# Ultra-Wide-Band Microstrip Concentric Annular Ring Antenna for Wireless Communications

**S. Azzaz-Rahmani[1], N. Boukli-Hacene[2]**

**Telecommunication Laboratory, Faculty of Technology,
Abou-Bekr Belkaid University
Tlemcen, 13000, Algeria**

**Abstract**
In this paper, a new design technique for bandwidth enhancement of concentric microstrip annular ring slot antennas is presented. Using this technique, an Ultra-Wide-Band antenna is designed with simulated bandwidth of 111.29%.
***Keywords:*** *Microstrip antenna, wideband, concentric patch, bandwidth, low impedance.*

## 1. Introduction

Microstrip patch antennas are widely used because of their several advantages such as light weight, low volume, low fabrication cost, and capability of dual, triple and several frequency operations. However microstrip antennas suffer from a number of disadvantages, particularly the narrow bandwidth[1]. This is a serious limitation of these microstrip patch antennas. Different techniques are used to overcome this narrow bandwidth limitation. These techniques include increasing the thickness of the dielectric substrate, decreasing dielectric constant and using parasitic patches [2]. These techniques have limitations like, excitation of surface waves and increase in antenna size [3].

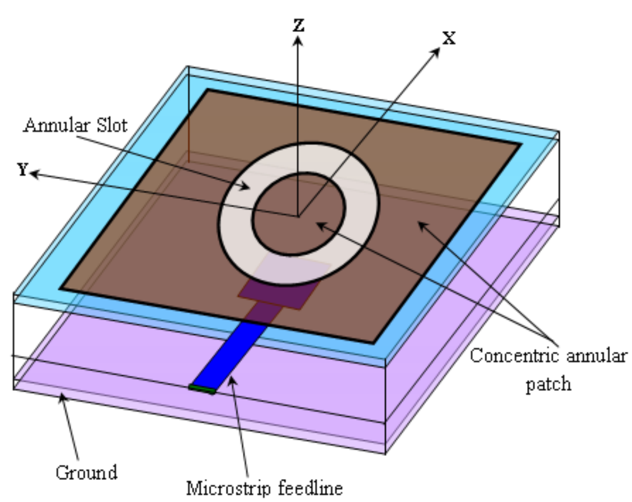
Annular ring slot antennas are considered to be among the narrowband resonant antennas [4]. Multi-element concentric ring slots have been used to design multi-band antennas. However, because of transmission zeros that exist between the different resonances, these resonances cannot easily be merged to obtain a wideband response [4, 5]. The purpose of this paper is to propose a microstrip structure which will increase the bandwidth without increasing its physical dimensions.

## 2. Antenna design

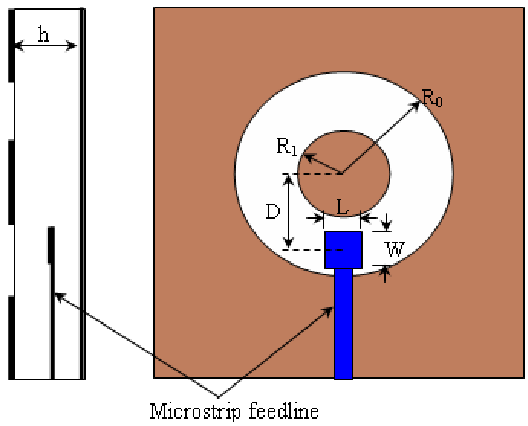
Annular ring slot antenna has a reduce size more than circular patch antenna and the ultra-wideband characteristic [6]. In this paper, to broaden the bandwidth of annular ring slot antenna, we placed the concentric annular patch inside circular slot and designed the low impedance feed line.

Because, for an annular ring slot antenna, the resonant frequency of the lowest order mode TM11 can be much lower than a circular patch of the same size, the annular ring slot antenna can be designed to the smaller size than the circular patch antenna [5, 6]. This fact could be appreciated physically by noting that the average path length travelled by the current in the annular ring is much longer than the circular ring for the lowest order mode [5, 6].

Fig. 1 shows the configuration of the ultra-wide-band concentric annular ring microstrip antenna. We placed a microstrip feed line to the bottom of a substrate with relative permittivity of 4.3 and thickness of 2mm. The concentric circular patch embedded in an annular slot is placed on the substrate to match the impedance.




(a)




(c) (b)

Fig 1. (a) Antenna structure, (b) top view, (c) side view, geometric parameters: $R_0$=26 mm, $R_1$= 10 mm, L=12 mm, W=10.5 mm and D= 18.34 mm.

The geometry parameters of our proposed concentric annular ring antenna are; $R_0$=26 mm, $R_1$= 10 mm, L=12 mm W=10.5 mm and D= 18.34 mm.

