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Design of ISM Band Integrated Feed Patch Antenna

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Abstract: A microstrip patch antenna (MSPA) is designed using integrated feed to improve the efficiency of the MSPA. The integrated feed comprises of microstrip line and probe feed. The proposed antenna gives efficiency of -1 dB as compared to probe feed antenna with efficiency of -0.5 dB . The attained efficiency is much better than the antenna with microstrip feed and gives efficiency of only -4.5 dB.

I. Introduction

MSPA plays very important role in wireless communication at any higher frequencies. The main issue with the printed antenna is that it has very low efficiency of about 25% this causes antenna to have very low gain, mentioned by Balanis (2005). Such antennas are not good for any practical applications due to short range. The efficiency can be improved using probe feed by increasing gap between radiating patch and ground but this antenna is not suitable for making array. This paper describes the design of an integrated feed which combines the microstrip feed and probe feed techniques. There are many antennas available in literature which uses probe feed technique to have higher efficiency as used by Selvaraj (2). Microstrip feed patch antenna has got the advantage of impedance matching as compare to probe feed but suffers with poor efficiency claimed by Irfan et. al (3).

II. Objectives of the Study

To analyze two antennas, probe feed and microstrip antenna.
To design and compare integrated feed antenna with the microstrip feed and probe feed antenna.

III. Materials and Methods

Figure 1 shows the MSPA with microstrip feed line. Printed antenna comprises of copper layer on a substrate Fr-4 with thickness 1.6 mm and is fed with a feed of 50 Ω microstrip line. The line is designed with reference to a ground plane again of copper layer of thickness 0.035 mm. Figure 2 shows antenna response in terms of reflection coefficient and is tuned around 2.4 GHz.

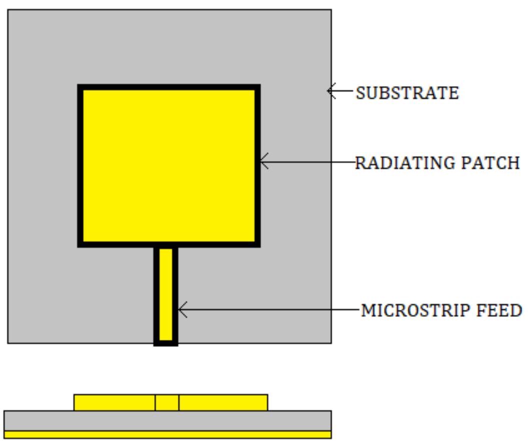

Figure 1: Microstrip patch antenna on Fr-4 substrate.

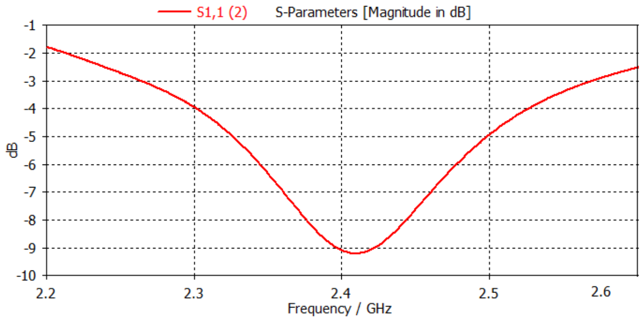

Figure 2: Frequency V/S reflection coefficient of MSPA

Figure 3 shows the efficiency of MSPA. It can be shown that the antenna efficiency is 28% which is very poor but is one of the limitations of printed antenna.

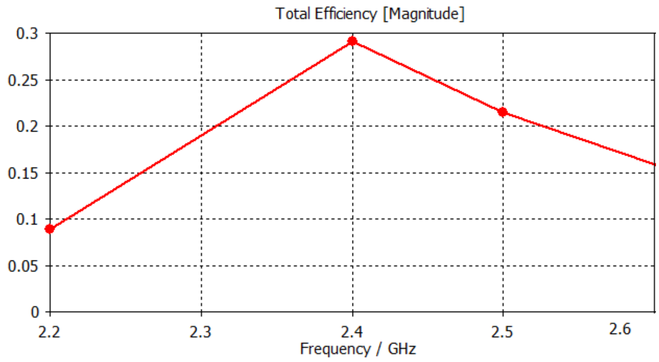

Figure 3: Antenna efficiency of MSPA.

Figure 4 shows another antenna using probe technique. The thickness of antenna is 1.6 mm which is thickness of substrate only.

