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Radiated EM Disturbance by a PIFA Antenna at 900MHz and its Magnetic Shielding

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ABSTRACT: In this paper, we propose a quantification study of a magnetic disturbance radiated by a PIFA antenna operating at a frequency of 900MHz and its magnetic shielding. The obtained results in simulation using HFSS simulator have permit initially to determine the near field radiates part if this antenna. A magnetic shielding of the antenna is obtained by using a ferrite. This shielding improves also the antenna performance. The shielded antenna has a reflection coefficient of -25dB.

KEYWORDS: PIFA antenna, Electromagnetic disturbance, magnetic shielding, ferrite magnetic, near field.

RESUME: Dans cet article, nous proposons une étude quantitative et d'un blindage magnétique de perturbation magnétique rayonné par une antenne PIFA fonctionnant à une fréquence de 900MHz. Les résultats obtenus en simulation à l'aide du simulateur HFSS ont permis dans un premier temps de déterminer la partie la plus rayonnante en champ proche de cette antenne. Puis, un blindage magnétique est obtenu à l'aide d'un ferrite. Ce blindage a permis également d'amélioration la performance de cette antenne. L'antenne blindée possède un coefficient de réflexion de -25dB.

MOTS-CLEFS: Antenne PIFA, Perturbation Electromagnétique, blindage magnétique, ferrite magnétique, champ proche.

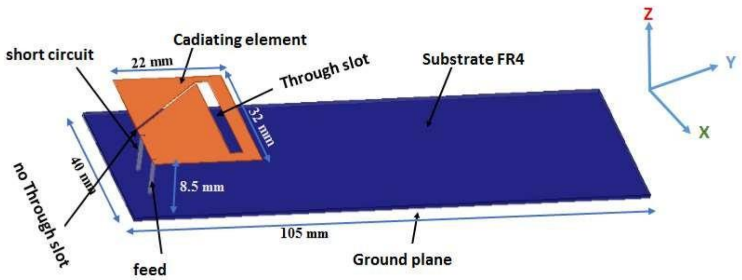
1 INTRODUCTION

Antennas are present in devices of all kinds for various contactless applications. The operation of electronic devices at higher frequencies requires a design of miniature antennas. This miniaturization allows among others to reduce losses and offers an easy integration of these devices. Integrated antenna such as PIFA (Planar Inverters-F antenna) is an essential element in various modern telecommunications systems. Especially in mobile communications field. The integration of this antenna is known by grouping it with other components. This gathering increases the electromagnetic disturbance in the vicinity of the antenna. In a mobile phone for example, antenna may be located near other analogue and digital components [1]. Studies [2], [3], [4] in literature, show that this approximation leads to increase electromagnetic disturbances (conducted and radiated). It can cause the disfunction of a system, affect the antenna performance or increases the Specific Absorption Rate of the antenna [5,6]. Thus, it is therefore necessary to study particularly the electromagnetic emissions in the near field of this antenna at design stage so that i twill not be at the cause of any EM disturbance to other components in its environment. Studies on EM coupling between PIFA antenna and devices located in its vicinity (input/output connector in a mobile phone or electronic components) have been carried out by [3] and [4]. The solutions proposed by the authors consist of placing electrical shields at the terminal ends of the antenna. Other authors are interested to electromagnetic disturbances that can attend antenna when it is placed near other components generating electromagnetic disturbance [7]. Many studies have been carried out on the electrical shielding of antennas with the aim of reducing specific absorption rate (SAR) [8], [9], [10]. The objective of our studies presented on this paper, is to quantify the near magnetic field emissions radiated by an integrated dual-band PIFA antenna. It also consists of providing magnetic shielding that minimizes the near magnetic field radiated by the antenna while improving its performance.

In this paper, we present firstly the studied structure. Then we present obtained results on the quantification of near magnetic field radiated by this antenna. Finally, we present the effect of ferrite that used to shield and improving antenna's performance.

2 PRESENTATION OF STUDIED STRUCTURE

In this part, we present the studied miniature PIFA antenna. It is a GSM type antenna which resonates on 900MHz frequency band. Its geometry is inspired from Pascal's works in [12]. The chosen software simulator for design and emission study of this antenna is HFSS (High Frequency Structure Simulator). The studied structure is constituted of a metal ground plane on which is deposited a FR4 substrate of the same dimensions of 40x105x0.005mm3. The radiating element (resonator) is made of copper and places above the substrate at a height of 8.5mm as shown in fig.1. a. A slot opening and another not opening plus a short- circuit are designed on the resonator part. The full dimensions of the antenna are shown in fig.1 a. Fig.1 b shows the reflection coefficient of the antenna.



