IJSS 2014

PROCEEDINGS OF THE 6th INDONESIA-JAPAN JOINT SCIENTIFIC SYMPOSIUM 2014

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29-30 October 2014

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Editors:
Muh Aris Marfai
Dyah R. Hizbaron
Estuningtyas W. Mei

Badan Penerbit Fakultas Geografi (BPFG) UGM

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FOREWORDS

The 6th Indonesia Japan Joint Scientific Symposium (IJJSS) held at Universitas Gadjah Mada, Yogyakarta, Indonesia from 29th October to 30th October 2014 is the premier event in the collaboration between Universitas Indonesia and Chiba University. This symposium is the sixth in the series held earlier at Chiba University and Universitas Indonesia. This symposium provided a venue to share and discuss various issues and development in the multi-field of scientific and technology.

The symposium accepted eighty three papers from students and researchers in Indonesia, Japan, and many other countries. The papers are derived from twenty four different themes as follows:

- Antenna and Microwave
- Architecture
- Agriculture
- Biomedical
- Coastal and Watershed Management
- Computer and Information Technology
- Disaster Management
- Electronic Circuit
- Energy and Power System
- Environmental Chemistry
- Environmental Science
- Humanities
- Image and Signal Processing
- Industrial Design and Management
- Mathematics
- Mechanical Engineering
- Medicine
- Micro satellite and UAV
- Nursing
- Pharmacy
- Remote Sensing and Geo-Information Science
- Social Sciences and Sustainabilities
- Socioeconomic Relations
- Vision and Biological Functions

Through these documented proceedings, may all findings enforce progress, stimulate growth and advance the state of knowledge between students from Indonesia and Japan, as well as those from other countries around the world. It is also hoped that these proceedings will be useful source of reference to scientific students, researchers, and professionals in other scientific-related fields.

Thank you.

General Chairman of
The 6th Indonesia Japan Joint Scientific Symposum (IJJSS)

Prof. Dr.*rer.nat.* Muh Aris Marfai, M.Sc.

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Design of Microstrip Antenna Square Patch with Slit for Ultra-Wideband Communication Application

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Abstract

The monopole of planar microstrip antenna designed for operating of multi wideband in Ultra wideband communication system. To multi wideband application of a square patch UWB antenna used to addition a slot surrounding on patch technique. Bandwidth of matching impedance influencing by shape of sub level in ground plane structure is centre of transmission line. Implementation of antenna design used simulation by method of moment through microwave office software applications. In experiment and fabricated of antenna prototype used material substrate of duroid RT 5880 type. Result of simulation and measurement to antenna design obtained of matching impedance bandwidth is dual wideband, each bandwidth above is 500 MHz that is C band application (4.408 GHz – 6.644 GHz) and X band application (8.354 GHz-11.06 GHz),VSWR 2:1 and Maximum directivity is 5.178 dB. Overall of antenna design showed good performance in dual wideband on Ultra-Wideband system with minimize shape, compact and low profile.

Keywords

Microstrip antenna, Square patch, Dual wideband, Slot, Ultra Wideband.

1. Introduction

Development of Ultra Wideband (UWB) technology is a solution to connectivity problems in wireless communications that require wide of bandwidth with high speed access and low power consumption. The technology is also able to overcome the interference problems that commonly occurs in a wireless communication system of bandwidth of 7.5 GHz (3.1 GHz-10.6 GHz) recommended by FCC (*Federal Communication Commission*), it is allows in application to optimize the performance of antenna. 54 Mbps data transfer capability with bandwidth above 500 MHz, UWB has ability to replace the role of blue tooth as well as Wi-Fi in networks development of WPAN (*Wireless Personal Area Network*)[1]. The UWB can be applied for various *indoor* and *outdoor* communications, such as for *radar imaging, medical imaging system, indoor communication system*, and so forth [1, 2].