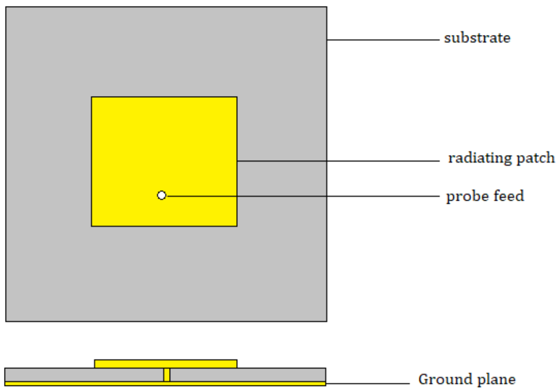

Figure 4: Microstrip antenna with probe feed.

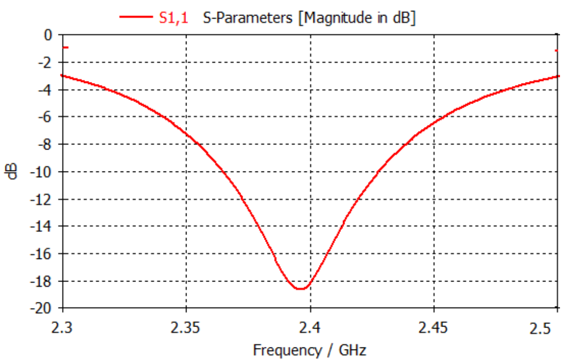

Figure 5: Frequency V/S reflection coefficient of MSPA with probe feed.

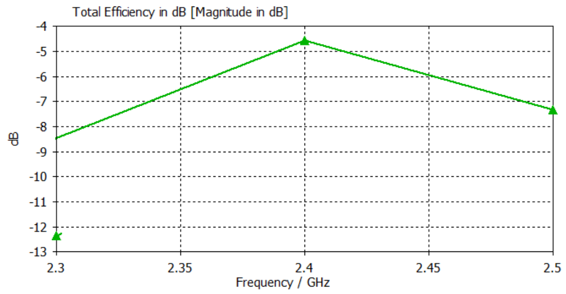

Figure 6: Efficiency of the probe fed antenna with thickness of 1.6 mm.

It can be observed that the efficiency of the antenna is very poor and is -4.5dB at 2.4 GHz. In order to improve the efficiency of the antenna, two different substrate is used with a separation gap of 4 mm. Top substrate contains radiation patch and bottom substrate contains ground plane.

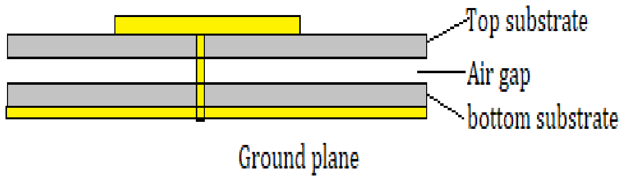

Figure 7: Microstrip antenna with two substrate and gap of 4mm.

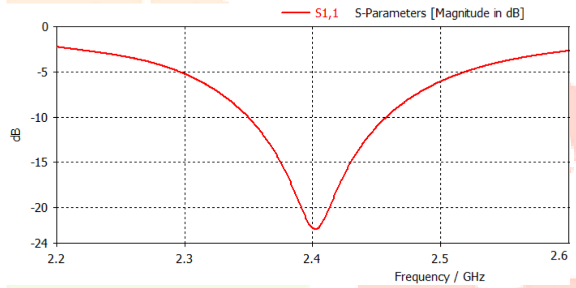

Figure 8: Frequency V/S reflection coefficient of MSPA with probe feed.

Figure 8 shows that the antenna is tuned at 2.4 GHz and figure 9 shows the efficiency of the antenna and is -0.5 dB which is a great improvement.

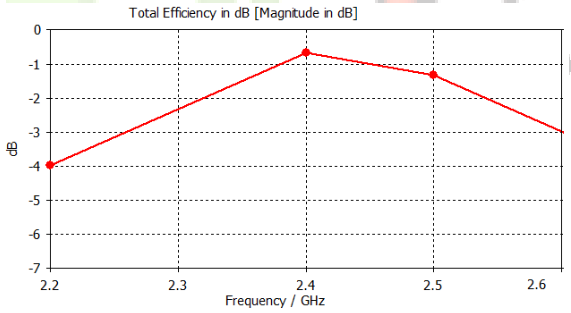

Figure 9: Efficiency of the probe fed antenna with thickness of 4 mm.

Design of Integrated Patch Antenna

Antenna with probe feed having gap between the two substrates improves the gain of antenna but is not suitable to make array of the antenna. Therefore, the earlier two antennas are combined and is named as integrated antenna.

