An in-depth treatment of array phenomena and all aspects of phased array analysis and design. Phased Array Antennas, Second Edition is a comprehensive reference on the vastly evolving field of array antennas. The Second Edition continues to provide an in-depth evaluation of array phenomena with a new emphasis on developments that have occurred in the field over the past decade. The book offers the same detailed coverage of all practical and theoretical aspects of phased arrays as the first edition, but it now includes:

- New chapters on array-fed reflector antennas; connected arrays; and reflect arrays and retrodirective arrays.
- Brand-new coverage of artificial magnetic conductors, and Bode matching limitations.
- A clear explanation of the common misunderstanding of scan element pattern measurement, along with appropriate equations.
- In-depth coverage of finite array Gibbsian models, photonic feeding and time delay, waveguide simulators, and beam orthogonality.

The book is complemented with a multitude of original curves and tables that illustrate how particular behaviors were derived from the author's hundreds of programs developed over the past forty years. Additionally, numerous computer design algorithms and numerical tips are included throughout the book to help aid in readers' comprehension.

Phased Array Antennas, Second Edition covers:

- Basic array theory
- Design of element patterns
- Array feeding networks
- Antenna array radiation patterns
- Beamforming techniques
- Beam steering
- Antenna array synthesis
- Advanced topics in phased array antennas

The book is suitable for engineers, researchers, and students in the fields of telecommunications, radar, and wireless communications. It provides a comprehensive resource for anyone involved in the design and implementation of phased array systems.
Phased Array Antennas

Phased arrays, while traditionally used in radar systems, are now being used or proposed for use in internet of things (IoT) networks, high-speed back haul communication, terabit-per-second satellite systems, 5G mobile networks, and mobile phones. This book considers systems engineering of phased arrays and addresses not only radar, but also these modern applications. It presents a system-level perspective and approach that is essential for the successful development of modern phased arrays. Using practical examples, this book helps solve problems often encountered by technical professionals. Thermal management challenges, antenna element design issues, and architectures solutions are explored as well as the benefits and challenges of digital beam forming. This book provides the information required to train engineers to design and develop phased arrays and contains questions at the end of each chapter that professors will find useful for instruction.

Phased Array Antennas

Discover a modern approach to the analysis, modeling and design of high sensitivity phased arrays. Network theory, numerical methods and computational electromagnetic simulation techniques are uniquely combined to enable full system analysis and design optimization. Beamforming and array signal processing theory are integrated into the treatment from the start. Digital signal processing methods such as polyphase filtering and RFI mitigation are described, along with technologies for real-time hardware implementation. Key concepts from interferometric imaging used in radio telescopes are also considered. A basic development of theory and modeling techniques is accompanied by problem sets that guide readers in developing modeling codes that retain the simplicity of the classical array factor method while incorporating mutual coupling effects and interactions between elements. Combining current research trends with pedagogical material suitable for a first-year graduate course, this is an invaluable resource for students, teachers, researchers, and practicing RF/microwave and antenna design engineers.

Affordable OTM Phased Array Antennas: Design and Fabrication of Temperature Stable and Performance Consistent Phase Shifters

This thesis explores the possibility of designing an electronically steerable phased array antenna system using a LC impedance matching network and sections of transmissions line as an interconnection medium between pairs of radiating elements. This interconnection network would be used to control the direction of the array's radiation pattern. Adjustments of the parameters of the LC network would attempt to enforce a desired current distribution on the elements of the array, resulting in the desired radiation pattern. Two design procedures have been investigated and are discussed with presentation of results and sample radiation patterns obtained. The first design method uses a Taylor's series expansion to linearize the network equations describing the array. The other design method utilizes an optimization routine to systematically adjust the parameters of the impedance matching networks until the desired current...
This is the first comprehensive treatment of conformal antenna arrays from an engineering perspective. While providing a thorough foundation in theory, the authors of this publication provide a wealth of hands-on instruction for practical analysis and design of conformal antenna arrays. Thus, you get the
Online Library Phased Array Antennas With Optimized Element Patterns
Artech House Antennas And Propagation Library

The book addresses surrogate-assisted design of antenna arrays, in particular, how surrogate models, both data-driven and physics-based, can be utilized to expedite procedures such as parametric optimization, design closure, statistical analysis, or fault detection. Algorithms and design frameworks are illustrated using a large variety of examples including real-world printed-circuit antenna and antenna array structures. This unique compendium contains introductory materials concerning numerical optimization, both conventional (gradient-based and derivative-free, including metaheuristics) and surrogate-based, as well as a considerable selection of customized procedures developed specifically to handle antenna array problems. Recommendations concerning practical aspects of surrogate-assisted multi-objective antenna optimization are also given. The methods presented allow for cost-efficient handling of antenna array design problems (involving CPU-intensive EM models) in the context of design optimization and statistical analysis, which will benefit both researchers, designers and graduate students.

