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Design of dual and triple band antennas using U-slots on stacked patches

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ABSTRACT

A different kind of approach to design dual and triple band antennas using U-slots on stacked patches is designed.Present approach is based on employing U-slots on stacked patches and the design is simulated using concerto software.It is observed that each U-slot included will include a notch in corresponding matching band.By changing certain feed position only we can achieve desired application with in single antenna.Same has been implemented by rotating planes of U-slots.This antenna can be used for several applications in X-band.

Keywords: Multiband antennas,slot antennas,stacked patches,U-slot antennas,X-band applications

1. INTRODUCTION

The rapid increase in communication standards has lead to greater demands for antennas with low profile,low size,low cost of fabrication and ease of integration with feeding network.Numerous applications were developed after designing of multiband antennas with desired slots which makes antenna conformal with arrays,reduces the size of the antenna to about 37% and also avoids the usage of two or more antennas for multiband responses.In[1],a new approach to get dual band and triple band antennas is verified using U-slots and the same has been verified by various feeding technique finally results of simulated and fabricated models is compared.In[2],dual band printed microstrip antennas using single layer and multi-layer patches have been reported.Triple band performance has been reported for a square patch antenna using spurline filter and perturbation technique.In [3],Multi band1 patch with shorting wall and slot was proposed in order to achieve different wireless applications wideband was achieved by using a slot on top patch.In [4], microstrip antennas (MSA) are loaded with monolithic stubs, shorting pins or slots, the electrical resonant length of the patch gets modified and hence tunable or multiple frequency antennas can be realized.In[5],a modified structure with a placard shaped slot having two stubs centered in the square patch is proposed to lower the fiequencies of the dual band operation.In [6],a multi band microstrip antenna operating at frequency 2.4GHz and 5.2GHz is presented.The dimensions of the single elements of the operating frequencies were calculated using the transmission line model.Two elements of inset fed microstrip antenna were used for each frequency band.In[7],microstrip line fed,printed isosceles triangular slot antennas,with a small rectangular slot for broad band operation ,were proposed and experimentally investigated.Experimental result sindicate that a 2:1 VSWR is achieved over a bandwidth of 2.9GHz, between 2.33 and 5.23GHz, which is nearly4.6 times that of a conventional microstrip-line-fed, printed isosceles triangular slot.

This paper presents a multi-band antenna design approach based on inserting U-slots on rectangular stacked patches.The MSA designed is being fed by a wireedge into the substrate with input impedance of 50 Ω.This design uses two different substrates with Er=2.23 and Er=1 for bottom and top substrate srespectively.Several results are presented and discussed to show the versatility of this antenna,developed by simple changes.The proposed antenna has many applications and can be used for any application in X-band range,by changing feed positions and by selecting slot dimensions.

2. DESIGN CONSIDERATIONS

The proposed antenna is designed using two different substrates.A substrate of Er=2.23 for bottom patch and of Er=1(air).Two patches of different dimensions has been designed on two substrates.Dimensions of the patches and U-slots are mentioned in the table below.Height of substrates for both patches are mentioned in the table.

