V-SHAPED DIPOLE ARRAY AND FEEDLINE EFFECT

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Straight dipoles have been widely used in the phased array design due to their low cost and easy construction. However, the straight dipole array has two inherent drawbacks which affect its performance. (1) E-plane scan resistance drops very fast when the scan direction is close to endfire. (2) Blind spots may occur in the region close to broadside. The first drawback can be improved by bending the dipole legs downward in a "V" shape. The second drawback which is caused by the strong coupling from the feedlines may be eliminated by connecting a choke on every feedline.

Figure 1(a) shows a dipole fed with a two-wire feedline. When the two wires are closely spaced ($s \ll \lambda$), the net radiation from the feedline due to balanced mode current can be neglected. In this event, the two-wire feedline can be modelled by a single cylindrical wire carrying only unbalanced mode current as shown in Figure 1(b). The balanced and unbalanced mode currents may be hypothetically separated as illustrated in Figure 1(c). The element "b" is a dipole exicted by the balanced mode current. The element "u" can be viewed as a scatterer. Using this model, the scan impedance of dipole is given by

$$Z_d = Z^{bb} - \Delta Z \tag{1}$$

where

$$\Delta Z = \frac{Z^{ub}\, Z^{bu}}{Z^{uu}} \quad . \tag{2}$$

In the above equations, Z^{bb} and Z^{uu} are the self-impedance of element "b" and element "u" respectively, Z^{ub} and Z^{bu} are the mutual impedances between element "b" and element "u". ΔZ is the quantity used for evaluating the coupling on the dipole (element "b") due to the unbalanced mode current on the element "u".

When a choke is loaded on the feedline, Equation (2) should be modified to

$$\Delta Z = \frac{Z^{ub} Z^{bu}}{Z^{uu} + jX_L} \qquad (3)$$

where jX_L is the impedance of the choke.

In this paper, we consider the dipole array as an infinitely large periodic structure. Also, the array elements are fed with Floquet's type currents. Therefore, Plane Wave Expansion Method [1] will be used to compute the impedances.

The self-impedances (Z^{bb}) of a straight and a V-shaped dipole (with 50 degree bend angle) are shown in Figures 2(a) and 2(b) respectively, where we see the E-plane impedance is substantially improved for the V-shaped dipole. Figure 3(b) shows the scan impedance Z_d of a straight dipole array with unloaded feedlines. Comparing Figure 3(b) with Figure 3(a), we note that strong feedline effect is existing within frequency band ranging from 7 to 8 GHz and a blind spot occurs at frequency 7.68 GHz. The self-impedance Z^{uu} is shown in Figure 4. From there we realize that the blind spot is induced at the freuqnecy when element "u" is resonant. To eliminate the blind spots in the desired frequency range, we can connect an appropriate choke on every feedline to prevent element "u" from being resonant. the detail about this and more resutls will be given in the presentation.

REFERENCE

[1] Munk, B.A., Burrell, G.A. and Kornbau, T.W., "A General Theory of Periodic Surfaces in Stratified Dielectric Media", AFAL-TR-77-219, Air Force Avionics Laboratory, Wright-Patterson Air Force Base, Ohio 45433, November 1977.

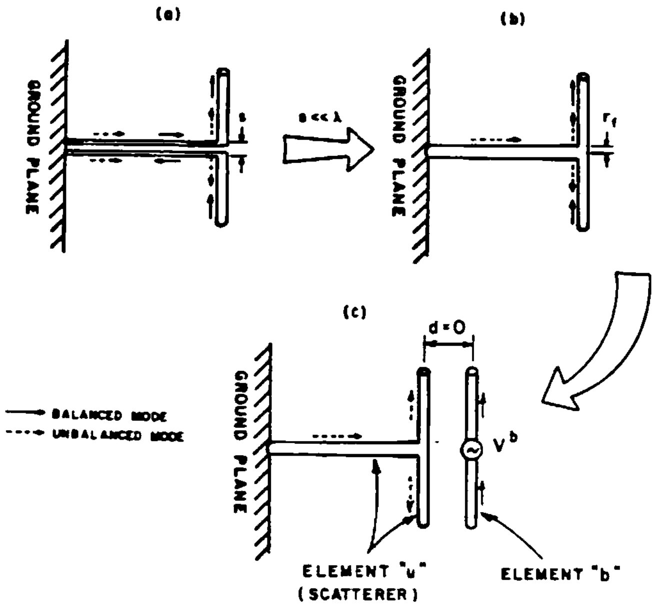

Figure 1. Theoretical model for evaluating Z_d.

