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Optimization of Corner Reflector Antenna at 900 MHz – 2400 MHz for RF Energy Harvester System

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Abstract

RF energy harvesting changes the radio wave to electrical energy. Some of sources are radio broadcasting and TV station, cellular base station and wireless network that can be harvested by antenna, one of antenna is corner reflector. This paper presents the design of corner reflector for RF energy harvesting with gain for 900 MHz, 1650 MHz, 1800 MHz, 2100 MHz and 2400 MHz is 4.11 dB, 7.29 dB, 4.45 dB, 9.09 dB and 7.22 dB.

Keywords: *Beamwidth; Corner Reflector, Energy Harvesting*

1 Introduction:

Corner reflector has function to change the radiation pattern and the beamwidth of antenna so that it can increase the gain of antenna by itself.

RF energy harvester process the radio frequency energy that radiated by sources that produces the high electromagnetic fields like TV signal, wireless radio network and cellphone tower, but through the circuit power plant related the receiver antenna it was caught and converted to be DC voltage that can be used to low electronic device [1].

In previous research, microstrip antenna for electronic energy harvesting system on 900 MHz – 2400 MHz had been developed [2] and will be used in this paper. There is also antenna for rf energy harvesting with fractal antenna [3] [4], using circularly polarized antenna [5], stepped rectangular antenna [6].

This paper presents design of corner reflector antenna at 900 MHz – 2400 MHz for RF energy harvester system with the average gain 8.72 dBi.

2 Corner Reflector Design

Feed antenna of corner reflector in this paper is an array antenna 1x2 with T-Junction rationing technique and direct rationing technique that has been developed before [2]. The antenna works in 900 MHz – 2400 MHz with the maximum gain is 6.84 dBi. The antenna using FR-4 Epoxy substrate. The geometry of antenna shows in Figure 1.

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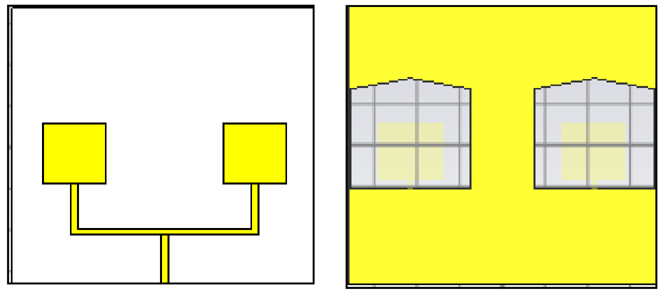

Figure 1. Design of Antenna Feed

Tables and Figures are presented center, as shown below and cited in the manuscript.

Table 1. The Performance of ...

Variable	Speed (rpm)	Power (kW)
x	10	8.6
y	15	12.4
z	20	15.3

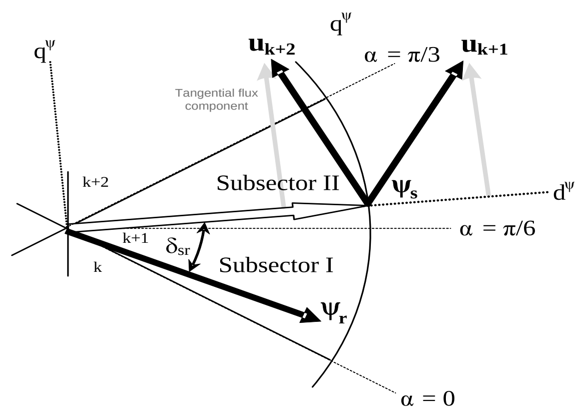

Figure 1. Effects of selecting different switching under dynamic condition

3 Geometry of Corner Reflector

The geometry of corner reflector showed at Figure 2 using horn approach formula (1) to determine the aperture of corner reflector (Da) [7]. The dimension of length of corner reflector use formula (2), width of corner reflector use formula (3) and space between antenna and vertex use formula (4) [8]. Corner reflector in this paper using aluminum with 1 mm thickness.

