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MONOPOLE RECTANGULAR MICROSTRIP ANTENNA FOR ULTRA WIDEBAND WIRELESS COMMUNICATION APPLICATIONS

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ABSTRACT

A novel ultra-wideband planar monopole rectangular microstrip antenna (UWBMRMSA) for wireless communication is presented in this paper. The antenna consists of symmetrical corner truncations on the rectangular patch. The proposed antenna is housed in a volume of 24 × 23.3 × 1.6 mm^3. The antenna is energized by microstripline feed arrangement. The operational impedance bandwidth of this antenna is 141.47% (1.76-10.27 GHz) with an impedance bandwidth ratio of 5.83:1 in its operating frequency. The antenna exhibits nearly omni-directional radiation characteristic. The peak gain of the antenna is 4.94 dB. The design of proposed antenna and its various parameters are studied by using the Ansoft High Frequency Structural Simulation (HFSS) software. The results are presented and discussed. The antenna shows good agreement of experimental and simulated results. This antenna may be used for different applications lies in the UWB range mobile such as Bluetooth (2.8 GHz) WIMAX (3.4 GHz), WLAN (2.4/5 GHz), UMTS and Ultra-wideband (UWB) (3.1- 10.6 GHz).

KEYWORDS: Monopole, UWB, Modified rectangular, Symmetrical corner truncations, Partial ground, UMTS

In personal mobile wireless communication system development the antenna having high data rate with large bandwidth is required. A conventional rectangular microstrip antenna exhibits the drawback of narrow impedance bandwidth. Numerous techniques have been investigated and reported to enhance the antenna impedance bandwidth. This includes employing slot on the patch, defective ground plane, truncated patch antennas, gap-coupled feed, monopole feed antennas (Lim, Wang, et al.; 2010). The monopole feed antennas with defective ground planes are widely used foe wide bandwidth (Dong, Hong, et al.; 2009). Many planar monopole antennas using different shapes like, rectangular, circular, triangular, hexagon, elliptical have been reported in the literature (Huang and W. Hsia, 2005), which yields UWB characteristics justifying the allocated UWB spectrum (3-10 GHz), including for the use of other narrowband services like, Wi-Max, C-band satellite communication (3.7-4.2 GHz), WLAN, IEEE 802.11a etc.

In this paper a simple compact geometry monopole rectangular microstrip antenna consisting of symmetrical corner truncations and a partial ground plane is presented for UWB frequency with stable radiation characteristics. Such kind of antenna is found to rare in the literature.

ANTENNA GEOMETRY AND DESIGN

Figure 1 (a) and (b) shows the top view and side view geometry respectively of conventional rectangular microstrip antenna (CRMSA). The L_s and W_s are the length and the width of the substrate. W and L are the length and width of the radiating patch respectively. A microstripline feed of length L_f width W_f is used to excite the antenna with a use of quarter wave transformer possessing the length L_t and width W_t to match impedance between radiating patch and microspline feed. The antenna is designed at 3GHz on low cost modify epoxy substrate material of thickness 1.6 mm with a relative dielectric constant of 4.2 and tan δ of 0.02.

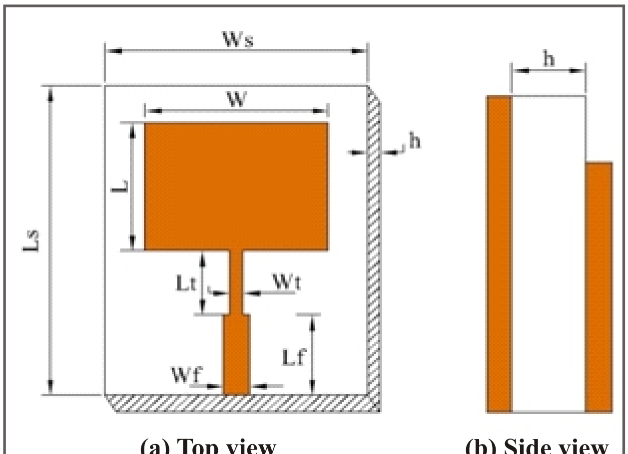

Figure1. Geometry of CRMSA (a) Top view (b) Side view

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Figure 2 shows the geometry of proposed UWBMRMSA. A and B are the length and width of the substrate which is 60×60 mm^2. The partial ground plane of length L_g= 21.3 mm with a 2 mm gap between the patch and the ground plane is used. The symmetrical truncations n_1 and n_2 of dimensions 4×5.5 mm^2 showing length L′ and width W′ are placed at the bottom edge of the patch. The design parameters along with dimensional values are given in table-1. The photograph of CRMSA and UWBMRMSA is as shown in Figure 3 (a) and (b).

