International Journal of communication and computer Technologies, ISSN: 2278-9723

Available at http://www.ijccts.org

A Design of Multiband Antenna using Main Radiator and Additional Sub-Patches for Different Wireless Communication Systems

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Received: 10-01-2014, **Revised:** 19-03-2014, **Accepted:** 28-04-2014, **Published online:** 03-06-2014

ABSTRACT

A design of compact printed multiband Microstrip antenna for the different wireless communication systems is proposed. The antenna comprises of a main radiating patch and some additional sub patches which is fed by a microstrip line feeding. This configuration is designed to operate with the center frequencies of 1.52GHz, 1.86GHz, 2.7GHz, 3.32GHz and 4.05 GHz with achievable bandwidths of 6%, 4.3%, 3.7%, 7% and 8.4%, respectively. These five bands supports for the applications of GSM1800, GPS, WIMAX I (2.7 - 2.8GHz), WIMAX II (3.3-3.4GHz), and Fixed Satellite Services. In this work, Reflection co-efficient for each band (S11= -17.16dB for 1.5GHz, S_{11} = -14.75dB for 1.87GHz, S_{11} = -13.89dB for 2.7GHz, S_{11}= -21dB for 3.32GHz, S_{11} = -33.98dB for 4.05GHz), VSWR, and Radiation patterns are simulated using Ansoft HFSS. Antenna is fabricated using ELEVEN LAB then reflection coefficients and VSWR values of the proposed antenna are measured by using the network analyzer. Simulated results are good agreement with practical results.

Keywords - Microstrip patch antenna, Multiband operations, slot, and wireless communication.

I. INTRODUCTION

Due to the rapid development in the wireless communication systems, it requires low profile, high gain, light weight, and simple structure antennas to promise mobility, reliability, good radiation pattern and high efficiency characteristics [1].

Microstrip patch antennas are well suited for most of the modern wireless communication systems due to their low profile, low-cost, ease of fabrication, simple to integrate with other system components, and well closed packages, that makes them well suited for consumer applications [2].

Although patch antennas have many advantages one of the main drawbacks its narrow bandwidth due to surface wave losses [2].

Therefore, attention in multi-band antennas are getting increased, particularly in order to reduce the number of antennas entrenched for combining many wireless applications on a distinct antenna.

Printed antennas with moderate radiating characteristics have the capability to operate at multiple frequency bands. It is advantageous for single handset to support different communication services such as data, voice and video simultaneously [3], [4].

Different techniques to accomplish multiband operations for printed antennas have been analyzed [5], [6]. These techniques includes the usage of one main radiator with some additional sub patches [5], different slot shapes [7], [8], multi layer stacked patch shapes [9] and fractal shapes [9]-[12].

In this paper multiband printed antenna is designed to operate at the five different frequency bands with the center frequencies of 1.5GHz, 1.87GHz, 2.7GHz, 3.32GHz and 4.05 GHz. The antenna consists of main radiating patch, three additional sub-patches and slot shapes to generate specified frequency bands. The operating bands of proposed antenna are evaluated with the criterion of return loss S_{11} < -10dB. Radiation patterns over the entire frequency bands are simulated.

In Section II the complete structure of the proposed antenna design and fabrication of the proposed antenna is described in detail. In section III simulated results with the evaluated parameter values such as return loss, VSWR, Radiation patterns and practically measured S_{11} and VSWR values are described. Finally, conclusions are briefly shown in Section IV.

II. ANTENNA DESIGN

The proposed antenna geometry is shown in fig 1. Antenna is fabricated on the FR4 Substrate with a dielectric constant of 4.4 and loss tangent of 0.02. Height of the substrate is taken as 2mm. Antenna is fed by 50 Ω Microstrip line. Dimensions of the proposed antenna are shown in the Table 1.Size of the antenna is 50×60 mm^2

Main patch is designed to operate at 2.7GHz. The dimensions of the main patch are optimized as width = 60mm and length =37mm. Then the length of the main patch is reduced from 37 mm to 8mm in order to add three sub patches without affecting the radiating characteristics of the antenna at 2.7GHz. After adding three sub patches with inverted U-Slot and inverted T-Slot in the 2nd sub patch and rectangular slot in 3rd sub patch, multiband operating characteristics of the antenna is obtained.