One of the main challenges in the UWB application systems is to improve optimally the ability of antenna . The important of step in the effort to design of antenna, which has frequency range with highly wide of bandwidth. There are many variant of UWB antenna according to the necessaries has been developed. In this study, a microstrip planar model antenna was designed, where a square patch with an addition of inverted U shaped slot which is surrounding the patch that resonates in the UWB center frequency at 6.85 GHz [10].

Design of the antenna is using simulation and measurement methods in laboratory test. The method of moment which is using in simulation based on microwave office software. In actual implementation, antenna has been fabricated in a prototype form used an RT/Duroid 5880 substrate media which has substrate thickness of 1.57 mm and dielectric constant of 2.2[11]. The result of design of antenna structure, a minimalist form was obtained, with top layer consist of a square patch connected by a transmission line and terminated by feeder connector on edge of the substrate. The bottom layers only include a partial shaped conductor as ground plane pointing to the feeder connector.

The technique to addition of slot type in the radiator patch as well as a ground plane on bottom layers were used to obtain the target of expected antenna parameters [9]. A slot will affect the amount of band and partial ground plane affect in widening bandwidth [3,4]. A prototype antenna has been measured in Electrical Engineering Department, University of Indonesia to validate the result of simulation. The result of targeted of project experiment, where, the antenna can operate in UWB system[5], these following data were obtained as antenna parameters, the performance of antennas with monopole characteristic and linier polarization in return loss ≤ -10 dB, and VSWR between 1 until 2.

2. Research Method

2.1 *Design of Square Patch*

A rectangular patch has dimensions of length (L) and width (W). The patch of microstrip can be designed by TE_{mn} or TM_{mn} dominant mode of propagation, where m, n are the order mode of propagation (0, 1, 2,...). Propagation mode is only determined direction of propagation of magnetic field or electric field conducting on one side of the surface of the radiator patch. The width (*W*) dimension of patch can be obtained by equation 1[8]:

$$W = \frac{c}{2 f_c \sqrt{\varepsilon_{eff}}} \qquad (1)$$

Where *c* is velocity of light (3 x 10^8 m/s), f_c is center frequency at 6.85 GHz and effective dielectric constant (ε_{eff}).

The width of square patch can be obtained by substitution the equation 2 into the equation 1, where dielectric constant (ε_r) is 2,2 and substrate thickness (*h*) is 1,57 mm. Effective dielectric constant of a substrate to dimension of width (W*)* can be obtained by equation 2[7,8]:

$$\varepsilon_{eff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + \frac{12h}{W}\right]^{-1/2} \qquad (2)$$

Result of analysis of equations substitution obtained the width (W) of square patch is 17.3 mm, and the effective dielectric constant of the substrate is 2.173.

2.2 *Design of Transmission line*

The microstrip transmission line is designed and analyzed to the value of impedance and width of patch conductor. Characteristic of impedance (Zo) of the transmission line printed on substrate materials affected by value of thickness and dielectric constant. In dominant mode propagation wave is propagated in open conductor, the propagation mode can be used TE_{10}. The characteristic of impedance (Zo) of a microstrip transmission line, applied when $w/h \geq 1$ used an equation 5 [6, 7]:

$$Z_{0(Ohm)} = \frac{\left[120\pi(\varepsilon_{eff})^{-\frac{1}{2}}\right]}{\frac{w}{h} + 1.393 + 0.667 \ln\left(1.444 + \frac{w}{h}\right)} \qquad (3)$$

Where *w* is width of conductor in millimeters, *h* is substrate thickness in millimeters and ε_{eff} is effective dielectric constant. The equation 5 provides the characteristic of impedance (Zo) is 50 Ohm, *h* the substrate thickness is 1.57 mm and dielectric constant (ε_r) is 2.2. Analysis for the calculation of the width (w) of transmission line can be done by substitution of equation 2 into the equation 5. Result of substitution from the both of equation obtain the width of microstrip transmission line is 4.8 mm.

