



## Design of Multiband Microstrip Slotted Antenna for Wireless applications

A.Madhuri , B.Phanendra, E.Sai Reddy, A.Prasanthe

Department of Electronics and Communication Engineering  
R.V.R.& J.C. College of Engineering

**Abstract:** Advancements of technology in the area of wireless communication production leads to the design and development of small, adaptable and accessible multiband antenna. To overcome the issue of using multi-frequency operation a novel method of multiband is proposed. This paper includes the design of microstrip patch antenna for multiband operations. This antenna covers various wireless frequency bands used for GSM (900MHz to 1800MHz), WLAN (5.2GHz to 5.8GHz), radar and satellite (8GHz to 12GHz) applications. It was designed using FR-4 substrate with dielectric constant 4.3, loss tangent of 0.025, substrate thickness of 1.6mm. Various parameters like return loss, radiation pattern, VSWR can be determined. The optimized antenna design is analyzed by using Computer Simulation Technology (CST) Software.

**IndexTerms-** Multiband, patch, Slots, Wireless, CST

### I. INTRODUCTION

The study of microstrip antennas has made great progress in recent years and is widely used in various types of applications. This antenna has more advantages and better prospects compared to conventional microwave antenna. Microstrip antenna provides various features such as comfortability and compatibility. Microstrip patch antenna have many admirable properties such as high performance, low cost. The well-known feature of the microstrip patch antenna is that they are reliable and robust in nature. Moreover, microstrip antennas can provide dual and circular polarizations, multi-frequency operation, frequency agility and feedline flexibility. The topology used for making microstrip patch antenna is U-shaped, which is used as multiband patch antenna.

Microstrip patch antenna is also known as printed antenna as it is fabricated on a printed circuit board (PCB). These plays a very significant role in today's wireless communication systems. These are majorly used at microwave frequencies. It consists of three layers one on top of the other namely ground, substrate and patch. Microstrip antennas consists of a very thin metallic strip placed on a ground plane in-between with a di-electric material. Patch is only the radiating element in the antenna and can be generally made up of conducting material such as copper and gold. The patch can be of any shape such as square, circular, rectangular, Annular ring, Triangular and elliptical. However, we usually prefer using square and rectangular shapes for the ease of analysis and fabrication. Patch can be fed by using various feeding techniques. These includes contacting methods such as coaxial probe feed, microstrip line feed and non-contacting techniques like aperture coupled feed, proximity coupled feed. The radiating patch and the feed lines are usually photo etched on the dielectric substrate. Microstrip patch antennas finds several applications in wireless communication such as WLAN, satellite communications, GPS (global positioning satellite) systems and also used in the fields of RFID (radio frequency identification), mobile communication and healthcare. Although patch antenna has numerous advantages like ease of fabrication, light weight and good radiation, it also has some drawbacks which include restricted bandwidth, low gain and a potential decrease in radiation pattern. The performance of microstrip patch antenna depends on several factors, including the shape and size of the patch, the thickness and dielectric constant of the substrate, the feed position, and the ground plane dimensions. These parameters can be optimized to achieve the desired radiation pattern and impedance matching.

### II. ANTENNA DESIGN

Firstly, the ground plane as Defected Ground Structure (DGS) with required dimensions is designed. Next , substrate of dielectric material FR-4 having dielectric constant  $\epsilon_r = 4.3$  , tangent loss  $\delta = 0.025$  and thickness 1.6mm is applied. The patch is designed in rectangular shape and is made of copper. Remove some portions of the rectangular patch so that it forms like inverted U-slotted patch antenna and can be fed by using microstrip line feed. The simple design of multiband microstrip antenna's front and back view are shown in figure 1 and figure 2.