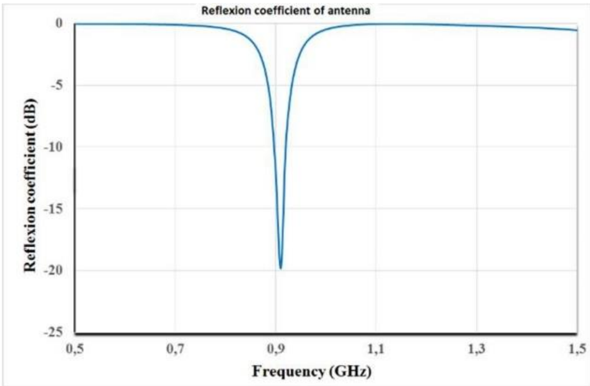


Fig. 1. a) Studied antenna, b) reflection coefficient of the antenna

3 STUDY OF H-FIELD RADIATED BY PIFA ANTENNA

3.1 PRINCIPLE OF STUDY

The developed principal method consists of supplying the antenna using a power source, then determining at a certain close height above and below the resonator, the radiated magnetic field according to the distance. It also consists of placing the studied structure inside a large air box in order to take into account all radiated field vectors. At the end of simulation, the calculated EM field can be viewed in three (3) forms: in a 2D or 3D form of field mapping, in vectors form or in amplitude. Our choice carries on the amplitude form of the radiated field. It can allow to trace the amplitude of 3 cartesian components of the radiated field Hx, Hy, et Hz as a function of a distance along x or y axis. the retained x and y distances are equal to approximately

±10mm outside the antenna surface. The objective is to determine at which distance the emitted near field can influence other component that placed in the proximity of the antenna. We can remark in Fig.2 that the amplitude of Hz component is highest compared to the amplitude of Hx and Hy components. The objective being to quantify the magnetic field amplitude assumed to be capable to interfere with other devices located in its vicinity. So, it is judicious to focus only the Hz component. Thus, for the remainder of our study, we interest only to the Hz component. We present in Fig.3 below by way of illustration, the amplitude of the 3 components Hx, Hy and Hz radiated by studied structure at a height of 3mm above the resonator (radiating element of the antenna).

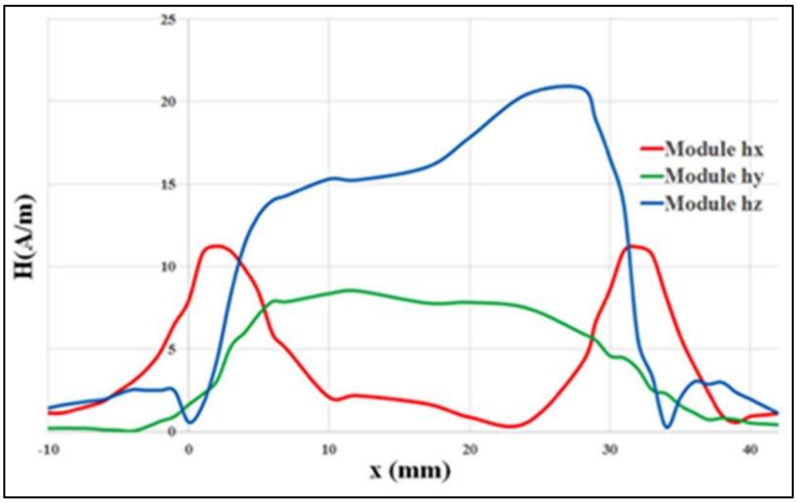


Fig. 2. Amplitude of H components along X axis

3.2 Quantification Of Near H-Field Radiated By The Antenna

The quantification study involves determining the most radiating part of the antenna. Then, to propose a solution to limit this radiation while maintaining or improving the antenna performance. Thus, we determined the radiated Hz field at different positions of length (x) and width (y) of the resonator for a fixed position in height (z). Indeed, the Hz component radiated by the antenna is determined at a close height of 3mm below and above the resonator. This 3mm height is justified by our objective which is to study the radiation in the near field of the antenna. We present in Fig. 3 below, the radiated Hz component determined at a height of 3mm below and above the resonator.

