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Broadband Truncated Rectangular Microstrip Antenna with E - Shaped Ground Plane

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Abstract: *A new design of rectangular microstrip antenna to enhance the bandwidth and reduce the size is presented. The proposed geometry consist of a truncated radiating patch and an E – shaped ground plane. The impedance BW determined is 37 % of the center frequency at 3.86 GHz. Size of the proposed geometry is also reduced by 13 % as compared to a conventional patch without any geometry on ground plane.. The microstrip antenna is fed by a coaxial probe to achieve linear polarization. The proposed geometry provides a band of 1420 MHz (3.15 GHz to 4.57 GHz) that is suitable for certain frequencies of S band as well as of C band applications. Also, the proposed geometry provides a peak directivity 7.29 dBi, gain 5.84 dBi, axial ratio 42.08 dB, aperture efficiency 88.56 %, radiation efficiency 94.76 % for a band (3.15 GHz to 4.57GHz). All the simulations are carried out using Zeland IE3D simulation software.*
Keywords : *Broadband , Truncated , Compactness , MSA .*

I. Introduction

An MSA in its simplest form consists of a radiating patch on one side of a dielectric substrate and a ground plane on the other side as shown in figure 1.1. There are different shapes of the microstrip antenna, such as the square, circular,triangular, semicircular, sectoral, annular ring, but the most common is rectangular. Due to its advantages such as low weight, low profile , low fabrication cost and capability to integrate with microwave integrated circuits technology, the microstrip antennas are well suited for applications such as wireless communication systems, cellular phones, pagers , radar and satellite communication systems[1]-[7]. A major drawback of the MSAs is that they have a narrow bandwidth, typically 1 – 5% which is the major limiting factor for the widespread application of these antennas.

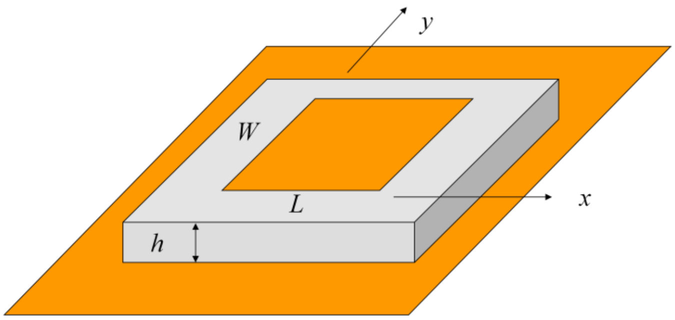

Fig. 1.1 Rectangular microstrip antenna

The BW of the MSAs can be increased by using the modified shape patches, planar multiresonator configurations, multilayer configurations, stacked multiresonator configurations [7,13].
In this paper, a new prototype is presented which consist of a truncated radiating patch and an E-shaped ground plane to enhance the bandwidth.

II. Proposed Antenna Geometry And Design

A typical design of rectangular microstrip antenna has been presented here and results are discussed at centre frequency of 2.0 GHz. The width and length of the patch are given by [1, 7]:--

$$w = \frac{c}{2f\sqrt{(\varepsilon r+1)/2}} \quad (1)$$

$$L = L_{eff} - 2\Delta L \quad (2)$$

$$\Delta L = \frac{0.412h\,[\varepsilon_{eff}+0.300]\left[\left(\frac{w}{h}\right)+0.264\right]}{[\varepsilon_{eff}-0.285]\left[\left(\frac{w}{h}\right)+0.8\right]} \quad (3)$$

$$\varepsilon_{eff} = (\varepsilon_r+1)/2+[(\varepsilon_r-1)/2](1+12h/W)^{-1/2} \quad (4)$$

$$L_{eff} = \frac{c}{2f\sqrt{\varepsilon eff}} \quad (5)$$

Where ,

C = velocity of light,
ε_r = dielectric constant of substrate,
f = operating frequency
ε_{eff} = effective dielectric constant,
L_{eff} = effective length,
ΔL = edge extension

