

Matlab Code to Design A Slotted Waveguide Array Antenna

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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], [3], [5]. 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]–[6]. 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

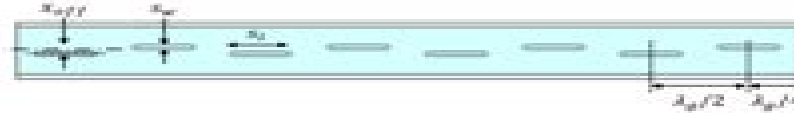


Fig. 1. Schematic of a SWA indicating the slot length a_s , slot width a_w and slot offset from the longitudinal axis x_{off} . λ_g is the guided wavelength at the operating frequency considering the waveguide dimensions.

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

$$E_r(\theta) = f(\theta) \sum_{n=1}^N \alpha_n e^{j + k \frac{a_s}{2} \cos \theta} \quad (1)$$

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

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

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.

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Optical Waveguide Coupling Structures for Integration in Commercial CMOS Aaditya B. Khimani, 2004 *Optical Communications from a Fourier Perspective* Palle Jeppesen, Bjarne Tromborg, 2023-11-17

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Silicon Photonics Design Lukas Chrostowski, Michael Hochberg, 2015-03-12. From design and simulation through to testing and fabrication, this hands-on introduction to silicon photonics engineering equips students with everything they need to begin creating foundry-ready designs. In-depth discussion of real-world issues and fabrication challenges ensures that students are fully equipped for careers in industry. Step-by-step tutorials, straightforward examples, and illustrative source code fragments guide students through every aspect of the design process, providing a practical framework for developing and refining key skills. Offering industry-ready expertise, the text supports existing PDKs for CMOS UV lithography foundry services (OpSIS, ePIXfab, imec, LETI, IME, and CMC) and the development of new kits for proprietary processes and clean-room based research. Accompanied by additional online resources to support students, this is the perfect learning package for senior undergraduate and graduate students studying silicon photonics design and academic and industrial researchers involved in the development and manufacture of new silicon photonics systems.

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 the principles of photonic crystal devices and microstructured fibers is described 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. Authors of this book believe 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.

Grating-assisted Glass Waveguide Devices and Fiber-optic Parametric Amplifiers for Optical Communication Systems Jaeyoun Kim, 2003 **Optical Fiber and Planar Waveguide Technology** Australian Optical Society, Tongxunshijie, Society of Photo-optical Instrumentation Engineers, Optronikususha, 2001

Frontiers in Optics and Photonics Federico Capasso, Dennis Couwenberg, 2021-06-08. This book provides a cutting edge research overview on the latest developments in the field of Optics and Photonics. All chapters are authored by the pioneers in their field and will cover the developments in Quantum Photonics, Optical properties of 2D Materials, Optical Sensors, Organic Optoelectronics, Nanophotonics, Metamaterials, Plasmonics, Quantum Cascade lasers, LEDs, Biophotonics and biomedical photonics and spectroscopy.

European Workshop on Structural Health Monitoring Piervincenzo Rizzo, Alberto Milazzo, 2022-06-21. This volume gathers the latest advances, innovations and applications in the field of structural health monitoring (SHM) and more broadly in the fields of smart materials and intelligent systems as presented by leading international researchers and engineers at the 10th European Workshop on Structural Health Monitoring (EWSHM) held in Palermo, Italy, on July 4-7, 2022. The volume covers highly diverse topics including signal processing, smart sensors, autonomous systems, remote sensing and support UAV platforms for SHM, Internet of Things, Industry 4.0 and SHM for civil structures and infrastructures. The contributions, which are published after a rigorous international peer review process, highlight numerous exciting ideas that will spur novel research directions and foster multidisciplinary collaboration among different specialists.

Arrayed Waveguide Gratings (AWG) and Optical Amplifier Subsystems for Their Applications in Advanced Optical Networks Jing Cao, 2007 *Japanese Journal of Applied Physics*, 2004 *Modeling Optical Waveguide Using Matlab*, 2005 Electro-optical System Design, Simulation, Testing, and Training Richard M. Wasserman, Scott Lawrence DeVore, 2002. The past few years have seen an upsurge in the numbers of known Neolithic settlements in Ireland. Many of these sites have been excavated by archaeologists based in field units but few are well known.

to the wider archaeological community The papers in this volume were presented at a conference held at Queen s University Belfast in 2001 which provided a forum for a discussion of the new Neolithic material from Ireland in its wider geographical context Although the bulk of the emerging Irish settlement evidence relates to substantial houses many of these papers consider wider themes including issues of contact and communication along the sea routes and coastal margins of north west Europe questions of diversity and regional patterns of sedentism and mobility and variations in regional food production strategies

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Integrated Approach to Wavelength Division Multiplexing Using Arrayed Waveguide Gratings Lilia Esther Flores Zambrano,2001 **Annales Geophysicae** ,2008 The Journal of the Acoustical Society of America Acoustical Society of America,2002 **Rare-earth-doped Materials and Devices III** Shibin Jiang,Seppo Honkanen,1999 Rare-earth-doped Materials and Devices ,1999

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