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Wideband and Miniaturized Triangular Folded Dipole Antenna

#Shingo Tanaka[1], Yongho Kim[2], Hisashi Morishita[2], Satoru Horiuchi[1], Yasunori Atsumi[1]
[1] Yazaki Research and Technology Center, Yazaki Corporation
3-1 Hikari-no-oka, Yokosuka, 239-0847, Japan (e-mail: si-tanaka@ytc.yzk.co.jp)
[2] Department of Electrical and Electronic Engineering, National Defense Academy
Yokosuka, Kanagawa 239-8686, Japan (e-mail: morisita@nda.ac.jp)

1. Introduction

A folded loop antenna without ground plane has compact construction and it has been reported that folded loop antenna with more than 50 % bandwidth (VSWR ≤ 2) can be constructed for 50 Ω impedance matching [1]. The folded loop antenna is essentially a planar folded dipole antenna with folded construction at both ends. It also has been reported that the folded dipole antenna (it is not folded at both ends and has planar construction) also have wideband properties [2-3]. In this paper, triangular folded dipole antenna, that is miniaturized from folded dipole antenna and maintains wideband characteristics, is proposed.

2. Miniaturization of Folded Dipole Antenna

Figure 1(a) shows the structure and parameters of conventional rectangular folded dipole antenna. When the parameter 1 and g is fixed to 88mm and 2mm, respectively, bandwidth more than 50 % is obtained with w_1 = 4 mm, w_2 = 32 mm, d = 2 mm, e = 2 mm and g = 2 mm [2-3]. The rectangular folded dipole antenna has two resonance frequencies so the wideband property is obtained. Figures 1(b)(c) show the simulated current distributions of the folded dipole antenna at two resonance frequency. The simulation is done by commercially available simulator based on the method of moment. The arrows show the vector of the current flow. The back color indicates the intensity of the currents, dark gray means larger currents and light gray means smaller currents. It is found from Figures 1(b)(c) that the current distributions are converged to the edges around T-shaped slit on the rectangular folded dipole antenna. So it is supposed that the bottom both end portions of the folded dipole antenna is not important for radiation, especially for upper resonance frequency, and the antenna size can be miniaturized.

Figure 2(a) shows the structure and parameters of the miniaturized triangular folded dipole antenna. Construction parameters of the triangular folded dipole antenna are optimized to obtain wideband characteristics for 50 Ω impedance matching. We found that when parameter 1 and g is fixed to 88mm and 2mm, respectively, bandwidth more than 40 % is obtained with w_1 = 3 mm, w_2 = 28 mm, w_3 = 3 mm, d = 2 mm, and e = 2 mm.

Figures 2(b)(c) show the current distributions of the triangular folded dipole antenna at two resonance frequency. The resonance frequencies are shifted-up from rectangular folded dipole antenna. When comparing Figures 1(b)(c) and Figures 2(b)(c), we can say that the current distributions of the rectangular folded dipole antenna and triangular folded dipole antenna have same tendencies essentially at lower and upper resonance frequencies.

3. Experimental Results

Figure 3 shows measured and simulated VSWR of the triangular folded dipole antenna. The measured bandwidth with VSWR ≤ 2 is from 1.44G Hz to 2.29G Hz (bandwidth = 46%) , and the simulated bandwidth with VSWR ≤ 2 is from 1.47G Hz to 2.27G Hz (bandwidth = 43%). The measured and calculated results agreed well each other.

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The bandwidths and area sizes of the triangular and rectangular folded dipole antennas are discussed. The simulated bandwidth (VSWR ≤ 2) of rectangular folded dipole antenna is 1.23 G Hz to 2.15G Hz (bandwidth = 54 %), so the center frequency is 1.69G Hz and the wavelength of the center frequency λ_{Cr} = 178 mm. The area size of the rectangular folded dipole antenna, including T-shaped slit, is 3344 mm^2 (38 mm x 88 mm) and can be written as $0.106\lambda_{Cr}^2$ ($0.21\lambda_{Cr}$ x $0.50\lambda_{Cr}$). On the other hand, the simulated bandwidth of triangular folded dipole antenna is 1. 47G Hz to 2.27G Hz (bandwidth = 43 %) so center frequency is 1.87G Hz and the wavelength of the center frequency λ_{Ct} = 160 mm. The area size of the triangular folded dipole antenna, including T-shaped slit, is 1760 mm^2 ((33 mm + 7 mm)/2 x 88 mm) and can be written as $0.068\lambda_{Ct}^2$ ($0.21\lambda_{Ct}$ +$0.04\lambda_{Ct}$)/2 x $0.55\lambda_{Ct}$). So it can be said that the size of triangular antenna is reduced by around 36 % from that of rectangular antenna, with the reduction of bandwidth from 54% to 43%. The simulated frequency range and the area size of rectangular folded dipole antenna and triangular folded dipole antenna are summarized on Table 1.