III. Designing Parameters

For designing the proposed antenna, the following parameters are used:--

Design frequency	=	2.0 GHz
Dielectric constant	=	4.4
Loss tangent	=	0.02
Thickness of substrate	=	1.6 mm
Length of the radiating patch L	=	36 mm
Width of the radiating patch W	=	46 mm
Length of the ground plane Lg	=	46 mm
Width of the ground plane Wg	=	56 mm
Length of the slot Ls	=	42 mm
Width of the slot Ws	=	4 mm
Truncated corner	=	6×6 mm^2

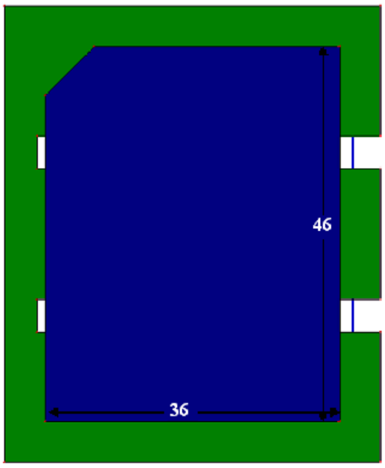

Fig 1.2 Rectangular microstrip antenna with truncated corner.

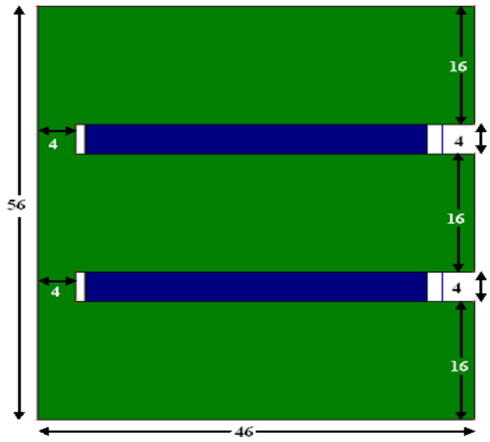

Fig 1.3 E- shaped ground plane of Rectangular microstrip antenna with truncated corner.

IV. Results & Discussions

The rectangular microstrip antenna with finite ground plane resonates at different frequencies such as 0.74GHz, 1.4 GHz, 4.0 GHz, with maximum impedance BW = 9.5 % (3.79 GHz to 4.17 GHz) at center frequency 3.98 GHz. Now, the ground plane geometry is modified to an E – shaped ground plane geometry. The new RMSA is simulated which resonates at 1.57 GHz, 1.94 GHz, 2.33 GHz, 3.35 GHz, 4.12 GHz, 4.4 GHz with maximum impedance BW = 30.7 % (3.10 GHz to 4.21 GHz) at center frequency 3.65 GHz and 6.5 % (4.31

GHz to 4.60 GHz) at center frequency 4.45 GHz. Now, a truncated corner (6 × 6 mm^2) is cut in the radiating patch with dimensions 36 × 46 mm^2. The new truncated RMSA with E – shaped ground plane is simulated and it resonates at 1.59 GHz, 1.93 GHz, 3.26 GHz, 4.08 GHz, 4.39 GHz, with maximum impedance BW = 36.8 % (3.15 GHz to 4.57 GHz) at center frequency 3.86 GHz. The new impedance BW is approximately 4 times the BW of the RMSA without any geometry on ground plane. Also, the proposed geometry provides a size compactness of 13 % , directivity of 7.29 dBi at 4.11 GHz, gain of 5.84 dBi at 4.09 GHz, axial ratio of 42.08 dB at 3.15 GHz, aperture efficiency 88.56 % at 3.21 GHz, and radiation efficiency 94.76 % at 3.15 GHz .

