International Journal of Engineering, Science and Mathematics
Vol. 7 Issue4, April 2018(special issue NCIME)
ISSN: 2320-0294 Impact Factor: 6.765
Journal Homepage: http://www.ijesm.co.in, Email: ijesmj@gmail.com Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gage as well as in Cabell's Directories of Publishing Opportunities, U.S.A

A NOVEL IMPLANTABLE ANTENNA FOR MEDICAL APPLICATIONS

[1]Anandhan C, [1]Aswath S

[1]Assistant Professor, Department of ECE, TRP Engineering College, Trichy

ABSTRACT

An implantable antenna is the key component of radio frequency linked telemetry devices. In proposed work, the liquid level of lungs is measured to find the patient status. The human body implantable antenna which works in 2.4GHZ through a wireless transmission .An MPAT is designed using HFSS software which gives greater accuracy in determining the antenna parameters. Return loss plays a major role in providing the affected patient status.

Keywords: FR4_ADK ,biomedical telemetry and coaxial feeding.

INTRODUCTION:

With the rapid development of wireless technologies,wireless communication is making inroads into every aspect of human life.

The microstrip patch antenna is used due to its light weight, less complexity, easy implementation, and compact shape..Generally the lungs consume 10-20ml of water in human body.If the water level of the lung is increased from the normal level, the concerned person may get affected from respiratory or breathing problem . To predict this issue an microstrip antenna is designed and placed on the outer surface of lungs .The IEEE 802.11 standard utilizes 2.4GHZ ISM band.The frequency band is license free,hence the WLAN equipment will suffer interference from microwave ovens,Bluetooth and other appliances that use this same band.The 802.11a standard uses the 2.4 GHZ band which supports high speed WLAN.

In this paper,researches on implantable antennas for wireless biomedical devices are reviewed and summarized.

REQUIREMENTS RELATED TO THE IMPLANTABLE ANTENNA DESIGN:

Unlike traditional antennas,Implantable antennas should consider many kinds of requirements as Implantable antennas are placed in human bodies.

The antenna may require miniaturization, patient safety, communication ability, power consumption,biocompatability and lifetime of the device and circuits.The detailed requirements are as follows.

A.Miniaturization:

Recent advances in technology of Implantable device electronics have led to ultra small designs for Implantable medical devices.One of the basic requirement for biomedical device is miniaturization. It operates at low frequency typically at medical implant communication service (MICS) band(402-405MHZ).Therfore,Miniaturization becomes one of the greatest challenges in Implantable antenna design.

B. Biocompatibility Issues:

Implantable antennas must be biocompatible for long term operation in order to preserve patient safety.There are two types of typical approaches to address the biocompatibility issues. One is to design antenna directly on biocompatible materials such as Teflon, Ceramic alluminia other in the case of implantable antenna with the thin layer of low loss biocompatible coating.Note that the thickness of encased biocompatible material may affect the antenna performance and encased biocompatible material should be taken into consideration for practical antenna design.

DESIGN AND MEASUREMENTS:

Antenna design:

An implantable antenna is designed using HFSS (High Frequency Structure Stimulator)is used for design and stimulation. The antenna is designed mainly to measure the liquid level rise in lungs. Implantable antenna substrate made of FR4_ADK substrate (Fig-1.2) which helps in providing the higher efficiency of antenna in human body. Coaxial feeding is used for feed up for MPAT.

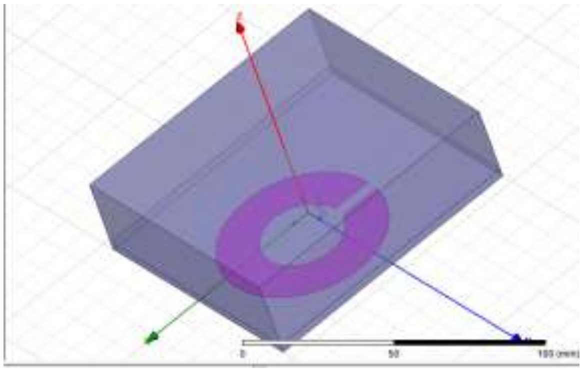


Fig1.1(a)-Design of MPAT without water molecule

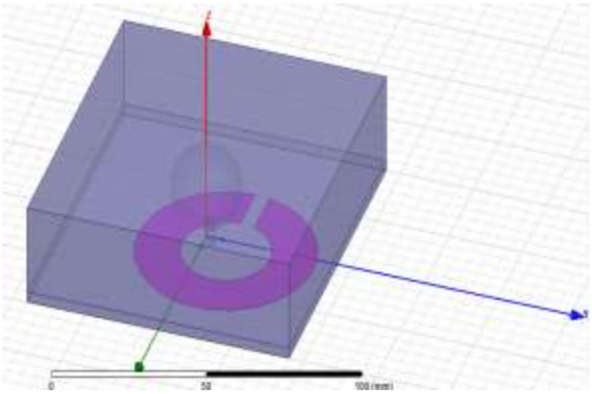


Fig 1.1(b)-Design of MPAT with water molecule

Antenna measurements:

The designed antenna consist of microstrip,FR4ADK substrate,coaxial feed made of Teflon(tm) and vacuum box are measured.

