OPTIMAL DESIGN AND ANALYSIS: IMPEDANCE MATCHING CHARACTERISTICS PATCH ANTENNA

M.Pachiyaannan
Communication system Laboratory, Affiliated to Anna university,
Nehru Institute of Engineering and Technology,
Coimbatore, Tamilnadu, India

Abstract

In this paper a new methodology in achieving matching impedance of a planar microstrip antenna for wireless application is described. The method is based on embedding an interdigital capacitor. The fine results obtained by using a microstrip interdigital capacitor for matching antenna impedance led to an efficient method to improve array antenna performance. In fact, a substantial saving on the whole surfaces as well as enhancement of the gain, the directivity and the power radiated was achieved. In this paper; a microstrip patch antennas is designed and tested for RADAR application at 8.465 GHz, and for a satellite TV signal at 11.843 GHz and 11.919 GHz. The return loss obtained for this design is -15 dB. Simulated the antenna and efficiency of 99.9% was obtained using this design.

Index Terms—: *Matching impedance. Inter digital capacitor. Planar micro-strip antenna. RADAR*

Introduction

In recent years, microstrip antenna has been more and more used in wireless equipment such as wireless sensors, RFID tags and cellular phones. Planar patch antennas are recognized to be the most useful type. However, patch antenna also have some limitations; narrow band width, large ohmic loss in the feed structure of arrays, reduced gain (6dB), reduced efficiency, complex feed structures required for high performance array [1].Among the various approaches to enhance antenna effectiveness, novel feeding structures are proposed; balanced feed for RFID applications [2], balun structures [3], proximity electromagnetically coupled microstrip feed [1].Basically, it is important to have an efficient input impedance matching the antenna with the load, to obtain maximum radiated power, many methods have been in use: stub [4], progressive balun [4], combined effects of the insert microstrip line and the slits [5].This study is carried out to evaluate the efficiency of using a microstrip Interdigital capacitor to guarantee both feeding and matching impedance. Inter digital capacitors find application in filter, hybrid couplers, Dc blocking circuits, tuning impedance matching network.In order to analyse the efficient results provided by using the microstrip Interdigital capacitor, we carried out a comparative study as well as a use of this structure for array antenna. Currently, a microstrip antenna consists of a dielectric substrate sandwiched between two conducting surfaces: the antenna plane and the ground plane. The simplified microstrip patch antenna is shown in Fig.1 For this study an epoxy dielectric was used (h=1,52mm, ϵr = 4,32, metallisation layer thickness=35μm and substrate loss Tanδ=0,018), patch dimensions are chosen such that the antenna resonates on a desired frequency (W=35and L=29mm resonate on 2.45 GHz).

Proposed Work

For planar antennas structures, the Method of Moments or that of Finite Element are quite popular. In order to streamline the antenna design process and generate accurate results before prototype construction, it is important to select an EM simulation program. The soft used has been MOMENTUM which is one of the tools in Advanced design System 2005(Agilent).

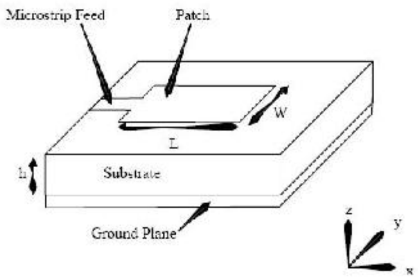

Fig. 1 Microstrip patch antenna construction

Approach

Basically, a matching juncture device is needed between the load and the feeding point in the patch antenna. This structure is shown in Fig.2.

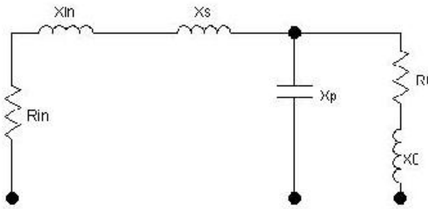

Fig. 2 Impedance matching solution

(Rin , Xin) the load impedance, (XS , XP) matching impedance and (R0 ,X0) antenna impedance. Several publications have surveyed many possible types of microstrip antenna feeding, among which are the microstrip coplanar feed[6], aperture-coupled microstrip feed[7], proximity-coupled feed[8] and gap–coupled feed[9]. Typically a gap-coupled feed is shown in Fig. 3.

