

Design and Analysis of S shaped Coupled Microstrip Patch Antenna

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ABSTRACT: In this research paper, microstrip patch antenna with S-shaped coupled is analysed. Proposed antenna is suitable for band (1.888 – 2.679 GHz) for wireless communication. The proposed antenna meet the required impedance bandwidth is 34.639 %. The dimension of proposed antenna is (29.5 × 38.0 × 1.6 mm³). This antenna exhibits bandwidth at 2.43 GHz and gain 3.184 dBi. The archived band can be optimized by change parameter of S – Shaped coupled microstrip patch antenna. The variation in the design structure from S-shaped antenna is coupling in the structure and varying the gap of coupling. The proposed antenna by introduces coupling in the rectangular S shaped radiating patch, is suitable for application such as WLAN 2.4 GHz is realized for VSWR around 1.01.

KEYWORDS: Slotted Microstrip patch antenna, Feed-line, Return loss, Radiation pattern, WLAN.

I. INTRODUCTION

Wireless communication devices mobility has increased the demand for compact and low profile antennas. The frequency range of proposed antenna is (1.888 - 2.679 GHz) used for wireless Communication such as Wireless Local Area Network (WLAN) which operated at 2.4 GHz resonant frequency. In the proposed antenna the patch is designed in S-shaped for WLAN application realized by coupling in the proposed antenna [1]. It may be used as indoor WLAN antenna application and is small enough that it will be compatible into any environment. To generate band for 2.4 GHz WLAN operation, a compact S- shaped antenna is designed whose top and bottom length and width of the patch antenna (29.50 × 38.00 × 1.6 mm³) and length and width of the ground of the antenna is (39.50 × 48.00 × 1.6 mm³). Patch antennas and planar antennas are proposed for cellular and WLAN applications [2]. The antenna dielectric substrate FR4 epoxy of thickness of 1.6 mm and dielectric constant of 4.4 is used because it is cheap and easily available. The antenna is driven by a 50 Ω microstrip line. In this paper design of single band of S-shaped microstrip patch antenna is designed that cover frequency band (1.888-2.679GHz) at 2.43 GHz resonant frequency which can be well used for 2.4 GHz WLAN applications. The directivity and gain of the antenna is satisfactory for wireless communication. Shifting in the resonant frequency is done by varying the parameters of the antenna. The VSWR of the antenna is around 1.01 which indicates the impedance matching of the proposed antenna is as per requirement [3]. The VSWR of proposed antenna is very important for used communication purpose. The advantages of the proposed S-shaped antenna are: easy configuration, good VSWR, good efficiency and good radiation pattern [4-7]. The proposed antenna used parameters of S-shaped couple in the rectangular antenna is analysed to adjust each of the operating bands; due to this the proposed antenna design can be used for other wireless band [8-10].

II. GEOMETRY OF THE PROPOSED ANTENNA

For calculation of dimension several parameter such as resonant frequency (f_r), substrate thickness (h), loss tangent (tan δ), and dielectric constant (ϵ_r), and 50Ω Microstrip line is used as feed into patch are required. The antenna specifications that are required are given in Table 1.

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Table 1: Antenna Design Specifications

S.No.	Antenna Parameter	Values
1	Resonant Frequency (f_r)	2.4 GHz
2	Substrate thickness (h)	1.6 mm
3	Dielectric constant (ϵ_r)	4.4
4	Loss tangent ($\tan \delta$)	0.0013

III. PROCEDURE FOR ANTENNA DESIGNING

In the designing of proposed antenna firstly design a rectangular patch with calculated dimension of patch and ground plane and design an S-shape on the patch. Then coupling is introduced with the gap of C_a , C_b , and C_c . S-shaped design has been modified by varying the thickness and position within the patch and introducing the coupling with the variable length and width and these steps is performed stepwise. By following this procedure the bandwidth has been enhanced and resonant peak shifted towards lower frequency side. Dimensional parameters of proposed antenna are listed in Table 2.