2.3 *Configuration of antenna design*

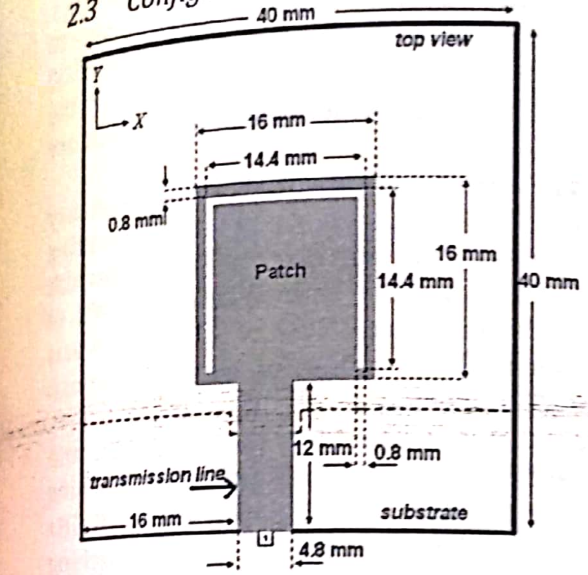

Figure1a. Configuration of antenna in top view

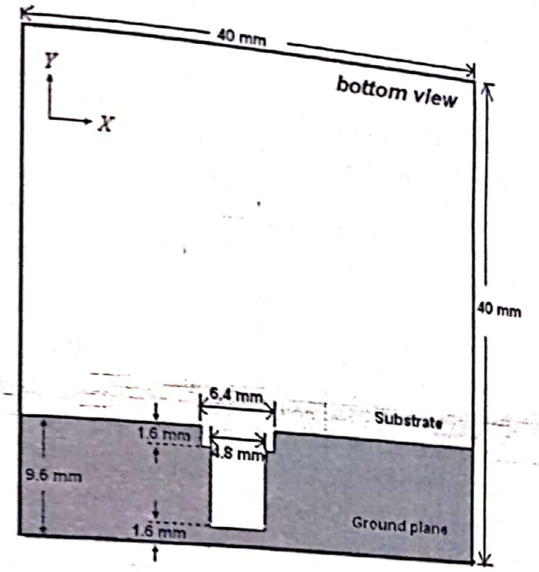

Figure1b. Configuration of antenna in bottom view

Figure 1a and 1b showed a configuration form of structure antenna design with using proximity coupling technique. For make antenna design needed material of substrate dimension is 40mm x 40mm. The structure of planar antenna in the top layer consist is a square patch with a slot round to patch and the microstrip transmission lines in figure 1a. The square patch has effective dimension of 16mm x 16mm and to the calculation results of the analysis shifted 7.5%. The width of slot is 0.8 mm and positioned at 0.8 mm from the edge of the patch with alongside of square patch is 14.4mm. Characteristic of impedance is 50 Ω fed point edge to transmission lines.

The microstrip transmission line with 50 Ω effective characteristic of impedance obtained 4.8 mm width dimension according to the calculation result. Figure 1a transmission line with the length of 12 mm and positioned at 16 mm from the left edge of substrate, obtaining *matching* impedance to the load of the patch.

Figure 1b shows ground plane structure view from bottom layer. Stepped ground plane structure was printed symmetrically to the transmission line pointed to the feeder connector. The Ground plane shape has width of 40 mm and length of 9.6 mm. In this experiment, changes of width of the ground plane effect to the result of the obtaining bandwidth. The partial ground plane has properties as coupling that can radiated a magnetic field back into the substrate. The structure of stepped ground plane has the following slot dimensions, first step has width of 6.4 mm and length of 1.6 mm. The second step has width of 4.8 mm and length of 1.6 mm from the edge of the substrate.

3. Results and Discussion

3.1 *Parameter of Antenna*

The study of antenna designing provides results obtained from the experiment, the design structure as well as the prototype of antenna. The performance of the fabricated antenna according to the measured parameters, such as : Bandwidth, VSWR, Gain, radiation pattern and polarization.

