IOSR Journal of Electronics and Communication Engineering (IOSR-JECE)
e-ISSN: 2278-2834,p- ISSN: 2278-8735.Volume 12, Issue 4, Ver. II (Jul.-Aug. 2017), PP 36-42
www.iosrjournals.org

A Review on Various types of Microstrip Antennas for Wireless Communication

*Y.Aruna, E.Kavitha
Department of ECE Vidya Jyothi Institute of Technology Hyderabad, India
Corresponding Author: Y.Aruna

Abstract: *Innovation of new types of antennas that is smart antennas (adaptive array antenna or multiple antenna) plays very important role in recent trends. Antenna is the major part in wireless communication systems. Antenna is the transition region between transmitter and freespace or viceversa. Antennas are used to transform electromagnetic energy in Omni direction or in point to point communication. In this paper we present the study of different types of Microstrip patch antenna and its applications. As in the modern era Microstrip antenna is more attractive because of its low profile and low cost. This paper will help the reader to understand various types of Microstrip antennas used in WLAN Applications.*

Keywords*: Microstrip antenna, types of antennas in wireless communications*

Date of Submission: 14-07-2017 Date of acceptance: 26-07-2017

I. Introduction

Antenna is a link between guided wave and freespace and is a composition of elevated conductors which matches the transmitter or receiver [1]. Antenna posses an important property of Reciprocity, so that Antenna exhibits same characteristics whether it is transmitting or receiving [2]. Irrespective of the type of the antenna ,all the antennas posses certain basic properties namely Radiation pattern, Radiation intensity, Polarization, Directive Gain, Power Gain, Efficiency ,Radiation Resistance, Beamwidth, Bandwidth etc. An efficient Antenna has high bandwidth, high Gain and low Beamwidth [2]. In antenna radiation resistance affect its efficiency, if it had a high radiation resistance the efficiency of the antenna is high.

Antenna has a wide applications ranging from telecommunications to biomedical. Antennas are used in biomedical and in defense RADAR.As in biomedical engineering, Antenna is used to cure breast cancer. A group of antennas is called antenna array (phased array).An array of antennas can be used to increase gain of the system[2]. The signals from antennas are combined or processed in order to achieve improved performance over that of a single antenna. Now a day's smart antennas are critical in communication systems. In this paper detailed studies of Micro strip Patch Antenna which is developed to meet the low profile and low cost in the field of wireless communications is presented.

I.MICROSTRIP PATCH ANTENNA

Microstrip antenna are one of the most popular types of printed antenna. These play a very significant role in today's wireless communication systems. Microstrip antennae are very simple in construction using a conventional Microstrip fabrication technique. Microstrip patch antenna consists of a radiating patch on one side of a dielectric substrate (FR4) that has a ground plane (Cu) on the other side as shown in Fig.1

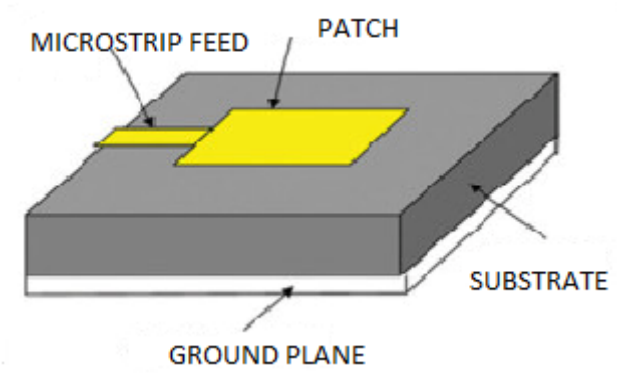


Figure1: Physical geometry of Microstrip antenna[3]

Printed antenna is one that is fabricated using photolithography technique. The most common version of printed antenna is Microstrip antenna, which consists of a metallic patch above a ground plane. The shape and size of patch determine the frequency of operation of the antenna and its performance. Microstrip patch antenna radiate primarily because of the fringing fields between the patch edge and the ground plane. For good antenna performance, a thick dielectric substrate having a low dielectric constant (<6) is desirable since it provides higher efficiency, larger bandwidth and better radiation. However, such a configuration leads to a larger antenna size. Permittivity is the measure of a material's ability to resist an electric field, not its ability to permit it.

