New Microstrip Antenna Design Approach Based On Harmonics Analysis And Radiation Monitoring Quality

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Abstract: Use of advanced design system and micro processed technology enhance the performance of transmission sub-system quality and control electromagnetic waves propagation in space, but at the same time resulting into transmitted waves quality problems for utility. One of the major issues of transmission quality is harmonics in transmission subsystem. Through mandatory regulations, harmonics in the transmission subsystem must be prevented to ensure good propagation quality. In this work, we present the design and characteristics of three types of tested Microstrip Antenna (MA). In the first place, longitudinally magnetized ferrite patch antenna is presented. We can control outside the resonance frequency by changing the tensor permeability which is a function of the magnetization of the ferrite substrate. The wavelength in the ferrite is short as the magnetization becomes stronger. This antenna becomes multi-band, used in transmission subsystems as well as IEEE standard transmission quality. A microstrip antenna ultra-wideband double circular slit fed with a coplanar line CPW is designed, and successful results are demonstrated. The proposed antenna is characterized by simplicity of design and food, a very low cost and a relatively stable radiation pattern in this part of the bandwidth. In the last part, we present simulations under HFSS antenna guide wave empty or filled with metamaterials to periodic square openings. This paper presents a new approach to design Microstrip Antenna for wireless transmission subsystems radiation quality monitoring and analysis considering harmonics. Successful results allow us develop a wide ultra antenna band. This is an innovative approach in telecommunication field in terms of radiated elements which thereby improves waves propagation quality. A case study of microstrip antenna performance is presented which encompasses the effects of harmonics on Antenna waveguide to metallic ultra band and double slit ULB patch antenna to find out the solution to be implemented.

Index Terms: Advanced Design System, Ferrite Antenna, Gain Peak, Harmonics, HFSS, Resonance Frequency, Meta Material Ultra Broadband, Microstrip Antenna, Wave Guide.

1 INTRODUCTION

IT is known that in Telecommunication subsystem operating in a high frequency band, the ferrite is a very useful magnetic material for the microwave antenna applications. The reason of the ferrite [1] microstrip structures use, is that in the magnetic field applied, the permeability values changes as well as the electrical properties of the material, that affects the microstrip antenna properties. So antenna [2] characteristics can be changed by a constant magnetic field applied externally we develop a longitudinally magnetized ferrite microstrip antenna, and we present the obtained results of its characteristics our analysis for the microstrip antenna begun first with a development of a rectangular adjustable antenna design, the printed element is made on a the substrate of magnesium ferrite TT1-414 of Trans-Tech, operating in S band, and it is characterized by a thick ferrite substrate equals to H and a length L.

2 MICROSTRIP ANTENNA STUDY

We consider a substrate of ferrite with a constant magnetic field $H_0$ applied longitudinally. The permeability of the ferrite magnetized longitudinally (management OX) is expressed by the tensor of Polder [3]. By increasing the magnetization M from O to 0.9 Ms, the frequency increases from 2.4 GHz to 3.08 GHz. Our antenna then became multi band. This is an external controlled antenna.

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The dimensions of the microstrip antenna [6] operating at 2.4 GHz, with the ferrite degaussed, are:

$W = 25$ mm
$L = 17.8$ mm,
$h = 1.6$ mm.

The ferrite microstrip antenna without magnetization is with a bandwidth equals 15 MHz, and a gain of 5 dB. Practical applications of UWB technology [7] have progressed rapidly in the fields of wireless telecommunication. The need for very high speed and versatile wireless communication system inevitably requires the use of antennas covering a frequency wideband [8-13]. Several antenna structures have been designed to meet different techniques of miniaturization and enlargement of bandwidth have been developed. We propose a new slots UWB antenna is proposed. Both numerical and experimental results show that our design allows an improvement of the performance of the antenna and offers potential benefits in various applications ULB [8].

3 NEW ULB MICROSTRIP ANTENNA DESIGN

We consider a substrate of ferrite with a constant magnetic field $H_0$, applied longitudinally. The permeability of the ferrite magnetized longitudinally (management OX) is expressed by the tensor of Polder [3]. By increasing the magnetization M from O to 0.9 Ms, the frequency increases from 2.4 GHz We consider the study of an antenna omnidirectional broadband. It is a dual slot antenna. It was printed on a substrate FR4 dimension 70 mm x 75 mm, thickness 1.6mm and relative permittivity $\varepsilon_r = 4.4$. The radiant structure consists of two nested slots, forms a circle of radii r1 and r2, engraved in the ground of a FR4 substrate plane single-sided. The two slots is powered by a coplanar line CPW (line 50 $\Omega$), spaced width W = 1.88 mm of the ground from a distance plane $s = 0.21$ mm, ending in a loop of varying width. The choice of a single-sided substrate allows the antenna to radiate omni-directional manner. The study carried out using HFSS, the distance d between the centres of the circles of radii r1 and r2, shows that the adjustment of the antenna is optimized for a distance $d = 12.77$ mm. Using the option ‘Optimetrics’ under HFSS allowed us to optimize the impedance of the antenna on the three radii (r1, r2, r3). Dimensions following $r1 = 23$ mm, $r2 = 10$ mm and $r3= 6$ mm. We provide a large enough frequency, up to 20.3 GHz band, with a reflection coefficient (S11) below-10 dB for frequencies higher than 2.3 GHz.
Fig. 1. Max gain changes depending on frequency.

