Improving Performance Of Microstrip Antenna Using Dual Feed Line Technique

Syah Alam, Indra Surjati, Lydia Sari, Yuli Kurnia Ningsih

Abstract: This paper proposes new design of square microstrip antenna with dual feed line for improving bandwidth and axial ratio at work frequency of 2400 MHz. To obtained circular polarization with axial ratio ≤ 3 dB and enhanced bandwidth of antenna, dual feed line is used to improve performance of conventional microstrip antenna. After the simulation process, dual feed line succeed to improved bandwidth of microstrip antenna 131.9 % compared with microstrip antenna with single feed and provide circular polarization with axial ratio 2.44 dB at working frequency of 2400 MHz compared with the microstrip antenna with a single feed. This research is very usefull for Wi-Fi application in order to improve the level quality of receiver signal.

Index Terms: square patch, dual feed line, circular polarization, bandwidth.

1. INTRODUCTION

Microstrip antennas have been developed for wireless applications because they have compact designs and are also affordable for fabrication [1]. One of the disadvantages of microstrip antennas is the narrow bandwidth and low directivity [2]. To overcome these shortcomings, several techniques can be used to optimize the performance of the microstrip antenna. The advantage of an antenna with a wide bandwidth is that it can be used for a wide range of work frequencies so that it is more efficient for field implementation, while a high level of direction is needed for the antenna to produce a good level of signal reception quality. Several optimization methods for increasing bandwidth have been described and investigated include using the coplanar wave guide [3], [4], proximity coupling [5], [6] and dual feed [7], [8]. Microstrip antennas generally have vertical polarization so that reception is only limited when the receiver and transmitter are in line of sight conditions, to produce a high level of signal reception an antenna with circular polarization is required. Several previous studies have described several methods for producing circular polarizations including truncated corner [9], [10], fractal [11], [12] and dual feed [13], [14]. In this paper, the microstrip antenna was designed with a square shape and dual feeder to increase bandwidth and produce circular polarization with axial ratio ≤ 3 dB at a working frequency of 2400 MHz. Previous study conducted by [15] showed that the dual feeder microstrip antenna obtained bandwidth of 42 MHz with an increase from the conventional design of microstrip antenna from 0.9% to 1.8 % at working frequency of 2.46 GHz but the axial ratio is ≥ 3 dB. In addition, the dual feeder method is also used by [16] to produce circular polarization with axial ratio ≤ 3 dB at working frequency of 2.35 GHz for Systentic Aperture Radar System with narrow bandwidth of 165.4 MHz. In this paper, dual feeder method is used because it has the advantage of being able to improve bandwidth and produce circular polarization so that it is more effective to design the proposed antenna. The contribution of this paper is produce designs of microstrip antennas with wider bandwidth and circular polarization with axial ratio ≤ 3 dB compared to previous studies.

2 ANTENNA DESIGN

In this research, the design of conventional microstrip antenna is square shape using FR-4 Epoxy substrate with a dielectric constant (ε_r) of 4.3, loss tan (tanα) of 0.0265, thickness (h) of 1.6 mm.