Microstrip patch antenna is a single layer design which contains patch, ground plane, substrate and the feeding part. Patch antenna can be considered as single element resonant antenna, means if frequency is given to the antenna the characteristics (Radiation pattern, input impedance etc) of the antenna are fixed. The patch is very thin ($t << \lambda o$, where λo is the freespace wavelength) located on one side of the non- conducting substrate, the ground plane is the same metal located on the other side of the substrate.

The Microstrip patch antenna is a low profile antenna that has a number of advantages over the other antennas: it is light weight, inexpensive, all electronic devices can be integrated with these antennas quite easily. Microstrip antennas are flat, so are referred to as planar antennas. The distance between patch and the ground plane is the substrate height (dielectric height) which determines the bandwidth of the Microstrip antenna. A thicker surface increases the gain, but undesired effects like surface wave excitation occurs which decreases the efficiency of the antenna.

The ground plane should extend beyond the edges of the patch by at least two to three times the board thickness for proper operation. A ground plane that is too small will result in a reduced front to back ratio. A larger ground plane increases the gain, but size is also increases, fringing fields near the edges increases so larger ground plane has less effect in increasing gain. The Microstrip line with coaxial feed is shown in below Figure2,

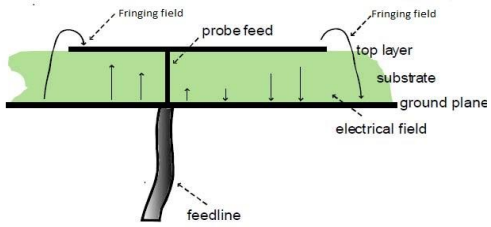


Figure2: Microstripline with co-axial feed

The center conductor of a coaxial line serves as the feed probe to couple the electromagnetic energy in and/or out of the patch. A thicker substrate lead to a longer feed probe, which induces inductance and causing degradation of Impedance matching. This can be compensated by using a different type of feeding technique.

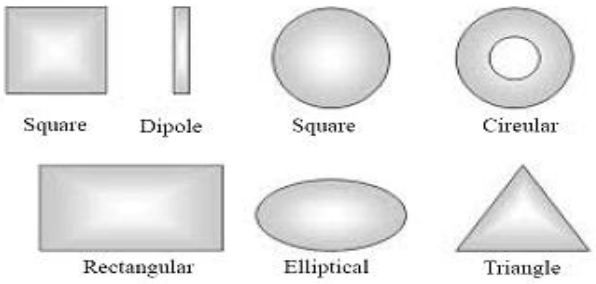
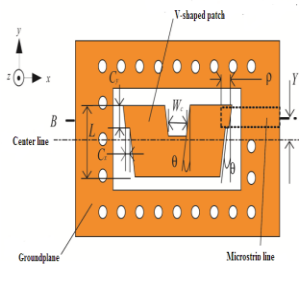


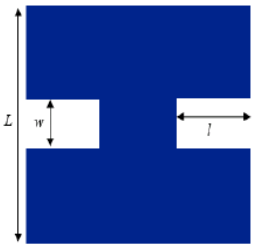
Figure3: Different shapes of the patch

Different shapes are there for Microstrip patch antennas. The reduced size of the Microstrip antenna makes it more attractive in integrated circuits technology, importance is laid on reducing the area covered on the chip. Thus, antennas required in such fields require minimum realizable area with a required gain and bandwidth. A Microstrip antenna incorporated with a single shorting pin is found to provide reduction in overall area with respect to a conventional patch.

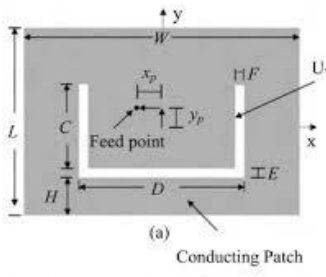
II. Multi Slotted Microstrip Patch Antenna

