

**WestminsterResearch**

<http://www.westminster.ac.uk/westminsterresearch>

**UWB Filtennas with Dual Bandnotch for WiMAX and WLAN Bands  
using Circular and Square Resonators**

**Ahmad, W. and Budimir, D.**

This paper is a postprint of a paper submitted to and accepted for publication in the 2016 *Active and Passive RF Devices Conference*, London, UK, 17 Feb 2016, Institution of Engineering and Technology (IET) and is subject to Institution of Engineering and Technology Copyright. The copy of record is available at the IET Digital Library:

<https://dx.doi.org/10.1049/ic.2016.0004>

---

The WestminsterResearch online digital archive at the University of Westminster aims to make the research output of the University available to a wider audience. Copyright and Moral Rights remain with the authors and/or copyright owners.

---

Whilst further distribution of specific materials from within this archive is forbidden, you may freely distribute the URL of WestminsterResearch: (<http://westminsterresearch.wmin.ac.uk/>).

In case of abuse or copyright appearing without permission e-mail [repository@westminster.ac.uk](mailto:repository@westminster.ac.uk)

# UWB Filtennas with Dual Bandnotch for WiMAX and WLAN Bands using Circular and Square Resonators

Waqas Ahmad\* and Djuradj Budimir<sup>†</sup>

\*<sup>†</sup>Wireless Communications Research Group, University of Westminster, 115 New Cavendish Street, London, W1W 6UW, United Kingdom

<sup>†</sup>d.budimir@westminster.ac.uk

**Keywords:** uwb, filtennas, bandnotch, ring resonators.

## Abstract

This paper presents the design and results of an UWB filtenna with dual bandnotch present at WiMAX 3.5 GHz and WLAN 5.8 GHz bands. The filtenna is formed by the implementation of a filtering section - consisting of a circular ring resonator and two square ring resonators - within an UWB antenna. The filtenna was simulated using electromagnetic software and the simulated results of return loss, radiation patterns, gain and efficiency have been presented. The return loss of the filtenna show a passband from 2.93–12.32 GHz; with dual bandnotch present at 3.48 GHz and 6 GHz at a return loss of less than 3 dB. Also, the results indicate that the gain and efficiency of the filtenna is significantly reduced at the dual bandnotch frequencies. Obtained radiation results show stable bi-directional patterns in the E-plane and omnidirectional patterns in the H-plane.

## 1 Introduction

Since the release of unlicensed frequency band 3.1–10.6 GHz for ultra-wideband (UWB) commercial communications [1], the race for commercialising UWB technology is heating up. The UWB covers a wide frequency range and is overlapped with a number of other wireless services; such as WiMAX and WLAN bands of 3.4–3.6 GHz and 5.725–5.825 GHz respectively. Since the power level of these frequency bands is more than that of the UWB, these services interfere with UWB signals, causing signal distortion and loss of sensitivity. Hence, filtering is needed for using the UWB in the best way.

A possible and effective solution is to realise notches at the unwanted frequencies. In order to achieve this, a number of techniques can be employed, such as employing stubs [2], [3] applying slots [4] and capacitive loops [4] or using split-ring resonators [5]. However, in the above-mentioned works, either the filters have been cascaded with the antenna [2]–[3], rather than being integrated within – thus the filtennas are higher in costs, have bigger sizes and are more complex – or the bandnotch are not sharp enough or not at a good rejection value [4]–[5].

This work presents an UWB filtenna, which is developed by incorporating circular and square ring resonators within the

top metallisation of an UWB filtenna. This procedure does not affect the size at all and the obtained bandnotch are measured at a good rejection value and are sharp.

## 2 Layout of the Proposed Filtenna

The proposed filtenna is illustrated in Figure. 1. The filtenna is designed with a mid-band frequency of 6.85 GHz. It is inductively coupled to the source and is excited via port 1 with a 50  $\Omega$  feedline. The designed structure utilises defected ground structure with a partial ground plane of length 13.1 mm. The filtenna is symmetrical with respect to in the longitudinal. A spade shape is chosen for the top design. Due to the gradual change in structure of the radiating patch of this shape, a broadband impedance bandwidth is easily achieved. This also provides a smooth shift from one resonant mode to another. Between the top patch and the feedline, lie two rectangular patches of different sizes. These improve impedance matching and also provide good characteristic at the higher frequencies.

The bandnotch at 3.5 GHz is caused by a  $\lambda_g/2$  circular ring resonator which lies within the top radiating patch; where  $\lambda_g$  is the guided wavelength at 3.5 GHz. The length of the circular resonator may be determined by subtracting the gap of 0.8 mm from the outer circumference of the resonator. The end-value would be roughly equal to  $\lambda_g/2$  at 3.5 GHz. The 5.8 GHz bandnotch is formed by the two coupled square ring resonators. Two resonators have been used in order to enhance the capacitive coupling and obtain better rejection characteristics. Each resonator is  $\lambda_g/2$  long; where  $\lambda_g$  is the guided wavelength at 5.8 GHz. Similar to the calculation of the circular resonator, the gaps of 0.5 mm have to be subtracted from the total perimeters of the two square resonators.

