

Single Layer Single Patch Dual Band with Single Slot and Triple Band with Dual Slot Patch Antennas

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Abstract: This communication presents an effective design of multiband microstrip-patch antenna. In this, the patch antenna can be designed for dual band and triple band application by cutting U-slots on the patch fed by coaxial cable. The dual band antenna is designed for the frequency range from 3.8 GHz to 4GHz and 5 GHz to 5.5GHz, when single U slot is cut in the patch. The triple band of radiation from 3.6 GHz to 3.75 GHz, 4.2 GHz to 4.3 GHz and 5.4 GHz to 5.7 GHz could be achieved with the aid of one additional U slot in the existing dual band patch. The feed is simple; structure remains single layer and single patch. Parameters of antenna such as impedance average bandwidth for dual band is 7.32% and triple band is 3.98% , return loss(less than 10dB), VSWR (approximately 1) were studied with the aid of FDTD numerical analysis. This could be used for WLAN, Wi-MAX and similar applications.

Keywords: Dual band antenna, Multi band antenna, U slot, Impedance bandwidth, Return loss, VSWR, WLAN, Wi-MAX.

I. INTRODUCTION

The basic geometry of U-slot antenna was introduced by Huynh and Lee in 1995[1]. Initially microstrip patch antenna with U-slot was mainly used for bandwidth enhancement. However, subsequent researches revealed that wideband characteristic can be modified to multiband characteristic by intelligent placement of U-slot, thereby perturbing the surface current flow in the patch [2], [3]. In [4], this new method was applied to the cases when the original broadband antennas was (1) a L-probe fed patch; (2) a M-probe fed patch; (3) coax-fed stacked patches; and (4) aperture coupled stacked patches. All these cases involve either relatively complicated feeds or more than one layer or more than one patch. In planar and ultra wideband antennas, it has been found that the

presence of U-slot introduces a band notch and is utilized to minimize interference [5], [6].

It is firmly established that the U-slot patch antenna can provide impedance bandwidths in excess of 30% for air substrate thickness of about $0.08\lambda_0$ and in excess of 20% for microwave substrates of similar thickness [7]. For dual- band patch antennas with small frequency ratios, an effective design is that of stacked patches, first reported by Long and Walton [8], by adjusting the relative sizes of the upper and lower circular discs, a dual band antenna with frequency ratios ranging from 1.11 to 1.18 was demonstrated. The radiations at the two bands are of the same linear polarization and the patterns are similar.

In this paper, we show that the Coax fed U-slot technique can also be used to design patch antennas with dual- and triple- band characteristics. Our approach is to cutting a U-slot in the patch, notch is introduced within the matching band, resulting in dual band antenna. Similarly, by cutting two U- slots in the patch, notches are introduced within the matching band, resulting in triple band microstrip patch antenna. This design has the advantages of simplicity of the feed as well as having only one layer and only one patch.

II. ANTENNA CONFIGURATION

The basic structure of the coax fed microstrip patch antenna is shown in Fig. 1. The overall thickness (H) of the antenna is 5.75mm, ground plane size is 71mm x 52 mm and thickness of patch metal is 1mm. The patch is intended to operate at centre resonant frequency having length (L) and width (W) is formed on the dielectric substrate above the ground plane. Air is used as a Substrate and its thickness is 3.75mm. This U slot patch antennas is fed by a coaxial feeding and its characteristic impedance is a 50Ω .

A. Dual Band U slot Microstrip patch Antenna

Uy1	19.5
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The geometry of Single U slotted dual band patch antenna is shown in Fig. 2. Basically a simple U slot microstrip antenna provides wide bandwidth. However, when a single U-slot is cut in the rectangular patch, a notch is introduced within the matching band results in dual band operation. The optimal parameters for dual band antenna are tabulated in Table I.

