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A WIDEBAND MONOPOLE WITH G TYPE STRUCTURE

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Abstract—In this paper, a new monopole with G type structure is proposed, consisting of two wires rectangle rings with radius of 2 mm. The software Numerical Electromagnetic Code (NEC) is used to analyze the proposed antenna and a prototype is designed. The experimental and numerical results of the designed wideband antenna are presented and analyzed, and a 510 MHz bandwidth from 0.86 GHz to 1.37 GHz is demonstrated. The experimental and numerical results fit well.

1. INTRODUCTION

Recently, a strong interest of the antenna industry has been dedicated to products able to operate across several communication standards. This stimulated the research community to keep designing broadband antennas conjugating compact size and stable gain throughout the operating bandwidth. Moreover, steady omnidirectional radiation pattern is a key issue that has been considered fundamental. Monopole antennas match most of these characteristics, so that they represent the starting point of the modern research on broadband radiators [1–4]. Wideband monopole has been studied many years, and there are many methods to realize wideband, such as top loaded monopole [5, 6], folded monopole [7, 8], RLC loaded monopole [9], fractal technology [10], wideband matching network technology [11], and Genetic Algorithm is used to optimize the wideband monopole [12, 13]. Different bandwidth enhancement techniques have been presented and successfully introduced in this antenna.

In this paper, a new type monopole with G type structure is proposed. The proposed antenna is comprised of wires with radius of 2 mm, and the top point of the proposed antenna is 11 cm high from the ground plane. The proposed antenna is simulated by Numerical Electromagnetic Code (NEC), which is based on Method of Moment (MOM), and the numerical results and measure results are presented. The results show that the proposed antenna can achieve a band of nearly 510 MHz with voltage standing-wave ratio (VSWR) less than 2 from 0.86 GHz to 1.37 GHz. The following will give full details of the proposed antenna design.

2. ANTENNA STRUCTURE

The basic configuration of the proposed wideband antenna is shown in Figure 1. The proposed antenna consists of two rectangle rings with a gap between them, and is mounted on a finite ground plane. The two rectangle rings share a common bottom point, thus the structure of the proposed antenna looks like a G character.

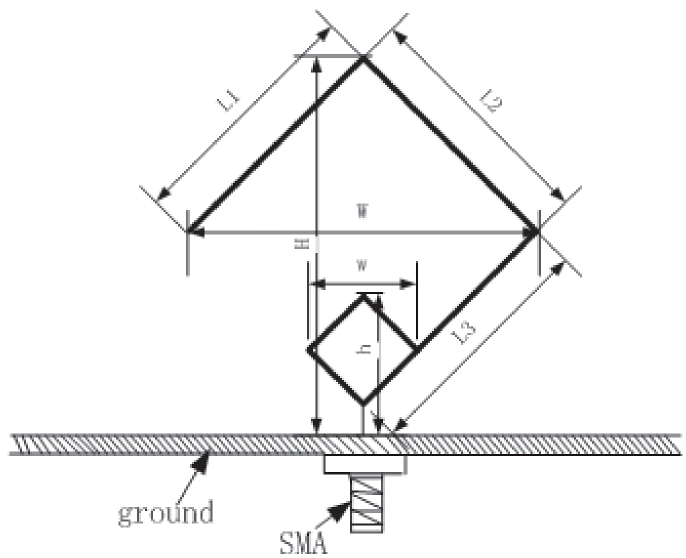

Figure 1. The wideband monopole with G type structure.

The proposed antenna has a dimension of $11\,\text{cm} \times 11\,\text{cm}$ ($W \times H$) and is compromised of copper wires with radius of 2 mm. The bigger rectangle ring has dimensions of L_1, L_2, and L_3, with $L_1 = 7\,\text{cm}$, $L_2 = L_3 = 7.5\,\text{cm}$, which is about 0.25λ with respect to the central frequency of 1.1 GHz. The small ring is a square with diagonal length $L = 5\,\text{cm}$, and has a height of $h = 5.5\,\text{cm}$. The antenna shape and its dimensions were first searched by using the software Numerical

Electromagnetic Code (NEC) and then the optimal dimensions were determined from experimental adjustment. The top point and the bottom point of the G type monopole and the top point of the square ring are on the same line. The proposed antenna is fed at the bottom point of the G type structure by 50Ω coaxial cable line. With a square ring at the bottom, the input impedance is about 50Ω, thus the proposed antenna can be directly fed by 50Ω coaxial cable line. By adjusting the L_1, wideband characteristic of the proposed antenna can be easily achieved.

