans. The rectenna exhibit can be worked by utilizing diverse interconnections of rectenna components [22, 23, 25]. Every association has its own yield highlights.

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Be that as it may, they all worry about ideal yield voltage. There is deficient in configuration to improve RF to DC change effectiveness for lower input control densities. Subsequently, the second inspiration of this work is to build up a rectenna exhibit which can adequately improve the rectenna transformation effectiveness for low info control densities.

III. LITERATURE

A planar dipole rectenna operating at 35 GHz with 39% conversion efficiency proposed in [46] as shown in Fig. 1.1. There was a low pass filter based on microstrip line technique and a Schottky diode which were connected to the antenna.

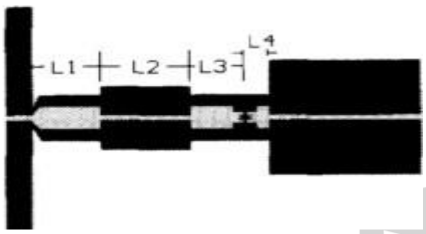

Fig. 1.1: "The planar dipole rectenna at 35 GHz"

A dual band dipole rectenna operating at both ISM bands (2.45 GHz and 5.8 GHz) was proposed [16]. As shown in Fig. 2.4 that apart from the antenna, there were other components also such as a rectifying diode, low- pass filter, band-pass filter, and a microwave block capacitor. The rectenna was highly efficient as it showed 84.4% and 82.7% conversion efficiency at 2.45 GHz and 5.84 GHz.

A decoupled dipole rectenna operating at 2.4 GHz band is proposed in [21] and shown in Fig. 1.2. There was 37% size reduction compared to two decoupled patch antennas. Proposed rectenna supports wireless power transfer and also few results were presented showing RF to DC conversion efficiency.

(1)

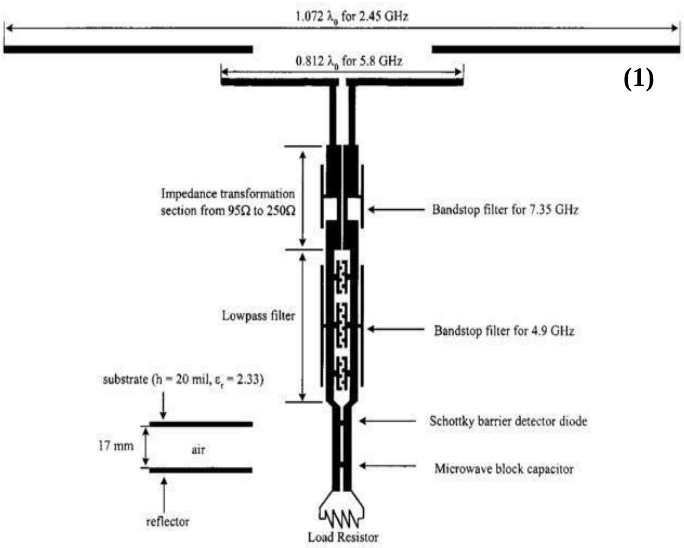

Fig. 1.2: "The dual-frequency rectenna for 2.45 and 5.8 GHz wireless power transmission"

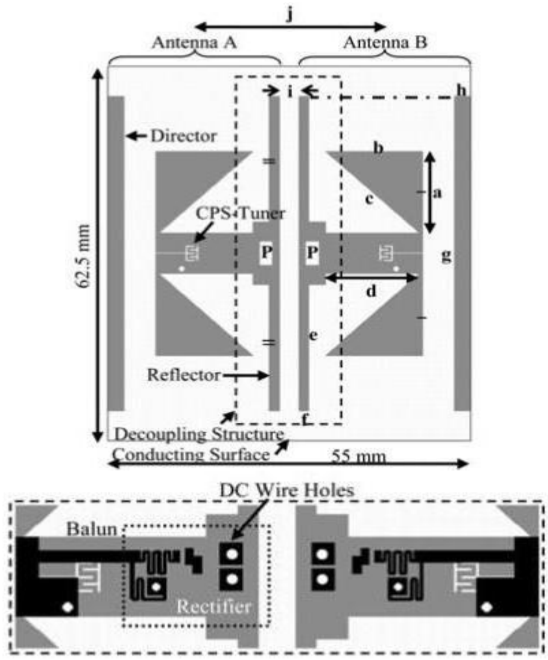

Fig. 1.3: "The decoupling dual-dipole rectennas"

A high efficiency and high gain rectenna was presented in [44] as shown in Fig. 1.3. The proposed antenna operates at 2.45 GHz and was designed to match rectifier circuit so that the requirement of a filter can be avoided. The conversion efficiency observed was around 83%.

