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Triple Frequency Stacked Patch Planar Antenna Array for L band RADAR

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Abstract: This paper presented a Triple Frequency passive array stacked patch antenna, which work on the L-band frequencies of 1.25 GHz, 1.46 GHz and 1.65 GHz. The array contained 16 rectangular stacked patch antenna elements and these 4×4array were fed by independent coaxial method. This design reduced the effects of the complex feeding network on antenna performance and the distance between each antenna element was only half of free space wavelength, so the size of whole array was reduced significantly. This antenna can also be combined into a bigger array with more elements, then make the miniaturization of the array more obvious.

Keywords: Miniaturization, Multi Frequency, Passive Array, Stacked Patch.

I. INTRODUCTION

With the development of the printed circuit board technology, the patch antenna array has been used widely with the advantages of low-profile, light weight and suitable for mass production [1-3]. However, this type of antenna array needs complex feed network, and with the quantity of the elements increasing, the complexity of the feeding network is increasing. Then bring some problems such as there is coupling between elements and feed lines, which will decrease the gain of the array antenna and make the axial ratio terrible. Then we have to increase the distance between each antenna element to cut down the coupled effects, but it will significantly increase the size of the antenna array again, which doesn't benefit to miniaturization. This paper presented a 4×4 patch antenna array with independently feeding ports.What's more, the distance between each antenna element was only half of free space wavelength, which could decrease the size of the array significantly.

II. STRUCTURE OF THE ANTENNA ARRAY

(A) Structure of the antenna element and 4×4 array

The Structure of the antenna element and array are shown in Fig. 1, the element is rectangular stacked patch antenna. Resonance at three L-Band frequencies is achieved by using three patches. These 16 elements were combined into a 4 × 4 antenna array. The dimension is as follows: Length and width of the substrate are taken as 238 mm. They were printed on a RT Duroid 5880 substrate, the board's thickness is h = 62 mils and relative dielectric constant is εr = 2.2. Each element was fed by a coaxial probe. The coaxial cable's diameter of inner conductor is 1 mm, and the outer conductor is 2.5 mm.

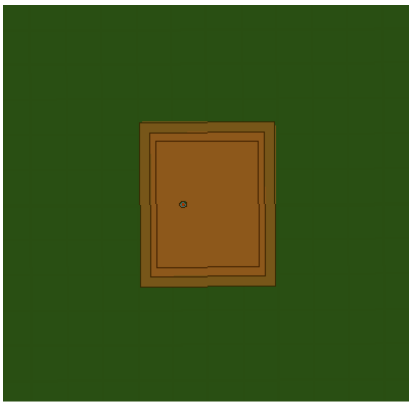

Fig. 1. Structure of the Antenna Element.

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Fig. 2 shows the layout of 4x4 microstrip patch antenna array. The microstrip patch antenna produces circular polarization which is achieved with diagonal truncations to the patch and with a single feed to the patch for an array.

