Dual frequency miniature microstrip antenna

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A single-feed dual frequency compact microstrip antenna with a shorting pin is described. This new antenna configuration gives a large variation in frequency ratio of the two operating frequencies, without increasing the overall size of the antenna.

Introduction: Compact dual frequency microstrip antennas are attracting more attention due to the fast developments in communications. A microstrip antenna could be made compact through a number of methods. Some of the methods involve the use of a shorting pin [1, 2], while others involve geometrical modification [3, 4]. In this Letter, we present a dual frequency microstrip antenna realised by adding a shorting pin to a compact microstrip antenna (with compactness achieved through geometrical modification) [4].The range of the frequency ratio of the antenna can be varied by changing the aspect ratio.

Design and experimental details: A schematic diagram of the proposed miniature dual frequency microstrip antenna is shown in Fig. 1. The configuration consists of a drum-shaped patch [4] etched on a substrate of thickness h and dielectric constant ε_r. L denotes length, B is the width and W is the central width of the antenna. The feed point and shorting pin positions are specified in terms of coordinates, (x_f, y_f) and (x_s, y_s), respectively.

It is noted that the maximum reduction in size of the antenna is achieved if the shorting pin is placed at the centre of the radiating edge. With prudent selection of the feed point along the Y-axis, matching without excitation of the TM_{10} mode can be achieved. Here, the antenna is found to resonate with the first two frequencies having the same polarisation.

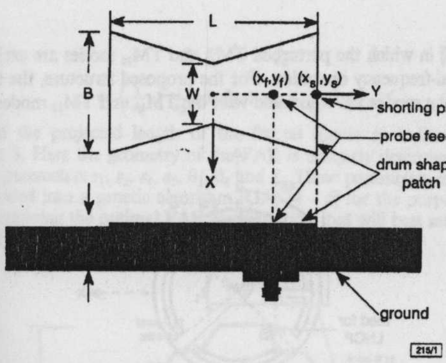

Fig. 1 *Geometry of proposed miniature dual frequency drum-shaped microstrip antenna*

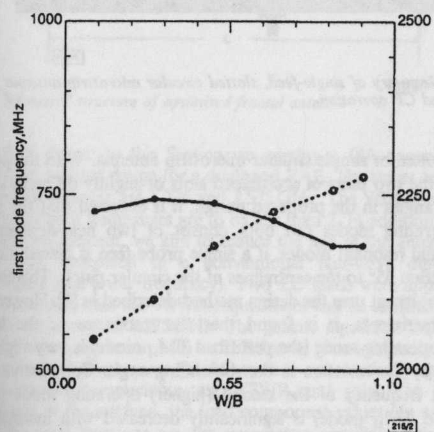

Fig. 2 *Variation of first and second mode resonant frequencies with central width*

—●— first mode
--○-- second mode

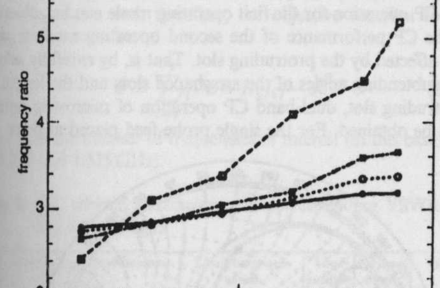

Fig. 3 *Variation of frequency ratio with central width for different aspect ratios*

—●— L/B = 2.0
--○-- L/B = 1.5
-·■·- L/B = 1.0
--□-- L/B = 0.5

Fig. 2 shows the variation of the first and second resonance frequencies with central width W for a typical drum shaped antenna with length L = 3.8cm and width B = 2.53cm, fabricated on a substrate of ε_r = 4.5 and h = 0.16cm. From the graph, it is observed that the first resonance frequency increases from 675 to 743MHz and the second resonance frequency decreases from 2275 to 2043MHz; i.e. the frequency ratio varies from 3.37 to 2.75. The variation in frequency ratio with W is maximum when $L/B < 1$ and decreases as we increase the L/B ratio. Fig. 3 shows the frequency ratio variation with respect to W, for different L/B values. From the observations it is found that a frequency ratio of ~5 is achieved when L/B is 0.5. Hence, the frequency ratio can be varied by trimming L/B and/or W/B.

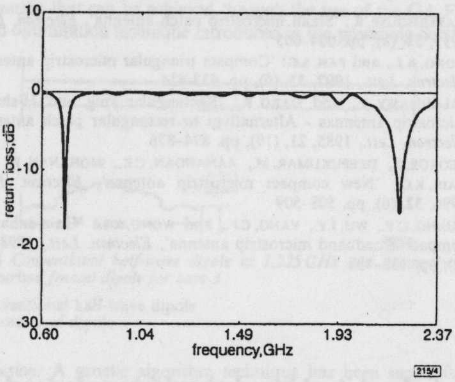

Fig. 4 *Variation of return loss with frequency for typical antenna configuration*

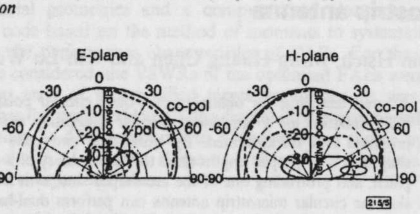

Fig. 5 *E and H-plane co-polar and cross-polar antenna patterns*

——— first mode
- - - - second mode

In a particular drum-shaped antenna configuration, there exists a feed point along the central line at which both the resonance frequencies can be excited with good matching. When $W = 0.7B$, for the typical antenna mentioned above, the feed point is found at (1.75cm, 0cm) when the shorting pin is at ($L/2$, 0). Fig. 4 shows the return loss variation of the antenna. The antenna is resonating at 701.8 and 2201MHz. The percentage bandwidths are 1.19 and 1.59%, respectively. Fig. 5 shows the E-plane and H-plane copolar and cross-polar patterns at the central frequencies of the two bands. The gain of the antenna has been studied using rectangular microstrip antennas fabricated on the same substrate and resonating at the same frequencies. For the second resonance, no deterioration in antenna gain is observed until the central width reaches $0.5B$; beyond that point, the gain decreases. For the first mode, the gain in all cases is found to be less than that of corresponding rectangular patch antennas. Here, the reduced gain may be compensated by integrating amplifiers on the substrate or by the superstrate technique [5].

Conclusions: A new dual frequency compact microstrip antenna configuration with a wide range of variation of the frequency ratio is presented. The new configuration takes advantage of the compactness of drum-shaped microstrip antennas, along with the dual frequency operation provided by a shorting pin. This new configuration may find applications in mobile satellite communication systems.

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