A CPW-Fed Broadband Regular-Hexagonal Slot Antenna With Loaded Spiral Slot

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***Abstract*— A regular-hexagonal slot antenna loaded with a spiral slot for wide impedance bandwidth is presented. A step-shaped monopole patch is protruded from the signal line of the feeding coplanar waveguide (CPW) into the regular-hexagonal slot. A spiral slot is loaded in the ground plane for increasing the bandwidth. The proposed antenna has the side length of 31mm and can cover the impedance bandwidth (S11<-10dB) from 2.14-4.87GHz with the bidirectional radiation.**

Keywords—wideband antenna; coplanlar waveguide; slot antenna, regular-hexagonal antenna.

I. INTRODUCTION

The printed slot antenna with the bidirectional radiation and tremendous bandwidth is a promising candidate for realizing broadband or multiple-band to accommodate multi-standard services[1-3]. On the other hand, the multi-band operation is in demand for various applications. Since these applications are used simultaneously in many system, a single antenna that can cover all these bands is needed. The impedance bandwidth for the conventional CPW-fed slot antenna can reach about 20%, and serval CPW-fed antenna structure have been reported to demonstrate the superior performances[1-4].

In [5], the regular-hexagonal structure of wide-slot antenna for broadband circular polarization based on coplanar waveguide feed is presented. By embedding two inverted-L grounded strips around two opposite sides of the slot together with a rectangular notch near the signal strip, the proposed antenna can provide a wide impedance bandwidth and an AR bandwidth, respectively. In [6], the CPW-fed slot antenna with broadband and circularly polarized operation is improved by loading two spiral slots into the ground plane, which obtain a wide impedance bandwidth and axial ratio bandwidth, respectively. In this paper, a regular-hexagonal slot antenna loaded with a spiral slot in the ground plane and embedded two inverted L-shaped strip in the slot for wide impedance bandwidth is proposed.

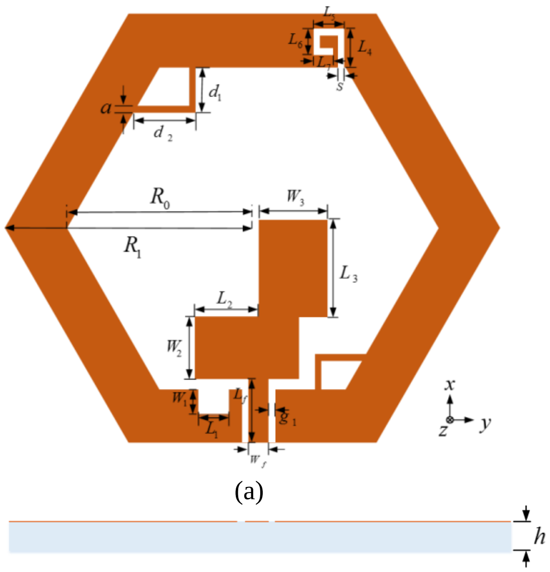
II. ANTENNA CONFIGURATION

The configuration of the proposed regular-hexagonal slot antenna is shown in Fig. 1, wherein the antenna is printed on the FR4 substrate with a thickness of h=0.6mm, $\varepsilon_r = 4.4$ and $\tan(\delta) = 0.02$. The outer and inner radius of the hexagonal ring are R_1=31mm and R_0=22mm, respectively. The slot antenna is fed by a CPW with a signal line width of W_f=3.2mm and gaps (g1) of 0.7mm. The signal line of the CPW is protruded into the slot to form a step-shaped strip to obtain wide bandwidth. Two inverted L-shaped strip are embedded around two opposite corners of the regular hexagonal antenna. A spiral slot is loaded in the hexagonal ground plane. A rectangle in the ground plane near the feed line is notched to fine tune the impedance match.

The optimized dimensions of the proposed antenna are obtained by using the electromagnetic simulation software and listed in table I. the optimized geometric parameters should be used as the reference for the following parametric studies in the succeeding sections.

