Rounded Patch Antenna with T-Shaped Probe Feeding and Shorted Wall

F. da Silva Paixão, M. N. Kawakatsu, and V. A. Dmitriev

Abstract—**In this work, a modified patch antenna with broad bandwidth and small size is proposed and investigated. Instead of rectangular patch of a known antenna we use a rounded patch. This modification increases significantly the upper frequency edge of the operating band. This allows one to obtain a -10 dB return loss bandwidth of 72 % and to flatten the gain characteristic. In our study, we use the parametric optimization of geometry of the antenna.**

Index Terms—**Patch antenna, T-shaped probe feeding, shorted wall, broadband.**

I. Introduction

Due to the well-know advantages of microstrip antennas, such as low profile, light weight, low cost and easy integration with impressed circuits, one can find in the literature many works devoted to improvement of the characteristics of conventional microstrip patch antennas. The antenna researches are normally interested in increasing the bandwidth (BW) and reducing the size of these antennas without degradation in others parameters such as gain, polarization purity and efficiency.

In [1] a rectangular patch antenna fed by a capacitively coupled L-shaped probe is presented. This feed structure compensates the large inductance introduced by the coaxial probe pin, which permitted obtaining a BW over 30 %. In [2], it is demonstrated that a rectangular patch with T-shaped probe can achieve a larger bandwidth in comparison to the L-shaped one. By using a short-circuited wall or pin it is possible to reduce the radiator size (one quarter wavelength resonance) obtaining the same or even larger bandwidths, as it was shown in [3]. In this reference, a rectangular patch antenna fed by a T-probe with shorted wall having a BW of 62 % is presented.

In our paper, we present a modified version of the antenna described in [3]. The modification is the use of a patch with the rounded corners. This modification increases significantly the upper frequency edge of the operating band. A parametric study of the return loss versus frequency with some of the geometrical parameters is presented to illustrate the optimization approach employed in this antenna. The return loss, radiation patterns and gain of the optimized configuration are compared with those of the referenced antenna. For the antenna simulations we used the commercial software Zeland IE3D [4].

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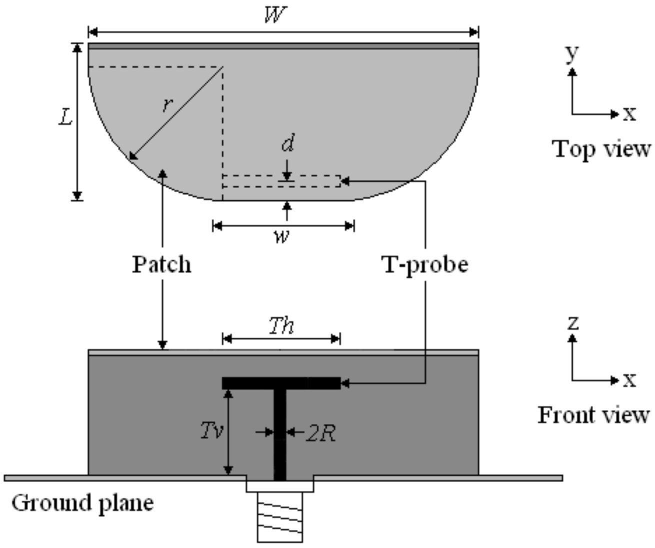


Figure 1. Antenna structures: top view and front view.

II. Antenna Structures

The antenna presented in this paper is of microstrip patch type excited by a T-probe and with a shorted wall, as shown in Fig. 1. The T-probe is located near one of the patch edges with the opposite edge electrically connected to the shorted wall, which is connected to the ground plane. The corners of the edge near the probe are rounded and have the shape of a quarter-circle.

The patch is of size *W* x *L* and the quarter-circle has a radius of *r*. The T-probe is a wire of radius *R* and the length of its horizontal and vertical portions are respectively *Th* and *Tv*. *H* is the total height of this antenna. The ground plane is assumed to be large enough to be approximate as infinity plane. The T-probe is connected to a 50 ohms coaxial cable.

III. Parametric Study

In the antennas return loss BW optimization, we used parametric optimization. To illustrate this optimization approach and give some physical insights of this antenna, we show in the following the behavior of the return loss versus frequency with the variation of the parameters *r* and *Tv*. The values of the others parameters are describe in Table 1. The parameter *w* is not given in this table since it depends on *r* ($w = W–2r$).

