L-STRIP EXCITED WIDEBAND RECTANGULAR MICROSTRIP ANTENNA

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ABSTRACT: *This paper presents the outcome of the experimental studies performed on L-strip-fed compact rectangular microstrip antenna. The effect of the feed parameters upon the characteristics of the antenna is studied in detail. The antenna offers an impedance bandwidth of nearly 20% and is suitable for broadband applications.* © 2004 Wiley Periodicals, Inc. Microwave Opt Technol Lett 42: 173–175, 2004; Published online in Wiley InterScience (www.interscience.wiley.com). DOI 10.1002/mop.20243

Key words: *microstrip antenna; bandwidth enhancement; L-strip feed; electromagnetic coupling*

1. INTRODUCTION

To assure reliability, microwave equipment requires an antenna with low profile and light weight. Even though a microstrip antennas offer excellent radiation characteristics and satisfies the above requirements, their uses are limited because of narrow bandwidth. Various techniques to enhance the bandwidth for microstrip antennas have been proposed [1]. The use of parasitic patches as either stacked or coplanar geometry can improve the bandwidth [2]. Other bandwidth-widening techniques include the use of thick substrates [3], multiple resonators [4], and the L-probe [5]. However, all these techniques increase the overall size or volume of the antenna. Recently, L-shaped microstrip feed has been successfully applied to the microstrip antennas for bandwidth enhancement [6] and has not significantly altered the overall volume of the radiating structure.

In this paper, the experimental investigation on the effect of the L-strip feed parameters upon the radiation characteristics of the antenna is reported. The L-strip-fed rectangular microstrip antenna offers a maximum 2:1 VSWR impedance bandwidth of about 20%.

2. ANTENNA GEOMETRY

The proposed antenna is comprised of a planar L-strip fed and an electromagnetically coupled radiating rectangular patch of size 4×2 cm^2. The L-shaped microstrip feed has a characteristic

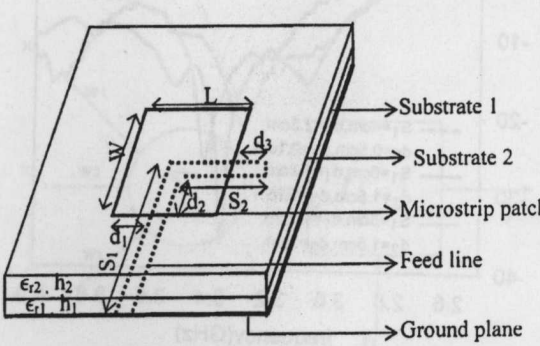

Figure 1 Geometry of the planar L-strip-fed microstrip antenna

TABLE 1. Reflection Characteristics for Different Feed Lengths of the Antenna ($h_1 = h_2 = 0.16$ cm, $\varepsilon_{r1} = \varepsilon_{r2} = 4.28$, $L = 4$ cm, $W = 2$ cm)

Feed Segment Length (S_2) cm	$S_1 = 4$ cm, $d_1 = 2.3$ cm, $d_2 = 0.5$ cm, $d_3 = 2.1$ cm		$S_1 = 5$ cm, $d_1 = 1.2$ cm, $d_2 = 1.5$ cm, $d_3 = 1$ cm		$S_1 = 6$ cm, $d_1 = 1.2$ cm, $d_2 = 1.5$ cm, $d_3 = 1$ cm	
	% Bandwidth	Frequency (GHz)	% Bandwidth	Frequency (GHz)	% Bandwidth	Frequency (GHz)
0.5	5.78	3.28	3.264	3.5	5.684	3.54
1.0	6.00	3.55	6.568	3.19	6.68	3.53
1.5	8.26	3.205	7.017	3.2	9.075	3.235
2.0	9.389	3.205	7.29	3.263	10.16	3.205
2.5	11.06	3.355	7.28	3.245	10.8	3.231
3.0	12.62	3.25	13.25	3.245	14.4	3.319
3.5	13.4	3.31	15.28	3.243	19.5	3.331
4.0	12.109	3.205	10.03	3.311	14.31	3.32

impedance of 50Ω and is fabricated on a substrate of dielectric constant $\varepsilon_r = 4.28$ and thickness $h = 0.16$ cm. The radiating patch is fabricated on another substrate with the same dielectric constant and thickness. The antenna geometry along with other geometrical parameters is given in Figure 1.

3. EXPERIMENTAL RESULTS

The radiation characteristics of the L-strip fed microstrip antenna with regard to the feed parameters are studied in detail using an 8510 CNetwork Analyzer. The feed parameters that determine the reflection and radiation characteristics are S_1, S_2, d_1, d_2, and d_3. The feed length S_1 is fixed as 4, 5, and 6 cm, and for each feed length, the feed-segment length S_2 is varied from 0.5 to 4 cm. The variation in return loss as function of frequency for different combinations of S_1 and S_2 are observed. Table 1 shows a summary of the reflection characteristics of the proposed antenna with the feed parameters.

