Bandwidth Enhancement of Printed Microstrip-Fed Open Slot Antenna Using a Small Slot

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Abstract

A novel bandwidth enhanced microstrip-fed open slot antenna using a small closed slot and fed by an inverted-L shaped feeding stub is investigated.

Keywords : Broad band slot antennas printed antennas

Introduction

The wireless communication systems have experienced explosive growth in the past few years. Antennas play an important part of the rapid growth of wireless communication systems. The microstrip-fed slot antenna is one of the most popular choices for antenna design featuring low cost, low profile, and lightweight. The theoretical studies of wide slot antenna have been reported in [1]. The design and principle of various slot antennas are also investigated [2],[3]. This paper reports a novel microstrip-fed open slot antenna with a small slot and an inverted-L (IL) shape matching stub to improve the input impedance matching while still maintaining the performance of antenna gain and radiation pattern.

Antenna Design and Performance

The geometry of proposed microstrip-fed open slot antenna structure is shown in Fig. 1. The antenna incorporated a dog bone shaped open slot, a small closed slot and fed by an IL shaped microstrip line. The wider width of the slot, W_{s1}, near the both open and close end are designed to get the higher gain and better input impedance matching, because the strongest magnetic currents are distributed at the open end of the slot. An IL shape matching stub and a small closed slot are used to improve the impedance matching in the proposed antenna design. The width of the IL stub, W_m, can almost independently control the lower band impedance matching without affecting the higher band. The length of IL stub, L_m, adjusts the higher band impedance matching, but loses the lower band matching and decreases the bandwidth. The IL shape stub not only improves the impedance matching but also reduces the antenna area. The closed small slot width, W_{s3}, improves the higher band matching without affecting the lower band. This slot length, L_{s2}, can improve the higher and lower band simultaneously. The self-resonance frequency of small slot is around 3.8GHz, which is much higher than the operation frequency of the open slot. Because the matching bandwidth is controlled by the IL stub and the small slot, and these elements do not radiate energy, therefore the radiation performance and the operation bandwidth can be designed separately. By properly choosing the dimensions of the IL stub and the small slot, the high performance slot antenna for a broadband application design can be achieved. A summary of proposed microstrip-fed open slot antenna physical dimensions are listed in the table I. The proposed antennas are investigated by Ansoft HFSS ver. 12 and designed on FR4 substrate with a dielectric constant ε_r =4.4 and a thickness of h=1.6mm. The overall size of the proposed antenna is $50\times70\times1.6$ mm^3. Fig. 2 shows the magnitude of reflection coefficient of the proposed antenna with and without a small closed slot. The impedance matching bandwidth is improved greatly by placing a small slot near the main open slot. The operation bandwidth is from 1.45GHz to 4GHz. The E plane(x-z) and H plane (x-y) simulation radiation pattern at 1.8GHz and 2.8GHz are plotted on Fig. 3 and Fig.4, respectively. The simulation antenna gain is 1.77dBi and 3dBi at 1.8GHz and 2.8GHz, respectively. The predicted radiation efficiency is up to 93% and 87% at 1.8GHz and 2.8GHz, respectively. Fig. 5 shows the peak gain of the proposed antenna with and without a small closed slot. It is clear that the small slot doesn't damage the antenna gain. More detailed input impedance matching and radiation patterns and design procedures will be presented in the conference.

Conclusions

A novel microstrip-fed open slot antenna with an IL shape stub and a small closed slot has been presented. The impedance matching bandwidth can improve greatly by proper design the IL stub and placing a small slot near the main open slot. The proposed antenna features a simple structure, compact size, easy design and is suitable for a wide variety of wireless communication systems applications.

References

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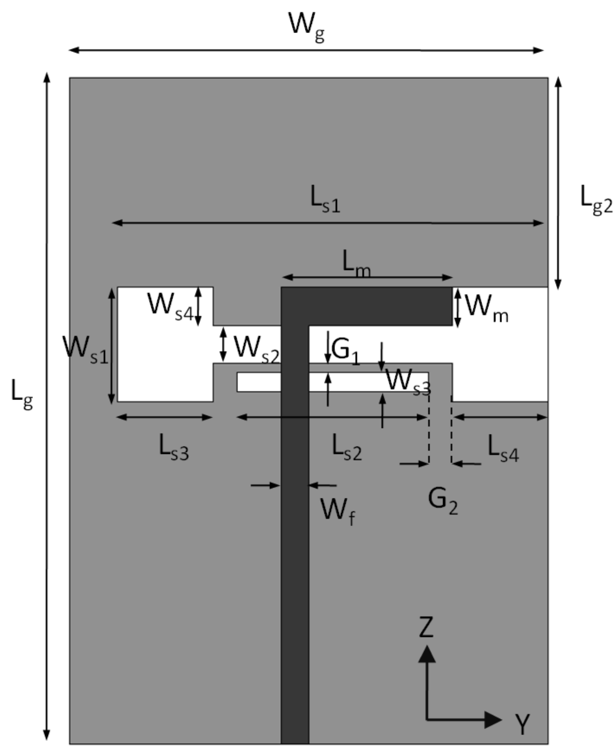


Fig. 1. Geometry of proposed microstrip-fed open slot antenna.

