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## A WIDEBAND MONOPOLE FOR RECONFIGURABLE MULTIBAND RADIO TERMINALS

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### INTRODUCTION

The square planar monopole was first reported in 1976 by Dubost and Zisler [1] and radiation patterns were given over a range of frequencies. Wideband planar disc antennas have been recently studied [2] and employed for the Japanese television band [3]. The dependency of impedance bandwidth on feedgap separation has been analysed [4] and an optimised shorted planar monopole covering 1.6 GHz to 6 GHz, with no distortion in radiation pattern has been reported [5]. The addition of a bevel on one side of the planar geometry is shown to increase the bandwidth with good control of the upper edge frequency.

### BACKGROUND

The use of a single ultra-wideband antenna which covers a wide range of frequencies is very desirable for future wireless communications systems. The emerging self-organising and ad-hoc networks are required to operate over a wide range of frequencies or operate in a multiband manner. Ultra-wideband antennas are an attractive alternative to multiband antennas for future software-defined and reconfigurable radio systems.

The proposed antenna can cover future wireless data networking frequencies from 800 MHz to greater than 8 GHz. Included in this range of frequencies are GSM900, DCS1800 (1.72 GHz to 1.88 GHz), PCS, the 2.4 GHz and 5.8 GHz ISM bands and the U-NII, (5.15 - 5.35 GHz) and (5.725 - 5.825 GHz). Also included are frequency bands employed by DECT (1.880-1.900 GHz), UMTS (1.920-2.180 GHz), wireless LANs, the European HiperLAN I, II recent Bluetooth systems and WLL (3.4-3.6 GHz, 10 GHz)..

### SQUARE PLANAR MONOPOLE ANTENNAS

The simple square planar monopole has been shown to have an impedance bandwidth of 75-100 % [4, 6] and the addition of a shorting post increases this to about 400% [5], which represents an impedance bandwidth ratio of 4:1. The simple square planar monopole and shorted planar monopole are shown in Figure 1. The shorting post is used to excite a lower order mode and reduces the lower edge frequency [7]. However, even though an impedance bandwidth ratio of up to 4:1 is feasible with this element, future systems demand more. The addition of a bevel on the opposite side to the shorting post is necessary to provide a 10:1 impedance bandwidth ratio. Trimming the square edge near the

groundplane yielding trapezoidal and pentagonal geometries, has been shown to increase the upper edge frequency significantly [8], [9]. The shorted planar monopole with bevel is shown in Figure 2. The bevel increases the upper edge frequency, and control of this frequency is possible by choice of bevel angle. The upper edge frequency is increased with increase of bevel angle up to about 40°.

#### ANTENNA DESIGN

The antenna is constructed using 0.2 mm thick copper sheet on a 100 mm square groundplane and feed using a SMA connector. The square dimension  $L$ , is 60 mm, the shorting strip is 2 mm wide and the feedgap used is 2 mm. The square geometry is bevelled on the side opposite the shorting strip and the angle is 30°. See Figure 2.

#### IMPEDANCE AND PATTERN BANDWIDTH

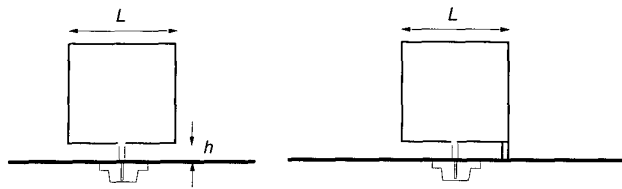
The return loss is greater than 8 dB over the frequency range 790 MHz to 10 GHz, and greater than 10 dB over the ranges 790-900 MHz, 1.1-1.9 GHz, 2.8-4.5 GHz, 5-6 GHz and 7.9-10 GHz. The swept return loss is shown in Figure 3. The radiation patterns are given in Figure 4 and 5 and indicate nearly omnidirectional patterns for the H-plane at lower frequencies and typical monopolar patterns for the E-plane cuts. The planar element lies in the  $\phi = 90$  plane with the shorting strip at  $\phi = -90$  and a right-handed coordinate system is used. The plots are simulated using a hybrid GTD/MoM code and are given at 900 MHz, 4.5 GHz and 7.5 GHz.

#### CONCLUSIONS

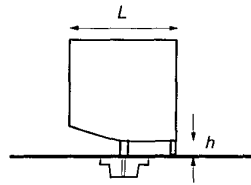
A wideband planar monopole employing two broadbanding techniques has been investigated, and is shown to yield an impedance bandwidth ratio of 10:1 or greater for a return loss of 8 dB. The radiation pattern bandwidth is also investigated.

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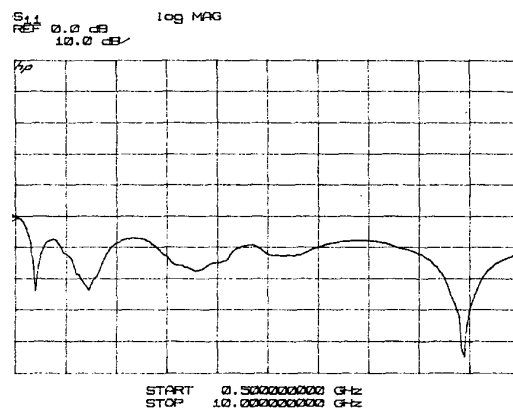
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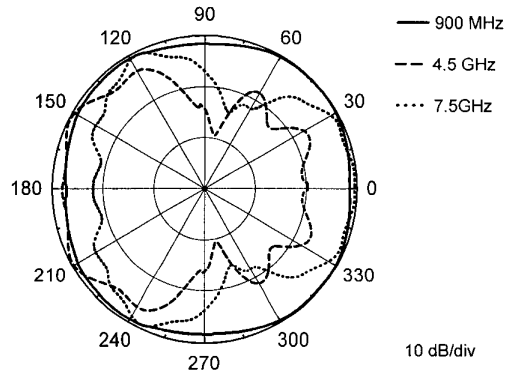
**Figure 1.** The simple square planar monopole and shorted planar monopole are fed using an SMA connector, through a 100 mm square groundplane.



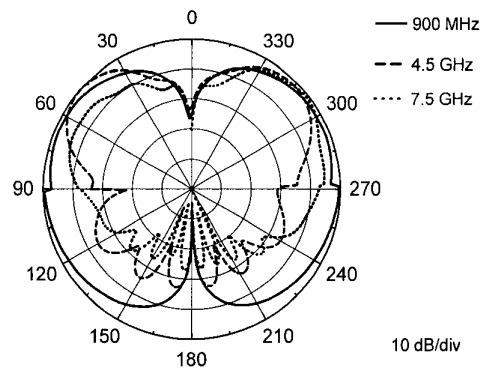
**Figure 2.** The addition of a 30° bevel to the shorted element raises the upper edge frequency significantly.



**Figure 3.** Return loss for the 60 mm square element with shorting strip and bevelled lower edge shows an 8 dB return loss from 790 MHz to higher than 10 GHz.



**Figure 4.** H-plane radiation patterns  $E_{\theta}(\phi, \theta = 90)$  for the antenna show a nearly omnidirectional pattern at the lower frequencies.



**Figure 5.** E-plane patterns  $E_{\theta}(\theta, \phi = 0)$  are typically monopolar.