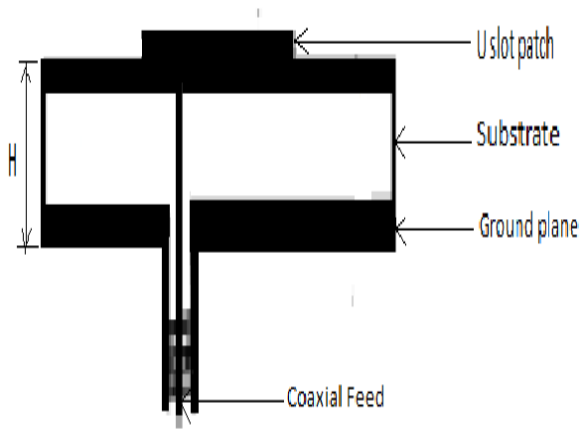


Fig. 1 Geometry of coax fed microstrip patch antenna

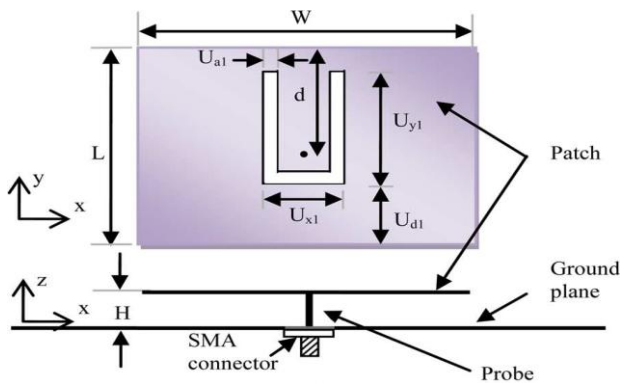


Fig. 2 Geometry of the Single U slotted dual band patch antenna

TABLE I

PROPOSED PARAMETERS OF SINGLE U SLOTTED DUAL BAND ANTENNA

Parameters	Unit(mm)
W	35.5
L	26
H	5.75
D	15.5
Ua1	2.1
Ud1	4.8
Ux1	12

B. Triple Band U Slot Microstrip Patch Antenna

For triple- band U slot microstrip antenna, apply the slight dimension modification and another U slot is cut in the same patch is shown in Fig. 3. With these two U-slots, two notches are introduced within the matching band, results in triple- band antenna. The optimal dimensions for triple- band antenna are tabulated in Table II.

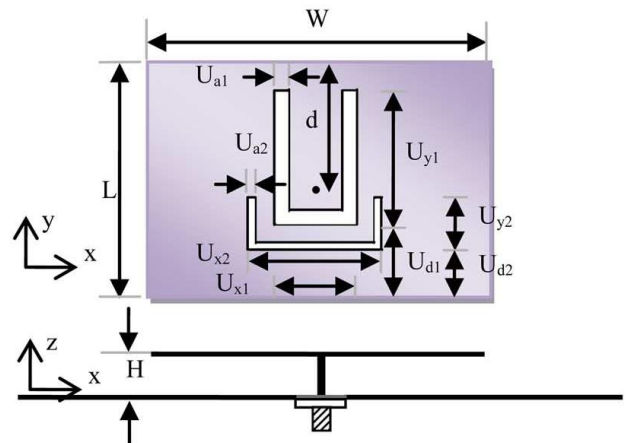


Fig. 3 Geometry of the Dual U slotted Triple band patch antenna

TABLE II

PROPOSED PARAMETERS OF DUAL U SLOTTED TRIPLE BAND ANTENNA

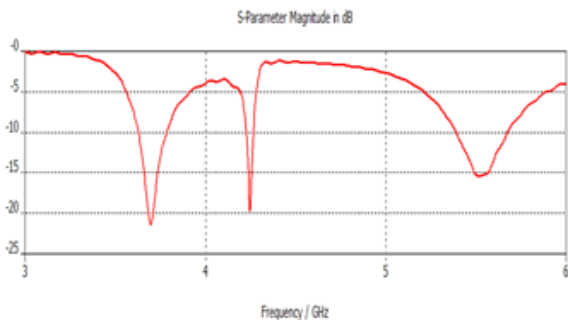
Parameters	Unit(mm)
W	35.5
L	26
H	5.75
d	15.5
Ua1	2
Ud1	5.8
Ux1	14
Uy1	18.7
Ua2	1
Ud2	3.5
Ux2	18
Uy2	9

