

Recent Advances in Microwave Planar Filter Technology

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SUMMARY This invited paper aims to present an overview of our recent research and development (R&D) of advanced microwave planar filters, in particular with miniaturization and/or electronically tunable/reconfigurable functionalities, which are in demand for future communication/radar systems as well as emerging wireless applications.

Key words: microwave filters, planar filters, multilayer filters, tunable filters, reconfigurable filters

1. Introduction

Recently, there is an increasing demand for miniature and/or tunable/reconfigurable microwave planar filters. For the filter miniaturization, we have exploited multilayer liquid crystal polymer (LCP) technology [1]–[11]. LCP has been popular not only due to its superior electrical properties up to millimeter-wave frequencies [12], but also because itself is an excellent packaging material for system-on-package [13]. It has a stable low dielectric constant around 3 and low dielectric loss tangent 0.0025 over a wide frequency range. Compared to LTCC, LCP has much lower processing temperature around 280°C. Although LCP has lower dielectric constant than LTCC, which makes it more challenging for RF/Microwave circuit miniaturization, it makes LCP circuit design less sensitive to fabrication tolerances than LTCC, which is very important for multilayer laminated circuit. Although some cheaper PCB laminates can be used for miniature filter designs, LCP offers much higher flexibility on circuit thickness and a very strong coupling can be achieved with a separation as small as 25 μm . This is very important for the design of low frequency filters that requires large capacitances. Furthermore, in the LCP adhesive system [14], circuit layers (core films) and prepreg layers (bonding films) have almost the same characteristics, such as thermal expansion coefficient, dielectric constant and water absorption, which can be a great benefit for both filter designs and practical applications.

In addition to the filter miniaturization, electronically tunable or reconfigurable filters are also in increasing demand in current and emerging multifunctional communication and radar systems owing to their efficiency in use and flexibility in control of frequency spectrum. In general, to develop an electronically tunable or reconfigurable filter,

active switching or tuning elements such as semiconductor p-i-n and varactor diodes, RF microelectromechanical systems (MEMS) or other functional material-based components including ferroelectric capacitors need to be integrated within a passive filtering structure [15]. Planar filters can conveniently facilitate this kind of integration with a small size and to this end we have carried out R&D for tunable or reconfigurable planar filters are based on planar structures [16]–[33].

In the following parts, several typical advanced planar filters resulting from our R&D are highlighted.

2. Packaged LCP Filters

This section is to demonstrate the methods for integrating filters within a package as one of the stages in the manufacturing process, using LCP multilayer technology. Including the packaging in the manufacturing process will reduce the number of processes needed and thus, the final cost of the solution.

2.1 Hermetic Packaged UWB Filter

The concept for packaging with CPW input/output (I/O) ports is illustrated in Fig. 1, which consists of two layers of LCP substrate holding the packaged device in between. The bottom layer will interface between the host board and the packaged device through a CPW structure. Since the CPW structure has both signal and ground on the same plane, it will simplify the connection of the device to the host board. On the other side, the top layer is the ground plane for both the CPW structure and the packaged device. In this way, the CPW becomes grounded-CPW (G-CPW). However, to simplify, G-CPW will be referred as CPW in this paper. CPW and ground plane are connected through via-holes. On top



Fig. 1 Main concept for packaging with CPW input/output (I/O) ports.

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Recent Advances in Microwave Technology Bharathi Bhat,1993 *Microwave Technologies - Recent Advances and New Trends and Applications* Hüseyin Şerif Savci,2024-06-05 This book is intended to serve as a technology reference for graduate students researchers and engineers on various microwave engineering subjects The chapters encompass a wide range of topics in microwave engineering from its core science for developers to state of the art applications for its users Besides the fundamental technology related chapters such as advanced analysis techniques of microstrip structures using the finite difference time domain in Julia and tunable microwave filter designs there are chapters covering implementations of microwave technology in different applications such as medical imaging medical heating food drying and remote sensing for radio astronomy The chapters are written based on a collection of theses research papers and case analyses by field experts and academicians The title of the book reflects that each chapter elaborates on a recent advancement or a brand new application of microwave engineering **International Symposium on Recent Advances in Microwave Technology**,1989 *Recent Advances in Mechanical Engineering* K.M. Pandey,R.D. Misra,P.K. Patowari,U.S. Dixit,2021-01-10 This book presents the select proceedings of the International Conference on Recent Advancements in Mechanical Engineering ICRAME 2020 It provides a comprehensive overview of the various technical challenges faced their systematic investigation contemporary developments and future perspectives in the domain of mechanical engineering The book covers a wide array of topics including fluid flow techniques compressible flows waste management and waste disposal bio fuels renewable energy cryogenic applications computing in applied mechanics product design dynamics and control of structures fracture and failure mechanics solid mechanics finite element analysis tribology nano mechanics and MEMS robotics supply chain management and logistics intelligent manufacturing system rapid prototyping and reverse engineering quality control and reliability conventional and non conventional machining and ergonomics This book can be useful for students and researchers interested in mechanical engineering and its allied fields *Recent Advances in Systems, Control and Information Technology* Roman Szewczyk,Małgorzata Kaliczyńska,2016-11-29 This book presents the proceedings of the International Conference on Systems Control and Information Technologies 2016 It includes research findings from leading experts in the fields connected with INDUSTRY 4.0 and its implementation especially intelligent systems advanced control information technologies industrial automation robotics intelligent sensors metrology and new materials Each chapter offers an analysis of a specific technical problem followed by a numerical analysis and simulation as well as the implementation for the solution of a real world problem *Proceedings of 3rd International Symposium on Recent Advances in Microwave Technology (ISRAMT '91), August 18-21, 1991, Reno, Nevada, U.S.A.* Banmali S. Rawat,Krishna K. Agarwal,1991 *Recent Advances in Postharvest Technologies, Volume 1* Nouredine Benkeblia,2024-09-09 The elapsing time from producer to consumer has significantly increased as a result of food marketing and trade globalization Consequently maintaining quality

