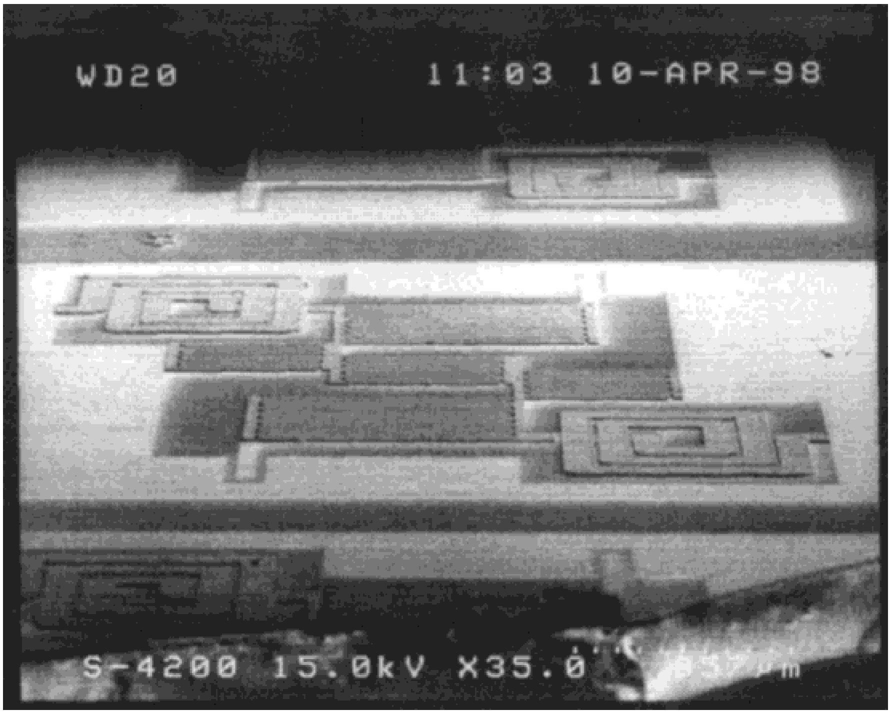


**Figure 6** SEM photograph of a 2.4 GHz bandpass filter (2 mm × 2 mm)

## V. CONCLUSIONS

High *Q*-value inductors were fabricated on high-resistivity $Al_2O_3$ substrates for MIC application. The measured results of these passive components were predicted well according to EM simulation, and equivalent circuit models were also extracted. A 2.4 GHz MIC bandpass filter was realized by these components to verify the inductor performance and the model accuracy.

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# A NEW CORNER REFLECTOR ANTENNA WITH PERIODIC STRIP SUBREFLECTORS

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**ABSTRACT:** *This paper presents the design of a new type of corner reflector (CR) antenna and the experimental investigation of its radiation characteristics. The design involves the addition of planar parallel periodic strips to the two sides of a CR antenna. The position, angular orientation, and number of strips have a notable effect on the H-plane radiation characteristics of the antenna. Certain configurations of the new antenna are capable of producing very sharp axial beams with gain on the order of 5 dB over the square corner reflector antenna. A configuration that can provide symmetric twin beams with enhanced gain and reduced half-power beam width (HPBW) is also presented.* © 1999 John Wiley & Sons, Inc. Microwave Opt Technol Lett 20: 326–328, 1999.

**Key words:** *antennas; reflector antennas; gain*

## INTRODUCTION

In the class of reflector antennas, CR antenna is a favorite choice where a moderate gain is required, due to the simplicity of its design. Since its introduction by Kraus [1], several researchers have performed much work on modifying the radiation characteristics of CR antennas, both experimentally and theoretically [2–6]. A recent paper by Mathew et al. [7]

reported the modification of CR antenna characteristics by adding two supplementary reflectors.

This letter presents the design of a CR antenna with periodic parallel planar metallic strips attached to the two reflecting sides and the resulting improvement in the radiation characteristics. It is seen that the gain of the antenna increases and the HPBW decreases. The performance of the antenna for different dimensions of the strip structures is analyzed. There are configurations that can provide axial gains on the order of 5 dB over the square corner reflector antenna. Also, cases providing sharp symmetrical twin beams with gain enhancement are noted. In this type of antenna, the primary corner angles above 90° are very effective, whereas acute angles require large antenna dimensions.

## ANTENNA DESIGN AND EXPERIMENTAL SETUP

The schematic diagram of the new CR antenna is given in Figure 1. It is constructed by attaching two metallic strip structures $S_1$ and $S_2$ to the two sides of a CR at a distance $l$ from the apex. The structure consists of $n$ metallic strips of width $w$ and length $h$ kept at a periodicity of $d$. $\alpha$ and $\beta$ are the primary and secondary corner angles, respectively. The distance $l$, angle $\beta$, and the number of strips $n$ can be varied. An HP 8350B sweep oscillator, together with an HP 8410B network analyzer, were used for studying the radiation characteristics. The antenna under test (AUT) was used as the receiver, and a standard pyramidal horn was used as the transmitter. The VSWR was measured using an HP 8510B network analyzer. The experiment was conducted in the $X$-band (at 8.5 GHz).