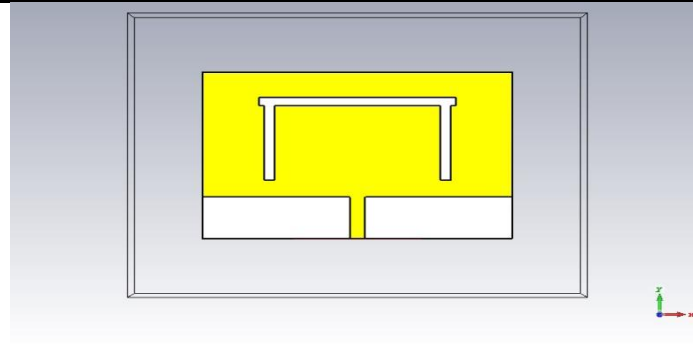


Fig.1: Front view

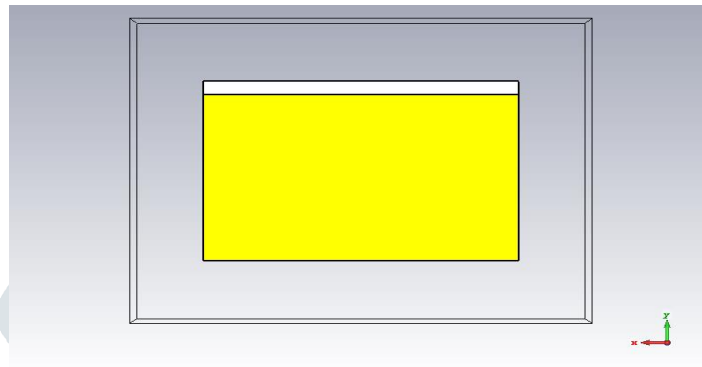


Fig.2: Back view

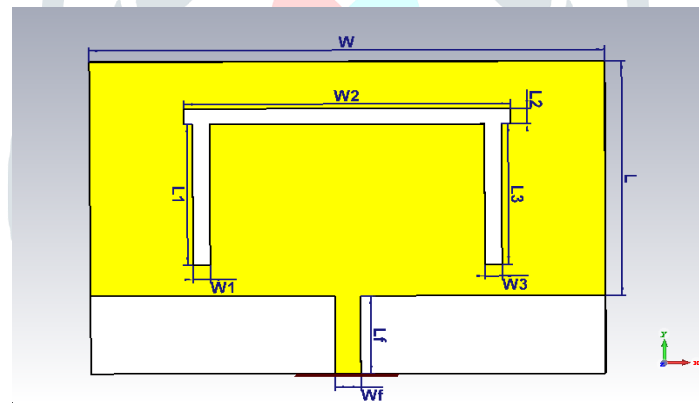


Fig.3: Dimensional view of Designed Antenna

The following Table 1 displays the dimensions of designed antenna structure.

Table 1: Dimensions of Antenna Structure

Antenna Dimensions	Measurement in mm
L	60
W	30
l1	18
w1	2
l2	2
w2	38
l3	18
w3	2
lf	20
wf	3

Here, W and L represents the width and length of patch. The l1, w1, l2, w2, l3, w3 are slots dimensions and lf, wf indicates the measurements of feed line as shown in Figure 3.

### III. SIMULATION RESULTS

Antenna simulation using CST involves several steps, including creating a virtual model of the antenna, setting up simulation parameters, running the simulation, and analysing the results. The simulation process involves the creation of a virtual model of the antenna, which includes the antenna geometry, material properties, and other relevant parameters. The virtual model is then solved using the FIT (Finite Integration Technique) method, and the results are analyzed to obtain the antenna's performance characteristics. CST provides a comprehensive set of tools for antenna simulation, including an extensive library of antenna models, a powerful post-processing tool for analyzing simulation results, and a user-friendly graphical user interface (GUI). The software package also allows for the optimization of antenna design parameters and automatically performing multiple simulations to find the optimal design.

Antenna simulation software is used in various fields that involve the design and optimization of antennas and other electromagnetic devices. Some of the fields where antenna simulation software is commonly used includes telecommunication, Automotive engineering, medical devices and consumer electronics. It helps engineers to accurately predict and optimize the performance of their designs.

#### RETURN LOSS

Return loss is an important parameter in antenna design and is often used to optimize the performance of antenna. It's a measure of how well the antenna is matched to the transmission line. A high return loss indicates that the antenna is well matched to the transmission line, and therefore most of the incident power is transmitted by the antenna, while a low return loss indicates that there is a mismatch between the antenna and the transmission line, which results in significant reflection of the incident signal. A return loss of 10dB or less is generally considered acceptable in many applications. The graphical representation of return loss( $S_{11}$ ) of simple multiband antenna at different frequencies is shown in figure 4.