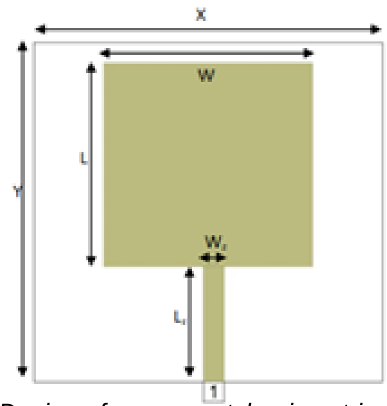

***Fig. 1**. Design of square patch microstrip antenna*

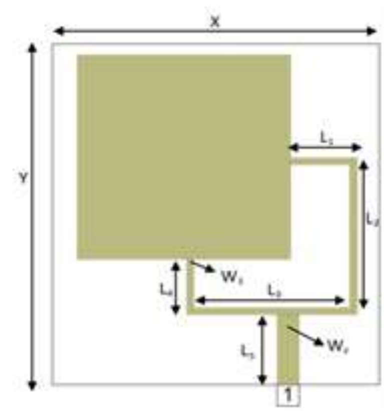

***Fig. 2**. Design of square patch microstrip antenna with dual feed*

After a simulation process with AWR Microwave Office 2009, the optimal dimensions of W and L are 30 mm, the design of square patch microstrip antenna is shown in Fig. 1. Design of square patch microstrip antenna shown in Fig. 1 with dimensions of ground plane is 50 mm x 50 mm and Lz is 17 mm. The design of the dual feed line on the microstrip antenna is done by adding a microstrip line feed that serves to supply the current of the antenna. The dimensions and position of the dual feed line are obtained from the results of optimization and iteration using AWR Microwave Office 2009. The design of the microstrip antenna with dual feed line shown in Fig. 2. Fig. 2 shown design of dual feed square patch microstrip antenna with dimension of L1 is 9.4 mm, L2 is 23 mm, L3 is 21.9 mm, L4 is 8.1 mm, L5 is 10.3 mm, W1 is 1 mm and Wz is 3.1 mm.

The effect of adding dual feed microstrip line is improve the bandwidth and produce axial ratio of square patch microstrip antenna.

3 RESULT AND DISCUSSION

To obtain the best of simulation results, several iteration is carried out by adjusting the distance, width and length of the dual feeder on the proposed antenna. The iteration process is done by controlling the dimensions of W1, L2 and L3 because these parameters have the most influence on the simulation process of the proposed antenna. The iteration process of the dimension of W1 microstrip line is shown in Table 1.

TABLE 1
ITERARION DIMENSION OF W_1

Iteration	Dimension of W_1
Iteration 1	1 mm
Iteration 2	2 mm
Iteration 3	3 mm

From the iteration process shown in Table I, the results of simulation of return loss, VSWR and axial ratio of the proposed antenna are obtained. Fig. 3 and Fig. 4 shown the results of simulation of the three iteration that have been carried out.

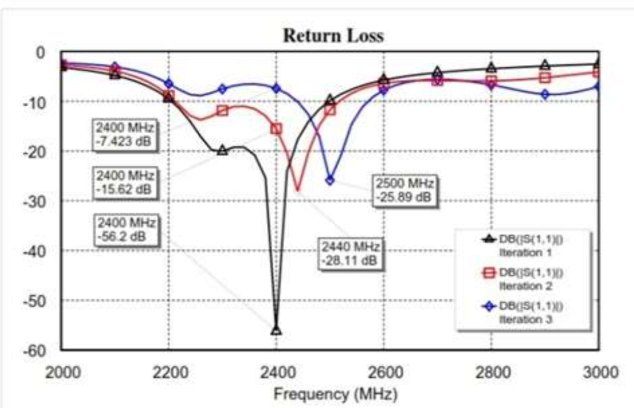

***Fig. 3**. Simulation of Return Loss From Iteration Process of W_1*

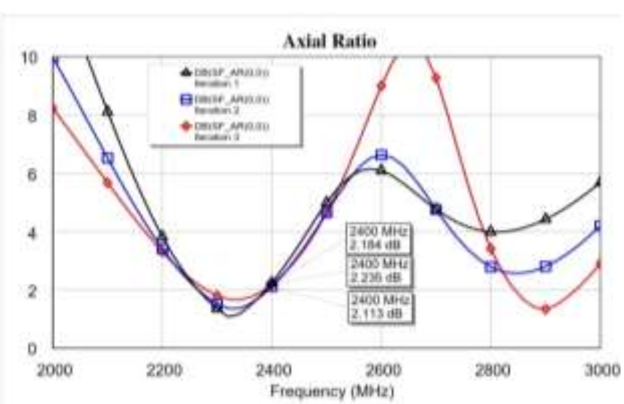

***Fig.4**. Simulation of VSWR From Iteration Process of W_1*

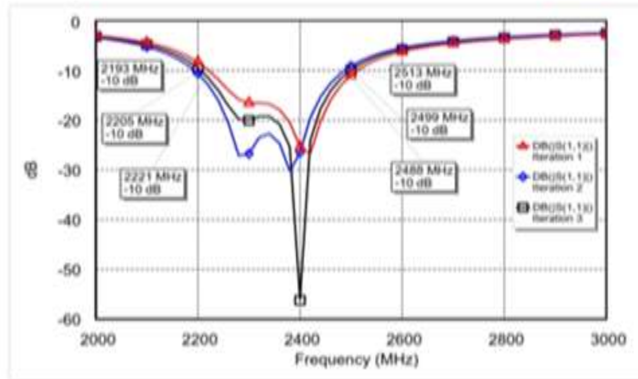

***Fig.5**. Simulation of VSWR From Iteration Process*

Fig.3, Fig.4 and Fig.5 show that the dimensions of the width of the feeder W1 of proposed antenna influence the return loss, VSWR and axial ratio of the proposed antenna. By controlling the dimensions W1, work frequency and axial ratio of antenna are shifting. The overall simulation results in the iteration process of W1 at work frequency of 2400 MHz can be shown in Table 2.

