# Dimensional Parametric Study of The Spiral Resonator as a Metamaterial Planar-Antenna

Mochamad Yunus[1], Fitri Yuli Zulkifli[2], Eko Tjipto Rahardjo[3]
[1,2,3] Antenna and Microwave Research Group, Electrical Engineering Departement, Faculty of Engineering, Universitas Indonesia
email[1] : mochyunus@yahoo.com,email[2] yuli@eng.ui.ac.id,email[3] eko@eng.ui.ac.id

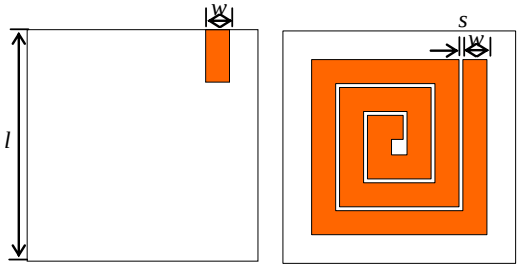
*Abstract* – In this paper, the square spiral resonator (SR) as a metamaterial planar-antenna with electromagnetically coupled (EMC) feed is proposed. The proposed antenna will be operated at the frequency range of 2.4 – 2.5 GHz. To define the dimensional parametrics of the proposed antenna such as the spiral turn number (*N*), strip width (*w*), and gap width (*s*), it is simulated. The highest gain obtained is –0.5 dB at the frequency of 2.43 GHz by using dimensional parametrics of *N* = 3; *w* = 3.1mm; and *s* = 0.5mm.

*Keyword* – Metamaterial planar-antenna, spiral resonator, antenna gain

## I. Introduction

Antenna parameters are degraded due to surface waves. To eleminate it, ENG or MNG metamaterial is used. The MNG metamaterial more suitable for designing of the microstrip antenna. The MNG metamaterial has two shapes such as split ring resonator (SRR) and spiral resonator (SR) [1]. Moreover, [3]–[4] are engineered magnetic material by using spiral structure as a substrate for applying small patch antenna. SR structure is used frequently to compose magnetic material as substrate, however it has not been found yet to be used as a planar antenna. Therefore, this paper will discuss the novelty of the SR structure as a planar antenna.

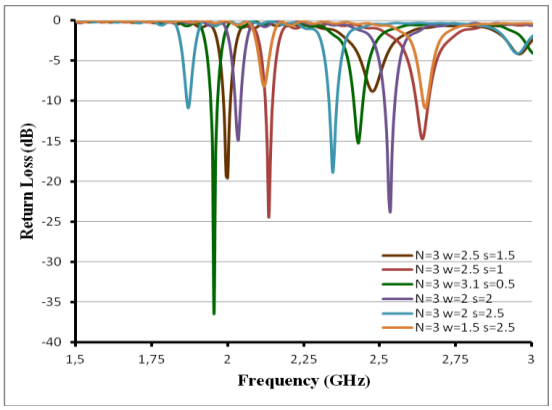
## II. Spiral Resonator as a Metamaterial Planar-Antenna



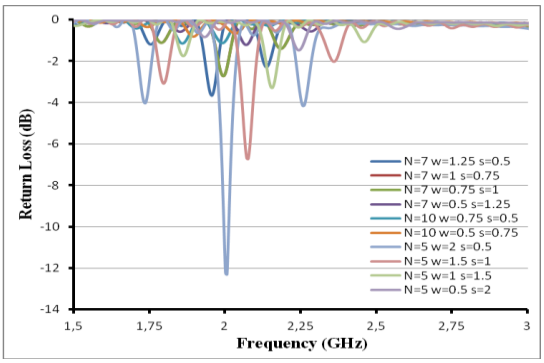

(a) (b)

Fig. 1. SR Structure as Metamaterial Planar-Antenna : (a) EMC Feeder and (b) Radiator

The simulation result is shown in Fig. 2.




(a)




(b)

Fig. 2. Return Loss of the Proposed Antenna : (a) with *N*=3; (b) with *N*=5,7,10 and Variations of *w* and *s*

From Fig. 2(a) and Fig. 2(b), they can be observed that the frequency range at 2.4 GHz – 2.5 GHz occured at the dimensional parametric of *N*=3 with combinational variations of *w*=3.1mm, *s*=0.5mm and *w*=2.5mm, *s*=1.5mm, while the others are out of range and they are not observed. The performance of the proposed antenna at the frequency range of 2.4 GHz – 2.5 GHz is shown in Table I

TABLE I
Antenna Parameters vs Dimensional Parameters

| Parameter | | Freq Range of 2.4 - 2.5 GHz | $S_{11}$ (dB) | Gain (dB) |
|---|---|---|---|---|
| *N*=3 | *w*=3.1 *s*=0.5 | 2.43 | -15 | -0.5 |
| | *w*=2.5 *s*=1.5 | 2.47 | -9 | -0.6 |
| | *w*=2.5 *s*=1 | out of range | not observed | not observed |
| | *w*=2 *s*=2 | out of range | not observed | not observed |
| | *w*=2 *s*=2.5 | out of range | not observed | not observed |
| | *w*=1.5 *s*=2.5 | out of range | not observed | not observed |

## III. Conclusion

Dimensional parametric study of SR as metamaterial planar-antenna lead to the conclusion that the proposed antenna with *N*=3, *w*=3.1mm, *s*=0.5mm has the highest gain than the others. The proposed antenna gain is –0.5 dB at the frequency of 2.43 GHz.

## References

[1]. F. Bilotti, A. Toscano, L. Vegni, K. Aydin, K. B. Alici, and E. Ozbay, "Equivalent-Circuit Models for the Design of Metamaterials Based on Artificial Magnetic Inclusions", *IEEE Trans. Microw Theory And Techniques*, Vol. 55, No. 12, December 2007

[2]. K. Buell, "Development of Engineered Magnetic Materials for Antenna Applications", *Doctor of Philosophy Dissertation*, University of Michigan, 2005.

[3]. J. D. Baena, R. Marques, F. Medina, and J. Martel, "Artificial Magnetic Metamaterial Design By Using Spiral Resonators", *Physical Review B 69*, 014402, The American Physical Society, (2004).