Table 2: Calculated Antenna Dimensions

S.No.	Antenna Dimension	Values (mm)
1.	Ground Length (L_g)	39.50
2.	Ground Width (W_g)	48.00
3.	Patch Length (L_p)	29.50
4.	Patch Width (W_p)	38.00
5.	L_a	13.90
6.	L_b	10.50
7.	L_c	14.15
8.	L_d	10
9.	L_e	2
10.	L_f	5
11.	C_a	3
12.	C_b	3
13.	C_c	3

IV. SIMULATION AND DISCUSSION

The performance of proposed microstrip patch antenna is analysed by antenna designing software like IE3D simulation software tool at select resonant frequency of 2.4 GHz. A 50Ω microstrip line feed is inserted at the middle of length of the patch antenna and the design of calculated S-shaped coupled microstrip patch antenna is shown in Fig.1. Simulation result of return loss is plotted for the range of frequency 1GHz to 3GHz and the curve crosses the -10dB as shown in Fig.2. It is calculated that the fractional bandwidth of proposed antenna is 34.639 % which lies between 1.888 GHz to 2.679 GHz band and Return loss is -42.025 dB at resonance frequency 2.43 GHz has been obtained.

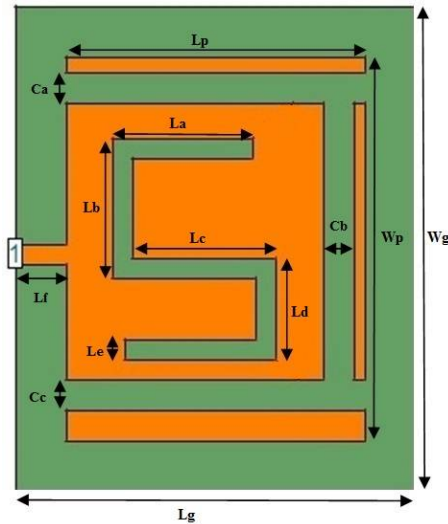


Fig.1 Geometry and dimension of the proposed Antenna

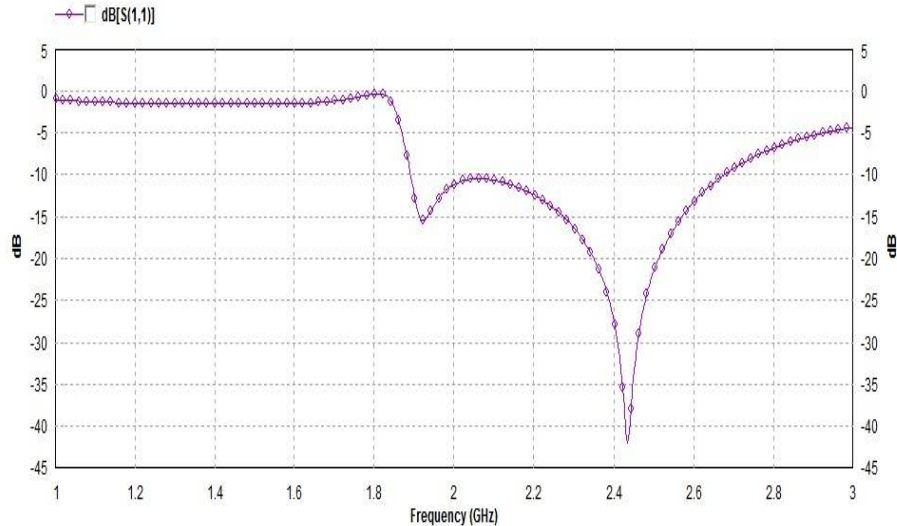


Fig.2 Simulation result of return loss

It is also observed that operating resonance frequency 2.43 GHz shows close agreement with designed resonance frequency 2.40 GHz, above Result is the optimized result which is obtained by performing the different variation in the antenna parameter which is discussed below stepwise:

A. Effect of Coupling

As the S-slotted patch antenna is optimized, it is necessary to improve the various characterized of the antenna by introducing the number of coupling in the antenna design. There are three coupling is introduced in the design first of all only one coupling is inserted which is left of the line feed as shown in Fig.3 (a), then an extra coupling is used which is along the width of the patch as shown in Fig.3 (b) and last coupling is inserted at the right of the feed line as shown in Fig.3(c). Variation in the resonant frequency, Return loss, bandwidth and Gain are listed in Table 3 and their simulated return loss is shown in Fig.4.