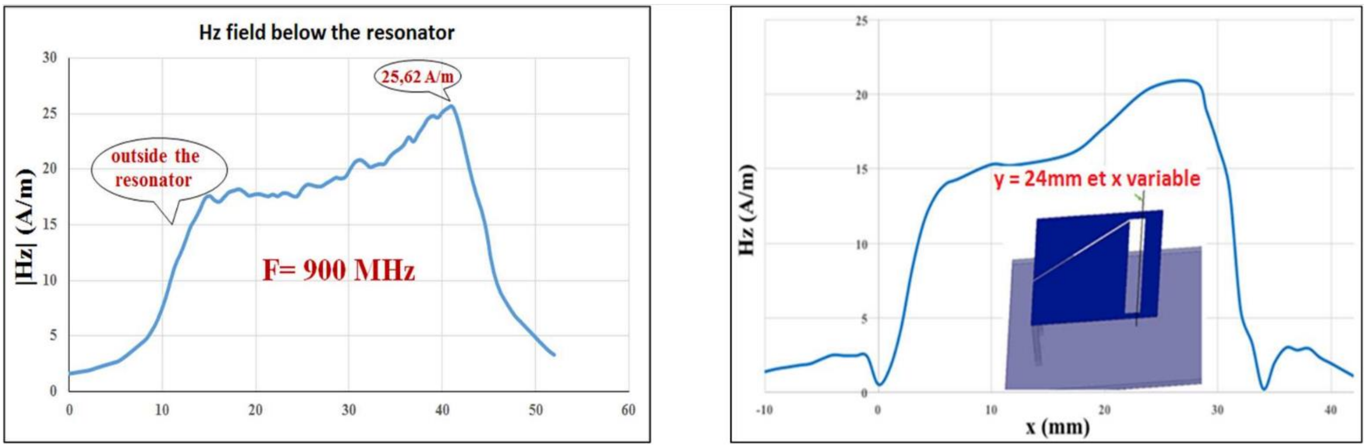


Fig. 3. Hz-field above and below resonator

We can notice in Fig.3 that the Hz amplitude is very high (22.5A/m below the resonator and 25.6 A/m above the resonator) at the position y=24mm. this y position corresponds to the centre of the non-opening slot of the resonator. This explains why the field lines are more concentrated at non-opening slot level. We can also remark that the Hz amplitude below resonator is little higher compared to that above resonator. This higher field amplitude between resonator and the ground plane may be a cause of training a high intensity of current on the ground plane and favours the increasing Specific Absorption Rate on one side and creating EM disturbance in conducted mode on the other hand. It is necessary to shield this field in order to reduce these EM disturbances. Thus, in the following paragraph, we present a study on the EM shielding of the antenna.

3.3 Shielding Of The Antenna

To decrease the higher amplitude of the magnetic field (25.6 A/m) between resonator and the ground, a high permeability ferrite operating in the frequency band of the antenna can be used. Much work has been carried out in recent years and significant advances have been made in the SAR reduction [13], [8], [9] using ferrite in miniature antennas of mobile phones.

Because of its high magnetic properties, ferrite is used for shielding electronic components that operate at high frequency [14]. The chosen ferrite for our study case has an electrical permittivity of 10 and a magnetic permeability of 40. This ferrite is widely used in HF domain. To the component, the ferrite is placed under the resonator without touching the power supply as shown in Fig.4 below.

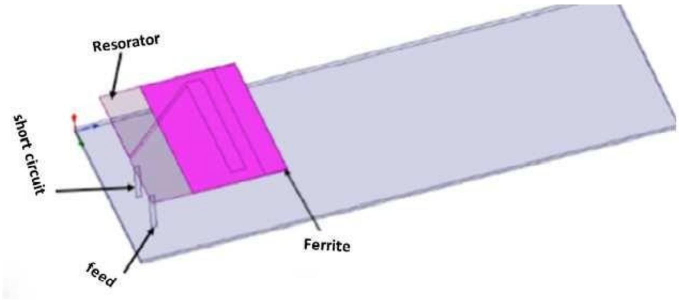


Fig. 4. Structure with ferrite

It should be noted that with the presence of ferrite, the impedance of the structure changes and of course the resonant frequency of the antenna too. Thus, before quantifying the field radiated by structure with ferrite, we first resized the structure in order to find the desired frequency band (900MHz). We compare in Fig. 5 below, the obtained reflection coefficient for antenna with and without before and after resizing.

