2005-01-01

Printed Triband Terminal Antenna

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Recommended Citation

John, M., Ammann, M. & Farrell, R. (2005) Printed Triband Terminal Antenna. *IEE Wideband and Multi-band Antennas and Arrays*, 7 September, 2005, pp.19- 23. doi:10.1049/ic:20050281

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Abstract

This paper presents a printed triple-band multibranch monopole for use in modern wireless systems. The antenna is designed to operate in three bands which cover virtually all wireless channels. Parameters of the antenna geometry are varied and the effects of these variations on the impedance bandwidth are shown.

Introduction

The proliferation of wireless communications systems has placed enormous demands on antenna development. The requirements of antennas to be small, low-cost, have quasi-isotropic patterns over wide or multiple bandwidths and be integratable into radio circuitry are generally not always attainable. Many trade-offs are commonly made, juggling between parameters. The printed monopole is a suitable candidate with many variations proposed for dualband operation [1-4]. In this paper, a simple multibranch monopole printed on low-cost laminate is proposed as a triple-band terminal antenna, offering all of the above requirements to a greater degree.

Antenna Geometry

The triple band monopole is printed on one side of an FR4 substrate with a square groundplane located at the back. The FR4 properties are (t=1.52 mm, 35 μm, Dk(2GHz) = 4.3, tanδ(2 GHz) = 0.02). The dimensions of the substrate are l=45mm by w=80mm by t=1.52mm. With l_g=45m the groundplane is square. The monopole is fed by a w_f=2mm wide microstrip feedline. The dimensions of the antenna are l_m=28mm, l_l=15.8mm, w_l=4mm, l_r=10.6mm and w_r=4mm. The tap-off point is located h_t=2mm above the groundplane. These dimensions were obtained using a quasi-newton-opimiser, optimising for the full coverage of three wireless bands. The antenna geometry is shown in Figure 1.

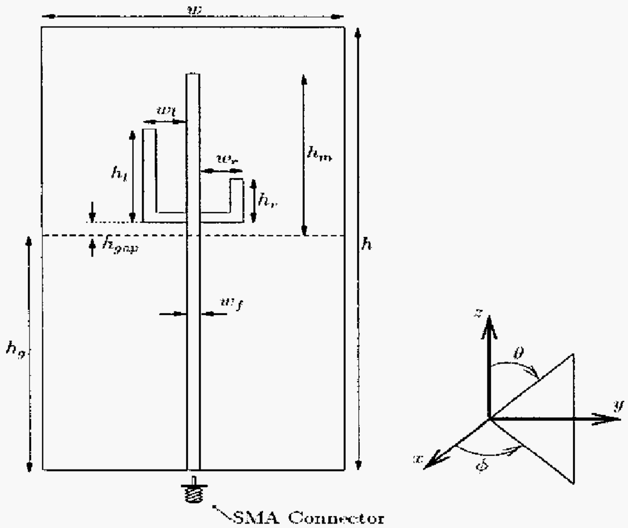

Figure 1: Geometry of the printed multibranch monopole

Simulation and Measurement

The antenna was modelled in CST Microwave Studio. The simulation with finite-integration time-domain technique is in good agreement with measurement results. The measurements were made using a Rohde & Schwarz ZVB network analyser. The simulated and measured return loss is shown in Figure 2. The three bands in which the return loss in greater than 10dB are 1.8GHz to 2.7GHz, 3.4GHz to 3.7GHz and 4.8GHz to greater than 6GHz. The lower band includes GSM1800/PCS1900, IMT-2000, the 2.45 GHz ISM band, WLAN, IEEE 802.11b, g and the IMT-2000 Extension band (2.5-2.7GHz). The middle band includes WiMax and WLL. The upper band covers IEEE 802.11j, a, the US-NII and the 5.8 GHz ISM band.

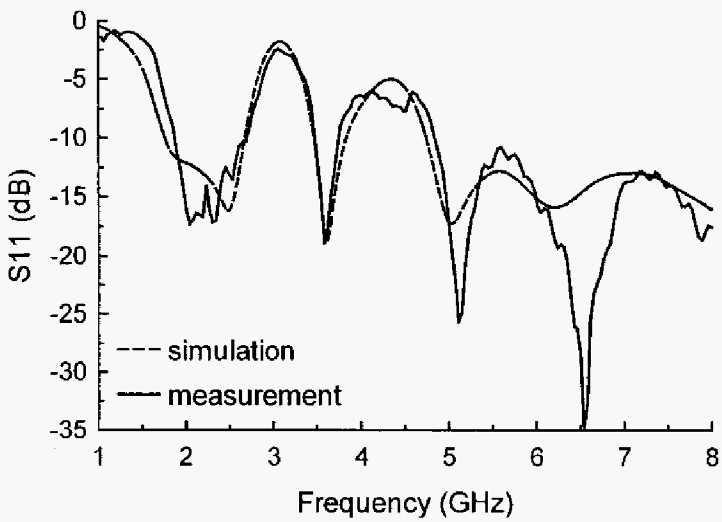

Figure 2: Measured and simulated return loss

Due to FR4 substrate being used, total radiation efficiency drops from 89% at 2GHz to 69% at 6GHz. This efficiency reduction must be considered above 6GHz

Parameter Dependence

The dependence of impedance bandwidth on the height of the tap-off point (h_t) was investigated for the three bands. Therefore, h_t was varied from 0mm to 4mm and the return loss was measured. The bandwidth of the three bands is shown in Figure 3. The upper and middle bands show maximum bandwidth for tap-off heights between 1.5mm and 2.5mm. The lower band increases steadily with tap-off height.

