Proceeding of International Conference on Electrical Engineering, Computer Science and Informatics (EECSI 2015), Palembang, Indonesia, 19 -20 August 2015

A Broadband MIMO Antenna for Access Network

Teguh Prakoso[1,2], N. Shazwani M. Noor[2], E.H. Hadyan[1], M.A. Riyadi[1], Razali Ngah[2]
[1]*Department of Electrical Engineering, Universitas Diponegoro, Semarang, Indonesia*
[2]*Wireless Communication Centre, Universiti Teknologi Malaysia, Johor Bahru, Malaysia*
E-mail: teguhprakoso@undip.ac.id

***Abstract*-This paper presents a compact and broadband MIMO antenna intended for wireless access network at 1.7 – 6.0 GHz. Impedance degradation introduced by half-cut technique is solved by inserting microstrip-line transformer.**

I. Introduction

Future and current wireless communication need MIMO antenna to increase the capacity, improve SNIR, and mitigate fading. There are also tendency to use larger bandwidth and multiple bands. However, space available for antenna in device and access point is limited. Hence compact and broadband MIMO antenna offers good solution in this respect. Half-cut technique [1] provides miniaturization method for broadband antenna but in many cases it degrades impedance matching condition of many antennas [2, 3]. In MIMO, it may also worsen isolation among antennas [2].

II. Design

MIMO antenna presented in this paper consist of two individual antennas [4] (see the prototype in Fig. 1(a)-(b)) arranged side-by-side in mirror (see the fabricated antenna in Fig. 1(c)-(d)). The pairing arrangement normally needs smaller space if integrated with circuit, compared to other arrangements, e.g. orthogonal, parallel, and front-to-front [5], although it produces higher coupling between antennas in pair. Therefore, isolation enhancement structure should be inserted to the MIMO antenna and in this case we use slotted ground technique [6, 7] due to its broadband characteristic.

The size of the individual antenna is 30 x 69 mm^2 whereas the MIMO antenna size is 80 x 69 mm^2. All of the antennas are fabricated using FR4 (ε_r=4.4) with thickness of 1.6 mm. The total width of 80-mm is chosen for the MIMO antenna to be comparable with miniaturized antenna pair presented in [7].

III. Results And Discussion

Reflection coefficient measurement ($|S_{11}|$ in dB) results are presented in Fig. 2(a). Acceptance criterion for this parameter is $|S_{11}| \leq -10$ dB. The individual antenna (designated as “Left Half-Cut w/ Transformer in the figure) is closely matched with Fig. 6 in [4]. There are resonances at around 2 GHz and 5 GHz and the shape of the curves are similar from 1.5 – 6 GHz. The $|S_{11}|$ values of the two curves are also similar at 3.0 – 4.5 GHz. The upper operating frequency is higher than 6.0 GHz. However, the individual antenna prototypes lowest operating frequency is 1.77 GHz, higher than the simulation, i.e. 1.7 GHz.

The next graphs in Fig. 2(a) are reflection coefficient values for the MIMO antenna using microstrip-line transformer (labeled as “Pair, Microstrip Transformer”) and the MIMO antenna employing extended ground (designated as “Pair, Extended Ground”). The extended ground antenna is not matched at 2.8 – 4.45 GHz and it lowest operating frequency is 1.8 GHz. On the other hand, the MIMO antenna with microstrip transformer is matched at 1.5 – 7.88 GHz and its $|S_{11}|$ values are significantly lower than the MIMO antenna with extended ground. This shows the efficacy of the microstrip-line transformer in improving half-cut antenna impedance. Nonetheless, in integration of slot in ground also improves impedance at low frequency.

Fig. 2(b) depicts a comparison of coupling between individual antennas in MIMO. The acceptance criterion for this parameter is $|S_{21}| \leq -20$ dB. Both MIMO antenna designs show similar performance. The MIMO antenna with extended ground has lowest operating frequency of 1.44 GHz whereas the MIMO antenna with microstrip transformer conforms the coupling criteria for frequency above 1.61 GHz. Therefore, both MIMO antennas fulfill the coupling requirement. It also can be stated that the integration of microstrip transformer does not degrade the isolation performance of MIMO antenna.

References

[1] W. J. Liu and Q. X. Chu, "Half-Cut Disc UWB Antenna with Tapered CPW Structure for USB Application," *Microwave and Optical Technology Letters*, vol. 52, pp. 1380-1384, Jun 2010.

[2] T. Prakoso, R. Ngah, T. Rahman, U. Okonkwo, and Z. Ghassemlooy, "An evaluation of half-cut technique for microwave-photonic access-point antenna miniaturization," in *2011 IEEE International RF and Microwave Conference (RFM 2011)*, Seremban, Malaysia, 2011, pp. 384-388.

[3] A. A. Ahmed Toaha Mobashsher, "Utilizing Symmetry of Planar Ultrawideband Antennas for Size Reduction and Enhanced Performance," *IEEE Antennas and Propagation Magazine*, vol. 57, pp. 153-166, April 2015 2015.

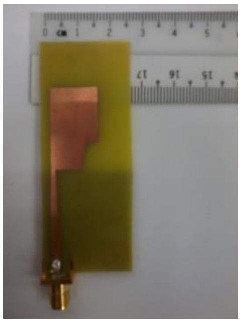
[4] T. Prakoso, M. Facta, R. Ngah, and T. A. Rahman, "Impedance Matching Improvement of Half-Cut Broadband Printed Monopole Antenna with Microstrip Feeding," *International Journal of Electrical and Computer Engineering (IJECE)*, vol. 3, pp. 612-617, 2013.

[5] S. Mohammad, A. Nezhad, H. R. Hassani, and A. Foudazi, "A Dual-Band WLAN/UWB Printed Wide Slot Antenna for MIMO/Diversity Applications," *Microwave and Optical Technology Letters*, vol. 55, pp. 461-465, 2013.

[6] F. Zhou, Z. Qian, T. Liu, J. Han, and C. Peng, "Design of Diversity Antenna for Ultra-Wideband Applications," in *2010 IEEE International Conference on Ultra-Wideband (ICUWB2010)*, Nanjing, China, 2010, pp. 1-4.

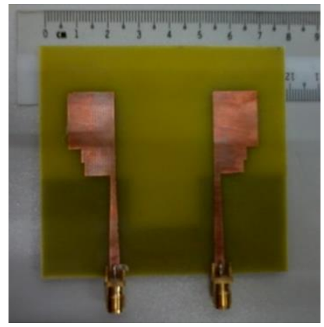
[7] T. Prakoso, R. Ngah, T. A. Rahman, and Z. Ghassemlooy, "Isolation Enhancement and Size Reduction of Printed-Antenna Pairs for Broadband Microwave-Photonic Access-Point," in *IEEE 20th International Conference on Telecommunications (ICT 2013)*, Casablanca, Marocco, 2013.

[6] .

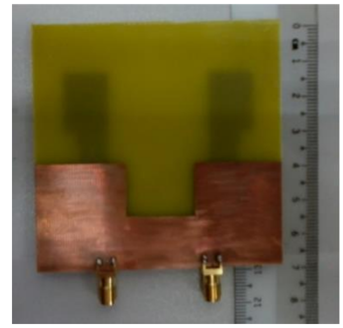


(a) Individual antenna, front-side

(b) Individual antenna, groundplane

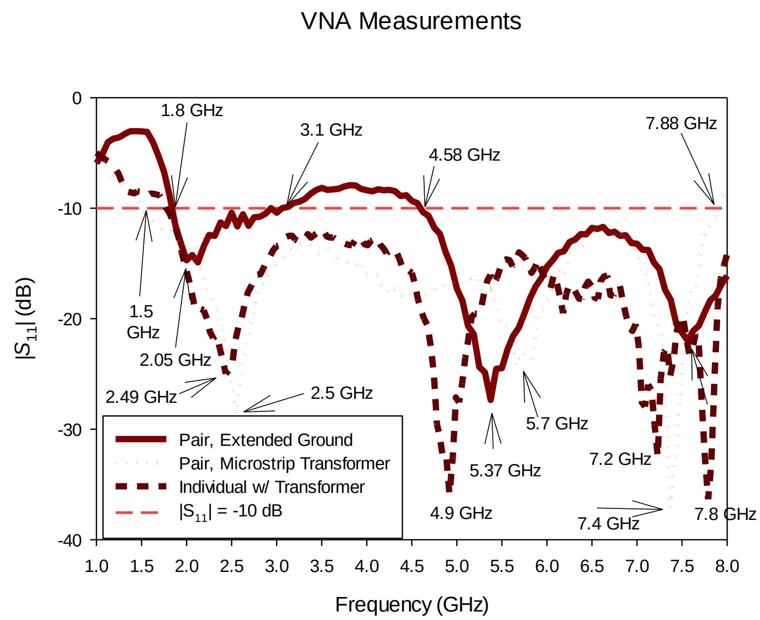


(c) 80mm-wide MIMO antenna, front-side

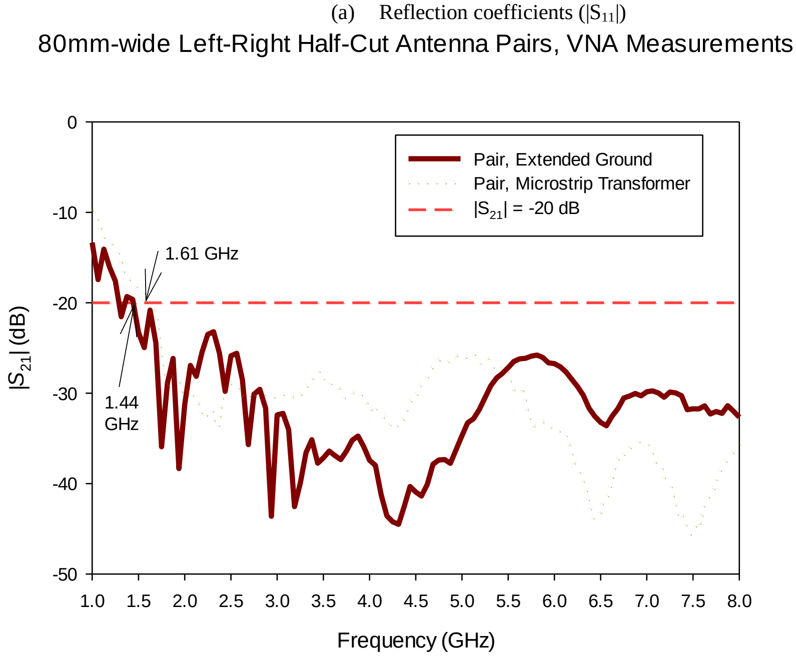


(d) 80mm-wide MIMO antenna, groundplane

Fig. 1. Prototypes of antenna



(a) Reflection coefficients ($|S_{11}|$)



(b) Coupling between antennas ($|S_{21}|$)

Fig. 2. Measured S-parameters of the antenna prototypes.