

DESIGN OF A PIFA ANTENNA USING FDTD

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Abstract

The design and analysis of antennas for mobile terminal depends on the implementation of simulation tools that can accurately model general structures. This work presents the analysis and the design of a double PIFA (Planar Inverted-F Antenna) using the Finite-Difference Time-Domain method. The technique is used to compute the radiation patterns and broadband input impedance of the antenna. Effects of the dimensions of the antenna on the variation of $|S_{11}|$ versus frequency had been also studied. By this technique it was possible to find the best geometry to achieve the desired performance, mainly the required bandwidth. Experimental results are provided to verify those given by the simulation.

1. INTRODUCTION

With the exponential development of mobile communications and the miniaturisation of RF transceivers, the need for small and low profile antennas at mobile frequencies is constantly growing, therefore, new antennas should be developed providing larger bandwidth and at the same time smaller dimensions. Although the gain/bandwidth performance of an antenna is directly related to its dimensions in relation to the wavelength, the idea is not only to decrease the overall size of the antenna, but also to find the best geometry and structure, for a specific problem. In this context the PIFA arises as a promising possibility to respond to such demands [1]. In its conventional format its bandwidth is about 10% which is not enough for some applications. The objective of the work described in this paper was to design a PIFA antenna with a larger bandwidth. This was achieved using a double plate PIFA as shown in Fig 1.

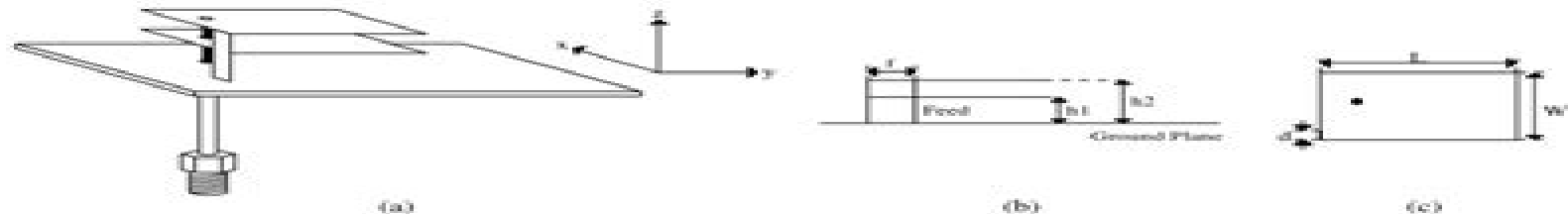


Fig 1 Geometry of the dual PIFA antenna
(a) General view (b) Side view; (c) Top view

The antenna was designed to operate over the two frequency sub-bands 1910-2000 MHz (up link) and 2110-2200 MHz (down link). These bands were attributed at WARC'92, Torremolinos, in order to be used by third generation cellular systems. The antenna will be used in the Portuguese research project named ITCOM which main objective is the integration of optical, millimetric and microwave technologies for the implementation of mobile communication systems.

II. METHOD OF ANALYSIS

Nowadays, the characterisation of antennas for mobile terminals is dependent on the simulation tools that can accurately model the antenna itself, and also the external elements as the body of the terminal, the hand and the head. So, it became essential to develop software tools to predict the electromagnetic propagation characteristics of the antenna under study. In an effort to meet these simulation needs, attention has been focused on the use of the FDTD method for the simulation of these antennas, [2], [3] and [4]. This method has been implemented to simulate the double PIFA. The derivation as well as the practical implementation of this algorithm are well covered in literature [5], [6] and therefore will not be covered in this paper.

Pifa Antenna Design Guideline

Thomas A. Milligan



Pifa Antenna Design Guideline:

Antenna Design for Mobile Devices Zhijun Zhang, 2017-06-13 Expanded and updated this practical guide is a one stop design reference containing all an engineer needs when designing antennas Integrates state of the art technologies with a special section for step by step antenna design Features up to date bio safety and electromagnetic compatibility regulation compliance and latest standards Newly updated with MIMO antenna design measurements and requirements Accessible to readers of many levels from introductory to specialist Written by a practicing expert who has hired and trained numerous engineers

