International Journal on Advanced Science Engineering Information Technology

Vol.3 (2013) No. 6
ISSN: 2088-5334

Microstrip Array Antenna with 16 Patches for UHF Band Television Signal Reception

Yulindon[#1], Firdaus[#2], Hendrick[*]

[#] *Telecommunication Engineering Study Program, Electrical Engineering Department, State Polytechnic of Padang, Indonesia*
E-mail: [1] yulindon@polinpdg.ac.id, [2] firdaus@polinpdg.ac.id

[*] *Electronic Engineering Study Program, Electrical Engineering Department, State Polytechnic of Padang, Indonesia*
E-mail: hendrick@polinpdg.ac.id

***Abstract*—There are 2 commonly known equipments for the reception of television broadcasts i.e. using a parabolic antenna connected to satellite receiver and a wire or pipe antenna that directly connected to the television receiver. Receiving the signal by means of a parabolic antenna is more expensive because it requires additional tools, namely satellite receivers, so generally the people like to choose the easier way by direct receiving the signal using wire antenna. The antenna construction which made of aluminum pipes has a weakness on easily bent or broken especially on the assembling phase as well as when there are high winds causing the antenna mast collapsed, confirmed that the antenna elements is bent, loose or broken. The paper relates to a microstrip antenna for reception of television signals using material printed circuit boards or printed circuit board (PCB) which is a thin but strong in the form of a number of patches array separated in a certain distance.**

***Keywords*— microstrip antenna; array antenna; television broadcast**

I. INTRODUCTION

On this last few decades the public demand for information is increasing very rapidly. One of the most popular media in the information society is television. Antenna is a device that plays an important role on the television. In Indonesia, the antennas are widely applied in terrestrial UHF TV broadcast reception. Generally the terrestrial UHF television antennas are relatively large in shape. It is necessary to develop an antenna that has a relatively small size and lightweight but able to give a good performance. Microstrip antenna can meet these requirements which is in the form of a thin board and able to work at high frequencies. Microstrip antenna was first coined by Deschamps in the U.S. and by Gutton and Baissinot in France in 1955. These antennas became popular in the 1970s due to the use of these antennas for military purposes. [1].

There are a lot of design of television reception antennas have been created on wireless technology applications. An amount of numerous latest designs of the antenna have been existed for wireless application. On [3], [4], [5] and [6], are found several design examples of the antennas for television signal reception.

By means of their extremely low up-state capacitance (series switches) and their very high capacitance ratio (capacitance contact switches), the microstrip technology offer an extreme bigger performance compared to solid-state switches for low to medium power applications [1].

The motivation of this paper is to plan a new blueprint of the microstrip patch antenna for microstrip technology for television reception application. This research develops a rectangular microstrip antenna having 16 patch arrays to obtain predetermined antenna characteristics. The advantages of this design are a simple design and easy fabrication process and can produce a wide bandwidth to meet the required specifications as the television antenna.

II. THE ANTENNA DESIGN

Firstly, the preliminary length and width of the antenna which according to the following microstrip antenna equations [5]:

$$W = \frac{c}{2f_0}\sqrt{\frac{\varepsilon_r + 1}{2}} \tag{1}$$

$$L = \frac{c}{2f_0\sqrt{\varepsilon_e}} - 2\Delta l \tag{2}$$

It must be noted that W is the patch width, L is the patch length, f_o is resonance frequency, c is the light velocity in a vacuum. The effective dielectric constant can be determined by:

$$\varepsilon_e = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r + 1}{2}\sqrt{\left(1 + \frac{10h}{W}\right)} \tag{3}$$

$$\Delta l = 0.412h \frac{(\varepsilon_r + 0.3)\left(w/h + 0.264\right)}{(\varepsilon_e - 0.258)\left(w/h + 0.8\right)} \tag{4}$$

The FR4, is chosen as material for the substrate, which has $\varepsilon_r = 4.7$ and $\delta = 0.0027$ with thickness of 1.6 mm (h). The calculation for patch dimension as follows:

$$L + 2\Delta L = \frac{c}{2 f_0 \sqrt{\varepsilon_r}}$$

$$L + 2\Delta L = \frac{3x10^8}{2 \cdot 610x10^6 \cdot \sqrt{4,7}} = 0,113425m$$

Then the width W can be calculated:.

$$W = 1.5(L + 2\Delta L)$$

$$W = 1.5(0,113425) = 0,1701375m = 170,1375mm$$

In order to determine the length L then,

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left(\frac{1}{\sqrt{1 + 12\frac{h}{W}}}\right)$$

$$\varepsilon_{reff} = \frac{4,7 + 1}{2} + \frac{4,7 - 1}{2}\left(\frac{1}{\sqrt{1 + 12\frac{1,6x10^{-3}}{0,1701375}}}\right) = 4,603$$

