A Dual Circular Polarization Radiating-Line Antenna

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INTRODUCTION

The concept of achieving wideband performance from a low-profile traveling-wave structure has previously been introduced [1], [2]. The dual circularly polarized (CP) radiating-line antenna is one such antenna: a two-port antenna from which both senses of circular polarization are available, one sense from each of the two ports. It has the low-profile, simplicity and conformability attributes of the microstrip patch antennas. However, the near fields have traveling wave rather than resonant mode characteristics and this yields a much wider impedance bandwidth than that of the resonant patch antennas. The impedance bandwidth is theoretically unlimited and an 8:1 input impedance bandwidth is easily achieved in practice. The CP bandwidth is much less than the impedance bandwidth, but still greater than that reported for CP resonant-patch antennas. CP bandwidth of 31% has been observed on one model. Power gain and beam squint are more likely to provide the ultimate limitations on the bandwidth of acceptable performance for an individual antenna.

ANTENNA STRUCTURE

The antenna geometry is shown in Figure 1. The outer radius of b = 3.5 cm is chosen based upon the desired frequency band (1.9-2.6 GHz). The inner radius (a) determines the fraction of the input power that is radiated. The height (h) above the ground plane is specified to produce a desired level of input impedance. The antenna arm is supported above the ground plane by a dielectric spacer of low permittivity. The antenna is probe fed in a manner to excite a decaying traveling wave with approximately one degree of phase progression along the outside of the arm per degree of rotation in azimuth. The fin at each port provides a smooth impedance transformation from the coaxial probe to the flat strip of the 270-degree sector of curved antenna arm. Both ports should be matched to eliminate reflections which would produce the opposite sense of polarization. RHCP is obtained by feeding the right port (as viewed from above the antenna) and terminating the left port in a matched load. LHCP is obtained by reversing the source and load.

ANTENNA PERFORMANCE

A Smith chart plot of the input impedance is shown in Figure 2. It is apparent that the input impedance is not the limiting factor in the performance bandwidth. Figure 3 shows radiation patterns taken from 2.0 to 2.6 GHz in the symmetry plane of the antenna using a rotating dipole. The pattern is primarily a broad, hemispherical lobe with an axial ratio on the beam maximum less than 1.0 dB from 2.0 to 2.4 GHz and less than 1.5 dB at 2.6 GHz. At the -3 dB points on the lobe the axial ratio is still less than 3.0 dB over 2.0 to 2.6 GHz. One possible limiting factor in the antenna performance is the beam squint which increases with increasing frequency. At 2.6 GHz the beam maximum deviates at most 15 degrees from the vertical axis.

An experimental study has been conducted to characterize the antenna performance in terms of the geometric parameters. Once the outer radius (b) has been selected for a given frequency band, the two variables which determine the performance are: a, the inner arm radius, and h, the height above the ground plane. In the experimental study the values of h were selected to produce 50-ohm input impedance. The aspect of the performance which is most greatly dependent upon the inner radius is the fraction of the input power that is radiated. This was found to vary from 35% for a narrow antenna arm to 72% for a very wide arm. While the resulting rather low values of power gain may not be adequate for some applications of the antenna as an individual radiator, the simple manner in which precise control of the power radiated can be achieved makes the radiating-line antenna an attractive element for use in series-fed arrays.

CONCLUSIONS

It has been demonstrated that both senses of circular polarization can be simultaneously achieved from one simple low-profile antenna. The input impedance of this dual CP radiating line antenna is near constant over very wide bands. Operating bandwidths are determined by pattern and power gain considerations rather than impedance. The fraction of the input power that is radiated by one of these antennas can be precisely controlled while maintaining a fixed level of input impedance by varying the width and height of the strip conductor.

REFERENCES

1. J. Drewniak, P. Mayes, D. Tanner, and R. Waller, "A log-spiral, radiating-line antenna," 1986 AP-S International Symposium Digest, pp. 773-776.