## EXPERIMENTAL DETAILS AND RESULTS

After arranging a particular configuration, the radiation patterns were plotted for different values of $\beta$. The value of $\beta$ for which the axial power is maximum is taken as $\beta_{opt}$. This is repeated for different values of $n$, and the effect is studied. The experiment is repeated for various fixed values of $l$, and corresponding patterns are plotted. $h$ is optimized as $1.5\lambda$ through experimental iterations. $w$ was varied, and it was seen that a width of $0.3\lambda$ is sufficient to provide the maximum gain observed. The effect of variation in $d$ was studied, and it was optimized as $1\lambda$.

Now, $\alpha$ is changed to other fixed values, and the whole experiment is repeated. It is seen that $\beta_{opt}$ also depends on $\alpha$, and increases with it. This is shown in Figure 2.

The results obtained from the experimental study are tabulated in Table 1. The gain of the antenna is seen to be increasing with the number of strips. In all cases, it is seen that when the axial gain increases, the HPBW decreases. A typical normalized radiation pattern of a configuration ($\alpha = 120°$, $\beta = 45°$, $n = 5$, and $l = 1\lambda$) is given in Figure 3 in comparison with that of a square corner reflector of equivalent dimensions. Contrary to ordinary CR antennas, this type of antenna with obtuse primary angles produces sharp fan

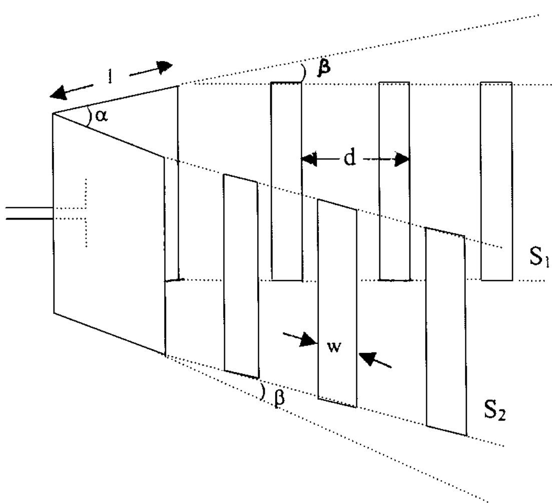


**Figure 1** Schematic diagram of the new CR antenna

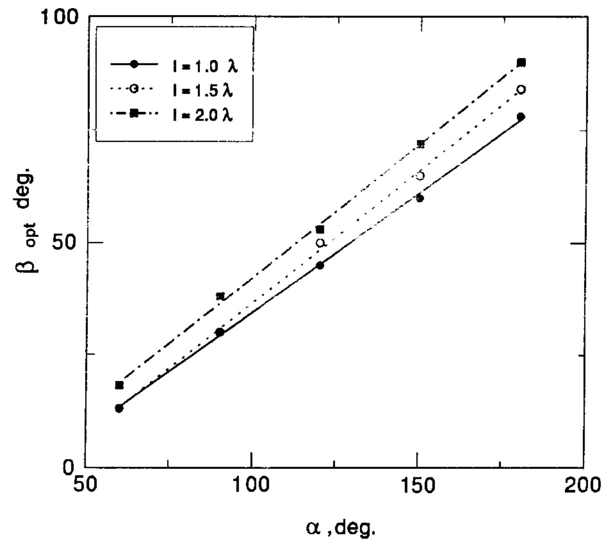


**Figure 2** $\beta_{opt}$ versus $\alpha$ for different values of $l$ when $n = 5$

**TABLE 1 Radiation Characteristics of Selected Configurations of the New Antenna**

| $\alpha$ | Antenna Parameters | $l = 1\lambda$ | | | | $l = 2\lambda$ | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $n = 2$ | $n = 3$ | $n = 4$ | $n = 5$ | $n = 2$ | $n = 3$ | $n = 4$ | $n = 5$ |
| 90° | $\beta_{opt}$ | 30° | 30° | 30° | 30° | 38° | 38° | 38° | 38° |
| | Relative gain | 1.6 | 2.2 | 3.4 | 4.0 | 2.4 | 3.6 | 4.2 | 4.6 |
| | HPBW | 18° | 16° | 11° | 11° | 13° | 12° | 10° | 10° |
| | VSWR | 1.52 | 1.58 | 1.49 | 1.29 | 1.92 | 1.83 | 1.85 | 1.85 |
| 120° | $\beta_{opt}$ | 45° | 45° | 45° | 45° | 60° | 60° | 55° | 53° |
| | Relative gain | 3.6 | 4.8 | 5.4 | 5.6 | 2.2 | 3.8 | 4.4 | 4.8 |
| | HPBW | 16° | 14° | 13° | 11° | 22° | 10° | 9° | 9° |
| | VSWR | 1.99 | 1.81 | 1.79 | 1.54 | 2.08 | 2.07 | 2.03 | 1.99 |

