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DESIGN OF RECTANGULAR WITH 3 SLOT MICROSTRIP ANTENNA FOR APPLICATION LTE 2.1 GHz

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Abstract *-- A rapid development of telecommunications technology, and over time, the existing network technologies continue to be developed. To create the latest technology called Long Term Evolution (LTE). With the technology that has a high transmission speed, of course, required new devices that can operate on this network. Antennas are needed on these networks is an antenna that is small and easily integrated. In this case, the right antenna to be used is the microstrip antenna. In this paper, which will be designed antenna is an antenna feed line rectangle shapes that can operate at a frequency of 2.1 GHz.*

Keywords*: LTE; Microstrip Antenna; Frequency of 2.1 GHz; Antenna Shape; Antenna Feed Line*

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INTRODUCTION

In the early 20th century, telecommunication technology is very grown up in the world. It is due to the development of cellular communication (Oktauliah et al., 2017). It becomes the public need to be able to communicate efficiently and quickly. An antenna is an essential part of the wireless communication system. An antenna with high gain performance is required in several applications in the communication field. If this concept is applied to the design of microstrip patch antenna, this causes the increase of microstrip patch antenna's bandwidth.

4G Long Term Evolution (LTE) is a standard for high-speed wireless data communications for mobile phones and data terminals. Frequencies that are used for LTE are 700 MHz, 900 MHz, 1800 MHz, 2100 MHz, 2300 MHz, and 2600 MHz. The LTE would have to use a new device, in addition to different speeds, the frequency used also must be adjusted (Rahayu et al., 2017).

Data from 4G LTE technology is received by the user through a 4G antenna. 4G antennas are generally small and thin. The microstrip antenna is popular, this is because of simple, small size and easy to create and integrate (Firmansyah et al., 2015). Various form of microstrip antenna that is commonly used such as rectangular, triangle, and square (Balanis, 2012). The simplest way of a microstrip substrate is an insertion of two intercellular conductive layers separated by a dielectric substrate (Lee et al., 2010). The slot antenna is widely used for a multiband operation. Some of the antennas listed are widely utilized for multiband operation such as U slot (Huang et al., 2008), bow tie (Qu and Xue, 2007), and slot V (Pandit et al., 2015). The paper (Amirullah, 2008) discusses the multiband antenna using a U-shaped slot on the patch and strip with operating frequency between 1.96 to 2.76 GHz (with 800 MHz bandwidth). While without the strip, the operating frequency obtained is 2.25 GHz to 3 GHz (with 750 MHz bandwidth). Design Microstrip Antenna using the Defected Ground Structure (DGS) technique of the Dumbbell Square-Head shape on the Linear Array triangle patch is also presented (Hendra et al., 2015). This antenna is designed with DGS technique and having an optimum measurement return loss of -40.081 dB, for a gain of 2.36 dB and working frequency of 2.6 GHz. In this paper, we will discuss the design of rectangular microstrip patch antenna with three slots for LTE application at 2.1 GHz.

The bandwidth of an antenna is defined as the frequency range in which the antenna work associated with some characteristics (such as input impedance, radiation pattern, gain and return loss) meets the standard specification (Daryanto, 2015). In general, the radiation pattern is determined in the far fields region and is represented as a directional coordinator function (Wijaya, 2009). The substrate was obtained at a rate of 104.5 mm and a substrate length of 100 mm. The material for making the antenna is in the patch using a copper material, on the dielectric or substrate using FR-4 material with dielectric constant ε_r 4.4 and has a thickness of 1.6 mm. (Grag et al., 2001). To determine the Length of the Patch (l), it is necessary to parameter Δl which is the length increase of l due to the fringing effect (James. 1989). The filtering channel used in the design to have an input impedance of 50 Ω. To obtain the characteristic impedance of the feeder conduit of 50 Ω (Makmur. 2013), several following formulas are used.

METHODE

In this paper, rectangular with 3 Slot Microstrip Antenna is designed at 2100 MHz. The radius is determined by using the following Equations (Wijaya, 2009) (Bezawada et al., 2013):

$$B = \frac{60\,\pi^2}{Z_{0\,\sqrt{\varepsilon r}}} \quad (1)$$

Where,

$$F = \frac{8.791 * 10^9}{fr\sqrt{\varepsilon_r}}$$

F = logarithmic functions radiation element
L = height substrate
ε_r = dielectric constant of a substrate
The antenna is designed and simulated by using CST Software, FR-4 with permittivity of 4.4 and height of 1.6 mm is chosen. Fig. 1 and Fig. 2 show the design of rectangular patch 3 slots and the ground. The dimension of the antenna is listed in Table 1 and Table 2.

