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Design and Simulation of CPW Fed Slot Antenna at different frequencies

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Abstract

This document proposes the 5.8 gigahertz planar wave guide powered broadband Associate in Antenna (CPW) for wireless energy harvesting. The CPW-powered slot associate degreetenna is used as a receiving element, that receives attractive force energy from the environment. and CPW transmission lines are used for rectenna design. Compared to Hertz and CPW, the microstrip line wants an earth affiliation for the association of the active parts gift inside the rectifier circuit. For the protection of the antenna data, cryptography has been performed on every ends of the transmitter and receiver exploitation the cryptanalytic algorithm. throughout this publication, the target is to seek out out the foremost economical force to possess for the transmission keep with the power getable inside the battery at each occasion. throughout this study, it' assumed that the miles that the energy gathering mode could also be a compound Poisson mode that the channel is static, these assumptions cause a compound Poisson version for the electrical garage unit. during a very versioning approach, the authors acquire a necessary circumstance for the optimality of on-line power policies. This circumstance is used to derive the association between the sending force and thus the content of the battery.

Introduction

Radiofrequency energy recovery (RFEH) may be an emerging and essential technology due to its advantages over standard additional optical [1], mechanical [2] and thermal [3] recovery technologies. The objective of this research is to research and develop efficient RFEH modes and devices, capable of producing enough energy for the operation of low-power stand-alone systems corresponding to wireless device networks (WSN), IoT devices , to radio frequency identification (RFID) systems and so on collecting surrounding energy is a well-known technique.Most of the exploitable close-up energy sources are found in stellar radiation, heat sources and physical movement, and which have already been collected victimization of panels of electrical phenomena [4], electricity [5] and KE reapers [6], respectively. However, none of them offer infinite power due to the character of their energy reserves. Harvesting energy from radio waves can be a possible method of energy harvesting, during which the collected structures are given out until the source signal is interrupted.There are many approaches to applying wireless power. Near-field inductive coupling generally operates over distances less than a few centimeters, but it is characterized by high efficiencies [8], [9]. Inductive coupling strategies do not retain the properties of radio propagation. They operate at abundant distances shorter than the signal wavelength from the source of the structure. This approach is all the rage in reversible wireless battery charging of commercial products, such as electric razors or toothbrushes. the magnetic coupling between 2 devices (normally coils) allows the transfer of energy in the near field.The transmitters and receivers used in this technology are generally huge [10], [11] and energy can only be transferred over short distances where the distances are similar to the physical dimensions of the receiver and also of the transmitter. the maximum output power in the market is simply achieved near an optimal operational target [12]. A transfer efficiency of up to 70 n is obtained, taking into account the loss between the transmitter and the receiver, at distances not exceeding 1 m, however, the overall efficiency of the system with this technique is less than 20%. Energy can also be transferred by exploiting the property of the high frequency (HF) field. High power RF energy has been transferred over distances greater than one click with energy yields greater than 70% [13]. an identical technique is also used for power transfer for the identification of main frequencies (HF RFID devices) [14] at distances less than 10 m, which victimize the HF radio spectrum.

System Description

The key elements of RFEH technology are the antenna as well as the rectifier circuit which converts the RF signal into a DC signal (Figure 1.). The load will be an immediate current energy storage device (battery, capacitor, etc.) or a direct high power device, however load parameters such as resistance and capacitance are often not constant. The requirements for the characteristics of a rectifier would be defined by analyzing the signals at the output of the antenna (or at the input of the rectifier) and at the input of the load.

