

Gain and Directivity Enhancement of Rectangular Microstrip Patch Antenna using HFSS

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ABSTRACT

In the recent years the improvement in communication systems requires the development of low cost, minimal weight, low profile antennas that are capable of maintaining high performance over a wide spectrum of frequency. This technological trend has focused much effort into the design of a Micro strip patch antenna. In this paper, we designed a rectangular micro strip patch antenna at 3.84GHz and study the effect of antenna dimension Length (L), Width (W), substrate parameter relative dielectric constant (ϵ_r) substrate thickness (h) and radiation pattern using Ansoft HFSS. It even describes the increasing effect of Gain and Directivity. The proposed antenna also presents the detail steps of designing the micro strip antenna and the simulated result. The feeding technique used to feed the antenna is coaxial probe feeding technique. Micro strip patch antenna is used in many fields like Antenna and mobile communication, Filters, PCB based model and EMC and EMI. Rogers RT/duriod 5880 (tm) substrate with a dielectric constant of approximately 2.2, is a feed and has a partial ground plane. The gain and directivity of the designed antenna is 7.7082 dBi and 7.76882 dBi respectively.

Index Terms: Micro strip patch antenna, Radiation pattern, Ansoft HFSS (High Frequency Structural Simulator) and Rogers RT/duriod 5880.

1. INTRODUCTION

Antennas play a vital role in the field of wireless communications. Some of the antennas are parabolic reflectors, patch antennas, slot antennas, and folded dipole antennas with each type having their own properties and usage. Micro strip antenna technology began its development in the late 1970s. Micro strip patch antenna is one of most important component of communication systems. By definition, an antenna is a device used to transform an RF signal, travel into an electromagnetic wave in free space. The rectangular micro strip antennas play a vital role in wireless communication due to its low-profile, small-size and light weight. A Micro strip Patch antenna consist of a radiating patch on one side of a dielectric substrate which has a ground plane on the other side. The patch is made up of conducting material such as copper or gold. The radiating patch and the feed lines are photo-etched on the dielectric substrate.

Micro strip antennas are characterized by a larger number of physical parameters than microwave antennas. They can be designed to have many geometrical shapes and dimensions but rectangular and circular Micro strip resonant patches have been used in many applications. In this paper, the design of probe feed rectangular micro strip antenna is for satellite applications is presented and is expected to operate within 3.8 GHz frequency span. This antenna is designed on coaxial probe feeding technique and its performance characteristics which include Return Loss, Gain, Directivity, VSWR, and input impedance are obtained from the simulation.

2. STRUCTURE OF ANTENNA

Micro strip patch antenna consist of patch on its top side, a radiating patch on one side of the dielectric substrate and a ground plane on the other side. The micro strip patch antenna

consists of three layers. The top layer shows the patch, the middle layer shows the substrate and the bottom layer constitutes the ground plane. The patch is generally made of conducting material such as copper or gold. The general structure of the micro strip patch antenna is shown in figure 1.

