ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

Design and Analysis of Nonagon - Torus Slot Antenna Working In Multiband Frequencies.

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ABSTRACT

This paper represents the design of a innovative patch of microstrip patch antenna which can be used for multiple purposes. The proposed antenna is suitable to operate at four different frequencies 3.5GHz, 5.1GHz, 7GHz and 9.4GHz with a return loss less than -10db.The antenna structure consists of nonagon and to the technique used to increase the frequency bands is slot technique i.e., Torus slot. The antenna parameters have been investigated and optimised by using HFSS tool. Simulated results show that the propound antenna has good radiation characteristics and operates in specific microwave applications. Due to it's tropical specific absorption rate the proposed antenna can be used in biomedical applications.

Keywords: Microstrip antenna, Nonagon, Torus slot, Specific absorption rate

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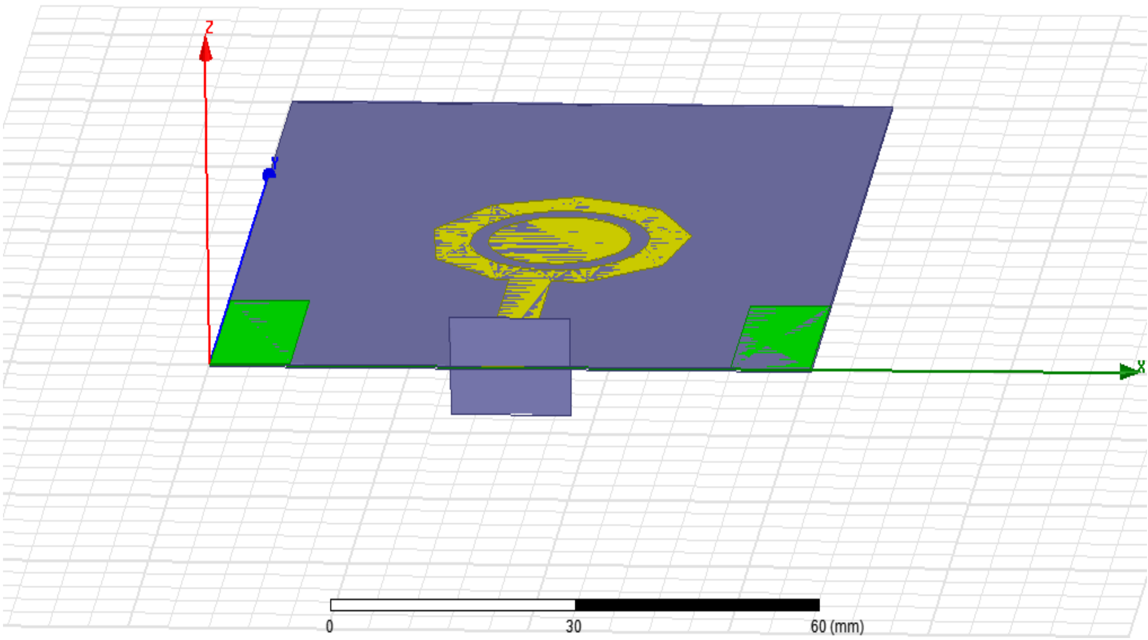
INTRODUCTION

In recent years, the technologies of wireless communication systems have been rapidly aggrandizing for greater capacities broadband service to support wireless devices and be operational in many frequency bands and in many applications. In order to respond to the rapidly aggrandizing ultimatums, an antenna should be active in multi-frequency bands. Therefore, the development of planar antennas with multi-frequency operation capacities, low cost, small size, low profile ,high efficiency and flexibility have become an attractive and a real challenge research in recent years . To achieve such antennas for the specific applications, there are some approaches and techniques used for designing microstrip antennas that operate in wide and multi frequency bands. In a symmetrical ground plane is used to obtain multiband operations which cover various wireless applications. In the use of meta materials for the antennas design caves to multiband characteristics. They have demonstrated the multiband operation by using fractal geometry. Some monopole antennas with slot loading, such as circular ring slot , square ring slot , rectangular slot , are reported, providing multi-frequency band. In this paper, a nonagon shape patched multiband antenna with simple structure, small size and wide frequency bands is presented. By using the polyester material as substrate, polygon patch and slot techniques also have many advantages over microstrip type to efficiently control the characteristics of the impedance bandwidth of the operating frequency and to reduce the specific absorption rate, E-field and H-field variation leads to use this antenna in biomedical applications. The frequency response of this antenna is in various band frequencies, so this antenna can be used as multi band purpose.

