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Enhancement of Quality of Radiation Pattern with Modification Of Metamaterial Superstrate Of Microstrip Antenna

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Abstract

High directive planner antenna has been already analyzed in the context of layer of metamaterial structures. This results of high negative permittivity and permeability. In this project a modification in the metamaterial structure is being done by a machine square cut of 4×4mm at centre of weight machine square cut shape patch antenna. The simulation has been done by IE3D software. In this due to the square cut the negative permittivity and negative permeability increases which enhances radiation of the microstrip antenna.

1. INTRODUCTION

Compact directive antennas with a single feeding point are highly Attractive demand[4,6].Conventional patch antenna has simple feeding mechanism, whereas its radiated pattern is affected by the surface wave and has low gain and bandwidth[5]. On the way modification of meta material superstrate of microstrip antenna can offer the directive feature. The high directive and wideband antenna with more compact structure and simple feeding is of great interest in recent years. New artificial materials, such as metamaterial, are introduced to design antenna for enhancing the performance and reducing the profile [4]. The magnetic field and the wave vector form a left handed system[1]. The improvement of the performances of antennas in the microwave range of frequencies [2, 3]. It is noted in that some principal properties of waves propagating in materials with negative permittivity and negative permeability are considered and high directivity can be obtained from conventional antenna using metamaterials [9]. next design we centrally cut 4×4mm by using these cut return loss is more and more negative . The simulate.ion results show that the gain and bandwidth of the antenna with cut in the next design. It is improved and the antenna directivity is enhanced Obviously.

2.DESIGN OF MICROSTRIP ANTENNA

2.1 Designing of Rectangular Micro Strip Patch Antenna

Operating frequency (fr) = 2.82 GHz, Dielectric constant of the substrate εr=4.4,

Height of the substrate (h) =1.6mm, Loss tangent = 0.01, Feed type Transmission line

2.2 Calculation of Width (W)

$$W = \frac{V_0}{2 f_r}\sqrt{\frac{2}{\varepsilon_r + 1}}$$

V**o** = free space velocity of light

ε_r = Dielectric constant of substrate.

2.3 Calculation of Effective Dielectric Constant

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{W}\right]^{-\frac{1}{2}}$$

2.4 Calculation of Effective Length (L_{eff})

$$L_{eff} = \frac{c}{2 f_0 \sqrt{\varepsilon_{reff}}}$$

2.5 Calculation of Length Extension (ΔL)

$$\Delta L = 0.412h \frac{(\varepsilon_{reff} + 0.3)\left(\frac{W}{h} + 0.264\right)}{(\varepsilon_{reff} - 0.258)\left(\frac{W}{h} + 0.8\right)}$$

2.6 Calculation of Actual Length

$$L_{eff} = L + 2\Delta L$$

2.7 Calculation of Half Power Beam Width (HPBW)

The HPBW of Electric and magnetic field

$$\theta_E = 2\,\mathrm{Sin}^{-1}\sqrt{\frac{7.03}{(3L^2 + h^2)\,k_0^2}}$$

$$\theta_H = 2\,\mathrm{Sin}^{-1}\sqrt{\frac{1}{2 + k_0 W}}$$

$$K_0 = \frac{\pi}{\sqrt{\varepsilon_{reff}}\;L}$$

2.8 Calculation of Directivity

$D = (41253/\theta_E\theta_H)$

2.9 Calculation of Gain

$G = (32400/\theta_E\theta_H)$

3. Simulation Results

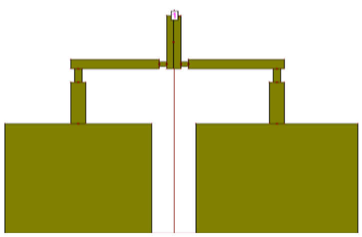


Fig. 1: Weight machine Shape Patch Antenna

Specification

1) Length1 = 24 mm, Width1 = 20 mm
2) Length2 = 24 mm, Width2 = 22 mm
3) Dielectric constant = 4.4
4) Substrate height = 1.6 mm
5) Loss tangent = 0.01
6) Width of the Strip Lines =2 mm & 1 mm.
7) Operating Frequency = 2.827 GHz
8) Dielectric material is Glass Epoxy

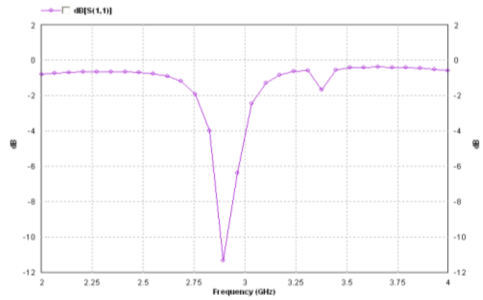
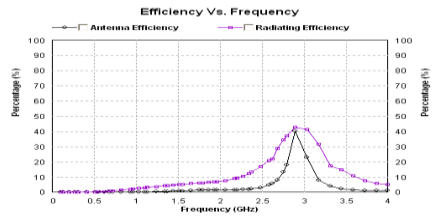


Fig. 2: Return Loss Graph v/s Frequency

Fig. 3: Efficiency Vs Frequency



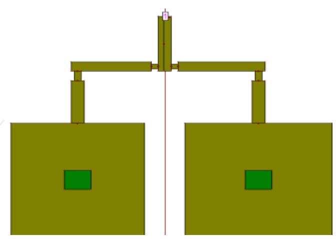


Fig. 4: Weight machine square cut Shape Patch Antenna

Specification:

1) Length1 = 24 mm, Width1 = 20 mm
2) Length2 = 24 mm, Width2 = 22 mm
3) Dielectric constant = 4.4
4) Substrate height = 1.6 mm
5) Loss tangent = 0.01
6) Width of the Strip Lines =2 mm & 1 mm.
7) Operating Frequency = 2.896 GHz
8) Dielectric material is Glass Epoxy
9). Cut at the centre 4×4mm

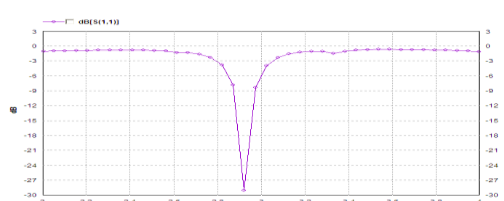


Fig. 5: Return Loss Graph v/s Frequency

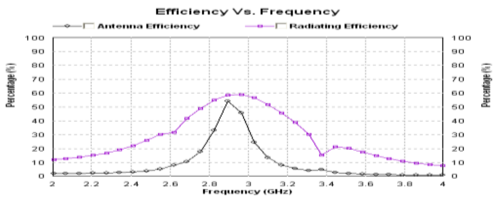


Fig. 6: Efficiency Vs Frequency

4. SIMULATION RESULTS AND DISCUSSION

Parameter	Weight Machine Shape Patch Antenna	Weight Machine Shape Square Cut Patch Antenna
Gain(dBi)	1.71635(dBi)	2.7087(dBi)
Directivity(dBi)	6.5469(dBi)	6.65038(dBi)
Efficiency	40.339%	59.65%
Operating Frequency	2.82759(GHz)	2.89655(GHz)
Band Width	(70.6736,164.056)deg.	(70.1625,90.817) deg.

After designing and simulation the antenna, ensuring that it operates at the desired frequency and recording its return loss. The new 'square cut' shaped structure is place on the without cut patch antenna at a height of 1.6mm from the ground plane. Patch antenna to observe the gain, directivity of the antenna. The return loss was also obtained at the same time and been analyzed. The simulation results of weight machine shape microstrip patch antenna with 'square cut' shaped structure are show in fig.2 & fig.5; simulation exhibits weight machine shape antenna alone shows the return loss of -11.65 dB while when it is designed with structure at 1.6mm it shows return loss of -18.45dB. Which shows significant reduction in return loss using such structure, that ultimately improves the quality of communication. Other supporting plots for various parameters like efficiency show in fig.3&6. Here that shows the quality of simulated antenna using square cut is improving without making variations in other parameters.

CONCLUSION

In conclusion metamaterial structures help to improve some features of microstrip antenna. The near zero refraction index of these structures concentrate radiation energy of patch of antenna,consequently, they increase Gain of antenna and beam shaping of antenna radiation pattern. Also they help to improve bandwidth or antenna when two layers metamaterial superstrate are used.

REFERENCE

[1] Ch. Caloz and T. Itah, "Electromaganetic Metamaterials: Transmission Line Theory and Microwave application".Wiley 2006.

[2] Lnoch, S. G.Tayeb, P. Sabouroux and P.Vincont," A metamaterial for directive emission". Physical Review Letters, Vol. 89. No. 21,213902:1-4, 2002.

[3]Lindell, L.V.S.A. Tretyakov, K.I. Nikoskinen and S.I1vonen, BW media with negative paraments,capable ofsupporting backward waves Microwave Opt Tech Lett.Vol. 31,No.2 ,129-133,2001.

[4]Huiliang Xu,Zeyu Zhao. Yueguang Lv, Chunlei Du and Xiangang Luo, "metamaterial superstrate and electromagnetic band –gap substate for high directive antenna" Int J Infrared milli waves 29:493-498 DOI 10.1007/s10762-008-9344-y,2008

[5] Jing Liang, Hung-Yu and David Yang,"radiation characteristics of a microstrip patch over an electromagnetic bandgap surface", *IEEE Transactions On Antennas and Propagation*, Vol. 55, NO. 6, JUNE 2007

[6] A. Chauraya, J. Kelly, G. K. Palikaras, C. B. Mulenga, J. A. Flint, A. P. Feresidis and J. C. Vardaxoglou, "Planar and cylindrical metamaterial structures for antenna applications," EMTS International URSI Commission B - Electromagnetic Theory Symposium, July 2007

[7] A. R. Weily, L. Horvath, K.P. Esselle, B. C. Sanders and T. S. Bird, "A planar resonator antenna based on a woodpile EBG material", *IEEE Transactions on Antennas and Propagation,* 53, 216–223, 2005.

[8] R.W. Ziolkowski and E. Heyman, "Wave propagation in media having negative permittivity and permeability," Phys. Rev. E,Vol. 64, No. 5, 056625:1-15, 2001.

[9] B. Temelkuaran, M. Bayindir, E. Ozbay, R. Biswas, M. M. Sigalas, G. Tuttle and K. M. Ho, "Photonic crystal-based resonant antenna with a very high directivity", Journal of Applied Physics 87, 603–605 (2000).