International Journal of Scientific Research in Science, Engineering and Technology
Print ISSN: 2395-1990 | Online ISSN : 2394-4099 (www.ijsrset.com)
doi : https://doi.org/10.32628/IJSRSET2293130

A Design for the Bandwidth Improvement for the Microstrip Patch Antenna for Wireless Network Sensor

Dr. Mawahib Sharafeldin Adam Boush[1], Dr. Chamandeep Kaur[2]
[1]Assistant Professor, Computer Science Department, Jazan University, Saudi Arabia
[2]Lecturer, Computer Science Department, Jazan University, Saudi Arabia
Orcid ID: https://orcid.org/0000-0002-9520-3411
Correspondence should be addressed to Dr. Chamandeep Kaur; kaur.chaman83@gmail.com

Article Info
Volume 9, Issue 3
Page Number : 396-403
Publication Issue :
May-June-2022
Article History
Accepted : 05 June 2022
Published: 14 June 2022

ABSTRACT
The microstrip patch antenna is extensively used in the wireless network because the Microstrip patch Antenna can be easily manufactured. Bandwidth Improvement of the Microstrip patch antenna is shown in this paper. The Antenna is made at the 8.5GHz frequency. The material used for the substrate is FR4-epoxy. For this material, the dielectric loss tangent is 0.0018. This antenna observes the Bandwidth to 660MHz, gain 5.4028, Directivity 5.5068, return loss -37.0048, and VSWR 1.0629. In this design there is an Improvement of bandwidth to 660 MHz which is suitable for wireless network applications and the software which is being used for the simulation is the High-Frequency Structure Simulator which is also known as HFSS.
Keywords – Parasitic patch with square slot, Bandwidth, Microstrip Patch Antenna, and Wireless applications.

I. INTRODUCTION

A microstrip patch antenna is one of the most popular types of printed antenna. Microstrip patch Antenna is widely used all over the world for wireless transmission. It plays a very significant role in today's world of wireless network systems as well as cordless transmission systems. Because of the miniature size of the Microstrip antenna, having a less price, and reduced mass for that reason they are used over the other Antenna. There are many advantages of the Microstrip patch antenna and there are many other technologies invented for the improvement of bandwidth, directivity, and gain. The bandwidth is increased by decreasing its dielectric constant value. However, increasing the bandwidth using this technique can cause some practical issues such as increasing in Antenna cost [1].

In this paper, the Microstrip Patch Antenna works on the 8.5GHz frequency. A parasitic patch with a square slot is made to improve the bandwidth. We can also use other methods for bandwidth improvement to increase the substrate thickness using a deflected ground [7]. There are some issues to enhance the thickness of the substrate. If the value of the thickness is enlarged beyond 0.1λ, then there happens an abasement of the Microstrip Patch antenna attainment due to the surface wave propagation [9]. So as we know the drawbacks of the above-mentioned method so we are using a parasitic patch with a square slot method for the bandwidth Improvement. With the help of this method, there doesn't exist a deterioration of the Microstrip Patch antenna performance. We have increased the Bandwidth by using a square slot instead of using a rectangle slot on the parasitic patch. Bandwidth Improvement of Microstrip patch antenna using parasitic patch is up to 660 MHz.

II. Microstrip patch Antenna Design

The below-mentioned figure shows the Antenna design. The substrate is made of FR4 epoxy material and the thickness given to this substrate is given as 1.6mm. The dielectric loss tangent for the material is 0.0018. In the given design the patch is divided into two parts named as main patch and the parasitic patch. In the main patch, a hexagon slot is used and a square slot is used in the parasitic patch. The dimensions are explained with the help of the given table.

