Circularly Polarized Log Periodic Dipole Antennas

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***Abstract*- This Modified Self-complementary LPDA [1] has a second array of dipoles so arranged that each dipole of the second array has a quarter-wavelength phase difference from that of the corresponding dipole of the standard LPDA array for the given radiation field. The cross-element LPDA does not need a broadband 90-degree hybrid junction to produce circular polarization.**

***Index Terms*- Broadband, LPDA antennas.**

I. INTRODUCTION

In this paper we propose a LPDA. This LPDA, called a "cross-element LPDA," has a second dipole array which is orthogonal to that of the standard LPDA. Though a cross-element LPDA for EMC measurement has been manufactured by EMCO, this version of the antenna requires a discrete broadband 90-degree hybrid junction to produce the circular polarization. However, our version of an LPDA antenna does not require such a hybrid junction.

The cross-element LPDA antenna can radiate the horizontal and vertical components of the electric field with a polarization ratio of about only 1 dB for the vertical plane, and so the cross-element LPDA gives good circular polarization.

II. CROSS ELEMENT OF THEORY AND MESUREMENT VALUE

The geometry of a standard N-element LPDA [2]-[3] with associated parameters is shown in Fig. 1. An antenna length shows the length of the ith element, the distance between element i-1 and i and the wire radius of the ith element of a standard 16-element LPDA. These parameters are referred to the model 3146 (a product of EMCO). The parameters of the LPDA, di/li, scale factor (τ=di/di-1), the frequency of the half-wave resonance spacing factor (σ=di/li) and apex angle α. Then, it reasoned that the LPDA would have circular polarization if the LPDA had a set of cross elements perpendicular to the original elements and if each cross element was shifted from the original elements a distance equivalent to a phase shift of π/4 for the given radiation field.

The geometry of the cross-element LPDA with 2N elements is shown in Figs. 2 (a) and (b). Each N+ith cross element is lengthened to be 14.2/13＝1.09 times longer than the corresponding i-th element so that α of the cross elements of the LPDA comes to the values of the original LPDA.

Fig. 3 shows the front view of the feed lines of the cross-element LPDA for the # i and # i+N elements. The characteristic impedance Z_0 of the feed line in Fig. 3 can be given as:

$$Z_0 = 138\log_{10}\frac{2\sqrt{2}D}{a},$$

It is found that $Z_0 \geq 62.3(\Omega)$, because D>a. In this paper, Z_0 is $75(\Omega)$, for example, if a=10.0 mm, then D= 12.4 mm.

Figs. 4 (a) and (b) shows values calculated by the moment method [4] and the typical measured radiation pattern of the cross-element LPDA for a frequency of 1 GHz. The calculated patterns seem to be in close agreement to the measured patterns.

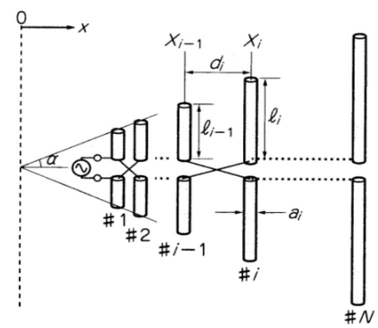

Fig. 1. Standard LPDA with associated parameters.

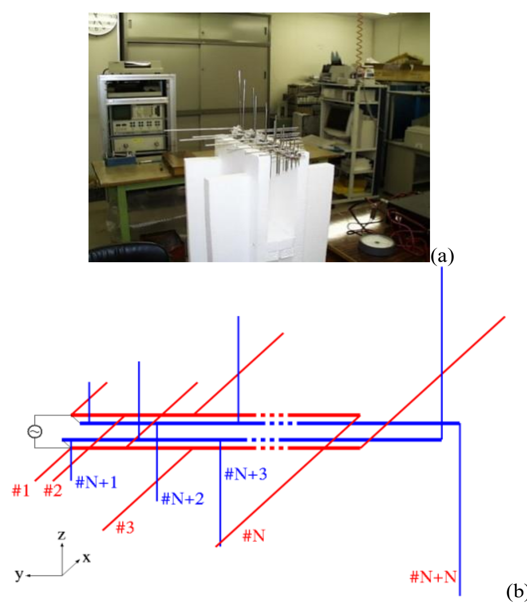

Fig. 2. (a) An exterior view of the suggested cross-element LPDA. (b) Suggested cross-element LPDA with associated parameters.

