International Journal
of Applied Information Technology

http://journals.telkomuniversity.ac.id/ijait/

Performance Analysis on Dual-band Annular Ring Microstrip Antenna at 1.9 GHz and 2.1 GHz Operating Frequencies

Cahya Adi Kuncara [a], Yuyun Siti Rohmah [b*], Dwi Andi Nurmantris [c], Radial Anwar [d]

[a, b, c, d] *School of Applied Science, Telkom University, Indonesia*

ARTICLE INFO

Received 01 March 2018
Revised 23 April 2018
Accepted 25 April 2018
Available online 28 May 2018

Keywords
A microstrip antenna, dual-band, annular ring

ABSTRACT

Annular ring antenna concept has been utilized in many applications. This paper presents the adoption of annular ring concept on a dual-band microstrip antenna. The antenna is designed to operate at 1.9 GHz and 2.1 GHz operating frequencies. The objective of this research is to observe the method potential of combining two patches operate at different frequencies as a single dual-band antenna. While the purpose of the annular concept is to enhance the bandwidth of an antenna, analysis from this work shows that for a dual-band antenna with operating frequencies close one to the other, the obtained bandwidths are relatively narrow, down to of about 5%. Nevertheless, the antenna is capable to operate at both designated frequencies with good return losses down to -24.40dB.

Acknowledgment

The authors would like to thank Telkom University for sponsoring this work.

* Corresponding author at:
School of Applied Science, Telkom University,
Jl. Telekomunikasi No. 1, Terusan Buah Batu, Bandung, 40257
Indonesia.
E-mail address: yuyunsr@tass.telkomuniversity.ac.id

ORCID ID:
Fourth Author: 0000-0002-2022-7195

https://doi.org/10.25124/ijait.v2i01.1185
Paper_reg_number IJAIT000020103 2018 © The Authors. Published by School of Applied Science, Telkom University.
This is an open-access article under the CC BY-NC 4.0 license (https://creativecommons.org/licenses/by-nc/4.0/)

1. Introduction

Annular ring microstrip antenna has been used in many applications including for satellite communication [1], wireless sensor network (WSN) application [2] and also has been proposed for aircraft [3] and integrated GPS and SDARS automotive applications [4]. The concept is adopted widely to obtain ultra wide band operating frequency [5]-[7] and also for its circular polarization capability [1], [8], [9].

This paper presents an analysis of dual-band annular ring microstrip antenna operating at 1.9 GHz and 2.1 GHz. These bands are employed for cellular communication in Indonesia. In different with [10] where the dual-band is achieved by applying notches in the antenna patch, the proposed antenna in this work has managed to obtain the dual-band characteristic by combining two annular ring patches with different sizes as a single microstrip antenna. Each patch is corresponding to its own operating frequency while at the same time affecting the characteristic of the other frequency. The design process was started by calculating the antenna geometry using standard equations which can be easily found in the textbook. The parameters were then varied to obtain the most suitable characteristic. This varying process was conducted using the simulator. After the optimum design was obtained, the proposed design was fabricated and gone through standard measurement process.

2. Antenna Architecture

The proposed antenna is developed by etching two annular ring patches into a substrate connected by a stripline feeder, as shown in Figure 1. Consequently, these patches are also sharing the same groundplane. It can be seen that one of the patches is smaller than the other. This smaller patch is responsible for operating frequency (2.1 GHz), while the bigger one corresponding to the lower frequency responds (1.9 GHz). Since they are sharing the same substrate and groundplane, the mutual coupling is quite pronounced that any slight changes on one patch will directly affect the other. The optimized parameters for the proposed antenna are listed in Table 1. For the substrate, the FR4 material is utilized. The groundplane is full without any defection.