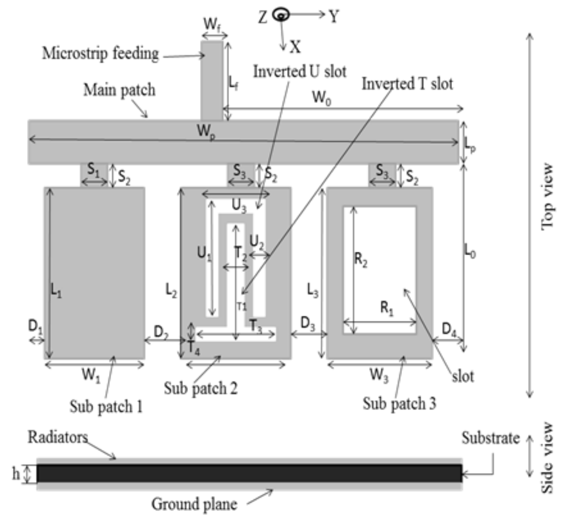

Fig. 1.Antenna geometry

TABLE 1.Dimensions of Proposed Antenna (Units: mm)

W_f	Lf	W0	Wp	Lp	L0	L1	W1
4	13	38	60	8	19	24	13
L2	W2	L3	W3	S1	S2	S3	U1
24	17	24	14	3	3	4	15
U2	U3	T1	T2	T3	T4	D1	D2
2	17	16	5	14	3	1	5
D3	D4	R1	R2	H	TOTAL SIZE		
4	4	10	20	2	50×60×2 mm^3		

Proposed antenna is fabricated by using the ELEVEN LAB as shown in the fig 2. Here the MITS Design Pro software is used to interface the ELEVEN LAB with PC. Fabricated proto type model is shown in the fig 3.

Fig.2.Fabrication of proposed antenna using ELEVEN LAB

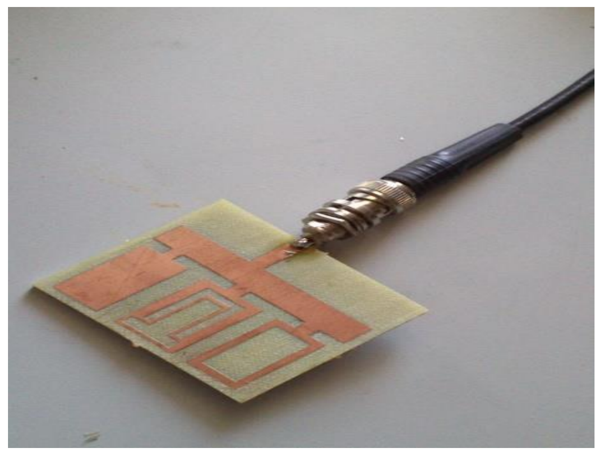

Fig.3.Prototype model

III. RESULTS AND DISCUSSION

Simulation Results:

a). Return Loss

The reflection coefficient (S_{11}) of the proposed antenna is shown in Fig 4.It is obtained from the simulation using Ansoft HFSS software. It is noted that, if the reflection coefficient is less than -10dB means the resonant is excited. For this, the antenna is operating at five different resonance frequencies 1.5GHz, 1.87GHz, 2.7GHz, 3.32GHz and 4.05 GHz.

The percentage (%) of bandwidth for each band is shown in the Table 2. It is measured as given below

$$\% \text{ of bandwidth} = \frac{f_u - f_l}{f_c} \times 100$$

Here f_u and f_l are the upper and lower limits of frequency band, fc is the center frequency.

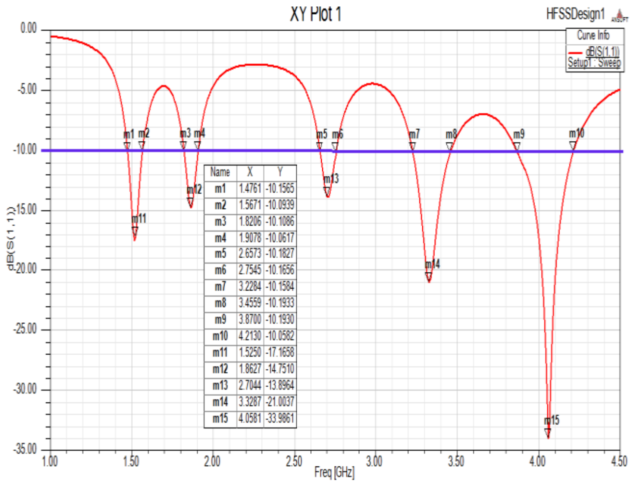

Fig.4.Reflection coefficient (S_{11}) of the proposed antenna

TABLE 2.Frequency and bandwidth of proposed antenna

Center Frequency (GHz)	Bandwidth (GHz)	% of bandwidth	S_{11}
1.52	1.47-1.56	6	-17.16
1.86	1.82-1.90	4.3	-14.75
2.70	2.65-2.75	3.7	-13.89
3.32	3.22-3.45	7	-21
4.05	3.87-4.21	8.4	-33.98