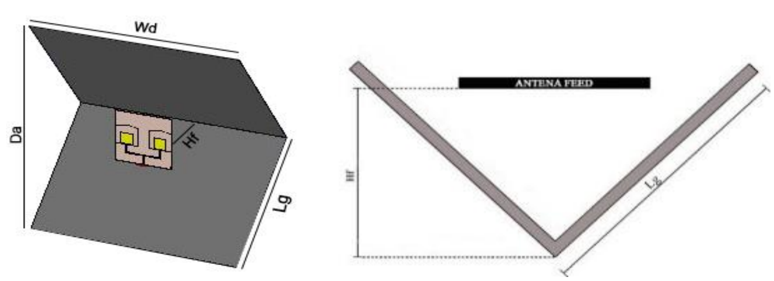

Figure 2. Geometry of Corner Reflector

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$$HPBW_H = 78^\circ \frac{\lambda}{A} \quad (1)$$

$$Lg = 2xHf \quad (2)$$

$$1.2\, Lg < Wd < 1.5\, Lg \quad (3)$$

$$\frac{\lambda}{3} < Hf < \frac{2\lambda}{3} \quad (4)$$

Where: Lg = Length of Corner Reflector

Wd = Width of Corner Reflector

Hf = Space between Antenna and Vertex

Table 1. Structure Dimension of Corner Reflector

Table 1. Structure Dimension of Corner Reflector

Variable	Parameter	Value (mm)
Da	Width of aperture corner reflector	552.605
Lg	Length of corner reflector	357.447
Wd	Width of corner reflector	536.168
Hf	Vertex	160.5

Corner reflector approach will be simulated using CST Studio Suite 2017 until gets the most optimal result.

4 Result and Discussion

Antenna with corner reflector has been simulated and analyzed by using CST Studio Suite 2017. The realization of corner reflector is shown in Figure 3.

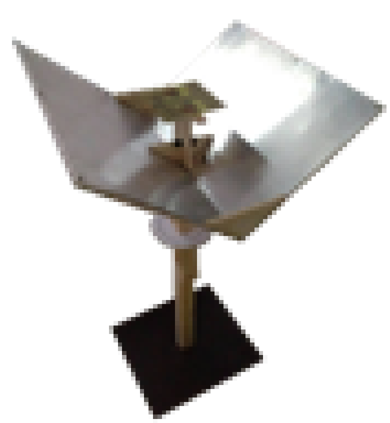

Figure 3. Realization of Corner Reflector

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The most optimal simulation is shown in Figure 4 until Figure 7. Figure 4 descript the increasing dimension of Wd resulting VSWR. Increasing the dimension of Wd then VSWR will decrease at the low frequency, but at another frequency, if the dimension of Wd increase, VSWR will increase.

In another case, the increasing dimension of Lg resulting VSWR shown in Figure 5. The more increasing the dimension of Lg the more decrease the VSWR value at the low frequency, but at another frequency, the more increasing the dimension of Lg the more increasing the VSWR value. Figure 6 descript the increasing dimension of Hf resulting VSWR. The more increasing the dimension of Hf the more decrease the VSWR value at the low frequency, but at another frequency, the more increasing the dimension of Hf the more increasing the VSWR value. Figure 7 descript the increasing dimension of Da resulting VSWR. The more increasing the dimension of Da the more decrease the VSWR value at the low frequency, but at another frequency, the more increasing the dimension of Da the more increasing the VSWR value.