It is worth noticing that a narrow gap width provides an efficient coupling of power.

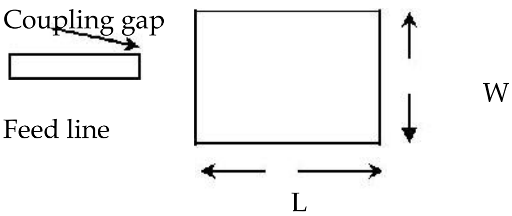

Fig. 3 Gap coupled patch

Gap introduces capacitive and coupling effects as the Fig.5 represents an equivalent lamped element circuit of a patch antenna fed by a strip line matched with a gap.In order to enable tuning capacitive effect, an Interdigital capacitor can be introduced between the feeding device and the patch antenna not just for coupling but also for matching impedance.

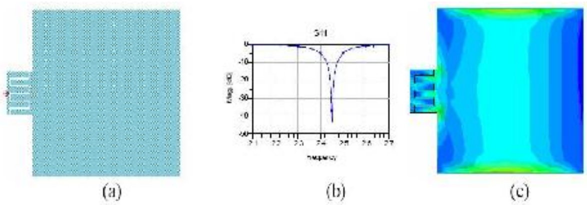

Fig. 4 Planar patch antenna using an Interdigital capacitor

Fig. 4 (a) shows a designed antenna fed with an Interdigital capacitor (b) the return loss S11 simulation results (c) current distribution.

A planar microstrip antenna fed with an Interdigital capacitor could be modulated with lamped elements circuit as illustrated in the Fig. 5

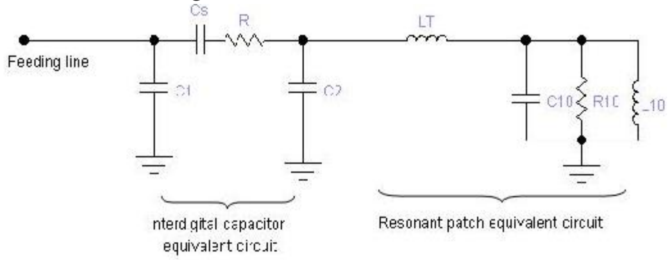

Fig. 5 Lamped–element equivalent circuit of a planar patch antenna

Patch Antenna Characteristics and Model

Modelling an Interdigital Capacitor

The role that the Interdigital capacitor is to match the real part of the input impedance of the patch, the capacitance is used to adjust the reactive component.The properties of the Interdigital capacitor revealed on Fig.6, have been studied by many authors. We can mention that the capacitor dimensions are much less than a quarter wave length. Value of the capacitance depends on the number of fingers, gap wideness between the fingers, metallisation thickness[13].

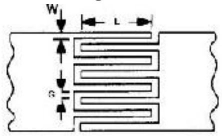

Fig. 6 A general form of the Interdigital capacitor [ADS]

An accurate study carried by [14] [15] established the lamped circuit equivalent of an Interdigital capacitor which is shown in Fig.7

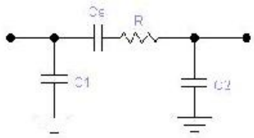

Fig. 7 Lamped–element equivalent circuit of an Interdigital capacitor

In this model, the series capacitor accounts for the capacitance between the fingers, whereas the series resistor represents metallization losses. The capacitors connected to ground are the parasitic capacitances.

Usually, R is very small and has a minor effect on the response of the Interdigital capacitor [14] on the other hand, the capacitance Cs is the most important element [16] presented the following expressions characterising the lamped element equivalent.

$$C_s = \frac{\epsilon_{eff} \cdot 10^{-3} K(k)}{18 \pi K'(k)} (N-1)L$$

K(k): is the complete elliptic integral of the first kind

The series resistance of an interdigital capacitor can be calculated by using the following formula (20)

$$R_s = \frac{4\,L}{3\,w\,N} R_F$$

Where RF is the frequency-dependent surface resistivity of the conductors

The previous expressions (5) and (6) are applied to choose the correct dimensions of Interdigital capacitor which need to be tuned once the design simulation is carried out.

