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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  $50 \times 50$  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  $\mu\text{m}$ .

## **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  $\Omega$  to 41  $\Omega$ . 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

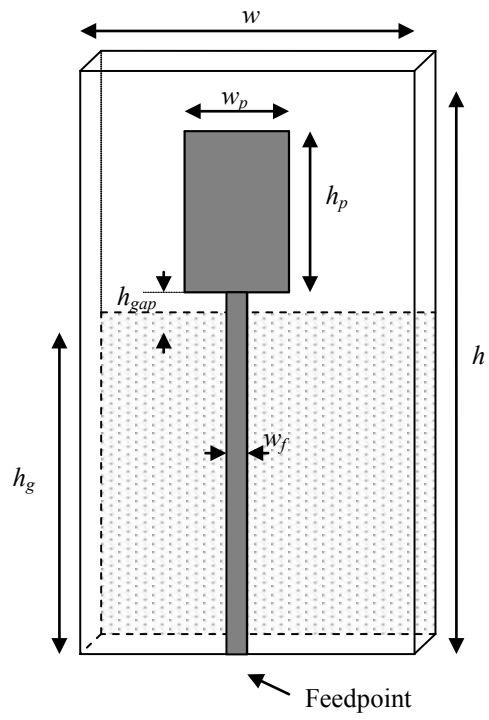
Figure 1: Geometry of the printed plate monopole

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

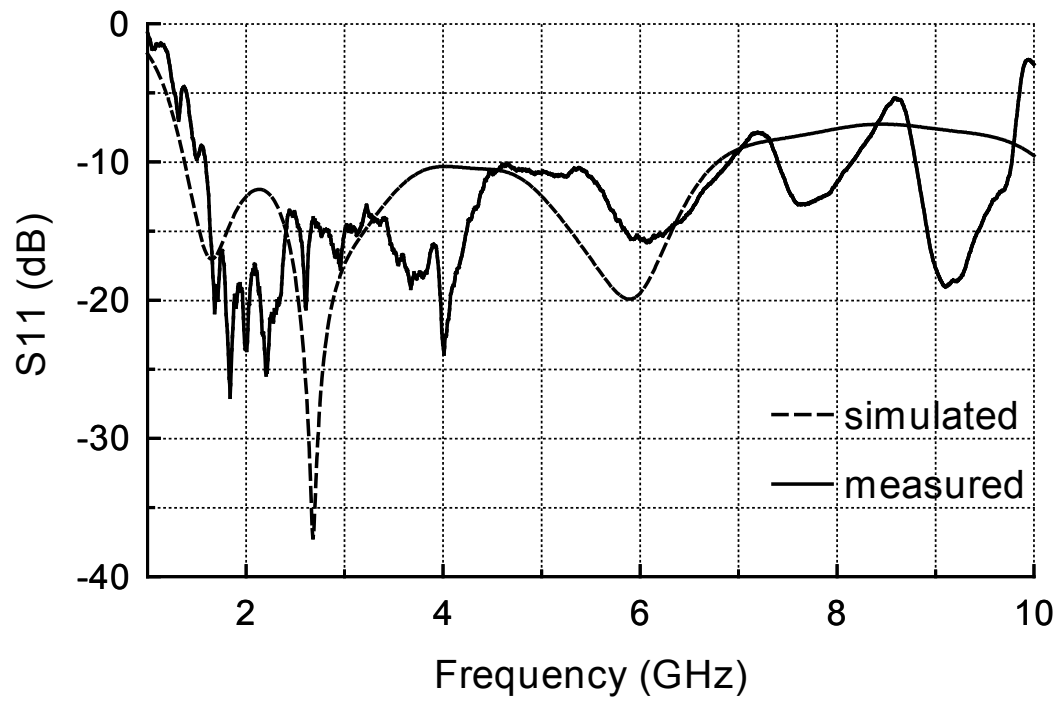
Figure 3: Plot of bandwidth sensitivity to feedgap

