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Multiband Microstrip Antenna Array with Slot and Array Method for GSM, WCDMA, and LTE

Teguh Firmansyah, Herudin, Fery Kurniawan
Department of Electrical Engineering.
University Sultan Ageng Tirtayasa (UNTIRTA).
Cilegon. Indonesia.
teguhfirmansyah@untirta.ac.id

Yus Rama Denny
Department of Physics Education.
University Sultan Ageng Tirtayasa (UNTIRTA).
Serang. Indonesia.
yusramadenny@untirta.ac.id

***Abstract*—The development of communication technology is increasingly fast and diverse. Some of these technologies include Global System of Mobile Communication (GSM) which has working frequency at 900 MHz, Wideband Code Division Multiple Access (WCDMA) has working frequency at 1.8 GHz, and Long Term Evolution (LTE) which has working frequency at 2600 MHz. To provide the needs of data access at high speed with various standards, a multiband antenna is designed which supports wireless communication. One type of antenna used for wireless communication is a microstrip antenna. As novelty, this research proposed a multiband microstrip antenna based on slot for GSM, WCDMA, and LTE. Array methods also was used to increase gain on microstrip antenna. The antenna is simulated using Advanced Design System 2009 (ADS 2009) software, and fabricated using FR4 substrate with εr= 4,3, tan δ = 0,0265, h = 1,66 mm, and measured using Vector Network Analyzer (VNA). The measurement results show the validation of the multiband antena design.**

Keywords—antenna, microstrip, multiband, stub

I. INTRODUCTION

A subsystem of wireless transceiver consists of band-pass filter (BPF) [1][2], low noise amplifier (LNA) [3], oscillator [4], and antena [5]. One type of antenna used for multiband wireless communication is a microstrip antenna. Microstrip antennas have an advantage when compared to other types of antennas, which are thin and small, have light weight, are easy to fabricate, can generate linear polarization and circular polarization using only simple, easy to integrate integration with other electronic devices, and the price is relatively cheap [5].

However, these microstrip antennas also have some weaknesses, namely low gain, low bandwidth, and low efficiency [5]. Several previous researches on microstrip antennas such as K. Fertas [6] designed a multiband array antenna with arrays at the frequencies of 3.7 GHz, 5.2 GHz and 5.8 GHz with bandwidth of 50 MHz, 80 MHz and 100 MHz. However, the bandwidth is small which was 50 MHz at the frequency of 3.7 GHz and the design of the antenna was complicated. Dongre Vinitkumar Research [7] designed dual-band microstrip antennas at frequencies of 900 MHz and 1.56 GHz with bandwidth of 25 MHz and 24 MHz. However, the bandwidth of both frequencies was very small. Yongqi Wang's research [8] designed a microstrip array antenna at 2410 MHz frequency with 80 MHz bandwidth. However, this microstrip antenna only worked on 1 frequency.

Prakash Kumar's research [9] designed a multiband microstrip antenna at frequencies 1815 MHz, 2227 MHz, and 3132 MHz with bandwidth of 148 MHz, 231 MHz, and 154 MHz. However, Prakash Kumar's microstrip antenna was not arrayed. Vishnupriya Shinde's research [10] designed microstrip antennas with frequencies of 1600 MHz and 2450 MHz with bandwidth of 40 MHz and 30 MHz. However the antenna only works on 2 frequencies and no array was done.

As novelty, this research proposed a multiband microstrip antenna based on slot for GSM, WCDMA, and LTE as shown in Figure 1. An array method also was used to increase gain on microstrip antenna. The antenna is simulated using Advanced Design System 2009 (ADS 2009) software, and fabricated using FR4 substrate with εr= 4,3, tan δ = 0,0265, h = 1,66 mm, and measured using Vector Network Analyzer (VNA).

