Design of Dual-Band Wearable Monopole Antenna

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Abstract—This paper presents Dual band monopole antenna for wearable applications designed on the FR4 substrate having a relative permittivity of 4.4, loss tangent 0.02 and thickness of 1.6mm. The designed antenna covers frequency band of 2.8-3.2 GHz and 6.8-7.3GHz provides the gain of 2.86 dBi and 5.1dBi respectively. The software used for designing this antenna is IE3D.

Key Words: Monopole antenna, IE3D software, FR4-substrate, Defected ground plane (DGS),Wearable antenna.

1. INTRODUCTION

Now a day's wearable antenna have received interest in applications like Health monitoring, battle field rescue system and tracking. Several frequency bands have been allocated for wearable devices to expanse WBAN (wireless body area networks) communication systems, which include the such Medical Implant Communication Services (MICS) 402–405 MHz band , the 2.4–2.48 GHz industrial, scientific, and medical (ISM) band and 3.1–10.76 GHz ultra-wide band (UWB) . So far, several configurations have been investigated for their suitability as wearable antennas, including vertical monopoles [1]-[2], inverted-F antennas [3]-[4], microstrip patch antenna [5], cavity-backed slot antenna [6], and artificial magnetic conducting (AMC) surface backed antennas[7], Dual-band meander monopole antenna for on body devices[8].

The antenna design consists up of planar monopole antenna mounted on FR4 substrate with a defected ground plane (DGP) which is mounted on opposite side of substrate.

2 .ANTENNA DESIGN

The schematic configuration of dual band wearable monopole antenna with defected ground plane (DGP) shown in fig 1 consist up of monopole antenna on top of substrate and a ground plane is etched on opposite side of substrate.

