Conformal Antennas Array for Wireless Communications at 2.5 GHz

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Abstract: This paper presents a conformal antenna array for wireless communications at frequency 2.5 GHz. The simulated results show a bandwidth ($S_{11} < -10$ dB) of 70 MHz (2.8%) from 2.459 GHz to 2.53 GHz with the maximum gain of 4.28 dB, significant for the operation of the 2.5 GHz application. The antenna uses, as substrate, ULTRALAM® 3850, from Rogers Corporation. A good approximation of the measured results with the simulated was observed.

Key words: Aerospace, antenna array, wireless.

1. Introduction

The microstrip antennas presents advantages: low weight, small volume, cost, performance, compatibility with integrated circuits and can be used in aerospace, aeronautical applications, satellites, rockets, missiles, aviation. The conformal antenna array can be used in aircraft, satellites, spacecraft, rocket and missile, because of their conformity with the aerodynamic [1].

The antenna uses, as substrate, ULTRALAM® 3850, from Rogers Corporation. For the achievement of results, simulations and analysis of the structure in study used the program HFSS® (High Frequency Structural Simulator) [2].

2. Antenna Design

The antenna design, with dimensions: W (width) and L (length), was calculated by the Eqs. (1), (3), (4) and (5) [3].

$$w = \frac{1}{2.f_r \sqrt{\mu_0 \epsilon_0}} \sqrt{\frac{2}{\epsilon_r + 1}} = \frac{v_0}{2.f_r} \sqrt{\frac{2}{\epsilon_r + 1}} \quad (1)$$

$$\epsilon_{ref} = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{2} \left(1 + 12 \frac{h}{w}\right)^{-1/2} \quad (2)$$

$$\frac{\Delta L}{h} = 0.412 \frac{(\epsilon_{ref} + 0.3) \left(\frac{W}{h} + 0.264\right)}{(\epsilon_{ref} - 0.258) \left(\frac{W}{h} + 0.8\right)} \quad (3)$$

$$L = \frac{1}{2.f_r \sqrt{\epsilon_{ref}} \sqrt{\mu_0 \epsilon_0}} - 2\Delta L \quad (4)$$

$$L_{ef} = L + 2\Delta L \quad (5)$$

Fig. 1 shows the simulated conformal patch with 8 elements applied for 2.5 GHz application.

3. Results

The substrate used was ULTRALAM® 3850, Rogers Corporation, relative permittivity, $\epsilon_r = 2.9$, thickness of 0.05 mm and a loss tangent, $\tan \delta = 0.0025$.

By the LTT method, Eqs. (1)-(5) and HFSS® program, was designed the conformal antenna to operate at 2.5 GHz. Fig. 2 relates the resonant frequency versus the L (length), with W (width) = 40 mm and $\epsilon_r = 2.9$ [4-6].

The results show that for frequency of 2.5 GHz, the dimension are: L = 35 mm and W = 40 mm.

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Fig. 1 Conformal array patch with 8 elements applied for 2.5 GHz application.

Fig. 3 shows the simulated reflection coefficient (S_{11}), resonant at 2.513 GHz a level of -11.1 dB and bandwidth ($S_{11} < -10$ dB) of 70 MHz from 2.48 GHz to 2.55 GHz.

Fig. 4 shows the antenna 3D gain total of 4.0 dBi at 2.5 GHz.

Fig. 5 shows simulated results radiation patterns in 2D at 2.5 GHz.

Fig. 2 Resonant frequency versus the length.

Fig. 3 Simulated results of reflection coefficient (S_{11}).

Fig. 4 Simulated results radiation patterns in 3D to 2.5 GHz.

Fig. 5 Simulated results radiation patterns in 2D at 2.5 GHz.

4. Conclusion

This paper proposed a conformal antenna array for wireless communications at frequency 2.5 GHz. The antenna has a good results reflection coefficient (S11), resonant at 2.513 GHz (-11.1 dB) and bandwidth 70 MHz (2.8%) at 2.5 GHz and gain of 4.0 dBi. A good approximation of the measured results with the simulated was observed.

References

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