International Journal of Multidisciplinary Research and Development

International Journal of Multidisciplinary Research and Development

Volume :2, Issue :4, 239-243
April 2015
www.allsubjectjournal.com
e-ISSN: 2349-4182
p-ISSN: 2349-5979
Impact Factor: 3.762

Manish Kumar
M-Tech Scholar Bhagwant University, Rajasthan

Anuj Jain
Asst. Professor Bhagwant University

Correspondence:
Manish Kumar
M-Tech Scholar Bhagwant University, Rajasthan

Design of rectangular micro strip patch antenna in geometrical shapes

Manish Kumar, Anuj Jain

Abstract
The microstrip patch is one of the most preferred antenna structures for their light weight, low cost, low volume, low profile, smaller in dimension and ease of fabrication and therefore can be easily mounted on moving vehicles such as cars, planes, rockets, or satellites. Since its introduction in 1985, this antenna has led to an extensive amount of development and design variations by workers throughout the world. In this paper we present designs of compact small size microstrip antennas by loading properly arranged slots on a rectangular microstrip patch, dual and triple frequencies and broadband operations of a single feed rectangular patch is achieved. Dual and triple frequency operation is achieved by loading A and H slots in rectangular patch. The impedance bandwidth of 220MHz and 1.87 GHZ band for A slot and 154MHz, 396MHz, 484MHZ for H slot is obtained in the proposed designs.

Keywords: Slotted Microstrip Antenna, Radiation Pattern

1. Introduction

Antenna is a transducer that is designed to transmit or receive electromagnetic waves. The microstrip antenna is low-profile, conformable to planar and nonplanar surfaces, simple and cheap to manufacture using modern printed-circuit technology, and mechanically robust. In addition, it is very versatile in terms of resonant frequency, input impedance, radiation pattern and polarization. Microstrip antennas have several advantages over conventional microwave antenna and therefore widely implemented in many applications such as in the wireless applications, satellites and of course even in the military systems just like in the rockets, aircrafts missiles etc. The usage of the Microstrip antennas is spreading widely in all the fields and areas and now they are booming in the commercial aspects due to their low cost of the substrate material and the fabrication. A microstrip patch antenna consists of a conducting patch of any planar or nonplanar geometry on one side of a dielectric substrate with a ground plane on other side. The patch can take various forms to meet different design requirements. Typical shapes are rectangular, square, circular and circular ring. There are different feeding techniques are used to excite to radiate by direct or indirect contact and most popular techniques among them are coaxial probe feed, microstrip line, aperture coupling and proximity coupling [1]. The major disadvantages of this type of antenna are: low efficiency, low power-handling capability, poor polarization purity, and relatively narrow frequency bandwidth. There are different structures of Microstrip antennas, but on the whole we have four basic parts in the antenna [2]: They are: The patch , Dielectric, Substrate ,Ground Plane, Feed Line. Intensive research has been done in recent years to develop bandwidth enhancement techniques and thus includes the utilization of thick substrates with low di-electric constant and slotted patch[3][4]. Use of electronically thick substrate provides limited success because a large inductance is introduced by the increased length of the probe feed. It results in few percentage of bandwidth at resonant frequency. By loading some specific slot in the radiating patch of microstrip antennas, microstrip antennas with compact size can be obtained [5]. The loading the slots in the radiating patch can cause meandering of the excited patch surface current paths and result in lowering of the antenna's fundamental resonant frequency, which corresponds to the reduced antenna size for such an antenna, compared to conventional microstrip antenna at same operating frequency. In this paper, rectangular microstrip antenna with H & U-shape slots are proposed.

2. Antenna Design

2.1. H Slot Rectangular Patch Antenna

In this paper, the microstrip patch for wide band width is cutted in H shape. H-shaped slots are easily formed by cutting three slots from a rectangular patch [6,7]. By cutting the slots from a patch, gain and bandwidth of microstrip antenna can be enhanced. For this proposed antenna,the thickness of dielectric substrate is taken as 3.2 mm with ε_r = 2.2.The geometry of H slot patch antenna is shown in table 1 with H-slot is presented in Fig.1(a) with top view and Fig. 1(b) with 3D Geometry.

