ANALYSIS OF DUAL-BAND MICROSTRIP PATCH ANTENNA ARRAY FOR WIFI/WIMAX APPLICATIONS WITH IMPROVED RADIATION CHARACTERISTICS

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Abstract*—In this paper the design and compact , microstrip patch antenna array for WI-FI network is proposed operating at 2.4GHz and 3GHz need dual band frequency for its application from a single antenna. A conventional patch antenna with dimension 28*37 mm^2 is designed on Fr4 substrate material with thickness of 0.0335mm. The antenna array configuration 2*1 met the requirements of parameterization of two rectangular and one circular slots to improve radiation characteristics and its configuration meets the commercial demands such as 50Ω and 70Ω coaxial cable and substrate material with thickness of 0.0335mm. The realized gain of 4.89dBi and 4.85 dBi with return loss value of -34.026 and -33.732 at 2.4GHz and 3GHz is achieved. The bandwidth is 2.093 at 2.4GHz .The VSWR value measured from simulation is 1.046 and 1.089 at dual bands frequency which is less than 2. The proposed is fed by corporate feed network technique.

Keywords*—MPA, dual band Patch Antenna, Microstrip Patch Antenna Array

I. INTRODUCTION

A lot of research is underway to use Microstrip patch antenna as multiband antenna because of its certain characteristics that include its simple structure, competences and its compatibility with another circuit elements.

To meet the necessities of 5G technology bandwidth of communicating signal should be greater than 1GHz [5]. For Multiband characteristics a lot of research is underway to achieve multiband peculiarity of 5G technology, especially dual band peculiarity is of prime importance in field of wireless communication [6].

Optimization of gain is another important entity of 5G technology; certain approaches are utilized for gain enhancement like utilization of slots approach or antenna array technique [7-10]. An antenna array comprised of 4 elements is depicted in [10] and 6 elements in [11] and of 8 elements with appropriate spaces among array elements [12-13]. A printed slot type antenna array with peculiarity of dual bands 28GHz and 38GHz is illustrated in [15]. An antenna of size $5\times 5\ \mathrm{NN}^2$, having substrate made of Rogers RT 5880 with dielectric constant 2.2 with thickness equal to 0.254mm having a gain of 6.6dB at 28GHz is delineated in [22]. A microstrip patch antenna with series feed approach designed for single band communication having dimensions of $29.1\mathrm{x}29.1\mathrm{NN}^2$ in depicted in [23] with gain of 5.1dB and return loss of -22 dB.

For gain optimization and bandwidth enhancement with better radiations patterns a single band microstrip patch antenna with 4x4 array is delineated in [24] it has dimensions of 46.62mmx36.6mm and gain enhancement form 6.758dB to 19.45dB. In [25] a microstrip patch antenna with single band is transferred into antenna array with comprised of two and four elements with corporate feed line approach to improve the gain from 2.853dB 8.35dB.

In [16] an antenna with feeding approach of coplanar feeding of size $5\mathrm{x}5\mathrm{NN}^2$ with Rogers RT 5880 substrate and 0.23mm thickness and gain of 6.6dB at 28GHz is illustrated. An E and H shaped slot antenna with 5.48dB gain and 60 GHz workable frequency is depicted in [17].A dual band printed array antenna with two different frequency bands 30GHz and 50GHz is presented in this proposed work with a gain of 10.19dB at 30GHz and 11.24dB at 50GHz and return loss of 12.5 and -14.9. The simulation and analysis is performed in CST software.

I DESIGN OF CONVENTIONAL MICROSTRIP PATCH ANTENNA ARRAY WITHOUT SLOTS:

The design of any Conventional MPA array requires the below Specification requirements. First step is deciding the operating frequency to design the patch Antenna for 2.4GHz .The next step is to select Substrate material ε_r and its thickness. The substrate material used is Fr4 with thickness=0.0335 and dielectric constatnt of ∈r=4.7 mm which is easily accessable for commercial purposes.

A simple Patch Antenna array resonating at 2.4GHz frequency is designed .The perspective view of the conventional MPA without Slots is shown in fig 6.1. The optimized dimension of proposed prototype is 28mm x 37mm, resonating on Fr4 substrate material of 0.0335 mm thickness and dielectric constant ∈r=1.96. The top layer is the radiating patch which is the copper cladding of 0.035mm. The frequency of resonance of a MPA relay on the permittivity of substrate ∈r and the length L of patch.

A. Conventional microstrip patch antenna array:

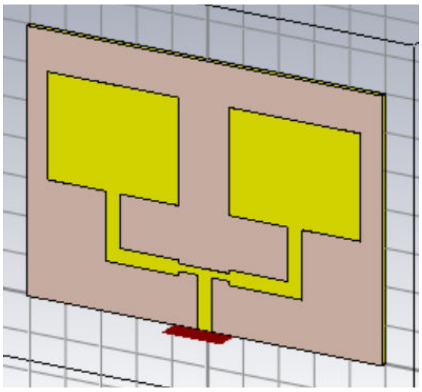

Figure 1 : A microstrip Rectangular patch antenna array without slots

Description	name	Value(mm)
Length of substrate	ls	60
Width of substrate	ws	100
Length of patch	l	28
Width of patch	w	37
thickness	t	0.0335
Height of substrate	h	1.6

Table 1: Parameters of antenna array without slots

II DESIGN OF SLOTS IN PATCH ANTENNA ARRAY:

To attain another band at higher frequency slots methods is used where two rectangular slots and one circular slot is etched. The length and width of rectangular slots are 8×2 mm^2 and radius of circular slot is 2 mm.