The ring patch have been placed over substrate patch X=100mm

The FR4ADK substrate have (l)*(b)*(h) where the substrate X=100mm,substrate Y=90mm,substrate H=3.2mm.

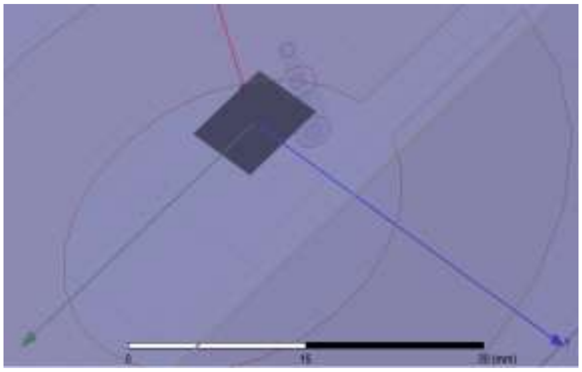


Fig 1.2-3D View of FR4-ADK Substrate.

The coaxial feed is made up of Teflon(tm) which is very thin low material and easily biocompatible.co axial inner radius=1.6mm, coaxial outer radius=30mm.

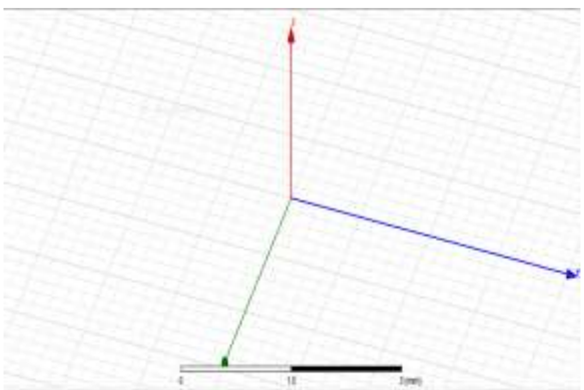


Fig 1.3 Coaxial Feed without Antenna surfaces.

RESULTS AND DISCUSSION:

The stimulation results for the proposed antenna gives the various basic parameters measured in the antenna design.Return loss is reduced ,gain is increased and efficiency of the antenna is high with directivity.

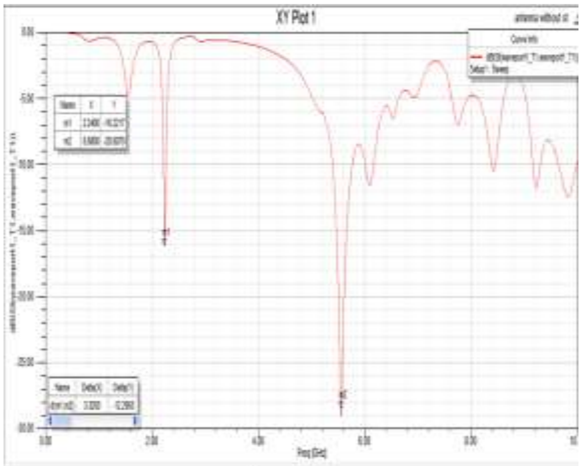


Fig 1.4(a)-Return loss comparison of the simulated antenna

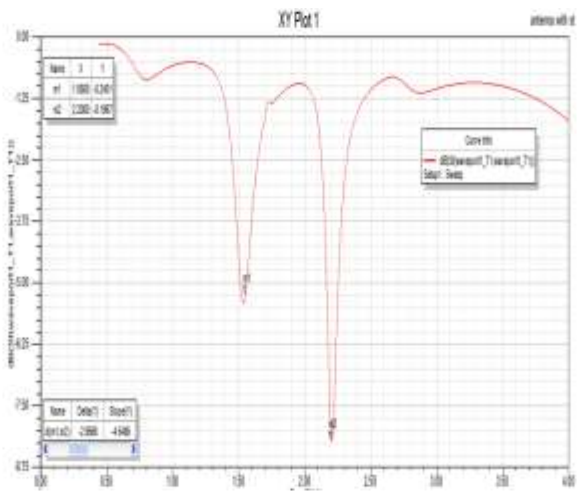


Fig 1.4(b)- Return loss comparison of the simulated antenna

Return loss:

Return losses of the antenna works at 2.4GHZ where the -32.6355db for not affected lungs and infected lung has -18.6322db

RETURN LOSS=-20log10(Pi/Pr)

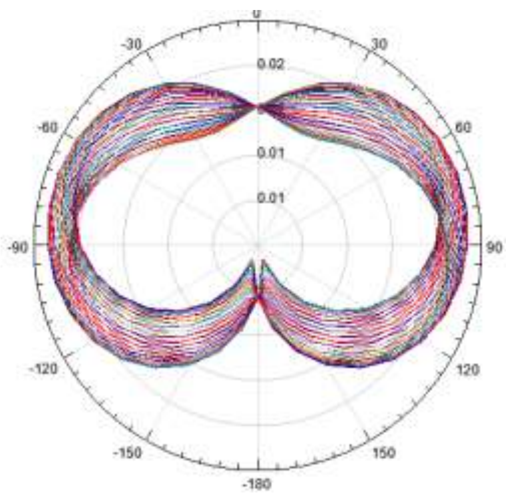
VSWR:

The voltage standing wave ratio (VSWR) is an important parameter in antenna design which means that the portion of entered power id reflected down and the incident signal will be mixed with the reverse signal this causes the voltage standing wave pattern , in which the ratio of maximum to minimum voltage is known as VSWR .

VSWR=(1+K)/(1-K)

RADIATION PATTERN:

The term radiation pattern refers to the strength of the radio waves from the antenna or other source. It is the graphical representation radiation properties of the antenna. The far field and near field 2D radiation patterns for the proposed patch antenna are shown.



Vol. 7 Issue4, April 2018(special issue NCIME)
ISSN: 2320-0294 Impact Factor: 6.765
Journal Homepage: http://www.ijesm.co.in, Email: ijesmj@gmail.com Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gage as well as in Cabell's Directories of Publishing Opportunities, U.S.A

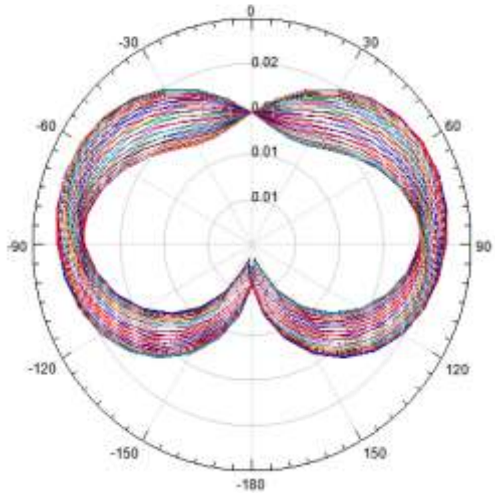


Fig 1.5-2D Radiation patterns of the simulated antenna.

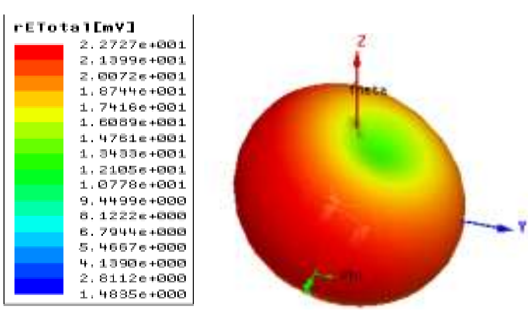
Gain:

The 3D gain plot is shown.The calculated gain of the non affected antenna is 6.63db but in infected lungs it differs at 6.81db.

GAIN=4πU/Pin

U=Radiation intensity

Pin=Total input power.



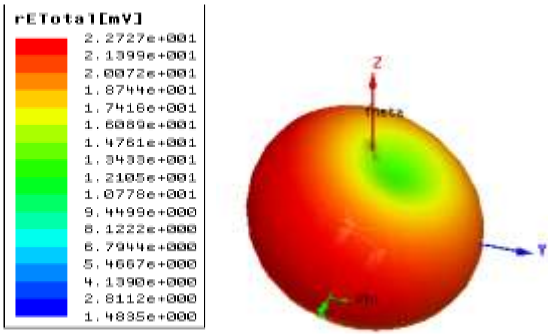


Fig 1.6-3D Radiation patterns of the antenna.

Directivity:

It is a relative measure of an antenna ability to direct RF energy in particular directions. It is defined as the power transmitted in the directions of peak radiations to the of an isotrophic source.

