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Design of Multilayered Stack Antenna for Wireless Communication

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Abstract

In Today's technology of wireless communication requires small, portable and low cost reconfigurable antenna which can be reconfigured through switching of different frequencies for different applications. This paper contains a multilayered reconfigurable antenna with two patches stacked one over the other is designed. In our design, patch 1 is designed for 5.42 GHz targeting ISM band & patch 2 is for 9 GHz satellite applications. The proposed antenna is designed on two substrates, Roger RT duroid 5880 (εr=2.2) and Teflon (εr=2.1). Here the design contains of two types of feed microstrip and probe feed. The results show that the designed antenna can be used switched between the two frequencies of operation using both feed separately or simultaneously. We have achieved good reflection co-efficient as per selected.

Keywords: **Microstrip antennas, Reconfigurability, ISM band, Satellite Communication, Probe Feed, Reflection co-efficient.**

1. Introduction

Wireless operations have long range communications, which are impossible or impractical to implement with the use of wires. But now from last few decades advances have increased the use of wireless communication services for various commercial and military applications. By using this large set of available wireless services it was important to design efficient shrinked antennas. A way to solve this type of problem is to use reconfigurable antennas that can be switched within patches so that we can operate for two or more set of applications by changing its operating frequency. Due to this feature of reconfiguration in antenna systems which has been recently received is noteworthy attention resulting in pioneering multifunctional antenna designs. Reconfiguration can be done by using MEMS technology [1]. Frequency reconfiguration can also be achieved by multilayered stacked antennas so that we can switch to different frequencies. Each patch is developing for different set of application [2].

In this paper, design of a reconfiguration antenna is proposed by using multilayered configuration.

2. Proposed Antenna Design

2.1 Review Stage

The proposed antenna consists of two patches over one another, use for achieving multilayered stacked design. It also consist of two different types of feeding technique i.e. probe and microstrip. Lower patch i.e. Patch 1 which is designed for 5.42 GHz thus targeting the 5.42GHz ISM band applications is feed with micro strip feed and upper layer which is designed for 10 GHz thus for targeting satellite application is feed with probe feed . The first is designed for Rogers RT Duroid 5880 as the substrate with dielectric constant ε r=2.2 and loss tangent tan δ=0.0009, whereas the upper substrate is Teflon with dielectric constant ε r=2.1 and loss tangent tan δ=0.001. Fig.1 below shows the proposed antenna design. The patch width and length are calculated using the formulae from Balanis [3]. Table I below shows the calculations of both the patches.

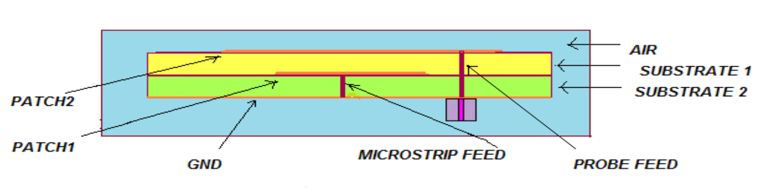

Fig. 1. Proposed Multilayered Stacked Antenna Design

TABLE 1
CALCULATIONS OF PATCH DIMESIONS

Dimensions/Parameters	Patch 1	Patch 2
Dielectric substrate	RT Duroid εr=2.2,	Teflon εr=2.1
Substrate height	1.6 mm	1.2 mm
$W = \frac{c}{2f_0}\sqrt{\frac{2}{\varepsilon_r + 1}}$	22mm	13.3 mm
$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{W}\right]^{-1/2}$	2.038	1.93
$\Delta L = 0.412h\frac{(\varepsilon_{reff} + 0.3)\left[\frac{W}{h} + 0.264\right]}{(\varepsilon_{reff} + 0.258)\left[\frac{W}{h} + 0.8\right]}$	0.646 mm	0.481 mm
$L_{eff} = \frac{c}{2f_0\sqrt{\varepsilon_{reff}}}$	20 mm	12 mm
$L = L_{eff} - 2\Delta L$	18.07 mm	11.89 mm

3. Results

The proposed antenna is designed using Ansys HFSS EM simulation software. Fig 2. below shows the proposed antenna design. We have used co-axial feeding technique in the proposed antenna design. The proposed antenna is initially simulated considering one patch at time. For this chase each patch in the antenna is excited individually and results are measured. Even though a single patch is excited there will be some electromagnetic coupling linking with the other patch. To achieve the desired set of operations the feed position is optimized in such a way that for a particular set of excitation the operation for only that specific patch is obtained. Recommended font sizes are shown in Table 1.

