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2.3 Ghz Lte Antenna Design Using Triangle Geometry and Array Structure

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ABSTRACT

Microstrip antenna is one of the most important devices in telecommunications systems. One example is the design of a microstrip antenna on a long time evolution (LTE) device. Disadvantages of this microstrip antenna include low gain, poor directionality, low efficiency, resistance losses on the feed line and narrow bandwidth. This research will design a triangular patch array microstrip antenna to increase the gain so that it can meet the desired work specifications with a working frequency of 2.300MHz. The antenna is designed using FR-4 Epoxy substrate material with a size of 120 mm x 60 mm, which has a dielectric constant (εr) of 4.3, a loss tangent of 0.035 and a material thickness of 1.6 mm. Antenna designed using CST studio suite software 2018. The results obtained in the working frequency band 2280.4 MHz – 2370.0 Mhz, middle frequency 2332 MHz, return loss – 47.360dB, bandwidth 24.7MHz, VSWR 1.008, gain 4.39dBi, impedance 49.90 , and unidirectional radiation pattern.

INTRODUCTION

Long Time Evolution (LTE) is a development of the 3G network and is a telecommunications technology for high speed data, voice and video. To support this telecommunications technology, high gain is required, a Voltage Standing Wave Ratio (VSWR) of less than 2 and other parameters. Wireless communication systems really need a device that can function as a transceiver (transmitter and receiver) of information. To be able to facilitate the need for currently developing telecommunications technology, a device is needed, namely an antenna that is capable of receiving signals at several different working frequencies. One type of wireless antenna that is widely used today is the microstrip antenna. Microstrip antennas have several advantages, including being small, compact and simple. Apart from the advantages, this antenna also has disadvantages including low gain, poor directivity, low efficiency, resistance losses in the supply channel and narrow bandwidth.

LITERATURE REVIEW

In current developments, telecommunications equipment is developing in increasingly smaller and compact sizes so that it is easy to store and operate. This shows that there is a need for a small sized device in the telecommunications system, namely an antenna that can be inserted or inserted into the telecommunications equipment. Microstrip antennas are very suitable for application to small telecommunications devices.

Several LTE antenna designs with a working frequency of 2,300 MHz have been produced by previous researchers as in (Mohammed Yunus, el, al, 2019) in the form of a triangular patch array with a returnloss of -35,375dB. Meanwhile (Syah Alam & Robi Fajar Nugroho, 2018) designed a 2x1 microstrip array antenna to increase gain for LTE applications at a frequency of 2,300MHz with a returnloss of -35.08dB. Then (Muthia Dwifarina Arza., et al, 2018) designed and realized a triangular patch linear array microstrip antenna for digital television with a returnloss of -18.79dB. And (Hilmy Wahyu I, 2020) triangular multi input multi output (MIMO) patch antenna with additional slots for 5G applications with a return loss of -22,383dB. Based on the research design above, the resulting antenna has a relatively large size, namely more than 130 mm, except for the design (Mochammad Yunus., et al, 2019) which has a return loss of -35,375dB. Therefore, a more optimal design is needed with the aim of obtaining high gain for better LTE application performance.

METHOD

Microstrip antennas for Long Time Evolution (LTE) applications have a standard working frequency of 2,320 MHz–2,403 MHz (Mochammad Yunus., et al, 2019) (Hoymann, C. el al, 2016). Meanwhile for other specifications such as gain, returnloss, bandwidth, VSWR and the resulting radiation pattern with values which is suitable as a

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characteristic of the Long Time Evolution (LTE) antenna transcaiver (Ali, M. et al, 2017). For more clarity, the parameters for LTE can be seen in table 1.

Table 1 Antenna Specifications for LTE Network Receivers

Parameter	Nilai
Frekuensi Kerja	2.320 MHz – 2.430 MHz
Return Loss	≤ -10
Bandwitdh	≥ 20 MHz
VSWR	< 2
Pola Radiasi	*Unidirectional*
Impedansi	50 Ω
Gain	> 0

Parametric studies (changes in parameter values) of the antenna design are carried out and studied to obtain appropriate antenna specifications as in Table 1. To obtain the desired specifications, things that must be considered include the choice of material, dielectric constant and impedance used. In this research, the material used is FR-4 type with a dielectric constant (εr) of 4.3, loss tangent of 0.035 and material thickness of 1.6 mm. Then the type of slot used is the rectangular slot type as in previous research (Primananda, Heroe, & Yuyu, 2016).

