A CIRCULARLY POLARIZED SHF PLANAR ARRAY COMPOSED OF MICROSTRIP PAIRS-ELEMENT

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1. INTRODUCTION

The circularly polarized microstrip antenna (CP-MSA) fed with a single feed point has been developed rapidly, and the microstrip pairs-element (MPE) composed of a pair CP-MSA has found many applications such as an array element due to broadband natures for the radiation properties [1],[2].

The completed SHF planar array constructed with the integration of this MPE has been used as receiving antenna for direct reception of the broadcasting satellite (BS-2a) TV-programmes. According to the direct reception for BS-2a TV-programmes, the receiving pictures obtained from this SHF planar array have high performance. The purpose of this paper is to describe the design method together with the radiation properties for new type of SHF planar array.

2. A BROADSIDE-TYPE CIRCULARLY POLARIZED SHF PLANAR ARRAY

The SHF planar array proposed here can be divided two categories; a broadside SHF planar array and a beamtilt-type planar array as shown in Fig.1.

The purpose of this section is to descrive general design approaches for the broadside-type SHF planar array.

Fig.2a illustrats the arrangement of MPE made up of two CP-MSA, and each CP-MSA element is fed uniformly in power by orthogonal feed points F1,F2 and the differential phase setting for those feed points can be controlled so as to F1= F2exp(-90°). The subarray unit made up of two MPE is shown in Fig.2b, and the input impedance for the subarray can be matched to 50Ω by using $\lambda_g/4$ impedance transformers such as Ta, Tb and Tc, where λ_g is wavelength in strip-line. The inter-element spacing (d) for the subarray unit is spaced d=0.68 λ_0 apart to prevent grating lobe, where λ_0 is wavelength in free space.

The 256-element planar array with uniform aperture distribution can be constructed with the integration of this subarray units, and the array is also made of copper-clad 0.6 mm Teflon fiberglass substrate with a dielectric constant of 2.55 and loss tangent of apploximately 0.0018.

The measured patterns for the array at 12 GHz band agree well with the theoretical values within the region of second sidelobe as shown in Fig.3.

The completed 1024-element SHF planar array composed of four 256-MSA array such as U1-U4 is shown in Fig.4, and the feeding network for the array can be fabricated by using 4-way power divider mounted on the rear panel of the array.

The radiation patterns got from this 1024-element planar array agreed well with the theoretical values within the limits of second sidelobe region.

The boresight axial ratio (AR) measured by spinning dipole is less than

2 dB over 6 % bandwidth as shown in Fig.5.

According to the direct reception for BS-2a TV-programmes, the receiving pictures got from this type of SHF planar array have high performance.

3. A BEAMTILT-TYPE CIRCULARLY POLARIZED SHF PLANAR ARRAY

The broadside-type planar array mentioned above is designed for broadside operation, while the beamtilt-type SHF planar array proposed here can be designed to have a single beam at any setting angle.

Accordingly this type of SHF planar array has several advantages compered with the broadside arrays, i.e. the beamtilted arrays can be mounted in parallel with the wall without any setting angle as shown in Fig.1.

The mainbeam position for the array depends on the inter-element phase setting (Φ_m) and the inter-element spacing (d). The relation between the tilt-angle of the mainbeam (Θ_m) and the inter-element phase setting (Φ_m) is shown in Fig.6, and the tilt-angle variation as a function of element-spacing (d) is also shown in the figure.

On the basis of this figure, the setting parameters for the array, that is inter-element phase setting (Φ_n) and element-spacing (d), can be decided so as to $\Phi_n = 110^\circ$ for $d= 0.6\lambda_o$ in order to steer the mainbeam to desired direction ($\Theta_m = -30^\circ$).

The completed 1024-element SHF planar array with a uniform aperture distribution is constructed with four subarray having 256-element CP-MSA.

The calculated pattern for the array at 12 GHz is shown in Fig.7, and the mainbeam position for the array is steered to desired direction as can be expected. The mainbeam position obtained from experiment agreed well with the theoretical values. According to the direct reception for BS-2a TV-programmes , the receiving pictures got from this type of planar array have high performance as well as broadside array.

