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Development of Compact Microstrip Patch Antenna for ADS-B

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Abstract: *A compact microstrip patch antenna for Automatic Dependence Surveillance System-Broadcast (ADS-B) is presented. T-slot is etched on the ground plane to achieve some degree of miniaturization of the design. The proposed antenna has a compact size of 82 mm x 65 mm with electrical size of $0.297\lambda_0$ x $0.23\lambda_0$ at 1.09 GHz. The antenna resonates at 1.09 GHz for ADB-S applications supplied by 50Ω transmission line. The design is validated by fabrication of the prototype hence; simulated and measured results were obtained and compared. The predicted gain of the ADS-B antenna is from 1dB to 5dB whereas the measured gain is about 3.10dB. It is anticipated that the proposed antenna can fulfill the ADS-B specification.*

Keyword: *Automatic Dependent Surveillance System-Broadcast (ADS-B), Microstrip Patch Antenna (MPA), Fabrication.*

1. INTRODUCTION

ADS-B is a system that uses transmission from aircraft to provide geographical positions, pressure, altitude data, positional integrity measures, and flight identity to the receiver base station [4]. It is a function on aircraft that periodically broadcasts its state of vector horizontal, vertical and other position information. The broadcast message provides surveillance information to other users, principally Air Traffic Control (ATC) [4].

Microstrip patch antennas (MPAs) commonly used in ADS-B's have gain tremendous recognition in microwave community. MPAs are usually design using different types of shapes and photo etched on a dielectric substrate [5]. The feeding techniques depend on the design specifications and area of applications of the antenna [3, 2]. The most commonly employed MPA is a rectangular patch [2]. The rectangular patch antenna is approximately a one-half wavelength long section of rectangular microstrip transmission line. Microstrip patch antennas with fully ground plane are characterized by high directive gain. However, they suffer from narrow bandwidth. Several MPAs have been introduced [1, 7] with different geometries in a quest to improve the performance characteristics of antennas; such as radiation pattern, gain, efficiency, size and directivity. However, limitations on these parameters still exist. Therefore, this study proposed MPA for Automatic Dependence Surveillance System-Broadcast (ADS-B) with a view to improve on the above mentioned parameters. To achieve a compact and small size MPA, T-shaped slots are etched on the ground plane so that the electrical size of the antenna can be reduced. The rectangular patch radiator is fed by 50Ω microstrip transmission line, simulated, measured the reflection coefficient of the antenna and compared with the commercial type to validate the design.

The MPA for ADS-B was designed, fabricated with thin profile planar configurations, simulated and presented. It is unique due to its light weight, low volume and low cost of fabrication.

2. ANALYSIS AND DESIGN

The geometry of the proposed MPA is shown in Fig. 1. A rectangular patch is employed as the antennas main radiating element. The patch is fed by a 50Ω transmission line. The antenna has overall dimensions of 82 mm x 65mm with electrical length of $0.297\lambda_0$ x $0.236\lambda_0$ at 1.09 GHz. The antenna is fabricated using FR4 substrate of relative permittivity of 4.6, loss tangent of 0.0027, and thickness of 1.6 mm. T- Slots are etched on the ground plane to reduce the size of the antenna and to have impedance matching. CST Microwave Studio software was used for modeling and simulation. Table 1 below shows the optimized dimension of the antenna..

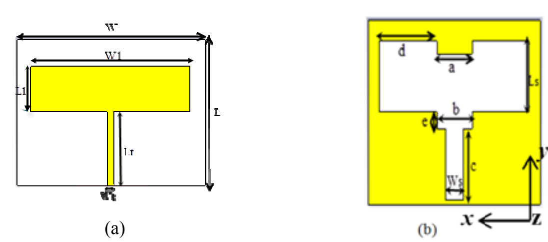

Fig. 1: Geometry of the proposed antenna :(a) Front view (b) Back view

Table 1: Dimensions of the proposed antenna

Parameters	Size (mm)
W	82
L	65
Wt	2.8
Lt	32
W1	69
L1	19.5
Ws	8.5
Ls	24.5
A	16.5
B	16.5
C	24.5
D	27.1
E	5.6

3. RESULTS AND DISCUSSION

To verify the advanced performance of the antenna, a prototype of the proposed antenna has been fabricated as shown in Fig. 2. The simulated and measured reflection coefficient (S11) of the antenna is shown in Fig. 3. The antenna resonates at 1.09 GHz with the impedance bandwidth of 300MHz. There is good agreement between the simulated and measured results. The measured and simulated radiation patterns for E and H-planes are shown in Fig. 4. It can be seen that the proposed antenna provides nearly stable omnidirectional behavior in H-plane and directional pattern in E –plane typical of patch antenna.

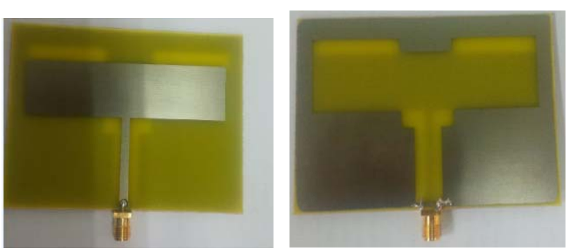

Fig. 2: Fabricated antenna for ADS-B application

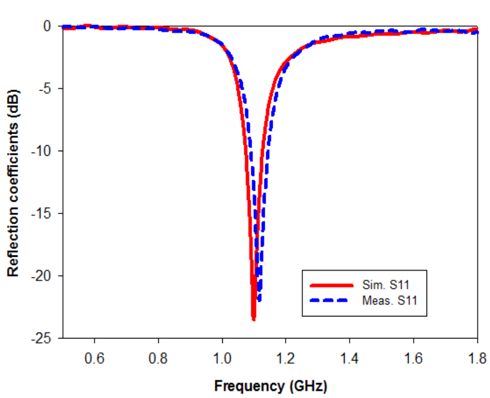

Fig. 3: Measured and simulated reflection coefficient (S11).