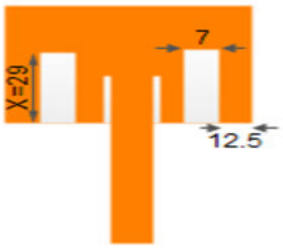
Conventional Microstrip patch antenna suffers from very narrow bandwidth. The bandwidth of the patch antennas can be increased by the use of thick substrate, cutting a resonant slot inside the patch, the use of a low dielectric substrate, multi resonator stack configurations, the use of various impedance matching and feeding techniques, and the use of slot antenna geometry. There exists a trade-off between bandwidth and size of an antenna. Bandwidth can be increased by shorting pins or shorting walls using multi layer structures with parasitic patches, which excites multiple resonant modes. A major contributing factor for recent advances of microstrip antennas is the current revolution in electronic circuit miniaturization brought about by developments in large scale integration[10]. As conventional antennas are very large and costly. As a part of an electronic system, Microstrip antennas are constructed using photolithographic technology.





a)V-Shaped patch b)H- Shaped patch





a) U-Shaped patch b)E- Shaped patch

Figure4: Different shapes of Slotted Microstrip patch antenna

Conventional Microstrip patch antenna suffers from very narrow bandwidth, typically about 5% bandwidth with respect to the center frequency[4]. This poses a design challenge for the Microstrip antenna designer to meet the broadband techniques. Several techniques have been proposed to enhance the bandwidth in the state-of-the art antenna research. By using the shorting pins or shorting walls on U-shaped patch, U-slot patch, or L-probe feed patch antennas, wideband and dual band antenna with electrically small in size have been reported in[4] . Other techniques involves employing multilayer structures with parasitic patches of various geometries such as E, V and H shapes, which excites multiple resonant modes. These antennas are generally fabricated on thicker substrates .An E-shaped patch antenna and U-slotted patch antenna have been designed for wireless communications. However, both of these patch substrate are non inverted and gives achievable gain.

III. A Spirally Slotted Microstrip Patch Antenna

Slot antennas are widely used in wireless applications which have wide frequency bandwidth, low profile, light weight, ease of fabrication, and integration with other devices or RF Circuitries. The slot antennas contains relatively high magnetic fields that they do not couple with nearby objects, hence these can find their application in which minimum near field coupling is needed[5]. The antenna with wide slot (slots) is meaning that it will contain wide bandwidth for the entire range of frequencies.

In spirally slotted Microstrip antennas, firstly a slot which is in the shape of the spiral was cut on the patch. The width and length was taken according to our requirement. Then a secondary slot can be cut again inside the boundary of first slot on the patch and lastly third slot was also cut out. Furthermore, the remaining part of the patch antenna was also cut in order to obtain better degree of compactness. The spirally slotted Microstrip antenna gives 60% efficiency more compared to normal conventional antennas[5].

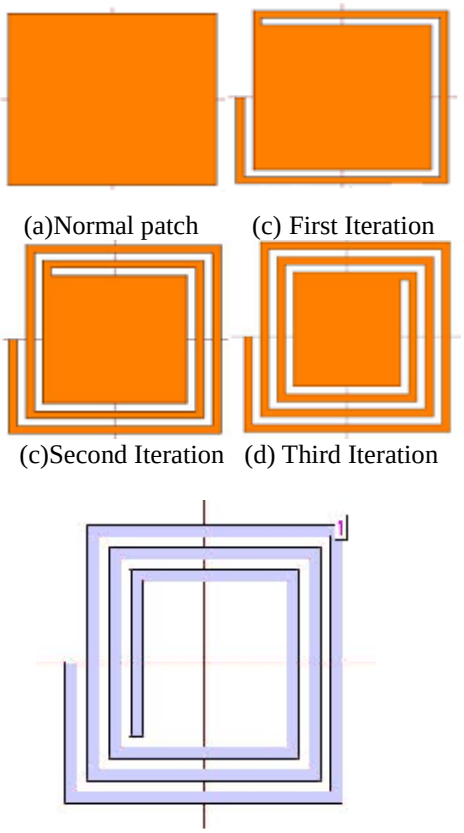


Figure5: Final structure of Spirally slotted Microstrip patch antenna[5]

IV. Stacked Microstrip Patch Antenna

Stacked configuration of Microstrip antenna array can be used for Millimeter wave applications. This configuration enhances the bandwidth and gain. In this configuration each antenna is an array of 2x2 Microstrip antennas. Stacked configuration uses Superstrate loaded design [6], in this design one layer can be superimposed on the other layer. Superstrate loaded design enhances the bandwidth. Let the design of 2x2 array antenna utilizing RT Duroid substrate, 2x2 array patch built on RT Duroid above the ground plane acts as a Driven patch, and the patch marked upon the superstrate acts as a parasitic patch. Millimeter wave technology exists between the devices and it is used for shorter distances.