Table 1: The Dimensions of the H Slot Patch in mm

L	W	H1	H2	F	H	ε_r	W1
40	30	20	18	10	3.2	2.2	1

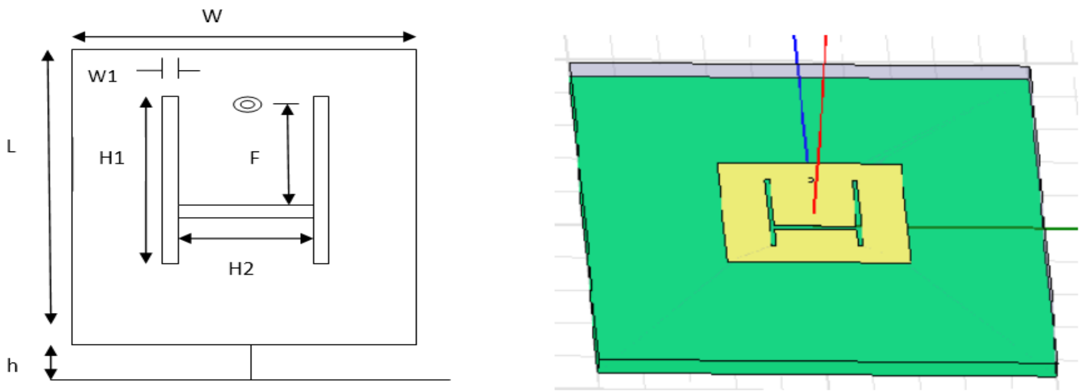


Fig 1: (a) Top View of H slot Patch Antenna,
(b) 3D Geometry of H slot Patch Antenna

Where the length and width for the rectangular microstrip patch are following:The height of the patch is

$$h \leq 0.3 \times \frac{c}{2\pi f_r \sqrt{\varepsilon_r}}$$

The width of the patch is

$$W=\left(\frac{c}{2f_r}\right) \times \left[\frac{\varepsilon_r+1}{2}\right]^{-\frac{1}{2}}$$

The length of metallic patch

$$L=\frac{c}{2f_r \times \sqrt{\varepsilon_{reff}}} - 2\Delta l$$

Where

$$\Delta l = 0.412h \times \left[\frac{(\varepsilon_{reff}+0.03) \times (W+0.264h)}{(\varepsilon_{reff}-0.258) \times (W+0.8h)}\right]$$

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

2.2. A Slot Rectangular Patch Antenna

Designing an antenna for Wi-max band doesn't require antenna dimension to be kept so bulky. The design idea was taken from broadband antennas to make the antenna work in a large band of frequencies, rectangular patch antenna was chosen. There are many methods to reduce the size of the patch i.e. shorting wall, shorting pin, slot cutting etc. [6]. The shorting microstrip antenna is a compact antenna but it suffers from of poor gain and degradation in the radiation pattern. An alternate way to reduce the resonance frequency of the microstrip antenna is to increase the path length of the surface current by cutting slots in the radiating patch. Hence the chosen shape of the patch was cut with an L-shaped slot, with an aim to achieve smaller size antenna.

In this design two different dielectric material i.e. FR4_epoxy (ε_r= 4.4, h= 3.2mm, tanδ=0.02) and foam material (ε_r= 1.06, h= 10mm) was used.The geometry of rectangular microstrip patch antenna is shown in Table 2 with A-slot is presented in Fig.2(a) with front view and Fig. 2(b) with side view. This A-slotted rectangular patch is fabricated on two dielectric substrates.