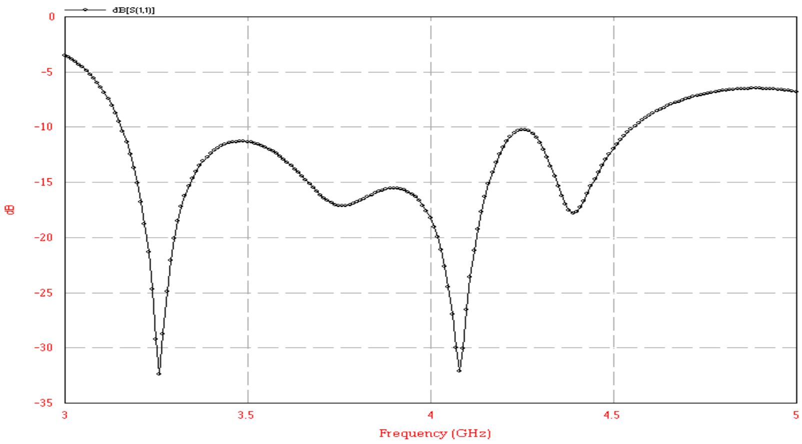

Fig 1.4 Return loss Vs Frequency

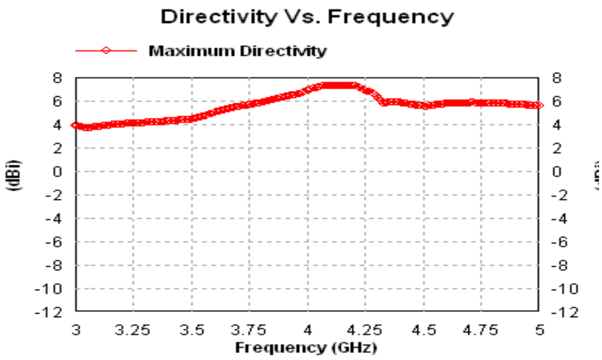

Fig 1.5 Directivity Vs Frequency

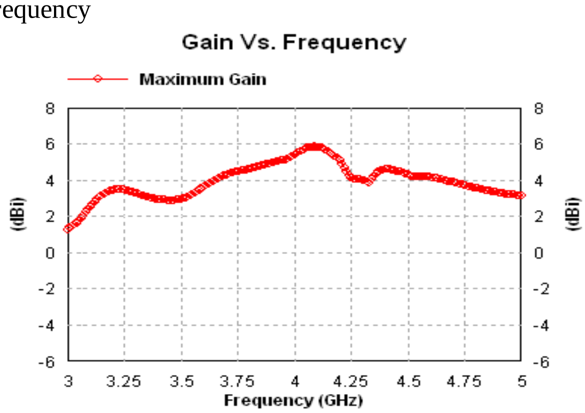

Fig 1.6 Gain Vs Frequency

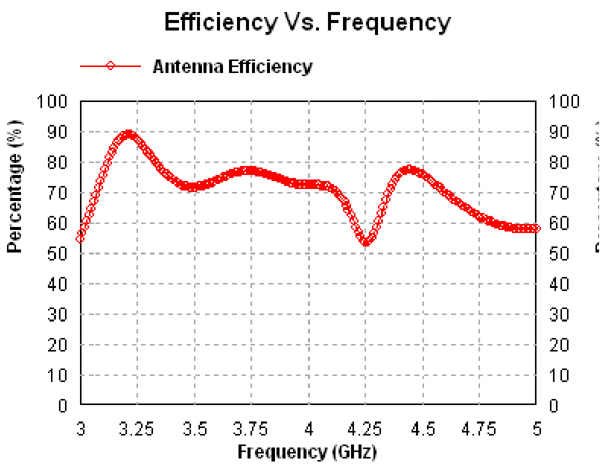

Fig 1.7 Aperture efficiency Vs Frequency

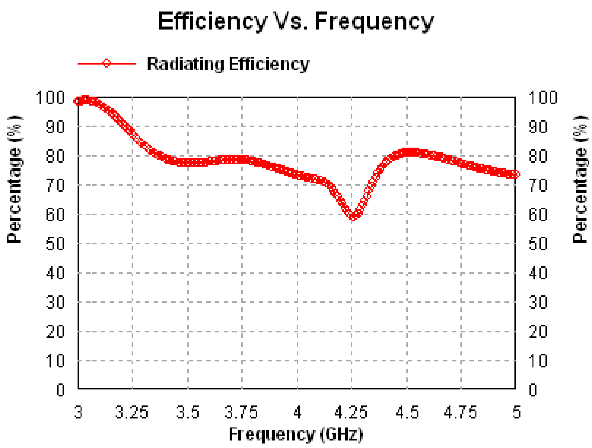

Fig 1.8 Radiating efficiency Vs Frequency

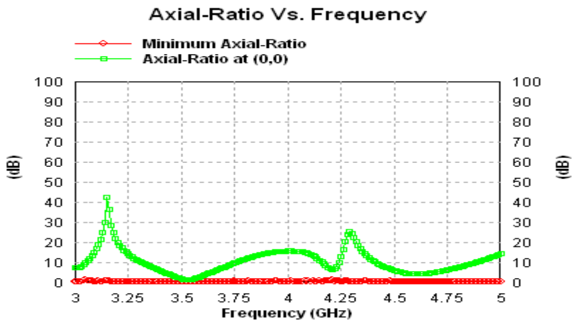

Fig 1.9 Axial Ratio Vs Frequency

IV. Conclusion

A coaxially fed broadband truncated rectangular microstrip antenna with an E – shaped ground plane is studied, designed and simulated and compared with a conventional rectangular microstrip antenna without any geometry on ground plane. This configuration provides the impedance bandwidth of 36.8 % with peak directivity 7.29 dBi, gain 5.84 dBi, axial ratio 42.08 dB, aperture efficiency 88.56 %, radiation efficiency 94.76 % for a band (3.15 GHz to 4.57GHz) which is suitable for higher frequencies of S band and lower frequencies of C band applications.

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References

[1]. Balanis C. A., “Antenna Theory: A Review,” Proc. IEEE, Vol. 80, No. 1, pp. 7–23, January 1992.
[2]. Bahl I. J. and P. Bhartia, Microstrip Antennas, Artech House, Norwood, MA, 1980.
[3[. Collin R. E., Antennas and Radiowave Propagation, McGraw-Hill, New York, 1985.
