RADIATION PROPERTIES OF TRIPLATE-TYPE PLANAR ANTENNA

M. HANEISHI, M. NAKAYAMA, S. SAITO and T. HASEGAWA
Department of Electrical Engineering
Saitama University
Urawa-shi, Saitama 338, JAPAN

1. INTRODUCTION

Planar arrays consisting of microstrip antenna are widely used as an efficient radiator in many communication systems [1,2] . A serious problem of such an antenna, however , is an excitation of undesirable radiation from its feeding systems .

In order to suppress such an undesirable radiation , a triplate-type planar antenna (TPA) has been developed recently [3,4] . The antenna is fed by a center conductor of the triplate-line to avoid the influence of undesirable radiation. This paper describes the designing techniques of a TPA-element and the radiation properties of the new planar antenna composed of this TPA-element .

2. BASIC CONFIGURATION OF TPA ELEMENT

The geometry of the TPA element and the coordinate system employed here are illustrated in Fig.1. A radiating element is printed on the upper surface of a grounded dielectric substrate , and its feeding system is made up of a center conductor of the triplate-line . In case of linearly polarized TPA-element ,however, a shorted-stub (Sb) shown in Fig.1b is useful for suppressing undesirable radiation caused by the cross-polarization component of the antenna . Consequently , the shorted-stub is set at an appropriate location in the antenna, as shown in the figure. The impedance matching of the antenna is also important for actual applications. Therefore , the input impedance of the test TPA is matched to that of the main feeder by controlling the length of offset feeding line (l). Furthermore, a circularly polarised TPA-element can also be achieved by setting perturbation segments Δs to the appropriate locations of the antenna, as shown in Fig.1c .

3. RADIATION PROPERTIES OF TPA

In designing this type of antenna ,it is important to estimate the value of unloaded Q(Q_0) and radiation efficiency(η) for the test TPA-element. Therefore , theoretical values of Q_0 were calculated for a typical sample by employing a commonly used technique known as the method of equivalent magnetic-current. For the present antenna,the theoretical values agreed with the experimental ones , as shown in Fig.2. Figure 3 also shows the experimental and the theoretical patterns of the TPA-element. As shown in the figure ,the theoretical patterns obtained by the GTD-method agreed well with the experimental ones . These results show that the TPA is applicable as an element antenna for a new type of planar array.

4. BASIC ARRANGEMENT OF PLANAR ANTENNA

Figure 4 shows the basic arrangement of the subarray unit composed of four TPA-elements.The test samples of the subarray were made of a copper-clad 0.6mm-thick ($2h/\lambda_0=0.047$) Teflon glass fiber substrate with a dielectric constant of 2.55 and loss tangent of 0.0018. In the present subarray , a TPA-element having a shorted-stub is printed on the upper surface of a grounded substrate . The input impedance of each TPA-element is also matched to that of the main feeder M1 by means of $\lambda_g/4$ impedance transformers, Ta and Tb , where λ_g is a wavelength in the triplate-line. The completed SHF planar array can be made by integrating large numbers of these subarray-units. For instance , the 8*8 planar array used for the test antenna in this experiment is constructed by sixteen pieces of this subarray-unit.

5. RADIATION PERFORMANCES OF NEW PLANAR ANTENNA

In order to verify the performance of this type of new planar array , a 4*4 planar array composed of four subarray-units was constructed firstly and tested at the SHF-band . Figure 5 shows the E- and H-plane patterns of the test array. As shown in the figure , the experimental patterns agreed well with the theoretical ones which considered the effect of mutual coupling . Figure 6 shows the frequency dependency of the input impedance for the planar array. The return-losses of the test antenna were suppressed below -20 dB at the desired frequency region of SHF-band , as shown in the figure. Figure 7 shows a typical sample for the 64-element new planar array composed of sixteen pieces of the subarray-units. A typical pattern of the test planar array is shown in Fig.8 . As expected , the experimental pattern agreed fairly well with the theoretical one,as shown in the figure. These results indicate that the antenna described here is applicable as a new type of planar array.

6. CONCLUSIONS

In this paper,a new type of planar antenna composed of the TPA-element was presented and tested at the SHF-band . The experimental results obtained from these antennas confirmed high performance compared to usual microstrip planar antenna . The antenna presented here is, therefore , considered to be effectively applicable as a new type of planar antenna.