TABLE 2
SIMULATION RESULT OF ITEATION PROCESS

Iteration	Parameters		
	Return Loss	VSWR	Axial Ratio
Iteration 1	-7.29 dB	2.475	2.235 dB
Iteration 2	-15.62 dB	1.4	2.113 dB
Iteration 3	-56.2 dB	1.003	2.184 dB

The simulation results in Table II show that the best value of return loss ≤ -10 dB and VSWR ≤ 2 is obtained in iteration 1 with the width of the feeder W1 is 1 mm. In iteration 2 and iteration 3, the work frequency of proposed antena shifting becomes 2440 MHz and 2500 MHz. This is caused by a change in the amount of current flowing in the dual feeder of the proposed antenna antenna which has an impact on the propagating wavelength so that the working frequency shifts. To control the bandwidth of the proposed antenna can be done by controlling the dimensions of L2 and L3. The simulation results of return loss from the iteration process on dimensions of L1, L2 and L3 are shown in Fig. 6 and Table 3.

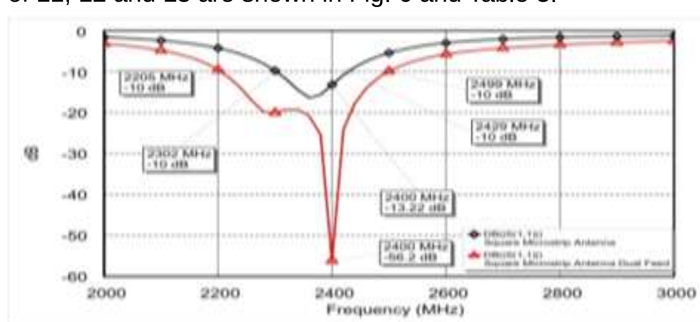

***Fig.**6. Simulation of VSWR From Iteration Process*

TABLE 3
SIMULATION RESULT OF ITEATION OF W_1

Iteration	Dimension (mm)			Bandwidth	Frequency
	L1	L2	L3		
1	9.4	22	24	292 MHz	2380 MHz
2	9.4	24	24	295 MHz	2420 MHz
3	9.4	23	24	294 MHz	2400 MHz

Fig. 6 and Table III show that changes in dimensions of L2 and L3 affect the bandwidth of the proposed antenna. The best simulation results are obtained in iteration 3 with bandwidth of 294 MHz in the working frequency of 2400 MHz. The results of the proposed antenna are also compared with an antenna that uses a single feeder. Comparison of simulation results from the two antennas can be seen in Fig. 7, Fig. 8 , Fig. 9 and Table IV.

