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Design of Planar Inverted F Antenna for Mobile Communication Band

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Abstract: This paper presents a wideband planar inverted F antenna for mobile application. The FR4 glass epoxy substrate is used to design the antenna with relative permittivity 4.4 and thickness 1.57mm. The proposed antenna has a compact size of 90 * 50 * 3.7 mm^3 and is fed by coaxial probes. The -6 dB impedance bandwidth of proposed antenna is simulated for the 540 MHz to 3 GHz. The antenna has the resonant frequency at . 2.0GHz The antenna is designed and simulated by using HFSS (High Frequency Structure Simulator) version 13 software. Proposed antenna can be used for various wireless communication applications such as WLAN, 4G LTE, WLAN/ Bluetooth (2.4-2.485 GHz), m-WiMAX (2.5 GHz)
Keywords: Microstrip Antenna, PIFA Antenna, wideband.

I. INTRODUCTION

In the past few years a multiband antenna that supports multiple frequencies with maximum coverage and compact size is required. The demand has increased due to advancements in wireless communication technologies and tremendous growth of cellular service users. Hence there is an upsurge for the requirement of an antenna that not only supports multiple frequency standards but also provides wide bandwidth characteristics. Therefore, mobile handsets and other wireless devices should be low profile and aesthetically good [10], [27]. This thesis is focused on the design and development of an antenna for USB devices. Thus, in this section a brief account of various antenna structures and designs that supports multiband frequencies is outlined in this research. Various designs discussed in this section have the potential to be used in future wireless devices In paper [1], authors proposed the microstrip patch antenna which covered the two frequencies of 1.8 and 2.4GHz as resonant using CST electromagnetic simulator. This antenna did not cover the wideband. Jong-Hyuk Lim *et al.* in [23] presented a frequency reconfigurable planar inverted-F antenna (PIFA) which used a PIN-diode to reconfigure the desired frequency band. The antenna not only alters the frequency bands of m-WiMAX but due to use of electro-magnetic coupling in a high dielectric constant substrate results in a small profile. The PIFA consists of a main radiating element, an additional parasitic patch, a coupled radiator, two PIN-diodes, and control circuits. One diode is placed between the main and additional parasitic patch on the top side of the antenna structure, and the other diode is placed between a coupled radiator and ground plane. Depending upon whether diodes are on or off, the antenna operates over 2.3 to 2.4 GHz, 2.5 to 2.7 GHz, and 3.4 to 3.6 GHz for worldwide WiMAX bands. By adjusting the bias of PIN-diode, the frequency reconfigurability of the PIFA was controlled. Authors proposed that this frequency reconfigurable PIFA structure should be useful for 4th-Generation applications. In this paper, the proposed antenna consists of PIFA design with rectangular shape with single feed. The rectangular patch is supported by the shorting plate at one of its side. The design was simulated at high frequency structure simulator. The antenna, which has compact dimensions of 90 * 50 mm^2, is printed on the top of Substrate FR4_epoxy of thickness 1.57 mm, relative permittivity 4.4 and tangent loss is 0.02. The dimension of the ground plane is same as the substrate dimension. The excitation of 50 ohms through co-axial probe feed is given to the patch. The design dimensions of the proposed antenna are obtained using HFSS (High Frequency Structural Simulator). The HFSS is based on the Finite Element Method (FEM) to simulate the proposed antenna.

II. PROPOSED WORK

The structure of the proposed PIFA antenna with slotted top patch is shown in Fig. 1. The proposed PIFA antenna consists of main radiating patch, a shorting plate, coaxial feed and a ground plane. By using the ground plane as a radiator along with PIFA's main patch situated above the ground plane, the height of PIFA can be reduced to a great extent, thus resulting in reduction of overall thickness. Total dimensions of the radiating parts of the antenna are 20 x 12 mm^2 and that of ground plane are 90 x 50 x 3.57 mm^3. It can be observed that radiating parts covers small portion of the total size of the antenna leaving more space available for other electronic components. As the main objective of this thesis work is to propose a small antenna having thin structure, therefore, the height of the PIFA selected is 2 mm from the FR4 substrate and 3.57 mm from the ground plane. With these dimensions selected for the antenna, the structure can operate at LTE, Bluetooth, m-WiMAX & WLAN bands with good enough bandwidth to serve for these applications.

