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A Novel Circular Polarized Horn Antenna Design

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Abstract

A horn antenna having dual-band and dual-polarization operation is proposed. To implement a small-sized structure providing circular polarizations in the Ka- and K-band, the antenna is designed by using the horn radiator on the basis of a conical helix which is exited by two ports for TX and RX in both ends. Through a design optimization process, a compactdual-band and dual-polarized horn antenna having high gain and high isolation performance was realized.

I. Introduction

In this paper, a radiating element having a circular horn with an inner conical helix to provide two orthogonal circular polarizations at the Ka- and K-bands for TX and RX, respectively, is suggested. This structure is very suitable to the satellite mobile station antenna which is required to be miniaturized for the installation in vehicles.

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II. Antenna Design

The structure of the proposed dual-band and dual-polarized horn antenna which operates at 30.085 ~ 30.885 GHz for TXand 20.355 ~ 21.155 GHz for RX is shown in Fig.1. This antenna is composed of a horn radiator and a conical helix, supported by a dielectric cone. The helix is excited by two semi-rigid coaxial cables connected to both ends of the helix at the points of P_1 and P_2, and the points are connected to Port1 for TX and Port2 for RX.

For TX transmissions, the cable is connected to the helix at the top of the cone, P_1, and it excites the current flowing from the top to the bottom of the helix. This current then excites the backward waveguide mode of the first type T_{-1}, of circular polarization which is propagating in a downward direction toward the bottom of the horn. Due to the fact that current spirals in a right-handed direction from the top to the bottom of the helix, the mode has a right-handed rotation. It is then reflected at the bottom of the horn in the opposite direction, and the mode reverses to the left-handed rotation. Consequently, the TX signal has a left-handed circular polarization (LHCP). On the other hand, the RX signal excites at the bottom of the helix, P_2, and has a right-handed circular polarization (RHCP),

which is the forward mode of the first type T_1, or the so-called axial mode.

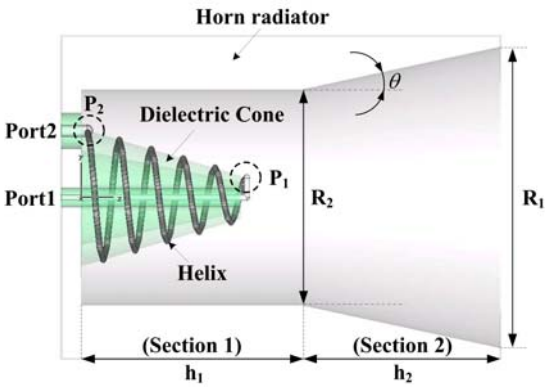
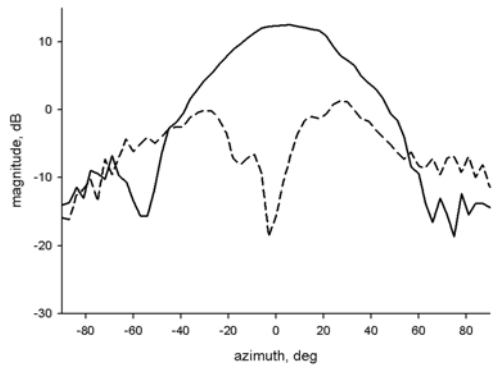


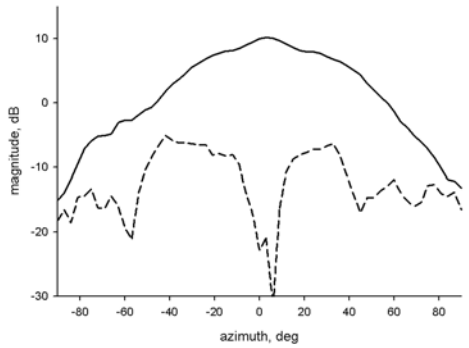
Fig. 1. Proposed horn antenna structure using a conical helix.

II. Measurement

The measured return losses of TX and RX are less than -17 dB and -13 dB, respectively, and isolation performances are more than 20 dB for all bandwidths. Fig. 2 shows the measured radiation patterns at the centre TX and RX frequencies. As shown in this figure, the proposed antenna has good beam patterns and cross-polarization levels for the frequency bands for TX and RX. Furthermore, the measured axial ratio is less than 1.0 dB at all bands, which is very good performance compared to the conventional patch antenna model most widely used that has a 3-dB axial-ratio bandwidth below 1%. It can also be shown that the antenna has the measured gain of about 12.5 dBi and 10 dBi at the centre frequencies.



(a)



(b)

Fig. 4. Measured E-plane radiation patterns.
(a) TX radiation pattern
: – – – Co-polarization, ---- Cross polarization
(b) RX radiation pattern
: – – – Co-polarization, ---- Cross polarization

III. Conclusion

A novel horn antenna with a conical helix is presented. The proposed antenna provides dual-band and dual-polarization characteristics with a compact size: an aperture diameter of 14 mm and a height of 23 mm. In addition, it can be easily constructed at low cost, due to itssimple structure. From the experimental results, it can be seen that the proposed antenna has good performance, especially the enhanced axial-ratio bandwidth and high isolation capacity in the operating frequencies. This makes the proposed antenna very suitable for applications in mobile satellite communications operated at high frequency.

References

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