Figure 3 shown graph of return loss versus frequency from the simulation and measurement results. The simulation result provides 2 bandwidths in UWB area frequencies, where are the return loss below -10 dB. First bandwidth of 2236 MHz obtained from 4.408 GHz (marker 1) to 6.644 GHz (marker 3) with minimum return loss of -30.9314 dB. Second bandwidth of 2706 MHz obtained from 8.354 GHz (marker 4) to 11.06 GHz (marker 5) with minimum return loss of -22.4281 dB. This result determined the property of antenna has dual band operating frequencies area at C band and X band. Whiles the result of measurement provides a single bandwidth for return loss below -10 dB. Bandwidth of 7509 MHz was obtained of 5.054500 GHz (marker 2) to 12.563500 GHz (marker 6) with minimum return loss of -24.913027 dB. As the target of the bandwidth above 500 MHz, both of obtained through simulation and measurement are qualified as UWB antenna.

Figure 4 shows graph of VSWR (*Voltage Standing Wave Ratio*) versus frequency from the simulation and measurement results. The graph of shown the UWB operating frequency area for VSWR below 2. The simulation result provides the first bandwidth with minimum VSWR of 1.05848 and second bandwidth with minimum VSWR of 1.16454. While the measurement result provides minimum VSWR of 1.15752674 was obtained. As the target of the VSWR between 1 and 2, both of obtained through simulation and measurement are qualified as UWB antenna.

Figure 5 shows matching impedance of bandwidth from the simulation and measurement results on smith chart graphic. Simulation result provides matching impedance at 5.3 GHz with input impedance of 1.00307 + j 0.133568Ω, and at 10 GHz with impedance of 1.0205 + j 0.0983028Ω. The measurement result provides matching impedance of 50.0183335 + j 6.039908174 Ω was obtained at 6.28 GHz.

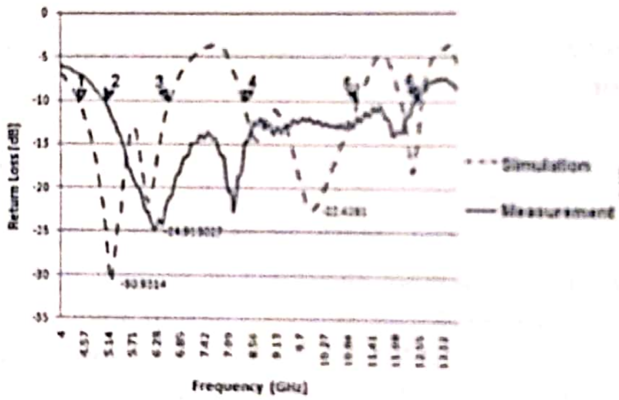

Figure3. Return Loss Vs Frequency

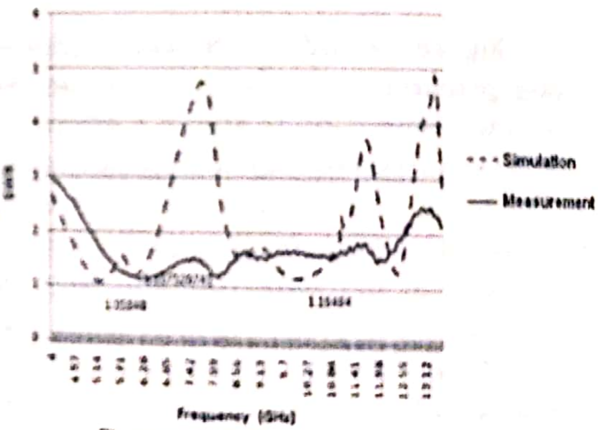

Figure4. SWR Vs Frequency

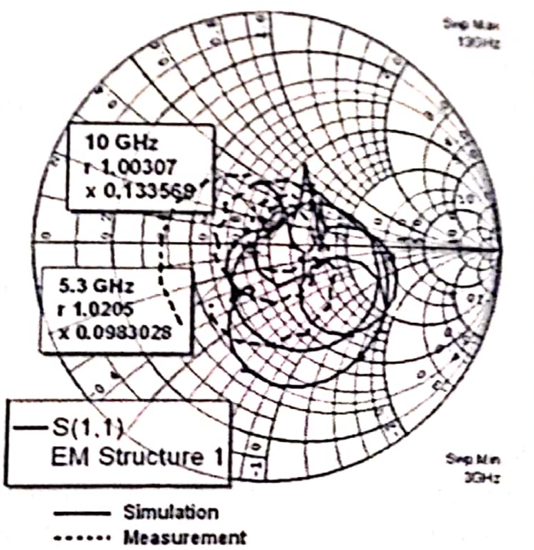

Figure5. Graph Smith chart Input Impedance.