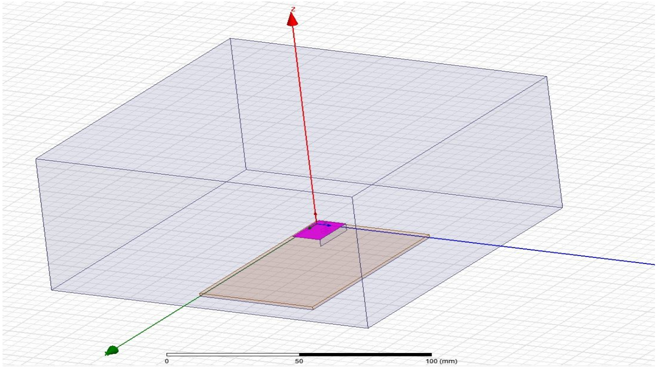


Figure 1. Proposed Design

III. RESULTS

After designing and analyzing a simple single band antenna then the next step was to design and simulate a Planar Inverted-F Antenna (PIFA). Proposed antenna covers multiple bands and this is achieved by using a modified ground plane. A rectangular slot is etched in the ground plane which helps in achieving wide band operation..

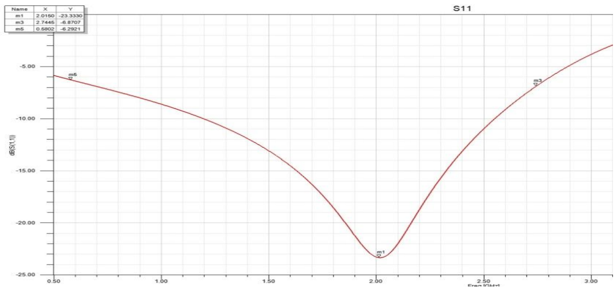


Figure 2 Return Loss

From the plot shown in Fig. 2, it can be seen that resonant frequency achieved is 2.0 GHz with return loss of -23.33 dB. The cellular bands covered by proposed antenna are 4G LTE bands (1 to 6, 8 to 30, 33 to 37, 39 to 45, 50 to 68, 70, 71, 74 to 76), Bluetooth (2400-2480 MHz), WLAN 802.11 {(2400-2485 MHz) & m-WiMAX (2500 MHz). The bandwidth coverage is from 540 MHz to 2.8 GHz which is 2.26 GHz.

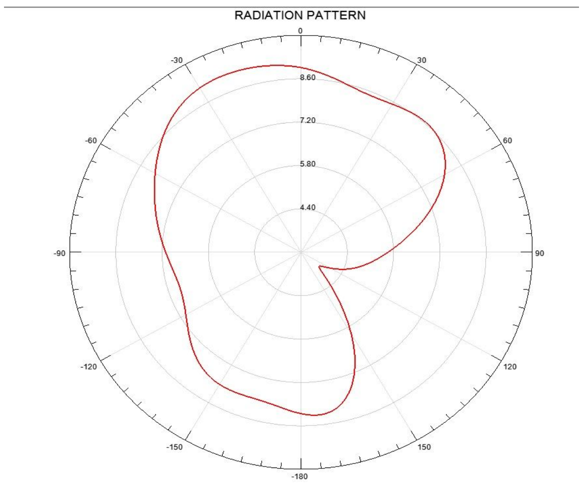


Figure 3 3D Radiation Pattern Plot

The simulated 3D radiation pattern resonance obtained from the simulation results is shown in Fig 4.2. It can be seen from the plot that the antenna is a good radiator with almost omnidirectional radiation and can be used for mobile terminals supporting multiple standards.

