Eight Slotted Patch Antenna for 5g Applications with Circular Polarization

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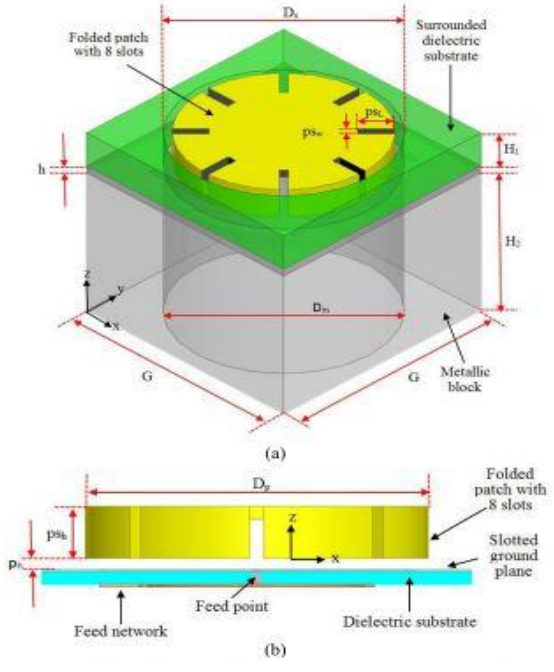
Abstract- A circular polarized patch antenna is presented for future fifth generation mobile phones.The miniaturization and improvement of the beam width of a patch antenna are the two main areas . Folding the edge of the radiant patch with the loading slots, the size of the patch antenna is 44.8% smaller than a conventional half-wavelength patch, which allows it to fit inside the phones easily. The width of the wide beam is obtained by surrounding the patch with a dielectric substrate and supporting the antenna from a block of metal. A beam width of half the measured power of 124◦.The impedance is realized the bandwidth of the antenna is greater than 10% and the bandwidth of the axial ratio of 3 dB is 3.05%. The proposed antenna covers a wide angle of elevation and a full range of azimuth. A parametric study on the effect of metallic block and the surrounding dielectric substrate in the gain at a low elevation angle and the axial ratio of the proposed antennas are presented.

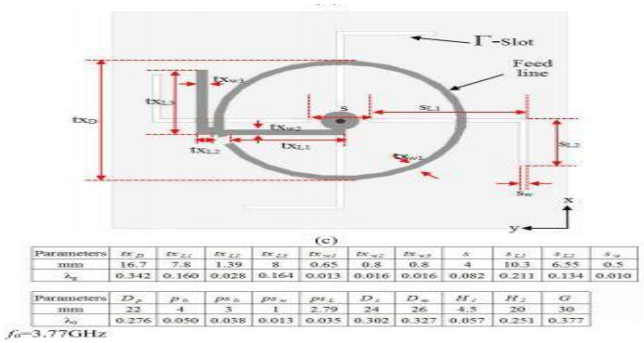
Index Terms- Antenna radiation pattern,amplitude improvement, microstrip patch antennas, satellite antennas, size reduction.

I. INTRODUCTION

Since the 4G has been implemented and becomes mature, many interests are focusing on future 5G communication system. Most research efforts are paying on the ground communication and polarization of the related antennas they are linear However, 5G mobile phones can include the function of satellite communication. Land cell phone system has been well developed in the urban area to provide good coverage and high quality of the telecommunication service. Users can enjoy an instant two-way voice, message and also data communications for sharing photos or watch streaming videos. However, the existing terrestrial the network may not completely cover all the remote areas of the world. In order to achieve ubiquitous wireless coverage on earth, the mobile satellite communication service [1] is the complement.Offersservices that include security communications, accurate global transmission and positioning.It has been mentioned in [2] that the antenna designed for personal satellite communication. The net should be about 10-12 cm thick (mainly described on the helical antenna) and a width is less than 3 cm. Therefore the antenna must be compact to be easy installation. The field of view of the antenna can be done with a directional, omnidirectional or semi-directional model [3]. In general, directional antennas have beam tracking capability [3] - [5] in which a bundle of directives can steer automatically in the direction of the satellite. This document aims to design a CP handheld patch antenna with wide beam width and high gain at low altitude angles of using the phone in the future 5G mobile satellite communication. A sequential feed approach [6] for the the proposed antenna is used, as a broad axial ratio bandwidth.It can be obtained. A normal half-wavelength patch is not small, then some reduction techniques are applied our design. Most of the miniature patch antennas were proposed. Include the use of dielectric substrate [7], [9], patch with slot loading [10] - [12], patch with slot loading [13], [14], folded patch [15], [16], deserted terrain [17], addition of shorted portions [18]. In fact, some beam width techniques have proposed in [7] and [19] - [23], for example three-dimensional ground structure [7], [19] - [21], folding conductive wall [22] and filling the antenna with dielectric [19], [23]. However, parametric study of antenna gain at low elevation angles can to be found in [19] - [23].

