An Asymmetrical Structure for Printed SWB Antenna Miniaturization

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Abstract—**An asymmetrical structure is proposed for miniaturization of super wideband (SWB) antennas. This type of antenna consists of an optimized ground plane and an elliptical semi-monopole. Simulation results show that an example antenna has 2:1 VSWR bandwidth from 0.47 GHz to 25GHz, giving a ratio impedance bandwidth of more than 50:1.**

Keywords-SWB;Miniaturization; semi-monopole; asymmetrical; ultrawideband; UWB; printed monopole; planar monopole

I. INTRODUCTION

In the last decades, much effort has been made on the bandwidth enhancement of antennas, recognising them as a critical component of wireless communication systems. Recently, some antennas with ratio impedance bandwidths of more than 10:1, which are sometime named as Super wideband (SWB) antennas in the antenna literature, have been proposed. These antennas have stable radiation-pattern characteristics over their frequency range of operation and mainly include several classes. The first class has a “cobra” shape, and is based on tapered travelling-wave structures [1], but this 3-D structure is somewhat large and heavy. The second class is the metal-plate monopole antenna configurations, [2-3] which need a perpendicular ground plane and result in a high profiles that are undesirable for many electronic devices. The third class is the printed ultra-wideband antennas with parallel ground planes that can be integrated conveniently with monolithic microwave integrated circuits (MMIC). In [4], a microstrip-fed printed triangular-ring antenna with a ratio bandwidth of 2:1 is presented. To improve the impedance bandwidth, in [5], an elliptical monopole antenna has been proposed, achieving a 2:1 VSWR bandwidth of 0.41-8.86 GHz (21.6:1).

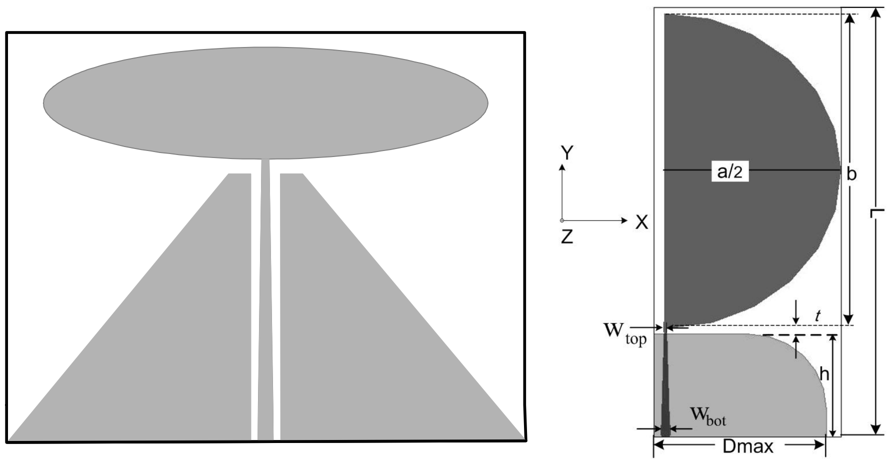
In this paper, the conventional symmetrical antenna is miniaturized through optimizing the radiation patch and the ground plane. As a result, a novel semi-monopole printed antenna with an asymmetrical structure is introduced. An example design based on this concept has a theoretical impedance bandwidth of 0.47～25 GHz, i.e. a ratio impedance bandwidth of more than 50:1. The proposed antenna design and the theoretical results are presented and discussed.

II. ANTENNA DESIGN

Based on the elliptical printed monopole antenna as shown in Fig. 1(a) [5], the proposed asymmetrical semi-monopole printed antenna is displayed in Fig. 1(b). By modifying the ground plane and the radiation patch, this semi-monopole design for antenna miniaturization is reached. The radiation patch and the ground plane are etched on the top and back surfaces of a substrate with thickness h=0.787 mm and relative permittivity $\varepsilon_r = 2.45$. The other detailed parameter values are listed in Table 1.