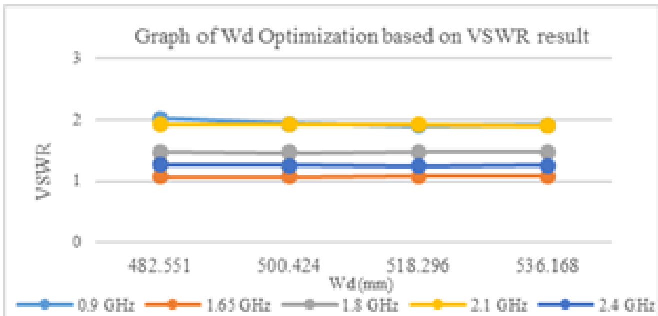

Figure 4. VSWR value with Wd Optimization

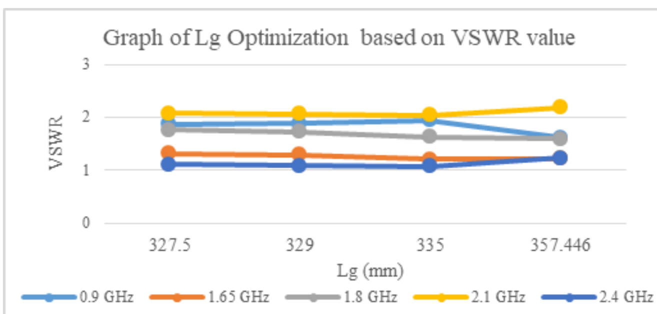

Figure 5. VSWR value with Lg Optimization

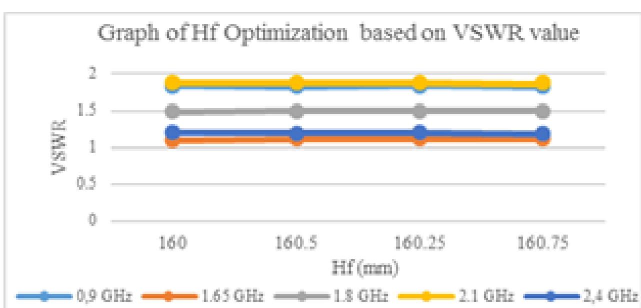

Figure 6. VSWR value with Hf Optimization

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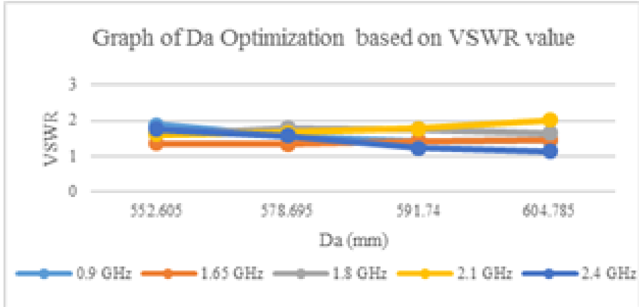

Figure 7. VSWR value with Da Optimization

Figure 8 until figure 11 shows the gain value with optimization Wd, Lg, Hf and Da. At 900 MHz, if the dimension of Wd increase so the gain will decrease. But at another frequency, gain is constant even though the dimension of Wd increase. It shown in Figure 8.

Figure 9 shows the dynamic of gain value. Gain has increased by increasing the dimension of Lg at 2400 MHz but gain will decrease if the dimension of Lg increase at 2100 MHz.

Gain is dominant decrease when the dimension of Hf increase. It shown in Figure 10. Figure 11 shows the increasing of Da. Gain will increase when the dimension of Da increase. But the increasing of Da will caused the decreasing of gain at 2400 MHz.