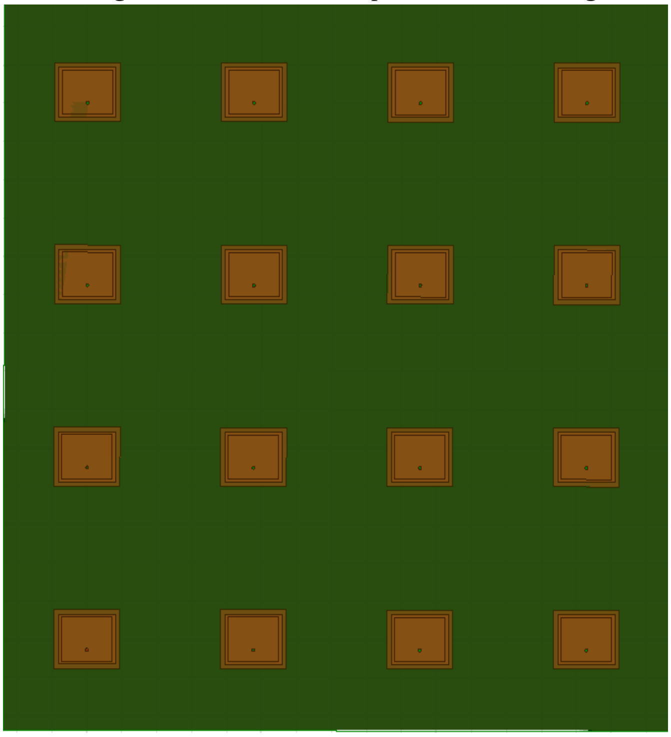


Fig 2. 4×4 Antenna Array

III. SIMULATION AND MEASUREMENT

(A) The Impedance Characteristic of Antenna Element

There's a reflection coefficient plot of the antenna shown in Fig .3, it's the simulated results of the antenna element. As can be seen from the plot that the working frequency of the antenna is 1.25 GHz, 1.46 GHz and 1.65 GHz.

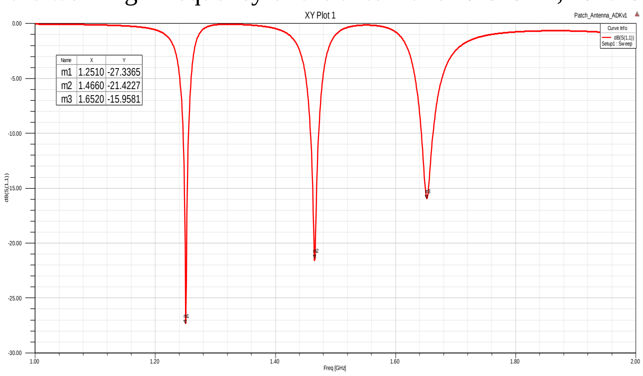


Fig. 3. Impedance Characteristic of Single Antenna Element

There's a reflection coefficient plot of the antenna shown in Fig. 4, it's the simulated and measured results of the antenna array element. As can be seen from the plot that the operating frequency of the antenna are1.25 GHz, 1.46 GHz and 1.65 GHz. Then we studied the radiation characteristics of the antenna under this frequency.

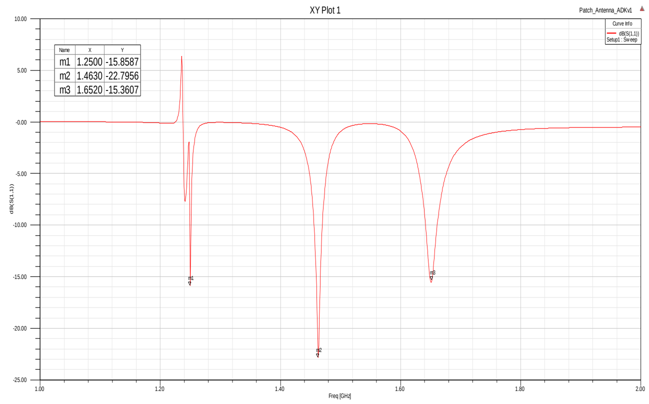


Fig. 4. Impedance Characteristic of 4×4 Antenna Array

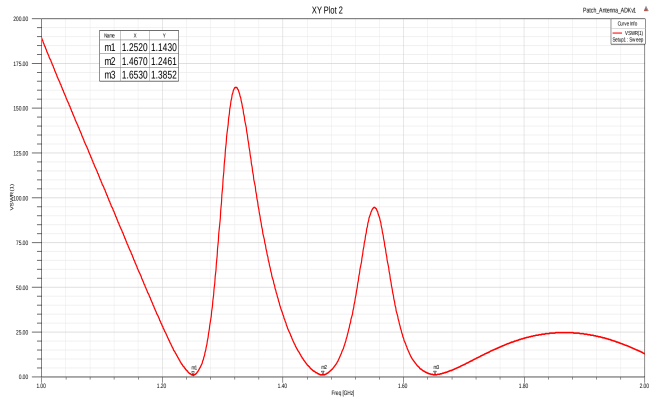
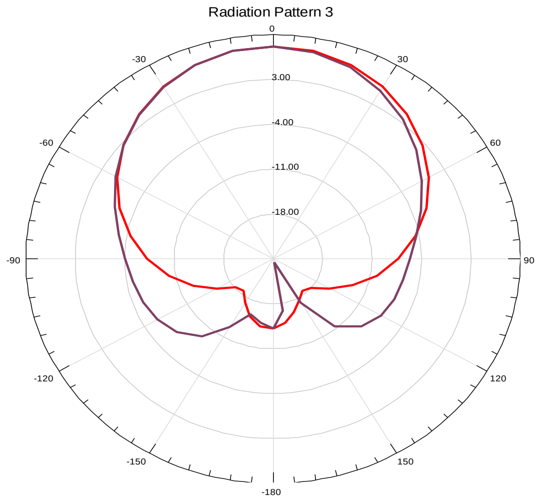