Table 1 Dimensions of the proposed antenna [mm]

Dmax	L	h	t	rbot	a	b	L	rtop
59	150	38	0.3	2.3	120	110	110	0.3



(a) (b)

Fig. 1 (a) Standard elliptical printed monopole antenna (b) The proposed antenna

III. RESULTS AND DISCUSSION

By simulating the antenna using CST Microwave Studio software [6], which is based on the finite integration method, the characteristics of the proposed antenna were calculated. The calculated 2:1 VSWR bandwidth covers a frequency range from 0.47 to 25 GHz, with a ratio bandwidth of more than 25:1 (see Fig. 2).

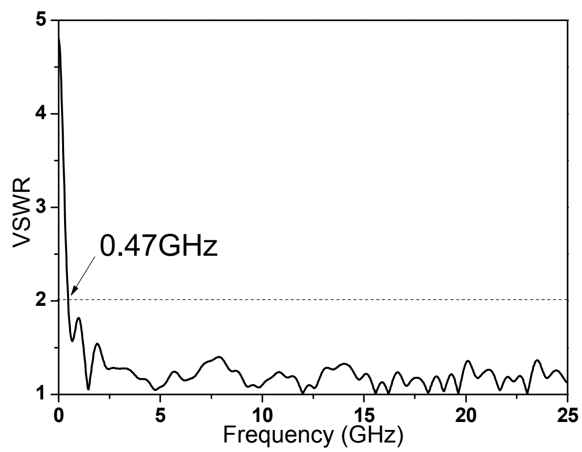


Fig. 2 VSWR of the proposed antenna

Figure 3 shows the VSWR variation between elliptical patches of different dimensions. It is shown that the lower limit decreases from 930 MHz to 470 MHz when *a* is increased from 60mm to 120mm and *b* is increased from 50mm to 110mm, improving the impedance ratio bandwidth effectively. Considering the impedance bandwidth and the size of the monopole antenna, the values of *a* and *b* are fixed at 120mm and 110mm, respectively.

The predicted radiation patterns of the antenna at 1, 5, 10 and 20 GHz are shown in Fig. 4. It is seen that the cross-polarization level rises with frequency owing to the relative increase of the horizontal components of the surface currents. This antenna has a very wide radiation pattern in the E-Plane at all frequencies. The pattern in the H-Plane is more directional, in general. The asymmetrical natures of the structure causes asymmetry in the radiation pattern.