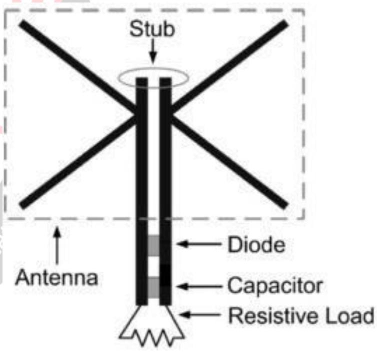

Fig. 1.4: "The high efficiency planar dipole rectenna"

A. Micro-strip Patch Rectennas

A dual polarised circular patch rectenna operating at 2.45 GHz was presented in [28]. As shown in Fig. 1.5, with the use of two orthogonal micro-strip feed lines resulted in dual polarisation. Rectification was performed by Schottky diodes on each feed line. The antenna showed the conversion efficiency of 48%.

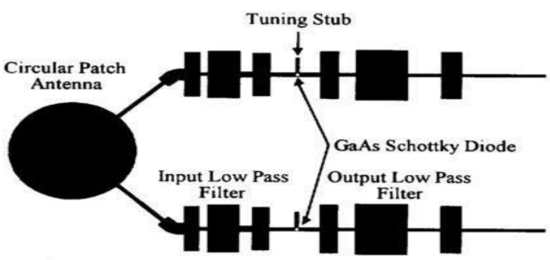

Fig. 1.5: "The dual-polarised circular patch rectenna"

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IV. RECTENNA MEASUREMENT

The estimation technique for the rectenna has been examined in [19]. The hardware setup. In this framework a transmitting horn recieving wire is associated with an advanced transmitter with a variable recurrence. The rectenna is put close to the transmitting recieving wires and the execution of the rectenna was confirmed by estimating the yield DC voltage utilizing a voltage meter. The transmitting recieving wire is a Vivaldi horn reception apparatus with an addition around 5 dB over the recurrence of intrigue. Estimations were performed by setting the proposed rectenna at a separation of 40 cm far from the horn radio wire. The meaning of the RF to DC transformation proficiency of a rectenna.

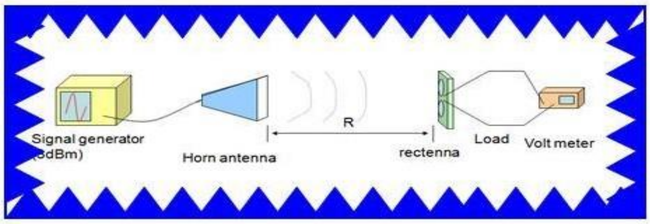

Fig. 1.6: Rectenna Measurement System

. In the condition, the power transmitted to the horn recieving wire was estimated by utilizing a range analyser. The increase Gt and productivity of the reference horn radio wire are given on the information sheet. The separation between the horn recieving wire and the rectenna were fixed. In spite of the fact that the power thickness utilized here is a hypothetical esteem it would be very like the deliberate esteem.

The rectenna was structured and reproduced by utilizing CST MWS and ADS PC programming [12]. The information impedance of the radio wire was given by utilizing the CST programming and after that it was imported to the ADS programming as the impedance of the power source. A Harmonic parity recreation was made in the ADS to get the DC yield voltage of the amending circuit (the diode and the heap). Fig. 1.6 demonstrates the deliberate and reproduced DC yield voltage as a component of the recurrence with a yield heap of 100 Ohm and the occurrence control (PRF) around - 3 dBm. Contradictions for reproduced and estimated results are accepted to be brought about by three components. Right off the bat, the recieving wire proficiency didn't consider in the reproduction yet practically speaking the reception apparatus radiation effectiveness would notablely influence the outcome. Also, the estimation position is another eminent factor influenced the estimation result in light of the fact that the planar recieving wire is an appropriated component. At long last, addition of the transmitting horn utilizing in the estimation is low at the recurrence go beneath 2.5 GHz. Clearly this roundabout dipole rectenna has corrected RF capacity to the DC power around 3.0 GHz. Note that the execution of rectenna as a component of recurrence is emphatically influenced by the recieving wire transfer speed. The reflection coefficient of the round dipole has been exhibited and the recieving wire covers the data transmission from 2.6 to 3 GHz. From the deliberate outcome, the transmission capacity of rectenna moved a tad upwards may result from the creation blunders and the coupling among reception apparatus and rectifier.