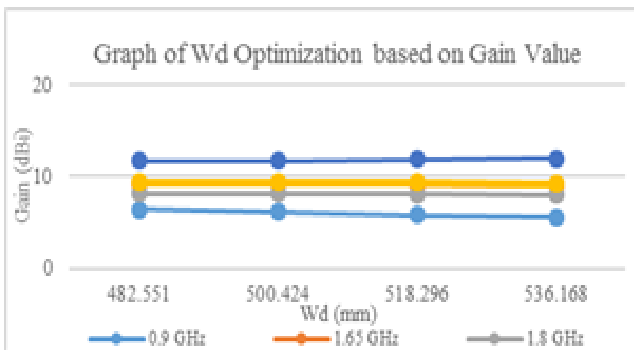

Figure 8. Gain value with Wd Optimization

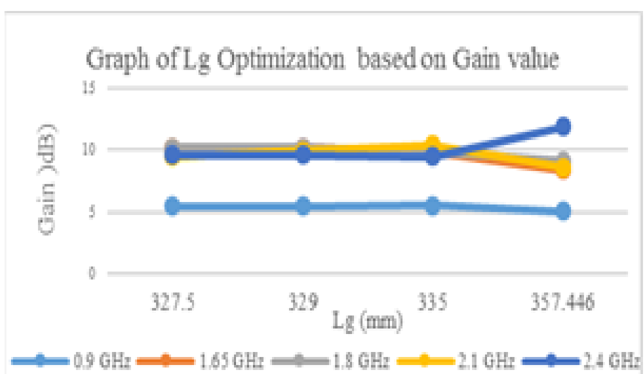

Figure 9. Gain value with Lg Optimization

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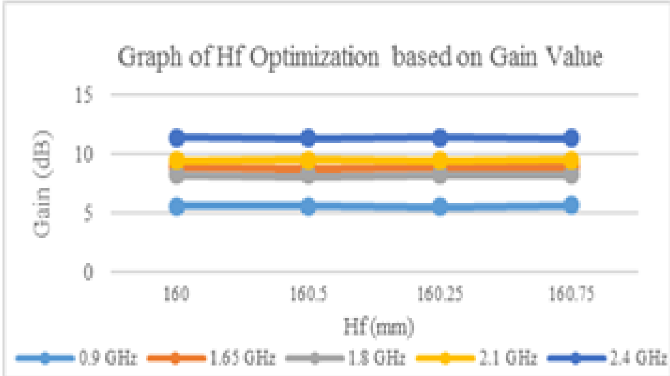

Figure 10. Gain Value with Hf Optimization

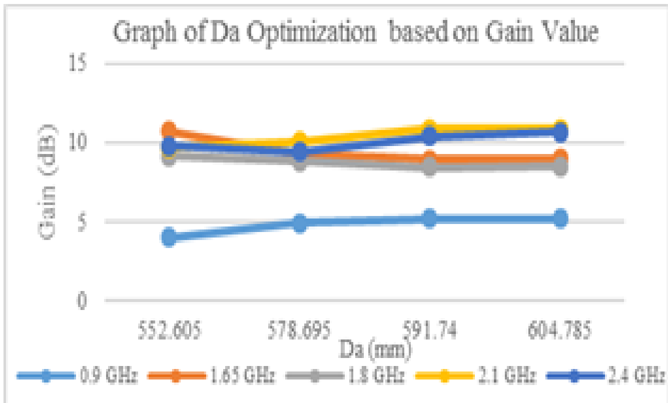

Figure 11. Gain Value with Da Optimization

Based on the eight graphs above, the dimension of corner reflector is very impact in determining the beginning specification. Figure 12 shows the result of simulation for VSWR and Figure 13 shows the result of measurement for VSWR. For the result of simulation for Returm Loss is shown in Figure 14 and the result of measurement for Return Loss is shown in Figure 15. Farfield simulation result is shown in Table 2 and farfield measurement result is shown in Table 3. Radiation pattern shown in Figure 16 until Figure 20.

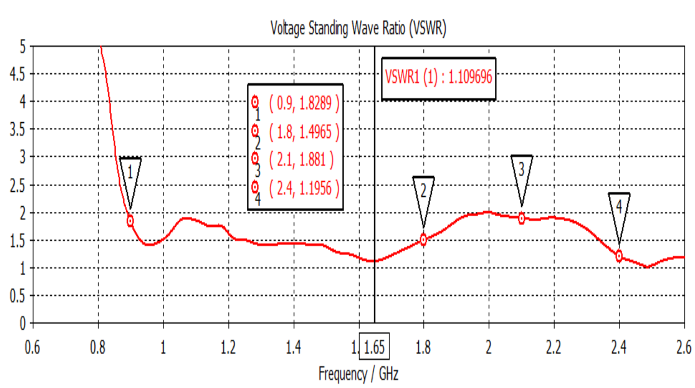

Figure 12. Simulation of VSWR

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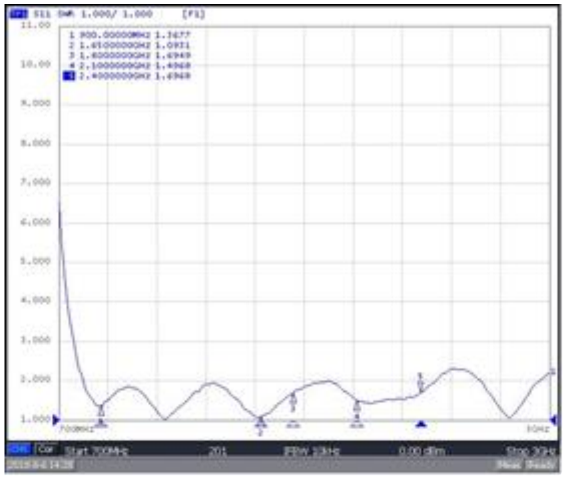