Figure 4: Bandwidth dependence on feedline width

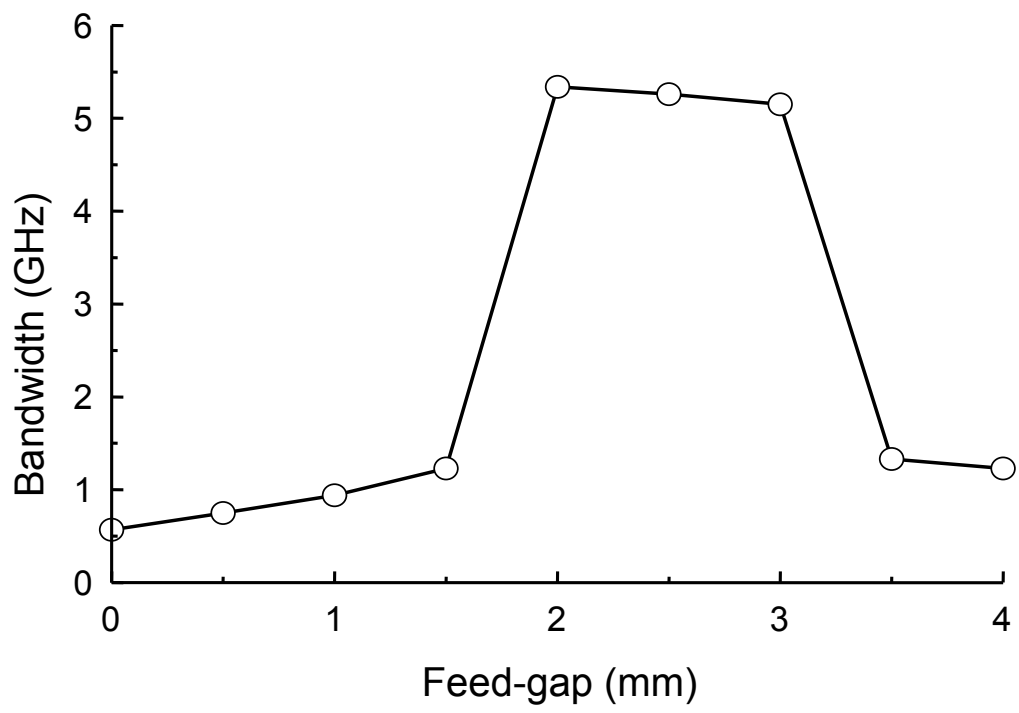
Figure 5: Bandwidth dependence on feedline width