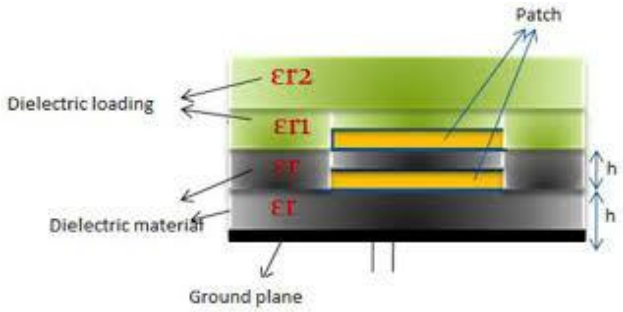


Figure6: Superstrate loaded design of Microstrip patch antenna

In the region of Millimeter wave frequencies, Oxygen absorption happens, which leads to attenuation of atmosphere about 10dB to 15dB per Kilometer[6]. Because of this high attenuation, the signal is not propagating beyond the specific range of propagation. This makes the Millimeter wave band more secure communication band for wireless applications (WLAN, WPANS etc).To get high gain, Superstrate layer is added at a height of 0.5λo from the ground plane[6]. Most of the applications needs reduced size with high gain and bandwidth; this can be achieved by change of dielectric substrate, Removal of semi substrate, Usage of high permittivity dielectric and array method.

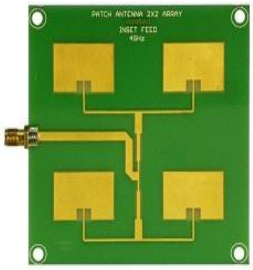
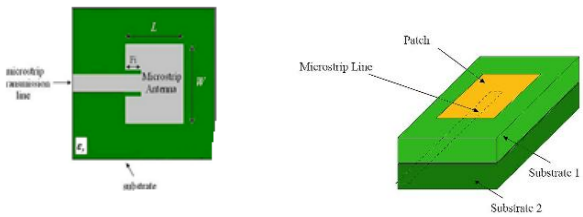


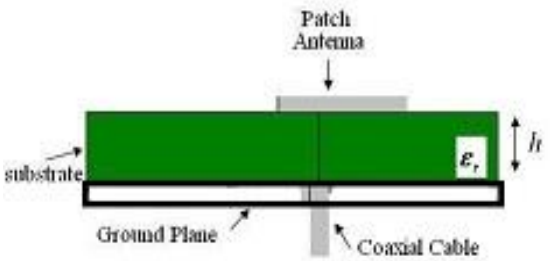
Figure7: Structure of stacked 2x2 array of Microstrip antennas

V. Proximity Feed Microstrip Patch Antenna

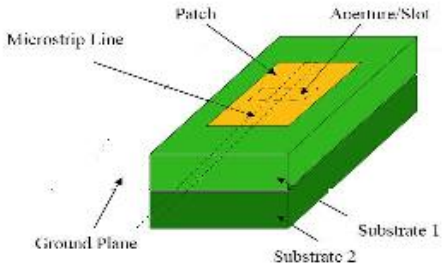
Feeding of microstrip antenna can be classified as two types: Contacting method and Non contacting method. In Contacting method, Radio Frequency power is fed directly to the radiating patch using microstrip line or Coaxial cable. In Non contacting method, Radio Frequency power is transferred to the patch indirectly by using electromagnetic field coupling. Examples of electromagnetic field coupling are Proximity coupling and Aperture coupling. Feeding plays very important role in transferring of power. Maximum power can be transferred iff matching of the feed line with the input impedance of the antenna. The efficiency of the antenna depends on type of feeding used, the poor feeding results poor performance of the antenna. A designer has to select good feeding method which increases the efficiency of the antenna. In Proximity feed, One dielectric substrate is for designing radiating patch and the other is for designing Microstripline. This provides extra bandwidth due to increase in the thickness of the antenna.



