AASCIT Communications
Volume 2, Issue 5
August 10, 2015 online
ISSN: 2375-3803

American Association for Science and Technology

Design Microstrip Antenna 400MHz – 800MHz for Digital Television with Customized Clover Patch

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Keywords

Microstrip Antenna, Digital Television, PCB, Indoor Antenna

Along with the development of technology, the demand for practicality and efficiency of an antenna is needed. Not only can provide a relatively large bandwidth, but also has a simple form. For example, now often found TV antenna that has a variety of shapes and sizes relatively small. So it can be placed in the room even once as a garnish. Now started to develop an antenna that has the form of a thin and small, so-called microstrip antenna which has a small and simple shape. Microstrip so comes as a solution to address these issues. Microstrip antenna is made of a copper plate in the middle there is a dielectric substrate. In this paper, microstrip antenna uses as its substrate FR-4 material with a substrate thickness (h = 1.6 mm), copper conductor with dielectric constant (ϵr = 3.9) and copper conductor thickness (c = 0.1 mm).Advantages of this antenna in addition is small shape, the aesthetic is also quite good and does not need outdoor installation. This paper will explain the design of microstrip antenna with a frequency of 400MHz – 800MHz that can be applied to the Digital Television antenna device. The design of this antenna begins with theoretical calculations and creating a design based on the results of calculations with the help of software CST2014 and then fabricated to then be measured with a device GWinstek GSP-827 and IFR Signal Generator 250kHz – 3GHz which aims to analyze differences in the results of simulation and real measurement.

Introduction

Based on his origin, microstrip consists of two words, namely micro (very thin / small) and strip (bar / piece). Microstrip antenna can be defined as one type of antenna that has the shape of blades / pieces that have a very thin size / small [1]. In general, the microstrip antenna consists of three parts, namely the patch, substrate, and a ground plane. The patch is located on top of the substrate, while the ground plane is located at the very bottom. These antennas are low-profile, cheap, conformable to planar and non-planar surfaces, simple to fabricate using printed circuit technology and compatible with monolithic microwave integrated circuit (MMIC) designs [7].

This microstrip can be used for small-needed-thing antenna such as for Digital Television [3].

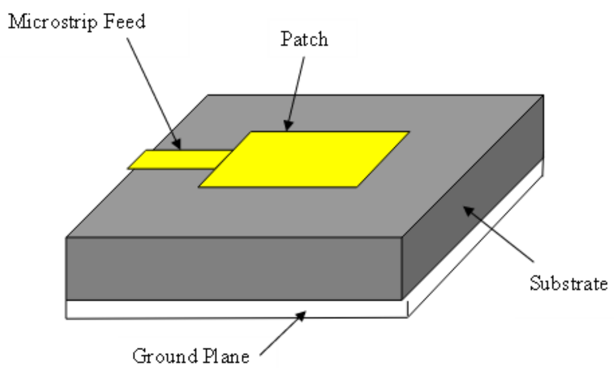

Fig. 1. *Microstrip Antenna Structure.*

To take advantage of Digital Television, we had to use the Digital Television receiver [6]. The task of the Digital Television signal receiver is looking for three or more of these satellites (by detecting signals emitted from the satellites), to determine the distance of each satellite from the receiver, and uses this information to determine the location of the observer who brought his receiver (based latitude and longitude) [7]. For information, the Digital Television signal is transmitted in the Lb and frequency, i.e.thenumber587.42and653.6MHz [2-5].

Element of radiation called patch, serves to radiate electromagnetic waves into the air. The patch is made pf conducting material which is usually used of metal with a certain thickness. That element serves as a dielectric substrate on the microstrip antenna to limiting radiation element and the defense element. This element serves as a grounding in microstrip antenna system, this element is usually made from the same material used in the radiating element [2, 8-10].

