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The Simulation of Two Array Microstrip Patch Antenna for Downlink Radio Access Point for Radio Over Fiber System

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Abstract: Microstrip patch antenna is one type of radio antenna that is small, low profile and compatible for embedded antenna for wireless devices. The function of this antenna is to receive a radiated radio signal for radio over fiber application. Currently, the one type of microstrip patch antenna is limited in covering the bandwidth of the return loss of antenna specification for wireless application band from 2.4 to 2.48 GHz. The single patch antenna can only cover up to 0.052 GHz bandwidth for return loss more than -10dB. Therefore, the two array microstrip patch antenna is designed as an alternative to overcome this. This paper presents the design and simulation result of two patch microstrip patch antenna to cover the wireless band frequency from 2.4 to 2.48 GHz for Downlink Radio Access Point for Radio over Fiber System by using the Microwave Office software. The simulation results shows the two patch microstrip antenna has the ability to cover the bandwidth of 0.08GHz for return loss more than -10dB.

Keywords: Radio, wireless, optical, antenna

1.0 INTRODUCTION

This paper shows the simulated result of the one patch and the two patch array microstrip antenna using Microwave Office software. The objectives of this technique are; (*i*) to improve the bandwidth requirement of wireless band for radio over fiber system and (*ii*) to maintain the gain of an antenna. These old and new designs are simulated by microwave office software and the comparison of these two designs is discussed. One patch microstrip antenna design is unable to cover the bandwidth of wireless band from 2.4 until 2.48GHz with return loss more than -10 dB and at the same time to maintain the antenna gain around 5 to 6 dB. Therefore, two patch array microstrip antenna design is examined to identify the outcome. The radio over fiber technologies consist of optical modulator, fiber optics cable, optical receiver, bandpass filter, power amplifier and antenna [1]. This paper however solely focuses on how to design and simulate an antenna for radio over fiber technologies. Fig. 1 shows the system of radio over fiber (ROF) technologies.

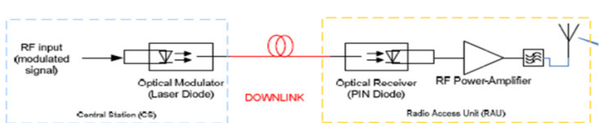

Fig. 1 Radio over Fiber Architecture.

2.0 DESCRIPTION OF EXISTING METHOD/ RELATED WORK

Before the two patch microstrip antenna is simulated, the one patch antenna needs to be simulated in order to confirm the theory and our reference that this design is deficient and has limitation to cover the bandwidth in our band. Fig. 2 below shows the simple microstrip antenna. This antenna consists of one side of a dielectric substrate with a ground plane and a conducting patch on the other side and the typical gain is between 5 to 6 dB [3].

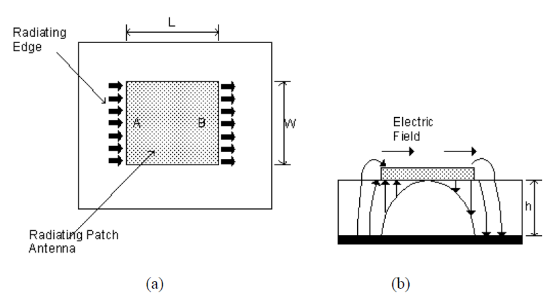

Fig. 2 (a) Microstrip patch antenna. (b) Electrical field distribution of a patch antenna.

Each antenna needs a correct feeding technique so they can provide the best performance. In this paper, the microstrip inset fed is chosen because it is simple, easy to simulate and easy to tune. A thick substrate with low dielectric constant is used to optimize the antenna efficiency and bandwidth [5]. Fig. 3 shows the microstrip inset feeding patch antenna.

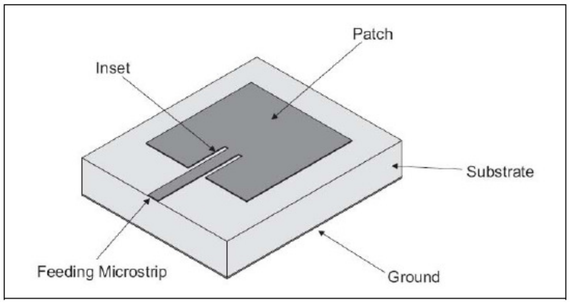

Fig. 3 Microstrip inset feeding technique.

2.1 Antenna design procedure

Before the simulation can be performed, the manual calculation is used to determine the length and width of the design [5]. Fig. 4 shows a single patch rectangular microstrip patch antenna of length L, width W on a substrate of height h.

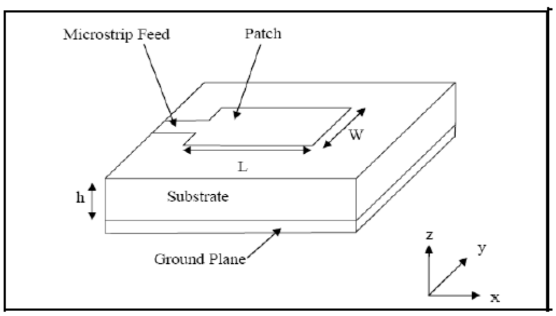

Fig. 4 The dimensions of microstrip antenna design.