along the food value chain is becoming a significant challenge Postharvest losses are considered a major component of food loss and waste in the supply chain from farmers to consumers due to improper handling storage transport preservation techniques and spoilage Postharvest science aims to extend the shelf life of fresh and perishable commodities and to reduce heavy losses thereby contributing to food security While significant progresses have been made in postharvest preservation and shelf life extension the continuous development of emerging technologies have changed our vision on postharvest science Furthermore recent advancements in molecular engineering of horticultural crops for quality improvement the development of genomics transcriptomics proteomics and metabolomics have led to a better understanding of the physiology and the biochemistry of the senescence processes resulting in better preservation and improved production of fresh crops This two volume work focuses on innovative technologies that extend and preserve shelf life of fruits and vegetables Volume 1 offers a review on the state of the art modern technologies in the postharvest field The accompanying Volume 1 explores advanced and novel technologies after harvest particularly the application of nanotechnologies to packaging materials

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Recent Advances in Electromagnetic Theory H.N. Kritikos, Dwight L. Jaggard, 2012-12-06 The contributions of this book represent only a small sample of the work of the many researcher electromagneticians who have had the pleasure of being associated with Professor Papas either as students or as colleagues Many of us continue to work in the many and diverse areas that modern electro magnetism encompasses There is however a common thread that was derived from our association with Professor Papas that has greatly influenced our thinking and technical style of expression Professor Papas from his studies at Harvard brought with him to Pasadena a very

fundamental and classical point of view that was instilled in all those who were associated with him He saw research problems as a combination of fundamental physical and mathematical principles and the electromagnetic reality He searched and demanded clarity and often in the rather involved and engaging discussions which took place in his office he demanded that the baby picture be clearly drawn on the blackboard This requirement certainly for some of us who were working in widely varied subjects ranging from relativistic plasmas to almost periodic media has forced us to reexamine the fundamentals The clear and lucid marriage of fundamental concepts to applications has been the trademark of Professor Papas's intellectual tradition and has greatly influenced the thinking of all of those who have associated with him

Recent Advances in Communication Networks and Embedded Systems Smain Femmam, Pascal Lorenz, 2024-05-11 This book is devoted to an enhanced version of selected papers presented at the 7th International Conference on Communication and Network Technology ICCNT 2023 The objective of the proceedings of ICCNT 2023 is to present the recent research results and technological advances in the fields of theoretical and experimental applications of embedded systems communications and signal processing decision as well as in emerging areas related to the tracks of the conference The specific topics of interest within the scope of this special issue include design tools for electronics and embedded systems embedded systems and software system on chip SoC multiprocessor system on chip MPSoC platforms and applications network on chip NoC design methodologies reconfigurable computing system design synthesis and optimization advanced communications circuits and systems for communications optical fibers applications optical communications sensors image laser applications in telemetry LiDAR system anemometry computer 3D visions range technique RF and wireless communications image and signal processing decision image and video processing technology compression coding and implementation cryptology and watermarking real time systems sensors and instrumentation data acquisition audio acoustic speech biomedical signal processing sensor microsystems and industrial sensors computer engineering and networks cloud computing technology internet technology computer security computing networks and data acquisition

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Crocco,Panos Kosmas,2019-04-02 Electromagnetic EM radio wave technologies for medical imaging represent an emerging alternative diagnostic modality with some unique features which is attracting the attention of many researchers worldwide Diagnostic devices based on EM technology have no side effects as they exploit non ionizing radiation and their intrinsic low cost makes them sustainable for healthcare systems This Special Issue provides a comprehensive account of this very active research area by gathering contributions that cover a variety of topics ranging from fundamental research questions to experimental validation and clinical translation *Free Space Optics Technologies in B5G and 6G Era - Recent Advances, New Perspectives and Applications* Jupeng Ding,Jian Song,Kejun Jia,Penghua Mu,2024-09-25

The need for disruptive transmission approaches in emerging application scenarios has led to the convergence of free space optics FSO technologies with B5G and 6G transmission services This book delves into the practical considerations of this integration and investigates FSO technologies to address the challenges in B5G and 6G scenarios In addition this book provides a foundational understanding of advances and perspectives in this field **Recent Advances in Edible Fats and Oils Technology**

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