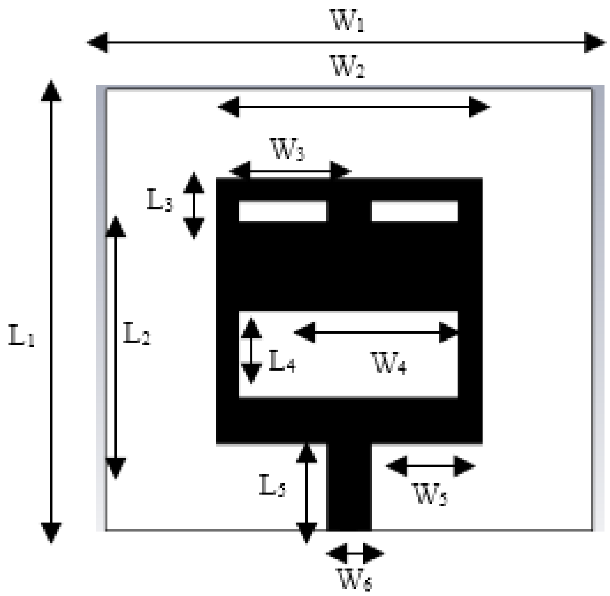

Figure 1. Rectangular Patch 3 Slot

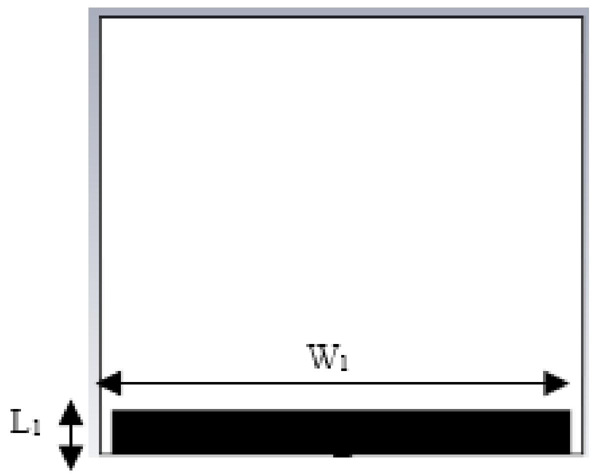

Figure 2. Ground

Table 1. Dimension Patch

Dimension	Size (mm)
W_1	110,5
W_2	60
W_3	30
W_4	50
W_5	25
W_6	10
L_1	100
L_2	60
L_3	5
L_4	20
L_5	20

Table 2. Dimension Ground

Dimention	Size (mm)
W_1	104.6
L_1	10

RESULT AND DISCUSSIONS

The design of microstrip antenna working on frequency susceptible 1.6 GHz up to 2.6 GHz with the middle frequency is 2.1 GHz. Software used to perform antenna simulation is CST studio suite 2014 which can display some antenna parameters such as Return loss, VSWR, gain, and radiation pattern. Here are some pictures of the results of simulated designed antennas.

Return Loss and Bandwidth

The bandwidth value can be known if the lower frequency and upper-frequency values of an antenna are known and return loss can occur due to discontinuities between the transmission lines and the load input impedance (antenna). So, it is not all irradiated, but some is reflected back.

Here are the pictures that will show the results of the simulation using CST studio suite software.

Table 3. Optimization Result of the proposed antenna

Number Optimization	1	2	3	4
L(mm)	10	**10**	10	10
W(mm)	97.5	**104.6**	105.2	88.3

Table 3 shows that W_1 size of the ground of antenna may affect the value of the frequency range, bandwidth, and return loss. The optimization result is shown in Fig. 6, which is performed of 4 times. The optimization has been done for W_1 sizes of a ground plane. For the first optimization with size W_1 of 97.5 mm, the S-1,1 result of -10,038 dB at 1974 MHz, the second optimization with size W_1 of 104.6 mm, the S-1,1 result of -31,75 dB at 2100 MHz, the third optimization with size W_1 of 105.2 mm, the S-1,1 result of -10.126 dB at 2282 MHz, the fourth optimization with size W_1 of 88.3 mm, the S-1,1 result of -9.9405 dB at 1833 MHz, and last the fifth optimization with size W_1 of 104.6 mm, the S-1,1 result -31,75 dB at 2100 MHz as shown in Fig. 6.

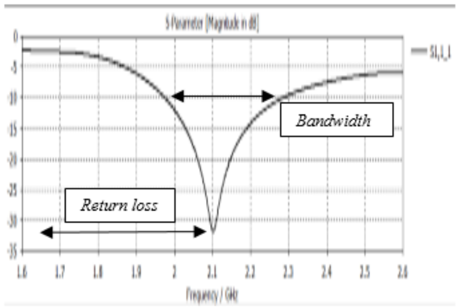

Figure 3.a. S-Parameter

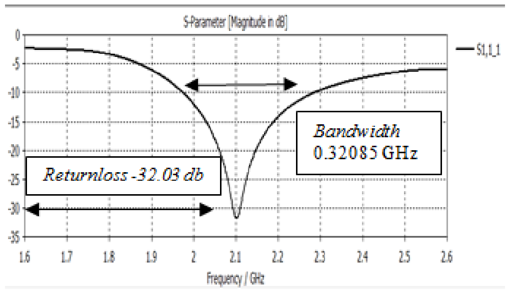

Figure 3.b. S-Parameter

From the simulation results, we can see that in Fig. 6 shows the value of return loss -32.03 dB and the bandwidth obtained for 0.32085 GHz.