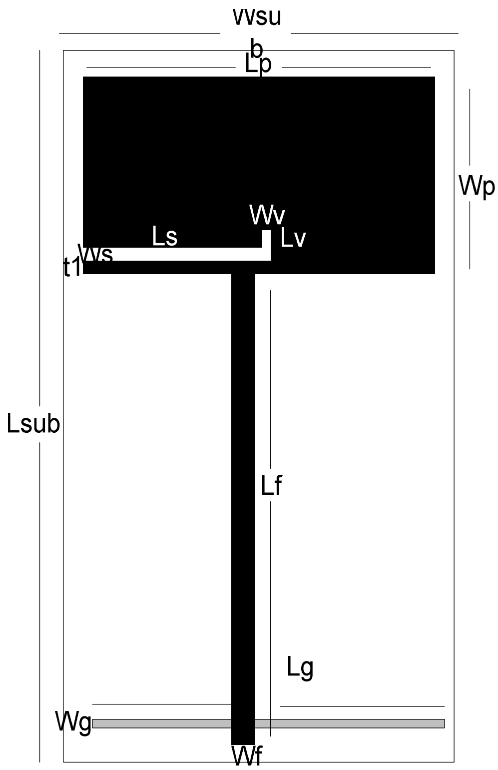

Fig 1. Microstrip antenna using slot method

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II. DESIGN OF MULTIBAND ANTENNA

Design of microstrip antenna was conducted by using manual calculation and software simulation of Advanced Design System 2009. A substrate with εr= 4,3, tan δ = 0,0265, h = 1,66 mm was used. Calculation of patch dimension is done to get 900 MHz frequency using equation as follows :

1. The following equation was used to get the width [2]:

$$W_P = \frac{c}{2fo\sqrt{\frac{\varepsilon_r+1}{2}}} = \frac{3\times10^8}{2\times900\sqrt{\frac{4,3+1}{2}}} = 102,3\ mm$$

2. The following equation was used to get the value of ε_{eff} [2]:

$$\varepsilon_{eff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left|\frac{1}{\sqrt{1+12\left(\frac{h}{w}\right)}}\right| = 4.17$$

3. The following equation was used to get the length [2]:

$$L_P = \frac{C}{2fo\sqrt{\varepsilon_{eff}}} = \frac{3\times10^8}{2\times900MHz\sqrt{4,17}} = 81,61\ mm$$

From the equation above it was obtained the value of length (L) = 81.61 mm and width (W) = 102.3 mm for 900 MHz frequency. To fulfill the multiband antenna specification slot method was conducted on patch antenna, as shown in Figure 3.1 Table 1 is a multiband microstrip antenna specification with slot method.

TABLE I. MULTIBAND ANTENNA MICROSTRIP PARAMETERS

Parameters	Length (mm)
Ground length (Lg)	45
Ground width (Wg)	1
Substrate length (Lsub)	83
Substrate width (Wsub)	50
Patch Length (Lp)	45
Patch width (Wp)	23
Transmission path length (Lf)	55
Transmission path width (Wf)	3
Slit length (Ls)	24
Slit width (Ws)	1,5
Slit distance (t)	1,25
Vertical Slit Length (Lv)	2
Vertical Slit width (Wv)	1

Figure 2 shows a return loss from microstrip antenna simulation with slot microstrip antenna method. Y axis represents the return loss from the range 0 dB to -30 dB, whereas the X axis is the frequency of the range 0.2 GHz to 2.7 GHz. Frequency 1 is at middle frequency 880 MHz with return loss -16,348 dB, frequency 2 is at middle frequency 1,8 GHz with return loss -19,161 dB, and frequency 3 is at frequency 2,62 GHz with return loss of -14,274. Bandwidth at each frequency was 60 MHz, 40 MHz, and 140 MHz. Gain at each frequency was 1,303 dB, -8,776 dB, and -12,069 dB. At frequency 1 there is a frequency shift from 0.9 GHz to 0.88 GHz, in frequency 2 there was the addition of new frequency at the middle frequency 1.8 GHz, while in frequency 3 there was a shift from 2.53 GHz to 2.62 GHz. After the method of microstrip antenna slot have multiband frequency and according to the specification that is at the frequency of 0.88 GHz, 1.8 GHz, and 2.62 GHz.

The antenna in Fig. 1 is in accordance with the frequency specification with the obtained multiband frequency but the gain of the antenna is small that is 1.303 dB, -8,776 dB, and -12,069 dB, therefore to increase the gain in multiband microstrip antenna a 1x2 array method was done. Figure 3 is a microstrip antenna design with slot method and 1x2 array.

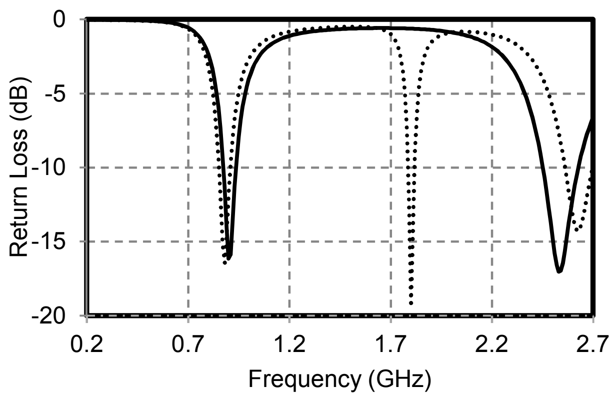

Fig 2. Return loss of multiband microstrip antenna using slot method.

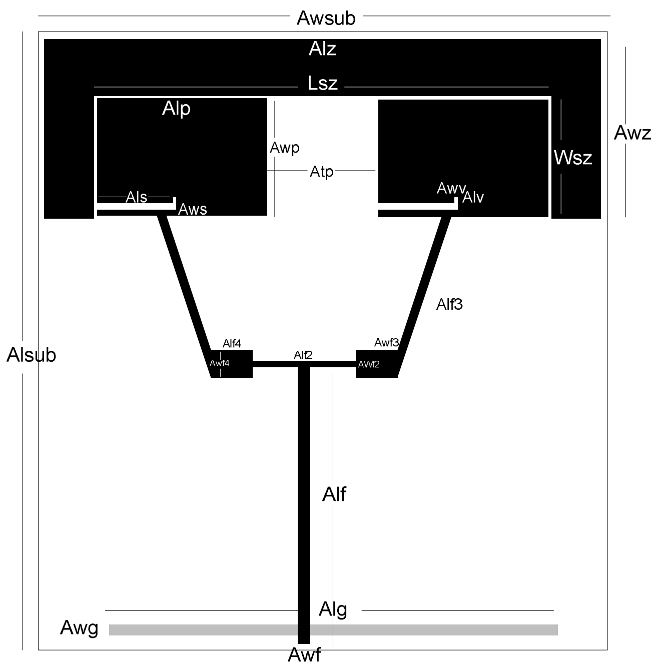

Fig 3. Design of antenna using Slot and Array 1x2 method

TABLE 2. MULTIBAND ANTENNA PARAMETERS WITH SLOT METHOD

Parameters	Unit (mm)
Ground length (Lg)	145
Ground width (Wg)	3,5
Substrate length (Lsub)	200
Substrate width (Wsub)	184
Patch Length (Lp)	55
Patch width (Wp)	38
Transmission path length (Lf)	53
Transmission path width (Wf)	3
Slit length 1 (Ls)	25,.5
Slit width 1 (Ws)	2
Slit distance1 (t)	1,25
Vertical Slit Length (Lv)	2
Vertical Slit width (Wv)	1
Patch space distance	36
Single element transmission path length (ALf1)	90
Single element transmission path width(AWf1)	4
Transmission path connector length 1 (ALf2)	34
Transmission path connector width 1 (AWf2)	2
Transmission path connector length 2 (ALf4)	13.5
Transmission path connector width 2 (AWf4)	9
Additional patch length (Alz)	181
Additional patch width (Awz)	58
Additional slit length (LSz)	149
Additional slit width (WSz)	40

From the specification in Table 2 it is known that there are many size optimize in multiband microstrip antenna from Table 1. Here is a figure of return loss of the antenna with 1x2 array on multiband multistrip antenna. Figure 4 shows a graph of return loss from microstrip antenna simulation slot method with slot and a 1x2 array. Y axis represents the return loss from the range 0 dB to -30 dB, whereas the X axis is the frequency of the range 0.2 GHz to 2.7 GHz.