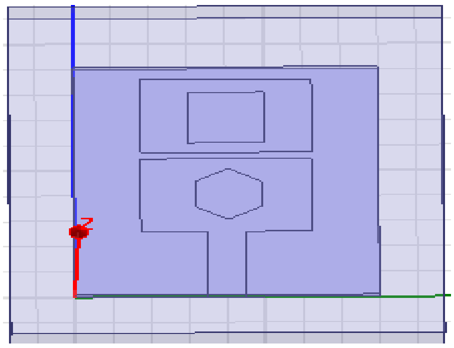

Fig. 1. Microstrip Patch Antenna Design

$fo, h, \varepsilon r$

Step 1: To find the Wavelength of the Antenna:

$$\lambda = \frac{C}{f}$$

Step 2: To find the width of the Patch:

$$w = \frac{c}{2f}\sqrt{\frac{2}{\varepsilon r + 1}}$$

Step 3: To find the Length of the Patch:

$$L = Leff - 2\Delta L$$

$$\text{Where } \sqrt{Leff = \frac{c}{2f\sqrt{\varepsilon reff}}}$$

$$\text{Where } \varepsilon reff = \frac{\varepsilon r+1}{2} + \frac{\varepsilon r-1}{2}\left[1 + 12\frac{h}{w}\right]^{-\frac{1}{2}}$$

Where Ereff = Effective dielectric constant

Step 4: The normalized extension in the length is given by:

$$\text{Where } \Delta L = \frac{0.412\, h(\varepsilon reff+0.3)\left(\frac{w}{h}+0.264\right)}{(\varepsilon reff-0.258)\left(\frac{w}{h}+0.8\right)}$$

Step 5: To find the various parameters of length

$$Lg = L + 6h$$

$$Wg = W + 6h$$

Where Lg and Wg are the length and width of the substrate.

$$h = \frac{0.0606\lambda}{\sqrt{\varepsilon r}}$$

Step 5: Feed line length is calculated by:

$$Lf = \frac{\lambda g}{4}$$

Where λg stands for the guided wavelength and it is given by:

$$\lambda g = \frac{\lambda}{\varepsilon reff}$$

Step 6: Efficiency of the Antenna is calculated by:

$$\eta = \frac{\text{Gain}}{\text{directivity}} \times 100\%$$

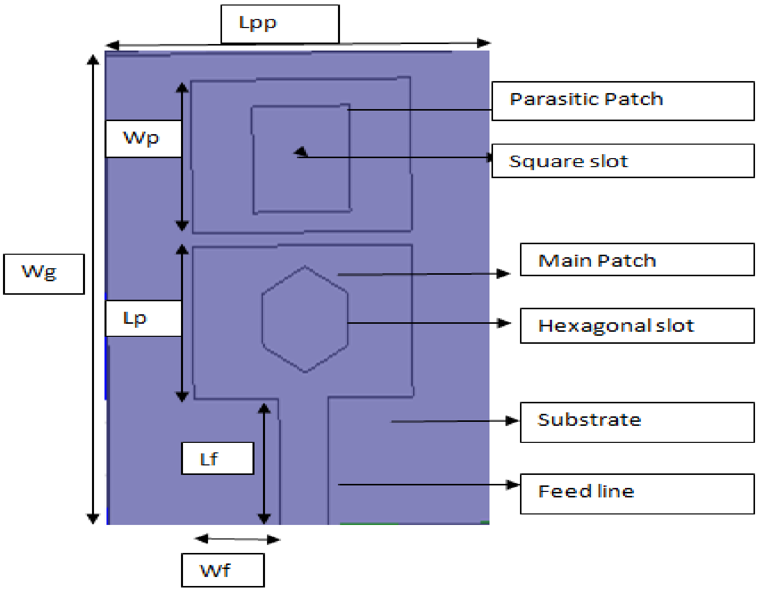

Fig. 2. Design Parameters of the Microstrip Patch Antenna

50 ohms input impedance for a feed line is used in this design. The patch is divided into two parts named as main and the Parasitic patch so there exists a gap between them of 0.5mm. The thing is less technical and more ethical and legal [6]. If there exists any variation in the distance then there is a change in the performance.

