Design and Development of Microstrip Patch Antenna Array with Improved Performance

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Abstract— Now a days, Microstrip patch antenna are widely used in in wireless communication for better performance. In this paper C slot Patch array is developed for WLAN applications. The patch antenna is designed at 2.4 GHz and C slot is introduced to improve the bandwidth upto 125MHz. The array of 4 such patches is developed to produce gain of 5.5 dB at -18 dB return loss. The patch antennas are simulated using IE3D software.

Key words: Microstrip antennas, C slot, antenna array, IE3D

I. INTRODUCTION

Microstrip patch antenna is widely used in wireless communication because of their inherent advantages .But it suffers from the limitations such as low gain, less efficiency, low bandwidth etc. The eliminations of these limitations is the demanding factor in today's scenario. In this paper we have constructed microstrip patch antenna arrays which results in performance improvement in terms of gain, directivity, efficiency and bandwidth. Initially patch antenna is designed and the C slot is introduced for bandwidth improvement such as C slot patch antennas are configured into an array to enhance the bandwidth. All the antennas are simulated in IE3D which is user friendly EM wave simulation software. These antennas are structured by using dielectric material FR4 which is having a substrate thickness of 1.56mm and dielectric constant of 4.4 and loss tangent of 0.002.

II. PATCH ANTENNA DESIGN

To design the rectangular microstrip patch antenna, the length and the width are calculated as below equations

$$W = \frac{c}{2f\sqrt{(\varepsilon_r + 1)/2}}$$

c is the velocity of light
$\varepsilon_{r\,is}$ the dielectric constant of substrate
f is the antenna working frequency
W is the patch width,

The effective dielectric constant and the length extension are given as,

$$\varepsilon_{eff} = \frac{(\varepsilon_r + 1)}{2} + \frac{(\varepsilon_r - 1)}{2}\left[1 + 10\frac{h}{W}\right]^{-\frac{1}{2}}$$

$$\frac{\Delta l}{h} = 0.412\frac{(\varepsilon_{eff} + 0.300)\left(\frac{W}{h} + 0.262\right)}{(\varepsilon_{eff} + 0.258)\frac{W}{h} + 0.813}$$

$$L = \frac{c}{2f\sqrt{\varepsilon_{eff}}} - 2\Delta l$$

In this project, a compact patch antenna having dimensions $L \times W$ has been designed on substrate of thickness 1.56 mm Figure shows the layout of a inset-feed slotted patch antenna. First the ground plane of Length L and Width W is made and then a rectangular patch of calculated dimensions is designed above the ground plane to increase the performance of microstrip antenna.

III. BASIC DESIGN

In this paper, a compact patch antenna having dimensions *30.44×38.0mm* has been designed on substrate of thickness 1.56 mm. Here we have using inset-feed slotted patch antenna. Design parameters are given in Table 1.

SL no	Parameter	Design
1	Operating frequency	2.4GHz
2	Dielectric constant of substrate	4.4
3	Loss tangent	0.0012
4	Thickness of substrate	1.56mm
5	Width of ground plane	47.36mm
6	Length of ground plane	37mm
7	Width of patch	38mm
8	Length of patch	30.44mm

