Radiation Pattern in Antenna Reflectors with QUAD Antenna

Kalina Kalinovska[1] and Kliment Angelov[2]
[1]Faculty of Telecommunications at Technical University of Sofia
8 Kl. Ohridski Blvd, Sofia 1000
Bulgaria
kalina.kalinovska@gmail.com

[2]Faculty of Telecommunications at Technical University of Sofia
8 Kl. Ohridski Blvd, Sofia 1000
Bulgaria
kna@tu-sofia.bg

ABSTRACT: *Antenna reflectors are designed for an application which is not aimed in this paper. We also performed the radiation pattern with 2biQUAD antenna. In a contrast we have performed the radiation pattern in the vertical direction. Radio networks are likely to use the radio coverage applications with the measurements we have drawn.*

Keywords: 2biquad, Radiation Pattern Experimental Mesurments, Antenna, Omni-antenna

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1. Introduction

In today's world of unlimited communication options are available many technologies using radio signals. They are providing coverage to subscribers with relevant services, while giving the opportunity to be mobile. Examples of such technologies are mobile cellular networks of second and third generation, Wi-Fi, WiMAX and others. Parallel to that the radio communications are used in different technologies for access control, RFID and others using radio signals in the ISM bands. The transmission of information in all of these technologies is made by providing radio in separate zones, aiming at the optimum use of radio resources. For example, Wi-Fi is using different access points (HotSpot), served by antennas that can be with narrow radiation pattern beam or with omni-directional radiation pattern. The directivity of the antenna must be appropriate to comply with the necessary radiation pattern and consistent with the structure of the building that the Wi-Fi coverage will be developed.

Solution for shopping centres and conference halls with many Wi-Fi users is 2biQUAD antenna with reflector. It can realize relatively uniform radiation pattern in a horizontal direction and the beam is more narrow in vertical plane. A member of the team of authors of this article had done a simulation design of 2biQUAD antenna with reflector for Wi- Fi bandwidth, but it is still in need for experimental determination of the radiation pattern to prove the theoretical model.

This article describes the experimental determination with Continuous Rotation Method (CRM) [1] of the radiation pattern of a 2biQUAD antenna with reflector for the purposes of Wi-Fi technology or other applications in different ISM frequency bands. CRM method is used to capture the radiation pattern of an antenna in determent plane. The antenna is put on a specialized stand which is rotated several times in this plane. In this way it is realized repeatedly reading the signal from the antenna, which describes the radiation pattern. With the aid of mathematical processing the received periodically repeated data is processed to minimize the random errors and improve the accuracy of the experiment.

2. Description of the Problem

2.1. The 2biQUAD Antenna Conception

It is known different types of loop antennas with different loop shapes [2]. Some of them have a shape close to a square, which can be used in the range of HF. These antennas have uneven radiation pattern and can not satisfy the condition of omni-directional antenna for broadcasting in one plane.

Combining two biQUAD antennas located in two perpendicular planes would contribute to the alignment of the omni-directional radiation pattern. On the other hand, by placing the reflector above the structure we can obtained a limited radiation pattern in vertical plane. Such an antenna can be used to realize the Wi-fi HotSpot in a conference halls or shopping centres, using a ceiling mounting. Figure. 1 shows a general view of 2biQUAD antenna with reflector.