Table 1: A summary of proposed microstrip-fed open slot antenna physical dimensions. (Unit: mm)

L_g	W_g	L_{g2}	L_{s1}	L_{s2}	L_{s3}	L_{s4}
70mm	50mm	22mm	45mm	20mm	10mm	10mm
W_{s1}	W_{s2}	W_{s3}	W_{s4}	L_m	W_m	W_f
12mm	4mm	2mm	4mm	17.85mm	4mm	2.85mm

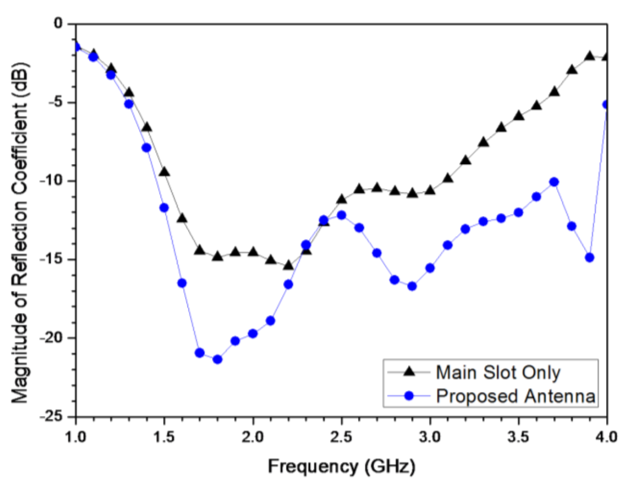
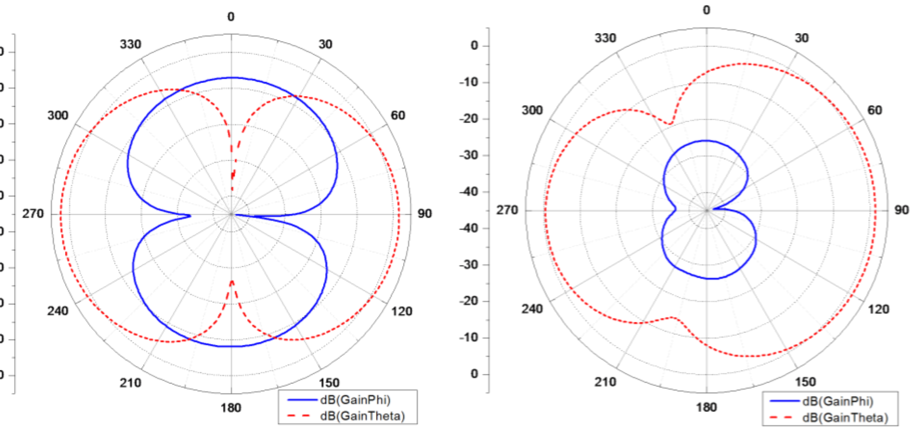
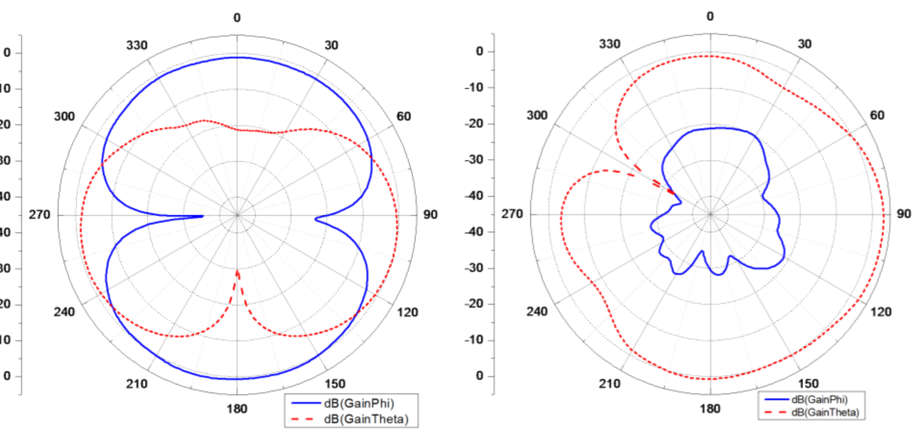


Fig. 2. Simulated magnitude of reflection coefficient of proposed antenna.



(a) (b)

Fig. 3. Radiation patterns at 1.8GHz. (a)XZ plane (b)YZ plane



(a) (b)

Fig. 4. Radiation patterns at 2.8GHz. (a)XZ plane (b)YZ plane

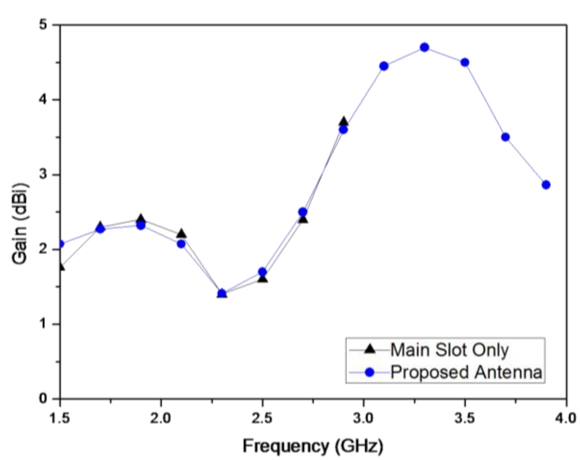


Fig. 5. Simulated peak gain of proposed antenna.