Further optimisation and fine-tuning of the lengths of the three resonators may be required with the aim of achieving the exact frequency bands. At each bandnotch frequency, the current within the top metallisation will be concentrated around the edges of the respective resonator; thereby a stopband at that frequency will be obtained.

In order to obtain the reference characteristics of the filtenna without the resonators, all three resonators were removed and the subsequent structure simulated as well.



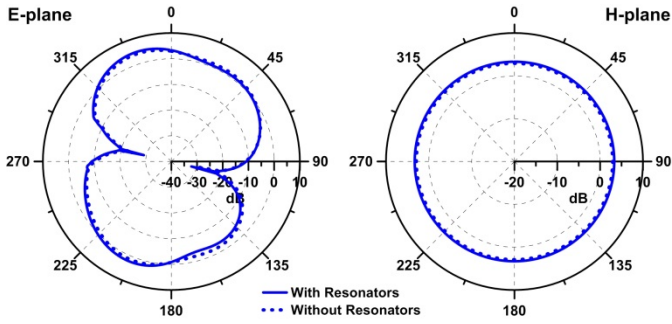


Figure 4: Radiation patterns of filtenna at 8.25 GHz.

### 3.3 Gain and efficiency

The simulated gain and efficiency of the filtenna have been presented in Figure. 5 and Figure 6 respectively. The average gain within the passband of the structure is 4.28 dBi. The gains at the dual bandnotch frequencies of 3.48 GHz and 6 GHz are reduced at 0.21 dBi and -2.48 dBi. The gain response is echoed in the efficiency result as well: while the average efficiency within the passband is 93.9 %, this value drops to about 15.8 % and 19.3 % at the two bandnotch respectively.

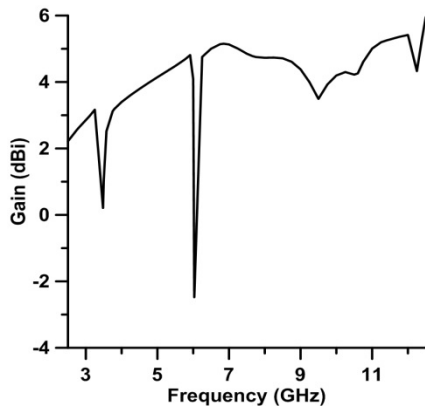


Figure 5: Gain of filtenna.

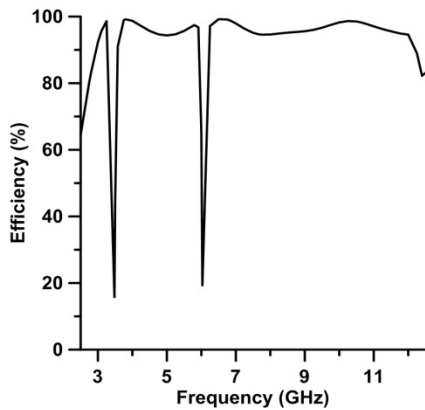


Figure 6: Efficiency of filtenna.

## 4 Conclusion

In this work, an UWB filtenna has been proposed and presented. The filtenna has been formed by incorporating a circular ring resonator and two square ring resonators within the top metallisation of the proposed structure. The simulation results of the filtenna have been provided. A full UWB, with dual bandnotch present at 3.48 GHz and 6 GHz, has been attained for the filtenna. Even though the dual bandnotch frequencies have been slightly shifted from the intended goal, these can be easily adjusted in the final design. The gain and efficiency of the filtenna also show a significant dip in their values at the dual bandnotch. This filtenna configuration could be quite useful for indoor UWB applications with no interferences from WiMAX and WLAN signals.

## References

- [1] FCC. "Revision of part 15 of the commission's rules regarding ultra-wideband transmission systems", *First Note and Order Federal Communications Commission*, pp. 98–153, (2002).
- [2] J. R. Kelly, P. S. Hall, P. Gardner. "Band-notch UWB antenna incorporating a microstrip open-loop resonator", *IEEE Transactions on Antennas and Propagation*, volume 59, number 8, pp. 3045–3048, (2011).
- [3] Y. Sung. "Triple band-notched UWB planar monopole antenna using a modified H-shaped resonator", *IEEE Transactions on Antennas and Propagation*, volume 61, number 2, pp. 278–280, (2013).
- [4] C. Lin, P. Jin, R. Ziolkowski. "Single, dual and tri-band-notched UWB antennas using CLL resonators", *IEEE Transactions on Antennas and Propagation*, volume 60, number 1, pp. 102–109, (2012).
- [5] J. Y. Siddiqui, C. Saha, Y. Antar. "Compact SRR loaded UWB circular monopole antenna with frequency notch characteristics", *IEEE Transactions on Antennas and Propagation*, volume 62, number 8, pp. 4015–4020, (2014).