Advanced Radio Frequency Antennas for Modern Communication and Medical Systems

This book provides engineers with a comprehensive review of the state-of-the-art in reflectarray antenna research and development. The authors describe, in detail, design procedures for a wide range of applications, including broadband, multi-band, multi-beam, contour-beam, beam-scanning, and conformal reflectarray antennas. They provide sufficient coverage of basic reflectarray theory to fully understand reflectarray antenna design and analysis such that the readers can pursue reflectarray research on their own. Throughout the book numerous illustrative design examples including numerical and experimental results are provided. Featuring in-depth theoretical analysis along with practical design examples, Reflectarray Antennas is an excellent text/reference for engineering graduate students, researchers, and engineers in the field of antennas. It belongs on the bookshelves of university libraries, research institutes, and industrial labs and research facilities.

Advanced Engineering Optimization Through Intelligent Techniques

Advances in Array Optimization

This book focuses on engineering design approaches for spacecraft antennas. Based on their functions in spacecraft, it discusses practical antenna design, measurement and testing. Most of the antennas covered originated at the China Academy of Space Technology (CAST), which has launched almost 300 satellites into orbit. The book presents antenna systems for seven existing spacecraft designs, while also introducing readers to new antenna technologies for spacecraft. This book is intended for researchers, graduate students, and engineers in various fields of aerospace technology and astronautics, especially
Online Library Phased Array Antennas With Optimized Element Patterns
Artech House Antennas And Propagation Library

Discover a modern approach to the analysis, modeling and design of high sensitivity phased arrays. Network theory, numerical methods and computational electromagnetic simulation techniques are uniquely combined to enable full system analysis and design optimization. Beamforming and array signal processing theory are integrated into the treatment from the start. Digital signal processing methods such as polyphase filtering and RFI mitigation are described, along with technologies for real-time hardware implementation. Key concepts from interferometric imaging used in radio telescopes are also considered. A basic development of theory and modeling techniques is accompanied by problem sets that guide readers in developing modeling codes that retain the simplicity of the classical array factor method while incorporating mutual coupling effects and interactions between elements. Combining current research trends with pedagogical material suitable for a first-year graduate course, this is an invaluable resource for students, teachers, researchers, and practicing RF/microwave and antenna design engineers.

Smart Computing Techniques and Applications
This book presents a new global optimization technique using Taguchi's method and its applications in electromagnetics and antenna engineering. Compared with traditional optimization techniques, Taguchi's optimization method is easy to implement and very efficient in reaching optimum solutions. Taguchi's optimization method is developed based on the orthogonal array (OA) concept, which offers a systematic and efficient way to select design parameters. The book illustrates the basic implementation procedure of Taguchi's optimization method and discusses various advanced techniques for performance improvement. In addition, the integration of Taguchi's optimization method with commercial electromagnetics software is introduced in the book. The proposed optimization method is used in various linear antenna arrays, microstrip filters, and ultra-wideband antenna designs. Successful examples include linear antenna array with a null controlled pattern, linear antenna array with a sector beam, linear antenna array with reduced side lobe levels, microstrip band stop filter, microstrip band pass filter, coplanar waveguide band stop filter, coplanar ultra-wide band antenna, and ultra-wideband antenna with band notch feature. Satisfactory results obtained from the design process demonstrate the validity and efficiency of the proposed Taguchi's optimization method. Contents: Introduction / Orthogonal Arrays / Taguchi's Optimization Method / Linear Antenna Array Designs / Planar Filter Designs / Ultra-wide Band (UWB) Antenna Designs / OA-PSO Method / Conclusions

Nature-Inspired Computing and Optimization
This authoritative resource provides you with a detailed description of ideal array element characteristics that help you estimate the quality of development of real-world phased array antennas. You find several approaches to optimum phased array design, allowing you to provide specified array gain in a specific region of scan, using a minimum number of expensive, controlled devices. Moreover, this practical book presents important numerical methods that you can use to optimize phased arrays, including genetic algorithms, particle swarm optimization, and other nature-inspired techniques. The book is designed for engineers and researchers who work on the design and optimization of phased array systems for various applications such as radar, communication, and medical imaging. It covers both theoretical foundations and practical applications, making it a valuable resource for professionals in the field. Contents: Introduction / Array Element Characteristics / Optimum Phased Array Design / Genetic Algorithms / Particle Swarm Optimization / Other Nature-Inspired Techniques / Applications / Conclusion
Online Library Phased Array Antennas With Optimized Element Patterns
Artech House Antennas And Propagation Library