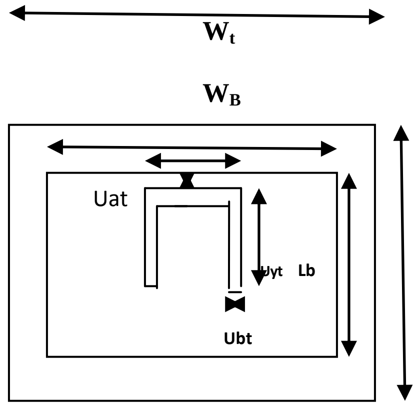

Fig1: Geometry of stacked patch antenna with U-slots

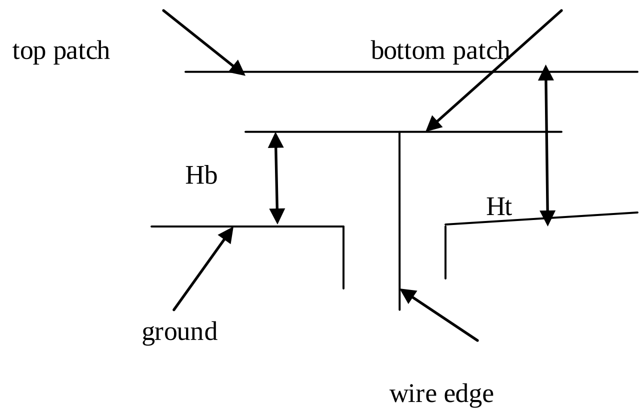

Fig2:heights of substrates from ground

Table1: dimensions of stacked patch antennas with U-slots

	w_t	L_t	w_b	L_b	U_{xt}	U_{yt}	U_{at}	U_{bt}	U_{xb}	U_{yb}	U_{ab}	U_{bb}
With no slots	16	15	12	13.5	-	-	-	-	-	-	-	-
With 1 U slot on bottom patch	16	15	12.5	13.5	-	-	-	-	6	5.5	0.5	0.5
With U-slots on both patches	16	15	12.5	13.5	6	6.5	0.25	0.5	6	5.5	0.5	0.5

DESIGN MODELS USING CONCERTO:

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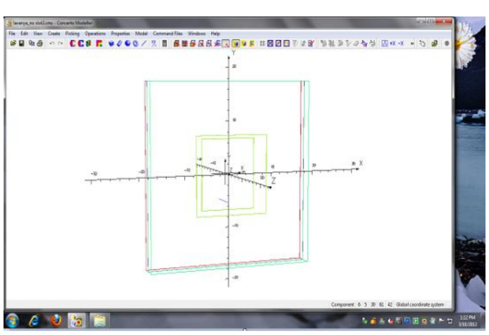

