AN ARRAY PROBE METHOD FOR ACTIVE ELELEMT PATTERN MEASUREMENT IN A NEAR FIELD REGION OF A PHASED ARRAY ANTENNA

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1.Introduction

This paper describes a measurement method for obtainning the amplitude and phase of active element pattern in a near field region. In this method, the fields of active elements are obtained by processing the relative element fields measured by the Rotating Element Electric Field Vector Method[1](briefly REV method) and the composite field picked by an array probe. By employing an array probe, an active composite field is obtained without any measurement phase.

2.Principle of Measurement

There are two measurement procedures in this method.

A measurement procedure of the relative element field by the REV method is as follows;

(1) Set an probe antenna in the direction of θ in a near field region of the phased array antenna as shown in Fig.1.

(2) Measure the amplitude of composite electric field of the array when the phase of only the n-th element is varied from 0 to 2 . Then, the relative amplitude and phase of the element are obtained by the REV method[1] as follows.

$$k_n = \frac{|e_n|}{|E_{on}|} \qquad (1)$$

$$X_n = \angle e_n - \angle E_{on} \qquad n=1,\cdots,N$$

where e_n is an acitve element field and Eon is an initial composite electric field.

We propose the method for obtainning the phase of Eon by measuring only the amplitude. In this method, the probe antenna is composed of two antennas #a and #b, and a phase shifter is connected with antenna #a as shown in Fig.2. Its mearurement procedure is as follows;

(a) Place the probe antenna #a in position m, and the probe antenna #b in position m+1, and vary the phase of antenna #a and obtain the ratio Ym by using the REV method,

$$Ym = \frac{E_{b,m+1}}{E_{a,m}} \qquad (2)$$

where Ea,m and Eb,m+1 is the received field of the probe antenna #a and #b, respectively.

(b) Move the probe antenna #a to position m+1 and the antenna #b to position m+2, and obtain the ratio Ym by using the REV method as in (a).

$$Y_{m+1} = \frac{E_{b,m+2}}{E_{a,m+1}} \qquad (3)$$

If the radiation pattern of probe antenna #a is equal to that of the probe antenna #b, the relation between Ea,m and Eb,m is given by,

$$E_{a,m} = \alpha E_{b,m} \quad (\alpha \text{ is constant}) \tag{4}$$

From the eqs. (2),(3), and (4), we obtain

$$\frac{E_{b,m}}{E_{a,1}} = \alpha^{(m-2)} \prod_{i=1}^{m-1} Y_i \tag{5}$$

Therefore, the amplitude and the phase of the received field of antenna #b can be obtained by measuring only the amplitude , with Ea as reference. In this method, the scanning step of the probe antenna is the distance between antenna #a and antenna #b, so that the reference electric field in a desired position can be obtained by interpolation with the spline function, etc.

According to the method described here, the active element pattern can be obtained in near field region, with exciting all elements and without phase measurement.

3.Experimental Results

Active element fields in the boresight direction in the planar array antenna have been measured. The planar array antenna consists of 29 microstrip elements operating at X-band(Fig.3) and 5-bit phase shifters.

Firstly, only one element was excited with the other element connected by a dummy load as shown in Fig.4. Then, the element amplitude and phase was directly measured setting the probe antenna at the boresight of the excited element. This value is called here a directly measured value. Fig.5 shows the difference between the value measured by the described method and the directly measured value. The difference between both values for the amplitude and phase are 0.3dB (rms) and 4.3deg (rms), respectively.

Next, phase shifters were set so that the phase of each active element field bocame the same in the boresight, from the measurement value by the REV method described in this paper. Then, the phase distribution of the array aperture was measured by the near field antenna measurement. Fig.6 shows the phase distribution on the array aperture. From this result, it is seen that the uniform phase distribution is obtainned on the array aperture.

4.Conclusion

An active element pattern of a phased array antenna can be measured with high accuracy in a near field region by using the combination of the REV method and the array probe method.

Reference

[1] S.Mano and T.Katagi, 1982, IECE Trans(B).