Antenna Design

Dimensions Radiating Element

Before determining the radiating element, then the first we must determine the resonant frequency (fr) were used. The resonance frequency microstrip antenna design jug shape is the center frequency so as to design an antenna that works at a frequency of400 - 800MHzfocusedonfrequency of600MHz.

$$\lambda_0 = \frac{c}{f_r} = \frac{3\times 10^8}{600\times 10^6} \quad [1]$$

After value of λ_0 is obtained, then the wavelength of the microstrip transmission line can be calculated by the equation [2]:

$$\lambda_d = \frac{\lambda_0}{\sqrt{\varepsilon_r}} \quad [2]$$

Dimensions Circular Patch

Dimensions circular patch can be calculated using equation [3], while F can be calculated using equation [4].

$$a = \frac{F}{\{1+\frac{2h}{\pi\varepsilon_r F}\left[\ln\left(\frac{\pi F}{2h}\right)+1.7726\right]\}^{1/2}} \quad [3]$$

$$F = \frac{8.791\times 10^9}{f_r\sqrt{\varepsilon_r}} \quad [4]$$

Dimensions *Ground Plane*

Dimensions of ground plane can be calculated using equation [5] and [6].

$$L_g = 6h + 2R \quad [5]$$

$$W_g = 6h + \frac{\pi}{2}R \quad [6]$$

Dimensions Transmission Line

For calculation transmission line using equation [7]:

$$B = \frac{60\pi^2}{Z_0\sqrt{\varepsilon_r}} \quad [7]$$

$$= \frac{60\times 3.14^2}{50\sqrt{3.9}} = 5.99$$

For defining transmission line wide using equation [8]:

$$W = \frac{2h}{\pi}\left\{B - 1 - \ln(2B-1) + \frac{\varepsilon_r - 1}{2\varepsilon_r}\left[\ln(B-1) + 0.39 - \frac{0.61}{\varepsilon_r}\right]\right\} \quad [8]$$

Meanwhile for transmission line length can be calculated by this equation

$$L = \frac{1}{4}\lambda_d \quad [9]$$

From those equation above, then we can draw a patch, ground plane, and substrate with CST 2014

Design by Using CST 2014

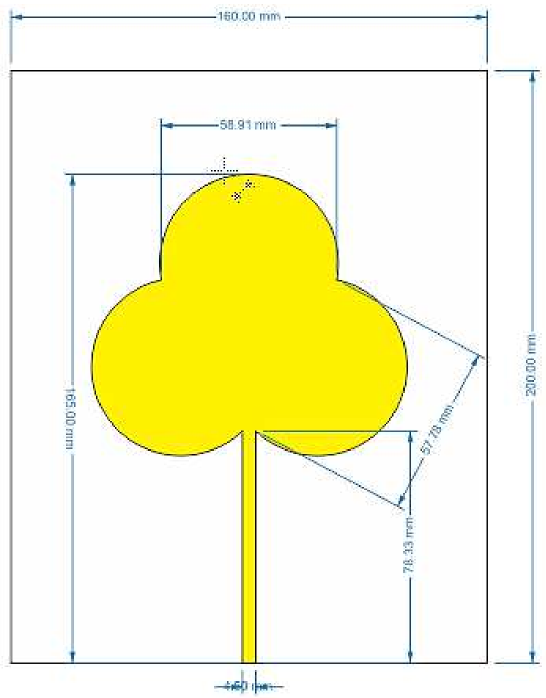

Fig. 2. Design Patch Using CST 2014.

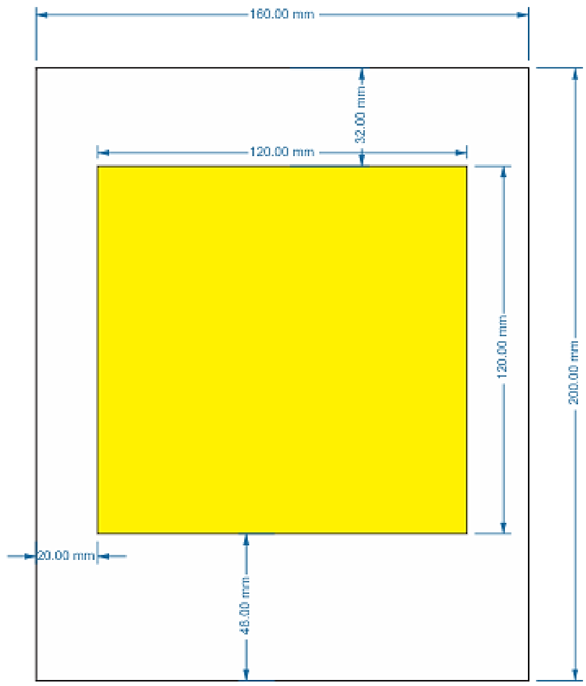

Fig. 3. Design Ground Plane Using CST 2014.