DESIGN SIMULATION:

Structure of Nonagon -Torus slot antenna



In this antenna, the polyester material is used as a substrate and the polygon with nine sides(nonagon) as a patch in which torus shape is inserted. The rectangle shape is used as ground and one more rectangle is given as wave port to the linefeed. The dimensions of the geometries are mentioned below as specifications.

ISSN: 0975-8585

SPECIFICATIONS:

PLANES	SHAPES	X-AXIS	Y-AXIS	Z-AXIS	COORDINATES (MM)
Substrate	Box	75	100	-0.254	0,0,0
Patch	Nonagon with torus as slot	_	_	_	Centre(38.75,48,0) Start(50,60,0) Torus(38.75,48,0)
Ground	Rectangle1	10	24	_	(0,0,0)
	Rectangle2	-10	24	_	(75,0,0)

ANTENNA DESIGNING FORMULAE:

FOR PATCH

wavelength(λ)=c/f ----------(1)

where c=velocity of light
f=frequency

w=c/2f($\sqrt{2}/\varepsilon$r+1)-----------------(2)

εreff=((εr+1)/2)+((εr-1)/2)[1+12(h/w)]^(-1/2)----------------(3)

ΔL=0.412h(((εreff+0.3)((w/h)+0.264))/((εreff-0.258)((w/h)+0.8)))----------(4)

Leff=c/(2f$\sqrt{\varepsilon}$reff)----------------(5)

L=Leff+2ΔL ------------------(6)

Feed length=λg/4-------------(7)

where λg=λ/εreff

FOR SUBSTRATE& GROUND

Wg=w+6h----------------(8)

Lg=L+6h-------------------(9)

where h=0.606λ/$\sqrt{\varepsilon}$r
εr=Relative permittivity

SIMULATED RESULT:

The simulated result shows that fig(a) return loss is less than -10db which is used for biomedical applications. For this specified antenna there is good result in directivity, gain and SAR(specific absorption rate) so we can easily define this antenna is used for biomedical field. The specific absorption rate can be defined as the amount of radiation absorbed by the skin tissue of human body .In the nonagon-torus slotted antenna due to the slot on the patch there will be a change in the radiation of antenna. The following figures represents the performance of various parameters of the antenna.

RETURN LOSS:

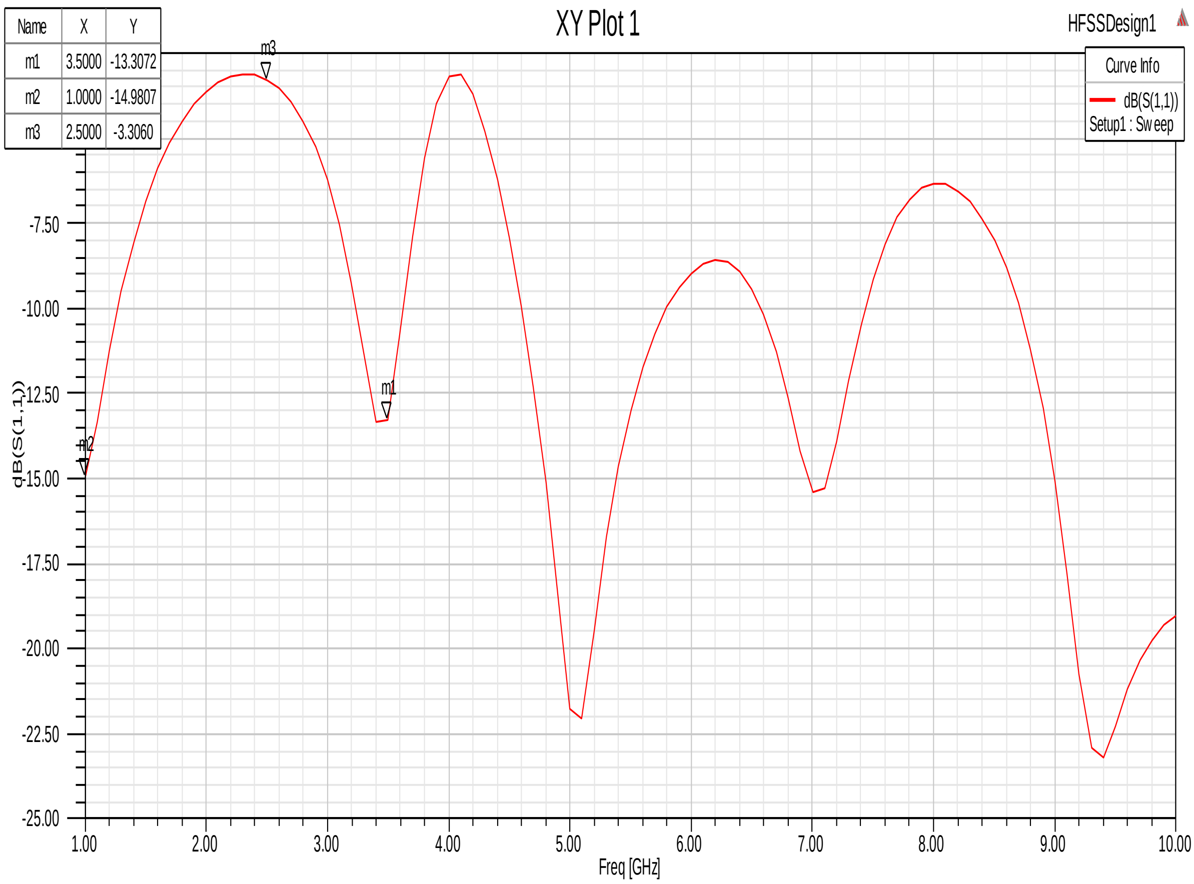


Fig 1(a)

GAIN:

Fig 1(b)

RADIATION:

Fig 1(c)

DIRECTIVITY:

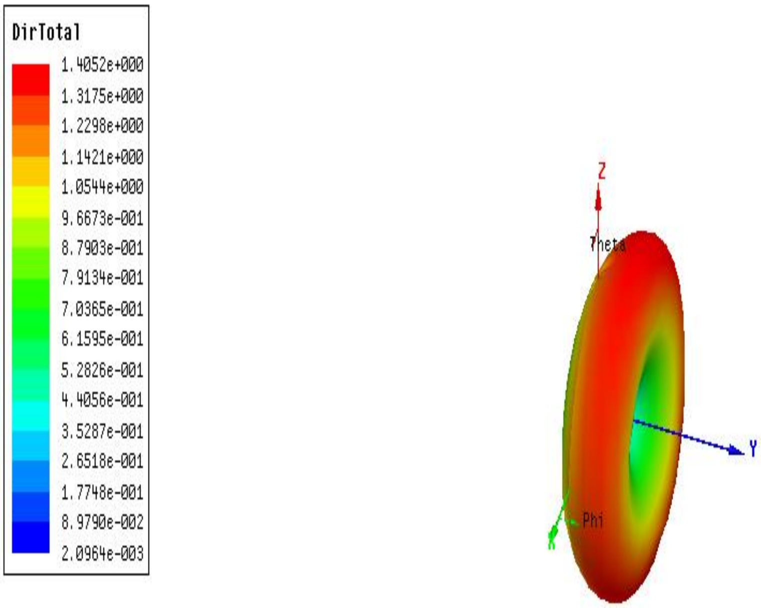


Fig 1(d)

E FIELD:

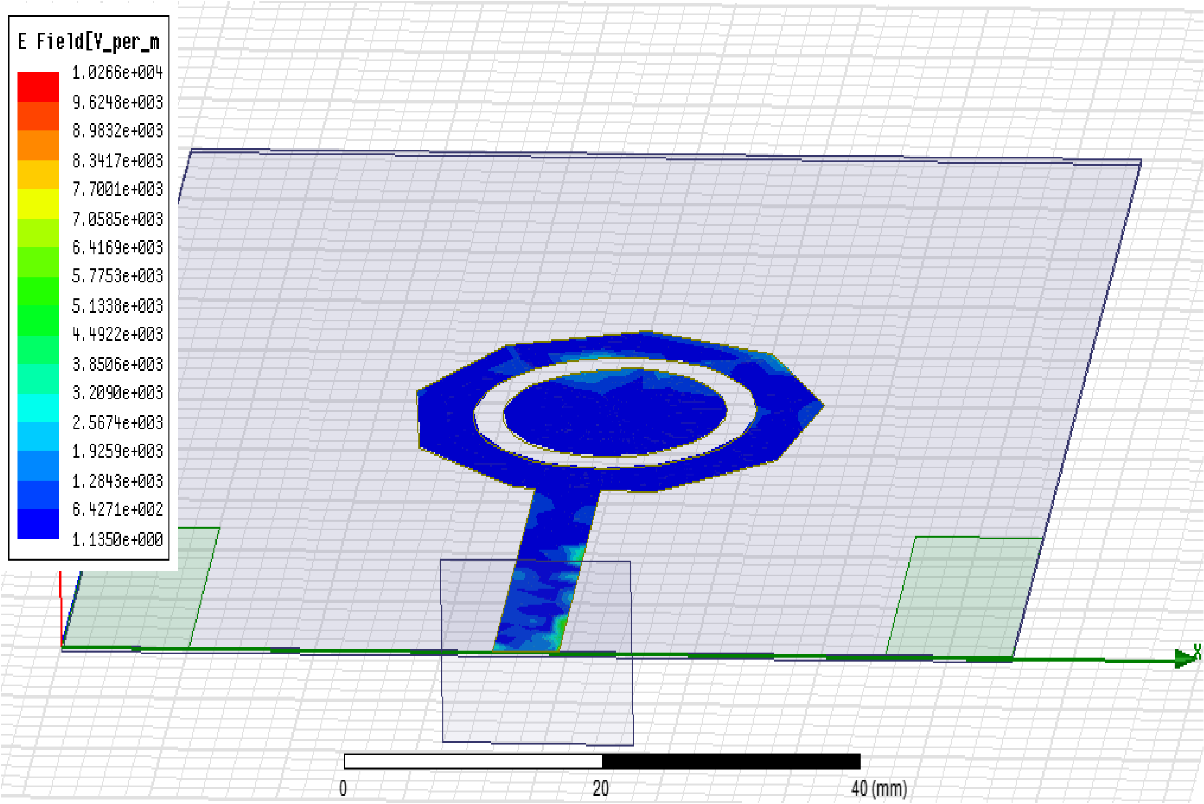


Fig 1(e)

H FIELD:

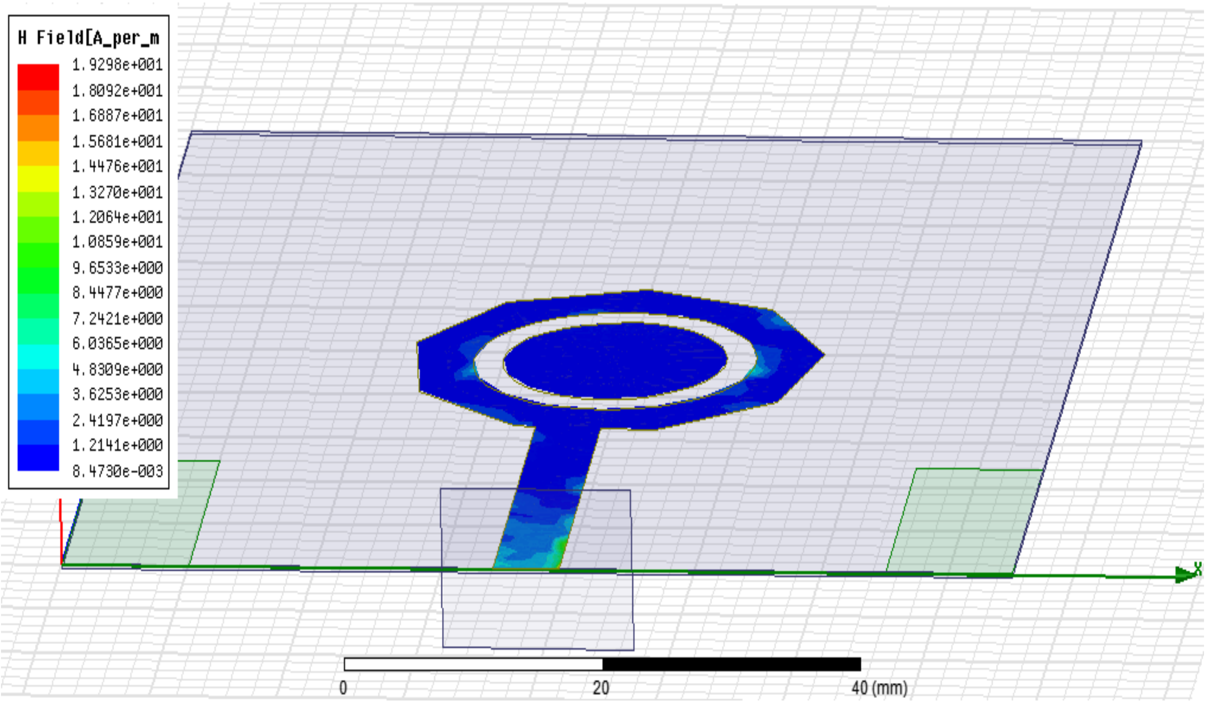


Fig 1(f)