Table1. Dimension of Microstrip Patch Antenna Design

Parameter	Dimension
Ground length	16mm
Ground width	18mm
Substrate length	16mm
Substrate width	18mm
Substrate thickness	1.6mm
Main patch length	9mm
Main patch width	5.75mm
Parasitic patch length	9mm
Parasitic patch width	5.75mm

III. RESULTS AND DISCUSSION

The result for the parasitic patch with square slot Microstrip Patch Antenna is given below in the figure. This Antenna works at the 8.5GHz frequency and the calculated Bandwidth is 660 MHz this Bandwidth can also be written in the percentage form i.e. 7.76%. The return loss is obtained at -37.0048. There exist an increase in the bandwidth from 557.2MHz to 660 MHz or 6.55% to 7.76%. The return loss obtained is-41.4030 dB. In the percentage form, the bandwidth can be written as 6.55%. Concerning execution time and accuracy, the results are compared [12].

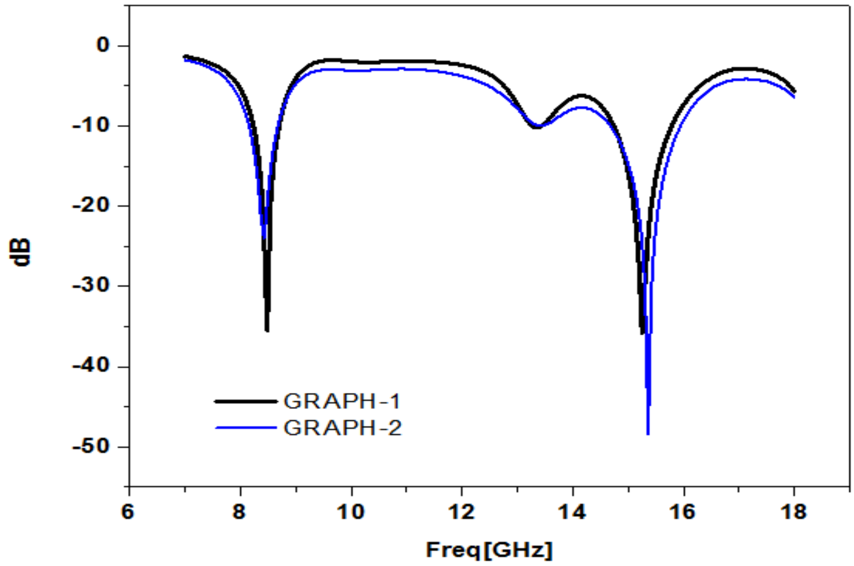

Fig.3 Bandwidth comparison of both the Antennas

The above figure shows the comparison between the bandwidth of the two antennas. The red & the black graph lines show the s11 parameters of the Microstrip antenna with different configurations.