b). VSWR

VSWR value for each frequency bands are shown in fig 5. For all the five resonating frequency bands its value is ≤ 2.

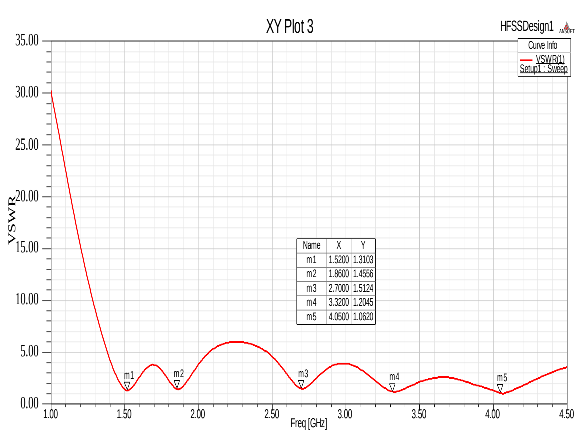

Fig.5.VSWR

c) Radiation pattern

Two-Dimensional Radiation Patterns of the all five resonant frequencies are shown in figs 6, 7, 8,9,10.

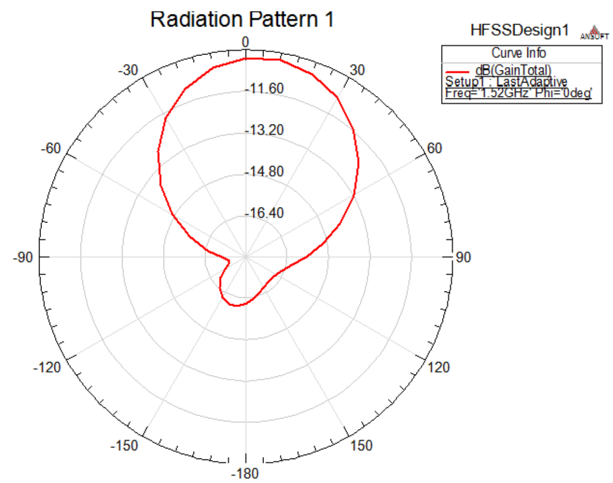

Fig. 6.Radiation Pattern at 1.52GHz

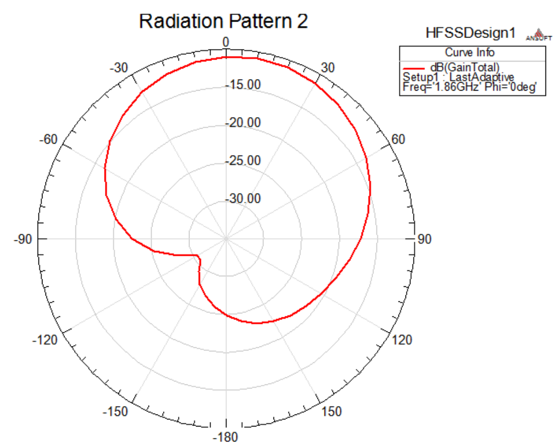

Fig. 7.Radiation Pattern at 1.86GHz

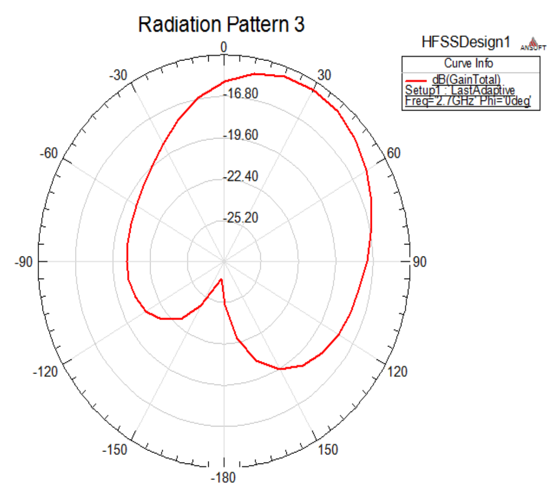

Fig. 8.Radiation Pattern at 2.7GHz

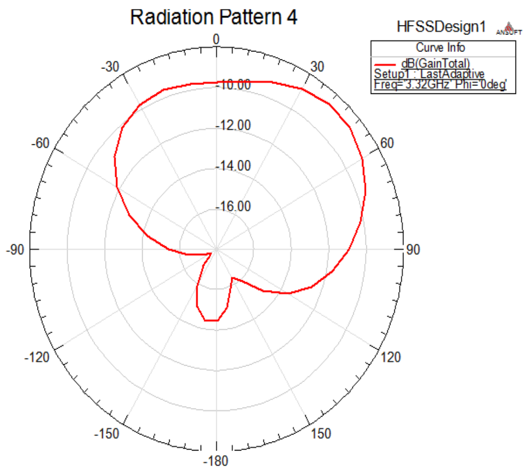

Fig. 9.Radiation Pattern at 3.32GHz

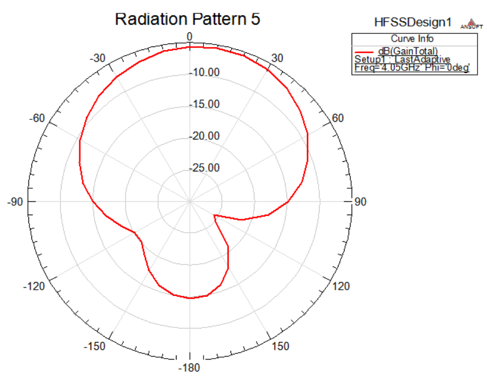

