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Preface

It is our great pleasure to welcome you to 2017 the 3rd International Conference on Communication and Information Processing (ICCIP 2017) which was held in Tokyo, Japan during November 24-26, 2017. ICCIP 2017 is dedicated to issues related to communication and information processing.

The major goal and feature of the conference is to bring academic scientists, engineers, industry researchers together to exchange and share their experiences and research results, and discuss the practical challenges encountered and the solutions adopted. Internationally known experts from several countries are invited as Keynote Speakers to deliver the latest information in their respective expertise areas. It will be a golden opportunity for the students, researchers and engineers to interact with the experts and specialists to get their advice or consultation on communication and information processing.

The proceedings contain 100 papers which were selected from a total of 155 papers submitted to the conference. All of the papers were subjected to peer-review by conference committee members and international reviewers. The papers selected for this volume depended on their quality and their relevancy to the conference. The volume tends to present to the readers the recent advances in the field of communication and information processing and various related areas, such as Data Engineering and High Performance Computing, Software Development and Program Design, Information System Design and Management, Virtual Technology and System Modeling and etc.

We would like to thank all the authors who have contributed to this volume and also to the organizing committee, reviewers, speakers, chairpersons, sponsors and all the conference participants for their support to ICCIP 2017.

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Mutual Coupling and Radiation Pattern Of Vivaldi Antenna with Slit

Nurhayati[1, 2*], Gamantyo Hendrantoro[1**], Eko Setijadi [1***]

[1]Departement of Electrical Engineering, Institut Teknologi Sepuluh Nopember, Indonesia

[2]Departement of Electrical Engineering, Universitas Negeri Surabaya, Indonesia

*nurhayati15@mhs.ee.its.ac.id,

**gamantyo@ee.its.ac.id, ***ekoset@ee.its.ac.id

ABSTRACT

Vivaldi antenna is one of the micro strip broadband antennas that can be applied in wide application such as wireless communication, imaging and radar. Many Vivaldi antenna research has been published to get higher directivity and smaller size of element. Beside that many research develop antenna performance to get higher gain and small beam width in the array. Smaller antenna can influence mutual coupling performance if it organized in closely spacing between elements. This paper will present mutual coupling of two coplanar Vivaldi antenna and radiation pattern of coplanar Vivaldi antenna in E plane array. For antenna element that has width of element smaller than a half wavelength of its lowest frequency, it will get worse S21 or S12 performance. Our purposed give method to improve mutual coupling performance and radiation pattern by adding slit structure in outer side of the coplanar Vivaldi antenna. It can improve mutual coupling reduction of 7.12 dB from -9.1437 to -16.283 at 2GHz. The design can reach mutual coupling of -19.636 at frequency 4 GHz. Our purposed can improve E-Field of antenna of 1.9 V/m and SLL 0.4 dB at 2 GHz. It gets 1.19 times of main lobe improvement at 3GHz.

CCS Concepts

• **Hardware→Radio frequency and wireless circuit; Electromagnetic interference and compatibility; Wireless devices**

Keywords

Mutual Coupling, antenna, Vivaldi, radiation pattern, array.

1. INTRODUCTION

Mutual coupling is one of the antenna parameter that must be considered in array antenna. Mutual coupling can change impedance of antenna and radiation characteristic of antenna that is caused by interaction of electromagnetic scattering from adjacent antenna element and surface current of antenna. Many researches about mutual coupling research have been published for antenna by EBG for ISM Band [1], spiral via EBG [2], EBG for four array [3], periodic structure [4], meander line slot [5], DGS [6], S-shape [7], H-Shape [8] and silted ground plane [9]. There are many methods can be applied to micro strip antenna to reduce mutual coupling performance with simple or complicated structure. In addition literature only discussed mutual coupling reduction to microstrip antenna that has narrow bandwidth, but not much is reported for wideband antenna.

Papers that explored radiation improvement have been published in recent year. Radiation pattern improvement for Antipodal Vivaldi Antenna as tapered slot edge [10], coplanar waveguide for AVA [11], Double Antipodal [12], Dielectric lens [13], sun slits [14], and comb shaped slit [15] has been reported. More papers explore antipodal Vivaldi antenna to improve radiation characteristic. Comparison of Co-planar, AVA and BAVA has been published in S band application [16]. However for Co-planar Vivaldi antenna is rarely studied for radiation pattern improvement.

In this paper, we compare mutual coupling and radiation characteristic between two elements of Coplanar Vivaldi antenna with and without slit that operates in S band. By adding slit structure to the outer side coplanar Vivaldi antenna, mutual coupling and radiation pattern performance between two closely between elements can be improved.