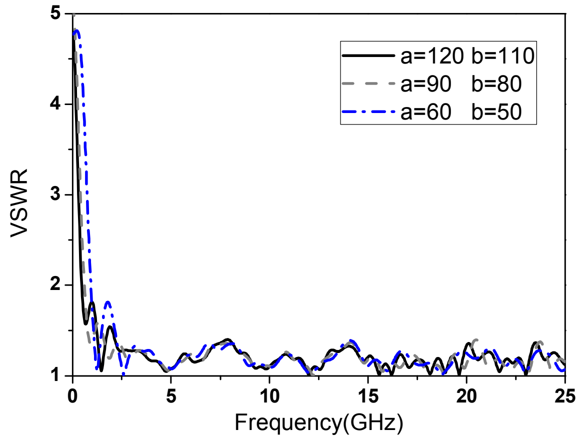
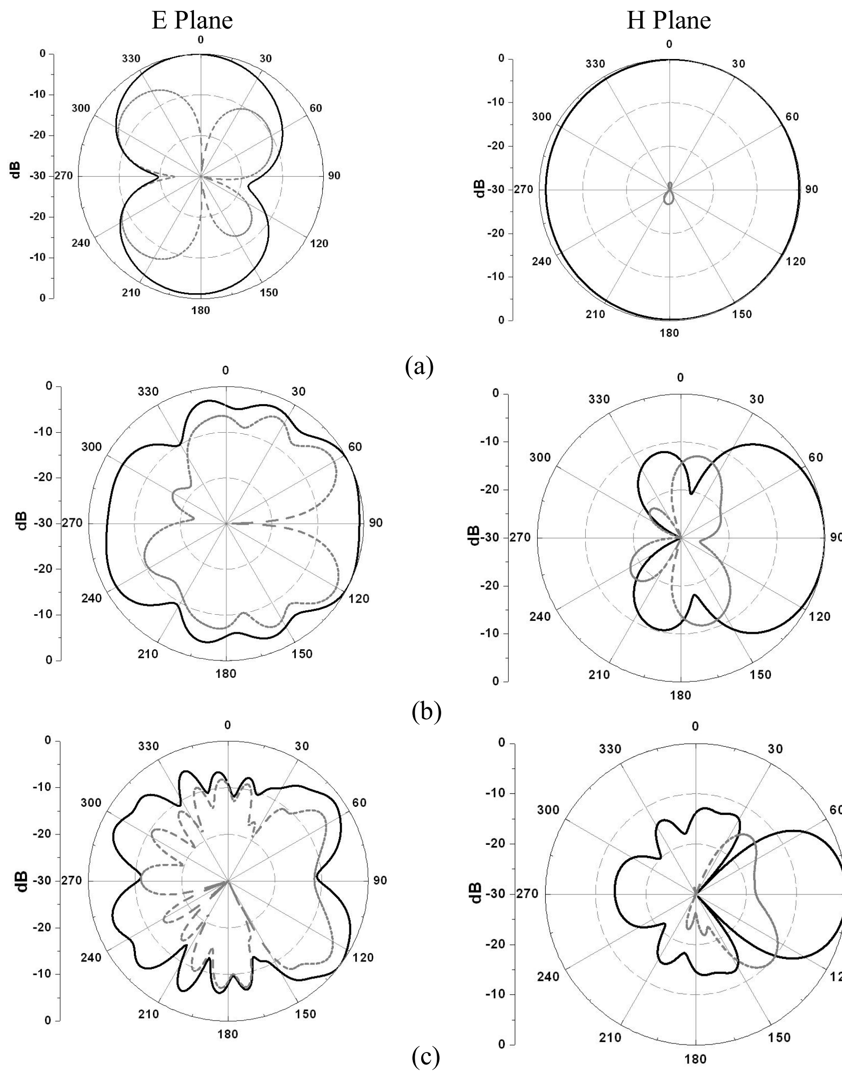
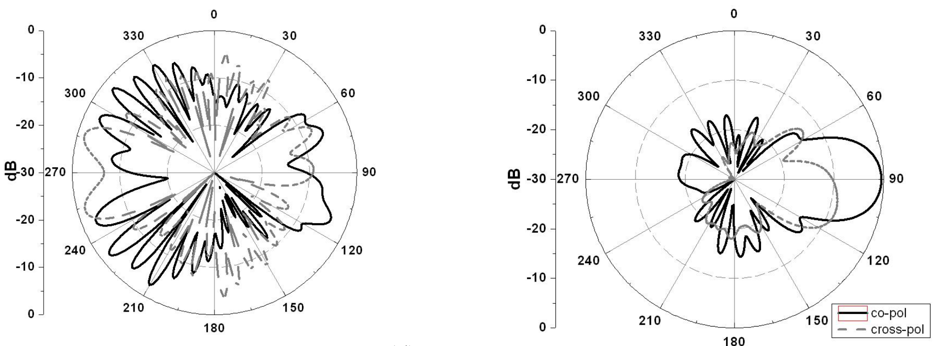


Fig.3 The VSWR of the antenna for different monopole dimensions





(d)

Fig. 4 Computed radiation patterns at (a) f=1GHz, (b) f=5GHz, (c) f=10GHz, (d) f=20GHz.

IV. CONCLUSION

A miniaturized super wideband antenna is presented in this paper. A remarkable 46% size reduction is achieved by modifying and optimizing the ground plane and the radiation patch. The proposed antenna exhibits extremely wideband impedance matching and can cover frequency bands from 0.47 to 25GHz with a ratio impedance bandwidth of more than 50:1.

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