2. C. Wood, "Curved microstrip lines as compact wideband circularly polarized antennas," IEE J. Microwaves, Optics, & Acoustics, Vol. 3, No. 1, pp 5-13, Jan. 1979.

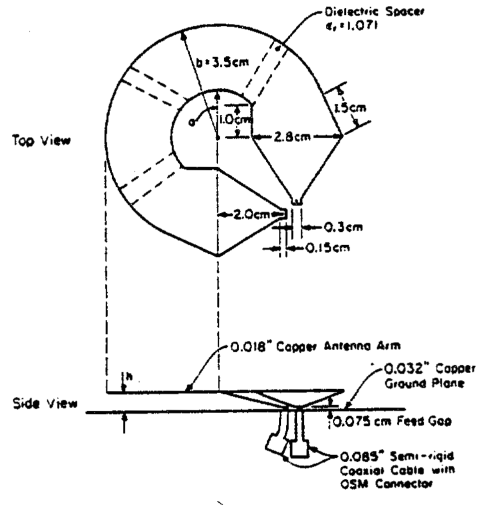
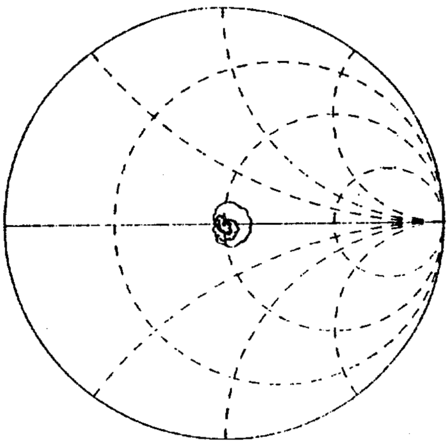


Figure 1. The dual CP radiating-line antenna.



0.5 - 4.0 GHz

Figure 2. Measured input impedance.

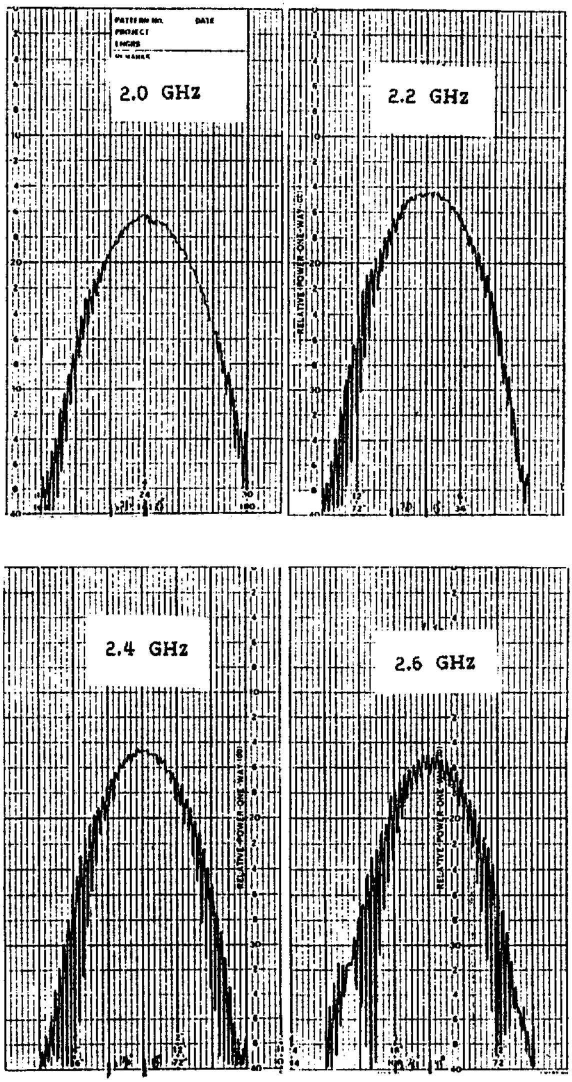


Figure 3. Radiation patterns taken with a spinning dipole.
(Horizontal scale: 5° per division)