POS2-42

Parametric Study of the Position of Textile Dipole Antenna above the Textile Artificial Magnetic Conductor

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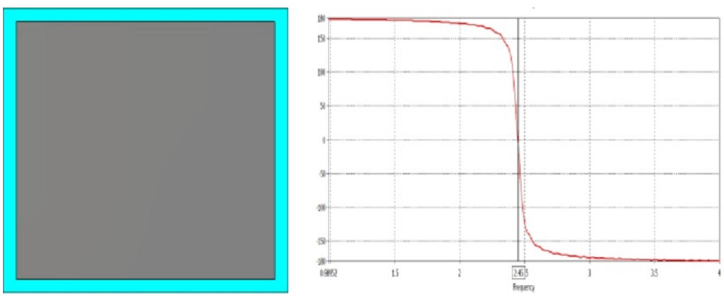
Abstract – This paper presents a 2.45GHz wearable textile dipole antenna and wearable textile artificial magnetic conductor (AMC). The dipole antenna and AMC are made of denim jeans which have 1.67 dielectric constant, 0.67mm of thickness and 0.0019 of loss tangent. Simulated results with different position of textile dipole antenna are used to validate the performance of the AMC. The simulated return losses, together with the H-plane and E-plane, are presented.
Keywords – Artificial magnetic conductor, Dipole antenna, loss tangent, dielectric constant.

1.0 Introduction

Wireless networks for body worn applications need small efficient antenna when working near to human body [1]. Generally, a textile antenna has a small gain due to the destructive interference between the antenna and its image. So, to remove the interference, a structure of the AMC is constructed and placed below of it. In this case, the interference between the antenna and its image would be constructive and consequently the antenna's gain is increased [2]. Different position of dipole antenna above the AMC alters the performance of the antenna such as radiation pattern, return loss and gain. A dipole textile antenna and wearable textile AMC were investigated to reduce or eliminate the signal radiation in the area of the user, thus reducing signal absorption in tissue.

2.0 Design and Consideration

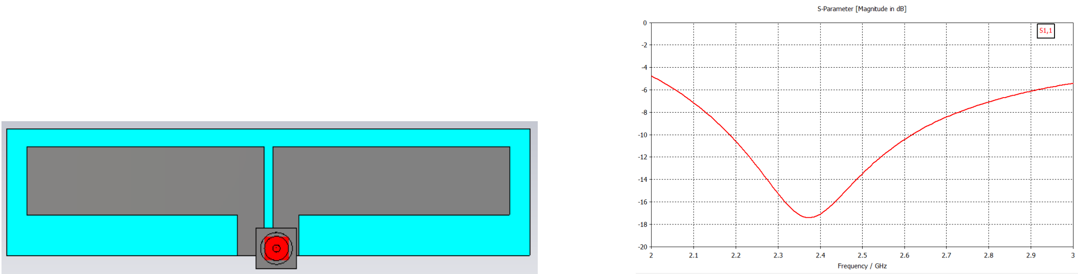
The simulation is done using Computer Simulation Technology (CST) software. Figure 1(a) shows the proposed geometry of the unit cell of the AMC. The size of the proposed AMC is 50 mm x 50 mm. It consists of a square patch of radiating element with 2.8 mm gap and full ground plane. Figure 1(b) shows that the reflection phases of the designed AMC. The resonance frequency of the AMC is at 2.45GHz which is reflection phase is equal to 'zero'.



(a) (b)

Figure 1: (a) Design structure of AMC, b) Reflection phase

Figure 2(a) shows the structure of the textile dipole antenna. A SMA port is placed at the top of the antenna. The width of the antenna is 7.5mm while the length of the antenna is 26.25mm. Figure 2(b) shows the S11 result for the dipole antenna alone. The obtained gain for the antenna is 2 dBi and omnidirectional radiation pattern.

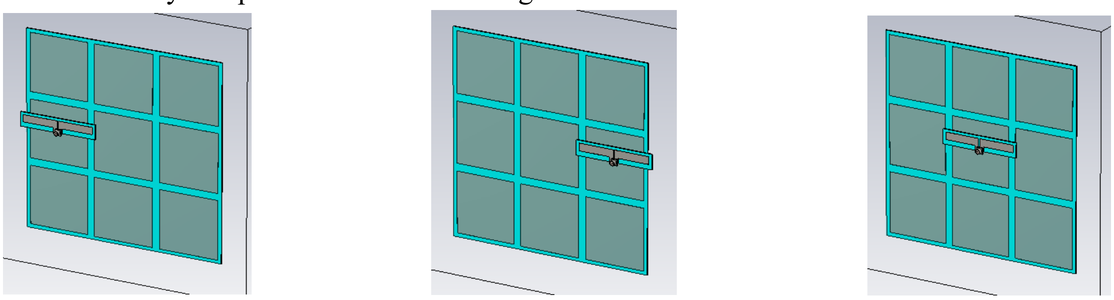


(a) (b)

