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Designing Two Models of a Radiated Patch Antenna, One Using the Strip Line Technique and the Other Using the Coaxial Feeding Technique, and Comparing Them In Terms Of Return Loss and Standing Wave Voltage VSWR

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Abstarct: In this research, two models of the radiated patch antenna were designed, each of which operates in a different feeding method from the other, and the material FR-4 was used as an insulating substrate with a dielectric constant of 4.3. Copper was also used as a conductive material for the radiated patch and the transmission line, with fairly close geometric dimensions. The first antenna has dimensions (31 x 26 x 1.6) m3 and the second antenna has dimensions (30 x 27 x 1.6) m3, The first one works with the coaxial probe technique. The user uses the linear feed technique. If it is found that the loss of the first antenna is equal to -26.0113 dB and a ratio of 1.1053 at a frequency of 3.59 GHz and -24.743 GHz and a ratio of 1.8908 at a frequency of 5.529 GHz, and the return loss of the second antenna is -27.468 dB and a ratio Frequency 1.0884 at a frequency of 3.45 GHz Both antennas were designed and operated using CST software (Computer Simulation Tool).

Key points: patch antenna, return loss, VSWR, strip line feed, coaxial probe fee.

Introduction:

An antenna is defined according to the IEEE system as a means of radiating or receiving electromagnetic waves [1]. An antenna is any device that converts electronic signals into electromagnetic waves (and vice versa) effectively with minimal signal loss [2]. An antenna can be defined in more detail as the structure associated with the transition region between a guided wave and a free space wave or vice versa. [3], Microstrip patch antennas are known for their performance, robust design, manufacture and usage. The advantages of patch antennas overcome their disadvantages like ease of design, light weight etc. Applications are in various fields like medical applications, satellites and of course even in military systems just like in missiles, aircraft, rockets etc.

Microstrip patch antenna

It is a substrate of insulating material on one side of which is a conductive material (the radiating patch) in a geometric shape that may be regular or irregular, and on the other side (the ground plane) there is also a conductive material. For narrowband microwave radio communications requiring hemispheric coverage [4].

Microstrip (coplanar) Feeds

Microstrip line feed: In such an arrangement, the edge of the microstrip patch is bonded with the conductive tape as seen in Figure [5], where the patch is larger than the conductive tape. Accordingly, electrodes can be etched on one substrate in order to create a straight configuration. [6].

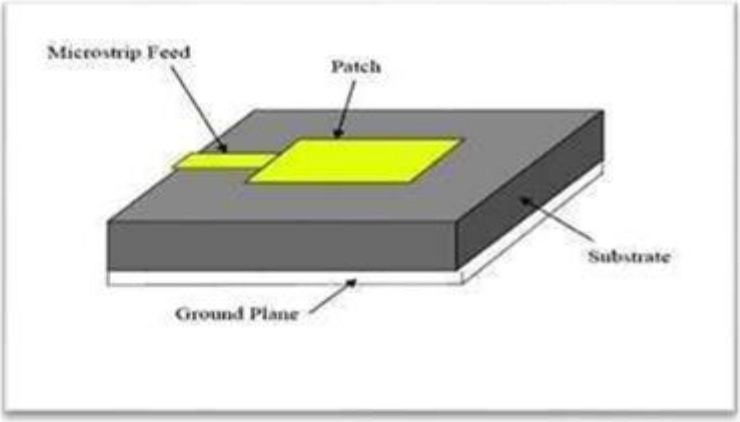

Figure 1. shows the microsripline technique.

Coaxial Wire Feed technique

The technology of powering an antenna through a coaxial probe is one of the basic mechanisms for transmitting microwave energy. In the coaxial sensor, the outer conductor is connected to the ground plane while the center conductor is connected to the radiation patch, as illustrated in Figure (2) [7]. The advantages of coaxial feed are simple production, convenient adjustment, and low interference radiation. The disadvantage is low bandwidth.