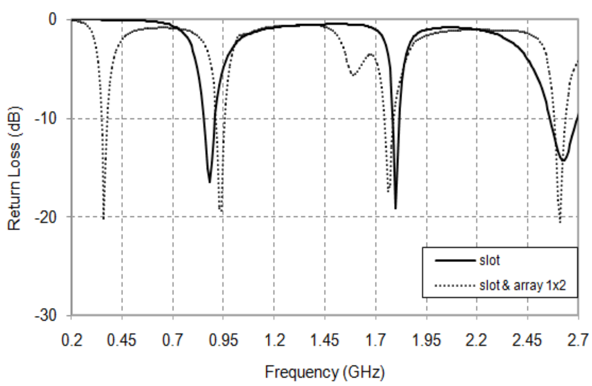

Fig 4. Return loss of multiband microstrip antenna using slot method and array 1x2

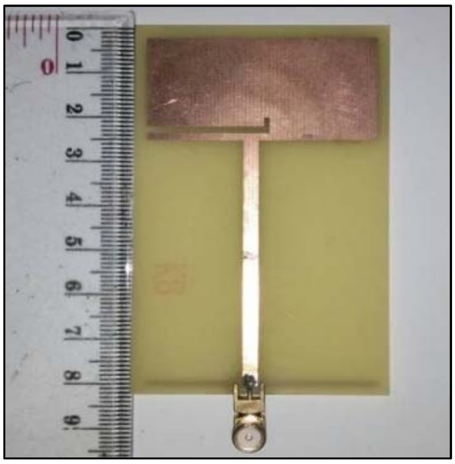

Fig 5. Fabrication of multiband antenna based on multiband slot

Microstrip antenna with slot method has 3 frequency that is at the frequency of 0.88 GHz, 1.8 GHz, and 2.62 GHz, while the microstrip antenna with slot method and 1x2 array has 4 frequency bands such as frequency 0.3 GHz, 0.94 GHz, 1.76 GHz, and 2.61 GHz, but for this study only 3 frequencies of 0.94 GHz, 1.76 GHz, and 2.61 GHz. The bandwidth of each microstrip antenna frequency with slots was 60 MHz, 40 MHz, and 140 MHz whereas microstrip antennas with slots and 1x2 arrays are 44 MHz, 60 MHz, and 52 MHz. The gains in each of the microstrip antenna frequencies with slots are 1,303 dB, -8,776 dB, and -12,069 dB, whereas with slots and arrays are -0.796 dB, 1.511 dB, and -0.841 dB.