Firstly, the width of the patch is calculated using equation as presented below [5]:

$$W = \frac{1}{2f_r\sqrt{\mu_0\epsilon_0}}\sqrt{\frac{2}{\epsilon_r+1}} = \frac{\upsilon_0}{2f_r}\sqrt{\frac{2}{\epsilon_r+1}}$$

Secondly, this equation below gives the effective of dielectric constant [5]:

$$\epsilon_{\text{reff}} = \frac{\epsilon_r+1}{2} + \frac{\epsilon_r-1}{2}\left[1+12\frac{h}{W}\right]^{-1/2}$$

Thirdly, the acquire ΔL is estimated using the below equation [5]:

$$\frac{\Delta L}{h} = 0.412\frac{(\epsilon_{\text{reff}}+0.3)\left(\frac{W}{h}+0.264\right)}{(\epsilon_{\text{reff}}-0.258)\left(\frac{W}{h}+0.8\right)}$$

Finally, the length L of the patch is obtained through equation as shown below [5]:

$$L = \frac{1}{2f_r\sqrt{\epsilon_{\text{reff}}}\sqrt{\mu_0\epsilon_0}} - 2\Delta L$$

2.2 Patch Antenna Simulation Design

After calculation of all required parameter which is needed in designing an antenna is made, the final designed antenna is shown in Fig. 5.

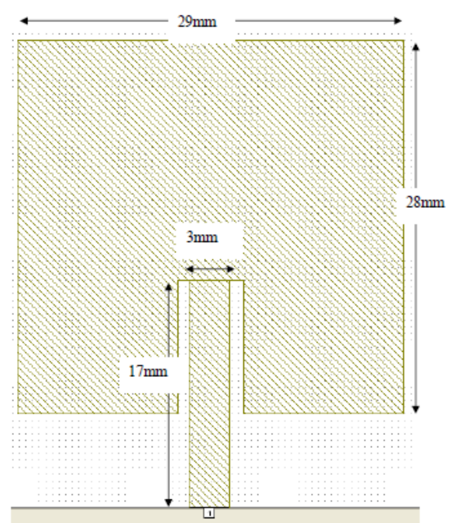

Fig. 5 Single patch antenna design

From Fig. 5, it can be seen that W is 29 mm and L is 28 mm. However, from the design, it can also be noted that W and L have slight difference from what is calculated. The feed in line is extended to 17 mm. Theoretically, longer feed in line will result higher loss on antenna because of higher impedances [5]. However, on this design the longer feed line does not show any observable difference. Fig. 6 below shows the simulation result of single patch antenna.

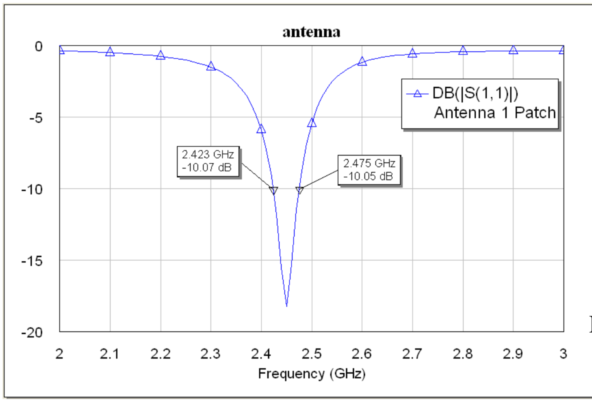

Fig. 6 Simulation result of single patch antenna.

From Fig. 6, it can be proven that the bandwidth for single patch antenna return loss is 0.052 GHz (2.423 GHz to 2.475 GHz).

2.3 The Proposed Technique

Based on the previous technique, the return loss that can be covered by single patch antenna is just 0.052 GHz. Hence, the 2 patch antenna is introduced with a goal to enhance the return loss. The patch has similar dimension with single patch antenna which is L x W and is printed on a substrate that has a thickness of 1.6 mm with a loss tangent of 0.019. The L and W are 29 mm and 28 mm respectively. Table 1 shows the antenna design specifications.

Table 1: Antenna design specification

Antenna Type	Microstrip Patch Antenna
Operating Frequency	2.4-2.48 GHz
Thickness	1.6 mm
Loss Tangent	0.019
Permitivity	4.7
Gain	5-6dBi
Return Loss	< -10 dB
Feeding Technique	Microstrip Inset Feed Technique

2.4 Hardware/ Software Development

Microwave office (AWR) software is utilised to design and simulate this proposed technique. Fig. 7 shows the two array microstrip patch antenna designed by Microwave Office (AWR) software.

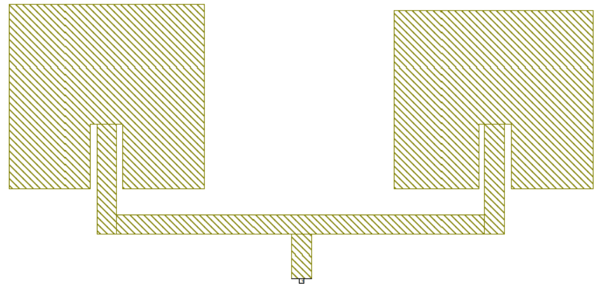

Fig. 7 Two array microstrip patch antenna design.

