Design of a High Gain Broadband Microstrip Patch Antenna for Cognitive Radio

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ABSTRACT
This research paper presenting the experimental investigations on the effect of metallic inclusions on a dielectric substrate for tailoring the properties of met materials and a dual band micro strip patch antenna along with the met material structure that is proposed at a height of 3.3 mm from the ground plane, which consists of a geometry incorporated with a special arrangement that is c fashioned arrangement. Actually this research paper principally paying attention on going up the probable parameters of high gain broadband microstrip patch antennas and analyzing the dual band procedure of the proposed antenna. dielectric properties of samples are measured with dissimilar metallic inclusions and the outcome are compared with and without inclusions. The proposed antenna is designed to resonate frequency at 2.488 GHz and 2.920 GHz frequency and the impedance bandwidth of the antenna is at 2.488 GHz along with the proposed metamaterial structure is improved with 20.5 MHz frequency and return loss is reduced by the 20.138 dB. At 2.920 GHz frequency the impedance bandwidth is improved by 25.5 MHz and return loss is reduced by 19.574 dB. For verifying that the proposed metamaterial structure possesses the designs of several samples leading negative values of Permittivity and Permeability within the operating frequency ranges presented along with their experimental results.

Index Terms – Metamaterials, Dual band operation, Returnloss, Microstrip Patch Antenna and Impedance bandwidth.

I INTRODUCTION

Actually Metamaterials are a broad class of imitation materials that could be engineered to demonstrate permittivity and permeability individuality to system necessities. With embedding unambiguous structures in a number of horde media the consequential material can be personalized to put on display sought-after individuality. Some Engineered Metamaterial have permeability and permittivity less than zero because product εμ is positive, refractive index (η) is positive and real. Many Metals such as gold or silver have negative ε at visible wavelength. Materials which have ε or μ negative but not both is denser to electromagnetic radiations. We know that this is the world of wireless communication systems and Metamaterials are a broad class of synthetic materials that could be engineered to show permittivity and permeability characteristics to system requirements. In spite of having a lot of advantages like low profile, low cost and omni directional radiation pattern. It has a number of drawbacks similar to less bandwidth and low gain. Several researches have been done to overcome the drawbacks. But this research paper discussed about the metamaterials have been lengthily useful for antenna applications newly to achieve.

(a) Beam width control
(b) Antenna miniaturization
(c) Improved directivity

A novel application of Metamaterials has been found in enhancing the magnetic permeability of otherwise nonmagnetic materials. Metamaterial based antennas can display improved performance characteristics like more radiated power for the same input power in comparison with conventional microstrip antenna.

II PROPOSED DESIGN

(a) **Shape & Geometry -** As we are seeing Figure 1 shows the top view of the proposed configuration and Figure 2 shows its side view. The proposed design consists layers of metallic patch on a layer of dielectric substrate. Both layers are in the shape of L. To excite the antenna, single probe feed is applied to the patch. The position of feed is also shown in figure no. 1.

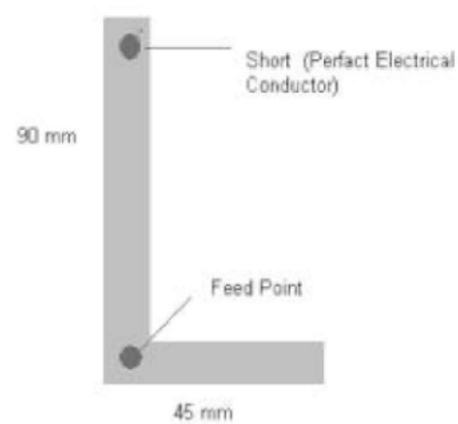

Fig.1

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Fig.2

The RMPA parameters can be calculated with the formulas given below-

Width Calculation (W) is-

$$W = \frac{1}{2fr\sqrt{\mu_0\varepsilon_0}}\sqrt{\frac{2}{\varepsilon r+1}} = \frac{c}{2fr}\sqrt{\frac{2}{\varepsilon r-1}}$$

Where, c = free space velocity of light and εr = Dielectric constant of substrate.