IV. Radiation Pattern of the Microstrip Patch Antenna

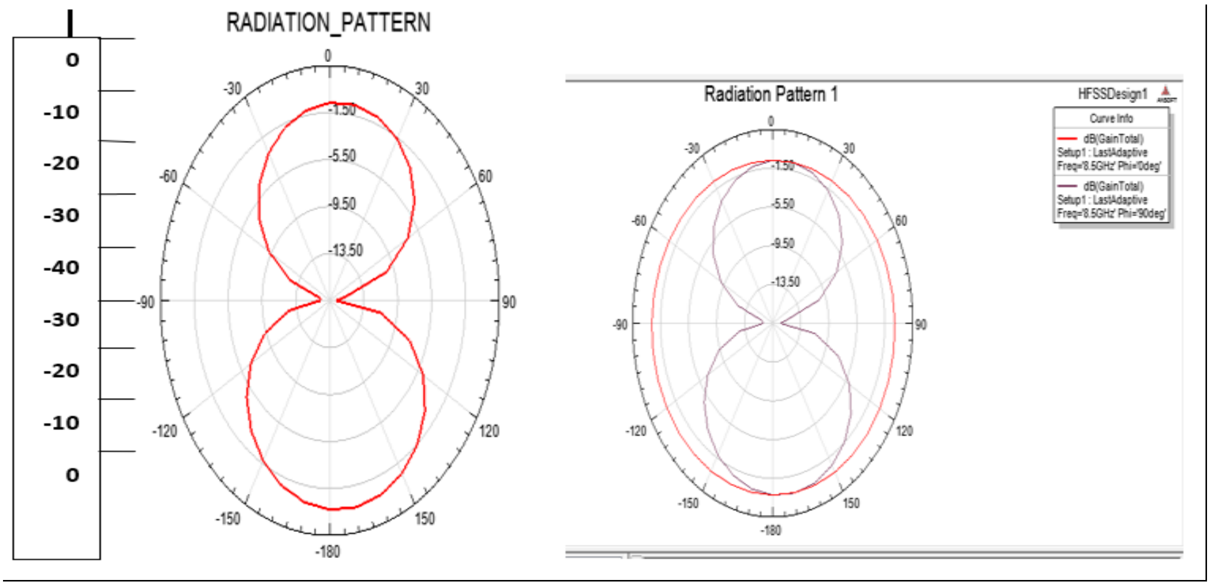

Fig.4 RADIATION PATTERN

Table 2. Comparison between design slots of both the Antennas

Design slot	VSWR	Return loss	Bandwidth
Rectangular slot	1.0172	-41.4030	557.2MHz
Square slot (This work)	1.0629	-37.0048	660MHz

The calculated VSWR is 1.0629.

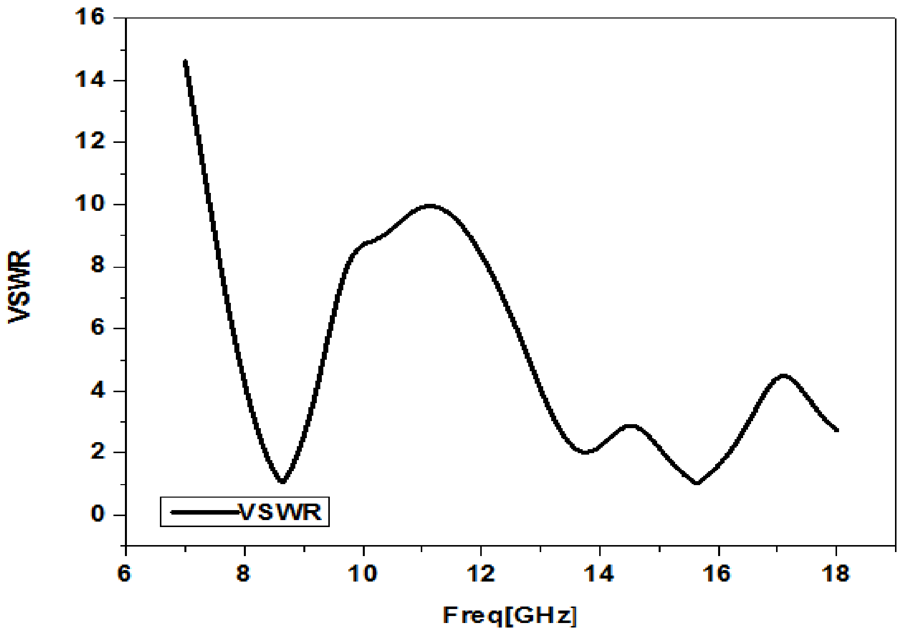

Fig 5. Plot of VSWR

The maximum gain of the made Microstrip Patch Antenna design is calculated to be 5.4028 dB.