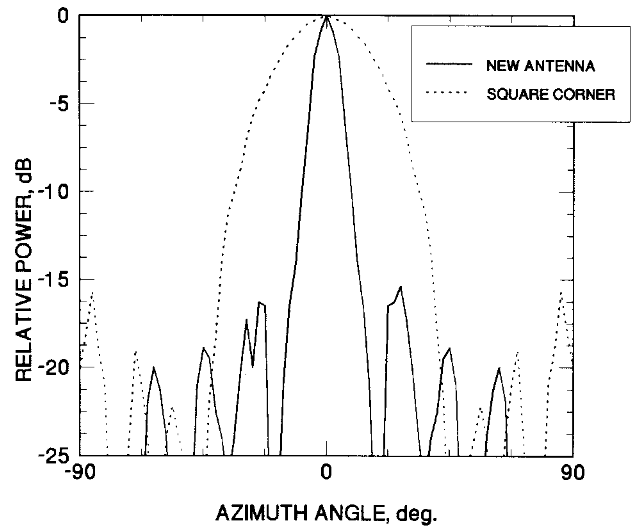


**Figure 3** Normalized $H$-plane radiation pattern of a typical configuration ($\alpha = 120°$, $\beta = 45°$, $n = 5$, and $l = \lambda$) at 8.5 GHz along with that of a square corner reflector

beams with large axial gains. When $\alpha$, $l$, and $\beta$ are fixed at certain particular values, the main beam splits into two with a very deep null along the axis. A typical radiation pattern is shown in Figure 4.

No appreciable deterioration in the VSWR could be observed due to the strip attachment of the corner reflector antenna when $l$ is small. But for large $l$, the VSWR goes high. The VSWR chart for a typical configuration ($\alpha = 90°$, $\beta = 30°$, $n = 5$, and $l = 1\lambda$) is given in Figure 5. It is seen that the cross-polar level is below $-18$ dB. The sidelobe level is seen to be below $-13$ dB in most cases.

## CONCLUSION

The design and experimental analysis of a new type of corner reflector antenna has been carried out. The configurations of the antenna offering enhanced performance were studied, and the characteristics were compared with those of a square corner reflector antenna. An axial gain enhancement on the order of 5 dB, and hence a reduction in the HPBW, are observed. It is also possible to get two very sharp beams symmetrically on either side of the axis with a sharp null at the center.

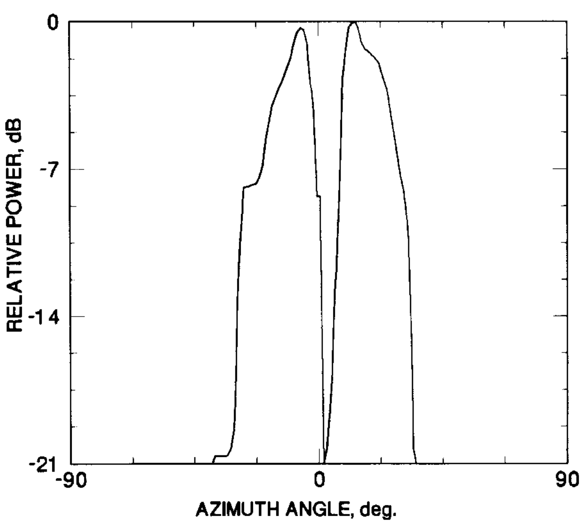


**Figure 4** Radiation pattern of a configuration providing symmetric twin beams ($\alpha = 180°$, $\beta = 60°$, $n = 3$, and $l = \lambda$) at 8.5 GHz

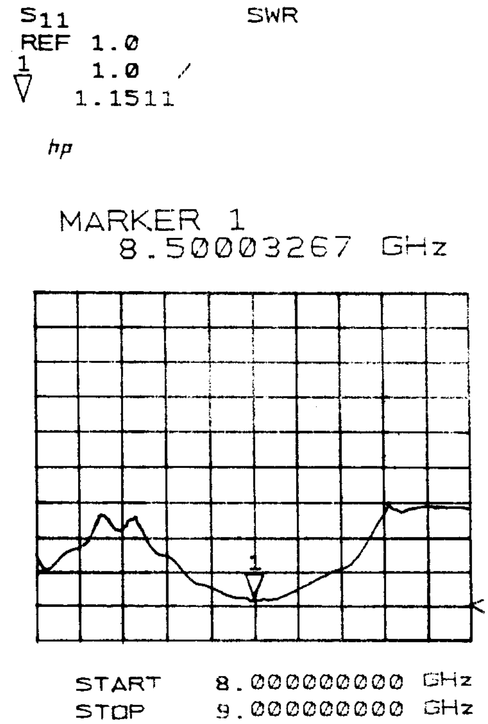


**Figure 5** Variation of VSWR with frequency for the configuration with $\alpha = 90°$, $\beta = 30°$, $n = 5$, and $l = \lambda$


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