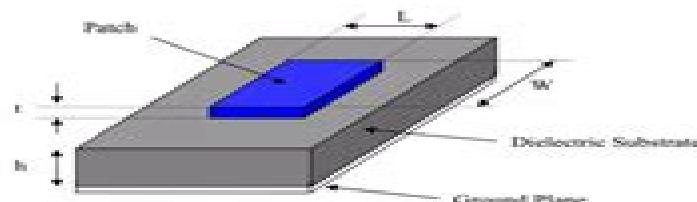


Fig.1. Structure of Micro-strip patch antenna

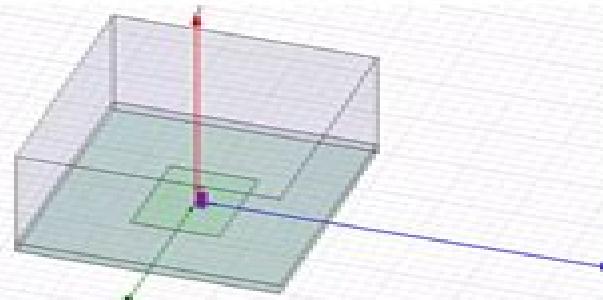


Fig.2. Rectangular micro strip patch antenna design

Ansoft Hfss Manual For Rectangular Microstrip Antenna

Kai Fong Lee,Kwai Man Luk

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Proceedings of International Conference on Recent Advancement on Computer and Communication Basant Tiwari,Vivek Tiwari,Kinkar Chandra Das,Durgesh Kumar Mishra,Jagdish C. Bansal,2018-04-18 The book is a compilation of best papers presented at International Conference on Recent Advancement in Computer and Communication ICRAC 2017 organized by IMPLab Research and Innovation Foundation Bhopal India The book covers all aspects of computers and communication techniques including pervasive computing distributed computing cloud computing sensor and adhoc network image text and speech processing pattern recognition and pattern analysis digital signal processing digital electronics telecommunication technologies robotics VLSI technologies embedded system satellite communication digital signal processing and digital communication The papers included are original research works of experts from industry government centers and academic institutions experienced in engineering design and research [RFID Handbook](#) Syed A.

Ahson,Mohammad Ilyas,2017-12-19 Radio Frequency Identification RFID tagging is now used by the department of defense and many of the world's largest retailers including Wal Mart As RFID continues to infiltrate industries worldwide organizations must harness a clear understanding of this technology in order to maximize its potential and protect against the potential risks it poses The RFID Handbook provides an overview of RFID technology its associated security and privacy risks and recommended practices that will enable organizations to realize productivity improvements while also protecting sensitive information and the privacy of individuals Expert contributors present a host of applications including RFID enabled automated receiving triage with RFID for massive incidents RFID and NFC in relation to mobile phones and RFID technologies for communication robots and a privacy preserving video surveillance system The unprecedented coverage also includes detailed descriptions of adaptive splitting protocols as well as tree based and probabilistic anti collision protocols Drawing on its distinguished editors and world renowned contributors this one of a kind handbook serves as the ultimate reference on RFID from basic research concepts to future applications [Handbook of Microstrip Antennas](#) James R.

James,Peter S. Hall,1989 The book reviews developments in the following fields circular microstrip antennas microstrip patch antennas circular polarisation and bandwidth microstrip dipoles multilayer and parasitic configurations wideband flat dipole and short circuit microstrip patch elements and arrays numerical analysis multiport network approach transmission line model rectangular microstrip antennas low cost printed antennas printed phased array antennas circularly polarised antenna arrays microstrip antenna feeds substrate technology computer aided design of microstrip and triplate circuits resonant microstrip antenna elements and arrays for aerospace applications mobile and satellite systems conical conformal microstrip tracking antenna and microstrip field diagnostics [Microstrip Antenna Design Handbook](#) Ramesh Garg,2001 Based on Bahl and Bhartia's popular 1980 classic Microstrip Antennas this all new book provides the detail antenna engineers and designers need to design any type of microstrip antenna After addressing essential microchip antenna theory the authors

highlight current design and engineering practices emphasizing the most pressing issues in this area including broadbanding circular polarization and active microstrip antennas in particular Special design challenges ranging from dual polarization high bandwidth and surface wave mitigation to choosing the proper substrate and shaping an antenna to achieve desired results are all covered **Microstrip Antennas** N Nasimuddin,2011-04-04 In the last 40 years the microstrip antenna has been developed for many communication systems such as radars sensors wireless satellite broadcasting ultra wideband radio frequency identifications RFIDs reader devices etc The progress in modern wireless communication systems has dramatically increased the demand for microstrip antennas In this book some recent advances in microstrip antennas are presented

Design and Analysis of Microstrip Patch Antenna for Beginners Dr. Anurima Majumdar,Dr. Antara Ghosal, Dr. Avali Banerjee,2024-06-28 In the world of communication engineering microstrip patch antennas MPA play an important role Hence the design and analysis of microstrip patch antennas are introduced in many disciplines of engineering Not only in the academic field but also in the research areas of broadband communication wireless communication satellite communication 5G 6G communication etc This book will be helpful for beginners to understand the basic steps to designing a MPA and its numerical analysis It covers topics ranging from the fundamentals of patch antennas to designing procedures MATLAB analysis and software simulation HFSS We hope this book will help the students of diploma and UG study to gain thorough knowledge in the subject We earnestly thank the students and teachers who helped us with their valuable suggestions We request that the readers give their feedback for further improvements **Microstrip Antennas** David M.