Designing and Measuring Antenna Effectiveness

In order to provide evidence for the antenna effectiveness design, many parameters were measured. The efficiency of the matching device is proved by the minimum return loss S11, which influences the remnant characteristics such as Directivity, Gain and band width

Antenna Designing

The Fig.8 shows a photograph of the patch antenna matched with an Interdigital capacitor.

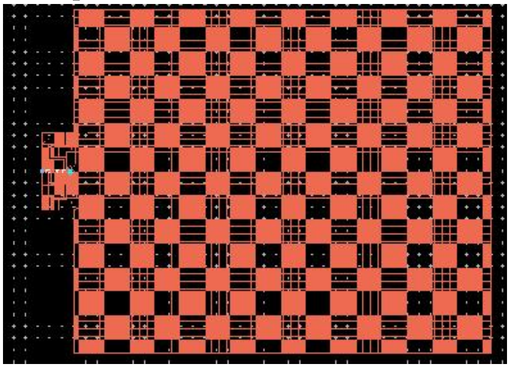

Fig. 8 Interdigital Capacitor Fed Antenna

The antenna parameters are summarized in Table 1

Table 1 Antenna Parameters

Patch	W	35mm
	L	28.87mm
Substrate	Єr	4.32
	h	1.59mm
	Tanδ	0.018
Metallisation	t	0.0035mm
	Metal Permeability	1
	Metal Conductance	1,83e+7
Interdigitalcapacitor	Gap width	0.1mm
	Finger large (w)	1mm
	Finger length (L)	1.717mm
	wt=wf	0.64mm
	Nbr pair of finger	3
	Cs (pF)	0.207
	Rs (Ω)	134

Results and Discussion

Validation of our analysis are demonstrated and discussed in this section defined as follow:

- Evaluating the accuracy of the matching impedance antenna resulting from simulating the return loss S11.
- Simulating the effectiveness and extracting the antenna parameters.
- Plotting currents.

- Simulating a conventional planar patch antenna and comparing results.
- Using the novel technique for array antenna.

Return Loss S11

Accurate matching impedance is provided by the adjustment of the Interdigital capacitor fingers number and length firstly obtained by using the analytic equation the results of the simulation is given by the Fig.9.

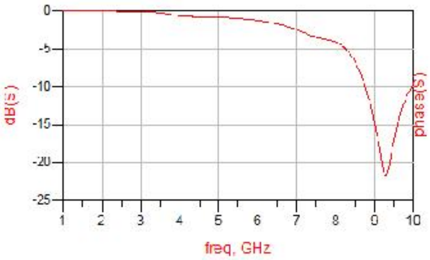

Fig. 9 Return loss S11 antenna simulation

Antenna Parameters

Smith chart shown in Fig. 10 shows the input impedance for the antenna

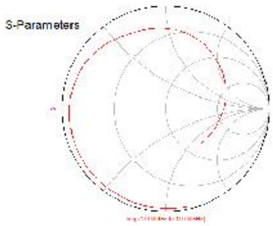

Fig. 10 Matching Input Impedance Antenna

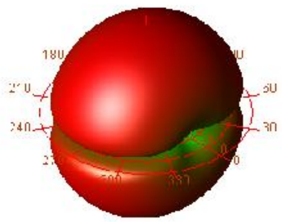

Fig. 11 Radiation Pattern

Table 2 shows the antenna parameter

Table. 2 Antenna Parameters Fed with an Interdigital Capacitor

Power radiated(watts)	0.0409
Effective angle(degrees)	163
Directivity(dB)	6.4511
Gain(dB)	6.4501
Max. Intensity(w/Steradian)	0.0143

The effectiveness of the antenna is given ; an efficiency of 99.9% was obtained.

References

1. Prasanna Venkatesan.G.K.D.,“ CDMA Technique with Inter process Communication” has published for Research Journal of Applied Sciences, Engineering and Technology(RJSET).Vol.7(8),pp.1691-1696, February 2014. ISSN:2040-7459.