Fig1:Design with no slot on patches

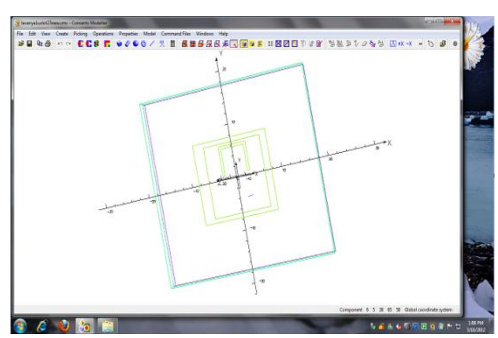

Fig2:Single U-slot on bottom patch

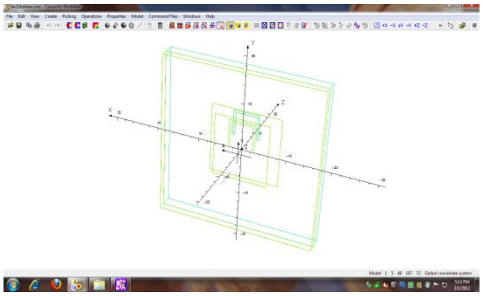

Fig3:U-slots on both patches

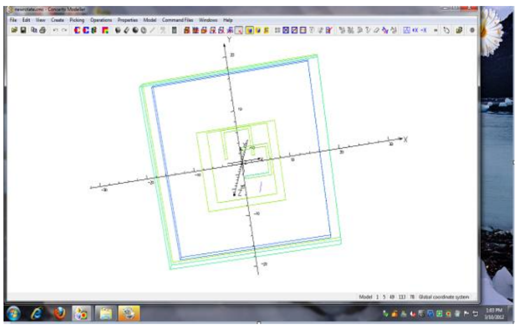

Fig4:Modified design when U-slot on top patch is rotated to 90^0

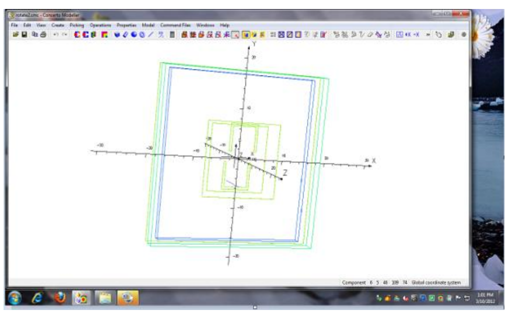

Fig5: Modified design when U-slot on top patch is rotated to 180^0

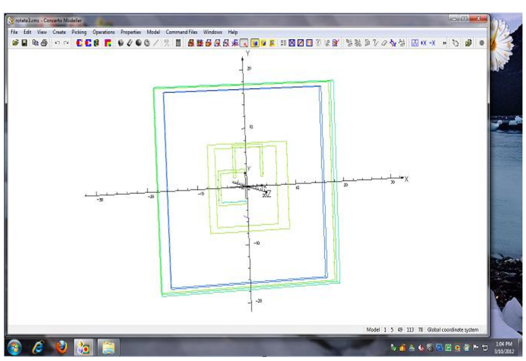

Fig6: Modifies design when U-slot on top patch is rotated to 270^0

5. RESULTS &DISCUSSION

Simulation is the process to verify the performance of the device for the given specifications under the specified conditions before actual manufacture of the device. So by using Simulator tool Concerto, we can first simulate the particular design of a multi band antenna and verify required parameters. We can observe the performance of the antennas by verifying the outputs and finally fabricate the antenna following the same specifications and thus minimizing the costs.Further,a perfect optimization was done, in order to find the best feeding point of the structure. Several points were tested in order to get an overview of the defined functioning of the antenna.At first the feeding point was choosen on –ve Y-axis and is adjusted slowly to get best return losses.