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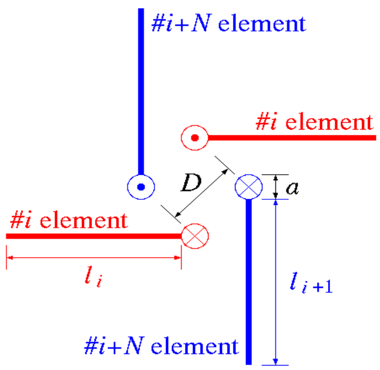

Fig. 3. A pair of feed lines with #ith and #i+Nth elements of the cross-element LPDA.

Figs. 5 (a) and (b) shows the measured an axial ratio of the cross-element LPDA for a frequency of 750MHz. An axial ratio of the cross-element LPDA is within 3 dB for the horizontal and 1 dB for the vertical plane in the forward direction. This shows that this type of antenna has circular polarization. Similar patterns are obtained for other frequencies from 300 MHz to 1000MHz. This antenna has a gain of about 5.8-5.0 dB at the frequency 300-1000MHz.

We consider that the two orthogonal components of the electric field, the E_φ component radiated from the original element and the E_θ component radiated from the cross element of the LPDA where maximum current is obtained, have a phase difference of π/4.

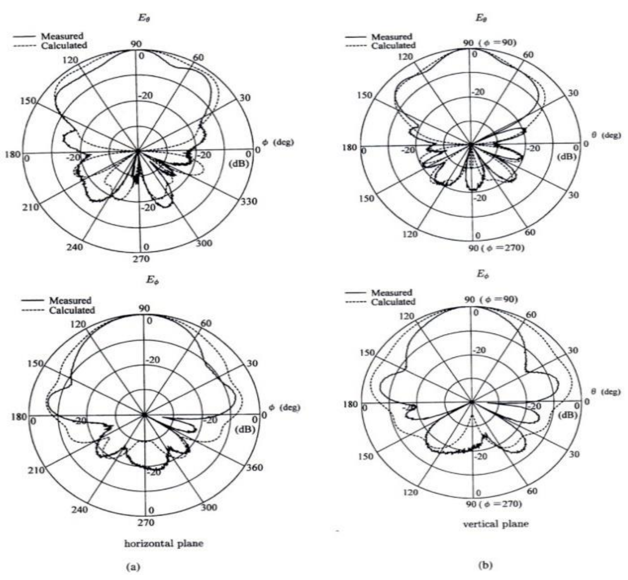

Fig. 4. Radiation pattern of the cross-element LPDA at 1000MHz: (a) horizontal plane and (b) vertical plane.

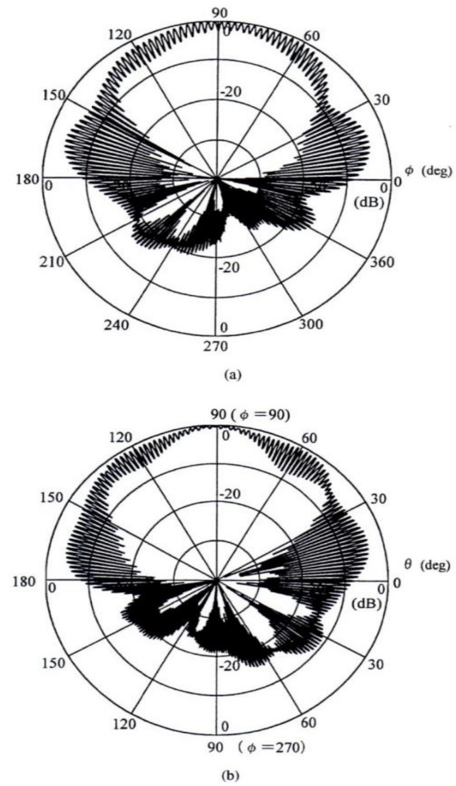

Fig. 5. Measured polarization ratio of the cross-element LPDA at 750MHz: (a) horizontal plane and (b) vertical plane.

III. Conclusion

It has calculated the gain for the cross-element LPDA and has shown the characteristics of the cross-element LPDA clearly. The cross-element LPDA has an axial ratio of about 1 dB for the vertical plane. The cross-element LPDA has almost circular polarization.

References

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