電磁結合型円偏波三角形パッチアレーアンテナ

Proximity fed circularly polarized triangular microstrip array antenna with a truncated tip

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1. Introduction

The Japan Aerospace Exploration Agency (JAXA) will launch a geostationary satellite called Engineering Test Satellite VIII (ETS-VIII) in 2006. ETS-VIII will conduct orbital experiments on mobile satellite communications at the S band frequency, especially to support the development of a technology for transmission and reception of multimedia information for land mobile systems [1]. Up to now, various antennas have been developed aimed at ETS-VIII [2].

In this paper, a novel model of antenna is proposed in order to simplify the feeding network and miniaturize the antenna. The antenna consists of three single-fed equilateral-triangular patch antennas with a truncated tip for left-hand circular polarization (LHCP). Here, an array configuration of antenna aiming at ETS-VIII applications is discussed.

2. Specifications and Targets

The designed antenna for LHCP operates in frequency bands 2.6555-2.6580 GHz and 2.5005-2.5030 GHz for transmission and reception unit, respectively. Here, a thin miniaturized antenna is designed for one hundred kbps data transfer (gain 5 dBic) and measurements are assumed to take place in the center of Tokyo. As a result, the targeted elevation angle *El* is set to 48°. Furthermore, in this research, the operating frequency is fixed to 2.5025 GHz for reception frequency.

3. Structure of the antenna

Fig. 1 shows the configuration of the antenna. The antenna is composed by three triangular patches for reception (Rx). With this configuration, it is expected to obtain compactness. Each of the antenna elements is fed by proximity feeding with a microstrip line whose width w is 3.0 mm. The substrate thickness for the microstrip line and the triangular patch layers are h_b=h_a= 0.8 mm with a relative permittivity ε_r = 2.17 and loss tangent tan δ = 0.0009. The length l_e and l_s are 14 mm and 5 mm respectively. A small triangular tip of surface area ΔS is cut in the triangular patch to ensure a circular polarization. Moreover, by shifting the microstrip line by l_f, LHCP can be obtained. Finally, the patch lengths are a = 49.35 mm and b = 52.74 mm. By considering the axial ratio performances, the length c = 10 mm is obtained.

4. Performance of the antenna

The beam of the antenna is generated by a simple mechanism that consists in switching OFF one of the radiating element of reception shown in Fig. 1. By considering the mutual coupling between fed elements, their phase and distance, the beam direction can be varied. Hence, the two fed elements theoretically will generate a beam shifted of -90° in the conical-cut direction from the element which is switched OFF, in the case the antenna configuration shown in Fig. 1. For example, when element #1 is switched OFF, the beam is directed towards the azimuth angle *Az*=0°. In the same manner, the other two beams can be generated by switching OFF element #2 and #3 successively.

Fig. 2 represents the radiation characteristics in the conical-cut plane at *El*=48°. The minimum gain is 5.1 dBic over 120° for each beam. In addition, the maximum axial ratio is 2.6 dB on the whole azimuth range.

5. Conclusion

The design of a simple left-handed circular polarized (LHCP) single proximity fed equilateral-triangular array antenna with a truncated tip is proposed in order to support the next generation of mobile satellite communications using ETS-VIII. The performances analyses of the antenna have been discussed. The proposed antenna satisfies the specifications for ETS-VIII with a gain more than 5 dBic and an axial ratio less than 3 dB in the azimuth plane.

Reference

[1] http://i-space.jaxa.jp/satellite/ETS-VIII_e.htm# (as of June 2005). [2] J. T. Sri Sumantyo and K. Ito, “Low profile satellite-tracking dual-band triangular-patch array antenna for mobile satellite communications, ” *Technical Report of IEICE*, AP2004-133, pp. 19-24, Tokyo, Oct. 2004.

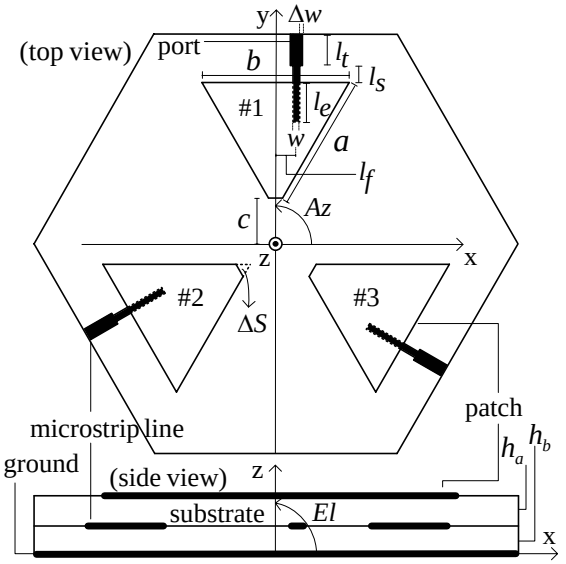

Fig. 1. Configuration of patch array antenna for reception (Rx)

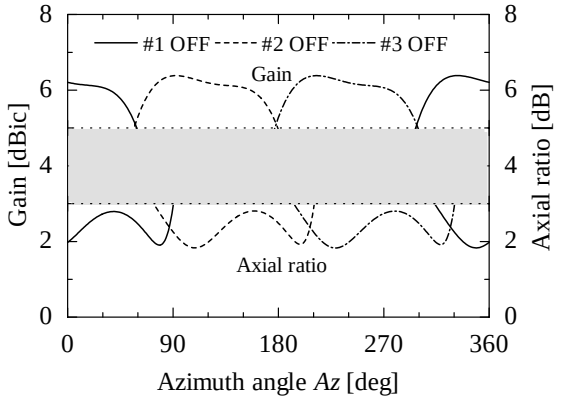

Fig. 2. Gain and axial ratio in the conical-cut plane at elevation angle *El* = 48° for reception (Rx)