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Enhancing Microstrip Patch Antenna Performance Using a Double-Layer Metamaterial Superstrate

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Abstract.
In this paper, a metamaterial antenna running at a frequency of five. Eight GHz is supplied. Metamaterial superstrate cover acts as a lens which focuses the EM radiations because of the unusual homes of the metamaterial.This results in improvement performance of patch antenna along side its bodily protection. The proposed metamaterial lens consists of a double layer of nine-through-nine matrix of cut up-Ring Resonators (SRRs), and is positioned above a probe-fed rectangular patch resonating at five. eight GHz. The shape improve the gain and directivity of a easy patch antenna up to 7 dB.Simulation effects of the proposed antenna are presented and discussed in this letter.

Keywords: Metamaterial (MTM),Split Ring Resonator (SRR).

1 Introduction

An widespread boom inside the subject of telecommunication has generated significant desires and has ended in a primary technological trade at the antenna degree, depending at the transmission frequency, statistics charge or transmission range.

The antenna is one of the maximum important components within the wireless communication systems, since the overall performance of the antenna alone can severely affect the overall overall performance of the entire system. The layout aim of an antenna is regularly governed with the aid of the specifications provided through the patron. Many applications specify that the antenna have to be conformal, and that it ought to have a excessive directivity along a course when transmitting. These requirements, namely high directivity is the main growing trends amongst antennas and usually provides a wonderful assignment to engineers running in this subject. The traditional antenna technology to gain the high directivity needs multiple radiating elements to manufacture the antenna array [1]. but, such array layout requires a complicated feed network, and the demands that the a couple of antenna factors be maintained nicely. this is due to the fact the malfunction of 1 or extra antenna factors may also occasionally seriously affect the overall overall performance of the antenna device, different thrilling answers to beautify the directivity of the patch antenna have been counseled: the primary one become to utilize a DGS method to modify the parameter of antenna and the second one proposed these days changed into to sandwich the antenna with the aid of dielectric layers of the equal permittivity [2] [3].

Greater recently, some other method is proposed so that you can enhance the directivity of the antenna, that is primarily based on the use of artificial substances such as left- exceeded metamaterials [4]. Those new styles of

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artificial materials, made out of periodic unit structures that are compactly crowded into an powerful fabric, open the manner to take a look at some wonderful homes which are not possible to achieve with natural materials.

Many research works had been done in acquiring the high directivity of antenna by using the usage of metamaterial systems [5–12]. MTMs may be fabricated thru diverse approaches which include photonic crystal [9], electromagnetic band gap (EBG) structure, frequency selective surface (FSS) [10–11], and other periodic artificial fabric which can be designed to have a low / 0 refractive index [12–13].particularly, terrible refractive index zero or near zero index metamaterial, and furthermore cause potential packages, many of which have been considered tough in the past. those encompass, for instance, best lensing [14], invisibility cloaking [15] and miniaturizing microwave gadgets [16].

In this paper, we provided a metamaterial antenna for WLAN software operating at the frequency of five.8 GHz. The double layer metamaterial superstrate used on this layout become built via cut up ring resonator (SRRs), delivered for the primary time by using Pendry et al. in 1999 [17] to reap a bad permeability in a positive frequency range. the main attractive characteristic of this element is its capability to exhibit a quasi-static resonant frequency at wavelengths that are a whole lot large than its very own size. we've investigated the effect of metamaterials Radom on the directivity, benefit and bandwidth of the antenna by way of the use of CST Microwave studio. it's far observed that by using optimizing the separation distance between the antenna and the double layer metamaterial superstrate the directivity of the antenna has been increased via 7 dB.