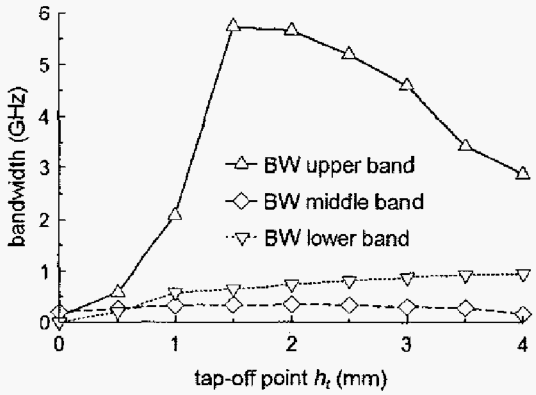

Figure 3. Impedance bandwidth dependence on tap-off point

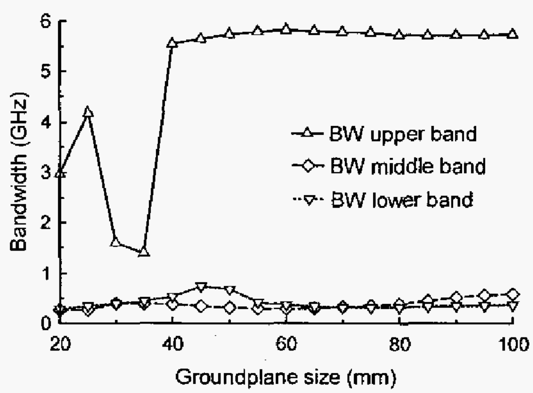

Figure 4. Impedance bandwidth dependence on groundplane size

The groundplane size was varied from 20mm to 100mm square. The bandwidth of all three bands is shown in Figure 4. The upper band shows maximum bandwidth for groundplane sizes above 40mm. The lower band has its optimum bandwidth from 40mm to 50mm groundplane size. The middle band shows very little dependence on groundplane size. It should be noted that the FR4 loss contributes significantly to antenna bandwidth at the upper band, but its contribution at the lower band is negligible. The bandwidth for the upper band for a tap-off point of 2.5 mm would be 3 GHz instead of 5.5 GHz, if the laminate were low-loss.

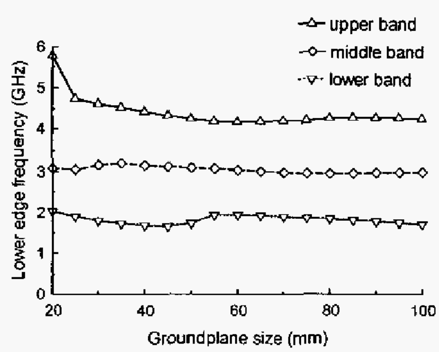

Figure 5. Lower edge frequency dependence on groundplane size

When dealing with small antennas, it is sometimes useful to examine the lower edge frequency (LEF) dependence on groundplane size. The effect on the lower edge frequency of the three bands is shown in Figure 5. Standard deviations of the lower edge frequencies are 10% for the lower band, 7% for the middle band and 37% for the upper band (16% ignoring the first value (20mm GP)). It can be seen that a GP size of 45 mm yields the lowest LEF for the first band.

Radiation Patterns

Simulated patterns are presented in Figure 6. The maximum gain is 3.0dBi at 2GHz, 2.5dBi at 3.4GHz and 3.4dBi at 5.5GHz.

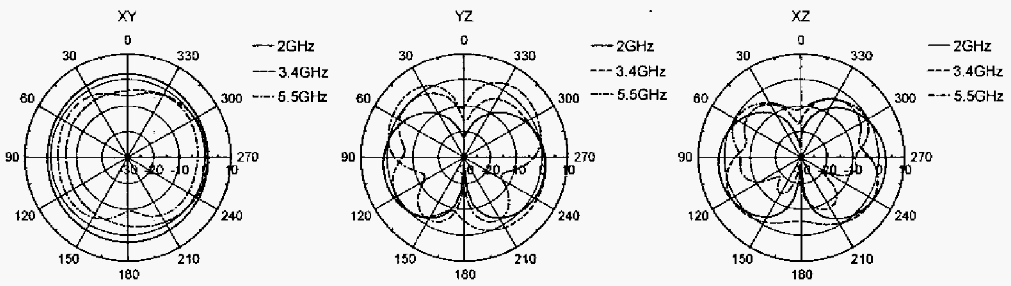

Figure 6: Radiation Patterns for the (xy), (yz) and (xz) planes at 2GHz, 3.4GHz and 5.5GHz

Conclusion

A printed tripleband multibranch monopole was presented in this paper. It was investigated how the bandwidth depends on various parameters of the antenna geometry. The antenna was optimised to achieve optimum bandwidth in the desired frequency bands.

Acknowledgements

This work has been supported by the Science Foundation Ireland.

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