ANTENNA CONFIGURATION:





Parameters	tx_{p1}	tx_{p2}	tx_{p3}	tx_{p4}	tx_{w2}	tx_{w3}	s	s_{p1}	s_{p2}	s_w
mm	16.7	7.8	1.39	8	0.65	0.8	0.8	4	10.3	6.55	0.5
λ_g	0.342	0.160	0.028	0.164	0.013	0.016	0.016	0.082	0.211	0.134	0.010

Parameters	D_p	p_{s1}	p_{s2}	p_{s3}	p_{s4}	D_1	D_m	H_1	H_2	G
mm	22	4	3	1	2.79	24	26	4.5	20	30
λ_0	0.276	0.050	0.038	0.013	0.035	0.302	0.327	0.057	0.251	0.377

f_0=3.77GHz

Fig.1: Geometry of the proposed antenna.

Fig. 1 shows the geometry of the proposed CP patchantenna The antenna consists of a slit-hat shapepatch, a double-sided printed circuit board (PCB), a metalblock and a dielectric substrate surround. The patch at the upper part and the double side of the printed circuit board (PCB)they are shown separately for clarity in Fig. 1 (b) and (c).

ANTENNA PERFORMANCE: All proposed antenna simulations are performed by using a commercial EM software, or HFSS (version 15).

VSWR: : Figure 6 shows the VSWR and selected by design. It can be observed that there are two resonances. These are the resonance modes from the patch the cracks on the ground floor and was discussed in [6]. The bandwidth of the measured impedance is 11.08% (VSWR <2), with a bandwidth from 3.58 to 4.00 GHz. The simulated VSWR is less than 2 from 3.53 to 4.01 GHz with an impedance bandwidth 12.73%.

AXIAL RATIO :

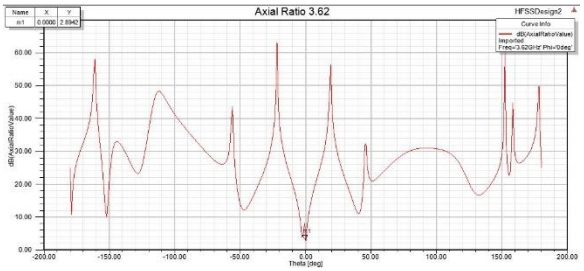


Fig.2: Simulated and measured axial ratio against theta.

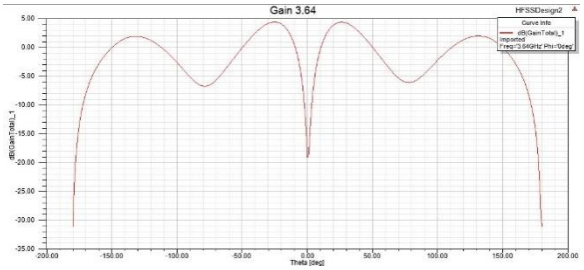
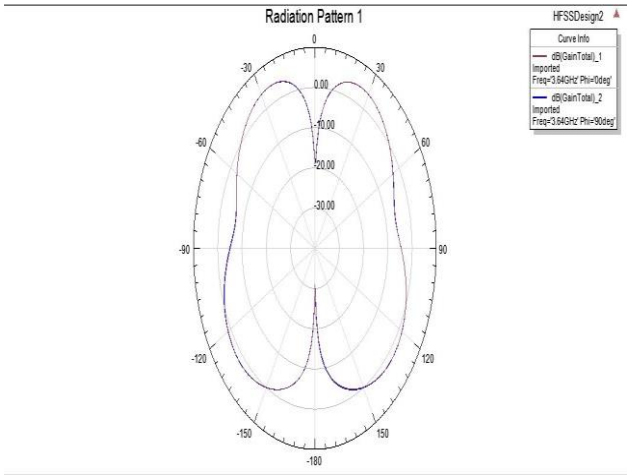
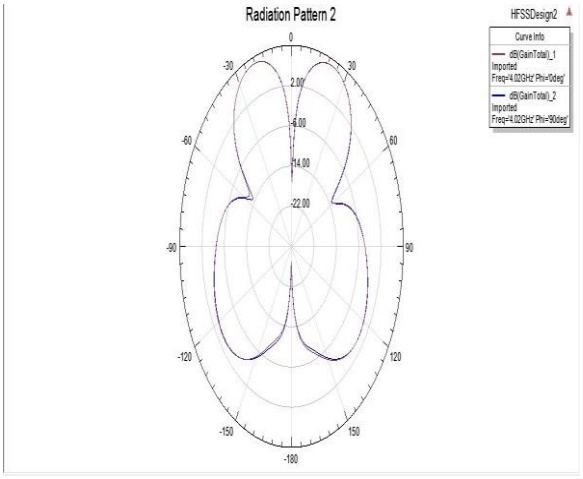


Fig.3: Simulated and measured gain against theta.