1. FR4_epoxy of thickness 3.2 mm.
2. Foam material of thickness 10 mm.

Table 2: Antenna dimensions

S.No.	Antenna Parameters	Specification
1	Length of the Patch (L)	40mm
2	Width of the Patch (W)	30mm
3	Height of the Substrate (h)	3.2mm
4	Height of the Foam (f)	10mm
5	Length of A slot arm(A1)	14.14mm
6	Width of Slot(A2)	5mm
7	Distance from Feed(F)	3.75mm

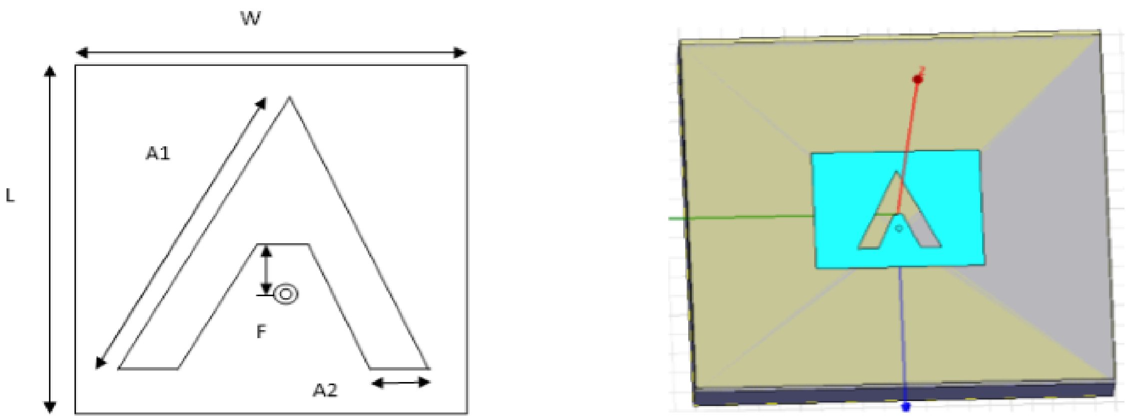


Fig 2: (a). Top view of slotted Rectangular Microstrip Patch Antenna

Fig 2: (b). Side View of Rectangular Microstrip Patch Antenna

Where the length and width for the rectangular microstrip patch are following: The height of the patch is

$$h \leq 0.3 \times \frac{c}{2\pi f_r \sqrt{\varepsilon_r}}$$

The width of the patch is

$$W = \left(\frac{c}{2f_r}\right) \times \left[\frac{\varepsilon_r + 1}{2}\right]^{-\frac{1}{2}}$$

The length of metallic patch

$$L = \frac{c}{2f_r \times \sqrt{\varepsilon_{reff}}} - 2\Delta l$$

Where

$$\Delta l = 0.412h \times \left[\frac{(\varepsilon_{reff} + 0.03) \times (W + 0.264h)}{(\varepsilon_{reff} - 0.258) \times (W + 0.8h)}\right]$$

&

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

In this work, co-axial or probe feed technique is used as its main advantage is that, the feed can be placed at any place in the patch to match with its input impedance (usually 50 ohm). The software used to model and simulate the A-slotted rectangular patch antenna was HFSS 11 and used to calculate and plot return loss, radiation patter

3. Results and Discussion

3.1. H Slot Rectangular Slot Antenna

The proposed antenna is simulated using HFSS'11[8] software.The simulation result for H-slot microstrip patch antenna are shown in Table 3 with return loss and gain pattern in Fig.3(a) and (b).

Table-3 Simulated Results for H Slot Probe Feed Patch Antenna

Patch Shape	Frequency	Gain	Return Loss	Bandwidth
H Shape	4.432	6.4771 dB	-23.5dB	3.47%(4.366-4.52 GHz)
	6.192		-14.5dB	7.81%(5.972-6.456 GHz)
	10.108		-28dB	3.9%(9.888-10.284GHz)