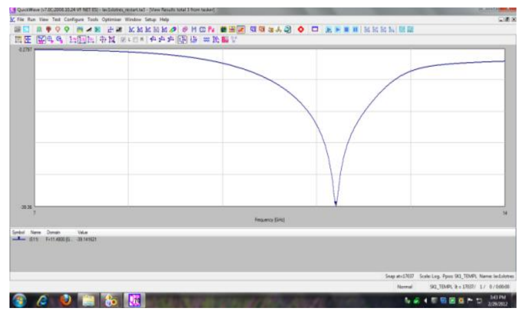

Fig 7: Return loss of design with no slots

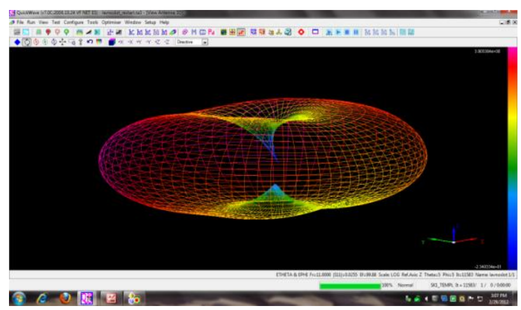

Fig 8: Simulated results for 3D gain at f=11.4Ghz in concerto software

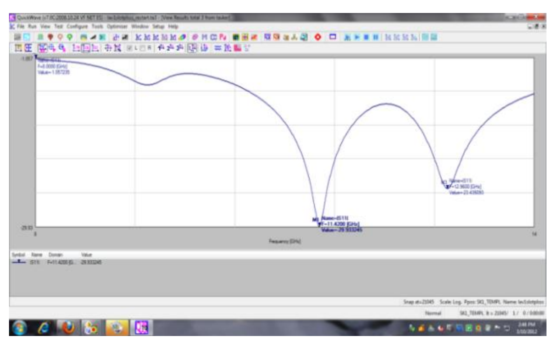

Fig9: Return loss of design with 1 U-slot

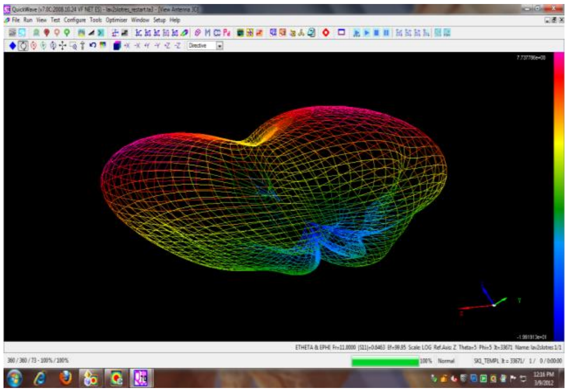

Fig 10: Simulated results for 3Dgain at f=11.42Ghz in concerto software

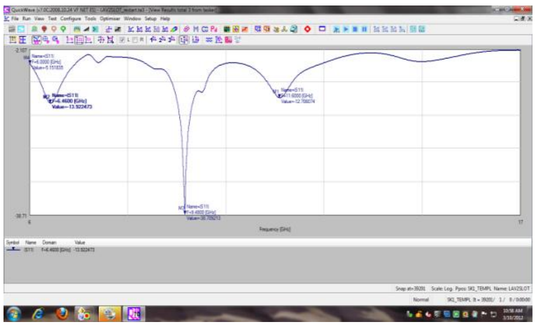

Fig11:Return loss of design with U-slots on both patches

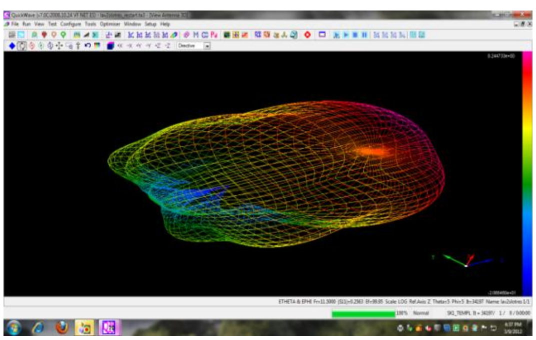

Fig 12: Simulated results for 3D gain at f=6.46Ghz in concerto software

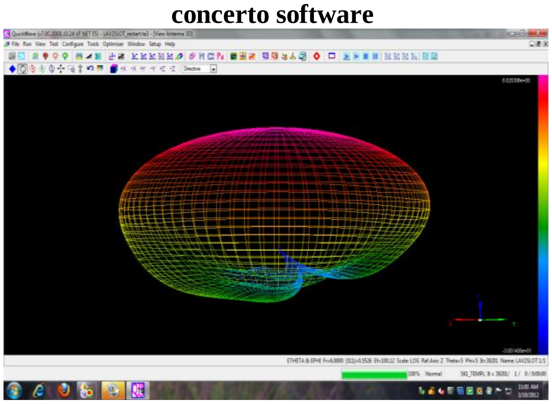

Fig 13: Simulated results for gain at f=9.48Ghz in concerto software

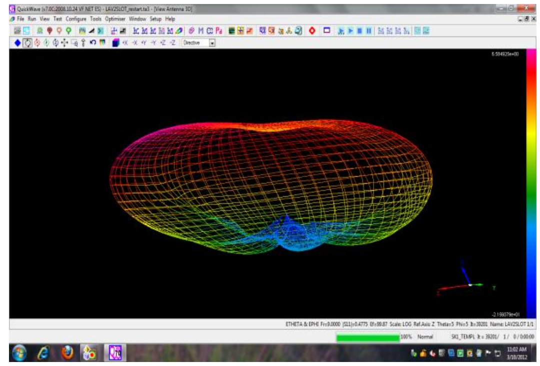

Fig 14: Simulated results for gain at f=11.6Ghz in concerto software

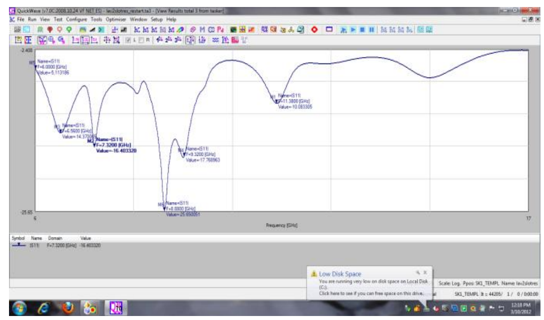

Fig15:Return loss of design with 2 U-slots and slot rotated to 90^0

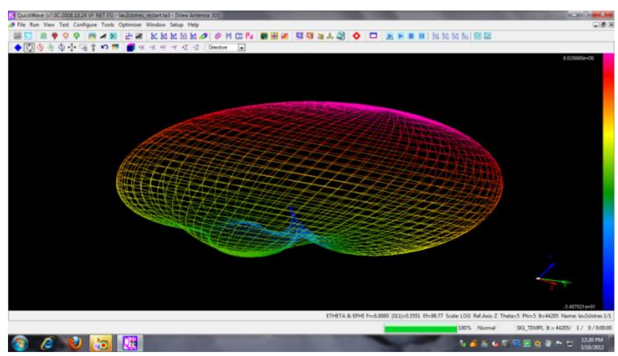