The simulated radiation patterns of the triangular folded dipole antenna are shown in Figure 4. As shown in Figure 4, the main polarizations (E_θ) of the antenna are almost constant to around 2 dBi and similar to the normal half-wavelength dipole from 1.5G to 2.2G Hz. The cross polarizations (E_φ) of the antenna are under -10 dBi and have tendency to increase when the frequency goes up. These characteristics are almost similar to the radiation patterns of folded loop antenna [1] and rectangular folded dipole antenna [2-3]. The measured and simulated radiation patterns at 1.5G Hz are shown in Figure 5. Both results agreed well each other.

4. Conclusion

The wideband and miniaturized triangular folded dipole antenna is proposed and evaluated. It is modified from wideband rectangular folded dipole antenna and has bandwidth (VSWR ≤ 2) from 1.47G Hz to 2.27G Hz (bandwidth = 43%). The area size is reduced by around 36 % from that of rectangular folded dipole antenna. The antenna has gain around 2 dBi at the operating band and the radiation patterns are similar to the rectangular folded dipole antenna.

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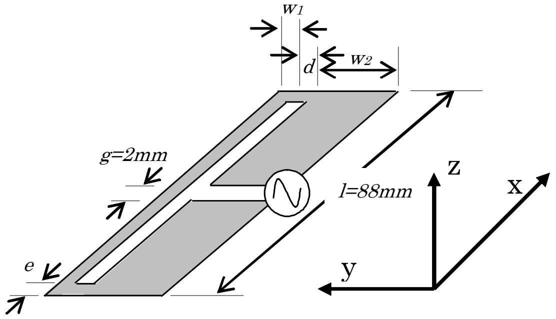
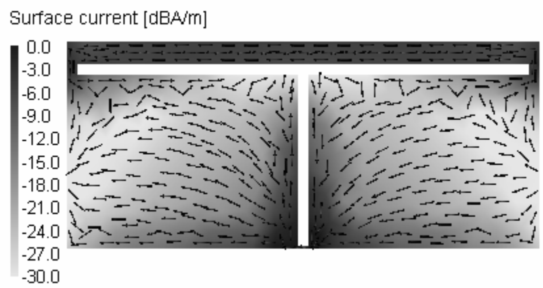
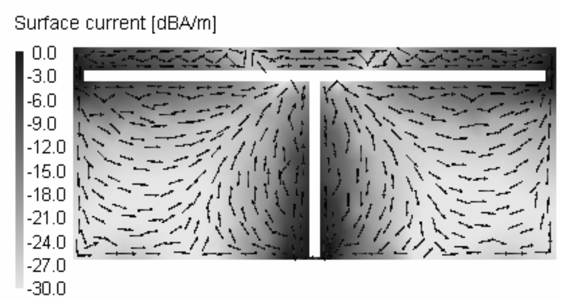