Fig. 5. VSWR of 4×4 Antenna Array

(B) Radiation Pattern

In Fig. 6, the three dimensional (2D) radiation pattern of singlestacked patch antenna element is shown.



E-plane& H-plane at 1.26 GHz

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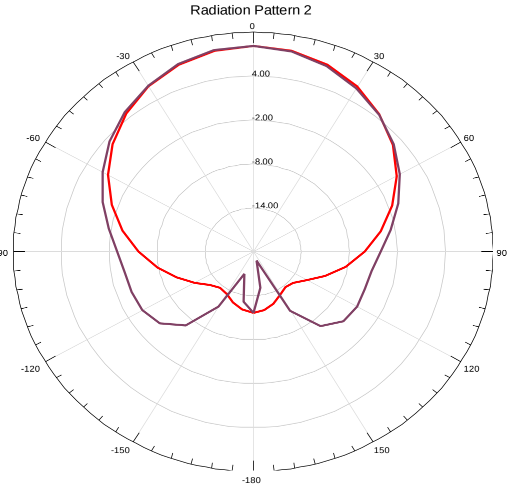
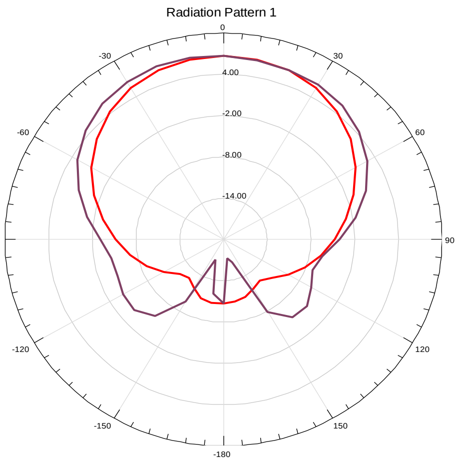


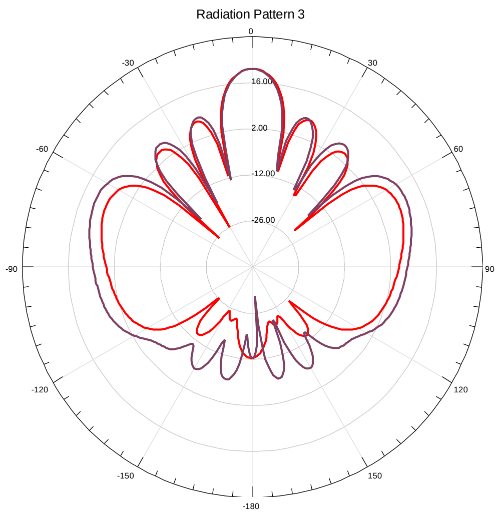
E-plane & H-plane at 1.45 GHz



E-plane & H-plane at 1.65 GHz

Fig. 6. Radiation patter of Single Antenna Element

In Fig. 7, the three dimensional (2D) radiation pattern of 4x4 stacked patch antenna array is shown. The radiation pattern from the simulated result shows in Fig. 7 that the array antenna has main lobe with increased gain and minor side lobes.



