A Parallel Strip Line Center-Probe Fed Dipole

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***Abstract*- A dipole antenna which can achieve good performance in a wideband of 820 MHz (1.73-2.55GHz, corresponding to a 38.3% bandwidth) is analyzed and implemented. A unique feed network with two overlapping cross-shaped patches printed on both sides and a 50Ω SMA connector settled in the center is designed to avoid the use of a balun which requires large space and adds the complexity of design. The parallel strip line is utilized to improve the impedance matching. Effects of the width and length of the radiation arm and the parallel strip line on the performance of the proposed antenna are also studied.**

***Keywords*- Feed network, parallel strip line, double-sided printed**

I. INTRODUCTION

The dipole antenna is the oldest, simplest and cheapest form of antenna available and yet it offers good performance, versatility and is still very widely used. On the other hand, printed microstrip architectures have been widely investigated and are attractive for their conformability, small size, and cost effectiveness. The printed dipole is an architecture that looks promising for providing many attractive features and it has found widespread usage in array antennas.

In the dipole antenna, a balun is usually required to make an unbalance-balance conversion between the symmetric dipole and the asymmetric coaxial feed line. Thus the performance of the balun becomes an essential issue that restricts the performance of the antenna. Many researches have been done to design a balun-integrated dipole to achieve desired performance [1], [2].

In this paper, a detailed investigation into the parallel strip line fed double-sided printed dipole element, which is a comparatively simple structure, is carried out. A unique feed network is designed to avoid the use of a balun which occupies large space. The parallel strip line is utilized to improve impendence matching. Effects of the arm width, parallel strip line width and length on the performance of the dipole element are also studied.

II. ANTENNA DESIGN

The geometry of the double-sided parallel strip line fed dipole is illustrated in Fig 1. The dipole has two identical arms with length *La* and width *Wa* printed on both sides (denoted as the front and back surfaces in this study) of the substrate. The shape of the arm is tapered in its center to improve the matching. The feed network is composed of two overlapping cross-shaped patches printed on both sides and a 50Ω SMA connector settled in the center to avoid designing of the balun, which is an essential technique for the transition between an unbalanced coaxial connector and the balanced parallel strip line network in the conventional feed network of dipole antenna and requires large space.

A quarter-wavelength parallel strip line is arranged between the dipole arm and feed network to perform as an impedance

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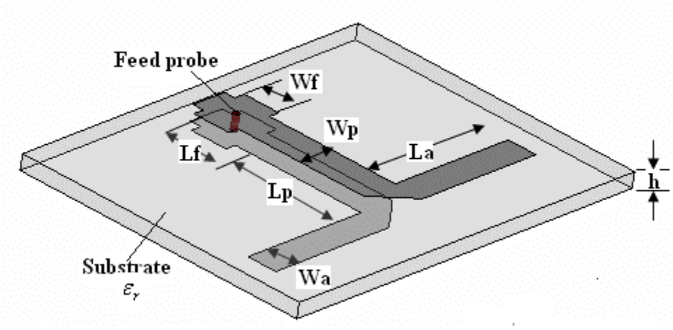
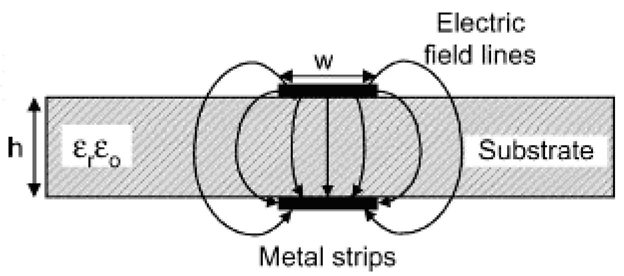
transformer to achieve good matching. The double-sided parallel-strip line is a balanced line consisting of two identical microstrip lines, one on top of the other (Fig 1 (b)). Thus it is easily to be integrated with the double-sided printed dipole arm. Using image theory, the parallel strip's geometry can be converted into a combination of two identical microstrip lines placed back to back. Therefore the design of the parallel strip line is simply related to the design of the microstrip line [3], [4].