III. SIMULATION RESULTS

Simulation of proposed antenna has been performed in FDTD simulator tool, commercial electromagnetic simulation software. The two antennas, dual band and triple band resonate at two same frequencies i.e. 3.8 GHz to 4GHz and 5 GHz to 5.5 GHz

and resonant frequency of triple band antenna is 3.6 GHz to 3.75 GHz, 4.2 GHz to 4.3 GHz and 5.4 GHz to 5.7 GHz. The return loss of proposed U- slot dual- band antenna is shown in Fig. 4(a). The lower band resonance is at 3.9GHz with return loss of -35 dB and upper band resonance occurs at 5.25GHz with return loss of -46 dB. U-slot triple band antenna resonates at 3.675 GHz, 4.25 GHz and 5.55 GHz with return loss of -22 dB, -20 dB and -15 dB respectively as shown in Fig. 4(b). For dual band antenna, VSWR at 3.9GHz and 5.25GHz is 1. Triple band antenna shows 1.2, 1.21 and 1.23VSWR at 3.675 GHz, 4.25 GHz and 5.55 GHz respectively. The proposed dual band and triple band U- slot microstrip patch antenna shows considerably good gain, minimum return loss and directivity values. These values are shown in Table III.

(a)



(b)

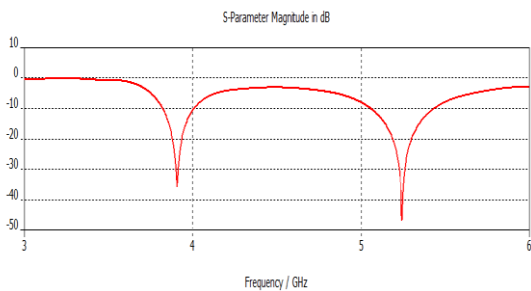


Fig. 4 Return loss (a) Dual band patch antenna with Single U slot (b) Triple band patch antenna with dual U slot

TABLE III

Gain and Directivity (a) Dual band antenna (b) Triple band antenna

(a)			
Frequency (GHz)	Gain (dB)	Directivity (dBi)	10 dB Bandwidth (%)
3.9	8.534	8.691	18.89
5.25	9.044	9.030	38.7

(b)

Frequency (GHz)	Gain (dB)	Directivity (dBi)	10 dB Bandwidth (%)
3.675	8.449	8.425	15
4.25	6.754	7.185	4.2
5.55	9.133	9.154	22.1

IV. CONCLUSION

Mainly U slot patch antenna is used for providing wideband characteristics but in this paper, we have shown that cutting of U-slots in the patch antenna, results in dual band and triple band antenna. Thus the proposed design of Dual band and Triple band antennas results in a structures which is simpler and easier to fabricate and its supports the Dual band frequencies are 3.8 GHz to 4GHz and 5 GHz to 5.5GHz and Triple band frequencies are 3.6 GHz to 3.75 GHz, 4.2 GHz to 4.3 GHz and 5.4 GHz to 5.7 GHz for multiple wireless applications such as WLAN, Wi-MAX. The resulting antenna does not involve a complicated feed such as the L probe and M probe. It also does not require, more than one patch and more than one layer, as in the case of coax fed stacked patches and aperture coupled stacked patches. The proposed dual band with single U slot and triple band with dual U slot antenna provides dual band and triple band characteristics without any stacking and provides moderate values of 10 dB bandwidth. These antennas can be further improved in terms of resonant frequencies and bandwidth by cutting additional slots on the patch.

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