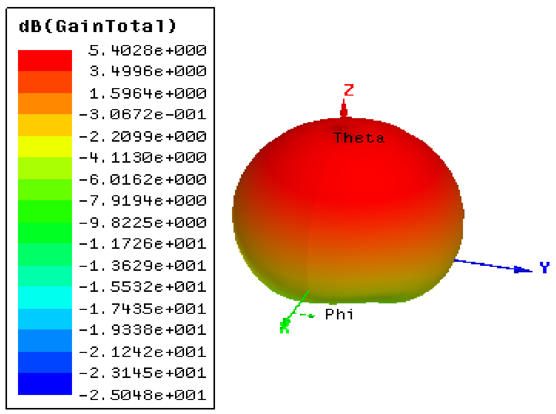

Fig. 6. Gain Result

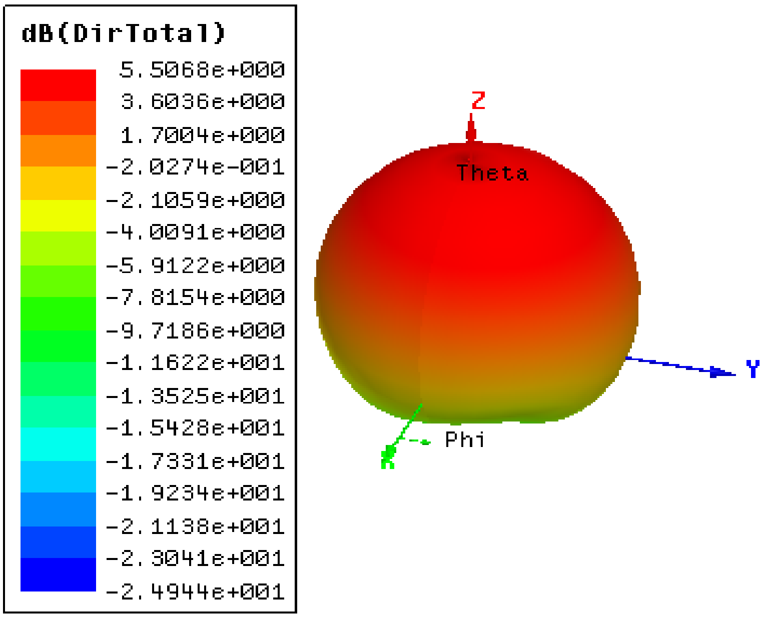

Fig. 7 Directivity Result

The maximum directivity of the Antenna is 5.5068.

Hexagon slot provides enhanced Bandwidth, Gain, Return Loss, directivity, and VSWR The comparative table is given below which shows all the comparisons done by the different methods and the analysis.

Table.3. Performance comparison with various slot on Microstrip Antenna

Slots used in the Microstrip Antenna	**Gain**	**Return loss**	**VSWR**	**Directivity(dB)**	**Bandwidth(MHz)**
Triangle	4.325	-35.80	1.21	5.348	423MHz
Square	4.532	-37.112	1.25	5.425	512MHz
Pentagon	5.723	-39.672	1.16	5.542	558MHz
Hexagon	5.402	-37.048	1.0629	5.506	660MHz

V. SURFACE CURRENT DISTRIBUTION ON THE PATCH

The surface current distribution of the designed Microstrip Patch antenna with the square slot is given below.

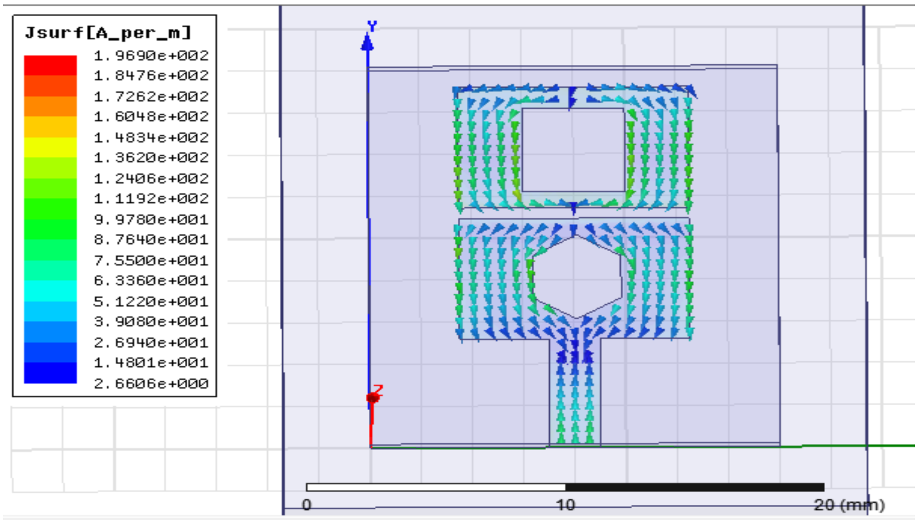

Fig. 8 Current distribution of Microstrip Patch antenna with the square slot.