2 Metamaterial antenna design

2.1 Presentation of Metamaterial antenna

Metamaterials are usually engineered by way of arranging a fixed of small scatterers or apertures in a regular array during a location of space, as a result obtaining some perfect bulk electromagnetic conduct. The favored assets is frequently one which isn't always normally observed clearly (bad refractive index, near-zero index, and so forth.). over the last ten years, metamaterials have moved from being simply a theoretical idea to a subject with evolved and marketed programs. 3 dimensional metamaterials can be prolonged by using arranging electrically small scatterers or holes into a -dimensional pattern at a floor or interface. This floor model of a metamaterial has been given the name metasurface for many programs; metasurfaces can be used in vicinity of metamaterials. Metasurfaces have the advantage of taking up less bodily space than do complete 3-dimensional metamaterial structures,Metamaterial Antenna is a category of antennas that use metamaterial to miniaturize antenna structures and improve their performance. Their motive, as for any electromagnetic radiated detail, is to propagate strength into unfastened area. It includes an MTM superstrate cover above a reference element.

The operation of the MTM superstrate is defined where the scattered radiations from the patch are concentrated because of the MTM superstrate cowl above. This function increases the benefit and directivity of the patch antenna. Furthermore, this type of antenna with metamaterial layer is referred to as resonant cavity antenna that typically consists of one or more surfaces Metamaterial, a ground aircraft and a supply of excitation located within the cavity.

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The unique planes are separated with the aid of the cavity height (H). This hollow space is also defined via its beginning (Lcav). The evolved antenna must have a finite

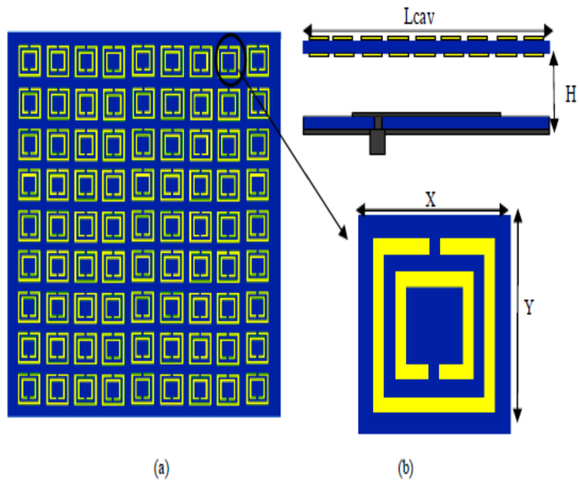

Fig. 1. Patch antenna with a double layer MMT layer. (a) top and and front view of the antenna (b)SRR unit cell.

3 Simulated results and discussion

The reflexion coefficient as opposed to frequency of the patch antenna with and without the double layer MTM superstrate is offered in figure 2.the discern show that the patch antenna itself isn't in a great matching circumstance as compared when the double layer MTM superstrate has now not been used. strong resonance in hollow space improves the matching and the resonant MTM antenna correctly and it operates over a reasonable band with a center frequency of five.eight GHz.The double layer MTM antenna is in an amazing matching with a go back loss of about -33 dB on the resonance frequency 5.eight GHz compared with the reference antenna on my own that is -12 dB.

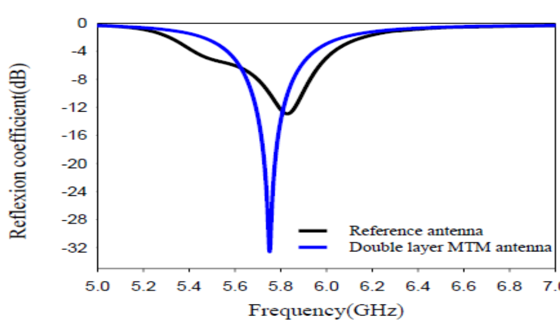

Fig. 2. reflection coefficient of the patch antenna with and without double layer MTM superstrate.

the directivity of the antenna with and without the double layer MTM superstrate is offered in figure 3. it's far visible that the directivity of the microstrip antenna protected via the double layer MTM superstrate is better than that of the antenna without using the metasurface. The maximum directivity attained on the center frequency of

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five.eight GHz is 7.2 dB (without double layer metamaterial superstrate) and 14.1 dB (with double layer metamaterial superstrate) which is about 7 dB development. This shows that the proposed double layer MTM has a brilliant impact at the enhancement of the radiation power, at an normal cavity top of 0.fiveλ.