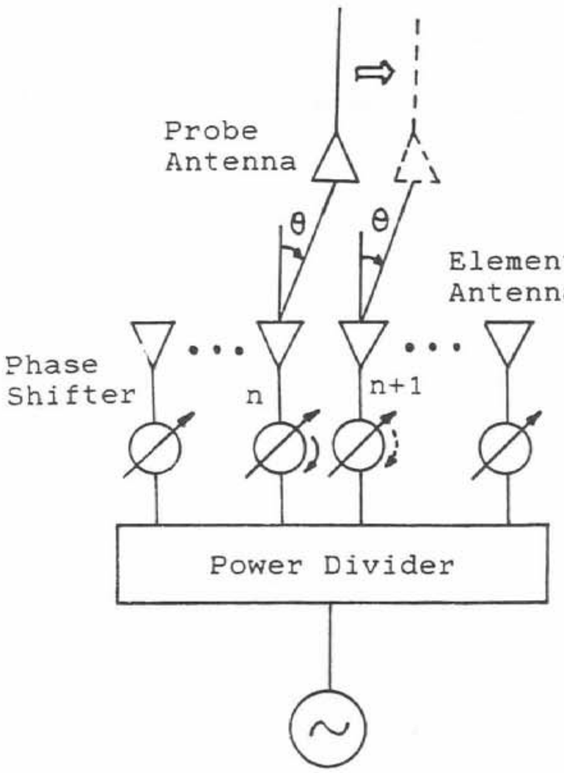

Fig.1 Measurement method for active element field in the direction by the REVmethod