The efficient dielectric constant of the broaband microstrip antenna is-

$$\varepsilon_{eff} = \frac{\varepsilon r+1}{2} + \frac{\varepsilon r-1}{2}\left(\frac{1}{\sqrt{1+\frac{12h}{W}}}\right)$$

The actual length of the Patch (L) is-

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

Where, $L_{eff} = \frac{c}{2fr\sqrt{\varepsilon eff}}$

Calculation of Length Extension is-

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

(b) Parameters & Dimensions- The thickness of the patch 0.0006 mm, Permittivity of the substrate 4.5, Loss tangent of lower substrate is 0.0002, Radius of Short is 6 mm and the Thickness of the substrate 1.7 mm

III RESULTS & DISCUSSION

Figure 3 shows the variations of S11 with Frequency.

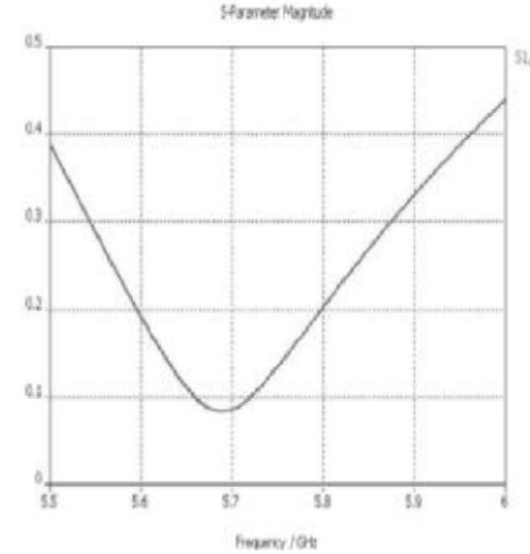

Fig.3

Figure 4 shows proposed metamaterial structure between the two waveguide ports.

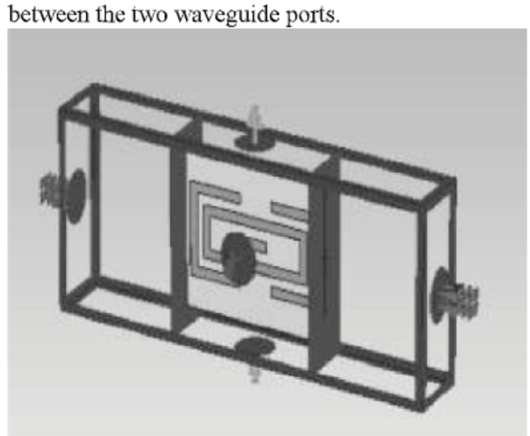

Fig. 4

Figure 5 shows the schematic memamaterial patch antenna.

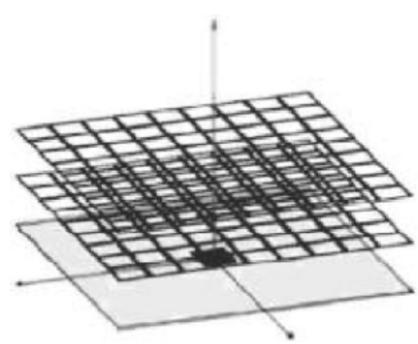

Fig. 5

Figure 6shows the discrepancy of VSWR through frequency of the antenna. From Frequency 5.55 GHz to3.75GHz the input VSWR is ≤ 2.

