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Linearly Tapered Slot Antenna Circular Array for Mobile Communications

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ABSTRACT

The design, fabrication and testing of a conformal K-Band circular array is presented. The array consists of sixteen linearly tapered slot antennas (LTSA). It is fed by a 1:16 microstrip line power splitter via electromagnetic coupling. The array has an omni-directional pattern in the azimuth plane. In the elevation plane the beam is displaced above the horizon.

1. INTRODUCTION

In mobile communications and intelligent vehicle highway systems (IVHS) there is a need for low cost conformal antennas [1]. These antennas must also have a toroidal shaped radiation pattern in order to receive signals from all directions. One configuration that can meet these requirements is a circular array of LTSAs. This paper presents the demonstration and fabrication at K-Band of such an array. The LTSA array was fabricated on the top surface of a thin dielectric substrate. The feed network consisting of a sixteen way microstrip power splitter was fabricated on the opposite side of the substrate and electromagnetically coupled to the array. During testing, a metal ground plane was placed below the array to simulate the top surface of a vehicle.

2. ARRAY DESIGN

The microstrip feed network and the LTSA array are shown in Fig. 1. The microstrip line feed, through a series of T-junctions and right angle bends, divides into sixteen radial output ports. The characteristic impedance of the microstrip line was maintained at $50\ \Omega$ throughout the splitter. The output ports of the splitter are electromagnetically coupled to the slotline of the LTSA through a microstrip-to-slotline transition. The transition consists of a microstrip line and a slotline which are orthogonal to each other and on opposite sides of the substrate. The microstrip line is terminated in an open circuit and the slotline in a short circuit. The slotline and the microstrip line characteristic impedances were chosen to be $112\ \Omega$ and $100\ \Omega$ respectively, in order to achieve tight coupling and fabrication ease. The LTSA was formed by gradually flaring the width of the slotline by an angle $\phi = 35^\circ$. The length of the LTSA was about 5 cm. The array was fabricated on a 0.254 mm thick RT-5880 Duroid substrate. The diameter of the circular array and the metal ground plane (used to simulate the top of a vehicle) are $10\ \lambda_0$ and $18\ \lambda_0$ respectively. Where λ_0 is the free space wavelength corresponding to the center frequency f_0 . The distance of separation between the array and the lower ground plane was $0.286\ \lambda_0$. The overall height of the antenna is less than 10 mm.

3. ARRAY PERFORMANCE

The measured H-plane pattern of the array is shown in Fig. 2(a). In the presence of a ground plane the pattern is displaced by about 28° in the elevation. Because of this, the E-plane pattern is measured by tilting the array in the elevation. Fig. 2(b) shows a typical peak pattern. This pattern however, shows the characteristics for only one quadrant of the array. Therefore, the measurement had to be repeated for the remaining three quadrants. This was done by rotating the array by 90° for each measurement. All four radiation patterns were similar to the first one. This demonstrates that the array is omni-directional in the azimuth plane. The measured return loss of the array is better than 10 dB over the frequency range 18 to 20 GHz. The array has a gain of about 10 dB.

4. CONCLUSIONS

The measured patterns show that the LTSA circular array has omni-directional characteristics in the azimuth plane and in the elevation plane, the main beam is displaced above the horizon. This antenna can conform to the vehicle surface and is low cost. The design of this array can be scaled down to the mobile communications frequency band.