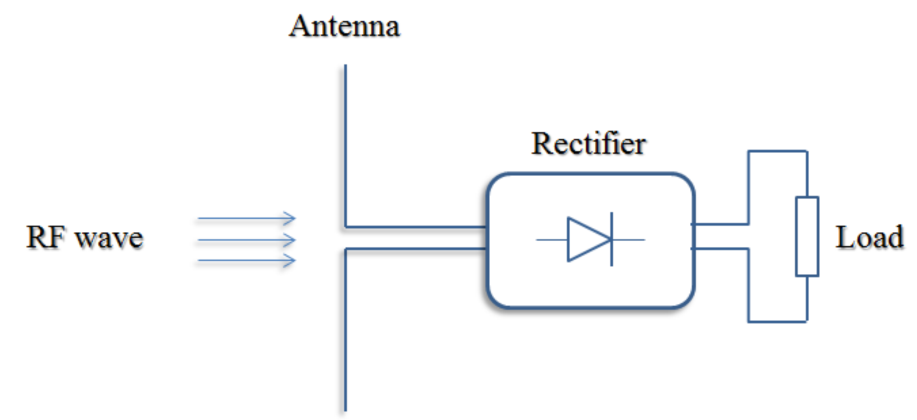
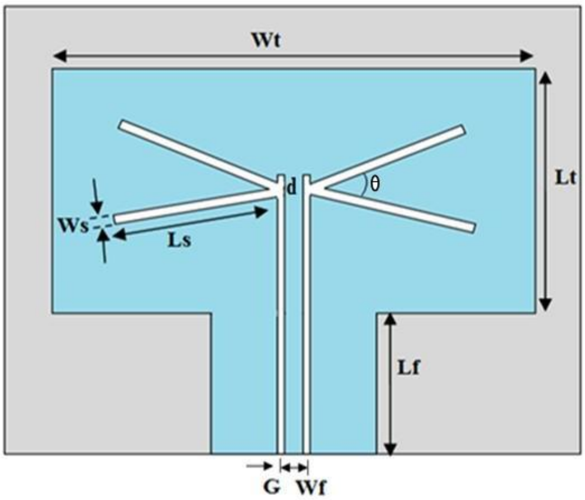


Figure 1. Block diagram of RF energy harvester

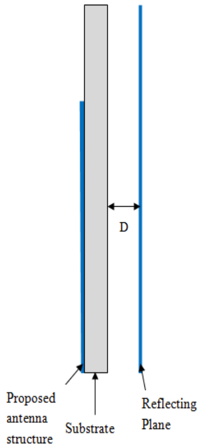
Increasing the converting power of RFDC circuit structure into RF energy harvesting circuits extends the reach and reliability of off-grid networks.Multi-frequency waveforms are a way to help overcome the diode voltage threshold of the energy harvesting circuit, which limits the efficiency of energy conversion at the low RF input powers normally encountered by electrical appliances. sensors to the perforation of their coverage area. As noted in [deleted] 1), each block contributes a conversion loss to the overall efficiency of the system.

Proposed Methodology Design of CPWFED Slot Antenna

The intended layout configuration of the CPW powered wideband slot antenna is shown in Figure 1. The structure of the CPW, although it does not use additional balun circuits, is intended for match the electrical resistance of the antenna and also of the rectifier in order to increase the RF conversion efficiency from rectenna to DC. The advantage of CPW transmission is that the diode and the passive parts are integrated into the antenna with less complexity, which is desirable for the design of the rectifier circuit.



(a) Top view



(b) Side view

Figure2 .Configuration of theproposedCPW fedslot antenna

The characteristic electrical resistance of CPW cable is 50. The CPW powered broadband antenna is unreal on 1.6mm thick PTFE material with dielectric constant of r of 2.1 and loss tangent (tanδ) of 0.0002. The style specifications of the projected antenna are listed in Table 1. The proposed dielectric material has a terribly low dielectric constant, low loss tangent, negligible water absorption, and resistance to hot temperature (the temperature is about 327 C). If the dielectric constant (εr) is lower, the size and length of the antenna increases, it will increase the fringing fields and the aperture space of the antenna.Therefore, every measure of information and income increases.

The material loss decreases as the loss tangent (tanδ) decreases, which ultimately increases the power and gain of the antenna. The projected dielectric material was ready to meet all the technical needs of RF and small wave circuit design. jointly provides a sensitive isolation between the ground plane of the antenna and therefore the structure of the bimetallic conductor, which

Lead memorizes the cancellation of the present inside the antenna because consequently the performance of the antenna will be improved and power losses reduced.