Table I optimized geometric parameters of the proposed antenna (unit: mm)

parameter	value	parameter	value	parameter	value
R_1	31	L_4	6	W_3	7
R_0	22	d_1	5	W_f	3.2
L_1	4	d_2	6.9	g_1	0.7
L_2	8	W_1	4	L_f	8.8
L_3	13.3	W_2	7.7	h	0.6



(a)

(b)

Fig.1 configuration of the proposed antenna

III. PARAMETRIC STUDIES

The effects of various parameters on the impedance bandwidth are analyzed for further study. When one parameter is studied, the others are kept constant. The results provide a useful guideline for practical design.

The spiral slots loaded in the hexagonal ground plane with three different widths, 1, 2, and 3 mm, are analyzed as other parameters fixed. As shown in Fig. 2, the widths of spiral slots can greatly affect the impedance matching in the upper frequency band, while it has almost no effect on the resonant frequency in the lower frequency band. When S=1mm, the widest impedance bandwidth can be obtained.

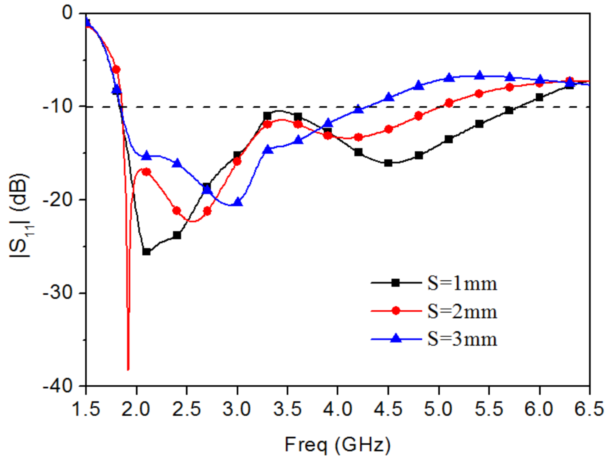


Fig.2 $|S_{11}|$ with varying widths of spiral slot, S.

The effects of the width of the singal line of the CPW on the impedance bandwidth are analyzed in Fig. 3. When the width of the singal line of the CPW decreases from W_f =4.2mm to W_f =3.2mm, the impedance bandwidth of the proposed antenna is extended toward the upper frequencies. The widest impedance bandwidth can be achieved by properly adjusting the width of the singal line of the CPW. Therefore, W_f=3.2mm is selected for good impedance matching.

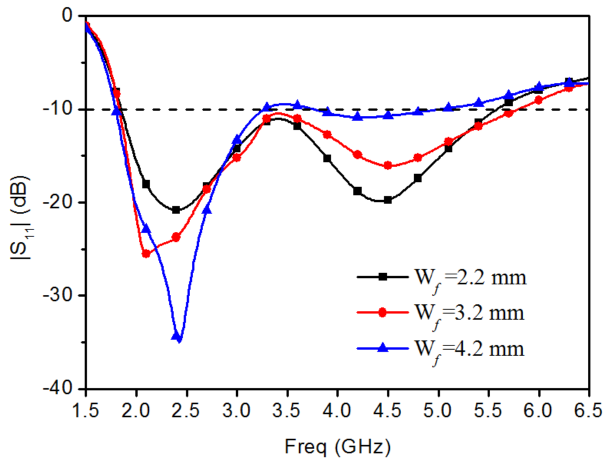


Fig.3 $|S_{11}|$ with varying widths of singal line of CPW, W_f.

IV. EXPERIMENTAL RESULTS

In order to verify the numerical results, the proposed CPW-fed slot antenna based on the optimized parameters shown in Table I is finally fabricated and measured. The Agilent E5071C vector network analyser and the anechoic chamber are used to measure the electrical performance of $|S_{11}|$ and radiation pattern, respectively.