5. REFERENCES

1. R. C. Johnson (Editor), Antenna Engineering Handbook, Third Edition, Chap.21, McGraw-Hill, Inc., New York, NY, 1993.

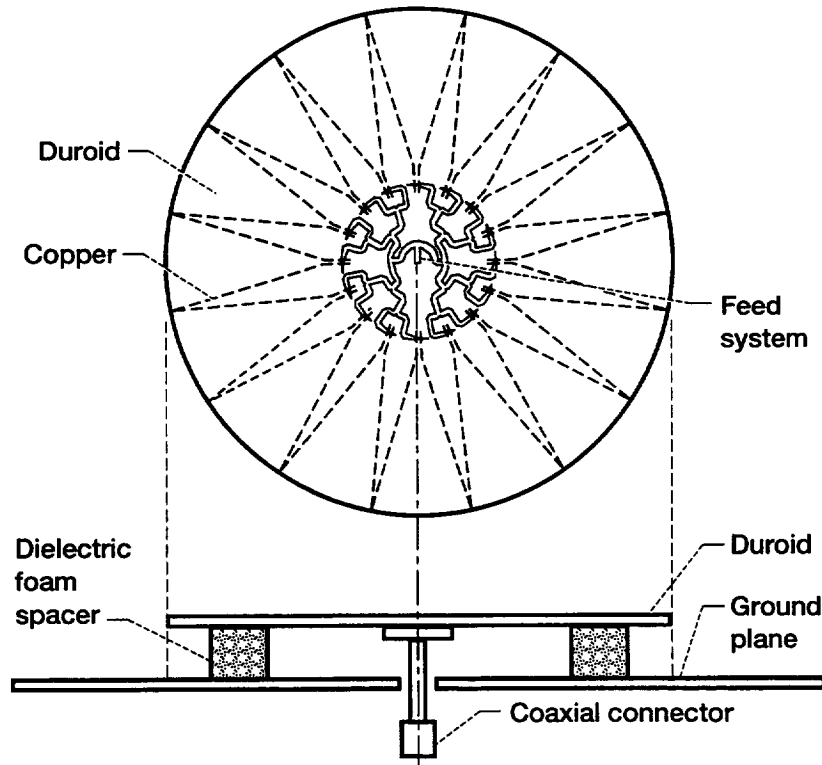
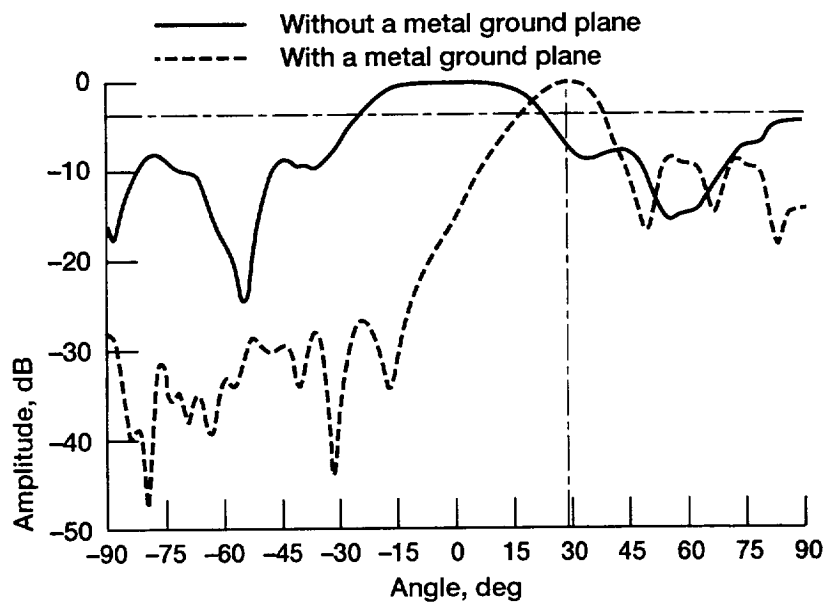
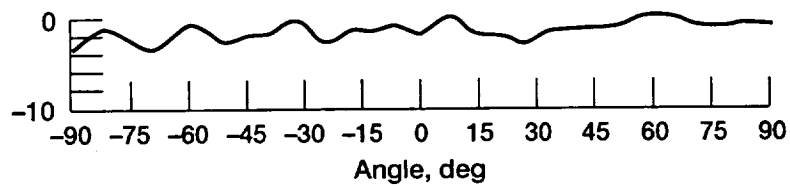


Figure 1.—Schematic illustrating the circular sixteen element LTSA Array.



(a) H-Plane.



(b) E-Plane with a metal ground plane and with the Array tilted.

Figure 2.—Measured radiation pattern of the Array at 19 GHz.

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