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Microstrip Antenna Design AT 800 MHz Frequency as A Television Receiver

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Abstract. Digital technology in broadcast media, one of which is television (TV), which has advantages, one of which is resistance to noise. Antenna is one of the most important components of digital telecommunications. Various kinds of antennas have been developed for various applications, one of which is the Microstrip antenna. In this research, a rectangular microstrip antenna is made. Microstrip antenna is an antenna that is widely developed in various applications. Microstrip antenna is an antenna that has a light mass, is easy to fabricate so that it can be placed on almost any type of surface and is small in size compared to other types of antennas, because of its properties, stinging microstrip antennas are in accordance with current needs, so they can be integrated with other telecommunications equipment which is small. Microstrip antennas have advantages over conventional microwave antennas, including having small dimensions and light weight and easy installation [1]. The results of this study are expected to be useful for use as well as further research and development. In radio wave communication, an antenna that has good bandwidth, working frequency, VSWR, Gain performance is needed. This research method uses AWR simulation to get the dimensions of the antenna at the specified working frequency. The simulation results or realization shows that the antenna works at a frequency of 800 MHz to produce a VSWR of 1.57, a return loss of -13.62, and an impedance of 1.20647-j0.420031.

Introduction

In analog television broadcasting, the farther away from the television transmitting station the signal will be weaker and the image reception will be poor and shadowy. It is different with digital television broadcasting which continues to deliver clear images and sound to the point where the signal can no longer be received. In short, digital TV broadcasting only recognizes two states: accept or not. That is, if the digital broadcast receiving device can capture the signal, the broadcast program will be received. Conversely, if the signal is not received then the sound image does not appear, then an antenna is needed that can receive digital television broadcasts [6].

This is also supported by the development of antennas that can meet the needs of these technologies. Various antennas have been developed for various applications, one of which is the Microstrip antenna. Based on the explanation above, a final project will be made with the title "Designing a Microstrip Antenna at a Frequency of 800 MHz as a Television Receiver". The purpose of this article is to simulate and analyze a rectangular patch microstrip antenna using a cotton substrate with a working frequency of 800 MHz. The results of the analysis are based on simulation results using the AWR Microwave Office software. The parameters analyzed include return loss, Voltage Standing Wave Ratio (VSWR), and input impedance. The material used is FR-4.

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The purpose of this article is to simulate a microstrip antenna for television using AWR software to get a good VSWR, return loss, and input impedance that is at least close to the existing standard by searching using the existing formula and optimizing it.

Substrate Type

The material used in this article is FR-4 with a dielectric constant (Ɛr) = 4.3; height = 1.6mm; tan δ = 0.0265. The method used in this article is a simulation using the AWR application and by using a rectangular patch in this simulation.

Dimensions of Antenna Patch

The patch shape of the designed antenna is rectangular. Therefore, it is necessary to calculate the width (W) and length (L) of the patch antenna. The width (W) dimension can be calculated using Equation (1) while the length (L) dimension is calculated using Equation (2)(3)(4) [5]. The results of the calculation of the patch antenna dimensions can be seen below.

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

$$\varepsilon_{reff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left[1+12\frac{h}{W}\right]^{-\frac{1}{2}} \tag{2}$$

$$\Delta L = 0{,}412h\frac{(\varepsilon_{reff}+0{,}3)(\frac{W}{h}+0{,}264)}{(\varepsilon_{reff}-0{,}258)(\frac{W}{h}+0{,}8)} \tag{3}$$

$$L = \frac{c}{2f_r\sqrt{\varepsilon_{reff}}} - 2\Delta L \tag{4}$$

Based on the calculations, the lengths of W and L for the dielectric constant of 4.3 and h of 1.6 are as follows

- Calculating W using formula (1) with 800 MHz frequency:

$$W = \frac{c}{2f_r}\sqrt{\frac{2}{\varepsilon_r+1}} = \frac{3x10^8}{2(800\text{ x }10^6)}\sqrt{\frac{2}{4.3+1}} = 0.1151\,m = 115.1\,mm$$