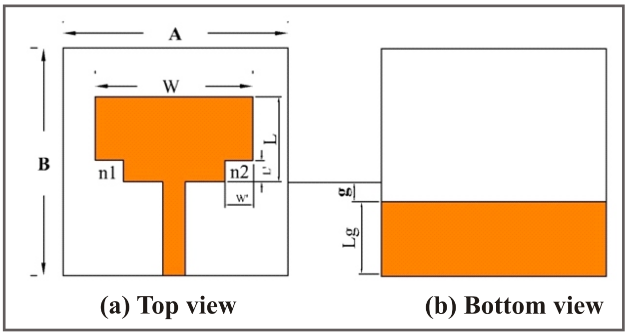
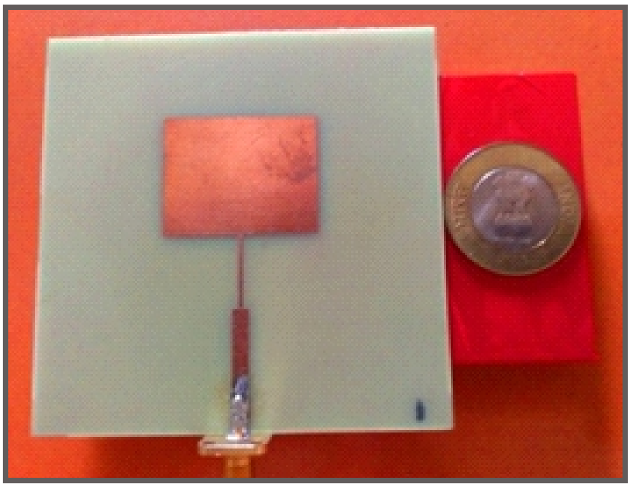


Figure2. Geometry of UWBMRMSA

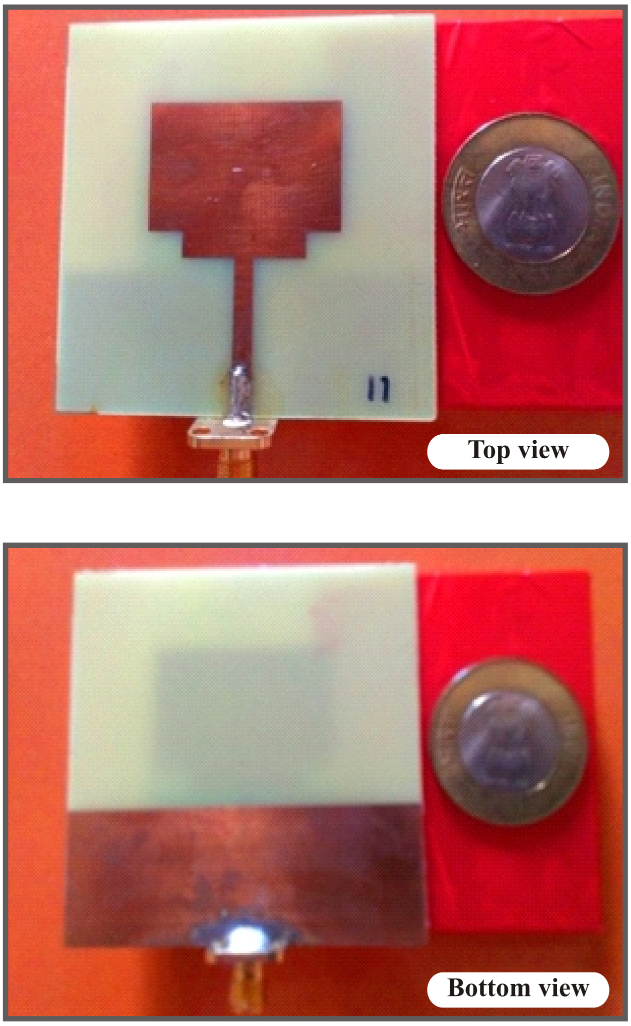
RESULTS AND DISCUSSION

The CRMSA and UWBMRMSA are simulated using HFSS software. The prototype of the antennas are fabricated and experimentally analyzed with a Rohde & Schwarz (ZVK model 1127.8651) vector network analyzer. Figure 4 shows the variations of return loss versus frequency curves for CRMSA. It is seen that, simulated and experimental results are almost same. The antenna resonates at 2.88 GHz, which is very close to the designed frequency of 3 GHz. The antenna gives an impedance bandwidth of about 2.43% with a maximum gain of 3.71 dB.

