International Journal on Recent and Innovation Trends in Computing and Communication ISSN: 2321-8169
Volume: 3 Issue: 11 6123 - 6126

AMM loaded Y-Shaped UWB Antenna for Health Monitoring Systems

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***Abstract*—** The Ultra-wideband antennas are suitable for low power and high data rate applications for short-range communication. WBAN utilizes human body as the transmission channel. In this paper, a transmission line based artificial magnetic material is deployed into the UWB antenna in order to prevent interference problem with other wireless system in the vicinity. The complementary geometry of proposed AMM is etched into the Y-shaped UWB antenna. The antenna performance is measured for Y-shaped patch with and without inclusion. The results are presented in terms of Return Loss, VSWR, Radiation Pattern, E-Field Distribution and Radiated power. The designed antenna has application in Body Area Networks(BAN) and Personal Area Network (PAN) for heath monitoring systems and security purpose.

***Keywords*-** *Artificial Magnetic material; Ultra-Wideband; Body Area Network; Co-Planar waveguide.*

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I. INTRODUCTION

In Modern telecommunication systems, many conventional antennas have reached their technologically outlined limits. To cope up with the high performance demand in the present scenario, alternative techniques ought to be explored which leads to further circuit integration and miniaturization.

Artificial Magnetic Materials i.e., Metamaterials are composite human-made materials that have physical and electrical properties not found in natural materials. Metamaterials are realized by embedding electrically small metallic inclusions aligned in parallel to a host dielectric medium. In the presence of a magnetic field, an electric current is induced within the inclusions leading to the emergence of an enhanced magnetic response inside the medium at their resonant frequencies. 'Ultra-wideband' (UWB) systems have a large relative, or a large absolute bandwidth, which offer specific advantages with respect to signal robustness, information content and/or implementation simplicity. According to FCC definition of UWB radiation, by 'large absolute bandwidth', we usually refer to systems with more than 500 MHz bandwidth. Federal Communications Commission (FCC) released the frequency band from 3.1 to 10.6 GHz for high data rate communication in 2002. UWB systems can suppress narrowband interferences, have high resilience to fading, and also leads to great improvement of the accuracy of ranging and geo-location. If a single antenna can operate in ultra-wideband that can cover multi-band applications, the necessity for multiple-single frequency antennas is not required. With this approach, applications requiring different frequencies can be operated simultaneously with only one multi-band antenna, which significantly reduces the circuit size.

Coplanar waveguide (CPW) feeding techniques have been widely applied in wideband antenna designs to provide stable antenna performance across the required band. The electric fields of dominant mode in CPW transmission lines called even quasi-TEM mode, in the two adjacent CPW slots are opposite to each other. Hence, CPW operating in the CPW mode has low frequency dispersion and low radiation loss that makes CPW appropriate for Ultra-wideband circuit applications.

Wireless body area networks (WBANs) are becoming an increasingly important part of the wireless communications system. In such wireless communication system various electronic devices carried by a person on his body can be connected through network to the person concerned as shown in Fig.1. Wearable computing and health monitoring are promising applications for WBANs.

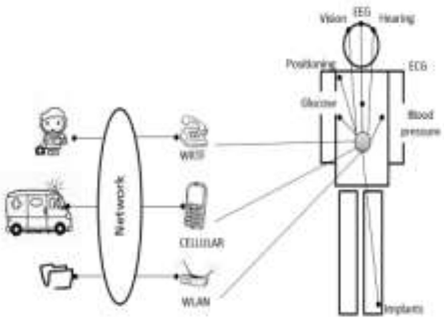

Fig:1 Illustration of Body Area Network

WBANs have special features and requirements in comparison to other existing wireless networks. The transmission power of the network should be low, due to the close proximity to the body,. Ultra Wideband (UWB) is a promising communication technology for short-range communication scenarios. It is a low-power high data rate technology which facilitates the compatibility of such technology in WBANs.

II. ANTENNA DESIGN

The proposed antenna is designed on FR4 substrate having permittivity (ε_r) = 4.4, and thickness (h) = 1.6 mm. The design of Y-shaped patch is influenced by many parameters such as L_{taper1} and L_{taper2} depicted in Fig.2. The dimensions and position of the etched AMMs inclusion into the Y-shaped patch plays a vital role in designing procedure. Besides its Y-shape patch, the antenna has a CPW ground plane printed on the back side of a 1.6 mm substrate.

The CPW feed is designed with 50Ω transmission line which consists of a single strip having width of 1.5 mm is used to feed the antenna as shown in Fig.4. The resonance frequency does not depend on the characteristic impedance of the open and short-ended stubs. This property gives us more design flexibility in choosing the width of the center stubs and the spacing between the finite grounds and the stubs. Therefore, these dimensions can be decreased to provide additional compactness, as long as they meet the fabrication limits.

