iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 **Issue:** V **Month of publication:** May 2018

DOI: http://doi.org/10.22214/ijraset.2018.5421

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue V, May 2018- Available at www.ijraset.com

A Triband Antenna for Smart Wearable Devices

Ajay Sankaran[1], Anusha G[2], Senthilnathan S[3], Sivaraj M[4] and Venkatesh D[5]
1, 2, 3, 4, 5Department of Electronics and Communication Engineering, Anna University

Abstract: A compact triband antenna suitable for IEEE 802.11 WLAN (Wireless Local Area Network), IEEE 802.15 Bluetooth and IEEE 802.16 WiMAX (Worldwide Interoperability for Microwave Access) applications is demonstrated in this dissertation. The dimensions of the antenna are trivial and has linear polarization. The required triple band characteristics is achieved by using meander line technique. The bends in this method make the antenna to resonate at various modes of microwave frequencies. The printed antenna is realized on a FR-4 PCB substrate which is cost-effective. The proposed antenna is excited by a simple 50Ω microstrip line. The simulated -10dB impedance bandwidth were obtained as 230 MHz (2.35-2.58 GHz) ,440 MHz (4.92-5.36 GHz) for WLAN and 500 MHz (3.4-3.9 GHz) for WiMAX.

Keywords: Printed Monopole antenna, Smart Wearable devices, Triband Antenna, WLAN, WiMAX.

I. INTRODUCTION

With the vast development in wireless communication, there is a wide variety of short range radio links such as Bluetooth, WLAN etc. Wi-Fi technology is used to provide internet access to devices within its range. Bluetooth can be used for wireless control and communication between a handset and a large number of devices such as car stereo system, portable wireless speakers, mouse, keyboard, headphones etc. WiMAX is used to provide broadband connectivity across cities and countries.

A large number of antennas were proposed to support these technologies. The typical design of these antennas is to use one monopole for one frequency or a branch structure of two monopoles to cover for two frequencies. They are large in size and cannot be fitted into a wearable device. Therefore, a single antenna having multiband characteristics have attracted much attention. Various tri-band antennas for WLAN, Bluetooth and WiMAX were presented. But all these antennas have larger dimensions which is practically not suitable for a small wearable device such as smart watch. Hence, there is a need for reduction in size. There are various methods for miniaturization technique.

Slots can be used in the design of printed monopole antenna. But this reduces the radiation efficiency. Slotted monopole antenna as mentioned in [8] was designed only for dual band operation with size of around 50mm × 30mm × 1.6mm. Defective ground structure(DGS) is another technique to reduce the size. In [3] a rectangular slot is introduced in the ground structure. But the dimensions of the antenna are still large (34mm × 18mm × 1.6mm) and it introduces Back lobe radiation. Meander line is a continuous bending and folding of the monopole structure. This bending makes the antenna to resonate in the dominant mode at lower frequency band and the second order mode at upper frequency band. This type of antenna is mentioned in [5] which shows appreciable triband operation. But the design is complex and dimensions are not still optimum ($20\times22\times1.6\ mm^2$). A circular planar antenna is mentioned in [7] for triple band operation. But then again, the size is still large. In this paper, a novel monopole antenna designed for WLAN, Bluetooth and WiMAX applications is demonstrated. The antenna is small in size, economical and has a fairly large bandwidth.

II. ANTENNA DESIGN

An efficient way to make a conventional wire antenna is to make suitable bends at appropriate places. Fig.1 shows the geometry of the proposed printed monopole antenna. The antenna is fed by a 50 Ω microstrip line.