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

[A Guide to the Wireless Engineering Body of Knowledge \(WEBOK\)](#) Andrzej Jajszczyk, 2012-10-18 The ultimate reference on wireless technology now updated and revised Fully updated to incorporate the latest developments and standards in the field A Guide to the Wireless Engineering Body of Knowledge Second Edition provides industry professionals with a one stop reference to everything they need to design implement operate secure and troubleshoot wireless networks Written by a group of international experts the book offers an unmatched breadth of coverage and a unique focus on real world engineering issues The authors draw upon extensive experience in all areas of the technology to explore topics with proven practical applications highlighting emerging areas such as Long Term Evolution LTE in wireless networks The new edition is thoroughly revised for clarity reviews wireless engineering fundamentals and features numerous references for further study Based on the areas of expertise covered in the IEEE Wireless Communication Engineering Technologies WCET exam this book explains Wireless access technologies including the latest in mobile cellular technology Core network and service architecture including important protocols and solutions Network management and security from operations process models to key security issues Radio engineering and antennas with specifics on radio frequency propagation and wireless link design Facilities infrastructure from lightning protection to surveillance systems With this trusted reference at their side wireless practitioners will get up to speed on advances and best practices in the field and acquire the common technical language and tools needed for working

in different parts of the world **Practical Microstrip and Printed Antenna Design** Anil Pandey,2019-03-31 This comprehensive resource presents antenna fundamentals balanced with the design of printed antennas Over 70 antenna projects along with design dimensions design flows and antenna performance results are discussed including antennas for wireless communication 5G antennas and beamforming Examples of smartphone antennas MIMO antennas aerospace and satellite remote sensing array antennas automotive antennas and radar systems and many more printed antennas for various applications are also included These projects include design dimensions and parameters that incorporate the various techniques used by industries and academia This book is intended to serve as a practical microstrip and printed antenna design guide to cover various real world applications All Antenna projects discussed in this book are designed analyzed and simulated using full wave electromagnetic solvers Based on several years of the author s research in antenna design and development for RF and microwave applications this book offers an in depth coverage of practical printed antenna design methodology for modern applications A Guide to the Wireless Engineering Body of Knowledge (WEBOK) G. Giannattasio,J. Erfanian,P. Wills,Hung Q. Nguyen,T. Croda,K. Rauscher,X. Fernando,N. Pavlidou,K. Daniel Wong,IEEE Communications Society,2009-03-17 The ultimate reference book for professionals in the wireless industry The information presented in this book reflects the evolution of wireless technologies their impact on the profession and the industry s commonly accepted best practices Organized into seven main areas of expertise A Guide to the Wireless Engineering Body of Knowledge WEBOK enhances readers understanding of Wireless access technologies Network and service architecture Network management and security Radio frequency engineering propagation and antennas Facilities infrastructure Agreements standards policies and regulations Wireless engineering fundamentals Complemented with a large number of references and suggestions for further reading the WEBOK is an indispensable resource for anyone working in the wireless industry *Antenna Design Solutions for RFID Tags Based on Metamaterial-Inspired Resonators and Other Resonant Structures* Simone Zuffanelli,2017-09-22 This book describes innovative design solutions for radio frequency identification RFID tags and antennas Focusing mainly on passive ultra high frequency UHF RFID tag antennas it examines novel approaches based on the use of metamaterial inspired resonators and other resonant structures as radiating elements It also offers an exhaustive analysis of the radiation properties of several metamaterial inspired resonators such as the split ring resonator SRR and related structures Further it discusses in detail an innovative technology for the RFID tagging of optical discs which has demonstrated a significant improvement over the state of the art and resulted in a patent By covering the entire research cycle of theory design simulation and fabrication evaluation of RFID tags and antennas while also reporting on cutting edge technologies the book provides graduate students researchers and practitioners alike with a comprehensive and timely overview of RFID systems and a closer look at several radiating structures Modern Antenna Design Thomas A. Milligan,2005-07-11 A practical book written for engineers who design and use antennas The author has many years of hands