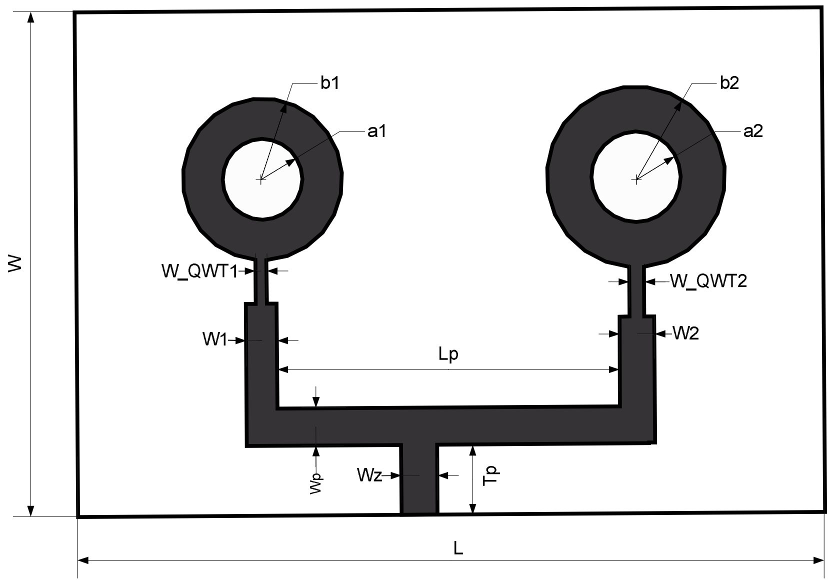

Figure 1 Geometry of the proposed antenna

Table 1 The proposed antenna parameters

Parameter	Dimension
W (Substrate width)	100 mm
L (Substrate length)	150 mm
H (conductor thickness)	0.035 mm
T (substrate thickness)	1.6 mm
a1(inner radius of 2.1 GHz)	0.104 λ
b1 (outer Radius of 2.1 GHz)	0.064λ
a2(inner radius of 1.9 GHz)	0.106 λ
b2 (outer radius of 1.9 MHz)	0.065 λ
W_QWT1 (width of 2.1 GHz)	0.0154 λ
W1(stripline width of 2.1 GHz)	0.0436λ
W_QWT2 (width of 1.9 GHz)	0.0191λ
W2(stripline width 1.9 GHz)	0.0445λ
Wp (width stripline parallel)	7.4 mm
Wz (feeding stripline width)	7.2 mm
Lp (stripline parallel Length)	67.57 mm
Tp (feeding stripline Length)	17 mm

3. Result & Discussion

Figure 2 shows the simulated return loss for the proposed geometry. The peaks are actually higher than the designated frequencies. Nevertheless, it can be seen that return losses lower than -10 dB has been achieved for both operating frequencies. At 1.9 GHz and 2.1 GHz, the obtained return losses are of about -22 dB and -11.47 dB respectively.

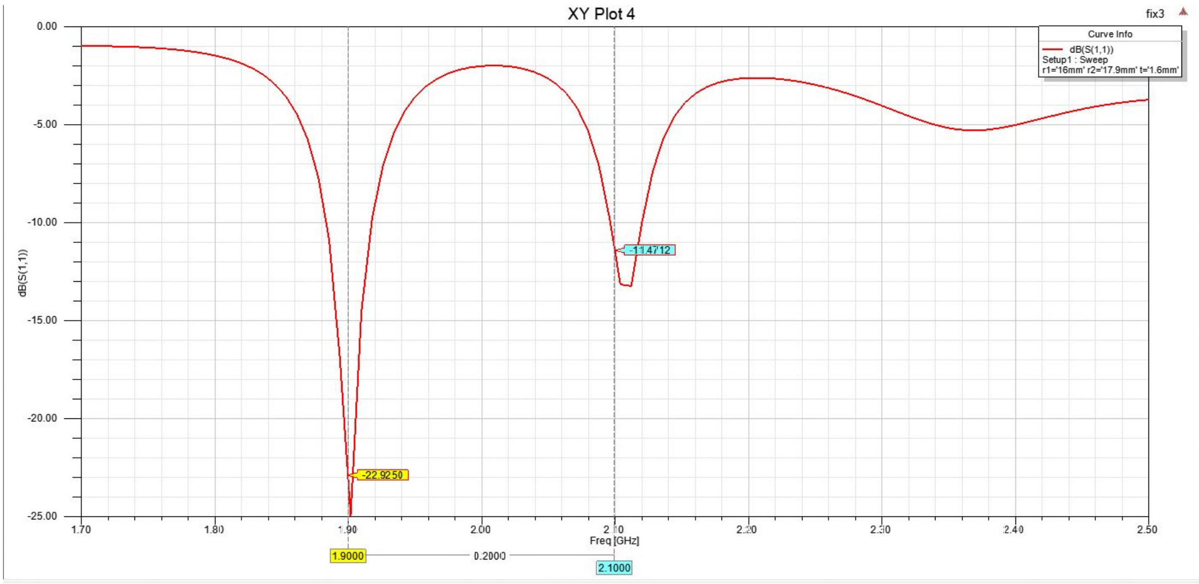

Figure 2 Simulated return loss of the proposed antenna

The proposed geometry was then fabricated and measured, as shown in Figure 3. Figure 4 depicts the measured return losses, which are better than the simulated result. -24.40 dB return loss has been achieved at 1.9 GHz with a bandwidth of about 100 MHz (5.2% bandwidth). Gain at this frequency is 2.67 dB. At 2.1 GHz, the measured return loss was -16.70 dB with a bandwidth of about 150 MHz (7% bandwidth) and gain of about 1.84 dB. The both obtained gains are within typical range for a microstrip antenna.