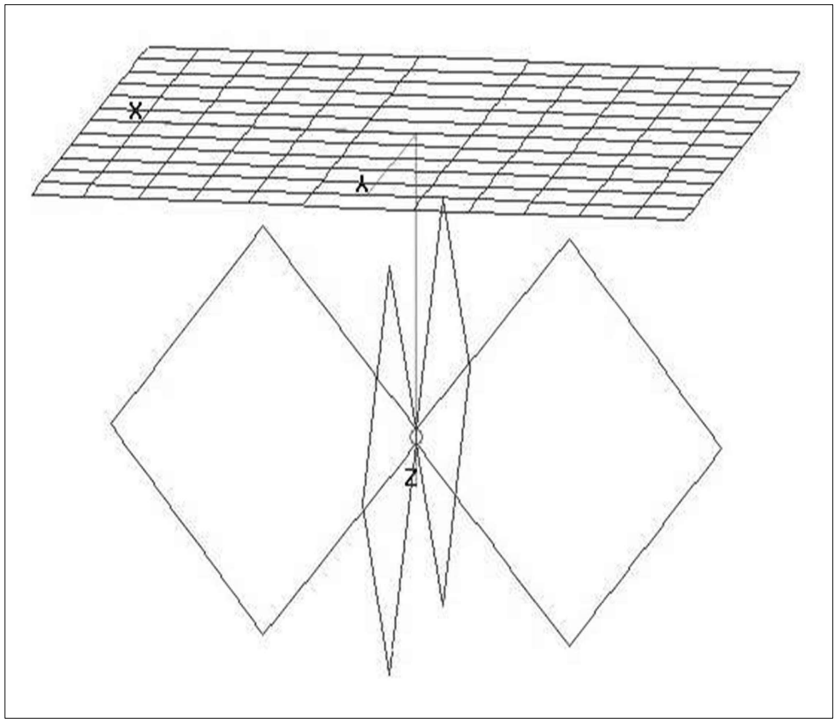

Figure 1. 2biQUAD antenna common view

Based on the idea of two 2biQUAD antenna with reflector were made simulations of two prototypes. One is for operating frequencies matching Wi-Fi technology, and the other -intended for use in ISM band at 433 MHz. Figure 2 shows a simulation resulting radiation pattern in three-dimensional space, and Figure 3 - diagrams directional horizontal and vertical plane.

The defining of horizontal and vertical plane of the antenna is based on the above mentioned reasons for ceiling mounting in case of HotSpot realizations.

After the simulation optimizing were relized two prototypes. One for Wi-Fi technilogy (2,45GHz) and second one for 433.05-434.79MHz frequency band. Their radiation pattern was reserched using CRM method.

