Modulation Designed for Wraparound Microstrip Antenna

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Abstract

This study describes the radiation properties of wraparound microstrip antenna operating at 430 MHz. This antenna has characterized by its omnidirectional coverage. Such is preferred over other antennas because they have compatibility to install with different surfaces, particularly in military applications with high-speed vehicles such as aircraft, missiles, and other applications. This design has simulated using CST EM Simulation Software, which is based on the finite integration technique (FIT) and finite element method (FEM). In this article, the antenna coefficients were obtained, by measuring the bandwidth (7.23), voltage standing wave ratio (VSWR) (1.0447), and the return loss around (-31.836dB).

Keywords: Microstrip Antenna, Wraparound Antenna, CST.

I. Introduction

The concept of microstrip antennas was developed in 1970 when electronic circuits became smaller with advances in science. Since this type of antenna has distinguished from the other antennas with many characteristics, including small size, lightweight, and ease of manufacture, it is also mechanically strong when installed on various solid surfaces. On the other hand, it suffers from a narrow bandwidth, researchers have worked a lot to find better results for this problem (Afridi, 2019). The innovation of these antennas is attributed to many researchers, including Deschamps, Greg, Engelman, and others who have devoted their efforts to making changes to the original antenna to obtain a wider bandwidth (El Hamdouni et al., 2018).

The presence of antennas for aerial vehicles plays a fundamental role in ensuring communication with the ground station. Also, these antennas are used for many purposes such as navigation, tracking, and telemetry. Due to the unique application, the design of aerial vehicles differs a lot compared to other applications. Therefore, some considerations must be taken when carrying out the design process to fulfill the requirements for the benefit of air vehicles(Munir et al., 2016). Wraparound microstrip antennas have gained a lot of attention in recent decades due to the need to install antennas on curved surfaces because many surfaces are not completely plane (Jos, 2014). In 1972, Munson studied the wraparound microstrip antenna, which led to the rise of the popularity microstrip antenna, in addition, he used metal strip as patches wrapped around missiles (Munson, 1974). With the continuous improvement in numerical techniques and computing power, the analysis of electromagnetic waves in curved surfaces has become easier and faster now because it allows us to reduce time and costs using commercial programs. CST is one of the programs used to simulate three-dimensional radioactive structures, planes, and multi-layered structures in free space (Awl et al., n.d.). In this study, the CST program was used to calculate bandwidth, input impedance include real and imaginary parts and radiation pattern.

II. Antenna Design

Wraparound microstrip antennas consist of an internal cavity of a typical cylindrical electrical conductor made of copper with a radius of *a*. It has surrounded by a dielectric cylinder (Roger RT5870), where *a* and *b* are the inner and outer radius, respectively. denotes the dielectric constant. The antenna length has usually expressed, as shown in figure (1). Then the small rings representing the stains are placed over the dielectric. The width of each ring is equal to, where is the wavelength in the dielectric substrate (its value) (Mohammed et al., 2020). As for dielectric zones, the width of the front dielectric zones has represented by (*h1*, *h2*), as can be seen in figure (1). Where (*h2*) indicates the width of the dielectric zone between the two rings. Besides, the thickness of the dielectric layer can be represented by (*h*). The dielectric substrate thickness is one of the most important factors affecting the antenna's performance, such as the bandwidth, radiation pattern, etc. This is extremely important for the manufacture of the proposed antenna, because it may not be flexible and difficult to bend, or the thin materials may be too brittle not be installed (Mendiratta et al., 2014). All these parameters have adjusted to determine the optimum dimensions for getting the best antenna results. Table (1) shows the resonant antenna dimensions.

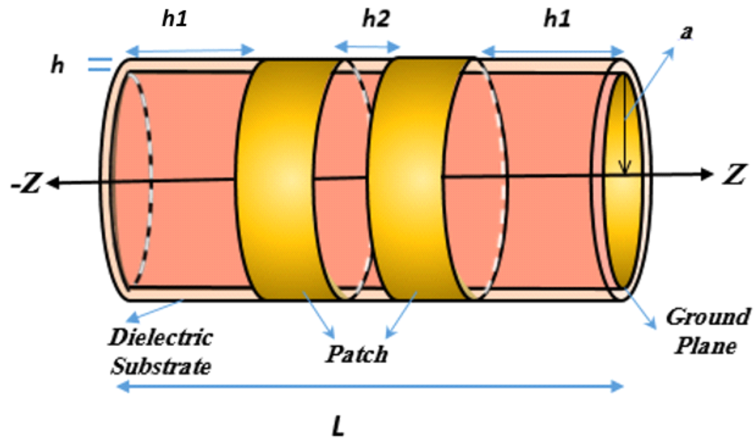

Fig. 1: Wraparound microstrip antenna with two patch.

Table (1): List of antenna design

Values	Components
430 GHz	Resonant frequency *Fr*
29.9794 cm	Inner radius (*a*)
31.3811 cm	Outer radius (*b*)
41.8414 cm	Total antenna length *L*
1.3947 cm	Dielectric thickness h
2.33	Dielectric constant
11.4213 cm	Width of the patches *W*
9.4993cm	*h1*
0.3487 cm	*h2*

III. Results and Discussion

To prove the validity of the program simulation, the radiation pattern obtained using CST software was compared with the method of moment (MoM) (James & Hall, 1989). Figure (2) shows the radiation pattern and how the antenna has directed to the energy it radiates in terms of the Cartesian coordinates.