Meanwhile (ΔL) calculated by:

$$2\Delta L = 0.824h \frac{(\varepsilon_{reff} + 0.3)\left(\frac{W}{h} + 0.262\right)}{(\varepsilon_{reff} - 0.258)\left(\frac{W}{h} + 0.813\right)}$$

$$2\Delta L = 0,824 \cdot 1,6x10^{-3} \frac{(4,603 + 0,3)\left(\frac{0,1701375}{1,6x10^{-3}} + 0,262\right)}{(4,603 - 0,258)\left(\frac{0,1701375}{1,6x10^{-3}} + 0,813\right)} = 1,48x10^{-3}\, m$$

Finally, L can be calculated by:

$$L = \frac{c}{2 f_0 \sqrt{\varepsilon_{reff}}} - 2\Delta L$$

$$L = \frac{3x10^8}{2 \cdot 610x10^6 \cdot \sqrt{4,603}} - 1,48x10^{-3} = 0,113172m = 113,172mm$$

The design process of the antenna use the method of moments based full-wave electromagnetic simulator IE3D. Each patch dimension is calculated using equation (1) and (2), then optimized by the software to have the resonance of 610 MHz.

III. Result And Discussion

In order to have the antenna with better gain it needs to develop the patch design into array configuration. Fig. 1 shows the completed design and geometry of the 16 patches in array configuration after designing and optimizing. The dimensions of each patch are 40 x 40 mm. The line widths which connecting the patches are 10 mm, while the overall optimum size of groundplane are 600 x 200 mm.

Fig. 2 shows the plot of the return loss of the proposed antenna which having the operating frequency of 460 MHz to 750 MHz or having the bandwidth of 290 MHz. The bandwidth is better than [4]: 280 MHz and [6]: 242 MHz but lower than [3]: 420 MHz, The gain is closely depending on the ground plane size. The antena gain is present on Fig. 3 with maximum gain is 4 dB.

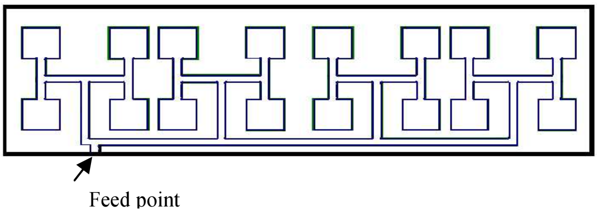

Fig 1. Geometry of the antenna

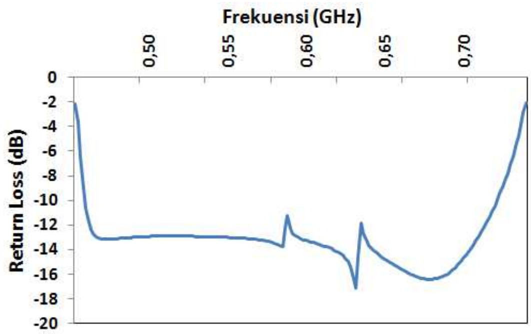

Fig 2. Return of the antenna

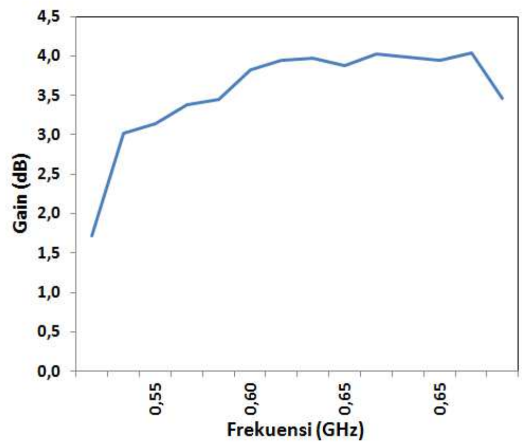

Fig 3. Gain of the antenna

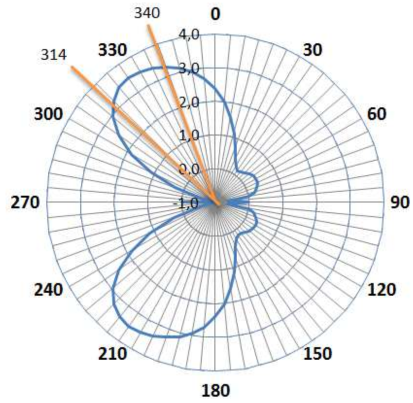

Fig 4. Radiation pattern of the antenna

Fig 5. Antenna prototype after fabrication

TABLE I

GAIN MEASUREMENT RESULTS

Antenna	**Level (dBm)**	**Gain**
Dipole (refference antena)	-32	-
This antenna prototype	-27	5 dB