Voltage Stage Wave Ratio

For VSWR simulation results we can see in Fig. 4.

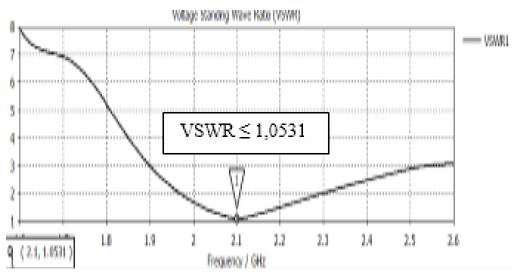

Figure 4. Result VSWR

Based on Fig. 3. VSWR value obtained is at number ≤1.0531. In VSWR this value obtained ≤ 2 or near the 1st antenna that we designed better. so, a good return loss value is smaller or equal to -9.54dB. Thus, the working frequency of a good antenna is when its return loss is worth ≤-9.54dB.

Gain and Radiation Pattern

For antenna gain simulation results can be seen in Fig. 5. Based on Fig. 5 omnidirectional gain 3D radiation pattern that can be in the number 2, 905 dB and on Fig. 6 2,945 dBi. Gain derived from results that use one ground. Because the higher the radiation pattern of the transmitted signal power the better.

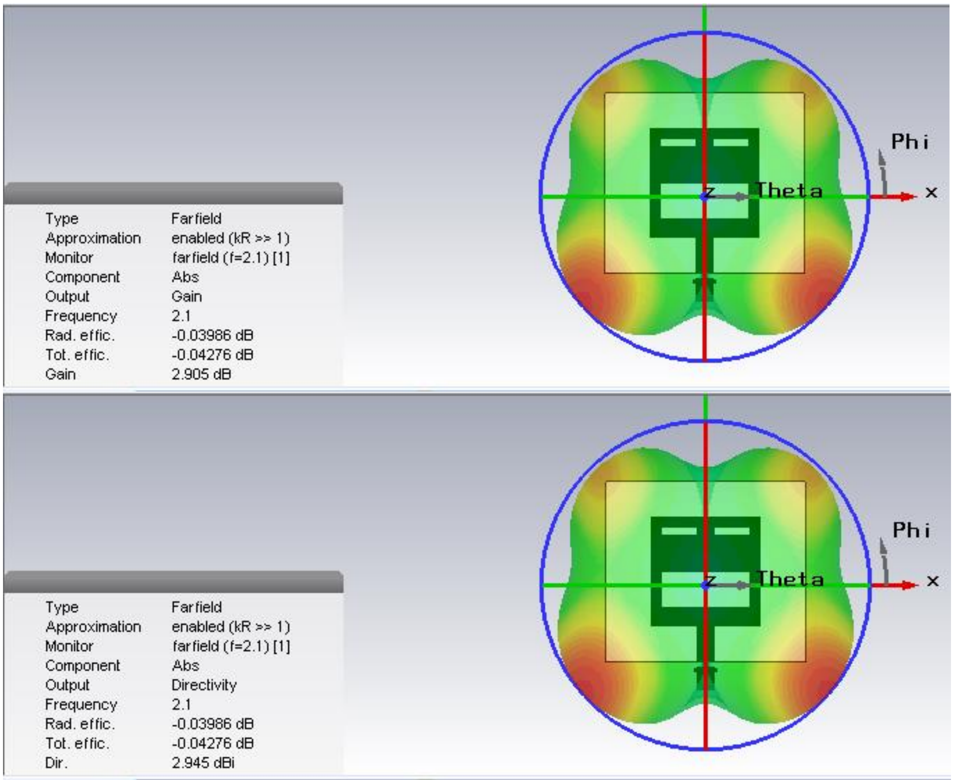

Figure 5. Gain and Radiation Pattern.

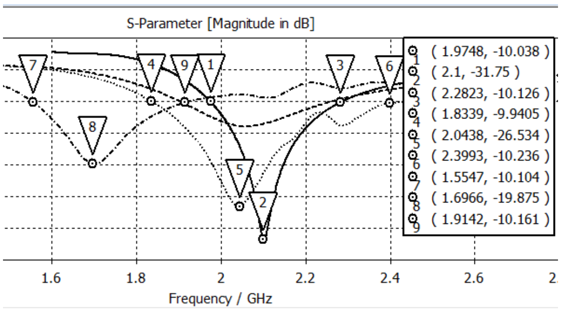

Figure 6. S-Parameter in dB

From the four times optimization, the best result is provided by second optimization 4, with Return loss pf -31.75 dB at 2100 MHz, and bandwidth 308 MHz.

CONCLUSION

After the simulation can be concluded that the design of the antenna that the bandwidth obtained from the simulation result is 0.32085. The return loss value obtained from the simulation result is quite good -32.03 dB and that means already under -10dB. VSWR value obtained less than ≤2 that is on the number ≤1,0531 dB. Its gain is large enough in the range of numbers ≥2,945 dBi.

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