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Design of a Modified Triangular UWB Antenna with a Cross-Shaped Slot

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Abstract: **This paper concerns the design of a new ultra-wideband antenna with a modified triangular configuration. The prototype has been simulated and designed. It has shown a permissible agreement between simulations and measures and an operation of ultra-wideband from 3.1 to 14 GHz (127.48) for wireless applications.**

Keywords: **Antennas – Triangular Antenna – Ultra-Wideband – Microstrip Access – cross-shaped slot – Wireless Communications.**

I. INTRODUCTION

Today the potential of mobility, access and sharing of information of high quality with a high speed between portable devices has grown with extraordinary rapidity; as well as with the rise of computer networks, various electronic devices and mobile phones, wireless applications have recently experienced a tremendous explosion.

It is to notice that the frequencies used by these various applications spread over several octaves and concurrent access from the same terminal as small and compact at these frequencies is impossible with a conventional antenna.

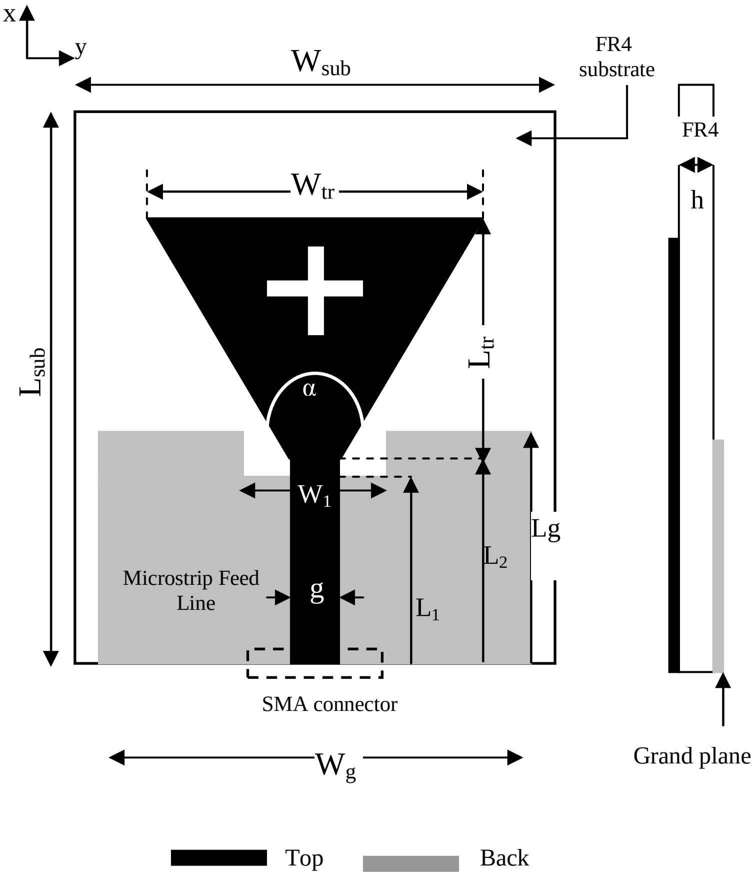
These already different existed communication systems will therefore need more compact and discrete antennas, running on one or more frequencies, allowing to ensure the compatibility of different standards or to access many services from the same device. To overcome this problem, some authors have proposed compact antennas that typically require certain geometric structures. Likewise, technology is moving on to new types of antennas, providing the functionality for many applications at once, called multi antennas and/or wideband. These latter have been the subject of many research and development; especially printed standard whose size and shape allow them to be integrated into the transmitting modules or receiving on the same substrate, in addition to their low cost and small footprint...

However, one limiting factor of these antennas is their low bandwidth. Therefore, several configurations were carried out to increase the bandwidth of planar antennas such as ultra-wideband antennas rectangle shape [1-3], circular [4-6], elliptical [7], octagonal [8] and several other types of antennas [9-12].

The objective of this work is to design a wideband planar antenna that can operate in the band [3.1 - 10.6] GHz. Hence in this article, a new ultra-wideband triangular antenna [13-14] will be presented along with the simulation and measurements obtained results presentation and discussion.