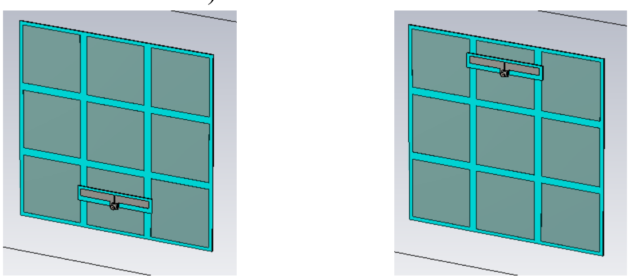
Figure2: (a) Structure of textile dipole antenna and (b) S11 result

2.1 Position of the Dipole Antenna over the AMC

In this paper, 5 cases represent the positions of the dipole antenna above the AMC. For case 1, the dipole antenna is placed at the left of the AMC as shown in figure 3(a) while figure 3(b) shows that the dipole antenna is placed at right hand side of the AMC. For case 3 the dipole antenna is placed at the centre of the AMC which is shown in figure 3(c). Figure 3(d) and 3(e) show the dipole antenna are placed at the below and on the top of the AMC. All cases have three layers of substrates denim as shown in figure 4. The first layer is AMC substrate while the third layer is for antenna's substrate. The second layer is put to cover the radiating element of the AMC.



a) case 1 b) case 2 c) case 3



d) case 4 e) case 5

Figure 3: The positions of the antenna studied

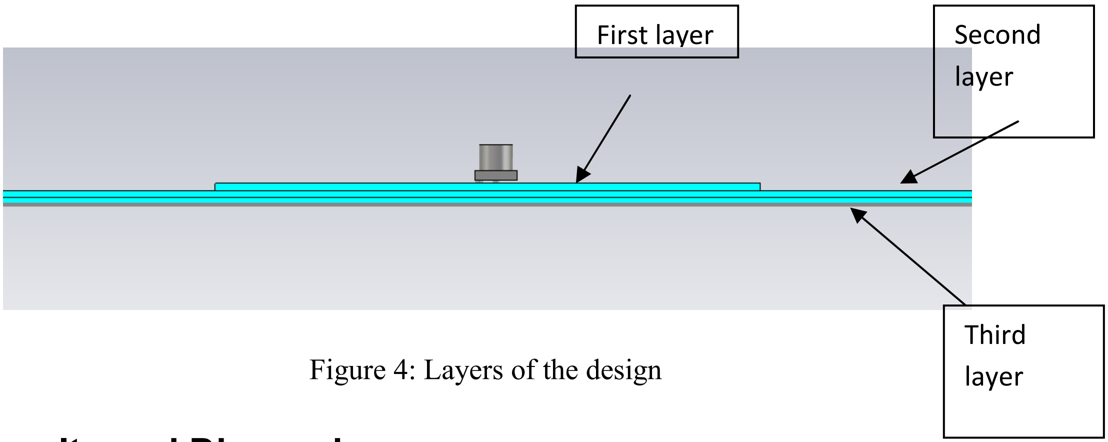


Figure 4: Layers of the design

3.0 Results and Discussions

In order to provide better investigation, this section will firstly present the simulated return loss ($|S_{11}|$) for all cases. Figure 5 below clarifies the S11 parameters for all cases above. From the figure, it shows that cases 3, 4 and 5 are operating at 2.45 GHz while case1 and case 2 resonances' frequency slightly move upward. The bandwidths for all cases are comparable with each other, which are about 1.1-1.5%. Figure 6 presents H-plane and E-plane for all cases. For all cases, the AMC has changed the direction of beam outwards the body. Nevertheless, different position of the antenna produces different direction of the beam. For an example, case 1 produces beam towards to the left and vice versa.

