Design of Reconfigurable Optical on Folded Dipole Antenna Based Resonator and Vector Network Analyzer (VNA)

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Abstract. A folded dipole antenna with a microstrip structure is designed in the super high frequency (SHF) range with a size of 15 × 3.1 × 0.03 mm. Then, a photodiode was installed and irradiated with infrared 808 nm, 200 mW on it. Based on the measurement results using a vector network analyzer (VNA), there was a change in frequency from 13.86 to 14.85 GHz before and after infrared irradiation. Next, a resonator is installed on it. So, the frequency changes from 16.29 to 4.86 GHz before and after being irradiated by infrared. The very wide frequency shift in the antenna can be applied to mobile phones with 5G technology.

Keywords. Antenna, Folded Dipole, Infrared, Photodiode, Resonator.

1. INTRODUCTION

With increasing technological advances, an antenna is needed that can absorb and emit electromagnetic wave radiation on a big scale. In this study, a folded dipole antenna with a microstrip structure is proposed. It was chosen because it has a simple shape, low price, easy fabrication, and is lightweight (1). To be applied to mobile phones or other wireless communications, it is designed with dimensions in millimeter scale. So, it can operate at a super high frequency (SHF) and produce high electromagnetic waves (2).

Next, to improve the work of the antenna when in an area low signal, it is necessary to make a reconfigurable antenna by installing a photodiode. Then, the photodiode was irradiated with infrared 808 nm, 200 mW. Furthermore, the folded dipole antenna is added by installing a resonator in order for the work can be improved further (3)(4). The resonator is mounted on the folded dipole antenna feedline. With the resonator, it is expected that a wider frequency change will occur when irradiated with infrared as an optical reconfigurable.

2. METHODS

In this study, a folded dipole antenna made of copper plates with a size of 15 × 3.1 × 0.03 mm was printed on FR-4 (ε_r = 4.4) with a thickness of 1.6 mm using a laser jet printer (5)(6). Its shape can be shown in Figure 1.

Furthermore, the folded dipole antenna is attached to a connector. So that it can be measured using a vector network analyzer (VNA) (7). The type of VNA used in this study is Saluki Technology S5105D which can work in the 30 kHz - 18 GHz frequency area. Then, it is installed photodiode as shown in Figure 2. The photodiode is illuminated by infrared so that it can work as an optical reconfigurable (8)(9).

(a)

(b)

(c)

(d)

FIGURE 1. Dimensions of the folded dipole microstrip antenna: (a) The length of the antenna dipole and the gap between the strips are measured from the top, (b) The width of the feedline and the gap between the strips are measured from the bottom, (c) The dipole width of the antenna and the distance between the two dipoles are measured from the right side, and (d) The width of the antenna dipole, the distance between the two dipoles, and the length of the feedline are measured from the left side.

(a)

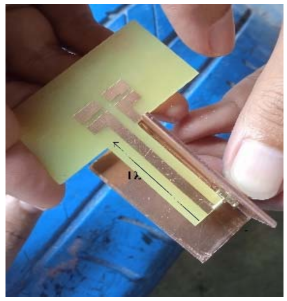
(b)

FIGURE 2. Dimensions of the folded dipole microstrip antenna after installing the connector and photodiode: (a) From the front, (b) From the back.

Next, the folded dipole antenna is designed by adding a resonator beam with a size of 1.25λ × 0.5λ × 0.5λ. Then, the positive feedline is added with a length of 1λ. The value of 1λ is obtained from the measurement of the folded dipole antenna without a resonator with a frequency of 13.86 GHz. The addition of a resonator is used so that the electromagnetic waves acting on the antenna do not spread out. it is expected that a wider frequency change will occur when irradiated with infrared as an optical reconfigurable. However, it added a copper resonator box with a thickness of 1.8 ± 0.2 mm. Some of the criteria used in this antenna as shown in Figure 3.

(a)

(b)



(c)

(d)

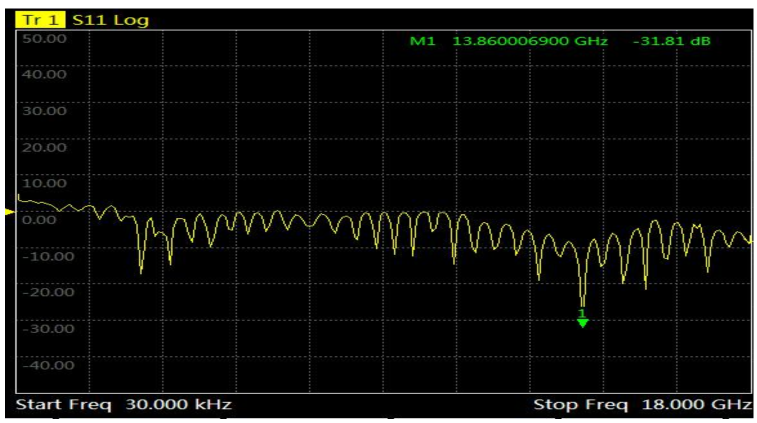
FIGURE 3. Dimensions of the folded dipole microstrip antenna after installing the connector, photodiode, and resonator: (a) From the front, (b) From the back, (c) From inside, (d) From outside.

Furthermore, the results of the optical reconfigurable on folded dipole antennas before and after the resonator is installed will be compared with each other.