Table1 .DesignspecificationsoftheproposedCPWfedslotantenna

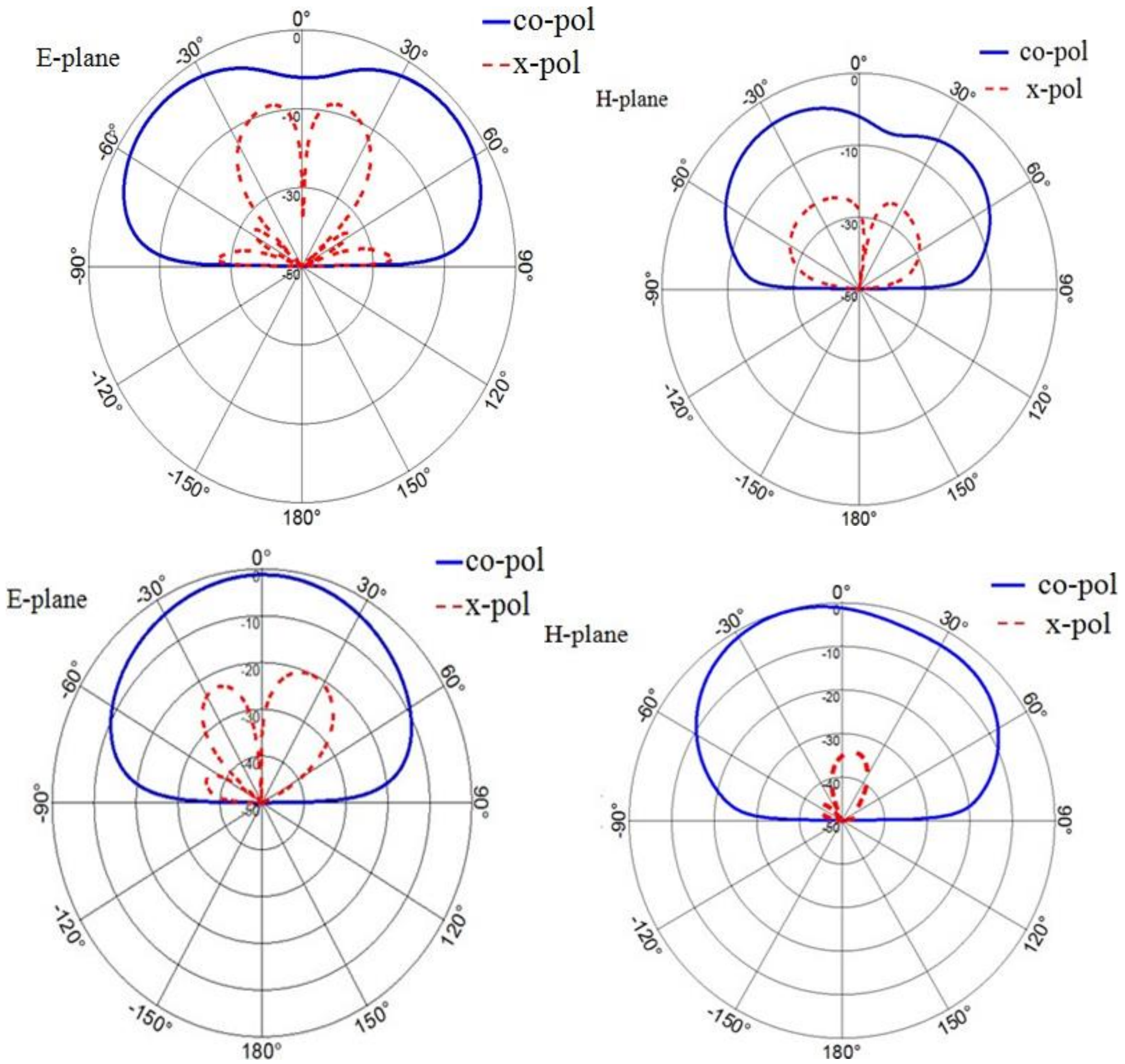
Parameters	Specifications
Resonant frequency (f_r)	5.8GHz(ISM)
Dielectric material	PTFE
Dielectric constant(ε_r)	2.1
Loss tangent(tanδ)	0.0002
Thickness of the dielectric material(h)	1.6mm
Conducting material	Copper
Conducting material thickness(t)	35µm

