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FOLDED DIPOLE ANTENNA ARRAY WITH TRANSPOSED FEED

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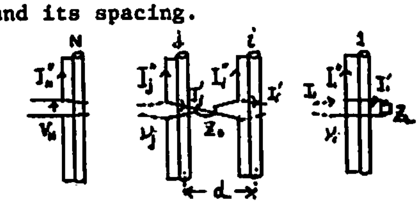
Introduction

An array antenna consists of folded dipole antannas which are fed by alternately transposed two conductor balanced line has been theoretically analyzed. If the length of each element dipole antenna is less than $\lambda/2$,and the phase of each feeding point current gradualy lags along the array axis toward radiation beam direction,this dipole array antenna can be used as an endfire array. But usually the amplitude of the feeding point current decreases along the array axis because of relatively large ratio of the characteristic impedance and the element dipole impedance.[1]

If the spacing of each element of transposed feed array becomes very close, the phase of the feeding point current of adjacent element becomes nearly π according to the effect of transposition, therefore the propagation constant(β) of the above feeding point phase is considered as almost infinite,the other hand spacing becomes almost $\lambda/2$,the phase becomes nearly the same and β is considered as 0.This means that β can be taken any value by adjusting the spacing of element dipole. The defect of above mentioned amplitude may be improved by using folded dipole antenna as element. Because the input impedance of the folded antenna shows high value according to the step-up ratio which is a function of radii of primary and secondary conductor and its spacing.

Fig.1



Analyzing method of transposed folded dipole array[2]

Now consider the array consists of parallel,nonstaggered N-folded dipole antenna with transposed feed,as shown in Fig.1. If we set $1/\nu_i^2$ as a step-up ratio of i-th element and total length of each element is just half-wave length,we obtain

$$I_i'' = \nu_i I_{ai} \qquad (1)$$

where I_{ai} is the zero-phase current on the i-th folded dipole antenna. The zero phase feeding point voltage $\nu_i V_i$ of i-th element is given by

$$\nu_i V_i = \sum_{j=1}^{N} I_{aj} Z_{ij} \qquad (2)$$

where, Z_{ii} is a self-impedance of i-th element and Z_{ij} is a mutual-impedance between i-th and j-th element.

Substituting Eq.(1) into (2), we can rewrite(2)

$$\nu_i V_i = \sum_{j=1}^{N} \frac{I_j''}{\nu_j} Z_{ij} \qquad (3)$$

And then, for the feeding point voltage

and the current of i-th and (i+1)-th element, we can find the following expression by transmission line equation

$$-V_{i+1} = V_i \cos kd + j Z_0 I_i \sin kd \quad (4)$$

$$-I'_{i+1} = I_i \cos kd + j \frac{V_i}{Z_0} \sin kd \quad (5)$$

$$V_i = Z_L I'_i \quad (6)$$

where Z_0 and Z_L is the characteristic impedance of the transmission line and load impedance respectively. k is given by $2\pi/\lambda$.

Substituting Eq.(4),(5),(6) into (3), we obtain

$$[V] = [A][I] \quad (7)$$

where

$$[V] = \begin{bmatrix} 0 \\ 0 \\ \vdots \\ V_N \end{bmatrix} \quad [I] = \begin{bmatrix} I'_1 \\ I''_1 \\ I'_2 \\ \vdots \\ I''_N \end{bmatrix}$$

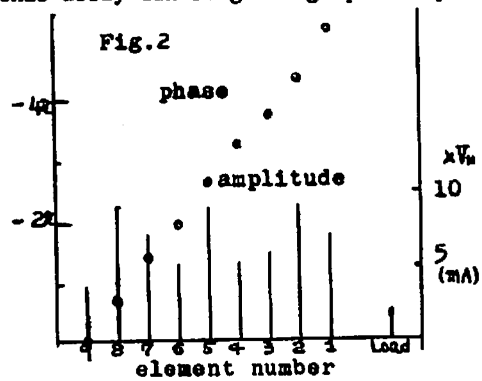
$[A]$ is (N+1)X(N+1) matrix.

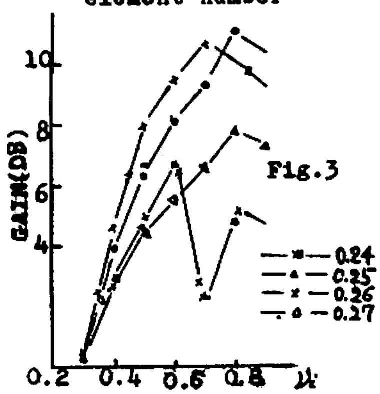
Result of numerical calculation

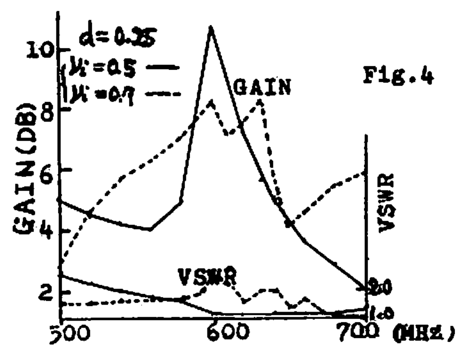
By solving directly the set of simultaneous equations given by (7) using improved circuit theory of array antenna[3], feeding point current is determined. Radiation pattern, gain and input impedance of this array can be solved by these currents.

Fig.2 shows feeding point currents along the array axis for 9-element array. The phase of each feeding point current will be found to lag gradualy along array axis. Fig.3 shows gain for various step-up ratio. This result describes there are adequate value for ν and d. By considering normal-phase impedance, the variation of gain and VSWR for frequency is calculated. Fig.4 shows frequency characteristics of gain.

As these results of numerical computation, we can find the folded dipole array with transposed feed can be used as the endfire array antenna, and the design of this array can be given graphically.







[1] P.E.Mayes: Tech Report No.60, Univ of Illinois Dec.1962

[2] H.Uchida: Foudamentals of coupled line and Muttiwire antennas. Sasaki, Co.1967

[3] N.Inagaki: IEEE Trans.AP-17, No.2, march.1969