The resonance and dispersive behaviors in AMMs are entirely determined by the geometry and the size of the inclusions. We can independently tune the values of the distributed passive elements by changing the length of the inner stubs. The AMM has only one controlling dimension to tune the resonance frequency i.e. the length of Open-ended stub and short-ended stub.

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This length is approximated by formula (1) :

$$l \leq \frac{\lambda}{8} \quad (1)$$

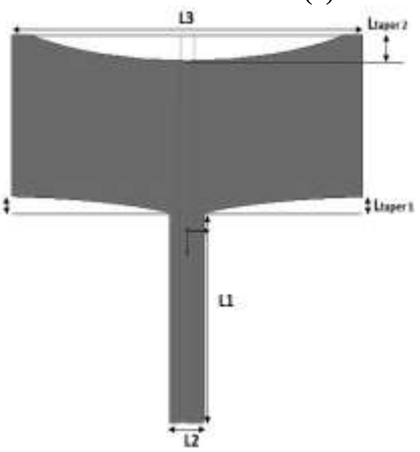

Fig:2 Y-Shaped Antenna without etched AMM Inclusion

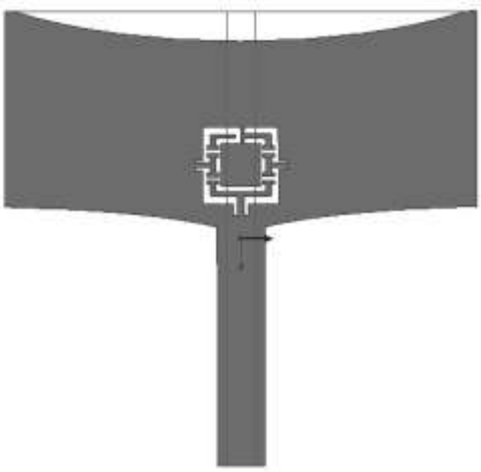

Fig:3 Y-Shaped Antenna with etched AMM Inclusion

The resonance frequency (2) of the proposed geometry can be defined as:

$$\omega_0 = \frac{1}{\sqrt{LC}} \quad (2)$$

where ω_0, is the resonance frequency of the inclusion. The resonance frequency of the proposed AMM is lower than the resonance frequency of a similar-size conventional square split resonator. Hence, a significant reduction in the size of the proposed AMM is achieved as compared to a conventional square SRR having the same resonance frequency

S.No.	Parameter	Value (mm)
1.	Length of substrate (l)	23.5
2.	Width of substrate	25
3.	L1	12.8
4.	L2	2.5
5.	L3	23.5
6.	L_{taper1}	1.05
7.	L_{taper2}	1.55
8.	Width of CPW strip	1.5
9.	Length of AMM	4

III. Results and Discussion

The design proposed here is modeled in HFSS 14.0 licensed version which is a FEM (Finite Element Method) based simulator. It is used to calculate various Electromagnetic

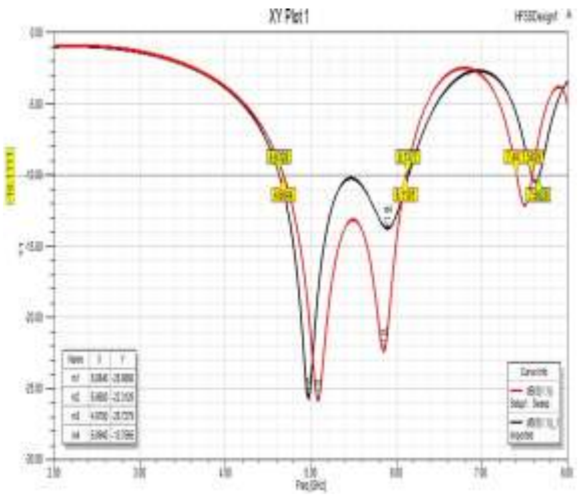

Fig:5 Return loss with / without etched AMM inclusion

behavior of the structure such as basic EM field quantities, S- parameters, resonance of the structure, etc.

The return loss v/s frequency graph for proposed antenna is plotted for designs with and without AMM inclusion as shown in Fig.5. Dual band nature is observed at 5GHz and 5.9GHz and antenna is having UWB characteristics in the band 4.6 - 6.14 GHz.

 ISSN: 2321-8169
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The value of S_{11} remains below -10dB for this band of frequencies. This simulated antenna has Bandwidth of approximately 1.5GHz. The fractional bandwidth for UWB antenna should be at least 25%. For the proposed antenna with AMM inclusion FBW of approximately 29% is achieved.