As we referenced before the rectifier change proficiency and the DC yield voltage are notably influenced by the information control level. A 30 dB enhancer was added before the horn reception apparatus to build the info control dimension of our rectenna estimation. The deliberate DC yield voltage as a component of information control thickness for different outside burden protections at 2.8 GHz is appeared in Fig. 3.5. Plainly with the increments of info control thickness the DC yield voltage for rectenna additionally increment. The DC yield voltage is 100 mV and 320 mV with power thickness of 0.05 mW/cm2 for 100 and 1100 Ω, individually. There is a comparable pattern for other rectenna: a bigger burden obstruction can accomplish a higher DC yield voltage.

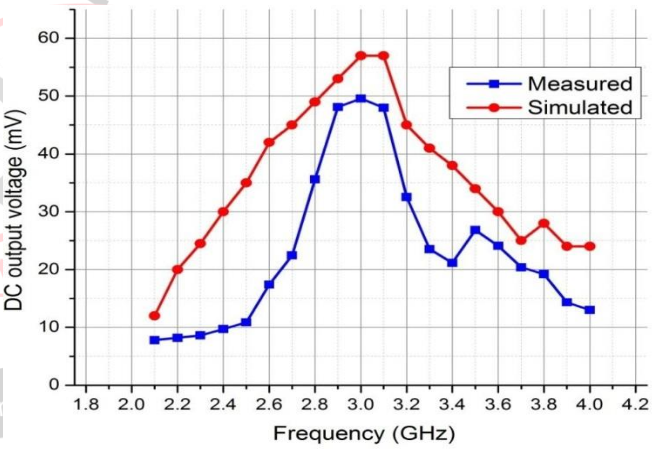

Fig. 1.7: Simulated and measured DC rectified voltage response across a 100 Ω load

Fig. 1.7 shows the RF to DC change proficiency as an element of the power thickness for different burdens. The best proficiency, 16.8 %, happens at a heap of1100 Ohm and the DC yield voltage is 227 mW. The RF to DC change proficiency for utilizing 100 Ohm load is around 16%. Clearly the proficiency increments with the expansion of intensity thickness. In addition, the effectiveness compasses to the pinnacle esteem and after that somewhat diminishes because of the diode qualities. There is an ideal info control thickness level for the redressing diode.

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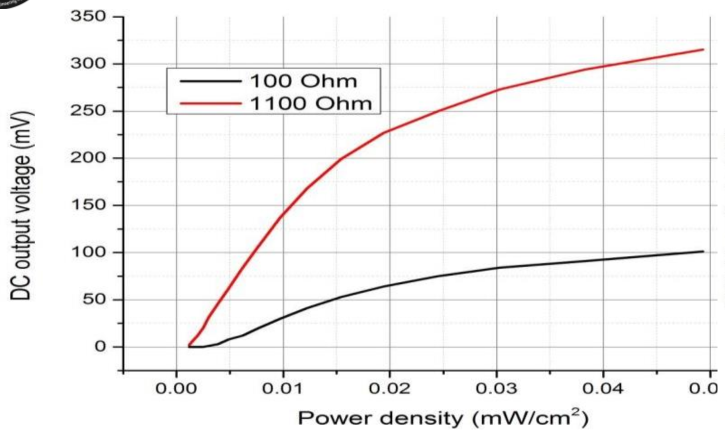

Fig. 1.8: Measured DC voltage as a function of power density at 2.8 GHz

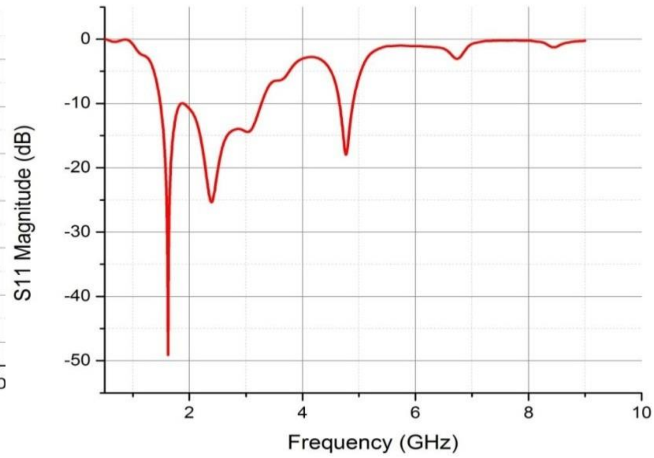

Fig. 1.10: Simulated S11 for proposed antenna with low-pass filter

V. DC COMBINER DUAL BAND RECTENNA

The second two-component wideband printed dipole double band is appeared in Fig. 1.9. The length of L is 40 mm; the separation between two recieving wires is d1 and a reflector place underneath the radio wire with a streamlined space of d of 35 mm. The trademark impedance of the parallel strip-line which sustained each component is 50 ohm and associated with the low-pass channel and rectifier.

