

Matlab Code to Design A Slotted Waveguide Array Antenna

Aritra Roy

Lab-STICC, Université de Bretagne Occidentale

Brest, France

aritra.roy@univ-brest.fr

Abstract

This article presents a MATLAB script used to design slotted waveguide array (SWA) antennas. A brief theory of the antenna is discussed to understand the scope and requirement of this code. A numerical comparison is also presented to design a SWA of 25 GHz to validate the proposed script.

I. INTRODUCTION

Slotted waveguide array antenna is known for its high power radiation and is often employed in space applications. It possesses a significantly high antenna gain by exploiting the radiations through multiple slots placed at half wavelength distances. The effects of slots on waveguide is thoroughly discussed in [1] which inspired the design of SWA as discussed in [2]–[4]. The slot placement on the waveguide plays a critical role to optimize the antenna radiation at a given frequency. In this article a MATLAB script is presented which is inspired by the analytical discussion presented in [3], [4]. A brief theory of SWA is discussed in Sec. II which is followed by the Matlab script in Sec. III, numerical validation in Sec. IV and conclusion in Sec. V.

II. THEORY

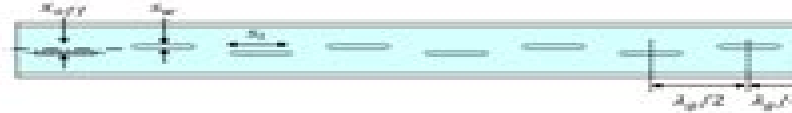


Fig. 1. Schematic of a SWA indicating the slot length s_l , slot width s_w and slot offset from the longitudinal axis x_{off} . λ_g is the guided wavelength at the operating frequency considering the waveguide dimensions.

Schematic of a conventional SWA is shown in Fig. 1. It consists of a rectangular waveguide terminated at one end with multiple slots on one of its broad wall. The slots are placed longitudinally in a tandem orientation by maintaining a distance of the multiple of the guided wavelength (λ_g). It increases the interaction of slots with the standing wave inside the terminated waveguide to increase the antenna radiation. The total radiated electric field ($E_r(\theta)$) can be approximated using array theory by considering the radiation from individual slots

$$E_r(\theta) = f(\theta) \sum_{n=1}^N \alpha_n e^{jnk \frac{\lambda_g}{2} \cos\theta} \quad (1)$$

where, $f(\theta)$ is the radiated electric field of a slot, α_n is the magnitude of excitation coefficient of the n th slot, k is the free space wave number at the operating frequency and θ is the angle of observation. Since the slot-field is a function its placement about the waveguide axis, the conductance of the n th slot can be calculated from the excitation coefficients as

$$g_n = \frac{\alpha_n^2}{\sum_{n=1}^{N/2} \alpha_n^2} \quad (2)$$

It can also be expressed in terms of the design parameters of the SWA as

$$g_n = 2.09 \frac{\lambda_g}{\lambda_0} \frac{a}{b} \cos^2\left(\frac{\pi \lambda_0}{2 \lambda_g}\right) \sin^2\left(\frac{\pi x_{off}}{a}\right) \quad (3)$$

where, a and b are the inner dimensions of the corresponding waveguide. These equations are used to design the SWAs at the operating frequency as will be explained in the following section.

Partially Filled Waveguide With Matlab Code

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Partially Filled Waveguide With Matlab Code:

Electromagnetic Propagation and Waveguides in Photonics and Microwave Engineering Patrick Steglich, 2020-10-21

Optical and microwave waveguides have attracted much research interest in both science and industry. The number of potential applications for their use is growing rapidly. This book examines recent advances in the broad field of waveguide technology. It covers current progress and latest breakthroughs in emergent applications in photonics and microwave engineering. The book includes ten contributions on recent developments in waveguide technologies including theory, simulation, and fabrication of novel waveguide concepts as well as reviews on recent advances. *Microwave*