E-plane & H-plane at 1.26 GHz

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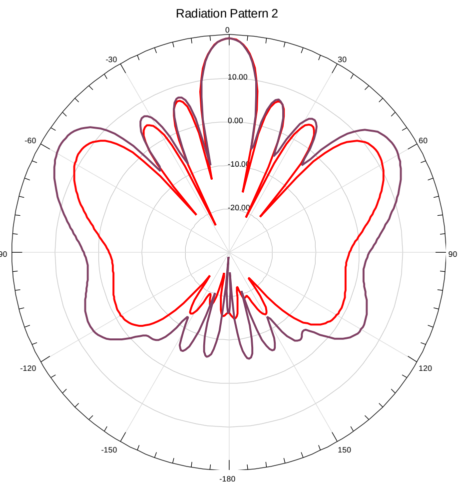
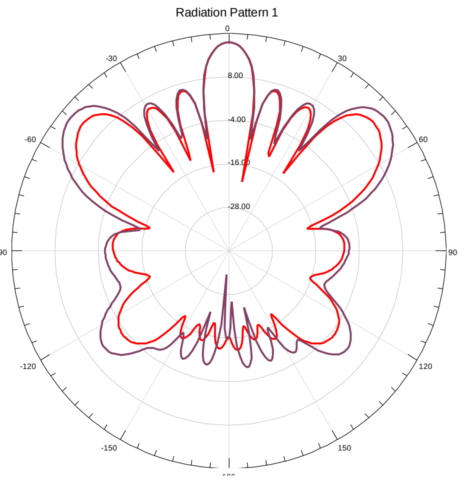


E-plane & H-plane at 1.45 GHz

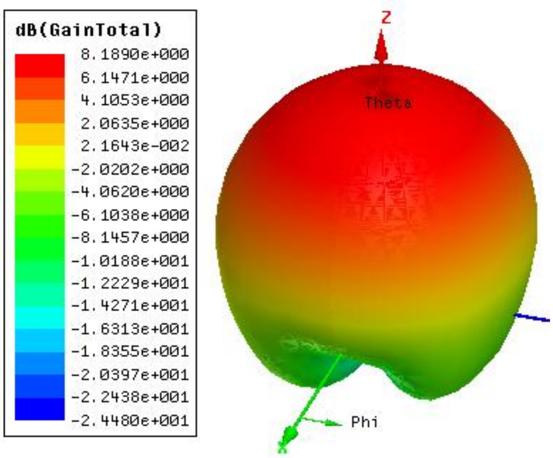


E-plane & H-plane at 1.65 GHz

Fig. 7. Radiation patter of 4×4Antenna Array

(C) Gain

The simulated gain of single antenna element and 4×4 Antenna Array are shown in Fig. 8, 9, a gain of 8.18 dB, 8.13 dB and 6.82 dB is achieved for single antenna element at 1.25 GHz, 1.46 GHz and 1.65 GHz respectively and a gain of 20.18 dB, 19.19 dB and 17.59 dB is achieved for 4×4 Antenna Array at 1.25 GHz, 1.46 GHz and 1.65 GHz respectively.



Gainat 1.26 GHz

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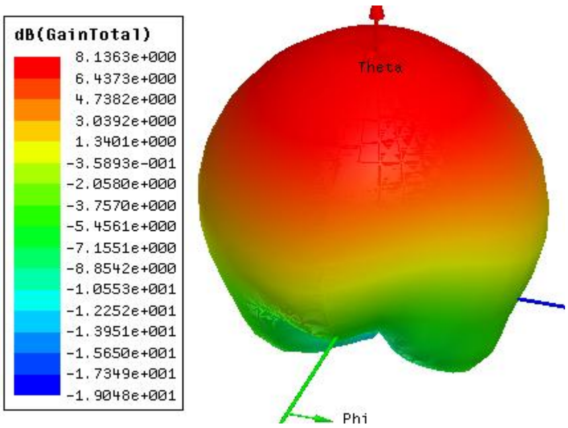
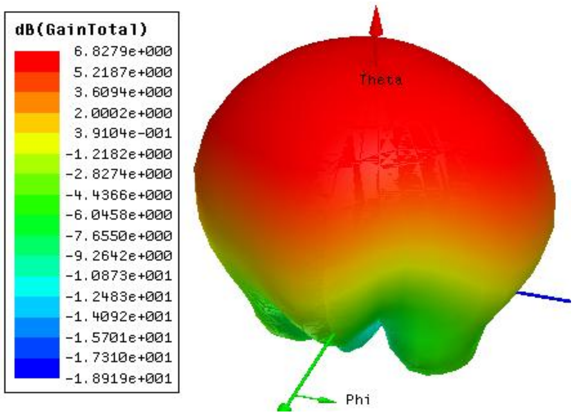
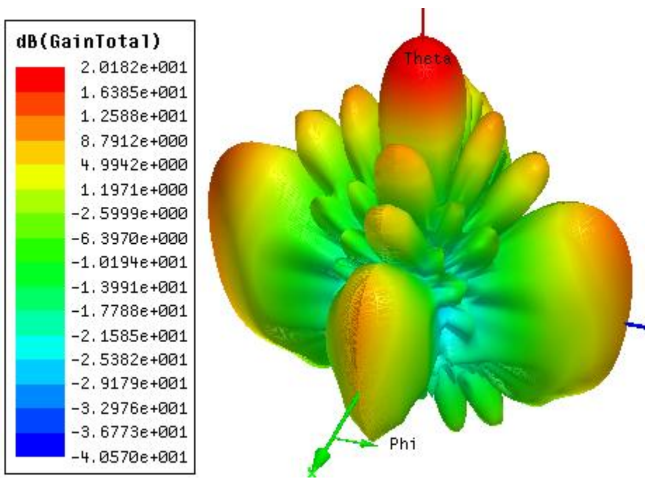