VI. CONCLUSION

A parasitic patch with a square slot is used for the enhancement of the bandwidth. When a single square patch is used then the bandwidth becomes 440 MHz i.e. 5.14%. And it is observed that when a parasitic patch is made then the bandwidth is observed is 660 MHz i.e. 7.76%. The calculated efficiency of the proposed Microstrip Antenna is 98.12%. So it is a very good technique for the bandwidth improvement and this proposed design of the Microstrip Antenna has wide use in the wireless communication system.

VII. REFERENCES

[1]. Paritaba B Parmar, Balvant J Makwana, "Bandwidth Enhancement of Microstrip Patch Antenna Using Partasitic Patch Configration" International conference on Communication Systems and Network Technologies 2012.

[2]. C.A Balanis." Antenna Theory and Analysis," Second Edition, John Wiley &Sons, 1997.

[3]. Bharat Rochani, Rajesh Kumar Raj, "Design of Broadband Microstrip Patch Antenna With Parasitic Elements" International Journals of Advanced Research in Electrical, Electronics and Instrumentation Engineering.

[4]. "Microstrip Patch Antenna," www.electronicshome.com,Jan 2007.

[5]. RaviKant Parsad, D.K.Srivastava and J.P. Saini, "Gain and Bandwidth Enhancement of Rectangular Microstrip Antenna by Loading Slot", International Conference on Innovation and Challenges in Cyber Security.

[6]. C. Kaur, H. M. Mourad, and S. S. Banu, "Security and Challenges using Clouds Computing in Healthcare Management System," 2019.

[7]. Mrs.Devashree S.Marotkar, Dr.Prasannu", Zade, "Bandwidth Enhancement of Microstrip Patch Antenna using Deflected Ground Structure", International Conference on Electrical,

Electronics, and optimisation techniques, ICEEOT-2016.

[8]. S.T. Fan, Y.Z. Yin, B. Lee, "Bandwidth Enhancement of a Printed Slot Antenna with a Pair of Parasitic Patches".

[9]. Sungjan Yoo, Gangil Byun, " Design of Parasitic Patch Antenna with Parasitic Element for Minimised Polarisation Mismatch" 2016 URSI Asia-Pacific Radio Science Conference August 21-25, 2016 / Seoul, Korea.

[10]. Jonghun Lee, Yoon-Gu Kim and Jinung An, 'Enhanced Bandwidth of a Microstrip Antenna using a ParasiticMushroom-like Metamaterial Structure for Multi-Robot Cooperative Navigation ", Journal of the Korean physical Society, Vol. 66, No. 1, Janauary 2015, pp. 92-95.

[11]. Mekala Harinath Reddy.et. al, "Bandwidth Enhancement of The Microstrip Patch Antenna Using Patch Antenna" in the international conference on smart technologies management Veltech and DR SR university Chennai T.N 2-4 august, 2017 pp.295-298.

[12]. Kaur, Chamandeep, Mawahib Sharafeldin Adam Boush, Samar Mansoor Hassen, Wafaa Abushmlah Hakami, Mohammed Hassan Osman Abdalraheem, Najla Mohammed Galam, Nedaa Abdulaziz Hadi, and Atheer Omar S. Benjeed. "Incorporating Sentimental Analysis into Development of a Hybrid Classification Model: A Comprehensive Study." https://doi.org/10.53730/ijhs.v6ns1.4924

Cite this article as :

Dr. Mawahib Sharafeldin Adam Boush, Dr. Chamandeep Kaur, "A Design for the Bandwidth Improvement for the Microstrip Patch Antenna for Wireless Network Sensor", International Journal of Scientific Research in Science, Engineering and Technology (IJSRSET), Online ISSN : 2394-4099, Print ISSN : 2395-1990, Volume 9 Issue 3, pp. 396-403, May-June 2022. Available at doi : https://doi.org/10.32628/IJSRSET2293130

Journal URL : https://ijsrset.com/IJSRSET2293130