Use to model and optimize phased array structure to obtain the best array characteristics that the chosen structure can provide. From arrays with beam-forming networks, arrays of coupled dual-mode waveguides, and arrays with reactively loaded radiators, to waveguide arrays with protruding dielectric elements, and arrays with strip, disk, and wire structures, this comprehensive reference explains a wide range of essential topics to help you with work in this challenging area. The book is supported with over 165 illustrations and more than 566 equations.

Gain Optimization for Arbitrary Antenna Arrays Subject to Random Fluctuations
Describing an innovative approach to phased-array control in antenna design
This book explores in detail phased-array antennas that use coupled-oscillator arrays, an arrangement featuring a remarkably simple beam steering control system and a major reduction in complexity compared with traditional methods of phased-array control. It brings together in one convenient, self-contained volume the many salient research results obtained over the past ten to fifteen years in laboratories around the world, including the California Institute of Technology's Jet Propulsion Laboratory. The authors examine the underlying theoretical framework of coupled-oscillator systems, clearly explaining the linear and nonlinear formalisms used in the development of coupled-oscillator arrays, while introducing a variety of state-of-the-art methodologies, design solutions, and tools for applying this control scheme. Readers will find:
- Numerous implementation examples of coupled-oscillator array prototypes
- A continuum model that permits application of diffusion theory to the analysis of phase dynamics
- A demonstration of the array behavior through experimental results that validate the linearized theory
- Examples of how incorporating coupling delay restores causality, including the latest published results
- Guidance on how to accurately analyze and optimize coupled-oscillator arrays using modern simulation tools
- A review of current developments, including the design of compact couple-oscillator array antennas

Antenna Arrays
Focusing antennas are of interest in many applications, including microwave wireless power transmission, remote (non-contact) sensing, and medical applications. Different kinds of antennas such as array antennas, reflector antennas, and Fresnel zone plate (FZP) antennas have been used for these applications. Here, first, a new scheme in designing focused array antennas with desired sidelobe levels (SLLs) in the near field region is presented. The performance of the large focused array antennas is predicted based on the knowledge of the mutual admittances of a smaller array. The effects of various focal distances on the near field pattern of these antennas are investigated. Then, electric field pattern characteristics of the focused Fresnel zone plate lens antennas in the near-field region are presented. The FZP antenna fed by a circular horn is implemented and the effects of various focal lengths on the near field pattern of this antenna are examined. It is shown that the maximum field intensity occurs closer to the antenna aperture than to the focal point and this displacement increases as the focal point moves away from the antenna aperture. The focusing properties of ultra-wideband (UWB) array antennas are also presented. Large current radiator (LCR) antennas are modeled by replacing the antenna with a set of infinitesimal dipoles producing the same near field of the antenna. LCR antenna arrays are used to provide high concentration of microwave power into a small region. It is shown that the defocusing effect...
occurs in pulse radiating antennas as well. Invasive weed optimization (IWO), a new optimization algorithm, is also employed to optimize the pulsed array antenna. In the attempt of optimizing the focused arrays, a new scenario for designing thinned array antennas using this optimization method is introduced.

It is shown that by using this method, the number of elements in the array can be optimized, which yields a more efficient pattern with less number of elements. By applying this new optimization method to UWB arrays, the peak power delivered to a localized region can be increased.

Advanced Antenna Array Engineering for 6G and Beyond Wireless Communications

Scanning arrays present the radar or communications engineer with the ultimate in antenna flexibility. They also present a multitude of new opportunities and new challenges that need to be addressed. In order to describe the needs for scanned array development, this book begins with a brief discussion of the history that led to present array antennas. This text is a compact but comprehensive treatment of the scanned array, from the underlying basis for array pattern behavior to the engineering choices leading to successful design. The book describes the scanned array in terms of radiation from apertures and wire antennas and introduces the effects resulting directly from scanning, including beam broadening, impedance mismatch and gain reduction and pattern squint and those effects of array periodicity including grating and quantization lobes and array blindness. The text also presents the engineering tools for improving pattern control and array efficiency including lattice selection, subarray technology and pattern synthesis. Equations and figures quantify the phenomena being described and provide the reader with the tools to tradeoff various performance features. The discussions proceed beyond the introductory material and to the state of the art in modern array design.