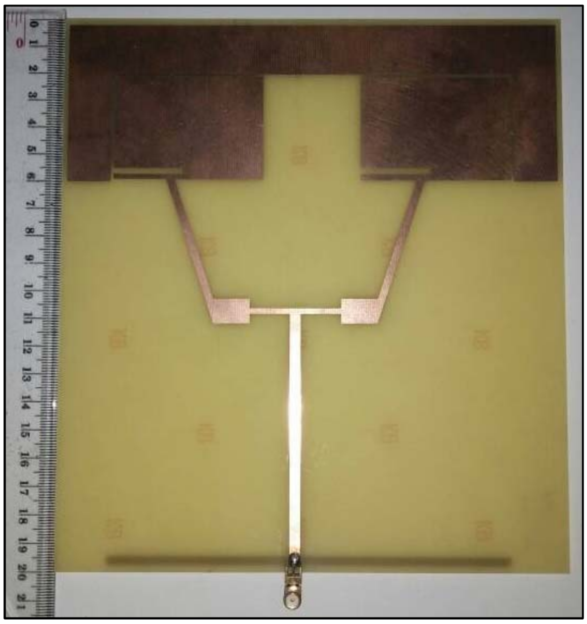

Fig 6. Fabrication of multiband antenna based on multiband slot and array 1x2

III. Result and Discussion

Figure 7 shows a comparison simulated and measured result. A microstrip antenna simulation operates at 0.94 GHz, 1.76 GHz and 2.61 GHz the return loss was -21,357 dB, -17,381 dB, and -21,242 dB whereas when microstrip antenna measurement operates at 0.89 GHz frequency, 1.76 GHz, and 2.58 GHz at the return loss of -22.47 dB, 11.29 dB, and -15.27 dB. The bandwidth of each antenna frequency during simulation is 44 MHz, 60 MHz, and 52 MHz while the measurement is 60 MHz, 80 MHz, and 60 MHz. At frequency 1 there is a frequency shift from 0.94 GHz to 0.89 GHz, at frequency 2 it was fixed at 1.76 GHz frequency, whereas in frequency 3 there was a shift from 2.61 GHz to 2.58 GHz. All frequencies at return loss below -10 dB mean multiband antenna according to the return loss antenna parameter specification was ≤ -10. At the time of measurement emerged new frequency at 1.46 GHz frequency with return loss value -45,33 dB and 90 MHz bandwidth, but this frequency is not used in this research.

Figure 8 shows a graph VSWR from the simulation and measurement of multiband microstrip antenna. The Y-axis represents the VSWR of the range 0 to 30, whereas the X axis is the frequency from the range of 0.2 GHz to 2.7 GHz. When microstrip antenna simulation operates at 0.94 GHz, 1.76 GHz, and 2.61 GHz a the value of VSWR 1,248, 1,303 and 1,207, while the measurement of microstrip antennas operates at 0.89 GHz, 1.76 GHz, and 2.58 GHz at VSWR values of 1.16, 1.75, and 1.207. All frequencies at VSWR below 2 mean multiband antenna according to VSWR antenna parameter specification that is ≤ 2.

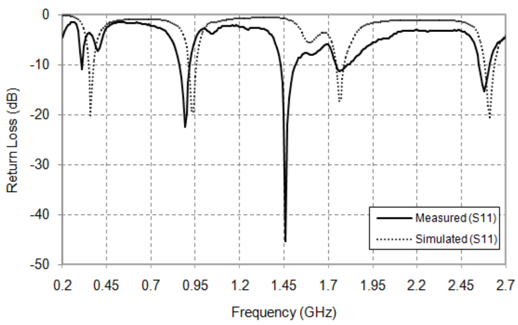

Fig 7. Simulated and measured result of return loss of multiband slot and array 1x2 antenna

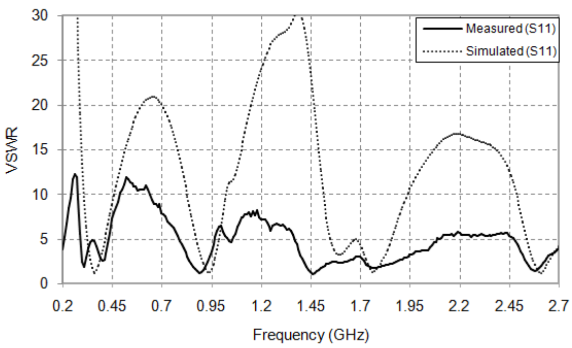

Fig 8. Simulated and measured result of VSWR of multiband slot and array 1x2 antenna

Figure 9 shows a graph of input impedance simulation results of multiband microstrip antenna. The graph on the smith chart is in the 0.2 GHz to 3 GHz frequency range. The microstrip antenna operates at a frequency of 0.94 GHz, 1.76 GHz, and 2.61 GHz, the input impedance value of each frequency is 62.05 Ω + 1.25j, 58.3 Ω + 12.5j, 51.75 Ω + 9.55j.

Table 3 shows a simulated and measured result, the measurement results show the validation of the multiband antenna design.

IV. Conclusion

This research proposed a multiband microstrip antenna based on slot for GSM, WCDMA, and LTE. Array methods also was used to increase gain on microstrip antenna. The antenna is simulated using Advanced Design System 2009 (ADS 2009) software, and fabricated using FR4 substrate with εr= 4,3, tan δ = 0,0265, h = 1,66 mm, and measured using Vector Network Analyzer (VNA). The measurement results show the validation of the multiband antenna design.