The return loss versus frequency response of the UWBMRMSA is as shown in Fig.5. From this figure it is clearly seen that, the antenna resonates over an operating frequency range of 1.76 to more than 10 GHz giving a maximum bandwidth of 141.47%. Further, it is also clear from this figure that, there is a qualitative agreement between the measured and simulated results. The slight difference between the measured and simulation results is observed due to influence of the coupling effect between the 50Ω SMA connector, physical tolerance in relative permittivity of dielectric material and surrounding reflections. By comparing the physical patch geometry of UWBMRMSA to that of CRMSA, the patch size of UWBMRMSA is 59.13% in small compared to the patch



(a) CRMSA



(b) UWBMRMSA

Figure3. Photograph of fabricated CRMSA and UWBMRMSA

area of CRMSA. With this compact size of UWBMRMSA the antenna gives 58.21% wider impedance bandwidth when compared to the impedance bandwidth of CRMSA.

Table 1: Distribution of Study Population

Antenna parameters in mm	CRMSA	UWBMRMSA		Antenna parameters in mm	CRMSA	UWBMRMSA	
L_s	80	n_1	n_2	60	-	L'	W'
						4	5.5
W_s	80	60		L_g	-	21.3	
L	24	24		g	-	2	
W	31	31		L_f	23.3	23.3	
L_t	14.64	-		W_f	3.2	3.2	
W_t	0.78	-					