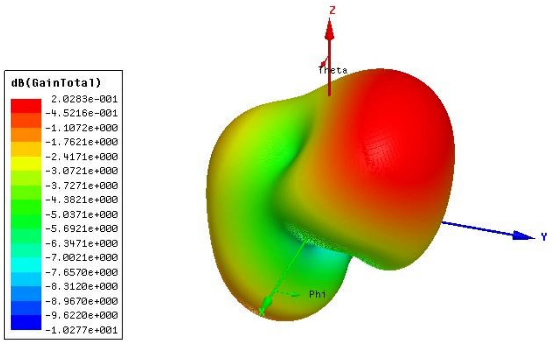


Figure 4 Polar Plot

The gain is important figure of merit of an antenna. The overall gain of the antenna obtained after simulation is shown in Fig. 4.3. A peak gain of 2.0dB is observed at 2 MHz

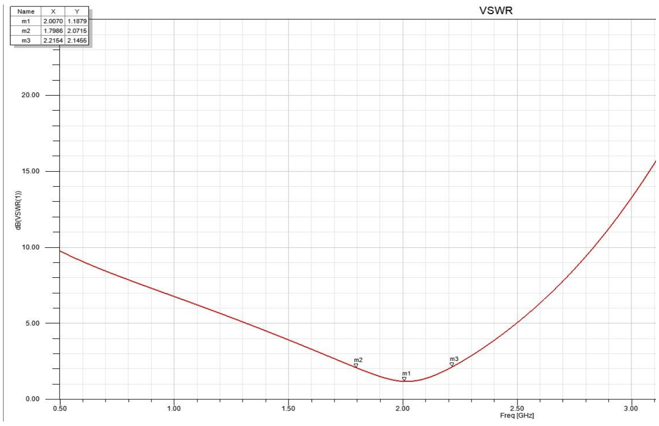


Figure 5 Simulated VSWR AT 2GHZ

IV. CONCLUSION

This thesis work deals with aspects of the Planar Inverted-F Antenna studies, design and simulation for wireless applications. The results show that the antenna structure is suitable for its use in wireless devices. It has also been observed that the simulation results obtained relates with the basic theory PIFA structures.

Based on the conclusions drawn and limitations of the work presented, future work can be carried out in the following areas:

Further, the antenna prototype developed can be used to study the performance of the antenna with human interaction and investigate the Specific Absorption Rate (SAR) value by employing human model testing.

The antenna structure can be placed inside a wireless device casing such as mobile phone so that it can be analyzed using an Anechoic chamber.

The design proposed in this thesis can be extended for supporting MIMO applications for the devices which supports LTE and WiMAX technologies

REFERENCES

[1] Yong-Ling Ban; Jin-Hua Chen; Li-Jun Ying; Li, J.L.-W.; Yu-Jiang Wu, "Ultrawideband Antenna for LTE/GSM/UMTS Wireless USB Dongle Applications," IEEE Antennas and Wireless Propagation Letters, vol.11, no., pp.403-406, 2012.

[2] Yamina BELHADEF, Nourediene BOUKLI HACENE, "Design of New Multiband Slotted PIFA Antennas", International Journal of Computer Science Issues (IJCSI), Vol. 8, No. 4, Pages: 325-330, 2011.

[3] Wen-Shan Chen; Wei-Chiang Jhang; Horng-Dean Chen, "Small and compact MIMO antenna for USB dongle applications," Cross Strait Quad-Regional Radio Science and Wireless Technology Conference CSQRWC), (vol.1, pp.438,441, 26-30 July 2011.

[4] Wen-Shan Chen; Bau-Yi Lee; Jing-Ju Lu; Ke-Ming Lin; Ching-Yu Huang; Chih-Kai Yang, "A PIFA type USB Dongle antenna for WLAN applications," Cross Strait Quad-Regional Radio Science and Wireless Technology Conference (CSQRWC), 2013, pp.203,206, July 2013.