Return Loss

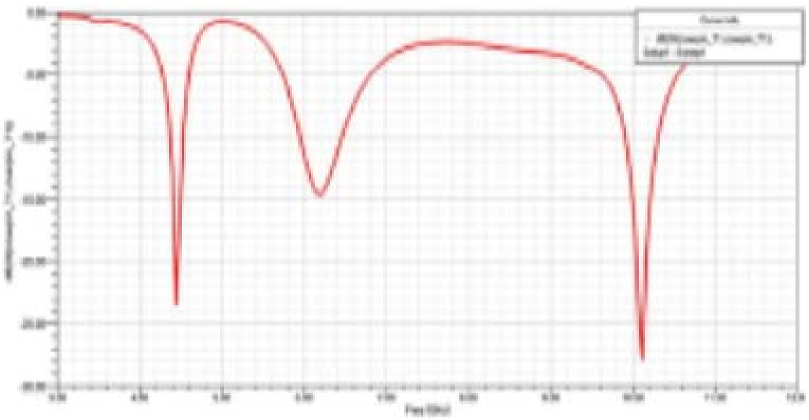
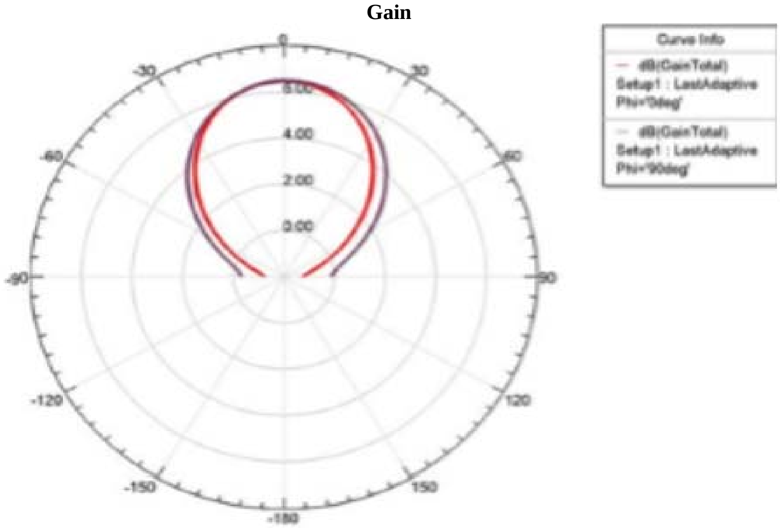


Fig 3: (a) Return loss vs. Frequency curve

Gain



(b)

Fig 3: (b) Rdiation Pattern

3.2.A Slot Rectangular Patch Antenna

The proposed antenna is simulated using HFSS'11[8] software. The simulation result for A-slot microstrip patch antenna are shown in Table 4 with return loss and gain pattern in Fig.4(a) and (b).

Table 4: Simulated Results for A Slot Probe Feed Patch Antenna

Patch Shape	Frequency	Gain	Return Loss	Bandwidth
A Shape	3.97	6.34	-30.71dB	5.54%(220Mhz-3.97 GHz)
	10.02	dB	-29dB	18.66%(1.87-10.02 GHz)