- Then calculating ε_{reff}

$$\varepsilon_{reff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left[1+12\frac{h}{W}\right]^{-\frac{1}{2}} = \frac{4.3+1}{2} + \frac{4.3-1}{2}\left[1+12\frac{1.6}{115.1}\right]^{-\frac{1}{2}} = 3.98$$

- After that, we are calculating ΔL for searching L

$$\Delta L = 0{,}412h\frac{(\varepsilon_{reff}+0{,}3)(\frac{W}{h}+0{,}264)}{(\varepsilon_{reff}-0{,}258)(\frac{W}{h}+0{,}8)} = 0{,}412\,x\,1.6\frac{(3.98+0{,}3)(\frac{115.1}{1.6}+0{,}264)}{(3.98-0{,}258)(\frac{115.1}{1.6}+0{,}8)} = 0.752$$

- Searching L from ΔL we get before

$$L = \frac{c}{2f_r\sqrt{\varepsilon_{reff}}} - 2\Delta L = \frac{3x10^8}{2(800\,x\,10^{6)}\sqrt{3.98}} - (2x0.752) = 90.18\,mm$$

Antenna Simulation

Testing on the antenna is done by running a simulation using the AWR Microwave Office software. After forming a patch as shown in Table 1 with the dimensions we have calculated, then run the simulation in the frequency range that includes the ISM band. By using a frequency range from 0.75 GHz to 0.85 GHz with a distance of 0.05 GHz. Then get a graphic image for return loss, VSWR and input impedance then verify the results.

TABLE 1. Antenna Dimensions Before and After Optimization

	W(mm)	L(mm)	w(mm)	h(mm)
Before Optimization	115.1	90.18		
After Optimization	110.1	86.7		
Coupler			10.7	27.6

Then the rectangular patches from the simulation is looks like Figure 1 below that is being optimized manually from the AWR Software because the width and length of the patch before optimization doesn't have the value that approach the standard until having the best VSWR, Return Loss, and Input Impedance.

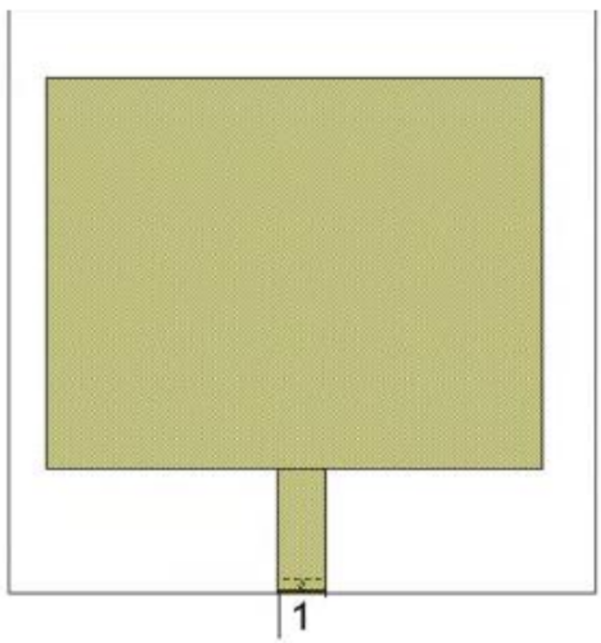

FIGURE 1. Dimension Patches

RESULTS AND DISCUSSION

Return Loss

Return loss is the ratio value of the reflected wave amplitude with the transmitted wave amplitude. A good return loss value is below or less than -10 dB [3]. The overall result for return loss is acceptable as values are below -9.54 dB. The return loss obtained in this simulation is -13.62 dB which can be seen in Figure 2.