Pozar,Daniel H. Schaubert,1995-05-15 This anthology combines 15 years of microstrip antenna technology research into one significant volume and includes a special introductory tutorial by the co editors Covering theory design and modeling techniques and methods this source book is an excellent reference tool for engineers who want to become more familiar with microstrip antennas and microwave systems Proven antenna designs novel solutions to practical design problems and relevant papers describing the theory of operation and analysis of microstrip antennas are contained within this convenient reference

Frequency Selective Surfaces based High Performance Microstrip Antenna Shiv Narayan,B. Sangeetha,Rakesh Mohan Jha,2015-09-24 This book focuses on performance enhancement of printed antennas using frequency selective surfaces FSS technology The growing demand of stealth technology in strategic areas requires high performance low RCS radar cross section antennas Such requirements may be accomplished by incorporating FSS into the antenna structure either in its ground plane or as the superstrate due to the filter characteristics of FSS structure In view of this a novel approach based on FSS technology is presented in this book to enhance the performance of printed antennas including out of band structural RCS reduction In this endeavor the EM design of microstrip patch antennas MPA loaded with FSS based i high impedance surface HIS ground plane and ii the superstrates are discussed in detail The EM analysis of proposed FSS based antenna structures have been carried out using transmission line analogy in combination with the reciprocity theorem

Further various types of novel FSS structures are considered in designing the HIS ground plane and superstrate for enhancing the MPA bandwidth and directivity The EM design and performance analyses of FSS based antennas are explained here with the appropriate expressions and illustrations **Microstrip Patch Antennas** Kai Fong Lee,Kwai Man Luk,2010-09-03

Microstrip patch antennas have become the favorite of antenna designers because of its versatility and advantages of planar profile ease of fabrication compatibility with integrated circuit technology and conformability with a shaped surface As there is currently an urgent need for graduate students and practicing engineers to gain an in depth understanding of this subject this book was written with this purpose in mind The authors are IEEE Fellows who have made significant contributions to their fields of expertise Professor K F Lee was the recipient of the 2009 John Kraus Antenna Award of the IEEE Antennas and Propagation Society a

Microstrip Patch Antenna Learning using MATLAB. Theory and Implementation

Jagadish Jadhav,Alkeshkumar M Khatri,Pramod J Deore,2021-07-30 Scientific Study from the year 2021 in the subject Engineering Communication Technology course M Tech language English abstract Microstrip patch antenna is used to send onboard parameters of article to the ground while under operating conditions By the study of this book we find out how to investigate a new method of teaching microstrip patch antenna design for undergraduate students by using MATLAB Effect of changes in basic parameter microstrip patch antenna on its radiation pattern and other parameters to study the effect of resonant frequency and substrate parameters like relative dielectric constant substrate thickness on the radiation parameters of bandwidth and physical dimension of the microstrip patch antenna can be determined by using GUI In this book we develops simple CAD GUI formulas that describe the basic properties of microstrip patch antenna using MATLAB By the usage of this teaching tool we can analyze the behaviour of the microstrip patch antenna and design of it for different material Satellite communication and wireless communication has been developed rapidly in the past decades and it has already a dramatic impact on human life In the last few years the development of wireless local area networks WLAN represented one of the principal interests in the information and communication field Thus the current trend in commercial and government communication systems has been to develop low cost minimal weight low profile antennas that are capable of maintaining high performance over a large spectrum of frequencies This technological trend has focused much effort into the design of microstrip patch antennas The variety in design that is possible with microstrip antenna probably exceeds that of any other type of antenna element In addition once the shape and operating mode of the patch are selected designs become very versatile in terms of operating frequency polarization pattern and impedance They are extremely low profile lightweight simple and inexpensive to fabricate using modern day printed circuit board technology compatible with microwave and millimeter wave integrated circuits MMIC and have the ability to conform to planar and non planar surfaces **Microstrip Antennas** Sudipta Chattopadhyay,2017-11-15 The progress in modern tiny multifunctional wireless devices has dramatically increased the demand for microstrip antennas in recent years