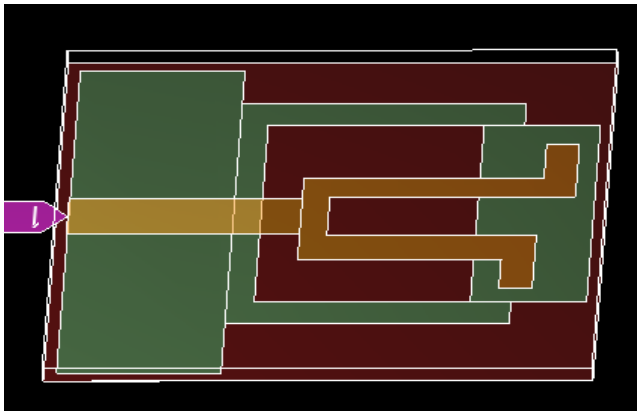

Fig. 1. 3D view of Dual band Wearable Monopole antenna

1.1 *Monopole antenna*

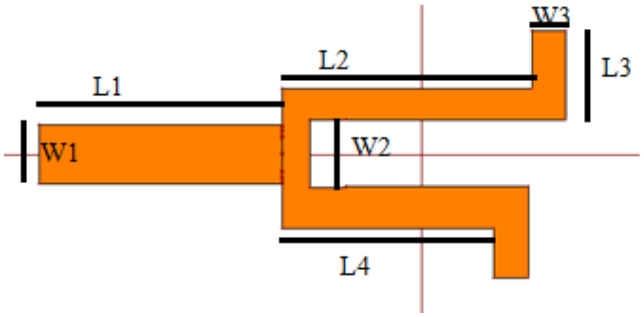

Fig. 2. Monopole antenna

TableI Monopole antenna design parameters

Symbol	Values(mm)
L1*w1	18.3*4.3
L2*w3	19*4.8
L3*w3	6.5*2.5
L4	16

1.2 Defected ground plane (DGP)

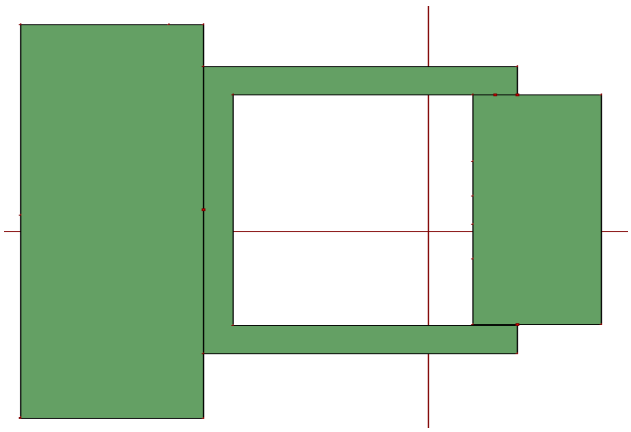

Fig 3 Defected ground plane (DGP) Surface

3. WEARABLE MONOPOLE ANTENNA WITH AND WITHOUT DEFECTED GROUND PLANE

Dual band wearable monopole antenna is design with and without defected ground plane .Antenna design consists up of monopole antenna on top of substrate and etched ground plane is on opposite side of substrate.