The simulated second E-plane and H-aircraft radiation pattern of the double layer MTM superstrate loaded antenna in contrast to the reference antenna on the resonant frequency 5.eight GHz are shown in discern 4. we will examine that the main lobe is as expected in the direction of the superb z-axis (the course of propagation) and that the back-lobe stage decreases and wide side level will increase by way of the loading of double layer MTM superstrate. It's clean from the plot that loading a microstrip antenna with MTM superstrate, has an critical effect on the reduction of the -3dB beam width which degrade from 28, three° to 104° within the E plan and from 30,4° to 83,five° within the H plan ,the reduction in three-dB beam width is indication of the advanced directivity inside the broadside course.

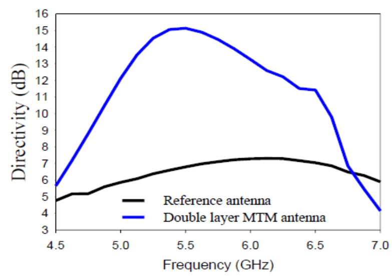
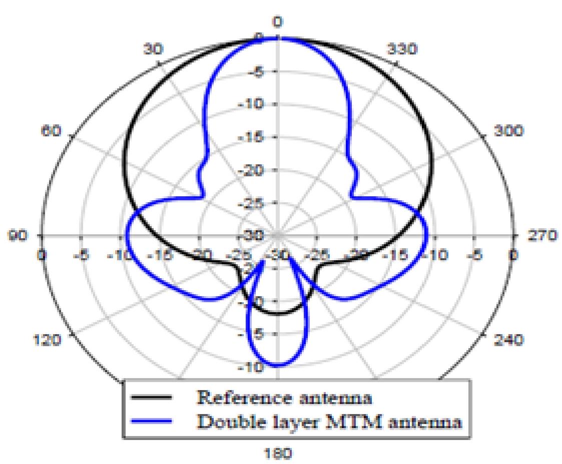


Fig. 3. Directivity of the patch antenna with and without double MTM superstrate.



(a)

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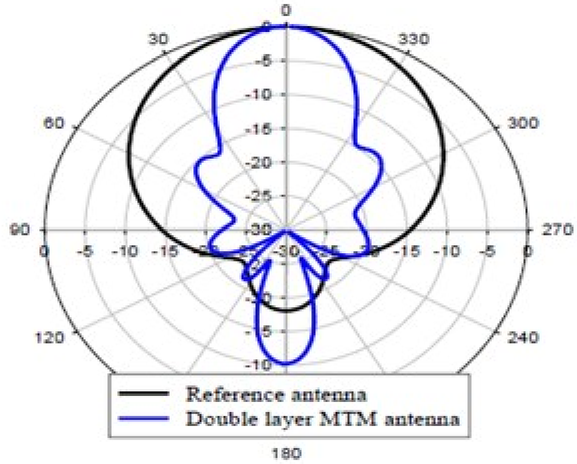

(b)

Fig. 4. Radiation pattern of designed antenna at 5.8 GHz with and without the double layer MTM superstrate: (a) H-plane radiation pattern (b) E-plan radiation pattern

4 Conclusion

The results obtained are encouraging, the structure allowed us to improve the directivity of the antenna patch in the frequency range of hobby through a value of 7 dB. this structure not only allows enhancing the directivity of the patch but also other characteristics, the double layer MTM antenna is in a very good matching with a go back lack of about -33 dB on the resonance frequency 5.eight GHz compared with the reference antenna by myself which is -12 dB,The HPBW of the antenna with metasurface is narrowed down to twenty-eight.three° from 104° diploma inside the E plan and to 30.4° from 83.five° inside the H plan,thinking about the radiation performance before and after the usage of the metasurface it has been advanced over the applicable variety of frequencies from 70% to eighty three%.This shows that the double layer metamaterial superstrate added has a very important effect on antenna patch overall performance. In conclusion, the double layer MTM superstrate concentrates the radiation energy of the patch antenna and therefore it makes feasible to improve positive characteristics of reference element, high directivity is the most important demand of telecommunication and space programs. hence the design of such antennas is the important thing requirement so as to conquer the restrictive parameters of the traditional antennas, we trust that similar idea can also be applied to different kinds of planar antennas and arrays.

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