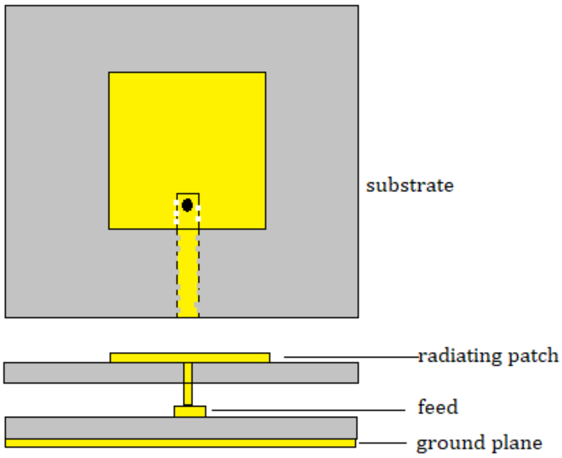

Figure 10: structure of microstrip antenna with integrated feed.

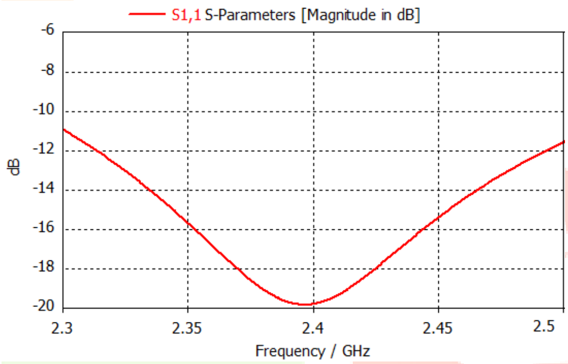

Figure 11: Frequency V/S reflection coefficient of MSPA with probe feed with gap of 4 mm.

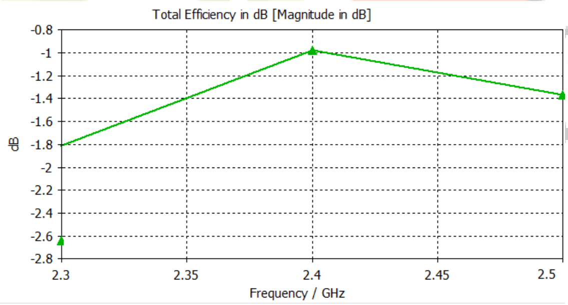

Figure 12: Efficiency of the probe fed antenna with gap of 4 mm.

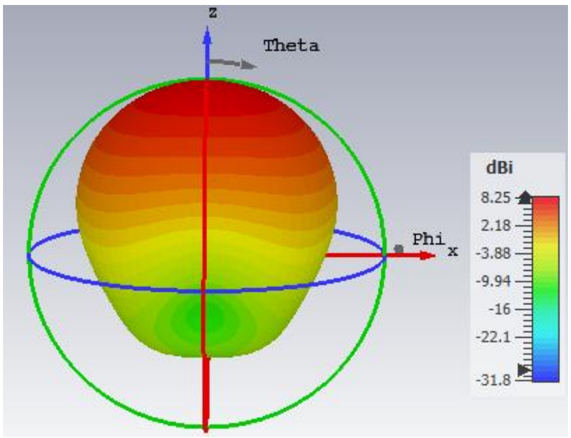

Figure 13: radiation pattern of the final antenna with probe feed and gap of 4 mm.

IV. RESULTS AND DISCUSSION

Table 1 summarizes the performance of all the antennas with respect to efficiency of the antennas. It can be observed from table that the antenna with probe feed and substrate gap of 4 mm gives efficiency of -0.5 dB and is highest. Antenna with microstrip feed line has only -4.5 dB of efficiency and is poor in performance. When the two techniques are combined the efficiency of integrated feed antenna reduces to -1 dB from -0.5 dB but is much better than microstrip feed based antenna. The separation gap between the substrate leads to increase in size of the radiating patch as shown in table 2. But the overall antenna size remains same as the ground plane of all the antennas is kept same.

Table1: Performance of all the antennas.

Sr. No.	Antenna feed	Thickness of antenna (mm)	Efficiency (dB)
1	Microstrip feed	1.6	-4.5
2	Probe feed	4	-0.5
3	Integrated feed	4	-1

Table 2. Size of the radiating patch of all the cases

Sr. No.	Antenna feed	Thickness of antenna (mm)	Antenna Size mm^2
1	Microstrip feed	1.6	29*29
2	Probe feed	4	41*41
3	Integrated feed	4	44*44

V. CONCLUSION AND RECOMMENDATION

It can be concluded that the probe antenna when combines with microstrip feed, the resultant integrated feed antenna performs very well in terms of efficiency. Such antennas can be very helpful in making array of antennas for high gain and narrow beam.

VI. REFERENCES

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