From the table, it is found that the optimum feed length for the 4×2 cm^2 patch is 6 cm and the feed-segment length is 3.5 cm. The feed parameters of the antenna when it offers the maximum impedance bandwidth are $S_1 = 6$ cm, $S_2 = 3.5$ cm, $d_1 = 1.2$ cm, $d_2 = 1.5$ cm, and $d_3 = 1$ cm. Figure 2 shows the variation of S_{11} with frequency for different feed lengths of the proposed antenna. It is clear from the figure that the antenna offers maximum impedance bandwidth of 20% when $S_1 = 6$ cm.

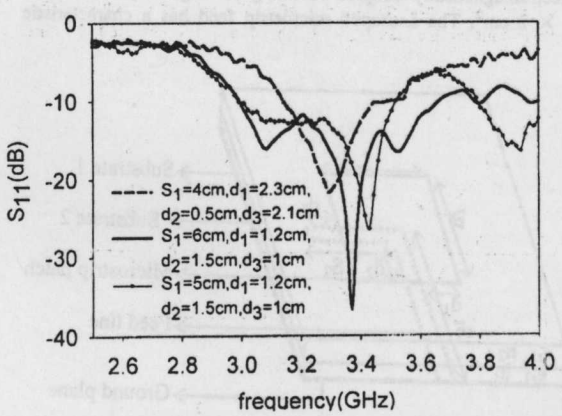

Figure 2 Variation of S_{11} with frequency for different feed lengths of the antenna ($h_1 = h_2 = 0.16$ cm, $\varepsilon_{r1} = \varepsilon_{r2} = 4.28$, $L = 4$ cm, $W = 2$ cm, $S_2 = 3.5$ cm)

The radiation characteristics of the antenna are also studied for different feed lengths and feed-segment lengths. Figure 3 shows the radiation patterns of the proposed antenna for the optimum feed length, in the operating band. Table 2 shows the radiation characteristics of the antenna for different feed parameters. From the radiation characteristics it is summarized that the present antenna is more directive than a conventional rectangular patch antenna and offers cross polarization of −30 dB along the boresight direction. The measurements are repeated for patches resonating at different frequencies; these are made on the same substrates as well as on different substrates in order to confirm the results.

4. CONCLUSION

The effect of the feed parameters on the characteristic of the L-strip fed antenna has been studied and reported. From the

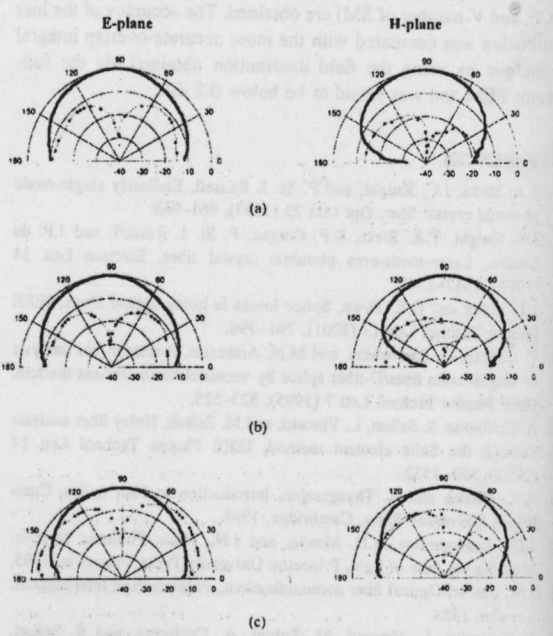

Figure 3 Radiation patterns of the antenna with the optimum feed parameters ($h_1 = h_2 = 0.16$ cm, $\varepsilon_{r1} = \varepsilon_{r2} = 4.28$, $L = 4$ cm, $W = 2$ cm, $S_1 = 6$ cm, $S_2 = 3.5$ cm, $d_1 = 1.2$ cm, $d_2 = 1.5$ cm, $d_3 = 1$ cm, co-polar ——, cross-polar ●●●): (a) 3.05 GHz; (b) 3.331 GHz; (c) 3.65 GHz

TABLE 2. Radiation Characteristics for Different Feed Lengths of the Antenna ($h_1 = h_2 = 0.16$ cm, $\varepsilon_{r1} = \varepsilon_{r2} = 4.28$, $L = 4$ cm, $W = 2$ cm)

Feed Length S_1 (cm)	3-dB Beamwidth		Cross-Polarization (dB)	
	E-Plane	H-Plane	E-Plane	H-Plane
4	80°	70°	−27	−31
5	84°	62°	−33	−40
6	74°	70°	−33	−39

measurements, it is observed that the feed parameters have a significant effect on the radiation and reflection characteristics of the microstrip antenna. The proposed feeding technique is very simple, as compared to other methods, and offers an impedance bandwidth of 20%.

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