[5] Wei-Yu Li; Chun-Yih Wu; Kin-Lu Wong; Ming-Fang Tu, "Internal small-size PIFA for LTE/GSM/UMTS operation in the mobile phone," IEEE Antennas and Propagation Society International Symposium (APSURSI), pp.1,4, 11-17 July 2010.

[6] W. Geyi, Q. Rao, S. Ali, and D. Wang, “Handset Antenna Design: Practice and Theory”, Progress in Electromagnetic Research Journal (PIER), Vol. 80, Pages: 123–160, 2008.

[7] Taeho Son, “Feeding point determination for PIFA type mobile phone handset internal antenna”, IEEE Antennas and Propagation Society International Symposium, Vol. 1A, Page(s): 475 – 478, 2005.

[8] Sunakshi Puri, Kiranpreet Kaur, Naveen Kumar, “A Review of Antennas for Wireless Communication Devices”, International Journal of Electronics & Electrical Engineering, Volume 2, Issue 3, Page(s): 199-201, September 2014.

[9] See, C.H., Abd-Alhameed, R.A., Zhou, D., Hraga, H.I., Excell, P.S., “Broadband dual planar inverted F-antenna for wireless local area networks/worldwide interoperability for microwave access and lower-band ultra wideband wireless applications”, IET Microwaves, Antennas & Propagation, Vol. 5 , No. 6, Page(s): 644 – 650, 2012.

[10] Rowell, C., Lam, E.Y., “Mobile-phone antenna design”, IEEE Antennas and Propagation Magazine, Vol. 54, No. 4, Page(s): 14 – 34, 2012.

[11] Redzwan, F.N.M.; Ali, M.T.; Md.Tan, M.N.; Miswadi, N.F., "Design of Planar Inverted F Antenna for LTE mobile phone application," Region 10 Symposium, 2014 IEEE, pp.19,22, 14-16, April 2014.

[12] Ray,J.A. , Chaudhuri S.R.B., “A review of PIFA technology”, IEEE Indian Antenna week (IAW), Page(s): 1 – 4, 2011.

[13] R. Vaughan, **“**Model and results for single mode PIFA antenna”, IEEE Antennas and Propagation Society International Symposium, Vol. 4, Page(s): 4028 – 4031, 2004.

[14] Qinjiang Rao and Dong Wang, “A Compact Dual-Port Diversity Antenna for Long-Term Evolution Handheld Devices”, IEEE Transactions On Vehicular Technology, Vol. 59, No. 3, Page(s): 1319 – 1329, 2010.

[15] Qi Luo, J.R. Pereira, H.M. Salgado, “Inverted-L Antenna (ILA) Design Using Fractal for WLAN USB Dongle”, ISEL Academic Journal of Electronics, Telecommunications and Computers CETC2011 Issue, Vol. 2, no. 1, 2013.

[16] Naveen Kumar, Abhishek Thakur, Jitender Sharma, “Study of Planar Inverted-F Antenna (PIFA) for Mobile Devices”, International Journal of Electronics & Communication Technology (IJECT), Volume 4, Issue SPL 3, Page(s): 83-85, April 2013.

[17] Mohamed, N.I.; Rahman, T.A.; Leow, C.Y., "Issues and challenges of LTE antenna designs for USB-dongle device," IEEE-APS Topical Conference on Antennas and Propagation in Wireless Communications (APWC), vol., no., pp.43-46, September 2012.

[18] Manoj K. Meshram, Reza K. Animeh, Member, IEEE, Ankur T. Pimpale, and Natalia K. Nikolova, Fellow, IEEE, “A Novel Quad-Band Diversity Antenna for LTE and Wi-Fi Applications With High Isolation”, IEEE Transactions On Antennas And Propagation, Vol. 60, No. 9, Page(s): 4360 – 4371, 2012.

[19] Lai, Shih-Chi; Jiang, Chi-Ming; Chiou, Yi-Shin; Tang, Chia-Lun, "A small size planar MIMO LTE antenna system for USB dongle application," Microwave Conference (APMC), 2014 Asia-Pacific , vol., no., pp.971,973, 4-7 Nov. 2014

[20] L. Guo, X. Chen, C.G. Parini, “Miniature ultra-wideband an dongle tenna for wireless universal serial bus USB applications”, IET Microwaves, Antennas & Propagation, Volume 6, Issue 1,p. 113 – 119, 11 January 2012.