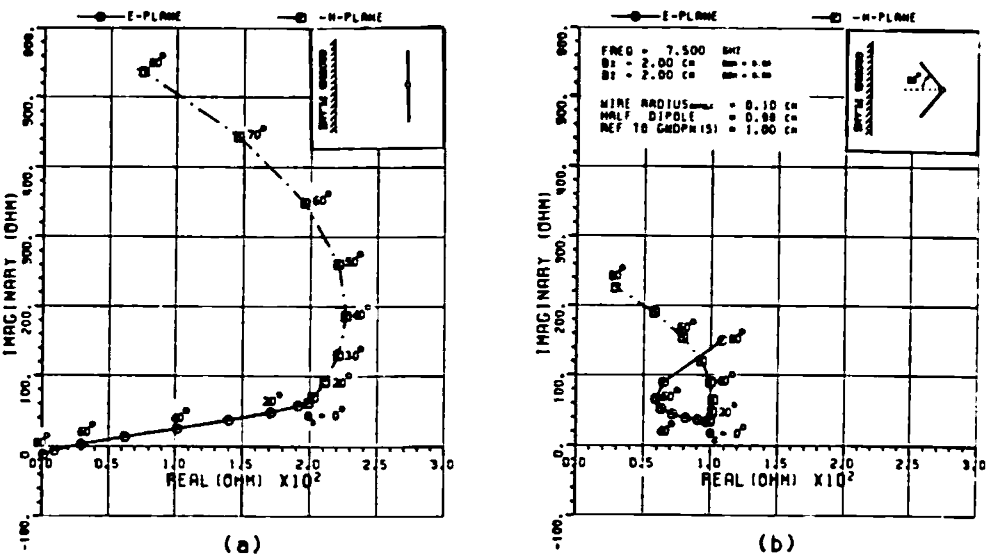

Figure 2. Impedance Z^{bb} for (a) straight dipole, (b) V-shaped dipole (50 degree bend angle).

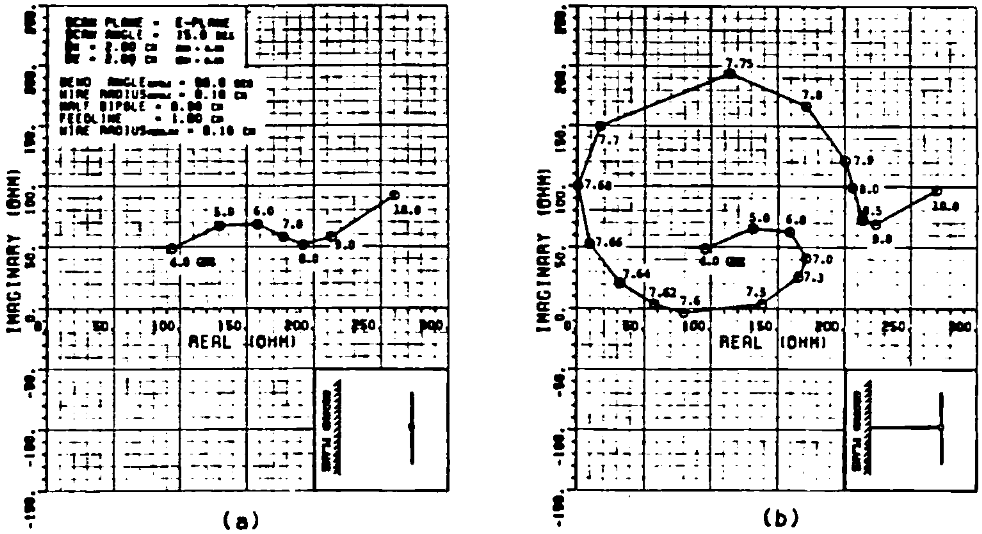

Figure 3. Impedances of a straight dipole array (a) Impedance Z^{bb}, (b) Impedance Z_d (with unloaded feedlines).

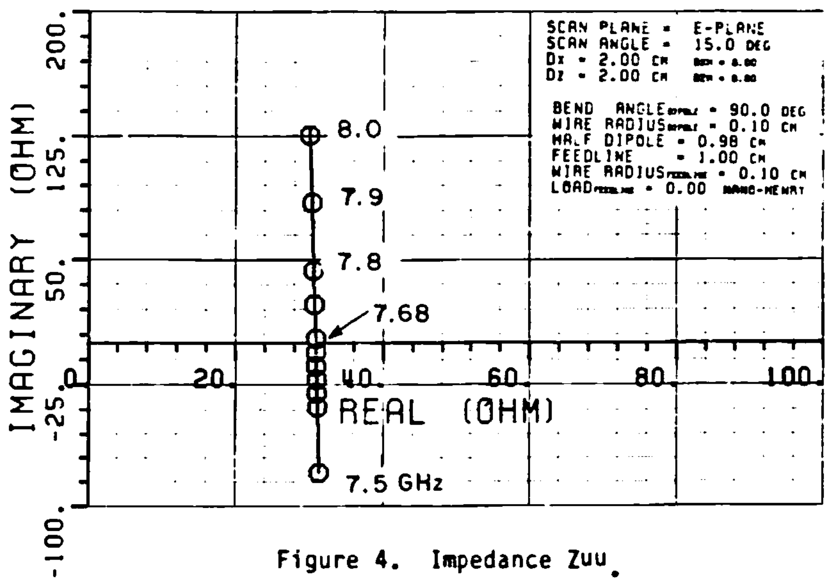

Figure 4. Impedance Zuu.