SAR:

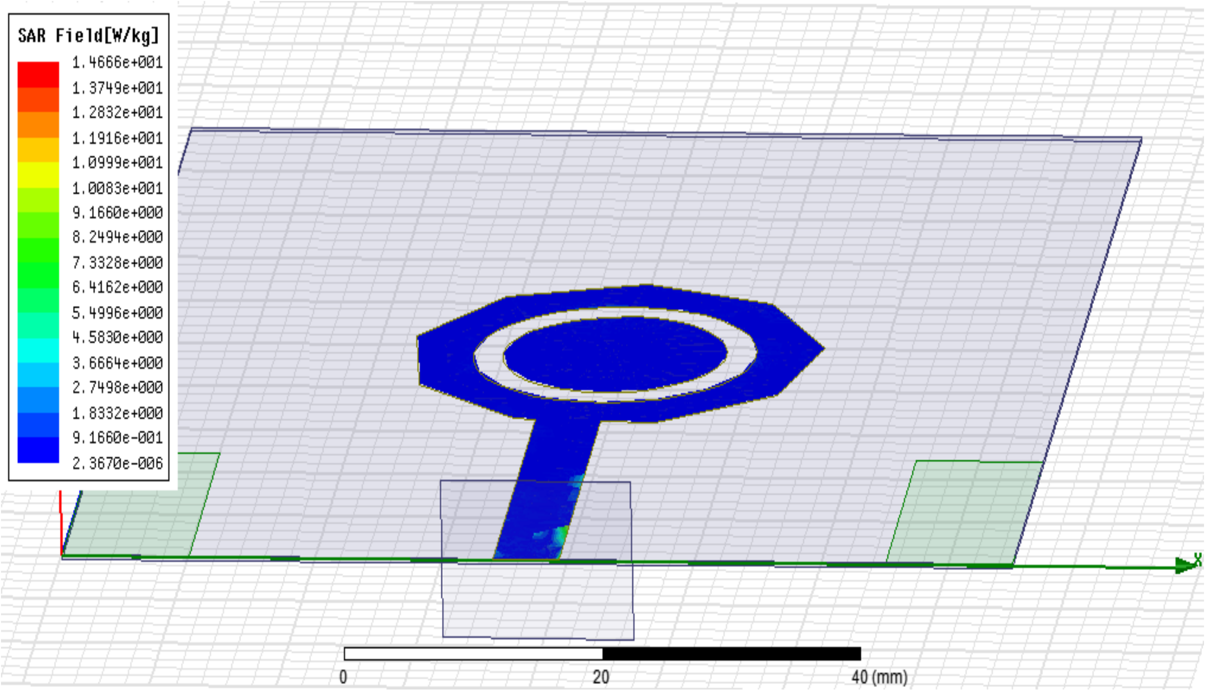


Fig 1(g)

Fig 1(a) represents return loss and it's mentioned working frequencies,1(b) represents gain in which the maximum gain is achieved as 1.536 db.Fig 1(c) and 1(d) shows the radiation and directivity. Also the E-field and H-field are shown in fig 1(e) and 1(f).Specific absorption rate is 1.46 (W/Kg);which has been shown in the tabulation.

ANTENNA PARAMETERS:

QUANTITY	VALUE
Peak directivity	1.4052e+000
Peak radiated power	6.6529e+003(mv)
Peak gain	1.536e+000(db)
Electric field intensity	1.0266e+004(v)
Magnetic field intensity	1.9298e+001(a)
Specific absorption rate	1.4066e+001(w/kg)

CONCLUSION

In this study, we have designed and validated a new low cost printed multi-band antenna structure, suitable to operate in wide frequency bands and biomedical applications. As described in this paper conception, optimization and simulation results are performed by using HFSS electromagnetic simulator. The slots technique used in this work is a simple way to optimize and to control the frequency band. The proposed antenna is composed of nonagon shaped patch with torus shape slot on a substrate that enables proper adjusting of the resonant bands. The proposed antenna can be an excellent choice for multiband applications due to its small size, simple edifice, valid multiband characteristics, and omni directional radiation pattern over the forenamed bands.

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