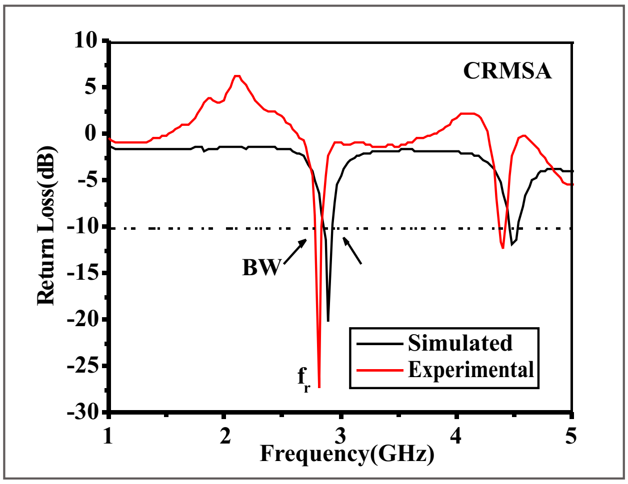


Figure 4: Variation of return loss and frequency of CRMSA

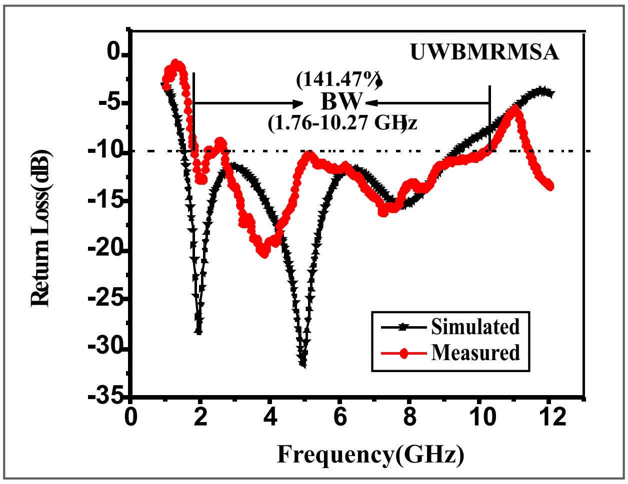


Figure 5: Variation of return loss and frequency of UWBMRMSA

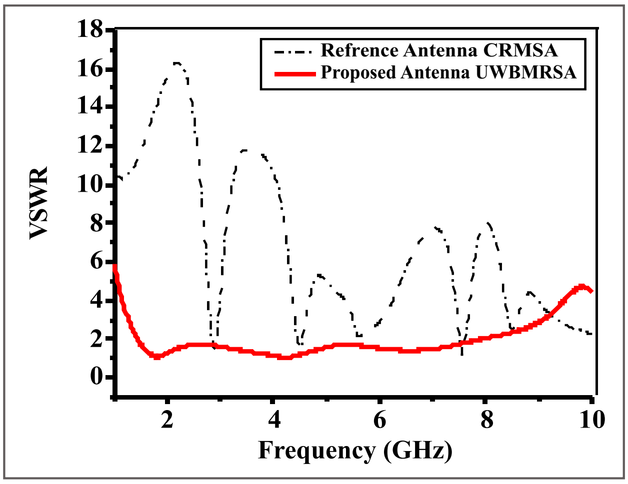


Figure 6: Simulated VSWR and frequency plot of CRMSA and UWBMRMSA

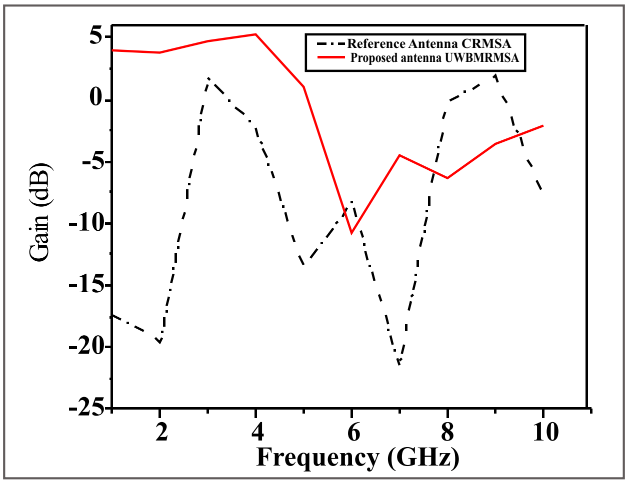
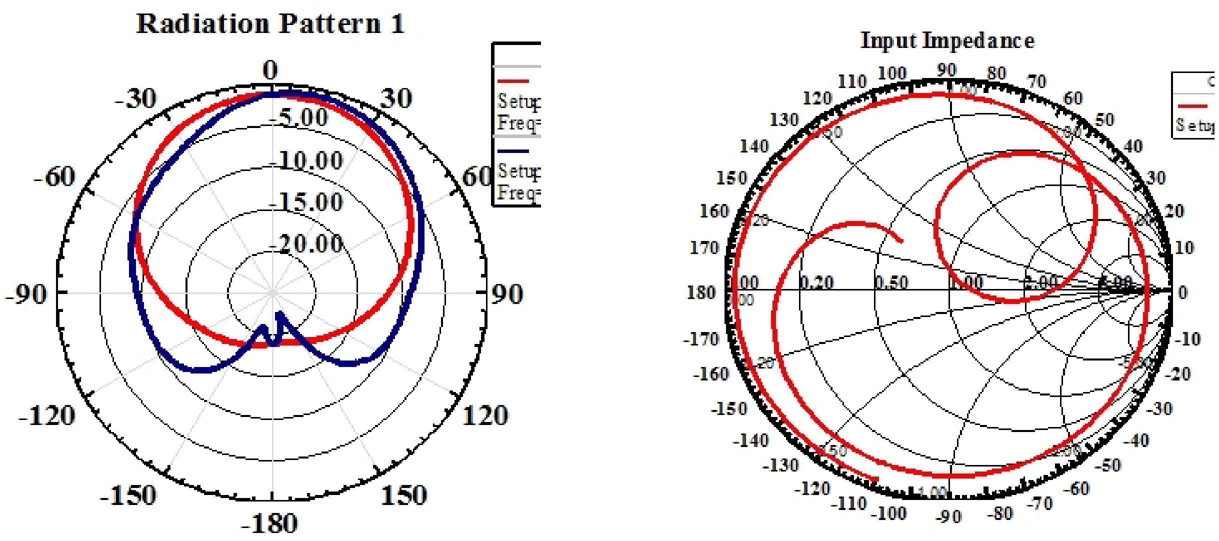


Figure 7: Simulated gains of CRMSA and UWBMRMSA

Figure 6 shows the simulated VSWR curves as a function of frequency of CRMSA and proposed UWBMRMSA. It is clearly seen from this figure that the VSWR is constant and it is less than 2 over entire operating frequency range i.e. from 1.76 to 10.47 GHz.