II. GEOMETRY OF THE PROPOSED ANTENNA

The simulated antenna is of an triangular shape (L_{tr} of 15.5 mm and W_{tr} of 24 mm) with a cross-shaped slot shown in figure 1 whose the following parameters values W_{slot} = 2.2 mm and L_{slot} = 5 mm, fed by a microstrip access line with a length of 14.5 mm and a width g of 2.25 mm, it is printed on a dielectric substrate of an epoxy glass type with a height L_{sub} and width W_{sub} (40 × 40) mm, a relative permittivity ε_r = 4.4 and a thickness h of 1.6 mm, and a ground plane with a length L_g of 16 mm and a width W_g of 28 mm, printed on the other surface of the substrate.



W_{tr}=24mm, L_{tr}=15.5mm, W_{sub}=40mm, L_{sub}=40mm, W_g=28mm, L_g=16mm, g=2.25mm, L_1=14.15mm, L_2=14.5mm, W_1=6mm, W_{slot}=2.2 mm, L_{slot}= 5mm, α=73.7º.

Figure 1. The proposed antenna.

III. RESULTS AND DISCUSSION

The design of UWB antennas requires more robust simulation tools. There are many numerical methods to predict the performance of these antennas; all these techniques are based on solving the discrete forms of Maxwell's equations of the field over time. The most used techniques are the method of moments MoM and the finite difference method FDTD.

The adopted simulation software in this work is powerful 3D commercial software which uses the method of moments.

The simulations carried out have been to determine the behavior of the reflection coefficient (S_{11}), the input impedance, the standing wave ratio (VSWR), radiation pattern and the gain in a frequency range of 1-14 GHz.

The representation of the reflection coefficient (Return Loss) S_{11} as a function of frequency in the range [1-14] GHz shows the presence of a wide frequency band from 3.1 GHz to 14 GHz $|S_{11}|$ <-10 dB (a bandwidth relative to **127.48%**) with several resonant frequencies (3.7GHz, 8.9GHz and 12.6GHz) allowing to cover the WPAN standard, the WiMAX standard as well as the HiperLAN1 and 2.

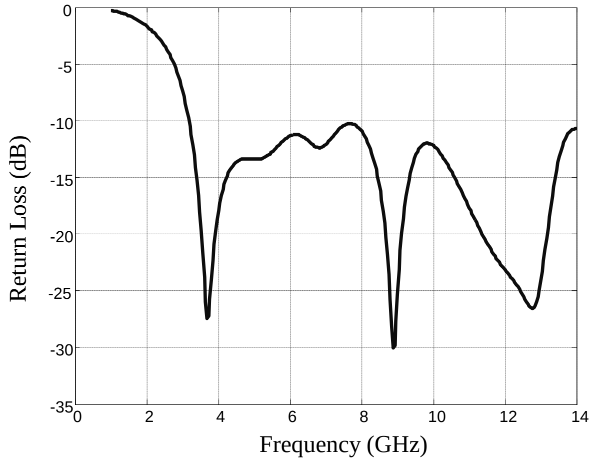


Figure 2. The behavior of the reflection coefficient.

Generally, it is necessary that the transmitter, transmission line and antenna have the same impedance of around 50 Ω so that an antenna would have a good performance. Figure 3 shows that the input impedance of the antenna is very close to this value; the first resonance for this order provides a real part of 48Ω , 47.8Ω for second and 51Ω for the last. These results indicate clearly the no need of matching network at the antenna feed circuit.