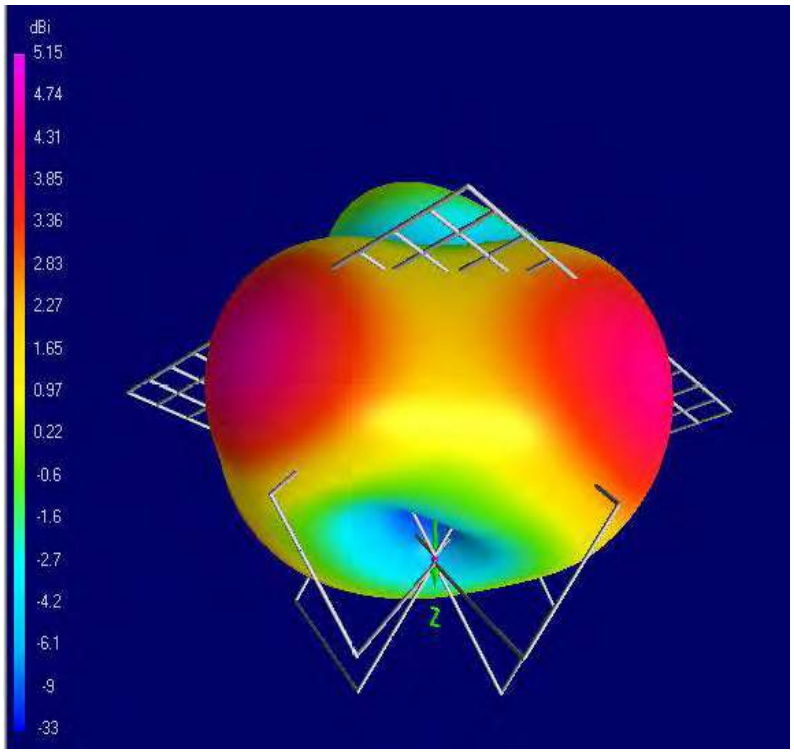

Figure 2 - 2biQUAD antenna simulated 3D radiation pattern

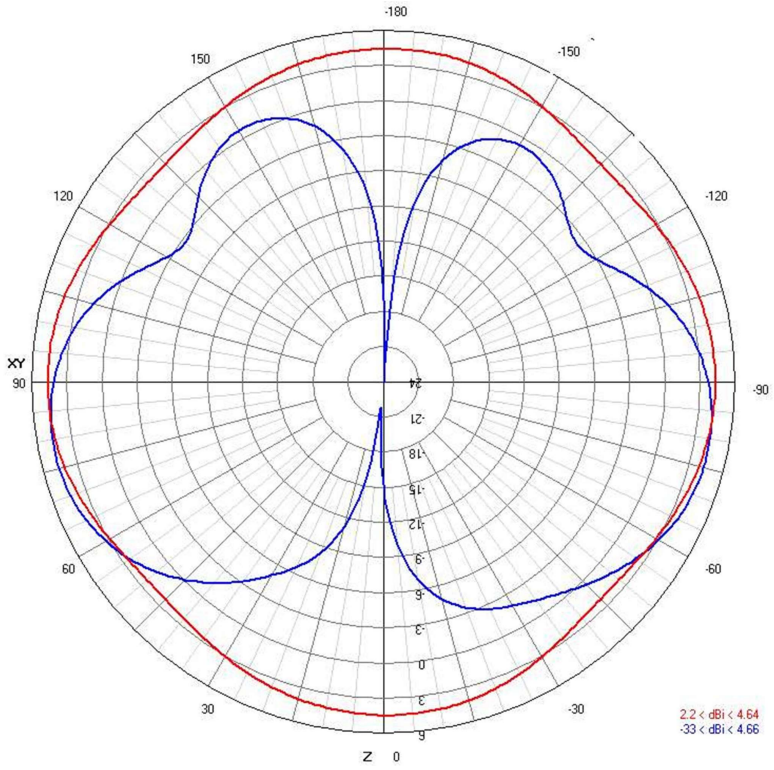

Figure 3. 2biQUAD antenna simulated radiation pattern (horizontal and vertical)

2.2. The CRM method

Members of the team of authors of this article have developed a method for measuring diagrams of directional antennas in which is used a long multi rotation with angular velocity ω of the test antenna (AUT). This method accumulates cyclic data with sampling time T_s, through constant periodic received signal. The subsequent mathematical processing can obtain the main period of repetition and reduce random error in determining the radiation pattern. An advantage of the method is also that the current angular position is set as the relative rotation of the AUT with accuracy that can be determined by [1]:

$$\theta_{\min} = 12.T_s.\omega. \quad (1)$$

The accuracy of the method is increasing with the number of turns of the stand. If the sampling frequency is not a multiple of the rotation frequency with angular velocity then each discrete reporting occurs in different point in the radiation pattern. With this way every turn will measure unique point of the polar coordinate system set for the radiation pattern. After mathematical processing the different discrete measurements will form one radiation pattern. A similar approach is appropriate for measuring the radiation pattern of 2biQUAD antenna with reflector. Figure 4 shows the principled scheme of the experimental set. In this experiment an interest is the radiation pattern in vertical plane, since the horizontal is expected to differ minimally from omidirectional.

In Table 1 is given initial parameters for capturing the radioation pattern of the physical prototypes. The distance between the Tx and Rx antenna must be more than the near field of the antenna (2) [4][5]:

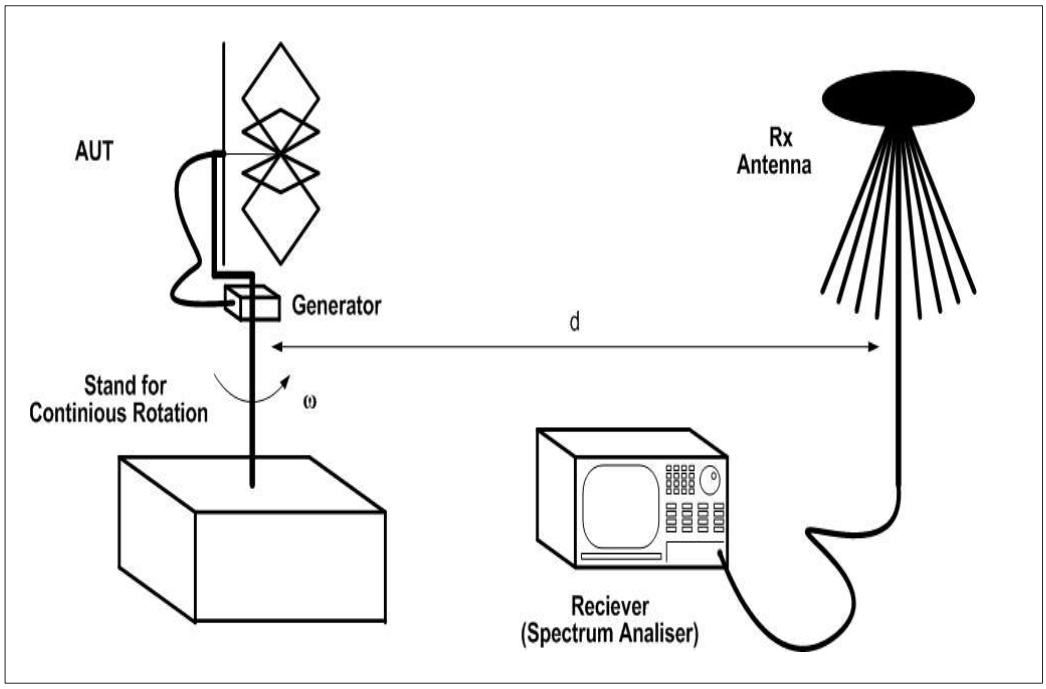

Figure 4. Scheme of Test Stand for Radiation Pattern Measurements of 2biQUAD antenna in vertical plane

$$d > \frac{2.D^2}{\lambda},$$

In Figure 5 is shown a photograph of the actual implementation of the test. In it 2biQUAD antenna with reflector is placed on a stand witch provide constant rotaition.

To reduce external interference the test with prototipe on 433,92MHz was held on the roof of one of the buildings of the Technical University - Sofia.

Figure 5. Photograph of Test Implementation

AUT	Type	2biQUAD
	Maximal Dimension	0,6 m
	Theoretical Directivity	5,15 dBi
Transmitter	Frequency	433,92 MHz
	RF Power	0 dBm
Measuring Distance		10 m
Rotation speed		~54 rpm
Receiving Equipment	Spectrum Analyser	GSP-830
	Receiving Antenna	Omnidirectional
	Sampling Speed	$1s^{-1}$

Table 1. Test Initial Parameters

3. Results

Using The Above Described Method Was Reported Crm Data. This Data Is Describing 10 Rotations Of The 2biquad Antenna With Reflector. Figure 6 Shows The Periodic Variation Of The Received Signal For The Rotations Of The Prototype With Working Frequency 433,92mhz.

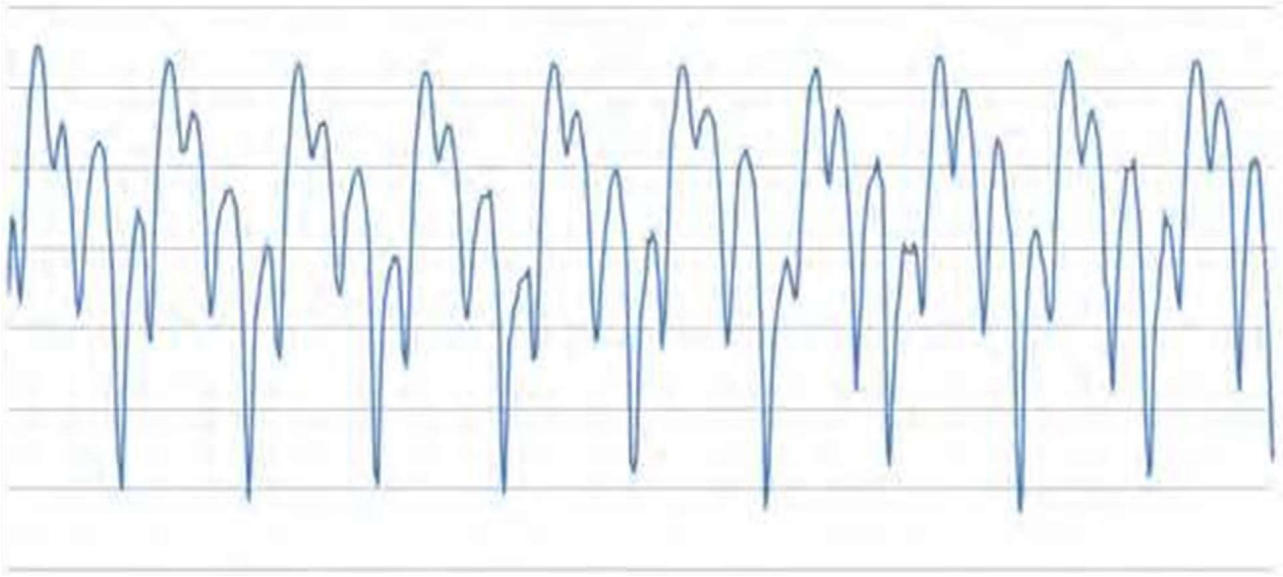

Figure 6. Received Signal on Periods of ten Revolutions of AUT

There was made a mathematical determination of the period of repetition of the received signal. The method is also used to reduce random errors that occurs in the experimental determinated radiation pattern. For the calculations was used the programming environment of matlab [6]. Figure 7 shows the experimentally obtained radiation pattern in vertical plane for the prototype in 433,92 mhz frequency band.