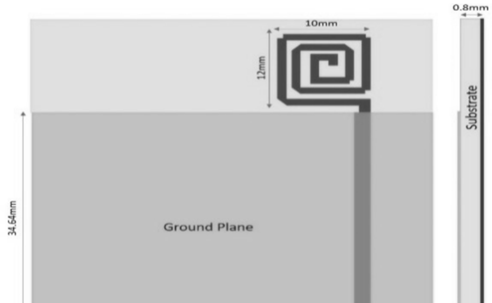


Fig.1 Geometry of the antenna

The antenna is simulated using Keysight Advanced Design System(ADS). The geometry of the antenna looks like a rectangular spiral shape. The total dimensions of the antenna are around 12 mm(L) × 10 mm(W) × 0.8 mm(H). The antenna is proposed to be fabricated on a FR-4 PCB substrate having a relative permittivity $\varepsilon_r = 4.4$ and loss tangent $\tan\delta = 0.0001$. The thickness of the conductor and the substrate is around 52 microns and 0.8 millimetres respectively. The ground plane dimension is about 34.64 mm(L) × 43 mm(W). The ground plane is right below the feed line and covers the feed line alone. It does not extend up to the spiral structure. This makes the printed structure behave like a monopole antenna.

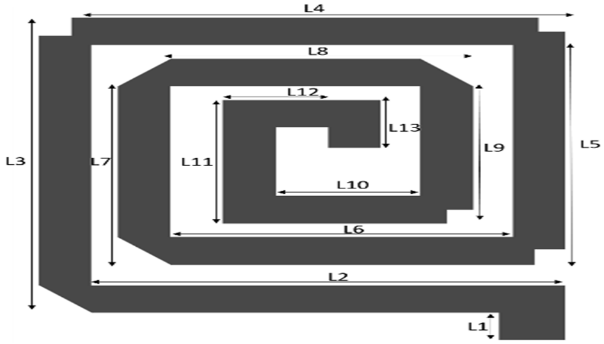


Fig.2 Antenna elements

TABLE I
PARAMETERS OF PROPOSED ANTENNA

Parameter	Size(mm)	Parameter	Size(mm)
L1	1.25	L8	5.75
L2	9	L9	5
L3	9.75	L10	2.75
L4	9	L11	4.5
L5	7	L12	2
L6	6.5	L13	0.75
L7	6.5	W	1

The length of the microstrip feed line is calculated as 34.64 mm which is the $\lambda/2$ length for 2.4 GHz. Thus, it can be said that the antenna is matched to 2.4 GHz frequency. The width of the feed line is around 1.5 mm and the total length of the monopole antenna is about 70 mm (approx.). The dimensions of all the elements in the antenna are shown in Fig.2. The width of each element is around 1mm. Chopping is done at appropriate edges to achieve the desired triband operation.

III. RESULTS AND DISCUSSION

The simulated reflection coefficient (S_{11}) of the antenna is shown in Fig.3. The results in Fig.3 show that the antenna has successfully achieved triple band characteristics for 2.4/5.2 WLAN, 2.4 Bluetooth and 3.5 WiMAX applications. The operating band at 2.4 GHz works for both Bluetooth and Wi-Fi.

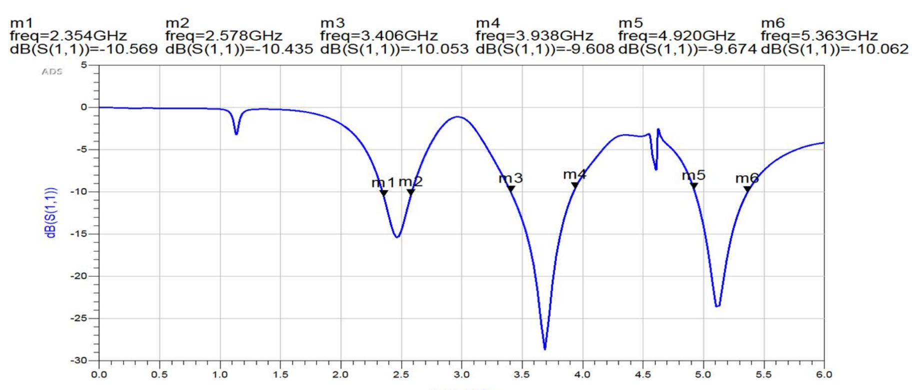
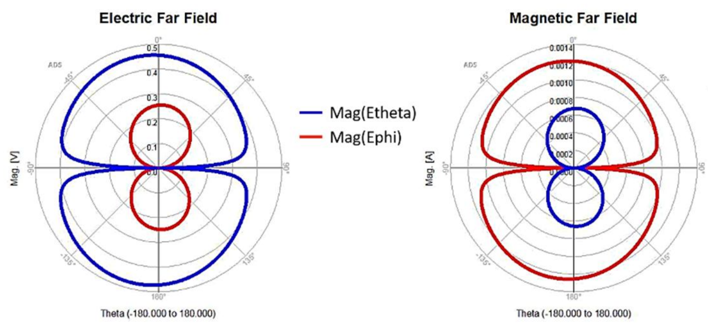