3. DESIGN AND ANALYSIS

The software Numerical Electromagnetic Code (NEC) is used to analyze the proposed antenna, which is based on Method of Moment (MOM). The monopole and ground plane are assumed to be perfect electrical conductivity (PEC) enabling the use of image theory to account for the effect of current and charge on the ground plane. The photograph of the wideband monopole with G type prototype is shown in Figure 2.

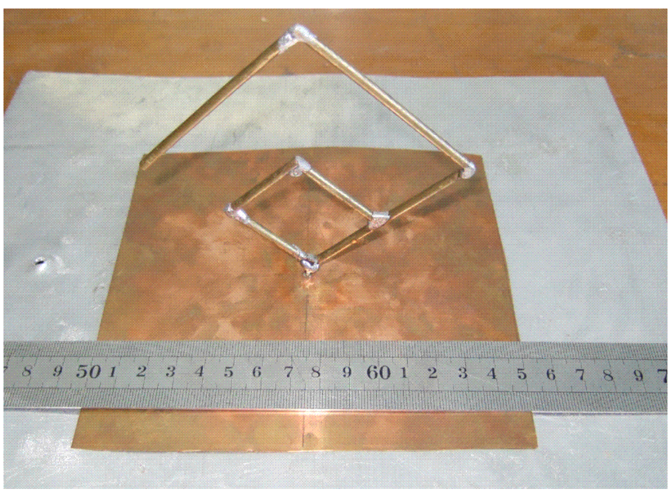

Figure 2. The photograph of the wideband monopole with G type structure.

Based on the design parameters illustrated in Figure 1, the proposed antenna was constructed and its characteristics were analyzed in NEC. With a square ring at the bottom, the current distribution of the proposed antenna is modified, and the input impedance is 50Ω, thus the proposed antenna can be easily fed by 50Ω coaxial cable. By adjusting the length of L_1, the impedance bandwidth of the proposed antenna can be much greater. The effects of the square ring and the L_1 are discussed in the following.

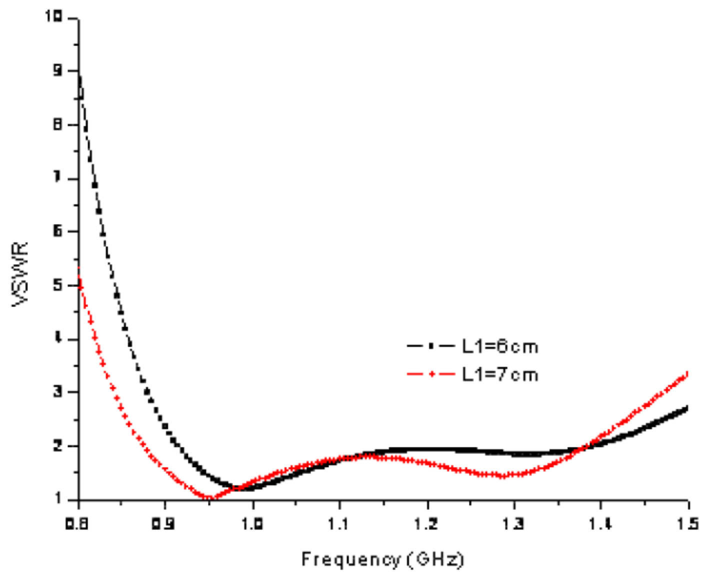

Figure 3. G type monopole with L_1 of different length.

