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Design and Analysis of Circular Patch Antenna for Wireless Applications

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Abstract: A compact circular microstrip patch antenna has been designed and proposed. The investigated antenna configuration was intended to work at the centre frequency of 2.4 GHz for Wi-fi (2.4 GHz) applications. The proposed comprises circular microstrip patch with microstrip feed line. The structure resonates at a ISM band which completely covers the 2.36–2.44 GHz. A microstrip feed line is utilized to acquire impedance coordinating over a wide band of frequencies. The return loss impedance transmission capacity values are enhanced significantly for desired resonant frequencies. Proposed antenna is described with better radiation patterns in the working bands. An intended structure parameters are analysed by the simulation of the structure with high frequency structure simulator (HFSS).The suggested model se is suitable for wireless wi-fi applications.

Keywords: Microstrip patch antenna (MPA); circular patch antenna; microstrip feed line; wi-fi.

I. Introduction

In recent couple of years, microstrip antenna [1], [3]s have excited great interest in both theoretical research and engineering applications because of their low profile, conformal structure, and ease in fabrication and integration with solid-state devices. As a result of the innate thin transfer speed of microstrip reception apparatuses, many endeavors have been made to enhance their transmission capacity qualities. In general, there are two productive ways to deal with widen the transmission capacity of the microstrip radio wires, i.e., by increasing the substrate thickness and by creating the slots [2], [4] on the same or different layers of an antenna structure. The different types MPAs such as circular ring, circular, rectangular, squares and ring slot shapes [1]-[5] have been portrayed in literature. Circular ring patch antennas [6] – [9]are having attractive features over the square slot shapes.

In traditional wi-fi, IEEE 802.11 [6] principles are generally embraced for correspondences over a distance of a few many meters. In the current time of cell communication, low profile reception apparatus with high productivity is broadly required. Mobile communication plays a vital role in the human life. The most widely recognized portable applications utilized as a part of recent years is wireless network. A lot of research works have been directed on wireless network radio wires at 2.4 GHz [14]. This gives users the ability to move around within a local coverage area and still be associated with the system and can give an association with the more extensive Internet. ISM is intended to work in the frequencies groups 2.38-2.45 GHz (802.11b). Later on, a cell phone ought to be more versatile to the flag condition and able to switch between high information rate short-go associations (HYPER LAN) and customary associations.

The designed patch antenna [10] in feeding models need, standardized knowledge to couple the resonators and elements. However, the resonant feeding framework set in these portrayed models, such as microstrip-fed, aperture-coupled, co-axial probe coupling, co planar slot feed and CPW-fed space course of action offers greater adaptability and is specifically perfect with various mounting surfaces. In this structure, in order to avoid via holes, the microstrip feed line is suggested [15]. The microstrip line set on a similar substrate of round ring patch that could be put straightforwardly on the feed line. The benefit of microstrip feed is easy to coordinate by controlling the inset encourage position.

The circular patch antenna [11]-[13] is designed for HYPER LAN applications and the proposed antenna model is fed with microstrip feed line. It consists of ISM band (2.4 GHz) of circular ring patch antenna and it is controlled by the radius of the circular slot. In this model, a microstrip line is presented on a same substrate for good impedance matching. The favourable position of microstrip feed is that it is less difficult to make, match and model.

The analytical and physical parameters of these models are varying correspondingly to get the aimed execution

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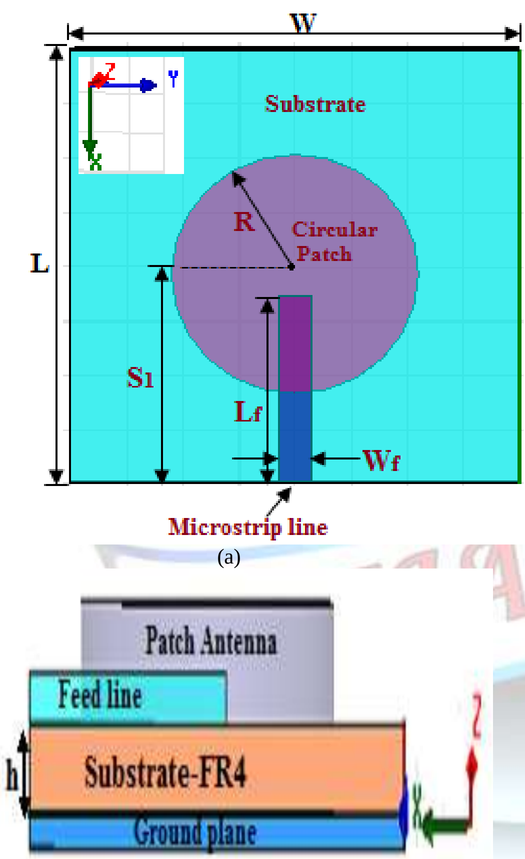
parameters. In this model, improvement of round ring patch receiving wire is executed for the ISM band which will be sensible for remote neighbourhood applications. This outline has the benefit of straightforward structure, conservative size, and can acquire ISM band with various emanating designs and the actualized antenna mol is intended to work at the centre frequency of 2.4 GHz for wireless local area network applications.