CONCLUSION:

The overview of the requirement related to the implantable antenna design has been provided, Meanwhile, different types of miniaturized techniques, stimulations and test methods for implantable antenna design have been studied Antenna types , operating frequency bands, safety considerations, design environments and testing methods have been reviewed. Low power consumption is a big concern in order to extend the life time of the implantable devices and maintain the safety considerations of the patients.

REFERENCES :

[1] P.Pragatheeswaran and A.Vinoth kannan,"Design and analysis of MPAT for biomedical applications"Asian Jpornal of Applied Science and Technology[AJAST],vol.1,issue 3,April 2017

[2] Changrong Liu, Yong-Xin Guo and Shaoqiu Xiao, "A Review of Implantable Antennas for Wireless Biomedical Devices," Forum for Electromagnetic Research Methods and Application Technologies (FERMAT)/2015.

[3] Kiourti.A and K. S. Nikita, "A Review of Implantable Patch Antennas for Biomedical Telemetry: Challenges and Solutions," Antennas Propag. Mag. IEEE, vol. 54, no. 3, pp. 210 – 228, Jun. 2012.

[4] Prasanna Lakshmi.Y, M.Umamaheswara Rao, B.Suresh Babu, "A Dual band Human Shaped Microstrip Patch Antenna for 2.4 GHz and 5.4 GHz Applications," International Journal Of Innovative Research In Electrical, Electronics, Instrumentation And Control Engineering Vol. 3, Issue 3, March 2015.

[5] Kiourti.A, J. R. Costa, C. A. Fernandes, A. G. Santiago, and K. S. Nikita, "Miniature Implantable Antennas for Biomedical Telemetry: From Simulation to Realization," IEEE Trans. Biomed. Eng., vol. 59, no. 11, Nov. 2012.

[6] Konstantinos Psathas, "Design Of Implantable Dual-Band Antenna for Biotelemetry," National Technical University of Athens, Athens - Greece, 2012.

[7] Bradley.P.D., "Wireless Medical Implant Technology – Recent Advances and Future Developments," Esscirc 2011 Proc., pp. 37 – 41, 2011.

[8] Skriverviky.A.K. and F.Merli, "Design strategies for implantable antennas," Antennas Propag. Conf. Lapc 2011 Loughb., pp. 1 – 5, Nov.2011.

[9] Kiourti.A., M. Tsakalakis, and K. S. Nikita, "Parametric Study and Design of Implantable PIFAs for Wireless Biotelemetry," Proc. 2nd Icst Int. Conf. Wirel. Mob. Commun. Healthc. Mobihealth 2012 Kos Isl. Greece, Oct. 2011.

[10] Kiourti.A., K. S. Nikita, and M. Christopoulou, "Performance of a Novel Miniature Antenna Implanted in the Human Head for Wireless Biotelemetry," IEEE Int. Symp. Antennas Propag. Spokane Wash., Jul.2011

[11] Merli.F, "Implantable Antennas for Biomedical Applications," Ecole Polytechnique Federale De Lausanne, 2011.

[12] Kiourti.A and K. S. Nikita, "Miniature Scalp-Implantable Antennas for Telemetry in the MICS and ISM Bands: Design, Safety Considerations and Link Budget Analysis," Ieee Trans. Antennas Propagation 2011.

[13] Skriverviky.A.K. and F. Merli, "Design and characterization of bio implantable antennas," ICECOM 2010 Conf. Proc., pp. 1 – 5, Sep. 2010.

[14] Kumar.A., A. Srivastava, I. Galaev, and B. Mattiasson, "Smart polymers: Physical forms and bioengineering applications," Prog. Polym. Sci., vol. 32, no. 10, pp. 1205–1237, 2007.

[15] Yazdandoost.K.Y. and R. Kohno, "An Antenna for Medical Implant Communications System," Proc. 37th Eur. Microw. Conf., pp. 968–971, Oct.2007.

[16] Burgahard.J, C. Campbell, T. Younkin, M. Kuhn, D. Shykind, and J. Maiz, "Biocompatible coatings for Medical Devices," US 2009/0169714 A1,007

[17] Riistama.J, J.Vaisanen, S. Heinisuo, J. Lekkala, and J. Kaihilahti, "Evaluation of an implantable ECG monitoring device in vitro and in vivo," Eng. Med. Biol. Soc., pp. 5703 – 5706, 2007.

[18] Buchegger.T, G. Obberger, A. Reisenzahn, E. Hochmair, A. Stelzer, and A. Springer, "Ultra-Wideband Transceivers for Cochlear Implants,"Eurasip J. Appl. Signal Process., vol. 18, pp. 3069–3075, 2005.