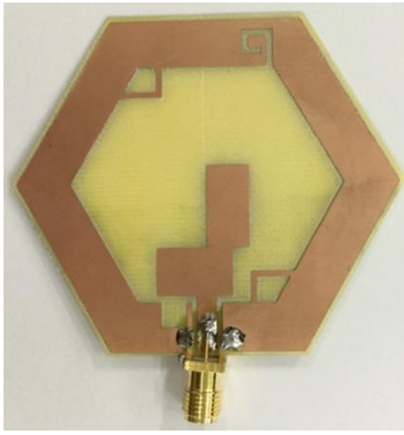


Fig. 4 Fabricated prototype of the proposed antenna

As shown in Fig. 5, the measured -10dB $|S_{11}|$ bandwidths are 2.73 GHz (2.14–4.87 GHz) and the simulated bandwidths are 4.01GHz (1.83-5.84 GHz). As can be seen, The measured results are in reasonable agreement with the simulated results. The discrepancies between them may be attributed to the mechanical manufacturing errors.

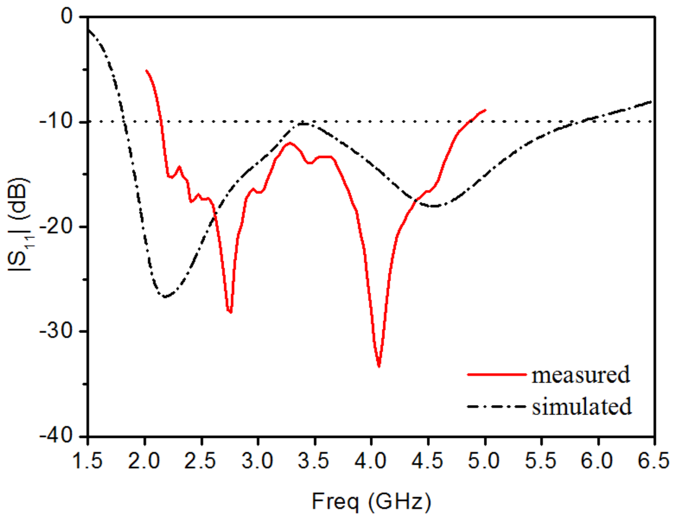


Fig. 5. Measured and simulated $|S_{11}|$ for the proposedantenna.

Fig.6 shows the measured and simulated radiation patterns in the xoz plane at the frequency of 3.0 GHz. It can be found that the simulated and measured radiation patterns are in good agreement. The maximum gain is 3.5dB (measured) and 3.8 dB (simulated) at 3.0 GHz. Note that the printed slot antenna is a bidirectional radiator and the radiation patterns in both sides are almost the same.

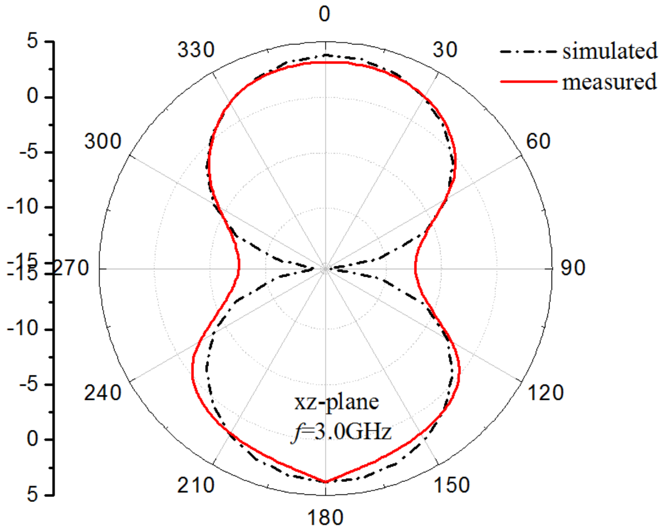


Fig. 6 Measured and simulated radiation patterns at f=3.0GHz of xoz plane.

V. CONCLUSION

A regular-hexagonal-slot antenna based on CPW-fed is presented. By protruding into the slot an step-shape monopole patch, loaded a spiral slot in the ground plane, and embedding two inverted-L grounded strips around two opposite sides of the slot together with a rectangular notch near the signal strip, the proposed antenna can provide an wide impedance bandwidth of 2.73 GHz (2.14 – 4.87 GHz). The proposed antenna can be used for indoors, WLAN communication systems, and other broadband communication systems for its advantages of low weight, low production cost, simple structure, easy fabrication, broad bandwidth.

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