Fig 16 Simulated results for 3D gain at f=7.32Ghz in concerto software

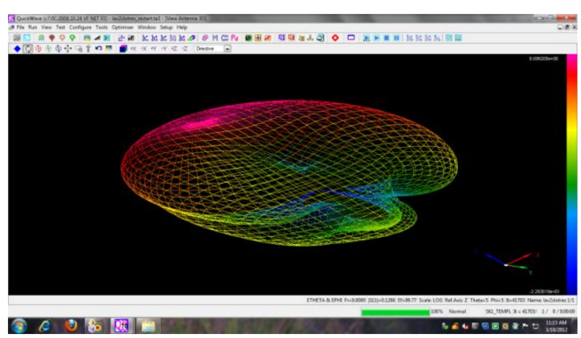

Fig 17: Simulated results for gain at f=5.8Ghz in concerto software

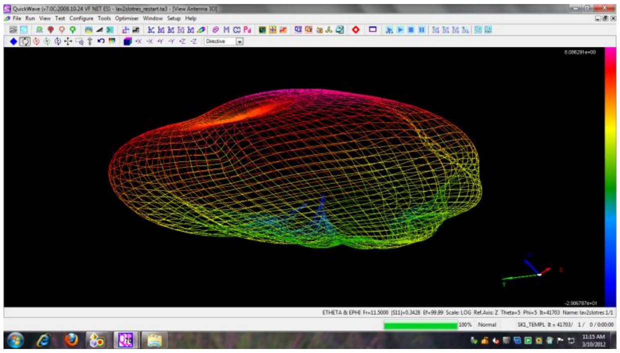

Fig 18: Simulated results for gain at f=8.8Ghz in concerto

Fig19:Return loss of design with 2 U-slots and slot rotated to 180^0

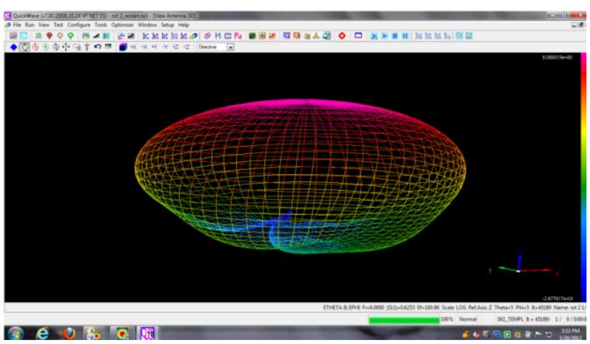

Fig 20: Simulated results for 3D gain at f=6.7Ghz in concerto software

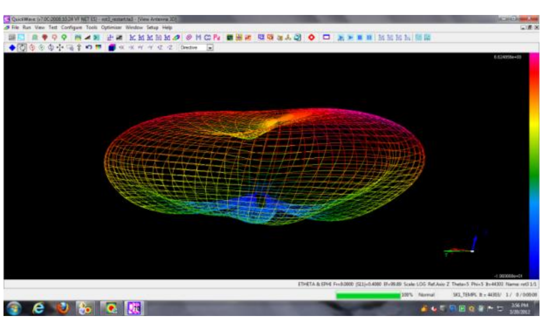

Fig 21: Simulated results for 3D gain at f=8.22Ghz in concerto software

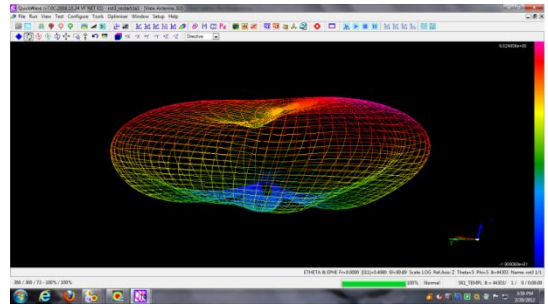

Fig 22: Simulated results for gain at f=11.78Ghz in concerto software

Fig23:Return loss of design with 2 U-slots and slot rotated to 270^0

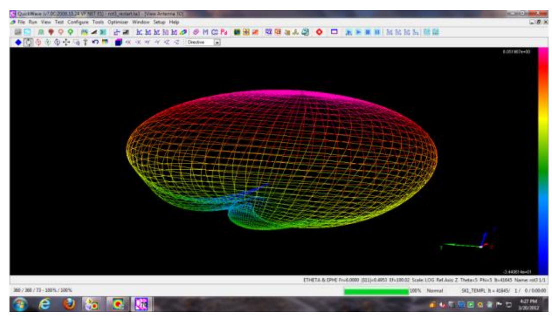

Fig 24: Simulated results for 3D gain at f=6.32Ghz in concerto software

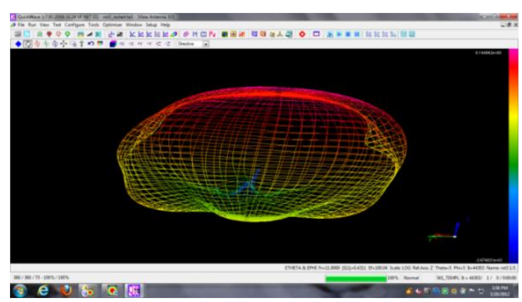

Fig 25: Simulated results for 3D gain at f=9.38Ghz in concerto software