on experience designing antennas that were used in such applications as the Venus and Mars missions of NASA The book covers all important topics of modern antenna design for communications Numerical methods will be included but only as much as are needed for practical applications *Design of Ultra Wideband Antenna Matching Networks* Binboga Siddik Yarman,2008-08-25 Design of Ultra Wideband Antenna Matching Networks via Simplified Real Frequency Technique SRFT will open up a new horizon for design engineers researchers undergraduate and graduate students to construct multi band and ultra wideband antenna matching networks for antennas which in turn will push the edge of technology to manufacture new generation of complex communication systems beyond microwave frequencies both in commercial and military line In Design of Ultra Wideband Antenna Matching Networks many real life examples are presented to design antenna matching networks over HF and cellular commercial multi band frequencies For each example open MatLab source codes are provided so that the reader can easily generate and verify the results of the examples included in the book **Mobile Antenna Systems Handbook** Kyohei Fujimoto,2008 This extensively revised and expanded edition of the Artech bestseller Mobile Antenna Systems Handbook puts the very latest technologies design and analysis procedures and applications at your command It features all new chapters on smart antennas MIMO systems and antennas for recently deployed mobile systems such as RFID UWB and terrestrial digital TV broadcasting and provides a wealth of problem solving guidance for tackling everything from propagation obstacles to SAR safety issues Like the previous editions this ultimate one stop reference is designed to save you a mountain of work You get hands on expertise for every type of mobile antenna base station and terminal system including its theory of operation application strengths and weaknesses performance characteristics design procedures analysis techniques and optimization methods complete with examples and worked out calculations at every step The material is further clarified with 567 diagrams charts and photos bringing mobile antenna selection design and construction into clear focus What s more this resource includes a detailed glossary of antennas and their applications to help you zero in on the right antenna for any job with a flip of the page From integrating MIMO antennas into handsets to expanding system capacities with smart antennas this information packed resource helps you evaluate design and configuration options locate crucial data and calculations perform key analyses and solve challenges standing in the way of your desired results It serves as an indispensable reference helping you design more powerful versatile and compact wireless mobile antenna systems *Antenna Fundamentals for Legacy Mobile Applications and Beyond* Issa Elfergani,Abubakar Sadiq Hussaini,Jonathan Rodriguez,Raed Abd-Alhameed,2017-10-03 This book highlights technology trends and challenges that trace the evolution of antenna design starting from 3rd generation phones and moving towards the latest release of LTE A The authors explore how the simple monopole and whip antenna from the GSM years have evolved towards what we have today an antenna design that is compact multi band in nature and caters to multiple elements on the same patch to provide high throughput connectivity The scope of the book targets a broad range of subjects including the microstrip antenna PIFA

antenna and the monopole antenna to be used for different applications over three different mobile generations Beyond that the authors take a step into the future and look at antenna requirements for 5G communications which already has the 5G drive in place with prominent scenarios and use cases emerging They examine these and put in place the challenges that lie ahead for antenna design particularly in mm Wave design The book provides a reference for practicing engineers and under post graduate students working in this field

Advances in Computing and Network Communications Sabu M. Thampi, Erol Gelenbe, Mohammed Atiquzzaman, Vipin Chaudhary, Kuan-Ching Li, 2021-04-20 This book constitutes the thoroughly refereed post conference proceedings of the 4th International Conference on Computing and Network Communications CoCoNet 20 October 14 17 2020 Chennai India The papers presented were carefully reviewed and selected from several initial submissions The papers are organized in topical sections on Signal Image and Speech Processing Wireless and Mobile Communication Internet of Things Cloud and Edge Computing Distributed Systems Machine Intelligence Data Analytics Cybersecurity Artificial Intelligence and Cognitive Computing and Circuits and Systems The book is directed to the researchers and scientists engaged in various fields of computing and network communication domains

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

Microwave and Millimeter-wave Antenna Design for 5G Smartphone Applications Wonbin Hong, Chow-Yen Desmond Sim, 2023-01-05 In depth and practical coverage of design considerations for 5G antennas In Microwave and Millimeter wave Antenna Design for 5G Smartphone Applications two distinguished researchers deliver a holistic multidisciplinary approach to antenna design methodologies The book covers approaches ranging from sub 6GHz microwave to the millimeter wave spectrum explaining how microwave and millimeter wave 5G antennas coexist and function both independently and collaboratively The book offers coverage of key considerations for designing millimeter wave 5G antennas within space constrained mobile devices as well as practical concerns like cost fabrication yield and heat dissipation Readers will also find explorations of the likely future directions of

5G antenna evolution as well as A thorough introduction to basic concepts in 5G FR1 Band mobile antenna design including discussions of antenna placement element design and topologies Comprehensive explorations of antenna feeding mechanisms and impedance matching including chassis considerations and effects Practical discussions of frequency tunable millimeter wave 5G antenna in package Fulsome treatments of compact millimeter wave 5G antenna solutions and millimeter wave antenna on display technologies for 5G mobile devices Perfect for antenna microwave communications and radio frequency engineers Microwave and Millimeter wave Antenna Design for 5G Smartphone Applications will also benefit graduate students policymakers regulators and researchers with an interest in communications and antennas **Radio**

Frequency Identification Fundamentals and Applications Cristina Turcu,2010-02-01 This book entitled Radio Frequency Identification Fundamentals and Applications Bringing Research to Practice bridges the gap between theory and practice and brings together a variety of research results and practical solutions in the field of RFID The book is a rich collection of articles written by people from all over the world teachers researchers engineers and technical people with strong background in the RFID area Developed as a source of information on RFID technology the book addresses a wide audience including designers for RFID systems researchers students and anyone who would like to learn about this field At this point I would like to express my thanks to all scientists who were kind enough to contribute to the success of this project by presenting numerous technical studies and research results However we couldn t have published this book without the effort of InTech team I wish to extend my most sincere gratitude to InTech publishing house for continuing to publish new interesting and valuable books for all of us **Printed MIMO Antenna Engineering** Mohammad S. Sharawi,2014-05-01