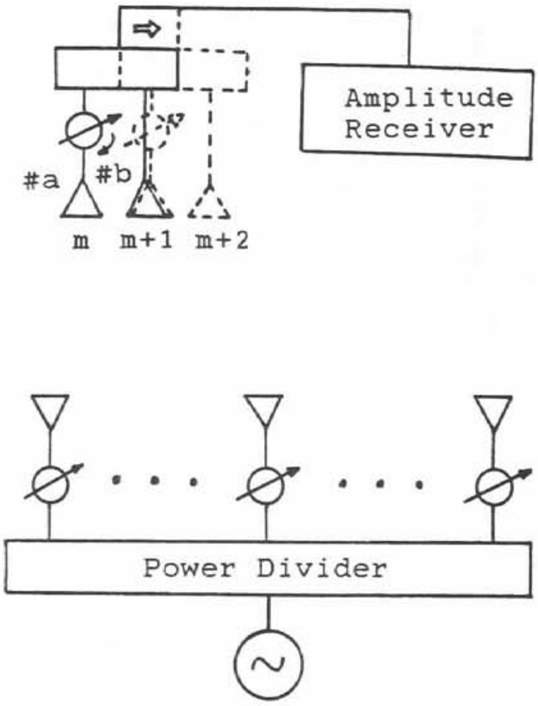

Fig.2 Diagram of the array probe method

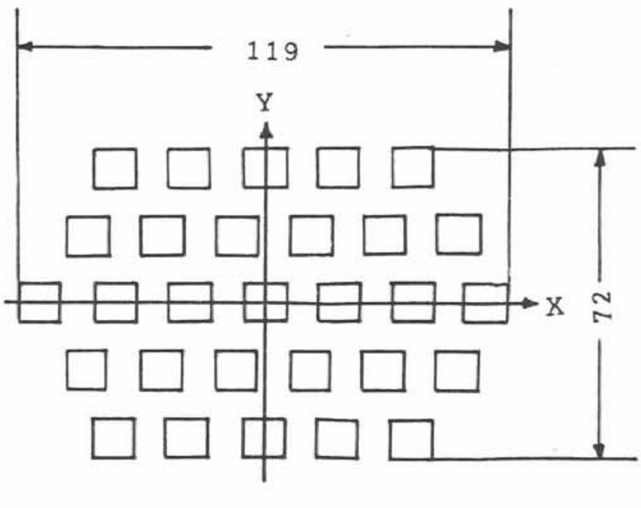

Fig.3 Geometry of phased array of rectangular microstrip elements

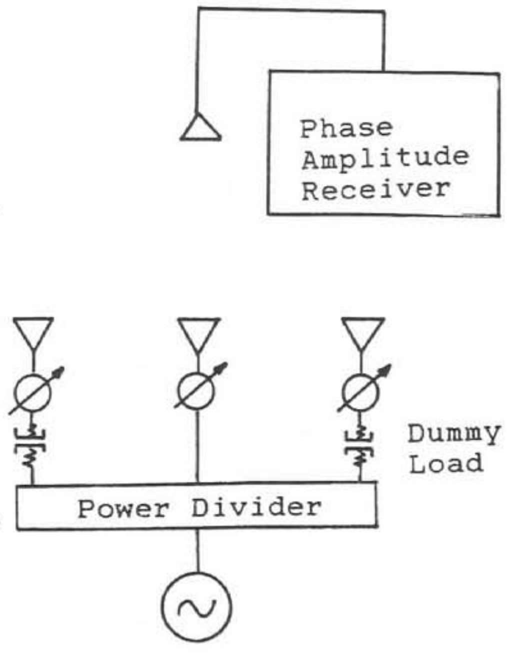

Fig.4 Diagram of method for mearurement of active element pattern directly

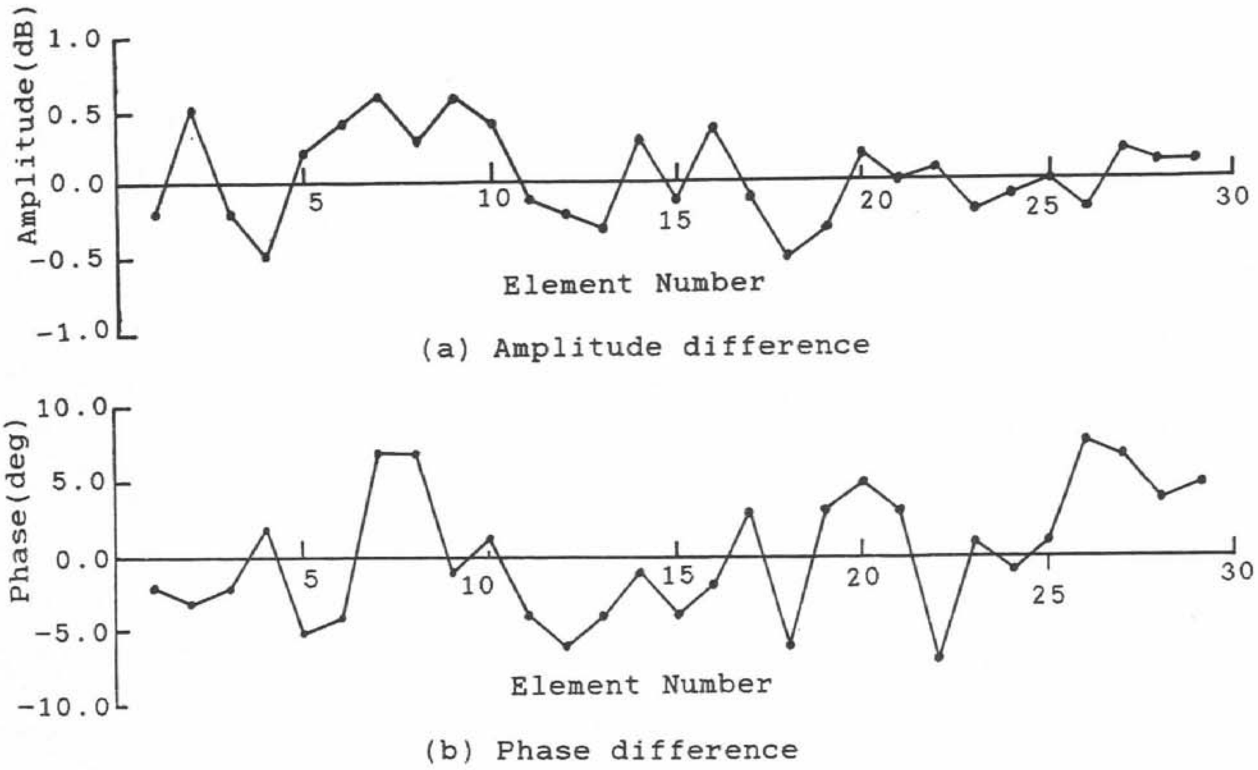

Fig.5 Difference between the value measured by this paper's method and the directly measured value