4. CONCLUSIONS

In this paper, a new type of SHF planar array consisting of a microstrip pair-element has been introduced and described. Both broadside and beamtilt-type SHF array were built and tested, and its patterns performance agreed well with the design specification.

According to direct reception for the BS-2a TV-programmes, the receiving pictures obtained from these planar array have high performance.

Therefore, it has been shown that this new type of planar array is applicable to the receiving antenna for direct reception of the broadcasting satellite such as BS-2a.

ACKNOWLEDGEMENT : I would like to express my thanks to Mr. S. Saito for his help in the experiment and the fabrication of this array.

REFFERENCE

[1] K.R.Carver and J.W.Mink ; " Microstrip antenna technology ", IEEE Trans. Antennas & Propagat., AP-29, pp.2-24 (Jan.-1981).

[2] M.Haneishi et.al.,; " A broadband microstrip array composed of CP-MSA ", IEEE APS International Symposium Digest, pp.160-163 (May-1982).

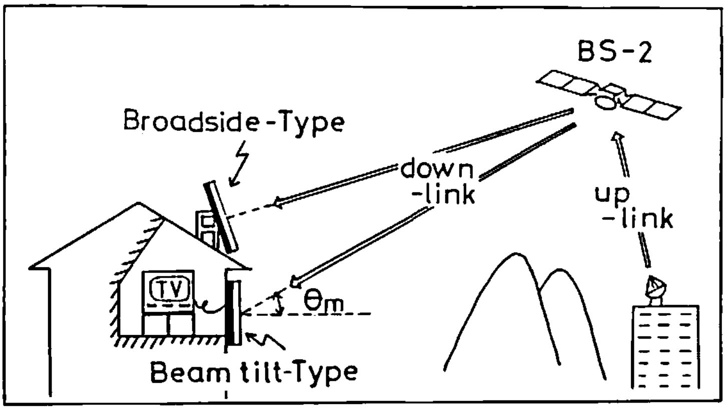
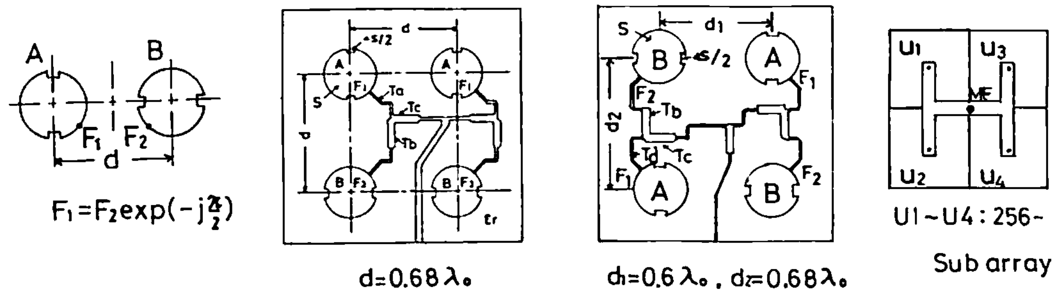


Fig.1 Receiving system for direct reception of BS-2 .



(a) pairs-element (MPE) (b) broadside-type (c) beamtilt-type (d) feed-system

Fig.2 Microstrip pairs-element and its subarray .

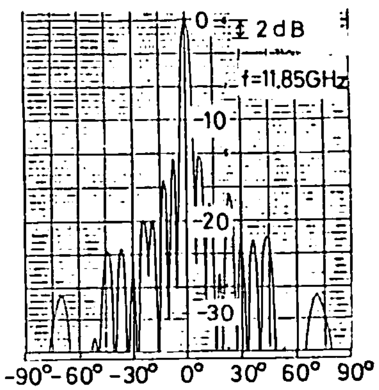


Fig.3 Radiation pattern for broadside planar array .