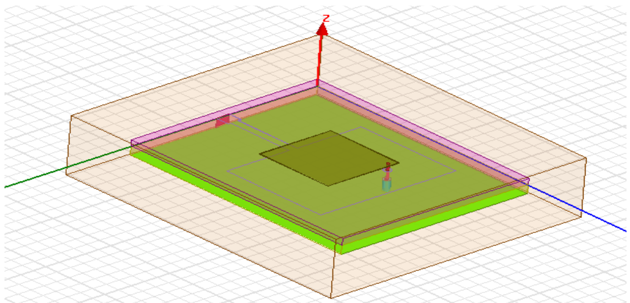

Fig. 2. Proposed Antenna Designed on HFSS

Fig 3. below shows the S11 graph for the proposed antenna with Patch 1 under consideration. The obtained frequency is 5.46 GHz with -30.26 dB. Fig 4. shows the smith chart, the matching of 48.37-j2.54Ω is achieved. Fig 5. shows the radiation pattern. The directive gain of the antenna is 6.45 dB.

Fig 6. below shows the S11 graph for the proposed antenna with Patch 2 under consideration. The obtained frequency is 9 GHz with – 28. 37 dB. Fig 7. shows the smith chart, the matching of 50.57+j6.4Ω is achieved. Fig 8. shows the radiation pattern. The directive gain of the antenna is 5.99 dB.

Fig 9. shows the S11 graph for the proposed antenna with Patch 1 and Patch 2 both under consideration. The obtained frequency is 5.42 GHz and 9 GHz with –24.08dB and -12.49 dB respectively. Fig 11shows the smith chart, the matching of 49.19+ j24.215Ω for 5.42GHz and 50.91-j117.94Ω for 9GHz. Fig 10. Shows the radiation pattern. The directive gain of the antenna is 6.236 db.