Rectangular slot is a microstrip antenna design method which can only be done in two layers, namely the patch section and the groundplane section. Microstrip antennas generally consist of three main layers, but rectangular slots only use two layers. Even though it can only be used on two layers, this does not mean that this type of antenna does not use a substrate, where the substrate is located between the groundplane and the patch so that it can save costs and support the practicality of the antenna because the resulting antenna will be lighter. The parametric study was carried out by changing the antenna parameters and the changes to the expected receiving antenna specifications can be seen using the CST suite 2018 software. The antenna parametric study can be seen in table 2.

Table 2 Initial Antenna Parameters (Mochammad Yunus., et al, 2019)

Parameter	L	P	L4	W1	L1	L2	L3
Size (mm)	60	120	15	3	1	5	57

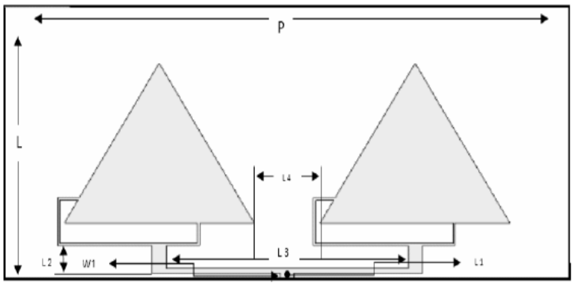

Figure 1. Initial Antenna Design (Mochammad Yunus., et al, 2019)

Figure 1 above is an initial research design created using CST studio suite 2018 software based on previous research (Mochammad Yunus., et al, 2019). The design was carried out based on an antenna parametric study which can be seen in table 2 above.

RESULT

The results of the antenna simulation process using CST suitestudio 2018 software include: bandwidth, gain, VSWR, impedance, returnloss and radiation patterns. After carrying out a parametric study, the antenna parameters with the best dimensions are obtained as in table 3 below and the final specifications of the antenna simulation results as an LTE transmitter are in table 4.

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Table 3. Final Antenna Parameters for which Parametric Studies have been carried out

Parameter	**wp**	**lp**	**wg**	**lg**	**D**
measurement (mm)	40.3	40	57	120	15
parameter	F	O	G	T	K
measurement (mm)	5	0.5	51.5	45	3
parameter	M	Q	J	X1	X2
measurement (mm)	1	4	85	30	5
parameter	X3	N			
measurement (mm)	20	10			

Table 4. Final specifications for antenna simulation results

Parameter	**Parameter Yang Diharapkan**	**Parameter Akhir Simulasi**
ReturnLoss	$\leq -10\ dB$	47.360 dB
VSWR	< 2	1.008
Gain	> 0	4.393
Bandwitdh (MHz)	> 20	24.7
Frekuensi (MHz)	2.320 – 2.430	2.280 – 2.370
Impedansi	50 Ω	49.903

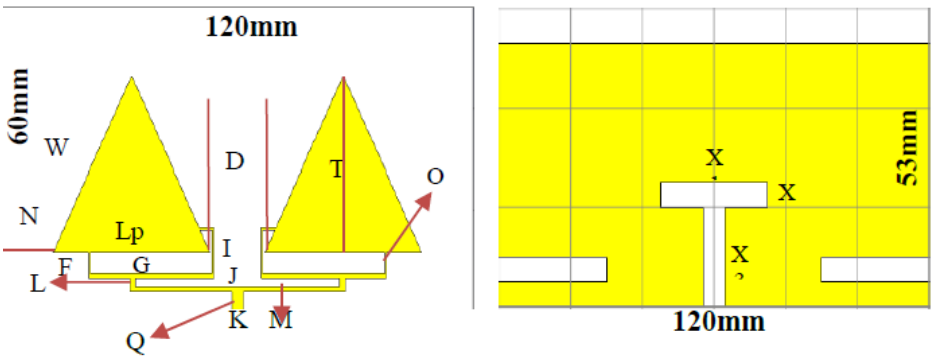

Figure 2. Final Antenna Design

In figure 2 above is the final design of the triangular patch array microstrip antenna which has been carried out a parametric study according to table 3 above, which uses CST studio Suite 2018 software.