Table 1: Parameter

IV. SIMULATION AND RESULTS

A. Simple patch structure:

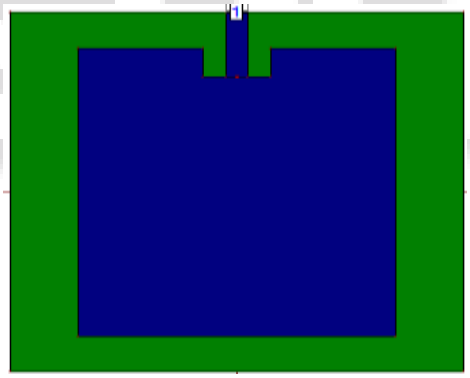


Fig 1: Simple patch antenna

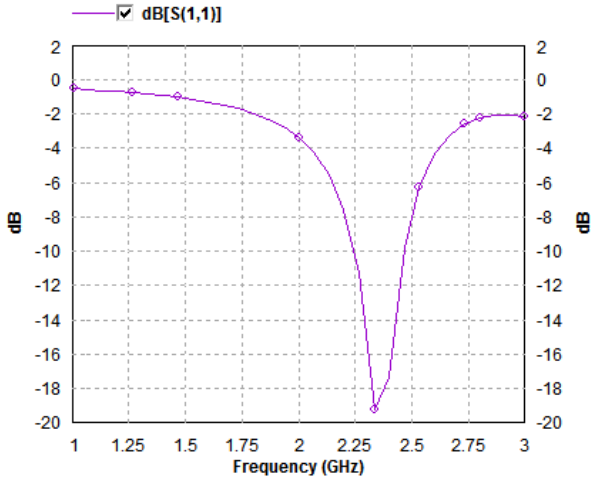
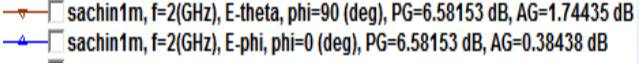


Fig. 2: Return loss of simple patch



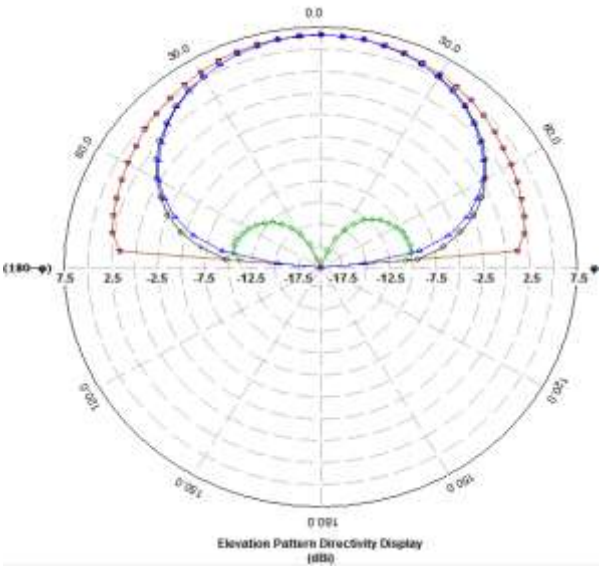


Fig. 4: Directivity of simple patch

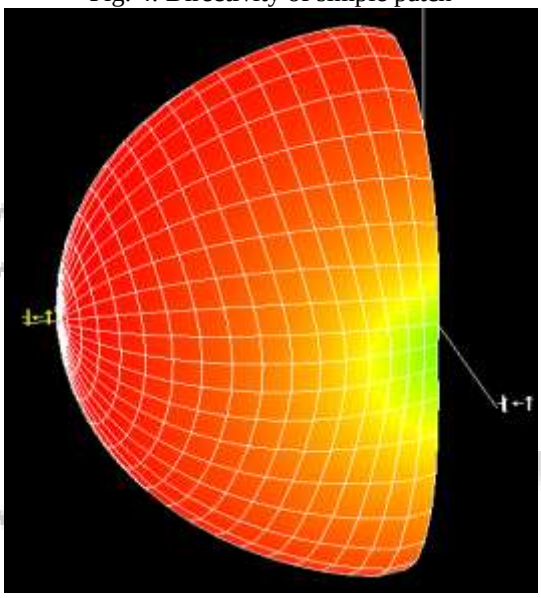


Fig. 5: 3D view pattern of simple patch

B. C slot antenna

C slot is introduced in the simple patch and is fed by inset line feeding technique as shown in Fig.6