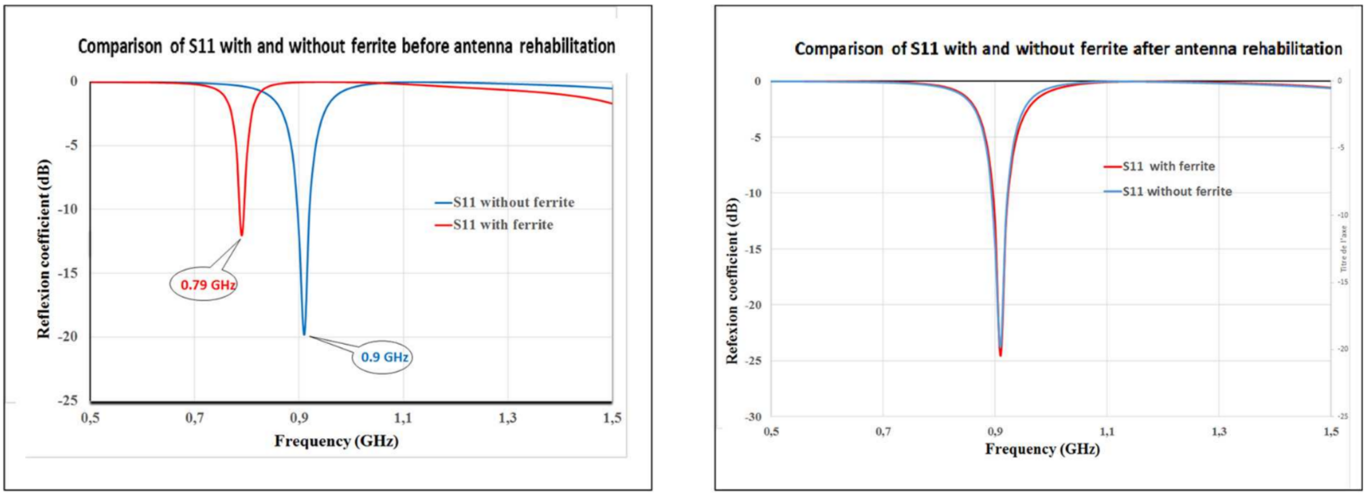


Fig. 5. S11 for antenna with and without ferrite: a) before resizing, b) after resizing

We present in Fig. 6 below, the evolution of radiated near field amplitude by antenna with and without ferrite as a function of the distance along x axis after resizing it.

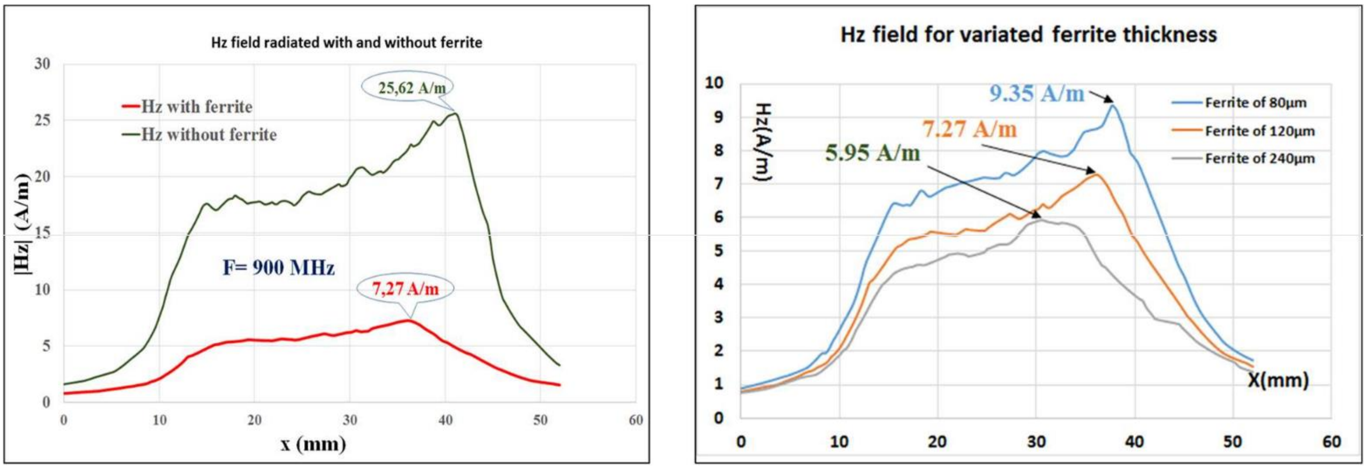


Fig. 6. H-field radiated by antenna with and without ferrite

We remark here that when a ferrite layer is added to the structure, the H field amplitude radiated below the resonator has decreased compared to that of an antenna without ferrite. The maximum value of the radiated Hz field goes from 25.6 A/m to 7.27 A/m for a ferrite thickness of 120µm. This decreasing amplitude is due to a canalization of the field lines by the magnetic material.

This reduction of amplitude field is not very significant enough. A study on the influence of ferrite thickness was carried out. We varied the ferrite thickness from 80µm to 240µm. The antenna is resized each time in order to stay on the operating frequency band (GSM 900). Then we determined the radiated H near field for each structure. shows the amplitudes of near H field radiated by these structures. We notice a decrease in the amplitude of the radiated near field when the ferrite thickness is large. The maximum amplitude of the field is 9.35 A/m for a thickness of 80µm, 7.27 A/m for a thickness of 120µm and 5.95 A/m for a thickness of 240µm. This can be explained by a high canalization of field lines when the thickness of the magnetic material is large.

4 CONCLUSION

In this article, we present a study on the quantification of the near magnetic field radiated by a GSM 900 antenna. The H-field amplitude in z-plane below resonator (radiating element of the antenna) is high compared to that above the resonator. A magnetic shielding is proposed in order to limit this magnetic disturbance while maintaining the antenna performance.

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