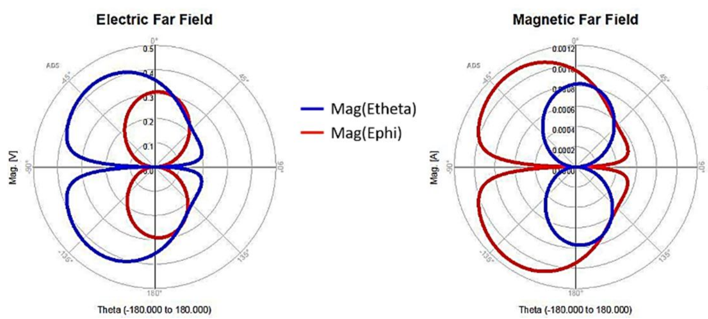
Fig.3 Simulated Reflection Coefficient

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue V, May 2018- Available at www.ijraset.com

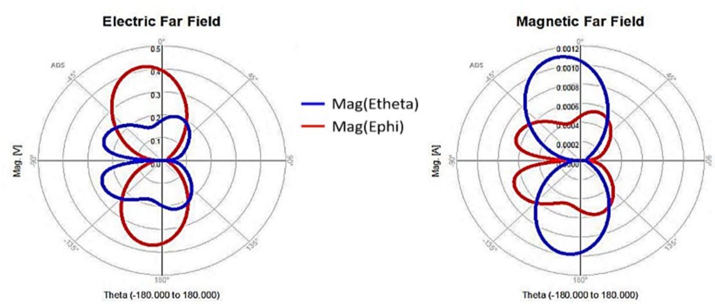
Three independent operation bands were obtained to fulfil WLAN, Bluetooth and WiMAX applications. The measured bandwidths (S_{11} < -10 dB) range are from 2.35 to 2.58 GHz (230 MHz), 3.40 to 3.9 GHz (500MHz) and 4.92 to 5.36 GHz (440 MHz).



(a)



(b)



(c)

Fig.4 simulated radiation pattern for proposed antenna

Fig.4(a) shows the radiation pattern for 2.4 GHz (b) shows the radiation pattern for 3.6 GHz and (c) shows the radiation pattern for 5.2 GHz. It can be seen that the radiation pattern is omnidirectional at 2.4 GHz. But as the frequency increases, this omnidirectional property diminishes and directional property enhances. But it does not affect the performance of the antenna.

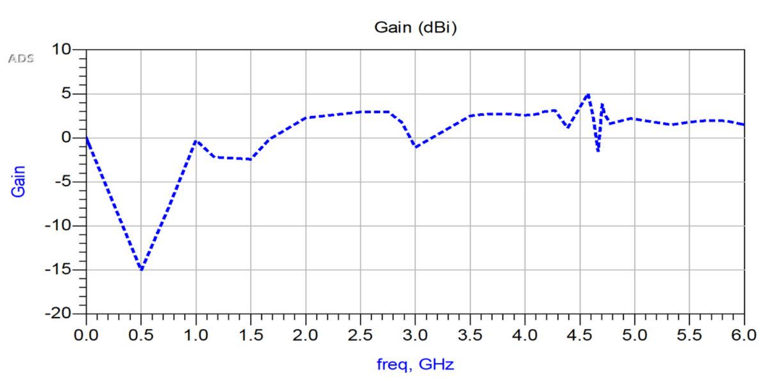


Fig.5 Simulated peak gain across the operating bands

The simulated peak gain for the operating bands is shown in Fig. 5. It is observed that the maximum gain is around 3 dB for 2.4 GHz. The optimum gain is around 2-3 dB for the operating frequency bands which is acceptable for wearable devices in these operating bands. The table below shows the required specifications and obtained results. It can be inferred that the required specifications are satisfied. The bandwidth obtained is more than sufficient.