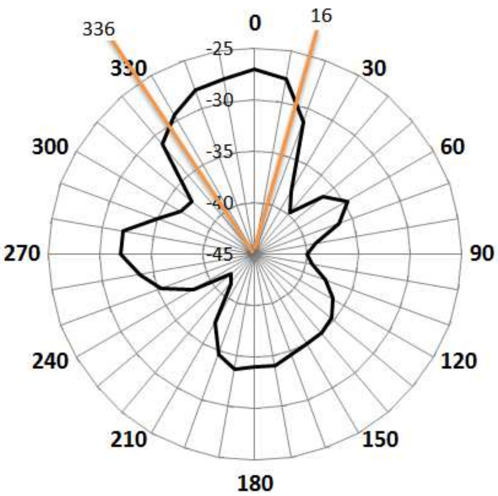

Fig 6. Radiation pattern after measurement

The simulation result of radiation pattern is ilustrated on Fig.4. The pattern forms a bi-directional having HPBW (half power beam width) equal 40^0-14^0 or 26^0. After the simulation and got results as Fig 2, 3 and 4, the next step is fabrication to have the prototype of the antenna as shown in Fig.5. The measurement result of radiation pattern is presented on Fig. 6, meanwhile Fig. 7 comparing the simulation and measurement results of the antenna radiation pattern. According to Fig. 6 the radiation pattern form uni directional with HPBW is equal (360^0-336^0)+16^0 or 30^0.

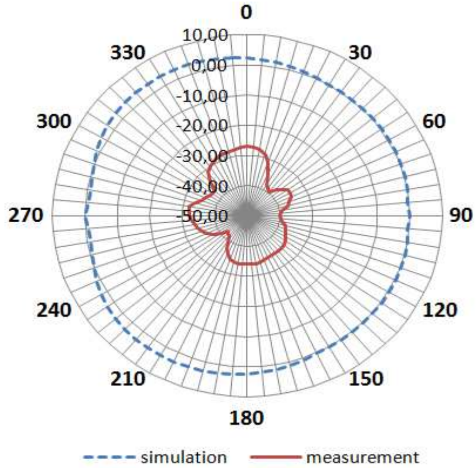

Fig 7. Comparing radiation pattern after simulation vs measurement

Table 1 shows the result of gain antenna after measurement. The dipole antenna is used as the reference antenna. After substracting the receiving level when using this antenna prototype -27 dBm and the receiving level using dipole -32 dB, then -27- (32) dBm resulting the gain of 5 dB, lower than [3]: 11 dB but better than [4]: 2 dB and the gain from simulation result 4 dB as Fig 3.

IV. CONCLUSIONS

The microstrip array antenna prototype with 16 patches has been present for UHF signal television reception application. The patches connected by 10 mm line have wide band operating frequency of at 460-750 MHz (bandwidth 290 MHz). This antenna has benefits of easy shape, and utilizing just one piece of PCB material with good return loss level and gain of 5 dB.

ACKNOWLEDGMENT

The authors would like to thank State Polytechnic of Padang, and the Directorate General of Higher Education, Indonesia, for sponsoring this work.

REFERENCES

[1] J. J. Bahl and P. Bhartia, “Microstrip Antennas Design Handbook,” Artech House, pp. 265-268, 2001.

[2] Warren L. S and Gary A. T, “Antenna Theory and Design,” John Wiley and Sons, 1998

[3] Taguchi, M., “Compact high gain reception antenna for digital terrestrial television,” Antennas and Propagation in Wireless Communications (APWC), pp: 394 – 397, 2011Publishers, 2007.

[4] Vainikainen, P.; Holopainen, J.; Kyro, M., “ Antennas for Digital Television Receivers in Mobile Terminals.” Proceedings of the IEEE, Volume: 100 , Issue: 7 pp: 2341 – 2348, 2012

[5] Pavlov, B., Samsonyuk, O., “All-Wave TV Antenna,” Modern Problems of Radio Engineering, Telecommunications, and Computer Science International Conference 2006. pp: 351 – 352, 2006

[6] Narampanawe, K.M.M.W.N.; Divarathne, C.; Wijayakulasooriya, J.V.; Kumara, J., “Ultra Wideband (UWB) antenna design for cognitive radios in the UHF TV band,” Industrial and Information Systems (ICIIS), 6th IEEE International Conference , pp: 27 – 31, 2011