II. Antenna Configuration



(a)

(b)

Fig.1. Proposed CMPA with ring slot: (a) Top view; (b) Side view

The analysed circular patch antenna fed by microstrip line is proposed [12]. The designed antenna model comprises the circular ring patch antenna at centre position of substrate. The suggested circular ring patch antenna oscillates at 2.4 GHz (ISM) which is reasonable for wireless local area network applications. The circular ring patch antenna is placed on the substrate – FR4 resonate at ISM band frequencies. By varying the radiating resonators' position and by adapting a circular slot at midpoint of circular patch, a compact circular ring path can be designed. The feed line [15] is placed on the substrate at the centre point.

Figure 1 illustrates the designed antenna model for wireless network applications. The implemented antenna has the dimensions of 50 mm × 50 mm × 1.6 mm, and an FR-4 dielectric with a relative permittivity of 4.2 is used as a substrate. It comprises a circular ring patch with a centre-fed microstrip line which is printed on an FR-4 substrate of thickness 1.6 mm and relative permittivity εr =4.4. The circular ring patch has a radius of R_P=14 mm as shown in Figure 1. The 50-Ω feeding line has a length of L_f =17.8 mm and a width of W_f =2.8 mm.

The idealized operating frequency of the circular patch antenna is determined [16] by the following equation and suitable to 2.4 GHz which is applicable for ISM applications.

$$a = \frac{F}{\left\{1 + \frac{2h}{\pi F \varepsilon_r}\left[ln\left(\frac{\pi F}{2h}\right) + 1.7726\right]\right\}^{1/2}} \quad (1)$$

Where,

$$F = \frac{8.791 \times 10^9}{f_r\sqrt{\varepsilon_r}} \quad (2)$$

a = radius of the circular microstrip patch
h = height of substrate
ε_r = dielectric constant of substrate
f_r = resonant frequency

III. Simulated Results And Discussion

Figure 2 exhibits the simulated return loss of the intended circular patch antenna. The proposed energized band is a direct result of circular ring patch. The -45 dB return loss is seen at 2.4 GHz. Note that there are no frequencies to be irritated ostensibly the presence of patch resonator, that is, the full resound space mode is instigated by the circular patch.

The return loss is another method of communicating mismatch. It is a logarithmic proportion estimated in dB that analyzes the power reflected by the receiving wire to the power that is bolstered into the radio wire from the transmission line. The connection amongst SWR and return loss is the accompanying:

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$$\mathrm{Return\,loss}(dB) = 20\log_{10}\frac{SWR}{SWR-1}$$

The term transmission capacity basically characterizes the recurrence extend over which a receiving wire meets a specific arrangement of detail execution criteria. The vital issue to consider with respect to transmission capacity is the execution tradeoffs between the greater parts of the execution properties portrayed previously. There are two strategies for processing a antenna data transfer capacity. The antenna is viewed as broadband if $f_H/f_L \geq 2$.

