Dwi Astuti Cahyasiwi - Wide Bandwidth Filtering Antenna with an LShaped Resonator

10% Overall Similarity

The combined total of all matches, including overlapping sources, for each database.

Filtered from the Report

- Bibliography

Exclusions

- 7 Excluded Matches

Match Groups

20 Not Cited or Quoted 10%
Matches with neither in-text citation nor quotation marks

0 Missing Quotations 0%
Matches that are still very similar to source material

0 Missing Citation 0%
Matches that have quotation marks, but no in-text citation

0 Cited and Quoted 0%
Matches with in-text citation present, but no quotation marks

Top Sources

5% Internet sources
10% Publications
0% Submitted works (Student Papers)

Integrity Flags

0 Integrity Flags for Review

No suspicious text manipulations found.

Our system's algorithms look deeply at a document for any inconsistencies that would set it apart from a normal submission. If we notice something strange, we flag it for you to review.

A Flag is not necessarily an indicator of a problem. However, we'd recommend you focus your attention there for further review.

Match Groups

- **20** Not Cited or Quoted 10%
  Matches with neither in-text citation nor quotation marks
- **0** Missing Quotations 0%
  Matches that are still very similar to source material
- **0** Missing Citation 0%
  Matches that have quotation marks, but no in-text citation
- **0** Cited and Quoted 0%
  Matches with in-text citation present, but no quotation marks

Top Sources

5% Internet sources
10% Publications
0% Submitted works (Student Papers)

Top Sources

The sources with the highest number of matches within the submission. Overlapping sources will not be displayed.

1	Internet	repository.uhamka.ac.id	2%
2	Publication	Kun-Zhi Hu, Ming-Chun Tang, Yang Wang, Dajiang Li, Mei Li, Daotong Li. "Design ...	<1%
3	Internet	journal.universitasbumigora.ac.id	<1%
4	Publication	Hui Chu, Hong Hong, Xiaohua Zhu, Yong-Xin Guo, Peng Li. "Implementation of Sy...	<1%
5	Publication	G. S. Cheng, Baoqing Huang, Zhixiang Huang, Lixia Yang. "A High-Gain Circularly ...	<1%
6	Publication	Khiem Nguyen Khac, Nikolay S. Knyazev, Vuong Le Quoc, Hung Luu Quang. "Band...	<1%
7	Publication	Zixian Wu, Anxue Zhang, Jianzhong Chen, Xinru Lu, Jianxing Li. "Co-design of low ...	<1%
8	Internet	www.researchgate.net	<1%
9	Publication	Dwi Astuti Cahyasiwi, Fitri Yuli Zulkifli, Eko Tjipto Rahardjo. "Switchable Slant Pola...	<1%
10	Publication	Patterson, Mark. "Alternative Applications of Composite Materials to Reduce Rad...	<1%

11 Publication

Xiao-Cong Li, Lei Ge, Zhi Hou, Guo Yang, Wen Wu. "Low-Profile Wideband Filtering... <1%

12 Internet

manuals.bioinformatics.ucr.edu <1%

13 Internet

www.jstage.jst.go.jp <1%

14 Publication

Dwi Astuti Cahyasiwi, Fitri Yuli Zulkifli, Eko Tjipto Rahardjo. "Orthogonal Resonat... <1%

15 Publication

Gang Zhang, Lei Ge, Jianpeng Wang, Jiquan Yang. "Design of A 3-D Integrated Wid... <1%

16 Publication

Tao Xu, Jian-Feng Li, Liang-Hua Ye, Duo-Long Wu, Gary Zhang. "A Wideband Circul... <1%

Wide Bandwidth Filtering Antenna with an *L*-Shaped Resonator

Dwi Astuti Cahyasiwi
Electrical Department
Faculty of Industrial Technology and Informatics
Universitas Muhammadiyah Prof. Dr. HAMKA, Jakarta, Indonesia
dwi.cahyasiwi@uhamka.ac.id

Fitri Yuli Zulkifli
Department of Electrical
Faculty of Engineering
Universitas Indonesia
Depok, Indonesia
0000-0001-6865-3188

Eko Tjipto Rahardjo
Department of Electrical
Faculty of Engineering
Universitas Indonesia
Depok, Indonesia
0000-0002-5071-4111

Muhammad Adnan Widodo
Electrical Department
Faculty of Industrial Technology and Informatics
Universitas Muhammadiyah Prof. Dr. HAMKA, Jakarta, Indonesia

Dian Widi Astuti
Department of Electrical Engineering,
Faculty of Engineering
Universitas Mercu Buana
Jakarta, Indonesia
dian.widiastuti@mercubuana.ac.id

Yus Natali
Electrical Engineering Faculty
Telkom University)
Jakarta, Indonesia
yusnatali@telkomuniversity.ac.id

***Abstract*— This study presents a filtering antenna that operates at 3.5 GHz. The design utilizes a rectangular radiator and a single *L*-shaped resonator. A feedline extension is inserted between the *L* resonator and the rectangular radiator with a coupled connection. The S_{11} parameter demonstrates three minimal responses with a bandwidth of 7.45%, centered at a frequency of 3.52 GHz. The selectivity is evidenced by the gain response, which remains flat over the range of 3.42-3.62 GHz and drops sharply outside this range, indicating good performance. The design is fabricated and the S_{11} measurement result shows an agreement with the simulation.**

Keywords—filtering antenna, 5G, a quarter wavelength resonator, via through hole.

I. Introduction

In modern communication systems, the demand for compact, efficient, and multifunctional components is ever-increasing. One such innovative component that has gained significant attention is the filtering antenna. A filtering antenna, integrates the functions of a filter and an antenna into a single device. This integration leads to several advantages, including reduced size, lower insertion loss, and improved overall system performance. A filtering antenna combines the radiation properties of an antenna with the frequency-selective characteristics of a filter. Traditionally, these two functions are performed by separate components: an antenna for transmitting or receiving electromagnetic waves and a filter for selecting or rejecting specific frequency bands. By merging these functionalities, a filtering antenna can provide both radiation and filtering in a single structure, simplifying the design and potentially reducing the cost of the system.

Various method have been studied to add the antenna with selectivity feature. One widely-used approach is to add a resonator to the radiator to design a filtering antenna. Some resonator such as hairpin [1], cavity resonator [2], interdigital [3], [4], [5], dielectric resonator [6], and E-shape slot [7], [8]. The primary technique to integrate an antenna and filter involves adding a resonator to the antenna feedline, which generates two transmission zeros. Many half-wavelength resonators are used to creates a filtering antenna, such as

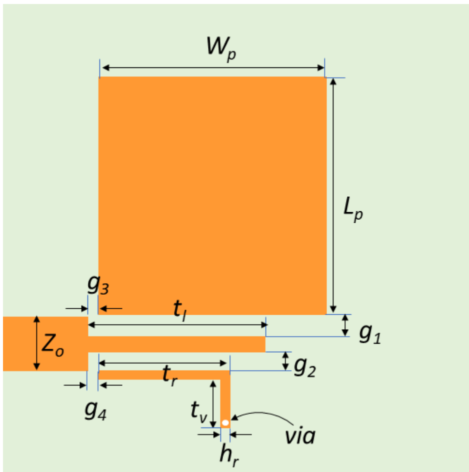

Fig. 1 Configuration of the filtering antenna where Z_0 = 4.8, g_1 = 0.9, g_2 = 1.2, g_3 = 1.1, g_4 = 1.05, t_l = 18, t_r = 12.4, t_v = 4.5, h_r = 1, L_p = 26.9, and W_p = 26 (all unit dimensions in mm)

hairpin, interdigital, and E resonator. Some design using a quarter wave-length resonator as in, [3], [9], [10] to design a filtering antenna. A quarter wave-length resonator is created by adding a via (vertical interconnect access) through hole at the ending arm of resonator. This method will change the capacity and inductivity of the resonator thus change the resonance frequency of the resonator to the lower frequency. In this study a filtering antenna using *L*-shape resonator is designed and fabricated. A via through hole is added to the one of the resonators arm for miniaturized a lower frequency operation resonator. The design based on second order band pass filter. The novelty of the design lies in the placement of the transmission line, which is coupled and inserted between the resonator and the radiator. This feeding method is intended to achieve an orthogonal vector relationship between the radiator and the feedline source. Additionally, the introduction of a gap induces a delay between the two vectors, resulting in circular polarization. However, in this study, the discussion is focused solely on the antenna's selectivity feature. The

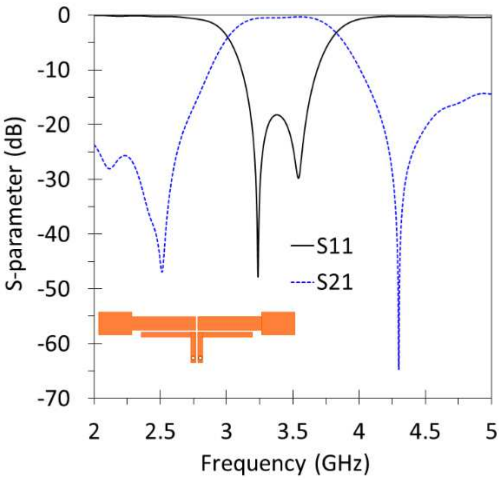

Fig. 2. Second order bandpass filter using L-shaped resonators with via through hole

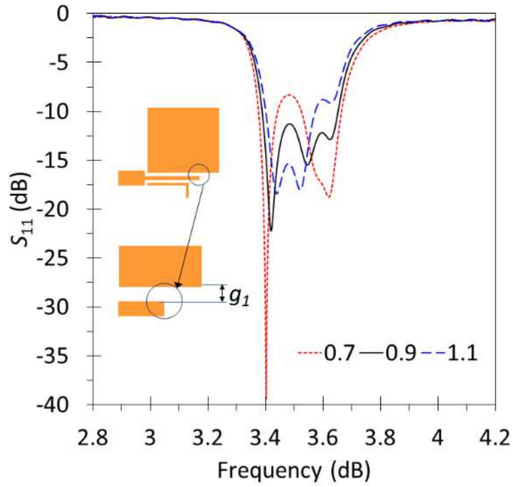

Fig. 3 S_{11} response with various g_1 (all unit dimensions in mm)

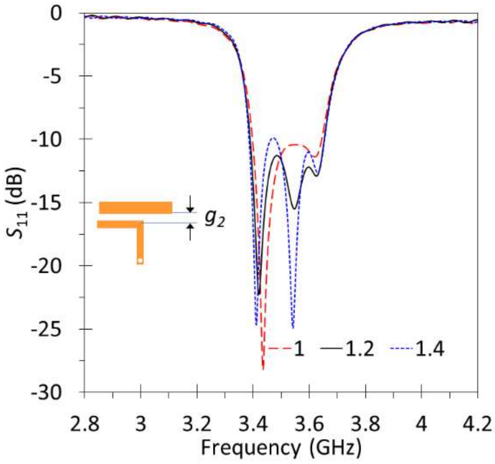

Fig. 4 S_{11} response variation with g_2 (all unit dimensions in mm)

proposed design is fabricated and measured, and the S_{11} measurement is presented to validate the design.

II. Filtering Antenna Design

The configuration of the proposed filtering antenna is shown at Fig.1. A rectangular patch radiator is coupled to the *L*-shaped resonators and a 1.3 mm feed is inserted between the two circuit. The *L*-shaped resonator, with a thickness of 1 mm, has a via through hole at the end of the arm, making it a λ/4 resonator [3]. Using the same length resonator will result in a lower resonance frequency if we add a via through hole at the end of the resonator's arm; in other words, the via hole also miniaturizes the resonator. For example, in [11], a filter with an *L*-shaped resonators operating at 3.45 GHz has a longer dimension than the filter with an *L*-shaped resonators with a via through hole shown in Fig. 2, despite having the same operating frequency. The filter and antenna are printed on 45 mm × 50 mm Roger Duroid 5880 substrate, with a permittivity 2.2, and thickness of 1.575 mm.

A. Filter Design

The design of the filter with an *L*-shaped resonator employs a second-order bandpass filter (BPF) configuration. The resonator features a via through hole at the end of the arm with a diameter of 0.8 mm. The *L*-shaped resonators are positioned in an opposing arrangement and are coupled to transmission lines that are also mutually coupled. The filter achieves a 500 MHz bandwidth with an impedance of -10 dB and an insertion loss of 0.5 dB at an operating frequency of 3.5 GHz. Fabricated on a 41.5 mm × 14 mm substrate, the proposed filter not only exhibits a wider bandwidth but also demonstrates a size reduction compared to the *L*-shaped resonator filter described in [11] which dimension is 60.5 mm × 20 mm. The incorporation of a via through hole in our proposed design results in a 73% miniaturization factor.

B. Integration Antenna-Filter

A second-order BPF is used to design a filtering antenna utilizing the same resonator. To integrate the filter and antenna, we must design the radiator to resonate at 3.5 GHz. The next step involves coupling the rectangular radiator to the transmission line, which is then coupled to the resonator, positioning the transmission line between the radiator and the resonator. The optimization of the antenna depends on four parameters: the length, width of the radiator, the gap between the transmission lines and resonator (g_1) and the gap between transmission line and resonator (g_2). Figure 3 shows the S_{11} of the filtering antenna with various g_1 values. Increasing or decreasing g_1 from 0.9 mm degrades the S_{11} response. Fig. 4 shows the impact of g_2 to S_{11} response. Adjusting g_2 from 1.2 mm, either by increasing or decreasing it, results in an increase in the S_{11} value. Both g_1 and g_2 affect the S_{11} response at the middle bandwidth , they have only a slight effect on the lower side or upper side S_{11}.

III. Result and Discussion

The optimized S_{11} and gain result of filtering antenna is shown in Fig. 3 and Fig. 4 with solid black line curve where it has -10 dB bandwidth impedance of 262 MHz or 7.45% in a range of 3.39–3.65 GHz and center frequency of 3.52GHz. The S_{11} shows three minima values at 3.42 GHz, 3.55 GHz and 3.63 GHz. Although the design using single resonators as in the second–order filtering antenna, the S_{11} result have three minimal values. The proposed design has a maximum gain of 6.7 dBi at 3.54 GHz. Gain response is flat along the operational bandwidth and decreases to less than −15 dB at lower frequency and −14 dB at the upper frequency.

The design is fabricated as depicted in Fig. 5 and measured using Vector Network Analyzer Agilent N5230C. The S_{11}

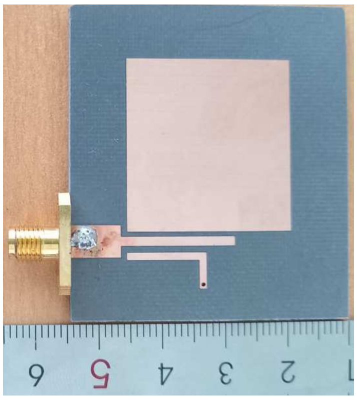

Fig. 5 Fabrication of filtering antenna

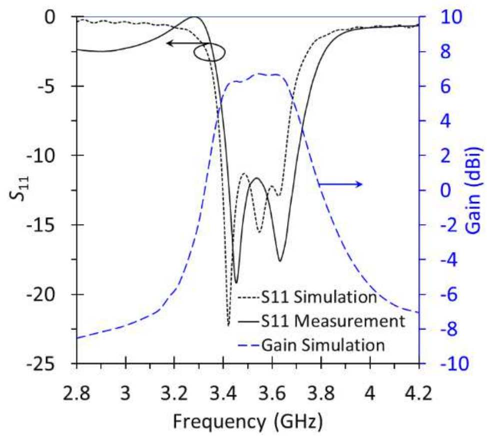

Fig. 6 Simulation and measurement results of filtering antenna

measurement result is shown in Fig. 6 where the −10 dB bandwidth impedance is laid between 3.41 – 3.7 GHz (286 MHz) or 8.1%, which is 0.55% wider than the simulation results. The center frequency measurement is 3.56 GHz or shifted slightly to the higher frequency. The $S11$ measurement result show two minimal response at 3.45 GHz and 3.63 GHz similar as a second–order filtering antenna with value of −19.17 dB and −17.61 dB respectively. The discrepancy between the $S11$ simulation and measurement result is due to fabrication accuracy because the difference of 0.1 mm dimension of patch or gap determines the oscillation occurred. The normalized radiation pattern simulation at 3.6 GHz is shown in Fig. 7, where there is more than 20 dB cross polarization discriminant at phi = 0° and phi = 90°. The radiation pattern shows a unidirectional in a broadside direction for both planes.

IV. Conclusion

A filtering antenna with a quarter wavelength L- resonator has been design and measured. The inserted coupled transmission line between the resonator and radiator affected the S_{11} oscillation. Using one resonator the antenna performed three minimal S_{11} as in the third order filtering antenna. The gaps between the transmission line and radiator, as well as between the resonator and radiator, play a crucial role in determining the S_{11} and the selectivity of filtering antenna.

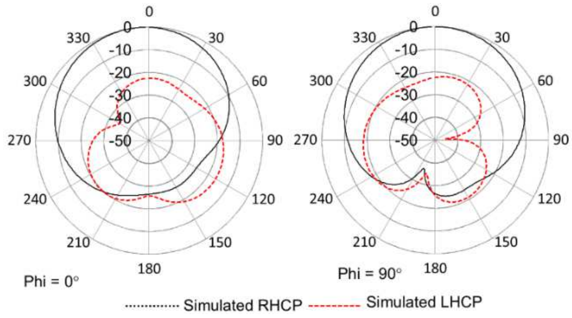

Fig. 7 Normalized radiation pattern of the proposed design

Acknowledgment

This work funded partly by Hibah Internal Universitas Muhammadiyah Prof. Dr. HAMKA under contract number: 67/F.03.07 /2024. The authors thank to the Indonesia Digital Test House for providing the measurement laboratory, Department of Electrical Engineering Universitas Indonesia for providing CST software, and Roger corp. for providing the substrate.

References

[1] D. A. Cahyasiwi and E. T. Rahardjo, “Circular Patch Filtering Antenna Design Based on Hairpin Band-Pass Filter,” in *International Symposium on Antenna and Propagation*, 2018, pp. 263–264.

[2] J. Y. Lin, Y. Yang, S. W. Wong, and R. Sen Chen, “In-Band Full-Duplex Filtering Antenna Arrays Using High-Order Mode Cavity Resonators,” *IEEE Trans Microw Theory Tech*, vol. 71, no. 4, pp. 1630–1639, 2023.

[3] D. A. Cahyasiwi, F. Y. Zulkifli, and E. T. Rahardjo, “Orthogonal Resonators for Circularly Polarized Filtering Antenna Using a Single Feedline,” *IEEE Trans Microw Theory Tech*, vol. 71, no. 10, pp. 4227–4235, 2023.

[4] D. A. Cahyasiwi, E. Roza, M. Mujirudin, N. M. Nashuha, F. Y. Zulkifli, and E. T. Rahardjo, “Selectivity improvement of interdigital filtering-antenna using different orders for 5 G application,” *Int J Microw Wirel Technol*, vol. 15, no. 7, pp. 1179–1187, Sep. 2023.

[5] W. Cheng and D. Li, “Circularly polarised filtering monopole antenna based on miniaturised coupled filter,” *Electron Lett*, vol. 53, no. 11, pp. 11–12, 2017.

[6] B. J. Xiang, S. Y. Zheng, Y. M. Pan, and Y. X. Li, “Wideband Circularly Polarized Dielectric Resonator Antenna With Bandpass Filtering and Wide Harmonics Suppression Response,” *IEEE Trans Antennas Propag*, vol. 65, no. 4, pp. 2096–2101, 2017.

[7] J. Wang, Y. Zhang, L. Ye, and Q. H. Liu, “A Wideband Circularly Polarized Filtering Antenna Based on Slot-Patch Structure,” *IEEE Antennas Wirel Propag Lett*, vol. 22, no. 8, pp. 1858–1862, Aug. 2023.

[8] Z.-H. Tu and Q.-R. He, “Filtering Endfire Dipole Antenna Based on Resonators,” *IEEE Antennas Wirel Propag Lett*, vol. 21, no. 4, pp. 803–807, 2022, doi: 10.1109/lawp.2022.3148193.

[9] Q. Wu, L. Zhu, and X. Zhang, “Filtering patch antenna on λ / 4-resonator filtering topology : synthesis design and implementation,” *IET Microw. Antennas Propag*, pp. 2241–2246, 2017, doi: 10.1049/iet-map.2017.0354.

[10] D. A. Cahyasiwi, F. Y. Zulkifli, and E. T. Rahardjo, “Stacked Interdigital Filtering Antenna with Slant Polarization,” in *Proceedings - CAMA 2019: IEEE International Conference on Antenna Measurements and Applications*, 2019. doi: 10.1109/CAMA47423.2019.8959695.

[11] T. Firmansyah, M. Alaydrus, Y. Wahyu, E. T. Rahardjo, and G. Wibisono, “A highly independent multiband bandpass filter using a multi-coupled line stub-sir with folding structure,” *IEEE Access*, vol. 8, pp. 83009–83026, 2020, doi: 10.1109/ACCESS.2020.2989370.