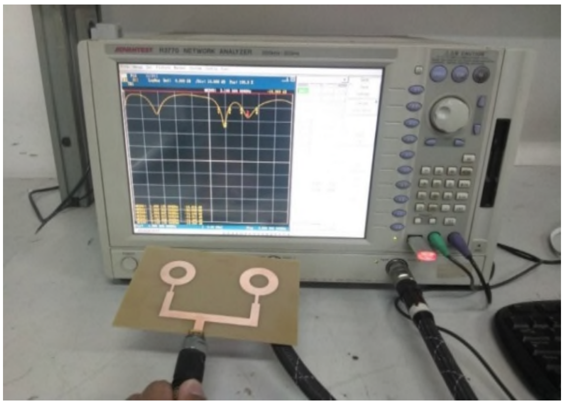

Figure 3 Fabricated antenna under measurement

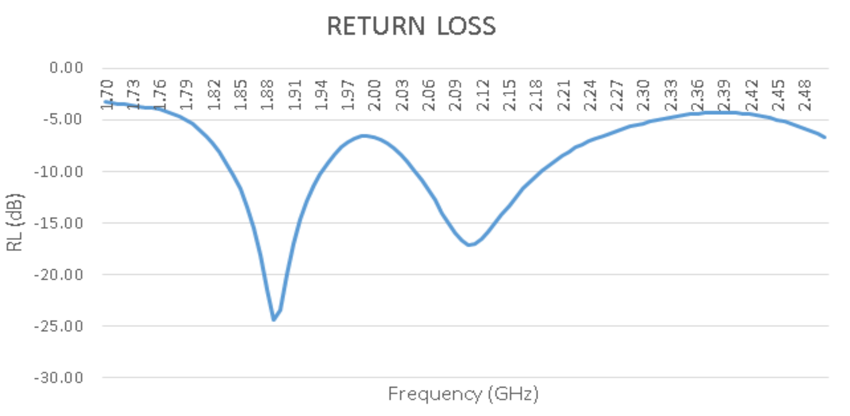

Figure 4 Measurement result (Return Loss)

The radiation patterns of the proposed antenna were also have been simulated and measured. However, the measurements were conducted not inside an anechoic chamber and hence the results were slightly different from simulation. Since a full groundplane is used in the proposed geometry, it is expected that the radiation patterns are directional towards the direction where the patches are facing on, with a small level of minor lobes. However, simulation and measurement show a different characteristic than theoretical.

Figure 5 and 6 depict the azimuthal and elevation radiation patterns for the 1.9 GHz frequency, while the same orientation of radiation patterns for 2.1 GHz operating frequency are depicted in Figure 7 and 8 respectively. It can be seen that there are strong features of side lobes on the azimuth patterns and back lobe on the elevation patterns for both operating frequencies. There are two possibilities for this shortcoming. First, it was purely due to the non-ideal condition of the measurements. Outside an anechoic chamber, measurement is prone to reflected signals from surrounding and hence will differentiate the results from what supposedly obtained. The second possibility is that the patches are also acting as a parasitic element. The smaller driven element is acting as parasitic element for the bigger driven element and vice versa. The existence of parasitic element may pull the radiated or received signal toward its direction and hence disturb the directional pattern of the proposed antenna.

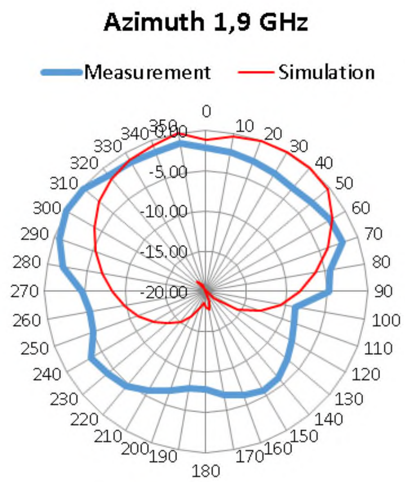

Figure 5 Radiation patterns at 1.9 GHz (Azimuth orientation)

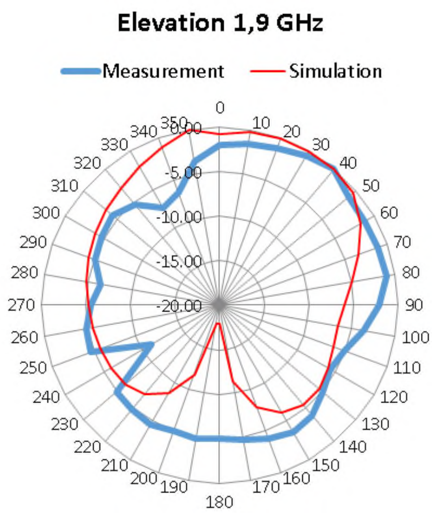

Figure 6 Radiation patterns at 1.9 GHz (Elevation orientation)