The dimensions are adjusted to optimize the impedance bandwidth response. The parameter to adjust is the length of L_1, typical results are presented in Figure 3. By properly choosing the dimensions of the L_1, the total bandwidth response of the proposed antenna becomes much greater. The reason for this is that the L_1 acts as a loading element on the monopole, tuning out the reactive components of the impedance.

Figure 4, obtained using Numerical Electromagnetic Code, shows the simulated input impedance curves with or without square ring at the bottom of the proposed antenna. Without the square ring, the input impedance at the range of resonate frequency is almost $200\,\Omega$, but with the square ring, the input impedance is almost $50\,\Omega$, thus with the square ring, the proposed antenna can be fed by $50\,\Omega$ coaxial cable.

Figure 5 presents a comparison between simulations and measured VSWR. The presented antenna offers a VSWR bandwidth less than 2 in the range of frequency 0.86 GHz to 1.37 GHz. The measured VSWR is lower than the simulated one at the frequency range from 0.99 GHz to 1.3 GHz, this may because there is a difference in the ground plane between the simulation and measurement. But a very good agreement is achieved.

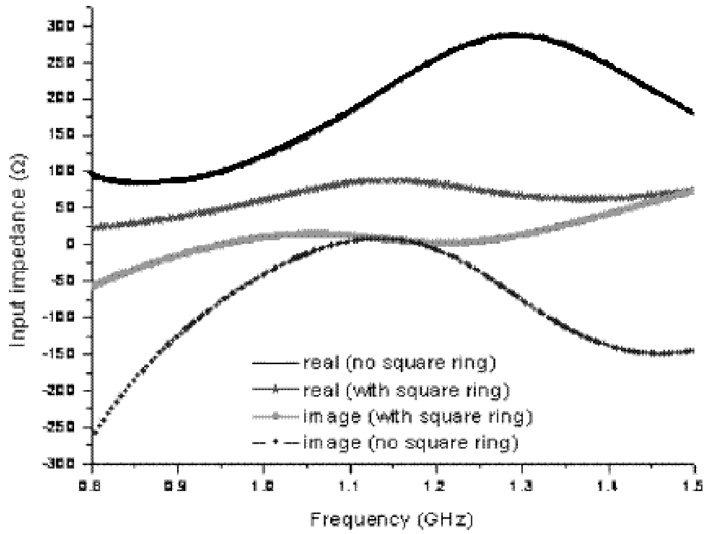

Figure 4. Comparison of the input impedance for the proposed antenna with square ring or without square ring at the bottom.

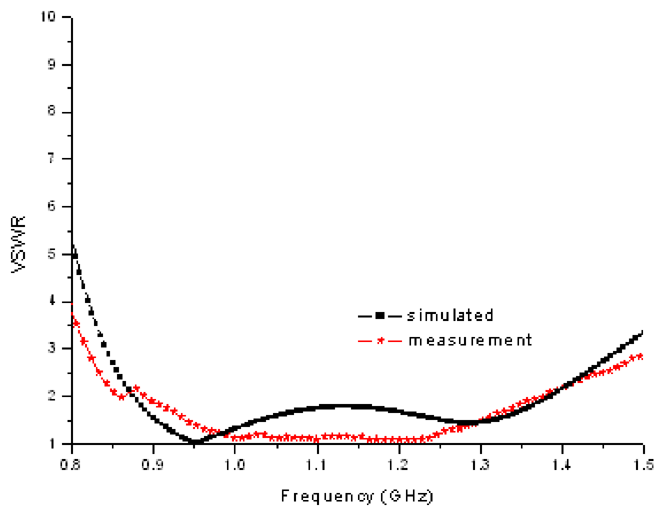

Figure 5. Simulated and measured VSWR.