2. Prasanna Venkatesan.G.K.D.,"A Novel mechanism for interconnection between peripherals in SOC'S using CDMA technique" has published for international journal of scientific and research publications (IJSRP) .volume 2,issue 8,August 2012, ISSN2250-3153.
3. Prasanna Venkatesan.G.K.D., "CDMA Coding techniques for interconnect between IP Cores", IOSR Journal of engineering (IOSREN),Vol.2,pp.84-90,September2012.ISSN:2250-3021.
4. Prasanna Venkatesan G.K.D."Low-power 1-bit full-adder cell using Enhanced pass transistor logic and power gating ", International Journal of Advanced Technology in Engineering and SciencVolume No.02, Issue No. 06, June 2014.
5. S.Jayakumar, P.V. Ananthapadmanabhan, K. Perumal, T. K. Thiyagarajan, S.C, Mishra, G. Suresh, L.T. Su, A.I.Y . Tok, J.Guo Materials Chemistry and Physics. 140 (2013) 176 - 182.
6. S.Jayakumar, P.V. Ananthapadmanabhan, K. Perumal, T. K. Thiyagarajan, S.C, Mishra, L.T. Su, A.I.Y . Tok, Materials Science and Engineering B. 176 (2011) 894 - 899.
7. S.Jayakumar, P.V. Ananthapadmanabhan, K. Perumal, T. K. Thiyagarajan, S.C, Mishra, L.T. Su, A.I.Y . Tok , "Synthesis of Nano-ZrO 2 by Reactive Plasma processing", AIP Conference Proceedings, 1349(1), (2011), 257 – 258.
8. G.K.D. Prasanna Venkatesan, J.Poongkothai, S. Jayakumar, "Effect of Synthesis Techniques on Size, Shape and Crystallinity of Zro2 Nano Particles", Shanlax International Journal of Arts, Science and Humanities, 5(1), (2017), 34-39.
9. G.K.D. Prasanna Venkatesan, J.Poongkothai, S. Jayakumar, "Synthesis of Spherical Agglomerated Nano ZNO Particles by Modified Precipitation Method", Shanlax International Journal of Arts, Science and Humanities, 5(1), (2017), 63-65.
10. G.K.D. Prasanna Venkatesan, J.Poongkothai, S. Jayakumar, "Thermal Plasma Spherodization Of Silica From Quartzite Powder", Shanlax International Journal of Arts, Science and Humanities, 5(1), (2017), 66-70.
11. PrasannaVenkatesan G.K.D." A Novel Approach To Papr Reduction With Reduced Complexity Based On OICF Algorithm ", has published in International Journal of Advanced Technology in Engineering ,Volume No.02, Issue No. 06, June 2014 .
12. Prasanna Venkatesan G.K.D " Analysis Of Power Efficiency In Clustering Based Routing For Heterogeneous MANETS", has published in International Journal For Technological Research In Engineering ,Volume 1, Issue 9, May-2014.
13. Prasanna Venkatesan G.K.D. "Glitchless Digitally Contrlled Delay Lines For Power Optimization", has published in International Journal For Technological Research In Engineering Volume 1, Issue 9, May-2014.
14. S Jegadeesan, GKD Prasanna Venkatesan, "Smart cow health monitoring, farm environmental monitoring and control system using wireless sensor networks", Int. J. Adv. Eng. Tech./Vol VII/Issue I/Jan–March 2016
15. Prasanna Venkatesan G.K.D."Fpga Based Optimal Charging In a Solar Powered Robot", has published in IOSR Journal of VLSI and Signal Processing (IOSR-JVSP)Volume 4, Issue 3, Ver. II (May-Jun. 2014), PP 29-33.
16. Prasannavenkatesan G.K.D." An Energy Efficient Data Collection for Mobile User With Cluster Points" has published in IOSR Journal of VLSI and Signal Processing (IOSR-JVSP) Volume 4, Issue 3, Ver. II (May-Jun. 2014), PP 44-47.
17. Prasanna Venkatesan G.K.D. "An Efficient Cluster head Selection Strategy for Multicasting and Geocasting" has published in International Journal of Advanced Research in Computer and Communication Engineering Vol. 3, Issue 5, May 2014.
18. Prasanna Venkatesan G.K.D."A Base Station Switching Scheme for Green Cellular Networks" has published in International Journal of Advanced Research in Computer and Communication Engineering Vol. 3, Issue 5, May 2014.
19. Shashidhar Kasthala, G.K.D.Prasanna Venkatesan, "Estimation of MIMO Power Line Communication Channel Capacity using Multi-Conductor Transmission Line Theory", 2nd