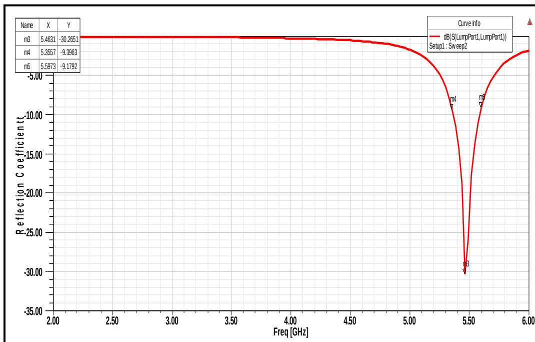

Fig. 3. S11 graph for Patch 1

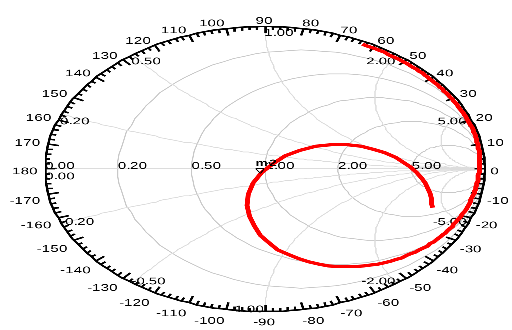

Fig. 4. Smith Chart for Patch 1

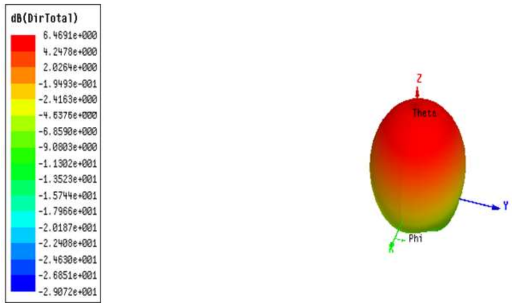

Fig. 5. 3D Radiation Pattern for Patch 1

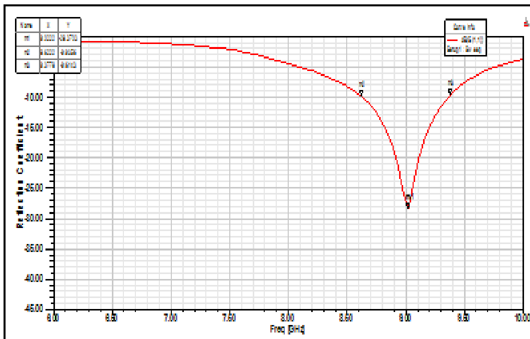

Fig. 6. S11 graph for Patch 2

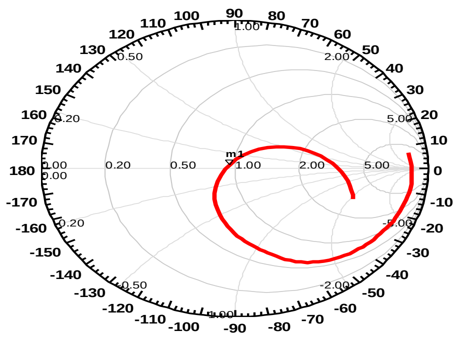

Fig. 7. Smith Chart for Patch 2

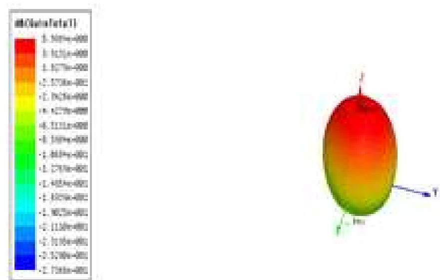

Fig. 8. 3D Radiation Pattern for Patch 2

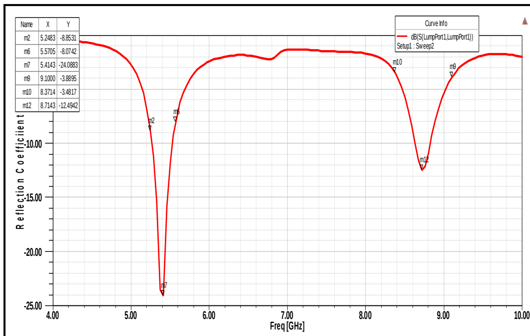

Fig. 9. S11 graph for Patch 1 and Patch 2

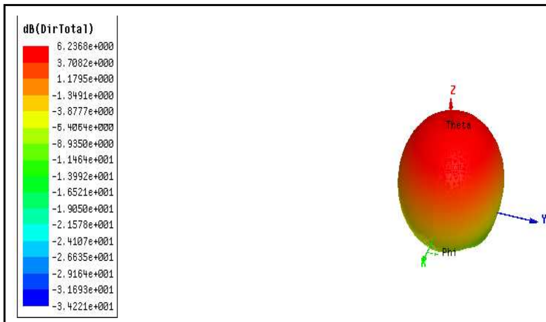

Fig. 10. 3D Radiation Pattern for Patch 1 and Patch 2

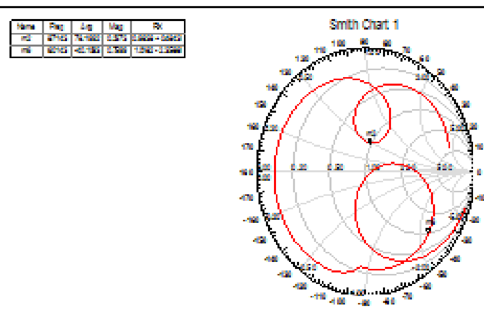

Fig 11 Smith Chart for Patch1 and Patch2

TABLE 2: COMPARISON OF RESULTS

Parameters	Patch 1	Patch 2	Patch 1 and 2
Frequency	5.46 GHz	9 GHz	5.42 GHz and 9 GHz
S11	-30.26 dB	-28.37 dB	-24.08 and -12.49 dB
Bandwidth	240 MHz	750 MHz	330 MHz and 730MHz
VSWR	0.8857	1.0793	1.1332 and 1.62
Gain	6.45 dB	5.99 dB	6.236 dB
Impedance	48.37-j2.54Ω	50.57+j6.4Ω	49.19+j24.215 Ω and 50.91-j117.94 Ω

Table 2. Above shows the comparative simulation results for the proposed stacked antenna for Patch 1, Patch 2 and both the patches simultaneously. Thus the proposed antenna can be made to operate on 5.4GHz ISM band or 9GHz satellite communication applications or on both simultaneously.

4. Conclusions

In this paper a stacked multilayered micro strip antenna is designed using HFSS software. The proposed antenna can be used for 5 GHz and 9 GHz application. We have triggered the patches using two different types of feeding technique. This antenna shows good gain for both the patch separately and simultaneously. Thus the proposed design can be switched to any of the proposed frequencies. We can use diodes here for switching between two different layers physically.

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