

Compact Broadband Planar Antennas with Modified Bow-Tie Patch

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Abstract – This study presents two microstrip-fed planar broadband antennas which are designed for 2G/3G/LTE application. The first broadband antenna is constructed by adding a rectangular patch on a bow-tie antenna. The second broadband antenna is constructed by etching a slot on a bow-tie patch. Both antennas operate at 1.7-2.7 GHz, i.e. a fraction bandwidth of 45.45%, for return loss (RL) > 10 dB. The numerical results are presented and discussed.

Index Terms — Broadband planar antenna, patch loaded bow-tie antenna, slotted bow-tie antenna, 2G/3G/LTE application.

I. INTRODUCTION

Recently, the rapid development and demand for mobile devices are increased, especially for 2G/3G/LTE applications. The frequency bands for second generation (2G) systems, such as GSM1800 and GSM1900, operate at 1710-1880 MHz and 1850-1990 MHz, respectively. The frequency bands for third generation (3G) systems, such as cdma-2000, WCDMA, and TD-SCDMA, operate at 1920-2170 MHz. The long term evaluation (LTE) systems, such as LTE2300 and LTE2500, operate at 2300-2400 MHz and 2500-2690 MHz, respectively. Therefore, a broadband antenna is required for operating at 1.7-2.7 GHz, which bandwidth is over 45.45%.

For broadband antenna designing, lots of papers are presented [1]-[5]. In these works, the bandwidths are all over 40% except [3] is over 30%. But these antennas are almost complicated or not planar structures. Therefore, a simplified broadband antenna design becomes important.

In this paper, a broadband planar antenna is presented firstly. This antenna is implemented using a broadband bow-tie monopole antenna with loaded patch having an operating band of 1.7-2.7 GHz. To reduce the antenna size, a bow-tie monopole antenna with a slot is presented. This compact slotted antenna has almost the same bandwidth with the previous antenna, but the size is reduced. Finally, the numerical results are presented and discussed.

II. ANTENNA DESIGN

A. Patch loaded Bow-Tie Antenna

For broadband antenna designing, planar bow-tie antenna is a good choice because its wideband characteristic. The bandwidth of bow-tie antenna is obtained with its graded

input shape which acts as an impedance matching network. To increase the bandwidth of traditional bow-tie antenna, a planar bow-tie antenna with extended top rectangular patch is proposed as shown in Fig.1. The operating frequency is determined by the length L_1+L_2 and the bandwidth is controlled by the included angle (θ).

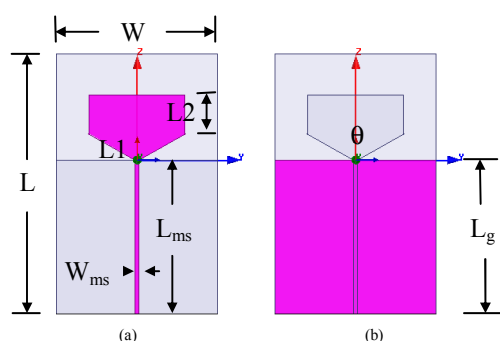


Fig. 1. The geometry of the patch loaded bow-tie antenna (a) top view, (b) back view.

B. Slotted Bow-Tie Antenna

In Figure 1, the top extended rectangular patch can be reduced to miniaturize the antenna size. However, the impedance matching becomes poor and bandwidth is also reduced. Therefore, a horizontal slot is etched to improve the bandwidth. Figure 2 illustrates the geometry of the new compact broadband antenna. Here the bent strip monopole antenna beside the slot is the radiating element and the operating frequency is determined by the slot length. Meanwhile, the length of the bent strip monopole antenna is almost the quarter-wavelength at the operating frequency.

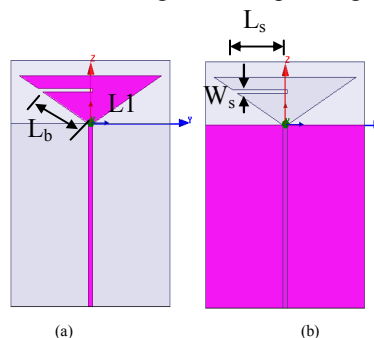


Fig. 2. The geometry of the slotted bow-tie antenna (a) top view, (b) back view.