TABLE II
REQUIRED SPECIFICATIONS AND OBTAINED RESULTS

Parameters	Value	Units	Note	Obtained results
Bandwidth	80	MHz	Bluetooth (2.4-2.48 GHz)	230 MHz (2.33-2.58 GHz)
	70	MHz	Wi-Fi (IEEE 802.11 b/g) (2.41 – 2.48 GHz)	230 MHz (2.33-2.58 GHz)
	160	MHz	Wi-Fi (IEEE 802.11 a) (5.1 – 5.33 GHz)	440 MHz (4.92 – 5.36 GHz)
	300	MHz	WiMAX (3.4-3.7 GHz)	500 MHz (3.3 – 3.9 GHz)
VSWR	1.5:1			Obtained (ref.coeff > -14 dB)
Polarization model	Linear Polarization			Linear Polarization
Impedance	50	Ω		Matched
Gain	0	dBi	Bluetooth	2-3.5 dBi
	2	dBi	Wi-Fi/ WiMAX	

IV. CONCLUSION

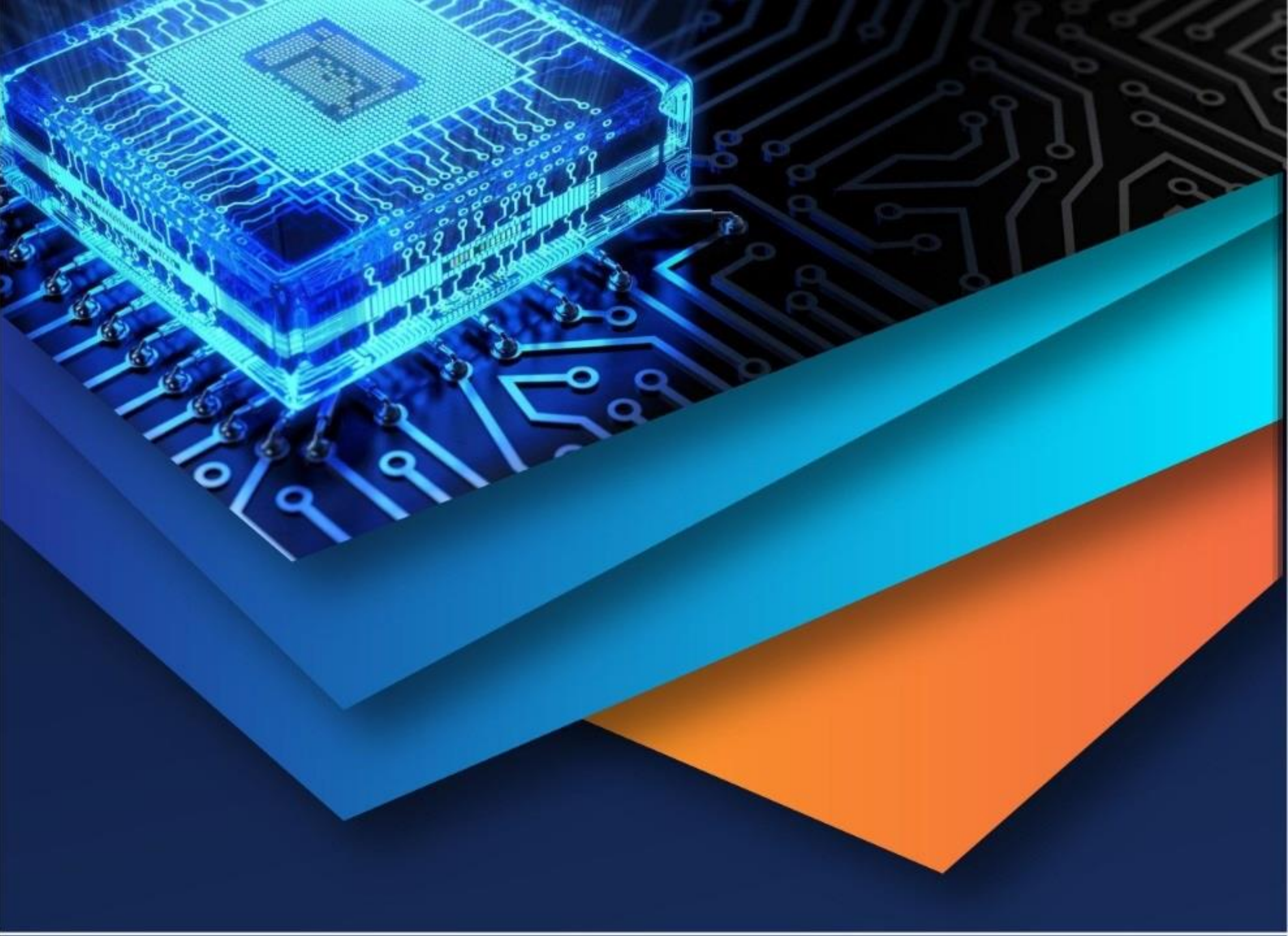
A novel triple band monopole antenna for wearable devices is presented in this paper. Thus, the antenna has a rectangular spiral shape with compact size. The simulated results show that the proposed antenna can support three bands of frequencies which are 2.4 GHz/5.2 GHz for WLAN and 3.5 GHz for WiMAX. The antenna has omnidirectional radiation pattern, reasonable gains, small size and it can be easily fabricated. These properties make it suitable for wearable applications.