(a)Microstrip line feeding (b) Proximity feeding



(c)Co-axial line feeding



(d)Aperture coupled feeding

Figure8: Different types of feeding techniques

The major disadvantage of proximity feed scheme is that it is difficult to manufacture because of the two dielectric layers that need proper alignment[7]. Also, there is a growth in the overall thickness of the antenna. The rapid performance in wireless communications makes interactive voice, data, and video services available anyplace and anytime.

Advantages of Microstrip antenna

1. Microstrip antennas are versatile in terms of their geometrical shapes and implementations. Beam steering phase antenna arrays find many applications in Microwave, RADAR and Communication systems[14]
2. Multi frequency operation is possible by creating some slots in the patch geometry.
3. Reconfigurable mechanism both in polarization an gain is possible by increasing some passive and active components into the patch[7]

Main factors which effects designing of Microstrip patch antenna

1. Parameters of the antenna are affected by the dielectric substrate and the electrical properties such as Dielectric substrate, Loss tangent an thickness of the substrate.
2. There are numerous dielectric substrates having dielectric constant lies in between 2.2 to 12.But we need to select proper substrate for the required operation.
3. For proper operation of the antenna Loss tangent should be as low as possible[7].
4. For low loss tangent the efficiency of the antenna should be high.
5. The thickness of the substrate is high for better performance but cost increases.

Different Dielectric Substrates Used In Microstrip Patch Antenna

To design a Microstrip Patch Antenna the following are the requirements: Type of the substrate, Shape of the patch, Dimension of the patch, Feeding technique, Resonant frequency, Thickness of the substrate. Though all these are the requirements for antenna fabrication but for the best results right substrate selection is a must on the basis of cost, efficiency and size. Role of feeding technique is considerable.

Different types of dielectric substrates can be use frequently in microstrip patch antennas to increase overall efficiency of the antenna. Various substrates like foam, duroid, benzocyclobutane, roger 4350, epoxy, FR4, Duroid 6010 are in use to obtain better gain and bandwidth [8]. A dielectric substrate is an insulator which is the main part of the microstrip antenna structure, where a thicker substrate is considered because it has direct proportionality with bandwidth whereas dielectric constant is inversely proportional to bandwidth. As lower the relative permittivity better the fringing field is achieved. Another factor that impact efficiency of the antenna directly is loss tangent it exhibits inverse relationship with efficiency. But substrate with lower loss tangent is costlier. A substrate gives mechanical strength and support to the antenna [8].

Substrates	Ɛr	Loss tangent	Resonance frequency	Return Loss	Gain
Benzocyclobutane	2.6	0	2.04GHz	-18.124	5.5
Duroid 6010	10.7	.0060	2.455	-9.449	4.02
Nylon fabric	3.6	.0083	989MHz	-35.42	6.11
Roger 4350	3.48	.004	2.586GHz	-25.29	4.62
RT-Duroid	2.2	.0009	10GHz		12.03
Foam	1.05	0	454MHz	-16.732	2.73
FR-4	4.4	.018	5.8GHz	-14.73	9.8

Substrates	Size Reduction	Bandwidth	Efficiency
Benzocyclobutane	Medium	medium	96.51
Duroid 6010	Lowest	minimum	93.51
Nylon fabric	Medium	medium	
Roger 4350	Medium	medium	99.66
RT-Duroid	Medium	medium	88.64
Foam	Highest	maximum	61
FR4	Medium	medium	99.60

Table1: Comparison of various substrates of the Microstrip patch antenna

THEORETICAL CALCULATION AND EFFECT OF SUBSTRATE PERMITIVITY

Width W controls the input impedance, larger width shows larger bandwidth.$W = \frac{c}{2fo\sqrt{\frac{(\varepsilon r+1)}{2}}}$

Effective substrate permittivity:

$$\varepsilon_{reff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{W}\right]^{-\frac{1}{2}}$$

Substrate permittivity effect on resonant frequency:

$$(f_r)_{110} = \frac{1.8412 v_0}{2\pi a_e \sqrt{\varepsilon_r}} \quad [8]$$

In rectangular patch antenna effective substrate and effective length relation:

$L_{eff} = \frac{C}{2fo\sqrt{\varepsilon reff}}$

VI. Conclusion

This paper describes the various types of Microstrip antennas which are useful for wireless applications. According to the required wireless communication system we can select the particular type of Microstrip antenna and this paper also used to select the particular substrate with specified dielectric constant. Different types of feed techniques are also presented here. In this paper applications and working of antennas are study according to their individual groups of the antennas.

VII. Future Work

The future work includes survey on Different types of microstrip antennas used for Mobile communications which increases bandwidth, Gain and having low profile.

Acknowledgment

We render our gratitude to the Correspondent, Director and Principal of Vidya Jyothi Institute of Technology, Hyderabad for their encouragement towards research.

References

[1] "Various Types of Antenna with Respect to their Applications: A Review", International journal of multidisciplinary sciences and engineering ,vol.7,no.3,march 2016.
[2] Antennas and wave propagation by John D Kraus and K.D Prasad.
[3] "Microstrip Antenna" by Anuj Mehta International Journal of Science and Technology Reaserch Volume 4, Issue 03, March 2015
[4] M. T. Islam, M. N. Shakib, and N. Misran, "Multi-slotted microstrip patch antenna for wireless communication," *Progress In Electromagnetics Research Letters*, Vol. 10, 11-18, 2009.
[5] "A Spirally slotted Microstrip antenna with improved bandwidth for lower C-band applications", International Journal of Advances in Engineering Science and Technology, ISSN 2319-1120
[6] Goel, Soni; Kamal, Ashmita; Choudhary, Priyanka "Bandwidth Enhancement Using Stacked Configuration in Microstrip Antenna Array for Millimeter Wave Applications". IUP Journal of Telecommunications. Feb2016, Vol. 8 Issue 1, p38-46. 9p.
[7] Y Pandu Rangaiah and R V S Satyanarayana, "Design and Analysis of High Gain Proximity Feed Microstrip Patch Antenna for Wi-Fi Applications" IUP Journal of Telecommunications.
[8] Kiran Jain, Keshav Gupta "Different Substrates Use in Microstrip Patch Antenna-A Survey " International Journal of Science and Research (IJSR) ISSN (Online): 2319-7064 .
[9] "Design of U Shaped Microstrip Patch Antenna for Dual Band Frequency Application" Conference on Advances in Communication and Control Systems 2013 (CAC2S 2013)
[10] Chaitali. J. Ingale1, Anand. K. Pathrikar2, "Designing of Bandwidth Improved 'h' Shaped Microstrip Patch Antenna for Bluetooth Applications using Ansoft HFSS" International Journal of Science and Research (IJSR) ISSN (Online): 2319-7064, Volume 3 Issue 4, April 2014
[11] "Design & Simulation of E-Shaped Micro Strip Patch Antenna for GPS Application",*M. Ravi Kishore et al Int. Journal of Engineering Research and Applications* www.ijera.com *ISSN : 2248-9622, Vol. 4, Issue 8(version 5), August 2014, pp.94-100.*
[12] "Design of 'V' Shape Microstrip Patch Antenna", International Journal of Innovative Research in Computer and Communication Engineering (An ISO 3297: 2007 Certified Organization) Vol. 3, Issue 3, March 2015
[13] "Design Of H-Shape Wideband Microstrip Patch Antenna With Slots For Wireless Communication", International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181,Vol. 2 Issue 6, June – 2013
[14] Patil sarang m & Bombale u. "Design of Beam steering rectangular microstrip antenna array for 2.45 Ghz", International Journal of Electrical and Electronics Engineering Research (IJEEER) ISSN 2250-155X Vol. 3, Issue 3, Aug 2013, 83-92.
[15] "Antennas and its Applications",Pramod Dhande, Armament Research & Development Establishment, Dr Homi Bhabha Rd, Pashan, Pune-411 021,DRDO Science Spectrum, March 2009, pp 66-78 © 2009, DESIDOC
[16] "A Survey of Antennas for Wireless Communication Systems".Florida State University Libraries Electronic Theses, Treatises and Dissertations.

IOSR Journal of Electronics and Communication Engineering (IOSR-JECE) is UGC approved Journal with Sl. No. 5016, Journal no. 49082.

Y.Aruna, E.Kavitha. "A Review on Various types of Microstrip Antennas for Wireless Communication." IOSR Journal of Electronics and Communication Engineering (IOSR-JECE) 12.4 (2017): 36-42.