Gainat 1.45 GHz

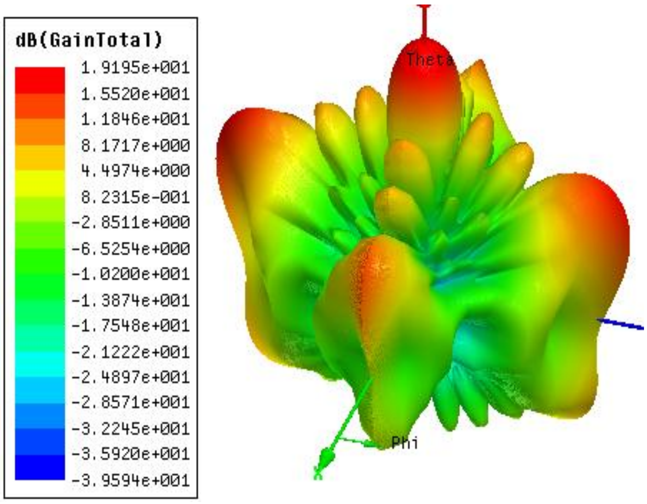


Gainat 1.65 GHz

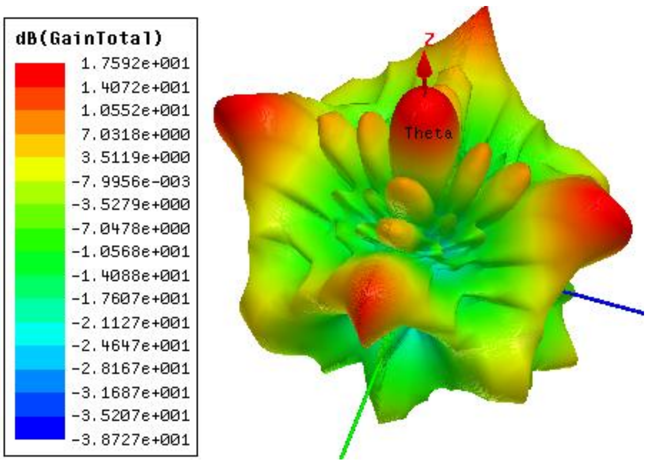
Fig. 8. Gain of Single Antenna Element



Gainat 1.26 GHz



Gainat 1.45 GHz



Gainat 1.65 GHz

Fig. 9. Gain of 4×4Antenna Array

II. CONCLUSION

In this communication, a triple frequency stacked patch antenna array is proposed. The array uses three rectangular patches as radiating elements and produces triple resonance. The gap in between the substrate and the ground plane is helpful for achieving high gain. The obtained 4×4 array has a wide bandwidth and satisfactory radiation performance. The measured results of the 4×4 array show that a higher gain is achieved while the impedance bandwidth is maintained.

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