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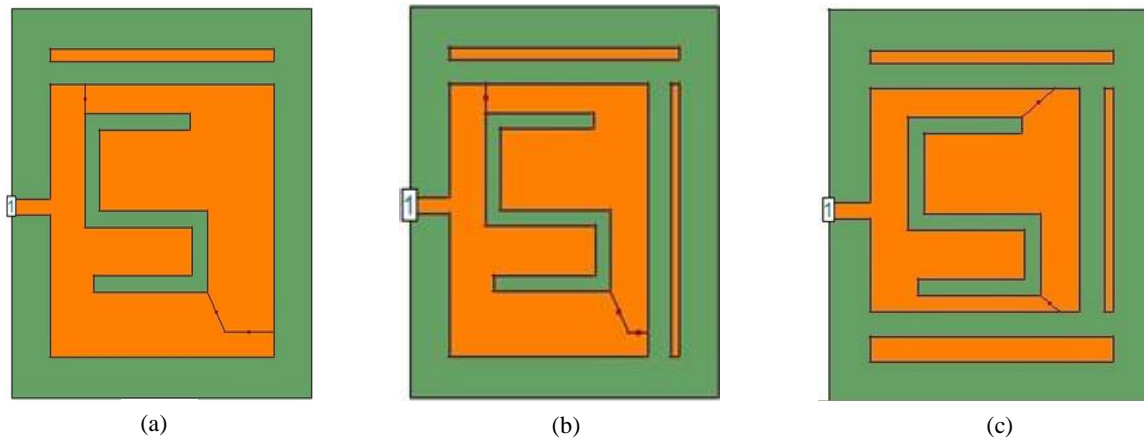


Fig.3 Antenna layout with coupling (a) with one coupling effect (b) with two coupling effect (c) with three coupling effect (proposed antenna)

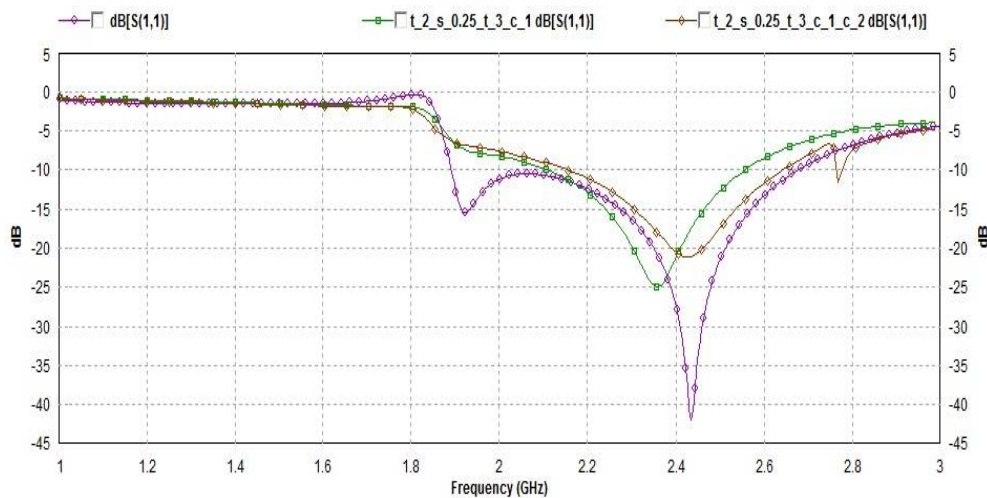


Fig.4 Representation of return loss of different number of coupling

Table 3: Result of the effect of number of the coupling in the S shaped antenna

No. of Coupling	Resonant Frequency (GHz)	Return loss (dB)	Lower Frequency (GHz)	Higher Frequency (GHz)	Bandwidth (%)	Gain (dBi)
1	2.357	-25.067	2.113	2.559	19.092	3.141
2	2.427	-21.164	2.153	2.643	20.456	3.221
3	2.434	-42.025	1.888	2.679	34.639	3.184

B. Effect of Varying Length and Width of Coupling

Once the coupling effect is done some parameters get improved .To obtained the optimum result variation of the parameter values of C_a , C_b and C_c is performed. For the analysis purpose let the coupling gap $C_a= C_b = C_c = C$.Let $C=1$ mm then obtained bandwidth is 28.99% and Gain is 3.176 dBi. If $C=2$ mm then obtained bandwidth is 32.22% and

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Gain is 3.196 dBi. If C=3 mm then obtained bandwidth is 34.63% and Gain is 3.184 dBi and if C=3.5mm then dual band is obtained whose bandwidth are 8.27% and 25.57% at resonant frequencies 1.898 GHz and 2.455 GHz respectively with Gain of 3.165 dBi. Variation in the resonant frequency, Return loss, bandwidth and Gain are listed in Table 4 and their simulated return loss is shown in Fig.5.