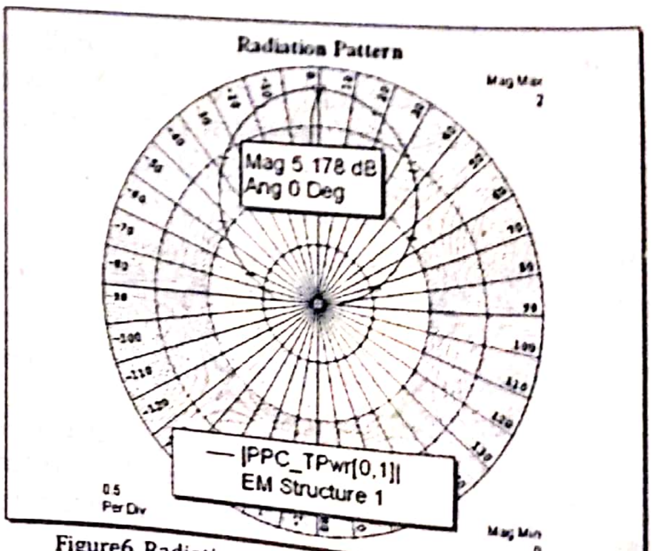

Figure6. Radiation pattern of simulation result

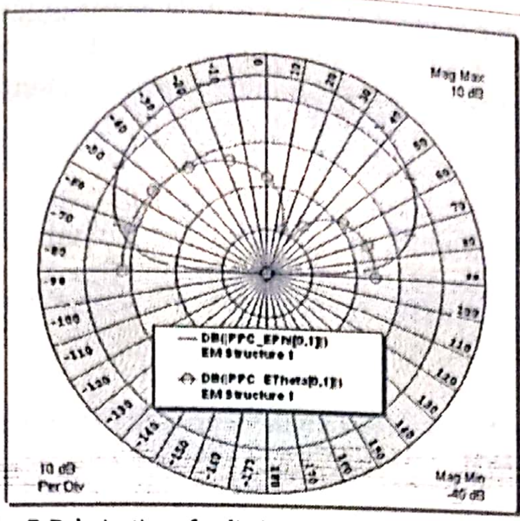

Figure7. Polarization of radiation pattern of simulation result

Figure 6 and 7 shows simulation result of the far field characteristic from the radiation pattern versus azimuth angle. Maximum power of 5.178 dB was obtained at 0^o angle point and that it value represent the gain of antenna. Figure 7 shows simulation result of the polarization characteristic. The radiation pattern shows two directions of polarization as a monopole antenna.

Figure 8a and 8b show the construction of UWB antenna. Figure 8a shows the patch structure and microstrip transmission line, view from top layer, where the microstrip line connected to the coax- SMA connector at the edge of the substrate. Figure 8b shows the bottom layer surface, where the partial stepped ground plane pointed symmetrically to the transmission line.