The voltage standing wave ratio (VSWR) is a measure of the impedance mismatch between the transmitter and the antenna. Large value of VSWR corresponds to the high mismatch. Minimum value of VSWR corresponds to a perfect match that is taken as unity. The VSWR v/s frequency plot for the proposed antenna is shown in Fig.6. It may be observed that the values of the VSWR are less than 2 for the whole band which is within the required limits

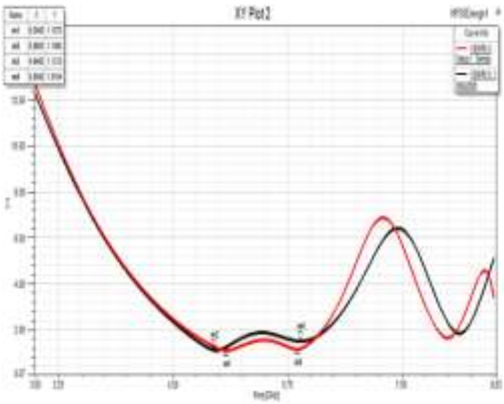

Fig:6 VSWR with/without etched AMM inclusion

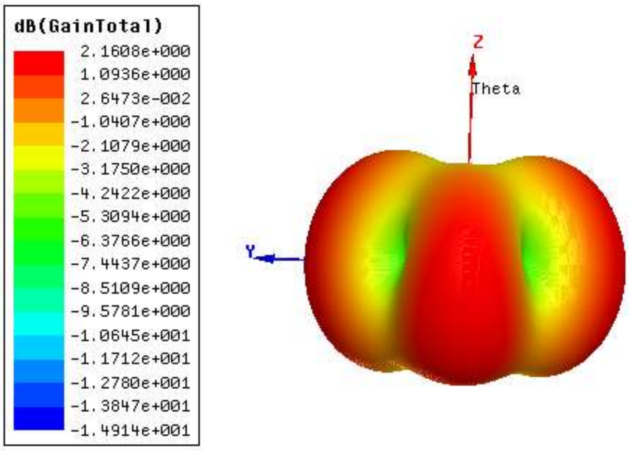

Fig:7 3D Gain Plot For Etched AMM Inclusion Antenna

The 3D Gain plot for AMM inclusion etched UWB antenna is shown in Fig.7. It shows maximum gain of 2.16 dB As mentioned above text, we need low power antennas, this is observed in Radiated power graph shown in Fig.8. We are getting very low radiated power of -0.845 dB i.e. approximately equal to 145mW. This amount of power is suitable for using in Body Area Networks.

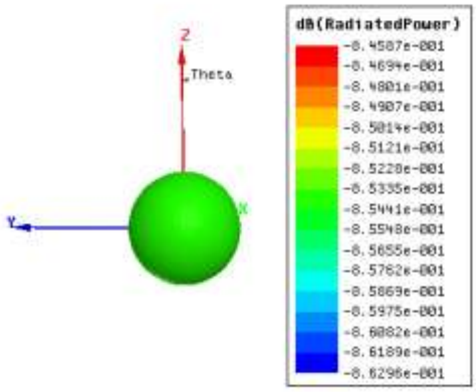

Fig:8 Radiated power for etched AMM inclusion

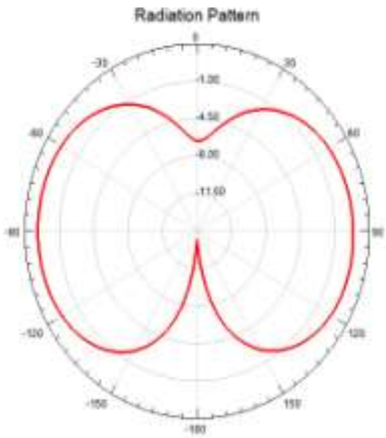

Fig.9: Radiation pattern of antenna with etched inclusion

Radiation Pattern is variation of power radiated as a function of direction away from antenna. The plot for this is shown in Fig.9. This shows that antenna is nearly omni-directional.