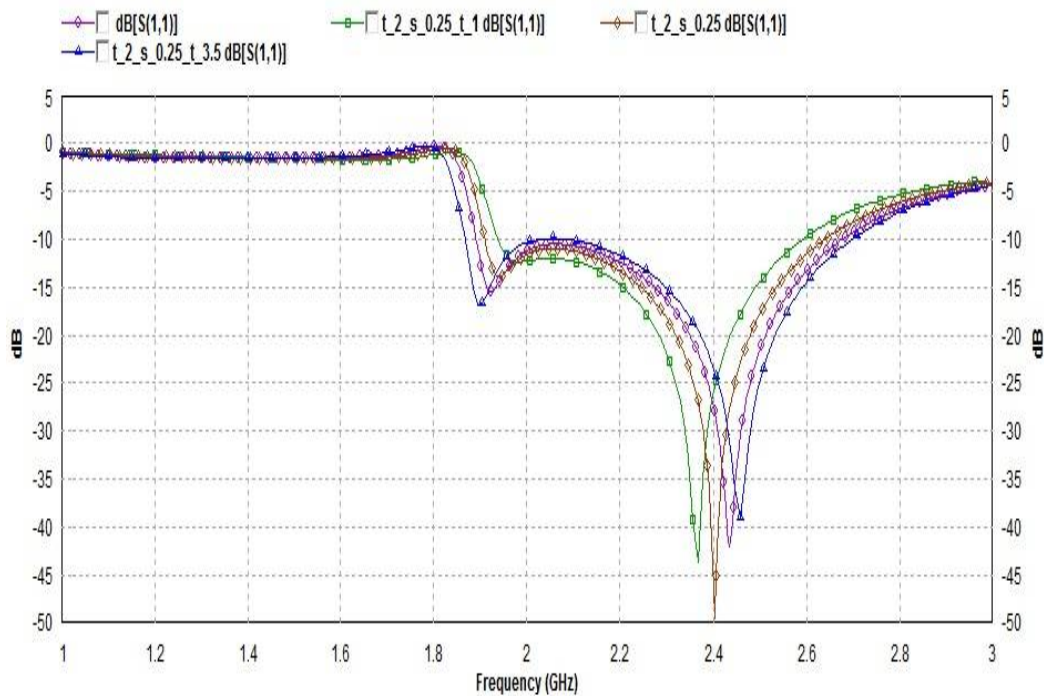


Fig.5 Representation of return loss on varying the coupling gap

Table 4: Result of the effect of the coupling gap in the S shaped antenna

S.No.	Coupling gap (C)	Resonant Frequency (GHz)	Return loss (dB)	Lower Frequency (GHz)	Higher Frequency (GHz)	Bandwidth (%)	Gain (dB)
1	1 mm	2.363	-45.25	1.936	2.593	28.99	3.176
2	2 mm	2.40	-49.57	1.908	2.641	32.22	3.196
3	3 mm	2.434	-42.02	1.888	2.679	34.63	3.184
4	3.5 mm	1.898	-17.02	1.866	2.027	8.27	3.165
		2.455	-39.19	2.087	2.699	25.57	

Graph of Gain vs. Frequency of proposed antenna are shown in Fig.6.