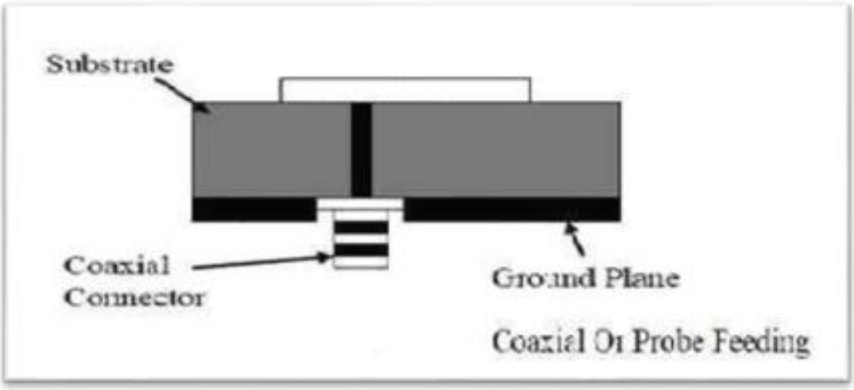

Figure 2. shows the axial probe technique.

Return loss

According to Return loss serves as the metric for signal evaluation in the field of telecommunications. strength with respect to the signal that reflects at any fault point on a transmission line or a fiber optic cable. This defect might result due to a mismatch of terminal or load connected to the line and the characteristic impedance. Return loss is usually given as a dB ratio and this depends on the standing wave ratio (SWR) and reflection coefficient. (Γ). Increased yield losses correspond to decreased standing wave ratio SWR

It is also known as the difference between forward and reflected power [8].

$$FP(dB) - RP(dB) = RL(dB) \tag{1}$$

$$RL = 10 \log \frac{P_r}{P_i} \tag{2}$$

RL(dB): is the return loss in dB.

P_i: is the incident power.

P_r: is the reflected power.

The return loss is related to both the standing wave ratio (SWR) and the reflection coefficient (Γ).

$$\Gamma = \frac{V_r}{V_i} \quad (3)$$

Vi : is the reflected wave.

Vr : is the incident wave.

Voltage Standing Wave Ratio

In radio frequency (RF) power delivery systems, the standing wave ratio (SWR) refers to a parameter that quantifies the efficacy with which a given power source feeds RF energy into the transmission line. In this sense, SWR implies the ratio between transmitted and reflected waves[9]. We obtain the highest power transfer rate when only the antenna impedance is compatible with the transmitter impedance, i.e. vswr = 1 [10].

When SWR is high, this implies that the transmission line is inefficient, and the power reflected can also be high, which could cause damage to the transmitter, resulting in a reduction in efficiency. Because SWR usually represents The voltage ratio, commonly referred to as the voltage standing wave ratio, is another term used to describe this concept. (VSWR) has an inverse relationship with the voltage reflection coefficient. (Γ) through the following equation:

$$VSWR = \frac{V_{max}}{V_{min}} = \frac{1+\Gamma}{1-\Gamma} \quad (4)$$

V_max : The highest voltage capacity on the transmission line.

V_min : The lowest voltage capacity on the transmission line.

Γ: Reflection coefficient.

1. Microstrip antenna design

In this design, epoxy FR-4 was used as an insulator Possessing a dielectric constant of 4.3 and a thickness of 1.6 mm. Copper was also used as a conductive material for the radiated patch and the ground plane. Both models of the microstrip antenna were designed using mathematical equations to calculate the dimensions of the rectangular radiated patch as follows:

1.1. Calculating the effective dielectric constant of the thin strip antenna ($\mathcal{E}_{reff}$)

The effective dielectric constant was calculated and was equal to 3.89 by applying the following mathematical relationship [11].

$$\mathcal{E}_{reff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left[1+12\frac{h}{w}\right]^{-1/} \quad (5)$$

2.1. Calculating the width of the radiated patch (wp)

Width of radiation patch at frequency 3.45 GHz was calculated by applying the following mathematical relationship [12]:

$$W = \frac{c}{f_r}\sqrt{\frac{2}{\varepsilon_{r+1}}} \quad (6)$$

3.1. Calculating the effective length of the radiating muscle (electrical length) (L_{eff})

$$L_{eff} = \frac{c}{2f_r\sqrt{\varepsilon_{reff}}} \quad (7)$$

4.1. Calculate the discrepancy between the physical and electrical distances of the radioactive patch (ΔL)

The difference between the physical and electrical length of the radiated patch is calculated and its value is found to be 0.737mm, by applying the following equation [13]

$$\frac{\Delta L}{h} = 0.412\frac{(\varepsilon_{reff}+0.3)(\frac{W}{h}+0.264)}{(\varepsilon_{reff}-0.258)(\frac{W}{h}+0.8)} \quad (8)$$