[REFERENCES]

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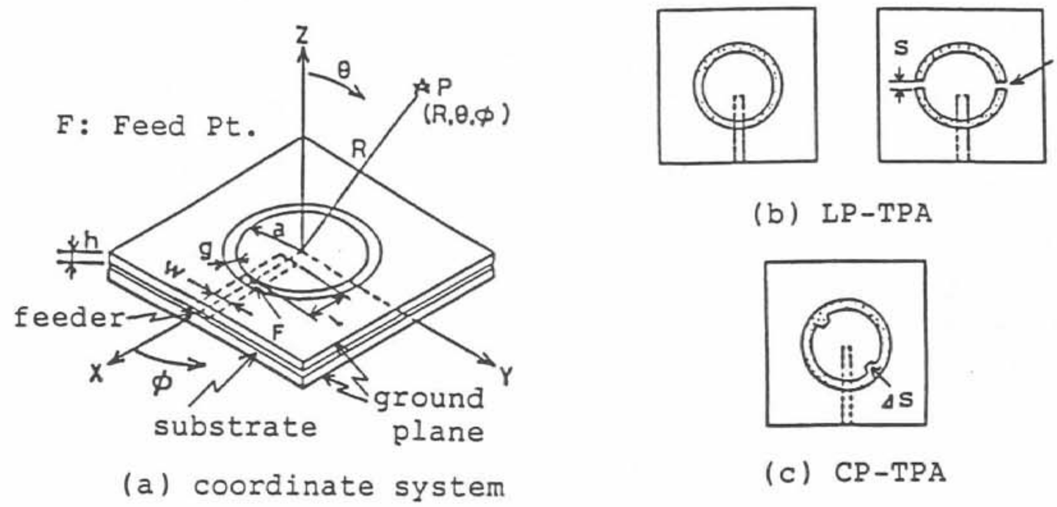

FIG.1 Basic configuration of test antennas.

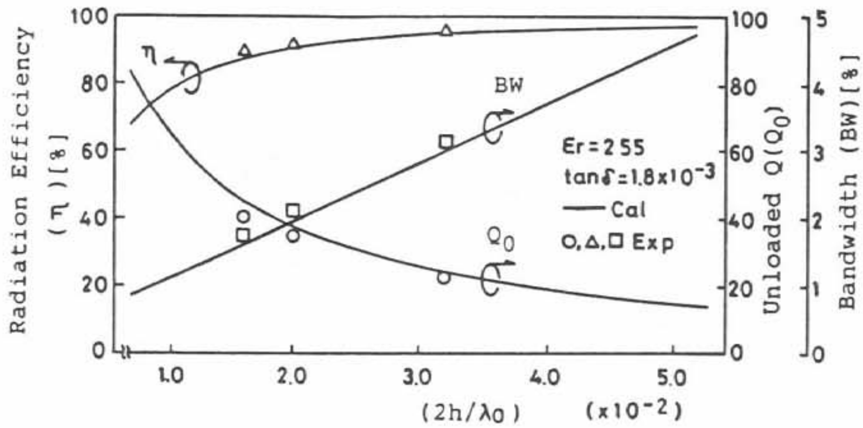

FIG.2 Unloaded $Q(Q_0)$,radiation efficiency(η) and bandwidth (VSWR<2) as a function of substrate thickness ($2h/\lambda0$).

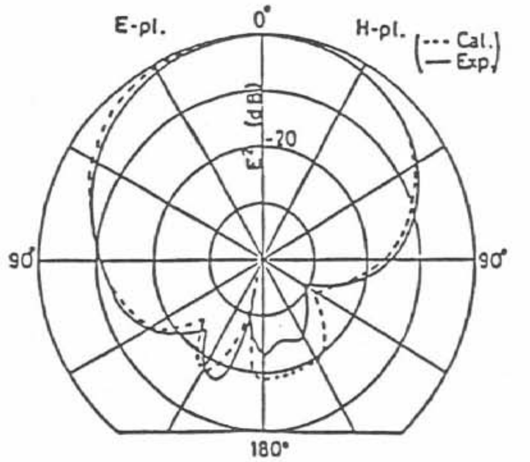

FIG.3 Typical element patterns for test antenna.

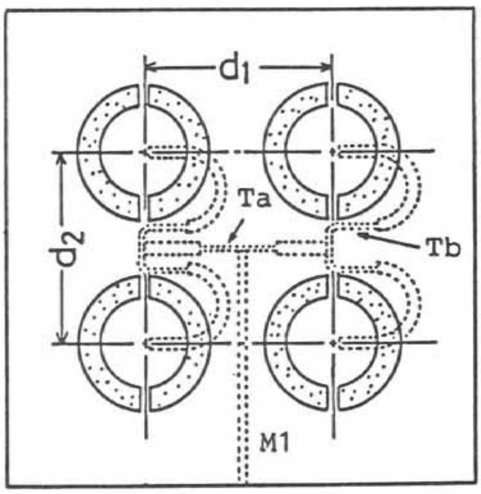

Fig.4 Basic arrangement of subarray-unit.