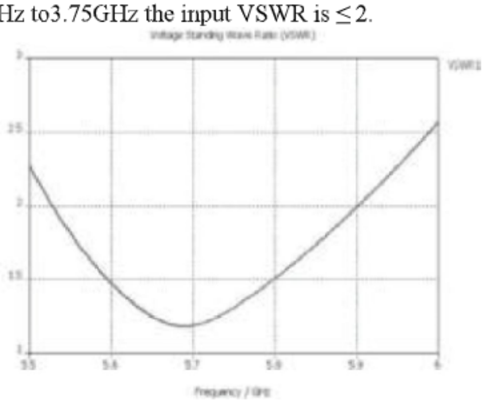

Fig.6

Figure 7 shows the Rectangular Microstrip Patch Antenna

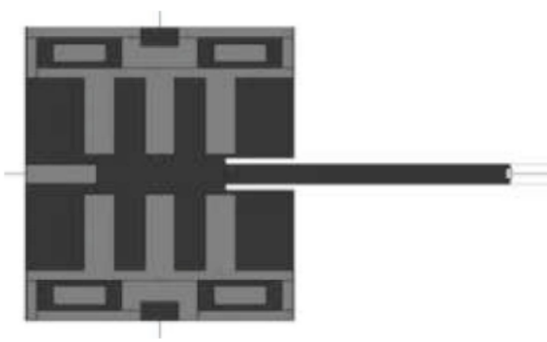

Fig. 7

Figure 8 shows Smith Chart

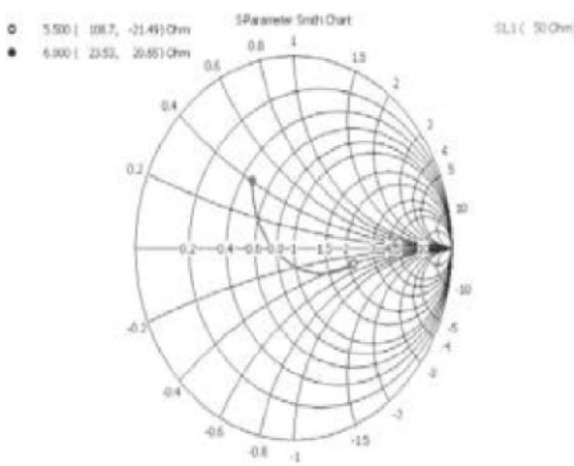

Fig.8

And if we'll talk about the distribution of the magnetic field then fig9 and fig10 shows the niceties regarding for the past said.

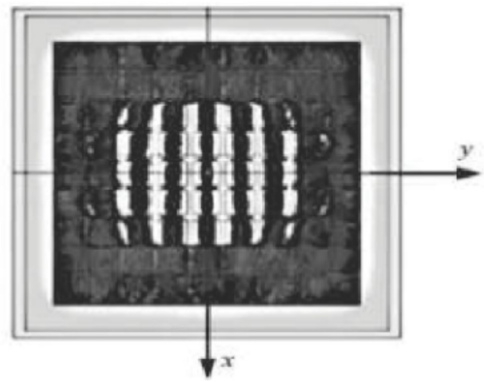

Fig.9

Fig 10 shows the first layer on the surface of the metamaterial cover an fig 10 shows the second layer from the substrate upward.

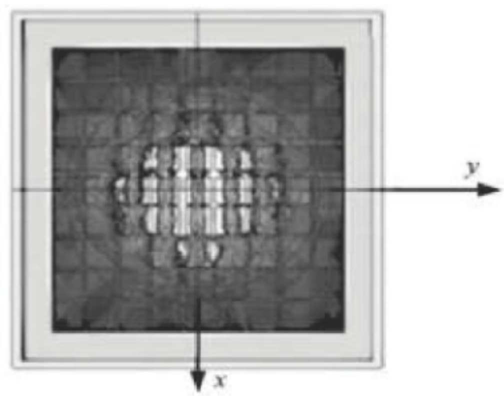

Fig.10

NRW's Method- Equations used for finding permittivity & permeability using NRW's approach.

$$\mu_r = \frac{2.c(1-v2)}{\omega.d.l(1+v2)}$$

$$\varepsilon_r = \mu_r + \frac{2.s11.c.l}{c.d}$$

$v_2 = S_{21} - S_{11}$

Where,

εr = Permittivity

μr = Permeability

ω = Frequency in Radian

d = Thickness of the Substrate

c = Speed of Light, and

v_2 = Voltage Minima

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