(b)

Fig. 1.9: The layout of the proposed rectenna dual band

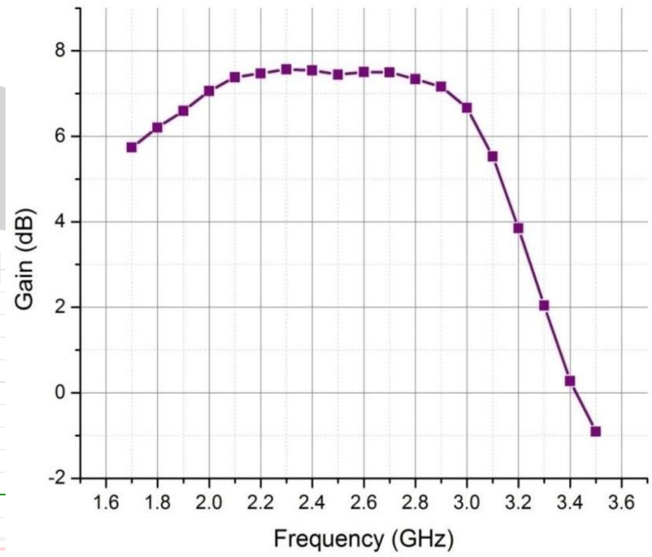

Fig 1.11: Simulated gain for each proposed antenna element with the low-pass filter

The improved reflection coefficient and addition for every reception apparatus component are appeared in Fig. 1.10 and 1.11. This two reception apparatus component is the equivalent and has a similar recieving wire execution. From Fig. 5.19 the reception apparatus has the data transfer capacity of 61%, which spread frequencies from 1.7 GHz to 3.2 GHz. The low-pass channel obstructs the high request sounds however because of the coupling among radio wire and low-pass channel there is a profound at 5 GHz. The increase of proposed radio wire demonstrates that the reception apparatus most extreme addition is 7.6 dB at 2.2 to 2.8 GHz and the normal addition is 7 GHz at entire recurrence run. Contrasting the increase of the recieving wire component to the addition of the single reception apparatus, the decline of the addition may cause by the shared coupling between two components. The DC yield is parallel joined in the rectifier and the hypothetical investigation is examined as pursues.

A. The Rectenna Implementation

The propose RF combiner rectenna was made and after that tried in an anechoic chamber. The estimation framework is delineated in Fig. 1.12(a) and the photo of the manufactured rectenna is given in Fig. 1.12(b). The source in the estimation was a flag generator associated a power intensifier, permitting far field estimations to be performed for a scope of episode control thickness on the incorporated rectenna at the typical occurrence. A standard horn recieving wire was utilized for transmitting the power from 1.4 to 3 GHz. Furthermore, the proposed rectenna was set in a fixed position and by estimating the yield voltage Vdc over the heap R, at that point the transformation proficiency can be gotten. The deliberate transformation productivity and yield voltage of the rectenna for various information control densities and frequencies are delineate. The ideal operational recurrence run for the wideband rectenna is observed to be 1.5 to 3.0 GHz at a power thickness run