Wireless communications has made a huge leap during the past two decades The multiple input multiple output MIMO technology was proposed in the 1990 s as a viable solution that can overcome the data rate limit experienced by single input single output SISO systems This resource is focused on printed MIMO antenna system design Printed antennas are widely used in mobile and handheld terminals due to their conformity with the device low cost good integration within the device elements and mechanical parts as well as ease of fabrication A perfect design companion for practicing engineers this book provides full design examples from literature along with detailed illustrations for the various antenna geometries This resource overviews the various applications that currently depend on printed MIMO antennas and provides design guidelines and remarks throughout the book for guidance Characteristic Modes Yikai Chen,Chao-Fu Wang,2015-06-15 Describes how to systematically implement various characteristic mode CM theories into designs of practical antenna systems This book examines both theoretical developments of characteristic modes CMs and practical developments of CM based methodologies for a variety of critical antenna designs The book is divided into six chapters Chapter 1 provides an introduction and discusses the recent advances of the CM theory and its applications in antenna engineering Chapter 2 describes the formulation of the characteristic mode theory for perfectly electrically conducting PEC bodies and discusses its

numerical implementations Chapter 3 presents the CM theory for PEC structures embedded in multilayered medium and its applications Chapter 4 covers recent advances in CM theory for dielectric bodies and also their applications Chapter 5 discusses the CM theory for N port networks and its applications to the design of antenna arrays Finally Chapter 6 discusses the design of platform integrated antenna systems using characteristic modes This book features the following Introduces characteristic mode theories for various electromagnetic structures including PEC bodies structures in multilayered medium dielectric bodies and N port networks Examines CM applications in electrically small antennas microstrip patch antennas dielectric resonator antennas multiport antennas antenna arrays and platform mounted antenna systems Discusses numerical algorithms for the implementation of the characteristic mode theories in computer code Characteristic Modes Theory and Applications in Antenna Engineering will help antenna researchers engineers and students find new solutions for their antenna design challenges

Introduction to Wireless System Design Henry Lau,Ludy Liu,Keith C. C. Chan,2025-09-30

Technical insights on the vital aspects of hardware and software components in modern wireless system design Introduction to Wireless System Design from Circuits to Web based Applications provides an introductory level overview for readers to acquire technical insights on the most important aspects of modern wireless system design from an industrial and practical perspective Various functional blocks of wireless systems and products are discussed and analyzed with practical examples of commercial products Software development is addressed to provide a comprehensive understanding of the development of complete wireless systems The book concludes by presenting practical design examples followed by future trends Core topics covered in this book include wireless standards for GPS Bluetooth cellular Wi Fi Zigbee LoRaWAN Sigfox and NBIoT major transmitter issues including power gain power efficiency harmonic prevention and suppression and server software development for building dynamic web interfaces using HTML CSS and JavaScript Written by three highly qualified authors the book also includes information on System characteristics of hardware receivers including noise temperature bandwidth figure and sensitivity Components of circuit blocks in hardware transmitters including oscillator modulator buffer amplifier frequency multiplier power amplifier output filter Types of antennas including dipole monopole loop beam forming and miniature designs like patch inverted L inverted F and meandered line Elements of software architecture design including user interface data and sequence flow and timing diagrams Smartphone application software development with insight on tools such as Android Studio Flutter React and Swift Introduction to Wireless System Design from Circuits to Web based Applications is a highly practical and actionable resource on the subject for practicing engineers and programmers as well as graduate and undergraduate students in related programs of study

Low-profile Natural and Metamaterial Antennas Hisamatsu Nakano,2016-09-02 Presents recent progress in low profile natural and metamaterial antennas This book presents the full range of low profile antennas that use novel elements and take advantage of new concepts in antenna implementation including metamaterials Typically formed by constructing lattices of simple elements metamaterials possess electromagnetic

properties not found in naturally occurring materials and show great promise in a number of low profile antenna implementations Introductory chapters define various natural and metamaterial based antennas and provide the fundamentals of writing computer programs based on the method of moments MoM and the finite difference time domain method FDTD Chapters then discuss low profile natural antennas classified into base station antennas mobile card antennas beam forming antennas and satellite satellite and earth satellite communications antennas Final chapters look at various properties of low profile metamaterial based antennas revealing the strengths and limitations of the metamaterial based straight line antenna metaline antenna metamaterial based loop antenna metaloop open metaloop antenna the effects of counter dual band CP radiation and more Offers comprehensive coverage of both metamaterials and natural materials for low profile antennas Written by an internationally recognized expert in the field of low profile antennas Depicts actual high performance low profile antennas for the antenna engineer Draws on classroom tested material in graduate courses and short courses over the past 20 years Low Profile Natural and Metamaterial Antennas is a must have reference book for advanced undergraduate and graduate level students as well as antenna engineers interested in low profile antenna design theory