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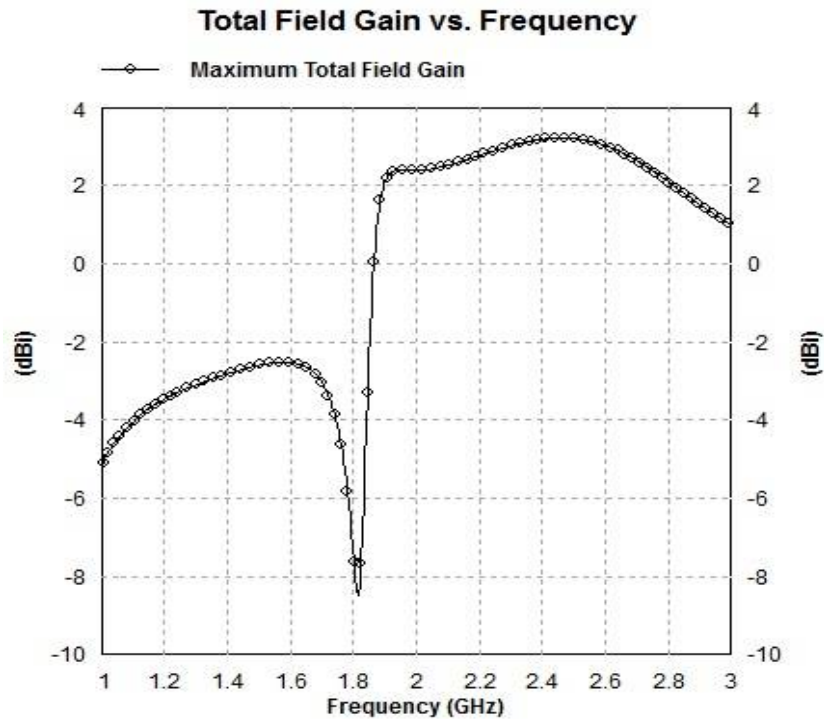


Fig.6 Gain vs. Frequency graph

The gain of proposed antenna at resonance frequency is 3.184 dBi.

Graph of and Directivity vs. Frequency of proposed antenna is shown in Fig.7.

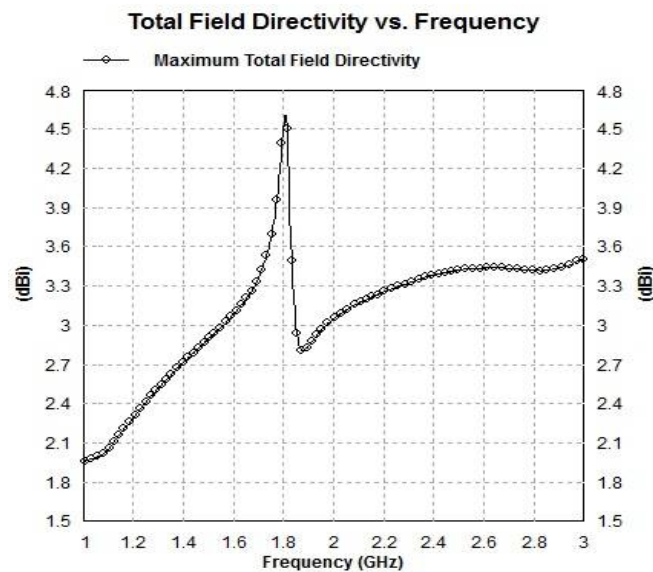


Fig.7 Directivity vs. Frequency graph

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The directivity of proposed antenna at resonance frequency is 3.387 dBi.

The graph of Efficiency of proposed antenna is shown in Fig.8.

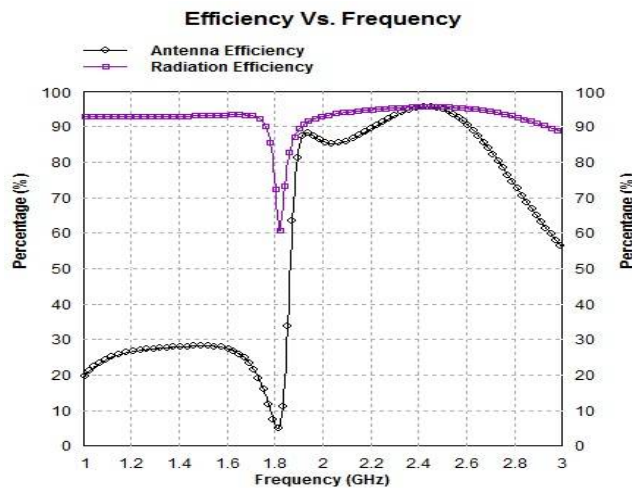


Fig.8 Efficiency vs. Frequency graph

It is calculated that the maximum antenna efficiency and radiation efficiency at resonant frequency of proposed antenna is 95.420 % and 95.539 % respectively.