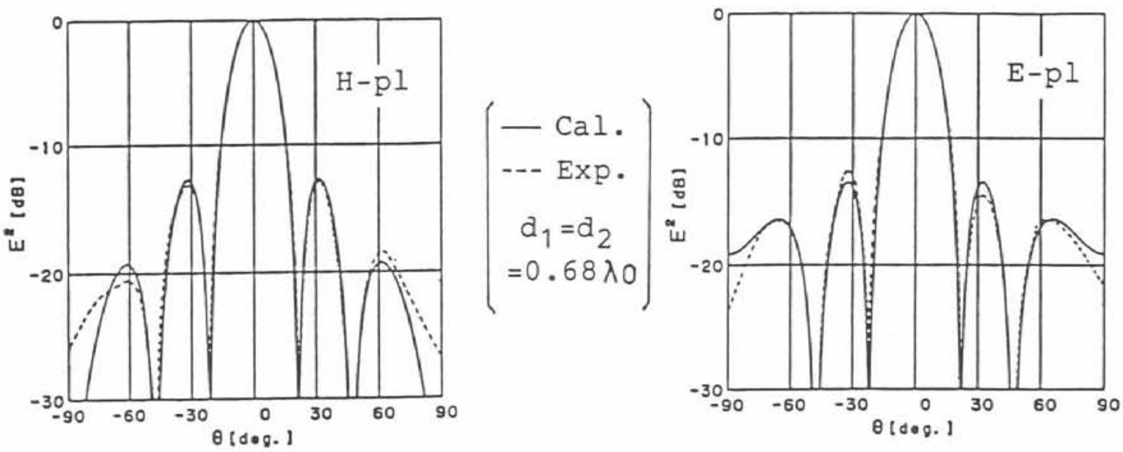

FIG.5 Radiation patterns of test subarray (4*4).

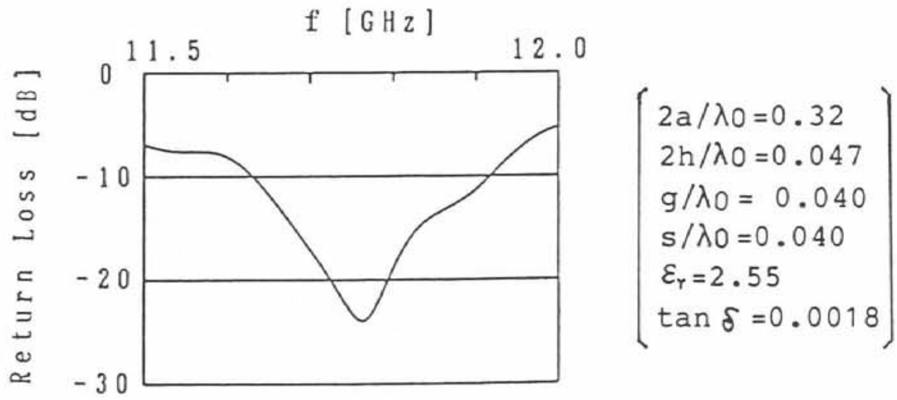

FIG.6 Frequency dependency of input impedance.

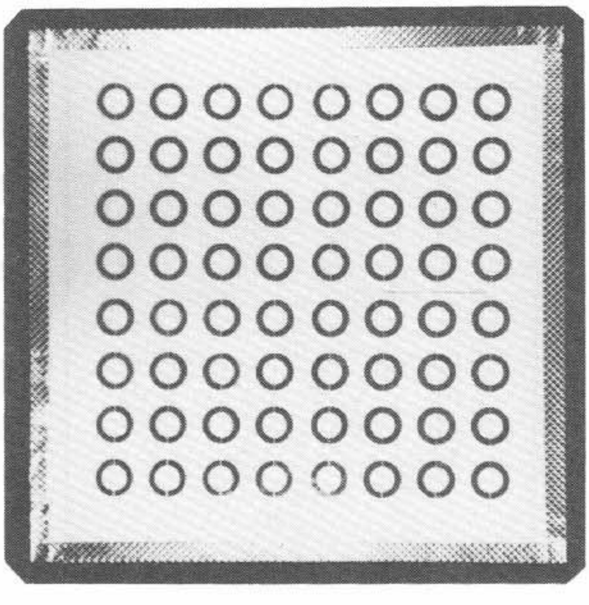

Fig.7 Typical sample for test antenna.

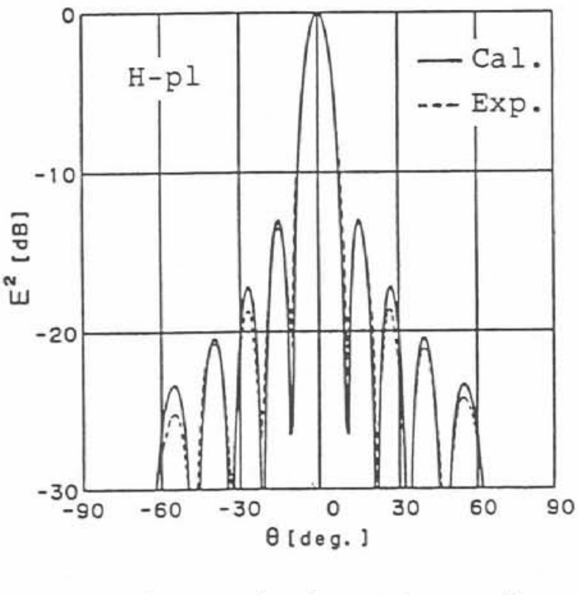

FIG.8 Typical pattern for test planar array.