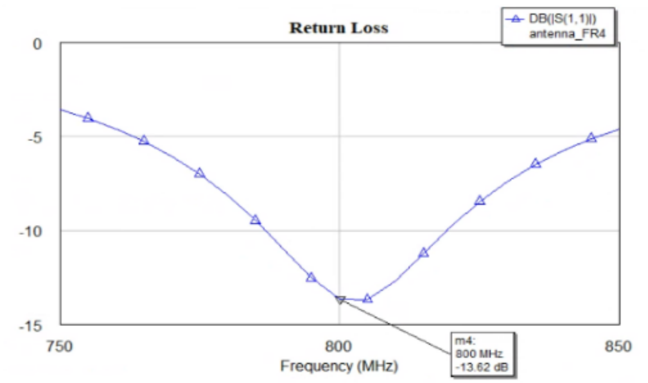

FIGURE 2. Return Loss

Voltage Standing Wave Ratio (VSWR)

VSWR is the ratio between the maximum value and the minimum value of the standing wave voltage on a transmission line. The ideal VSWR value is 1 which is meant to be a perfect match or no reflection on the transmission line. The acceptable value is below 2 [2]. The VSWR obtained is 1.57 which can be seen in Figure 3.

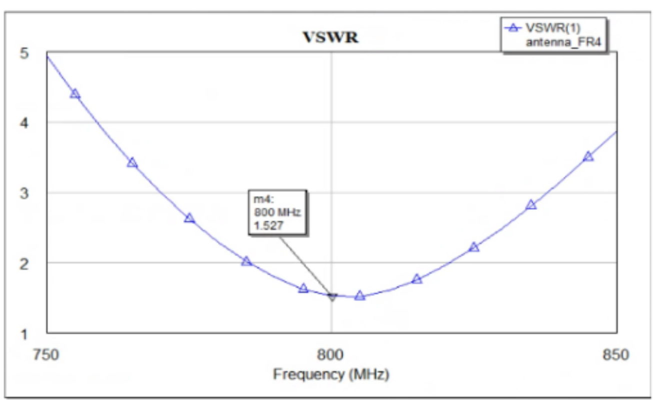

FIGURE 3. Voltage Standing Wave Ratio (VSWR)

Input Impedance

The purpose of this input impedance is to achieve perfect matching or no reflection at the end of the load line. We know that the impedance of the transmission line is equal to 50 Ω [3]. So, the input impedance must be equal to this value. In normal form, Zin = 1. In this simulation, the result is 1.20647-j0.420031 which can be seen in Figure 4.

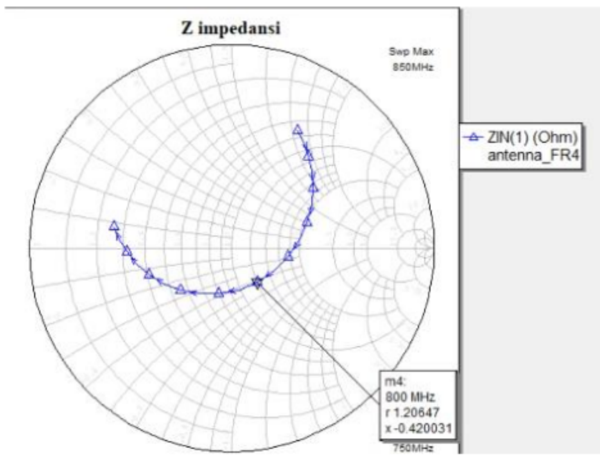

FIGURE 4. Input Impedance

CONCLUSION

Based on the results obtained in this article, it can be concluded that the results of the calculations obtained width 115.1 mm, length 90.18 mm using FR-4 (epoxy) material with Ɛr = 4.3, h = 1.6 mm and tan δ = 0.0265. After calculating each antenna dimension, the design process is carried out. The antenna simulation results obtained a working frequency of 800 MHz. The antenna design after optimization changed the patch width to 110.1 mm and the length to 86.7 mm. The conclusion obtained is that the results of Return Loss = 13.62 dB and VSWR = 1.57 are quite good and according to standards, while the results of Z impedance 1.20647-j0.420031are not too good.

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