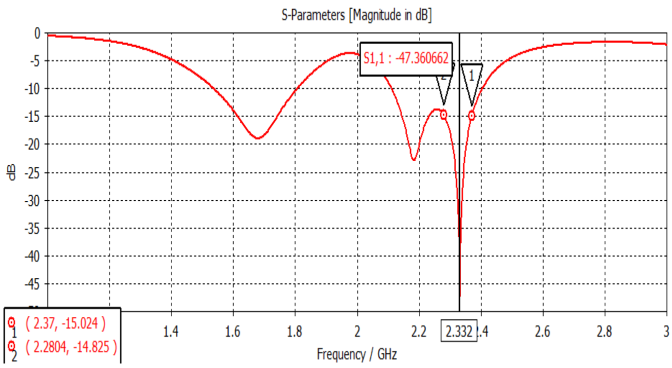

Figure 3. *ReturnLoss* and *Bandwitdh*

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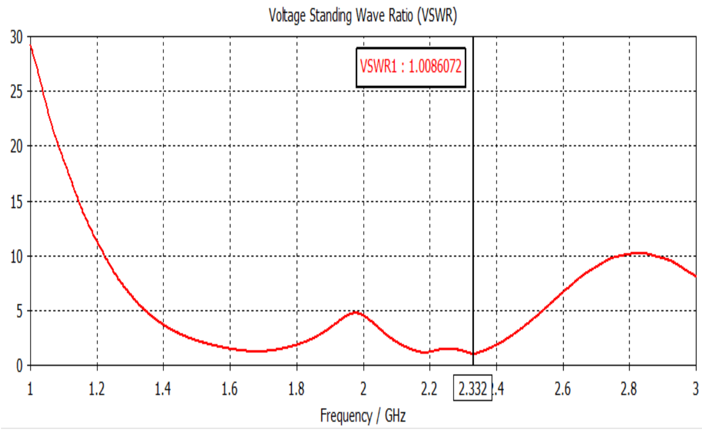

Figure 4. VSWR

Based on Figure 3 above, the resulting return loss value when the simulation is finished is -47,360 dB with a working frequency of 2,332 MHz. From the data that has been obtained, the return loss value is very good because it has reached the desired specifications, namely ≤-10 dB. Then the resulting working frequency is very good, namely int he LTE working frequency range, namely 2,320MHz – 2,430 MHz. Antenna performance will work better if the returnloss value is smaller than ≤-10 dB because returnloss is the ratio of the value of the reflected wave to the amplitude of the transmitted wave, resulting in returnloss resulting in a discontinuity between the transmission line and the input impedance of the antenna load. In simple terms, a smaller returnloss value will mean that the maximum power transmitted and received will be captured by the antenna rather than reflected. And from the antenna design simulation, the bandwidth value obtained is in line with what was expected, because the bandwidth for the LTE application is 20 MHz, while the bandwidth obtained in the simulation results is 24.7 MHz.