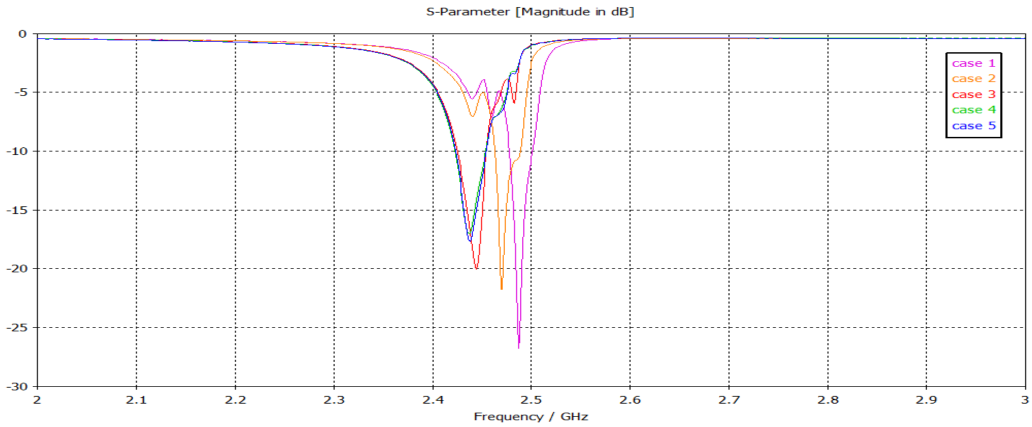
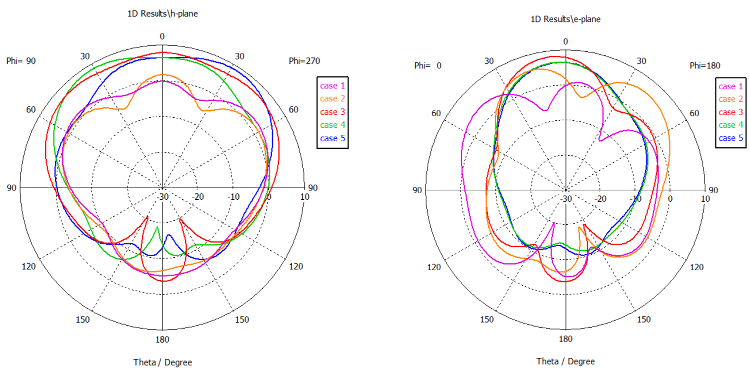


Figure 5: Return loss for all cases



(a) (b)

Figure 6: (a) H-Plane, (b) E-Plane

Table 1 shows the performance of different position of dipole antenna above the AMC. The table consists of return loss, realized gain, total efficiency and directivity for all cases. Total efficiencies, realized gain and directivity for case 1 and case 2 are lower compared to the other cases because the designs not resonate at 2.45GHz.

Table 1: The performances of different position of ribbon antenna above the AMC

Cases	Return loss(dB)	Realized gain (dB)	Total efficiency (%)	Directivity (dB)
1	26.77	2.36	37	6.67
2	21.76	4.4	47	7.7
3	20.02	6.87	72	8.3
4	17.04	8.75	72	10.14
5	17.68	8.86	73	10.23

4.0 Conclusions

This work demonstrates that fully textile antenna and AMC have strong potential to be used for transmission purposes in garments. The function of the AMC as a shielding for human body is successfully approved and the gain of the antenna with AMC is totally increased. Different position of the antenna above the AMC gives different direction of beam.

5.0 Acknowledgements

The authors thank the Ministry of Higher Education (MOHE) for supporting the research work, Research Management Centre (RMC), School of Postgraduate (SPS) and Radio Communication Engineering Department (RACeD) Universiti Teknologi Malaysia (UTM) for the support of the research grant no.Q.J130000.7123.02H02

6.0 Reference

[1] Feresidis, A.P.; Goussetis, G.; Shenhong Wang; Vardaxoglou, J.C.; , "Artificial magnetic conductor surfaces and their application to low-profile high-gain planar antennas," Antennas and Propagation, IEEE Transactions on , vol.53, no.1, pp. 209- 215, Jan. 2005 doi: 10.1109/TAP.2004.840528

[2] Foroozesh, A.; Shafai, L.; , "Investigation Into the Application of Artificial Magnetic Conductors to Bandwidth Broadening, Gain Enhancement and Beam Shaping of Low Profile and Conventional Monopole Antennas," Antennas and Propagation, IEEE Transactions on , vol.59, no.1, pp.4-20, Jan. 2011 doi: 10.1109/TAP.2010.2090458

[3] Abbasi, N.A.; Langley, R.J.; , "Multiband-integrated antenna/artificial magnetic conductor," Microwaves, Antennas & Propagation, IET , vol.5, no.6, pp.711-717, April 26 2011 doi: 10.1049/iet-map.2010.0200

[4] de Cos, M.E.; Las Heras, F.; Franco, M.; , "Design of Planar Artificial Magnetic Conductor Ground Plane Using Frequency-Selective Surfaces for Frequencies Below 1 GHz," Antennas and Wireless Propagation Letters, IEEE , vol.8, no., pp.951-954, 2009 doi: 10.1109/LAWP.2009.2029133

[5] Hadarig, R.C.; de Cos, M.E.; Álvarez, Y.; Las-Heras, F.; , "Novel bow-tie antenna on artificial magnetic conductor for 5.8 GHz radio frequency identification tags usable with metallic objects," Microwaves, Antennas & Propagation, IET , vol.5, no.9, pp.1097-1102, June 27 2011 doi: 10.1049/iet-map.2010.0574