Simulated gain curve as the function of frequency of CRMSA and UWBMRMSA is plotted for the frequency range of 2 to 10 GHz which is shown in Fig. 7. From this figure it is clearly observed that, the peak gain of CRMSA and UWBMRMSA is 3.71dB, and 4.94 dB respectively.



a) Radiation pattern **b) Input impedence**

Figure 8: Simulated far field radiation pattern and input impedance of CRMSA

The far-field E-plane and H-plane radiation pattern of CRMSA measured at 2.88 GHz is shown in Fig. 8 (a). From figure it is clearly observed that antenna gives broad side radiation patterns. Figure 8 (b) shows the variation of input impedance of CRMSA. It is seen that the loop of impedance loci at the centre of the smith chart indicates operating impedance bandwidth of CRMSA with VSWR <2.

The far-field E-plane and H-plane radiation pattern characteristics of the proposed UWBMRMSA antenna measured at the frequencies of 1.78, 2.24, and 6.60 GHz respectively are shown in Figure 9. From these radiation patterns it is clear that, the proposed antenna gives nearly unidirectional pattern in X-Y (E-plane) plane and a

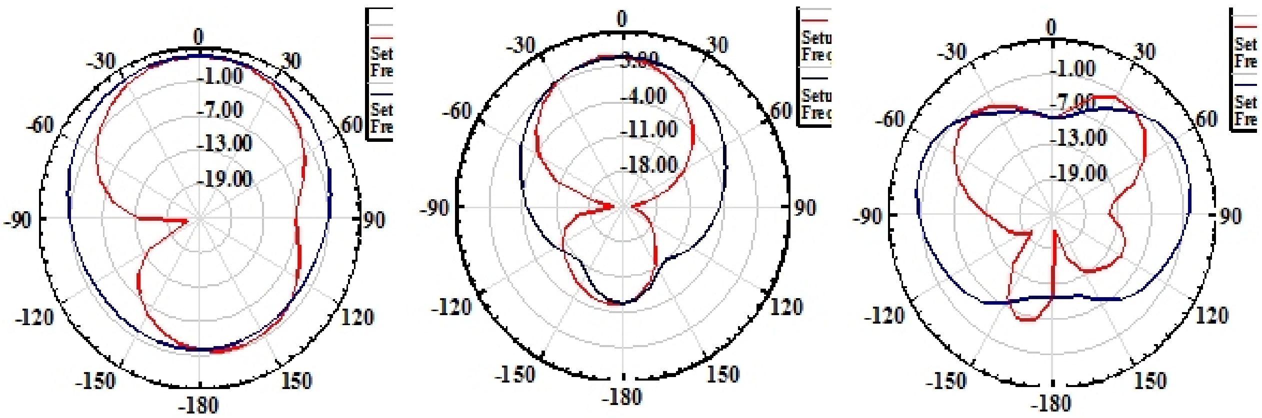
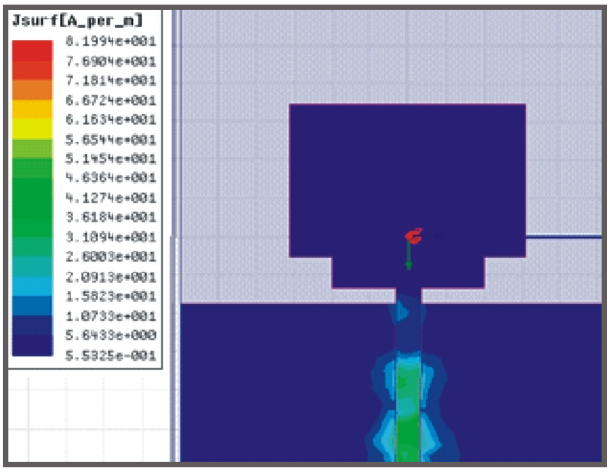
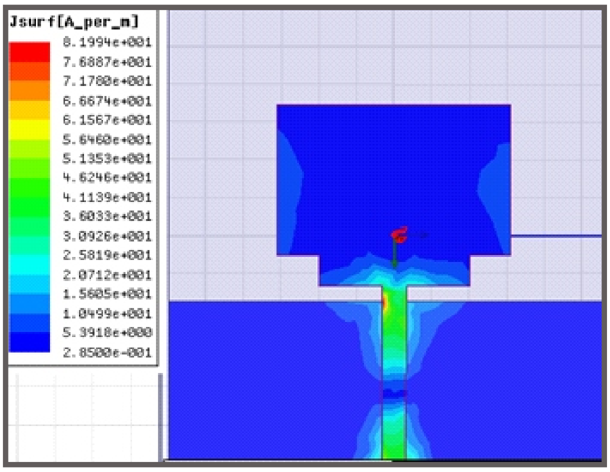