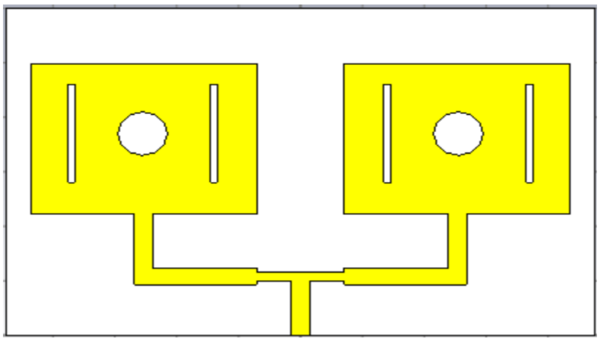

Figure 2 : A microstrip Rectangular patch antenna array with slots

DESCRIPTION	NAME	VALUE(mm)
Length of substrate	ls	60
Width of substrate	ws	100
Length of patch	l	28
Width of patch	w	37
Thickness of copper	t	0.0335
Thickness of substrate	h	1.6
Rectangular slot length	lr	10
Rectangular slot position	Rcr	6
Rectangular slot width	wr	2
Circular slot radius	r	2

Table 2 : parameters of antenna array with slots

In this proposed system the microstip patch antenna array is designed with two rectangular and one circular slots to improve the radiation characteristics. The parameterization of two rectangular and one circular slots by changing the slots width and changing the position of the slots.By changing the width and position of the slots we get the better gain performance and good VSWR which is less than 2.

III SIMULATION AND RESULTS FOR PATCH ARRAY

The simulation was carried out by a high frequency simulation tool CST micro- wave studio suite 2020. Fig 3 shows a S-parameter of the rectangular patch antenna array. In this simulated s-parameter dual band has occurred at 2.4GHz and 3GHz and better gain has been achieved.

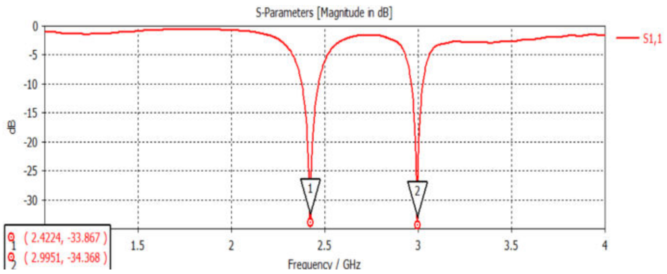

Figure 3: simulated S-parameter of patch antenna array

In Fig 4 shows the return loss plot of a microstrip patch antenna array, Fig 6 shows the radiation pattern. In Fig 3 the return loss plot of the proposed design shown and it is observed that all the elements are satisfying minimum value i.e. < -10dB at a frequency of 2.4GHz.