Fig.10.Radiation Pattern at 4.05GHz

Practical Results:

The reflection coefficient and VSWR values of the antenna is tested by using NA7300A/50Ω Vector Network Analyzer (300 KHz-3000MHz) as shown in the fig 11.

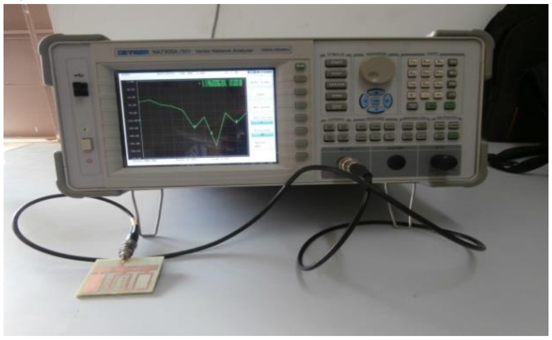

Fig. 11.Testing of antenna

Antenna is actually designed for five bands with center frequencies of 1.52GHz, 1.86GHz, 2.7GHz, 3.32GHz and 4.05 GHz. Here testing range of the network analyzer is up to 3GHz. So that reflection coefficient of the antenna at 1.52GHz, 1.86GHz, and 2.7GHz are measured as shown in the fig 12. VSWR values for these three bands are measured as shown in the fig 13.