[21] Kumar, Naveen, "A Multiband PIFA for Mobile Handheld Devices", National Institute of Technical Teachers' Training & Research, Chandigarh, Thesis, 2013.

[22] Kin-Lu Wong, “Planar Antennas for Wireless Communication”, Published by John Wiley & Sons, Inc., Chapter: 2, Pages: 26-65, 2003.

[23] Jong-Hyuk Lim, Gyu-Tae Back, Young-Il Ko, Chang-Wook Song, Tae-Yeoul Yun, “A Reconfigurable PIFA Using a Switchable PIN-Diode and a Fine-Tuning Varactor for USPCS/WCDMA/m-WiMAX/WLAN”, IEEE Transactions On Antennas And Propagation, Vol. 58, No. 7, Page(s): 2404 – 2411, 2010.

[24] Hraga, H.I., See, C.H., Abd-Alhameed, R.A., Zhou, D., Adnan, S., Elfergani, I.T.E., Elmegri, F., Excell, P.S., “PIFA Antenna for UWB Applications with WLAN Band Rejection using Spiral Slots”, Proceedings of the 5th European Conference, IEEE Antennas and Propagation, Page(s): 2226 – 2229, 2011.

[25] Hattan F. AbuTarboush, R. Nilavalan, T. Peter and S. W. Chuang, “Small and Thin Inverted-F Antenna with Insensitive Ground Plane for Mobile Handsets”, IEEE Loughborough Antennas and Propagation Conference (LAPC), Page(s): 109 – 112, 2010.

[26] Hassan Tariq Chattha, Yi Huang, Xu Zhu, and Yang Lu, “An empirical equation for predicting the resonant frequency of planar inverted-F antennas”, IEEE Antennas and Wireless Propagation Letters, Vol.8, Page(s): 856 – 860, 2009.

[27] Hang Wong, Kwai-Man Luk, Chi Hou Chan, Quan Xue, Kwok Kan So, Hau Wah Lai, “Small antennas in Wireless Communications”, Proceedings of the IEEE Journal, Vol. 100, No. 7, Page(s): 2109 – 2121, 2012.

[28] Dong-xiang Lv, Li-guo Liu, Ai-qun Long, “Research and Simulation Design on Ultrathin Tri-band RF Antenna”, IEEE 13th International Conference on Communication Technology (ICCT), Page(s): 315-318, 2011.

[29] Ding-Bing Lin; En-Tsao Chang; I-Tseng Tang, "Novel miniaturized PIFA with interdigital coupling feed for multitband operation," IEEE International Conference on Wireless Information Technology and Systems (ICWITS), pp.1,4, Aug. 28 2010-Sept. 3 2010.

[30] C. Picher, J. Angueral, A. Andújar, C. Puente1, and S. Kahng, “Analysis of the Human Head Interaction in Handset Antennas with Slotted Ground Planes”, IEEE Antennas and Propagation Magazine, Vol. 54, No. 2, Page(s): 36 – 56, 2012.