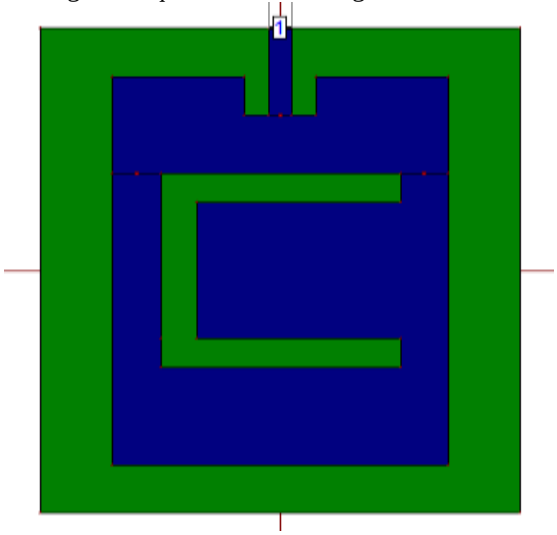


Fig. 6: C slot Antenna

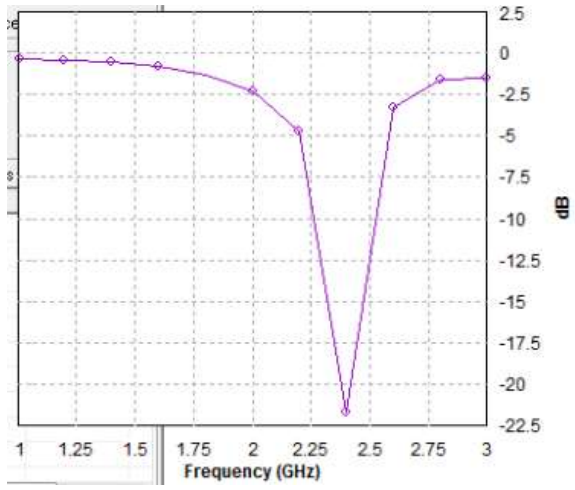


Fig. 7: Return loss of c slot

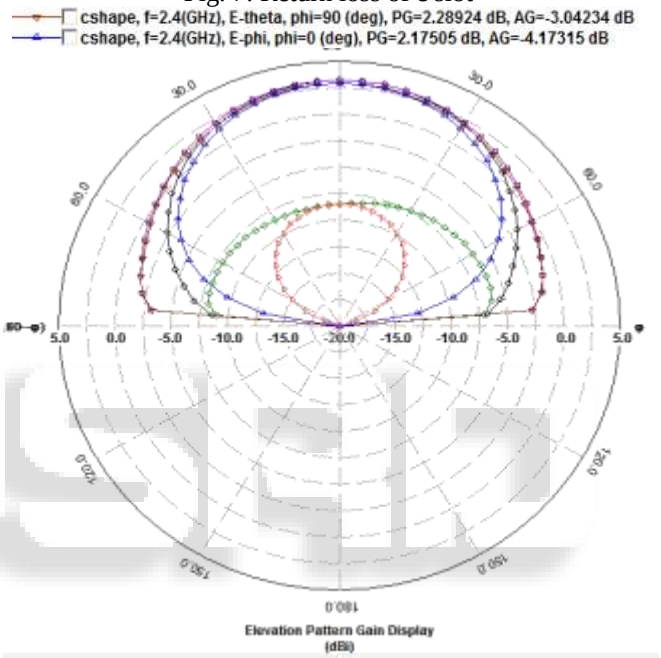


Fig. 8: Gain of c slot

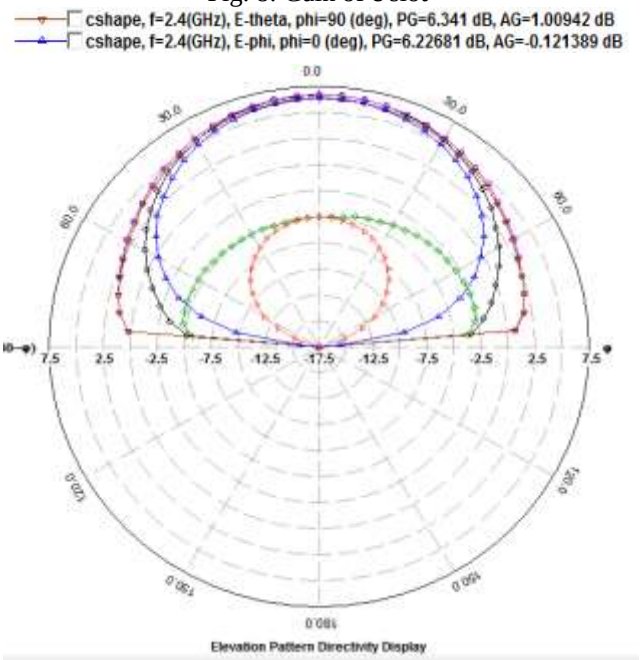


Fig. 9: Directivity of C slot

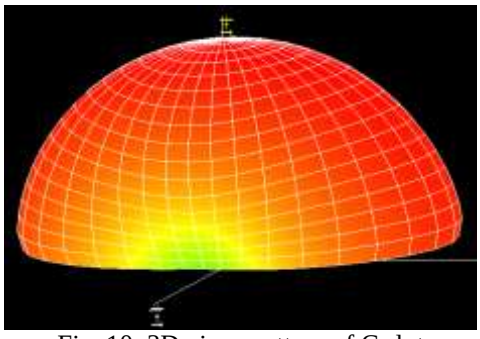


Fig. 10: 3D view pattern of C slot

C. C Slot Array Structure

We have configured the 2x2 array of C slot patch antennas and impedance matching is achieved between the feed point and the strip line by using quarter wave transformer strip.