The graph of radiation pattern of proposed antenna is shown in Fig.9.

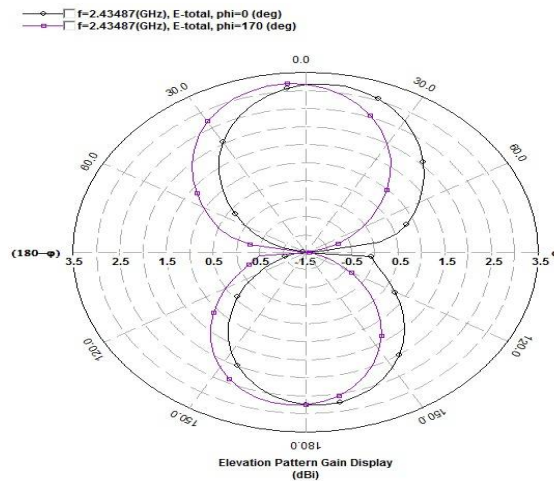


Fig.9 Radiation pattern

The radiation pattern represents radiation of all power in two directions therefore it shows that the proposed antenna has bidirectional radiation pattern.

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V. CONCLUSION

S-shaped coupled microstrip patch antenna is proposed and analysed for the operation of Wireless Local Area Network (WLAN) band (1.888 – 2.679 GHz) at 2.43 GHz resonant frequency and enhanced bandwidth is up to 34.639 %. The measured VSWR is about 1.01 is obtained at 2.43 GHz. Small variation is obtained between the operating frequency and design frequency of the proposed antenna. The design technique of the proposed antenna is used for the wireless Communication.

REFERENCES

- [1] U. Chakraborty, "Compact Dual-Band Microstrip Antenna for IEEE 802.11a WLAN Application", IEEE Antenna and Wireless Propagation, vol. 13, pp. 407-410, 2014.
- [2] Bahadir Yildirim, "Dielectric – Loaded Compact WLAN / WCDMA Antenna with shorted and Monopole Element.", IEEE Antenna and Wireless Propagation, vol. 12, pp. 288-291, 2013.
- [3] Garg, R., Bhartia, P., Bahl, I., Ittipiboon, A., "Microstrip Radiators", Microstrip Antenna Design Handbook, Artech House, Inc, Boston, London, 2001.
- [4] C. A. Balanis, "Antenna Theory: Analysis and Design", John Wiley and Sons, INC., New York, Third Edition, 2005.
- [5] Chih-Ching Chen, "Novel Compact Quad - Band Narrow strip-Loaded printed Monopole Antenna.", IEEE Antenna and Wireless Propagation, vol. 8, pp. 974-978, 2009.
- [6] A.A Deshmukh and G. Kumar, "Compact broadband S-shaped microstrip antennas", Electronics Letters, vol. 42, no. 5, pp. 260 – 261, 2006.
- [7] J. M. Patel, S. K. Patel and F. N. Thakkar, "Design of S-shaped multiband microstrip patch antenna," 2012 Nirma University International conference on Engineering (NUiCONE), Ahmedabad, pp.1-3, 2012.
- [8] K. L. Wong and W. H. Hsu, "A Broadband Rectangular Patch Antenna with a Pair of wide slits", IEEE Transactions on Antennas & Propagation, 49, pp. 1345 – 1347, 2001.
- [9] Shuo Liu, Wen Wu, and Da-Gang Fang "Single-Feed Dual-Layer Dual-Band E-Shaped and U-Slot Patch Antenna for Wireless Communication Application" IEEE Antennas and Wireless Propagation Letters, Vol. 15, pp.468-471, 2016.
- [10] X.M Yang, X. G Liu, Xiao Yang Zhou, and Tie Jun Cui, "Reduction of Mutual Coupling between Closely Packed Patch Antennas using Wave guided Metamaterials", IEEE Antennas and wireless propagation letters, Vol. 11, 2012.