Furthermore in the last few years such microstrip antennas found numerous applications in both the military and the commercial sectors Therefore microstrip patch antenna has become a major focus to the researchers in the field of antenna engineering In this book some recent advances in microstrip antennas are presented This book contains mainly three sections In the first section some new approaches to modern analytical techniques rather than the conventional cavity model transmission line model or spectral domain analysis have been discussed In the second section of the book a light has been showered on some new techniques for bandwidth enhancement of microstrip radiators In the last section of the book the recent trends in microstrip antenna research have been showcased Some newfangled application oriented approach to this field is vividly discussed The books main objective is to facilitate the microstrip antenna researchers for exploring the subject in more vibrant manner and also to revolutionize wireless communications A sufficient number of topics have been covered some for the first time in a research handbook I hope that the book will surely be beneficial for scientists practicing engineers and researchers working in the field of microstrip antennas

Analysis of a Linear Series-fed Rectangular Microstrip Antenna Array Sohini Sengupta,2011

Microstrip and Printed Antenna Design Randy Bancroft,2009-06-30

Offering extensive coverage of microstrip antennas from rectangular and circular to broadband and dual band this text gives a complete introduction to useful designs and the implementation aspects of these types of antennas

Microstrip Antenna Design K. C. Gupta,Abdelaziz Benalla,1988

Size Reduction of Microstrip Antennas Using Left-handed Materials

Realized by Complementary Split-ring Resonators Aparna U. Limaye,2006 Recently metamaterials MTMs engineered to have negative values of permittivity and permeability resulting in a left handed system have provided a new frontier for microwave circuits and antennas with possibilities to overcome limitations of the right handed system Microwave circuit components such as waveguides couplers power dividers and filters constructed on left handed materials have demonstrated properties of backward coupling phase compensation reduced sizes and propagation of evanescent modes However there is very limited work to date on the microstrip antennas with metamaterials Microstrip antenna is widely used for its low profile simplicity of feed and compatibility with planar microstrip circuitry As the trend towards miniaturization of electronic circuitry continues antennas remain as the bulkiest part of wireless devices There are three primary objectives to the present work 1 Explore the possibility of miniaturizing microstrip patch antennas using left handed materials through phase compensation 2 Achieve negative permittivity using Complementary Split Ring Resonators CSRR 3 Implement CSRR in the ground plane of a rectangular patch antenna and validate through simulation and measurement A rectangular patch antenna with a combined DPS DNG substrate has been analyzed with the cavity model from which the condition for mode propagation has been derived Criteria for electrically small patch using phase compensation have been developed and propagating modes that satisfy these criteria have been obtained With an objective to design practically realizable antennas amongst several available LHM structures the Complementary Split Ring Resonators CSRR has been chosen primarily for the ease of

implementation in the ground plane CSRRs are periodic structures which alter the bulk effective permittivity of a host medium in which they are embedded. The effective permittivity becomes negative in a certain frequency band defined as a stop band. In the present work the frequency response of the CSRR and the stop band has been determined using a full wave solver from which effective permittivity of the composite with CSRRs has been obtained by parameter extraction. Finally several combinations of patch and CSRR in the ground plane have been designed and constructed in the X band frequency range. Measurements of input characteristics and directivity have been validated through simulation by Ansoft Designer and HFSS. It has been observed that the best designs are achieved when the stop band of the CSRR corresponds to the desired resonant frequency of the antenna. Under these conditions a size reduction of up to fifty percent has been achieved and it is noted that the back lobe is negligible and the directivity is comparable to that of a right handed microstrip antenna.

Abstract
Microstrip Antenna Design for Wireless Applications Praveen Kumar Malik, Sanjeevikumar Padmanaban, Jens Bo Holm-Nielsen, 2021-11-29 This book focuses on recent advances in the field of microstrip antenna design and its applications in various fields including space communication, mobile communication, wireless communication, medical implants and wearable applications. Scholars as well as researchers and those in the electronics, electrical instrumentation engineering fields will benefit from this book. The book shall provide the necessary literature and techniques using which to assist students and researchers would design antennas for the above mentioned applications and will ultimately enable users to take measurements in different environments. It is intended to help scholars and researchers in their studies by enhancing their knowledge and skills in the latest applications of microstrip antennas in the world of communications such as world like IoT, D2D, satellites and wearable devices to name a few. FEATURES: Addresses the complete functional framework workflow in printed antenna design systems. Explores the basic and high level concepts including advanced aspects in planer design issues thus serving as a manual for those in the industry while also assisting beginners. Provides the latest techniques used for antennas in terms of structure, defected ground, MIMO and fractal designs. Discusses case studies related to data intensive technologies in microchip antennas in terms of the most recent applications and similar uses for the Internet of Things and device to device communication.