Non-Destructive Testing and Evaluation of Fibre-Reinforced Polymer Composites Zhen Li, 2025-05-02. This book provides a detailed exploration of microwave testing, a Non-Destructive Testing (NDT) method fully recognized by the American Society for Non-Destructive Testing (ASNT) within the past decade. Designed with a special focus on carbon fibre and glass fibre reinforced polymer composites, it addresses the needs of industries where these advanced materials are increasingly used, including aerospace, wind energy, electronics, marine, automotive, construction, sports, and piping. For NDT practitioners, understanding this new technique is essential. The book offers an in-depth analysis of the electromagnetic properties of composites. In addition, a thorough discussion of the detection principles, advantages, and applications of various methods is presented. The methods are not limited to composites and can be readily adapted to other dielectric materials. This handbook is tailored for engineers and researchers specialising in NDT of composites. It also doubles as a reference for graduate students and senior undergraduates studying microwave engineering or composite materials. Elevate your expertise in microwave testing with this essential guide crafted for professionals, researchers, and educators driving innovation in advanced non-destructive testing and evaluation. *Electromagnetic Waves, Materials, and Computation with MATLAB*

Dikshitulu K. Kalluri, 2016-04-19. Readily available commercial software enables engineers and students to perform routine calculations and design without necessarily having a sufficient conceptual understanding of the anticipated solution. The software is so user-friendly that it usually produces a beautiful colored visualization of that solution, often camouflaging the fact that it is a numerical solution. **Quick Finite Elements for Electromagnetic Waves** Giuseppe Pelosi, Roberto Coccioli, Stefano Selleri, 2009. The classic 1998 Artech House book *Quick Finite Elements for Electromagnetic Waves* has now been revised and expanded to bring you up to date with the latest developments in the field. You find brand new discussions on finite elements in 3D, 3D resonant cavities, and 3D waveguide devices. Moreover, the second edition supplies you with MATLAB code, making this resource easier to comprehend and use for your projects in the field. This practical book and accompanying software enables you to quickly and easily work out challenging microwave engineering and high frequency electromagnetic problems using the finite element method (FEM). Using clear, concise text and dozens of real-world application examples, the book provides a detailed description of FEM implementation, while the software provides the code and tools needed to solve the three major

types of EM problems guided propagation scattering and radiation With this unique book and software set in hand you can compute the dispersion diagram of arbitrarily shaped inhomogeneous isotropic lossless or lossy guiding structures analyze E and H plane waveguide discontinuities and devices and understand the reflection from and transmission through simple 2D and 3D inhomogeneous periodic structures CD ROM Included Easy to use finite element software contains ready made MATLAB and FORTRAN source code that you can use immediately to solve a wide range of microwave and EM problems The package is fully compatible with Internet freeware so you can perform advanced engineering functions without having to purchase expensive pre and post processing tools

Hands-On Accelerator Physics Using MATLAB® Volker Ziemann, 2019-04-29 Awarded one of BookAuthority's best new Particle Physics books in 2019 Hands On Accelerator Physics Using MATLAB provides an introduction into the design and operational issues of a wide range of particle accelerators from ion implanters to the Large Hadron Collider at CERN Many aspects from the design of beam optical systems and magnets to the subsystems for acceleration beam diagnostics and vacuum are covered Beam dynamics topics ranging from the beam beam interaction to free electron lasers are discussed Theoretical concepts and the design of key components are explained with the help of MATLAB code Practical topics such as beam size measurements magnet construction and measurements and radio frequency measurements are explored in student labs without requiring access to an accelerator This unique approach provides a look at what goes on under the hood inside modern accelerators and presents readers with the tools to perform their independent investigations on the computer or in student labs This book will be of interest to graduate students postgraduate researchers studying accelerator physics as well as engineers entering the field Features Provides insights into both synchrotron light sources and colliders Discusses technical subsystems including magnets radio frequency engineering instrumentation and diagnostics correction of imperfections control and cryogenics Accompanied by MATLAB code including a 3D modeler to visualize the accelerators and additional appendices which are available on the CRC Press website MATLAB live scripts to accompany the book can be found here <https://ziemann.web.cern.ch/ziemann/mybooks/mlx>

[Transform Methods for Solving Partial Differential Equations](#) Dean G. Duffy, 2004-07-15 Transform methods provide a bridge between the commonly used method of separation of variables and numerical techniques for solving linear partial differential equations While in some ways similar to separation of variables transform methods can be effective for a wider class of problems Even when the inverse of the transform cannot be found ana