Contents:
- Basic Principles and Applications of Array Antennas
- Element Coupling Effects in Array Antennas
- Array Pattern Synthesis
- Subarray Techniques for Limited Field of View and Wide Band Applications

Simulation-based Optimization Of Antenna Arrays

The need to develop technology and communication necessitates the design of flexible and high-capacity radiating systems in today’s communication infrastructure. In this context, antenna arrays are the ideal solution and have been one of the priority research subjects of the science community dealing with electromagnetics from past to present. Optimization of an array may be performed in various ways such as the optimization of excitation, reflector structure, feed network, etc. depending on the array structure. This book is a collection of seven research studies focused on the optimization of array structures in classical phased array or time modulation, including radiator, reflector, feed network, and radiating element optimizations.

Reflectarray Antennas

This book considers a cylindrical phased array with microstrip patch antenna elements and half-wavelength dipole antenna elements. The effect of platform...
and mutual coupling effect is included in the analysis. The non-planar geometry is tackled by using Euler's transformation towards the calculation of array manifold. Results are presented for both conducting and dielectric cylinder. The optimal weights obtained are used to generate adapted pattern according to a given signal scenario. It is shown that array along with adaptive algorithm is able to cater to an arbitrary signal environment even when the platform effect and mutual coupling is taken into account. This book provides a step-by-step approach for analyzing the probe suppression in non-planar geometry. Its detailed illustrations and analysis will be a useful text for graduate and research students, scientists and engineers working in the area of phased arrays, low-observables and stealth technology.

Electromagnetics and Antenna Optimization Using Taguchi's Method

Array pattern optimization is a very important and necessary issue in the majority of modern communication systems in a variety of applications such as sonar, radar, navigation, wireless communications, and many other engineering fields. Classical methods for array pattern synthesis have worked mainly with analytical models that are linear, local and, thus, their performances were not optimum. They have always been designed with closed-form mathematical models. Unlike these analytical methods, the global optimization methods with powerful computing tools offer optimum solutions. During the last few years, the design of the antenna arrays has been a topic of significant research activity. This book presents recent advances in the field of array pattern optimization. It is targeted primarily toward students and researchers who want to be exposed to a wide variety of antenna array design and optimization. It includes five chapters as well as the introductory chapter. These five chapters are categorized into five different areas depending on the application. These applications are ordered to address interference suppression, electronic toll collection, mmWave and ultra-wideband, integrated antennas, and educational packages for modeling smart antenna for 5G wireless communications. The book has the advantage of providing a collection of applications that are entirely independent and self-contained; thus, the interested reader can choose any chapter and skip to another without losing continuity.