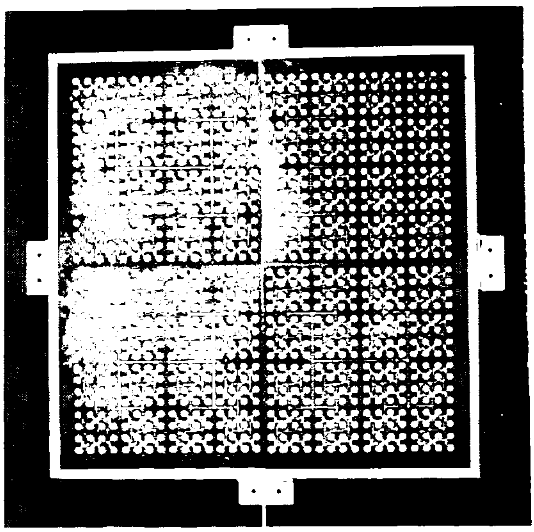


Fig.4 Typical sample for broadside array.

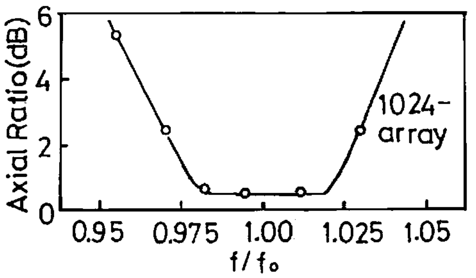


Fig.5 Boresight axial-ratio for the broadside-type 32×32 element planar array .

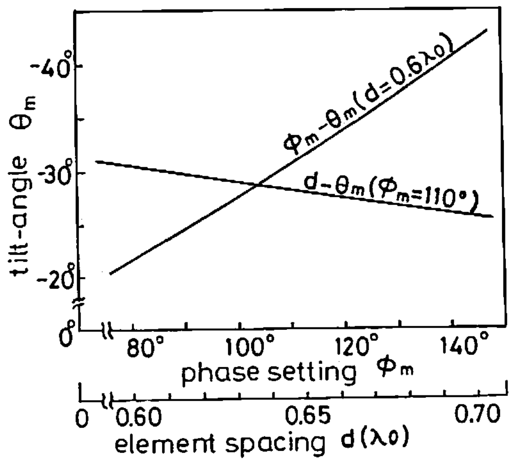


Fig.6 Tilt-angle variation as function of setting phase and element spacing .

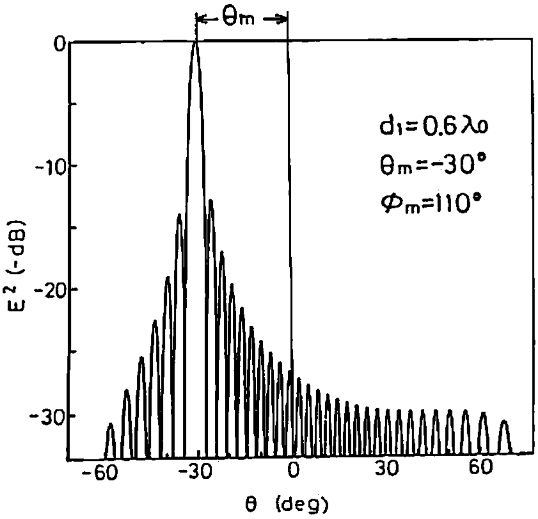


Fig.7 Typical pattern for beamtilt-type SHF planar array .

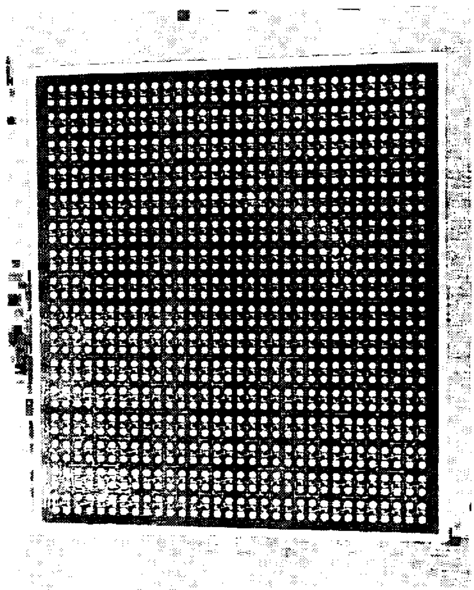


Fig.8 Typical sample for beamtilt-type planar array having 32×32 element .