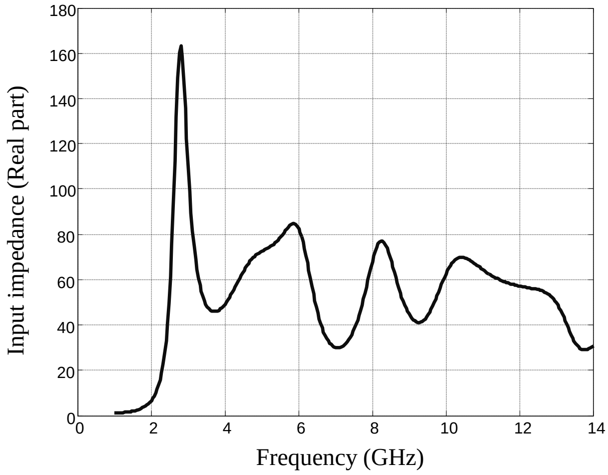


Figure 3. Frequency evolution of the input impedance (Real part)

The evolution of the standing wave ratio is shown in Figure 4. Practically, a good adaptation is obtained for $VSWR \leq 2$; The VSWR values at the resonant frequencies in ascending order are 1.08, 1.06 and 1.12 respectively.

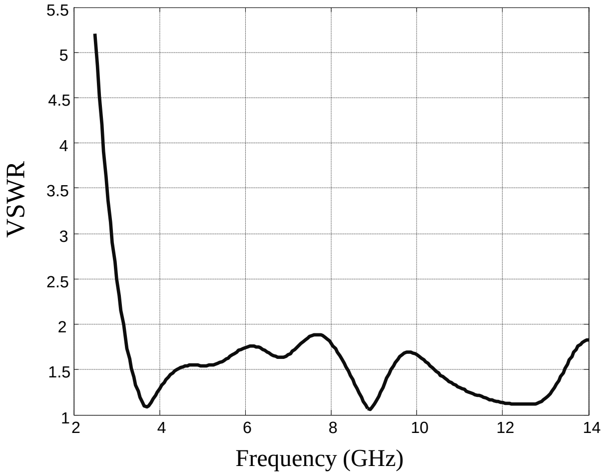


Figure 4. Standing wave ratio.

Figure 5 shows the behavior of the radiation patterns at 3.7 GHz, 8.9GHz and 12.8GHz in the plans E and H respectively. As can be seen from the figures, omnidirectional patterns can be observed for the H-plane, which is expected from a wideband antenna.

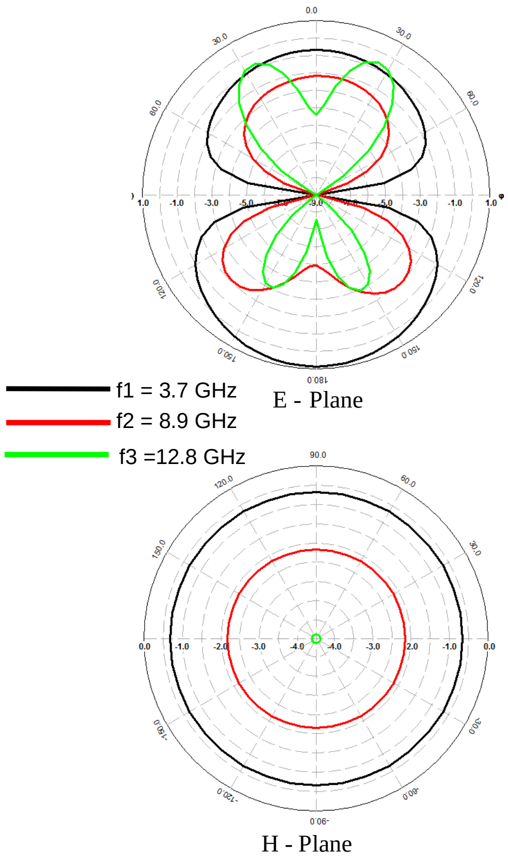


Figure 5. Radiation pattern for the three resonances.

The 3D plots of simulated radiation patterns at specific frequencies about the modified antenna without a slot are illustrated in figure 6.