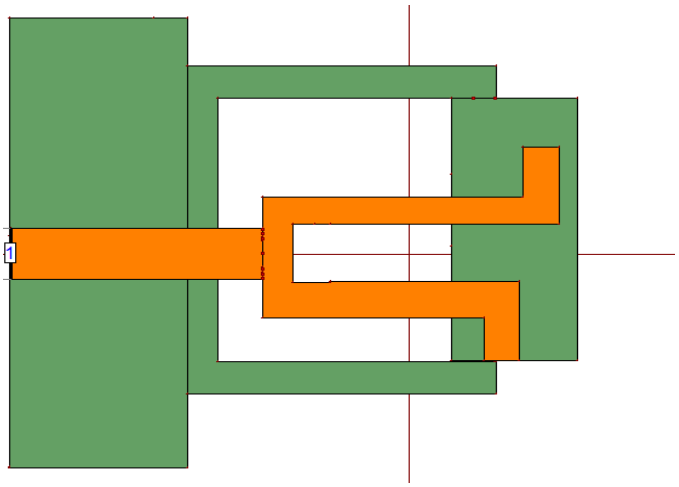

Fig .4. Monopole antenna with defected ground plane

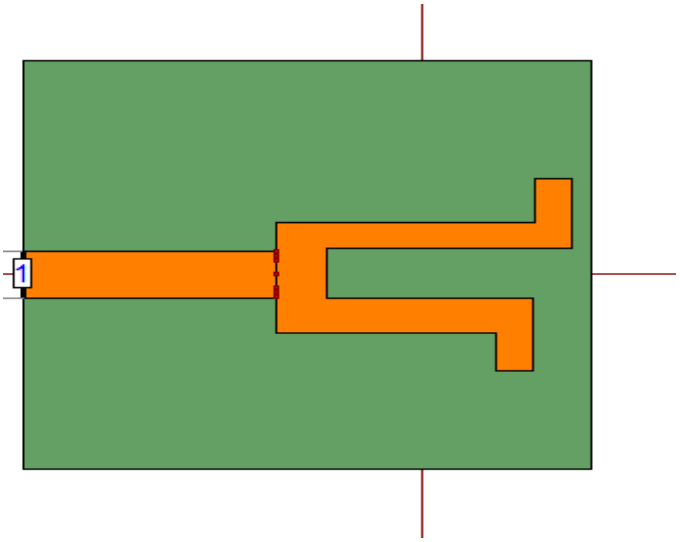

Fig .5. Monopole antenna without defected ground plane

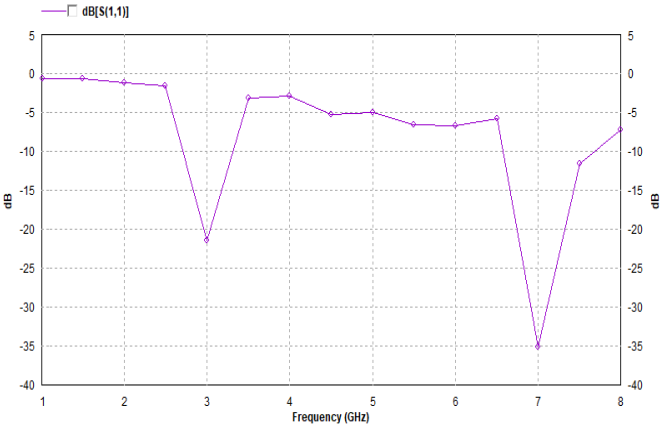

Fig .6. S11(Return loss) of Monopole antenna with defected ground plane

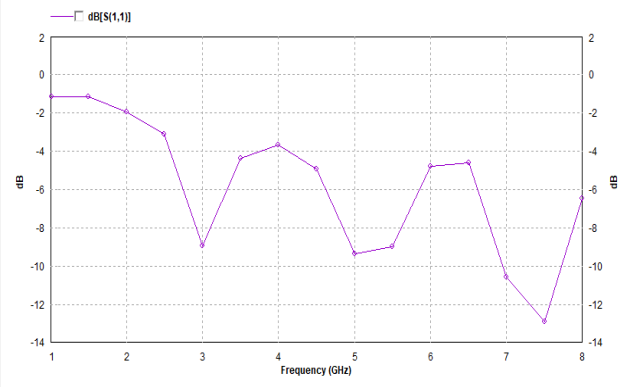

Fig .7. S11(Return loss) of Monopole antenna without defected ground plane

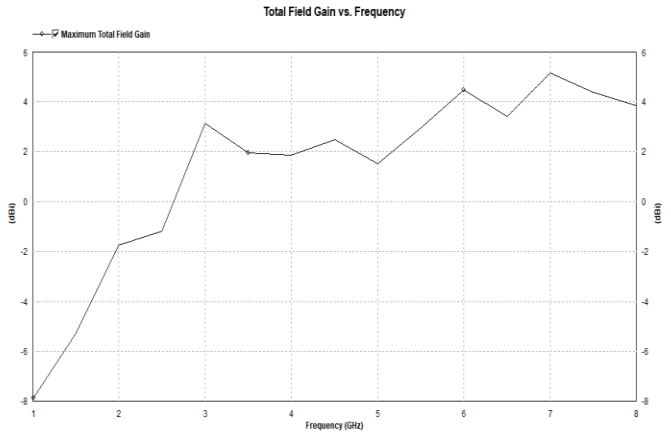

Fig. 8. Gain of Monopole antenna with defected ground plane

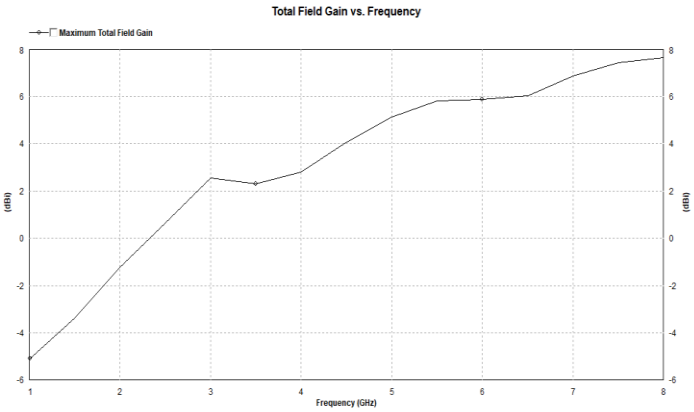

Fig. 9. Gain of Monopole antenna without defected ground plane

TABLE II. Comparison of optimized Antenna Parameter on Modeled human body phantom and Off body condition.

Parameters	**Antenna design with defected ground plane**		**Antenna design without defected ground plane**	
Operating Frequency	3GHz	7Ghz	3GHz	7.5
Return loss(dB)	-21.25dB	-34dB	-8dB	-13dB
Gain(dBi)	2.86dBi	5dBi	5dBi	7.7dBi
Radiation Efficiency	78%		68.54%	

Dual band wearable monopole antenna is design with and without defected ground plane and result obtained are compared in table II .Antenna design with defected ground plane gives return loss of -21.25dB and gain of 2.86dBi at 3GHz frequency and return loss of -34dB and gain of 5 dBi at 7GHz frequency as shown in fig 6 and 8. Dual band wearable monopole antenna is design without defected ground plane gives return loss of -8dB and gain of 2.5dBi at 3GHz frequency and return loss of -13dB and gain of 7.7dBi at 7.5GHz frequency as shown in fig 7 and9.