Experimentally, the antenna simulations results as is figure 1, demonstrates that its maximum gain increases depending on the frequency up to 7 GHz, then fluctuates between 5 dBi and 10 dBi beyond this frequency. These fluctuations are due number of side lobes that increases depending on the frequency.

4 RESULTS AND DISCUSSION

Radiated energy distribution in space is studied, in order to demonstrate that the pattern shape depends on the operating frequency, in addition at low frequencies (figure 2a, figure 2b, figure 2c, and figure 2d); We have a quasi-omni directionnel [9] radiation diagram for the S band. And in the band [5 GHz, 8 GHz], we have rather a directional pattern with two main lobes. The number of main directions grows beyond to 6 GHz, because of the appearance of standing waves at the level of the two slots which increases the number of maximum frequency that depends on it.

We observe also that maximum intensity into the slots we have, is considered as a point array. The number of point sources is presented the more directivity, gain and the number of lobes increases. The current distribution of surface shows that the number of maximum increases with the frequency of use. In figure 2 electromagnetic field radiation patterns have been presented at 2 Ghz, 4 Ghz, 10 Ghz and 20 Ghz in plan E (XZ plane) and the H plane (YZ plane). A prototype of this dual slot antenna was directed. Measurement of the coefficient of reflection of the antenna shows a good correlation with the simulation. We compare HFSS and ADS simulators made in Laboratory in order to measure results. The reflection coefficient is less than or equal to value 10dB over the entire measured band ranging from 2.3GHz up to 20 GHz. This antenna is interesting for use in electromagnetic [10] energy recovery system. It is nearly omni directional for low frequencies [2 GHz - 4 GHz] and its gain is greater than 4 dBi. Its only drawback is its bandwidth with lower limits beginning to the 2.3 GHz frequency. To overcome this problem, we have tried to modify the dimensions of the antenna in order to expand its bandwidth to lower frequencies, around 1 GHz. The frequency band where the intensity of RF power is important is the 1 GHz-3 GHz band. After several simulations of the
antenna [11] under HFSS, we managed to define new dimensions of the antenna, for operation around 1 GHz and beyond:

\[ r_1 = 31.5 \text{ mm}, \]
\[ r_2 = 22 \text{ mm}, \]
\[ r_3 = 14 \text{ mm}, \]
\[ d = 13 \text{ mm}. \]

With a ground plan of 80 mm X 70 mm). The variation of the coefficient of reflection (S11) depending on the frequency is presented. This reflection coefficient falls below-10 dB for frequencies greater than 1.15 GHz. The variation of the maximum gain depends on the frequency. This maximum gain [12] is greater than 3dBi over the entire frequency band. The radiation[13] of the antenna is still Omni for low frequencies (up to 6 GHz). Beyond this frequency, side lobes are beginning to appear linked to the appearance of standing waves [14] in the slots of the antenna[15]. By plotting direct polarization antenna[16], (co-polarization Eo) and cross-polarization (cross-polarization Ecross) the angle theta , note that the double slots antenna has a linear polarization [17]. throughout the band 1GHz-3 GHz, with a difference between the Eo and the order of 50dB Ecross field. With a coefficient of reflection (S11) below -10 dB for frequencies above 1GHz, in addition a distribution Omni of the radiated power[18]. with a maximum gain of more than 3dBi. We note that for frequencies above 1 GHz, the use of this antenna to this double-slotted [19] so a clear interest in an electromagnetic energy recovery system. Linear is its only drawback polarization that allows to capture only a single incident electromagnetic polarization.

5. CONCLUSION

The antenna designed in rectangular form which has been developed on a substrate ferrite in the 2.4 GHz frequency has been presented. This antenna has a gain of 5 dBi. We can externally control the resonance frequency by varying the tensor permeability which is a function of the magnetization of the ferrite. The resonant frequency increases by increasing the magnetization. We have obtained a multi band antenna. On the other hand, a new antenna printed for applications for ultra wide band is proposed. Measurement of losses by reflections in summer performed up to 20 GHz and shows a good correlation with the simulation. Characterizations to higher frequencies have been planned, because, according to simulations with Simulator HFSS we have less than one-10dB return loss in the 20 to 25 GHz band. We can explain the slight difference between the results of the simulations and measurements by using SMA connectors and substrate FR4 which reached its limits of frequency. The results of radiation pattern obtained with HFSS Simulator show the existence of many forms for different frequencies with a peak of gain which is more 4dBi.

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