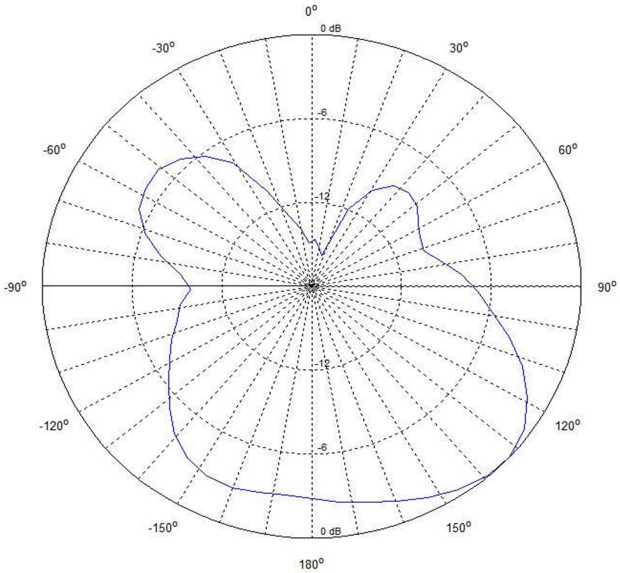

Figure 7. Experimental Radiation Pattern of AUT @ 433,92 MHz

Similarly is the experimental radiation pattern of the prototype for Wi-Fi frequency band. A graphic is shown in Figure 8. The radiation pattern varies because of the different conditions that the experiment was made. This experiment was held in a laboratory because of the weather conditions. There were many reflections from the walls and etc.

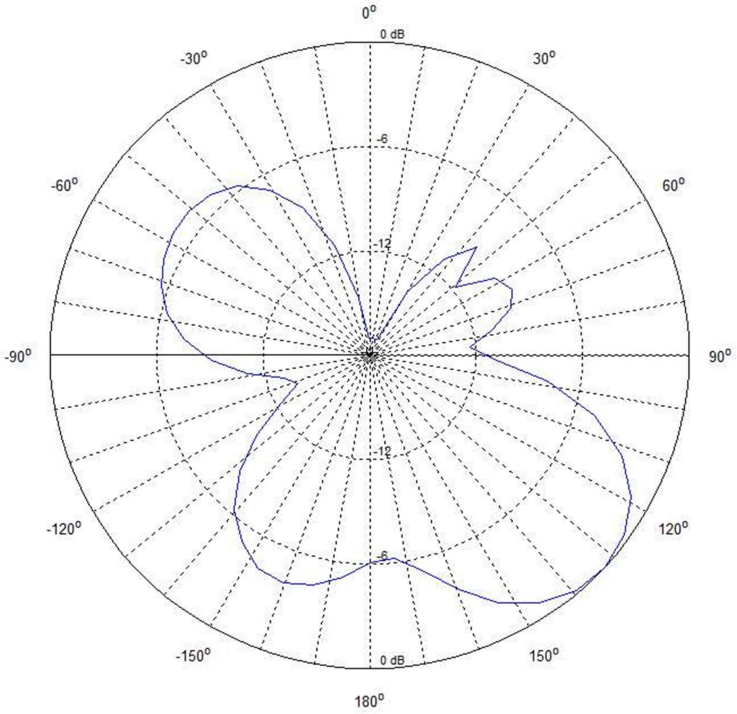

Figure 8. Experimental Radiation Pattern of AUT @ 2,45 GHz

The obtained experimental radiation pattern of 2biQUAD antenna with reflector shows that it is suitable for the proposed use, which provides radio coverage of a HotSpots. Figure 9 shows clearly the idea of using this type of antenna to provide Wi-Fi access.

Figure 9 An example of practicle application of 2biQUAD antenna with reflector in Wi-Fi frequency band

4. Conclusion

Based on the experimental results the following conclusions can be made:

- 2biQUAD antenna with reflector has a omni-directional radiation pattern in horizontal plane;

- Despite some irregularities in experimental readings the results confirmed the simulations of the diagram of this type of antenna in a vertical plane,

- 2biQUAD antenna reflector is suitable in case of installing HotSpot with ceiling mounting;

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