International Conference on Applied and Theoretical Computing and Communication Technology (iCATccT) 21-23 July 2016
20. G.K.D.PrasannaVenkatesan G.K.D." Multiple Error Recovery in TMR System", has published in International Journal of Engineering Trends and Technology (IJETT) – Volume 11 Number 7 - May 2014.
21. Prasanna Venkatesan G.K.D "Design and Implementation of an On-Chip Permutation Network with Fault Addressing"has published in International Journal of Engineering Trends and Technology (IJETT) – Volume 11 Number 7 - May 2014.
22. PrasannaVenkatesan G.K.D. " An Efficient Location Based Anonymous Routing Protocol for ADHOC Networks",has published in IJREAT International Journal of Research in Engineering & Advanced Technology, Volume 2, Issue 2, Apr-May, 2014.
23. Prasana Venkatesan G.K.D. ,"A Hybrid Communication Infrastructure Power System Using Effective Sensor Network",has published in IJREAT International Journal of Research in Engineering & Advanced Technology, Volume 2, Issue 2, Apr-May, 2014.
24. Shashidhar Kasthala, GKD Prasanna Venkatesan, A Amudha, "Design and Development of Protective Coupling Interface for Characterizing the Residential Broadband PLC Channel," Journal of Advanced Research in Dynamical and Control Systems, 1943-023X /May 2017/Vol. 9 SI.2
25. M.Pachiyaanan, Prasanna venkatesan G K D "Compact Size K-band UWB Antenna for Surface Movement Radar: Design and Analysis" has presented in IEEE International Conference on Applied and Theoretical Computing and Communication Technology (iCATccT), Pages:695-698,IEEE Explore Digital Library. The IEEE part Number is CFP15D66-USB and ISBN Number is 978-1-4673-9222-8.
26. K Priyadharshini, RR Jegan, GKD Prasanna Venkatesan, "Automatic registration of images with simulated rotation and translation estimation using HAIRIS", International Conference on Current Trends in Engineering and Technology (ICCTET), 2013
27. S Ramya, GKD Prasanna Venkatesan, "Study of various transmission schemes of MIMO systems", International Journal of Emerging Trends in Engineering and Development, 2(3), 2013
28. K.Sampath Kumar, G.K.D.Prasanna Venkatesan, "Effective Method of Prevention of Cache Poisoning for Wild Card Secure DNS – A Novel Approach", IRACST – Engineering Science and Technology: An International Journal (ESTIJ), ISSN: 2250-3498, Vol.3, No.2, April 2013
29. S Jayakumar, TK Thiyagarajan, PV Ananthapadmanabhan, SC Mishra, K Perumal, "Synthesis of spherical nanoparticles of zirconium oxide by reactive plasma", Proceedings of the third international conference on frontiers in nanoscience and technology: technical programme and abstract book, 45(5), 2011, 80
30. Y Chakravarthy, KP Sreekumar, S Jayakumar, TK Thiyagarajan, PV Ananthapadmanabhan, AK Das, LM Gantayet, K Krishnan, "Process development for synthesis and plasma spray deposition of LaPO 4 and YPO 4 for nuclear applications", Proceedings of international conference on peaceful uses of atomic energy-2009, 41(4), 2009, 624 – 625
31. Shashidhar Kasthala, GKD Prasanna Venkatesan, "A Review On Plc Modeling Techniques For Residential Networks", International Journal, 8(8), 2017
32. M Kumaresan, GKD Prasanna Venkatesan, "Cloud Scheduling Using Hybrid Heuristic Based HEFT and Enhanced GRASP Approach: A Study and Analysis", 8th International Conference on Computational Intelligence and Communication Networks (CICN), 2016
33. M Pachiyaannan, GKD Prasanna Venkatesan, "Dual-Band UWB Antenna for Radar Applications: Design and Analysis", 8th International Conference on Computational Intelligence and Communication Networks (CICN), 2016
34. Prasanna Venkatesan G.K.D.,"A Spectrum Decision Framework for Scheduling and Primary User Emulation Attack in Cognitive Radio Network", has published in International Journal of Science and Research,Volume 3 Issue 5, May 2014.