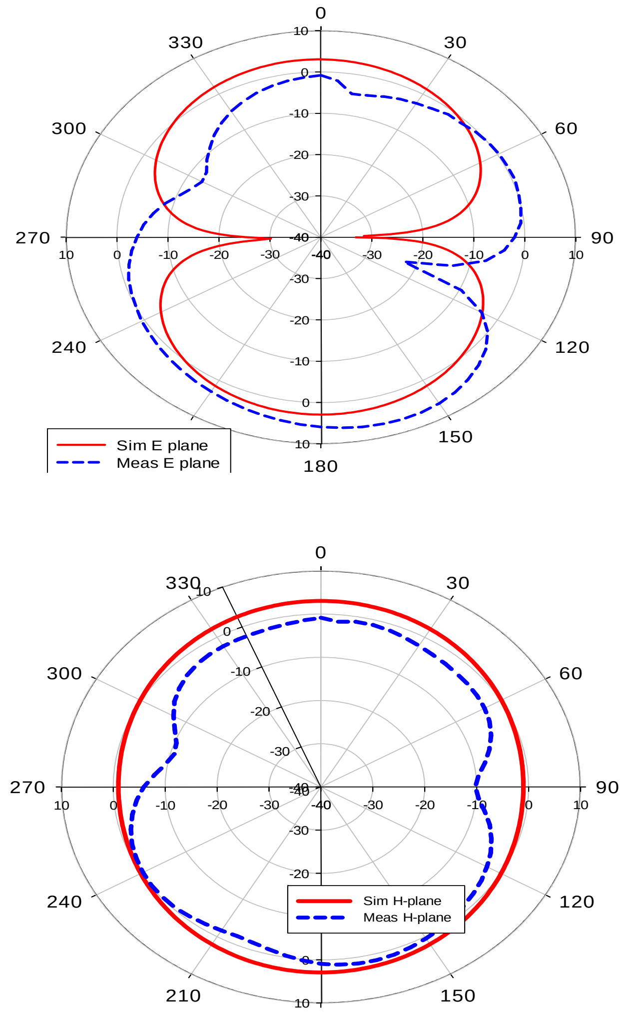

Fig. 4: Measured and Simulated E-plane and H-plane

4. CONCLUSION

A MPA for ADS-B operation has been designed and presented. The rectangular radiating patch of the antenna is fed by a 50Ω transmission line. A T-slot is etched on the ground plane to have more compact and reduced size design. The design is validated by experimental results and fabricated prototype. The antenna resonates at 1.09 GHz typical for ADS-B applications. The predicted gain of the ADS-B antenna is from 1dB to 5dB whereas the measured gain is about 3.10dB. It is anticipated that the proposed antenna can fulfill the ADS-B specification. The study focused on the design, fabrication and simulation aspect of the ADS-B antenna. It is expected that future researcher should cover its implementation and operation. The Antenna was designed using FR4 substrate only due to material limitation. Further studies should combine two or more types of materials which may better define a perfect match of antenna performance.

Similarly, technique of Array Antenna with another shape on the ground can be employ which may further reduce the antenna size and improve its gain.

REFERENCES

[1] Y. Guo, M. Yan, W. Chia, and Z. N. Chen, "Miniature Built-In Multiband Antennas for Mobile Handsets," *IEEE Transactions on Antennas and Propagation*, vol. 52, no. 8, pp. 1936–1944, 2004.

[2] P. Lindberg, E. Öjefors, and S. Member, "A Bandwidth Enhancement Technique for Mobile Handset Antennas Using Wavetraps," *IEEE Transactions on Antennas and Propagation*, vol. 54, no. 8, pp. 2226–2233, 2006.

[3] E. Arnieri, S. Member, L. Boccia, G. Amendola, G. Di Massa, and S. Member, "A Compact High Gain Antenna for Small Satellite Applications," *IEEE Transactions on Antennas and Propagation*, vol. 55, no. 2, pp. 277–282, 2007.

[4] A. Bettray, O. Litschke, and L. Baggen, "Multi-beam antenna for space-based ADS-B," in *2013 IEEE International Symposium on Phased Array Systems and Technology*, 2013, pp. 227–231.

[5] R. Saini, D. Parkash, and S. Singh, "Investigation of Multi Band Microstrip Line Fed Antenna using DGS Technique for WLAN / WiMAX Applications," *International Journal of Computer Applications*, vol. 83, no. December, pp. 7–11, 2013.

[6] B.-Y. Lee, W.-S. Chen, and P.-Y. Chang, "A compact microstrip-line-fed slot antenna for wideband operation," in *2009 Asia Pacific Microwave Conference*, 2009, pp. 1884–1886.

[7] L. C. Paul and N. Sultan, "Design , Simulation and Performance Analysis of a Line Feed Rectangular Microstrip Patch Antenna," *International Journal of Engineering Sciences and Emerging Technologies*, vol. 4, no. 2, pp. 117–126, 2013.