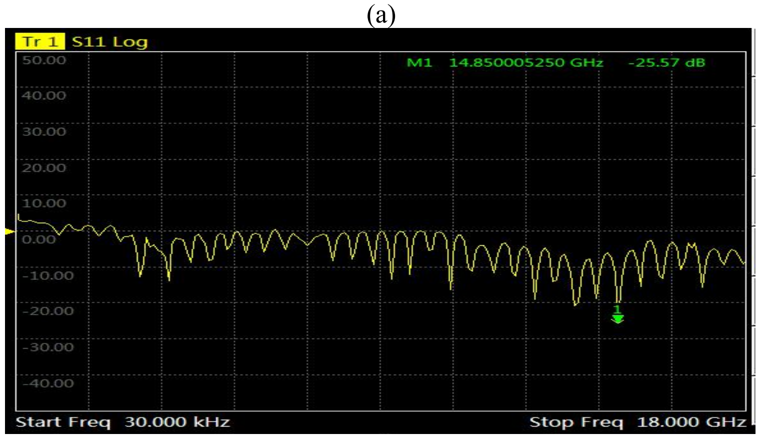
3 RESULTS

3.1 Results of Antenna without Resonator

Based on the measurement results using VNA, the optical reconfigurable on the folded dipole antenna before installing the connector has a higher frequency change than before being irradiated by infrared as shown in Figure 4.



(a)

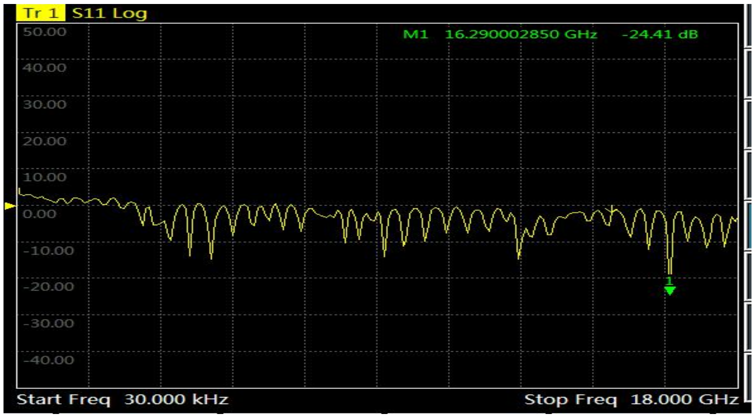


(b)

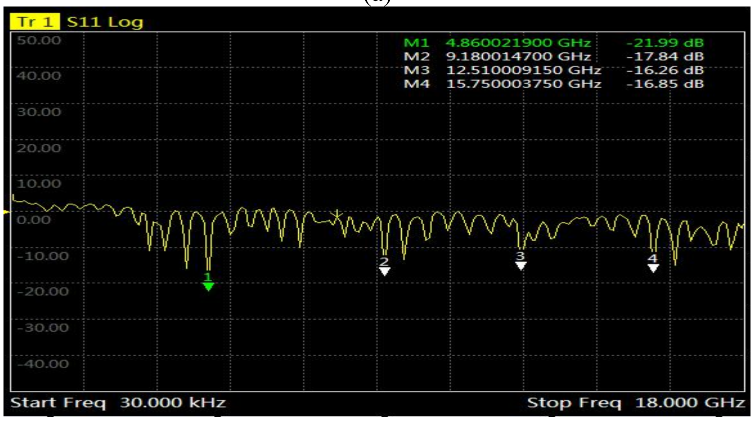
FIGURE 4. The graph between return loss and frequency on the folded dipole antenna before installing the connector: (a) Before infrared irradiation, (b) After infrared irradiation.

3.2 Results of Antenna with Resonator

Next, the optical reconfigurable on the folded dipole antenna after installing the connector has a lower frequency change than before being irradiated by infrared as shown in Figure 5.



(a)



(b)

FIGURE 5. The graph between return loss and frequency on the folded dipole antenna after installing the connector: (a) Before infrared irradiation, (b) After infrared irradiation.

Based on Figure 5, the addition of a resonator to the folded dipole antenna can cause the frequency change to be wider than before the resonator was installed in Figure 4.

TABLE 1. The experimental results on folded dipole antenna before and when the resonator is installed.

Parameter	**Without resonator**		**With resonator**	
	without infrared	**with infrared**	**without infrared**	**with infrared**
Frequency on antenna (GHz)	13.86	14.85	16.29	4.86
Wavelength on antenna (mm)	11.98	11.18	10.19	34.16
VSWR	1.05	1.07	1.14	1.17
Reflection Coefficient	0.024	0.039	0.065	0.078
Return Loss (dB)	-31.81	-25.57	-24.41	-21.99
Phase	-33.78^o	-112.82^o	-88.88^o	36.86^o
Characteristic impedance of antenna (Ω)	51.90-i1.16	47.99-i4.47	49.92-i6.67	56.61+i5.32

4 DISCUSSION

Using a resonator on folded dipole antenna can cause frequency changes to be wider than without resonators. So, this type of antenna can be applied to mobile phones with 5G technology (10). However, based on table 1, the reflection coefficient on the folded dipole antenna after the resonator is installed is higher than before the resonator is installed. It can cause the electromagnetic waves absorbed by the antenna to be slightly less than before.

Next, the optical reconfigurable on the dipole antenna using infrared 940 nm 1.6 W performed by (8) can experience a frequency change of 0.8 GHz. In addition, research conducted by (9) using infrared 940 nm 8 mW can produce a change of 0.005 GHz. In this study, the optical reconfigurable on the folded dipole antenna with 808 nm 200 mW before the resonator was installed could change the frequency of 0.99 GHz and 11.43 GHz after the resonator was installed.

5 CONCLUSION

Reconfigurable optics in dipole antennas can have very wide frequency changes for several reasons. First, there is a change in the dipole shape of the antenna from a regular dipole to a folded dipole. Second, the antenna frequency spectrum is higher at SHF upward. Third, the type of electromagnetic wave is used for irradiation has a greater wavelength and power. In this study, reconfigurable optics on folded dipole antennas can be used for microwave devices/communications.

6 ACKNOWLEDGMENTS

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