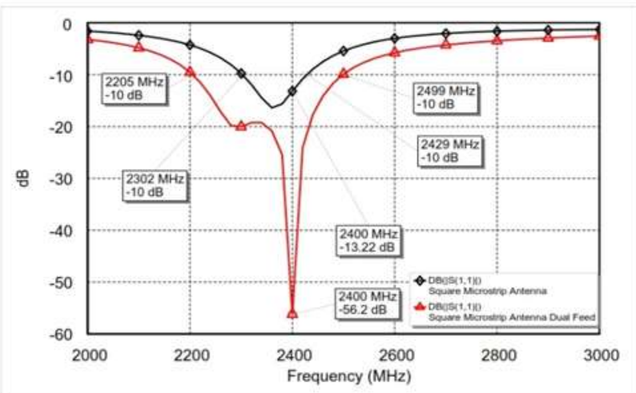

Fig.6. *Simulation of Return Loss From Iteration Process of L_1, L_2 and L_3*

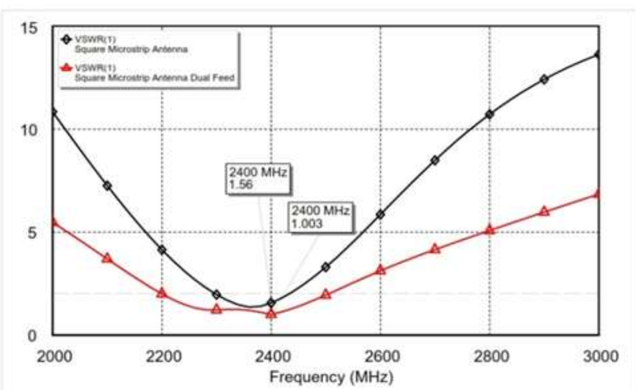

***Fig.7**. Simulation Result of Return Loss From Single and Dual Feed Microstrip*

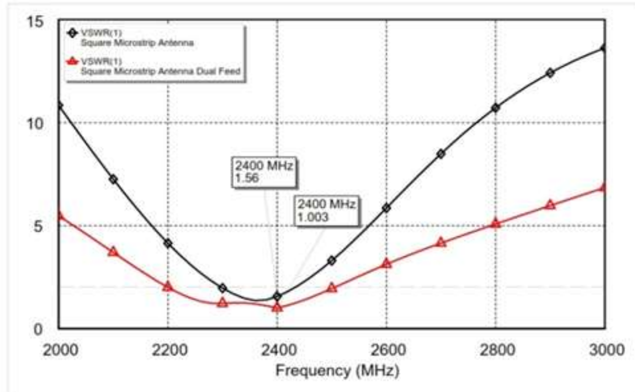

Fig 8. *Simulation Result of Return Loss From Single and Dual Feed Microstrip*

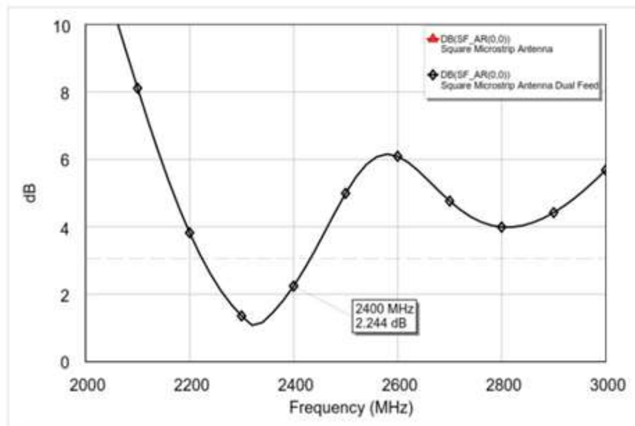

Fig 9. *Simulation Result of Axial Ratio from Single and Dual Feed Microstrip*

TABLE 4
COMPARISON RESULT FROM SINGLE AND DUAL FEED LINE

Condition	Parameter			Bandwidth
	Return Loss	VSWR	Axial Ratio	
Single Feed	-13.22 dB	1.56	-	127 MHz
Dual Feed	-56.22 dB	1.003	2.44 dB	294 MHz

From the results shown in Fig.7, Fig.8 and Fig.9 can be seen that the antenna with dual feeder has a better performance than a single feeder antenna. Table IV shows that the use of dual feeders succeeded in increasing the return loss from -13.22 dB to -56.22 dB, VSWR from 1.56 to 1.003 at a working frequency of 2400 MHz while the bandwidth also increased from 127 MHz to 294 MHz. Besides that, the use of dual feeders also produces circular polarization with axial ratio ≤ 3 dB which is 2.44 dB at a working frequency of 2400 MHz. From the overall results obtained, it can be concluded that the use of dual feeders succeeded in increasing the performance of the proposed antenna. The best value is obtained by controlling the dimensions of W1, L2 and L3 which cause a change in the amount of current flowing in the microstrip antenna which affects the wavelength of the antenna. The results obtained in this paper are also compared with previous studies shown in Table 5.

TABLE 5
COMPARISON RESULT WITH PREVIOUS STUDIED

Title	Parameter			Bandwidth
	Return Loss	VSWR	Axial Ratio	
[15]	-28.85 dB	1.19	-	42 MHz
[16]	-30.56 dB	1.10	2.1 dB	165.9 MHz
Proposed Antenna	-56.2 dB	1.003	2.44 dB	294 MHz

From Table 5, it can be seen that the proposed antenna has a better performance than the antenna that was investigated and examined previously. The target of this study is to produce microstrip antennas with parameter of return loss ≤ -10 dB, VSWR ≤ 2 and bandwidth ≤ 150 MHz at working frequency of 2400 MHz has been achieved using the dual feeder method. The current distribution of the proposed antenna at the frequency of 2400 MHz is shown in the Fig. 10.