[4]. James J. R. and P. S. Hall (Eds.), Handbook of Microstrip Antennas, Vols. I and II, Peter Peregrinus, 1989.
[5]. Jordan E. and K. Balmain, Electromagnetic Waves and Radiating Systems, Prentice-Hall,New York, 1968.
[6]. Kraus J. D., Antennas, McGraw-Hill, New York, 1988.
[7]. Kumar G. and K. P. Ray,Broadband Microstrip Antennas, Artech House, 2002.
[8]. Sarkar, S., Majumdar, A. D., Mondal, S.,Biswas, S.,Sarkar, D. Sarkar, P. P., “Miniaturization of rectangular microstrip patch antenna using optimized single-slotted ground plane”. Microwave and Optical Technology Letters,53,2011: pp.111–115.
[9]. Wong K.L.,C.L. Tang, and J.Y. Chiou , “Broad-Band Probe-Fed Patch Antenna With a W-Shaped Ground Plane”, IEEE Transactions On Antennas And Propagation, Vol. 50, No. 6, June 2002 .
[10]. Wong K.L and J.Y. Sze , “Slotted rectangular microstrip antenna for bandwidth enhancement,” IEEE Trans. Antennas Propag., Vol. 48, No. 8, pp.1148-1152, August, 2000.
[11]. Wong K. L. and J. S. Kuo, “A compact microstrip antenna with meandering slots in the ground plane,” Microwave Opt. Technol. Lett. **29**, 95–97, April 20, 2001.
[12]. Wong K. L. and T. W. Chiou, “Designs of compact microstrip antennas with a slotted ground plane,” IEEE Antennas Propagat. Soc. Int. Symp. Dig. pp. 732–735, 2001.
[13]. Wong Kin-Lu-, Compact and Broadband Microstrip Antenas, John Wiley & Sons,INC.