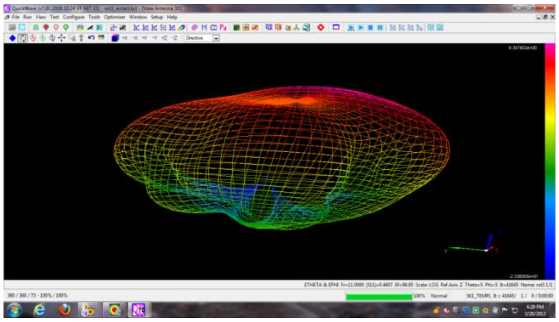

Fig 26: Simulated results for gain at f=11.44Ghz in concerto software

6. APPLICATIONS

Can be used for military communications satellites and various X-band applications such as radar applications including continuous-wave, pulsed, single-polarization, dual-polarization, synthetic aperture radar, and phased arrays

7. CONCLUSION

A new approach to obtain multi-band response has been presented, using U-slots to improve bandwidth (each U-slot included will introduce a notch in matching band)Same model was implemented by rotating the planes of U-slot and radiation patterns,return losses are observed and the best model is evaluated comparing various parameters.In the same model cross polarisation is reduced by designing a antenna with opposite slots.The antenna has many applications in X-band and this single antenna can be used for versatile applications in the range due to multiband response.

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