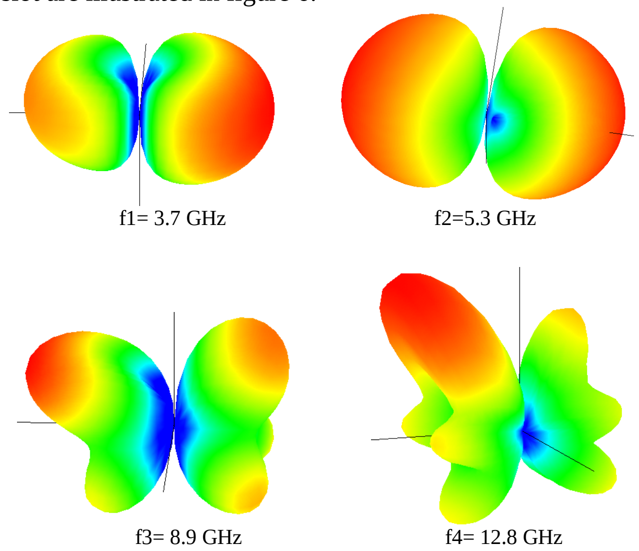


Figure 6. Radiation pattern for the different resonances (3D).

Figure 7 shows the simulated maximum gain of the proposed triangular microstrip antenna. It is shown that this antenna has a good gain varies between 1.22dBi and 8.38dBi inside the UWB band.

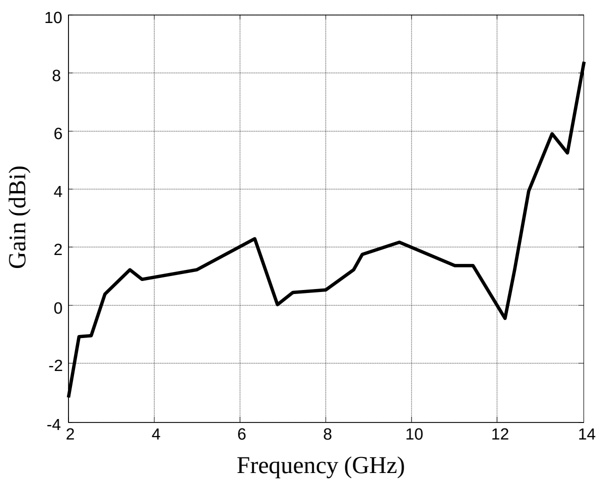
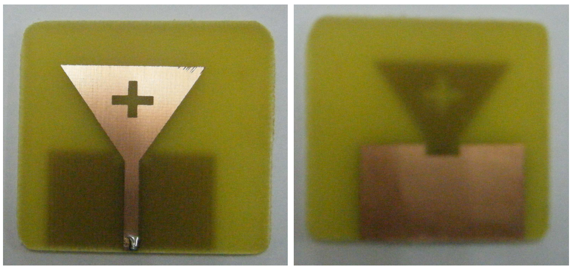


Figure 7. Maximum gains.

IV. EXPERIMENTAL RESULTS

In order to compare simulation results with those of the measure and draw conclusions about the obtained performance compared to the expected ones, we move on to the completion stage where the Return Loss is to be the fundamental parameter to compare between measurements and simulations. The performed antennas are printed on an epoxy glass substrate type (ε_r = 4.4, th δ=0.017 and h=1.6mm) with microstrip access. The antenna characteristics were measured with an HP8719ES type network analyzer (Figure 9) running in the band [30 MHz-13.5 GHz].



Top View   Back View

Figure 8. Photographs of realized antennas.

Figure 9. Antenna measurement with network analyzer.

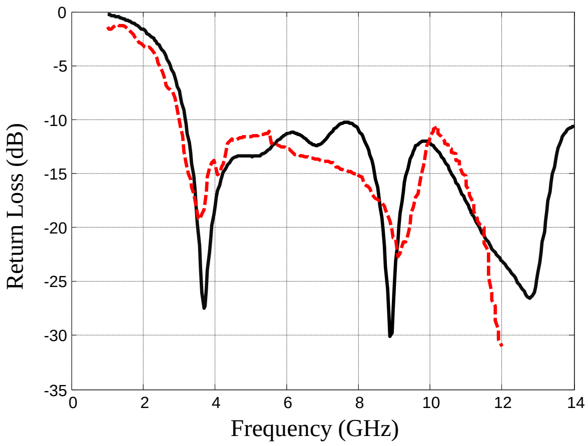


Figure 10. Comparison between simulation and measurements of the reflection coefficient.