## 3. Simulation results

The variation of the return loss magnitude and phase of the concentric annular ring antenna as a function of frequency are shown in fig. 2 and 3 respectively. The bandwidth is calculated using the formula:

$$BW = \left[\left(\frac{1}{f_c}\right)\times\left(f_H - f_L\right)\right]\times 100\% \qquad (1)$$

Where, $f_H$ and $f_L$ are the higher and lower frequency band respectively, for which the return loss $S_{11}$ is less than -10dB and $f_c$ is the centre frequency of this band.

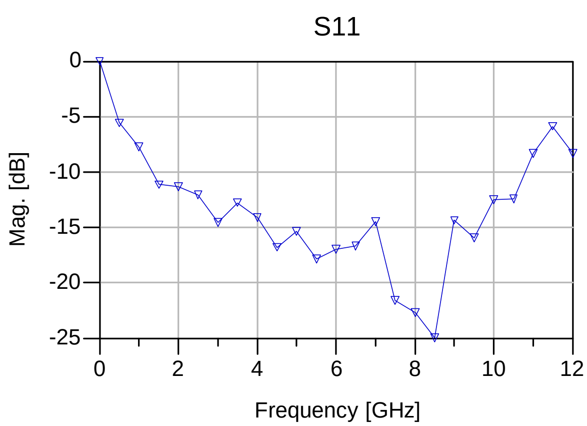



Fig 2. Simulated return loss of concentric annular ring antenna as a function of frequency.

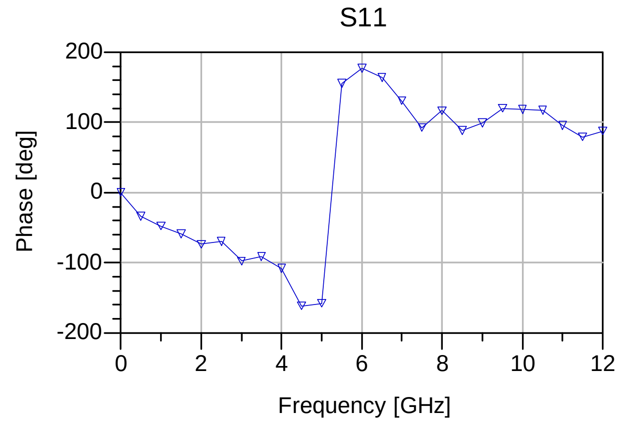



Fig 3. Simulated phase of concentric annular ring antenna as a function of frequency.

From Fig. 2, we see that the antenna operates from 1.34 to 10.8 GHz which provides a bandwidth of 111.29%.

The simulated E-plane radiation pattern is presented in Fig 4. The cross-polarization component (E_cross) is also illustrated. This pattern is simulated at 8.5 GHz.

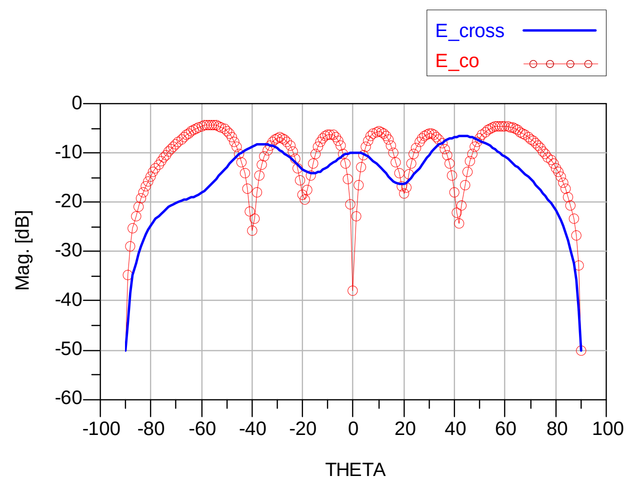



Fig 4. E-plane radiation patterns at 8.5 GHz. Simulated copolarization (E_co); simulated cross-polarization (E_cross).

Fig 5 shows 3D radiation pattern of this antenna measured at frequency of 8.5 GHz. On this plot appear several side-lobes, these shows very well the multibandes functioning.

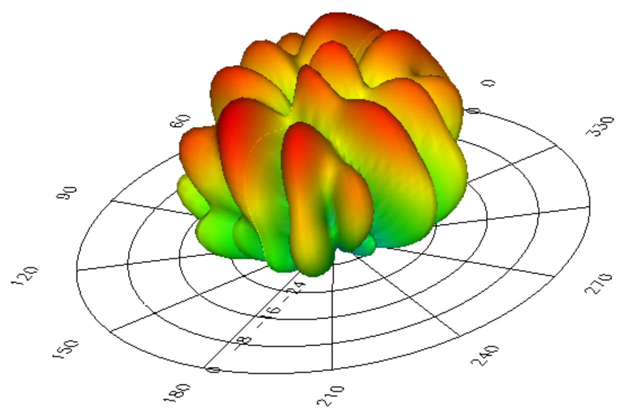



Fig 5. 3D radiation patterns measured at frequency of 8.5 GHz.