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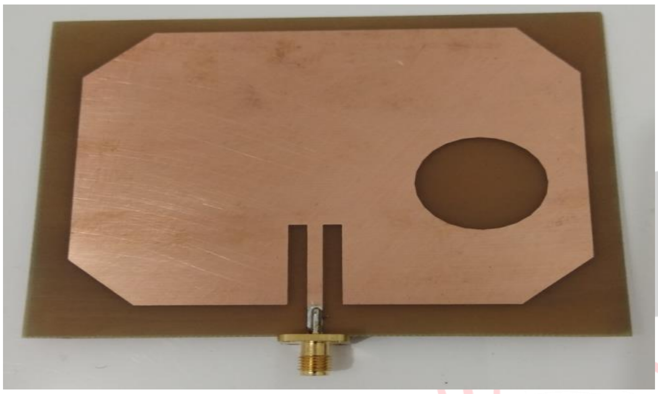
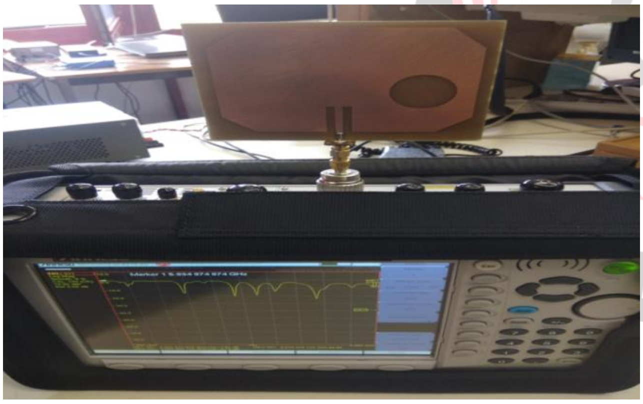
from 0.1 to 120 μW/cm2. It is seen that the greatest transformation effectiveness of 37% is accomplished around 80 μW/cm2 at 2.2 GHz. Over a higher recurrence extend (2.4 GHz-3.0 GHz) transformation efficiencies decline because of the material misfortunes on the rectifier and a bungle between the radio wire and the low-pass channel and the rectifier brought about by manufacture mistakes. Also, from 1.5 to 3 GHz the general transformation proficiency of the rectenna is over 20 %. Contrasting and other wideband rectennas, the proposed rectenna has generally great change productivity over a wideband range. The Fig. 5.12 demonstrates the deliberate DC yield voltage of the rectenna as a component of the recurrence and power thickness.



(a)



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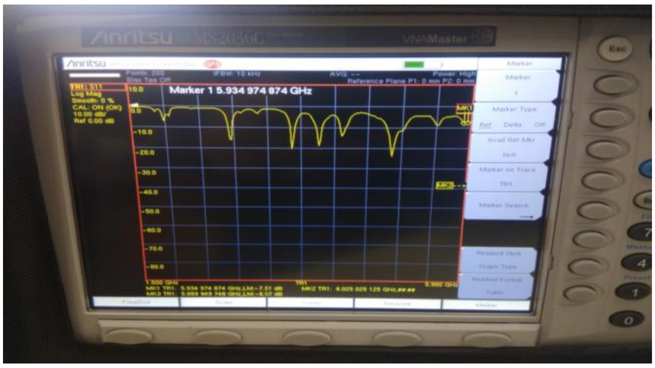
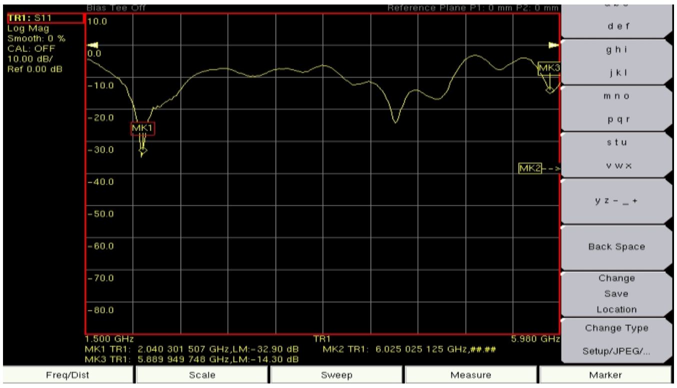


(c)



(d)

Fig. 1.12. a,b,c,d The photographs of proposed rectenna under test. the measurement system in anechoic chamber

From Fig. 1.12(c) and 1.12(d), it is demonstrated that the yield voltage and RF to DC change proficiency are lower than the reenacted outcomes. The difference is cause by three components. Right off the bat, the FR4 substrate cause material free at high recurrence (>1.5GHz). Furthermore, the manufacture mistake and the association among reception apparatus and rectifier influence the rectenna execution. At long last, the poor confinement combiner influenced the reception apparatus execution. In this manner, in my future work, the rectenna execution can be increment by defeating these three components.

VI. Conclusion

A basic rectenna and duel-energized rectenna double groups has been planned. A hypothetical examination has been displayed to explore diode execution. What's more, in spite of the fact that the rectenna progressed toward becoming narrowband because of the confinement on hole size of recieving wire it has demonstrated that the most extreme RF to DC change productivity for the rectenna is around 16%. Moreover, with a course interconnection, rectenna component has been worked as two-component and three-component rectenna double groups. The outcome gave that the yield voltage of the rectenna double band is plenteous higher than that of a solitary rectenna component. In the meantime due to the disperse component attributes the rectenna yield voltage is touchy to the deliberate position.

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