2.5 Applying the Proposed Technique

To improve the bandwidth of the return loss, the 2 patch antenna has been used for this antenna simulation. Fig. 8 shows the actual antenna dimension.

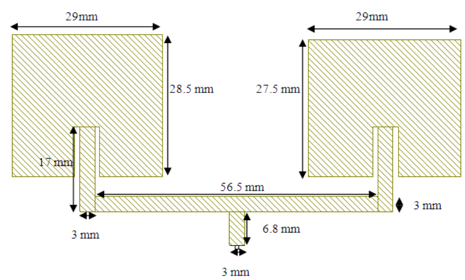

Fig. 8: Two array microstrip patch antenna dimension.

3.0 RESULT AND DISCUSSIONS

This chapter shows the simulation result of two patch array antenna using microwave office software. Fig. 9 shows the return loss of the two patch antenna.

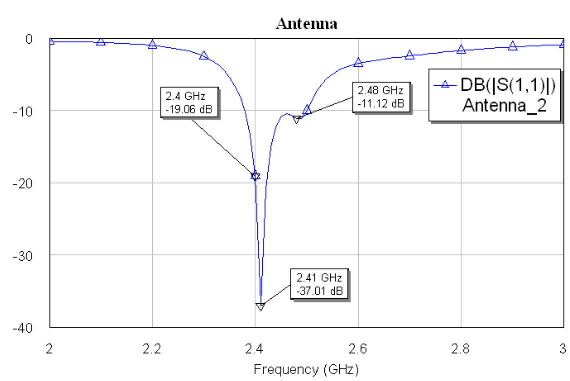

Fig. 9 Return loss for 2 patch antenna simulation.

From Fig. 9, it can be asserted that this antenna is competent to cover the return loss for more than -10 dB from frequency 2.4 GHz to 2.48 GHz. In order to check the gain for this antenna, the radiation pattern of this antenna needs to be simulated using AWR software. Fig. 10 shows the result for antenna gain and radiation pattern.

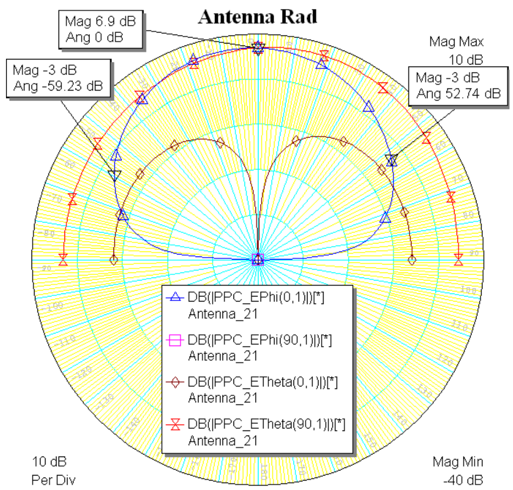

Fig. 10: 2 Array Microstrip Patch Antenna.

The maximum gain is around 6.9 dBi which has met our design specification.

4.0 CONCLUSION

It can be concluded that the proposed system is capable to cover the return loss more than -10 dB for frequency between 2.4 to 2.48 GHz and at the same time, maintain the gain of antenna between 5-6 dBi.

REFERENCES

[1] A. F. Molisch, *Wireless Communications*. Chichester, U.K.: Wiley,2005.

[2] A. Goldsmith, *Wireless Communications*. Cambridge, U.K.: Cambridge Univ. Press, 2005.

[3] A. J. Paulraj, D. A. Gore, R. U. Nabar, and H. Boelcskei, "An overview of MIMOcommunications—A key to gigabit wireless," *Proc. IEEE*, vol. 92, no. 2, pp. 198–218, Feb.2004.

[4] "In-building Wireless Systems", AB1 Research,2004.

[5] "Microstrip Patch Antennas: A Designer's Guide" By Rodney B. Waterhouse, Published 2003 Springer.

[7] Teguh Prakoso, Razali Ngah, Tharek Abdul Rahman, and Mohd Amin Mualif, "5.8 GHz Photonic Antenna for Point to Point Applications," in IEEE International Rf And Microwave Conference Proceedings, 2008, pp. 131-134.

[8] "Optisystem" By Optiwave system, inc ,Published 2008, Optiwave system inc.

[10] Istvan Frigyes, "Basic Microwave Properties of Optical Link" In: Hamed Al- Raweshidy,

Shozo Komaki. Radio over Fiber Technologies for Mobile Communications Network. : Artech House Inc., USA, 2002.

[11] Tim McGovern, "A Planar, Balanced Approach to Increase Transmitter Linearity", Texas Instruments Appplication report, USA, 2005.

[14] S.O.Kasap, Optoelectronics and Photonics, Principles and Practices, Prentice-Hall International, NJ, USA, 2001.