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Optimization of Impedance Bandwidth for the Printed Rectangular Monopole Antenna

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Optimisation of Impedance Bandwidth for the Printed Rectangular Monopole Antenna

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Abstract

This paper describes a printed rectangular-plate monopole, fed by microstrip line. The effect of varying plate width, feed-gap height and feedline width on the impedance bandwidth is examined. It is shown that for a fixed ground-plane size, that optimisation of these parameters can yield an impedance bandwidth ratio of 4.3:1, without using any broadbanding techniques.

Introduction

The planar monopole antenna has been shown to be a useful candidate for wideband communications systems. Broadbanding techniques such as the use of shorting posts and bevels have enhanced the bandwidth [1]. Recently, these antennas have been fabricated onto printed circuit boards, which enables easy integration. [2]. Multiband printed monopoles have been reported [3, 4] and techniques employed to reduce the lower edge frequency [5]. The printed rectangular antenna described, has been optimised to provide an impedance bandwidth of 1.59GHz to 6.89GHz. This makes it suitable for systems such as GSM1800, PCS1900, IMT-2000, WLANs and UWB. Radiation patterns for a similar printed geometry have been reported [6] to be suitable for wireless communications and are not shown here for brevity.

Antenna Geometry

The structure of the antenna is shown in Figure 1. A rectangular monopole is printed on one side of an FR4 substrate with the groundplane located on the other side. The dimensions for the substrate are l=90 mm and w=50 mm. With h_g=50 mm the groundplane is 50 × 50 mm. This size yielded the optimum impedance bandwidth. The antenna plate is fed by a microstrip feedline (w_f=2.5 mm) using an SMA connector. The dimensions of the plate are w_p=20 mm and h_p=30 mm. It is located h_{gap}=2 mm above the groundplane, as shown in Figure 1. The substrate is 1.52 mm thick and the metallization thickness is 35 μm.

Measurements and Simulation

The antenna was simulated in CST Microwave Studio using the finite-integration time-domain technique. Figure 2 shows the measured and simulated return loss from 1 GHz to 10 GHz, which are in good agreement. The measured return loss is greater than 10 dB from 1.59 GHz to 6.89 GHz.

Parameter Dependence

For printed monopole type antennas, the impedance bandwidth is heavily dependent on the ground-plane size. In many cases, the ground-plane size is fixed, due to physical limitation. Hence, it is useful to optimise using parameters such as plate width, w_p,, feedgap height, h_{gap} and feedline width, w_f. The optimisation sweeps were carried out using a quasi-Newton interpolation optimiser.

Feed-Gap

The height of the gap (h_{gap}) between the ground-plane and the rectangular plate was varied from 0 mm to 4 mm. The return loss was measured and the impedance bandwidth (10 dB return loss) variation with feed-gap is shown in Figure 3. It can be seen that the maximum bandwidth is achieved when the gap is between 2 mm and 3 mm with a peak at 2 mm.

Feedline Width

The width of the microstrip feedline was varied from 1mm to 4mm. This represents varying the characteristic impedance of the feedline from 85 Ω to 41 Ω. The plot of impedance bandwidth against feedline width is illustrated in Figure 4. It can be seen that the bandwidth is relatively constant between 1.5 mm and 3 mm, implying that the bandwidth is not very sensitive to feedline width.

Plate Width

The width of the rectangular antenna element was varied from 10 mm to 30 mm. Figure 5 shows the behaviour of impedance bandwidth when the plate width is varied. The plot shows that the maximum bandwidth is achieved for a 20 mm wide plate.

Conclusions

A wideband printed rectangular plate monopole has been presented. The Dependence of the bandwidth on the plate width and feed gap has been investigated. The results have shown that a plate width of 20 mm and a feed gap of 2 mm yield the widest bandwidth. The achieved impedance bandwidth ratio is 4.3:1.