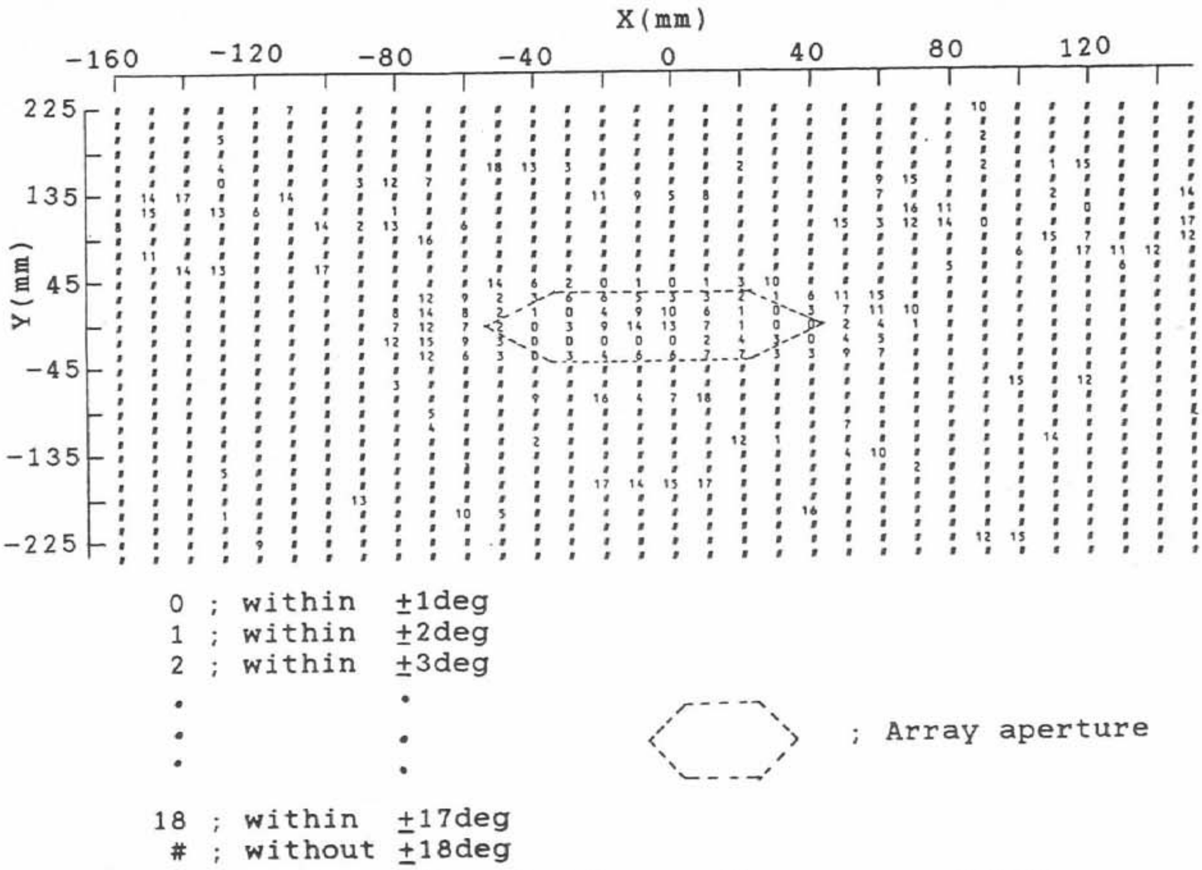

Fig.6 Phase distribution on the array aperture