Figure 13. Measurement of VSWR

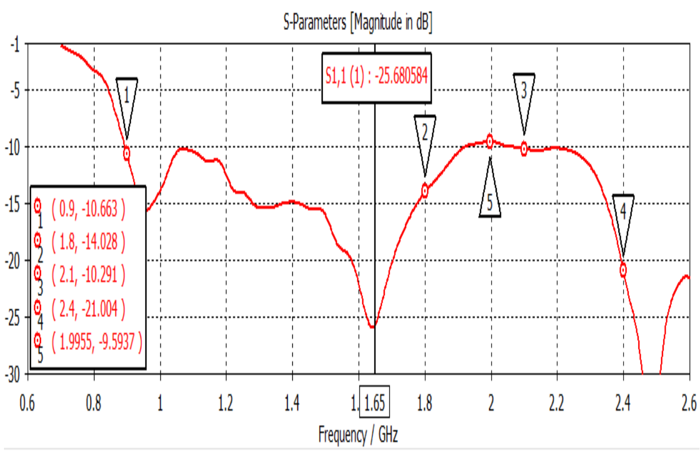

Figure 14. Simulation of Return Loss

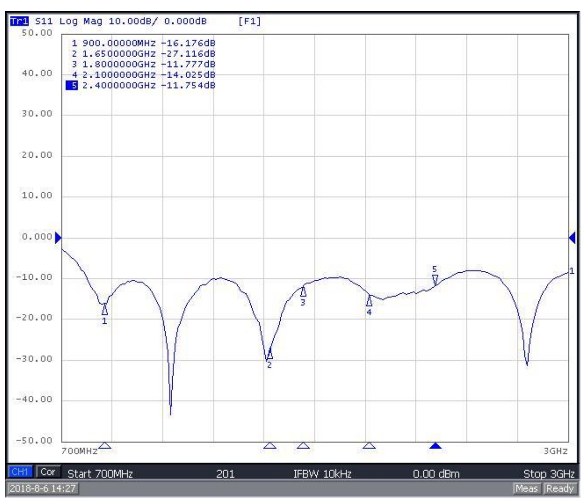

Figure 15. Measurement of Return Loss

Table 2. Farfield Simualtion Result for Corner Reflector

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Frequency (MHz)	Pola Radiation	Beamwidth		Gain (dB)
		Elevation	Azimuth	
900	unidirectional	55.7°	109.1°	5.6038
1650	unidirectional	64.2°	63.1°	8.8890
1800	unidirectional	35.1°	39.6°	8.2087
2100	unidirectional	27.1°	61.3°	9.4873
2400	omnidirectional	41.1°	40.3°	11.3665

Table 3. Farfield Measurement Result for Corner Reflector

Frequency (MHz)	Pola Radiation	Beamwidth		Gain (dB)
		Elevation	Azimuth	
900	omnidirectional	32°	70°	4.11
1650	omnidirectional	23°	15°	7.29
1800	omnidirectional	50°	30°	4.45
2100	omnidirectional	45°	38°	9.09
2400	omnidirectional	10°	36°	7.22