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Figure Captions

Figure 1: Geometry of the printed plate monopole

Figure 2: Plot of measured and simulated return loss for the printed antenna

Figure 3: Plot of bandwidth sensitivity to feedgap

Figure 4: Bandwidth dependence on feedline width

Figure 5: Bandwidth dependence on feedline width

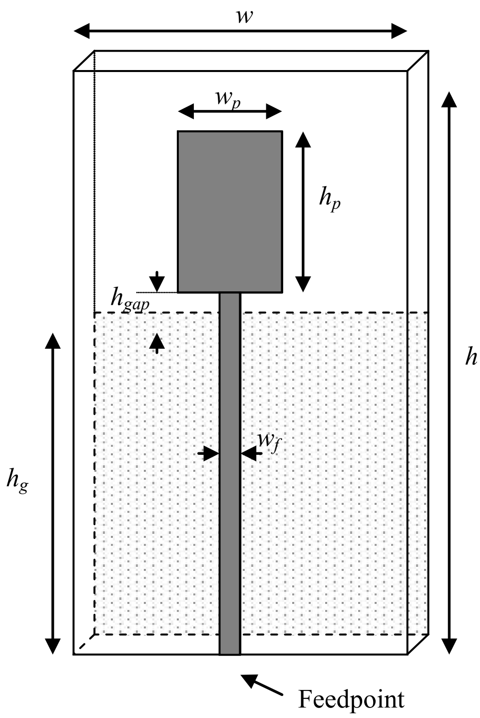