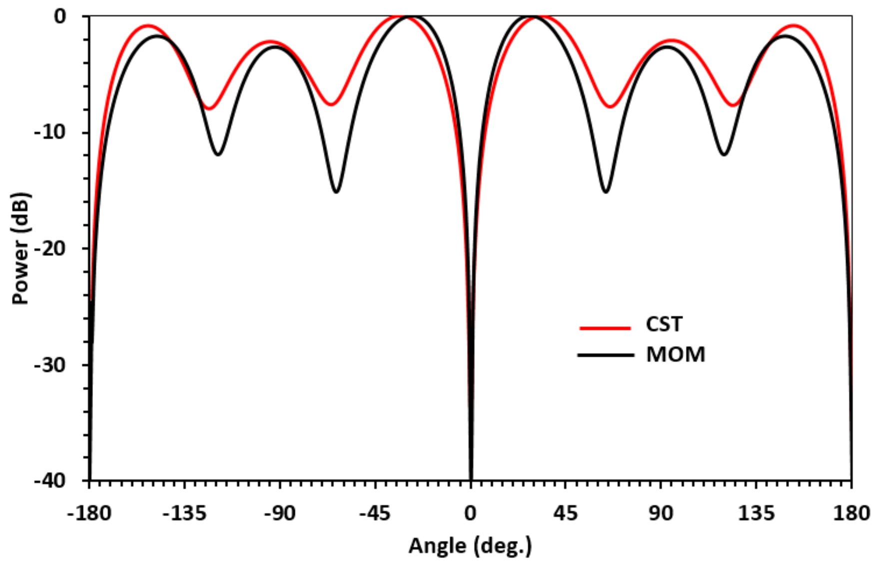

Fig.2: Comparison of radiation pattern between CST and moment method for wraparound microstrip antenna with dual patch.

The reflection coefficient (S11) represents the decreasing amplitude of the reflected energy compared with the front power. Figure (3) shows the reflection coefficient as a function of the frequency. The resonant frequency has been observed according to the energy level (−10dB). According to the reflection coefficient curve, we notice that when the resonant frequency is 409.5MHz, the reflection coefficient is equal to (−31.836); and the bandwidth is (7.23 MHz).

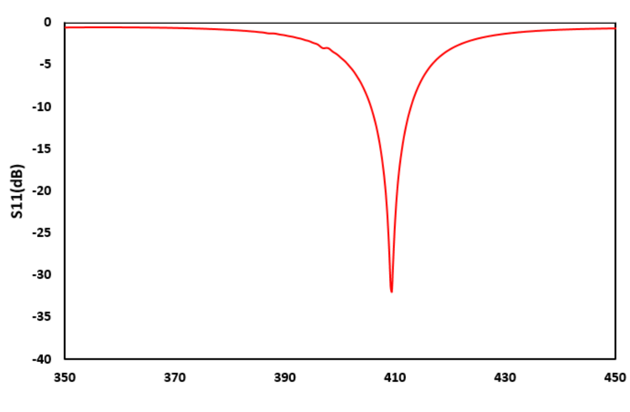

Fig.3: The reflection coefficient for wraparound microstrip antenna with dual patch.

The optimum minimum value of voltage standing wave ratio (VSWR) is around 1−2. Thus, the VSWR has been studied for the wraparound microstrip antenna, see Figure (4). This figure shows that values of VSWR are closely 1, which indicates that we have well resonant parameters of antenna designed.

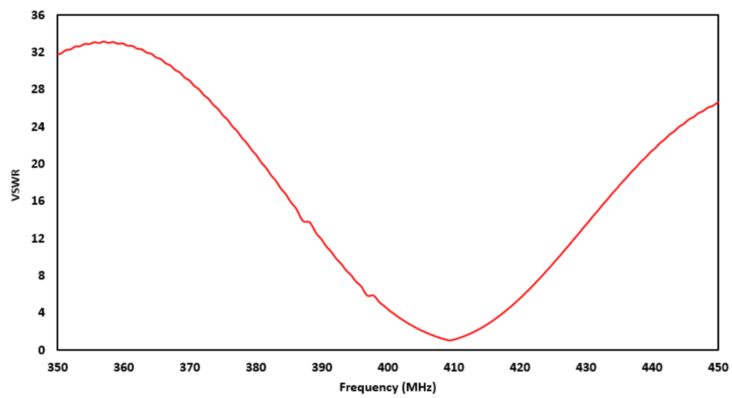

Fig.4: VSWR for wraparound microstrip antenna with dual patch.

However, Figure (5) shows the results of the input impedance, as it's evident from the figure that the values are 50.5 Ω of the substrate thickness of 1.3947 cm.

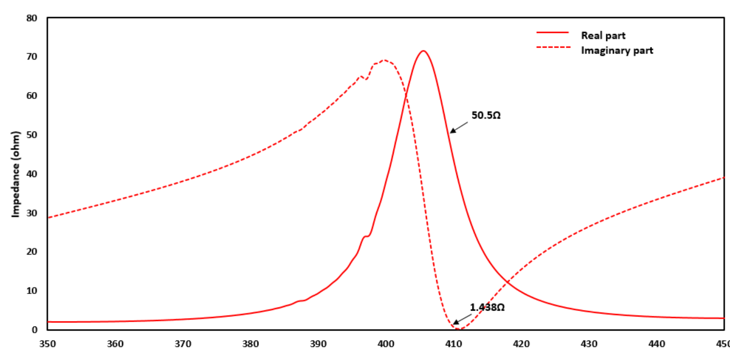

Fig.5: Shows the real and imaginary part of the input impedance *vs.* frequency

IV. Conclusion

In this paper, the results of the wraparound microstrip antenna with a dual patch have been obtained using CST-Software. These results have been compared with the predictions analyzed by the method of moment. Various coefficients have been used to calculate the parameters for the suggested antenna. The thickness of the dielectric material has been taken into consideration to determine the resonance frequency and bandwidth to obtain a radiation pattern with omnidirectional directions.

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