Design and Implementation of Rectangular Patch Antenna for Tri-Band Operation Prashant S. Mahajan, Jagadish B. Jadhav, Pramod J. Deore, 2015-04-15 Master's Thesis from the year 2013 in the subject Electrotechnology grade First Class course Master Of Engineering language English comment. These antennas can be designed in a variety of shapes in order to obtain enhanced gain and bandwidth for dual band and tri band operation. This book focuses on a detailed study of how to design and simulate a microstrip fed rectangular patch antenna using IE3D software with effect of antenna dimensions length L, width W, relative dielectric constant, substrate thickness t on the radiation parameters of bandwidth and gain. The design parameters of the antenna calculated using the transmission line model abstract. In today's modern communication industry antennas are the most important components required to create a

communication link Microstrip antennas are the most suited for aerospace and mobile applications because of their low profile light weight and low power handling capacity These antennas can be designed in a variety of shapes in order to obtain enhanced gain and bandwidth for dual band and tri band operation This book focus on a detailed study of how to design and simulate a microstrip fed rectangular patch antenna using IE3D software with effect of antenna dimensions length L width W relative dielectric constant substrate thickness t on the radiation parameters of bandwidth and gain The design parameters of the antenna calculated using the transmission line model Here antenna operates for tri band operation the operating bands are GSM PCA and UTMS for antenna geometry I and WLAN and WiMAX for antenna geometry II The fractional bandwidths FB after simulation obtain under criterion S_11 Microstrip Antenna J. R. James,Peter S. Hall,Colin Wood,1986 In the past few years the concept of creating microwave antennas using microstrip has attracted increasing attention and viable practical designs are now emerging The purpose of this monograph is to present the reader with an appreciation of the underlying physical action up to date theoretical treatments useful antenna design approaches and the overall state of the art situation The emphasis is on antenna engineering design but to achieve this goal it has been necessary to delve into the behaviour of microstrip in a much wider sense and also include aspects of electromagnetic analysis As a consequence the monograph will also be of interest to microstrip circuit designers and to some extent those seeking electromagnetic problems of a challenging nature The astronomical progress in miniaturising and integrating electronic circuits in the past decade has recently crerated a positive demand for a new generation of antenna systems In principle microstrip antennas are thin planar configurations that are leightweight low cost easy to manufacture and can be made conformal with the surfaces of vehicles missiles etc The compatibility of microstrip antennas with integrated electronics is another great advantage However the microstrip wavetrapping effects inhibit the radiation mechanism and must be taken into account in antenna design Wave trapping effects in substrates involve the study of surface waves and discontinuities in open waveguide structures The microstrip antenna designer must therefore encompass many more effects than previously considered by microstrip circuit designers It is for these reasons that the scope of this monograph is necessarily somewhat wider than the title may suggest The ten chapters are a blend of introductory practical and theoretical treatments and likely future developments are also highlighted A good selection of past and current references are given and each chapter concludes with a helpful summary comment Microstrip Patch Antennas: A Designer's Guide Rod Waterhouse,2013-04-17 Microstrip Patch Antennas A Designer s Guide provides the reader with a current overview of where microstrip patch antenna technology is at and useful information on how to design this form of radiator for their given application and scenario The book describes the general properties and the many different forms of microstrip patch antennas highlighting the advantages and disadvantages of each from a designer s prospective The book outlines procedures on how to optimize antennas in terms of bandwidth size polarization control and radiation performance Practical design cases are provided for

each goal Throughout the book design philosophies are presented to ensure the best performance from the printed antenna is always achieved Important performance trends are given enabling the designer to understand what the most appropriate printed antenna solution exists for the problem at hand Companies specializing in antenna development using printed antennas in their systems and graduate students alike will find Microstrip Patch Antennas A Designer's Guide is a useful tool

Rectangular-patch Microstrip Antenna Analysis and Design James Wesley Hall, 1994

The book delves into Ansoft Hfss Manual For Rectangular Microstrip Antenna. Ansoft Hfss Manual For Rectangular Microstrip Antenna is a crucial topic that needs to be grasped by everyone, ranging from students and scholars to the general public. This book will furnish comprehensive and in-depth insights into Ansoft Hfss Manual For Rectangular Microstrip Antenna, encompassing both the fundamentals and more intricate discussions.

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