(a)antenna structure and parameters

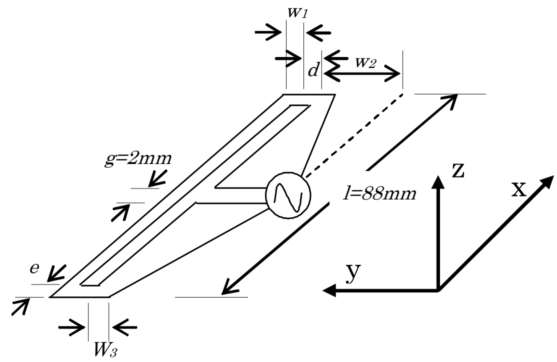


(b) current distribution at 1.3GHz

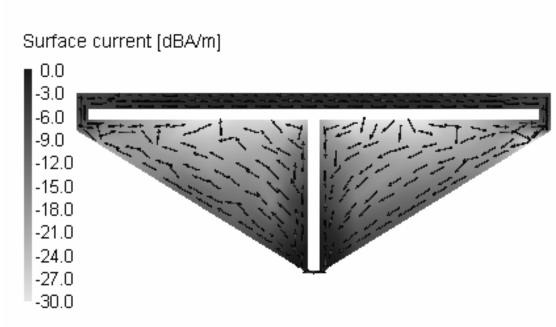


(c) current distribution at 2.0GHz

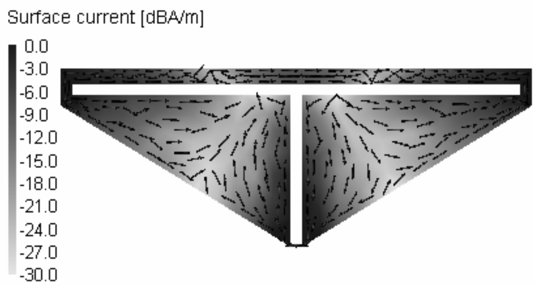
Figure 1 Rectangular folded dipole antenna and its current distributions.



(a) antenna structure and parameters



(b) current distribution at 1.55GHz



(c) current distribution at 2.15GHz

Figure 2 Triangular folded dipole antenna and its current distributions.

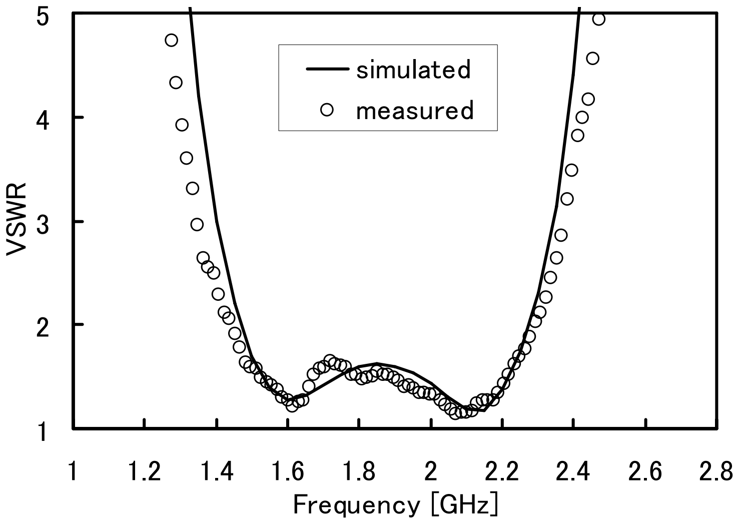
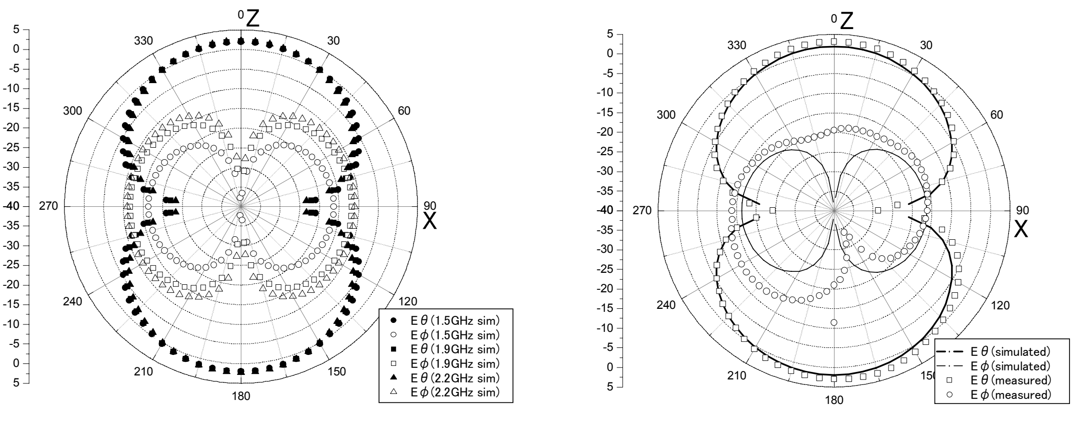


Figure 3 Measured and simulated VSWR of triangular folded dipole antenna

Table 1 Simulated bandwidths and area sizes of rectangular and triangular folded dipole antennas.

	bandwidth	area size
rectangular	1.23G-2.15GHz (54%)	3344 mm^2 ($0.106\lambda_{Cr}^2$)
triangular	1.47G-2.27GHz (43%)	1760 mm^2 ($0.068\lambda_{Ct}^2$)



(a) (b)

Figure 4 Simulated radiation pattern of triangular folded dipole antenna