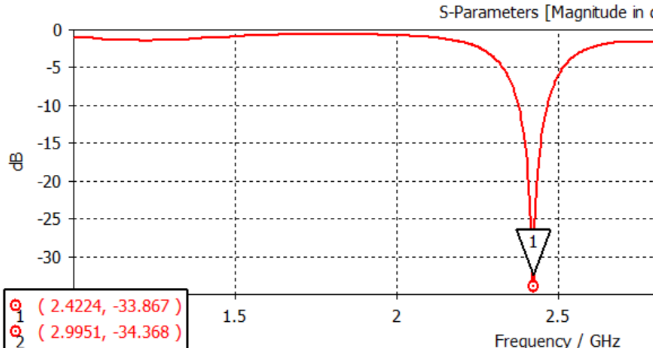

Figure 4: Return loss for patch antenna array

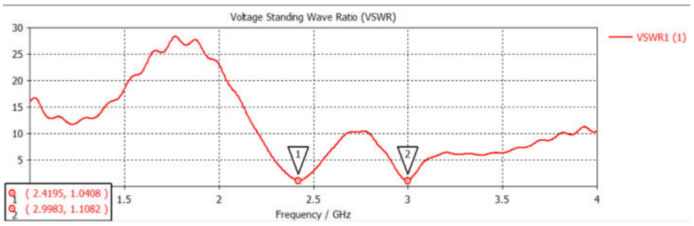

Figure 5: VSWR for patch antenna array

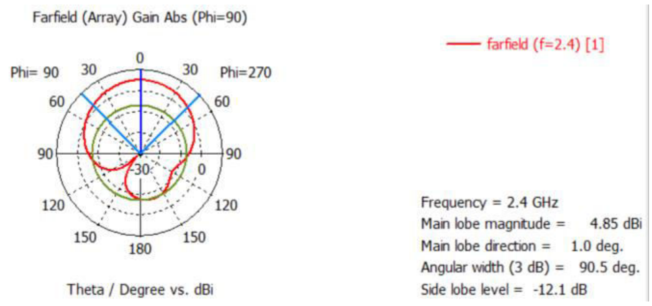

Figure 6: Radiation pattern at 2.4GHz

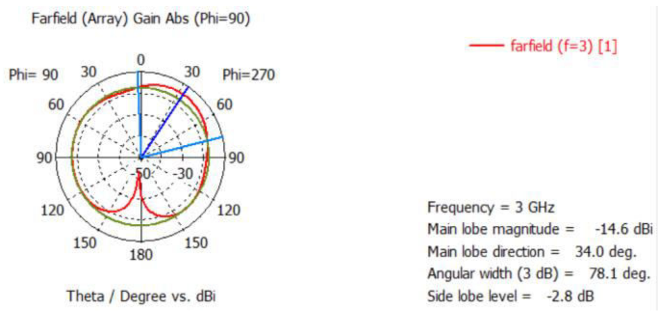

Figure 6: Radiation pattern at 3GHz

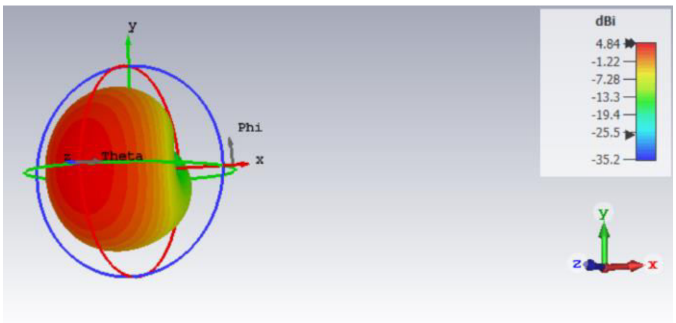

Figure 7: Farfield pattern at 2.4GHz

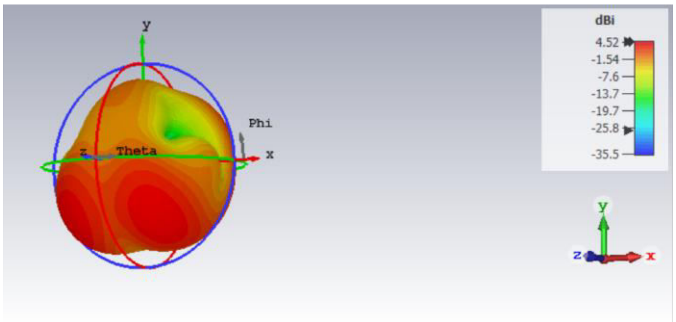

Figure 8: Farfield pattern at 3GHz

DEVIATION OF GAIN AND RETURN LOSS WITH CHANGING Rcr:

Rectangular slot position Rcr (mm)	Return loss	VSWR	Gain (dBi)
6mm(f=2.43ghz)	-34.352	1.2461	3.952
8mm(f=2.42ghz)	-34.263	1.1812	4.857
10mm(f=2.40ghz)	-33.166	1.0472	4.895

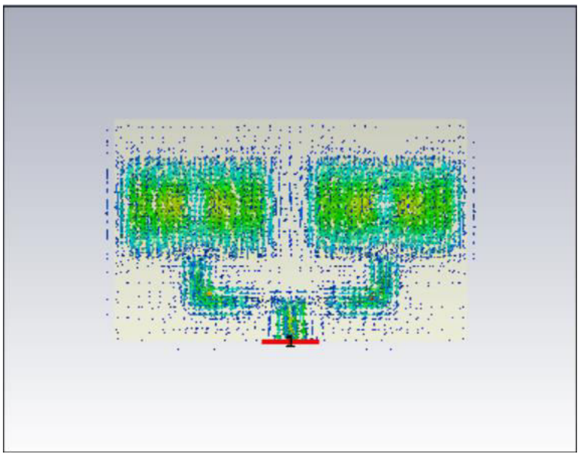

Figure 9: Surface current at 2.4GHz

DEVIATION OF GAIN AND RETURN LOSS WITH CHANGING Wr:

Rectangular slot width wr (mm)	Return loss	VSWR	Gain (dBi)
2mm(f=2.40ghz)	-34.026	1.0462	4.895
3mm(f=2.42ghz)	-22.245	1.0783	3.529
4mm(f=2.43ghz)	-22.314	1.3818	2.840

IV CONCLUSION

The proposed antenna design is achieved by a dual band printed array antenna 2*1 with parameterization of two rectangular and one circular slots with edge feed at frequency band 2.4GHz and 3GHz is presented with a gain of 4.98dBi and return loss of -33.867. The simulation and analysis is performed in CST microwave studio suite 2020.The Antenna is properly matched with the transmission line through the corporate feed network. Both patches are properly fed by two 50ohm feeding lines parallel to each other. Both the two 50 ohm parallel feeding lines are properly matched by 70 ohm main feeding line. The VSWR value measured from simulation is 1.048 at dual bands frequency which is less than 2.

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