5.1. Calculating the length of the radioactive patch(L_P)

The length of the radiated patch was calculated and its value was equal to 19.5738 mm, by applying the following mathematical relationship [14].

$$L=L_{reff} - 2\Delta L \quad (9)$$

2. Results

2.1. Return loss

From Figure .3 it is clear that the return loss of the first antenna that was fed by the microstrip-line method is equal to -27.468dB at the resonant frequency of 3.45 GHz.

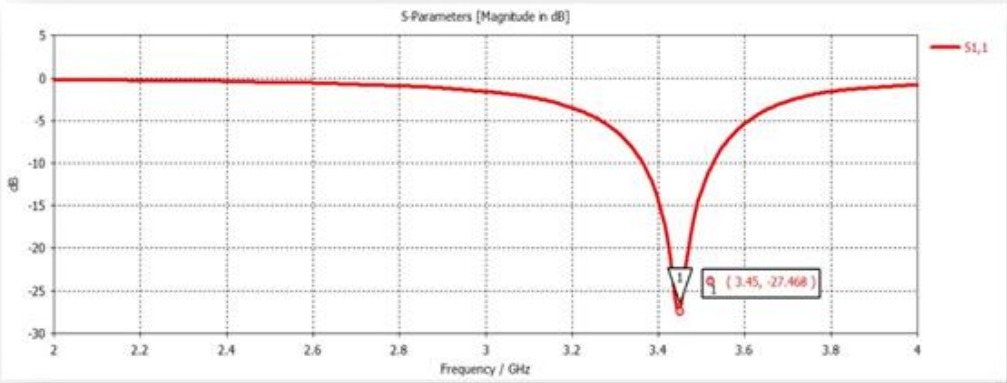

Figure 3. Return loss of the first antenna.

Figure 4. shows the return loss of the second antenna that was feed by the coaxial probe method, which is equal to -26.0113dB at the resonant frequency of 3.69 GHz and equal to -24.74318 GHz at the resonant frequency of 5.529 GHz.

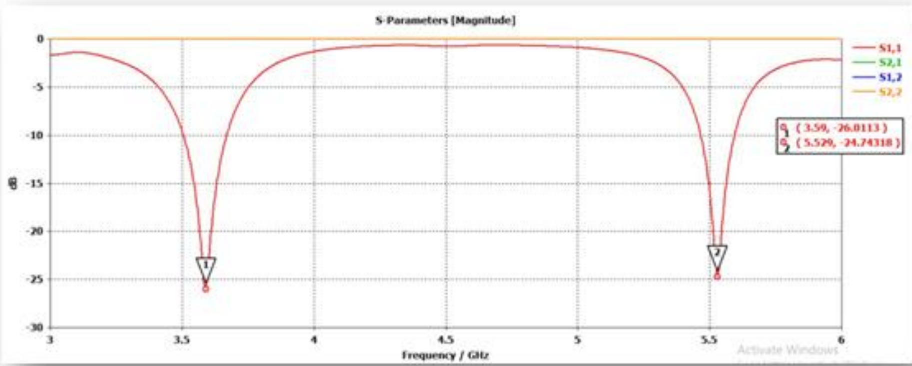

Figure 4. Return loss of the second antenna.

2.2. Standing wave voltage ratio of the first antenna

From Figure .5 it was found that the standing wave voltage ratio of the antenna is equal to 1.0884 at the frequency at which the energy is stored of 3.44995 GHz, and this value is good for compatibility.