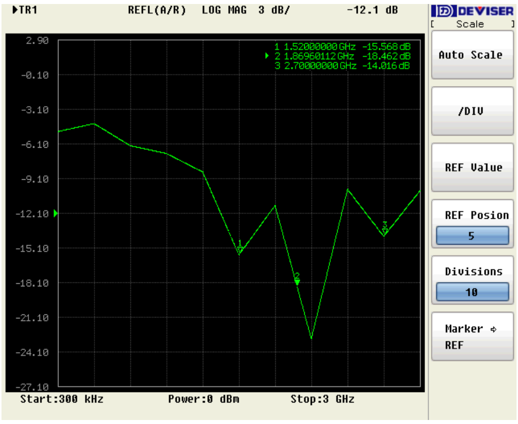

Fig.12.Measured S_{11}

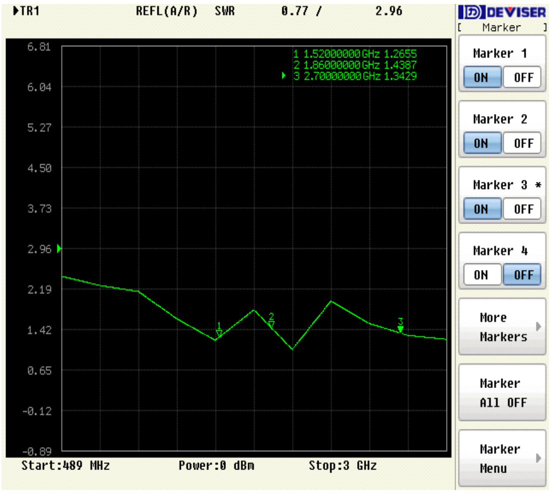

Fig.13.Measured VSWR

IV.CONCLUSION

In this paper the multiband Microstrip patch antenna is designed, fabricated and analyzed to operate at five different frequency bands with the center frequencies of 1.52GHz, 1.86GHz, 2.7GHz, 3.32GHz and 4.05 GHz. Reflection coefficient, Operating bandwidth , VSWR, Radiation Pattern of each band is analyzed by using HFSS Software. The reflection coefficients and VSWR values of the antenna is measured practically using network analyzer. Practical results are good agreements with the simulated results. The proposed antenna model is compact, easy to fabricate and is fed by simple Microstrip feeding that makes it more suitable for modern wireless communication systems.

REFERENCES

[1] Radouane Karli and Hassan Ammor, *"A Simple and Original Design of Multi-Band Microstrip Patch Antenna for Wireless Communication*", IJMA., Volume 2, No.2, March – April 2013.

[2] C.A. Balanis, Antenna Theory, 2nd ed. Ch. 14. New York: John Wiley & Sons, Inc., 1997.

[3] P. Salonen, M. Keskilamni, and Kivikoski, *"Single-feed dual band planar inverted-F antenna with U-shaped slot,"* *IEEE Trans. Antennas Propag.*, vol. 48, pp. 1262–1264, Aug. 2000.

[4] P. Salonen, M. Keskilamni, and Kivikoski, *"Dual-band and wide-band PIFA with U and meanerline-shaped slots,"* in *Proc. IEEE Int. Symp. Antennas Propag. Dig.*, Jul. 2001, vol. 2, pp. 8–13.

[5] Hsuan-Wei Hsieh, Yi-Chieh Lee, Kwong-Kau Tiong, and Jwo-Shiun Sun, *"Design of a Multiband Antenna for Mobile Handset Operations*", *IEEE Antennas And Wireless Propagation Letters, V*OL. 8, pp.200-203, 2009.

[6] Cheng-Chi Yu, Jiin-Hwa Yang, Chang-Chih Chen, and Wen-Chao Hsieh, *"A Compact Printed Multi-band Antenna for Laptop Applications*", *Progress In Electromagnetics Research Symposium Proceedings, Suzhou, China,*pp.611-614, Sept. 12-16, 2011.

[7] Hattan F. Abutarboush, R. Nilavalan, S. W. Cheung, and Karim M. Nasr, "*Compact Printed Multiband Antenna With Independent Setting Suitable for Fixed and Reconfigurable Wireless Communication Systems*" *IEEE Trans. Antennas Propag.*, vol. 60, no. 8, august 2012.

[8] Y. Lee and J. Sun, "*A new printed antenna for multiband wireless applications*," *IEEE AntennasWireless Propag. Lett.*, vol. 8, pp. 402–405, 2009.

[9] N. Bayatmaku, P. Lotfi, M. Azarmanesh, and S. Soltani, *"Design of simple multi-band patch antenna for mobile communication applications using new E-shape fractal," IEEE Antennas Wireless Propag. Lett.*, vol. 10, p.p 873-875,2011.

[10] J. Anguera, C. Puente, C. Borja, and J. Soler, *"Dual-frequency broadband- stacked microstrip antenna using a reactive loading and a fractalshaped radiating edge," IEEE Antennas Wireless Propag. Lett.*, vol. 6, pp. 309–312, 2007.

[11] Homayoon Oraizi and Shahram Hedayati, *"Miniaturized UWB Monopole Microstrip Antenna Design by the Combination of Giusepe Peano and Sierpinski Carpet Fractals", IEEE Antennas Wireless Propag. Lett.*, vol.10, pp. 67-70,2011.

[12] M. Sanad, *"Double C-patch antennas having different aperture shapes*," in *IEEE Proc. on Antennas and Propagation*, pp. 2116–2119, Jun. 1995.