V. ACKNOWLEDGEMENT

The authors would like to thank PSG Institute of Technology and Applied Research, Department of Electronics and Communication Engineering and The Head of the Department, Dr E. Malar for providing constant support and resources.

REFERENCES

[1] The Viet Hoang and Hyun Chang Park, “Very simple 2.45/3.5/5.8 GHz triple-band circularly polarised printed monopole antenna with bandwidth enhancement”, Electronic letters, 2014., vol. 50, pp. 1792–1793.
[2] C.-C. Lin, S.-W. Kuo and H.-R. Chuang, Member, “A 2.4-GHz Printed Meander-Line Antenna for USB WLAN With Notebook-PC Housing”, IEEE Microwave and Wireless Components letters, 2009, vol. 15, no.9.
[3] Li Li, Xiaoliang Zhang, Xiaoli Yin and Le Zhou, “A Compact Triple-Band Printed Monopole Antenna for WLAN/WiMAX Applications”, Journal of Latex Class files, 2014, vol.13, no.9.
[4] Hanyang Wang and Ming Zheng, “A Triple-Band WLAN Monopole Antenna”, The second European Conference on Antennas and Propagation,2007.
[5] Y. Xu, Y.-C. Jiao and Y.-C. Luan, “Compact CPW-fed printed monopole antenna with triple-band characteristics for WLAN/WiMAX applications”, Electronic Letters, 2014, vol.48, no.24.
[6] Mahdi Moosazadeh and Sergey Kharkovsky, “Compact and Small Planar Monopole Antenna with Symmetrical L- and U-Shaped Slots for WLAN/WiMAX Applications”, IEEE Antennas and Wireless Propagation Letters”,2014, vol.13.
[7] Aidin Mehdipour, Abdel-Razik Sebak, Christopher W. Trueman and Tayeb. A. Denidni, “Compact Multiband Planar Antenna for 2.4/3.5/5.2/5.8-GHz Wireless Applications”, IEEE Antennas and Wireless Propagation Letters, 2012, vol.11.
[8] Chih-Yu Huang and En-Zo Yu, “A Slot-Monopole Antenna for Dual-Band WLAN Applications”, IEEE Antennas and Wireless Propagation Letters, 2011, vol.10



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY