A DISK COUPLED RESONANT ANTENNA EXCITED BY A CIRCULAR PATCH

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1. Introduction.

The coupled resonant directive antennas excited by a crossed dipole have been used as ground station antennas for space communication in the VHF and UHF bands(1). Its simple and axially symmetric structure makes the antenna suitable for elements of an array.

To extend the operating frequencies of the antenna over the UHF band, a patch exciter (i.e., microstrip antenna structure) is introduced. By adapting this structure, it is easy to produce the antenna even in the X band. Numerically calculated, and experimental results for this antenna are described in this paper.

2. A Disk Coupled Resonant Antenna Excited by a Circular Patch.

Fig.1 shows a picture of the disk coupled resonant antenna excited by a circular patch. The antenna consists of a circular patch, a reflector of about 2λ (λ :wavelength) diameter or 2λ square,and disks of about $\lambda/2$ diameter. The $\lambda/2$ spacing between the reflector and the first disk and the $\lambda/2$ spacing between disks constitute leaky resonant cavities which are mutually coupled. The antenna shows a relatively high gain per element and good suppression of sidelobes.

The antenna having the parameters indicated in Fig.2 which shows the radiation patterns for circular polarization has a gain of 15.1 dBi, and those patterns are the same as the patterns of the antenna excited by a dipole.

The antenna radiates circular polarization by inserting a short post between the ground plate and the circular patch as shown in Fig.2(2). The antenna has an axial ratio of 0.7 dB and a VSWR of 1.4 at the center frequency.

3. Theoretical and Experimental Results.

Characteristics of the antenna are analyzed by the moment method(3). The disks, the ground plate and the patch are replaced by the wire-grid model(4) as shown in Fig.3, and the triangular expansion function is used here. The circumferential grids of the ground plate are futher divided until they are the same length as the other segments. The antenna, consisting of a wire-grid model, has 322 segments.

Fig.4 and 5 show the calculated, and measured patterns of the wire-grid model antenna, respectively. A fair agreement is obtained for the main beam and the sidelobes. Ignoring the back-lobe, the difference between the metal and the wire-grid model is a little, so the method is available for analysis of this antenna.

The calculated curves, and measured results of the gain, the half power beam width and the sidelobe level of the antenna are shown in Fig.6. Although the measured values of the E-plane half-power beam width are narrower than the calculated values, a fair agreement is obtained. The maximum gain is obtained when the diameter of the first and second disks are 0.40λ and 0.35λ, respectively.

Fig.7 shows the axial ratio of the antenna when the circular polarization is excited by inserting the short post shown in the figure. Fair agreement was obtained around the center of the varied angle. From those results, it is posible to design a circularly polarized disk coupled resonant antenna excited by a circular patch.

4. Conclusions.

The proposed disk coupled resonant antenna excited by a circular patch has a gain of 15.1 dBi and an axial ratio of 0.7 dB for circular polarization.

The characteristics of the antenna were analyzed by the moment method using a wire-grid model. The results were confirmed by experimental measurements.

By using this antenna as the array element, it is possible to reduce the number of elements per aperture area, and to simplify the feeding network.

We are going to realize the arrays consisting of the disk coupled resonant antenna excited by a circular patch at 1.7 GHz and 12 GHz.

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5. References.

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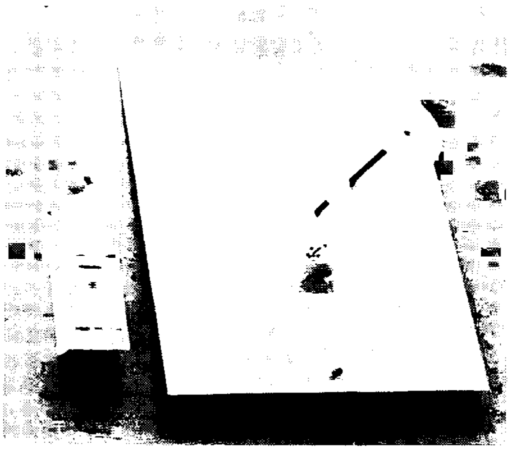
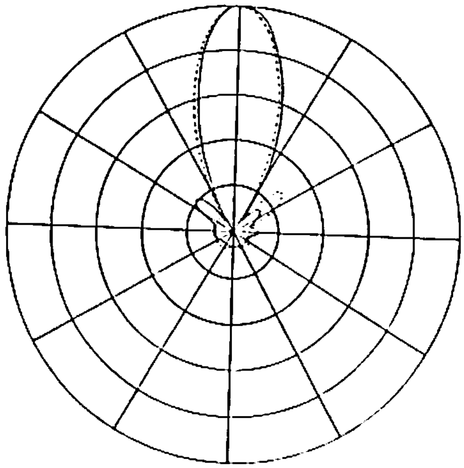


Fig.1 A disk coupled resonant antenna excited by a circular patch



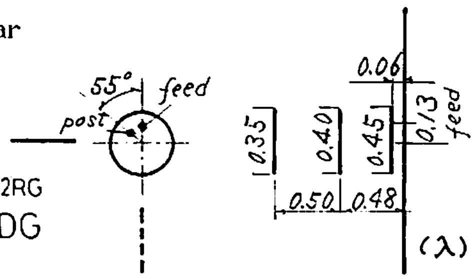


Fig.2 Radiation patterns for circular polarization

Gain =15.1 dBi,
Axial Ratio=0.7 dB.
Frequency =1.68 GHz

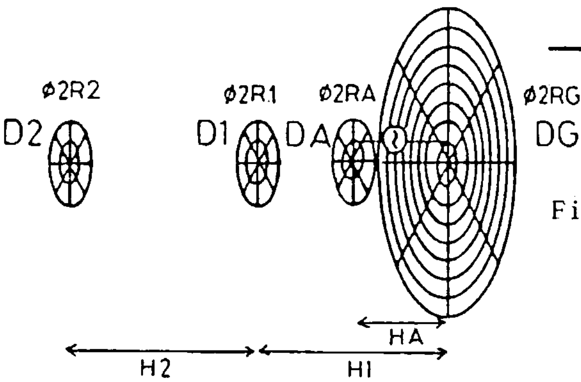
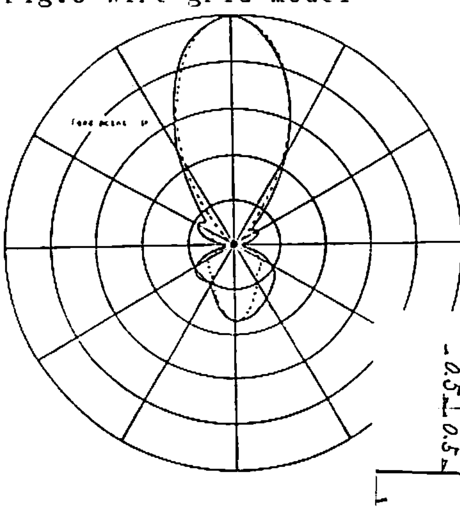


Fig.3 Wire-grid model



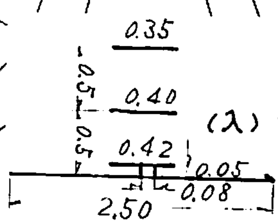


Fig.4 Calculated E- and H-plane patterns of wire-grid model

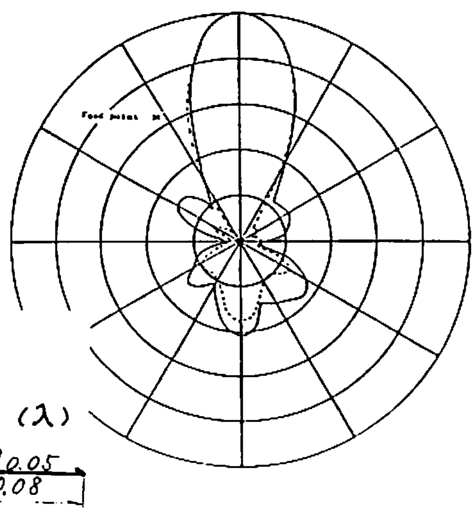


Fig.5 Measured E- and H-plane patterns of wire-grid model

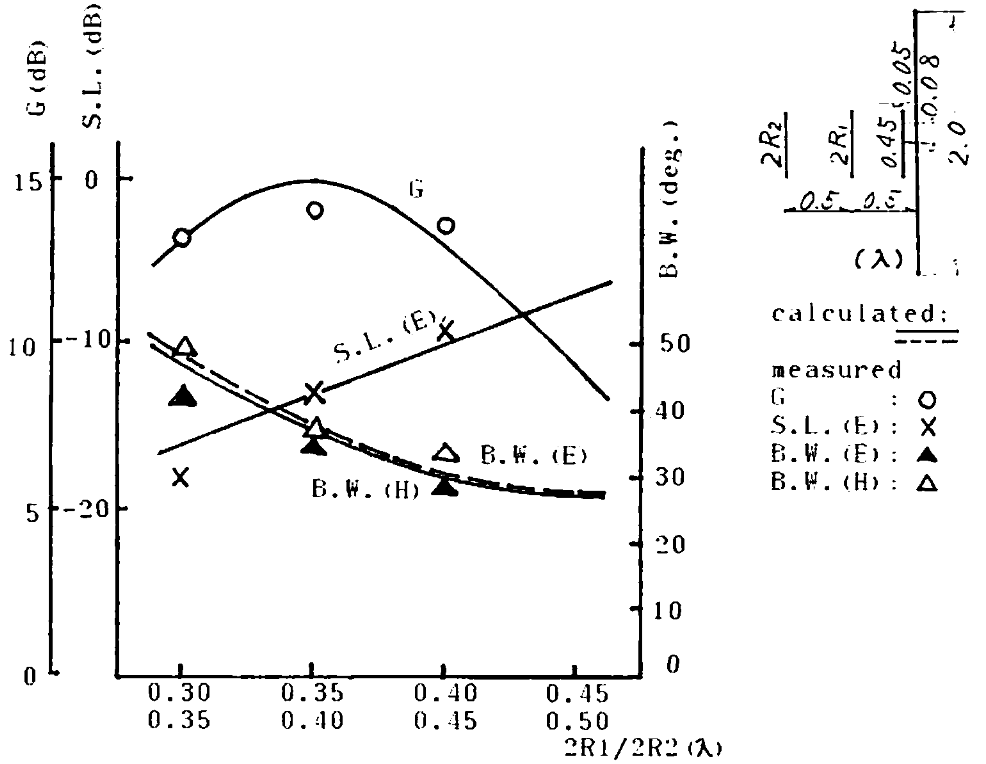


Fig.6 Characteristics (Gain, Sidelobe Level and half power Beam Width) of the antenna

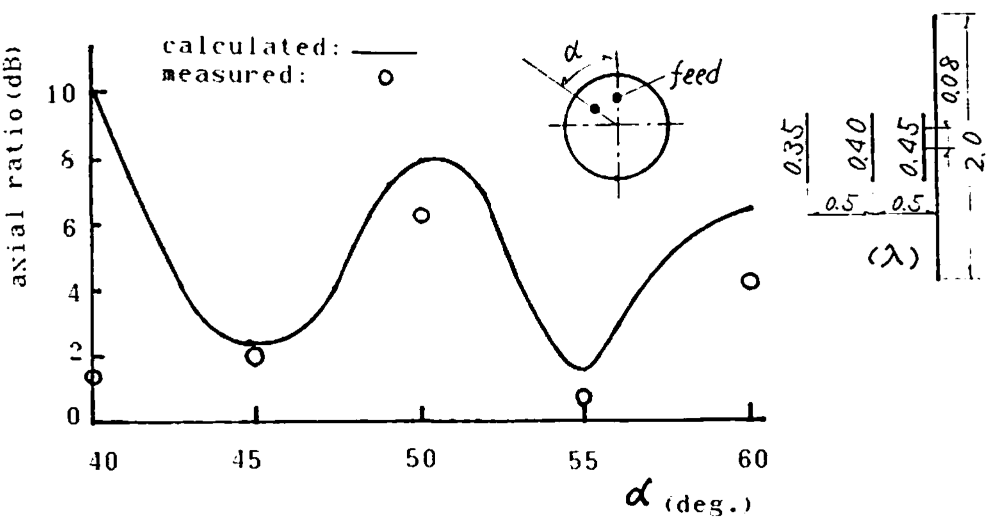


Fig.7 Axial ratio vs. angle of the short post