RADIATION CHARACTERISTICS:Fig. 4 shows the verse of the simulated and measured gain frequency of the proposed antenna. Within the frequency bandwidth interval of the axial ratio of 3 dB, the measured gain is 5 dB with a variation of 0.2 dB, which is less than 0.5 dB compared to the simulation The loss of antenna gain may be due to cable and loss of polarization. The simulated and measured radiation models of the antenna in its resonance in the elevation cutting plane (phi = 0◦and phi = 90◦) have been illustrated in Fig. 5. Because the circular polarization of the right hand is less than circular polarization on the left, the proposed antenna works with circular polarization on the left. In the measurement, the half of the power beam width at 3.77 GHz is 124◦ in phi = 0◦ airplane and 123◦ in phi = 90◦ plane. The gain variation is only 0.2 dB at theta = 30◦ , 0.47 dB at theta = 50◦ and 1 dBat theta = 70◦. . So, the proposedPatch antenna possesses both half power and axial ratiobeam width, which can cover much of the upper hemispherearea.



(a)



(b)

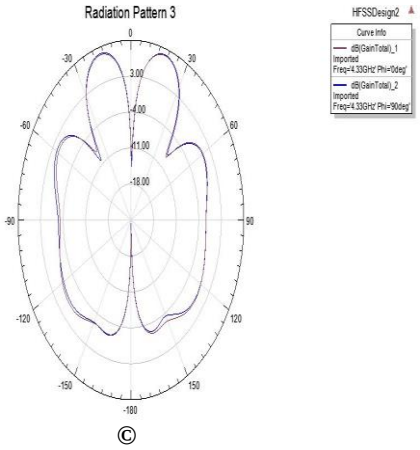


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FIGURE 4.(a) Normalized radiation pattern at 3.64GHz simulated. (b) Normalized radiation pattern at 4.02GHz simulated. (c) Normalized radiation pattern at 4.33GHz simulated.

II. PROCEDURE of ANTENNA DESIGN AND PARAMETRIC STUDIES

MINIMIZATION-The proposed antenna design starts with the simulation ofa simple circular patch fed by a microstrip line couplingthrough four slots in the form of 0. If a half-length circular wavethe patch is used, the antenna size is too large and it is notapplicable to portable devices and therefore to miniature techniquesare required. At the beginning, a circular patch with an initial onea diameter of 24 mm is used, and is shown in Figure 5 (a). Thethe patch is 4 mm above the ground level. Folding the edge ofpatch with 3 mm downwards as shown in Fig. 5 (b) is nextstep. A hat-shaped patch is created. After this, four and eightthe slots are subsequently loaded onto the patch. The structuresthey are shown in Fig.5 (c) and5(d),respectively**.**

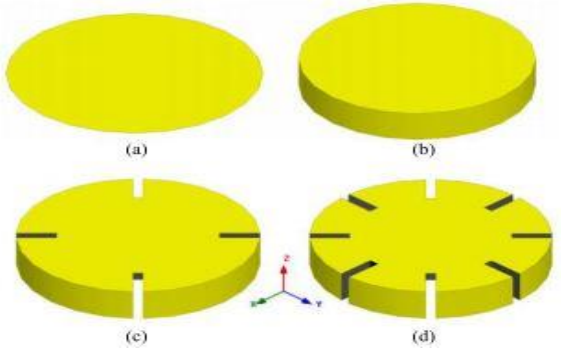

Fig.5: Different patch shape (a) circular patch (b) Folded patch (c) Folded patch with 4 slots and

(d)Folded patch with 8 slots.