This microstrip antenna uses as its substrate FR-4 material with a substrate thickness (h = 1.6 mm), copper conductor with dielectric constant (ϵr = 3.9) and copper conductor thickness (c = 0.1 mm).

Fig. 4. Design Microstrip Clover Patch after Fabrication.

Results and Analysis

This results coming from simulation by CST 2014:

VSWR

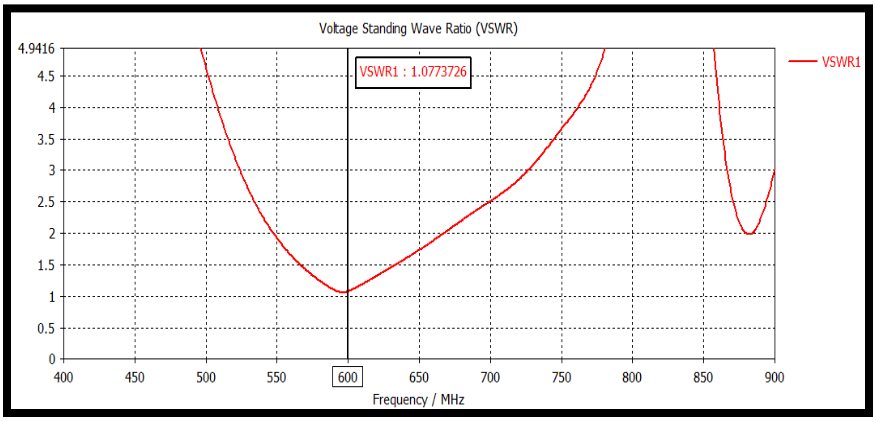

Fig. 5. *VSWR.*

Based on graph, VSWR value at 550-675 MHz frequency is currently close to 1. However when the frequency 650-800 MHz, VSWR value jump up and more than 2.

Return Loss

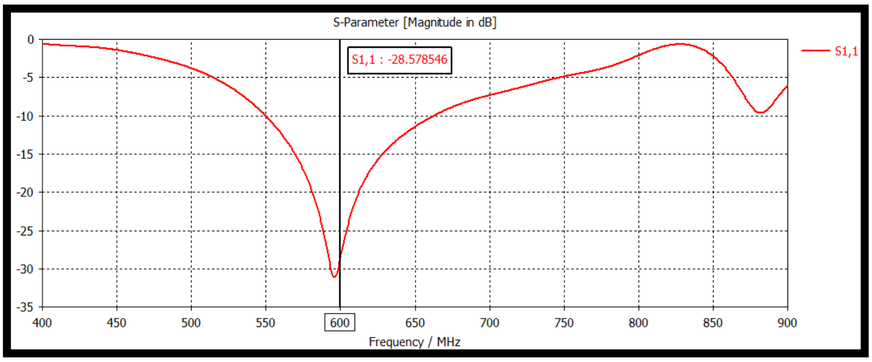

Fig. 6. *Return Loss.*

The graph above shows the return loss at operating frequency (400-800 MHz) is worth from -5 dB to -30 dB. But the middle value return loss of the antenna at frequency 600 MHz is -28.578546 dB.

Bandwidth

The simulation result showed that the value of the bandwidth at frequency 400 – 800 MHz is 119 MHz

From the graph known that return loss of microstrip antenna is below-10 dB jug shape, i.e.90% of the signal can be absorbed, and 10% of reflected back. This return loss value is-38.3dB. The best VSWR value is approaching a value of 1and much of the value of VSWR 2. From the graph showed the smallest is worth 1:02 and at a frequency of 600GHz. Bandwidth known one through graphs VSWR. Then right click ‘Show measure line’.

By cutting the graph on the Y axis, the value of VSWR=2 at the upper frequency and Lower frequency, it will be known value of 0972GHz bandwidth. Gain on this microstrip antenna, can be displayed by clicking on the Far field. The gain of the antenna is 4.168dB.

