

A NEW COMPACT COPLANAR ANTENNA

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ABSTRACT

An extremely compact coplanar printed antenna configuration, which is highly suitable for personal communication is proposed. A prototype of the proposed antenna for Digital Cellular System (DCS) has been constructed and tested. The antenna exhibit an impedance bandwidth of 6% and average gain of 5.5 dBi with good radiation coverage. The proposed low profile antenna occupies only an overall area of 4.7 cm², where as the conventional rectangular microstrip antenna need an area of 20.8 cm².

INTRODUCTION

Recent advancements in personal communication demand the need of compact antennas with large impedance bandwidth and excellent radiation performance. Various antenna configurations suitable for today's personal communication demand were reported in the literature [1-3]. The coplanar transmission line antenna configurations are more attractive for antenna designers due to its simplicity and easiness of integration of active and passive components on the same layer. A coplanar transmission line together with microstrip transmission line feed configuration having end fire radiation has been proposed [4]. In this paper a compact coplanar antenna (CCPA) with excellent radiation coverage, comparatively good impedance bandwidth and gain for DCS 1800 band is proposed. The presence of two coplanar grounds of the antenna makes it as a good choice for active antenna design. Simulation results and experimental observations are presented to illustrate the characteristics of the proposed antenna. The Finite difference time domain based Zeland Fidelity simulation tool was employed for initial design optimization.

ANTENNA DESIGN

As outlined before, the antenna structure is based on co-planar geometry and shown in Fig.1. The CCPA consists of three coplanar copper strips (a centre conductor and two lateral ground planes) without bottom ground plane. The inner strip is wider than the two ground conductors. The strips are etched on FR4 substrate of dielectric constant $\epsilon_r = 4.2$ and height $h=1.6$ mm.

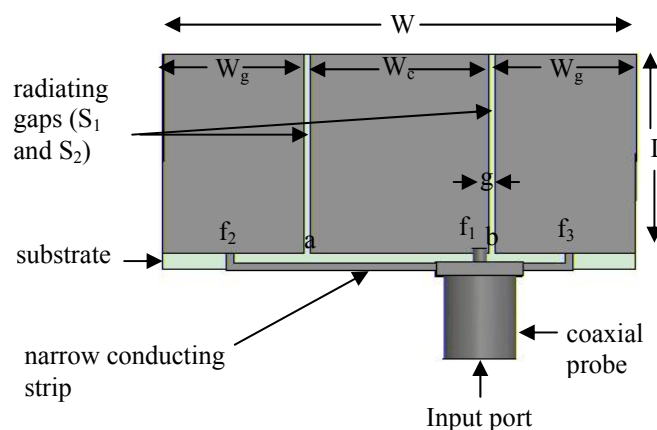


Fig. 1 Geometry of the proposed Compact Coplanar Antenna
 $L = 14.4$ mm, $W = 32.9$ mm, $W_g = 9.8$ mm, $W_c = 12.35$ mm, $g = 0.48$ mm

Centre conductor has dimensions length $L = 0.087 \lambda_0$ and width $W_c = 0.075 \lambda_0$, where λ_0 is the free space wave length at the operating frequency. Ground conductors are separated from the centre conductor with two identical radiating gaps S_1 and S_2 of length $L = 0.087 \lambda_0$ and width $g = 0.003 \lambda_0$ as shown in Fig. 1. The antenna is fed across the radiating gaps using a coaxial probe. Optimum feed point of the antenna is at the corner marked as f_1 for the centre conductor. The other two patches are grounded nearly at the centre at f_2 and f_3 respectively using thin conducting strips of width 1 mm as shown in Fig. 1. Input matching can be easily achieved by varying the feed point f_1 along the side a-b of the centre conductor. The overall dimension of the present antenna for DCS 1800 is only $L = 14.4$ mm, $W = 32.9$ mm and $h = 1.6$ mm.