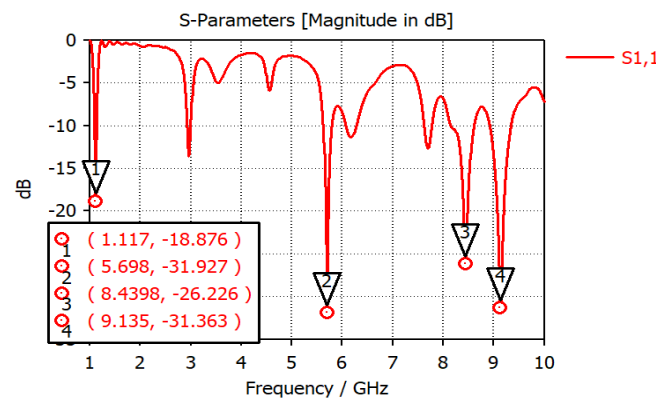


Fig.4: Return loss of Designed Antenna

#### VSWR (Voltage Standing Wave Ratio)

VSWR or Voltage Standing wave ratio is defined as the ratio of the maximum voltage to the minimum voltage along the length of the transmission line. In practical applications it is difficult to achieve a perfect match, and the VSWR value will be higher than 1:1. However, the goal is to minimize the VSWR to ensure maximum power transfer and minimize signal reflection. A high VSWR can result in significant signal loss, reduced range, and increased interference. In general, a VSWR value of less than 2:1 is considered acceptable in most applications, while values between 1.5:1 and 1.2:1 are considered good. However, the specific requirements may vary depending on the application, and in some cases, a VSWR value of less than 1.5:1 may be required for optimal performance.

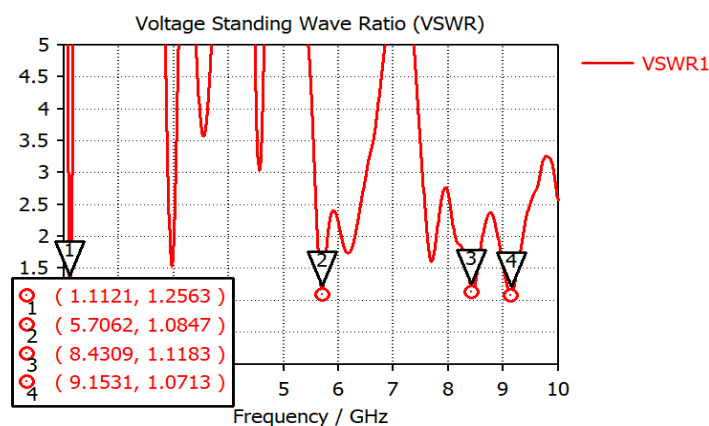


Fig.5: VSWR of Designed Antenna

## DIRECTIVITY

The Directivity is a measure of the concentration of radiated power in particular direction relative to the average radiated power. It is a key parameter in antenna design and is closely related to antenna gain, which is a measure of increase in power that an antenna provides in a particular direction compared to an isotropic radiator. A high directivity antenna is desirable in many applications, as it allows for greater power concentration in a particular direction, resulting in longer range, better signal-to-noise ratio, and increased signal strength. In general, microstrip patch antennas have moderate directivity, with values typically ranging from 6dBi to 12dBi.