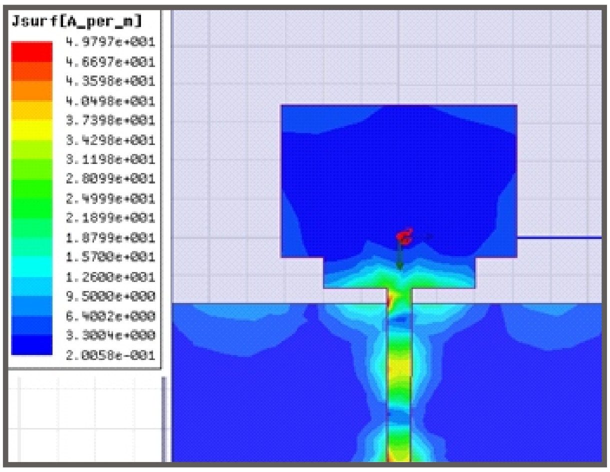
Figure9. Simulated far-field radiation patterns of the proposed UWBMRMSA antenna measured at (a) 1.78, (b) 4.24 and (c) 6.60 GHz



(a) 1.78 GHz



(a) 4.24 GHZ



(c) 6.30 GHZ

Figure10. Simulated surface current distribution of the proposed UWBMRMSA observed at (a) 1.78GHz (b) 4.24 GHz and (c) 6.60 GHz

Figure 10 shows a simulated surface current distribution on the radiating element and the ground plane of the proposed antenna observed at 1.78, 4.24, and 6.60 GHz respectively. The current density is mainly distributed across the feed line and bottom of the patch which helps in enhancement of bandwidth.

CONCLUSION

A novel design and development of UWBMRMSA have been discussed and proposed in this paper. The monopole feed line technique and partial ground plane is used for bandwidth improvement and structure compactness. The impedance bandwidth of 141.47 % with an average gain of 4.25 dB is observed. The impedance bandwidth of proposed antenna is 58.21% more and is compact by 59.13% on patch side and 79.87 % at the ground plane than the impedance bandwidth and size of conventional CRMSA. The UWBMRMSA shows nearly omnidirectional radiation pattern. The proposed antenna is simple with design and fabrication and is suitable for many UWB wireless communication applications.

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REFERENCES

Ansoft HFSS, 2008. 3D EM-field simulation for high performance electronic design. ver.11, Ansoft Corp., Pittsburgh, PA.

Dong Y. D., Hong W., Kuai Z. Q. and Chen J. X., 2009. Analysis of planar ultra wideband antennas with on-ground slot band-notched structures. Antennas and Propagation, IEEE Transactions on, **57**: 1886-1893.

Huang and Hsia W., 2005 Planar Elliptical Antenna for Ultra wideband Communications, Electronics Letters, **41**: 296-297.

Lim. C E. G., Wang Z., Lei C. U., Wang Y., and Man K., 2010. Ultra Wideband AntennasPast and Present, IAENG International Journal of Computer Science, **37**: 304-314.

Naser-Moghadasi, M., H. Rousta, and B. S. Virdee., 2009. Compact UWB planar monopole antenna," IEEE Antennas and Wireless Propagation Letters, Vol. **8**:1382-1385.

Schantz G. and Wolenec G., 2003. Ultra-Wideband Antenna Having Frequency Selectivity, U.S. Patent Publication no. 0090436.

Valderas D., Melendez J.,and Sancho I., 2005. Some Design Criteria for UWB Planar Monopole Antennas Application to A Slotted Rectangular Monopole, Microwave and Optical Technology Letters, **46**,.6-11.

Z. Chen and Y. Chia., 2000. Impedance Characteristics of Trapezoidal Planar Monopole Antennas Microwave and Optical Technology Letters, **27**: 120-122.