Handbook of Research on Modern Optimization Algorithms and Applications in Engineering and Economics
Vasant, Pandian, Weber, Gerhard-Wilhelm, Dieu, Vo Ngoc, 2016-03-08 Modern optimization approaches have attracted many research scientists decision makers and practicing researchers in recent years as powerful intelligent computational techniques for solving several complex real world problems The Handbook of Research on Modern Optimization Algorithms and Applications in Engineering and Economics highlights the latest research innovations and applications of algorithms designed for optimization applications within the fields of engineering IT and economics Focusing on a variety of methods and systems as well as practical examples this book is a significant resource for graduate level students decision makers and researchers in both public and private sectors who are seeking research based methods for modeling uncertain real world problems

Printed Antennas for Wireless Communications Rod Waterhouse, 2008-03-11 Printed antennas also known as microstrip antennas have a variety of beneficial properties including mechanical durability conformability compactness and cheap manufacturing costs As such they have a range of applications in both the military and commercial sectors and are often mounted on the exterior of aircraft and spacecraft as well as incorporated into mobile radio communication devices Printed Antennas for Wireless Communications offers a practical guide to state of the art printed antenna technology used for wireless systems Contributions from renowned global experts within both academia and industry enable the reader to design printed antennas and associated technologies and offer valuable insights into important breakthroughs in these areas Divided into 3 sections covering fundamental wideband printed radiating elements for wireless systems small printed antennas for wireless systems and advanced concepts and applications in wireless systems Provides experimental data and applies theoretical models to present design performance trends and to give the reader an in depth coverage of the area

Presents summaries of different approaches used in solving wireless systems such as WPAN wireless personal area network and MIMO multi input multi output offering the reader an overall perspective of the pros and cons of each Focuses on practical design examples and real world solutions Printed Antennas for Wireless Communications offers an excellent insight on printed antennas from the theoretical to the practical hence it will appeal to practicing design engineers within commercial and governmental military organisations as well as postgraduate students and researchers in communications technology

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Table of Contents Pifa Antenna Design Guideline

1. Understanding the eBook Pifa Antenna Design Guideline
 - The Rise of Digital Reading Pifa Antenna Design Guideline
 - Advantages of eBooks Over Traditional Books
2. Identifying Pifa Antenna Design Guideline
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Pifa Antenna Design Guideline
 - User-Friendly Interface
4. Exploring eBook Recommendations from Pifa Antenna Design Guideline
 - Personalized Recommendations
 - Pifa Antenna Design Guideline User Reviews and Ratings
 - Pifa Antenna Design Guideline and Bestseller Lists

5. Accessing Pifa Antenna Design Guideline Free and Paid eBooks
 - Pifa Antenna Design Guideline Public Domain eBooks
 - Pifa Antenna Design Guideline eBook Subscription Services
 - Pifa Antenna Design Guideline Budget-Friendly Options
6. Navigating Pifa Antenna Design Guideline eBook Formats
 - ePub, PDF, MOBI, and More
 - Pifa Antenna Design Guideline Compatibility with Devices
 - Pifa Antenna Design Guideline Enhanced eBook Features
7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Pifa Antenna Design Guideline
 - Highlighting and Note-Taking Pifa Antenna Design Guideline
 - Interactive Elements Pifa Antenna Design Guideline
8. Staying Engaged with Pifa Antenna Design Guideline
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Pifa Antenna Design Guideline
9. Balancing eBooks and Physical Books Pifa Antenna Design Guideline
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Pifa Antenna Design Guideline
10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
11. Cultivating a Reading Routine Pifa Antenna Design Guideline
 - Setting Reading Goals Pifa Antenna Design Guideline
 - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Pifa Antenna Design Guideline
 - Fact-Checking eBook Content of Pifa Antenna Design Guideline
 - Distinguishing Credible Sources
13. Promoting Lifelong Learning

- Utilizing eBooks for Skill Development
- Exploring Educational eBooks

14. Embracing eBook Trends

- Integration of Multimedia Elements
- Interactive and Gamified eBooks

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