Power Integrity for Electrical and Computer Engineers J. Ted Dibene, II, David Hockanson, 2019-09-24 A professional guide to the fundamentals of power integrity analysis with an emphasis on silicon level power integrity Power Integrity for Electrical and Computer Engineers embraces the most recent changes in the field offers a comprehensive introduction to the discipline of power integrity and provides an overview of the fundamental principles Written by noted experts on the topic the book goes beyond most other resources to focus on the detailed aspects of silicon and optimization techniques in order to broaden the field of study This important book offers

coverage of a wide range of topics including signal analysis EM concepts for PI frequency domain analysis for PI numerical methods overview for PI and silicon device PI modeling Power Integrity for Electrical and Computer Engineers examine platform technologies system considerations power conversion system level modeling and optimization methodologies To reinforce the material presented the authors include example problems This important book Includes coverage on convergence accuracy and error analysis and explains how these can be used to analyze power integrity problems Contains information for modeling the power converter from the PDN to the load in a full system level model Explores areas of device level modeling of silicon as related to power integrity Contains example word problems that are related to an individual chapter s subject Written for electrical and computer engineers and academics Power Integrity for Electrical and Computer Engineers is an authoritative guide to the fundamentals of power integrity and explores the topics of power integrity analysis power integrity analytics silicon level power integrity and optimization techniques Numerical Techniques in Electromagnetics with MATLAB Matthew N.O. Sadiku, 2018-10-08 Despite the dramatic growth in the availability of powerful computer resources the EM community lacks a comprehensive text on the computational techniques used to solve EM problems The first edition of Numerical Techniques in Electromagnetics filled that gap and became the reference of choice for thousands of engineers researchers and students This third edition of the bestselling text reflects the continuing increase in awareness and use of numerical techniques and incorporates advances and refinements made in recent years Most notable among these are the improvements made to the standard algorithm for the finite difference time domain FDTD method and treatment of absorbing boundary conditions in FDTD finite element and transmission line matrix methods The author also has added a chapter on the method of lines Numerical Techniques in Electromagnetics with MATLAB Third Edition continues to teach readers how to pose numerically analyze and solve EM problems to give them the ability to expand their problem solving skills using a variety of methods and to prepare them for research in electromagnetism Now the Third Edition goes even further toward providing a comprehensive resource that addresses all of the most useful computation methods for EM problems and includes MATLAB code instead of FORTRAN **Computational Electromagnetics with MATLAB, Fourth Edition** Matthew N.O. Sadiku, 2018-07-20 This fourth edition of the text reflects the continuing increase in awareness and use of computational electromagnetics and incorporates advances and refinements made in recent years Most notable among these are the improvements made to the standard algorithm for the finite difference time domain FDTD method and treatment of absorbing boundary conditions in FDTD finite element and transmission line matrix methods It teaches the readers how to pose numerically analyze and solve EM problems to give them the ability to expand their problem solving skills using a variety of methods and to prepare them for research in electromagnetism Includes new homework problems in each chapter Each chapter is updated with the current trends in CEM Adds a new appendix on CEM codes which covers commercial and free codes Provides updated MATLAB code Non-Imaging Microwave and Millimetre-Wave Sensors for

Concealed Object Detection Boris Y. Kapilevich, Stuart W. Harmer, Nicholas J. Bowring, 2017-12-19 In response to the ever increasing global threat of terrorist attacks the personal screening industry has been growing at a rapid rate Many methods have been developed for detecting concealed weapons and explosives on the human body In this important new book the authors discuss their experiences over the last decade designing and testing microwave and millimetre wave detection and screening systems It includes examples of actual devices that they have built and tested along with test results that were obtained in realistic scenarios The book focuses on the development of non imaging detection systems which are similar to radar These systems do not form a conventional image of the scene and the person s being screened Instead the sensors detect and analyze the effect that the body and any concealed objects has on a transmitted waveform These systems allow remote detection of both metallic and dielectric devices concealed on the human body in both indoor and outdoor environments The book discusses a number of sensor types including active millimetre wave sensors using the direct detection and the heterodyne approach active microwave sensors for CNR based object detection passive millimetre wave sensors and the role of shielding effects in operating non imaging MM wave sensors The goal of this book is to systemize the test results obtained by the authors helping specialists to develop improved screening systems in the future Another goal is to show how the use of non imaging systems can reduce the cost of the screening process