We note first that the wideband character is confirmed by measuring, and acceptable agreement between simulations and measurements in second.

V. CONCLUSION

In this paper, we have presented the design and construction of a new triangular ultra-wideband antenna with a cross-shaped slot. The obtained results in simulation and measurement show a behavior wideband and better impedance matching. The proposed configuration gave a bandwidth of about **127.48%**. This allows their use in various telecommunication standards and integrating them in many configurations (WPAN, WiMAX, WLAN...).

BIBLIOGRAPHY

1. Ramu Pillalamarri, G. Sasi Bhushana Rao and S. Srinivasa Kumar, “Novel Printed Rectangular Patch Monopole Antennas with Slit Ground Plane for UWB Applications”, the NEHU Journal, Vol VIII, No. 1, January 2010.

2. Yi-Cheng Lin, and Kuan-Jung Hung, “Compact Ultra-wideband Rectangular Aperture Antenna and Band-Notched Designs”, IEEE transactions on antennas and propagation, vol. 54, no. 11, November 2006.

3. N. H. M. Sobli and H. E. Abd-El-raouf, “Design of a compact printed band-notched antenna for Ultra-Wideband communications”, Progress In Electromagnetics Research M, Vol. 3, 57–78, 2008.

4. Ramu Pillalamarri, Jyoti Ranjan Panda and Rakhesh Singh Kshetrimayum , “Printed UWB Circular and Modified Circular Disc Monopole Antennas”, International Journal of Recent Trends in Engineering, Issue. 1, Vol. 1, May 2009.

5. Rakhesh Singh Kshetrimayum , Jyoti Ranjan Panda and Ramu Pillalamarri, “UWB printed monopole antenna with a notch Frequency for coexistence with IEEE 802.11a WLAN devices”, January 16-18, NCC 2009.

6. Bouchouicha, M. Latrach, F. Dupont, A. Bremond, and L. Ventura, “ A Novel Design of Ultrawide-band Antenna” , PIERS Proceedings, Moscow, Russia, August 18-21, 2009.

7. Symeon Nikolaou, Boyon Kim, Y.-S. Kim, John Papapolymerou, and Manos M. Tentzeris, “CPW-fed Ultra Wideband (UWB) Monopoles with Band Rejection Characteristic on Ultra Thin Organic Substrate”, Proceedings of Asia-Pacific, Microwave Conference, 2006.

8. S.Natarajamani, S K Behera, S K Patra & R K Mishra, “CPW-fed octagon shape slot antenna for UWB application”, international conference on microwaves, antenna, propagation & remote sensing, 2009.

9. Norhayati Hamzah, Kama Azura Othman, “ Designing Vivaldi Antenna with Various Sizes using CST Software”, Proceedings of the World Congress on Engineering 2011, Vol II, London, U.K, July 6 - 8, 2011.

10. Sawsan Sadek, Zahra Katbay, “UWB Cedar Patch Antenna”, International Journal of Research and Reviews in Computer Science (IJRRCS) Vol. 1, No. 2, June 2010.

11. X. Zhang, Y.-Y. Xia, J. Chen, and W.T. Li, “Compact Microstrip-fed Antenna for Ultra-Wideband Applications”, Progress In Electromagnetics Research Letters, Vol. 6, 11–16, 2009.

12. M. M. Abd-Elrazzak, Ibrahim S. Al-Nomay, “A Modified E-Shaped Microstrip Antenna for Ultra Wideband And ISM band applications” ,IJCSNS International Journal of Computer Science and Network Security, VOL.10 No.7, July 2010.

13. C.-C. Lin and H.-R. Chuang, “A 3–12Ghz UWB planar triangular monopole antenna with ridged ground-plane”, Progress in Electromagnetics Research, PIER 83, 307-321, 2008.

14. J. William and R. Nakkeeran, “CPW-Fed UWB Slot Antenna with Triangular Tuning Stub”, International Journal of Computer and Electrical Engineering, Vol. 2, No. 4, August, 2010.