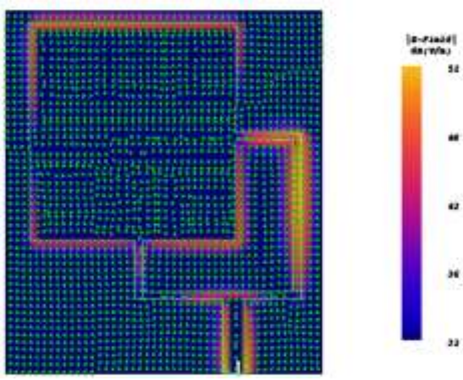

***Fig. 10**. Current Distribution of Proposed Antenna*

Fig. 10 shows that the current distribution of the proposed antenna is evenly distributed across the entire patch antenna. Fig. 11 shows the comparison of the gain of the square antenna with the proposed antenna while the radiation pattern of the proposed antenna is shown in Fig. 12.

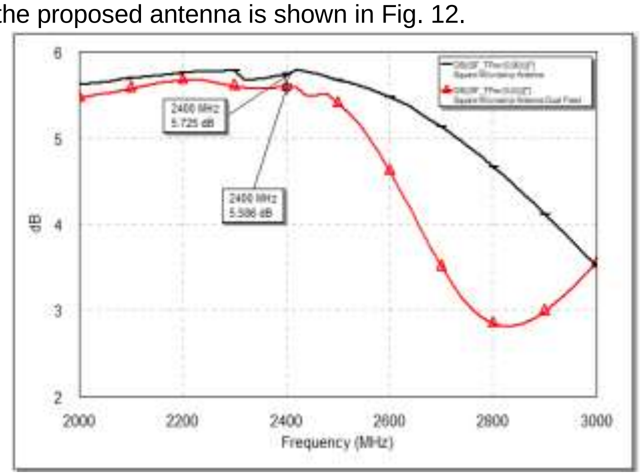

***Fig. 11**. Gain of Proposed Antenna*

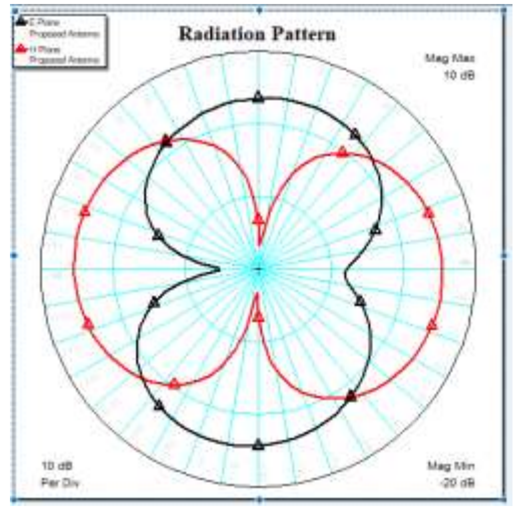

***Fig. 12**. Radiation Pattern of Proposed Antenna*

Fig.11 shows that the gain of the proposed antenna has decreased compared to the square patch antenna. This is because the bandwidth obtained from the proposed antenna is wider so that it reduces the gain. However, the gain of the proposed antenna still meets the minimun criteria for this research. Fig. 12 shows the radiation pattern of the proposed antenna at a working frequency of 2400 MHz. The red part indicates that the E plane is perpendicular to the H plane. The proposed antenna produces a bidirectional radiation pattern with azimuth centers at 0° and 90°.

4 CONCLUSION

Implementation of dual feeder of microstrip antenna have been investigated and reported in this paper. The performance of proposed antenna have been improved after using dual feeder method. From the simulation result obtained return loss of -56.2 dB , VSWR of 1.003 and bandwidth of 294 MHz at working frequency of 2400 MHz. The bandwidth of the proposed antenna has been increased until 131.9% compared to the microstrip antenna with a single feed. Furthermore proposed antenna also produce circular polarization with axial ratio ≤ 3 dB which is 2.4 dB at working frequency 2400 MHz. The future of this research is to verify the simulation results by fabricating and measuring the performance of antennas designed in the laboratory.

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