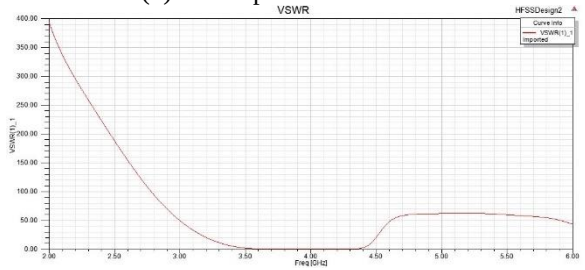

Fig.6: VSWR

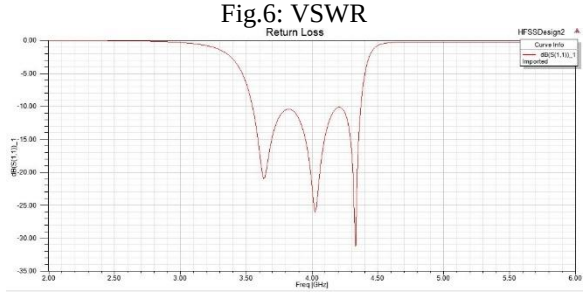

Fig.7:.Return loss

BEAMWIDTH ENHANCEMENT: In our design, two beamwidth enhancement techniques are implemented. One is surrounding the radiating patch with adielectric substrate and the other one is added to metallic blockat the back of the antenna. 1)change the thickness of the surrounded dielectric substrate2) change the height of the metallic block.

TABLE 1. Performance of the proposed antenna and some exiting small-size antenna.

	Gain at (0, 0°)	Frequency	AR Bandwidth	3dB Beamwidth	Patch Length (Ground length)	
	dBic	GHz	%	°	mm	λ_g
Proposed antenna	5	3.77	3.05	124	22 (30)	0.276
Ref [7]	-0.6	1.575	0.76	132	46.5 (150)	0.25
Ref [8]	3.94	2.33	1.61	101	28 (28)	0.218
Ref [9]	6.5	2.33	1.07	<80	23 (30)	0.18
Ref [10]	6	1.525	0.65	83	66.62 (70)	0.34
Ref [11]	*	2.295	1.3	<90	33 (35)	0.25
Ref [12]	*	1.768	0.91	<90	48 (>50)	0.28
Ref [13]	*	2.306	0.41	80	40 (140)	0.31
Ref [14]	4.59	2.492	0.38	90	29 (45)	0.24
Ref [15]	4.7	1.114	1.53	100	30.5 (90)	0.11
Ref [16]	7.5	2.28	3.5	75	30 (90)	0.23
Ref [17]	2.5	1.07	1.6	96.4	19.6 (100)	0.18
Ref [18]	3.8	2.492	0.682	<85	11.35 (21)	0.1

*No information provided in the paper.

III. SUMMARY

In actual application, antenna performance is often in particular, deteriorated from the casing of portable devices metal casings. The study of the metal block on the back of the antenna can not only investigate the influence of the optimization of the beamwidth but also imitates the true wrappingof phones. From the parametric study, it is found that the axial ratio of the proposed antenna is very stable with different ones height (H2) of the metal block. Furthermore, the height of the metal block can help improve half the power beam width and gain at low elevation angles. The result implies this antenna performance can be improved by use of a metal casing in the product design. Even if it seems that the metal block increases the height of the antenna, the improved height can be considered as a portion wrap. In our design, a metal casing has a contribution the antenna performance, in particular the low elevation gain and half width of power beam.

The comparison between the dimensions of the antenna, the width of the beam of 3dB, the gain and the bandwidth of the axial ratio between the proposed antenna and some small CP antennas [7]? [18] are summarized in Table I. Show that the lengths of the antenna patches range from 0.1 to 0.34? 0. Even if the patch the dimensions of the antennas are compact, does not mean this the antenna dimensions are small due to the relatively large terrain the aircraft are used The data in Table I also indicate that 3dB bandwidth of the axial ratio of most small CP patch antennas are less than 2%, except the antenna in [16]. however, the antenna shown in [16] has a large ground plane and the beam width of 3dB is not wide enough. The proposed antenna has a very wide beam width of 3 dB and a high gain in terms of its small size and wide bandwidth of the axial ratio 3dB, which it is comparable to other compact patch antennas.

IV. CONCLUSION

A compact polarized circular patch antenna with widebeam width for handheld devices for future 5G applications has been presented in order to adapt to use in the phone and respecting the requirements of the application model, a care of miniaturization and improvement of the beam width for the proposed CP antenna has been shown in detail. The optimized design was created and tested. The measured results show that the CP antenna is able to cover widely elevation angles and full azimuth range (0 360). Get an average gain of 5 dBic and the measured 3dB. The bandwidth of the axial ratio is 3.05%. Promising results allow the proposed CP patch antenna will be used in the future 5G Mobile phones for satellite communication applications.

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