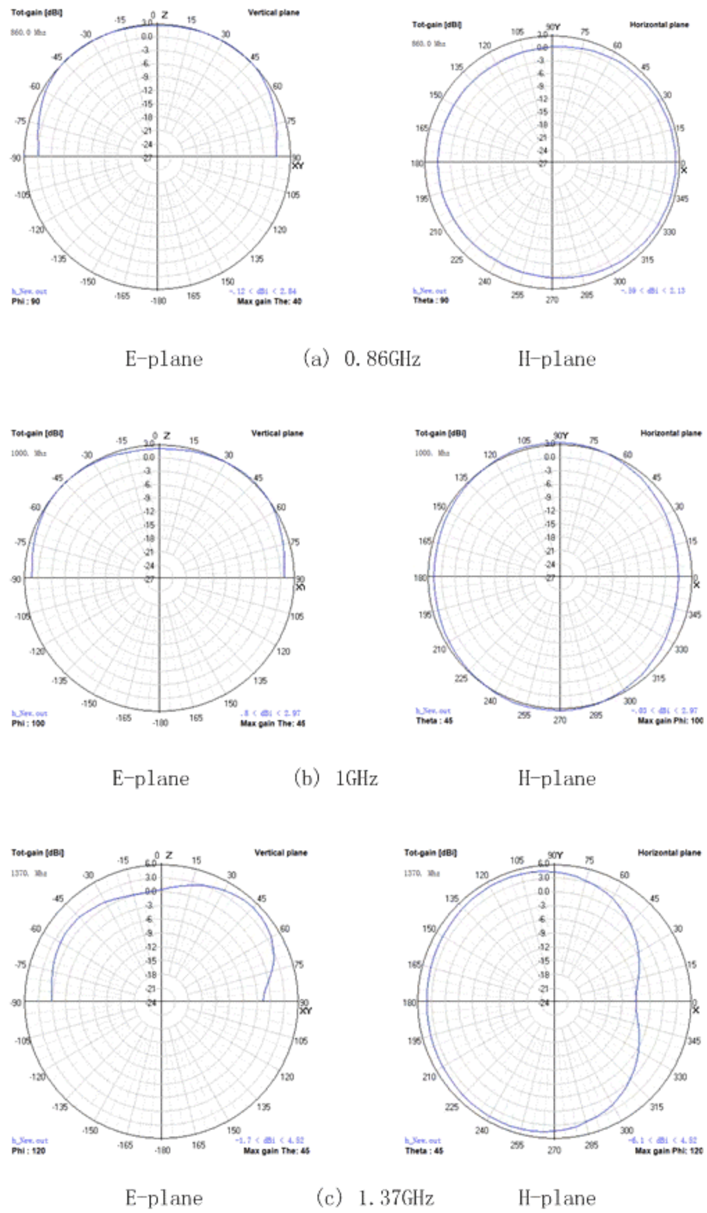

Figure 6. Simulated radiation patterns for the proposed antenna: (a) 0.86 GHz; (b) 1 GHz; (c) 1.37 GHz.

Figure 6 shows the simulated radiation pattern for the proposed antenna at 0.86 GHz, 1 GHz and 1.37 GHz, and the gain of the proposed antenna is more than 2.84 dBi. From the curve shown in Figure 6, it can be seen that the radiation pattern is almost omnidirectional, and the proposed antenna has not been studied before, so studying the G type monopole antenna is much more signification.

The proposed antenna can achieve wideband by adjusting the length of L_1, and it can be directly fed with $50\,\Omega$ coaxial cable by adding a small square ring at the bottom of the proposed antenna.

4. CONCLUSION

A small wideband monopole antenna with G type structure has been introduced. Compromised to other monopole, the proposed antenna has a simple configuration and is easy to fabricate, by selecting appropriate length of L_1 and adding a square ring at the bottom, the proposed antenna can easily achieve wideband operation and be fed by 50Ω coaxial cable line. The effects of the small square ring and the length of L_1 have also been investigated to enhance the proposed antenna impedance bandwidth. By appropriately selecting the dimensions of the small ring at the bottom of the proposed antenna and the length of the L_1, this antenna is capable of achieving a wideband response. Simulation results and measurements of sample prototype antennas have demonstrated that the proposed antenna can achieve a VSWR bandwidth less than 2 of 510 MHz in the frequency range from 0.86 GHz to 1.37 GHz.

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