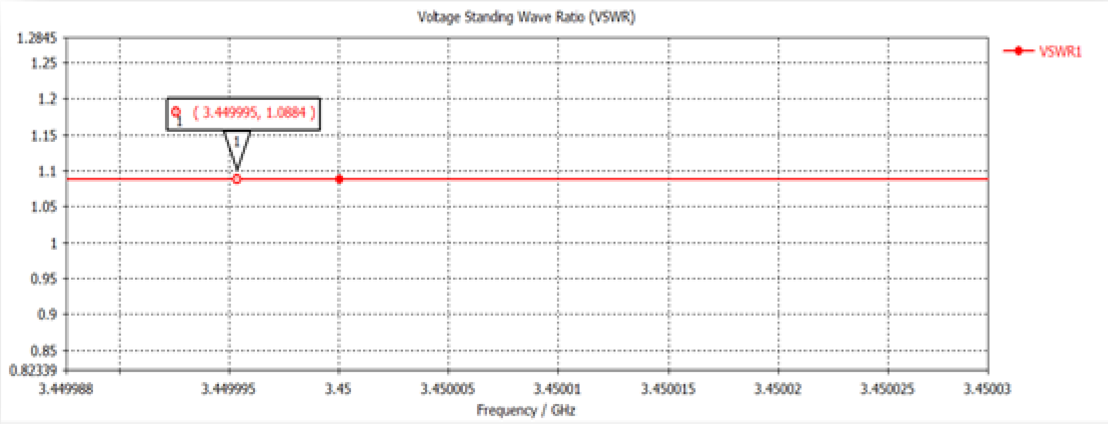

Figure 5. standing wave voltage ratio.

2.3. Standing wave voltage ratio of the second antenna.

From Figure .6 which represents the standing wave voltage ratio, it is equal to 1.105387 at the frequency of 3.59 GHz and equal to 1.890823 at the frequency of 5.592 GHz.

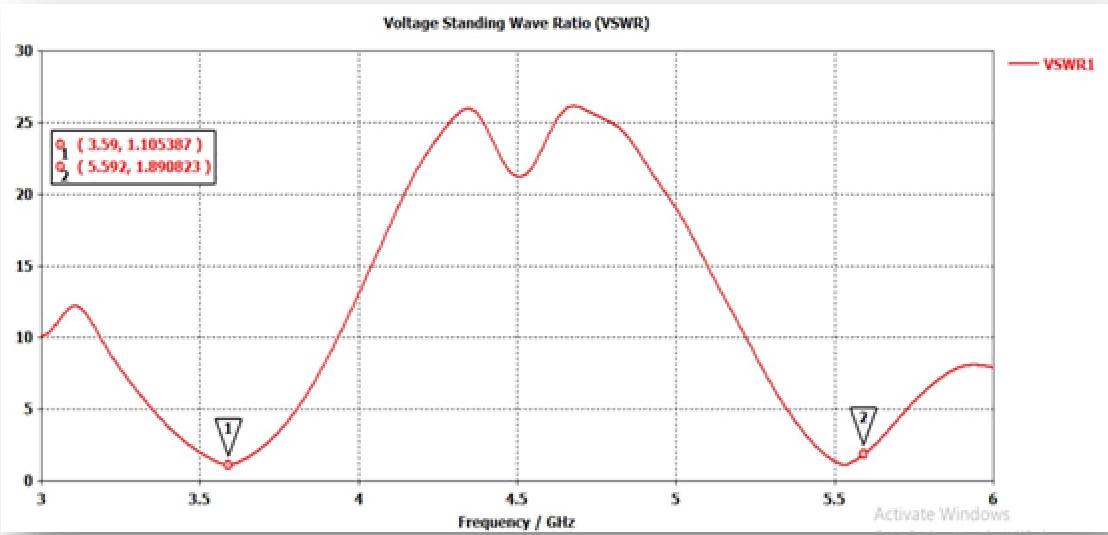

Figure 6. shows the ratio of on and off voltages.

Conclusions

After completing the design and simulation and comparing the results for the two different antennas in terms of the connection method, it was found that the loss of the first antenna that was fed by the strip-line method is less than the return loss of the second antenna that was fed by the coaxial probe method, knowing that the two antennas operate in the same frequency range, and the wave voltage ratio is The alignment of the first antenna is closer to the correct one than the second antenna, and this means that the alignment of the first antenna is better than that of the second antenna. From the above, we can say that the first antenna that was fed using the strip-line method is better than the second antenna that was fed using the coaxial sensor method in terms of return loss and ratio. Standing wave voltage.

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