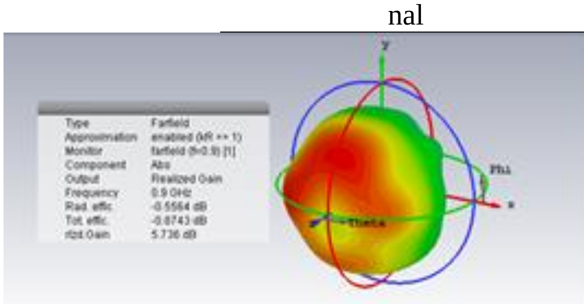

Figure 16. Radiation Pattern of 900 MHz

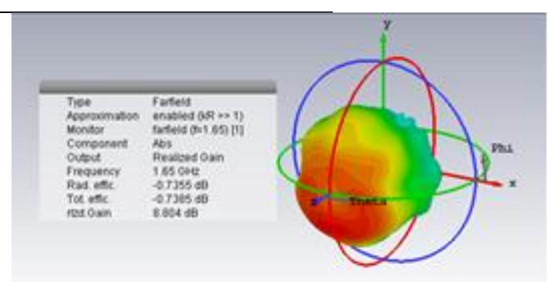

Figure 17. Radiation Pattern of 1650 MHz

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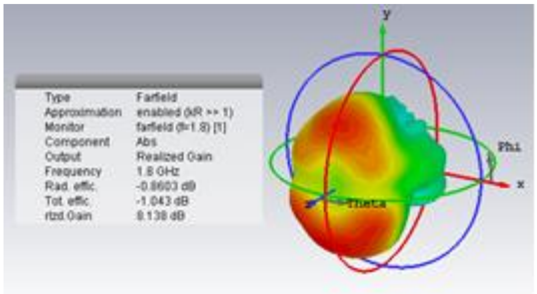

Figure 18. Radiation Pattern of 1800 MHz

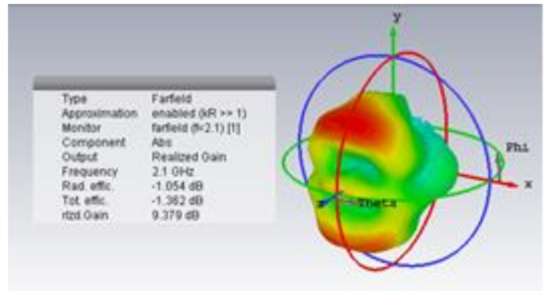

Figure 19. Radiation Pattern of 2100 MHz

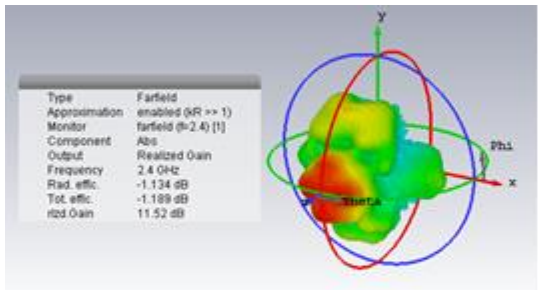

Figure 20. Radiation Pattern of 2400 MHz

5 Conclusion

The corner reflector for RF energy harvester system has been achieved with the best optimization. This corner reflector antenna has the average gain 8.72 dBi and unidirectional radiation pattern. This corner reflector has beamwidth 55.7° of elevation angle and 109.1° of azimuth angle.

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References

1. G.J.K. Moernaut and D. Orban. The Basics of Antenna Arrays. Orban Microwave Products.
2. N. Gunaranti, R. Anwar, Y. S. Amrullah and D. A. Nurmantris, "DEVELOPMENT OF ULTRA WIDEBAND UHF MICROSTRIP ANTENNA FOR RADIO WAVE ENERGY HARVESTING," Submitted to Progress in Electromagnetics Research.
3. K. Çelik and E. Kurt, "Design and simulation of the antenna for RF energy harvesting systems," 2018 6th International Istanbul Smart Grids and Cities Congress and Fair (ICSG), Istanbul, 2018, pp. 148-150.
4. M. Zeng, A. S. Andrenko, Xianluo Liu, Hong-Zhou Tan and Bo Zhu, "Design of fractal loop antenna with integrated ground plane for RF energy harvesting," 2016 IEEE International Conference on Mathematical Methods in Electromagnetic Theory (MMET), Lviv, 2016, pp. 384-387.
5. S. Ghosh, "Design and testing of RF energy harvesting module in GSM 900 band using circularly

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polarized antenna," 2015 IEEE International Conference on Research in Computational Intelligence and Communication Networks (ICRCICN), Kolkata, 2015, pp. 386-389.
6. M. Kurvey and A. Kunte, "Design and optimization of stepped rectangular antenna for RF energy harvesting," 2018 International Conference on Communication information and Computing Technology (ICCICT), Mumbai, 2018, pp. 1-4.
7. K. B. Baltzis, “Calculation of the Half-Power Beamwidths of Pyramidal Horns with Arbitary Gain and Typical Aperture Phase Error,” in IEEE Antennas and Wireless Propagation Letters, vol. 9, pp. 612-614, 2010.
8. J. D. Kraus, "The corner-reflector antenna," Proc. IRE, vol. 28, no. 11, pp. 513-519, November 1940

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