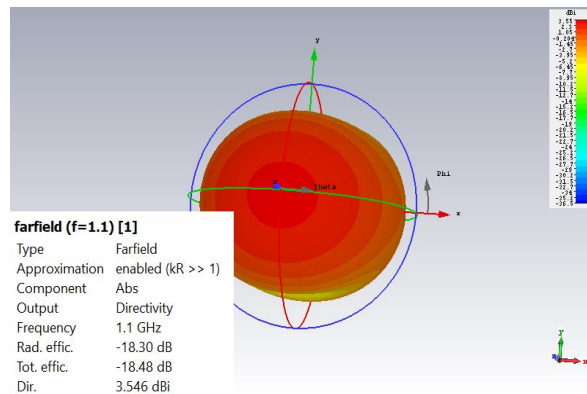


Fig.6: Directivity at 1.1GHz

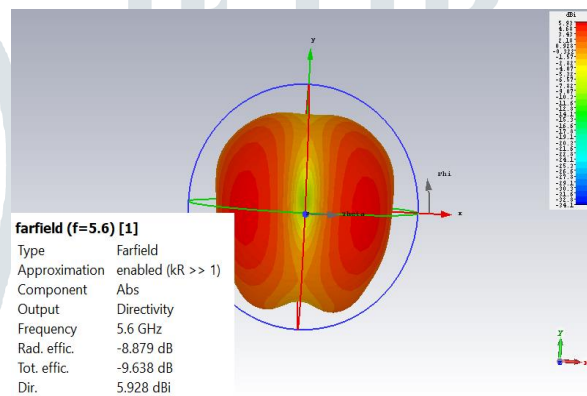


Fig.7: Directivity at 5.6GHz

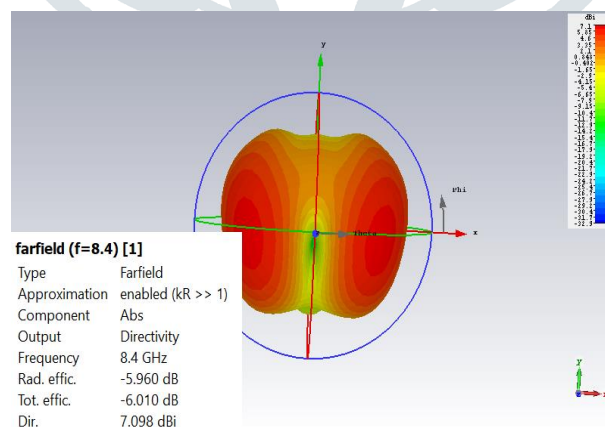


Fig.8: Directivity at 8.4GHz

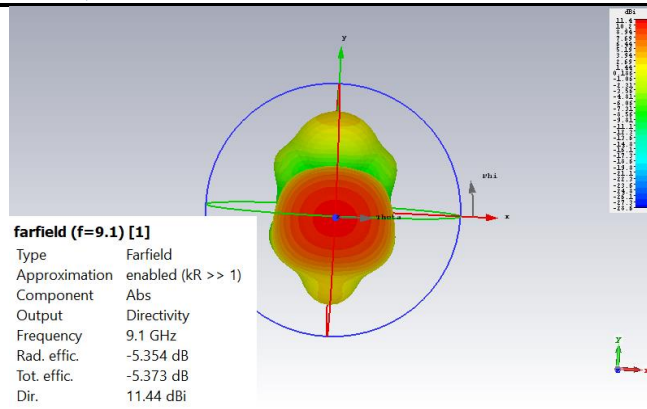


Fig.9: Directivity at 9.1GHz

### REFERENCE IMPEDANCE

The reference impedance in antenna design is typically the characteristic impedance of the transmission line used to feed the antenna. In most RF applications, this is usually 50ohms, although other values may be used in some applications. When designing an antenna, it is important to ensure that the input impedance of the antenna closely matches the reference impedance of the transmission line feeding it. This is known as impedance matching and is necessary for maximum power transfer and minimal signal reflection. In practice, it is difficult to achieve a perfect match between the input impedance of the antenna and the reference impedance of transmission line, and a certain amount of mismatch is usually unavoidable. However, the goal is to minimize mismatch to achieve the best possible performance. Here, we obtained a value of 51.9ohms which is used for real time applications as shown in figure 10.

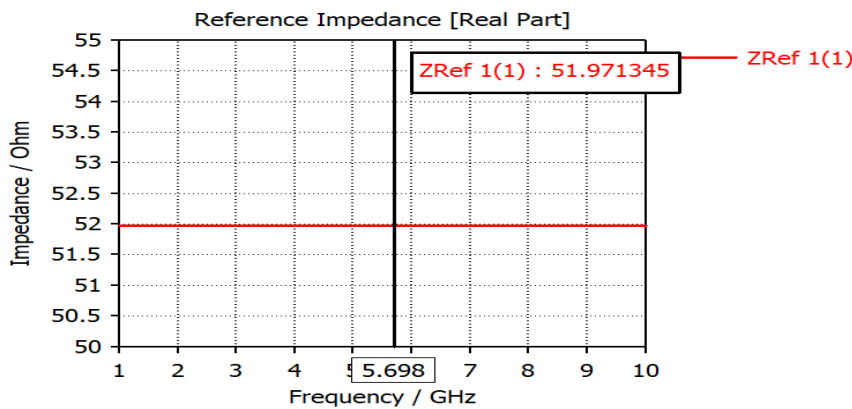


Fig.10: Reference impedance of designed antenna

### IV. CONCLUSION

In this paper, a modern approach to multiband antenna structure is shown for increasing the number of operating frequency bands. Multiband antennas offer the advantage of covering several bands with a single antenna, reducing the need for multiple antennas and simplifying installation. The proposed antenna at 1.1GHz,5.6GHz,8.4GHz and 9.1GHz cab be useful in GSM, WLAN and Radar& satellite applications respectively.