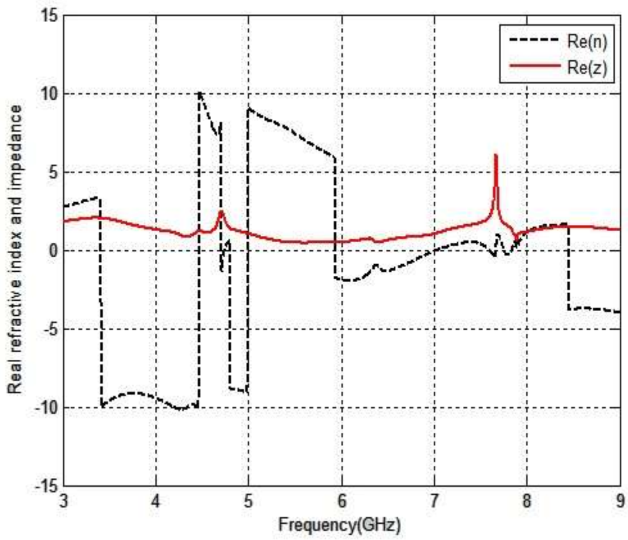

Fig.10: MATLAB plot for negative refractive index for proposed AMM unit

The plot in Fig.10 depicts the value of negative refractive index for the proposed AMM unit in this paper, which verifies that Inclusion used here is a metamaterial unit.

IV. CONCLUSION

There is increasing trend in the research publication of Artificial Magnetic Materials and their implementation to meet the need circuit integration and miniaturization. The results obtained are in good agreement and shows enhancement in the values of return loss, VSWR, Radiated power when Y-shaped patch was loaded with AMM inclusion In this paper we introduced concept of AMM, its application in biomedical field and gives overview of employing metamaterials in health monitoring equipments. The AMMs in biomedical applications opens a wide area of research in the near future.

REFERENCES

[1] Chahat N., Zhadobov M., Sauleau R., Koichi Ito "*A Compact UWB Antenna for On-Body Application"* IEEE TRANSACTIONS on antennas and propagation, vol. 59, no. 4, april 2011.
[2] Pendry, J. B., A. J. Holden, D. J. Robbins, and W. J. Stewart, "*Magnetism from conductors and enhanced nonlinear phenomena*," IEEE Trans. on Microwave Theory and Tech., Vol. 47, No. 11, Nov. 1999.
[3] Kumar, H., R. K. Kanth, P. Liljeberg, and H. Tenhunen, "*Metamaterial based slotted patch antenna*," IEEE 10th International Conference on Telecommunication in Modern Satellite Cable and Broadcasting Services *(TELSIKS)*, 43{46, 2011.
[4] Wang. G., J. Fang, and X. Dong, "*Resolution of near-field microwave target detection and imaging by using flat LHM lens*," *IEEE Transactions. Antennas Propag.*, Vol. 55, No. 12, 3534{3541, 2007.
[5] Raghavan S. and Rajeshkumar V.,"*An Overview of Metamaterials n Biomedical Applications"* PIERS Proceedings, Taipei, March 25{28, 2013}
[6] Baena J. D., Marques R., Medina F., and Martel J., "*Articial magnetic metamaterial design by using spiral resonators*," Phys. Rev. B (Condensed Matter Mater. Phys.), vol. 69, no. 1, pp. 141– 145, Jan. 2004.
[7] Falcone F., Lopetegi T., Baena J. D., Marqués R., Martín F., and Sorolla M., "*Effective negative- stopband microstrip lines based on complementary split ring resonators*," IEEE Microw. Wireless Compon. Lett., vol. 14, no. 6, pp. 280–282, Jun. 2004.
[8] Pozar D. M., *Microwave Engineering*. New York: Wiley, 2005.
[9] Hettak K., Dib N., Sheta A.-F., and Toutain S., "*A class of novel uniplanar series resonators and their implementation in original applications,*" IEEE Trans. Microw. Theory Tech., vol. 46, no. 9, pp. 1270–1276, Sep. 1998.
[10] Simons R. N., *Coplanar Waveguide Circuits, Components, and Systems*. New York: Wiley, 2001.
[11] Bonache J., Martín F., Falcone F., García J., Gil I., Lopetegi T., Laso M. A. G., Marqués R., Medina F., and Sorolla M., "*Super compact split ring resonators CPW bandpass filtres*," in IEEE- MTT Int. Microw. Symp. Dig., Fort Worth, TX, Jun. 2004, pp. 1483–1486.
[12] Alhawari, A.R.H.; Ismail, A.; Mahdi, M.A.; Abdullah, R.S.A.R. "*Miniaturized ultra-wideband antenna using microstrip negative index metamaterial".* Electromagnetics **2011**, *31*, 404–418.
[13] Zhu, J.; Eleftheriades, G.V., "*A compact transmission-line metamaterial antenna with extended bandwidth*". IEEE Antennas Wirel. Propag. Lett. **2009**, 8, 295–298.
[14] Erentok, A. and R. W. Ziolkowski, "*Two-dimensional e±cient metamaterial- inspired electrically-small antenna,"* Microwave and Optical Technology Letters, Vol. 49, No. 7, July 2007.