2. ANTENNA DESIGN

2.1 Element Design

Coplanar Vivaldi element under study has dimension of 60×60 mm^2 (0.6λ×0.6λ), where λ is wavelength at the center frequency. But the antenna's dimension becomes 0.4λ×0.4λ at the lowest frequency and 0.8λ×0.8λ at the highest frequency.

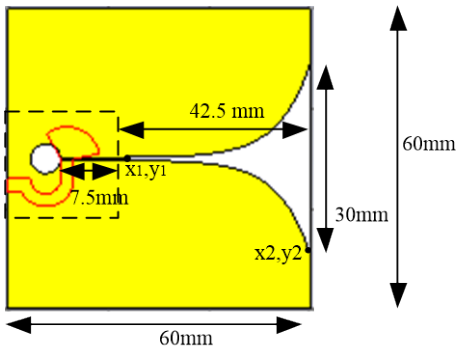

Figure 1. Dimension of antenna.

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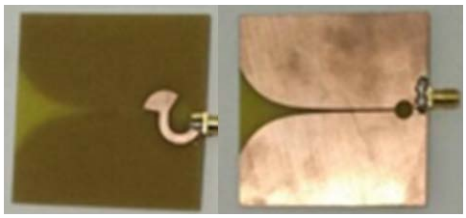

Figure 2. Fabricated antenna element: Bottom and top view

Our antenna is designed on FR4 with permittivity 4.6 and thickness 1.6 mm. Its feeding shape follows the design in [17]. However in this paper we limit the discussion on Coplanar Vivaldi antenna for S band application (2-4 GHz) because in the lowest frequency at 2 GHz antenna has element spacing of less than a half of its operate frequency.

2.2 Array Design

In this paper mutual coupling is obtained by comparing scattering parameter S_{12} or $S_{21}$of two type antenna arrays, without and with slit at each element array, which consist of Coplanar with ragged slit on outer side of patch antenna element.

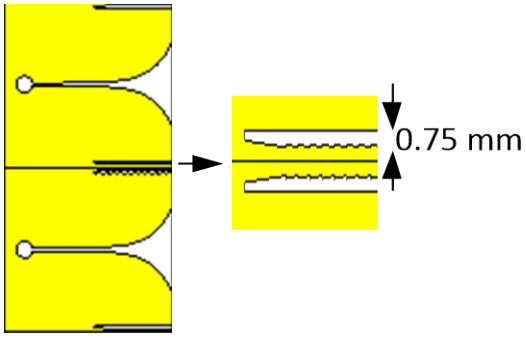

Figure 3. Array with ragged slit

3. SIMULATED RESULT OF RETURN LOSS

3.1. Return loss of antenna element

The antenna element operate at S band application from 2 GHz until 4 GHz. The antenna design was evaluated through simulation on electromagnetic computation software, and subsequently fabricated and measured. Measurement was made using Vector Network analyzer (VNA). Measurement and simulation results of antenna element are shown with dashed line and solid line, respectively, in Figure 4.The simulated and measurement results are slightly different, but the measurement result shows that the frequency range of interest experiences return loss below -10dB.

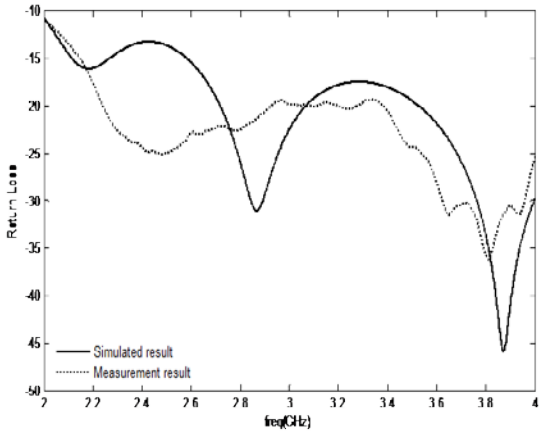

Figure 4. Simulated result and measurement result of return loss

3.1 Return Loss of array antenna.

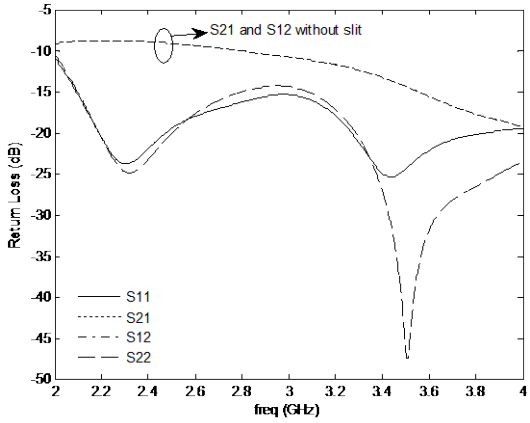

Figure 5. S-parameter result of array without slit.