Fig. 6 shows the variation of the simulated return loss for different values of the distance between the center of circular slot and the center of low impedance feed line. It is observed that the return loss of high frequency is varied much smaller than that of low frequency.

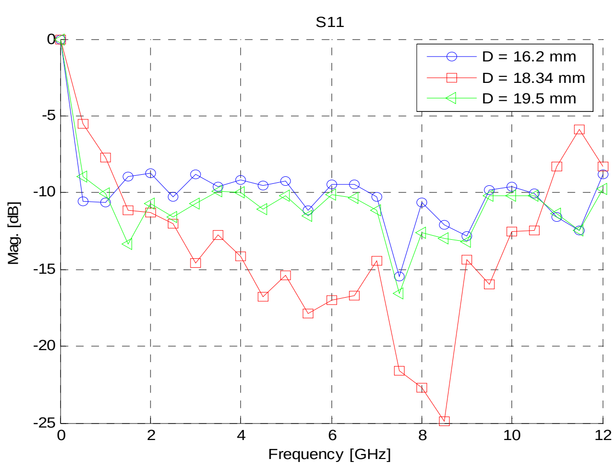



Fig 6. Variation of simulated return loss for diferent values of D.

It was also found that the distance between the center of low impedance feed line and the center of circular slot (D) have much influence on the return loss. In fact, the antenna has multiband operating: the frequency bands are respectively: [7GHz – 9.5GHz], [10.5GHz – 11.8GHz] for D=16.2mm, and [1GHz – 3.5GHz], [4GHz – 10GHz], [10.5GHz– 12GHz] for D=19.5mm. For D = 18.34 mm the antenna has an Ultra Wide Band operating where the bandwidth is 111.29%

## 4. Conclusions

A new technique for bandwidth enhancement of concentric annular ring antennas is presented. The use of a discontinuous microstrip feed line has permitted to obtain an antenna bandwidth equal to 111.29%, which is much larger than that of a conventional ring antenna.

Using this technique, we obtained an Ultra-wide bandwidth with small size antenna. It may find proper applications in wideband mobile communication system.

## References

[1] Ramesh Garg, Prakash Bartia, Inder Bhal and Apsiak Ittipiboon, “Microstrip Antenna Design Hand Book,” Artech House, Norwood, MA, 2001.

[2] D.M.Pozzar “Microstrip Antenna Coupled to Microstripline,” Electron Lett., Vol. 21, No.2, pp. 49-50, January 1995.

[3] Y. Coulibaly and T. A. Denidni, "Design of a Broadband Hybrid Dielectric Resonator Antenna for X-Band Applications," Journal of Electromagnetic Waves and Applica-tions, Vol. 20, No. 12, pp. 1629-1642. 2006.

[4] N. Behdad and K. Sarabandi, “Wideband double-element ring slot antenna” Eelectronics Letters, Vol. 40 No. 7 , pp. 408 – 409, April 2004,

[5] H.K. Kan, R.B. Waterhouse and D. Pavlickovski, “Compact dual concentric ring printed antennas” IEE Proc.-Microw. Antennas Propag., Vol. 151, No. 1, pp. 37-42, February 2004.

[6] Debatosh Guha, , Sujoy Biswas, Manotosh Biswas, Jawad Y. Siddiqui,, and Yahia M. M. Antar, Fellow, IEEE, “Concentric Ring-Shaped Defected Ground Structures for Microstrip Applications », IEEE antennas and wireless propagation letters, Vol. 5, pp.402-405, Dec 2006.

**Salima Azzaz-Rahmani** was born in Algeria in 1981. She obtained here engineering degree in 2003 and a magister degree from Abou Bekr Belkaid University, (Tlemcen) Algeria, in 2006. She is a doctorate student in the same university. Currently she is a lecturer at Djillali Liabes University (Sidi Bel-Abess). Here research interests are the analysis and syntheses of microstrip concentric annular ring and ultra wideband antennas.

**Noureddine Boukli-Hacene** Noureddine Boukli-Hacene was born in 1959 in Tlemcen, Algeria. He received the ‘Diplome d'Etudes Approfondies’ in microwave engineering (DEA Communications Optiques et Microondes) and the Doctorate degree (prepared at the Centre National d'Etudes Spatiales, Toulouse, France) in electrical engineering from Limoges University, France, in 1982 and 1985 respectively. Recently, he is a Lecturer at the University of Tlemcen. His research interests include, among others, microstrip antennas and microwave circuits.