TABLE 1
GEOMETRICAL PARAMETERS OF THE ANTENNA IN MILLIMETERS

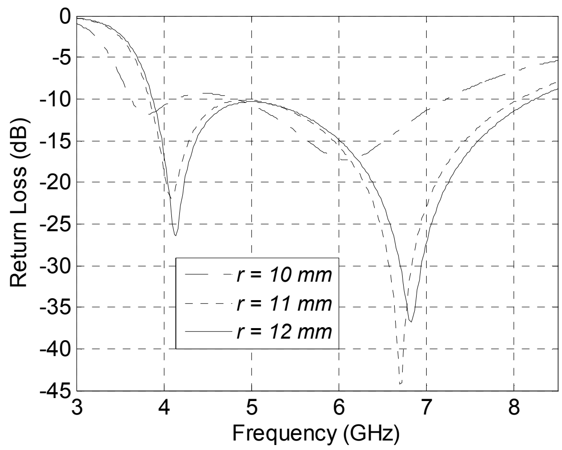
L	*W*	*Th*	*d*	*R*	*H*
12	30	9.5	1.15	0.5	6

The return loss versus frequency for different values of *r* and *Tv* are shown respectively in Figs. 2a and 2b. In Fig. 2a, *Tv* = 4.5 mm and in Fig. 2b, *r* = 12 mm.

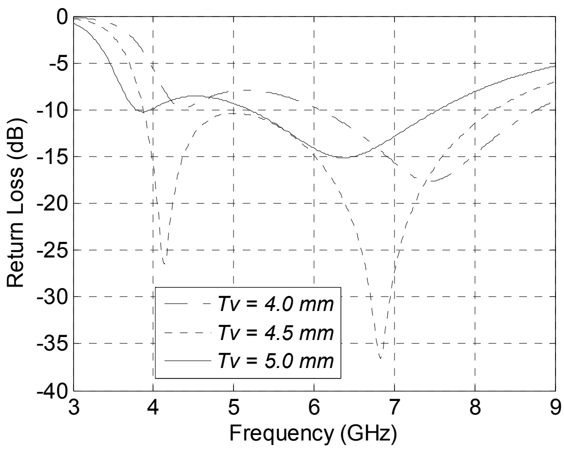
From Fig. 2a, increasing *r* from 10 to 12 mm is observed that the return loss BW is increased, considering the level of -10 dB as reference. Since the largest BW occurs when *r* = 12 mm, which is equal to *L*, it was defined as the optimum value.

It can be seen from Fig. 2b that the parameter *Tv* has a great influence on the impedance matching of this antenna, since it is related to the coupling distance between the T-probe and the patch. From this analyses, *Tv* = 4.5 mm gives the largest BW and was defined as the optimum value.

The return loss and input impedance of the configuration proposed in [3] (with rectangular patch), denoted here as Case 1, and the configuration proposed in our work, denoted as Case 2, are shown respectively in Fig. 3a and 3b for comparison. The BW of Case 1 is 62%, while that of Case 2 is 72%. From Fig. 2a, it is observed that Case 2 presented a displacement of the lower frequency edge of the operating band to a higher frequency in comparison to Case 1, which is caused by the reduction of the patch's area. It is clear from Figs. 2a and 2b that the utilization of a rounded patch improved significantly the impedance matching of this antenna on the higher frequencies, thus enlarging the BW.

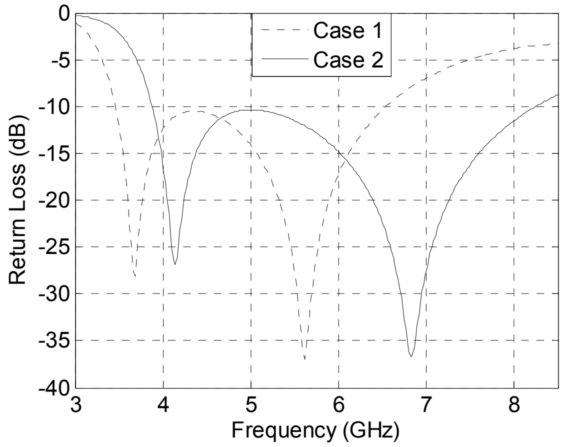


(a)

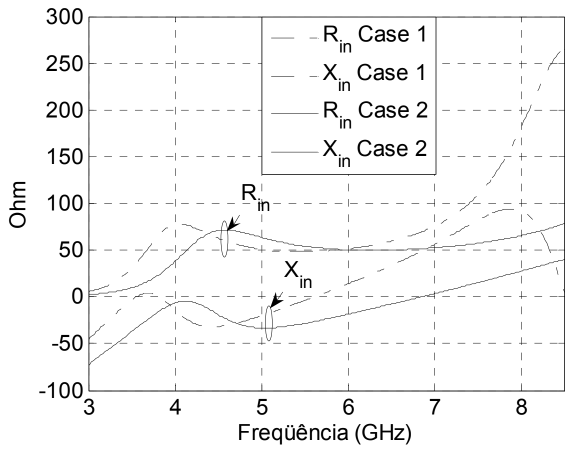


(b)

Figure 2. Return loss versus frequency for different values of *Tv* (a) and *r* (b).