Advanced Electromagnetic Computation Dikshitulu K. Kalluri, 2017-11-28 Advanced Electromagnetic Computation with MATLAB discusses commercial electromagnetic software widely used in the industry Algorithms of Finite Differences Moment method Finite Element method and Finite Difference Time Domain method are illustrated Hand computed simple examples and MATLAB coded examples are used to explain the concepts behind the algorithms Case studies of practical examples from transmission lines waveguides and electrostatic problems are given so students are able to develop the code and solve the problems Two new chapters including advanced methods based on perturbation techniques and three dimensional finite element examples from radiation scattering are included

Small Scale Optics Preecha Yupapin, Jalil Ali, 2013-08-28 The behavior of light in small scale optics or nano micro optical devices has shown promising results which can be used for basic and applied research especially in nanoelectronics Small Scale Optics presents the use of optical nonlinear behaviors for spins antennae and whispering gallery modes within micro nano devices and circuits which can be used in many applications This book proposes a new design for a small scale optical device a microring resonator device Most chapters are based on the proposed device which uses a configuration know as a PANDA ring resonator Analytical and numerical methods demonstrate that many applications can be exploited using this device in particular when it is coated with metallic material The book begins with the background and description of the PANDA ring resonator The authors examine optical bistability in microring resonators and test the analytical results with those predicted by the OptiFDTD software package They then describe their new design for a microring resonator device which can be used to generate four forms of light on a chip while also allowing the storing and

harvesting of trapped atoms molecules The four behaviors of light for instance fast slow stopping and storing can be manipulated and seen simultaneously by using the PANDA ring planar waveguide which can be fabricated and tested on chip Chapters examine optical spin nano antennas optical mesh networks micro optical gyroscopes and spin transport networks They also address applications for optical devices including molecular motors for drug discovery short pulse lasers for treatment of cancer microsurgery nano antenna use in radiotherapy and neuron cell communications There are many other possibilities of applications for the PANDA ring resonator such as quantum coding optical tweezers and stopping light which will play an important role in future optical devices

Plasma and Fusion Science J. Julio E. Herrera Velázquez, 2006-12-13 Mexico City Mexico 5 9 December 2005

Electromagnetic and Photonic Simulation for the Beginner: Finite-Difference Frequency-Domain in MATLAB® Raymond C. Rumpf, 2022-01-31 This book teaches the finite difference frequency domain FDFD method from the simplest concepts to advanced three dimensional simulations It uses plain language and high quality graphics to help the complete beginner grasp all the concepts quickly and visually This single resource includes everything needed to simulate a wide variety of different electromagnetic and photonic devices The book is filled with helpful guidance and computational wisdom that will help the reader easily simulate their own devices and more easily learn and implement other methods in computational electromagnetics Special techniques in MATLAB are presented that will allow the reader to write their own FDFD programs Key concepts in electromagnetics are reviewed so the reader can fully understand the calculations happening in FDFD A powerful method for implementing the finite difference method is taught that will enable the reader to solve entirely new differential equations and sets of differential equations in mere minutes Separate chapters are included that describe how Maxwell's equations are approximated using finite differences and how outgoing waves can be absorbed using a perfectly matched layer absorbing boundary With this background a chapter describes how to calculate guided modes in waveguides and transmission lines The effective index method is taught as way to model many three dimensional devices in just two dimensions Another chapter describes how to calculate photonic band diagrams and isofrequency contours to quickly estimate the properties of periodic structures like photonic crystals Next a chapter presents how to analyze diffraction gratings and calculate the power coupled into each diffraction order This book shows that many devices can be simulated in the context of a diffraction grating including guided mode resonance filters photonic crystals polarizers metamaterials frequency selective surfaces and metasurfaces Plane wave sources Gaussian beam sources and guided mode sources are all described in detail allowing devices to be simulated in multiple ways An optical integrated circuit is simulated using the effective index method to build a two dimensional model of the 3D device and then launch a guided mode source into the circuit A chapter is included to describe how the code can be modified to easily perform parameter sweeps such as plotting reflection and transmission as a function of frequency wavelength angle of incidence or a dimension of the device The last chapter is advanced and teaches FDFD for three dimensional devices composed of

anisotropic materials It includes simulations of a crossed grating a doubly periodic guided mode resonance filter a frequency selective surface and an invisibility cloak The chapter also includes a parameter retrieval from a left handed metamaterial The book includes all the MATLAB codes and detailed explanations of all programs This will allow the reader to easily modify the codes to simulate their own ideas and devices The author has created a website where the MATLAB codes can be downloaded errata can be seen and other learning resources can be accessed This is an ideal book for both an undergraduate elective course as well as a graduate course in computational electromagnetics because it covers the background material so well and includes examples of many different types of devices that will be of interest to a very wide audience