**Figure 1** Geometry of the printed plate monopole

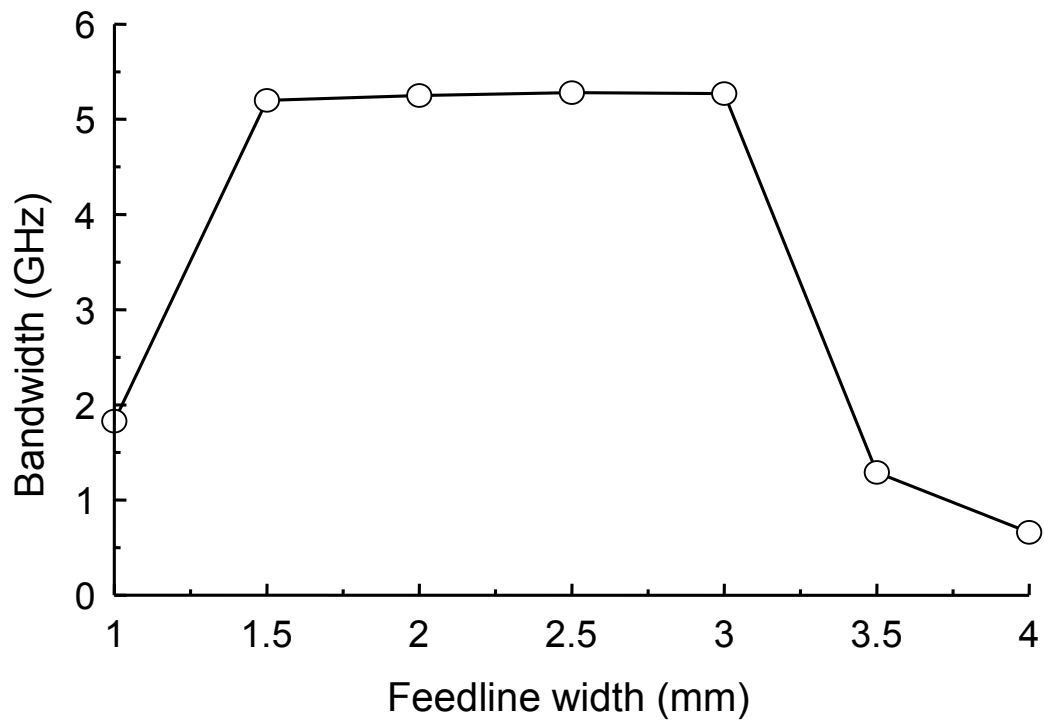


**Figure 2** Plot of measured and simulated return loss for the printed antenna

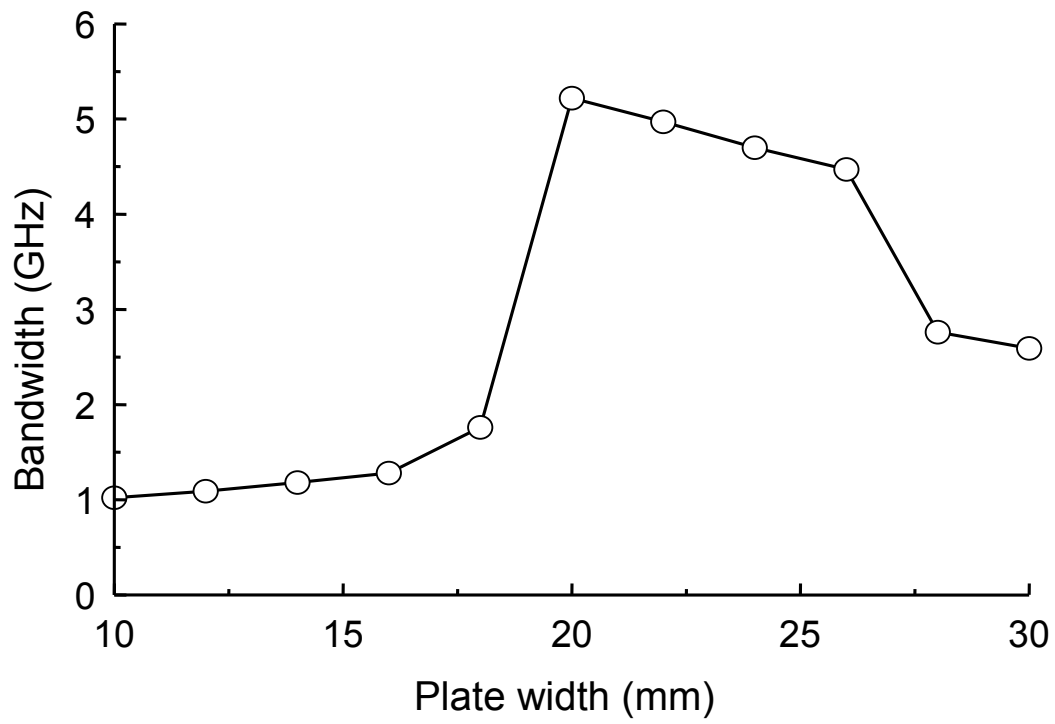


**Figure 3** Plot of bandwidth sensitivity to feedgap





**Figure 4** Bandwidth dependence on feedline width



**Figure 5** Bandwidth dependence on feedline width