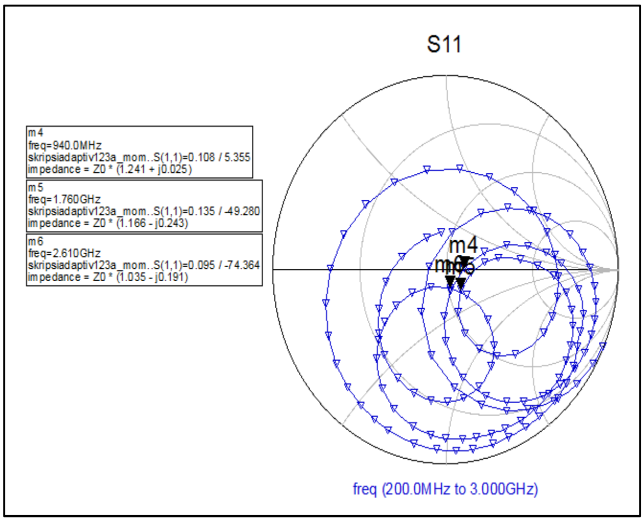

Fig 9. Input Impedance of Multiband Antenna

TABLE 3. Simulated and Measured Comparison

Parameters	Slots			Slot and Array (simulated)			Slot and array (measured)		
fc (GHz)	0.88	1.8	2.62	0.94	1.76	2.61	0.89	1.76	2.58
BW (MHz)	60	40	140	44	60	52	60	80	60
RL (dB)	-16.3	-19.1	-14.2	-21.3	-17.3	-21.2	-22.4	-11.2	-15.27
VSWR	1.35	1.31	1.47	1.24	1.30	1.20	1.16	1.75	1.42
Gain (dBi)	1.3	-8.7	-12.0	-0.7	1.51	0.84	NA	NA	NA

ACKNOWLEDGMENT

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REFERENCES

[1] G. Wibisono, et al., *"Multiband Bandpass Filter (BPF) based on Folded Dual Crossed Open Stubs".* International Journal of Technology, v. 5, n. 1, p. 32-39, jan. 2014. ISSN 2087-2100.

[2] G. Wibisono, T. Firmansyah, T. Syafraditya., *"Design of Triple-Band Bandpass Filter Using Cascade Tri-Section Stepped Impedance Resonators".* J. ICT Res. Appl., Vol. 10, No. 1, 2016, 43-56 43.

[3] Teguh F., Supriyanto S., Herudin H., Gunawan W., Mudrik. "Multiband RF low noise amplifier (LNA) base on multi section impedance transformer for multi frequency application". *International Journal of Applied Engineering Research.* Vol. 11., No. 5. Pp.3478-3483. 2016.

[4] G. Wibisono and T. Firmansyah., "*Design of dielectric resonators oscillator for mobile WiMAX at 2,3 GHz with additional coupling λ/4,"* TENCON 2011 - 2011 IEEE Region 10 Conference, Bali, 2011, pp. 489-493.

[5] Constantine. A. Balanis, "Antena Theory : Analysis and Design", John Willey and Sons, USA, 1997.

[6] K. Fertas, H. Kimouche, M. Challal, H. Aksas and R. Aksas, *"Multiband microstrip antenna array for modern communication systems,"* 2015 4th International Conference on Electrical Engineering (ICEE), Boumerdes, 2015, pp. 1-5.

[7] V. Dongre and A. K. Mishra, *"Design of single band and dual band microstrip antennas for GSM, GPS and Bluetooth applications,"* International Conference & Workshop on Electronics & Telecommunication Engineering (ICWET 2016), Mumbai, 2016, pp. 207-212.

[8] Yong-qi Wang, Xing Jiang, Xiao-lei Zhao and Xin Liao, *"Design of microstrip array antenna for angle measurement based on dual-baseline method,"* 2015 IEEE International Conference on Communication Problem-Solving (ICCP), Guilin, 2015, pp. 282-285.

[9] P. K. Mishra, V. Sachdeva, D. Sharma and S. D. Gupta, *"Multiband Microstrip Antenna for 4G Mobile Application,"* 2015 Fifth International Conference on Communication Systems and Network Technologies, Gwalior, 2015, pp. 60-63.

[10] V. A. Shinde and S. R. Gagare, *"Design and simulation based comparative study of coplanar dual band microstrip antenna with and without Koch structure,"* 2015 International Conference on Information Processing (ICIP), Pune, 2015, pp. 418-422.

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