Return Loss

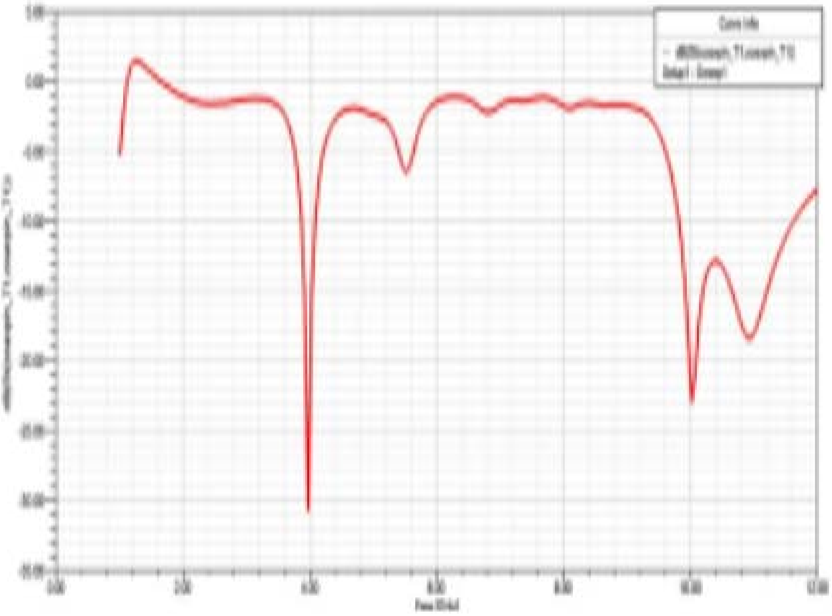


Fig 4: (a) Return loss Vs. Frequency curve

Gain

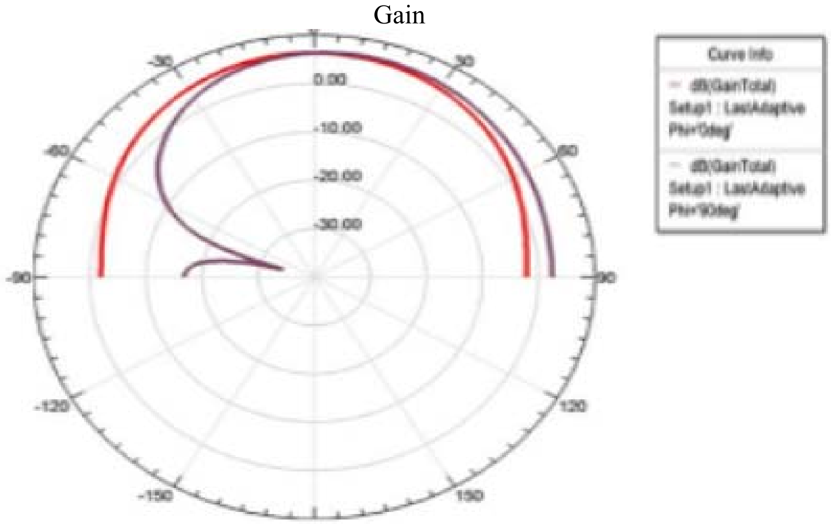


Fig 4: (b). Radiation Pattern

4. Conclusions:-

In this paper, the small triple band for H slot and double-band for A-slot microstrip patch antennas are designed. The parameters, gain and return losses are shown . The probe feed technique and HFSS11' [6] for simulation are used. The gain and return losses were good in comparison to conventional antennas for these bands. The antenna is designed to be used for multi-band and Wi-Max applications.

5. References:-

1. Ramesh Garg, Prakash Bartia, Inder Bahl, Apisak Ittipiboon, ''Microstrip Antenna Design Handbook'', 2001, pp 1-68, 253-316 Artech House Inc. Norwood, MA.
2. Y T Lo and S W Lee, editors, ''Antenna Handbook Theory, Applications & Design'', Van Nostrand Rein Company, NY, 1988.
3. James, J.R. and Hall, P.S.: 'Handbook of Microstrip Antennas' (Peter Peregrinus)
4. Constantine A. Balanis : 'Antenna Theory, Analysis and Design' (John Wiley & Sons)
5. D.M. Pozar, "A reciprocity method of analysis for printed slots and slot coupled microstrip antennas", IEEE

Transactions on Antennas Propagat., Vol. AP34, pp. 1439- 1446, December 1986.

6. Noori, O.; Chebil, J.; Islam, M.R.; Khan, S.," Design of a triple-band h slot patch antenna "2011 IEEE International RF and Microwave Conference (RFM), December 2011.
7. K. F. Lee1, K. M. Lu, K. M. Ma, and S. L. S. Yang1, "On the Use of U-Slots in the Design of Dual-and Triple-Band Patch Antennas" IEEE Antennas and Propagation Magazine, Vol. 53, No.3, June 2011
8. Ansoft Designer, www.ansoft.com.