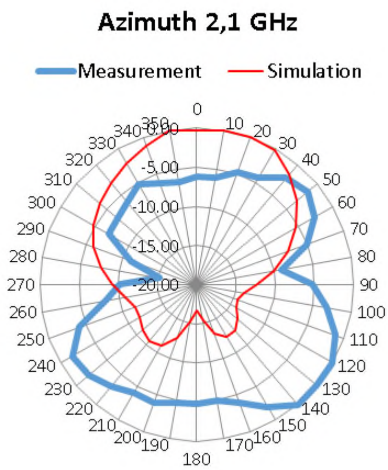

Figure 7 Radiation patterns at 2.1 GHz (Azimuth orientation)

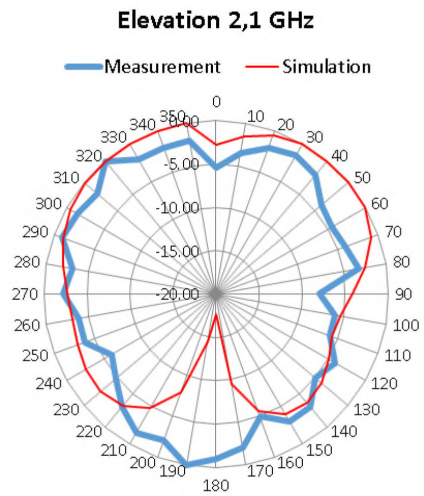

Figure 8 Radiation patterns at 2.1 GHz (Elevation orientation)

4. Conclusion

Performance of a dual-band annular ring microstrip antenna operates at cellular communication band in Indonesia has been analyzed in this paper. The antenna is able to work at 1.9 GHz and 2.1 GHz with good return losses (down to -24.4 dB) but inherits narrow bandwidths (down to 5.2%). The obtained gain (2.67 dB and 1.84 dB) are also typical for a microstrip antenna, but not at the poor side. The radiation patterns of the proposed antenna are not unidirectional despite the utilization of full groundplane, which lead to possibility of the patches acting as a parasitic element. Nevertheless, the patterns are still suitable for cellular communication application.

Bibliography

[1] M. Ramirez, J. Parron, J. M. Gonzalez-Arbesu and J. Gemio, "Concentric Annular-Ring Microstrip Antenna With Circular Polarization," in IEEE Antennas and Wireless Propagation Letters, vol. 10, pp. 517-519, 2011.

[2] D. Wang, L. Song, H. Zhou, Z. Zhang, "A Compact Annular Ring Microstrip Antenna for WSN Applications," Sensors, vol. 12, no. 7, pp. 8663-8674, 2012.

[3] L. Sun, B-H. Sun, G-X. Zhang, D. Cao, and B. Fan, "Design and Investigation of A Dual-Band Annular Ring Slot Antenna for Aircraft Applications," Progress In Electromagnetics Research C, vol. 38, pp. 67–78, 2013.

[4] M. M. Bilgic and K. Yegin, “Modified Annular Ring Antenna for GPS and SDARS Automotive Applications,” IEEE Antennas Wirel. Propag. Lett., vol. 15, no. 1, pp. 1442–1445, 2016.

[5] R. Chandel, A. K. Gautam, and B. K. Kanaujia, “Annular-ring antenna for UWB applications,” 2015 IEEE Appl. Electromagn. Conf., pp. 1–2, 2015.

[6] S. Azzaz-Rahmani and N. Boukli-Hacene, “Ultra-Wide-Band Microstrip Concentric Annular Ring Antenna for Wireless Communications,” Int. J. Comput. Sci. Issues, vol. 9, no. 1, pp. 132–134, 2012.

[7] Q. Zhang and Y. Gao, “Design of an UHF UWB doubled annular ring antenna using characteristic mode analysis,” 2017 11th Eur. Conf. Antennas Propagation, EUCAP 2017, pp. 3464–3466, 2017.

[8] S. Pyo, N. Kim, and J.-M, Kim, "Reconfigurable microstrip annular ring antenna for circular polarization diversity," Microw. Opt. Technol. Letter, vol. 56, pp. 1706–1709, 2014.

[9] J. S. Row, "Design of aperture-coupled annular-ring microstrip antennas for circular polarization," in IEEE Transactions on Antennas and Propagation, vol. 53, no. 5, pp. 1779-1784, 2005.

[10] P. Singh, "Rectangular notch loaded dual band annular ring patch antenna," J. Microw. Optoelectron. Electromagn. Appl. vol. 13, no. 1, pp. 85-96, 2014.