The proposed CPW powered slot antenna comprises a single layer bimetallic structure on one facet of the substrate while; the opposite face is free from metallization. The CPW slot antenna consists of a CPW power line separated from the lower floor by two thin slot lines. the 2 symmetrical resonances formed in g tonnes are introduced on the CPW ground plane, the length of which is sufficient for half the wavelength of the desired frequency. The Vshape locations are supplied by the central conductor of the CPW power line.The frequency of the operation depends on the size of the slot (Liu et. 2017; Palandoken2016).

Result

The projected associated degree-tennes radiation characteristics are described in terms of E plane and H plane graph records. The plane is that plane which contains the vector of the electric field, while the plane contains the magnetic field. The two-dimensional radiation characteristics of E plane and H plane are simulated at 3 frequencies: 5.1 GHz , 5.8 GHz and 6.1 GHz

The characteristics of the simulated radiation pattern E and Hplane are similar to the dipole with an infinite ground plane or a single pole antenna with a finished ground plane. The reflector is placed on the rear face of the antenna because as a result, the rear radiation is reduced and the front-to-rear magnitude relationship is improved. The E and Hplane radiation patterns are taken at 3 completely different frequencies like 5.1 gigacycle, 5.8 GHz and 6.1 GHz



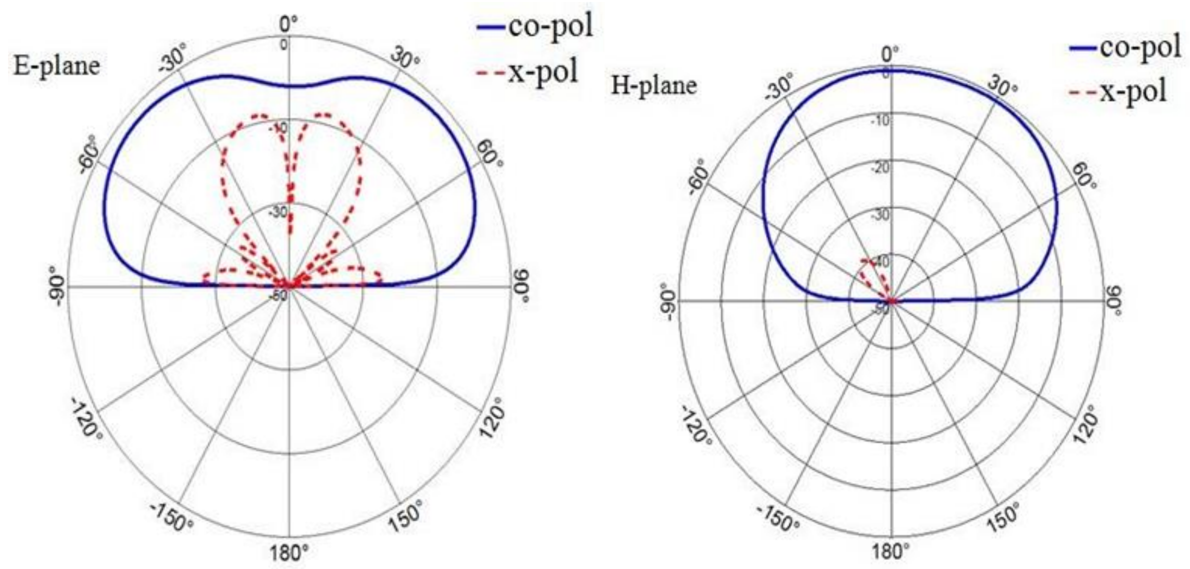


Figure 3. Simulated E-plane and H-plane far-field radiation patterns at three different frequencies (a) 5.1 GHz (b) 5.8 GHz (c) 6.1 GHz

From figure 3. (a), frequency 5.1 GHz, l The antenna shows a high level of cross polarization and a low value of co-polarization.At 5.1 GHz, the electrical resistance of the antenna is not fully adapted to a characteristic impedance of fifty Ω. Therefore, the signal loss at this frequency is increased, which reduces the radiation efficiency of the antenna. At 5.1 gigacycles, the antenna shows a cross polarization of 8 dB and dB at E and Hplane respectively. .