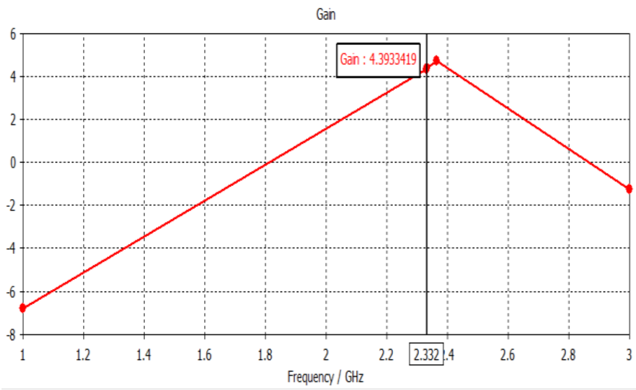

Figure 5. Gain

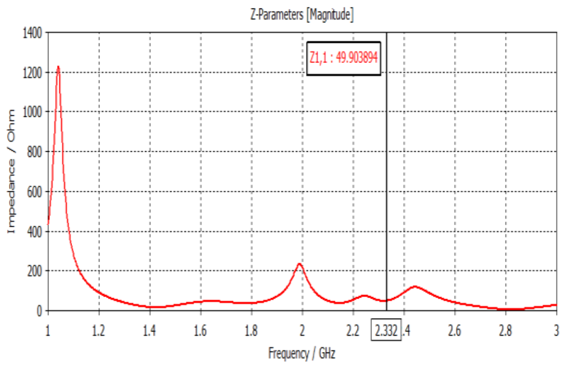

Figure 6. Impedance

In Figure 4 above, good VSWR values are ≥1 and ≤2 in accordance with the expected target antenna parameters. From the antenna simulation results, the VSWR value obtained is 1.0086, while the calculation simulation results

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obtained for the VSWR value are 1.0089. From the calculation results and simulation results, the antennas are compatible with each other and have met the desired specifications, namely ≥1 and ≤2 with a VSWR value of 1.0089.

In Figure 5 the resulting impedance is 49.90 Ω, whereas theoretically the impedance obtained is 50.35076 Ω. From the simulation results and the calculation or theoretical results they agree, even though the impedance obtained from the simulation results is 0.1 different, it can be rounded up to 50 Ω.

Then in Figure 6 above it can be seen that the antenna gain value obtained is 4,393 dB with a working frequency of 2,332 MHz. A higher gain value will result in better antenna performance.

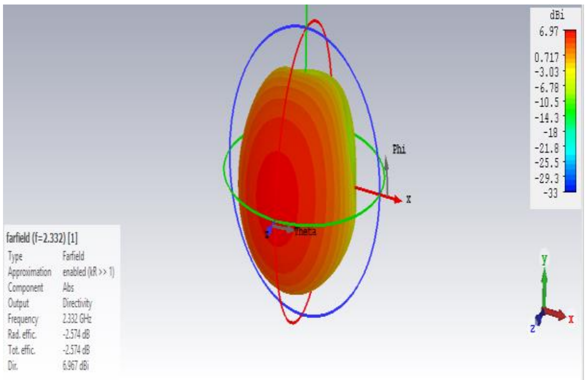

Figure 7. 3D radiation pattern display

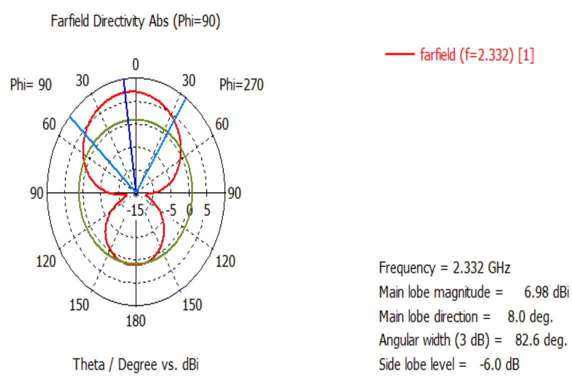

Figure 8. 2D Radiation Pattern Display

In Figure 7 and Figure 8 it can be seen that the antenna radiation pattern from the simulation results meets the expected specifications, namely a unidirectional radiation pattern.

DISCUSSION

The triangular microstrip patch array antenna for LTE applications designed with a substrate size of 120mm x 60mm has met the desired specifications when researchers carried out optimization in the patch and groundplane fields. The antenna simulation results have a working frequency band of 2,280 MHz – 2,370 MHz, where the antenna works optimally at a frequency of 2,332 MHz with a return loss of -47,360 dB, bandwidth 24.7 MHz, gain 4,393 dB, VSWR 1,008 and impedance 49.90 Ω and the resulting radiation pattern is unidirectional.

CONCLUSION

From the results of this final assignment it can be concluded that:

1. The quality of the 4G LTE network on Jalan Hassanuddin, Padang City, West Sumatra, based on the RSRP and SINR values, changes in the distance between the user equipment of 100m and the eNodeB, experiencing changes in value, namely decreasing.
2. Comparison of the RSRP values from the calculation results shows that the PCS Extension to Hatta propagation model is close to the measurement results. This is because the standardization used in the Extension to Hatta propagation model equation formula is closer to the Telkomsel eNodeB specifications and regional characteristics and propagation environment in the drive test data collection area.

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