Characteristics of Different Focusing Antennas in the Near Field Region

Reflecting a growing interest in phased array antenna systems, stemming from radar, radio astronomy, mobile communications and satellite broadcasting, Array and Phased Array Antenna Basics introduces the principles of array and phased array antennas. Packed with first-hand practical experience and worked-out examples, this is a valuable learning tool and reference source for those wishing to improve their understanding of basic array antenna systems without relying heavily on a thorough knowledge of electromagnetics or antenna theory. Features a general introduction to antennas and explains the array antenna principle through discussion of the physical characteristics rather than the theory Explores topics often not covered in antenna textbooks, such as active element pattern, array feeding, means of phase changing, array antenna characterisation, sequential rotation techniques and reactively loaded arrays Guides the reader through the necessary mathematics, allowing them to move onto specialist books on array and phased array antennas with a greater understanding of the topic Supported by a companion website on which instructors and lecturers can find electronic versions of the figures An ideal introduction for those without a background in antennas, this clear, concise volume will appeal to technicians, researchers and managers working in academia, government, telecommunications and radio astronomy. It will also be a valuable resource for professionals and postgraduates with some antenna
Superdirective beamforming deals with designing an antenna array that gives high gain, narrow radiation pattern and also cancels the signal in unwanted directions. It is not practically possible to achieve the same properties as an array antenna without use of an array; to do so would require a huge antenna that is too complex and expensive to be practical. Use of an array antenna induces a white noise gain into the output of an antenna array due to the mismatches between the antenna elements in an array. In optimum array gain method array gain optimization is considered as eigenvalue problem and antenna weights are the eigenvector of the largest eigenvalue. Optimum array gain method gives the maximum value of array gain and white noise gain which is not possible in practice, due to induced white noise gain. In this thesis, we present a design for a superdirective receiving circular antenna array. In the design process, complex (amplitude and phase) weights for each antenna element in the array are calculated in order to reduce white noise gain using a constraint for white noise gain depending on white noise gain from optimum array gain method. The output beam pattern of an array antenna is a function of the weights and antenna element positions. Beam patterns of each individual antenna element are multiplied by their respective complex weights and then summed together to give the output radiation pattern. Antenna arrays using the weights found with this design process have lower white noise gain than antennas designed using optimum array gain method. The circular antenna array has a drawback in that it has high side lobe levels in the radiation pattern. In order to design antennas with a more narrow radiation pattern, the design method is further extended to different antenna array geometries namely elliptical, concentric elliptical, cylindrical elliptical, hexagonal and concentric hexagonal array geometries. The array gain and white noise gain are calculated and the radiation patterns of these geometries are plotted using MATLAB. All these simulation results are compared with the optimum array gain method which does not consider white noise gain for calculation of antenna weights. Use of other geometries in place of circular array geometry has advantages like reduced side lobe level and increase of array gain considering same number of antenna elements in elliptical array compared to circular array. Then, simulation results for optimum array gain and constrained optimum array gain are generated at 60 GHz and 30 GHz frequency waves which are millimeter waves and results are compared and discussed with 30 MHz wave results. These results show that use of millimeter wave frequency reduces the size of the array antenna.
Unfortunately, there is concern that in practical applications the device performance will be compromised due to the temperature dependence of the BST based device capacitance. We report a material design which controls the magnitude and the sign of the temperature coefficient of capacitance (TCC) via a multilayer paraelectric BST/buffer layer/ferroelectric BST coplanar device structure. To realize this multilayer device structure we have designed, fabricated, and optimized an Al doped Ta2O5 barrier layer with low loss, moderate permittivity, low TCC, and excellent bias stability of capacitance. The integration of the barrier layer with the BST layers was optimized for structure, microstructure, interfacial/surface morphology, and dielectric properties as a function of Al doping concentration, annealing temperature, material growth and integration process parameters.

This completely revised third edition of an Artech House classic, Phased Array Antenna Handbook, Second Edition, offers an up-to-date and comprehensive treatment of array antennas and systems. This edition provides a wealth of new material, including expanded coverage of phased array and multiple beam antennas. New modern machine learning techniques used for analysis are included. Additional material on wideband antennas and wideband coverage in array antennas are incorporated in this book, including new methods, devices, and technologies that have developed since the second edition. A detailed treatment of antenna system noise, sections on antenna pattern synthesis, developments in subarray technology, and in-depth coverage of array architecture and components are additional new features of this book. The book explores design elements that demonstrate how to size an array system with speed and confidence. Moreover, this resource provides expanded coverage of systems aspects of arrays for radar and communications. Supported with numerous equations and illustrations, this practical book helps evaluate basic antenna parameters such as gain, sidelobe levels, and noise. Readers learn how to compute antenna system noise, design subarray geometries for given bandwidth, scan and sidelobe constraints, and choose array illumination tapers for given sidelobe levels.
Phased Array Antennas with Optimized Element Patterns

A need exists for wideband phased array radars. This report presents the results of some experimental studies made on improving bandwidth and scanning range performance of phased array antennas. A parallel plate waveguide element, operating in the S band (2.8 to 4.2 GHz) was used as the radiating element. Such an element permitted the needed less than one-half wavelength interelement spacing for broadband applications and has been found to provide good aperture matching for H plane scanning. The element is fed by a broadband, end on, base fed, coaxial to waveguide transition. H plane waveguide simulators have been used to study aperture match performance and to optimize array parameters to improve bandwidth and scan range. The waveguide simulator results showed that a good aperture match, with voltage standing wave ratio (VSWR) of about 2.1 over a 40% bandwidth and ±60 deg scan angle, is achievable for H-plane scanning. Experimentally optimized array parameters are then used to build an 11 x 11 element array. The scanning performance of that array in H and E planes was studied by measuring active element patterns. This does not give precise results, but did show that the aperture match is about equally good, over ±60 and 40% bandwidth, for H and E plane scanning.

Keywords: Phased arrays; Wide bandwidth; Experimental studies; Aperture matching; Parallel plate waveguides; Waveguide simulators; Active element pattern.