The co and cross-polarization of E and H-plane for the resonant frequency of 5.8 Gc per second are shown in Figure 3. (b). The result shows that the antenna exhibits low cross-polarization and better co-polarization values. as a results of at 5.8 GHz, the antenna physical phenomenon is completely matched with fifty Ω provide impedance, that the foremost power is transferred to the antenna and it' radiated off from the antenna. As a result, the antenna radiation efficiency has been improved. The simulated cross-polarization of -20 unit of measurement and -35 sound unit are achieved at E and H-plane respectively. The E d H-plane co and cross-polarization at 6.1 Gc per second are shown in Figure 6. (c). The planned antenna exhibits high cross-polarization level at 6.1 GHz. The simulated cross polarization of E and H-plane are -7 unit of measurement and -39 dB. At 6.1 GHz, the projected antenna provides an occasional cross polarization level in H-plane, once compare to E-plane cross polarization.

Table 2. Performance analysis of the proposed antenna with existing antenna structures

Parameters	**Structure**	**Dimensions 3 mm**	**Substrate & εr**	**Frequency**	**Return loss (S11)dB**	**Bandwidth (%)**	**Gain (dBi)**
Chen *et al.* (2017)	CPW fed bended monopole antenna	35×35×1.6	Fr4 & 4.4	3.6,6.8,9 GHz	<-20	-	2.5
Liu *et al.* (2017)	CPW fed slot antenna	66.4× 54×1.4	Fr4 & 4.4	2.45 GHz	-30	33.3 %	3
Jiang *et al.* (2010)	CPW-fed Asymmetrical slot antenna	35×35×1.6	Fr4 & 4.4	2.45 GHz	-20	118.7%	2.95

Zhang *et al.* (2008)	Bent triangular antenna	94×82×1.6	Fr4 & 4.4	980 MHz & 1800 MHz	<-10	-	7
Palandoken (2016)	Microstrip antenna	50×50×0.8	Fr4 & 4.4	1.95,2.45GHz	19 & 35	-	8.3,7.
Zhang *et al.* (2014)	CPW fed monopole antenna	70×70×0.8	Fr4 & 4.4	2.45,5.51GHz	-20	41.89%, 90.91 %	7.1
Proposed work	CPW fed slot antenna	60×60×1.6	PTFE &2.1	5.8 GHz	-23	20.69%	8.66

The proposed rectenna conversion efficiency is tested using VSA and a voltmeter. The signaling is generated by the VSA and transmitted using a 5.8 gigacycle transmitting antenna.Figure 5.34 shows the measured RF to DC conversion power of the rectenna projected at a totally different input power level of 15 dBm to +5 dBm. it is established that the height conversion efficiency of 75% is obtained at the input power of 4 dBm.

The measured overall conversion efficiency remains at 50% of the input power from 7 dBm to +4 dBm. The DC voltage across the electric load device is shown in Figure 5.35, which illustrates the measured DC output voltage of 650 mV is obtained with a load resistance KΩ at an input power of 4 dBm. it is also established that the DC voltage will increase with increasing The comparisons of the proposed rectifier with existing rectifier circuits are listed in Table 3.