Narrowband by %

$$BW = \frac{f_H - f_L}{f_0} x100\%$$

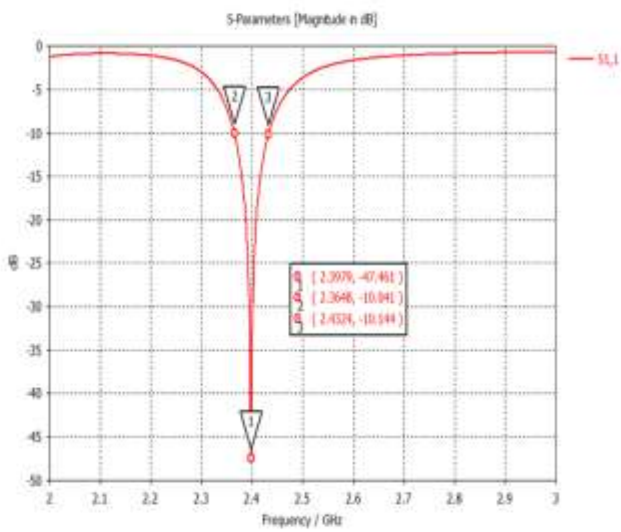

Fig.2. Simulated return loss at ISM band

Figure 3 shows that the radiation waves of the simulated antenna model at 2.4 GHz with phi=0 (deg) and phi = 90 (degree). The antenna emanates a most extreme in the broadside bearing at 2.4 GHz, which oscillates to the far-field radiation from the enhancement method of the patch as shown in Figure 3. The radiation pattern of antenna gives the data that depicts how the reception apparatus coordinates the vitality it transmits. All antennas, if 100% efficient radiate the same total energy for equal input power regardless of pattern shape.

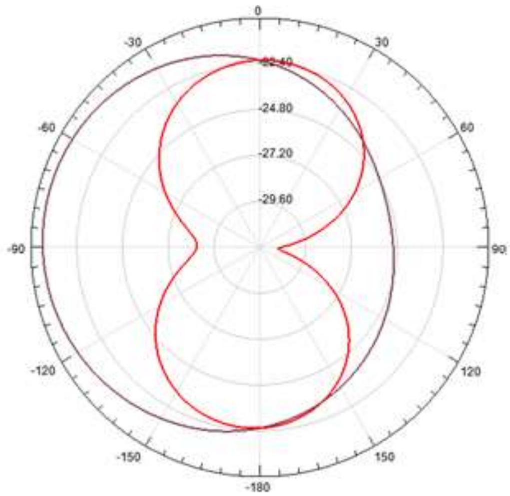

Fig.3. Simulated radiation patterns at ISM

Figure 4 exhibits the voltage standing wave ratio (VSWR) of the proposed model. It represents the analysis of the mismatch between the load and the transmission line. For good impedance matching, the significant value of VSWR is 1. The VSWR of proposed model is 1.16 at 2.4 GHZ. The VSWR indicate that how closely or efficiently an antenna's terminal input impedance is matched to the characteristic impedance of the transmission line. By using VSWR, mismatch between the transmission line and antenna can be analysed.

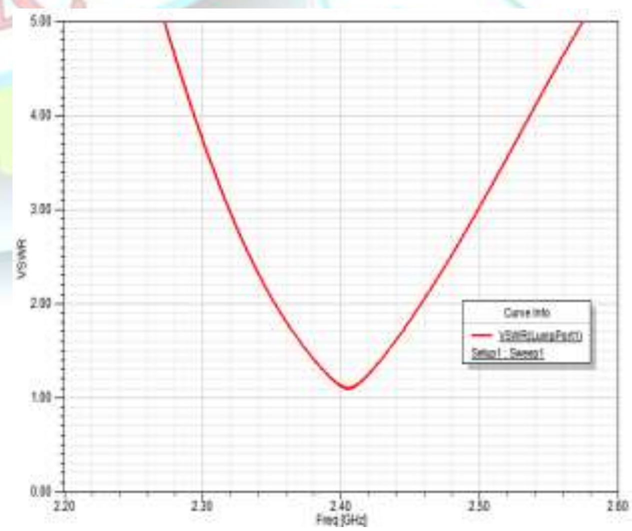

Fig.4. Simulated VSWR at ISM

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IV. CONCLUSION

A compact circular microstrip patch antenna sustained by a microstrip line has been designed. The ISM band of the circular patch antenna are implemented by the circular patch mode. A parametric report is done to explore the antenna functional and design parameters. The model has been reproduced and it is watched that a transmission capacity and return loss of 5.85% and -45 dB at the resonant frequencies of 2.4 GHz. The designed model takes a less volume, compact size, simple shape and adequate operational bandwidth, such that it is suitable for wireless network applications.

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BIOGRAPHY

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