Table.2: Tabulated Results

Frequency (GHz)	Obtained values		
	S11(dB)	VSWR	Directivity(dBi)
1.1	-18.8	1.2	3.54
5.6	-31.9	1	5.92
8.4	-26.2	1.1	7.09
9.1	-31.3	1	11.44

## REFERENCES

- [1] Sanjeev Dwivedi, Abhishek Rawat and R.N Yadav, "Design of U-shaped Microstrip patch antenna For WiMAX Applications at 2.5GHz" IEEE WiMAX sys. applications and comm., 2013
- [2] Kai Fang Lee, Shing Lung Steven Yang, Ahmed A. Kishk, and Kwai Man Luk, "The versatile slot patch antenna," IEEE Antennas and Propagation Magazine, vol. 52, no. 1, February 2010.
- [3] K. F. Lee, K. M. Luk, K. F. Tong, S. M. Shum, T. Huynh, and R. Q. Lee, "Experimental and simulation studies of the coaxially fed slot rectangular patch antenna," in Inst. Elect. Eng. Proc.-Microw. Antennas Propagat., vol. 144, Oct. 1997, pp. 354–358.
- [4] Y. L. Chow and K. H. Shiu, "A theory on the broadbanding of a patch antenna," in Asia-Pacific Microwave Conf. Proc., vol. 1, 1997, pp. 245–248.
- [5] K. M. Luk, K. F. Tong, S. M. Shum, K. F. Lee, and R. Q. Lee, "FDTD analysis of U-slot rectangular patch antenna," in IEEE Antennas Propagat. Society Int. Symp. Digest, vol. 4, 1997, pp. 2111–2114.
- [6] J. R. James and P. S. Hall, Handbook of microstrip antennas, Vol. 1, Peter Peregrinus Ltd., London, 1989
- [7] Ali, Z.; Singh, V.K.; Singh, A.K.; Ayub, S., "E-Shaped Microstrip Antenna on Rogers Substrate for WLAN Applications," Computational Intelligence and Communication Networks (CICN), 2011 International Conference on , vol., no., pp.342,345, 7-9 Oct. 2011
- [8] Singh, V.K.; Ali, Z.; Singh, A.K., "Dual Wideband Stacked Patch Antenna for WiMAX and WLAN Applications," Computational Intelligence and Communication Networks (CICN), 2011 International Conference on , vol., no., pp.315,318, 7-9 Oct. 2011 J. Clerk Maxwell, A Treatise on Electricity and Magnetism, 3rd ed., vol. 2. Oxford: Clarendon, 1892, pp.68–73.
- [9] Kaushik Mandal, Partha Pratim Sarkar, High Gain Wide-Band U-Shaped Patch Antennas With Modified Ground Planes in IEEE Transactions On Antennas And Propagation, Vol. 61, No. 4, pp.2279-2282, April 2013.
- [10] Gulshan Rana, Saranjeet Singh, 'Design and Optimization of Multiband U Slots Microstrip Patch Antenna with DGS for Wireless Applications', in International Journal of Innovative Research in Computer and Communication Engineering, Vol. 2, pp. 5668-5671, Issue 9, September, 2014.
- [11] Chandan, G.D. Bharti, Toolika Srivastava, B.S. Rai. Dual Band Monopole Antenna for WLAN 2.4/5.2/5.8 with Truncated Ground, AIP Conference Proceedings, American Institute of Physics, 2018, 200361- 200366. doi:10.1063/1.5031998
- [12] Chandan, B.S. Rai. Dual-Band Monopole Patch Antenna Using Microstrip Fed for WiMAX and WLAN Applications, Springer Proceedings Information Systems Design and Intelligent Applications, 2, 2016, 533-539.
- [13] K. Kumar Naik, "Asymmetric CPW-fed SRR Patch Antenna for WLAN/WiMAX Applications," Int. J. Electron. Commun. (AEU), vol. 93, pp. 103-108, Apr. 2018.