Figure 1 Geometry of the printed plate monopole

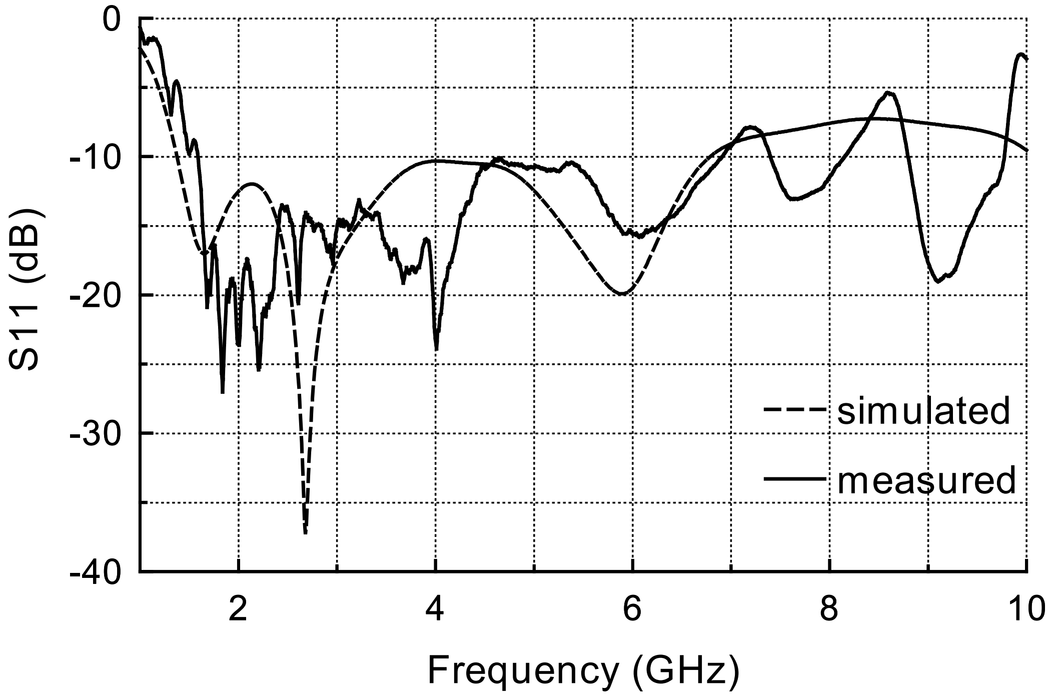

Figure 2 Plot of measured and simulated return loss for the printed antenna

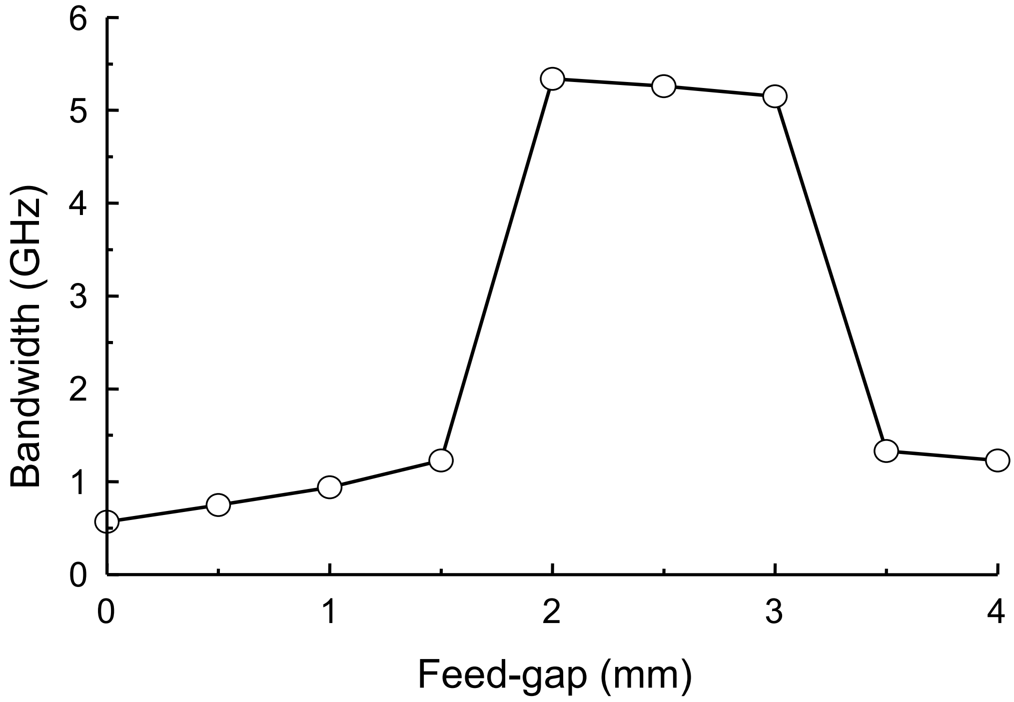

Figure 3 Plot of bandwidth sensitivity to feedgap

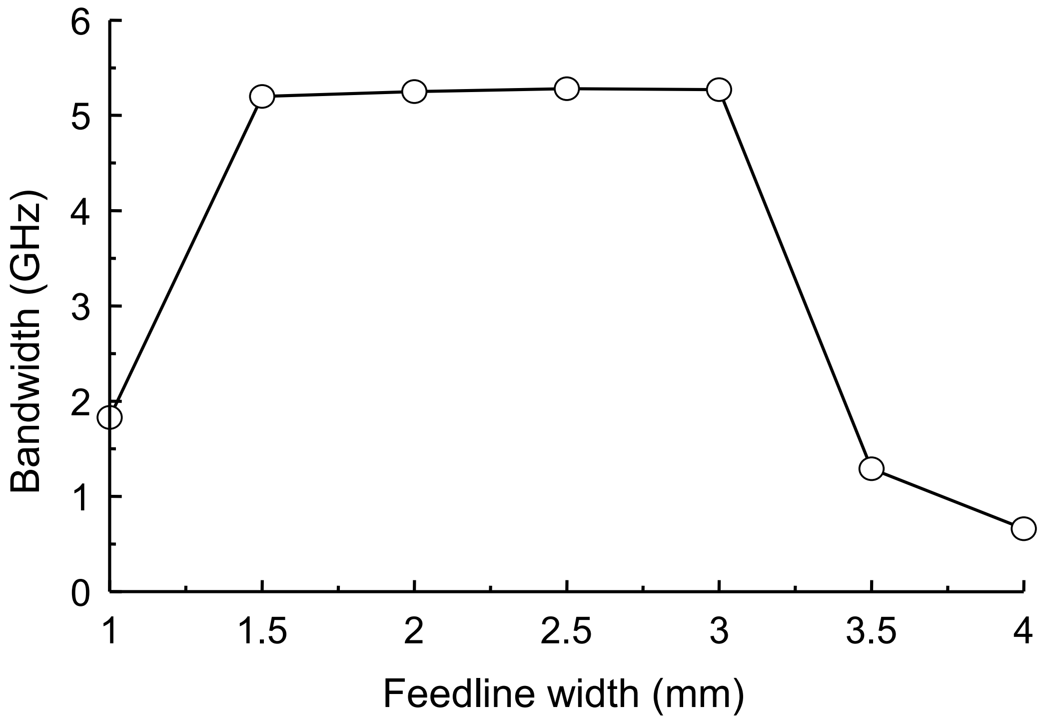

Figure 4 Bandwidth dependence on feedline width

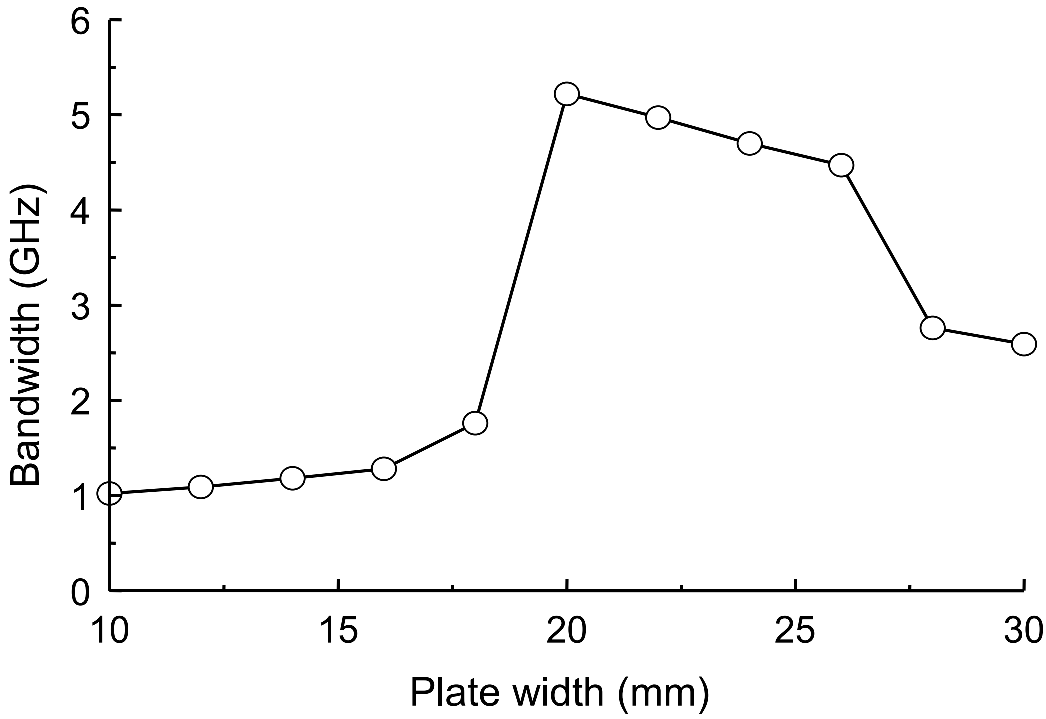

Figure 5 Bandwidth dependence on feedline width