(a)



(b)

Fig 1. Geometry of the double-sided parallel strip line fed dipole

(a) dipole geometry

(b) Cross section of the double-sided parallel-strip transmission line

III. EXPERIMENTAL RESULTS AND DISCUSSION

A prototype of the proposed antenna achieving good performance in the wide band from 1.73GHz to 2.55GHz was constructed and tested. The dipole is simulated and constructed using the inexpensive RT Duroid 5880 substrate of thickness h=2mm, relative permittivity $\varepsilon_r = 2.2$ and $\tan\delta$=0.0009. The other dimensions illustrated in Fig 1 are Lf=12mm, Wf=7.5mm, Lp=19mm, Wp=7.5mm, La=26mm and Wa=6mm.

Return loss of the proposed dipole antenna is shown in Fig 2. The measured impedance bandwidth, determined from 2:1 VSWR or about 10dB return loss, reaches 820 MHz (1.73-2.55GHz), which covers the operating bandwidth of the 1.8GHz DCS band (1.72-1.88GHz), DECT band (1.88-1.9GHz), UMTS band (1.92-2.18GHz) and 2.4GHz WLAN band (2.4-2.484GHz). The range corresponds to a 38.3% bandwidth with respect to the center frequency at 2.14GHz.

Measured radiation patterns show a nearly frequency-independent performance comparable to that of a conventional half-wavelength dipole over the entire operating bandwidth.

It can be clearly seen from Fig 2 that the prototype antenna has two adjacent resonant modes excited at frequencies near 2.14GHz: one at 1.85GHz and the other at 2.4GHz. By managing good matching between the two bands, the enhancement of the impendence bandwidth is achieved.

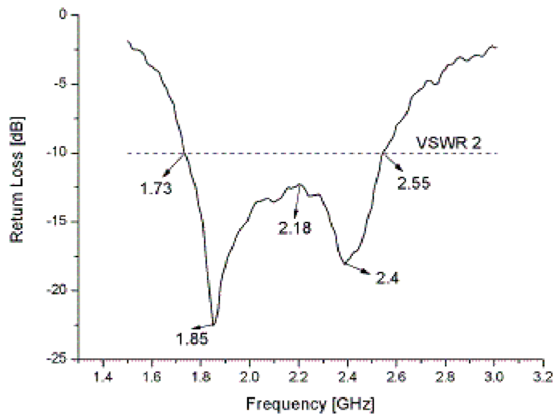
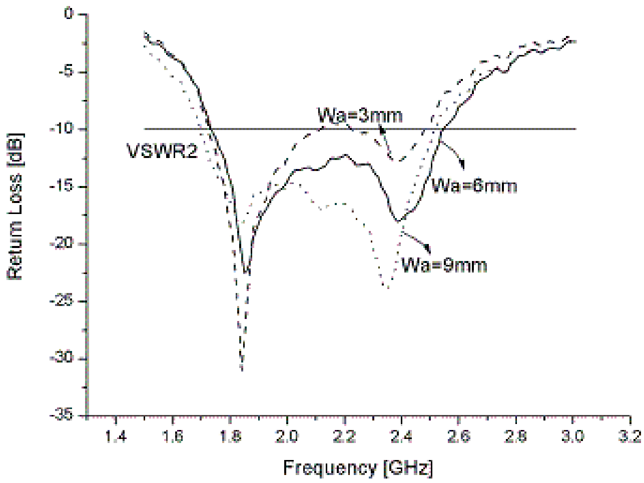