4. ON BODY PERFORMANCE

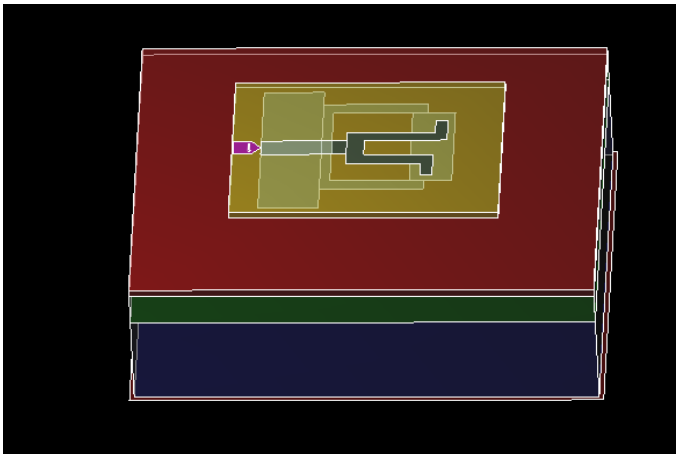

Fig.10 Antenna design on multilayer body phantom

To check the performance of antenna on human body, designed antenna is placed on human body phantom model which is implemented in IE3D software. The phantom model contains 3 layers muscles (Thickness=30mm, permittivity = 52.7, loss tangent= 0.24), fat (Thickness=2mm, permittivity = 5.2, loss tangent= 0.19), and skin (Thickness=1mm, permittivity = 31.2, loss tangent= 0.28), as shown in figure 10.

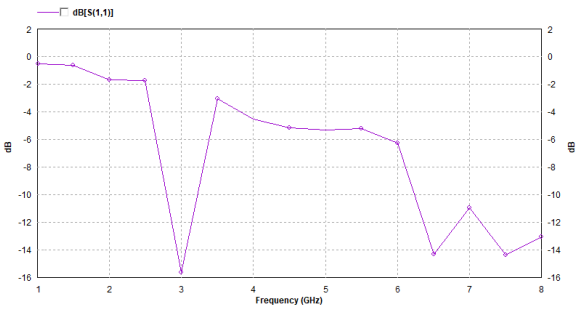

Fig.11.Return loss of antenna design on multilayer body phantom

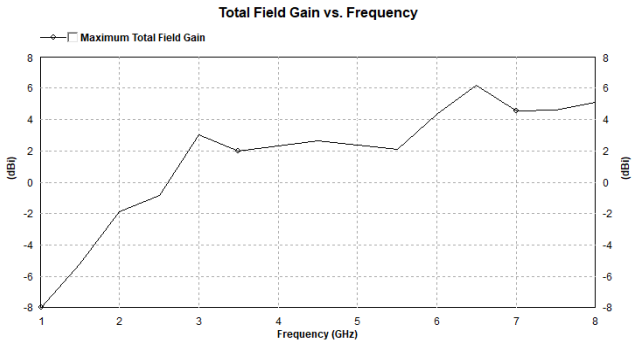

Fig.12.Gain of antenna design on multilayer body phantom

Antenna design on human body model gives return loss of -14.88 dB and gain of 2.5dBi at 3GHz frequency and return loss of -14dB and gain of 4.6 dBi at 7.4GHz provides frequency as shown in fig 11 and 12.

5. CONCLUSIONS

A dual band monopole antenna with defected ground plane structure is designed on the FR4 substrate having 4.4 permittivity and 1.6 mm for wearable applications operating at frequency of 3 GHz and 7 GHz. Providing a good return loss , gain and efficiency. The antenna design with exhibits good response when placed on a modeled human body phantom .The proposed design is compact in dimension as required for wearable application.

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