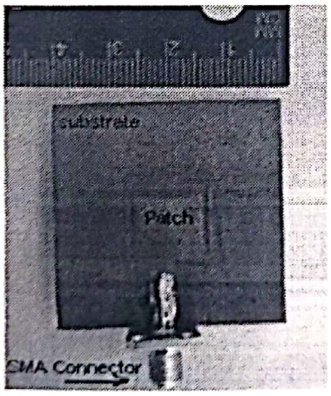

Figure8a. Antenna prototype of top view

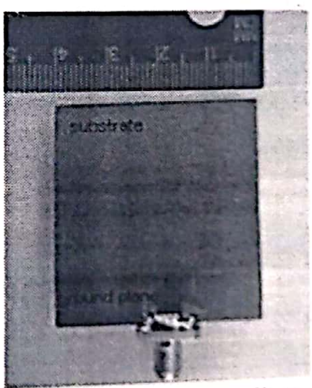

Figure8b. Antenna prototype of bottom view

Table1. Result Parameters Antenna of Simulation and measurement

Parameters	Simulation		Measurement
Bandwidth	2236 MHz	2706 MHz	7509 MHz
Resonant frequency	5,3 GHz	10 GHz	6,28 GHz
Minimum Return Loss	-30,9 dB	-22,42 dB	-24,9 dB
Minimum VSWR	1,05	1,16	1,15
Input Impedance (Zin)	1,0205 + j0,098 Ω	1,02492+j 0,0165321Ω	50.0183335+j6.0399 Ω
Max of Directivity (Gain)	5,178 dB		-
Impedance	50 Ohm		
Polarization	Linear		

4. Conclusion

The result of experiment provides the technique of addition of inverted U shaped slot at surrounding the patch of UWB antenna, obtaining a dual band property which has bandwidth above 500 MHz for each frequency band. In that range covered the C band and X band working frequencies area, where, in application of UWB system allows the antenna to be applied for development of WPAN communication and for *radar imaging system*. However, only a single band was obtained as the measurement result of antennas. It is still necessary correction in the measurement technique. The bandwidth of matching impedance was obtained at resonant frequency of 5.3 GHz and 10 GHz, where minimum VSWR obtained of 1.05 and 1.16. Result of the measurement of resonant frequency was obtained at 6.4 225 GHz and minimum VSWR of 1.15. As the result, a monopole with a cross polarization were obtained as the characteristic and properties of an UWB antenna, where, the antenna has a minimal dimension, compact and low profile.

5. References

Lim, Eng Gee, et al, "Ultra Wideband Antennas – Past and Present.IAENG International Journal of Computer Science. 2010.

M.maidurrahaman S., et al.New Compact Tri-Band Microstrip Patch Antenna Using Dual T-Shaped Slit for Wi-Max and Microwave C Band Application. International Journal of Engineering Sciences Research-IJESR, Vol. 03, Issue 05; September-October 2012.

Baskaran Kasi, Lee Chia Ping, Chandan Kumar Chakrabarty. A Compact Microstrip Antenna for Ultra Wideband Applications. European Journal of Scientific Research, ISSN 1450-216X Vol.67 No.1 (2011), pp. 45-51.

http://www.europeanjournalofscientificresearch.com

Breed, G.A summary of FCC rules for ultra wideband communications. High Frequency Electronics, 42–44, Jan. 2005.

Robert Fontana, Aitan Ameti, Edward Richley, Lance Beard, Dennis Guy. Recent Advances in Ultra Wideband Communications System. Proceedings IEEE Conference on Ultra Wideband Systems and Technologies. May 2002.

JR James & PS Hall. Handbook of Microstrip Antennas.Peter Peregrinus Ltd, Volume 1. 1993.

Kai Chang,Inder Bahl,Vijay Nair. RF and Microwave Circuit and Component Design for Wireless System. John Wiley & Son. 2002.

Wong, K. L.Compact and Broadband Microstrip Antenas. (New York : John Willey & Son, 2002). http://vrtp.ru/files/Compact%20and%20Broadband%20Microstrip%20Antennas

Guha, Debatosh. and Antar, Yahi.Microstrip and Printed Antennas : New Trends, Techniques, and Application. John Wiley & Sons Ltd. 2011.

Masahiro Yanagi, Shigemi Kurashima, Takashi Arita, Takehiko Kobayashi. A planar UWB Monopole Antenna Formed on a Printed Circuit Board. www.fujitsu.com/downloads/MICRO/fcai/.../uwb_monopole_antenna.pdf.

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