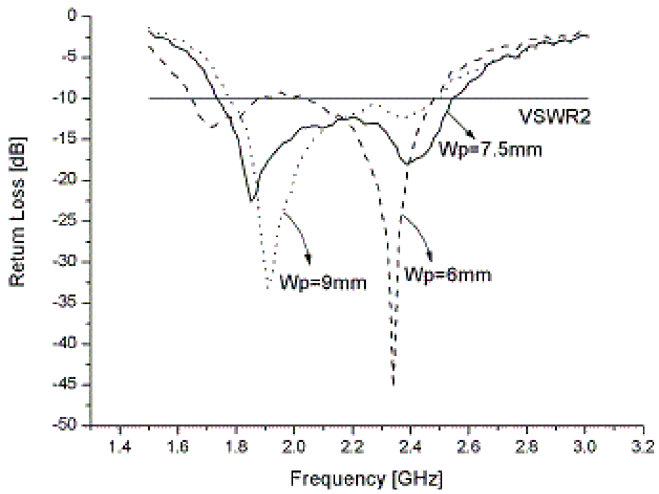
Fig 2. Measured return loss of the proposed dipole element

IV. FURETHER STUDY ABOUT THE EFFECT OF THE PARAMETERS

To study the effects of the arm width Wa, parallel strip line width *Wp* and length *Lp* on the performance of the dipole, prototypes with various values of *Wa*, *Wp* and *Lp* were constructed and studied.



(a)



(b)

Figure 3 Effects of *Wa* and *Wp* on the performance of the proposed dipole

(a) return loss as a function of *Wa* with *Lp*=19mm, *Wp*=7.5mm

(b) return loss as a function of *Wp* with *Lp*=19mm, *Wa*=6mm

As can be seen in Fig 3, which shows the measured return loss with the variation of *Wa* and *Wp*, although the two resonant frequencies and the impendence bandwidth is slightly affected, the impendence matching condition of the two resonant frequencies are changed: the matching of the lower frequency is improved while that of the upper frequency is deteriorated with the decrease of *Wa* (Fig 3 (a)) or increase of *Wp* (Fig 3 (b)), vice versa.

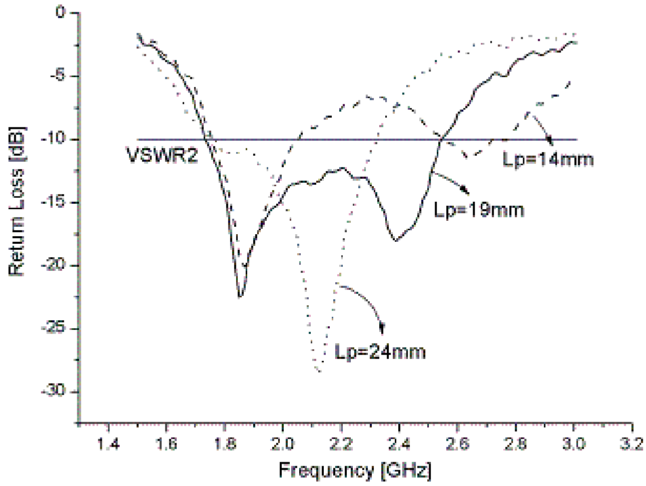


Fig. 5. Measured return loss as a function of *Lp* with *Wp*=7.5mm, *Wa*=6mm

The effect of the parallel strip line length *Lp* are also studied. Fig 4 shows the measured return loss of the cases with *Lp* =14, 19, and 24. The obtained results indicate that, when *Lp* varies, the resonant frequency of the proposed antenna also varies. When *Lp* is lengthened, the two resonant frequencies get close. While when *Lp* is shortened, they go far apart from each other, which implies the possibility of dual-band operation.

To conclude, the width of the arm and parallel strip line mainly affect the impendence matching condition of the two resonant frequencies, while the length of them will change the operating frequency band. By properly adjusting these parameters, it is possible to create versions of these antennas that have either a broadband or a multiband response.

IV. Conclusion

Detailed investigation into the proposed parallel strip line fed double-sided printed dipole element is carried out. An antenna with wide operating bandwidth of 820MHz (1.73-2.55GHz), which covers the operating bandwidth of the 1.8GHz DCS, DECT, UMTS and 2.4GHz WLAN band is analyzed and implemented. Effects of the width and length of the dipole arm and the parallel strip line on the performance of the antenna are studied to give some guidance to the future design. The structure is expected to be used in array antennas.

Acknowledgments

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