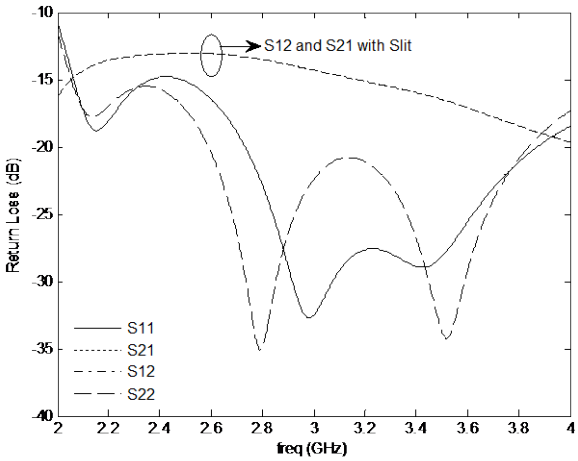

Figure 6. S-Parameter result of array with slit.

As shown in Figure.5 and Figure.6 there are differences in return loss performance between arrays with and without slit. From simulated result, the purposed antenna has better performance at S21 an S12. It can be seen at frequency 2 GHz, S21 antenna improve from -9.14 dB to -16.283dB, showing an increase in mutual coupling performance of7.12dB. This improvement is achieved by adding slit structure to the outer side of the element arrays so that unwanted current becomes less coupled from each other. It can improve mutual coupling performance without increasing element spacing and the array physical size.

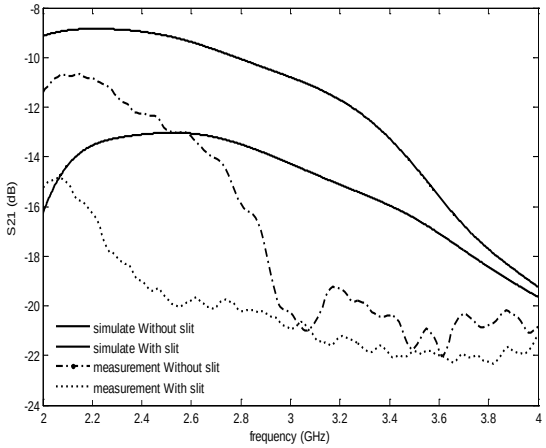

Figure 7. S12/S21 simulated and measurement result.

In the E plane, mainly at lower frequency, surface wave propagation is concentrated on the slit, which in turn can reduce mutual coupling. Figure 7 denotes comparison of S12 from simulated result and measurement results of arrays with and without slit. Both simulated and measurement results indicate that array with slit has better mutual coupling performance than array without slit. From measurement result for frequency 2 GHz, array no slit achieves S21 of -11.26 dB and array with slit obtains S12 of -15.15 dB, indicating an improvement of 3.89 dB While the measurement exhibits different result compared to simulation, it indicates that arrays with slit outperforms those without slit in terms of mutual coupling.

4. SIMULATED RESULT OF RADIATION PATTERN

Vivaldi antenna can operate in wide frequency band and have different radiation pattern performance at each frequency [18]. Mutual coupling in antenna array can influence radiation pattern performance especially for lower frequency. It can happen because in lower frequency antenna has smaller spacing corresponding to its operating frequency. At frequency 2 GHz, the wavelength 150 mm, whereas at frequency 4 GHz it is 75 mm. If the antenna array has element spacing of 60 mm, it means the spacing between elements is 0.4λ at 2 GHz frequency and 0.8 λ for 75 mm. The antenna exhibits worse mutual coupling if its element spacing is between elements less than 0.5 λ.

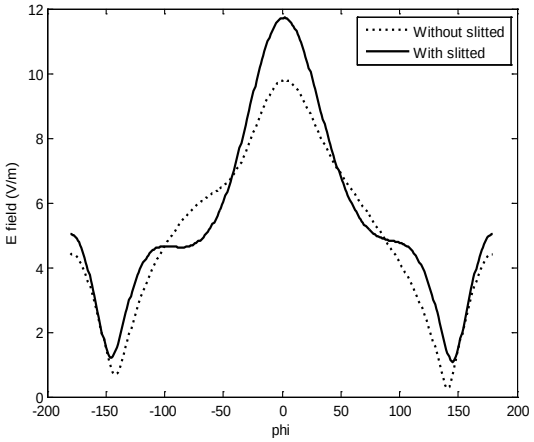

Figure 8. Radiation Pattern at 2 GHz

Fig 8 demonstrates radiation pattern of two Vivaldi antenna arrays which is arranged with zero element spacing (edge to edge element spacing). As shown in the figure, the E field for array with slit is better than that without slit. Antenna with slit achieves E field of 11.7 V/m while one without slit exhibits main lobe magnitude of 9.8 V/m. It gets improvement as 1.9 V/m. Antenna with slit has Side Lobe Level (SLL) of -7.3 dB and without slit has SLL of -6.9 dB

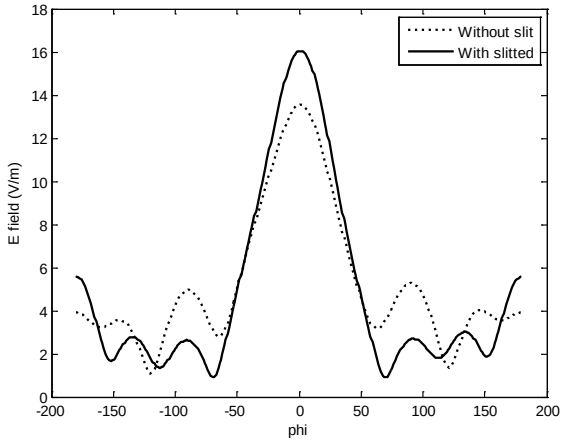

Figure 9. Radiation pattern at 3 GHz

Main lobe magnitude E field for array with slit is higher than one without slit at 3 GHz. It can be shown from Figure 9, where array with slit shows E field main lobe magnitude of 16.1 V/m and array without slit has main lobe of 13.5 V/m. If we compare the main lobes at frequency 2 GHz and 3 GHz, it shows main lobe improvement of 1.19 times or power pattern gain improvement of 1.53 dB As can be expected, increasing frequency can improve E field performance.

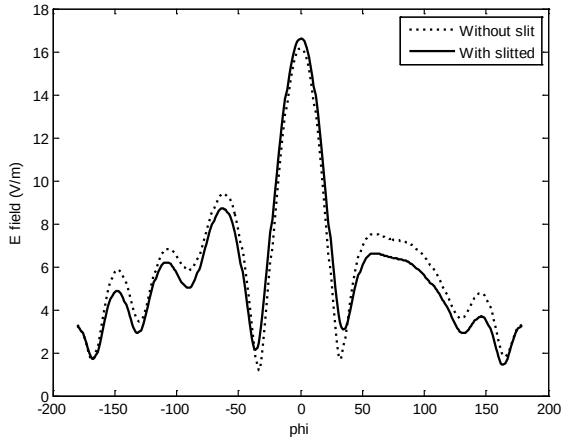

Figure10. Radiation pattern at 4 GHz

Figure 10 demonstrates E field pattern at frequency 4 GHz. Antenna array with slit shows main lobe of E field of 16.6 V/m and one without slit shows E Field of 16.1 V/m. Maximum SLL for antenna with slit -5.6 dB and for one without slit is -4.7 dB with respect to the maximum directivity. At 4 GHz the antenna has spacing between feeding point of 0.8 λ. Mutual coupling performance does not affect main lobe of radiation pattern performance for array with element spacing of more than half wavelength of its operating frequency. But for higher frequency, it yields higher SLL because the element spacing is more than 0.5 λ.

5. CONCLUSION

Two coplanar Vivaldi antennas are arranged at E plane in two array configurations, with and without slit. The mutual coupling and radiation pattern performance of the arrays with and without slit are compared, following evaluation by simulation and measurement. It is found that antenna array with slit exhibits mutual coupling performance improvement of 7.12 dB at 2 GHz with respect to that without slit. The array with slit has main lobe magnitude of E field of 11.7 V/m at 2 GHz, 16.6 V/m at 3 GHz and 16.6 at 4 GHz, better than antenna without slit that gives E field of 9.8 V/m at 2 GHz, 13.5 V/m at 3 GHz and 16.1V/m at 4 GHz. These results indicate that the proposed use of slit for Vivaldi array can improve mutual coupling and radiation pattern performance of two-element coplanar Vivaldi array.

6. ACKNOWLEDGMENTS

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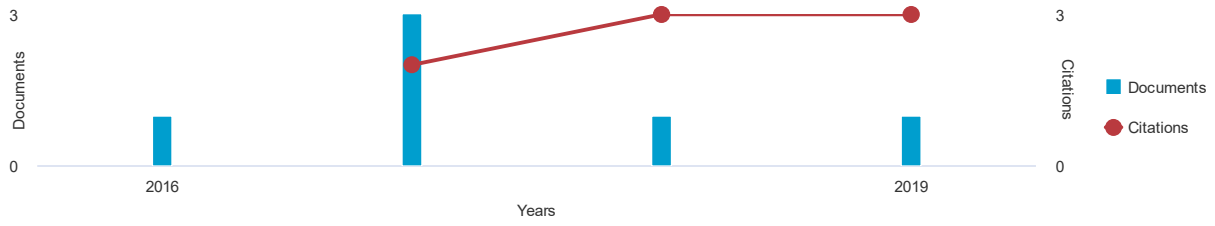

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