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# Design of CPW-Fed Conformal T-Shaped Flexible Patch Antenna With Slits for Biomedical Applications

Ketavath Kumar Naik, Koneru Lakshmaiah Education Foundation, India*
https://orcid.org/0000-0002-1338-0239

B. V. S. Sailaja, Koneru Lakshmaiah Education Foundation, India

## ABSTRACT

In this paper, a conformal T-shaped flexible patch antenna is designed for biomedical applications. The proposed antenna designed using to resonate at 2.45 GHz operating frequency at ISM band. The proposed antenna operates in free space and muscle tissue. The proposed T-shaped patch antenna in free space resonates at 2.47GHz operating frequency with a bandwidth of 300MHz (2.45GHz and 2.75GHz).The antenna implanted in muscle tissue operates at 2.47GHz frequency with a bandwidth of 600MHz (2.25GHz – 2.85GHz). The return loss of -13.04dB is observed for T-shaped patch antenna in free space and the return loss for the antenna implanted in human tissue is -20.6dB respectively. The proposed flexible conformal patch antenna is compact in size, efficient in functioning, safe, and can effectively work within specified medical frequency bands.

## KEYWORDS

antenna, asymmetric CPW, conformal patch, flexible, ISM band, Monopole antenna, polyamide, T-shape bandwidth

## 1. INTRODUCTION

Wireless biomedical antenna applications are getting expanding consideration these days, step by step turning into a concentration for research. Checking of different physiological boundaries, like temperature, glucose, and so forth, need wireless devices for use in biomedical applications. The Medical Implant Communication Services (MICS) and industrial, scientific, and medical (ISM) groups have been supported for these applications. MICS works in the 402-405MHz band. Regular frequencies considered for ISM applications are 27MHz, 433MHz, and 2.45 GHz (Smith et al.,1999). These wireless devices might keep away from long clinic stays using remote health monitoring (Soontornpipit et al., 2005). Such type of devices can screen the clinical information of a patient at home, working with determination, treatment, and sickness forecast, just as control of patient condition. Because of their practical low profile, microstrip antennas play a vital part in these applications. The many investigations on microstrip antennas for such applications display the developing interest for minimization. Numerous methods have been depicted in literature to scale down microstrip antennas (Liu, W.C., et., 2009). This is on the grounds that, by extending the current way, the size of antenna can be decreased. Numerous different strategies for scaling down are reported in (Huang, F.J., etal.,2011, Yeh, F.M.,et.al, 2008).

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The biomedical applications depend on technology. However, the antennas play a very import role in biomedical applications. The antennas are used in implantable devices through telemedicine for long distance (P. S. Hall et al., 2006, F.-J. Huang et al., 2011, C. Liu et al., 2014, M. L. Scarpello et al.,2011). For implantable antennas, the miniaturization of antenna can be performed by considering the high dielectric constant substrate material (V. A. Shameena et al., 2012) and slots on the radiating patch (Mohammed N et al., 2015), physiological reasons (F. Yang et al., 2001), when an antenna is implemented in human body. In (Jianchun Xu et al., 2017), the properties of skin and the other tissues are collected from Gabriel et al. In (Kiourti, K. S. Nikita et al., 2012) to simulate the antenna for MICS and ISM band frequency. In (Naik, K.K.,etal.,2019, Anil Kumar et al., 2016, P. Amala Vijaya Sri et al., 2021, Kumar, B.K., etal.,2018, Chaitanya, R.P.S et al., 2018, Sundar etal., 2015, Manikanta M.H.V. etal.,2018, Govathoti, P.R., etal.,2018,) a circular planar inverted-F antenna with meandered and spiral stacked antenna was designed for medical applications. In (Dattatreya et al., 2019, Ahmad A et al., 2016, Ketavath, K.Net al., 2019, Imran Gani etal., 2016, Naik, K.K et al., 2021), antenna with CPW feed having asymmetric feed are presented for wireless applications. circular patch antenna and also in ground plane to operate at communication bands. In (C. Gabrieletal.,1996, Ketavath, K.N., etal.,2019, S. Gabriel etal.,1996, Sailaja,.etal.,2021 Asimina Kiourti et al., 2011, Kumar Naik etal.,2020, Sailaja B.Venkata Sai et al., 2020) a compact implantable antenna is presented to operate at ISM band biomedical applications.

The microstrip antennas are more appropriate as a body worn device by reason of its simple manufacture, well directivity and significant increase in gain for biomedical applications. Miniature antennas have the advantages of expanding the data transfer capacity by introducing different types of slots to the antenna which is presented in this work (Pozar, D.M. et al, 1995, Gupta H et al., 2016, LiL,). Many of the antenna structure utilize planar design which are built on a coplanar waveguide (Chen et al., 2008, Yang F et al., 2006, Pirhadi et al., 2003). These structures have minimal and low profile, however, requires an EBG substrate to save the host body from the radiation. Without utilizing such a method might cause the host body impacted by toxic radiation and specific absorption rate (SAR) values while utilizing the antenna (Lui, K.W. et al., 2013, Jalil, M.E. et al., 2013). Rather than using EBG structures, this design use ground plane as it makes the structure stronger (Chen et al., 2008, Yasasvini, N., et al.,2017, Palla, Ravi.K., et al.,2018, Kousalya, K., et al.,2017, Appana, H., et al.,2014, Kota, M.B., et al.,2021, Naik, K.K et al.,2013) to separate the body from the antenna, likewise supports better radiation performance and low SAR.

In (Rezaeieh et al., 2014), a UWB frequency antenna with dimension ($30\times 25\times 1.6mm^3$) was reported which has good reflection coefficient and bandwidth, however SAR was not assessed. With an efficient design and low profile, antenna proposed in the article (Ouerghi et al., 2017, Venkata Sai.S.B.V.S. et al., 2020, Gopi. Dattatreya et al., 2019,

Ravikumar Palla et al., 2019, Sailaja, B.V.S et al., 2020,) showed relatively low reflection coefficient (- 26 dB) than other literature designs. One more wearable antenna with more modest dimension (33 x 23 x 1 $mm^3$) introduced in (Chowdhury, T.,et al.,2017, Priyanka, M., et al., 2020, Reddy, T.S., et al.,2017, Krishna, O.R. et al., 2020, Palla, R. et al.,2 020, Surendra, C., et al., 2018, Palla, Ravi, et al., 2020, Subhani, S.M., et al., 2018, Rani, S.S. et al., 2018,) have good return loss, yet for various places of the growth the impact have not been estimated. A Vivaldi antenna with UWB frequency was exhibited in the article (Zhang, H et al., 2012). In spite of it had required frequency band for biomedical frequencies, yet its viable execution would be difficult due to its design dimensions (329.25 x 153 x 1.6 $mm^3$). The antenna estimation (Jamlos M.A.et al., 2015) is similarly greater (80 x 45 $mm^3$), however it shows incredible directivity of 12.12 dBi. The profile of (Rokunuzzaman et al., 2017) is low ($25 \times 25 \times 10.5$ $mm^2$), notwithstanding, the directivity and specific assessment of reflection coefficient are not determined. In the two cases, SAR estimation hasn't been found.

A large number of these structures offer great execution and have been utilized for size decrease. Slots are utilized to acknowledge wide-band activity (Song, Y etal.,2006, Lin, C.I., etal.,2007 Jing, X., etal.,2006, PAV Sri, etal.,2018, Ramakrishna, T.V., etal.,2020, Gopi Dattatreya et al., 2019,