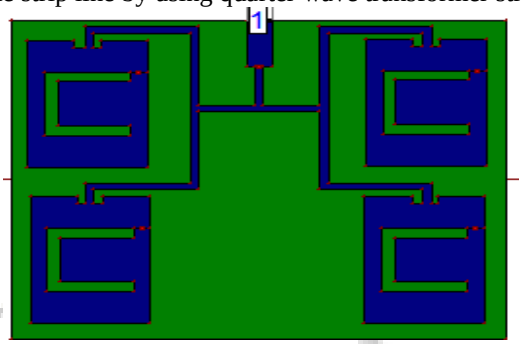


Fig 10: c slot patch

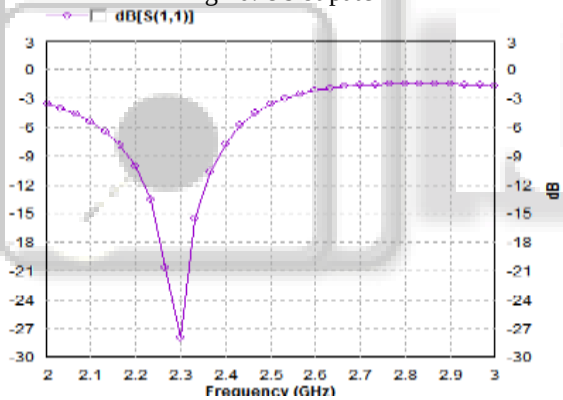


Fig 11: Return loss of c slot patch array

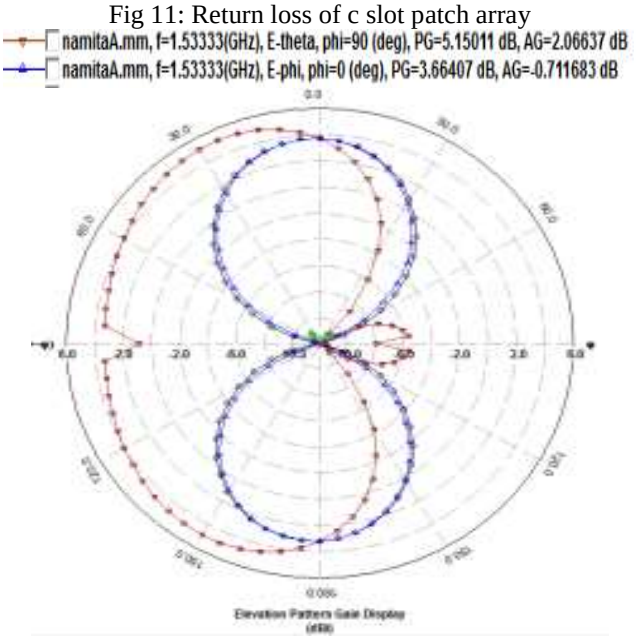


Fig 12: Gain of c slot patch array

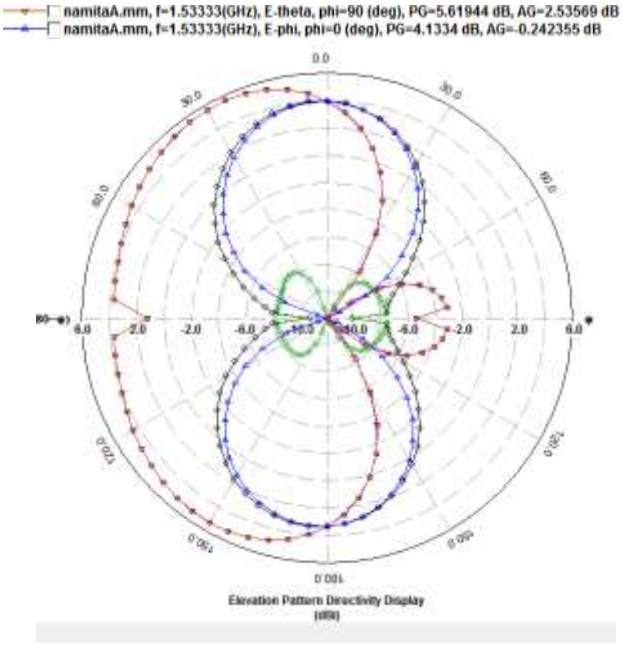


Fig 13: Directivity of c slot patch array

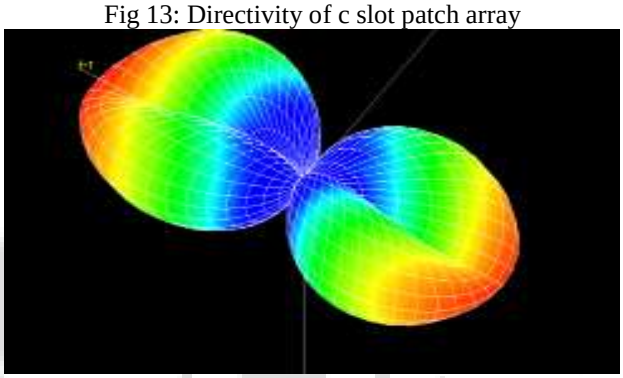


Fig. 14: 3D view pattern of C slot array

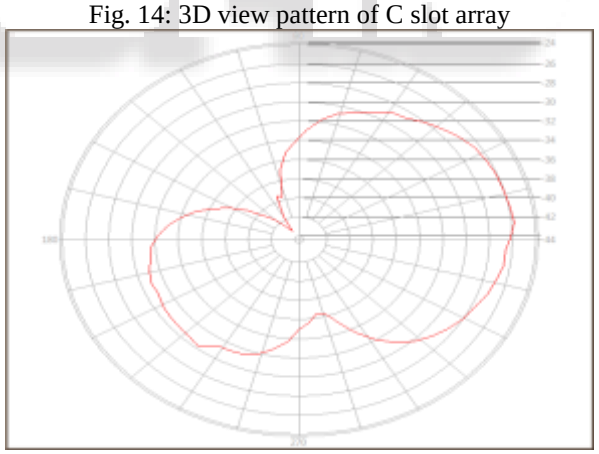


Fig. 15: Polar chart of c slot

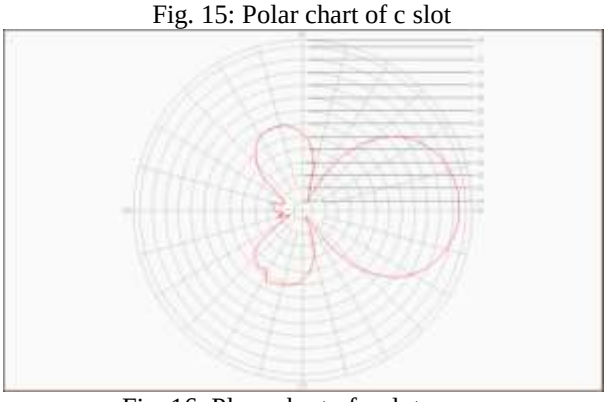


Fig. 16: Ploar chart of c slot array

V. SIMULATION RESULTS

SL. NO	Design type	Return loss dB	Gain dB	Directiviy	Bandwith MHz
1	simple	-18	1.76	6.5	65
2	C slot structure	-22.5	2.33	5.6	125
3	C slot Patch array	-30	5.50	6.3	85

Table 2: Results

A. Tested Results

SL.NO	structure	GAIN (dB)	DIRECTIVITY (dB)
1	C slot structure	3.2db	5.8db
2	C slot array structure	5.6db	6.2db

Table 3: Results

VI. CONCLUSION

In C slot antenna there is enhancement of bandwidth up to 125MHZ at -18 dB return loss and gain is 2.33dB which are improved compared to simple patch antenna . The gain is high has 5.5dB in case of C slot patch antenna but the bandwidth is decreased to 85MHZ .However the bandwidth of c slot array is well above that of simple patch

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