III. NUMERICAL RESULTS AND DISCUSSION

Table I lists the dimensions of the patch loaded bow-tie antenna. The simulated S_{11} is shown in Figure 3. Figure 3 indicates the bandwidth of the original bow-tie antenna is not enough for 2G/3G/LTE applications. The patch loaded bow-tie antenna, which consists of bow-tie patch and the top rectangular patch, has a wider bandwidth.

TABLE I
DIMENSIONS OF THE PATCH LOADED BOW-TIE ANTENNA

Unit	L	W	L _g	L _{ms}	W _{ms}	L1	L2	θ
mm	100	60	60	60	1.6	20	14.5	120°

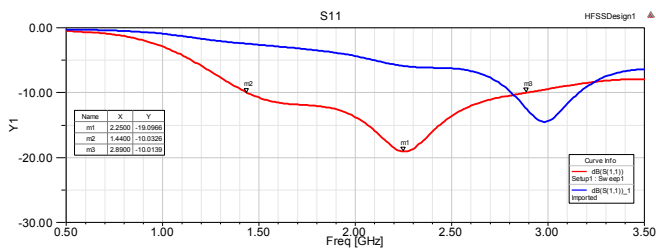


Fig. 3. The simulated S_{11} of the (a) bow-tie (blue line) and (b) patch loaded bow-tie (red line) antenna.

Table II lists the dimensions of the slotted bow-tie antenna. The simulated S_{11} is shown in Figure 4. Figure 4 indicates the original bow-tie antenna without a slot has a narrower bandwidth compared to the slotted bow-tie antenna which is constructed by etching a slot in the bow-tie patch. Table III compares the bandwidths of these two broadband antennas.

TABLE II
DIMENSIONS OF THE SLOTTED BOW-TIE ANTENNA

Unit	L	W	L _g	L _{ms}	W _{ms}	L1	L _b	L _s	W _s	θ
mm	80	60	60	60	1.6	30	20	20.57	1.0	120°

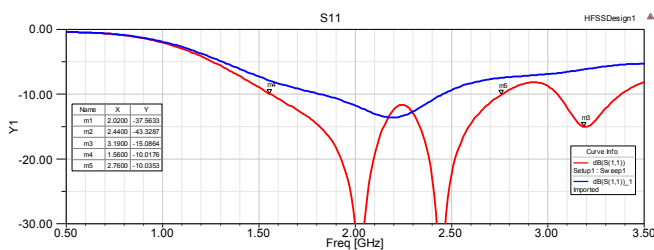


Fig. 4. The simulated S_{11} of the (a) bow-tie (blue line) and (b) slotted bow-tie (red line) antenna.

Table III indicates that the patch loaded bow-tie antenna has broader bandwidth than the slotted bow-tie antenna, but the later one has a smaller size and a better impedance matching than the first one. Both of these two designed antennas satisfy the frequency requirement for 1.7-2.7 GHz and can be used for 2G/3G/LTE applications.

TABLE III
COMPARISONS OF THESE TWO BROADBAND ANTENNAS

Patch loaded Bow-Tie Antenna	Without patch loaded	With patch loaded
	2.81-3.15 GHz (11.41%)	1.44-2.89 GHz (66.97%)
Slotted Bow-Tie Antenna	Without slot	With slot
	1.82-2.45 GHz (29.51%)	1.56-2.76 GHz (55.56%)

IV. CONCLUSION

This work presents two broadband planar antennas operating for 2G/3G/LTE applications. The first broadband antenna consists of a bow-tie and a rectangular patch. The second antenna constructed by etching a slot on a bow-tie patch. Both antennas operate at 1.7-2.7 GHz and the simulated bandwidths are all over 55.56%. Besides, the lengths of these designed antennas can be easily estimated.

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