Nanoelectronic Materials, Devices and Modeling Qiliang Li,Hao Zhu,2019-07-15 As CMOS scaling is approaching the fundamental physical limits a wide range of new nanoelectronic materials and devices have been proposed and explored to extend and or replace the current electronic devices and circuits so as to maintain progress with respect to speed and integration density The major limitations including low carrier mobility degraded subthreshold slope and heat dissipation have become more challenging to address as the size of silicon based metal oxide semiconductor field effect transistors MOSFETs has decreased to nanometers while device integration density has increased This book aims to present technical approaches that address the need for new nanoelectronic materials and devices The focus is on new concepts and knowledge in nanoscience and nanotechnology for applications in logic memory sensors photonics and renewable energy This research on nanoelectronic materials and devices will be instructive in finding solutions to address the challenges of current electronics in switching speed power consumption and heat dissipation and will be of great interest to academic society and the industry *Scientific and Technical Aerospace Reports* ,1994 [NASA Tech Briefs](#) ,2004 *Guided Wave Photonics* Le Nguyen Binh,2016-04-19 A comprehensive presentation of the theory and simulation of optical waveguides and wave propagations in a guided environment Guided Wave Photonics Fundamentals and Applications with MATLAB supplies fundamental and advanced understanding of integrated optical devices that are currently employed in modern optical fiber communications systems and p *Exploration of the Human Brain using Magnetic Resonance Imaging and Spectroscopy with Transcranial Direct Current Stimulation* Chang-Hoon Choi,Jon Shah,Ferdinand Binkofski,2025-01-02 A large body of molecular and neurophysiological evidence attaches synaptic plasticity and connectivity to specific functions and energy metabolism in particular areas of the brain A favourable approach to investigating various brain functions in humans that enables a well defined modulation of neuronal excitability and energy is to stimulate the brain using a dedicated transcranial direct current stimulation tDCS protocol and then to observe the effect on neurometabolites and brain functioning using magnetic resonance spectroscopy and magnetic resonance imaging tDCS is a non invasive technique for brain stimulation that modulates the level of cortical excitability hyper or hypo polarisation of the membranes to investigate the biochemical and physiological roles of the brain The technique is also utilised for clinical and therapeutic purposes such as depression

chronic pain epilepsy stroke induced aphasia or Parkinson's motor symptoms and can also be used to boost ongoing activities including accelerated learning focus memorisation or relaxation

Photonic Crystals Igor A. Sukhoivanov, Igor V. Guryev, 2009-09-21

The great interest in photonic crystals and their applications in the last 15 years is being expressed in the publishing of a large number of monographs collections textbooks and tutorials where existing knowledge concerning operation principles of photonic crystal devices and microstructured fibers their mathematical description well known and novel applications of such technologies in photonics and optical communications are presented They challenge authors of new books to cover the gaps still existing in the literature and highlight and popularize of already known material in a new and original manner

Author of this book believes that the next step towards wide application of photonic crystals is the solution of many practical problems of design and computation of the specific photonic crystal based devices aimed at the specific technical application

In order to make this step it is necessary to increase the number of practitioners who can solve such problems independently

The aim of this book is to extend the group of researchers developers and students who could practically use the knowledge on the physics of photonic crystals together with the knowledge and skills of independent calculation of basic characteristics of photonic crystals and modeling of various elements of integrated circuits and optical communication systems created on the basis of photonic crystals

The book is intended for qualified readers specialists in the field of optics and photonics students of higher courses master degree students and PhD students

As an introduction to the subject the book contains the basics of wave optics and radiation propagation in simple guiding media such as planar waveguides and step index fibers

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