RESULTS

The prototype of the proposed antenna operating at DCS 1800 band is fabricated and tested using HP 8510C vector network analyzer. Fig. 2 shows the experimental and simulated return loss of the proposed antenna. The antenna resonates at 1.79 GHz offers a 10 dB return loss bandwidth of 6% (1.753 GHz to 1.867 GHz). Experimental data are in well agreement with the simulated results using Zeland Fidelity. Fig. 3 shows the measured E and H plane radiation patterns of the antenna at 1.79 GHz. The E-plane radiation pattern in Fig. 3a is figure of eight and the H-plane pattern is nearly omni directional as shown in Fig. 3b. Radiation patterns at other frequencies across the operating band are similar to those shown in Fig. 3, suggesting the usefulness of the antenna in the entire band. Fig. 4 shows the measured antenna gain in the operating band. The antenna offers an average gain of 5.5 dBi in the operating band. A peak gain of 6.2 dBi is observed at 1.77 GHz. Characteristics of the proposed antenna are compared with that of a standard rectangular microstrip antenna in Table 1. The proposed configuration has an area reduction of 77 % with respect to the standard rectangular patch resonating at the same frequency.

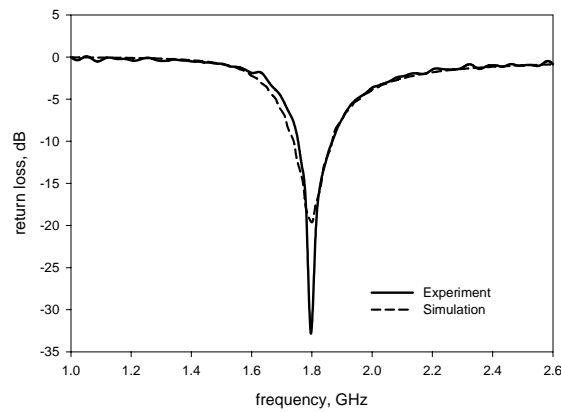


Fig. 2 Measured and simulated return loss of CCPA

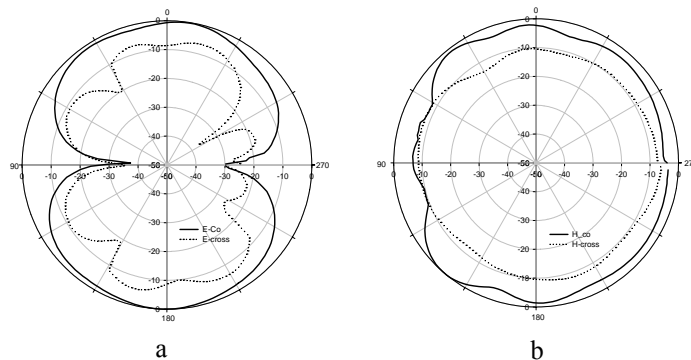


Fig. 3 Measured radiation patterns of CCPA at 1.79 GHz
a. E plane b. H plane

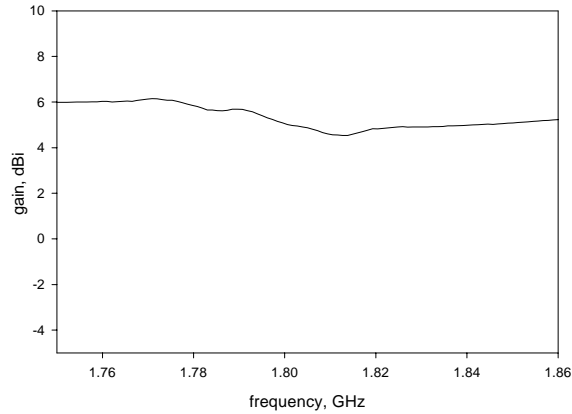


Fig. 4 Gain of the proposed antenna in the operating band

Table 1 Comparison of proposed antenna and a Standard rectangular patch

Antenna	% Bandwidth	Gain (dBi)	Area (cm ²)	Pattern coverage
Rectangular patch	2	7.07	20.8	Broadside
Proposed antenna	6	5.5	4.7	Omni directional

CONCLUSION

An extremely compact coplanar antenna configuration is proposed and its characteristics have been confirmed by simulation and experiments. The proposed antenna has 77 % area reduction compared to standard rectangular microstrip antenna, 6.2 dBi peak gain, 6 % impedance bandwidth and omni directional radiation coverage. The coplanar configuration having two ground planes make the antenna as a good choice for active antenna designs. The above excellent radiation characteristics make the antenna an ideal choice for personal communication.

ACKNOWLEDGEMENTS

The authors acknowledge **University Grants Commission (UGC), India** and **Kerala State Council for Science, Technology and Environment (KSCSTE), India** for financial assistance.

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