35. M. Pachiyannan, Prasanna venkatesan G.K.D., "Design a 4G MIMO Antenna over wireless sensor node transmission for LTE band" has published in Australian Journal of Basic and Applied Sciences (AJBAS) on May Issue 2015,9(11),Pages:235-252.
36. K Sampath Kumar, GKD Prasanna Venkatesan, "Certain Investigation in DNS Performance by Using Accelerator and Stub Network", 2016 8th International Conference on Computational Intelligence and Communication Networks (CICN).
37. M Pachiyaannan, GKD Venkatesan, " Optimal Design of 6.1 GHz UWB Antenna for off Body Communication", Asian Journal of Information Technology 15 (21), 4229-4235, 2016
38. Shashidhar Kasthala, GKD Prasanna Venktesan, "Evaluation of Channel modeling techniques for Indoor Power Line Communication," International Conference on Advanced Computing & Intelligent Engineering , Advances in Intelligent Systems and Computing (AISC), series of Springer, 2194-5357/ Dec 2016
39. S Jegadeesan, GKD Prasanna Venkatesan, "Distant biometry in cattle farm using wireless sensor networks", International Conference on Communication and Electronics Systems (ICCES), 2016
40. Shashidhar Kasthala, GKD Prasanna Venkatesan, A Amudha, "Design and Development of Protective Coupling Interface for Characterizing the Residential Broadband PLC Channel," Journal of Advanced Research in Dynamical and Control Systems, 1943-023X /May 2017/Vol. 9 SI.2
41. A Anitha, RK Arun Kumar, P Nanthini, GKD Prasanna Venkatesan, M Pachiyaannan, "Analysis And Design Of Cylindrical Shaped Conformal Uwb Antenna", International Journal of Advances in Engineering & Technology, 9(2), 177, 2016
42. M Kumaresan, GKD Venkatesan, "An Effective Scheduling Algorithm for Auditability Awareness using Cloud", Asian Journal of Research in Social Sciences and Humanities, 6(12), 154-165, 2016.
43. K.Sampath Kumar and G.K.D.PrasannaVenkatesan, "A Novel Approach to Enhance DNSCache Performance inWeb Browser using SPVAlgorithm" Indian Journal of Science and Technology, Vol 8(15), DOI: 10.17485/ijst/2015/v8i15/54635, July 2015
44. M Pachiyaannan, GKD Venkatesan, " Optimal Design of 6.1 GHz UWB Antenna for off Body Communication", Asian Journal of Information Technology 15 (21), 4229-4235, 2016
45. K.Sampath Kumar, G.K.D.Prasanna Venkatesan, "Effective Method of Prevention of Cache Poisoning for Wild Card Secure DNS – A Novel Approach", IRACST – Engineering Science and Technology: An International Journal (ESTIJ), ISSN: 2250-3498, Vol.3, No.2, April 2013
46. M Kumaresan, GKD Prasanna Venkatesan, "Classification Of Images Distributed On Social Sharing Sites In View Of Ba-Svm", Int J AdvEngg Tech/Vol. VII/Issue II/April-June, 2016
47. Dr.G.K.D.Prasanna Venkatesan S.Jegadeesan, "Increasing the Life Time of the Network by Adjusting the Transmission Power of Nodes Based on Received Signal Strength in Wireless Sensor Networks", Research Journal of Applied Sciences, Engineering and Technology, 8(18), 9, 2014
48. Praveen Kumar.M Dr.G.K.D.Prasanna Venkatesan, "MIMO Based Transceiver System for Unmanned Ground Vehicle for Surveillance In War Field", 1(3),4,2010
49. P Deepa, T Manikandan, GKD Prasanna Venkatesan, "Design and Implementation of an On-Chip Permutation Network with Fault Addressing", International Journal Of Engineering Trends And Technology, 1(11), 359-361.