Gain can be said to be good if the amount is more than 3dB. Power accepted is received by the radiating power. In 600MHz frequency is 0.5 watts and is the greatest power in the range of 0-3GHz and compared with real measuring

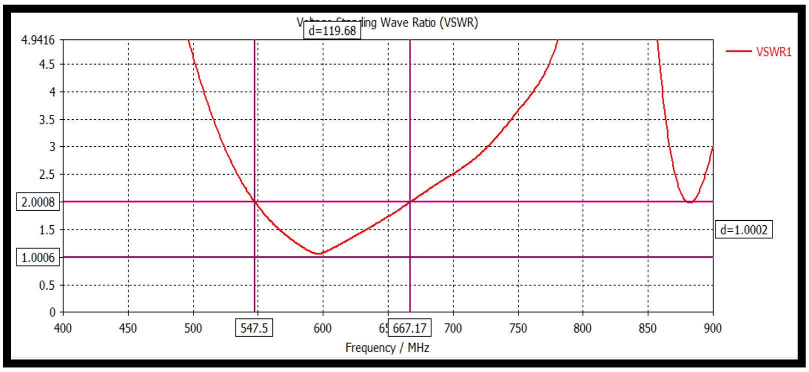

Fig. 7. Return Loss using CST 2014.

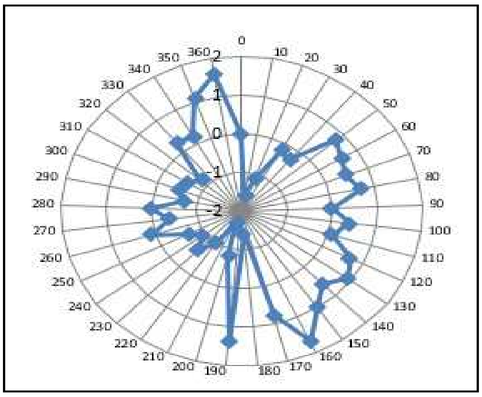

Fig. 8. Power Radiation Pattern Horizontally.

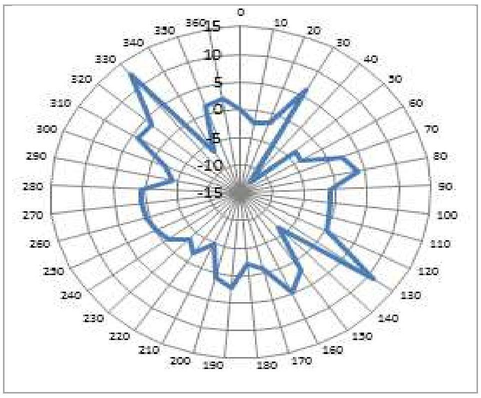

Fig. 9. Power Radiation Pattern Vertically.

From the above results it can be concluded that the power received by the results of measurements and simulation results but with the difference that is almost the same shape in terms of graph,

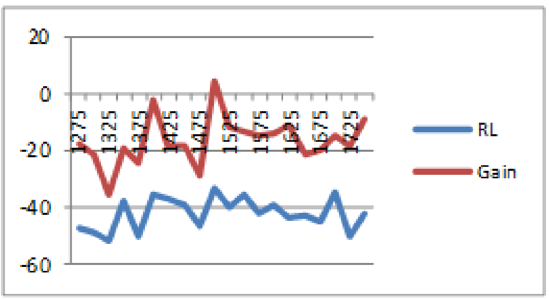

Fig. 10. Comparison return loss and the gain on the measurement.

In the calculation of Return Loss in getting from the calculation:

RL=data results-Reference (-2dB) -ah (-20 dB)

And for gain, is obtained by the calculation:

Gain=Presults-Pref+2.15dB (dipole antenna gain)

Conclusions

For novel microstrip antennas operating at 2.4GHz, the standard wireless frequency are proposed. Fractal technique together with the array arrangement concept is used to design the radiating patch. These new antennas demonstrate improved properties: returning loss, VSWR bandwidth, gain. Moreover, the radiating patch area is smaller as compared to the conventional antennas and other fractal patch antennas. The 2nd iteration of the pentagonal shape presents the best performance, resulting in an increase of 115.5%, 41.26% and 23.92% respectively, in returning loss, VSWR bandwidth and gain, in comparison with conventional antennas. The area of the radiating patch decreases with 81.3%. These new antenna designs not only improve VSWR bandwidth, gain, returning loss, but also can provide a smaller size of radiating patches, which will cause an overall reduction in antenna size.

Acknowledgment

The authors wish to thanks to the Ministry of Research and Technology, and, Electrical Engineering Department, Brawijaya University, Malang, Indonesia for supporting this research. ■

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