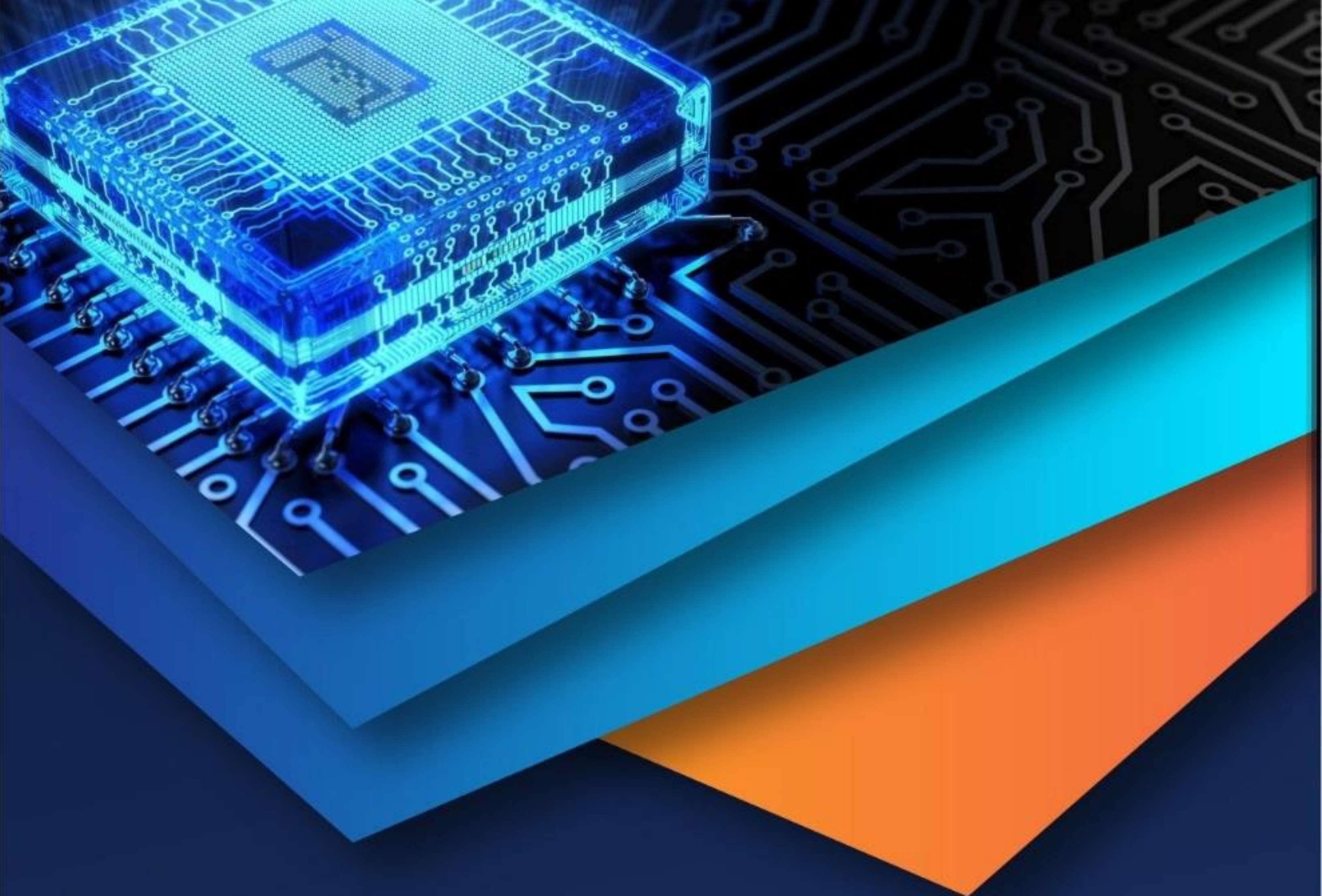
[31] Belhadef, Y.; Boukli Hacene, N., “PIFAs antennas design for mobile communications”, 7th IEEE International Workshop on Systems, Signal Processing and their Applications (WOSSPA), **Page(s):** 119 – 122, 2011.

[32] Abu Tarboush, H.F., Nilavalan, R., Peter, T., Cheung, S.W., “Multiband Inverted-F Antenna with Independent Bands for Small and Slim Cellular Mobile Handsets”, IEEE Transactions on Antennas and Propagation, Vol. 59, No. 7, Page(s): 2636 – 2645, 2011.

[33] Liu, Mingyang, and Bin Zhao. "Dual-feed small-size penta-band PIFA for LTE/WWAN mobile handset applications." International Journal of Antennas and Propagation, 2014.

[34] Web: www.edaboard.com/thread116727.html

[35] Web: www.antenna-theory.com/antennas/patches/pifa.php



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