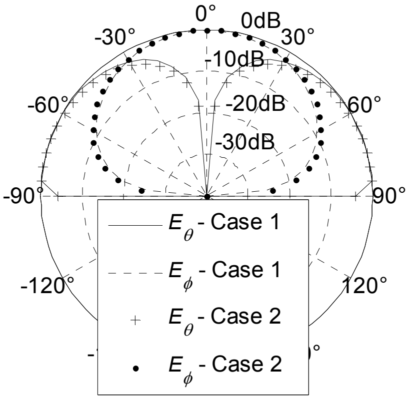
(a)



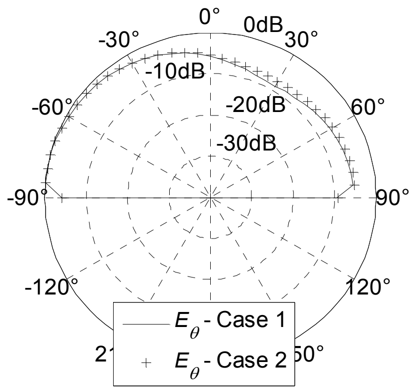
(b)

Figure 3. Return loss (a) and input impedance (b) versus frequency for Case 1 and Case 2.

In Fig. 4, the radiation patterns of Case 1 and Case 2 are shown for the x-z, y-z and x-y planes at the frequency of 5 GHz. As it can be seen, the radiation patterns of both cases have practically the same characteristics. In the x-z plane, these antennas have equal maximum amplitude of the co-polarization (E_ϕ) and the cross-polarization (E_θ) components. These antennas have radiated fields linearly polarized in the y-z and x-y planes.



(a)



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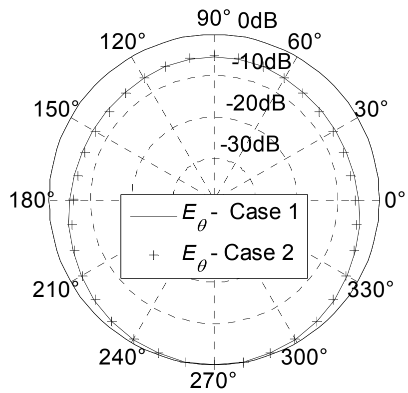

(c)

Figure 4. Radiation patterns at 5 GHz on the planes x-z (a), y-z (b) and x-y (c).

From the radiation patterns, one can see that the maximum directivity of the antennas does not occur in the direction normal to the patch (z direction). For analysis purpose, the gain of both cases was calculated in the z direction and is shown in Fig. 5. As it can be observed, the gain of Case 2, in comparison to Case 1, is slightly bigger and more flat within the operating band.

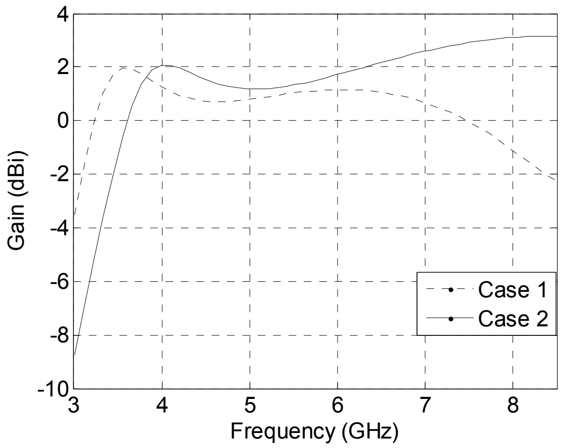

Figure 5. Gain versus frequency for Case 1 and Case 2.

IV. Conclusion

We presented a modified patch antenna with T-shaped probe and shorted wall. The modification is utilization of a rounded patch. In comparison with the configuration having rectangular patch, the proposed antenna gives an increase in the return loss bandwidth from 62% to 72%. Another advantage is a more flat gain in the operating band. The utilization of a rounded patch does not alter the characteristics of the radiation patterns.

Acknowledgment

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References

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