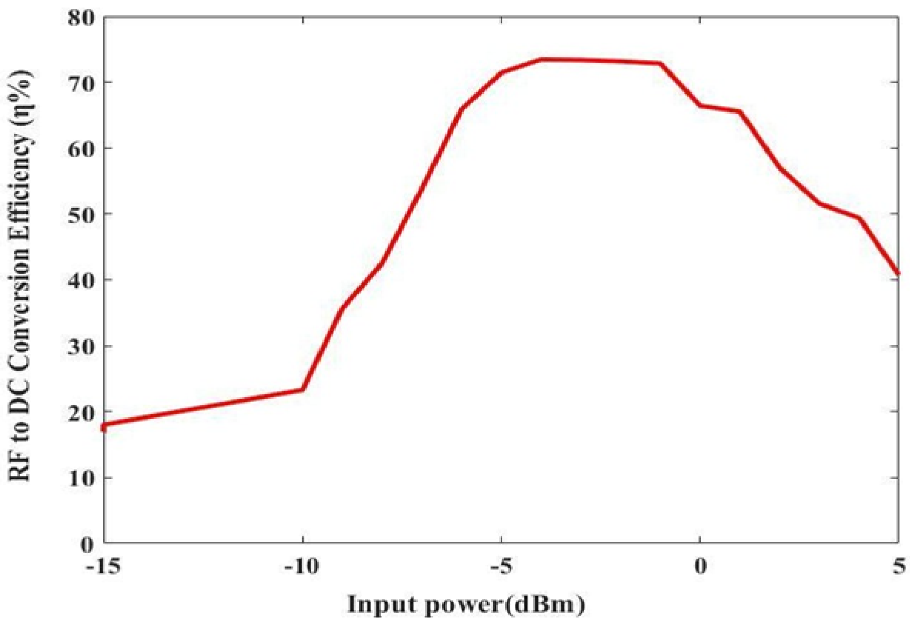


Figure 4. Measured RF to DC conversion efficiency(η%) vs. Input power(dBm)

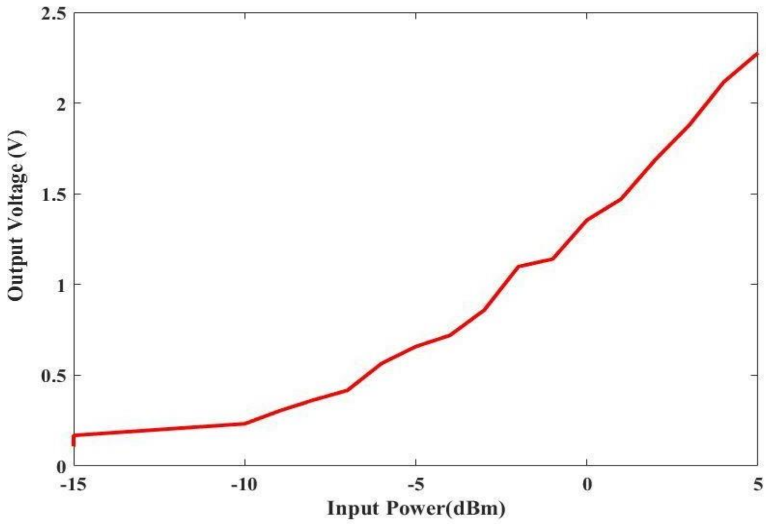


Figure 5. Measured output voltage (V) vs. Input power (dBm)

Table 3. Comparison of the proposed rectifier with existing rectifier structures

Reference	**Rectifier structures**	**Maximum RF to DC conversion efficiency (η%)**	**Output DC voltage (V)**
Arrawatia *et al.* (2016)	CPS load single port rectifier	83 % @-5 dBm	900mV
Sun *et al.* (2012)	Microstrip based voltage doubler circuit	46.9%	-
Yang *et al.* (2013)	Single port rectifier	86% @ 11 dBm	5 V
Hagerty *et al.* (2004)	Single shunt diode rectifier	41%	-
Huang *et al.* (2011)	Single voltage doubler circuit	57% @ 9 dBm	100 mV
Okba *et al.* (2017)	Differential port rectifier circuit	68% @ -2 dBm	25 µV
Proposed work	CPW fed voltage doubler rectifier circuit	75 % @-4 dBm	650 mV

Conclusion

The proposed CPW fed slot antenna and the CPW fed rectifier are integrated into a single device to form a rectenna. The measured rectenna provides the maximum RF to DC conversion efficiency of 75% at the input power of -4 dBm and the load resistance of 1 KΩ. The rectenna exhibits 50% conversion efficiency from the input power of -7 dBm to +4 dBm. The maximum output DC voltage of 650 mV across the 1KΩ resistive load and the input power of -4 dBm.

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